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Many voices of the Manukau:
Participatory modelling, ecosystem services
and decision making in New Zealand

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Abstract

Ecosystem service approaches are increasingly utilised in coastal areas, often as part of an ecosystem-based management or adaptive governance framework that aims to address complex or ‘wicked’ coastal problems. The popularity of ecosystem service approaches stems in part from their potential to link human well-being to the functioning of ecosystems and provide a common language for negotiating trade-offs. This is particularly enticing in situations where there are a multiplicity of stakeholders, conflicting values, and accompanying disputes. However, at present, most ecosystem service models are driven by ecological research and are deficient in incorporating context-specific cultural services. A participatory approach to model-building can integrate social values into ecosystem service frameworks while simultaneously contributing to the generation of social capital. Elements of social capital, such as social learning and social capacity, are needed to support adaptive governance and ecosystem-based management frameworks, and to resolve wicked problems. This research draws on a case study from an urban estuary in Aotearoa New Zealand’s Manukau Harbour, the second largest harbour in the country. Manukau Harbour has a long history of environmental degradation and conflict that is inextricably linked with the cultural values of local and regional stakeholders. Using a novel participatory modelling method, the research included a diverse group of participants in a rapid process of identifying, valuing, and considering trade-offs associated with the ecosystem services of the study area. This approach revealed that the participants often shared a common interest in recreational values and other cultural services, and that participants associated a majority of their values with seascapes, rather than landscapes, in the area. These findings could have important implications for improving decision-making approaches, as an emphasis on cultural services and seascapes could contribute to benefits across multiple ecosystem services and functions in the degraded area. Additionally, the research provides important insights into how participatory modelling methods can be utilised to integrate a diverse range of social values into an ecosystem service framework while enhancing social learning, social capacity, and other elements of social capital, among participants.

Keywords: Aotearoa, ecosystem services, Mangere Inlet, Manukau Harbour, New Zealand, participatory modelling, social capacity, social capital, social learning, social values

*For William and Matilda,
who have thrived living by the Manukau.*

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Abbreviations

DOC – Department of Conservation

EBM – Ecosystem-based management

ES – Ecosystem services

MPI – Ministry for Primary Industries

MWTP – Mangere Wastewater Treatment Plant

NIWA – National Institute of Water and Atmosphere

NZCPS – New Zealand Coastal Policy Statement

PM – Participatory modelling:

PNS – Post-normal science:

RMA – Resource Management Act (1991)

SEA – Significant Ecological Area:

SES – Social-ecological system

1. Introduction

I need the sea because it teaches me – Pablo Neruda

1.1 Situating the study: an introduction to wicked coastal problems

Nearly 40% of the world's human population is concentrated on or near coasts (Millennium Ecosystem Assessment, 2005d), placing growing demands on coastal resources, increasing risk levels associated with coastal hazards, and degrading many of the biophysical and social systems that previously provided resilience to these areas (Beatley, 2009; Nicholls & Mimura, 1998). Many coastal ecosystems such as coral reefs, estuaries, wetlands, and mangrove forests are among the most highly threatened, degraded, and vulnerable in the world because of their location downstream from a wide range of human activities and human-induced pollution sources (Millennium Ecosystem Assessment, 2005a). The degradation of coastal ecosystems has important global implications because these systems provide ecosystem services (ES) essential to human life and well-being (Costanza et al., 1997); examples of coastal ES include climate regulation, food provision, disturbance prevention, and leisure and recreational opportunities (Millennium Ecosystem Assessment, 2003). The term 'social-ecological system' (SES) is used throughout this thesis to emphasise the inextricable linkages between human and natural systems (Berkes et al., 2003; Berkes & Folke, 1998); the management and governance of coastal SES is complicated because of the countless interactions that occur among and between these interconnected systems.

As a result of the high levels of complexity and connectivity associated with coastal SES, a change at one scale of the system can easily ripple out to affect others. Additionally,

many coastal problems are exacerbated by climate variability, climate change, and related changes in the marine environment (Moser et al., 2012). Thus, coastal areas are associated with increased scientific uncertainty and risks, as well as a multiplicity of conflicting values. Such complex, multifaceted problems are often referred to as ‘wicked’ (Berkes, 2012; Jentoft & Chuenpagdee, 2009; Khan & Neis, 2010; Moser et al., 2012; Rittel & Webber, 1973). Wicked problems are characterised by complexity, uncertainty, interdependence, and dispute, and are found in highly interconnected SES (e.g. Balint et al., 2011; Brown et al., 2010; Turnpenny et al., 2009). Conventional command and control approaches typically fail to achieve positive management outcomes when wrestling with wicked problems (Berkes et al., 2003). Because of these failures, new approaches to knowledge production, management and governance are needed.

This research explores ways to address some of the wicked problems that plague coastal SES using a case study from Mangere Inlet and surrounding areas of Manukau Harbour in Aotearoa New Zealand, a nation with approximately 18,000 km of shoreline. The research asserts that adaptive approaches to governance and management are needed to address the wicked problems of the 21st century (Folke et al., 2005). In particular, to protect the long-term health of the world’s oceans and coasts and the well-being of the human populations that depend upon these systems, it is necessary to implement governance frameworks that: enable the provision of ES; incorporate social-ecological perspectives; and support appropriately scaled, coordinated management (Millennium Ecosystem Assessment, 2003). Although command and control approaches still wield some influence in established frameworks, the governance and management of natural resources is undergoing a much needed paradigm shift toward a more integrated and participatory style (Pahl-Wostl et al., 2007). The methods by which this paradigm shift is being implemented are, however, still emerging.

1.1.1 Research problem

Recent approaches to dealing with wicked problems often focus on the development of adaptive governance and ecosystem-based management (EBM) frameworks (Folke et al., 2005). These frameworks can benefit from being grounded in the common language and metrics of ES, but the methods used to identify and value ES are still being developed (Bennett et al., 2009), particularly in the context of coastal and marine SES (e.g. Chan & Ruckelshaus, 2010). ES are defined as the benefits that people obtain from ecosystems; these services are usually grouped into categories that include provisioning services (e.g. food and

water), regulating services (e.g. flood control,) cultural services (e.g. recreational opportunities), and supporting services (e.g. nutrient cycling) (Millennium Ecosystem Assessment, 2003). Historically, ES have been measured in biophysical or economic terms and utilised to increase interest and investment in environmental management (Daily et al., 2009a). However, there are myriad ways that humans benefit from nature, and therefore the value of ES should include a social component (Raymond et al., 2009). Elements of social dynamics such as management regimes, power relationships, skills, and values, can dramatically affect the definition and delivery of ES (e.g. Fulton et al., 2011). Integrating diverse knowledge and value sets across academic disciplines, management practices, and public domains also remains a critical challenge (Cook & Spray, 2012; Cote & Nightingale, 2012) because of the relative influence and privilege associated with each set (Raymond et al., 2010). The inability to fully account for the value of ES in decision making has contributed to the decline of ES on a global scale (Daily et al., 2011). There is a need to develop methods that explicitly consider the social values of ES, and integrate these values with environmental and economic data (Bryan et al., 2010) so that EBM and adaptive governance approaches can be more effective in circumstances where timeframes are short, budgets are limited (Stringer et al., 2006), and problems are wicked (Berkes, 2012). Chan et al. (2011; 2012) argue that cultural services in particular need to be better accounted for in ES approaches because they are intimately integrated with the way that humans value the land and seascape; but this can be challenging because some values do not fit naturally within the ES approach. This research joins with Chan et al. (2012, p. 8) in seeking to contribute to the establishment of “an ES approach that provides appropriate space for ill-fitting values such that important cultural and moral values are not dismissed as hidden externalities.” The hope is that by incorporating the consideration of a broader range of values, diverse stakeholders and perspectives will be treated with greater respect, and will simultaneously contribute novel ideas that may help to address wicked problems.

Participatory modelling (PM) methods can be utilised to both capture social values and develop appropriate management strategies and governance frameworks (e.g. Korfmacher, 2001; Lynam et al., 2007). PM is the use of modelling in support of a decision-making process that involves stakeholders (Voinov & Bousquet, 2010). PM has emerged from a myriad of modelling methodologies as a powerful tool that can enhance stakeholder understanding of a system, facilitate collaborative learning, and identify and clarify the effect of solutions to problems associated with policy, regulation, or management-based decision making (Voinov & Bousquet, 2010). Stakeholder participation in governance and

management decision making is key to dealing with wicked problems for several reasons: first, early and on-going stakeholder input can improve the efficiency of implementation processes, saving time and money on litigation and political wrangling (Pahl-Wostl & Hare, 2004); second, stakeholder engagement can lead to higher quality and more durable environmental decision making (Millennium Ecosystem Assessment, 2005a); third, stakeholder participation can contribute knowledge at a range of scales, which is needed to support an EBM programme (Gadgil et al., 2003). Finally, stakeholder participation can develop social capital, a term commonly used to describe social investment in relations of trust and reciprocity, the establishment of common rules and norms, and the connectedness of institutions and social networks (Folke et al., 2005; Pretty & Ward, 2001). Social capital has been linked to the generation of adaptive governance and management and is often considered to be a critical element that enables collaboration and collective action (Adger, 1997, 2003; Berkes & Seixas, 2005; Lebel et al., 2006).

Social capital is associated with the capacity to resolve wicked problems (Morris et al., 2013), but it does not simply emerge from any type of social interaction. The generation of important elements of social capital such as social learning requires the convergence of appropriate political, institutional, and social contexts, as well as the deployment of particular participatory processes (Tippett et al., 2005). In this thesis, PM is viewed as a way to facilitate outcomes that increase the common good, including but not limited to articulating and improving understanding. This study was therefore designed to test the potential of using PM methods in combination with an ES approach to enhance the social learning and capacity building elements of social capital, as well as with the intention of integrating social values into ES approaches. The generation of other elements of social capital was also considered in this research. In particular, this study focused on increasing transparency, mediating power, and building trust, as these characteristics interact in complex ways, and can make important contributions to the resolution of wicked problems.

1.1.2 Research question

This research explores the usefulness and applicability of PM methods and ES approaches in the context of coastal governance and management problems associated with high levels of complexity. The central question addressed by this research is:

How can a small scale, short term participatory modelling method contribute to the improvement of ecosystem services approaches and the development of adaptive governance and ecosystem-based management frameworks that will aid in addressing wicked coastal problems?

1.1.3 Research objectives

The research objectives are to:

- 1) Develop and test a novel method for participatory modelling and the identification and valuation of ecosystem services that could be utilised to address similar issues in other areas;
- 2) Include stakeholders involved in the governance and management of Mangere Inlet and Manukau Harbour in a participatory modelling process that identifies and estimates the relative value of ecosystem services provided by Mangere Inlet and Manukau Harbour, and considers possible trade-offs associated with these services; and
- 3) Determine to what extent and under what conditions the utilisation of a small scale, short term participatory modelling method can integrate social values into ecosystem services approaches and generate social characteristics that may aid in resolving wicked governance and management problems associated with coastal areas.

1.2 Research methods and context

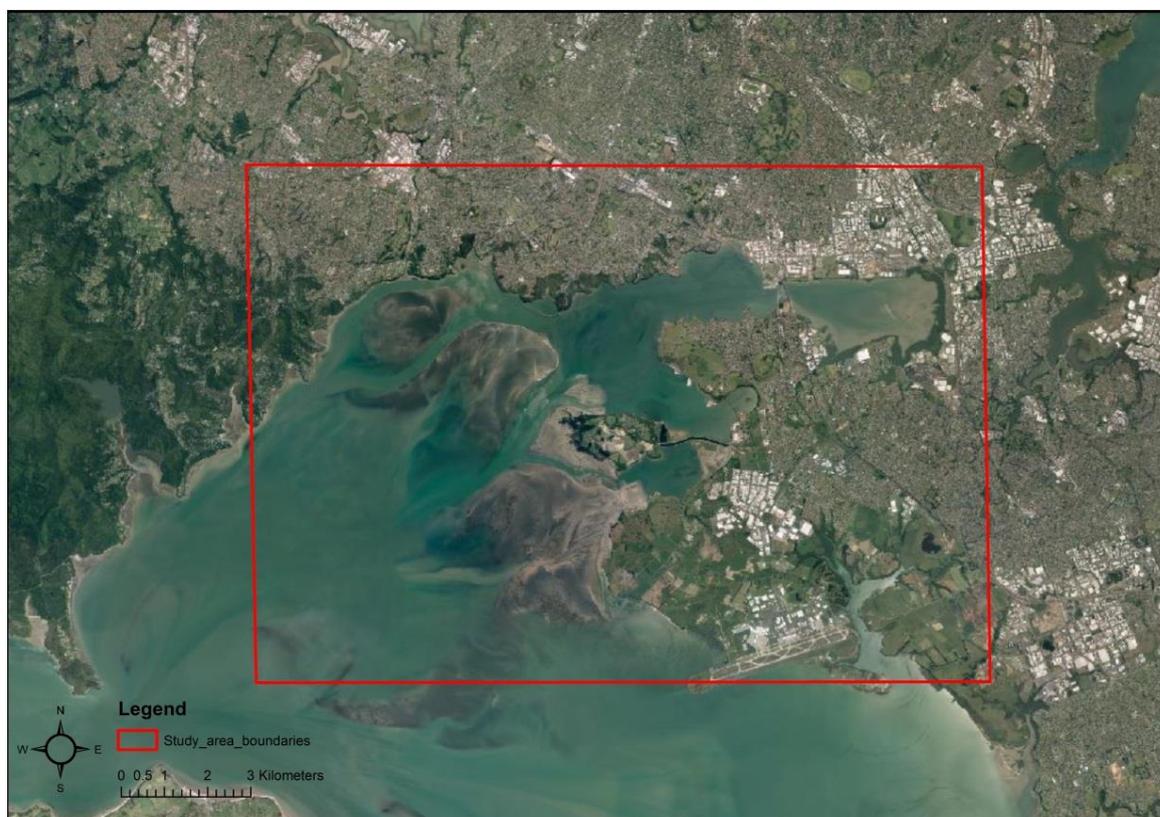


Figure 1.1: The study area in and around Mangere Inlet in the Manukau Harbour, Aotearoa New Zealand.

1.2.1 Interdisciplinary mixed methods research

This research explores the use of PM methods and ES approaches to address environmental management and governance problems in and around Mangere Inlet, an estuary located in the Manukau Harbour and surrounded by an urbanised catchment (Figure 1.1). The study was supervised by two social scientists, an ecologist, and a geomorphologist, a situation which afforded many unique insights and opportunities to bridge critical gaps between otherwise disparate subject areas (Hicks et al., 2010). However, interdisciplinary studies are associated with many challenges. In addition to navigating initial language barriers, (Bracken & Oughton, 2006), this research also required negotiations regarding the methods to be utilised, the information that would be included in the thesis, the manner and style of data presentation, and the emphasis and location of any related publications (Bammer, 2005). A mixed methods research design which utilised both qualitative and quantitative data to answer research questions was employed in part as a way to balance these

different interests (Hesse-Biber, 2010). These combined data sets enable an interdisciplinary narrative to emerge from the dissertation. This narrative bridges the divide between the physical sciences and the humanities (Castree et al., 2009) and highlights a new methodological way forward.

1.2.2 Mangere Inlet in Manukau Harbour: social-ecological context

Manukau Harbour is New Zealand's second largest harbour, covering an area of about 365 km² (Vant & Williams, 1992). It has extensive areas of intertidal sand and mud flats and is characterised as a well-flushed, meso-tidal, coastal lagoon (Kelly, 2008a). Mangere Inlet, located in the inner north-eastern corner of Manukau Harbour, has an area of 6.6 km² and a catchment area of 34.5 km² (Hume, 1979). The inlet has been plagued by pollution throughout the last century (Kelly, 2008a). It is still regularly affected by non-point source pollution from contaminated storm water runoff from roads and other aspects of urban development, such sedimentation and unauthorised discharges from industrial sites or misconnected sewage pipes (Kelly, 2008b). The area around the inlet is highly modified by adjacent land uses including a port, an extensive network of roads, and coastal reclamation projects. A mangrove fringe extends around the shores of much of the inner inlet and up into the few relatively unmodified streams (Kelly, 2008a).

The dominant circulation patterns of Mangere Inlet result in contaminants being retained within the inlet, which has led to its characterisation as a sediment and contaminant sink (Williamson et al., 1996). Kelly (2008a) noted that despite many improvements in the control of contaminants, unauthorised discharges of industrial waste and stormwater contaminants still regularly occur, and while upgrades to the Mangere Wastewater Treatment Plant (MWTP) undertaken between 1998 and 2005 significantly improved the condition of the inlet, discharges still affect water quality.

Notwithstanding the extensive contamination of the area and the negative effects on ecological communities, large portions of the inlet have been designated Significant Ecological Areas (SEAs) because of their regionally, nationally, or internationally significant ecological, landform, or geological values (Proposed Auckland Unitary Plan, 2013). The areas of Mangere Inlet designated as SEAs are associated with geology and landforms, wading birds, mangroves, shrublands and saline vegetation, and intertidal mud or sandflats (Kelly, 2008a). The inlet also continues to provide a wide range of ES including cultural services such as recreation and ecotourism, regulating services such as waste treatment and disposal, provisioning services such as food provision, and supporting services such as

nutrient cycling. The area has a history of human use dating back to approximately 1280 AD (Wilmshurst et al., 2008). The three local boards included in the study area (Figure 2.11) are home to approximately 193,899 people including 21,693 (11.2 percent) who identify as indigenous Māori (Statistics NZ, 2013). The area is also home to a diversity of fish and bird species, including several endangered birds (Kelly, 2008a).

Mangere Inlet makes an excellent case study for several reasons:

- The area has only recently acquired a specific political forum (Manukau Harbour Forum) whose sole purpose is to explore the governance and management of the harbour (Auckland Council, 2011), making it unlikely that stakeholder fatigue will be a significant concern for this research (Millennium Ecosystem Assessment, 2005b).
- Of the three major estuaries in Manukau Harbour, only Mangere Inlet does not have a current or proposed management plan. This gap in the planning processes associated with the study area means that this research could influence future decision making in the area, thereby adhering to best practice (Lynam et al., 2010).
- Estuaries are important ecosystems that support a diversity of wildlife and provide a range of ES (Lotze et al., 2006). But while there is a history of ecological and biophysical research associated with Manukau Harbour and Mangere Inlet,¹ to my knowledge no extensive studies have yet been conducted on the social values or ES of this area.

1.3 Research contributions

The translation of coastal and marine ecosystem understanding into effective management and social responses has been identified as the major gap in decision-making processes associated with New Zealand's Hauraki Gulf (Thrush & Montgomery, 2011). A similar situation exists for the nearby Manukau Harbour, which is subject to the same overarching research, governance, and management regimes as Hauraki Gulf. In fact, problems related to communication and implementation in the context of coastal and marine systems is the focus of much research worldwide (e.g. Hughes et al., 2005; Ruttenberg &

¹ In April 2008 the Auckland Regional Council hosted a technical symposium that celebrated the significant body of long-term environmental monitoring and research conducted on the Manukau Harbour. For more on this see: <http://www.arc.govt.nz/albany/index.cfm?6DC67D69-145E-173C-986A-3FC0FC5CDED4&>

Granek, 2011). These challenges extend to natural resource management in general (van Wyk et al., 2008). Compounding these problems in coastal and marine areas is the fact that, at present, no framework exists for considering the linkages between land and sea in research, management, or policy agendas (Peart, 2009b). Utilising PM methods in conjunction with ES frameworks may provide a pathway towards better communication and implementation in this world of wicked natural resource management problems, but the usefulness of this approach is contingent on a wide variety of factors (Irvin & Stansbury, 2004), including context, goals, and implementation processes.

This research contributes to the development of adaptive governance and EBM frameworks that can address wicked coastal problems, in particular those elements associated with communication, implementation, and connectivity. It does so by examining the ability of a time and resource constrained PM method to identify and integrate social values into an ES framework, and to enhance social learning and capacity building within the participant group. The ability of the method to communicate understanding about the underlying ecosystem functions that support the provision of ES, and the ability to consider both land and sea perspectives, is also considered. The capacity of the PM method to generate or enhance other elements of social capital such as increasing transparency, mediating power, and building trust, are also explored. This is in contrast to the two social values data collection methods reported thus far in the literature in relation to ES. The first method employs one-on-one interviews to facilitate the development of ES maps that include social values (after Raymond et al., 2009). The second involves a self-administered internet-based participatory GIS mapping system to develop ES maps that include social values (after Brown et al., 2012). While both of these methods collect extensive spatial data and arguably integrate social values into an ES framework, neither contributes much to the generation of the elements of social capital considered in this thesis, which are needed to facilitate the establishment of EBM and adaptive governance frameworks. The approach taken in this research highlights the role for and importance of the social sciences in improving environmental outcomes when problems are wicked.

The strict time constraints placed on the participatory activities undertaken during this research form an important element of the research contributions; short (two hour) workshop time frames were allocated so that the research could explore what these methods could achieve under less-than-ideal conditions. This approach was chosen in recognition of the glaring mismatch between the demands placed on decision-making organisations, the resources that they have available, and the scale of many ES projects to date, which

commonly require significant investments of time, money, and skills to succeed (e.g. Costanza et al., 1997; Guerry et al., 2012; Tallis & Polasky, 2011; Videira et al., 2011). The resources required to implement PM methods are as varied as the methods themselves. Several methods require the involvement of highly trained experts, but others only require interested parties to invest their time. At either end of the spectrum, resourcing is always an important consideration. Who invests, why they are investing, and how this investment will affect the definition of project objectives is a concern for development and implementation projects (Irvin & Stansbury, 2004), especially those that involve a diverse range of participants, and that include challenges such as addressing wicked problems. This research highlights both what may be possible, and what may be impossible, assuming strict resource constraints and a keen interest in ES frameworks and PM methods.

Another contribution to ES research lies in the explicit focus of this study on coastal ES; while some work has addressed these areas, the vast majority of ES research has considered terrestrial systems in isolation (Guerry et al., 2012). For example, de Groot et al. (2010) outline some of the main research questions that should be addressed to more effectively integrate ES into governance and management processes, but considers these in a landscape context. This research considers several of the main research questions identified by de Groot et al. (2010) but from a coastal SES perspective (Table 1.1).

Table 1.1: Main research questions to address for the integration of ecosystem services into governance and management processes after de Groot et al. (2010, p. 261) and considered in part by this research, but adjusted to include a coastal SES focus.

Valuing ecosystem services
What are the most appropriate economic and social valuation methods for ecosystem and landscape services, including the role and perceptions of stakeholders?
What is the influence of scaling-issues on the economic value of ecosystem and landscape services to society?
How can values (ecological, social and economic) be mapped to facilitate the use of ecosystem services in (spatial) landscape planning and design?
Use of ecosystem services in trade-off analysis and decision making
How can analytical and participatory methods be combined to enable effective participatory policy and decision making dialogues?
How can spatial and dynamic ecosystem services modelling be linked to participatory trade-off assessment methods to optimize multi-functional use of the “green and blue space”?

Finally, this thesis will consider issues associated with the new metrics of ES by employing a relative metric to quantify stakeholder values regarding ES in the study area. ES can provide performance metrics that help illuminate and balance the multiple objectives and

trade-offs inherent in ecosystem-based decision-making (National Research Council, 2004). There is increasing emphasis worldwide on the role that ES play in the governance and management of vital SES (Baker et al., 2011), but there is little guidance available on how these services should be measured, making this approach difficult to implement (Tallis et al., 2012). The employment of a relative metric contributes new dimensions to the utility of ES as a communication tool.

1.4 Thesis overview

This chapter has provided an introduction to the research problem and study area in order to situate the study within a meaningful context. The remainder of the thesis is structured around the central research question and research aims as follows. Chapter Two elaborates on the background and context of the study area, a process that is needed to ground the thesis in a critical narrative of place. Several key perspectives on the wicked problems associated with the study area, and appropriate ways to respond to and resolve these problems, are highlighted. These ideas will be woven throughout the remainder of the thesis. Chapter Three considers the theoretical frameworks that form the backbone of the research, focusing specifically on what wicked problems are, delving into frameworks for addressing these problems, and describing the role of various participatory models and the generation of particular elements of social capital in addressing these problems. This chapter grounds the analysis conducted in the thesis. Chapter Four describes the mixed methods and methodology utilised to explore how PM interventions can improve ES frameworks and aid in the resolution of wicked problems associated with Mangere Inlet, Manukau Harbour. Chapter Five describes the results of the PM exercises and discusses the implications of these findings in terms of the contributions that they make to existing ES approaches and decision-making frameworks. Chapter Six further analyses the research results to determine the capacity of the PM methods to integrate social values into an ES framework and generate elements of social capital needed to resolve wicked problems. Chapter Seven describes the limitations of the research, summarises the most important conclusions emerging from the study, and offers reflections and prospects for future research to extend this work.

2. Many voices of the Manukau

*In the beginning was the story.
Or rather: many stories, of many places, in many voices, pointing toward many ends.
– William Cronon*



Figure 2.1: A map of many of the places in and around Mangere Inlet, Manukau Harbour, Aotearoa New Zealand discussed in this chapter and throughout the thesis.

2.1 Introduction

This chapter provides contextual background and introduces several narratives that dominate the decision-making landscape associated with the study area that are intended to be both creative (Rose, 2006) and compelling (Gibson-Graham, 2008; Pratt, 2009). The goal is to encourage the reader to emotionally engage with the material contained in this thesis, and through this engagement, to allow for the possibility of a radical transformation of geographic understandings of the politics of this place (Cameron, 2012). Narratives are utilised to illuminate both the boundaries that delineate experiences unique to the study area, and the bridges that connect this place and its people to others throughout the past, present, and future. The term ‘narrative’ is used to reflect the representation of an overarching set of values. This is distinguished slightly from ‘stories’, which are defined as a more individual perspective. Stories can contribute crucial examples to the narrative, but do not alone constitute it. Many of the stories, perspectives, ideas, and goals introduced in the narratives in this chapter are also woven throughout the thesis. In an effort to remain true to these diverse narratives, but also to reflect the conflict that characterises the cultural dialogue about this particular place, some of the opinions and interpretations of facts and figures provided in this chapter may not agree with one another, or with other elements of this thesis. Cronon argues that narrative is ‘our best and most compelling tool for searching out meaning in a conflicted and contradictory world’ (1992, p. 1374). These differing perspectives are therefore an important part of the thesis and its context, and do not detract from the research findings. Instead, the conflicting narratives presented in this chapter emphasize the importance of the small but significant moments of agreement, cooperation, and compromise that arise from this research.

In the sections that follow, pertinent elements of indigenous, local, government, and research perspectives on the study area are explored. Narratives missing from the thesis are also mentioned. Each narrative is bounded in part by ethnicity, history, legislation, training, place, and myriad other socio-cultural and social-ecological factors. The narratives chosen focus on illuminating key elements of the complex and interconnected SES of the study area that contribute to the wickedness of its problems. The approach also aims to allow highly valued ES to emerge from the Manukau through the voices of those who use and value it, rather than to impose an outsider’s perspective on what ES exist, and are of value.

I begin by describing the geographic and ecological features of the area, to ground the study in the physical characteristics of the place. In the indigenous perspectives section, I outline events and qualities of great importance to Māori world views and cultural identity,

including pertinent origin stories, the concept of kaitiakitanga or guardianship, and the relationship with non-indigenous settlers and the Crown. The local perspectives section describes the early European settlement and industrial development of the study area, laying the foundations for a discussion of contemporary local concerns. The Government section describes the perspectives of three government agencies that have authority over the study area; Auckland Council, the Department of Conservation (DOC), and the Ministry of Primary Industries - Fisheries (MPI). The narratives in these sections are embedded primarily in pertinent legislative documents that inform the activities and relationships of these institutions with other stakeholders and with the study area itself. In the research section I have included scientific and academic evaluations of the environmental condition and values associated with the study area. I have included this section after the more social narratives to emphasise that while science and research can provide critical benchmarks and information about the study area, the problems and their possible resolutions are firmly embedded in the entangled social dynamics described in the previous sections. In the final section I highlight a few examples of perspectives that have not been included in this study, but could contribute to future work. My goal in drawing attention to the missing voices early in the thesis is to be transparent about the contributions that this thesis makes, and those that it cannot.

Of course, reality is much more complex than what can be conveyed in a written account. I do not presume to speak for any individuals, who may choose to identify with some, all, or none of the perspectives described here, nor do I attempt to represent all possible perspectives associated with the study area. However, individuals who self-identify with one or more of the perspectives described in this chapter participated in this study, and I have used their voices to develop and punctuate these narratives where appropriate. My goal is to present these many voices in this chapter, to invoke a dialogue about the challenges and values associated with Mangere Inlet, Manukau Harbour, Aotearoa New Zealand.

2.2 Geographic and ecological features

Essential geographic and ecological features of Mangere Inlet and the Manukau Harbour are described in this section. These characteristics set the scene for the narratives that follow, providing common ground from which to begin an exploration into the social-ecological dimensions of this place.

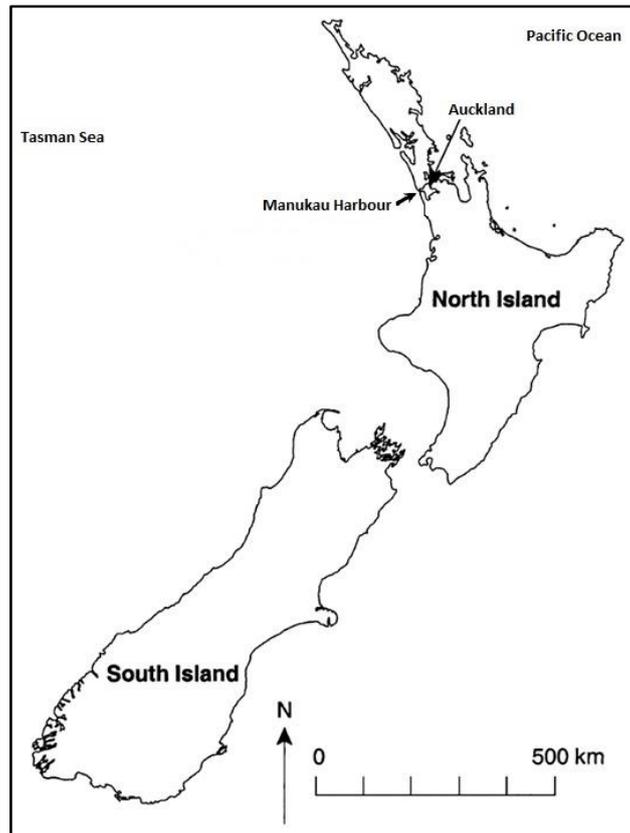


Figure 2.2: Map of Aotearoa New Zealand indicating the location of the Manukau Harbour.

Located on Aotearoa New Zealand's west coast (Figure 2.2), Manukau Harbour is the second largest of New Zealand's harbours, covering an area of about 365 km² (Vant & Williams, 1992) and associated with a catchment of approximately 895 km² (Kelly, 2008b). Manukau Harbour was formed when a Quaternary dune barrier (<2.6 million years before present, today known as Awhitu Peninsula) enclosed a large bay between Port Waikato and the Waitakere Ranges (Kelly, 2008b). This area may have been connected to the Pacific Ocean at times by narrow straits, but its development was primarily directed by the deposition caused by the ancestral Waikato River, the flow of which has since been disrupted by volcanic activity in the Pukekohe–Bombay area (McLintock, 1966a). Today, the Waikato River empties directly into the Tasman Sea.

Volcanic activity has repeatedly re-shaped the land in and around the study area. As recently as 140,000 to 60,000 years ago, nearly 50 volcanoes erupted in the Auckland area, forming the Auckland volcanic field (Figure 2.3), an area that is still considered active (Campbell & Hutching, 2007). Several iconic volcanic features from the Auckland volcanic field are associated with the study area including the Mangere Mountain scoria cone,

Pahoehoe lava flows at Kiwi Esplanade, and several lava caves preserved at Ambury Park (Figure 2.1) (Department of Conservation, 2014b).

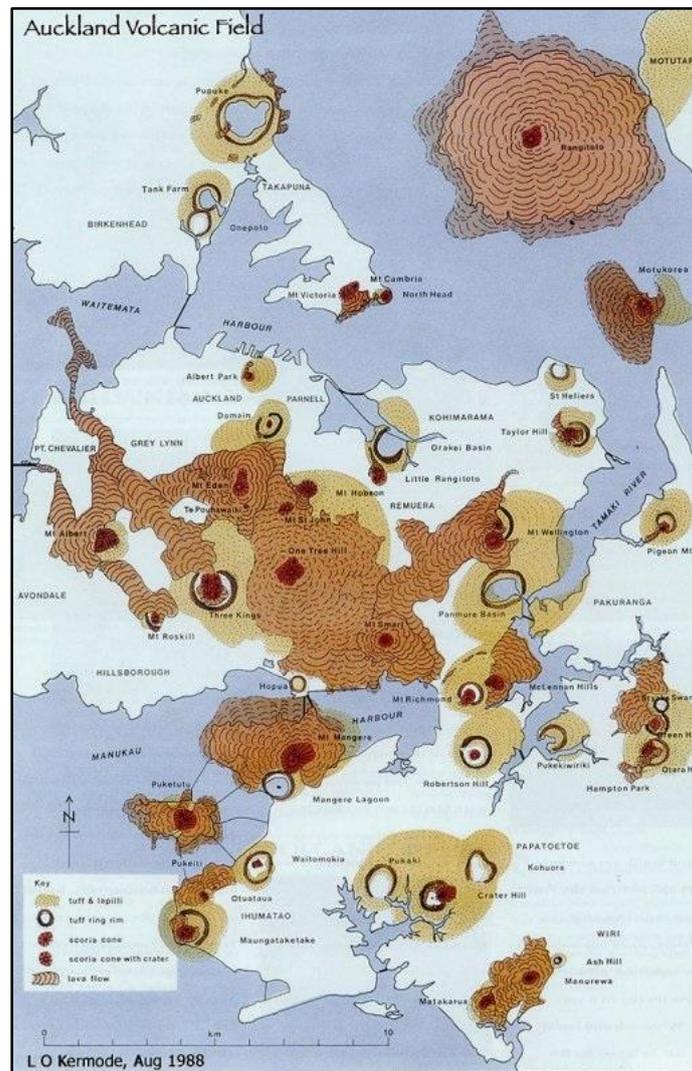


Figure 2.3: The distribution of volcanic centres in Auckland, known as the Auckland volcanic field (from Kermode, 1988).

The entrance to the Manukau Harbour is narrow in relation to the harbour itself (Figure 2.4), with a width of only 2.3 km, and tidal flows in combination with littoral drift have generated a large offshore ebb-tide delta (Hicks & Hume, 1996). The harbour is a relatively shallow basin with a spring tide range of 2.8 m and average depth of 6.1 m (Kelly, 2008b). Extensive intertidal mud flats and sand banks are “a dominant, and ecologically important, feature” (Kelly, 2008b, p. 8). Four channels in the central harbour radiate from the harbour entrance: Wairopa and Purakau in the north lead to Mangere Inlet, while Waiuku leads to the Waiuku River in the south and Papakura leads to Pahurehure Inlet in the

southeast (Figure 2.4). At low water, these are the only navigable areas for larger vessels, but the primary hazard for ships utilising the harbour is the shifting sand bar, which creates heavy swell and strong breakers that have long made navigating the harbour entrance dangerous (McLintock, 1966a).

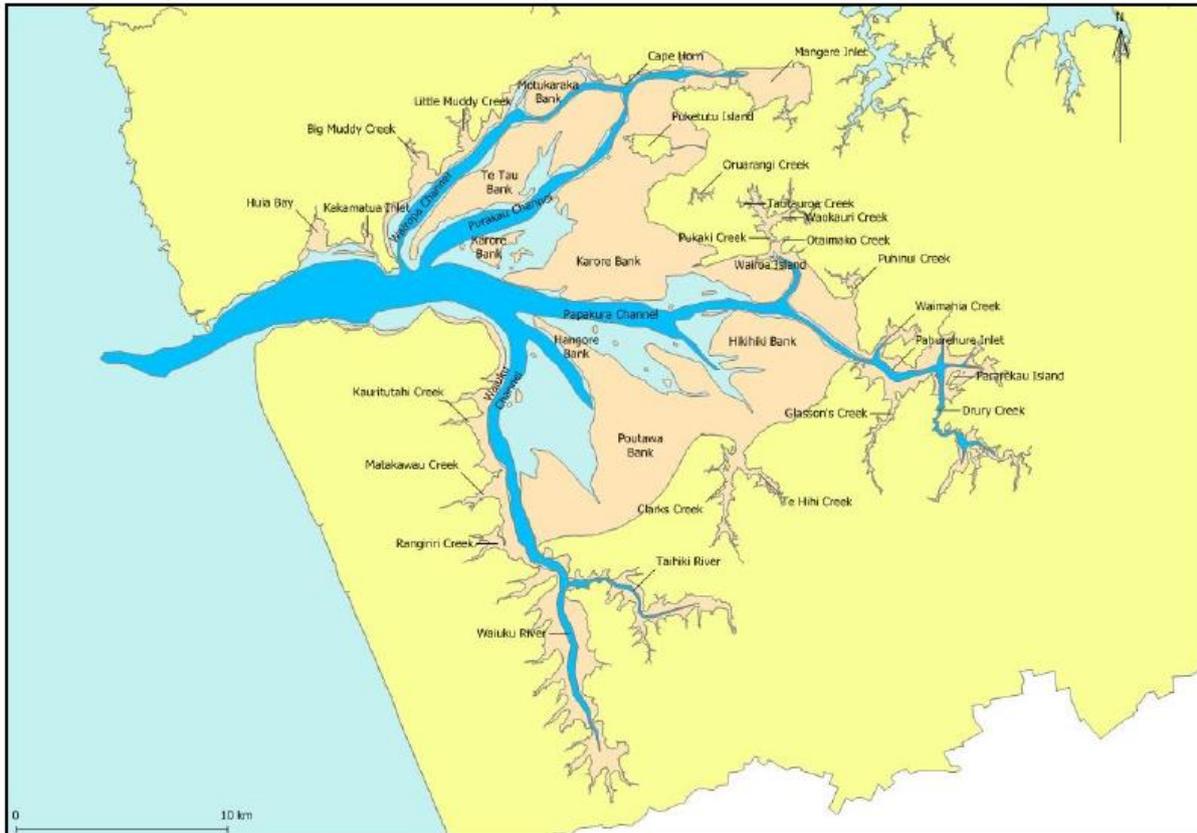


Figure 2.4: Major channels, inlets and intertidal sand and mud banks in Manukau Harbour (Kelly, 2008b, p. 10).

Manukau Harbour is defined as an estuary (Category F) by Hume et al (Hume et al., 2007). Estuarine environments are characterised by a range of extremes. Temperature, nutrient concentration, salinity, currents, turbidity, changes in bottom sediment, and exposure/submersion can all shift dramatically in a matter of days or even hours (Henriques, 1977). Organisms that live in estuaries are therefore generally adapted to tolerate a wide range of environmental fluctuations, and due to the range of habitats and environmental conditions found in estuaries, these areas often support a diversity of wildlife and provide many ES (Table 2.1) (Levin et al., 2001; Lotze et al., 2006).

Estuaries continuously provide goods and services through a complex suite of ecosystem processes, the diversity of habitats within estuaries, and the connections between habitats within estuaries, but the significance of these processes is largely unrecognised in

decision making frameworks (Thrush et al., 2014). Management and governance of these areas is further complicated because the goods and services are not always utilised or valued in the same location as the processes that support them (Hein et al., 2006).

Table 2.1: Estuarine ecosystem services, their overarching categories and underpinning processes (Thrush et al., 2014).		
Services category	Services	Roles contributing to these services
Provisioning Services	Production of food Production of raw materials Production of medicines and pharmaceuticals	Primary production Secondary production Trophic relationships Reproductive habitats Refugia for juvenile life stages Ontogenetic habitat shifts Biogeochemical cycles associated with nutrient supply Biogenic habitat Biodiversity
Regulation and Maintenance Services	Regulation of waste Assimilation processes Storing & cycling nutrients Gaseous composition of the atmosphere & climate regulation Sediment formation & stability Maintaining hydraulic cycles & shoreline protection	Biogeochemical cycles Storage and processing Benthic-pelagic coupling Bioturbation/irrigation Molluscs, corals and other calcimass generators Shell formation and bivalve abundance Biogenic structure/reef makers Fringing vegetation Bioturbation and burrow formation Species, spatial structure, size and density influences on hydraulic processes
Habitat and Ecological Community Services	Provision of habitat structure Resilience Genetic resources	Invasibility Provision of habitat Maintenance of trophic structure Biodiversity Resource use complementarity Facilitation Allee effects
Cultural Services	Cultural and spiritual heritage Recreation & tourism Aesthetics Cognitive benefits Non-use benefits Speculative benefits	Ecosystem, community and population processing Processes influencing water clarity, habitat diversity Biodiversity

The National Institute of Water and Atmosphere (NIWA) includes the Manukau Harbour in the Northern New Zealand climate zone (National Institute of Water and

Atmosphere, 2014). This area experiences sub-tropical climate conditions with warm, humid summers and mild, wet winters. Summer daytime maximum temperatures usually range from 22°C to 26°C, but rarely surpass 30°C, while winter daytime maximum air temperatures typically range from 12°C to 17°C. SW winds prevail for much of the year, but in summer and autumn, storms of tropical origin may bring high winds and heavy rainfall from the east or northeast.

2.3 Indigenous perspectives

2.3.1 Introduction

Five Māori tribes claim traditional links to the study area and are currently involved in elements of decision making that affect the area. These tribes are: Ngāti Te Ākitai, Ngati Te Ata, Ngāti Tamaoho, Ngāti Whātua-o-Orākei and Te Kawerau-a-Maki. Representatives from each of these tribes were invited to participate in this study, but not all chose to do so. Therefore, instead of describing the perspectives of each of these tribes in detail, this section provides a general indigenous perspective on the study area, relaying key concepts and events that have shaped Māori relationships with the resource management and governance of this area throughout history. This narrative illuminates the historical claims of Māori jurisdiction over and connection to the area, and the disenfranchisement experienced by Māori at the hands of non-indigenous groups. Government approaches towards resolving these problems are described, and reflections on the current state of relations are offered.

2.3.2 Narrative

In the beginning, Ranginui (the sky) and Papatūānuku (the earth) were joined together, and their children were born into the darkness that existed between them. To allow light into the world, the children decided to separate their parents. The children then became the gods of the natural world; Tāne became the god of the forests and Tangaroa the god of the sea, but there were many others (Royal, 2012b). Tāne made the first woman from soil. Her name was Hineahuone (the female element who comes from the soil). She had a daughter with Tāne named Hinetītama, later known as Hine-nui-te-pō, who is seen in the dawn and in the setting sun. In many Māori traditions, it is said that all human beings are descended from these ancestors (Royal, 2013).



Figure 2.5: Dittmer, Wilhelm, 1866-1909: Maui fishing New Zealand out of the ocean. [London, Routledge, 1907]. From the collections of Alexander Turnbull Library, Wellington, New Zealand. Ref: PUBL-0088-049. Permission of the Alexander Turnbull Library, Wellington, New Zealand, must be obtained before any reuse of this image.

The land that forms New Zealand's North Island is said to have been dragged up from the ocean by the demigod Māui, who used the jawbone of his grandmother as a hook (Figure 2.5). The Māori name for the island is Te Ika-a-Māui (Māui's fish). The South Island is referred to as Te Waka-a-Māui, or Māui's canoe. Rakiura (Stewart Island) is the canoe's anchor. The ruggedness of New Zealand's landscape is attributed to Māui's brothers, who greedily tried to cut up the fish while it was still alive, causing it to thrash, thereby creating mountains, cliffs, and gorges (Orbell, 1995). These events are of great importance to the Māori world view, as they provide an origin for tribal land tenure in New Zealand (Royal, 2013).

According to tribal histories, the first human inhabitants of the area today known as the Manukau Harbour settled along the northern shores in about 900 AD; these people were known as the Tāmaki and Maruiwi (Waitangi Tribunal, 1985). The name "Manukau" may not have been bestowed upon the area until 1350 AD, when Māori traditions indicate that the

great double hulled Tainui sailing canoe arrived in the Waitemata Harbour and was hauled across the Tamaki isthmus to Manukau Harbour (Figure 2.1):

Local community representative 3: When they [Tainui] arrived they sent out a scouting crew because they heard huge noises out here, and thinking it could be other tribes living there, but it was found to be birds. Huge birds, a lot of birds, so they called the place Manukau after the birds.

There are several stories associated with the origins of the name “Manukau”, but the most common explanation suggests that the name is derived from the harbour’s connection with large populations of birds; the word “manu” means bird, and “kau” means a swim, suggesting that the Manukau was a “bathing place for sea birds” or a “place of the wading birds” (McLintock, 1966b). The area became well known for its ample supply of fowl, but also for its plentiful fish and other kaimoana (food from the sea). Snapper, flounder, mullet, and shellfish such as scallops, cockles, and pipi made the Manukau an important fishing ground (McLintock, 1966b). One tanagata whenua representative (a tribal authority over land or territory) who participated in this study explained that “the Manukau, traditionally even in the early contact period, was a very lively place. It was thick with canoes at times.” Terraced gardens planted by the Māori settlers throughout the area provided bountiful harvests of kūmara and taro, which thrived in the rich volcanic soil. The vestiges of one of the largest of these can still be seen today at the Otuataua Stonefields (Figure 2.1) (Peart, 2009a). Portages from Manukau Harbour to both the Pacific Ocean (Figure 2.1) and the Waikato River made the area an important transportation centre for Māori, and many villages were established along the shores of the harbour, and pā (fortified settlements) were built in most of the volcanic cones that dotted the landscape (McLintock, 1966b). An important strategic pā was established and the remnants are still visible at Mangere Mountain (Figure 2.1).

The concept of kaitiakitanga, which means guardianship or stewardship, played a central role in the traditional relationship that tangata whenua (Māori people – literally people of the land) had with the environment. Customary practices often sought to maintain a balance between the use of resources and maintaining their availability (Royal, 2012a). Local hapū (sub-tribes) were frequently considered to be the kaitiaki, or guardians, of a nearby lake or forest, and the health of these areas reflected on and was reflected by the health of the entire community (Royal, 2012a). A related concept, manaakitanga, which means hospitality,

kindness, or generosity, is traditionally practiced by offering visitors the very best of the local resources to eat and drink.

Although the first recorded contact with Europeans dates from 1642, when Able Tasman's Dutch ships sighted New Zealand but did not come ashore (King, 2003), European immigrants did not begin to arrive in large numbers until the late 1830s (Peart, 2009a). To enable as peaceful a settlement of New Zealand as possible, the British Crown negotiated with Māori rangitira (chiefs), a process that resulted in the signing of the Treaty of Waitangi, a document written in both English and Māori, on 6 February 1840. Unfortunately, differing interpretations of the Treaty (Waitangi Tribunal, 2014a) have contributed to decades of conflict, despite the fact that the Treaty itself is not part of domestic law in New Zealand (except where it has subsequently been referred to in Acts of Parliament) (Ministry for Culture and Heritage, 2014).

In 1975 the debates about the Treaty reached a crescendo, culminating in the passage of the Treaty of Waitangi Act 1975, which established the Waitangi Tribunal, a permanent commission of inquiry whose sole purpose is to make recommendations on claims brought by Māori relating to actions or omissions of the Crown which breach the promises made in the Treaty of Waitangi (Waitangi Tribunal, 2014b). This development gave the Treaty of Waitangi legal standing in New Zealand for the first time (Treaty of Waitangi Act, 1975). Since the establishment of the Tribunal, more than 2000 claims have been lodged against the Crown, and several major settlements have been reached (Ministry for Culture and Heritage, 2014).

Many of these claims concern the abuse of land and water by encroaching European settlers and the subsequent widespread damage and pollution that has been caused throughout the New Zealand landscape. In the 1980s, Waikato-Tainui submitted a claim to the Waitangi Tribunal because of concerns over the Manukau Harbour and its environments (Waitangi Tribunal, 1985). The Manukau Claim is about "the despoliation of the Manukau Harbour and the loss of certain surrounding lands of the Manukau tribes...underlying the claim is an enormous sense of grievance, injustice and outrage that continues to haunt the Manukau Māori and bedevil the prospect of harmony in greater Auckland" (Carton & Thissen, 2009, p. 1). The Manukau Claim (Waitangi Tribunal, 1985) alleged that the Crown had not met its Treaty responsibilities in relation to Waikato-Tainui but that instead, Crown policies had caused a serious and continuing deterioration in the quality and quantity of seafood available to the Waikato-Tainui hapū. Specific grievances related to land confiscation; the failure of the Crown to protect tribal interests and tribal rights to resources in and around the harbour; loss

of access to parts of the harbour and resources therein either through restrictions/prohibitions or as a consequence of pollution from farm run-off, sewage, and industrial discharge affecting opportunities for fishing; and infringement of tribal rights due to the location of industries near the harbour which affected the health of the harbour. The findings of the Waitangi Tribunal in response to the Manukau Claim acknowledged the traditional rights of Waikato-Tainui in relation to the harbour and made recommendations to various government departments to give greater recognition to Māori rights and values as they relate to the management of resources in and around the harbour. The Claim provided impetus to improve the Mangere Wastewater Treatment Plant (MWTP) (Figure 2.1) and to address pollution problems associated with the discharge of sewage and other contaminants into the harbour.

Today, tangata whenua representatives are frequently involved in the management of natural resources and heritage areas around New Zealand as co-managers due to legislated rights afforded by the Treaty of Waitangi Act (1975), and the Resource Management Act (1991) (RMA). In the study area, tangata whenua have been extensively involved in a project to redevelop the Onehunga foreshore (Figure 2.1) (Auckland Council, 2012a; Thompson, 2012). The relationship between tangata whenua representatives and other legislated authorities is far from perfect, but the reconciliation process is ongoing (Orange, 2012). Tangata whenua representatives generally support the protection of and continued access to or use of heritage areas, the continuation of traditional activities and practices such as waka ama paddling and collection of kaimoana, and practices that sustain or improve the environment (Independent Māori Statutory Board, 2012). Māori access to markets, jobs, and other social opportunities is also often a strong motivating factor for tangata whenua representatives (Independent Māori Statutory Board, 2012). But even without legislative rights and statutory obligations, many Māori still consider themselves to be guardians of the land and water that is their ancestral home. In Mangere Inlet and the surrounding areas of the Manukau Harbour, the interest and involvement of tangata whenua in coastal redevelopment projects is strong:

Tangata whenua representative 1: This [the redevelopment of the Onehunga foreshore] is one of the larger scale contemporary projects that has happened in the area since legislation like the Resource Management Act and since Treaty claims have been processed, and I think that the degree of interest in Auckland Iwi in it reflects our contemporary desire to be kaitiaki for our environment.

2.3.3 Conclusion

Māori cosmology and identity are intimately tied to New Zealand's land and seascapes. The stories, histories, practices, and physical spaces described here are important elements of this connection, but many of these have been disrupted by several hundred years of development and disenfranchisement due primarily to contact and subsequent conflict with non-indigenous groups. In modern times, the Treaty of Waitangi Act (1975), the RMA (1991), and resulting claims and consenting processes have provided methods for restoring some of the historical connections between Māori and the land and waters of their ancestral home, but this process is imperfect and requires careful and often extensive negotiation and facilitation among many conflicting interests.

2.4 Local perspectives

2.4.1 Introduction

More recently, local interests, which include both indigenous and non-indigenous cultural groups, have rebelled against a long history of environmental degradation in Mangere Inlet and the Manukau Harbour. This degradation is perceived to continue today primarily for the benefit of the greater Auckland area, rather than in consideration of local needs. The conflict exists primarily between local stakeholders and regional governing agencies, but as a result of the strict hierarchical structure of the New Zealand Government, many of the existing decision-making frameworks which frustrate local stakeholders are also supported at the national level.

2.4.2 Narrative

European influence over the Manukau Harbour began in earnest following the signing of the Treaty of Waitangi in 1840, and has increased since that time. Matthews et al. (2005) outline some of the key phases of European development to impact the area, starting with the intensive European settlement of Onehunga, the land around Mangere Inlet, in the 1840s. This settlement quickly grew, and by the 1850s Onehunga was considered to be Auckland's agricultural centre. By the 1870s the European influence had spread further south after land acquisitions made during the New Zealand Land Wars of the 1860s, and many small industries such as meat works, tanneries, and brickworks, were established around the inlet, discharging their waste directly into the nearby waters. By 1875, a bridge between Mangere

and Onehunga was built so that travellers were no longer dependent upon a ferry or other boat, and a railway line was constructed along the easternmost foreshore of the inlet (Figure 2.1). These developments led to the concentration of industrial development in and around the inner inlet throughout the 1880s and into the 1900's. Kelly (2008a, pp. 44-45) compiled a list of contaminant sources that discharged directly to the inlet during this time period from Glasby et al. (1988) and Williamson et al. (1992):

- three large meat works;
- an abattoir;
- three phosphate fertiliser works;
- two wool scours;
- fellmongeries;
- soap and candle works;
- a wood-pulp works;
- a battery works;
- a woollen mill;
- a tannery;
- a glue works;
- Middlemore Hospital;
- Otahuhu Borough Council's septic tank;
- leachate from various refuse tips;
- run-off from the Otahuhu railway workshops; and
- run-off from the Pacific Steel plant at Otahuhu.

Despite the increasing pollution of the inner inlet, many local residents recall the first half of the 20th century as an idyllic time to live in and around Mangere Inlet (Figure 2.6). Activities typical of this period are described by Norine Borchard (2004), who explains that in the 1920s, Mangere Mountain Domain (Figure 2.1) was a favourite picnic spot for families with young children, and Mangere Bridge (Figure 2.1) was a popular spot for hand line fishing, providing many families with protein during the lean years of the Great Depression. Over the summer holidays, local fisherman would take families from Onehunga wharf (Figure 2.1) out to Waiuku, Huia, Whatipu, Graham's Beach, or another of the beaches around the Manukau to spend the day swimming and picnicking before returning at dusk. Children living in the area were routinely introduced to spear fishing for flounder, trapping eels, dinghy rowing, and shellfish gathering:

Dad always encouraged us to enjoy the delicacy of shellfish. We were taken to gather scallops (in season), digging for pipi on the Onehunga beach and the odd time of gathering mussels and oysters from the rocks. My brother and I did acquire a taste for shellfish, but for my taste I liked all my shellfish cooked – but not my Dad, he maintained that cooking spoilt the delicious flavour. Those were halcyon days indeed, what’s more all for free (Borchard, 2004, p. 41).

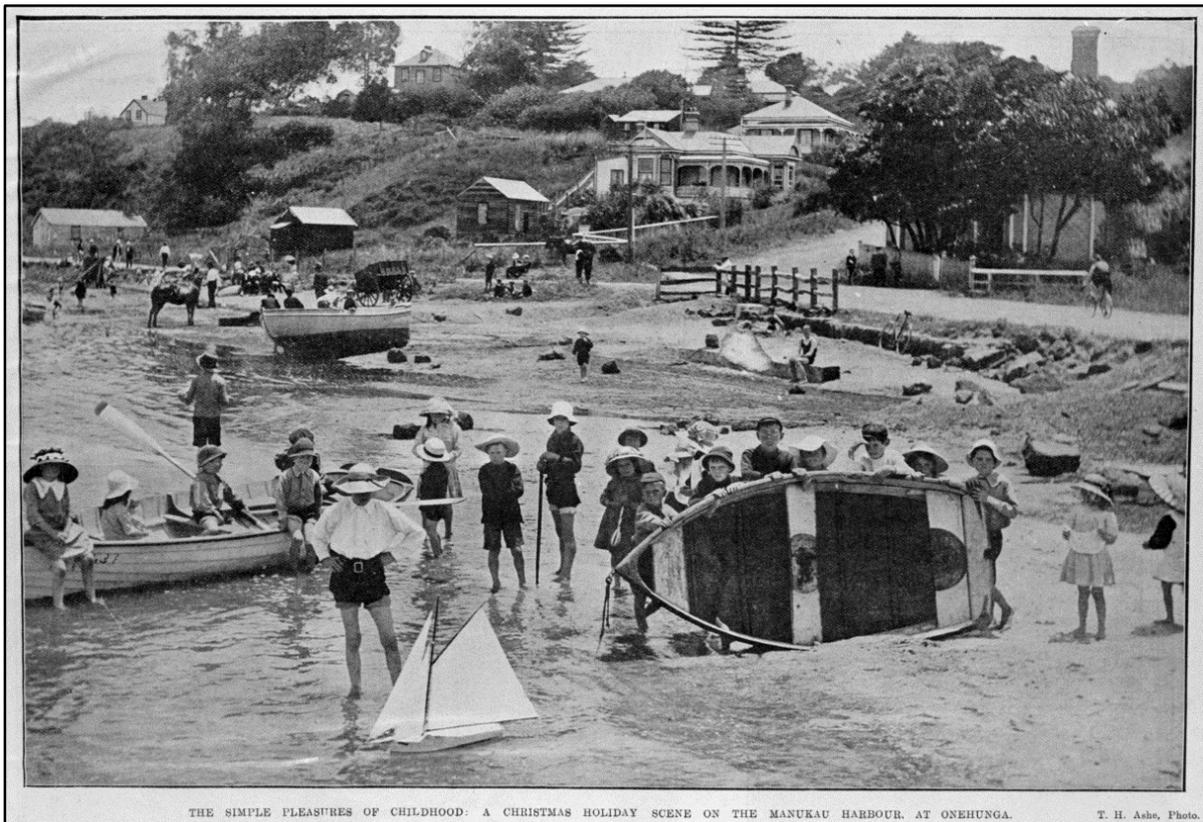


Figure 2.6: Ashe, T.H. (1913). The simple pleasures of childhood: A Christmas holiday scene on the Manukau Harbour. At Onehunga. Permission received from Auckland War Memorial Museum Library to reprint.

By the 1950s, the decomposing organic wastes stranded on the mud flats in the inner harbour were causing complaints due to the strong smell of hydrogen sulphide, released under the anaerobic conditions, and the lead paint on nearby houses was turning black for the same reason (Glasby et al., 1988). To address these problems, the Mangere Sewage Purification Works was opened in 1960 and began to process the household and industrial wastes that had previously been discharged directly into both the Waitamata and Manukau Harbours. This led to significant improvements in environmental conditions (Kelly, 2008a).

Upgrades to the wastewater treatment plant continued over the next few decades, and each led to improvements in harbour water quality, but these improvements were not without other localised costs: the modification and loss of approximately 500 ha of intertidal flats and coastline between Puketutu Island and Mangere; the loss of habitat within Mangere Lagoon; the blocking of the Oruarangi Creek discharge; and the creation of a significant midge problem (Figure 2.1) (Kelly, 2008b). A major upgrade to what is now MWTP (Figure 2.1) between 1998 and 2005 shifted treatment from the oxidation ponds installed in the harbour to a land-based system and restored Oruarangi Creek, Mangere Lagoon, and several other beaches, but midge, algae, and contaminated sediment problems still remain, and treated wastewater continues to be discharged into the Manukau Harbour near Mangere Inlet (Kelly, 2008b). The relationship between Auckland Council and Watercare, in which the Council serves as both a controlling organisation and an environmental watchdog, contributes to the concerns of local citizens, who feel that the relationship constitutes a conflict of interest (Jackson, 2014). This perceived conflict has contributed to the local view that Mangere Inlet is paying the environmental price for the disposal of Auckland's waste.

The poor environmental quality of Mangere Inlet, and by extension the Manukau Harbour, due in part to its continued use as a discharge site for treated wastewater, is keenly felt by many in the local community, some of whom personally recall a relatively unspoiled harbour. Anger and a deep sense of disenfranchisement are often described by local residents in relation to the historic management and governance of the area:

Local community representative 2: The community has basically been Auckland's rubbish tip for 70 years and where I grew up, a number of my parents' neighbours were either the major or senior councillors of Onehunga Borough Council, and they were screwed for probably my life time, for 60 years, okay? And they tried to bring change but were always unsuccessful. I guess in a way, I have inherited the attitude that our community has been compromised by the way our society has developed, and I would go as far as saying that Auckland has prospered at the demise of our harbour. New Zealand has prospered.

There are few reasons for local stakeholders to feel that this situation has changed dramatically today. The Central Interceptor Project, a planned expansion of the MWTP to incorporate approximately 200,000m³ of additional storage (Watercare Services Limited, 2014a), has reignited local rancour over the continued use of Manukau Harbour as

“Auckland’s rubbish dump” (Orejana, 2012). Approximately 700 submissions were made to Auckland Council against the planned MWTP expansion, and a court battle was launched by Manukau Harbour Restoration Society (MHRS) and several other local interest groups who are in favour of the total cessation of treated waste discharges into the harbour (Thompson, 2014).

Despite the poor environmental quality of the Manukau Harbour, many local interest groups actively utilise the area for cultural purposes. The areas in and around Mangere Inlet are particularly popular because of their proximity to large residential populations in Onehunga, Favona, Mangere, and Otahuhu. Fishing and boating organisations (including traditional waka ama paddling), the local chapter of the New Zealand Ornithological Society (based in Pukekohe but responsible for bird monitoring within the study area), local biking chapters, and other recreational users regularly utilise the study area. Recreational use of the area is likely to grow in the future, as the completion of a NZ\$28 million project to redevelop a large section of Onehunga’s foreshore is scheduled for 2015 (Figure 2.1) (Thompson, 2012). This redevelopment project comes more than 35 years after the area was first disrupted to pave the way for a major motorway expansion (Auckland Council, 2012a). MHRS is a particularly active local interest group that has been instrumental in seeing the redevelopment of the foreshore come to fruition. Members of this group primarily advocate for the following goals:

- To lobby for the restoration of the Manukau Harbour wherever possible back to its original water quality, and environmental state;
- To represent all communities and organisations that border on or are influenced by the Manukau Harbour;
- To recognise the sensitivities and aspirations of the Manu Whenua;
- To prevent pollution and abuse of the Harbour as a natural resource;
- To reinstate water borne passenger transport on the Harbour;
- To establish navigational aids on the Harbour;
- To re-establish a Manukau Harbour Authority with responsibility for maintaining the Harbour and its facilities; and
- To enable the Harbour to become a recreational asset to the City of Auckland (Manukau Harbour Restoration Society, 2014a).

In addition to their work against the Central Interceptor and for the redevelopment of the Onehunga foreshore, MHRS actively advocates for the return of ferry transport to the

Manukau Harbour (Morgan, 2013; Staff, 2014) and public access to Onehunga Wharf (Figure 2.1), which is currently controlled by Ports of Auckland and is closed to the public. The organisation has also become cautiously involved with NIWA and Auckland Council in the removal of mangroves from areas in and around Mangere Inlet. MHRS received a resource consent as well as a grant from Auckland Council to continue this work through to the end of 2014 (Manukau Harbour Restoration Society, 2014b). Under most circumstances, a resource consent is required from Auckland Council to remove the plant, which many locals see as an invasive species that hinders their enjoyment of and access to the inlet and harbour. Some popular recreational activities such as boating, waka ama paddling, and kayaking can be significantly hindered by the growth of mangroves in areas that might otherwise serve as easy access points to the harbour, previously unrestricted views may be blocked by rapidly expanding mangrove forests, and the risk of flooding may be increased due to the blocking or slowing of stormwater drains and drainage channels (Jackson, 2014; see also Chapter 5).

2.4.3 Conclusion

In recent decades, local interests, including both indigenous and non-indigenous cultural groups, have become frustrated with the long history of environmental degradation in Mangere Inlet and the Manukau Harbour. Many local interest groups believe that continued abuses of the area benefit greater Auckland at the detriment of local utilisation of an important historical and cultural resource. Some improvements have been made to the MWTP and foreshore access after decades of negotiations and court battles between local stakeholders and regional and national authorities, but the relationship between local leadership and government officials remains suspicious and strained.

2.5 Government perspectives

2.5.1 Introduction

Several important pieces of legislation guide the management and governance of the New Zealand coast in general, and the Manukau Harbour in particular. This legislation conforms to a hierarchical structure, with national legislation sitting at the top and providing guidelines and rules that must be adhered to throughout the lower ranks (Figure 2.7). At the national level, the RMA (1991), the Treaty of Waitangi Act (1975), and the Local Government Act (2002) are the most relevant Acts to this study. The RMA (1991) aims to achieve a coordinated, streamlined, and comprehensive approach to environmental

management in New Zealand. The Treaty of Waitangi Act (1975) established the Waitangi Tribunal to uphold the principles of the Treaty of Waitangi and make recommendations on claims relating to the practical application of the Treaty. The Local Government Act (2002) provides a democratic framework for the designation of powers and purpose to local authorities. Operating alongside these Acts is the New Zealand Coastal Policy Statement (NZCPS), which is developed by the Minister of Conservation and DOC, and provides guidelines for the development of coastal policies and plans by regional authorities such as Auckland Council (New Zealand Coastal Policy Statement, 2010).

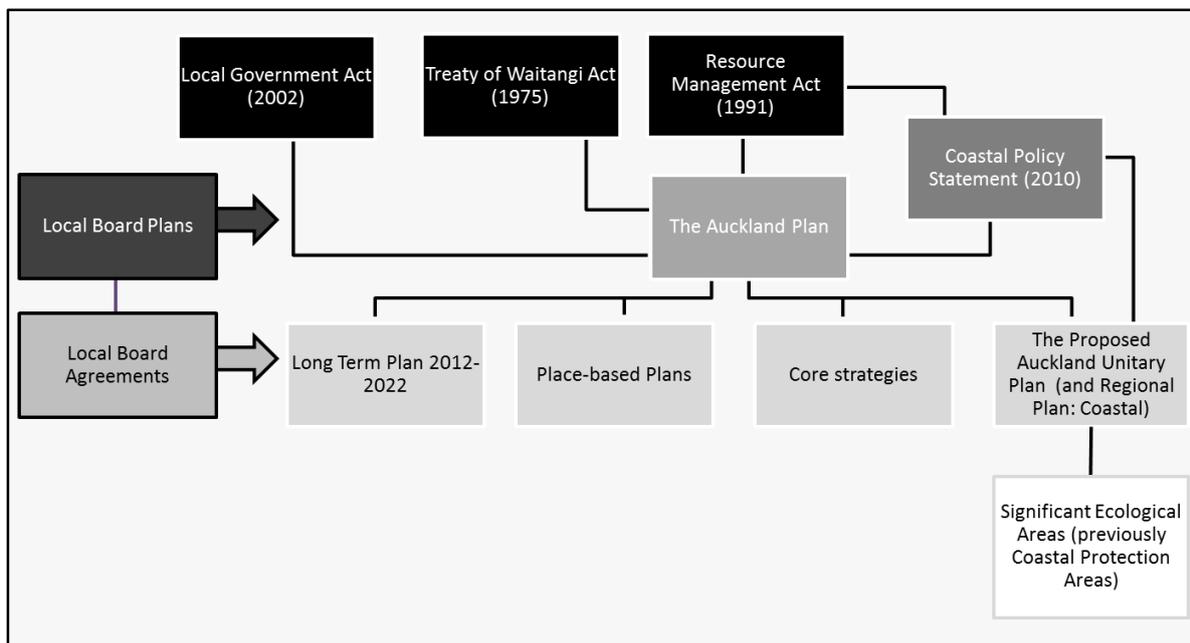


Figure 2.7: Hierarchical relationships between legislative documents with particular relevance to the Manukau Harbour (adapted from Auckland Council, 2014d). Significant Ecological Areas (previously Coastal Protection Areas as designated by the Regional Plan: Coastal) are designated as part of the Proposed Auckland Unitary Plan. They are not a statutory layer on their own, but are included in that document as a planning overlay.

Auckland Council is comprised of the governing body (including the Mayor and 20 councillors), the local boards (21 from around the region), the Auckland Council staff organisation, and the seven council-controlled organisations (CCOs) (Figure 2.8). An independent Māori statutory board sits alongside this governance structure but is independent of the Auckland Council. The purpose of this board is to assist Auckland Council in taking the views of Māori into account in decision making. To do this, the board advocates for cultural, economic, environmental, and social issues significant for tangata whenua in the

Auckland Region, and ensures that the council complies with statutory provisions that refer to the Treaty of Waitangi (Auckland Council, 2014e).

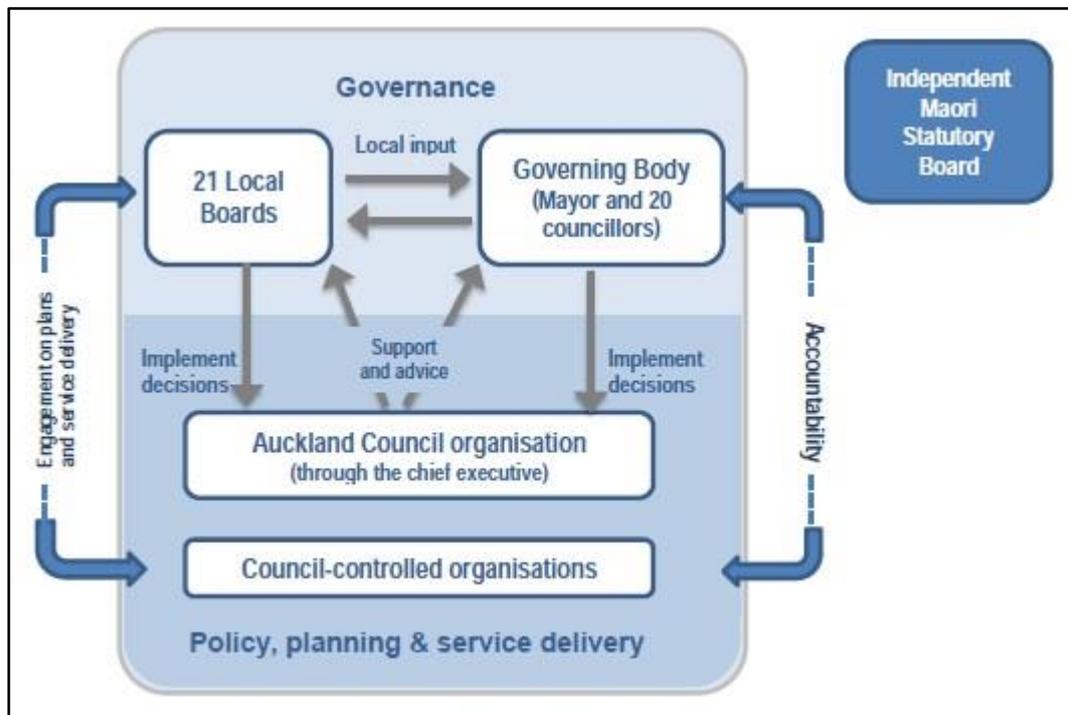


Figure 2.8: Auckland Council governance, policy, planning, and service delivery structure (Auckland Council, 2014b, p. 1).

2.5.2 Auckland Council organisation perspectives

Auckland Council represents the interests and needs of the entire population of Auckland, an area with a population of approximately 1.5 million residents, according to recent estimates from Statistics New Zealand (2014). The council has a statutory obligation to be involved in the governance and management of the Manukau Harbour through the range of legislative documents illustrated in Figure 2.7, and is therefore responsible for managing, monitoring, and ensuring compliance with all resource consent conditions. Input from the local boards is provided to Auckland Council primarily via the Auckland Plan and the Long Term Plan 2012-2022 (Figure 2.7). Of particular relevance to this study are the council’s obligations to manage several SEA – Marine 1 and 2 areas in and around Mangere Inlet as designated by the Proposed Auckland Unitary Plan (2013); these areas are not a statutory layer on their own, but are included in that document as a planning overlay (Figure 2.9). SEAs are areas of significant indigenous vegetation or a significant habitat of indigenous fauna (Proposed Auckland Unitary Plan, 2013), and as such they must be protected under the RMA (1991). According to the Proposed Auckland Unitary Plan (2013), SEA Marine 1 areas

are areas which, due to their physical form, scale or inherent values, are considered to be the most vulnerable to any adverse effects of inappropriate subdivision, use and development. SEA Marine 2 areas are areas of regional, national or international significance which do not warrant an SEA-Marine 1 identification as they are generally more robust.



Figure 2.9: Significant Ecological Areas as designated in the Proposed Auckland Unitary Plan (2013) and located within the study area.

Despite the extensive SEA designations in and around Mangere Inlet, the surrounding areas of the harbour and especially the inner or easternmost portion of the inlet are generally associated with intensive industrial, commercial, and urban use and high levels of contamination. The urbanised catchments that contribute to the inlet are largely responsible for this contamination (Kelly, 2008a), but studies have also characterised Mangere Inlet as a sediment and contaminant sink because the mass fluxes of suspended sediment in the inlet were greater during the flood than the ebb tide, a natural feature of the hydrodynamics of the area (Williamson et al., 1996). The sediment levels in the inlet have contributed to the expansion of native mangroves, which are protected under current legislation due to their indigenous status. Strict rules associated with mangrove removal have been developed because the plant is a native species that may provide:

- Erosion control and shoreline protection;
- A food source within the local food web;
- Support for other plants; and
- Support for animals, especially fish and birds (Morrisey et al., 2007b).

The extensive SEA designations associated with the inner inlet have conflicted with some local interests. For example, these designations indicate that there are restrictions on mangrove removal, and place limitations on the areas where harbour access infrastructure can be installed (2013).

2.5.3 Local board perspectives

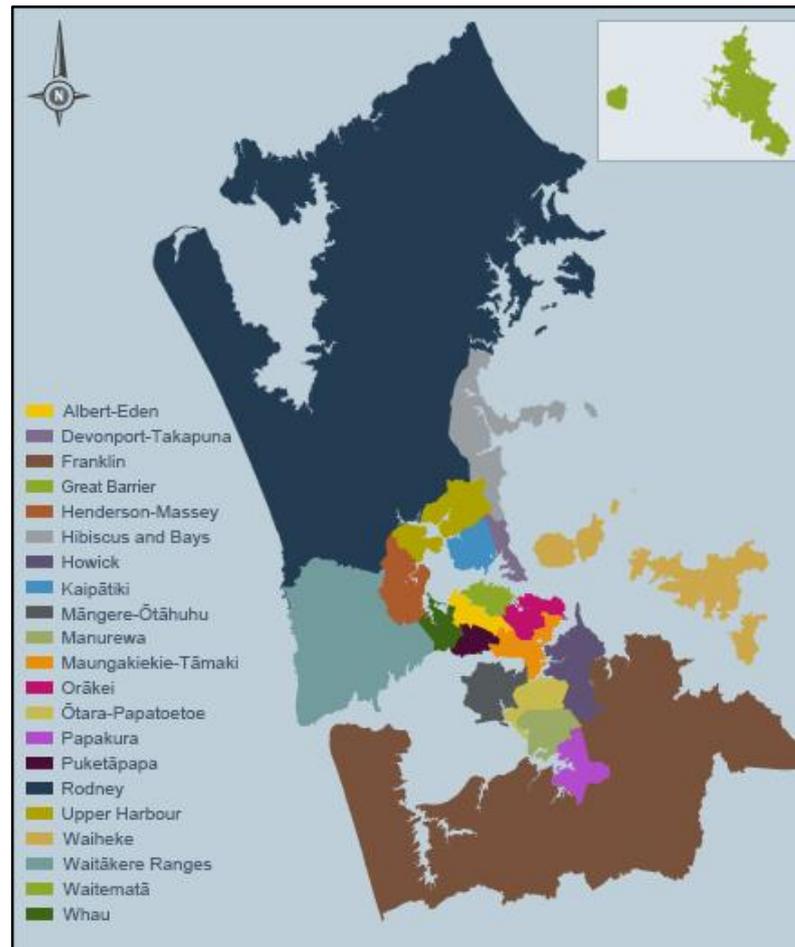


Figure 2.10: Map of Auckland’s 21 local boards, including three relevant to the study area: Maungakiekie-Tāmaki; Puketāpapa; and Māngere-Ōtāhuhu (Auckland Council, 2014f).

In addition to the interests of local user groups, there are three local boards within the study area: Maungakiekie-Tāmaki; Puketāpapa; and Māngere-Ōtāhuhu (Figure 2.10). Each local board makes decisions about non-regulatory local matters; provides local leadership; aims to support strong local communities; and provide important localised input into region-wide strategies and plans (Auckland Council, 2014a). These three local boards share several similar values and goals for their communities including (Māngere-Ōtāhuhu Local Board, 2014; Maungakiekie-Tāmaki Local Board, 2014; Puketāpapa Local Board, 2014):

- Strong community that participates, celebrates, and thrives.
- Healthy, protected, and treasured environment and cultural areas.
- Safe built environment that brings community together and celebrates culture and heritage.
- Successful businesses and strong local economies that provide good jobs.
- Connective transport that is safe and efficient.

Work to achieve these goals in Manukau Harbour is often united through the work of the Manukau Harbour Forum, a joint committee supported by Auckland Council that pools the resources of the local boards in an effort to enhance a united management approach to the area. Nine local boards constitute the Manukau Harbour Forum: in addition to the three in the study area, there are also Franklin, Papakura, Manurewa, Ōtara-Papatoetoe, Whau, and Waitakere Ranges (Auckland Council, 2012b) (Figure 2.10). Currently this group does not have any specific authorising document or mandate beyond the authority vested in the individual local boards.

2.5.4 Watercare perspectives



Figure 2.11: Mangere Wastewater Treatment Plant (from Watercare Services Limited, 2014b, p. 5).

Watercare Services Limited (Watercare) is a CCO, which means that the council controls 50% or more of the votes or has the right to appoint 50% or more of directors or trustees (Auckland Council, 2014c). CCOs are governed by their boards of directors or trustees, but are accountable to the council, which determines the objectives for each CCO and monitors their performance. Auckland Council is Watercare's sole shareholder.

Watercare operates MWTP (Figures 2.1 and 2.11), and therefore has a responsibility to collect domestic and industrial wastewater and treat/re-use wastewater in an environmentally responsible manner. The plant serves a population of approximately 1 million people and treats approximately 150 million litres of water per day (Watercare Services Limited, 2014b). MWTP's performance is regularly reviewed by experts in wastewater treatment, plant design and operation, marine water quality, microbiology, environmental virology, and public health. The resource consent conditions governing the operation of MWTP also require an independent audit to ensure the plant's operation meets consent requirements (Watercare Services Limited, 2014c).

In an effort to meet steadily improving environmental standards, cultural expectations, and increasing volumes, MWTP has been upgraded many times since it was first installed in 1960. Major upgrades were made to the plant in 1987 in response to the Waitangi Tribunal recommendations and public aspirations for improved water quality, and further improvements were made in 2001 (Watercare Services Limited, 2014b). The most recent upgrades involved decommissioning 500 ha of oxidation ponds, upgrading the plant facilities, and restoring and rehabilitating large areas of the Manukau Harbour's foreshore through dredging and reclamation projects and the development of walkways, beaches, plantings, and bird roosts. The coastal marine restoration efforts undertaken along 13 kilometres of shoreline as part of the facility upgrade constitute New Zealand's largest coastal restoration project to date (Peart, 2009a). Watercare's Coastal Walkway provides access to the Mangere Ihumatao foreshore, an area rich in cultural history, stretching seven kilometres from Ambury Park to the Otuaatua Stonefields (Figure 2.1). The area is dominated by the ancient volcanoes of Mangere Mountain and Puketutu Island. Walkways along the restored beaches make it possible to observe some of the thousands of migratory wading birds that come to feed in the harbour.

Despite these improvements, public safety concerns still exist, although a very high standard of disinfection is achieved at the upgraded plant. There is a negligible risk to contact recreation users outside the non-compliance zone. Consuming shellfish from the area may

still be associated with health risks, but they are vastly reduced and largely associated with post-storm time periods (Kelly, 2008a).

To address the estimated increases in wastewater capacity in the Auckland area in the coming years, prepare for the inevitable failures associated with aging infrastructure, and control possible overflows, Watercare has applied for and been granted resource consents from Auckland Council to begin work on the Central Interceptor project in 2017. The Central Interceptor will be a new 13 kilometre wastewater tunnel that is proposed to cross the Manukau Harbour at a depth of approximately 30 metres below the seabed. It will connect to the existing trunk sewer network to divert flows and overflows into the tunnel, and will “provide a total storage capacity of approximately 200,000m³ and will achieve estimated cost savings of at least \$500 million over its main alternative solution (Watercare Services Limited, 2014a).”

2.5.5 Department of Conservation perspectives

The Department of Conservation manages natural and historic resources throughout New Zealand for the use and enjoyment by the public and future generations, working to protect native species and maintain or improve the health of New Zealand’s public conservation lands and waters (Department of Conservation, 2014a). This mandate applies to the Manukau Harbour in many ways. For example, several of DOC’s main functions include: the protection of areas of high natural or historic conservation value, the protection of marine mammals and other native wildlife, advocacy for the conservation of natural and historic resources, and exercising responsibilities under legislation such as the RMA (1991) related to council’s policies and plans, and consent applications regarding the coastal and marine environment (Department of Conservation, 2014a).

The Minister of Conservation is also responsible for the development of an NZCPS (New Zealand Coastal Policy Statement, 2010) as mandated by the RMA (1991). The purpose of the NZCPS is to state policies which guide local authorities in their daily management of the coastal environment, in order to promote the sustainable management of natural and physical resources in relation to New Zealand’s coastal environment, and thereby achieve the purpose of the RMA (1991, section 56). Local and regional authorities must give effect to relevant provisions of the NZCPS in planning and consenting processes. The NZCPS applies to coastal land, foreshore, and seabed, and coastal waters from the high tide mark to the 12 nautical mile limit (New Zealand Coastal Policy Statement, 2010).

The Department of Conservation is primarily concerned with geographic areas much larger than the study area. Therefore, from the perspective of DOC, the values of the inner harbour mostly relate to its relationship to the harbour as a whole. However, the presence of several SEAs within the study area (Figure 2.9) raises its profile in terms of its interest for DOC. General concerns for the area are primarily related to issues such as biosecurity, biodiversity, and water quality, particularly in relation to how these issues might affect threatened and endangered species such as the black stilt, the brown teal, the grey duck, the New Zealand dotterel, the Caspian tern, the reef heron, the wrybill, and great white sharks.

2.5.6 Ministry for Primary Industries – Fishing perspectives

The Ministry for Primary Industries – Fisheries acts as the government’s principal adviser on New Zealand’s fisheries management and the effect of fishing on the aquatic environment. This role is undertaken within the frameworks provided by a range of laws, but the most critical is the Fisheries Act (1996). This Act provides for the utilisation of fisheries resources while also aiming to ensure the sustainability of these resources. MPI also plays an important role in fulfilling the Crown’s obligations to Māori under the Treaty of Waitangi (Fisheries Claims) Settlement Act (1992), the Māori Commercial Aquaculture Claims Settlement Act (2004), and the Māori Fisheries Act (2004).

Manukau Harbour has always been an important source for subsistence, recreational, and commercial fishers. Commercial fisheries do not operate specifically within the study area, although several operate within the wider Manukau Harbour. Recreational fishers must adhere to the relevant bag limits in marine areas, but are not required to obtain licences. The primary commercial fish species obtained from Manukau Harbour, with set nets being the main fishing method, are grey mullet, yellow-eyed mullet, rig, and parore (National Aquatic Biodiversity Information System, 2012). A substantial amount of recreational fishing is carried out by boat, shore-based line, netting, and spear within the harbour (Kelly, 2008b). The old Mangere Bridge in Mangere Inlet is a very popular land-based fishing spot, with large numbers of anglers in attendance at any given time of day or year (Figure 2.1 and see also section 5.4). Yellow-eyed mullet and sand flounder are the most common species found in Mangere Inlet (Kelly, 2008a).

2.5.7 Conclusion

In general, coastal governance and management are difficult because of the large geographic areas involved, the multiplicity of decision-making bodies with jurisdiction over

these areas, the conflicting values that pervade the use of land and seascapes, and the extensive resources required to deal with these problems. The governance and management of the Manukau Harbour is no exception to this rule. Although the area has recently come under the authority of a single organisation (Auckland Council), a major change in the relationship between this authority and local stakeholders has yet to occur.

2.6 Research perspectives

2.6.1 Introduction

Long term scientific monitoring data is available for the Manukau Harbour and Mangere Inlet as a result of concerns about the environmental quality of the area that have been discussed at length in previous sections in this chapter. This research, which clearly indicates the degraded nature of the harbour, in particular the inner areas of Mangere Inlet, has been considered by several decades of decision-making frameworks related to the area, and has therefore contributed to some of the important improvements in environmental quality that have occurred in the area. However, poor environmental quality persists in the area due to diffuse sources of pollution in combination with urban uses such as the discharge of treated wastewater.

2.6.2 Narrative

Mangere Inlet has a long history of environmental degradation resulting from decades of untreated discharges from local industries (Kelly, 2008a). Many of the contaminants discharged during this early industrial period are known to persist in the marine environment, and therefore continue to affect the environmental quality of the area today (Fox et al., 1988; Williamson et al., 1996). Improvements to infrastructure and contaminant disposal methods installed in the area since the 1950s (including the installation of a sewage treatment plant in 1960) have improved the environmental health of the area in general (Kelly, 2008a). Despite these improvements, urban stormwater contamination remains a significant threat to marine environments and their associated values. Untreated stormwater may contain a toxic blend of contaminants washed off of paved and unpaved roads, buildings, and other surfaces; untreated wastewater can be discharged from overflows, illegal connections, or other failures; and sediment is mobilised from developing or re-developing sites throughout the catchment (Kelly, 2008b). These contaminants can collectively have a range of negative effects on coastal and marine areas (Fox et al., 1988; Roper et al., 1988).

An extensive study of the environmental condition and values associated with Mangere Inlet was conducted by Kelly (2008a), who found that concentrations of zinc, copper, and lead in the inner inlet regularly exceed Auckland Council's "amber" and "red" environmental response criteria, as well as being above several international safe metal concentration guidelines. Statistically significant increases in these metal concentrations have been recorded between 1998 and 2005 in the inner harbour, primarily at the Ann's Creek monitoring site (Figure 2.1). High levels of DDT, PCB, copper, and zinc are found in oysters and mussels from Granny's Bay (Figure 2.1), located just outside of Mangere Inlet, relative to other oyster and mussel monitoring sites located around the Manukau Harbour. Kelly (2008a) also notes that:

Water quality in Mangere Inlet is strongly influenced by the discharge from the Mangere Wastewater treatment plant. Consequently, the concentrations of nitrate, nitrite, ammonia-N, total phosphorus and dissolved reactive phosphorus at the Mangere and Puketutu sites are amongst the highest in the region (p. 60).

Since the completion of the MWTP upgrade in 2005, the concentrations of ammonia-N at monitoring sites at Mangere and Puketutu Island have improved, but nitrate and total phosphorus concentrations have trended towards higher peak concentrations, with nitrate concentrations often exceeding water quality guidelines (Kelly, 2008a). Other parameter values, including faecal coliforms and enterococci, tend to be within the ranges found at other harbour and estuarine sites in the Auckland Region; however, suspended solid concentrations and turbidity at the Mangere Inlet site are generally high (Kelly, 2008a). A recent ecological monitoring programme report notes that "sites monitored in Mangere Inlet range from poor to unhealthy and both have low functionality (Greenfield et al., 2013, p. 1)."

Industrial development and urban expansion throughout the 20th century has affected Mangere Inlet and the surrounding areas of Manukau Harbour in other ways as well. From the 1970s to the 1990s, landfills along the northern coast of the inlet led to reclamation projects and extensive shoreline straightening (Matthews et al., 2005). Development projects further up the catchment led to increasing sedimentation throughout the inner harbour, enabling the rapid expansion of mangrove forests (Lundquist et al., 2014). Mangroves are now the most common and widely distributed coastal plant in Mangere Inlet, and in 2006 covered approximately 110 ha of the inner inlet, particularly the eastern end and in Harania, Tararata, and Ann's Creeks (Figure 2.1) (Kelly, 2008a). Aerial photos indicate that

mangroves were largely absent from the inlet in 1959, and evidence suggests that much of the expansion of this plant has occurred since the mid-1970s (Kelly, 2008a). Although mangroves can contribute valuable services such as storm, erosion, and contamination regulation to these areas (Morrisey et al., 2007a), mangrove expansion is frequently perceived by local residents as impinging on aesthetic, recreational, and ecological values due to the invasion of harbor access points such as boat ramps and beaches, and the conversion of formerly sandy areas to muddy ones (Harty, 2009). Mangrove expansion is also cited as having negative impacts on customary and historic values because of the degradation of historic sites and the depletion of wild food sources such as shellfish (Jackson, 2014).

Despite the poor ecological condition of Mangere Inlet, the area is a national hotspot for coastal bird diversity, with up to 48 coastal bird species frequenting Mangere Inlet and/or adjoining areas (Robertson, 2007). Of these 48 species, 15 have been classified as threatened and seven have the highest threat codes including the black stilt, brown teal, grey duck, New Zealand dotterel, Caspian tern, reef heron, and wrybill (Hitchmough et al., 2005). The extensive sand and mud flats of the harbour are a rich food source for shore birds, and Mangere Inlet is used by a range of New Zealand resident and migratory shore birds for roosting and foraging (Kelly, 2008a). The largest populations of pied oystercatchers and pied stilts are consistently found in Manukau Harbour. Relatively high numbers of banded dotterels are counted in the Manukau Harbour, where these birds migrate in the winter. The Manukau Harbour wintering grounds of wrybills have been deemed critical to the survival of the species by some authors (Dowding & Moore, 2006).

2.6.3 Conclusion

Scientific research and monitoring in Mangere Inlet and Manukau Harbour demonstrates that the study area is environmentally degraded. At the same time, it is clear that the quality has improved with recent upgrades to MWTP and that some important ecological values persist. In particular, the area remains a valuable resource for a variety of nationally and internationally important bird species. However, diffuse sources of pollution in combination with urban uses such as the discharge of treated wastewater continue to impact the inlet and the surrounding Manukau Harbour.

2.7 Missing perspectives

Not all perspectives on Mangere Inlet, Manukau Harbour have been presented in this chapter, primarily because representatives of these perspectives either could not be found,

chose not to participate in this study, or were not invited to participate as a result of the research focus. Some examples of these missing voices include representatives from Pasifika, youth, and low-income communities. Tourists from other parts of the country or the world, Ports of Auckland, and the Manukau Harbour itself (see Finlayson, 2012, for an example of the NZ government bestowing a legal identity upon a natural body of water) are also not included. It is my hope that future work can find ways to incorporate these and other voices into decision-making frameworks associated with the area, but some stakeholders may continue to choose not to participate because they believe that their interests and voices cannot be adequately represented (Hayward et al., 2004).

2.8 Conclusions

This chapter has provided background and context regarding Mangere Inlet, Manukau Harbour, and New Zealand by introducing several dominant narratives from the decision-making landscape associated with the study area. Events, legislation, and qualities related to the study area that play key roles in decision-making processes have been described from indigenous, local, government, and research perspectives. Perspectives missing from these dominant narratives have also been briefly discussed. The conflicts among and between the indigenous, local, and government perspectives highlighted in this chapter are primarily social in nature and relate to divergent world-views, values, and goals. These distinctly social conflicts cannot be resolved by the kinds of scientific research currently being applied to the problems in the area. It is my hope that the research described in this thesis can begin to make headway in this regard. The next chapter will explain the theoretical frameworks that form the foundations of this research.

3. Wrestling with wicked problems: a review

Ma whero ma pango ka oti ai te mahi/With red and black the work will be complete –

Whakataukī/Māori proverb

3.1 Introduction

This chapter provides a review of the literature on wicked problems in an environmental context, with a specific focus on coastal SES and the role of ES and PM in developing governance and management resolutions that address these problems. The chapter argues that PM and ES approaches can reduce uncertainty and risk and contribute to the resolution of wicked problems by integrating social values into ES frameworks and enhancing four specific elements of social capital. Together the five ‘social qualities’ argued for in this chapter and considered throughout the thesis are: integrating social values into ES frameworks (Daniel et al., 2012), enhancing social learning and capacity building (Krueger et al., 2012; Pahl-Wostl & Hare, 2004), increasing transparency (Granek et al., 2009; Korfmacher, 2001), mediating power (Stringer et al., 2006); and building trust (Lebel et al., 2006). To develop this argument, an overview of wicked problems is provided, followed by a review of the current approaches and frameworks for wrestling with wicked problems. This review is followed by three sections that discuss important features needed to improve the current approaches to wicked problems. These features are participation, models, and the five social qualities.

3.2 Our wicked world

In the 21st century it is increasingly clear that human activities can impact ecosystems at every scale and that ‘wicked problems’ (Rittel & Webber, 1973) often result from these interactions. Wicked problems, such as those associated with climate change, aquaculture, or genetically modified foods, are characterised by complexity, uncertainty, interdependence, and dispute, and are found in highly interconnected social-ecological systems (SES) (Balint et al., 2011; Brown et al., 2010; Turnpenny et al., 2009).

Wicked problems, as opposed to ‘tame’ ones, cannot be definitively stated or solved (Rittel & Webber, 1973). Instead, multiple definitions of the problem can exist, depending on the perspective and values of the individual or organisation stating the problem; consequently, no single ‘correct’ solution is possible, only *re*-solutions that are ‘better’, ‘acceptable’, ‘satisfactory’, or ‘good enough’ under the circumstances, and which are likely to change over time (Rittel & Webber, 1973). Balint et al. (2011) outline the relationship between tame, complicated, and wicked problems and necessary forms of analysis and decision-making. Tame problems may be solved using existing traditional scientific analysis and decision-making structures, and even complicated problems may only require additional technical expertise and public trust in institutional decision-making to be addressed. However, where complexity, referring to something with many parts interacting in multiple ways, and conflict are both high, technical analysis alone is unlikely to lead to a successful resolution. Where problems are wicked, stakeholder involvement in analysis and decision making is critical because of the high levels of associated uncertainty, multiple conflicting values, and increased risk connected to decision making.

Efforts to resolve wicked problems also benefit from modelling processes. Models are tools which, broadly defined, are idealised and simplified representations of reality (Millennium Ecosystem Assessment, 2005e). The complexity, multiple spatio-temporal scales, and practical and political issues associated with wicked problems cannot easily be addressed by more traditional experimental methods of manipulation (Irvin & Stansbury, 2004; Klain & Chan, 2012). But in complex SES, “modelling can be used to predict outcomes, clarify questions, and allow virtual experiments to manipulate key variables that would otherwise be impossible to do in real life (Peck, 2001, p. 36).” Modelling can also contribute important heuristic value needed to help stakeholders better understand and resolve wicked problems.

Balint et al. (2011) focus their exploration of wicked problems and how to manage them on three key features: uncertainty, values, and risk. They posit that wicked problems

arise when there is a high degree of scientific uncertainty associated with an issue, coupled with deep disagreement over values, and high stakes, or levels of risk (Funtowicz & Ravetz, 1993). These three qualities of wicked problems will be discussed in more detail in the following three sub-sections, and will be used throughout the chapter to guide the analysis of different approaches to wicked problems.

3.2.1 Uncertainty

Uncertainty is considered in this thesis to be a property of an event, relationship, or phenomenon which can be reduced through the application of science or other ways of knowing, but generally cannot be eliminated. By definition, SES are complex and multi-scalar, making conventional controlled and replicable experiments challenging to perform; it is, therefore, generally difficult to achieve certainty or consensus about these systems, particularly where future predictions are concerned (Ludwig et al., 1993).

Many kinds of uncertainty are pervasive in environmental management and governance. Balint (2011, p. 20) outlines several particularly relevant types of uncertainty including scientific, implementation, and stochastic. Scientific uncertainty acknowledges that ecosystems are complex, that the human capacity to understand these systems is limited, and that better science can reduce uncertainty but not eliminate it. Implementation uncertainty refers to the possibility of unexpected outcomes associated with any given management strategy, particularly due to the influence of social dynamics. For example, discrepancies in management outcomes may arise from decision-makers ignoring scientific advice due to social or political considerations, from a lack of regulatory controls such as enforcement, or from unexpected behavioural responses by resource users (Fulton et al., 2011). Considering a wider range of drivers in the development of management and governance decision-making can aid in reducing implementation uncertainty (Fulton et al., 2011). Stochastic uncertainty refers to the possible occurrence of events that are by their nature, unpredictable and uncontrollable, such as lightning strikes or tsunamis (Balint et al., 2011).

Uncertainty can manifest as either surprises, qualitative disagreements between ecosystem behaviour and *a priori* expectations that can be met and managed through existing governance structures, or crises that require novel forms of management and governance to address (Gunderson, 2003). Management and governance in uncertain circumstances is challenging, however, and not very well understood. Approaches that aim to confront and reduce uncertainty are often partitioned into categories of technical (understanding and explaining the mechanisms associated with an issue) and social (agreement on social

objectives, values, and norms) uncertainty (Lee, 1994). This partitioning reduces some elements of uncertainty associated with an event, relationship, or phenomenon, but it does not necessarily lead to improved management and governance outcomes in the face of wicked problems, which may require more integrated approaches to be successful (Gunderson, 2003).

The establishment of the precautionary principle in several legal iterations internationally has helped to bridge the divide between technical and social uncertainty by providing a legal framework that favours decision makers taking action to prevent serious or irreversible environmental degradation, even in circumstances where there is a lack of full scientific certainty as to environmental outcomes (Peel, 2005). A widely quoted definition of the precautionary principle states that “where there are threats of serious or irreversible damage, lack of full scientific evidence shall not be used as reason for postponing cost-effective measures to prevent environmental degradation” (United Nations General Assembly, 1992, Principle 15). Addressing high degrees of uncertainty also requires iterative, interdisciplinary approaches that are capable of considering future impacts of current decisions, as well as learning from decisions (Polasky et al., 2011). Therefore, uniting the inclusive and iterative structure provided by PM methods with the integrated perspective of ES approaches provides a promising framework to address many of the kinds of uncertainty associated with wicked problems.

3.2.2 Values

The uncertainty associated with environmental decision-making is aggravated by the wide range of possible human values to consider when decisions have to be made. Defining ‘value’ is difficult, but five central features are generally agreed upon: that a value is 1) a belief 2) pertaining to desirable end states or modes of conduct that 3) transcends specific situations, 4) guides the selection or evaluation of behaviour, people, and events, and 5) is ordered by importance relative to other values to form a system of value priorities (Schwartz, 1994, p. 20). This definition helps to distinguish values from the related concepts of needs and attitudes: for example, the belief that all species are worth protecting is a value, whereas thirst is a need, and a preference for blue ties is an attitude (Schwartz, 1994). Confusion can arise, however, because people can hold certain ‘values’ but also express ‘value’ for certain objects; the distinction between these two concepts is largely subjective and contingent upon the definition of terms utilised (Brown et al., 2002). Rokeach (1973) contributes three additional points to the Shwartz (1994) definition above: 1) values are learned and

determined by culture, society, institutions, and personal experience; 2) values change as a result of changes in society, situation, or self-conception; and 3) value changes have important consequences for central cognitions (thinking, learning, remembering) and social behaviours. The role of learning and experience in shaping values is important to acknowledge because resolving wicked problems often requires individuals and society to both learn and change (Brown et al., 2010).

Value domains that have been defined and utilised to contribute important information in the context of wicked problems and environmental decision-making include the ecological, socio-cultural, and economic value domains related to ecosystems outlined in Table 3.1. Where values are considered explicitly in environmental decision-making there is a need to first identify what values exist within a particular context, and then prioritise existing values where possible (Guerry et al., 2011). This process allows for an exploration of the underlying ecosystem function that supports these values, and can help to ensure that changes are not made that negatively affect these functions and subsequent service provision (Tallis & Polasky, 2011). A clear set of priorities can also aid in engaging multiple stakeholder groups in negotiations and trade-off discussions. Stephenson (2008, p. 129) claims that values should only be identified and ranked by “those who are part of the cultural context, or by those who are in a position to observe and understand.” This idea has important implications for environmental decision making and ecosystem service approaches in particular, because it raises questions about who gets to participate in the process of identifying, ranking, and assigning value, and who benefits and who loses from the process. Hein et al. (2006, p. 213) agree that “[t]he values that are attributed to ecosystem services depend upon the stakeholders benefiting from these services.” As it has become generally accepted that values play a role in all sectors and levels of decision-making, and that even science is not value-free (Carolan, 2006a), a wider range of stakeholders and a broader definition of expertise have become common features of environmental decision-making processes (Bäckstrand, 2003).

Table 3.1: Value domains related to ecosystems adapted from de Groot et al. (2010)

Value domain	Operationalization
Ecological	The state of an ecosystem's health, as measured by ecological indicators such as biodiversity.
Socio-cultural	The importance assigned by people to, for example, cultural identity and the degree to which that is related specifically to an ecosystem and/or resource use.
Economic	Economic values include categories of use, non-use, and option values. The sum total of use and non-use values associated with a particular resource or activity is called the Total Economic Value (TEV).
	Use values include direct consumptive use such as the value of fish, but also direct non-consumptive use such as recreation. Indirect use is also included in this category; water purification and erosion prevention are examples of indirect uses that could be valued (using monetary designations).
	Non-use value is the value attributed to the existence of an object such as a wilderness area.
	Option value is the value placed on keeping a service available for possible future use.

Obtaining information about and incorporating public values into environmental decision-making can be difficult. Professional biases against the knowledge, practicality, and stability of public beliefs can be a significant barrier (O'Brien, 2003), and incorporating stakeholder values into ES frameworks has also proven to be a highly contested undertaking. It has been argued that some values cannot or should not be accounted for in an ES framework because they are incommensurate and therefore not amenable to trade-offs (Chan et al., 2012). These highly contested values are usually associated with the ES category of cultural services, akin to the category of socio-cultural values as defined by de Groot et al. (2010). The methods used to value this service category are an area of active research and a focus of much of this thesis (see in particular Chapter 4). In the context of addressing wicked problems, it is critical to explicitly consider a diverse range of values because values guide judgements about what is problematic; the illumination of the values of all stakeholders through a process of public discourse, scientific study, and economic assessment, enables stakeholders to learn from one another, that may in turn modify values (Balint et al., 2011).

3.2.3 Risk

Despite the challenges posed by scientific uncertainty, conflicting values, and wicked problems in general, decision making and management actions are still needed. This can be helped by the identification and characterisation of risk. Experts usually quantify risk in terms of probabilities and magnitudes (Balint et al., 2011), or describe the sensitivity of an element of a system to a disturbance and the likelihood that such a disturbance will occur (Tallis et al., 2010). However, the classification of risk may vary widely depending on factors such as the cultural values and objectives of stakeholders, the indicators chosen to facilitate the tracking of status and trends, and the thresholds set to determine the desired level of system ‘health’ (Tallis et al., 2010). Common reliance on the calculation of risk by experts has perhaps contributed to the general conception that any other understanding of risk lacks legitimacy, but different risk knowledge cultures can remain distinct but equally valid (Li, 2010). Where there is uncertainty about the exact level of a threshold or limit, choices about acceptable risks require societal input (Schneider, 2006).

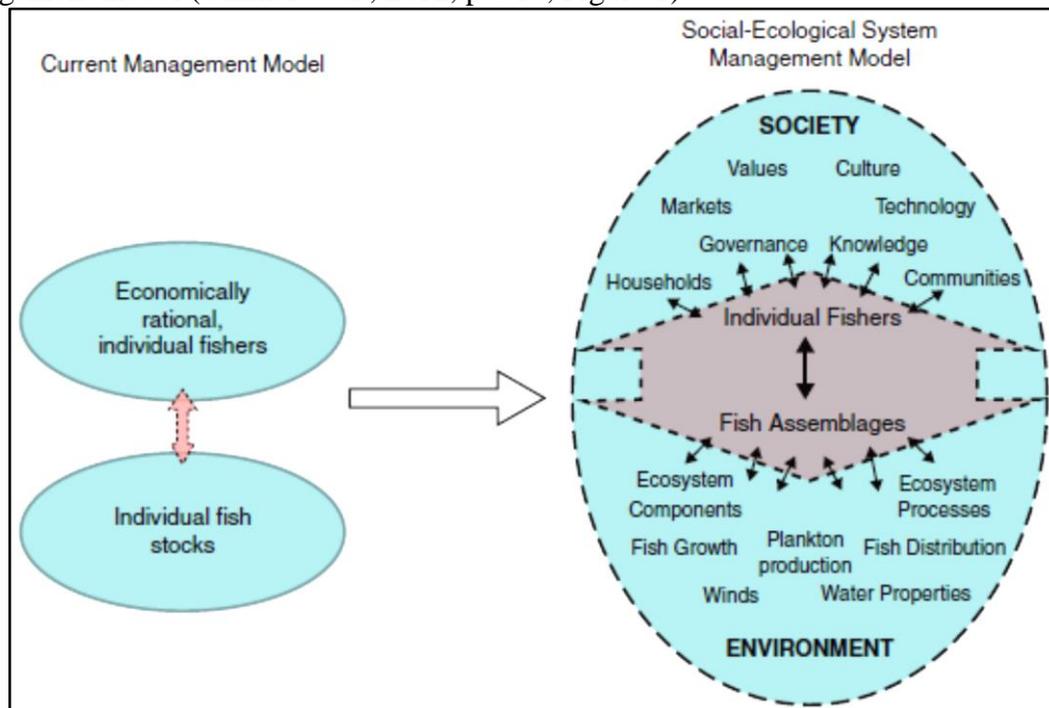
In this context, guidance from the precautionary principle has again been advised (Lempert & Collins, 2007). Including scenario methods and other forms of PM in decision-making processes can also encourage the consideration of a range of risk distributions and likely possible futures (McKenzie et al., 2012). However, it is important to include consideration of a broad range of unknown or unanticipated events when conducting these activities, as discussions of the ‘known uncertainties’ can easily come to dominate proceedings (Wilsdon & Willis, 2004).

3.3 Approaches and frameworks for wrestling with wicked problems

Wicked problems require holistic, integrated and democratic approaches to knowledge production, management, and governance which represent a revolutionary shift from past and current tactics (Berkes, 2012; Hicks et al., 2010; MacMynowski, 2007). Such approaches embrace the linkages among social, political, economic, biological, physical, and chemical systems, and aim to provide dynamic, cross-system explanations and management options for these interrelated systems (Gallopín et al., 2001). Conventional single species or single sector science, management, and decision-making approaches, on the other hand, do not address the wicked problems associated with SES (Figure 3.1) (Folke, 2006; Turnpenny et al., 2009). This is because conventional approaches are generally sectarian and based on the dominant environmental management paradigm that, until recently, assumed most environments were stable and provided predictable resource flows that could be managed and manipulated using relatively simplistic models and reductive regulations (Berkes & Folke,

1998). Management based on this conventional paradigm has led to the homogenization of landscapes, increases in systemic vulnerability to disturbances such as pest or disease outbreaks, and the unintentional collapse of SES (Gunderson et al., 1995).

Figure 3.1: A current fisheries management model vs. a social-ecological system fisheries management model (Ommer et al., 2012, p. 317, Figure 1).

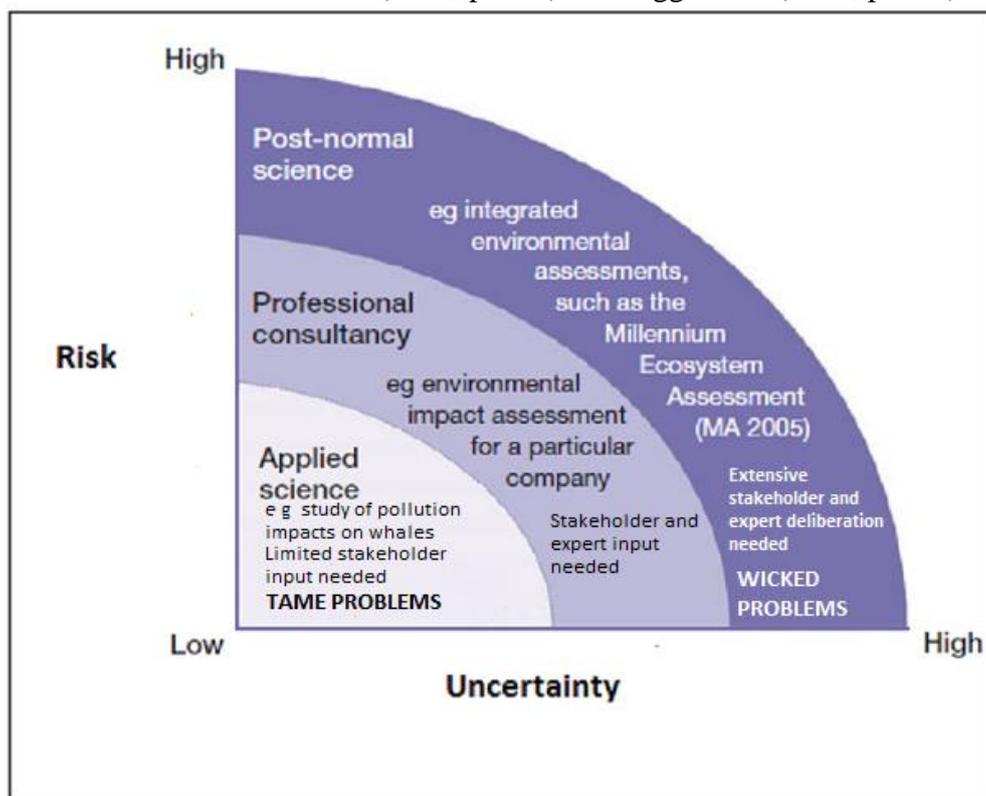


Emerging approaches for dealing with wicked problems often incorporate elements of ecosystem-based management (EBM) and adaptive governance (Folke et al., 2005; Leslie & McLeod, 2007). These approaches can benefit from being grounded in the common language and metrics of ES (Granek et al., 2009). The integrated approaches of adaptive governance and EBM enable the continued provision of ES and achieve more positive outcomes for SES (McLeod & Leslie, 2009), particularly in coastal areas such as estuaries, where the systems are both vulnerable to human impacts and vital to human survival (Lotze et al., 2006). The next three sections will outline some of the frameworks, methods, ways of knowing, and approaches that support the implementation of EBM and adaptive governance approaches and that are being explored in the context of wicked problems.

3.3.1 Post-normal science, knowledge production, and the transdisciplinary revolution

The enquiry tradition known as post-normal science (PNS) contributes important approaches to knowledge production that aid in tackling wicked problems. These involve accounting for context and perspective; explicitly stating values; encouraging dialogue; and recognising and accepting uncertainty and incomplete control over complex systems and processes (Funtowicz & Ravetz, 1993). In contrast to Kuhnian ‘normal science’ (Kuhn, 1962), in which the application of conventional scientific methods can yield scientifically factual answers, PNS approaches are inclusive of many different forms of knowledge, evidence, and data, and may not yield clear answers or lead to obvious policy solutions to problems (Funtowicz & Ravetz, 1993). As illustrated in Figure 3.2, normal, applied science has a key role to play in the production of knowledge and in decision-making processes related to wicked problems, but PNS approaches are also needed, particularly when uncertainty and risk are high and values are disputed.

Figure 3.2: Problem solving strategies across a spectrum from tame to wicked problems. Adapted from Funtowicz and Ravetz (1993, p. 745) and Biggs et al. (2010, p. 268).



PNS requires stakeholders, Funtowicz and Ravetz’s (1994) “extended peer community,” to be involved in decision making (Turnpenney et al., 2009). The inclusion of new stakeholder participants in management and governance dialogues has important and

exciting implications for both science and society (Funtowicz & Ravetz, 1993). There are, however, many challenges associated with integrating diverse knowledge and value sets across academic disciplines, management practices, and public domains (Cook & Spray, 2012; Cote & Nightingale, 2012) due to the relative influence and privilege associated with each set (Raymond et al., 2010). MacMynowski (2007) points out how the (perceived or real) divides that exist among various scholarly disciplines infuse knowledge claims with differential power:

Biophysical and social scientists are not just bringing information and different understandings of biophysical and social systems with them. Those knowledge claims have differential power associated with them: within the sciences, between social and biophysical sciences, and between science and society...Power can manifest in many ways: an accepted account of an environmental problem, individual scientific status, the inclusion or exclusion of researchers, relative impacts of research findings, access to resources, or perceived relevance to policy decisions...In other words, power is synonymous with influence, authority, and validity, and it can be exercised in many overt and subtle social and institutional venues (p. 4, ¶ V).

These problems can be exacerbated further when transdisciplinary approaches that include participants who are not scientists are attempted. Transdisciplinary research attempts to a) grasp the complexity of problems, b) take into account diverse perceptions of problems, c) link abstract and case-specific knowledge, and d) develop knowledge and practices that promote what is perceived to be the common good (Pohl & Hirsch Hadorn, 2007). Because of its overt focus on complexity, diverse participation, connectivity, and action, transdisciplinary research approaches seem appropriately adapted to dealing with wicked problems, but there is much work to be done before transdisciplinary approaches in the tradition of PNS become a generally accepted way to address wicked problems in decision-making frameworks. In addition to problems with the management of power and the integration of knowledge sets mentioned above, collaborations can be hindered by basic problems such as the incompatibility of theory and methodology (Stephenson, 2008). Despite these challenges, transdisciplinary research approaches may be used to support the implementation of EBM and the institutional and political frameworks of adaptive governance through the application of research methods in the transformative tradition (e.g.

Mertens, 2003). Transformative procedures integrate diverse knowledge spheres and maintain a strong focus on increasing the common good through action-based research (Creswell, 2003) (see also 4.2.1).

3.3.2 Resilience science, ecosystem-based management, and adaptive governance

Resilience approaches recognise change as an inherent property of systems, rather than an aspect that must be controlled (Folke et al., 2003; Holling, 1973). Resilience science therefore embraces SES as complex adaptive systems that are constantly responding to changes at different scales. Understanding resilience, or the extent to which a system can maintain its structure, function, identity, and feedbacks in the face of disturbance (Scheffer, 2009; Walker & Salt, 2006), can clarify how a system will respond to different perturbations or management regimes (McLeod & Leslie, 2009). Attempting to narrowly control the variability of a system can reduce that system’s resilience, increasing the likelihood of a system ‘flipping’ to an alternate, potentially less desirable state scenario (Holling, 1996). The failures of conventional environmental management and decision making to adequately address the complexity and connectivity of SES can be addressed, at least in part, by resilience science (Berkes & Folke, 1998), but long-term data and extensive knowledge of the functional links between key processes is needed to enable predictive modelling of possible regime shifts. Currently, empirical resilience studies are not a common feature of ecological work (Thrush et al., 2009).

In SES, the capacity of humans to influence and manage risk, vulnerability, and resilience, is called adaptability (Folke, 2006). Certain principles, outlined in Table 3.2, enable the adaptive management and governance of ecosystems. Sustaining the capacity of systems to deliver ES in the long-term is the core goal of EBM (Rosenberg & McLeod, 2005).

Table 3.2: Principles that enable adaptive management and governance of ecosystems after (Folke et al., 2003, p. 355).
1. Learning to live with change and uncertainty
2. Combining different types of knowledge for learning
3. Creating opportunities for self-organization
4. Nurturing diversity for reorganization and renewal

Spatially explicit consideration of human uses and their compatibility and conflicts with ecosystems is needed to support the goals of EBM, but decision makers typically have limited capacity to map and integrate the many, often conflicting, issues associated with coastal and marine areas. Most existing tools, even advanced tools such as marine spatial planning (Foley et al., 2010), struggle to handle multiple diverse services or are incapable of modelling changes in ES in tandem with management alternatives (Guerry et al., 2012). These problems contribute to the criticism that EBM is too complicated and requires too much information to be workable; these challenges are compounded by the scarcity of successful long-term EBM applications (Tallis et al., 2010). Even the Chesapeake Bay Project, which started in 1983 and is considered an early model of EBM, has repeatedly failed to make significant improvements to the current degraded state of Chesapeake Bay despite incorporating extensive science and high level engagement from federal and state governments as well as many local organisations (Boesch & Goldman, 2009).

Nonetheless, EBM is useful for addressing wicked problems because the approach emphasises connectivity, adaptability, learning, and the application of a precautionary approach to management. This involves relying on the best available information and practices to make decisions in the face of uncertainty in order to minimise risks (Table 3.3) (Rosenberg & Sandifer, 2009). There is, however, a need for broader dialogue among scientists, decision makers, and other stakeholder groups about the goals of EBM (Tallis et al., 2010). More discussion, engagement, and collaboration among these groups can also aid in the application of resilience science to EBM by encouraging the development of participatory scientific investigations, the synthesis and communication of existing knowledge (Leslie & Kinzig, 2009), and the establishment of practices and possibly institutions that can bridge the gaps in knowledge culture, and values that exist between these groups (Cash et al., 2003).

Table 3.3: Five key principles of EBM (Rosenberg & Sandifer, 2009)

1)	Goal setting which considers all ecosystem services , including supporting services such as nutrient cycling and regulating services such as erosion regulation, not just extractive provisioning services such as fisheries harvesting;
2)	The recognition that natural boundaries are more relevant to the continued provision of ecosystem services than artificial (political, legal, etc.) boundaries imposed by human social systems and that these natural boundaries are extremely porous;
3)	Integrated management of human systems and activities that impact on coastal and marine systems may be necessary if the impacts of these systems are to be adequately controlled;
4)	Cumulative impacts and trade-offs among services must be explicitly considered and accounted for in management and decision-making processes or unintended consequences may arise; and
5)	Making decisions under uncertain circumstances where risk levels may be high requires the application of a precautionary approach to management, which involves relying on the best available information and practices to make decisions while considering associated uncertainty and risks and conducting ongoing information gathering and periodic reassessment and modifications to conditions or other requirements as needed.

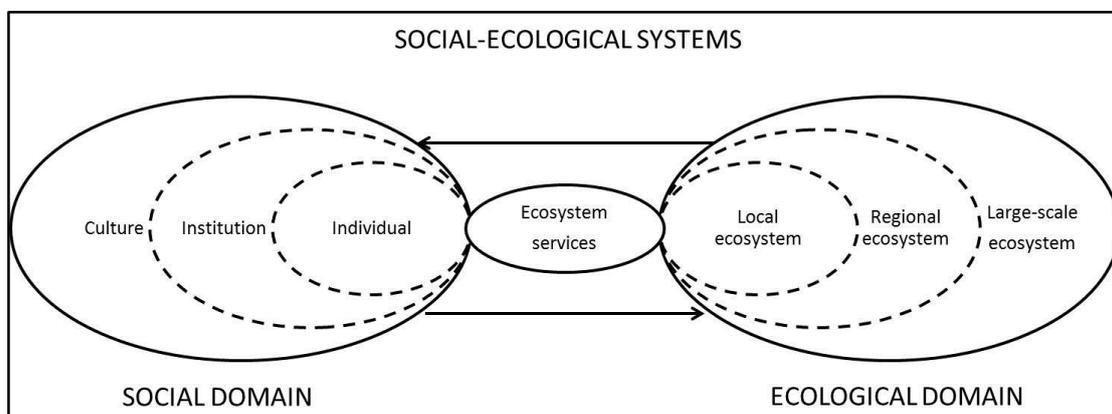
The implementation of EBM is supported by adaptive governance approaches (Olsson et al., 2004; Olsson et al., 2006). Adaptive governance is defined as institutional and political frameworks that adapt to changing relationships between society and ecosystems in ways that sustain ES (Carpenter & Folke, 2006). Effective adaptive governance frameworks are formed from nested institutional arrangements and social networks operating at multiple scales (Olsson et al., 2006), and rely on the participation of individuals who provide leadership, trust, vision, meaning, knowledge, and memory (Folke, 2006; Folke et al., 2005). The ability of an SES to successfully grapple with uncertainty and risk and adapt to changes depends largely on the ability of a governance system composed of individuals, institutions, and their associated networks to collaborate, experiment, self-organise, and self-enforce at multiple scales (Leach et al., 2007; Olsson et al., 2006). Adaptive governance approaches explicitly position the common good as the primary goal of policy, and demand broad participation and collaboration supported by legislation to achieve this goal (Brunner et al., 2005). Multiple means to advance the common good are expected, and the diffusion and adaptation of successful innovations by community-based initiatives form the foundation of an adaptive governance approach (Brunner et al., 2005).

The establishment of governance regimes that exhibit these qualities will generally require substantial changes in the way humans relate to and govern SES (Folke et al., 2005). As Hughes et al. (2005) point out, sharing management, power, and responsibility across multiple user groups, communities, government agencies, and non-government organisations from the local to the international level presents challenges. For example, institutions that manage fisheries at a large scale are likely to ignore local heterogeneity, while small scale institutions are susceptible to external drivers (Hughes et al., 2005). Adaptive governance frameworks are often established during critical windows of opportunity, however, and therefore tend to develop organically to address a need within an ailing SES (Olsson et al., 2006). By conceptualising change and uncertainty as a part of all SES, recognizing and incorporating a range of values at multiple scales, and reducing risk through the application of the precautionary principle, adaptive governance approaches can provide support to approaches which aim to wrestle with wicked problems.

3.3.3 Ecosystem service approaches

To resolve wicked problems, it is necessary to address the interactional nature of ecological and social processes (Brown et al., 2010). In this capacity, ES approaches have emerged as a promising way to link the effective functioning of ecosystems with social values (Figure 3.3), but there are several challenges yet to be addressed when it comes to realising their potential. Relevant benefits and challenges associated with ES approaches will be described in this section. A more detailed discussion of ES modelling is included in section 3.5.2.

Figure 3.3: Ecosystem services as a connective framework between social and ecological domains. Adapted from (McLeod & Leslie, 2009, p. 9).



The benefits that people obtain from ecosystems, otherwise known as ecosystem services (ES), can be grouped into four categories: provisioning services (e.g. food and water), regulating services (e.g. flood control,) cultural services (e.g. recreational opportunities), and supporting services (e.g. nutrient cycling) (Millennium Ecosystem Assessment, 2003). By recognising the connectivity between underpinning ecosystem processes and values, ES approaches aim to incorporate a broader, more holistic set of objectives into decision making than what conventional, single species or single sector approaches to environmental management, or even conventional conservation goals, would normally include (Tallis & Polasky, 2009a). In particular, ES approaches can incorporate objectives that include the maintenance or enhancement of human well-being by explicitly recognizing that human well-being is derived from functioning ecosystems through ES (Guerry et al., 2011).

Ecosystem functions, such as productivity or carbon sequestration, are the result of interactions between organisms and their physical and chemical environment (Millennium Ecosystem Assessment, 2005a). These interactions may be non-linear and are context and scale dependant, making it difficult to simply link functions to the services they provide (Barbier et al., 2008). For example, estuary floor habitats typically form a mosaic of salinity, wave and tide energy and depth, and biological gradients, these habitats are utilised over different time scales by organisms. For example, many of the shellfish and fish valued by humans through provisioning and cultural ES are therefore supported by a range of functioning habitats within an estuary (Thrush et al., 2014).

The societal value (economic or otherwise) of ES is determined by both the locations of ecological processes, and the locations of the people who use that service; for this reason ES identification, valuation, and modelling efforts benefit from spatial orientation (Tallis & Polasky, 2011). Maps of ES can provide spatial arguments for conservation areas or aid in the assessment of trade-offs (Martínez-Harms & Balvanera, 2012). However, the scale and location of ecosystem functions, services, and beneficiaries are often disconnected; for example, trees fixing carbon in the Amazon rainforest benefit people all around the world, while at the local level upstream water users may divert water or increase nutrient loading in ways that threaten the use of those downstream (Tallis & Polasky, 2011). Although these and other challenges are associated with the process of quantifying ecosystem functions and measuring the services resulting from these functions, ES frameworks allow for the explicit examination of trade-offs in service provision, aiding in the process of identifying who benefits and who loses under alternative management scenarios (Granek et al., 2009).

Initially, ES were mapped and measured in biophysical and economic terms, generally as a way to increase interest and investment in environmental management (Daily et al., 2009b). Early efforts at valuing ES used the “benefit transfer approach”, which relies on estimates of the economic value of goods derived from a habitat such as an estuary and then transfers those values to similar habitats elsewhere (e.g. Costanza et al., 1997). The benefit transfer approach utilises existing monetary estimates per hectare by habitat type and therefore is inexpensive and expedient, which is appealing when decisions are imminent or data collection is not feasible (Wilson & Hoehn, 2006). However, this approach ignores differences in scarcity, configuration, quality of habitat, and social dynamics such as practices and preferences, all of which can significantly impact the value of the ES provided by an area (Tallis & Polasky, 2011). Additionally, making projections using the benefit transfer approach assumes that current conditions will remain unchanged in the future, weakening its applicability in management and governance contexts (Chan & Ruckelshaus, 2010). Because of these limitations, this approach is not particularly useful where complex, wicked problems are a concern.

Much research is still devoted to the economic and biophysical valuation of ES (National Research Council, 2004), and methods have even been developed to estimate the costs associated with some social values (e.g. contingent valuation methods, such as willingness to pay and hedonic pricing (Mitchell & Carson, 1989)). But concerns about the lack of non-economic social valuation included in ES approaches and decision-making processes have been raised with increasing frequency and authority in recent years (Kumar & Kumar, 2008; Peterson et al., 2009). The main point of contention is that while some values, such as those associated with provisioning services (e.g. the market price of fish), may be adequately assessed through economic methods, the full value of ecosystems cannot be expressed through economics alone (Martin-Lopez et al., 2009). For example, the value of regulating services such as erosion regulation or water purification can only be estimated through avoided cost and replacement cost methods (Chan & Ruckelshaus, 2010). Supporting services, which underlie and support ecosystem functions and provide critical life-support for humans and all other species, have also proven difficult to value, with many practitioners avoiding these services altogether due to concerns over ‘double counting’ (Chan & Ruckelshaus, 2010). Meanwhile, no markets currently exist for supporting services, making economic valuation a purely academic exercise.

Cultural service valuation has proven to be the most contentious to undertake, with a wide range of associated methods utilised for individual cultural services, but few providing

satisfactory integrated results (Daniel et al., 2012). Cultural services provide immaterial benefits such as spiritual fulfilment, but are often central to public dissatisfaction with environmental decision making. Attaching monetary metrics to strongly held cultural values has proven to be both challenging and controversial, and is ultimately not needed to inform decisions (Chan et al., 2011). Guerry et al. (2012) agree, pointing out that while the economic valuation of ES can be useful, it is not required for the incorporation of a broad suite of services in decision making. Guerry et al. (Guerry et al., 2012) go on to describe how percentage changes in relative terms may be enough information for stakeholders to make comparisons among alternative scenarios, and that absolute values for some services such as water quality were neither necessary nor appropriate because stakeholders were interested in maintaining good water quality across a large area rather than many distributed point estimates. Finally, some values are central to worldviews, and to rank or prioritise these values would be to undermine the structure of that perspective (Chan et al., 2012).

As the importance of incorporating social dynamics and cultural or community values into ES valuation processes has become more obvious to decision makers and researchers alike, efforts to incorporate social values into ES frameworks have gained momentum. For example, spatial measures of social values and preferences were made through the application of preference surveys and ES maps (Brown, 2005; Bryan et al., 2010; Raymond et al., 2009; Raymond et al., 2010), and non-market valuation methods such as revealed preference and stated preference methods were developed to capture the value of ES that were not traded in markets (National Research Council, 2004).

Advances in the sciences of ecosystem functions, processes, and modelling have now made it possible to model the impacts of resource use and management decisions on a variety of ecosystem processes, leading to the development of the “production function approach”, which relies on models of local ecosystems to establish ES value and supply based on ecosystem condition and processes (Daily et al., 2011). Improvements in spatially explicit modelling have made particularly important contributions to this approach (Bennett et al., 2009). To date, most applications of the production function approach have been conducted at a small scale and on a limited number of ES (Tallis & Polasky, 2011), but there is an interest in integrating modelling across larger scales and service ‘bundles’ (Reyers et al., 2013) to provide decision makers with more detailed information about thresholds, relationships, and trade-offs among services. In some cases an understanding of production functions alone is sufficient to enhance environmental decision making: for example, many agencies only need to assess how changes in activities might affect contaminant levels in

water bodies, and the likelihood that water quality would cross a contamination threshold (Tallis & Polasky, 2011). However, in other instances production function approaches have been combined with market prices and non-market valuation methods in an effort to estimate economic value and show how changing conditions can affect the monetary value of services (Barbier, 2007). The integration of these various ES approaches is generally expensive, time-consuming, unwieldy, and difficult to replicate (Tallis & Polasky, 2011), and can render environmental decision making which relies heavily on ES inputs largely unworkable.

All of the ES approaches aim to render trade-offs more explicit and to minimise surprises and crises associated with environmental decision making and subsequent changes in the provision of ES. However, none of these approaches satisfactorily accounts for social and ecological factors, or the interactions between them (Reyers et al., 2013). Additionally, while it can be useful to determine the monetary value associated with ES for decision-making purposes, few markets for ES currently exist, which makes these values primarily useful on a local scale rather than in a global context and, therefore, easily ignored in large-scale, long-term decision-making contexts.

Improving ES frameworks for the purposes of addressing wicked problems requires the involvement of a diverse group of people, each an expert in their own domain (Krueger et al., 2012), whose knowledge sets are equivalently considered (Pahl-Wostl & Hare, 2004). Input from management practitioners and concerned citizens, who can contribute critical experiential knowledge of the system being studied and who will be directly affected by the decisions being made, is needed alongside input from scientists and social scientists (Lane et al., 2010; Stringer et al., 2006). Diverse stakeholder input is also needed because ES can be associated with different values and priorities depending on the stakeholder perspective and scale being considered.

The use of ES as a communication tool adds new dimensions to its utility over a purely economic or functional approach to the valuation of nature; by providing a common language for the facilitation of EBM and adaptive governance, ES approaches can enable efficient communication when timeframes are short and budgets are limited (Granek et al., 2009). Additionally, if ES approaches are utilised as a means to communicate and learn about SES dynamics through a process of PM that includes activities such as identification, valuation, mapping, and negotiation about possible futures and associated trade-offs, the approach can contribute to the generation of social capital, which is recommended for management and governance systems to respond to ecosystem feedback and change (Adger, 2003; Folke et al., 2005; Pretty & Ward, 2001). International environmental science and

policy institutions have largely embraced ES approaches (Daniel et al., 2012), but literature on the critical role that social dynamics play in the capacity of ES approaches to address wicked problems is scarce. The contribution that ES approaches can make to this area of the literature and practice is a critical consideration of this thesis and will be discussed in more detail in section 3.6.

3.4 Participation and wicked problems

Participation from a diverse group of stakeholders is needed to address the inherent uncertainty, conflicting values, and high levels of risk associated with wicked problems, especially if the goal is to produce outcomes that benefit the common good. Including perspectives gathered from a range of diverse stakeholders, some of whom may never have previously been included in a decision-making framework, can generate a more robust factual base regarding problems and possible solutions, thereby reducing uncertainty (Berkes et al., 1998; Olsson et al., 2004; Stringer et al., 2006). Engaging stakeholders can also develop clarity around social values and agendas (Voinov & Bousquet, 2010). Exploring both what is valued and how those values and associated practices impact other stakeholders, including the ecosystem itself (Cote & Nightingale, 2012), can provide context that may enable coordination, cooperation, and compromise (Davies et al., 2015) and reduce the risk of policy implementation failures (Videira et al., 2011).

There are many dimensions of participation that could be explored in relation to the resolution of wicked problems, but at the heart of all of these elements of participation lie two critical questions: who gets to participate in decision-making processes, and who benefits or loses from the outcomes associated with participation? These two questions must be addressed if wicked problems are to be resolved in a manner which enhances the common good. Exploring whose views and values are incorporated and accounted for in the production of knowledge and actions related to wicked problems is an essential aspect of transparent, democratic SES management and governance in the 21st century (Kasemir et al., 2003). Consideration of these issues plays an important role in defining the efficacy and success of any participatory undertaking.

3.4.1 Participation, representation, and recruitment

Much has been written about the need for more and better public participation in environmental management (see Reed, 2008 for a thorough treatment), and governance and management agencies have responded by increasingly requiring some form of public

participation in environmental decision making (Videira et al., 2011). Definitions of “participation” , however, are highly variable (e.g. Arnstein, 1969; Nelkin & Pollak, 1979; Weidemann & Femers, 1993) and can refer to the public’s passive reception of information generated by decision-making bodies; token forms of consultation such as systems of check-box approval; the collection of public opinion and input through questionnaires, interviews, or focus groups; and the participation of representatives in decision-making processes such as advisory committees (Rowe & Frewer, 2000).

Table 3.4: Six concepts of participation adapted from (Renn & Schweizer, 2009)	
Functionalist	Participation aims to improve the quality of decision output and is seen as a way of getting all the problem-relevant knowledge and values incorporated into the decision-making process.
Neoliberal	Participation aims to represent all values and preferences in proportion to their share in the affected population thus focusing primarily in the collection and representation of (well-informed) public preferences.
Deliberative	Participation oriented toward the determination of common good through the rational competition of arguments reaching consensus through argumentation.
Anthropological	Participation based on the belief that common sense is the best judge in reconciling competing knowledge and value claims, thus promoting the inclusion of non-interested laypersons representing social categories such as gender, income, and locality.
Emancipatory	Participation aims to give the less-privileged groups of society an opportunity to have their voices heard; participation is seen as a vehicle for strengthening the resources of those who are more negatively affected and challenging traditional power structures in society.
Post-modern	Participation aims to demonstrate variability, plurality, and legitimacy of dissent, thus leaning toward acknowledgement of plural rationalities with no need to reach a final product or joint statement (i.e. reaching closure).

Different approaches toward facilitating public input into decision making have been compiled into six broad categories by Renn and Schweizer (2009) and are shown in Table 3.4. Where wicked problems are concerned, it is likely that more intensive participatory processes that incorporate technical information, education, and analysis will facilitate more effective long-term resolutions than processes involving low levels of participation such as traditional public hearings (Pahl-Wostl & Hare, 2004). But while intensive participatory processes may benefit the common good, involving the general public can be difficult to facilitate, require a large investment of resources, and lack a focus on outcomes. For these reasons, a group of key stakeholder representatives who can both provide insight and facilitate outcomes is often established as a way to encourage practical participation in

resolving wicked problems (Sweetman et al., 2010). The representation of diverse interests including, where appropriate, establishing representatives for future generations and others who cannot represent themselves such as the ecosystem under consideration, is an important element of composing a representative stakeholder group (Cote & Nightingale, 2012).

The issue of representation is a central one for participatory processes, as the legitimacy of participatory work can be called into question if representation is not adequate. The goals of the participatory project usually play a key role in determining who participates in environmental decision-making processes, as well as the mechanisms used for selecting participants (Kallis et al., 2007). Selection procedures (e.g., open invitation, stakeholder analysis, and random selection, among others) are associated with both advantages and disadvantages. If objectives include the resolution of conflicts, stakeholder-based representation based on stakeholder analysis is likely to be the most effective approach to recruitment, but where a more representative community vision is sought, open invitation or random selection methods are likely to be more applicable (Videira et al., 2011). Combining input from different processes with different selection rules is likely to produce the most defensible set of decisions (Kallis et al., 2006).

Some have argued that determining the appropriateness of participatory techniques, or even the projects that are candidates for a participatory methodology, is in itself an act of power and valuation and must be conducted with extreme care (Beierle & Cayford, 2002). It has also been noted that withholding participation may be an appropriate and even effective strategy when processes do not adequately represent the interests of a particular group (Hayward et al., 2004; Lebel et al., 2006). These critiques serve to highlight the importance of addressing issues such as fairness, equity, and legitimacy (including issues associated with expertise, experience, and trust) in a transparent manner when developing approaches to participation.

3.4.2 Knowledge is power

Philosophers of science have argued that knowledge must exist within an interpretive context in order to be imbued with meaning (Kuhn, 1962; Latour, 1987; Polanyi, 1962). For example, personal motivations, funding agendas, and social values can influence environmental science research at individual, institutional, and societal scales (Huesemann, 2002). The context in which knowledge is formed, and its associated legitimacy and trustworthiness (Carolan, 2006b), is of particular importance in participatory processes because problems of power are so intimately connected to frames of knowledge (Juntti et al.,

2009). The role of the ‘expert’ in participatory processes is a pertinent example of this problem.

Historically, experts were narrowly defined as those who possessed the best available knowledge on a topic and could provide it to decision makers so that the best possible decisions could be made (Bäckstrand, 2003). The concept of the unquestioned expert has been significantly eroded in recent years, and it is “now widely accepted that expert judgements need to be supplemented by other inputs under conditions of uncertainty (Jasanoff, 2003, p. 160).” This input can be provided via participatory processes ranging from the “extended peer community” (Funtowicz & Ravetz, 1994), to the “stakeholder model” (Krueger et al., 2012), to “collaborative rationality” (Innes & Booher, 2010). The goal of each is to extend legitimacy to new collaborative groups of pertinent participants in order to enhance ways of knowing and deciding. This democratisation of expertise has radically altered the original meaning of ‘expert’; today anyone whose experience is relevant to a particular topic of interest may be termed an expert, and included as such in a participatory process (Fazey et al., 2006). Carolan (2002) outlines categories of expertise (Table 3.5) that may be associated with participatory processes appropriate to include under different circumstances:

Table 3.5: Categories of expertise associated with participatory science after Carolan (2002, p. 664).

Category of expertise possessed by an individual	Definition of expertise in relation to topic of interest
No expertise	A degree of expertise insufficient to engage in an even cursory discussion of the topic in question.
Contributory expertise	Enough expertise to contribute to the knowledge base of the topic in question.
Interactional expertise	Contributory expertise plus an ability to interact with others who possess other forms of contributory expertise.
Public expertise	Expertise regarding the views and values of concerned individuals.

While this definition of ‘expert’ is more inclusive, it does not imply that the same authority is extended to every participant automatically. In fact, the legitimacy and authority of participatory processes, especially those that include non-scientists, are often still highly contested (Juntti et al., 2009). This is not surprising since even within the disciplines of science itself, degrees of authority are still generally delineated into truth hierarchies (MacMynowski, 2007), making the allocation of authority to non-scientists a long-term goal rather than a short-term solution.

Increasing emphasis in academia and communities of practice on expanding the notion of expertise and incorporating public participation into environmental decision-making processes indicates acknowledgment that sharing these diverse epistemologies has the potential to improve and enhance understanding, particularly in cases of high uncertainty (Bammer, 2005). For example, in the Solomon Islands, indigenous local knowledge was instrumental in the identification of appropriate areas to designate as marine reserves for the highly threatened Bumphead Parrotfish (Fazey et al., 2006). Locals helped to identify critical sensitive habitats in need of protection, and contributed information that helped explain how different habitats contributed to the size distribution of the fish and how other factors, such as lunar periodicity, affected fish behaviour (Aswani & Hamilton, 2004). The scientific research required to establish these parameters for a marine reserve without the help of local input would have been prohibitively expensive (Aswani & Hamilton, 2004). This example illustrates how local knowledge can be crucial for addressing context-related problems and developing viable policy solutions, but also how local knowledge can lead to new understandings, and perhaps even resolutions, to wicked problems. Incorporating the participation of local stakeholders in the Solomon Islands project created opportunities to develop a locally supported programme of governance (the marine reserve), and for social learning to occur. Taking advantage of these opportunities could represent an enhancement of the social capacity of this community (Folke et al., 2005), and its subsequent empowerment. The participation of citizens in environmental decision making has important epistemological implications because it is capable of reshaping existing frameworks of knowledge and power to make room for new ways of knowing and doing (Juntti et al., 2009).

The participation of individuals who can contribute expert knowledge (Krueger et al., 2012), and the development of a fair and equitable process for integrating the knowledge sets of these diverse individuals (Pahl-Wostl & Hare, 2004), is a critical step toward resolving wicked problems. However, the goal of free and full participation in decision making can be adversely affected by power relationships and institutional barriers (Turnpenny et al., 2009). Furthermore, the politics of power are firmly embedded in the process of knowledge production whether it is produced within the confines of normative science, post-normative science, or otherwise (Carolan, 2006a, 2006b). It is important to make these power associations transparent and to constantly reflect upon the process of knowledge generation within these frameworks, but the power frameworks themselves cannot be dissolved (Haraway, 1988; Rose, 1997).

3.5 Models and wicked problems

Modelling is heavily relied upon in governance and management decision making when levels of uncertainty and complexity are high (Stringer et al., 2006). The kinds of models that can be utilised to address wicked problems are wildly diverse. Models can be qualitative or quantitative in nature and vary dramatically in form; heuristic devices, mathematical equations, and computer simulations are all examples of common models that may be applied to wicked problems. One of the greatest advantages of any kind of modelling, be it conceptual or mathematical, is that it requires users to clearly define the essential elements of a problem or system and specifically identify the important variables and the relationships among them (Lynam et al. 2007). Through simulation, models can also facilitate the assessment of tradeoffs among indicators of environmental, economic, and social outcomes (Jakeman et al., 2011). This process of identification, negotiation, and communication about what constitutes valuable and appropriate data, information, knowledge, and outcomes is an essential aspect of decision making using models (van Wyk et al., 2008); it both reduces uncertainties and clarifies the values associated with wicked problems.

Modelling can also address wicked problems by helping to identify and characterise risk. Rigorous modelling can aid in defining the safe or precautionary approach by simulating the system under management; applying sensitivity analysis to determine the stochastic system elements; and determining likely outcomes associated with different management options (Balint et al., 2011). Finally, modelling can play a key role in facilitating the communication, capacity building, and learning that is needed to address wicked problems (Daily et al., 2009b; Granek et al., 2009).

Models and the process of building them are “good vehicles for supporting learning, participation, and promoting a shared level of understanding about complex challenges (Videira et al., 2011, p. 83).” But while models are ideally utilised as tools for learning, and modelling can contribute important qualities to human understanding such as comprehensiveness, consistency, explicitness, and flexibility, models should not be dogmatically considered as accurate predictors of future events and, in fact, the usefulness of models is severely limited by this kind of expectation (Meadows & Robinson, 2002). The following three subsections will provide some background on models and model building that relates specifically to this research, and the advantages and challenges associated with each

when it comes to addressing wicked problems. Particular attention will be paid to the capacity of models to address uncertainty, values, and risk.

3.5.1 Models in the coastal context

Modelling methods, like any other process or tool, should be chosen with care to suit the situation. Coastal scientists and decision makers have relied on a range of models to address problems for decades, but the reasons for conducting a modelling exercise, the kinds of models chosen, the questions being asked about coastal systems, the objectives being defined, and the way that model outcomes are utilised, need to be re-examined if they are to support EBM and adaptive governance approaches (e.g. Daily et al., 2009b; Hapke & Plant, 2010). For example, the assumptions that underlie many coastal mathematical models are out of date and inaccurate, calling into question the usefulness of these models for the purposes of coastal engineering and management (Cooper & Pilkey, 2004a, 2004b).

Coastal and marine environments present some unique modelling challenges. While there is extensive land use and land cover data available for use in terrestrial models, most seafloor habitats affected by human activities cannot be illuminated with satellite or other remote sensing technology, making the generation of habitat type and condition maps a significantly more expensive process for marine environments than terrestrial ones (Guerry et al., 2012). Other complications arise because marine habitats and the processes that maintain them are highly dynamic and three dimensional, making species and habitat interactions hard to distinguish (Carr et al., 2003). Human use of marine systems is also three dimensional, incorporating activities that use the sea surface (e.g. shipping), the water column (e.g. hook and line fishing), and the benthic habitats below (e.g. cable laying or mining) (Guerry et al., 2012). All of these activities take place in an environment that is largely managed as commons (Ostrom, 1990); generally perceived to be a 'featureless' expanse (Crowder et al., 2006); and mostly remote from human settlement. These distinctive biophysical and management aspects of marine SES place significant constraints on data availability for model building and testing.

In coastal and estuarine systems, Videira et al. (2011) argue for the application of integrated modelling approaches that explicitly address the interactions within and between human and natural systems (Lui et al., 2008). In particular, integrated approaches that support EBM are needed to help organise problems, processes, and knowledge produced from multiple domains into a single, holistic, coherent framework (Videira et al., 2011). Scenario generation and decision-support capabilities that aid in governance and management decision

making can be built into these integrated modelling approaches (Jakeman et al., 2011). Expert systems, agent-based modelling, Bayesian Belief Networks, coupled complex systems, and system dynamics, are some of the most common types of integrated modelling approaches (Gilbert et al., 2008). Each of these methods integrate elements of physical and human systems, but few aim to structure knowledge so that it is accessible for decision makers, and there are a wide range of problems associated with the existing interactive model-building processes (van Kouwen et al., 2007). Coastal problems related to lack of knowledge about human and ecological processes, inappropriate and uncoordinated laws and policies, lack of stakeholder participation, and lack of coordination among relevant institutions, could all be addressed using more integrated modelling approaches that more effectively support public and stakeholder participation in the model-building process (Videira et al., 2011).

3.5.2 Ecosystem services modelling

The unique features of coastal and marine habitats and associated modelling and management challenges described in section 3.5.1 above are particularly relevant for coastal and marine ES modelling and indicate that approaches to modelling in marine systems that are less reliant on detailed habitat maps would have an advantage (Guerry et al., 2012). Decision support tools that enable the mapping, modelling, and valuing of multiple ES also have a distinct advantage because of their capacity to estimate changes under different scenarios and consider the outcomes in terms of service trade-offs (Guerry et al., 2012). The minimisation of surprises and crises associated with environmental decision making and subsequent changes in the provision of ES is a primary goal of ES modelling, but social and ecological factors, and the interactions between them, are not satisfactorily addressed in any current modelling processes (Reyers et al., 2013).

Several new modelling tools have been developed in recent years to address some of the existing gaps. Models that assess the impacts of economic and environmental factors on the provision of goods and services include IMAGE-GLOBIO, GUMBO, and MIMES. These models do not consider a wide array of services and lack mechanisms for linking changes in services with changes in management, and therefore fail to make trade-off comparisons (de Groot et al., 2010) and/or provide much utility for marine spatial planning processes (Guerry et al., 2012). The Natural Capital Project has developed a set of computer-based models called InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) that aim to reveal relationships, synergies, and trade-offs among multiple services (Tallis & Polasky, 2011). The tool has been used in a variety of case studies to assess the possible impacts of different

management and governance strategies (e.g. Natural Capital Project, 2010; Tallis & Polasky, 2009b), but it is not a panacea. Like any suite of modelling tools, the model outputs are only as good as the inputs provided, and the complexity of the modelling tool itself could be construed as a drawback despite the detailed results that it is capable of providing due to the lack of transparency involved in the modelling process (Brown Gaddis et al., 2010; Davies et al., 2015). Additionally, while InVEST may be an improvement over some methods of ES valuation, employing the programme requires an extensive investment of resources such as money, time, and expertise, that can be daunting for decision makers with limited science capacity or constrained timeframes (Guerry et al., 2012), making this approach currently unfeasible for the vast majority of coastal zone decision makers. ARIES is a similar modelling suite but also integrates artificial intelligence technology and claims to be designed for ‘rapid’ ES assessment and valuation. However, a two week training course is needed prior to utilising this programme (Villa et al., 2014).

Each of these modelling methods have been developed based on the belief that “to facilitate planning, design, and decision making, large amounts of data on ES (and their values) are needed” (de Groot et al., 2010, p. 270). But Chan and Ruckelshaus (2010) caution that given the complexities inherent in building ecosystem models and our embryonic state of understanding about the interrelationships between human and natural systems, current ES models provide an important, though largely qualitative or strategic, contribution.

3.5.3 Participatory modelling

PM is the use of modelling in support of a decision-making process that involves stakeholders (Voinov & Bousquet, 2010). This definition emphasizes that PM is both a method and a process; because of this duality, outcomes can result from the method, the process, and the combination of the two. PM is a particularly useful methodology to utilise when dealing with coastal SES and their associated wicked problems because it can facilitate a collective approach to decision making that explicitly considers uncertainty, values, and risk. Additional advantages of PM approaches are that the model(s) may act as a heuristic device which enables the development of a common understanding of complex problems (Haag & Kaupenjohann, 2001). In these instances, models can enable stakeholders to engage in scenario testing in a virtual world (Prell et al., 2007).

In the conditions of uncertainty associated with wicked problems, many policies fall short of or even contradict what available evidence suggests is required (Juntti et al., 2009). According to McNie (2007), decision makers tend to focus on increasing the supply of

information, rather than demanding useful scientific information, which by definition “improves environmental decision-making by expanding alternatives, clarifying choice and enabling decision makers to achieve desired outcomes (p. 17).” There is always a level of uncertainty associated with data, methods, and models, but in decision making, perceptions of uncertainty can become more important than actual uncertainty (associated with the data, methods, or models) (Voinov & Bousquet, 2010). Stakeholders who are involved in the development of a model are much more likely to be comfortable with the level of uncertainty associated with the model and to believe its outputs (Yearley, 2006). This has important advantages for the utilisation of PM in governance and management activities that aim to address wicked problems.

Turnpenny et al., (2009) point out that technical uncertainty is often cited as a reason for pursuing certain policy directions, but epistemological or value uncertainties are actually at the root of the problems; this argument is strongly supported by Weber, Memon, & Painter (2011). The experiences of Weber and colleagues (2011) suggest that the science behind a model or models is not necessarily incorrect, incomplete, or in any other way lacking, but that effective policy still may not be developed. This is because a problem or set of problems may be framed as strictly scientific, but is in fact firmly grounded in the adversarial social and political institution dynamics and values of the stakeholders (Weber et al., 2011).

PM can address these adversarial elements in two ways; by explicitly incorporating stakeholder values into the model, and by providing a process that facilitates collaboration and learning about diverse values (Brown Gaddis et al., 2010). Participants can provide input into questions that the model should answer and contribute critical contextual knowledge and values that help to define key model parameters and processes (Brown Gaddis et al., 2010). At the same time they can engage in positive interactions about environmental management issues, become actors in a neutral process, and develop new networks for information sharing by coming into contact with new people (Harp, 2006).

Management of risk can also be enhanced using PM methods that encourage heterophilous approaches to problem solving by creating new networks to facilitate information sharing (Souchère et al., 2010). PM is hailed as one of only a few mechanisms that can both facilitate social learning and encourage the multi-directional exchange of information which can positively impact outcomes (Stringer et al., 2006). Yearley (2006) also points out that PM and citizen peer reviews of models can extend the process of model development by extending the community of reviewers, increasing the suite of ideas being

explored, contributing previously unknown information, and encouraging the incorporation of a more holistic perspective on the problems at hand.

The ability to incorporate a diversity of the people is one of the most important strengths of the PM approach but also one of its primary drawbacks, as the variety of power relationships (Reed, 2008), opinions, values, emotions, and capacities to process information can be difficult to manage (Prell et al., 2007). Currently, knowledge of stakeholders, their perceptions of environmental issues, their beliefs about future management and governance options (Kasemir et al., 2003), and how these social dynamics effect planning initiatives that incorporate modelling (Brown Gaddis et al., 2007) is incomplete. Participatory modelling can help to address some of these problems, but is itself a complex, contingent social process that interacts with institutional structures, knowledge frameworks, and power relationships at different scales. As such, PM can yield unexpected outcomes, and should not be considered a tool or process that can be applied with precision and predictability. PM can also be time consuming and outcomes are not always imminent, which places participatory projects at risk of losing the engagement of participants, managers, or policy makers charged with effecting change (Prell et al., 2007). Other PM challenges include accounting for the informal processes that contribute to knowledge generation and the networks that support governance and management (Cook & Spray, 2012), and the verification and validation of participatory models (Millington et al., 2011).

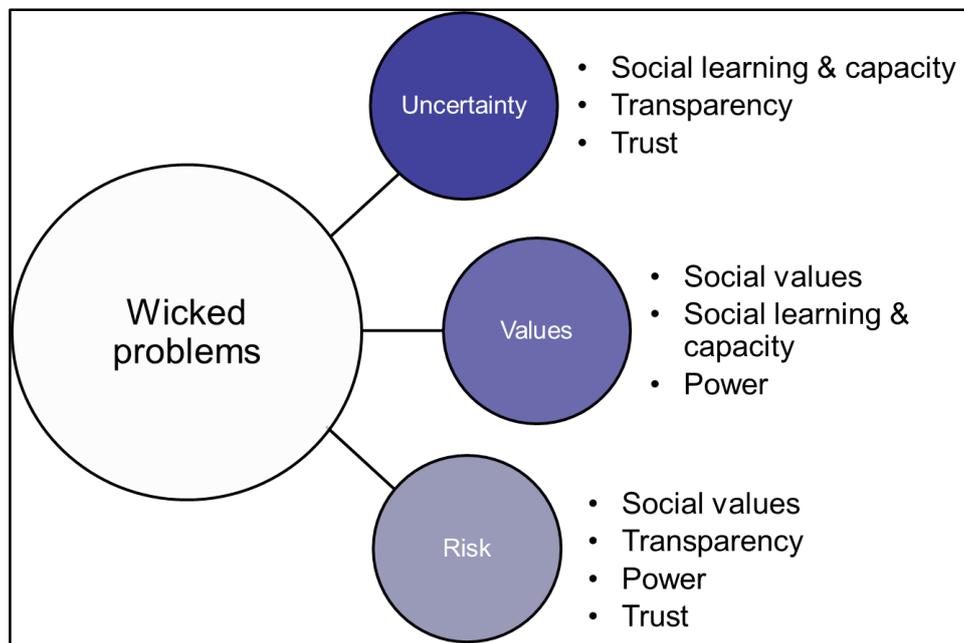
The ability of PM to contribute to the reduction of uncertainty, the clarification of values, and the prioritisation of risk depends upon the manner in which participation occurs. There is a diversity of definitions, goals, and methods within the PM literature and some types of PM can integrate social values into ES frameworks and address wicked problems better than others (Davies et al., 2015). In most participatory situations, however, a simple model that can be communicated clearly is more useful than a complex model that lacks transparency, has narrow applications, high data costs, and more uncertainty (Brown Gaddis et al. 2010).

3.6 Social qualities for addressing wicked problems

PM is well positioned to address wicked problems because of its dual purpose as 1) a method that can integrate social values into decision-making frameworks, and 2) a process that can reduce uncertainty and risk by developing particular elements of social capital (Figure 3.4). Social capital refers to relations of trust and reciprocity, the establishment of common rules and norms, and the connectedness of institutions and social networks (Folke et

al., 2005; Pretty & Ward, 2001). Social capital has been linked to the generation of adaptive governance and management, is often considered to be a critical element that enables collaboration and collective action (Adger, 1997, 2003; Berkes & Seixas, 2005; Lebel et al., 2006), and is associated with the capacity to resolve wicked problems (Morris et al., 2013). The following five subsections will argue that PM and ES approaches can reduce uncertainty and risk and address wicked problems by encouraging the integration of social values into ES frameworks (Daniel et al., 2012) and enhancing four elements of social capital, including social learning and capacity building (Krueger et al., 2012; Pahl-Wostl & Hare, 2004), transparency (Granek et al., 2009; Korfmacher, 2001), the mediation of power (Stringer et al., 2006), and trust (Lebel et al., 2006). The justification for the integration of social values into ES frameworks has already been made throughout this chapter, and therefore will only be briefly summarised in section 3.6.1 below.

Figure 3.4: Wicked problems are defined by high levels of uncertainty and risk, and the presence of conflicting values. These elements of uncertainty, values, and risk can be mediated through participatory modelling methods that integrate social values into decision-making frameworks and also enhance elements of social capital needed to address wicked problems.



Many other qualities also enhance the capacity of governance and management structures to address wicked problems. For example, resourcing (time, expertise, money) is an important consideration, as are legislative frameworks that enable adaptive governance and EBM, and the ability to monitor and respond to environmental feedbacks, among others

(Olssen et al., 2004). However, these are institutional rather than social qualities, and therefore do not fall into the particular focus of this research, which seeks to determine outcomes that can be enhanced by PM methods in conjunction with ES frameworks.

3.6.1 Integrating social values

Social values must be considered when establishing ES frameworks because these values are connected to current or aspirational activities and can be translated into practices that impact ecosystem function. Culture, history, identity, and subsequently, values, are all intimately connected with the tangible environment, and are therefore not only associated with social relationships, but also spatial ones (Stephenson, 2008). Considering the range of values associated with a given area, and the spatial representation and interactions among these values, can help to avoid an irreversible break in this connection (Stephenson, 2008). Trade-offs among values should be considered prior to making management or governance changes that will impact both social and physical space (Brown & Reed, 2012). However, Chan et al. (2012) caution against treating all values equally, and some cannot reasonably be traded-off or measured against other values.

Despite these challenges, the integration of social values into ES frameworks can be achieved by establishing a process that emphasizes participation from a diverse group of stakeholders, including opportunities for non-human actors to be represented. Representation is a central concern for the integration of social values, as questions of validity can arise if important stakeholders are not included, or if participants are not perceived to be representing the values of the area (see Krueger et al., 2012; Lane et al., 2010; and Reed, 2008 for more). A process that explores both what is valued and how those values and associated practices impact other stakeholders, including the ecosystem (Cote & Nightingale, 2012), can make important contributions to the development of ES frameworks by providing context which may enable coordination, cooperation, and compromise (Davies et al., 2015).

3.6.2 Enhancing social learning and capacity building

To sustain natural resources and maintain the provision of ES, ecosystem dynamics should be carefully considered in management, a process that requires the ability to observe, interpret, learn, and communicate about the essential processes and variables involved in ecosystem dynamics (Berkes et al., 1998; Carpenter et al., 2001). This in turn requires the development of the social capacity to collectively respond to environmental feedback and change; processes that generate learning, meaning, knowledge, and experience of ecosystem

dynamics expressed in management practice support the development of social capacity (Folke et al., 2005). Certain types of PM can be utilised to identify and clarify social values and increase social capacity to manage the ecosystems by clarifying system dynamics and trade-offs and emphasizing a collaborative learning approach (c.f. Davies et al., 2015). Using PM to develop ES approaches enables the explicit incorporation of social and ecological values into management and planning considerations while also increasing social capacity.

Types of PM that generate and enhance characteristics such as social learning and social capacity are more likely to contribute to the establishment of ES frameworks that address wicked problems. Social learning is a process that changes individual thinking and the thinking of the wider community of practice through social interactions (Reed et al., 2010), while social capacity is the ability of a social group, network, or community to respond to feedback due to processes that generate and retain learning, meaning, knowledge, and experience (Folke et al., 2005). The social capacity to cope with change is required for building resilience in an SES (Folke et al., 2003). The ability to communicate, learn, and respond to feedback regarding the system in question as a social group is a critical element of any ES approach that intends to improve a wicked world (Granek et al., 2009).

The establishment of ES frameworks that build SES resilience necessitates that stakeholders learn about the problems at hand, specifically ecosystem function and the role that underpinning services play in service delivery, so that the trade-offs associated with decision making will be more clearly comprehended and considered. This learning can coincide with the development of communication and negotiation skills that are needed to address wicked problems (Turnpenny et al., 2009). PM processes that focus on social learning and capacity building can meet both of these criteria by creating situations where stakeholders have to share knowledge to answer a question or resolve a problem (Pahl-Wostl & Hare, 2004). These kinds of PM processes may also be more likely to create the informal situations that contribute to knowledge generation and the networks that support adaptive governance and management (Cook & Spray, 2012). The ability of social learning and capacity building to develop shared understanding and agreement among stakeholders and decision makers on which actions can be based is dependent on many factors, however, and should not be taken for granted (Muro & Jeffrey, 2008). While Reed (2008, p. 2422) admits that “stakeholder participation can lead to more effective and durable decisions”, he also indicates that more work is needed to evaluate the capacity of these processes to promote social learning.

3.6.3 Increasing transparency

Transparency is critical to enabling communication among a diverse group of participants and decision makers. A lack of transparency can constitute one of the major factors responsible for failures in communication (McNie, 2007), and therefore must be considered when aiming to resolve wicked problems. The transparency of a modelling process and the resulting model is intimately linked to the trust that stakeholders place in the PM process and its outputs (Korfmacher, 2001), and therefore ways to increase transparency should be considered with care, especially if trust building is a project goal. Documentation, explanation of assumptions, and inspection of components are all techniques that can be used to design for transparency (Fleischmann & Wallace, 2005).

In general, models and processes that are more transparent will be user-friendly, open and flexible, easy to update, well-documented (Korfmacher, 2001), simple, and thereby engender trust among users (Brown Gaddis et al., 2010). A transparent modelling process is more likely to produce outputs that are supported by participants and the wider community because the process builds trust in output validity and reasonableness (Yearley, 2006), while also developing trust among participants (Granek et al., 2009). In some cases, model transparency might be exchanged for more detailed model outputs, but if stakeholders and decision makers do not trust a complicated model, they may be less likely to utilise its information (Primmer & Furman, 2012), so this choice must be undertaken with care and, ideally, consultation.

3.6.4 Mediating power

Power is conceived within this thesis as being derived from the relations and practices of human and non-human actors that produce particular outcomes, favouring some over others (Allen, 2003; Castree & MacMillan, 2001; Latour, 2005). This relational or ‘network power’ does not have to be wielded or exchanged through traditional power struggles, but “can be catalysed by the mutual benefits vested in effective collaboration” (Juntti et al., 2009, p. 211). Mutually beneficial power exchanges can be encouraged by participatory processes that engage a host of relevant stakeholders and decision makers. But because power is derived from social relations, and PM is a social process, power mediation should be considered from the inception of a project in order to address inequalities that may diminish the capacity of participants to meaningfully engage (Reed, 2008), to avoid engaging only the ‘usual suspects’ (Stringer et al., 2006), and to avoid reinforcing or reproducing existing social structures (Hayward et al., 2004). Establishing fair and equal processes can enable

collaboration and the redistribution of power (Shucksmith, 2000, p. 209), but applying participatory approaches in contexts that are characterised by social tensions and power differentials must be carefully considered because of the potential to disadvantage less powerful actors (Becu et al., 2008). Where stakeholder interests cannot be adequately represented, withholding participation may be a good strategy (Hayward et al., 2004; Lebel et al., 2006).

Providing a voice to all participants increases the likelihood that the PM process will be perceived as fair and valid (Tippett et al., 2007), and will provide opportunities to review existing power structures and enhance social learning (Stringer et al., 2006). The inclusion of a moderator in the process is a common way to address problems of power, but is not infallible (Reed, 2008). The ways in which the participant group mediate the boundaries among themselves and their respective outside interests and identities is a key component of how successful a participatory project may be perceived to be (Pahl-Wostl et al., 2007); an ES framework alone, even one developed through a carefully established PM process, does not address deeper institutional and structural patterns of power and privilege in society. An assessment conducted by Davies et al. (2015) revealed that few PM methods to date mediate power particularly well, and this problem should be considered carefully when designing any participatory approach..

3.6.5 Building trust

Building trust has consistently been identified as necessary to the establishment of management and governance approaches that address wicked problems (Lebel et al., 2006), primarily because “trust lubricates collaboration” (Olsson et al., 2004, p. 83). As Carolan (2006b, p. 327) succinctly explains “we often find truth in those social relations we trust.” PM can address both of these elements by establishing a process through which participants develop relationships, thereby building trust and creating the conditions for collaboration that are needed to facilitate improved outcomes for all parties. A process that builds trust is likely to result in high levels of information sharing and more tightly-knit social networks (Olsson et al., 2006), while enabling the linkages among different networks arguably makes it easier to avoid customary response paths and facilitate flexible or even novel solutions to management problems (Tompkins & Adger, 2004). Conversely, highly polarised communities can become locked into undesirable management paths because of pre-existing conflict and mistrust among decision makers (Olsson et al., 2006). For this reason, successful

co-management invariably involves long periods of trust building (Olsson et al., 2004; Pretty & Ward, 2001).

The opportunity to improve the welfare of all parties involved is a critical element of trust building (Ostrom & Ahn, 2009), and therefore managing participant expectations in relation to outcomes should be considered before beginning a study that intends to build trust (Lane et al., 2010). For example, the use or anticipated use of research findings in ways inconsistent with participant hopes can cause a breach of trust. The role of particular kinds of outcomes in the process of trust building is not clear from the literature; whether more trust is generated when working with high stake or low stake outcomes needs to be explored further (Kolkman et al., 2005; Steelman & Ascher, 1997).

In PM processes that aim to address wicked problems, there are many different facets of trust that could be considered. For example, is the emphasis on building trust in the PM process and resulting decision-making, in the model resulting from the process, in the modellers or other experts, or among the participants? Trust in the modelling process and the resulting model can be developed by including stakeholders in the process of model development; this generally requires a simple, elegant model interface that allows a diverse group of stakeholders to clearly comprehend the structure of the model and all of its associated variables (Korfmacher, 2001). Increasing stakeholder comprehension of the modelling process and input into model development can lead to improved model outputs as well as increased stakeholder trust in those outputs (Yearley, 2006). Trust among participants and researchers can be developed by outlining clear goals and expected outcomes, and by involving stakeholders throughout all stages of a project, including defining process outcomes, thus creating a comfortable space for communication (Reed, 2008).

3.7 Conclusion

This chapter reviewed literature on wicked problems in an environmental context, with a focus on coastal SES and the role of ES and PM in developing governance and management resolutions that address these problems. The chapter argued that PM and ES approaches can reduce uncertainty and risk and contribute to the resolution of wicked problems by integrating social values into ES frameworks and enhancing four particular elements of social capital. To develop this argument, an overview of wicked problems was provided, followed by a review of the current approaches and frameworks for wrestling with wicked problems. This review was followed by three sections that described important features needed to improve the current approaches to wicked problems; participation, models,

and the five social qualities argued for in this chapter and considered throughout the thesis: integrating social values into ES frameworks (Daniel et al., 2012), enhancing social learning and capacity building (Krueger et al., 2012; Pahl-Wostl & Hare, 2004), increasing transparency (Granek et al., 2009; Korfmacher, 2001), mediating power (Stringer et al., 2006); and building trust (Lebel et al., 2006).

4. Methodology and methods

We've got no money, so we have to think. –Ernest Rutherford

4.1 Methodological approach

The purpose of this research is to explore the usefulness and applicability of PM methods and ES approaches in the context of resolving coastal governance and management problems associated with high levels of complexity. To achieve this, I developed a PM method designed to facilitate the identification, valuation, and consideration of ES trade-offs, and invited a diverse group of stakeholders involved in decision making in a coastal area associated with high levels of complexity and conflict to trial the method. This research takes a primarily qualitative approach towards the conduct of mixed methods (after Hesse-Biber, 2010). Qualitative approaches share the common assumption that reality is socially constructed and that subjective meaning is a central element of knowledge building, but the notion of objectivity is not rejected outright. The qualitative perspectives that guide this research are in the transformative tradition, and therefore emphasise social justice and change as primary research objectives (after Mertens, 2003). This approach addresses a common criticism that mixed methods studies are deficient in considering issues of social justice or human well-being in general (Sweetman et al., 2010).

The approach is also appropriate given the transdisciplinary nature of the project and its associated interdisciplinary supervision (provided by two social scientists, an ecologist, and a geomorphologist). Incorporating a range of qualitative approaches “can provide a

broader theoretical lens through which to look at novel and often thorny interdisciplinary research problems and issues (Hesse-Biber, 2010, p. 16).” An open transdisciplinary methodology, meanwhile, respects the contributions of a range of knowledge cultures, while also seeking to establish a relationship between the parts that is capable of providing new insight and functionality that could not have been achieved using any of the parts alone (Brown, 2010).

Researchers enter into a project with certain assumptions about how and what they will learn from the inquiry; making these assumptions explicit is an important element of any methodological approach (Creswell, 2003). This research draws on a range of what Creswell refers to as “knowledge claims” (2003), which are also commonly known as ontologies and epistemologies. Four key traditions, which share several common or related perspectives, have guided this research and will be outlined briefly in the following sections (Figure 4.1).

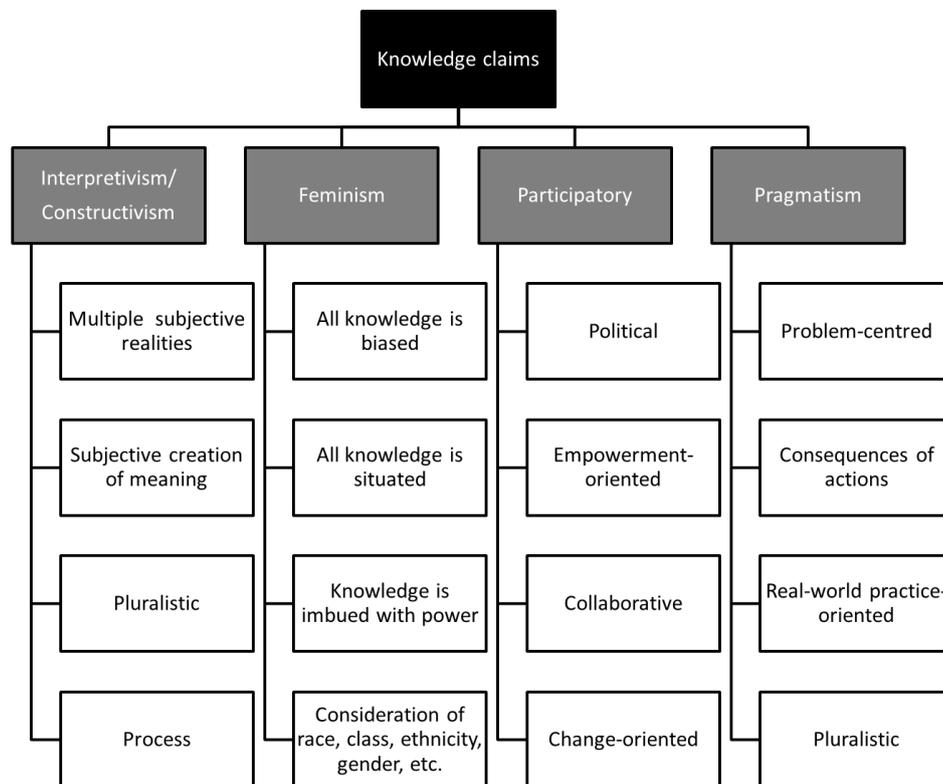


Figure 4.1: Key knowledge claim traditions that provide ontological and epistemological foundations for this research.

4.1.1 Interpretivism/Constructivism

An interpretative approach to research assumes that individuals construct multiple subjective realities within their “natural” or contextual settings, but does not outright reject the notion of objectivity. Pluralism, in which multiple ways of being and knowing are embraced, is a key tenet of interpretivist approaches (Hesse-Biber, 2010). Constructivism

makes similar knowledge claims, but also focuses on the processes involved in interactions among individuals, including the interactions among researchers and the researched (Creswell, 2003).

4.1.2 Feminism

Feminist perspectives assume that all knowledge is inherently biased, situated (Haraway, 1988; Rose, 1997), and imbued with power (Hesse-Biber, 2010). This approach therefore focuses on the examination of perspectives that have been marginalised or misrepresented in traditional positivist investigations (Hesse-Biber, 2007). Consideration is commonly given to issues associated with race, class, ethnicity, and gender, among others.

4.1.3 Participatory

Participatory perspectives focus on advocacy and action to aid marginalised or excluded individuals and groups (Creswell, 2003). These studies often begin with the recognition of an important issue or stance about a social problem. The agenda of participatory projects is recognised as being highly political and demands collaborative approaches to avoid further disenfranchising groups of concern (Kindon et al., 2007). Participatory perspectives are closely related to feminist ones, but tend to go further in their calls for change.

4.1.4 Pragmatism

Pragmatic approaches to research are generally concerned with applications and solutions to problems (Morgan, 2007). The problem is central to the research, and to advance solutions to the problem, inquirers in this vein draw from both quantitative and qualitative methodologies and assumptions as needed. Truths are considered to be of the moment (Creswell, 2003).

4.2 Strategy of inquiry: mixed methods for wicked problems

At the level of application, strategies of inquiry provide a research design with direction (Creswell, 2003). The mixed methods research design utilised in this research emphasises qualitative approaches but also incorporates quantitative data. Through mixed methods, qualitative data such as text, narrative, and pictures can be combined with quantitative, numerical data to allow research results to be examined from different angles and more easily generalised (Sweetman et al., 2010). Mixed methods are often utilised to

address novel research questions arising from the theoretical contributions made by feminists, postcolonialists, postmodernists, and critical theorists (Hesse-Biber, 2010). The mixed methods emphasis on interconnections and complexity also makes it well suited to addressing wicked problems.

4.2.1 Transformative procedures

Transformative procedures utilise the transformative purpose of the research as an overarching theoretical lens to guide the design of studies that include both quantitative and qualitative data. This lens helps to focus the topics of interest, methods for collecting data, and outcomes or changes anticipated by the study (Creswell, 2003):

Transformative . . . scholars recommend the adoption of an explicit goal for research to serve the ends of creating a more just and democratic society that permeates the entire research process, from the problem formulation to the drawing of conclusions and the use of results (Mertens, 2003, p. 159).

The transformative procedures that support the integration of social values into ES frameworks and the generation of the four elements of social capital considered in this thesis are described below. In Chapter 6, these procedures are linked to a set of outcomes that provides evidence of the extent to which the social qualities were generated and the procedures followed (Figure 6.1). Four key processes are considered necessary to generate the five social qualities needed to address wicked problems: 1) fair and respectful process management, 2) diverse and iterative participation, 3) integration across scales and domains, and 4) sufficient time.

1) Fair and respectful process management

This key process includes elements such as a democratic structure and high quality facilitation which enables respectful and inclusive discourse among a group of participants who ideally represent a diverse set of perspectives (Johnson et al., 2012). A democratic structure ensures that all participants can make an equal contribution (Dana & Nelson, 2012), while the facilitator sets the tone, provides structure to participatory proceedings, and creates a safe and welcoming physical and social space in which participation can occur (Daniels & Walker, 2001). These are critical components of a successful participatory experience and therefore essential to successful proceedings. Fair and respectful process management also

requires a clear set of goals and outcomes that are supported by good documentation, explanations of assumptions, and the ability to inspect process components (Fleischmann & Wallace, 2005).

2) Diverse and iterative participation

A diverse and iterative participatory process includes participants who represent a broad range of scales and interests, and facilitates regular and open communication among participants and organisers (Reed, 2008). Diverse participation fosters the inclusion of a broad spectrum of world views in the participatory process (Jones et al., 2011); this creates the opportunity for novel perspectives and ideas to emerge (Folke et al., 2003). Iterative participation insures that the process will be responsive to participant interests, needs, and feedback (Reed, 2008), which can help build trust among participants and organisers and creates opportunities for participants to develop the capacity that they need to enhance their own welfare (Olsson et al., 2006; Ostrom & Ahn, 2009) or direct the process towards other substantive outcomes that matter most to those involved (Mostert et al., 2007).

3) Integration across scales and domains

Integration across scales and domains is frequently cited as an integral step towards addressing wicked problems (Bammer, 2005; de Groot et al., 2010; Hein et al., 2006; Rodríguez et al., 2006). This is particularly true for problems related to ES, which are notoriously spatially derived, but often do not align easily with relevant social scales or policy domains (Millennium Ecosystem Assessment, 2005b; Tallis & Polasky, 2011). Although challenging to undertake, the consideration of values, priorities, and trade-offs at a range of relevant scales is needed to resolve wicked problems. Implementing a multi-stakeholder participatory process creates a new boundary around the process and those who are involved (Mostert et al., 2007). This can generate beneficial group dynamics, but the relationship between the representatives in the process and their constituencies, and the relationship between the group and those who are excluded from it, should be considered with care (Mostert et al., 2007).

4) Sufficient time

Any process that aims to generate social qualities requires a sufficient time commitment for social interactions to occur. A wide range of time scales may be considered 'sufficient', however, and the definition may vary according to the particular focal

characteristic. For example, social learning can be successfully generated during a series of workshops (e.g. Johnson et al., 2012), but Lebel et al. (2006) suggest that trust building may take as long as a decade. The amount of time allowed for social interactions to occur during a participatory process will have an impact on the capacity of the group to generate social qualities, and therefore time should be considered in the analysis of the process used.

4.2.2 Researcher positionality

The transformative framework of this research is associated with certain assumptions about knowledge, positionality, power, and participation which can contribute to procedural benefits and challenges. For example, participatory research has the potential to generate important new knowledge by facilitating the sharing of indigenous, local, scientific, and other knowledge sets, and where appropriate, combining and/or re-deploying these sets to generate useful outcomes for the community of participants involved in transformative research (Kindon et al., 2007). However, the situated, biased, and partial nature of knowledge as understood in feminist paradigms (Haraway, 1988; Rose, 1997) requires the researcher to practice transparent and reflexive methods, a process which entails explicit acknowledgement of the positionality and power relations of the participants and the researcher, as well as regular reflection, examination, and, where appropriate, modification, of the research process (Dowling, 2005; Rose, 1997).

Consideration of positionality and power is critically important in transformative and transdisciplinary research, which by virtue of the approach involves a process of defining and enhancing the common good (Brown et al., 2010). ‘Positionality’ is the idea that people do not have fixed identities, but can be defined instead, within changing networks of relationships which can be analysed (Maher & Tetreault, 2001). This means recognising where individuals stand in relation to others in terms of dominant/subordinate, marginal/central, empowered/powerless, and therefore determining the positions from which it is possible to challenge power and encourage change (Takacs, 2002). In participatory research, multiple positions and power relationships can interact. Because power comes from the relations and practices of human and non-human actors that produce particular outcomes, favouring some over others (Allen, 2003), power must be considered from the inception of a project to avoid engaging only the ‘usual suspects’ (Stringer et al., 2006). Power relationships should also be considered to address inequalities which may diminish the capacity of some participants to meaningfully engage (Reed, 2008). Providing a voice to every participant increases the likelihood that the participatory process will be perceived as fair and valid

(Tippett et al., 2007), and will provide opportunities to review existing power structures and enhance social learning (Stringer et al., 2006).

England (1994) has described three key power relationships that are particularly helpful to consider and manage in research relationships: these are reciprocal, asymmetrical, and potentially exploitative. The research methods described in this chapter were developed with the intention of establishing, as nearly as possible, a reciprocal relationship between participants and researchers, and to limit asymmetrical and potentially exploitative relationships by managing multiple power relationships and minimising the influence of any particular positionality on the data, but there is no way to remove power structures from the research process (Dowling, 2005). Exploitative relationships which could undermine the value and legitimacy of the knowledge gained from the research were addressed by providing participants with as much transparency as possible, both in writing and in verbal communications, by consulting with stakeholders and potential participants about the research goals, design, and conduct of the research, and by reporting back to the research participants periodically on research progress and findings (see section 4.3 below for details on these efforts) (Dowling, 2005).

This research involved 14 individuals representing six different groups in the first workshop, and 11 individuals representing five different groups in the second workshop. Each individual had a unique way of relating to me as the primary researcher, to the facilitator and research assistants, to the other participants, and to the research subject and area. Similarly, my position as a woman, American, Pākehā (non-indigenous person of European descent), student, previous Auckland Council employee, local community member, and mother, played a role in my relationship with participants and other researchers, and allowed for the pursuit of some topics over others, and the development of certain insights throughout the research (England, 1994). The interactions among these multiple identities, relationships, and positionalities affects the truths produced by the research; instead of asking ‘is this true?’ it is therefore more useful to ask ‘whose truth is being told?’ (Mohammad, 2001, p. 119). This issue of multiple truths has been considered during the analysis and presentation of the data. Where possible, taking into account ethical restrictions associated with confidentiality and anonymity, the origins of the knowledge gained from this research has been presented along with the data itself to maintain transparency and allow the value of the multiple truths presented here to be weighed by the reader.

To encourage critical reflexivity in the project, I kept a research journal during the period when workshops and interviews were being conducted, as well as during the data

analysis process (Dowling, 2005). Research assistants who participated in the workshops were also encouraged to provide written reflections on their experiences, and debrief meetings were held following both workshops to discuss the experience. The combination of these efforts enabled me to conduct a study that did not exploit the participants and that yielded some important, though inherently limited, truths.

4.2.3 Case study approach

A case study approach was employed to fulfil the research objectives. This methodology captures the characteristics of real life events, an essential aspect when studying complex social phenomena (Yin, 2003). Case studies are useful when a complex assessment is being undertaken that must be bounded by geography and time in order to be manageable for the researcher and to generate meaningful results (The Resilience Alliance, Millennium Ecosystem Assessment, 2005c; 2005d). The spatial and temporal boundaries utilised in this research were developed after considering associations with governance and management regimes, the geographic location of stakeholders affecting the inlet, stakeholder interests and suggestions, and the need to provide a manageable research focus. Relationships to natural processes such as water quality and stormwater drainage were also considered.

An extended area of Mangere Inlet was included in this research so that participants from Ambury Park, Mangere Mountain, and Mangere Wastewater Treatment Plant, all important stakeholders in the area, could participate in the study if they chose (refer to Figure 2.1 for the location of these stakeholders). Approximately 205 km² of land and water was included in the study (Figure 1.1).

A scenario timeframe of 30 years (2010 to 2040) was utilised throughout the research in accordance with the planning and visioning timeframes designated in the Auckland Plan (2012). Input related to historic events which influenced present and future social-ecological conditions in Mangere Inlet and Manukau Harbour helped to provide essential context for the scenario discussions. For example, the decommissioning of MWTP's oxidation ponds in 2001 dramatically reduced the inputs to the harbour, and was also associated with distinct changes in the management and governance of the area (see Chapter 2).

4.2.4 Constructivist grounded theory and critical review

A review of secondary source materials was undertaken to provide geographical, historical and socio-economic context to the primary data-collection programme (Clark, 2005). Secondary sources included relevant published literature, reports, data sets from

Auckland Council, Statistics New Zealand, and NIWA, articles and interviews in local newspapers, magazines, and other media, newsletters, seminar presentations, and conference papers and posters. A constructivist grounded theory analysis of these materials was conducted (after Charmaz, 2014; Glaser & Strauss, 1967). Grounded theory analysis is a systematic but flexible approach to collecting and analysing data that allows for the construction of theoretical frameworks grounded in the literature and other data (Strauss & Corbin, 1990). To adhere to this approach, the following protocols (Charmaz, 2014) were followed:

- Simultaneous data collection and analysis using the constant comparison method, which relies on explicit coding and analytic procedures.
- Constructing analytic codes and categories from data, rather than from preconceived, logically deduced hypotheses.
- Memo-writing to advance theory development during each step of data collection and analysis, usually focusing on topics such as elaborating categories, specifying properties, defining relationships, and identifying gaps.
- Sampling aimed at theory construction (theoretical sampling), rather than for population representativeness.

Critiques of the positivism of early versions of grounded theory led to the development of constructivist grounded theory, which explicitly acknowledges subjectivity and the researcher's role in the construction and interpretation of data, and aligns with the social constructivists who view knowing and learning as embedded in social life and stress the role of social contexts and interactions in interpretation and understanding (Lincoln & Guba, 2013). In alignment with constructivist grounded theory approaches, a literature review was conducted in the early stages of the research (Thornberg, 2012) rather than after the development of an independent analysis, as suggested in traditional grounded theory (Glaser & Strauss, 1967). Thornberg (2012) outlines several problems with delaying the literature review and argues that it is possible to use literature in a constructive and sensitive way while also maintaining an open mind about future data collection. Using this method, a list of themes which was later used for coding primary data was compiled from secondary materials, along with a list of stakeholder groups and individuals who could be potential participants in the research, and a list of potential interview questions (Dunn, 2005; Olsson et al., 2004).

4.3 Methods

This research was undertaken across three interconnected research phases conducted between 2011 and 2014. A literature review and consultation phase was conducted early in the research. Because literature indicates that participatory processes should be iterative (Millennium Ecosystem Assessment, 2005a), three pilot workshops were run with students prior to participant workshops and adjustments to the methods were made as needed. Primary data was then collected from participatory workshops and semi-structured interviews. These results were not explicitly triangulated; instead, the methods employed in this study were chosen to complement one another and to reveal comprehensive as well as in-depth insights related to the study area (Longhurst, 2003). Finally, analysis and evaluation of research results were undertaken and a seminar was held to report the research findings to the community. These methods, my reasons for choosing them, and the detail they sought to capture, are described in the sections that follow.

4.3.1 Research Phase 1: Background, context, and consultation

Table 1 provides an outline of the tasks, methods, and objectives associated with the first phase of this research, which was undertaken from August 2011 to February 2012. Further details about these activities are provided in the following sections.

Table 4.1: Research phase 1 – Background, context, and consultation		
Tasks	Methods	Objectives
Critical review of secondary source materials (Clark, 2005)	Constructivist grounded theory analysis (Charmaz, 2014; Glaser & Strauss, 1967)	To provide research context, construct theoretical frameworks, develop a list of themes for coding, and identify possible research participants and interview questions.
Identification of and consultation with key stakeholders	Secondary literature review (Thornberg, 2012), snowball technique (Fontana & Frey, 1998)	To develop a list of themes for coding and identify possible research participants and interview questions.
Submission of application for ethics approval	Not applicable.	To receive approval from The University of Auckland Human Participants Ethics Committee to conduct research.
Sought location and time to hold workshops	Consultation with stakeholders.	To hold workshop in an appropriately neutral location and at a time that was acceptable for the majority of stakeholders.
Sought appropriate facilitator	Consultation with experienced facilitators.	To find a neutral facilitator with experience in PM techniques.

4.3.1.1 Participant identification, contact, and consultation

Key stakeholders and potential research participants were identified through secondary resources, peer networks, and the application of the snowballing technique (Fontana & Frey, 1998). In keeping with each of the knowledge claim traditions associated with this research, I invited key stakeholders to meet informally with me early in the study to discuss their interests and concerns as they related to coastal ES in the Auckland Region, and together we considered possible research-based approaches to addressing some of these problems.

Stakeholder consultation aided in focusing the project on a particular study area (Manukau Harbour) and helped to illuminate the project purpose. It also contributed to topics such as evaluation criteria, project boundaries, the number of workshops, and appropriate dates, times, and locations of workshops (Adger, 1997). The workshop locations were chosen with particular care so as to provide a welcoming space for all stakeholders, and to avoid the

perception that the research was affiliated with a particular group or perspective; an education centre and a community hall provided neutral locations. This early and extensive consultation process engaged stakeholders in the research by establishing a dialogue about their needs and interests, and how these might be met (or not) within the structure of the research project. Through this dialogue, I was able to establish and build trust with potential participants.

4.3.1.2 Ethics

Ethics approval for this research was granted by The University of Auckland Human Participants Ethics Committee (UAHPEC) in March 2012 (Appendix A). Participation in the study was voluntary. The recruitment of participants and procedures to ensure informed consent conformed to all the requirements of UAHPEC. To provide for the safety and comfort of the participants, the option to participate in this study without being identified in presentations or publications resulting from the research was extended to all participants because of the contentious nature of some of the topics which were discussed. The political status of some participants, their roles as leaders within the community or as experts in their fields, and their involvement in on-going or upcoming legal and political proceedings was also a consideration. However, participation in workshops involving multiple participants could not be undertaken anonymously, and confidentiality could not be guaranteed although it was strongly encouraged through written and verbal reminders. A few stakeholders opted to participate only in one-on-one interviews to increase the chances of maintaining anonymity and confidentiality. This option was available to all study participants who expressed concerns about participation.

4.3.1.3 Participant engagement

Multiple strategies were used to recruit participants. Special contact methods were developed to expand the participant group beyond the usual group of policy and planning networks and politically active community members (Videira et al., 2011) and incorporate a wider set of social interests (Kallis et al., 2006). Particular efforts were also made to engage participants in ways that established and built trust (Valentine, 2005). For example, in an attempt to engage wider business interests, information was published about the research online and through a printed newsletter that was sent out by the Onehunga Business Association, where a contact had been established. Special engagement methods were also developed to encourage the participation of stakeholders such as Ministry of Primary Industries, Ports of Auckland, and Watercare, whose representatives expressed concerns

about discussing contentious issues in a workshop setting. These stakeholders were invited to participate in interviews that mimicked the workshop activities (see section 4.3.2.2 for more details). Finally, an anonymous questionnaire was developed and deployed at popular boating, fishing, and food gathering sites in the study area to reach individuals who participate in these activities, but are not represented by a cohesive organisation (see section 4.3.2.5 for more details).

To adhere to process-oriented constructivist approaches, special care was taken to provide possible participants with coherent information about the research and to make myself accessible to respond to questions and feedback. Potential participants were provided copies of the most recent draft of the “Information for potential participants” document (Appendix B). This document provided background information about the project and the role of participants in the research, and specified that I would welcome research-related questions and suggestions. The information document was regularly updated in response to feedback from potential participants. After receiving the document, three potential participants sought to discuss the project in more detail over the phone, and two others requested a follow-up presentation or meeting. I was happy to comply with these requests because participatory projects clearly benefit from early and ongoing stakeholder engagement (e.g. Korfmacher, 2001; Lynam et al., 2010; Millennium Ecosystem Assessment, 2005a; Pahl-Wostl & Hare, 2004; Primmer & Furman, 2012; Voinov & Bousquet, 2010).

4.3.1.4 Representation and sampling

Critical case sampling techniques were utilised in this study. Participants were chosen because of their ability to discuss critical experiences that may be generalised to other situations. Research into the social value of ES of an area requires the exploration of interests and opinions and the development of themes rather than comparisons of groups or the testing of hypotheses; under these circumstances a study that involves a relatively small number of participants, as long as they have relevant expertise, will provide a valid sample (Ryan & Bernard, 2003). Given the project objectives, which involved exploring the usefulness and applicability of PM methods and ES approaches in the context of resolving coastal governance and management problems, non-random purposive sampling was an appropriate method. Morse (1994) points out that the researcher may learn enough about a research topic to identify appropriate informants whose participation in a study is crucial. Good informants are those participants chosen through a process of primary selection: participants who have the knowledge and experience needed to answer the specific research questions, the ability to

reflect on the subject at hand, the skills to articulate their perspectives, the time to be interviewed, and the willingness to participate (Morse, 1994).

The goal of the stakeholder identification, contact, and consultation process was to create a stakeholder group that served both advisory and representative roles (Korfmacher, 2001) in the process of identifying and valuing the ES of Mangere Inlet and nearby areas of the Manukau Harbour. The research aimed to engage specific stakeholders and stakeholder groups, rather than the wider public; for the purpose of efficiency, it is appropriate to focus natural resource management engagement processes on involving those who have something at stake, either directly or indirectly (Millennium Ecosystem Assessment, 2005a). The participation of individuals with direct roles in decision making at local and regional levels was sought in an attempt to facilitate linkages with implementation, but the limitations and constraints to implementation were stated explicitly in the informational materials about the research, to avoid creating impractical expectations for the participants (Lynam et al., 2010). The participation of individuals who had roles in decision making at the national level was also sought, but was not the focal scale of the research. The participation of Māori representatives who have tribal links to the study area in Tāmaki Makaurau, Auckland, individuals possessing specialist knowledge essential to the project, representatives from local user groups, and relevant business interests was also sought (Morse, 1994; Valentine, 2005). Additionally, any individual with experience relevant to the study area who expressed an interest in being involved in the project was invited to participate (after Krueger et al., 2012; Lane et al., 2010). Table 4.2 summarises some of the important characteristics of individuals who participated in interviews, workshops, or both. During this first phase of the research, 37 individuals from 28 different organisations, departments, and stakeholder groups were identified as potential participants, and responded positively regarding the possibility of participating in future research workshops. 20 individuals representing 15 different organisations ultimately participated in the research.

Table 4.2: List of study participants.

Group represented	Number of participants	Focal scale of interest & influence	Activities, responsibilities and/or interests
Tangata whenua	2	Local	Tangata whenua representatives have a special cultural and spiritual relationship with the local environment and a role in helping to safeguard it on behalf of all New Zealanders. These interests are represented by local tribal authorities.
Local community	5	Local	Local organisations representing community interests and concerns that may relate to health, well-being, the environment, etc.
Local conservation	4	Local	Local organisations representing species and habitat conservation interests and concerns.
Local businesses	1	Local	Organisations representing local businesses and related community interests.
Local boards	1	Local	Represent communities in their area and make decisions on local issues, activities and facilities.
Auckland Council	4	Regional	Develop region-wide council plans, strategies, policies, bylaws and budgets (The Auckland Plan (2012), Auckland Council Regional Plan: Coastal (2004)). Responsible for research, advice, consenting, and compliance on these issues, as well as those related to council assets, services, and infrastructure. Legal obligation to uphold the RMA and NZCPS.
Watercare	1	Regional	Responsible for region- wide water supply, wastewater and trade waste treatment and disposal, as well as planning, constructing, and delivering new water and wastewater infrastructure for the region. Owned by Auckland Council.
Department of Conservation	1	National	Responsible for protecting, monitoring, managing, and restoring species and habitats throughout New Zealand. Responsible for the development and enforcement of the NZCPS.
Ministry for Primary Industries (Fisheries)	1	National	Responsible for New Zealand- wide fisheries research, management, and governance. This includes access, allocation, and compliance.

4.3.2 Research Phase 2: Participatory modelling

The second research phase encompassed the majority of the fieldwork portion of the project, and was undertaken from March to November 2012. An outline of the tasks, methods, details, and objectives associated with this phase is included in Table 4.3. Details on how the workshops and follow-up interviews were conducted are included in the sections that follow.

Table 4.3: Research phase 2 – Participatory modelling			
Tasks	Methods	Details	Objectives
Pilot workshops	Group mapping and scoring (Bryan et al., 2010; Kalibo & Medley, 2007; Raymond et al., 2009)	Ran three pilot workshops with approximately 120 university students, who role-played stakeholders and conducted mapping and scoring activities which could be used with real stakeholders in upcoming Workshop 1. Changed methods based on pilot experiences.	To improve the workshop processes based on pilot experiences.
Invited stakeholders to PM workshops	Letter of invitation with RSVP	Invitations sent to 37 stakeholders representing 28 different organisations, departments, and stakeholder groups key to governance and management of the study area.	To engage a diverse group of study participants
Pre-workshop interviews	Semi-structured interviews	Three semi-structured interviews were conducted with stakeholders who could not attend Workshop 1. Two semi-structured interviews conducted with stakeholders who could not attend Workshop 1, but wished to attend Workshop 2.	To maintain an inclusive and representative process.
Workshop 1: Identify, map, and value ES	Group mapping and scoring (Bryan et al., 2010; Kalibo & Medley, 2007; Raymond et al., 2009)	Two hour workshop held on a mid-week evening (6-8pm) at an education centre in the study area. 14 participants watched presentation on ES, discussed ecosystem service definitions, and adjusted list of services as needed. Completed a mapping and scoring activity to identify and value ES of the study area.	To identify who benefits and loses, and highly valued areas and ES. To provide opportunities for participants to learn about other values, contribute local knowledge to ES, identify ES most relevant to decision-making goals, critical or disputed ES, and provide opportunities to learn about underlying ecosystem functions.

Table 4.3 continued: Research phase 2 – Participatory modelling

Tasks	Methods	Details	Objectives
Workshop 2: Scenarios	Scenario planning (Peterson et al., 2003; Van der Kerkhof & Wieczorek, 2005; Wollenberg et al., 2000)	Two hour workshop held on a mid-week evening (6-8pm) at a community hall in the study area. 11 stakeholders participated. Eight of the participants also attended Workshop 1 and two participated in interviews prior to attending Workshop 2. All participants watched a presentation which covered ES, findings from Workshop 1, and outlined three scenarios. Participants discussed scenario winners, losers, and trade-offs in small groups, then presented findings to whole group and discussed as a whole group.	To encourage creative thinking about complex and uncertain futures, highlight key comparisons among approaches to development, and to inform decision-makers about the consequences for ES of contrasting development paths.
Follow-up interviews with all workshop participants	Semi-structured interviews with individuals	Semi-structured interviews lasting about an hour were conducted with 14 workshop participants.	To evaluate the real-world usefulness of the methods trialled in Workshops 1 and 2 and to provide a one-on-one setting for discussion in case some participants were uncomfortable in the group settings.
Continued contact with participants	Phone, email, attendance at local events	Post-workshop summaries, semi-regular research updates, other email and/or phone contact, participation in local events, organisation of collaborative seminar.	To build a trusting, collaborative relationship with participants.

4.3.2.1 Pilot workshops

Three pilot workshops were held with students from a third year geography course at The University of Auckland. These pilot workshops were intended to refine the methods and activities that would be utilised during the actual workshops; as such the outcomes of the pilots were treated as important methodological input but not actual data for analysis in this research. Each pilot workshop included approximately 40 students who were randomly assigned to role play members of stakeholder groups likely to be represented in the actual workshops. Students were given background information about the stakeholder group that they were assigned to so that they could adequately represent likely stakeholder interests and concerns during the mapping and scoring exercise. Conducting these pilot workshops enabled the research team to refine the mapping and scoring methods used in the workshops. Several

changes were made to the methods, materials, and timeframes based on the experience that we gained from the pilot exercises.

4.3.2.2 Semi-structured pre-workshop interviews

Semi-structured interviews were held with three individuals who could not or chose not to attend the first workshop, but who were considered to be key stakeholders in the study area and who agreed to participate in the research in a limited capacity (Table 4.4). Semi-structured interviews were also held with two individuals who could not attend the first workshop, but who wished to participate in the study and intended to attend the second workshop (Table 4.4).

Table 4.4: Pre-workshop interview participant characteristics.	
Pre-workshop 1 interview participant characteristics	
Group represented	Focal scale of interest & influence
Watercare	Regional
Ministry for Primary Industries (fisheries)	National
Tangata whenua	Local
Pre-workshop 2 interview participant characteristics	
Group represented	Focal scale of interest & influence
Auckland Council	Regional
Local businesses	Local

The semi-structured interview method allows for comparisons among standardised questions but also for variation and the development of interests and themes throughout the conversation (Dunn, 2005; Fontana & Frey, 1998). A feminist approach to interviewing was utilised to allow for reciprocity and the development of an intimate discourse (Fontana & Frey, 1998). Interviews were conducted at a time and place convenient for the interviewees and took approximately one hour. With the permission of the participants, interviews were recorded and then transcribed. Notes were also taken.

The pre-workshop interviews were designed to enable the collection of data equivalent to that which would be collected from the first workshop from participants who were uncomfortable or unable to participate in a group setting. However, these interviews did not generate the mutually beneficial characteristics such as social learning and capacity building that could be gained from the participation of stakeholders in a collective experience such as a workshop. The interviews began with a brief presentation about ES; moved onto a discussion of a list of 22 ES provided by the study area; and concluded with completion of a

mapping and scoring exercise similar to that conducted in Workshop 1 (see 4.3.2.3 for details). Questions designed to garner information about threats and drivers of change affecting the study area which might contribute to the development of scenarios for Workshop 2 were asked after the completion of the mapping and scoring exercise. This feature was unique to the pre-workshop interviews, and provided important data that was utilised in the development of materials for both workshops. The two interviews conducted prior to the second workshop were conducted in essentially the same manner, except that important discussion points made during the first workshop and changes to the ES categories made by Workshop 1 participants were introduced to better prepare the individuals for Workshop 2.

4.3.2.3 Workshop 1

a. Workshop setting, facilitator, assistants, and participants

An agenda was developed prior to the workshop and is included in Appendix C, however, as a result of the adaptive nature of the research, the agenda was adjusted where necessary to suit the needs of the participants. The first workshop was held at Ambury Park. A total of 14 stakeholders representing a diverse set of backgrounds and interests, some more focused on particular issues and scales than others, participated in Workshop 1, as shown in Table 4.5 below.

Group represented	Focal scale of interest & influence	Number of attendees
Auckland Council	Regional	4
Local boards	Local	1
Local interests	Local	5
Department of Conservation	National	1
Conservation interests	Local	2
Tangata whenua	Local	1

Facilitation was a key consideration when structuring the workshops in a way that would support participation, because of the potential for conflict between different stakeholder groups and the need to manage these power relationships (Millennium Ecosystem Assessment, 2005a). A highly qualified facilitator, well versed in managing group dynamics and deploying PM methods, was hired to conduct the workshop activities. The facilitator was

familiar with the study area but was not a member of that particular community, and therefore reviewed background materials on the area prior to the workshops. The position of the facilitator as an ‘outsider’ was chosen purposefully, to avoid aligning him with any particular stakeholder group. The facilitator’s knowledge of the specific subject of ES was preliminary, but this was accounted for by involving a small group of research assistants, all with ES experience, in running the workshops. The inclusion of research assistants was necessary because of the lack of specific knowledge of the facilitator, the need for me to conduct group observations, and because participatory methods are labour intensive and can be complex to explain to a diverse group of participants.

Research assistants included a senior marine ecologist, a senior lecturer in geography, an associate professor in geography, and a postgraduate student in environmental management. These individuals mostly observed the proceedings, but the postgraduate student also helped check in participants, and all of the assistants helped record the evening’s events by taking photographs and answering questions about the activities as needed. A video camera was placed in an elevated stationary position in one corner of the room to capture the transactional nature of the proceedings (Mondada, 2007), as well as to provide a transcript for the workshop where possible.

The room was organised with a welcome/check-in table near the entrance; coffee, tea, and refreshments located along one wall; and a large semi-circle of small tables placed in the centre of the room (Chambers, 2002). A small table where the large map of the study area could be placed at the appropriate time was located in the centre of the semi-circle. Participants could sit in small groups at the tables, but could also see all of the other participants in the room when facing the inside of the circle. Participants could also see the introductory presentation from anywhere in the semi-circle.

b. Welcome and introductions

Efforts were made during the workshop welcome and introductions to encourage respectful collaboration and learning among participants despite the long history of conflict and disenfranchisement associated with the study area. For example, to discourage participants from making snap judgements about one another based on affiliations alone, name badges did not include affiliations. Additionally, time was allocated for participants to enjoy refreshments and relaxed conversation before the official start of the workshop. I then welcomed participants in both te reo Māori and English, and introduced the facilitator and research assistants to the group. A brief “icebreaker” activity was conducted to help

participants get to know one another in a fun and friendly manner. Because time was a limiting factor in the workshop, I did not allocated time for extensive introductions around the entire room, but rather allowed participants the time to meet one new person during the icebreaker, and encouraged participants to use the time at the beginning and end of the evening, or during breaks in the evenings' schedule, to get to know one another better. The icebreaker involved allowing participants two minutes to introduce themselves to a person in the room whom they had never met, and explain their reason for attending the workshop to that person.

c. Introduction to ecosystem services

An introductory presentation which outlined the research project, the workshop goals and methods, and an explanation of ES was given to the entire group. Different stakeholder groups with different interests, knowledge, and backgrounds often use unique terminology that can render communication and subsequent decision making difficult (Berkes & Folke, 1998); the overview presentation was aimed at facilitating the use of ES as a common language (Granek et al., 2009).

The presentation described four categories of ES based on the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment, 2003): provisioning services, regulating services, cultural services, and supporting services. Examples from the study area were utilised to illustrate each service category. A list of 22 possible ES provided by the study area was compiled from Guerry et al., (Guerry et al., 2011) and provided to participants (Table 4.6). This list of services was chosen because it specifically outlines coastal ES and is based on the four Millennium Ecosystem Assessment categories, but it was also heavily biophysical, and lacked a nuanced description of social and cultural elements and services. The intention was to provide participants with a starting place, but that the list would be modified by participants as needed to better reflect their interests and experiences in the study area. Therefore, at the end of the presentation, participants were given the opportunity to ask questions and discuss the list of services in some depth. Participants were encouraged to clarify or add ES to the list as needed. This discussion was mediated by the facilitator to ensure the group stayed on topic and kept to time. This process allowed the biophysical elements of the ES list to be preserved, but to be expanded upon and enhanced through participant input.

Table 4.6: Ecosystem services provided by oceans and coasts with examples that may be relevant to Mangere Inlet and Manukau Harbour.

Category	Subcategory	Examples
Provisioning services		
1. Food	Capture fisheries	Grey mullet, yellow-eyed mullet, rig, and parore
	Wild foods	Mussels, oysters, scallops
2. Fiber		? Mangrove wood (construction, boat-building),
3. Biomass fuel		? Mangrove wood (charcoal), biofuel from algae
4. Water		Shipping, tidal turbines
5. Genetic resources		Marine diversity for bioprospecting
6. Biochemicals, natural medicines, and pharmaceuticals	Medicines	Anti-viral and anti-cancer drugs from sponges, tunicates, and other organisms
	Food additives	? Seaweed harvest for carrageenans (seaweed extract used in cooking and baking)
Regulating services		
7. Air quality regulation		The ocean can act as a sink for airborne contaminants and plants in the ocean make O ₂
8. Climate regulation		Major role in global CO ₂ cycle
9. Water regulation		Natural stormwater management by coastal wetlands and floodplains
10. Erosion regulation		Nearshore vegetation and shellfish beds stabilizes shorelines
11. Water purification and waste treatment		Uptake of nutrients from sewage wastewater, detoxification of PAH's by marine microbes, sequestration of heavy metals
12. Disease regulation		Natural processes may keep harmful algal blooms and waterborne pathogens in check
13. Pest regulation		indigenous biodiversity may limit the spread of invasive species
14. Pollination/assistance of external fertilization		Many marine species require seawater to deliver sperm to egg
15. Natural hazard regulation		Coastal and estuarine wetlands and mangroves and sandbanks protect coastlines from storms
Cultural services		
16. Ethical values	Non-use	Spiritual fulfilment derived from estuaries, coastlines, and marine waters
17. Existence values	Non-use	Belief that all species are worth protecting, no matter what their direct value to humans
18. Recreation and ecotourism	Non-consumptive use	Beachcombing, boating, waka ama paddling, kayaking, bird watching
	Consumptive use	Fishing, clamming
Supporting services		
19. Nutrient cycling		Major role in carbon, nitrogen, oxygen, phosphorus, and sulfur cycles
20. Soil formation		Many salt marsh surfaces vertically accrete; eelgrass slows water and traps sediment, molluscs shells can add substantively to the quantity of sediment
21. Primary production		~40% global NPP (Net primary production is the rate at which plants produce carbohydrates via photosynthesis after accounting for the plants metabolic use of carbohydrates.
22. Water cycling		96.5% of earth's water is in oceans

d. Participatory mapping and group mapping

ES mapping is an essential part of the implementation of EBM (e.g. Natural Capital Project, 2010; Tallis & Polasky, 2009a). Humans use marine resources at multiple spatial and temporal scales; the recognition of the social and biophysical interactions which operate across different spatial and temporal scales is therefore vital to understanding ES, the benefits they provide, and the risks of loss of service delivery (Hein et al., 2006). Several recent studies have used spatial indices containing data on social values to map ES in an attempt to identify priority management areas in terrestrial ecosystems (e.g. Brown et al., 2012; Klain & Chan, 2012; Raymond et al., 2009).

The vast majority of the mapping literature refers to all methods resulting in a collective spatial representation as ‘participatory mapping’. However, mapping conducted by an individual participant during an interview, versus mapping conducted as a member of a collective group, are very different experiences that can yield distinctly different outcomes. The ability of a method to build trust and develop social capacity and social learning are important to the establishment or improvement of ES frameworks, but these characteristics are difficult or impossible to generate if participants do not spend time in a face to face setting. For these reasons, this thesis utilises the term ‘group mapping’ to describe the process of representing spatial relationships among real-world structures or objects undertaken by a group of people who are physically present for the development of a collective representation (Davies et al., 2015; Kalibo & Medley, 2007).

Maps can produce, rather than reflect, the world (Kitchin et al., 2013); thus they do more than just reveal knowledge, they create it (Kitchin & Dodge, 2007). As a social activity (Perkins, 2004), the practice of mapping is imbued with purpose (Law & Urry, 2005). Group mapping activities therefore provide opportunities for the democratisation of knowledge production and, in this case, the assembly of multiple knowledges regarding the social value of ES in Mangere Inlet and the surrounding areas of Manukau Harbour.

Participants used the ES list (Table 4.6), an A4 size aerial photograph of the study area, and worksheets provided (Appendix D) to describe which ES were most important to them; spatial extents within the study area associated with these services; and why these services are important to them. The worksheets provided participants with the opportunity to share memories, short stories, scientific information, and other details about the study area, and to integrate these different forms of prior knowledge with the ES framework in such a way that a more nuanced ES framework emerged from the process. In completing the

worksheets, participants expanded the ES list beyond the primarily empirical and relatively simplistic categories that they were originally provided, and into new dimensions that could potentially form the foundations of a collective decision making framework (Brown, 2010). Additionally, the worksheets provided valuable background data that helped to determine the extent to which participants understood the tasks and associated ES concepts. Some of these details and stories were later used to develop the scenario narratives (Workshop 2 – section 4.3.2.4) and other materials for the study. Using aerial photographs as the basis for the group mapping activity invited participants to first consider a conventional portrayal of place, and then to disrupt the organisation of that space and re-imagine the area (Gerlach, 2014) using the ES framework. This process allowed participants to make and discuss important knowledge claims about the space, and to relate the ES concept to their own experiences and understandings.

Participants were then asked to use exactly 22 beads to associate relative values with ES that matter to them and locate their values and associated ES on the map (first using a small map for notes then later attaching their beads permanently to the large group map). Each participant was assigned a unique bead colour or shape and number identifier. The number of beads was chosen to provide a mechanism for valuation that was loosely connected to the number of services being valued (also 22). One bead per service was selected because of the limited timeframe; more beads would have demanded more time. Participants added a 23rd service to the list during Workshop 1, but a 23rd bead was not added because the valuation process was intended to be relative rather than exact.

Participants had many questions about the best way to go about their mapping and all of the assistants were needed to successfully complete the activity. Assistants were encouraged to answer questions using jargon-free language and to avoid leading the participants. The approach encouraged a collaborative rather than authoritative exploration of the study area and the values that participants attribute to it.

Once participants brainstormed the areas and services which were the most valuable to them using their individual lists, maps, and worksheets, they were asked to go to the large map and permanently pin their beads to it, stacking their beads where appropriate to indicate increased value (Figures 4.2, 4.3). White board markers were also provided so that spatial extents of service value and other notes could be added to the large map (after Raymond et al., 2009). Large scale services such as air quality regulation, which were difficult to map to a specific point or spatial extent, were included in the mapping exercise by pinning beads in the

upper left hand corner of the map and writing in the service associated with those beads (Figure 4.4).

Figure 4.2: Participants referring back to their worksheets as they developed the collective map.



Figure 4.3: A view of the collective map showing stacked beads indicating “scores” associated with locations. Different bead colours represent different stakeholders.



Simple scoring methods are commonly used in the social sciences to quickly and easily get a sense of the values of a group (Lynam et al., 2007). The method developed for this study paired a simple scoring method with the mapping exercise similar to that of Raymond et al (2009) to integrate social values into ES identification. This method provided an overview of how a multiplicity of values, uses, and interests are represented in the study area. It is also possible to perform quantitative analyses on the results of scoring exercises (Sheil & Liswanti, 2007). The simplicity of scoring is one of its primary benefits, however the method is not flexible enough to account for nuances or complicated sets of priorities, and therefore its utility is limited.



Figure 4.4: Photograph of the completed group map of the study area showing site-specific ecosystem service identification and ranking as well as the identification and ranking of large scale services (upper left box).

Participants who finished the mapping activity early were encouraged to observe, discuss, and assist others with the group mapping process, or to take more time to complete their worksheets. Space for additional comments was provided on the worksheets. Participants who expressed concerns about specific threats to the area and did not think the ES approach captured these concerns adequately were encouraged to use this space to write about the threats that worried them.

e. Group tally, reporting back, and conclusions

As participants finished the group mapping activity, they were asked to report the total number of beads they had allocated to each ES to an assistant who listed all 22 possible services, plus the additions and changes made during the discussion on a white board. At the end of the evening, the white board revealed the top priority ES as determined by group tally (see Table 5.3 for the results of this exercise). A brief summary and discussion of the group tally was led by the facilitator.

4.3.2.4 Workshop 2

a. Workshop setting, facilitator, assistants, participants, and welcome

The setting and cast of facilitators and assistants remained unchanged from that described in section 4.3.2.3.a, except for the inclusion of another senior lecturer in geography to assist with facilitation and observation of the small group discussions. As shown in Table 4.7, 11 stakeholders representing a diverse set of interests and backgrounds participated in Workshop 2. Out of 11 total participants, eight had participated in Workshop 1. Three did not attend Workshop 1, but two of these three participated in pre-Workshop 2 interviews (section 4.3.2.2). The room was organised in a similar manner to the previous workshop and the format of the welcome was also similar, but because the majority of participants were returning for the second workshop, and to save time, lengthy introductions were omitted.

Table 4.7: Workshop 2 participant characteristics.

Group represented	Focal scale of interest & influence	Number of attendees
Auckland Council	Regional	4
Local boards	Local	1
Local interests	Local	3
Conservation interests	Local	2
Local businesses	Local	1

b. Scenario planning

Information about ES can be provided from many different sources, but this information is generally limited in two significant ways: first, it is a static snapshot of the current state of ES, and second, it is not usually considered within a set of comparisons or alternatives (McKenzie et al., 2012). Scenario planning can help to address these problems by incorporating explicit consideration of alternatives and trade-offs using a variety of qualitative and quantitative data sets. When scenarios are developed through participatory processes involving stakeholders, the development of scenarios may itself encourage collaboration and learning (Peterson et al., 2003; Van der Kerkhof & Wieczorek, 2005; Wollenberg et al., 2000). Participatory scenario planning can lead to new insights, surprising findings, the development of consensus or new options being considered, and can ensure that the process is relevant to decision makers (McKenzie et al., 2012).

c. Introduction to scenarios and scenario development

My introductory presentation included a review of Workshop 1; an explanation about why ES approaches are often paired with scenario activities; a description of how the scenarios were developed; an outline of the trends and challenges that are likely to face the study area in the next 30 years; and a description of the three scenarios that I developed for the workshop. Participants were given an opportunity to ask questions and make comments at the end of the presentation. Instructions were then given regarding the next phase of the workshop.

The scenarios developed for Workshop 2 utilised resources collected during the preliminary research phase 1 and the data provided by participants during pre-workshop interviews and Workshop 1. Following Biggs et al. (2010), with additional ideas incorporated from various other sources (Francis et al., 2011; McKenzie et al., 2012; Millennium Ecosystem Assessment, 2005d; Peterson et al., 2003; Wollenberg et al., 2000), several possible focal issues were identified and a system analysis was conducted to identify people, institutions, and ecosystems connected to possible focal issues. Major drivers, uncertainties, and possible alternative trajectories were identified. Scenario narratives were developed that tracked key indicators relevant to the focal issues. Plausible winners, losers, and trade-offs associated with each scenario were identified. Table 4.8 below summarises the key elements of the scenarios developed for Workshop 2 (the detailed scenario documents are included in Appendix E).

Table 4.8: Key elements of scenarios for Workshop 2

Key elements of scenarios for workshop 2						
	Core story	Key uncertainties	Key changes	Winners	Losers	Trade-offs
Scenario 1 - Eco-community	The area is characterised by village centres, good access to the harbour, an eco-tourism and recreation-based economy, and good environmental quality.	Population dynamics	Some gentrification, slow rate	Upper middle class residents/renters	Low income residents/renters	The wastewater purification and treatment services provided by the study area are improved by shifting more of the treatment to land, but this comes with an increased cost to ratepayers and an increase in landfill contamination of groundwater in other areas. The improvements made to the regulating services that lead to improvements in water quality, ecological quality, and stormwater management increase bird and other wildlife populations (existence values) and improve many of the supporting ecosystem services. But while there are increases in population densities of many species, there are also dramatic increases in the number of people seeking to harvest food from the area and a balance of provisioning services is hard to strike. Landscape amenity is limited because of spread of mangroves and limited access due to
		Economic structure	Ecotourism and recreation, local commercial/light industrial	Small business owners		
		Infrastructure	Ferry, harbourmaster, general improvements to roads/walkways/bikepaths			
		Water quality	Improvements from upgrades to MWTP, installation of wetlands and other natural stormwater management			
		Ecological quality	Improvements all around	Birds, other wildlife		
		Cultural heritage	Preservation highly valued			
		Landscape amenity (?)	Mixed: mangroves spread, access limited, but use still increases due to improved water quality			
Scenario 2 - Beach chic	The area is characterised by boutique-based town centres, excellent access to the harbour, a recreation-based economy, and good environmental quality.	Population dynamics	Rapid gentrification	Property owners, wealthy residents	Low income residents/renters	The wastewater purification and treatment services provided by the study area are improved by shifting more of the treatment to land, but this comes with an increased cost to ratepayers and an increase in landfill contamination of groundwater in other areas. The improvements made to the regulating services that lead to improvements in water and ecological quality are limited by the changes made to the shoreline and substrates in the area put in place to improve beaches (and therefore increase the cultural value of the area). Critical wildlife habitat (existence values) is significantly reduced by development (cultural values). With improved access and regulating services there are also dramatic increases in the number of people seeking to harvest food from the area. This demand leads to the decline of provisioning services associated with fish and other wild foods.
		Economic structure	Recreation, commuter economy	Small business owners		
		Infrastructure	Hovercraft, harbourmaster, vast improvements to roads/walkways/bikepaths, removal of working port			
		Water quality	Improvements from upgrades to MWTP			
		Ecological quality	Improvements limited by noise/habitat area, major ecological changes due to beach substrate		Birds, other wildlife	
		Cultural heritage	Development prioritised over preservation		Iwi	
		Landscape amenity (?)	Improvements all around			
Scenario 3 - Industrial integration	The area is characterised by sprawling town centres, an industrial-based economy, limited access to the harbour, and severely damaged environmental quality.	Population dynamics	Expansion of local working class	Population of greater Auckland	Local residents	Supporting, regulating, provisioning, and cultural services all decline due to pressure placed on the system by an influx of unauthorised industrial discharges, an increasing number of overflows from MWTP, an increase in contaminants from roadways, and invasive species.
		Economic structure	Industrial	Industry		
		Infrastructure	Expansion of working port, increased dredging			
		Water quality	Declines significantly			
		Ecological quality	Declines significantly		Birds, other wildlife	
		Cultural heritage	None			
		Landscape amenity (?)	Declines significantly			

d. Small group scenario discussions

I divided the participants into two small groups of five and six individuals each. Group composition was purposefully chosen to distribute representatives of different focal scales and interests as evenly as possible between the two groups. One assistant was assigned to each group to observe the discussion, take notes, answer questions, and if needed, help the group stay focused on the discussion questions and complete the activities in the allotted timeframes. Groups then chose representatives from within the group to serve as a moderator, scribe, timekeeper, and presenter. The two groups each discussed one unique scenario and one common scenario, and then reported back to see how discussions compared and contrasted. Group 1 worked on scenarios 1 & 3 and Group 2 worked on scenarios 2 & 3. Participants had approximately 40 minutes to respond, as a group, to three questions about each scenario:

Question 1: Who (or what) do you think are the winners and losers in this scenario?

Question 2: What are the trade-offs that are made, in terms of the provision of ecosystem goods and services (see attached list if needed), for this scenario to come about?

Question 3: How do you feel about the trade-offs that have been made in this scenario?

The questions were designed to encourage holistic thinking about ES by focusing on the trade-offs associated with maintaining some services over others. Participant answers to the scenario questions were written on a large (A0 size) worksheet with markers so that a written record of the group's answers could be kept and presented later on to the other group. With the approval of all participants, audio recordings were made of the group discussions to help capture this data.

e. Presentations and discussion

Once the small groups completed the worksheets, they nominated someone from within the group to present the findings on their unique scenario to the rest of the participants in a brief (approximately five minute) presentation. These findings were then discussed by the whole group. The whole group then discussed the findings relating to the common scenario (scenario 3). The facilitator encouraged the large group discussion by asking the group if there was information missing that would have helped them to understand the implications or ramifications of the scenarios.

f. Conclusions, thank you, and workshop evaluation

I briefly drew conclusions from the evening's discussion, thanked the participants and asked everyone to complete a brief (seven question) anonymous workshop evaluation which included five Likert-type scale questions (Likert, 1932) and two open-ended questions. Likert-type scales utilise a summated scale to assess survey respondents' attitudes towards a given topic. This evaluation was designed to quickly and easily capture a range of data about participants' workshop experiences. Statistical analysis of these Likert-type scales must be undertaken with care to avoid the misrepresentation of results (Cohen et al., 2000); therefore proportional responses are primarily used to describe the results obtained from all 11 participant evaluations.

4.3.2.5 Continued engagement with participants

Post-workshop communication with participants was carefully maintained in accordance with my constructivist, participatory, and pragmatic epistemologies (Creswell, 2003). For example, a summary of the workshop proceedings and preliminary findings was sent to all workshop participants via email for review and feedback following the completion of both Workshops 1 and 2, and two general project updates were sent to workshop participants during the third and final stage of the research to keep them up to date on research progress. I communicated my availability and openness to feedback from participants at every opportunity. This proved to be a useful stance. Following the second workshop, three emails were received from participants who had questions, comments, or concerns related to the structure, purpose, and direction of the research. This input was carefully considered and responded to on a case-by-case basis. A theme of suspicion and frustration about the usefulness of the research and the ways that it would be utilised connected two of the three participant reflections received. It was therefore deemed worthwhile to send a project update via email to all of the workshop participants to clarify some of the common points in case there were other participants with similar issues who had not raised them in writing. These important participant reflections were also addressed by re-visiting the follow-up interview questions, which were adjusted to ensure that common points could be discussed in person with all workshop participants.

In November 2014, with the completion of the research imminent, I invited all of the participants to attend and/or participate in a seminar called "Many Voices of the Manukau: An evening of presentations on the past, present, and future of New Zealand's second largest

harbour’’. In keeping with the co-learning goals of this research, the seminar included presentations from three local experts who described some of their work and research relevant to the study area; a collaborative project that involved a local high school and several university lecturers; and a presentation of my own research results. Approximately 40 people attended the event, seven of whom had previously been involved in the research. The aim of this event was to create a space for the sharing of knowledge, stories, experiences, hopes and dreams about the past, present, and future of the Manukau Harbour, as a thank you to the participants for sharing their knowledge and values with me.

4.3.2.6 Semi-structured follow-up interviews

After both workshops were completed, semi-structured interviews were undertaken with all individuals who could be reached and who participated in either one or both workshops. Interviews were conducted at a time and place convenient for the interviewee and took approximately one hour. Interviews were recorded and then transcribed (with the permission of the participant), and notes were taken. A total of 14 follow-up interviews were conducted. Three participants could not be reached for follow-up interviews; all three participated in the first workshop but not the second. Everyone who participated in the second workshop participated in a follow-up interview.

Copies of the list of mapped and scored ES, blank maps of the study area, and scenario descriptions were available during the interviews to encourage detailed discussion about the workshops and to enable participants to add information to their data sets. Explanatory type questions were asked to explore how the modelling process affected participants (Korfmacher, 2001). Questions focused on previous instances of conflict surrounding environmental issues in Mangere Inlet and the effects the modelling process had on participants personally, as well as on relationships with other stakeholders. Some questions focused on understanding participant perception of the accuracy and effectiveness of the maps produced by the exercise. See Appendix F for a copy of the interview schedule. See section 4.3.3 below for an analysis of the follow-up interviews.

4.3.2.7 Questionnaire

Four participants expressed concern at various points in the study regarding how the research would address problems of stakeholder representation; in particular, three of these participants pointed out that fishing and boating interests appeared to be under-represented in the workshops. Efforts were made during the early stages of Phase 2 to engage fishing and

boating representatives, but these attempts were unsuccessful. In keeping with feminist and participatory paradigms, particularly the tenets of conducting adaptive collaborative research and the representation of marginalised groups, a further attempt to incorporate fishing and boating interests was made by developing a questionnaire which was approved by the UAHPEC and administered to 17 people who were fishing, boating, or gathering wild food at four popular locations in the study area (Figure 4.5). To access a diversity of respondents, questionnaires were given out over a range of dates and times including two weekend days and two weekdays, and two mornings and two afternoons (Table 4.9).

Figure 4.5: Map of popular fishing, boating, and food gathering locations in the study area where questionnaire was administered to one or more participants.



Table 4.9: Fishing, boating, and wild food gathering questionnaire.

Location	Date	Time	# Questionnaires
Old Mangere Bridge	14.08.12	3-4 pm	2
Boat ramp at Mangere Bridge	14.08.12	3-4 pm	0
Old Mangere Bridge	18.08.12	9-11 am	3
Boat ramp at Mangere Bridge	18.08.12	9-11 am	1
Wharf 2	18.08.12	11 am - 12 pm	3
Mangere Boating Club	18.08.12	11 am - 12 pm	1
Old Mangere Bridge	19.08.12	1-3 pm	3
Old Mangere Bridge	20.08.12	9-10 am	4
Boat ramp at Mangere Bridge	20.08.12	9-10 am	0

The postgraduate research assistant administered the questionnaire by approaching people who were conducting fishing, boating, or wild food gathering activities and asking if they were interested in giving approximately 10 minutes of their time to participate in a study. If they expressed an interest, individuals were provided with a copy of a Participant Information Sheet (see Appendix G), an oral explanation of the research, and an opportunity to ask questions about the project. Participation in the research was anonymous; no personal information or identifying details about participants was collected. By completing the questionnaire, individuals consented to participate in the study and have their data used in the associated research. One questionnaire was completed per participant, all participants were at least 16 years of age, and the questionnaire was administered by asking participants the questions provided on the sheet and writing their responses down; participants did not complete the questionnaire on their own.

4.3.3 Research Phase 3: Analysis and evaluation

An outline of the final research phase is shown in Table 4.10 and described in more detail in the following sections. This phase of the research was undertaken from December 2012 to December 2014.

Table 4.10: Research phase 3 – Analysis and evaluation		
Tasks	Associated methods	Objectives
Transcription and analysis of interviews and other data such as worksheets, reflections, emails, and audio visual data	Transcription, coding, (Miles & Huberman, 1994; Ryan & Bernard, 2003), constructivist grounded theory analysis (Charmaz, 2014; Glaser & Strauss, 1967), photo-elicitation (Harper, 2002) and photo and video analysis (Suchar, 1997).	To analyse the data for patterns, boundaries, integration, connections, and develop data driven theory.
Analysis of maps and models	Descriptive and inferential statistics (after Brown et al., 2012; Raymond et al., 2009), comparative studies.	To analyse the data for patterns, boundaries, integration, connections, and develop data driven theory.
Evaluation of all data and research results	Data comparison with expected outcomes derived from literature review.	To evaluate the integration of social values into ES frameworks and generation of social capital. To evaluate the usefulness of the methods trialled in workshops.

4.3.3.1 Evaluation of participatory modelling in general

The evaluation of participatory projects is notoriously difficult (Pahl-Wostl & Hare, 2004), as is the validation of modelling activities (Abraham & Parker, 2008). The evaluation of PM exercises, which include elements of both participation and modelling, should therefore be undertaken with extreme care; choosing evaluation criteria and the data by which PM activities is judged can be the most contentious aspect of the evaluation process, and should involve stakeholder participants from the outset and throughout the process (Adger, 1997). Issues associated with the evaluation criteria, bounding, focus, timing, and purpose of the research were all considered in consultation with stakeholders in adherence to best practice protocols, as described in section 4.3.1.1.

4.3.3.2 Coding analysis and evaluation

Coding is central to whole-text analysis (Miles & Huberman, 1994) and is a critical method utilised to analyse the data collected during this study. Coding requires the researcher to make judgements about the meanings inherent in blocks of text (Ryan & Bernard, 2003). In the process of coding data the researcher must sample, identify themes, build codebooks, mark texts, construct models, and test these models against empirical data. Several theoretical traditions utilise coding extensively; grounded theory, schema analysis, classic content analysis, content dictionaries, analytic induction, and ethnographic decision trees are some of the most well-known (Ryan & Bernard, 2003). This research analysis is based in constructivist grounded theory traditions (Charmaz, 2014), which emphasise that research is an iterative process through which the researcher becomes increasingly knowledgeable about the data as the research progresses (Bulmer, 1979). Grounded theorists identify categories and concepts which emerge from data and link these concepts to existing theories using coding (Ryan & Bernard, 2003).

Text that reflected single themes were analysed, although sections of text have often been coded to several themes rather than to a single one in an attempt to more accurately reflect the complexity of the topics discussed (Krippendorff, 1980). Finding themes can be difficult because they can often be abstract constructs identified before, during, and after data collection (Ryan & Bernard, 2003). However, with the help of the literature review, secondary source data, and extensive stakeholder consultation prior to conducting fieldwork, many themes were identified before the primary data collection was conducted (Bulmer, 1979). These themes were then refined as the data analysis progressed to more accurately reflect the themes captured in the primary data (Miles & Huberman, 1994). Constructivist

grounded theory encourages researchers to develop themes for use in the analysis and evaluation of data, but also allows for the emergence of new and unexpected themes as the data analysis and evaluation unfolds (Charmaz, 2014). Memoing was used to record the process of emergence and the relationships between themes. Code notes (describing the concepts that are being discovered), theory notes (summarizing ideas about what is going on in the text), and operational notes (related to practical things) were also kept (Strauss & Corbin, 1990).

Building codebooks is a way to organise lists of codes into hierarchies. The NVivo 10 software encourages this type of analysis with its tree node and free node structure, following MacQueen, McLellan, Kay, and Milstein (1998). Miles & Huberman write that “coding is analysis” (1994, p. 56), but Miles (1979) cautions that coding is supposed to be data reduction, not data proliferation. I have utilised a “codes as tags” approach to coding, in which sections of text are marked off for later retrieval or indexing. This approach is in keeping with grounded theory analysis methods (Ryan & Bernard, 2003).

All pre- and post- workshop interviews conducted as part of this research were professionally transcribed (see Appendix A for a copy of the confidentiality agreement related to this service). I reviewed each transcript and also allowed participants to review and edit their transcripts so they could make clarifications and changes. Five participants took advantage of this opportunity. After being approved by participants, the transcripts were analysed using the QSR International NVivo 10 computer software, which enables coding of complex data and recognition of connections and correlations among data sets. All additional written materials such as pre- and post-workshop reflections, emails, and worksheets were also analysed and evaluated using this programme and associated methods.

To determine the extent to which and under what conditions the PM methods described in this chapter could improve ES frameworks and resolve wicked coastal problems, data was initially coded for five qualities: integrating social values, enhancing social learning and capacity building, increasing transparency, mediating power, and building trust. A justification for these particular social qualities was provided in Chapter 3. Table 4.11 lists the definitions that have been utilised in my codebook to guide the coding process. As coding progressed, it became clear that six other categories were needed to distinguish specific elements of the data (Table 4.12). The categories of “Method criticism” and “Method praise” were added to better capture the strengths and weaknesses of the PM method.

Table 4.11: Five social qualities to evaluate and associated definitions coded for in NVivo 10.

1) Building trust
Elements that encourage development of trust in the model or trust among participants and organisers. Also can be elements that hinder trust building.
2) Enhancing social learning and capacity building
Category includes references to: sharing knowledge to answer a question or resolve a problem; co-learning about ecosystem function, underpinning services, and social values; developing communication and negotiation skills; and contributing to knowledge generation and network development.
3) Increasing transparency
Category includes references to elements associated with mechanics of process openness, communication, and accountability. Also may refer to user-friendliness, flexibility, ease of updates, quality of documentation, and simplicity.
4) Integrating social values
Category includes references to integrating opinions about social values, especially representativeness, inclusiveness, and enabling participation. Should NOT include references to learning with and/or about others (included in the Social learning and capacity building category) or the mechanics/process of integrating social values (included in the Transparency category).
5) Mediating power
Elements that enhance the management of power relations. This is a critical element of any PM process which should be considered from the inception of a project to avoid engaging only the ‘usual suspects’ (Stringer et al., 2006), and to address inequalities which may diminish the capacity of participants to meaningfully engage (Reed, 2008). Elements that hinder the management of power can also be included.

Table 4.12: Additional characteristics and associated definitions coded for in NVivo 10.

6) Context
Background, history, information and opinions about the study area that provides context for the study but may not be specifically about the study methods.
7) Map
Any comments related specifically to mapping activities.
8) Scenarios
Any comments related specifically to scenarios.
9) ES approach
References to the ES approach, specifically related to the language of ES and the process associated with valuing, scoring, ranking, prioritising, and trading off ES. Should avoid including references to mapping and scenario planning if possible.
10) Method criticism
Any criticism of the project methods. May not fit into any of the other nodes. Not all of the comments coded here are strictly criticism; some may just be suggestions for alternative ways to undertake the study or ways to make the study better.
11) Method praise
Any praise of the project methods. May not fit into any of the other nodes.

The NVivo software provides several different query functions that can be utilised to analyse codes and themes. I used these functions to develop data nodes, tables, and charts to

illustrate where codes do or do not overlap. Where appropriate, this process enabled me to explore connections and boundaries among and between data sets.

4.3.3.3 Audio visual footage

Photographs (and video footage) are useful in mixed methods research because they provide a record for future analysis (Collier, 1967) and encode an enormous amount of information (Grady, 2004). They also provide research participants with the means and opportunity to reflect on aspects of their lives that they might not otherwise consider at length (Rose, 2007). This study used photo-elicitation, the insertion of a photograph or other image (such as a map) into an interview, to prompt discussion about things that might not be easily accessed without the image (Harper, 2002, p. 13). Collier (1967, p. 49) argued that it is only through interviewing that the information carried by the photo can be accessed by the researcher. This argument is limited in the age of Participatory GIS (Dunn, 2007), a method that has made it possible to collect mapping data from a wide range of participants without conducting interviews by utilising online mapping programs. However, there are many layers of data that can only be accessed using an interview process, and the combination of interview and photo-elicitation is clearly powerful. Latham (2003) described how photos provided some distance from the ordinary routines of his subjects, enabling them to articulate some of their taken-for-granted practical knowledge about their everyday experiences negotiating public spaces. In summarising the various uses of photographs in research, Rose explains that photos “can alter both the quantity and the nature of the interview material” (Rose, 2007, p. 241). Rose (2007) takes pains to emphasize that ethical and reflexive vigilance is required of the researcher when these methods are utilised.

Digital photographs and audio/video footage were captured from Workshop 1, and digital photographs, audio/visual footage, and audio recordings were captured from Workshop 2. Audio footage from Workshop 2 was loaded into NVivo 10, transcribed where pertinent, and coded after section 4.3.3.2. Photographs and footage were analysed for visual examples of the codes described in section 4.3.3.2, but also for additional interactional features that might have been missed during the proceedings and not obvious from written or audio materials. This modified grounded theory approach to visual data analysis is based loosely on the work of Sucher (1997), who developed an approach to photo analysis that is analogous to coding.

4.3.3.4 Maps and scenarios

The qualitative and participatory paradigms associated with this project guided the use of maps and scenarios as tools to stimulate in-depth data sharing from participants (Rose, 2007) and to generate opportunities for participant collaboration and learning (Peterson et al., 2003), rather than to provide extensive quantitative data for analysis. The process of map development and the role of the map and the scenarios as learning tools was therefore more important than the validation and verification of the model itself (Voinov & Bousquet, 2010).

The worksheets from Workshop 1 were transcribed into Microsoft Excel and correlated with the data points provided on the A0 group map of the study area. Any confusion or discrepancies between the worksheet data and the points provided on the physical map were clarified by discussing them with individual participants. Once any problems with the worksheets and mapping information had been resolved, the map was digitised and the worksheet information was transferred into information points which could be accessed using ArcGIS. The scenario worksheets and other data obtained from Workshop 2 was also transcribed and analysed using the coding methods described in section 4.3.3.2.

Descriptive and inferential statistics were used to explore the effectiveness of PM methods in revealing social values of the ES associated with Mangere Inlet and surrounding areas, and I intersected the ES point data with a GIS land use designation layer developed by the Ministry for the Environment and obtained from the New Zealand land cover database (LCDB) to determine whether there were significant relationships between social values and land or water designations (after Brown et al., 2012; Raymond et al., 2009). Information collected during Workshop 1 from worksheets and group mapping was digitised and imported into ArcGIS.

4.3.3.5 Limitations of methodological approaches

The methodological approaches outlined in this chapter were developed with the intention of addressing several key gaps in current ES approaches. First, ES approaches benefit from the integration of social values (Daniel et al., 2012). Second, while the literature often calls for a diverse group of stakeholders to be involved in identifying and valuing ES, ways to incorporate, value, and reconcile diverse knowledge sets and interests have so far proven to be unsatisfactory (Reyers et al., 2013). Finally, many of the existing ecosystem service approaches require long term, large scale, and costly methods to produce outcomes (e.g. Costanza et al., 1997; Guerry et al., 2012; Tallis & Polasky, 2011; Videira et al., 2011).

Limitations are associated with each of the methodological approaches developed to address these current gaps. These will be discussed in the concluding chapter (section 7.4). In general, the knowledge generated from this research is recognised as being situated, partial, and prejudiced. To address this inherent limitation of all knowledge, a transparent and reflexive methodological approach has been utilised throughout the research.

4.4 Conclusion

This chapter has described the underlying knowledge claims, strategies of inquiry, and methods employed within this thesis. Primarily mixed qualitative methods were utilised during three interconnected research phases which were designed to explore the usefulness and applicability of PM methods and ES approaches in the context of resolving wicked coastal problems in Mangere Inlet and the Manukau Harbour. The first research phase focused on obtaining background information, study context, and consulting with key stakeholders to develop appropriate research methods. The second research phase was composed primarily of field work; the primary data collected during this phase was acquired from workshops; semi-structured interviews; and model outputs such as maps and worksheets. The third and final research phase consisted primarily of analysis, evaluation, and continued contact with study participants as needed. In the following two chapters, the results of this research will be discussed.

5. Participatory modelling and ecosystem services approaches

5.1 Introduction

This chapter describes the results of the PM exercises and related research undertaken in Mangere Inlet, Manukau Harbour, and discusses the implications of these findings in terms of the contributions that they make to existing ES approaches and decision-making frameworks. The discussion of Workshop 1 reveals several important findings about how ES associated with the study area are perceived and valued by a diverse group of stakeholders operating at a range of scales. The importance of cultural values is particularly evident from this work, and implications for decision-making frameworks based on these findings are discussed along with some lessons learned from this particular workshop. The discussion of Workshop 2 focuses on successes and challenges arising from the scenario planning methods deployed in this research. Lessons learned from the application of a short-term scenario planning process, in an area associated with a long history of conflict and mistrust, are highlighted in this section. The findings and associated implications arising from the recreational fishing questionnaire are discussed in the final section of the chapter. The following chapter will evaluate the research results further, using a novel analysis framework to determine the capacity of the PM methods to integrate social values into an ES framework and generate four elements of social capital that are needed to resolve wicked problems.

5.2 Workshop 1

5.2.1 Ecosystem services list

In a short timeframe (approximately 20 minutes), participants discussed, clarified, and modified the original list of 22 coastal ES in an effort to make the list of services more applicable in the context of Mangere Inlet, Manukau Harbour (see Chapter 4 section 4.3.2.3.c). Changes that participants agreed upon are compiled in Table 5.1, and an updated ES list is included in Table 5.2. Three types of issues with the original ES list identified by participants either during the workshop or in follow-up interviews include: 1) missing social values; 2) disagreement with the ES definitions or distinctions; and 3) confusion about the ES concept and service definitions.

Missing social values were the most common problem with the original ES list identified by participants, with four out of the five changes undertaken to account for this gap. The identification of missing values by a diverse group of stakeholders is needed to improve the application of ES frameworks for the purposes of addressing wicked problems (Davies et al., 2015), but Chan et al. (2012) caution that not all values can or should be accounted for in an ES framework due to the centrality of certain values to some epistemological and ontological frameworks. For example, a tangata whenua representative pointed out that the ES approach did not capture many of the deeper elements of Māori cultural identity. To a limited extent, this problem was addressed by adding the customary and historic service to the ES list (Tables 5.1 and 5.2), and by creating opportunities for a dialogue about the boundaries and overlap between the ES framework and Māori world views, but this problem will require further work to address in a more meaningful manner. Several sophisticated frameworks have been developed in the last 15 years to provide Māori with culturally appropriate environmental assessment and monitoring tools (Harmsworth & Awatere, 2014), but this work has not yet been undertaken for an ES framework. A small but critical step forward, however, would be to expand any process of ES identification and valuation to include a cultural services category that assesses customary and historical values.

The second problem with the ES list was that almost all participants expressed some disagreement with ES definitions, distinctions between services, or otherwise felt that their values could not be accurately described using the ES approach. The second change that participants made to the original ES list (Table 5.1) falls into this category: participants felt that the original title of “Water purification and waste treatment” did not describe the service adequately. Participants often described their disagreement with the list of services at length

during their interviews. For example, participants expressed dissatisfaction with the distinctions between the two regulating services of water regulation, and water purification and waste treatment, and the distinctions between the provisioning service of capture fisheries and the cultural recreational service of fishing. The ambiguities among these definitions could cause problems in terms of service ranking and prioritisation for categories that shared similar scores (see section 5.2.2). However, the debates about the categories and service definitions that occurred during both Workshop 1 and interviews provided an important collaborative learning opportunity for both researchers and participants, and served to ‘break the ice’ and get participants thinking critically about the ES approach and its particular application to the study area. Additionally, the worksheet questions (Appendix D) encouraged participants to reflect on and clarify their own conceptions of the ES list using examples and language that was comfortable for each individual.

Finally, three participants expressed confusion related to the ES vocabulary, the interrelatedness of the services and categories, and/or how to utilise the ES approach to capture their values. Opportunities were provided during Workshop 1 for participants to ask questions and clarify the ES language and definitions, and some participants continued to debate amongst themselves and with researchers long after the formal list discussion session ended. Not all participant confusion was addressed by this process, but all participants comprehended the ES list and associated definitions enough to successfully complete the mapping and ranking activities. However, the confusion expressed by these three participants in relation to the ES approach is likely to have reduced the research transparency, social learning, and capacity building opportunities for these individuals.

Table 5.1: Changes to the original ES list agreed upon by participants during Workshop 1.

1) The title of the provisioning services – water category was changed to water transport (4), and the subject matter was expanded to include ferries and other water transportation methods, as well as air transportation over water so that Auckland Airport considerations could be incorporated into this category.
2) The regulating services – water purification and waste treatment category title was changed to water purification, waste treatment, and waste disposal (11).
3) The regulating services – pollination/assistance of external fertilization category title was changed to ecological services (14), and the subject matter was expanded to include passageways for spawning, biodiversity, overall health of the harbour, and its ability to support plant and animal life.
4) Participants agreed that the cultural services section needed to be expanded to include a customary and historic (16) service. This service includes all references to areas of historical significance or areas associated with customary practices such as the waka portage crossing (outrigger canoe).
5) The cultural services – existence values category was updated to include existence, landscape amenity, and access values (18), expanding the category beyond the inclusion of references to beliefs that all species are worth protecting no matter what their direct value to humans, to include references to landscape amenity values and the belief that all people should have access to the harbour for their personal use and fulfilment.

Table 5.2: Updated list of ecosystem services provided by oceans and coasts with examples relevant to Mangere Inlet and Manukau Harbour developed at Workshop 1 with input from participants.

Category	Subcategory	Examples
Provisioning services		
1. Food	General	Not specified and/or inclusive of all food sources.
	Capture fisheries	Grey mullet, yellow-eyed mullet, rig, and parore.
	Wild foods	Mussels, oysters, and scallops.
2. Fibre		Mangrove wood (construction, boat-building).
3. Biomass fuel		Mangrove wood (charcoal), biofuel from algae.
4. Water transport		Shipping, ferries, other water transport vessels, and air transport.
5. Genetic resources		Marine diversity for bio-prospecting.
6. Biochemicals, natural medicines, and pharmaceuticals	Medicines and food additives	Anti-viral and anti-cancer drugs from sponges, tunicates, and other organisms, and/or seaweed harvest for carrageenans (extract used in cooking and baking).
Regulating services		
7. Air quality regulation		The ocean can act as a sink for airborne contaminants and plants in the ocean make O ₂
8. Climate regulation		Major role in global CO ₂ cycle
9. Water regulation		Natural stormwater management by coastal wetlands and floodplains.
10. Erosion regulation		Nearshore vegetation and shellfish beds stabilizes shorelines.
11. Water purification, waste treatment, and waste disposal		Uptake of nutrients from sewage wastewater, detoxification of PAH's by marine microbes, sequestration of heavy metals.
12. Disease regulation		Natural processes may keep harmful algal blooms and waterborne pathogens in check.
13. Pest regulation		Indigenous biodiversity may limit the spread of invasive species.
14. Ecological services		Innumerable marine species require seawater to deliver sperm to egg, passageways for spawning, etc. Also includes biodiversity, overall health of the harbour, and its ability to support plant and animal life.
15. Natural hazard regulation		Coastal and estuarine wetlands and mangroves and sandbanks protect coastlines from storms.
Cultural services		
16. Customary and historic		Areas of historic significance or areas associated with customary practices such as the traditional outrigger canoe (waka ama) portage crossing.
17. Ethical values	Non-use	Spiritual fulfillment derived from estuaries, coastlines, and marine waters.
18. Existence, landscape amenity, and access values	Non-use	Belief that all species are worth protecting, no matter what their direct value to humans. Also includes landscape amenity values and the belief that all people should have access to the harbor for their personal use and fulfilment.
19. Recreation and ecotourism	General	Either not specified, or both non-consumptive and consumptive use.
	Non-consumptive use	Beachcombing, boating, traditional outrigger canoe (waka ama) paddling, kayaking, bird watching.
	Consumptive use	Fishing, clamming.
Supporting services		
20. Nutrient cycling		Major role in carbon, nitrogen, oxygen, phosphorus, and sulfur cycles.
21. Soil formation		Many salt marsh surfaces vertically accrete; eelgrass slows water and traps sediment, molluscs shells can add substantively to the quantity of sediment.
22. Primary production		~40% global NPP (Net primary production is the rate at which plants produce carbohydrates via photosynthesis after accounting for the plants metabolic use of carbohydrates).
23. Water cycling		96.5% of earth's water is in oceans.

In the short timeframe allocated for this purpose, participants identified, discussed, and resolved several important issues related to the original ES list. Additionally, participants described several threats or concerns related to harbour health, management, and/or governance. These concerns were specifically associated with reduced food gathering capacity in the harbour due to ongoing pollution, MWTP treatment and disposal methods, inappropriate or insufficient economic and social valuation of the harbour, artificial water regulation options for the area, and a lack of safe water access infrastructure. Threats and drivers of change will be discussed in more detail in section 5.2.3.

The discussion of the ES list and related concerns about the study area and the wider Manukau Harbour encouraged social learning among researchers and participants (Reed et al., 2010), and helped to integrate a diverse range of participant's social values into the ES framework (Daniel et al., 2012). The process of modifying the ES framework to include both biophysical and social elements also encouraged participants to reflect on their values and consider them within a broader, interconnected suite of values, risks and uncertainties. As illustrated in the following quote, the discussion of the ES list in association with the mapping activity encouraged participants to think holistically about the study area, while also creating opportunities for participants to consider the area in new and different ways:

Auckland Council employee 2: I suppose I was heartened by the fact that I was surprised by the diverseness of people's approach to it [the ES list and mapping] and the wide view that a lot of people had in terms of the harbour and what it could support. I had the initial impression that people would be focused on their one aspect, but I guess I was pleasantly surprised to see that people were thinking about it more holistically. I guess there were a couple of things; the transport mechanism of the harbour is one that I have never really envisioned as being an important factor, but for some people, it was quite a key part of the harbour and maybe underutilized in terms of its potential.

The time constraints imposed on participants in relation to comprehending and clarifying the ES list proved to be a challenge for some, with five participants commenting that they felt more time to discuss the ES list would have contributed to a better understanding of the ES approach. Additional time allocated to this activity may have increased the transparency of the project, improved participant comfort in relation to

subsequent workshop activities, and heightened opportunities for social learning to occur, as described in the following quote from a local interest representative:

Local community representative 1: For instance, on the ecosystem services construct, what I felt and saw at the first workshop was, that was really hard for people to get their minds around, and that required a lot more time and letting people work through and maybe even modifying, even though there is this international nomenclature for it, maybe more time was needed to get it into New Zealand language and maybe even changing some of the categories for some of the importance in a New Zealand context. Really working with that better and getting people feeling more comfortable about the tools they were using, the construct they were using. That they really identify “okay if I use this term, I am meaning this.”

Although the tight timeframe proved challenging for many, two participants said that the time limitation encouraged the group to stay on task, and was therefore an acceptable compromise over increased transparency and/or social learning opportunities. Two other participants suggested that transparency and social learning could be increased by providing resource materials in advance, thereby allowing participants to familiarise themselves with the ES terminology. While many participants criticised the ES terminology and definitions to some degree, two participants felt that the terminology was explained clearly and that the facilitators helped to clarify any remaining confusion.

5.2.2 Ecosystem service scoring and ranking

Table 5.3 shows the rankings of the 23 ES that were scored during Workshop 1 by 14 participants, and during pre-workshop interviews by five participants (see section 4.3.2 for details). Normalised scores for both data sets are also included to enable comparisons between the rankings. The Workshop 1 and pre-workshop scores were normalised by dividing the total number of values scored for each ES by the number of participants involved in the scoring process. These normalised scores reveal that the two different sets of participants occasionally emphasized different ES. The first three ES listed, recreation and ecotourism, existence values, and ecological services, were all valued more highly by workshop participants than by interview participants, while the fourth (water purification), seventh (customary and historic), and tenth (water regulation) scored higher in the pre-workshop interviews than in the workshop.

Table 5.3: Comparisons of ES category, rank, and value between Workshop 1 and pre-workshop interviews.							
Category	Ecosystem service	Rank	Workshop 1 Total # Values Scored by 14 participants	Workshop 1 normalised score	Rank	Pre-workshop Total # Values Scored by 5 participants	Pre-workshop normalised score
Cultural	Recreation and ecotourism	1	70	5.0	3	11	2.2
Cultural	Existence values	2	55	3.9	4	9	1.8
Regulating	Ecological services	3	43	3.1	5	7	1.4
Regulating	Water purification/waste treatment/disposal	4	28	2.0	2	15	3
Provisioning	Food (TOTAL)	5	16	1.1	5	7	1.4
Cultural	Ethical values	5	16	1.1	8	3	0.6
Cultural	Customary and historic	6	13	0.9	1	18	3.6
Provisioning	Water transport	7	10	0.7	5	7	1.4
Supporting	Nutrient cycling	8	8	0.6	7	4	0.8
Regulating	Water regulation	9	7	0.5	2	15	3
Supporting	Primary production	9	7	0.5	6	5	1
Supporting	Water cycling	9	7	0.5	9	2	0.4
Supporting	Soil formation	10	5	0.4	7	4	0.8
Regulating	Air quality regulation	10	5	0.4	11	0	0
Regulating	Disease regulation	11	4	0.3	11	0	0
Provisioning	Biochems/natural meds/pharmaceuticals	12	3	0.2	11	0	0
Regulating	Erosion regulation	13	2	0.1	9	2	0.4
Regulating	Natural hazard regulation	13	2	0.1	10	1	0.2
Regulating	Climate regulation	13	2	0.1	11	0	0
Provisioning	Biomass fuel	14	1	0.1	11	0	0
Provisioning	Genetic resources	14	1	0.1	11	0	0
Regulating	Pest regulation	14	1	0.1	11	0	0
Provisioning	Fibre	15	0	0.0	11	0	0

The differences in service emphasis made by the two separate groups of participants can be explained by inspecting who was included in each group. The five individuals who participated in pre-workshop interviews (section 4.3.2.2) included Auckland Council employee 4, an MPI employee, tangata whenua representative 1, the local business representative, and a Watercare employee. While the Auckland Council employee, MPI employee, and local business representative did not rank their values in any extreme ways, tangata whenua representative 1 placed a great deal of value on the customary and historic services, and the Watercare employee heavily emphasised the value of the water regulation and water purification and waste treatment capacity of the study area. The emphasis on these particular ES categories aligns with what might be expected from representatives of these stakeholder groups.

Other interesting features of the rankings include that both groups emphasised the same two provisioning services; water transport, and food, and that supporting services did not appear in the rankings until nutrient cycling in eighth place for the workshop participants and in seventh place for the interviewees. This low ranking of the supporting services aligns with the findings of Bryan et al. (2010), who found that supporting services were assigned the lowest social value after cultural, provisioning, and regulating services. Ruiz-Frau et al. (2011) similarly noted that only participants from the academic sector and government agencies mentioned supporting ES.

The only ES on the list that was not associated with any value by Workshop 1 participants as well as interview participants was the fibre category. This is not surprising, as there is no evidence to suggest that fibres from mangroves or other materials found in the study area are used.

A Spearman's rank-order correlation was used to compare the separate rankings obtained in Workshop 1 and the pre-workshop interviews (Equation 1). This analysis yielded a correlation coefficient (r_s) of 0.843, indicating a statistically significant relationship between the two data sets ($p \leq .0005$) (Zar, 1984, Table B.19).

Equation 1: Spearman's rank equation

$$r_s = 1 - \frac{6 \sum d^{(2)}}{n^3 - n}$$

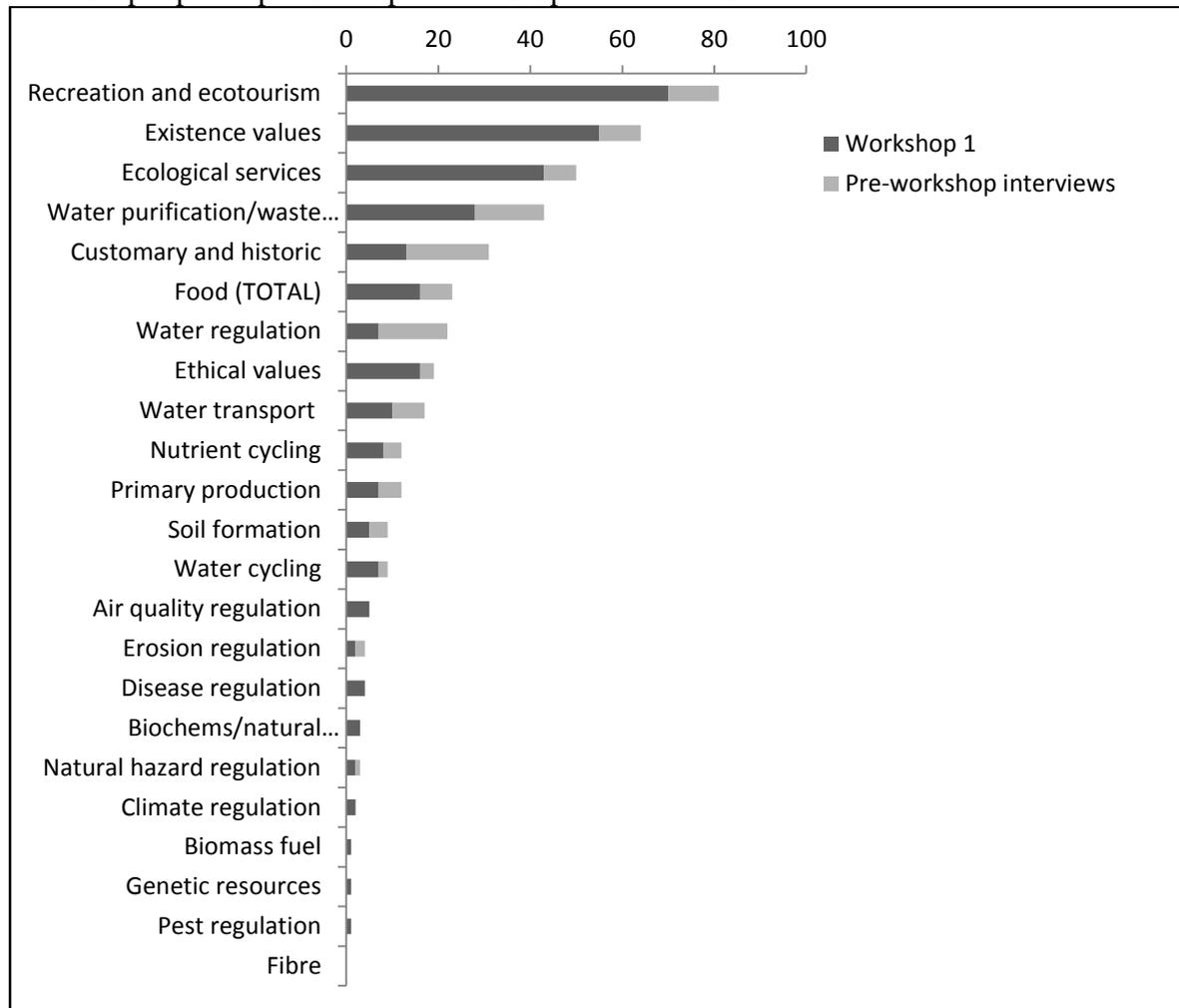
$$\sum d^{(2)} = 318.5$$

$$n = 23$$

$$r_s = .843$$

When the data from Workshop 1 and the pre-workshop interviews was combined into a single set (Figure 5.1), the top four services remained unchanged from the Workshop 1 data, but several other ranking adjustments occurred. In the top ten of the combined data set, the food service moved down from fifth to sixth place, while customary and historic services moved up to fifth from sixth place. Ethical values moved down from a tie at fifth place in the workshop to eighth place in the combined data set, while water regulation moved up from ninth place in the workshop rankings to seventh place in the combined set. Water transport took ninth place in the combined rankings, moving down from seventh place in the workshop. Finally, nutrient cycling and primary production are tied for tenth place in the combined rankings, moving from eighth place and ninth place respectively in the workshop rankings.

Figure 5.1: Ecosystem services categories ranked in order of importance by a combination of Workshop 1 participants and pre-workshop interviewees.



Combining the individual service values by overarching ES categories (Figure 5.2) reveals that all three data sets emphasise the cultural services category above the others, with 50% of the total assigned value from Workshop 1, 37% of the total value from the pre-workshop interviews, and 47% of the total value from the combined data set associated with this category. The regulating services category received the second highest value, with 31% (Workshop 1), 36% (pre-workshop interviews), and 32% (combined) allocated. Interviewees ranked supporting services third (14%) and provisioning services last (13%), while in the Workshop 1 and combined data sets provisioning services were ranked third (10% and 11%, respectively) and supporting services were last (9% in Workshop 1 and 10% in the combined data set).

Figure 5.2: Percentage of ecosystem services category valued by Workshop 1, pre-workshop, and combined data sets.

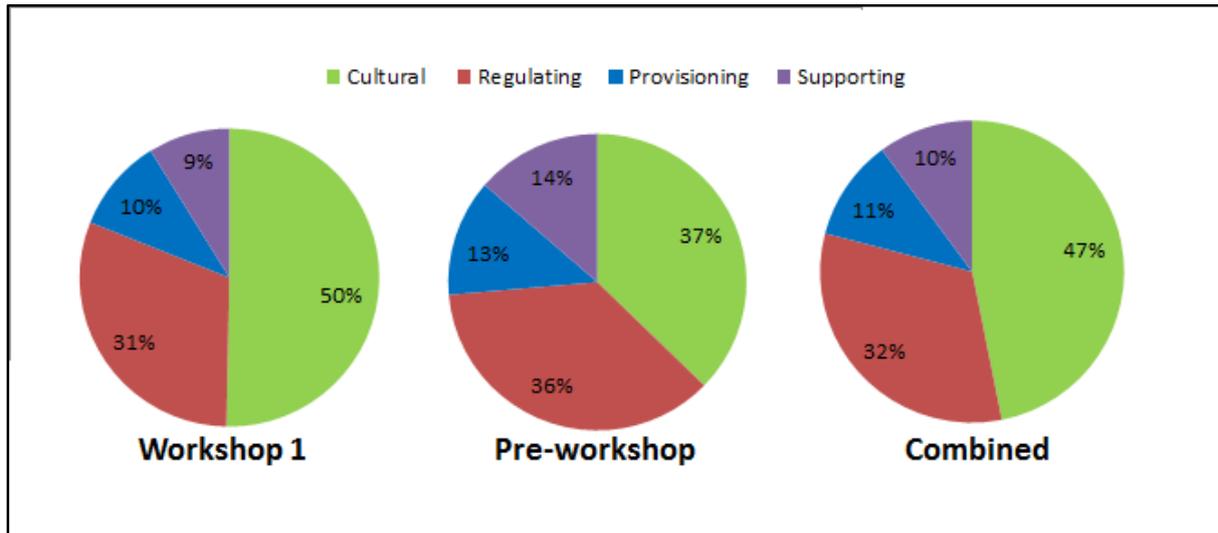
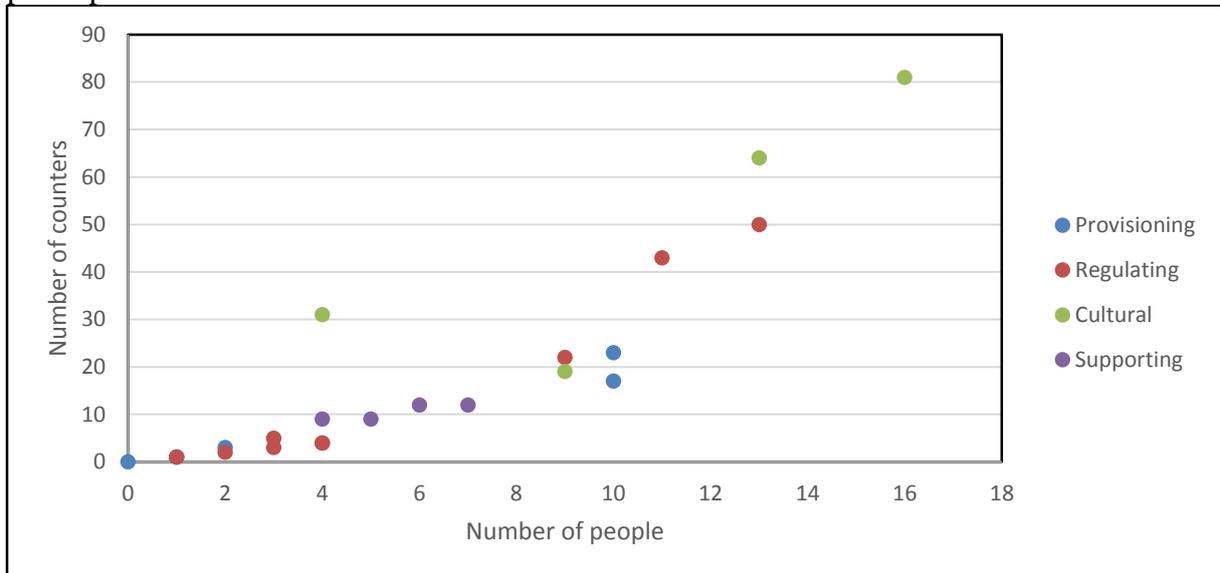


Figure 5.3 shows the relationship between the value associated with each ES and service category (number of counters), and the number of participants who valued it. In general, the more people that value a service, the more counters (beads) there were; however, the customary and historic category was highly valued but only by a few participants.

Figure 5.3: Ecosystem service category valuation by number of bead counters and number of participants.



It is useful to consider each data set (pre-workshop and Workshop 1) on its own as well as in comparison with the others to discern overall trends or significant differences, because while the data collection methods were designed to provide comparable data sets,

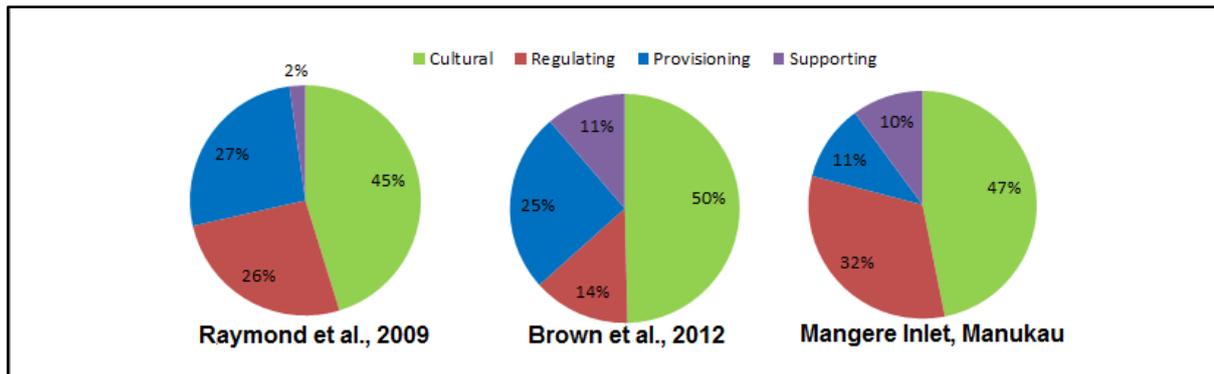
there were very different social factors at work in the two settings (one-on-one interviews vs workshop), and this may have influenced the valuation process to some extent. For example, three participants explained during their follow-up interviews that they adjusted their workshop mapping and valuation process when they noticed how other people were doing it. While this kind of adjustment might be a concern for a purely statistical data extraction process, this outcome is an anticipated element of a social learning experiment (Pahl-Wostl & Hare, 2004). However, it is not possible to re-create this experience in one-on-one interviews. The participant quoted below added that she would have liked more time to discuss the valuing process with other participants so that she could learn more from them:

Auckland Council employee 3: I found it really hard to divvy up those points. I thought I had done it quite well and then I would look over my shoulder and see someone else had given two to this and one to that and it pretty much had such a big range of things that they valued so I would cross it all out and try and spread it out. I go with what I know – but if there had been more time it would have been nice to say ‘why is that?’ Talk with that person and say ‘why do you see that like that?’

Further evaluation of the ES values produced by the PM methods used in this study was conducted by comparing the frequency distribution of the results from this study with two published studies of ecosystem values; the work of Raymond et al. (2009) and Brown et al. (2012). Comparison of results from Mangere Inlet, Manukau with these two studies is instructive because all three studies included a diverse group of stakeholders in the identification, valuation, and mapping of ES and relied primarily on the ES category designations described in the Millennium Ecosystem Assessment (2003), but allowed for modification of the sub-categories as needed to provide site-specific context. The methods of participation used, the kinds of stakeholder participants involved, and the environmental contexts of these studies were very different, however, so comparisons must be made with caution. Raymond et al. (2009) used structured one-on-one interviews to collect their data from the South Australian Murray-Darling Basin, while Brown et al. (2012) used internet-based PPGIS to gather theirs from Grand County, Colorado. Neither of these studies takes place in a coastal environment, nor do they involve a social learning experiment. In fact, the definition of ‘participation’ utilised in each of these studies is quite different; according to the categories described by Renn and Schweizer (2009) (Table 3.4), Raymond et al. (2009) takes

a functionalist approach to participation, while Brown et al. (2012) is closer to a neoliberal one. This study, meanwhile, most closely aligns with Renn and Schweizer's (2009) emancipatory and post-modern definitions of participation. Despite these different theoretical frameworks, the methodological similarities among the three studies merit some comparison of study results.

Figure 5.4: Comparison of the percentages of ES valuation by category among three different studies.



Comparing the findings of Raymond et al. (2009)², Brown et al. (2012), and this study by overarching ES category (Figure 5.4), all three studies indicate that cultural services are the first priority for participants, with 45% of the total value assigned to cultural services in the Raymond study, 50% in the Brown study, and 47% in this study. Supporting services were the lowest ranked category in all three studies, with 2% (Raymond), 11% (Brown), and 10% (this study). The studies by Raymond et al. (2009) and Brown et al. (2012) both ranked the provisioning services as the next most valuable, with the Raymond participants allocating 27% of the total value to these services, and the Brown participants allocating 25%. The regulating services followed suit in both of those studies, with 26% in the Raymond study, and 14% in the Brown study. This study, on the other hand, ranked the regulating services as the second most valuable, with those services capturing 32% of the total value allocated by participants, and the provisioning services in third place, with 11%.

A Spearman's rank-order correlation analysis (Table 5.4) shows that a statistically significant correlation exists among the findings from all three studies. To perform this analysis, services that were not comparable had to be cut from the lists, but all 23 services from this study were comparable with services ranked by Raymond et al. (2009), 17 services

² Figures were obtained from Table 1 (p. 1307) and include all of the ecosystem service intensity values provided in that table.

were comparable between this study and Brown et al. (2012), and 21 services were comparable between the Raymond and the Brown studies.

Table 5.4: Spearman’s rank correlation analysis comparisons.

Studies Compared	<i>n</i>	<i>r_s</i>	<i>P</i>
Raymond et al. 2009 and Manukau	23	.459	<.025
Brown et al. 2012 and Manukau	17	.580	<.01
Raymond et al. 2009 and Brown et al. 2012	21	.730	<.0005

Key differences in the service rankings among these studies, and in the proportional differences among the overarching service categories, can be explained by differing environmental contexts and service definitions (inclusion/exclusion of services) between the studies. For example, in the provisioning services category, the largest difference in value allocation among the three studies is associated with the water service, which was valued highly in the arid environments of Australia (Raymond, 10%) and Colorado (Brown, 14%), while this study largely valued the water service for transportation purposes, and changed the title of the sub-category to reflect this value (see Tables 5.1 and 5.2) (this study, 4%).

Participants in this study of the Manukau Harbour were primarily interested in and concerned with water quality, rather than water provision; these interests and concerns were consequently included in the regulating services sub-categories of water regulation, water purification, waste treatment and disposal, or ecological services, rather than in the provisioning services sub-category of water (Brown et al., 2012) or fresh water (Raymond et al., 2009).

Differences in sub-category definitions and the inclusion or exclusion of certain elements from a category or sub-category can also have ramifications for result comparisons at the category level. For example, Brown et al. (2012) included an additional habitat sub-category in the supporting services, but Raymond et al. (2009) did not include any other sub-categories related to this element. In this study, the ecological services sub-category was the highest valued regulating service (12% total assigned value), and in the Brown study, the habitat sub-category was the highest valued supporting service (9% total assigned value). Moving either the ecological services sub-category into the supporting services category, or the habitat sub-category into the regulating services category, would change the proportions of those overarching categories and have a potential impact on future prioritisations; therefore comparisons must be carefully analysed for these types of anomalies.

Although the participatory processes utilised in these three studies were quite different, each study aimed to capture social values that are currently given cursory, if any, attention in existing ES frameworks (Daniel et al., 2012). The results of these studies indicate that incorporating a diverse group of stakeholders into a participatory process, even using widely divergent methods and methodologies, is likely to place values associated with cultural services above other service categories. This finding is not consistent with some studies that have previously described ES preferences as being ranked in order of provisioning, regulating, cultural, and supporting services (Foley et al., 2005; Pereira et al., 2005; van Jaarsveld et al., 2005), although Rodríguez et al. (2006, ¶25) admit that “at some point...cultural services may become critical and trade-offs may occur between different cultural services.”

The overt interest in cultural services, and the consistently low social valuation of the underlying supporting services demonstrated by several recent studies (Bryan et al., 2010; Klain & Chan, 2012; Raymond et al., 2009; Ruiz-Frau et al., 2011), including this one, should be carefully considered in decision-making, as these values are likely to have important implications for the management and governance of ecosystems. The clear take-home message from the valuation process conducted in Mangere Inlet is that the stakeholders value Manukau Harbour as much more than a contaminant sink or food basket. The area also provides recreational opportunities, spiritual fulfilment, biodiversity, and access to cultural heritage. But for many stakeholders the valuation of cultural services appears to be disconnected from the valuation of the supporting services that provide these cultural benefits. These findings may indicate a lack of understanding or familiarity with supporting services on the part of some stakeholders. If so, this problem could likely be addressed in part through a stronger emphasis on social learning in ES processes, but this issue would benefit from further study.

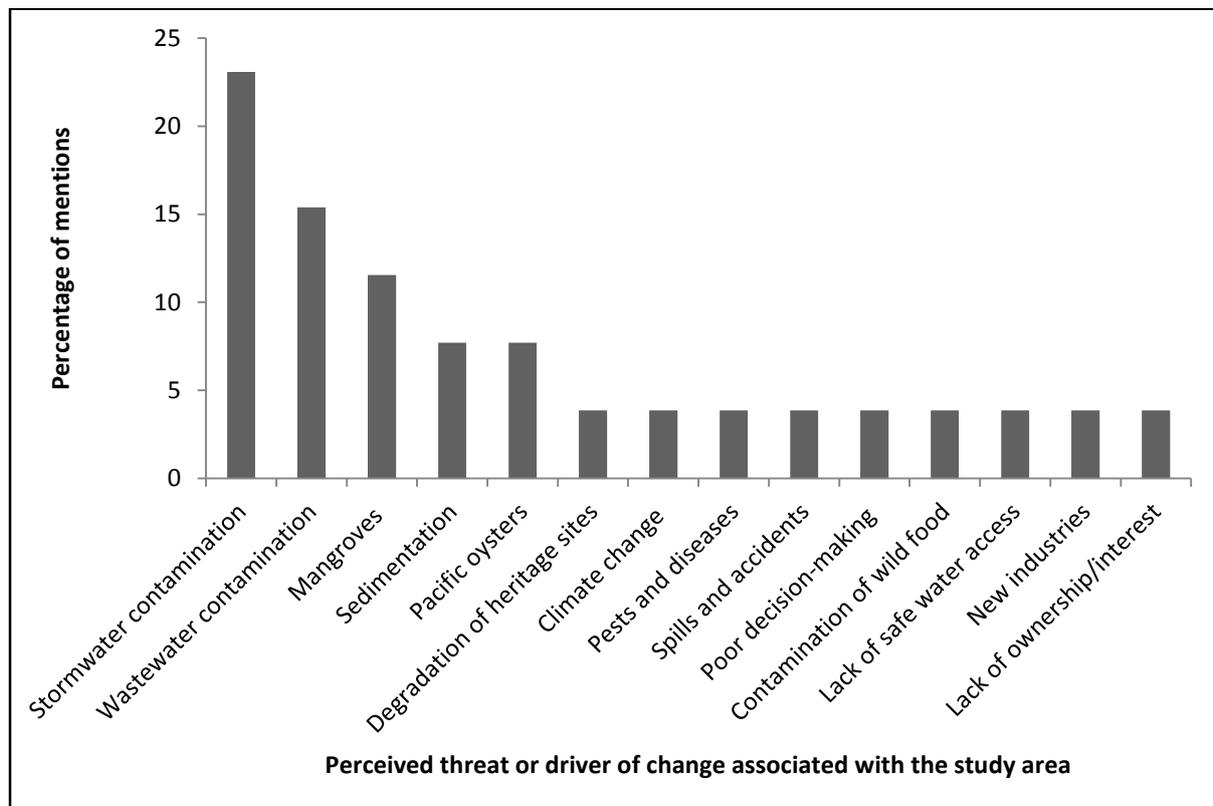
Despite the low valuation of the supporting services indicated by this and other studies, the prioritisation of cultural services could provide decision makers with a clear set of guidelines related to water quality and other thresholds. For Mangere Inlet and the surrounding areas of the Manukau Harbour, prioritising cultural values in decision making could lead to a very different set of uses and/or guidelines for the study area. These changes could lead to improvements in supporting services as well as cultural ones. For example, using the strongly shared interest in the ES of recreation and ecotourism to guide decision making could unite previously disparate stakeholder groups in focusing on protecting the underpinning elements of ecosystem function that ultimately provide this service. Recreation

and ecotourism in the area depend upon high water quality standards, extensive biodiversity, and safe harbour access points, among other things, indicating that managing for these multiple values, instead of just one value or service at a time, can provide benefits across the system.

5.2.3 Threats and drivers of change in the focal system

The first workshop aimed to identify the social value of Mangere Inlet and Manukau Harbour using mapping and scoring approaches, but the consideration of the threats and drivers of change associated with the focal system was also included to encourage discourse about ES trade-offs (see 4.3.2.3.d). Participants in the pre-workshop interviews were asked about threats and drivers of change, and Workshop 1 participants were encouraged to describe what they considered to be study area threats or drivers of change on their worksheets. Participants who wished to discuss threats or drivers of change during their post-workshop interviews were also welcome to do so.

Figure 5.5: Threats and drivers of change described by seven study participants.



Not all study participants discussed threats or drivers of change related to the study area, but of the seven participants who did (Figure 5.5), 23% considered stormwater

contamination to be a serious threat to the study area, and 15% considered wastewater contamination to be a threat. The encroachment of native mangroves on harbour access areas was cited by 12% of respondents as a concern for the area, followed by sedimentation and the spread of invasive Pacific oysters, both cited by 8% of respondents. The remaining threats and drivers of change were each cited by 4% of respondents. The information about threats and drivers of change associated with the study area provided during the pre-workshop interviews and on the worksheets was incorporated, where possible, into the scenarios developed for Workshop 2 (see scenario Table 4.8).

5.2.4 Mapping ecosystem services

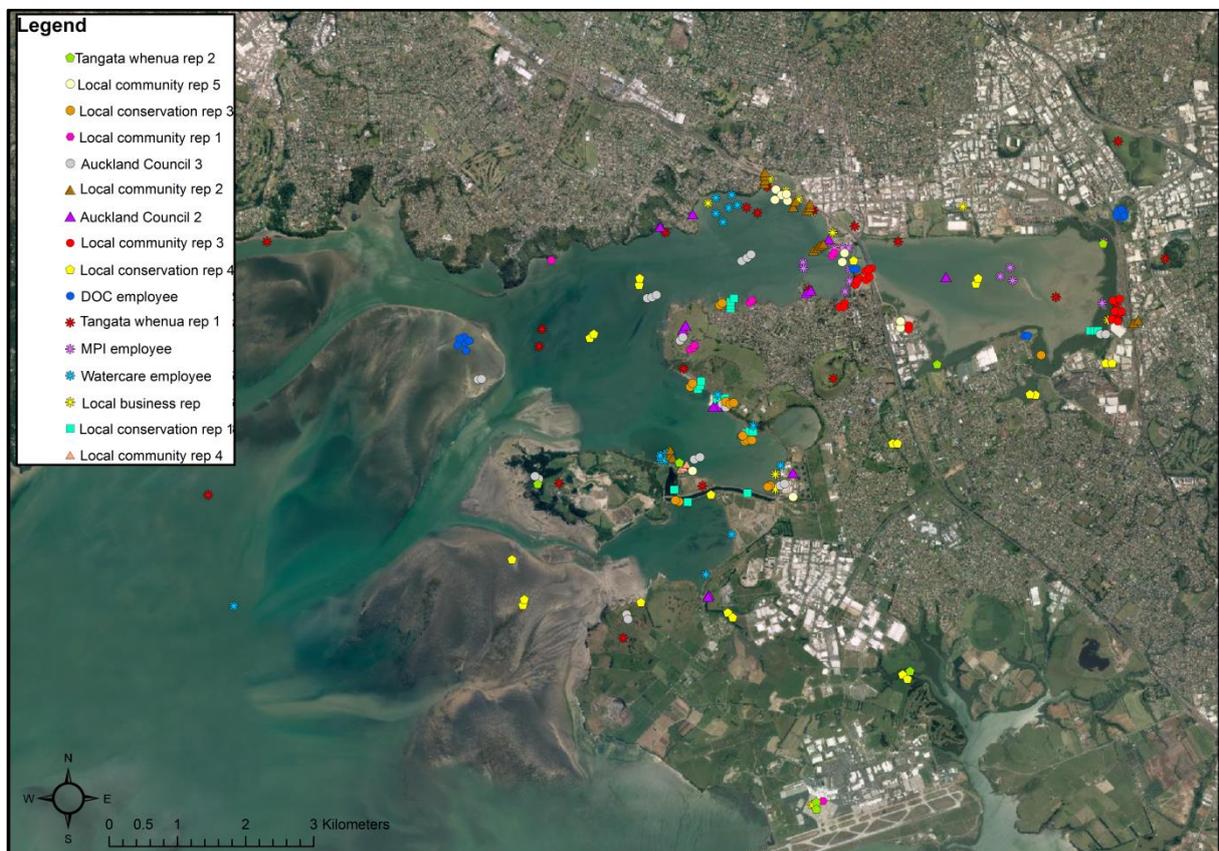


Figure 5.6: Local scale ecosystem services and values mapped by study participants during Workshop 1 and pre-workshop interviews.

The ES worksheets and mapping activities encouraged participants to reimagine a familiar space in two primary ways: 1) by linking their individual knowledge of the study area, consisting of memories, stories, scientific data, or other elements, to the ecosystem services provided by the area; and 2) by integrating these diverse knowledge cultures in a

collective space (Figure 5.6). These processes distinguish the method from other primarily empirical ES mapping tools, which generally do not require participants to reflect on how their knowledge connects with an ES framework, and rarely enable participants to integrate their knowledge with that of others through group mapping. The group mapping of diverse knowledge cultures undertaken in this study expands the ES framework into new dimensions that could form the foundations of a collective decision making framework (Brown, 2010). Worksheets and follow up interviews also provided opportunities for participants to critique the methods, establishing an adaptive cycle through which the framework could be changed or updated as needed. A new ES framework emerged from this process; one that was capable of respecting the contributions of disparate knowledge cultures, while simultaneously bringing them together to create something more than the individual cultures could have achieved alone (Brown, 2010). This new framework enabled participants to clearly connect their social values with the ecosystem functions provided by the study area; learn about new activities and values associated with the study area; discover areas where activities and values overlap; and gain a new appreciation for how all of these activities and values might be interacting with one another and the environment.

Local community representative 3: Yes, the mapping was good in pin pointing things because then you could see, especially with different colours and that. Once it was all completed you could see the picture of a lot of the activities and the different things that are happening in that area. That was a bit of an eye opener to see that.

Local conservation representative 3: But it was interesting, the whole thing was interesting, a lot of it was new, a lot of it pushed me to understand different people's perspectives. I did fight in my own corner, but I was listening to the other people's perspectives and seeing some real passion there.

Local board representative: I certainly learnt a lot about what other people think. I thought it was valuable from that perspective. I learnt that birds are very, very, important to an awful lot of people!

Local community representative 3 went on to describe how being included in the group mapping process made him feel that his values and interests were legitimised, thereby empowering this particular individual in new ways (Shucksmith, 2000):

KD: When you came along to the first workshop, did you feel like you were able to express the importance of the waka ama and your connection to the Manukau Harbour?

Local community representative 3: Oh yes. Especially with the pins and that. I could identify where waka ama was important for us and the areas like the Portage Crossing and where we were going to build our club rooms down at Mangere Bridge. I felt that by being there, we included our aspirations, our dreams for waka ama in that workshop.

KD: So that process was a useful one for you. It wasn't too confusing?

Local community representative 3: No. It was quite good. I could see the relevance of everyone else there so I was sort of feeling that we were included in that, in your research.

The integration of social values into an ES framework, along with the enhanced social learning, capacity building, and empowering benefits that arose from the ES mapping activities conducted during this research, are balanced by several challenges. For example, several participants mentioned that the time constraints made the mapping somewhat difficult. Approximately one hour was allocated for the mapping activity, but this was inclusive of instructions, questions, completing the worksheets, and the actual mapping process. More time for this activity may have improved the transparency and social learning elements of the process; one participant expressed confusion related to the reasons for the mapping exercise, saying that she was not clear at first whether she was supposed to be mapping the way that she currently values the area, or her aspirations for the area in the future. She went on to say that she received conflicting answers about this from some of the other participants.

Additionally, a few participants described struggling to illustrate all of their values with the limited number of bead counters that they were supplied, and several mentioned

difficulties with prioritising their values and/or aligning them with specific sites on the map. Prioritising social values can be difficult because some values cannot be easily compared or traded off due to their centrality to world views (Chan et al., 2012; Klain & Chan, 2012). Due to the interconnectedness of social values with space (Stephenson, 2008), it can also be difficult to prioritise and value one space, or scale, over another. The two sections that follow explore the challenges and successes associated with mapping and integrating social values into an ES framework that arose from this study, focusing primarily on these issues of prioritising scale and space.

5.2.4.1 Social values and issues of scale

In this thesis, as in human geography generally, scale is understood to be created from the interactions between actors and organisations, without being reducible to those actors and organisations (MacKinnon, 2010). Once established through social construction and reproduction, scales become independent of individual actors' conceptions and come to possess a certain durability (Jones, 2009), yet scales remain subject to modification and transformation through emergent social processes (Brenner, 2001). Past approaches to environmental decision making have largely taken scale for granted (Bulkeley, 2005) or failed to adequately account for the cross-scale dynamics of SES (Cash et al., 2006). To address these failings, decision-making frameworks increasingly promote processes that operate at multiple scales. Multi-scalar approaches seek to deconstruct traditional scalar hierarchies which conceive of power operating at a particular geographic scale or institutional level (Bulkeley, 2005; Castree, 2005). The creation of new scalar configurations and arrangements occurs "at the point of interaction between inherited and emergent projects and scales (MacKinnon, 2010, p. 31)."

Important implications for this research are that existing scalar politics associated with the study area, some of which are likely to be privileged over others (Brenner, 2004), will inevitably influence the assignment of social values to the ES map as well as shape the conditions and possibility for political action (Leitner et al., 2008). However, the inclusion of a diverse group of participants in the group mapping, whose values are likely to be associated with a range of scales and subsequent networks of power, created an opportunity for new conceptions of scale and possibilities for change to emerge from the study.

Table 5.5 illustrates that participants mapped the majority of points (247) at the study area or "local scale", meaning that they were placed on a specific site located within the boundaries of the study area map. However, many points (169) were also mapped at the

“large scale”, indicating that the scale could not be easily shown on the study area map provided to participants. The local scale values of 16 participants are spatially represented on maps produced by this study (Figures 5.6-5.8), but participants could choose to map any or all of their values at the larger scale if they wished, and some did. The large scale services were included on the map at the workshop for consideration and discussion (Figure 4.4), and all participant values were included on the worksheets and incorporated into the elements of the research that were not spatially oriented. However, Figures 5.6-5.8 exclude the large scale points, as they are not spatially meaningful.

Table 5.5: Summary of group mapping results by ecosystem service category and scale.

Scale		Value	Percentage
Study area scale TOTAL		247	59%
Large scale TOTAL		169	41%
ES Category	Scale	Value	Percentage
Cultural	Study area	142	73%
	Large	53	27%
	TOTAL	195	
Regulating	Study area	65	49%
	Large	69	51%
	TOTAL	134	
Provisioning	Study area	27	60%
	Large	18	40%
	TOTAL	45	
Supporting	Study area	13	31%
	Large	29	69%
	TOTAL	42	

Some study participants placed a great deal of value on the large scale services, and therefore struggled to spatially illustrate their values using the mapping method provided. Three participants in this study refused to map any of their values at the local scale, instead assigning all of their values to the larger scale. As explained by the DOC employee below, certain institutional or organisational values primarily operate at larger scales than the study area under consideration:

DOC employee: The only thing I struggled with was the prioritising part. At the top, prioritising particular areas because a lot of the services that we’re interested in are delivered over quite a large area and they are generic things provided by

tidal mud flats and tidal channels, those sorts of things. That's the only bit of it that I really struggled with.

These “generic” services are usually provided by multiple aspects of overlapping ecosystem functions and therefore cannot easily be associated with a specific site. However, considering services at a single scale, either large or small, can easily lead to the framing of inappropriate variables and subsequently jeopardise the continued provision of services (Galaz et al., 2008).

Despite this problem, certain service categories are more likely to be associated with larger scales, and therefore difficult to assign to a specific site, than others. Supporting services are frequently excluded from social value mapping in part due to this problem (Klain & Chan, 2012). There are also concerns that ‘intrinsic values’, those associated with spirituality and/or the intrinsic importance of place, are difficult to assign to particular areas or features on a map (Brown & Raymond, 2007; Klain & Chan, 2012). Klain and Chan (2012) take pains to point out that while intrinsic values are difficult to map, they are not less important values.

In this study, as shown in Table 5.5, the cultural and provisioning services categories were associated with more local scale points, while the regulating and supporting services categories were associated with more large scale points. This is not a surprising outcome given the nature of these services and the particular context of the study area. The regulating and supporting services are often provided by complex ecosystem interactions that occur over large areas, and therefore many participants felt that it was more appropriate to map these services at the larger scale. The regulating services were very closely divided between the local and the large scale, however, and this may have been due to the high number of points assigned to the water purification, waste treatment and disposal service and allocated to areas surrounding the discharge point of the MWTP. In total, 49% of the points were allocated to this service at the local scale. At the large scale, only 16% of the points were allocated to this service. The particular context of the study area may have skewed these results somewhat due to the inclusion of the MWTP within the study area boundaries.

Similar to the findings of Raymond et al. (2009) and Brown et al. (2012), the participants in this study did not place a lot of value on the supporting services, with a total of only 42 mapped at both the local and large scales. The low values associated with the provisioning services category is somewhat surprising however; only 45 points were mapped to this category across both local and large scales and in a study area representing over 200

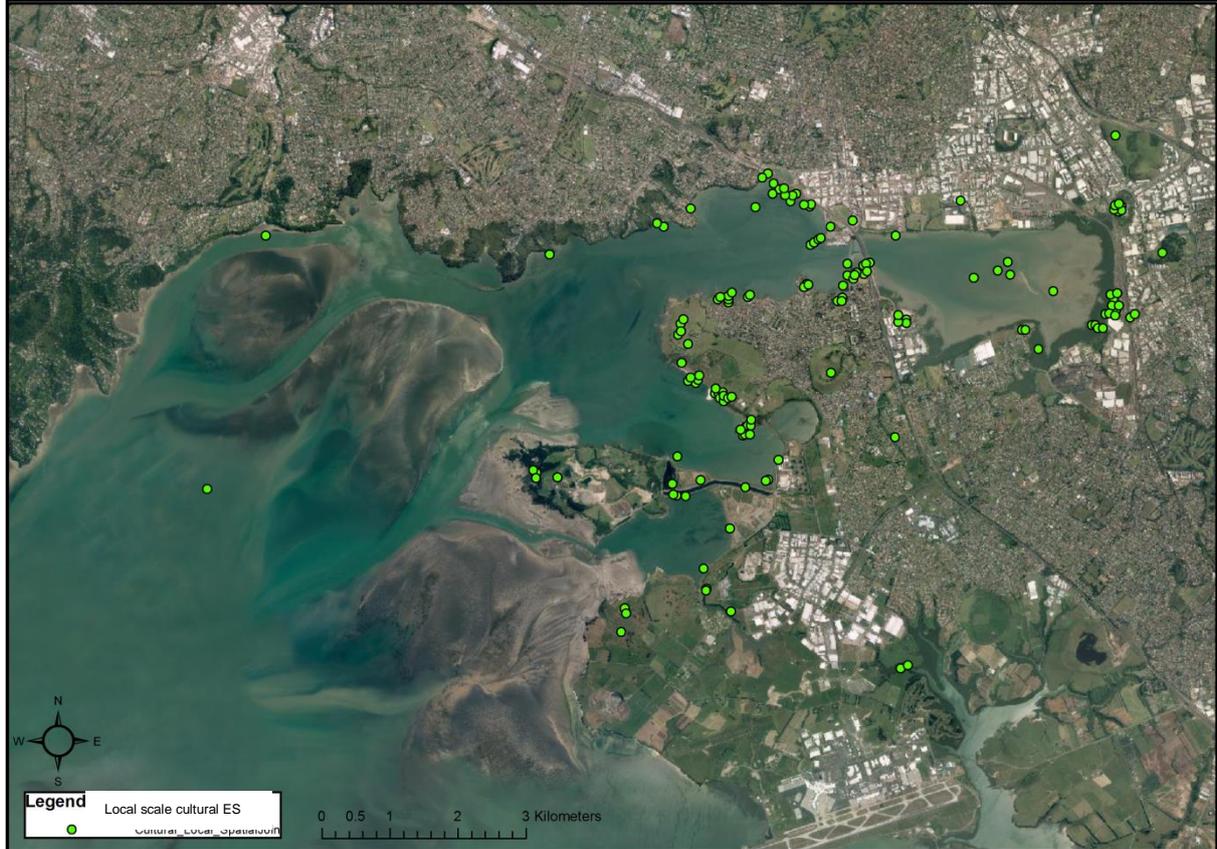
square kilometres of land and sea. This result may be partly attributable to the absence of experienced fishers and wild food collectors from the workshop participant group. I attempted to address this gap by conducting additional field work aimed at capturing some of these missing values from fishers and people collecting wild foods (see section 5.4 below), but it was not possible to incorporate the questionnaire data into the spatial data collected from the group mapping activity.

Both the cultural and provisioning service categories include services linked to activities that usually take place in a specific location, such as a bridge or other access point in the case of fishing, (Figure 5.7) or an open space (land or sea) in the case of recreation (Figure 5.8 and more on this in section 5.2.4.2). The concentration of the provisioning services mapping illustrated in Figure 5.7 shows that 74% of the local provisioning service points were mapped on or near a bridge where many locals fish, and a port nearby where the commercial fishing boats dock. Of this 74%, 60% are assigned to the water transport service, 30% to the food service, 5% to genetic resources and 5% to biochemicals.

Figure 5.7: Map showing majority of provisioning services concentrated within an area of approximately 10 square kilometres, demarcated by the red circle. 74% of all the provisioning services mapped at the local level are located within a 1.8 km radius of each other.



Figure 5.8: Map of the local scale cultural services provided by participants.



The nature of the services clearly has some influence over the scale at which they are mapped, but another important factor likely to effect the distribution of stakeholder values is the focal scale of the participant’s own interests and influence. Stakeholders operating at different scales may benefit from different services (Vermeulen & Koziell, 2002); this can have an effect on the value different stakeholders attach to the services (Hein et al., 2006). For example, as shown in Figure 5.9 below, participants whose focal scale of interest is at the local level (as defined in Table 4.2) placed a great deal of value on the customary and historic services that are generally associated with particular sites, while very few regional representatives and no national representatives valued this service.

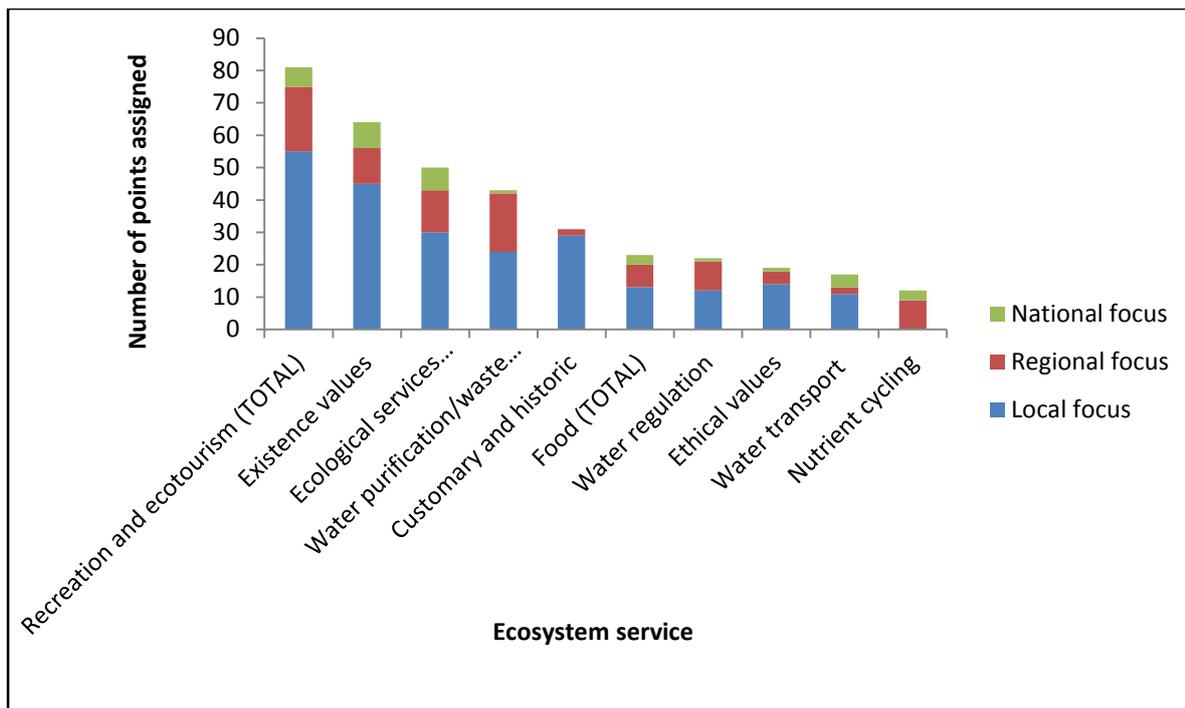
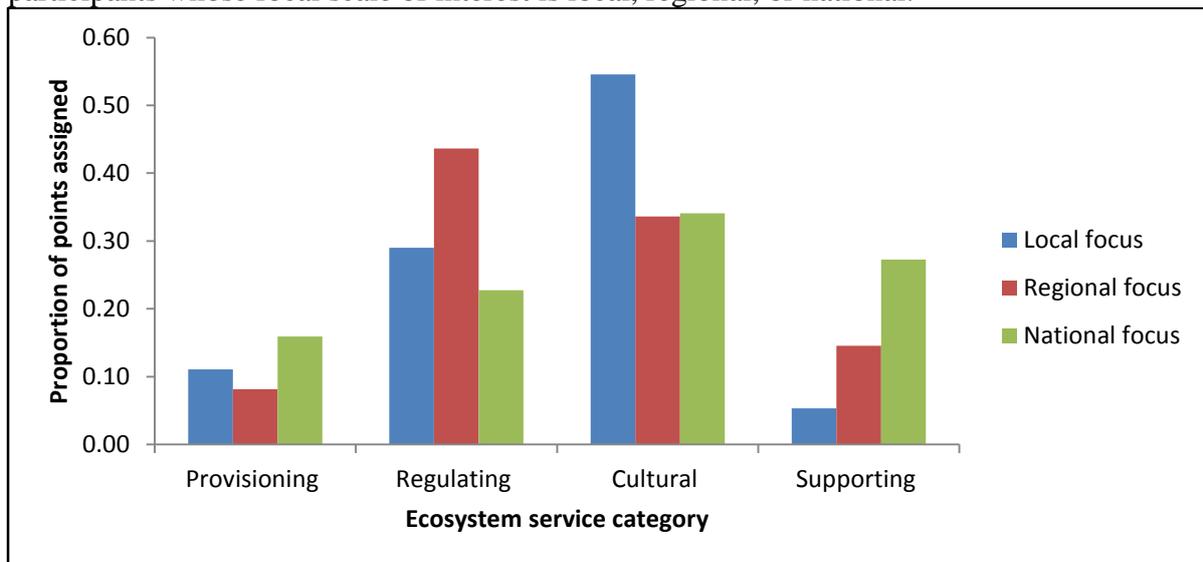


Figure 5.9: Participants with local, regional, and national interests occasionally exhibited very different ecosystem service values. This chart illustrates the high local value associated with the cultural and historic service, but very little regional value and no national value was associated with this service. Similarly, regional and national value was associated with nutrient cycling, but no local values. These results may have important implications for management and governance options in the study area.

Distinctions among proportional valuation by focal scale of interest become even more evident when the scored services were grouped by categories (Figure 5.10). National, regional, and local interests all placed similar values on the provisioning services, but regional interests valued the regulating services more highly than the other two groups, local interests focused their values on cultural services, and national interests placed more value on the supporting services than the other two groups. The emphasis placed on the supporting services by regional and national representatives from environmental government agencies is in keeping with the work conducted by Ruiz-Frau et al. (2011), who noted that only participants from the academic sector and government agencies mentioned supporting ES in their study. These distinct value sets are each important, but their distinctiveness can contribute to prolonged disagreement or generally poor environmental decision making. This research provides a method to integrate these perspectives, as well as an opportunity to explore shared interests and goals across a diverse range of stakeholder groups.

Figure 5.10: The proportion of points assigned to each ecosystem service category by participants whose focal scale of interest is local, regional, or national.



Neither focal scale of interest nor representative organisation seem to correlate with a preferred mapping scale (e.g. local or large), but Figure 5.11 illustrates a general trend towards valuing more ES with increasing focal scale; in general national interest representatives valued a larger number of ES than local interest representatives. While the study sample is small, this trend again draws attention to the scale conflicts that can arise in environmental decision making due to mismatches in spatial (and temporal) scales (Folke et al., 2007).

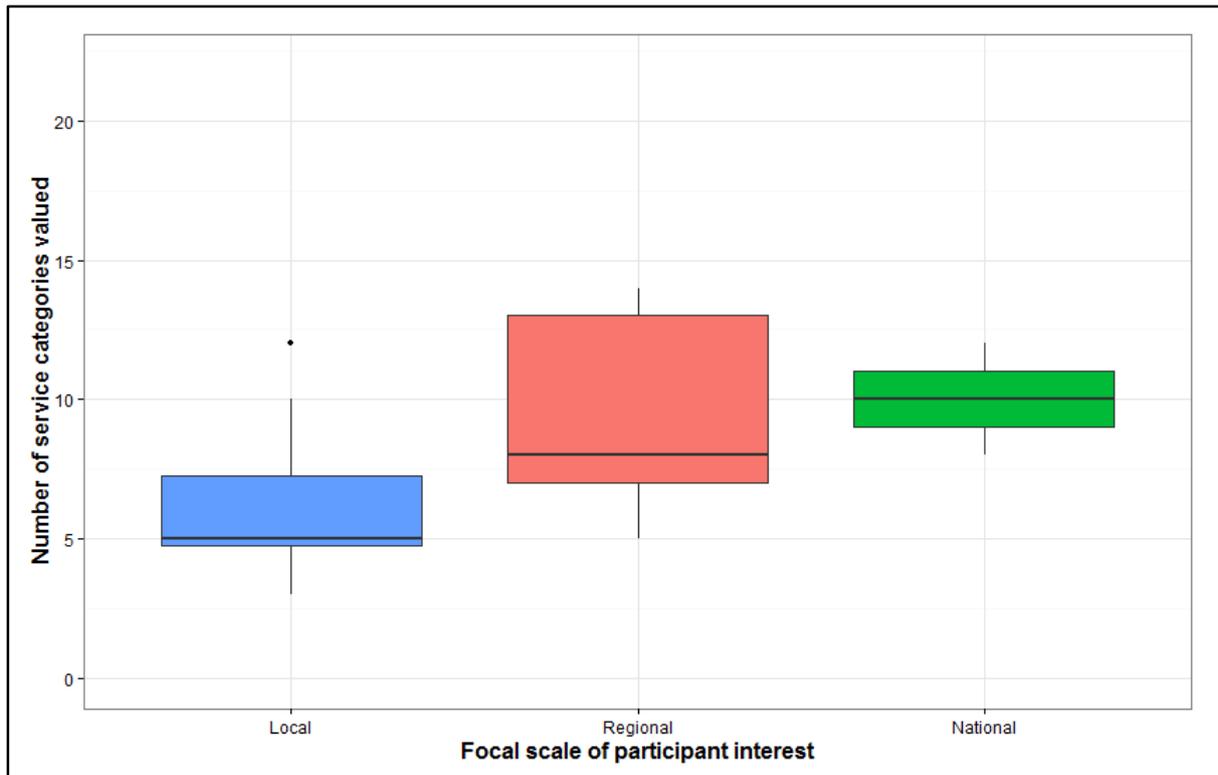


Figure 5.11: Increases in focal scale of participants (local-regional-national) correlate with increases in the median number of ecosystem services associated with any value (1-22), indicating a broadening of stakeholder interests and values with each additional scale. At the local scale, the median number of ecosystem services associated with any value (1-22) was five, while at the regional level the median number of services was eight, and at the national level the median number of services valued was ten. While the study sample, particularly for national representatives, was quite small, this trend would be an interesting one to explore further.

It is particularly important to consider how scale can impact valuation when EBM plans are being developed, because ignoring the critical role of this factor in valuation could lead to considerable miscommunication and conflict (Hein et al., 2006). However, the mapping of ES values by a diverse group of participants can also enable the targeting of management actions to areas of local value, which is likely to enhance community engagement in environmental management, build trust in decision-making processes, and increase political support for local and regional priorities (Raymond et al., 2009). Results indicate that management and planning processes that use cultural values to guide thresholds and other benchmarks, and which focus more attention on preserving access to and use of coastal areas and seascapes, could see benefits across multiple ES and functions in the study area.

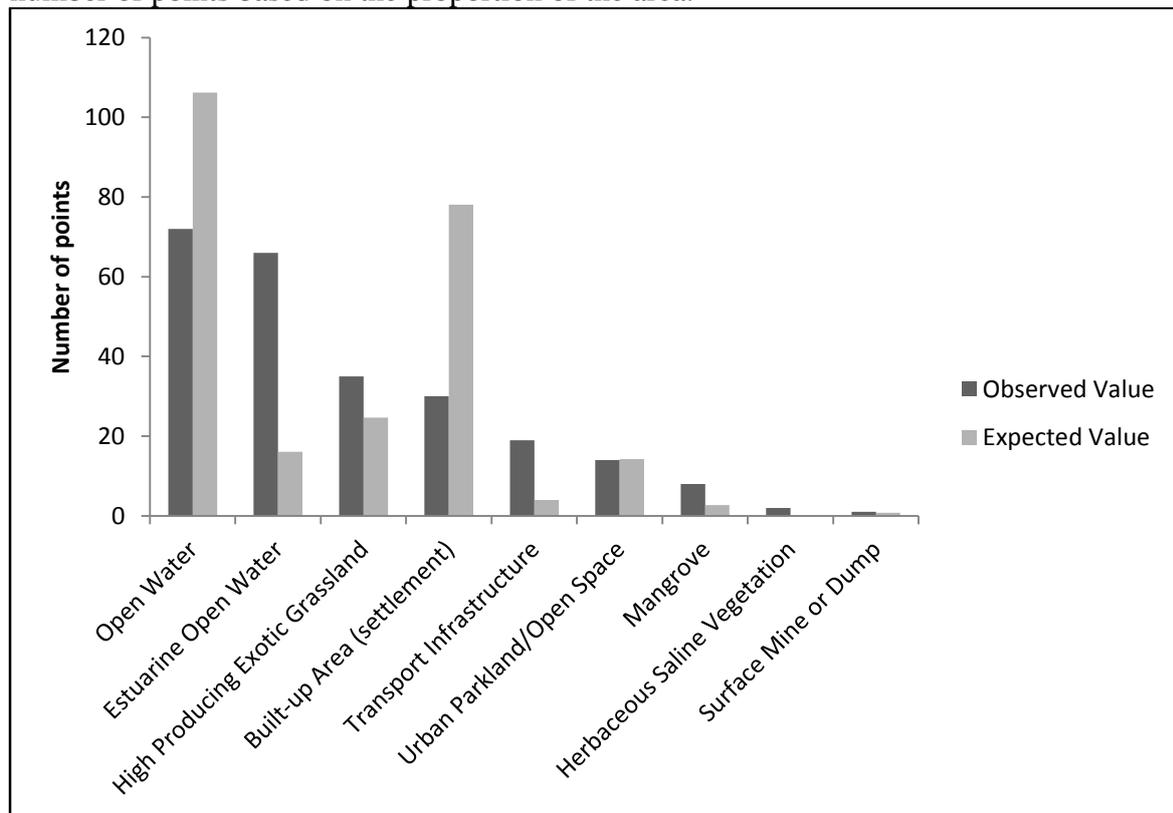
5.2.4.2 Social values and land or water use designations

To determine whether there are significant relationships between social values and land or water designations, I intersected the ES point data with a GIS land use designation layer developed by the Ministry for the Environment and obtained from the New Zealand land cover database (LCDB). The LCDB only provides land cover designations, which includes estuarine open water, but excludes any other seascapes; therefore for the purposes of this study, all areas that are not designated by the LCDB have been designated as “open water”. I then ran chi-squared statistics and analysis of residuals to determine whether the number of observed ES points differed significantly from what would be expected based on the relative size of the land or water use designation within the study area. Significant relationships that emerged from this analysis could provide an opportunity to focus decision making activities on particular designations.

Table 5.6: Distribution of ecosystem service points by land or water use designation.

Land or water use designation	Total value (# points)	Shape (km²)	Proportion of area (%)	Proportion of points (%)	Over or under-represented
Open Water*	72	83332	43.0	29.1	Under
Estuarine Open Water	66	12597	6.5	26.7	Over
High Producing Exotic Grassland	35	19353	10.0	14.2	Over
Built-up Area (settlement)	30	61243	31.6	12.1	Under
Transport Infrastructure	19	3152	1.6	7.7	Over
Urban Parkland/Open Space	14	11157	5.8	5.7	Same
Mangrove	8	2152	1.1	3.2	Over
Herbaceous Saline Vegetation	2	135	0.1	0.8	Over
Surface Mine or Dump	1	649	0.3	0.4	Same
TOTAL	247	193770			

Figure 5.12: Observed number of points associated with land and water uses versus expected number of points based on the proportion of the area.



The new data layer indicated that as a group, study participants value the open land and seascapes highly for cultural services such as recreation and ecotourism and existence values; much more so than they value built up areas or infrastructure for these services (Table 5.6). In fact, 84% of the local scale recreation and ecotourism values, and 82% of the local scale existence values were mapped to open land or seascapes. The aggregated ES points shown in Table 5.6 and Figure 5.12 also indicate that estuarine open water, high producing exotic grassland (mostly associated in the study area with farms, parks, and other managed open spaces), transport infrastructure, mangroves, and other herbaceous saline vegetation, all have more ES associated with them than would be expected based on proportion of area, while open water and built-up settlement areas have fewer mapped ES than would be expected by proportion of area. Urban parkland/open space designated areas and surface mines/dumps have the same number of ES associated that would be expected based on the proportion of the area designated for these activities.

Table 5.7: Seascape versus landscape value.

Seascapes	Total value (# points)	Landscapes	Total value (# points)
Open water	72	High Producing Exotic Grassland	35
Estuarine open water	66	Built-up Area (settlement)	30
Mangrove	8	Transport Infrastructure	19
Herbaceous saline vegetation	2	Urban Parkland/Open Space	14
TOTAL	148	Surface Mine or Dump	1
		TOTAL	99

Another important message to take away from this set of results is that this diverse group of participants valued the seascapes associated with this study area more highly than the landscapes, placing 60% of the total value on the seascapes and only 40% on the landscapes (Table 5.7). This finding indicates that current land-based decision-making approaches that do not incorporate an explicit consideration of coastal goods and services are missing a large proportion of the value associated with these areas, which is likely to perpetuate poor decision making and conflict related to coastal areas. In a country with as much coastline as New Zealand, and in an age when climate change is placing increasing pressure on coastal areas (Moser et al., 2012), this is a serious concern, and this research provides a way to incorporate more meaningful consideration of these areas into decision-making processes.

5.3 Workshop 2

5.3.1 Scenario 1: Eco-community

The first scenario, *Eco-community*, was given to Group 1 for analysis. Group 1 was composed of the senior marine ecologist (small group facilitator), Auckland Council employee 1 (scribe/presenter), local board representative (moderator), local business representative, local community representatives 2 and 4 (time keeper), and local conservation representative 2. Box 1 shows the summary of Scenario 1 that was given to participants, along with further details, which are included in Appendix E. Participants were asked to use the information provided about the scenarios to respond to three questions, shown in Figure 5.13 along with the group responses, which have been compiled from the worksheet data.

Box 1: Scenario summaries

Scenario 1: Eco-community

The area is characterised by village centres, good access to the harbour, an eco-tourism and recreation-based economy, and good environmental quality.

- Some gentrification, slow rate
- Ecotourism/recreation/commercial/light industrial
- Ferry, Harbourmaster, general improvements to roads/walkways/bike paths
- Upgrades to MWTP, installation of wetlands and other natural stormwater management
- Improved ecological quality/species abundance/biodiversity
- Preservation of cultural and historic sites highly valued
- Mangroves spread, harbour access limited

Scenario 2: Beach chic

The area is characterised by boutique-based town centres, excellent access to the harbour, a recreation-based economy, and good environmental quality.

- Rapid and extensive gentrification
- Recreation/commuter-based economy
- Hovercraft ferry, Harbourmaster, vast improvements to roads/walkways/bikepaths, removal of working port
- Upgrades to MWTP
- Water quality improves but ecological quality declines due to substrate changes/noise/loss of habitat
- Development prioritised over preservation
- Mangroves removed, harbour access abundant

Scenario 3: Industrial integration

The area is characterised by sprawling town centres, an industrial-based economy, limited access to the harbour, and severely damaged environmental quality.

- Expansion of local working class
- Industrial economy
- Expansion of working port, increased frequency of dredging
- Water quality and ecological quality decline
- Cultural and historic sites neglected
- Mangroves managed unevenly, harbour access limited

Figure 5.13: Questions and Group 1 answers regarding *Scenario 1: Eco-community*.

Question 1: Who (or what) do you think are the winners and losers in this scenario?

Winners	Losers
<ul style="list-style-type: none"> • Local area community • Environment • Harvesting (to a point) 	<ul style="list-style-type: none"> • Larger Auckland community • Local area community

Question 2: What are the trade-offs that are made, in terms of the provision of ecosystem goods and services, for this scenario to come about?

Question 3: How do you feel about the trade-offs that have been made in this scenario?

- Shifting rather than addressing the problem – need more developed options
- Need coherent governing body that sits above that whole Manukau Harbour area

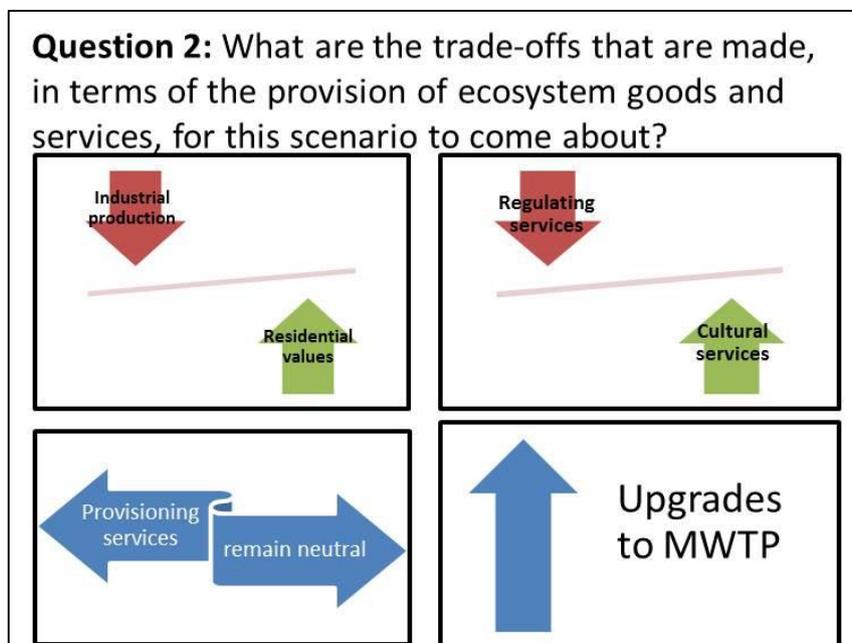
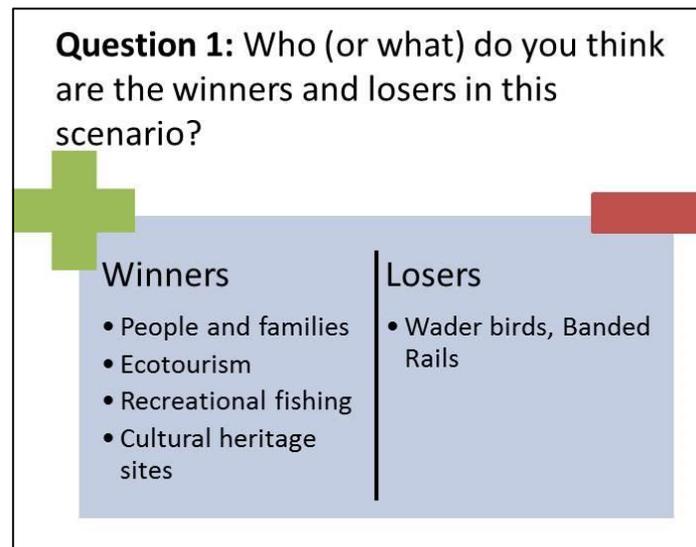
Group 1 agreed that the winners in this scenario were the local area community and environment, while the losers were the larger Auckland community, primarily due to rates increases. It was agreed that the local community also lost somewhat because of rates increases that they would have to pay. The small group facilitator expressed the sense that “thinking about trade-offs was very hard for this group”, but after some discussion the group came up with a few concise responses to the second question. The group did not attempt to use any ES language in any of their responses, but instead preferred to utilise more common terminology to describe the trade-offs associated with Scenario 1. The variety of trade-offs identified by Group 1 included bird roosting areas limited by mangroves, harbour access limited by mangroves vs climate change protection, local values vs regional values, and harbour access vs harbour ecology. Group 1 was able to reach a consensus in response to the third and final question about Scenario 1; all participants felt that the scenario was shifting problems to other locations rather than addressing them head-on. Participants also agreed that a coherent governing body that controlled decision-making for the entire harbour would provide firmer guidance towards achieving some of the scenario elements in reality.

This response, while interesting, does not engage with any of the specific trade-offs outlined in response to the second question. There is a desire for change expressed here, but not a clear alignment or willingness to take a stand as a group on any of the specific trade-offs expressed in this scenario. The reflections of the group facilitator supported the idea that the group was able to work with the scenarios in a general way, but struggled to come up with management approaches or consider consequences much beyond their own individual interests, which suggests that little collaboration occurred within this group at this stage.

5.3.2 Scenario 2: Beach chic

The second scenario, nicknamed *Beach chic*, was given to Group 2, which included a senior lecturer in geography as the small group facilitator, Auckland Council employee 3 (scribe) and 4 (moderator/presenter), local conservation representative 1 and 4, and local community representative 1 (timekeeper). Box 1 shows the summary of Scenario 2 that was provided to participants, along with further details, which are included in Appendix E. Participants were asked to use the information provided about the scenarios to respond to the same three questions listed in the previous section (Figure 5.13). The questions and group responses are included below in Figure 5.14.

Figure 5.14: Questions and Group 2 answers regarding *Scenario 2: Beach chic*.



- Question 3:** How do you feel about the trade-offs that have been made in this scenario?
- Not acceptable/Preferred scenario/Not happy about affecting wader birds
 - Positives being people use the harbour – negatives not being managed to look after birds
 - Upgrading MWTP is a winner for whole harbour. Improved water quality.
 - Maintaining artificial beaches and sea level rise
 - Degradation of some regulating services – erosion, water regulation (lack of storm water controls) – decreased ecosystem integrity and gradual decline in environmental quality (ecosystem resilience)

Both the small group facilitator and the audio recording of the session indicate that Group 2 struggled to embrace the scenario method of analysis. Several participants in the group expressed frustration with the details of the scenarios, and spent a good deal of time challenging the scenarios rather than working within them. The group was able to agree on some answers to the first question, however. For example, they agreed that wader birds and Banded Rails would suffer in this scenario if management options such as restricted areas were not put into place to protect them. The group also agreed that people and families would be winners because they would have ample access to the harbour, and eco-tourism operators would benefit because they could provide commercial bird tours. The closing of the port in the scenario was perceived as leading to more recreational fishing opportunities, and improvements in water quality were associated with increasing numbers of fish. The group suggested that cultural heritage would benefit from this scenario.

Almost all of these answers are at odds with the details provided in the scenario description document. For example, the scenario document states that many of the fish and bird populations that previously thrived on the muddy substrates found in the area were in decline or extinct due to the change in substrates from mud to sand and the subsequent impacts of this change on harbour ecology. Despite this information being provided, the group insisted that fish populations would increase and that bird-based eco-tourism would thrive under this scenario. This optimistic re-working of the scenario may have arisen because of a combination of short timeframes (not enough time to read the scenario descriptions closely), and a single-issue focus on the part of some of the participants, who liked certain elements of the scenario and therefore chose to ignore others.

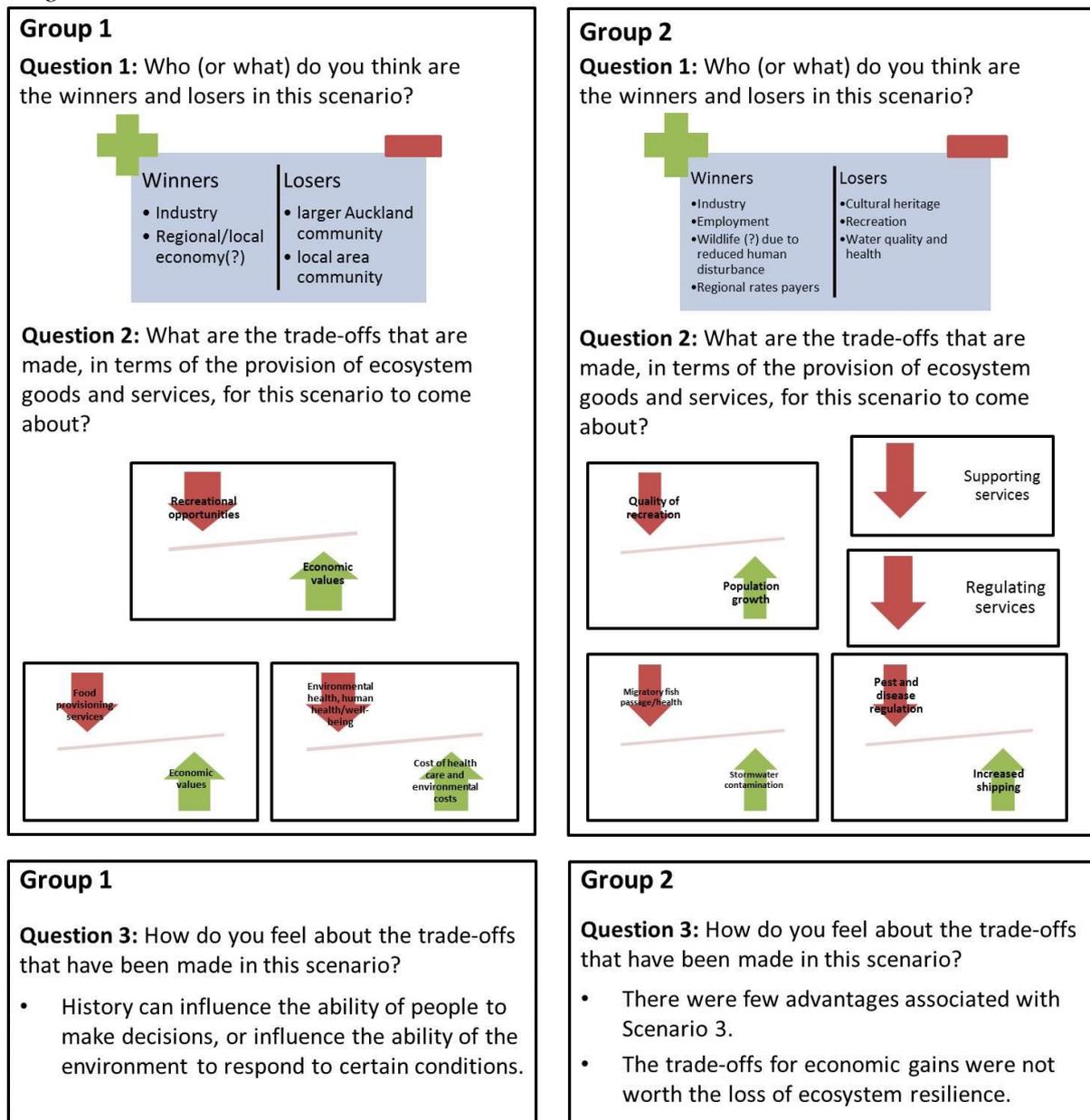
The second question elicited a more focused response from the group, and they utilised some of the ES language in their answer. In fact, the only service category that was not considered by the group under this scenario was supporting services. Trade-offs outlined by the group included loss of industrial production vs an increase in residential values and declining regulating services due to artificial modifications vs highly ranked cultural services. The group determined that provisioning services would remain neutral, and pointed out that upgrades to MWTP would occur under this scenario. While the use of ES terminology suggests a certain level of comfort with the ES approach, some of the trade-offs stated by the group seem to be based again largely on wishful thinking, rather than the version of reality presented by the scenario document, which states that provisioning services such as food production would decline, and indicates that the negative impacts on regulating services would lead to reduced fish and bird populations available for cultural enjoyment.

No attempt was made by anyone in the group to seek agreement or achieve consensus in response to the third question. Instead, each member of Group 2 was invited to respond to question three, eliciting responses which ranged from “not acceptable” to “preferred scenario”. One participant pointed out in their response to this question that the degradation of some regulating services would likely lead to overall decreases in ecosystem integrity and a gradual decline in ecosystem resilience, but this complex response was not picked up by the group at large. The inability of Group 2 to agree on basic scenario details indicates a need for more time to work with the scenarios so that the details and consequences can be expressed more clearly and so that participants don’t feel compelled to push their personal agendas in response to these questions. This issue will be discussed in more detail below in section 5.3.4.

5.3.3 Scenario 3: Industrial integration

The third scenario was given to both Group 1 and Group 2 for analysis. Box 1 shows the scenario summary that was provided to participants. The questions and group responses are included below in Figure 5.15. For a complete copy of the scenario description, please refer to Appendix E.

Figure 5.15: Questions and Group 1 and 2 answers regarding *Scenario 3: Industrial integration*.



Group 1 was generally able to agree on their responses to this scenario, although the group largely stayed away from discussing specific topics such as birds or mangroves, and instead focused on the large scale impacts of the scenario on the study area. The group felt that while the regional economy of Auckland would benefit from the industrial integration scenario, and there might be some local winners in terms of economic gains, the value of the study area to the whole of Auckland was not being accounted for in this scenario. Because of this lack of full-cost accounting, the local area as well as the region was perceived to be losing. The group highlighted the fact that the quality of food and food provision services, as well as swimming and other recreational activities, would decline under this scenario, and

they added that the cost of health care might go up because of poor food quality, poor environmental quality, and other trade-offs resulting from this scenario that would impact human health and well-being. In their response to this scenario, Group 1 utilised some of the ES language (food provision, human health and well-being) for the first time, suggesting an increasing comfort with the ES topic and scenario method on their second attempt. The third question sparked some discussion in Group 1 about history, and how history can influence the ability of people to make decisions, or influence the ability of the environment to respond to certain conditions, but the group failed to give a clear answer to the question.

Group 2 again struggled with what they felt were inconsistencies within the scenario around the bird issues and spent some time challenging the scenario assumptions, but in general the groups' responses to scenario three aligned more consistently with the information provided in the scenario document than their response to scenario two, indicating an increasing comfort with the method on the second attempt. The group identified logical winners and losers such as industry and employment winners and cultural heritage and recreation losers, and utilised some ES terminology in their discussion of trade-offs. Identified trade-offs included storm water disposal vs migratory fish passage, increased shipping vs vulnerabilities to disease and invasive species, and population growth vs decline in recreational quality. The group also pointed out that the reduction in human disturbances to wildlife could be a benefit for birds, although it was also admitted that water quality and contamination could negatively impact the food source for birds, and that both the supporting and regulating services would decline under this scenario. In general, the group felt that there were few advantages associated with Scenario 3 and that the trade-offs for economic gains were not worth the loss of ecosystem resilience. The group tried to think through the logical result of the scenario playing out on bird populations, which was not the assignment, but does illustrate how the scenarios can be a good learning and experimentation tool.

5.3.4 Summary discussion of Workshop 2

Scenario planning aims to engage participants in the collection of dynamic, comparative information about the future of ES provision and associated trade-offs under different plausible futures (McKenzie et al., 2012). When it includes stakeholder participation, the process of scenario planning may simultaneously stimulate creative and imaginative thinking and learning (Van der Kerkhof & Wieczorek, 2005; Wollenberg et al., 2000).

In this study, however, participants expressed a lot of frustration related to the scenario planning process. Criticism included that the initial scenario presentation was too long and complex, making it difficult to follow and learn why the scenario planning process was a useful one, and how to go about participating in a productive manner. Two participants wanted information to be distributed prior to the workshop so that they could come prepared with background knowledge that would help them learn and contribute more fully on the evening. Several participants suggested that facilitated introductions would have enhanced transparency during the second workshop, and therefore would likely have contributed to more opportunities for trust building. More clarity around the goals of the second workshop might also have enhanced transparency and trust. The strong opinions expressed by a few participants, who consistently challenged the scenarios, may have limited the ability of the group to use the scenarios as a productive learning tool. And finally, the timeframe allocated for the scenario planning process was uniformly censured by participants, who said that they would have learned more if they had more time.

In relation to the scenarios themselves, some participants felt that they were internally inconsistent, too complex, or not contextualised enough. Many participants expressed an interest in being able to contribute more directly to the development of the scenarios, particularly earlier on in the research process. The specific feedback on ways to improve the scenarios was largely contradictory, however, as demonstrated in the quotes below:

Auckland Council employee 4: ...I appreciate that it is quite difficult to make a simple set of scenario descriptives, but the simpler it is, even though it might be a bit broad, the easier it is for people to actually appreciate and understand. The less they get to argue about because you don't actually give them all the details I guess.

Local community representative 1: ...if we had the time to do it, we could have said, "look, here are the big infrastructure projects that are going to monumentally effect this area." And told you, "here's Transpower, here's NZTA, here's Railroad" and you could have gone away and said "okay, I need to have in my scenarios, those projects somehow incorporated in it" and then we could have brought out our aspirations for like, reinstating the ferry service, pulling back the mangroves so that people have recreational use and have their beaches back,

getting in and getting the oyster beds out, doing some dredging and all the sort of things that when they are just thrown in, are out of context.

Three participants whose primary scale of interest was the local level gave feedback that they wanted to contribute more specific details and context to the scenarios to make them more realistic, while two participants whose interests were focused at the regional scale suggested that making the scenarios more ‘cartoony’ and less realistic might have helped the participants to engage with them in a more meaningful manner. Very few participants were happy with the scenarios as they were presented, which was an attempt to hybridise both of these approaches to scenario writing.

It was clear from the research results that participants would have preferred to spend more time with the scenarios so they could become more comfortable with them. Many participants described themselves as being overwhelmed by the amount of complex information included in the scenarios and explained that they didn’t have enough time to develop a coherent response to the scenario questions. An email from the local board representative received after the workshop summarises these concerns and possible solutions suggested by several participants:

You expected the comments [regarding the scenarios] to be finished in a very short time frame, considering that people had only just heard the information, had not had time to assimilate it, and certainly did not have time to use the information sheets handed out. How much better it would have been if you had distributed reading material several days beforehand with some idea as to the format of the workshop and the reasons why you wanted this kind of thinking from the workshop participants.

Despite the extensive criticism levelled at the scenarios, four people reported learning from the process, and said that they enjoyed this aspect of the scenario experience. One participant said that the experimental element of the scenarios made her reconsider some of the large scale impacts associated with the study area and how these might change over time:

Auckland Council employee 3: The scenarios in the second workshop were really awesome and I was sorry I got there late because I did miss a few bits and pieces but that was really cool. It was like ‘well, hold on how do I want this, how

do I want the place that I live to be like?’ and the types of things that can change it. The beach chic, that sounded quite cool but then actually, not that cool (laugh). I mean I want people on the water, using the water, and then there is the other side of that coin. It was really good in that regard.

Another participant pointed out that he learned much more from the social process of the workshop than he would have from a book:

Local conservation representative 2: I think that even the little discussion that we had, we worked off each other, and I think that's really a real benefit of the process. If you gave it to me all as a 20 or 30 page book, I wouldn't read it, but sitting around the table for 10 minutes, we suddenly started learning things.

This feedback from participants indicates that, especially with more time allocated, the scenario planning process could be a productive way to enhance the social learning and capacity building of a participant group.

The data from Workshop 2 also suggests that, despite the many challenges described here, participants improved their ability to work with the scenarios, and each other, over time. Both groups provided more complete responses which coincided with the scenario descriptions better in response to the second scenario than to the first. Groups also utilised ES language and designated more reasonable and/or appropriate trade-offs that would occur after the second scenario than after the first. However, participants tended to write down multiple individual responses to the questions, or give very general answers, rather than try to establish an acceptable collective answer in the short time frame allocated to them for the scenario planning activities. Despite this limited amount of collaboration, participants mostly reported being pleased with how respectful all participants were of one another's opinions and values.

Overall the scenario planning method utilised in this research is associated with high levels of complexity and a lack of user-friendliness which indicates low levels of transparency. This may also have somewhat reduced the capacity of the method to enhance social learning and capacity building among the participant group. However, feedback from participants suggests that more time for scenario planning activities and/or preparation in advance would help to alleviate this problem.

5.4 Fishing, boating, and wild food gathering questionnaire

5.4.1 Questionnaire results

A fishing, boating, and wild food gathering questionnaire was administered to 17 respondents at four popular fishing and boating locations in the study area, in August 2012 (see Figure 4.5 and Table 4.8 for details). Of these 17 respondents, 16 were fishers, one was a boater, and four were both fishers and boaters. Five collected wild foods such as scallops in addition to fish. Respondents most often cited fishing 1-2 times per week (37%) as the frequency with which they fished in the Manukau Harbour (Figure 5.16). All participants reported their primary reason for fishing was for recreational purposes, although three participants also said that they fished for subsistence purposes. Three of the boaters who responded to the questionnaire cited going out in a boat on the Manukau Harbour 1-2 times per week, and one boater cited going out 1-2 times per month. Respondents indicated that Kawhai is by far the most frequently caught species of fish in the area, followed by Snapper (Figure 5.17).

Figure 5.16: Frequency of fishing in Manukau Harbour reported by questionnaire respondents.

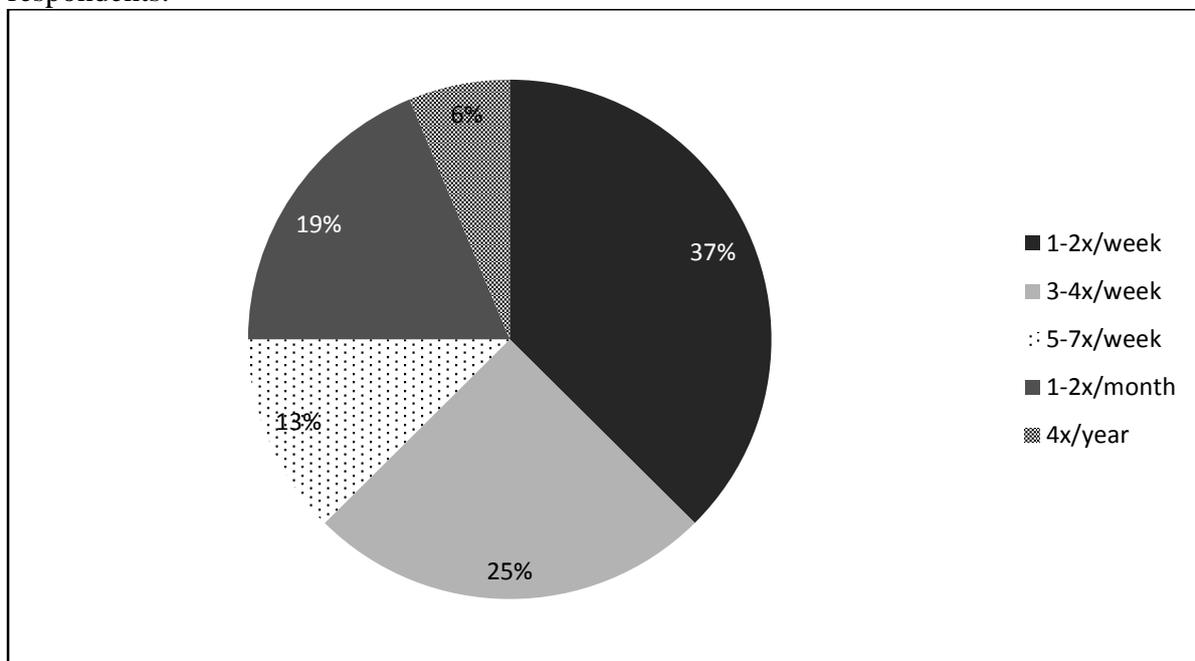
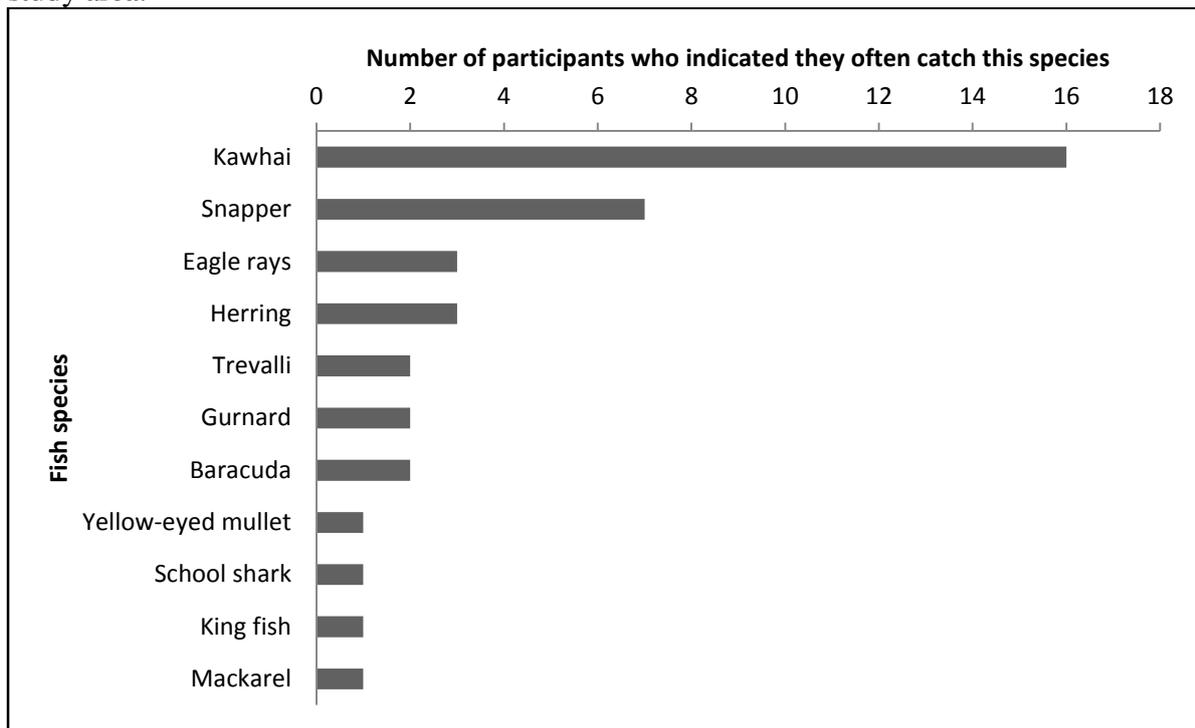
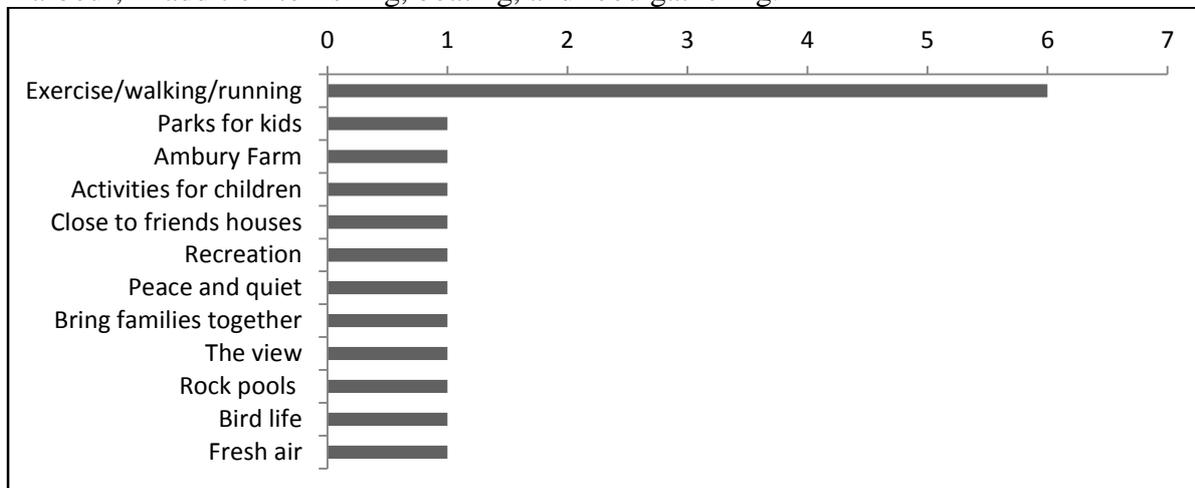


Figure 5.17: Species of fish that respondents reported catching with some frequency in the study area.



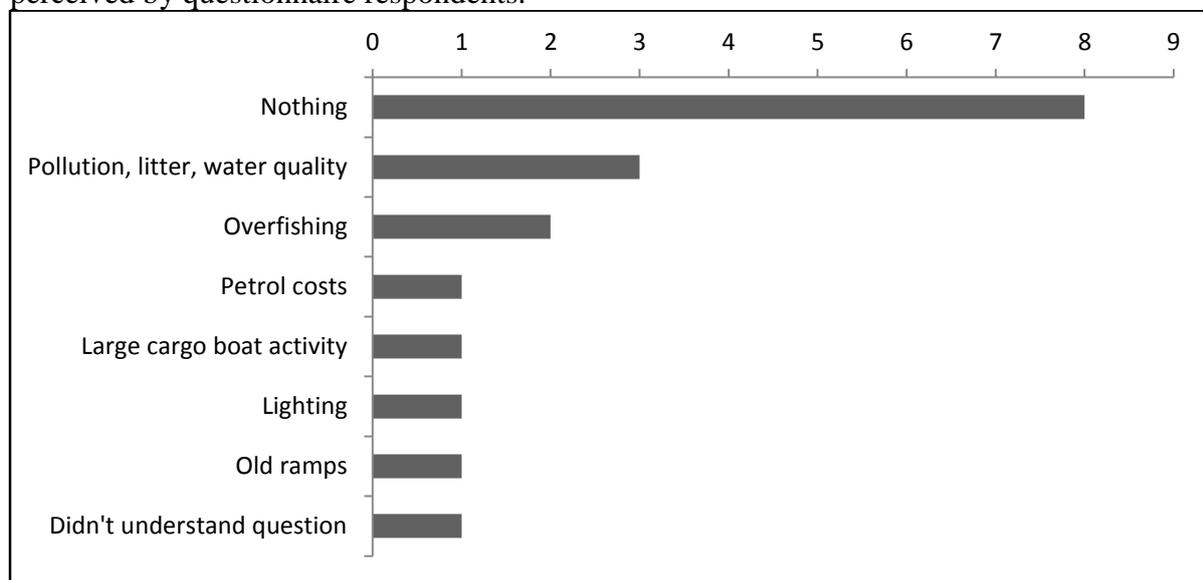
In response to the question “Are there other activities or reasons (besides the use of the area for fishing/boating/food gathering) that you enjoy having access to the harbour? If so, what are these activities or reasons?” 35% of participants said that they also enjoyed having access to the harbour for the purposes of walking, running, and other forms of exercise. A wide range of other kinds of activities were also listed by participants, and are included in Figure 5.18.

Figure 5.18: Activities or reasons that participants enjoy having access to the Manukau Harbour, in addition to fishing, boating, and food gathering.



In response to the question “Are there things that threaten your ability to fish/boat/food gather in this area, or that threaten any of the other activities or reasons that you enjoy the area? If so, what are they?” 47% of participants said that nothing threatened their ability to continue to utilise or enjoy the area, 18% said that pollution, litter, or water quality was a threat, and 12% of respondents said that overfishing was a threat. Several other threats were also listed by participants in response to this question, and are included in Figure 5.19.

Figure 5.19: Threats to fishing, boating, and food gathering in the Manukau Harbour, as perceived by questionnaire respondents.



5.4.2 Implications of findings

The questionnaire findings indicate high recreational values associated with the fishing that is conducted in Mangere Inlet and the surrounding areas of Manukau Harbour. This finding supports the results of the scoring exercise conducted during Workshop 1 and the pre-workshop interviews (Figure 5.1). A significant minority (18%) of the questionnaire respondents also reported fishing in the area as a subsistence activity. This finding suggests that if more fishers had been included in the workshops, a stronger emphasis on provisioning services such as food would have been a likely result. Questionnaire respondents indicated that in addition to fishing, boating, and food gathering, they also enjoy having access to the study area for purposes that roughly align with the cultural services of recreational, ethical, and existence values, as well as the regulating service of ecological values (Figure 5.18).

The threats perceived by the questionnaire respondents were almost entirely different from those described by the workshop and interview participants. This is an important finding because it starkly reveals the importance of incorporating all critical stakeholders into a participatory process; the novel contributions of one missing group might have important implications for decision makers. Almost half of the questionnaire respondents (47%) felt that nothing threatened their ability to utilise the study area for fishing, boating, and wild food gathering purposes. This response contrasts sharply with the litany of harbour threats perceived by many workshop participants. This divergence could be accounted for by many factors, ranging from level of education to duration of habitation in the area, but based on the available data it is not possible to make any reasonable inferences about these differences of opinion. The most frequently cited threat identified by questionnaire respondents does align with the concerns of workshop and interview participants; 18% of respondents described pollution, litter, and water quality as a concern, which aligns with the water quality concerns expressed by many of the workshop participants. All of the remaining threats identified by the questionnaire respondents are unique to this aspect of the study, including the 12% who suggested that overfishing was a problem for the area, a novel contribution to the study that was never raised by workshop or interview participants, and that could have important implications for management and governance in the study area.

Only a small sample of respondents completed the questionnaire during the time allocated to this method. A larger data set including a range of survey dates over the course of a year would be preferable to gain a clearer insight into the values and habits of fishing, boating, and wild food gathering stakeholders utilising Mangere Inlet and the surrounding areas of Manukau Harbour. The difficulties associated with meaningfully engaging representatives from the fishing, boating, and wild food gathering community should be considered in future work in the area.

5.5 Conclusions

This chapter described the results of the PM exercises and related research undertaken in Mangere Inlet and the surrounding areas of Manukau Harbour, and evaluated these methods for their ability to improve existing ES approaches and decision making frameworks. Workshop 1 contributed new knowledge about how ES associated with the study area are perceived and valued by a diverse group of stakeholders operating at a range of scales. The critical role of cultural values became evident from this work, and implications for decision making frameworks based on these findings were discussed along with lessons

learned from this workshop. Workshop 2 highlighted the challenges associated with a time limited scenario planning process and explored ways to alleviate these problems in future work. The final section of the chapter describes the results of a questionnaire deployed to recreational fishers, boaters, and wild food gatherers. These findings reveal several similarities and important differences between the questionnaire responses and the findings of the workshops and interviews, which may have implications for future work on ES frameworks and environmental decision making. The following chapter will expand on several of the findings from this chapter and explore additional research results using a novel analysis framework to determine the capacity of the PM methods to integrate social values into an ES framework, and generate four elements of social capital that are needed to resolve wicked problems.

6. Participatory modelling, social values, and social capital

6.1 Introduction

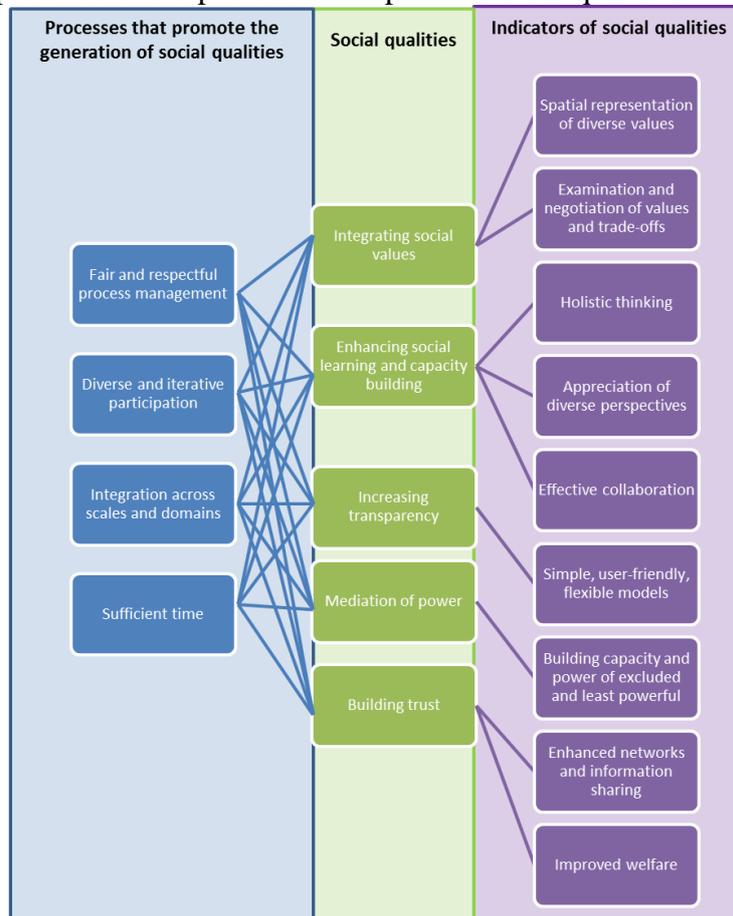
This chapter analyses the research results to determine the capacity of the PM methods applied in Mangere Inlet and the surrounding areas of Manukau Harbour to integrate social values into an ES framework (Daniel et al., 2012) and generate four elements of social capital that are needed to resolve wicked problems: social learning and capacity building (Krueger et al., 2012; Pahl-Wostl & Hare, 2004), transparency (Granek et al., 2009; Korfmacher, 2001), the mediation of power (Stringer et al., 2006), and trust (Lebel et al., 2006). An argument in favour of these five social qualities (the integration of social values and the generation of the four elements of social capital) was made in Chapter 3, and a framework for analysing them was introduced in Chapter 4. This chapter expands on the theoretical framework outlined in Chapter 3, the analytical framework outlined in Chapter 4, and some of the pertinent findings that emerged from Chapter 5, to evaluate whether or not these qualities are generated by this research. This is undertaken by situating the experience of the case study within the literature on ES, PM, and wicked problems using an analysis framework that explores process outcomes and indicators associated with the integration of social values into ES frameworks and the generation of the important elements of social capital. This framework allows lessons to be drawn from and positioned within the current literature. Through this analysis, an appreciation of the ways in which PM utilised in conjunction with ES frameworks can enable

and deliver resolutions to wicked problems, is extended beyond the current literature. The chapter concludes with five central messages that have been drawn from the research about how ES and PM applied in a constrained timeframe can resolve wicked coastal problems.

6.2 Processes that promote the generation of social qualities

The five social qualities needed to resolve wicked problems do not simply emerge from any type of social interaction; the generation of these qualities is dependent upon the convergence of appropriate political, institutional, and social contexts, and on the deployment of particular participatory processes (e.g. Tippett et al., 2005). Four key processes that support the integration of social values into ES frameworks and the generation of the elements of social capital considered in this thesis are described in Chapter 4. These processes are: 1) fair and respectful process management, 2) diverse and iterative participation, 3) integration across scales and domains, and 4) sufficient time. These four processes can be linked to the generation of social qualities and to a set of indicators regarding the extent to which these qualities were generated, and consequently, how well the processes were followed (Figure 6.1).

Figure 6.1: Analysis framework for the assessment of social qualities. Four key processes (blue column, left) provide a stable foundation upon which important social qualities can develop (green column, centre). Each of these four processes contributes to the establishment of each of the five social qualities considered in this thesis. These five social qualities are associated with their own unique indicators (purple column, right). The extent to which indicators are observed reveals the extent to which social qualities have been generated, and also suggests the presence of the processes that promote these qualities.



6.2.1 Fair and respectful process management

Participatory process outcomes are extremely sensitive to the way in which they are conducted – the choice of process is therefore in some ways more crucial than the choice of particular modelling tools (Reed, 2008). Fair and respectful process management is needed so that all participants can contribute to the proceedings. This requires a clear set of process goals and outcomes (Fleischmann & Wallace, 2005); communication that incorporates participant feedback (Reed, 2008); a democratic structure; and high quality facilitation that enables respectful and inclusive discourse among a diverse group of participants (Johnson et al., 2012). These elements of process management were achieved to varying degrees during the study.

Transformative research literature indicates that establishing collaborative goals and clarifying expected outcomes with the help of participants is likely to enhance study benefits for all involved (Mertens, 2009). However, in recognition of the time, resource, and capacity constraints inherent in PhD research, I chose to consult with stakeholders about their interests and concerns in relation to the study area during phase 1 of the research (see section 4.3.1.1), but to develop a set of goals and expected outcomes without the explicit input of the participant group. I attempted to take the wide range of participant interests and concerns into account during the development of goals and outcomes by designing research objectives that were as inclusive and generalizable as possible. This approach allowed for the exploration of the contributions that PM could make towards improving ES frameworks and addressing wicked coastal problems in general, while avoiding the possibility of alienating some stakeholders by focusing on a very specific issue associated with the study area (e.g. the encroachment of mangroves or the continued discharge of treated wastewater). Additionally, I did not want to choose a specific issue to address in advance, risking that participants might develop unrealistic expectations that the project alone could solve the problem. Instead, I designed the research process and methods so that detailed concerns could emerge from the PM process, thereby enhancing the possibility of collective learning.

Two participants reported that the research goals and outcomes were clearly relayed early on in the workshops, but one participant said that she would have liked the goals of the research to be more clearly explained, and two others stated that they wished the goals and outcomes were more specifically related to improving the welfare of the local community. The frustration expressed by these two participants in relation to the project goals may be partly historical, because there is a long history of research and subsequent inaction associated with the study area (see Chapter 2 for details). My decision to develop generalised project goals without the direct input of project participants is likely to have exacerbated this frustration. These findings support the concept that, ideally, collaborative goals and expected outcomes would be developed with the help of participants, particularly in areas where a history of mistrust and conflict abound (Voinov & Brown Gaddis, 2008). However, these findings also indicate that most research participants were comfortable with the researcher-designated project goals and expected outcomes. The acceptance described by most participants is likely due to the efforts that were made to develop a set of relevant goals and outcomes, and to convey these clearly and repeatedly to all study participants (Lynam et al., 2007).

Typically, stakeholders are only invited to participate at the implementation phase of a project, rather than in the early stages of project development (Reed, 2008). New approaches are emerging, however, which provide opportunities for stakeholders to be involved from the development of the initial concept through all stages of PM (Prell et al., 2007). This research follows Prell et al. (2007) by inviting participant input and feedback at all stages of the research, from the early consultation stages to the final stages of the writing, although as previously stated the study did not explicitly incorporate a collaborative component into the formation of project goals and outcomes. Communication with and feedback from participants was encouraged through face-to-face contact at meetings and events, regular email contact, and updates about the research progress. Participants were responsive to this technique and provided extensive input in person, over the phone, and via email throughout the project. As a result of this approach, the study was perceived by many participants to be focused on relevant issues and inclusive of a wide range of relevant stakeholder groups (see 6.2.2 below for more).

Finally, a democratic structure which aimed to facilitate equal contributions from all participants was implemented at both workshops (Johnson et al., 2012). This structure worked well in the first workshop, when participants were not required to collaborate extensively, but the second workshop faced some challenges in terms of small group facilitation, which may have undermined the capacity of all participants to contribute to a respectful discourse. These challenges may have contributed to the privileging of some perspectives over others in the results of this workshop, and reduced the capacity of some participants to fully engage with, learn from, and collaborate with others (McCullum et al., 2004; Muro & Jeffrey, 2008). The one-on-one follow up interviews provided an opportunity to discover these problems and fill some of the knowledge gaps that they exposed, but the privileging of one set of voices over another because of process management problems is a concern that can arise even in a carefully orchestrated research process such as this. Other studies have also emphasised the importance of highly skilled facilitation (Irvin & Stansbury, 2004; Reed, 2008; Voinov & Brown Gaddis, 2008). Reed (2008) goes on to point out that while facilitation is an important component of a fair and respectful process, the skills required are difficult to learn and good facilitators can be hard to find.

6.2.2 Diverse and iterative participation

A diverse and iterative participatory process is needed so that new ideas and perspectives that may help to address wicked problems have the opportunity to emerge (Brown et al., 2010). Participation from representatives of a broad range of scales and interests, and regular and open communication among participants and organisers, is needed for a diverse and iterative process to be in place (Reed, 2008).

This study did not incorporate the perspectives of all possible stakeholders with an interest in the management and governance of Mangere Inlet and the surrounding areas of Manukau Harbour, but it did include a range of perspectives far beyond what is normally considered in natural resource management decision making in New Zealand (c.f. Weber et al., 2011):

Department of Conservation employee: I liked the cross section of people that you had there, the really broad representation of different interests. I like the fact that it wasn't dominated by scientists because their take on ecosystem services, of what may or may not be of use in the area, is not always closely related to how it actually is used. No, I thought it was good getting those community groups there.

Diverse representation and participation was achieved through a variety of engagement methods described in Chapter 4 (section 4.3.1.4). By extending the participant group beyond the usual decision makers and incorporating a range of perspectives, this research provides an opportunity to approach decisions from a more complete factual base (Olsson et al., 2004), and to incorporate social values that cannot be gained through traditional scientific approaches (Stringer et al., 2006). An iterative approach to the research was achieved by implementing three pilot workshops (see 4.3.2.3) and responding to ongoing participant consultation and feedback. This adaptive approach to the research contributed to improvements in research processes and tools, and made participants feel that their concerns were taken seriously.

Several important stakeholders such as Ports of Auckland, youth representatives, fishing and boating representatives, and three of the five iwi with traditional links to the study area, chose not to engage in this research. Missing stakeholders could have implications for the research in terms of the ability of the study to resolve some problems associated with the study area. However, as stakeholder representatives from the local, regional, and national scale were included in the research, careful generalisations can be made from the findings with some confidence (Hein et al., 2006). Additionally, several stakeholders usually excluded

from decision making processes (except in the final stages of planning processes through submissions or due to litigation proceedings) were included in this study and expressed pleasure about this divergence from the norm. The incorporation of previously excluded opinions and values into this study provided opportunities for the generation of new knowledge that would not have been recognised through a standard process (Berkes, 2012). In particular, the identification of local, contextual values contributed important knowledge about the study area that could lead to better outcomes and improved sustainability for the area (Stringer et al., 2006). The early and ongoing contact established with participants encouraged open communication while the adaptive approach to the research supported the incorporation of new ideas wherever possible.

Representation is always a concern for participatory studies (Reed, 2008), but non-participation is a valid and sometimes powerful choice that stakeholders have the right to make (Hayward et al., 2004). The study results are representative of those who chose to participate, and does not claim to be representative of more than that particular group, although it is possible to make some careful generalisations from the information provided by this group (Castree, 2005).

6.2.3 Integration across scales and domains

The consideration of values, priorities, and trade-offs at a range of relevant scales and across various domains is needed to resolve wicked problems (Bammer, 2005; de Groot et al., 2010; Hein et al., 2006; Rodríguez et al., 2006). This requires the capacity to explicitly consider diverse social values along with ecological and economic priorities (Raymond et al., 2009), as well as the capacity to locate these values in space (Daily et al., 2011).

A wide range of social values were spatially oriented using the group mapping methods described in Chapter 5 (section 5.2.4). In a review of the literature (Chapter 3), only a few other published studies were found that have attempted to do the same (e.g. Brown et al., 2012; Klain & Chan, 2012; Raymond et al., 2009). Of these, none utilised a group mapping method, but instead chose to take individual data sets and manually integrate them into a collective representation. This quantitative approach is ‘cleaner’ in the sense that data are well documented through a one-on-one interview process or an application of Public Participation GIS, and there are fewer complex and messy social dynamics that need to be considered. However, none of the social outcomes associated with this research, and therefore none of the social integration, is possible using these individual methods (more details in section 6.3.1 below).

The unique approach to establishing the social value of ES employed in this study introduced participants operating at a range of scales and focal systems to one another's ideas and interests, thereby encouraging the integration of social values across scales and domains (Raymond et al., 2010). The awareness of other value sets and priorities operating within the study area was greatly enhanced by the research, and tolerance for other perspectives and a willingness to discuss trade-offs was also increased, suggesting that integration successfully occurred in several areas. Not all values could be spatially evaluated due to some scalar problems with the mapping method (section 5.2.4.1), but these values were captured on worksheets and therefore incorporated into the study using other techniques (section 4.3.2.3.d).

6.2.4 Sufficient time

Processes that aim to generate social qualities require sufficient time for social interactions to occur and qualities to be generated. However, the definition of 'sufficient' is likely to vary according to the quality being considered, and therefore time should be considered in the process development and analysis stages. Social learning can be successfully generated during a series of workshops, but in researching participatory methods it became apparent that participatory studies regularly employ five or more workshops, frequently of day-long duration, often over the course of a year or longer (e.g. Brown Gaddis et al., 2010; Etienne et al., 2011; Johnson et al., 2012; van den Belt et al., 2012). These long-term approaches are likely to generate durable social learning outcomes, but at the exclusion of certain participant groups such as those attending school (youths) or working standard nine to five jobs or long shifts. All but the most dedicated participants in this study, or those who are retired, would have been unlikely to attend such a schedule. Additionally, multiple demands on stakeholders' time can become a major stumbling block to the broader implementation of PM and ES approaches. The challenge is to establish processes that both involve stakeholders in a meaningful way and respect their other commitments.

To test the efficacy of shorter time commitments, time was purposely limited in this study to see how much participants could accomplish in two workshops, each of two hour duration (for a total of a four hour time commitment). In general, participants felt that integrating social values would have been easier with more time allocated so that group mapping tasks were not so rushed and there was more time for participants to discuss their reasons for allocating particular ES to particular locations. Most participants also suggested that additional time allocated for the activities would probably have allowed them to learn

and contribute more. For example, during the first workshop, allowing participants more time to develop their own ES categories and definitions, and consider the services within the context of the area may have enabled them to understand the ES processes more and subsequently to provide better feedback about how their values related to these services. While it is clear from this feedback that participants felt they could have learned and contributed more with additional time, the most common praise of the workshops was that participants learned a great deal about the study area, other participants, and/or the concept of ES.

In terms of transparency, many participants described being overwhelmed by the amount of complex information included in the scenarios and said that they didn't have enough time to develop a coherent response to the scenario questions. Mediating power may also have benefitted from longer timeframes. For example, in the second workshop, the strong opinions voiced by some participants who challenged the scenarios may have limited the ability of the group to use the scenarios as a productive learning tool, and two participants mentioned that they didn't feel it was worth their effort to speak up and try to change the opinions of other members of the participant group during the small group discourse because the abbreviated timeframes made lengthy arguments impossible. Building trust is generally associated with extended timeframes in the literature (a decade or longer) (Lebel et al., 2006), and this research indicates that more time would be necessary to address historical mistrust among particular stakeholder groups, although it is not clear that more time would be needed for all groups to develop some trust. Trust has been established elsewhere during short timeframes using role playing methods (Castella et al., 2005) or by establishing a 'working group' that met occasionally outside of workshop timeframes (Brown Gaddis et al., 2007; Voinov & Brown Gaddis, 2008).

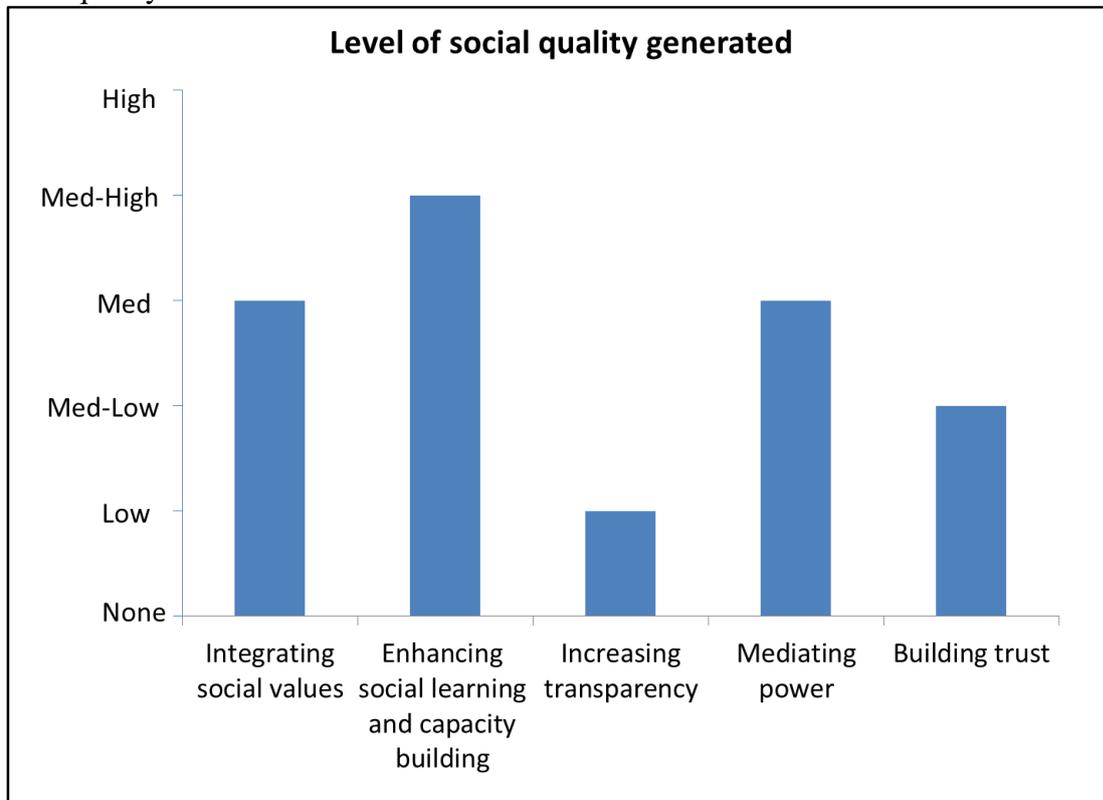
In general, participants felt that more time allocated for PM activities would have generated more extensive social qualities outcomes. There were two exceptions to this rule; two participants from the first workshop felt they had enough time to complete the activities and mentioned that the time limitation may have encouraged participants to stay on task. All participants felt that more time was needed to complete the activities outlined in the second workshop, and most added specifically that they would have learned more from the activity if they had more time. Participants generally indicated a willingness to spend more time on the tasks allocated to achieve a better result, but time was a significant limiting factor for most potential participants who were asked to comment on the length of time that they could expect to commit to the project during the consultation phase. Therefore, additional time

commitments would likely have led to reduced representation and participation from a diverse group of stakeholders. Future studies could address these problems by either allocating slightly more time to complete the tasks described in Chapter 4, or assigning fewer tasks to participants.

6.3 Indicators associated with the generation of social qualities

This study was designed primarily with the intention of integrating social values into an ES framework and enhancing social learning and capacity building, but the capacity of the study to increase transparency, mediate power, and build trust was also considered, as all of these qualities are interconnected and interact in complex ways to contribute to the resolution of wicked problems. Despite the interconnectedness of these qualities, it is possible to provide reasonable boundaries between them for discussion through a process of careful definition (see Table 4.10 for definitions). In the sections that follow, each quality is also distinguished through association with specific indicators that provide evidence of the extent to which these qualities were generated during this study. These indicators were developed from secondary literature in combination with primary data coding using constructivist grounded theory and critical review methods as described in sections 4.2.4 and 4.3.3.2. The development of these indicators was an iterative process involving the identification of categories and concepts that emerged from the data and which were linked to existing theories using coding (Charmaz, 2014; Ryan & Bernard, 2003). A summary of the research findings in relation to the generation of the five social qualities considered in this thesis is provided in Figure 6.2.

Figure 6.2: Summary figure of the extent to which this study generated the five social qualities that contribute to resolving wicked coastal problems based on an assessment of social quality indicators.



6.3.1 Integrating social values

Social values affect ES definition and prioritisation and are connected to current or aspirational activities. These values can therefore be translated into practices which affect ecosystem function and service delivery, so it is important to integrate social values into ES frameworks, especially where resolutions to wicked problems are being developed. This more holistic approach to the development of ES frameworks and wicked problem resolutions is likely to be supported by a broad community base (Yearley, 2006) (see also section 3.6.1). The integration of social values is associated with two key indicators; the spatial representation of diverse values (Stephenson, 2008), and the negotiation and examination of values and trade-offs (Chan et al., 2012), which will be explored in detail below.

6.3.1.1 Spatial representation of diverse values

Participatory methods that involve a diverse group of stakeholders can provide a holistic perspective on the relative value of an area (Stephenson, 2008), but these values must be spatially explicit to address ES (Tallis & Polasky, 2011). The diversity of the group of participants has been established in section 6.2.2 above, and Chapter 5 section 5.2.4 describes the spatial successes and challenges associated with this research in some detail. Important problems arose in accurately representing large scale services in the mapping activity. Three participants chose to represent all of their values at large scale rather than locate them at a specific site within the study area. Overall, 41% of the values assigned by participants were assigned to the large scale rather than to a specific site including 27% of all participant cultural values points, 51% of all regulating service points, 40% of all provisioning service points, and 69% of all supporting service points (Table 5.5). The worksheet associated with the map provided an opportunity for these values to be counted and incorporated into other elements of the study analysis, and the box for “Large scale services” included on the physical map allowed for the discussion of these services during Workshop 1 (Figure 4.4), but the spatial representation of these particular values was not possible.

Similar to the results produced by Klain and Chan (2012), the findings of this research indicate that while maps are a provocative method of knowledge elicitation and collaborative learning, assigning social values to specific locations within the study area was not possible for a significant minority of participant values. In this study, 19% of all study participants refused to assign value to specific locations, instead choosing to allocate all of their values to scales larger than the designated study area. Several additional participants chose to allocate some of their values to larger scales as well, resulting in 41% of all participant values being assigned to scales larger than the study area, rather than to specific sites or polygons within the area. Although their study area was much larger (20,288 km² of land and 9,880 km² of ocean), in the Klain and Chan (2012) study a similar significant minority (30%) of participants refused to assign relative non-monetary values to specific locations or refused to identify locations of non-monetary importance (16%). The similarity of these findings suggests that certain social values are by nature difficult to capture in a spatial frame. Despite these issues of scale, the flexibility of this study, which included the option to discuss large scale services even if they could not be spatially located, and to describe the importance of these services using stories, examples, and other details on the worksheets, enabled participants to describe and justify their values in a more detailed manner than was possible in the Klain and Chan (2012) study. Additionally, the scenario planning approach that was

included in this study enabled participants to examine and negotiate their values and trade-offs, which is a critical component of ES decision making (see section 6.3.1.2 below). These additions to the ES framework are important components that should be incorporated where appropriate into future work. Despite some challenges associated with scale and missing stakeholder representatives, the workshops were able to incorporate a more holistic and spatially explicit perspective of the social values associated with the study area than has ever previously been compiled.

6.3.1.2 Examination and negotiation of values and trade-offs

Some values cannot be ranked or prioritised because they are central to worldviews; where relevant, this problem can be identified and negotiated as needed prior to considering value trade-offs (Chan et al., 2012). An important critique of the ES approach in this vein was provided very early in the study by one of the tangata whenua representatives, who was only able to participate in a pre-workshop interview and did not attend either of the workshops. The participant explained that the “otherwise comprehensive” approach did not capture many of the deeper elements of Māori cultural identity, which is interconnected with the ancestral land and waters:

Tangata whenua representative 1: For Māori, our identity is intimately linked to and actually derived from the land and waters. So if you have any knowledge of Māori cosmology, there is that basic belief system that the primal parents are the earth and sky and that their children cover most of the eco-types. Tangaroa – the sea, Tāne – the forest, these sorts of environments that we encounter. However it is not as abstract as it sounds. It is genuine recognition of the whakapapa, the linkages between all of those elements and the people, so that mangroves and mullets etc are our relations. We derive from the same primal parents and so that is recognised in that cosmology.

This representative went on to point out that the capacity to utilise and provide guardianship to these ancestral areas is severely limited today. This is primarily due to the usurping authority of the Crown and the government, the extensive private and commercial ownership of ancestral areas, and the environmental degradation that has occurred over the last 150 years. The representative felt that the ES approach did not acknowledge these issues, or recognise the extensive heritage sites and the important role of the Manukau in traditional stories and activities. Harmsworth and Awatere agree with this critique, pointing out that "an ecosystem services framework for Māori must recognise that 'cultural values' range across material (e.g. provisioning, regulating, supporting) to non-material values (e.g. customary-

cultural, spiritual, sacred) (2014, p. 282).” Klain and Chan (2012) encountered related issues in their study of coastal ES values in the northern region of Vancouver Island in British Columbia, Canada, where spatial identification of traditional occupancy, use, and importance plays an important role in First Nations strategies to influence development and otherwise exert control over resources. This project aimed to identify a wide range of perspectives on the relative value associated with the ES of the study area, not to exhaustively represent the range of indigenous perspectives related to this space. However, the special legal and ethical position of indigenous groups in this study area demands particular consideration in decision making (Klain & Chan, 2012).

The criticism that cultural heritage was underrepresented by the ES approach was also noted by the participants in Workshop 1, who took the opportunity provided for this purpose to add a customary and historic service to the ES list in an attempt to capture some of these missing values (section 4.3.2.3.c). The relevant data provided by tangata whenua representative 1 was subsequently incorporated into this newly established category for the purposes of scoring and mapping. While these adjustments do not adequately account for the complexities of Māori identity or experience, they do provide a mechanism through which the cultural and historic values associated with any cultural group can be considered explicitly in decision making. The inclusion of a diverse set of participants, rather than those associated with status quo decision-making processes, provides a much needed opportunity to capture some of these missing values, but it must be acknowledged that an ES framework alone does not provide a basis for addressing deeper institutional and structural patterns of power and privilege in society. Rather, ES frameworks developed using transformative participatory methods create opportunities for improved approaches to these problems to emerge.

Another complicating factor in the examination and negotiation of trade-offs, was the language of ES. Although intended to bring stakeholder groups together through a common language (Daily et al., 2009b; Granek et al., 2009), three workshop participants felt that the complexity of the ES approach made it difficult to describe or define social values. They felt that it would have been possible to communicate about values in a more straight-forward manner, without all of the associated jargon and confusion, if they could have discussed more basic things such as water quality, rather than having to consider a whole range of services related to water quality:

Local business representative: One of the biggest things is the provisioning services, you talk about food and fiber, biomass fuel, genetic resources and all that sort of thing; that all depends on having water quality and my biggest problem is that we do not have that water quality and all of the benefits that could possibly come out of the Harbour are being destroyed at the moment in so many ways so the regulating services, though I do not understand some of the details of it because it is not my field, that is my biggest area of concern because without that being put right the rest is a load of wishful thinking really.

This idea was also supported by a regional-scale Auckland Council employee, who pointed out that it would be possible to include stakeholders in a process of identifying values, and then to subsequently link these values to the underlying services that support them.

Auckland Council employee 1: That is the challenge of goods and services... it is not all about fish. But when you have conversations with people, it is often all about fish. So how do you broaden that scope, or do you not broaden that scope, and you do it by making the links to those fish so that again, the value might be fish, but here is all the things that support fish. Maybe we don't have conversations with people around goods and services, maybe we have conversations with them around values and then it is a separate process to link out what are the services that supply those values and we manage those services rather than those values. Maybe it is a leap too far to ask people about services.

The confusion and frustration expressed by three study participants in relation to the ES language and framework is an important factor to consider in future work. In many ways, it would be easier to discuss values with stakeholders independent of any ES framework. However, the ES framework utilised in this research provided several benefits when dealing with the social values of a diverse group. First, it encouraged social learning about SES, ecosystem functions, other stakeholder values, and forced stakeholders to consider how their own values connected to services and sites. Second, it helped to diffuse conflict within the group, and instead focused discussion on learning. For example, the long history of social disenfranchisement and environmental degradation in and around Mangere Inlet, primarily represented today for local people by the ongoing operations of MWTP, have contributed to a great deal of angst within the local community. The ES approach allowed the group gathered at Workshop 1 to discuss the MWTP activities against a backdrop of ecosystem supported contaminant processing. This discussion diffused a potentially difficult and disruptive conversation, while still allowing several angry and frustrated participants to feel that they had been heard and that their values were accounted for by the ES approach.

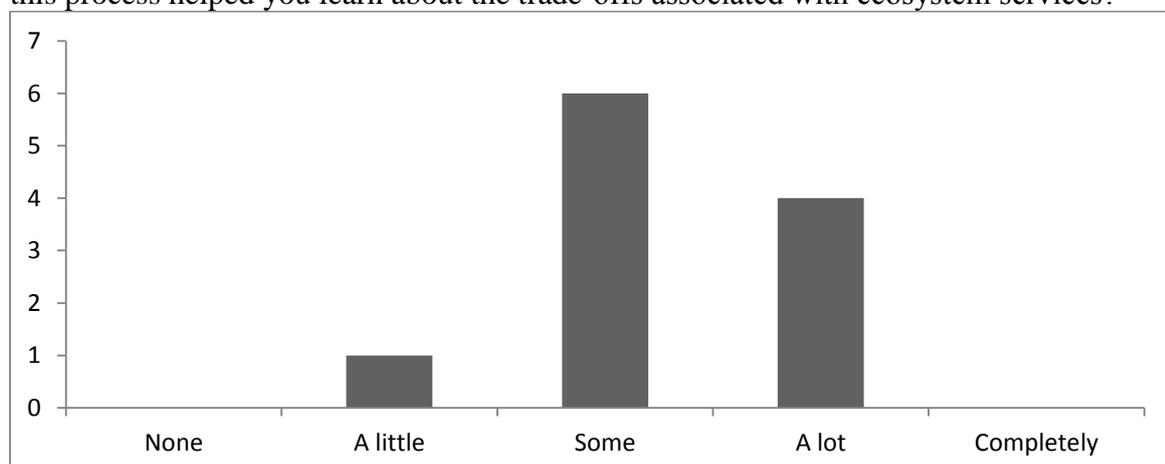
The approach suggested by the frustrated local participants and the pragmatic AC employee in the previous quotes would ultimately maintain the status quo in terms of experts making final decisions about trade-offs without the participation of local stakeholders. Additionally, including stakeholders in a discussion about values alone would not engage participants in a process of social learning about the underlying ecosystem functions that support their values or the trade-offs associated with those values and the values of others. This social learning is needed to improve long-term decision making under wicked conditions. Finally, while several participants did struggle with the ES approach and were vocal in their critique, many other participants embraced the method:

KD: Did you think that eco-system services approach was useful? Did that language and that way of thinking about things in terms of service provision, was that a useful approach or was that not really the gist of things for you?

Local board representative: It suited me; I didn't mind it at all. It could be that some people who are fixated on one thing like mangroves, that's the big 'thing', it could be that they don't understand that kind of thing. But then that is something you have to take on board when you are meeting with the community that there are going to be some like that.

Participants uniformly agreed that they needed more time for the scenario workshop, the primary focus of which was the examination and negotiation of trade-offs, yet despite this limitation, 36% of workshop evaluation respondents said that they learned “a lot” about trade-offs associated with ES from the workshops, and 55% said that they learned “some” (Figure 6.3). This data indicates that, despite some challenges, participants successfully examined and negotiated values and trade-offs using the PM method in combination with an ES approach.

Figure 6.3: Participant responses to the workshop evaluation question “To what extent has this process helped you learn about the trade-offs associated with ecosystem services?”



6.3.1.3 Summary of integrating social values findings

The integration of social values is associated with two key indicators: the spatial representation of diverse values (Stephenson, 2008), and the negotiation and examination of values and trade-offs (Chan et al., 2012). In the previous two sections, both of these indicators were associated with some successes and some challenges that arose from the research. The combination of these successes and challenges contributes to an overall finding that a medium level of achievement occurred. Consequently, it can be stated that the integration of social values was achieved to a medium degree by the research.

6.3.2 Enhancing social learning and capacity building

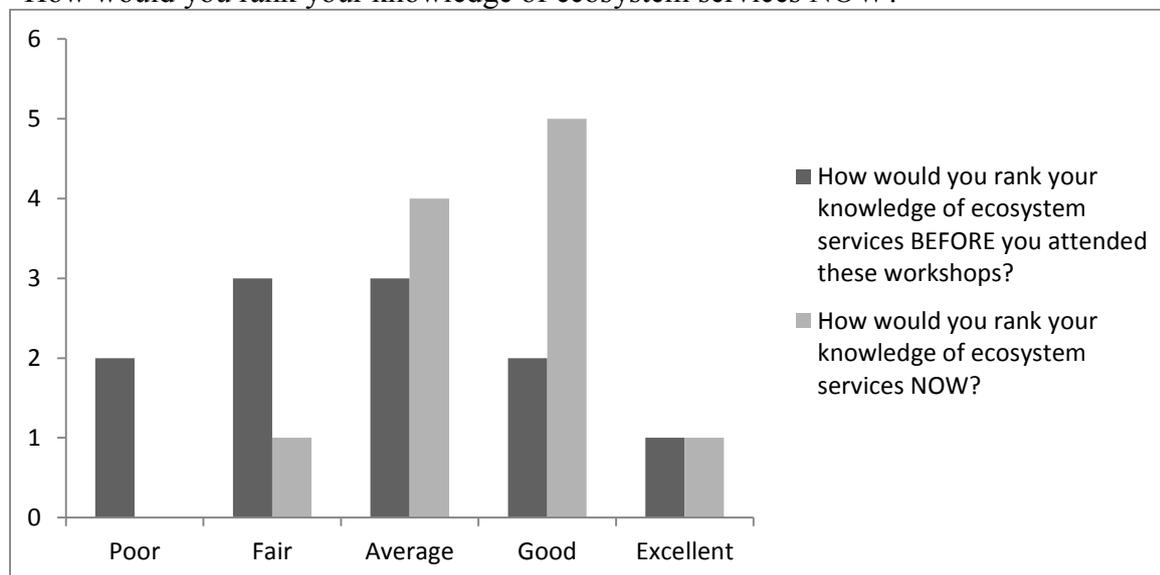
As discussed in Chapter 3, social learning involves a change in individual understanding that is situated within a larger social context, and which came about because of social interactions and processes within a social network (Reed et al., 2010). This research evaluated three key social learning and capacity building outcomes: holistic thinking, appreciation of diverse perspectives (Johnson et al., 2012; Muro & Jeffrey, 2008), and effective collaboration in response to problems (Folke et al., 2005). The achievement of these outcomes requires the sharing and negotiating of knowledge (Pahl-Wostl & Hare, 2004; Turnpenny et al., 2009).

6.3.2.1 Holistic thinking

Individuals who think holistically about a system find it easier to adjust their mental models in relation to that system because they understand that it is complex and multi-faceted (Daniels & Walker, 2001). ES approaches can facilitate holistic thinking about an SES by connecting ecosystem functions to the benefits (services) derived from these functions (Granek et al., 2009). PM approaches can support holistic thinking about a system through a process of clearly defining boundaries, components, and connections within a system (Etienne et al., 2011).

Workshop evaluation data (Figure 6.4) indicates that participants felt that the workshops helped them to learn a great deal about ES; five study participants said that before the workshop their knowledge of ES was “poor or fair”, but this number dropped to one participant after the workshops. Participants who felt that they had a “Good” understanding of ES increased from two before to five after.

Figure 6.4: Participant responses to the workshop evaluation questions “How would you rank your knowledge of ecosystem services BEFORE you attended these workshops?” and “How would you rank your knowledge of ecosystem services NOW?”



Further evidence that holistic thinking was generated by the workshops is derived from the interviews, in which 65% of interviewees (11 out of 17) reported learning about an element or elements of the social-ecological system about which they were previously ignorant :

Auckland Council employee 3: I really liked it [the workshops]. It made me think a lot broader. Thinking about those tiny little micro things that people don't think count, but they matter so much. Also seeing how my perspective was quite narrow until I left there...I have been going for big walks in places I wouldn't normally go, basically because it has given me an interest, it has made me think about 'what are people doing?' in and around this area.

Even the scenario workshop, which was generally associated with a great deal of criticism, was praised by several participants for encouraging them to consider new possibilities regarding the future of the study area (section 5.3.4). This is a clear indication that, at least for some study participants, holistic thinking was enhanced by participation in the workshops.

6.3.2.2 Appreciation of diverse perspectives

Learning from others is predicated upon an appreciation of diverse and sometimes conflicting values and world views (Mezirow, 1996). In response to the question "What did you gain most from these workshops?" 55% (6 out of 11) of workshop evaluation respondents wrote that they gained new knowledge about alternative perspectives on issues related to Manukau Harbour. During their interviews, 59% (10 out of 17) of participants described learning about, and coming to appreciate, the opinions and values of other study participants during the course of the workshops:

Local conservation representative 4: That was really stimulating to hear people putting forth different views. It is great to have such a range of people.

This feedback makes it clear that one of the primary strengths of the study was its ability to illuminate a variety of values for careful consideration, and appreciation, by participants. This contribution is not unique to PM in general, but it is an important contribution to the specific area of ES mapping.

6.3.2.3 Effective collaboration

Wicked problems demand multi-stakeholder, multi-scaled resolutions; this requires a willingness to engage in collaboration and collective action (Folke et al., 2005). Although participants developed a group map in the first workshop and were encouraged to discuss this process with one another, they were not required to collaborate. The group mapping methods only required participants to contribute their own ideas, and to observe the contributions of others. This process clearly stimulated social learning in some participants, but had it required effective collaboration, it is likely that it would have stimulated more. In the second workshop there was more opportunity for collaboration; the format required the small groups to discuss and respond to the scenario questions, and generate answers that could be presented to the larger group. However, a member of Group 1 complained during her interview that the group responses presented to the larger group were not an accurate reflection of the group discussion, and Group 2 generally chose to present a range of opinions in response to the questions, rather than a single collective answer. Despite these challenges, the small group facilitator for Group 2 commented that the group dynamics "softened a little as the experiment went on. I felt the group interaction became generally quite positive, open, and there was an interest in sharing information/learning from others." These findings

indicate that the workshops were generally unable to generate collaboration or collective action in the allocated timeframes, but that more time is likely to have allowed for this to occur.

6.3.2.4 Summary of social learning and capacity building findings

Three key social learning and capacity building outcomes were evaluated above: holistic thinking, appreciation of diverse perspectives (Johnson et al., 2012; Muro & Jeffrey, 2008), and effective collaboration in response to problems (Folke et al., 2005). The first two indicators were associated primarily with high levels of successes, while the third was associated primarily with challenges. The combination of these successes and challenges contributes to an overall finding that a medium-high level of achievement occurred. Consequently, it can be stated that social learning and capacity building was achieved to a medium-high degree by the research.

6.3.3 Increasing transparency

Transparency can be associated with either the participatory process, the models that are associated with that process, or both. This is because transparent participatory processes require a relatively simple, open, flexible, easily-updated process that a wide range of participant experiences and levels of understanding can make contributions towards (Voinov & Bousquet, 2010). The best way to facilitate this kind of process is to utilise and develop simple, user-friendly, flexible models (Brown Gaddis et al., 2010; Korfmacher, 2001). Clear documentation and explanations of assumptions, the ability to inspect components (Fleischmann & Wallace, 2005), and iterative communication among participants and organisers (Prell et al., 2007) support these kinds of outcomes.

6.3.3.1 Simple, user-friendly, flexible process and models

A transparent research process and transparent models facilitate open communication and clear accountability at all levels of the research, which are needed for the generation of the other four social qualities discussed in this research. Because of this interaction, there is a great deal of overlap between the *Increasing transparency* coding and the four other social qualities codes (section 4.3.3.1).

Confusion as a result of complexity or lack of clarity was described by several participants in relation to the workshop language, processes, and/or models. During the first workshop, one participant described confusion about the goal of the mapping process and

referred to the confusion of others. Several other participants discussed confusion related to the ES list definitions and issues of scale, which have been discussed at length in Chapter 5 sections 5.2.1 and 5.2.4 as well as section 6.3.1.1 above. This confusion is summarised by Auckland Council employee 2:

Auckland Council employee 2: ...it is difficult because you get that division between say cultural things that might be site specific, for a lot of the regulating ones, it is a function of, there are areas that do it more than others, but it is kind of a function of the whole system. I think it is useful for people to be able to think about where things are in space. It may also be complicated by its inter-relation say, with the rest of the Manukau.

As discussed in section 5.2.1, participants described missing values, disagreement with definitions, and general lack of comprehension as concerns about the ES list. The confusion and ambiguity related to this list could cause problems in service ranking and prioritisation, particularly for categories that shared similar scores. Participants often suggested that having more time to discuss and define categories and services as a group would help to address this transparency problem. Additional time would also be likely to enhance opportunities for social learning to occur. Two participants suggested that providing resource materials in advance would have allowed participants to familiarise themselves with some of the ES terminology prior to the workshop.

The language of ES is not generally user-friendly. Many examples of ES use scientific terminology, abbreviations, or refer to complex scientific processes (Table 4.6). Three participants clearly expressed their frustration with this terminology. However, the majority of the participants were able to discuss their values and relate them to ES despite this language barrier, and by the end of the second workshop, the small group facilitators reported that many of the participants were using the language of ES with increasing confidence and comfort. The evidence from Chapter 5 section 5.3.4 also supports the argument that participants became increasingly comfortable using the ES language to discuss trade-offs as the workshop progressed, because the group responses to the second scenario that they were given correspond more closely and reasonably to the questions asked than the group responses to the first scenarios.

During the second workshop, several participants complained about the lack of facilitated introductions, which they felt reduced the transparency of the workshop process, and subsequently increased their confusion and suspicion about the workshop motives. Two participants mentioned that having access to the scenario materials prior to the workshop

would have helped them to participate more fully and comfortably during the workshop itself, because the scenarios were extremely complex and difficult to comprehend in the short time allocated. Many participants felt that the scenario planning process, and their comprehension of it, would have benefited from more direct contributions from participants to the development of the scenarios.

One participant requested that there be a clearer agenda (see sections 6.2.1 and 6.3.5 for more on this) in terms of project goals and expected outcomes, although two others said that the project aims were clearly laid out early on in the workshops. To provide continued clarity and maintain iterative and open communication with all participants, regular updates regarding workshop outcomes and other elements of research progress were provided, and participants were encouraged to raise questions or concerns about the research if and when they arose. Three participants did so after the second workshop via email; these concerns related in large part to issues with workshop transparency, and subsequent problems associated with power, trust and learning (see 4.3.2.3 for more details). Although it is unfortunate that these issues arose, the fact that participants were comfortable discussing their concerns demonstrates that an acceptable mechanism was in place to address these issues.

These findings indicate that the scenario planning method is associated with high levels of complexity and a lack of user-friendliness which indicate low transparency, and may also have reduced the capacity of the method to enhance social learning and capacity building among the participant group. However, feedback from participants suggests that more time for scenario planning and/or preparation in advance of the workshops would help to alleviate these problems.

6.3.3.2 Summary of transparency findings

Transparent participatory processes require a relatively simple, open, flexible, easily-updated process that a wide range of participant experiences and levels of understanding can make contributions towards (Voinov & Bousquet, 2010). The best way to facilitate this kind of process is to utilise and develop simple, user-friendly, flexible models (Brown Gaddis et al., 2010; Korfmacher, 2001). In the previous section, both the participatory processes and participatory models associated with this research are primarily connected to challenges that arose from the research. These challenges contribute to an overall finding that a low level of achievement occurred. Consequently, it can be stated that increasing transparency was achieved to a low degree by the research.

6.3.4 Mediating power

A participatory process that successfully mediates power exchanges (Allen, 2003) through careful process planning and facilitation can build the capacity and power of previously excluded or otherwise less powerful individuals (Shucksmith, 2000), thereby encouraging more effective collaboration among all participants (Folke et al., 2005). Effective collaboration is considered in the social learning and capacity building section (6.3.2.3). Engaging in collective action is needed to respond to wicked problems (Brown et al., 2010), but this often requires a novel reorganisation of roles among a multi-stakeholder group, and can be quite challenging to facilitate (Stringer et al., 2006).

6.3.4.1 Building capacity, power of excluded, and least powerful

Addressing wicked problems requires both adaptive and holistic approaches to decision making. This necessitates unconventional power arrangements which place more responsibility on smaller scale, adaptive arrangements, while simultaneously linking these into larger information networks to provide feedback and support (Folke et al., 2005). Social learning also depends upon interactions with stakeholders who may previously have been excluded from decision-making; otherwise the process simply engages with the status quo and does not introduce new perspectives or ideas (Stringer et al., 2006).

To facilitate the equal inclusion of all participants' perspectives in the first workshop, a strict process was developed for input which required every individual to place the same number of pins on the group map to represent an equal number of values of their choosing. No negotiation about these values or choices was required. Consequently, participants were generally quite happy with the mediation of power associated with the first workshop. In fact, the DOC employee pointed out that the ES approach, which de-emphasised the politics associated with decision-making in the area, was critical to enabling a productive discussion during the first workshop. This participant also felt that the neutrality of the study encouraged an open exchange of information which would have been impossible if the research was affiliated with one of the regional or national stakeholders. The feedback provided by local community representative 3 (Chapter 5 section 5.2.4), who explained that he felt that being included in the group mapping process legitimised his values and his organisation, thereby empowering him and his organisation, also supports the argument that the workshop built the capacity and power of the excluded and least powerful (Shucksmith, 2000).

In the second workshop, the process of facilitating participant input was less strictly enforced, and therefore relied more heavily upon the small group facilitators and the

participants themselves to regulate the group discourse in a fair and equitable manner. This proved to be tricky, and several participants complained about the mediation of power at this event, although the facilitation was defended by others. Some participants felt that in the second workshop the facilitation was heavy-handed and that the facilitator seemed to be pushing an agenda by either leading participants or ignoring their comments. Meanwhile, others from the same group felt that the facilitator made sure that everyone's perspectives were heard. Still other participants felt that the facilitator became too involved in the discussion and was not able to provide the group with enough guidance. In a similar vein, one participant questioned the way that the scribe/presenter "picked and chose" what to write down, while another participant from that same group felt that the scribe/presenter "presented a reasonable consensus of what the group did, she wasn't just pushing her own agenda." These mixed reviews suggest that more care should be taken with the facilitation and presentation of scenario discussions, to ensure that focus is maintained and participants feel that all perspectives are heard.

Several participants in the scenario planning workshop also commented on the lack of mechanisms included to balance the input of all attendees. Although there was a small group facilitator present in each group, as well as a group leader chosen from by the study participants themselves who was supposed to facilitate a fair discussion within the group, there was a concern that as a result of the natural dominance of certain individuals, the natural shyness of others, and the somewhat hands-off approach of the facilitators, some voices and opinions were not heard equally. One participant was concerned that she had not vocalised her value of fish clearly enough to the group during the scenario planning workshop. Although she blamed this lack of participation on herself rather than the workshop process, saying that she is "not a very fluent speaker", the problem of who participates and to what extent must be considered carefully in any participatory approach that intends to address wicked problems (Hesse-Biber, 2007; Reed, 2008).

Without providing an opportunity for the disenfranchised and powerless to participate, the research will only support either the loudest voices or the status quo (or both), instead of contributing alternative perspectives which might illuminate novel resolutions to complex problems (Stringer et al., 2006). Providing clear structures for the mediation of power is an important element of providing opportunities for the least powerful to participate (Voinov & Bousquet, 2010). While the first workshop provided this structure, the second workshop struggled to mediate power relationships and enable the open and easy participation of all present. One participant did point out that the information provided by all

participants was captured on the worksheets and in the presentations to the large group despite the involvement of several dominant personalities in the small group discussions of the scenarios. However, the lack of a mechanism to control these dominant personalities may have created a polarising dynamic within the group, causing some participants to become defensive during the scenario discussion, rather than being open to sharing and learning.

Both workshops were intentionally structured to reduce bias with the goal of providing more equal footing for all. Representation was raised by several participants who were uncomfortable or unhappy about how the structure of the second workshop facilitated this equity. One participant questioned the logic behind a participatory structure that reduced scientific knowledge to one opinion within the context of the group:

Auckland Council employee 1: ...if you just provide your scientific opinion when you're sitting around the table, does it lose weight against all the other opinions, do people not want to listen because you are just some scientist in the mix?

Two participants sought to undermine the authority of other participants' knowledge sets by pointing out reasons that the information provided by other participants was faulty, lacking in expertise, or otherwise not representative of the study area. For example, one made the following observation:

Local community representative 1: And we actually didn't have enough people around the table that were well learned enough experts. Somebody could be an expert in a little thing but it wasn't a big enough picture for people to feel comfortable. For example, at our table there was a guy who was a real expert on birds, but when you started talking about mangroves, I knew he was not up to play on the research that has been going on in mangroves, because now people are starting to question what he was saying as like, biblical truths, where, what I have been reading is "hmmmm, maybe not even", and so there wasn't the time to go back and re-question some of that stuff.

The perspectives of these participants are valuable, but an important contribution of this research lies in its ability to incorporate a diverse set of opinions about the social value of ES in the study area, rather than its capacity to present a single 'correct' perspective (Krueger et al., 2012). The dissatisfaction described by these participants indicates that this particular goal was achieved.

Finally, the power of the primary researcher/organiser is important to consider when conducting participatory work (Voinov & Bousquet, 2010). Issues associated with this emerged through discussions with participants around research outcomes. Several

participants stated concerns that outcomes associated with the research would be put forward as viable options for the management and governance of Manukau Harbour without the approval of participants, or with the seeming approval of participants. This concern is tightly linked to the lack of trust established between some of the participants and authority figures in general, but also myself in particular (see section 6.3.5 for more on this topic).

6.3.4.2 Summary of mediating power findings

Participatory processes can successfully mediate power exchanges (Allen, 2003) through careful planning and facilitation designed to build the capacity and power of previously excluded or otherwise least powerful individuals (Shucksmith, 2000) and encouraging more effective collaboration among all participants (Folke et al., 2005). The previous section described both successes and challenges related to the ability of this research to build the capacity and power of the excluded and least powerful. The combination of these successes and challenges contributes to an overall finding that a medium level of achievement occurred. Consequently, it can be stated that the mediation of power was achieved to a medium degree by the research.

6.3.5 Building trust

Through repeated interactions of stakeholders, shared understanding and trust can both be developed (Lebel et al., 2006). In particular, social interactions leading to collective action that enhances the welfare of both the trustor and the trustee, build trust. Therefore, two primary outcomes can be used to determine if trust-building has occurred: enhanced social networks and information sharing, and improved welfare (Ostrom & Ahn, 2009).

6.3.5.1 Enhanced networks and information sharing

In responses to the questionnaire distributed at the end of the second workshop, 64% of workshop participants stated that the networking opportunities available at the workshops were good or excellent. No respondents indicated that the networking opportunities provided were poor and only 9% classified them as fair. During interviews, participants described meeting new contacts whom it would be helpful to know, and several also stated that the workshop enhanced previous relationships. By enhancing social networks, the research aimed to encourage information sharing among these stakeholders and the organisations that they are affiliated with outside of the structured research process. An email update sent to me on 4 November 2014 by local conservation representative 2 confirmed that this has occurred:

You may have heard that I gave a presentation, in Onehunga, to the Manukau Harbour Restoration group last week, based on the comments that arose from the last session that you ran in Onehunga where there was a clear lack of understanding about the birds of Mangere. It went well but not too many of the locals there.

These successes must be weighed against several challenges that arose during the research, particularly during the scenario planning workshop. Four participants repeatedly emphasised concerns related to trust and elements of networking and information sharing. These concerns also frequently overlapped with references to transparency and power. For example, local community representative 1 stated that she was concerned about an Auckland Council employee, who was not initially identified as such through a formalised introduction process, taking on a leadership role within the small group. She was afraid that surreptitiously allowing a council employee to take on this role was part of a conspiracy to bias the small group discussion towards existing council perspectives, rather than allow the local community the opportunity to voice their concerns about decision-making in the Manukau Harbour. Local interest representative 4 generally agreed, declaring that council employees should be included in the workshop, but only in a limited capacity:

Local interest representative 4: They should be there listening, they shouldn't be there advocating, they should be listening. There is some really interesting feedback, okay?

These concerns arose primarily out of a historically antagonistic relationship between these participants and Auckland Council (see Chapter 2), which clearly biased some local community representatives towards mistrust. The conditions of the second workshop unwittingly exacerbated these concerns. Although it might not have been possible to change this situation dramatically for these four participants because of their predisposition towards suspicion, a more transparent process that involved more careful mediation of power would probably have increased their openness to the information provided by council employees, and possibly contributed to these participants gaining new perspectives on council employees, rather than coming away from the workshop with their fears aggravated and their suspicions heightened:

Local community representative 1: I think ideally, if we could get regulators to participate, not in a paternalistic way, but as an equal participant, then maybe we

could have a much better exchange of aspirations and information and expertise and build up some trust and end up with regulations that make more sense and regulators who are much more human and that are easier to work with.

The decision to skip a facilitated introduction at the beginning of the session combined with the inclusion of a diverse group of stakeholders also contributed to the four mistrustful participants' anxieties about the workshop objectives and the motives of other participants. A quote from an email that I received from the local business representative after the second workshop clearly summarises several of these concerns:

I was unaware of the other participants involved. Having been involved in many, many community events/issues I am concerned that I could only identify four other participants who are commonly involved. I was unaware of the others and there were no introductions. I am very concerned to discover that one of the participants is a council officer which leads me to ask the purpose and use of the information gained/is there an agenda with the findings.

Related concerns were echoed by all four of the mistrustful participants, but the majority of the study participants were not concerned about the workshop structure or the identities of other participants, some even defending the workshop when pressed during interviews. One participant pointed out that the lack of facilitated introductions was not a problem because the small group segment enabled participants to get to know a few other people quickly and easily and made them "feel at home".

Two of the mistrustful participants linked the fear and suspicion that they experienced during the workshops to the limited time allocated. However, while the short time frame may not have enabled extensive trust building to occur, the evidence suggests it is unlikely that the workshops did anything other than expose latent pre-existing conditions of suspicion and doubt, which this participant describes as coming "galloping to the top":

Local interest representative 3: And then there are the conspiracy theories that started to arise as you might have noticed towards the end there. Where people were saying 'Hang on, we have got Council Officers here that have been anti everything since day one and this is going to end up as Council policy and we have been involved with it so we have supported it!' And all those fears came galloping to the top.

The mistrust of council employees that was emphasised repeatedly by the same four participants, all of whom represented local interests, including local business interests, was not reflected in the majority of the group. Even when asked specifically if they had concerns

about the presence of council members at the workshop, or about the relationship between the council and the community in the study area, the majority of the participants responded by saying that they were aware that some people had concerns, but that they personally did not. The clear distinctions between the four mistrustful participants and the rest of the participants regarding issues of trust suggest that the workshop itself did not have a significant impact on the capacity of the group to build trust, but that whatever mind set participants arrived with (i.e. trustful or suspicious) was maintained, rather than changed by the workshop process.

The concerns raised by participants about the scenario method and trust building, although limited to a minority of the participants, should be considered carefully in future research. The scenario method is increasingly employed to engage participants at different scales in environmental decision-making (McKenzie et al., 2012), but this research suggests that it may not be ideal to utilise this method in short time frames or in areas where long-term mistrust between participant groups exists, as the application of the method may expose or even exacerbate distrust among these groups.

As described in previous sections, several participants said that they would have appreciated the opportunity to provide more direct input into the development of the scenarios, and to have the scenario materials provided in advance. These changes might have enhanced the transparency associated with the scenario planning workshop, thereby enabling participants to be more trustful of the process. They also might have enhanced the learning capacity of the participants, whose mistrust of one another occasionally handicapped their ability to learn, as illustrated by this small group exchange:

Facilitator: Just going back to Scenario 1, did you have enough information to actually weigh up the trade-offs? Is there other information - what is the missing information that would help you?

Local business representative: I don't know enough about the ecology or anything like that. So we were having this discussion about are the birds going to have less feeding grounds, and, well, I don't know! [giggles]

[pause]

Local conservation representative: Trust me!

[group laughs]

Local business representative: Well but I [personally] don't know about that. I don't know about the impact it's actually going to have...I needed to know a lot more so I can actually make an informed decision about the impacts of anything that we're deciding. I

can't make a decision on that, and it's like, I have a problem with the wastewater, why are we talking about [incomprehensible].

This exchange illustrates how a participant's claims to expertise do not automatically translate to social learning; because of the lack of trust within the group, the expert knowledge is either ignored or rejected (Carolan, 2006b). This is an important concern within a suspicious group where participants have a history of disenfranchisement.

Trust is often described as being essential to successfully generating participatory outcomes (Reed, 2008), but as it is generally agreed in the literature that trust cannot be developed in short timeframes (Lebel et al., 2006), trust building was not a primary focus of the research. This research indicates that while it is unlikely that a great deal of trust can be generated by a short term project, short time frames do not necessarily have a negative impact on those who are not pre-disposed to suspicion, and may in fact build some trust among these participants. However, among groups where a history of suspicion exists, a longer time frame and methods more specifically designed with trust, transparency, and power in mind, are likely to be needed to build trust among participants.

6.3.5.2 Improved welfare

As a result of the historical local mistrust of authorities associated the governance and management of the Manukau Harbour, one person felt that the PMprocess would have benefitted from being more clearly disassociated from any possible outcomes because of the ongoing mistrust among different participant groups:

Local community representative 1: I think you do have to make it really clear that you have two outcomes in mind, you are testing this academic construct and then the other is that you are trying to see if you can use that for some beneficial outcomes and give people comfort around what those outcomes might be. Because in this case, people are so nervous about it coming back to bite them in a negative way, and them getting something that is just a continuation of the problems that they have had in the past.

Balancing the relationship between building trust and providing outcomes in a participatory process proved to be somewhat difficult. While this participant felt that the research needed to be more clearly disassociated from any possible outcomes, two others felt that there was no reason to do research unless it would contribute to clear outcomes that would benefit the local community:

Local community representative 4: If you go and search on reports on the Manukau Harbour by NIWA and ARC, these guys have had a great time writing reports but nothing ever happens and that becomes the frustration of the process. How you start to make a change and I guess as a community of total mismanagement of the Harbour for 70/80 odd years, how do you recover it?

This conflict implies that, as suggested in section 6.2.1, collaborative goals and expected outcomes would ideally be developed with the help of participants, particularly in areas with a long or intense history of mistrust and conflict (Voinov & Brown Gaddis, 2008). While the majority of research participants were comfortable with the project goals and outcomes, the vocal minority may have been appeased by becoming involved in a working group, which could have enhanced the relevance and satisfaction associated with all subsequent proceedings (Sweetman et al., 2010). It was clear from the follow up interviews that most participants felt that being involved in the project was ultimately a worthwhile experience, but convincing some stakeholders of the usefulness of the research at the outset, without prior credentials or community based support, proved to be somewhat challenging. This problem would similarly be addressed by involving local, passionate leaders in a working group from the early stages of the research.

6.3.5.3 Summary of building trust findings

Two primary outcomes can be used to determine if trust-building has occurred; enhanced social networks and information sharing (Lebel et al., 2006), and improved collective welfare (Ostrom & Ahn, 2009). The first of the previous two sections was associated with some successes and some challenges that arose from the research, but the second was associated primarily with challenges. The combination of these successes and challenges contributes to an overall finding that a medium-low level of achievement occurred. Consequently, it can be stated that building trust was achieved to a medium-low degree by the research.

6.4 Conclusion

This chapter has evaluated the research results to determine the capacity of the PM methods applied in Mangere Inlet and the surrounding areas of Manukau Harbour to integrate social values into an ES framework (Daniel et al., 2012), which was achieved to a medium degree, and generate four elements of social capital that are needed to resolve wicked problems: social learning and capacity building (Krueger et al., 2012; Pahl-Wostl & Hare,

2004), which was achieved to a medium-high degree, transparency (Granek et al., 2009; Korfmacher, 2001), which was achieved to a low degree, the mediation of power (Stringer et al., 2006), which was achieved to a medium degree, and trust (Lebel et al., 2006), which was achieved to a medium-low degree. This evaluation was undertaken by situating the experience of the case study within the literature on ES, PM, and wicked problems using an analysis framework that explored process outcomes and indicators associated with the integration of social values into ES frameworks and the generation of the important elements of social capital. Using this framework, five central messages were drawn from the research about how ES and PM applied in a constrained timeframe can resolve wicked coastal problems. These messages are as follows:

- 1) *Collaborative goals and outcomes*: Project goals and outcomes would ideally be established in collaboration with a diverse group of participants. The establishment of a working group early in the process which includes participants particularly troubled by historical conflicts may help to improve the legitimacy and impact of the research by creating ongoing opportunities for social learning and trust building. The development of goals and outcomes should aim for relevance to a diverse group of stakeholders and be clearly and frequently relayed to all study participants.
- 2) *Adaptive and participatory approaches*: Research approaches should be adaptive and responsive to participant feedback, which should be invited early and often.
- 3) *Good facilitation*: Good process facilitation is critical to positive project outcomes, especially if small group discourse is utilised.
- 4) *Diverse representation from relevant scales and domains*: Potential participants should be identified with the input of the working group and include representation from all relevant scales and domains of interest. Previously excluded or underrepresented stakeholders should be included because this builds trust and facilitates the incorporation of new knowledge into the research.

5) *Time considerations:* Time allocation should be considered carefully in the process design phase in connection with the social qualities that are important to project aims. It is likely that social values, social learning and capacity, and transparency can all be enhanced by the addition of a small amount of time, possibly as little as an hour per workshop. However, mediating power and building trust are likely to require more of an investment of time, particularly to address the concerns of mistrustful individuals. This is why including individuals who are likely to be mistrustful in a working group may help to resolve wicked problems.

7. Conclusions

If you do not change direction, you may end up where you are heading. —Lao Tzu

7.1 Introduction

This chapter presents the concluding messages drawn from this thesis. It begins with a description of the principal contributions that the thesis makes to the literature and practice of participatory modelling, ecosystem services, and the resolution of wicked coastal problems, by reflecting on the research aims and objectives. This is followed by an appreciation of the limitations of the research, and suggested future research directions. The thesis ends with an epilogue that reflects upon the future of the study area.

7.2 Research question and methodological approach revisited

The central question addressed by this research was:

How can participatory modelling and ecosystem services approaches contribute to the development of adaptive governance and ecosystem-based management frameworks that will aid in addressing wicked problems in a coastal context?

The methodological approach utilised in this research was fundamental to answering this question and achieving the research objectives outlined in the next. To complete these tasks, I developed a PM method designed to facilitate the identification, valuation, and consideration of ES trade-offs, and invited a diverse group of stakeholders involved in decision making in a coastal area associated with high levels of complexity and conflict, to trial the method. This research took a primarily qualitative approach towards the conduct of

mixed methods in the transformative tradition (after Hesse-Biber, 2010), and therefore emphasised social justice and change as part of the research objectives (after Mertens, 2003). This approach addressed a common criticism that mixed methods studies are deficient in considering issues of social justice or human well-being in general (Sweetman et al., 2010). The approach was also appropriate given the transdisciplinary nature of the research, which required a range of qualitative and quantitative methods to wrestle with the often prickly research problems and questions (Hesse-Biber, 2010).

This study has been drawn within the bounds of a transparent and reflexive methodology based on the recognition of the situatedness, partiality, and prejudice of all knowledge. My findings, therefore, are a reflection of the theoretical framework that I have applied to this study and my own positionality, rather than a revelation of any ‘ultimate truths’. Instead, the study contributes an important perspective towards the growing body of knowledge about the ES of Mangere Inlet, Manukau Harbour, New Zealand, and how more generally we can advance the linkages between social values and ES to implement better decision making in our wicked world.

7.3 Summary of conclusions and implications of findings

7.3.1 Objective 1: Identification, valuation, and consideration of ecosystem services

This research sought to include stakeholders involved in the governance and management of Mangere Inlet and Manukau Harbour in a PM process that identified and estimated the relative value of ES provided by Mangere Inlet and Manukau Harbour, and considered possible trade-offs associated with these services. The research achieved this objective through the application of a PM methodology in combination with an ES approach as described in Chapter 4. Several important conclusions and implications arose from the results and discussion in Chapter 5 that relate to this particular objective:

- 1) Diverse groups of stakeholders consider cultural services to be of critical value. This clear interest, only identified in a few previous studies (e.g. Brown et al., 2012; Raymond et al., 2009), could be leveraged in decision-making processes, as it indicates that connecting governance and management options to cultural services may improve broad-based support for a more stringent set of environmental indicators and rules. The valuation process conducted in this study indicates that stakeholders value the Manukau Harbour as much more than a

contaminant sink or food basket; they value it because it provides them with recreational opportunities, spiritual fulfilment, biodiversity, and access to their cultural heritage, among many other things. Management and planning processes that use these cultural values to guide thresholds and other benchmarks could see benefits across multiple ecosystem services and functions throughout the SES.

- 2) This research has delivered stakeholder-generated ES maps of the study area. No such maps existed previously. This new spatially explicit knowledge provides a coarse filter for identifying the location and relative value of ES as determined by a diverse group of stakeholders.
- 3) The ES worksheets and mapping activities conducted during this research encouraged participants to reimagine a familiar space in two primary ways: 1) by linking their individual knowledge of the study area, consisting of memories, stories, scientific data, or other elements, to the ES and ecosystem function of the area; and 2) by integrating these diverse knowledge cultures in a collective space. The ES framework that emerged from this process was thus expanded into new dimensions that could form the foundations of a collective decision making framework (Brown, 2010). However, supporting services, which represent the bulk of the ecosystem functions, were valued lowest of all of the service categories, indicating that there is still work to be done to clarify the connection between these underlying services and the provision of other services that are valued by a diverse group of stakeholders.
- 4) The diverse group of participants in this research valued seascapes more than landscapes, with 60% of the value assigned by participants to coastal and marine environments rather than to land-based ones. A possible implication of this valuation imbalance is that current land-based decision-making approaches that do not incorporate an explicit consideration of coastal goods and services may be missing a significant proportion of the value associated with these areas, which is likely to perpetuate poor decision-making and conflict related to coastal areas. This research provides a way to incorporate more meaningful consideration of these areas into decision-making processes. Coastal management and planning processes that focus more attention on preserving access to and use of coastal

areas and seascapes for a diverse range of uses may experience more harmonious decision-making processes than under current regimes.

- 5) PM provides a method that can successfully integrate social values, including cultural values, into an ES approach. More time to undertake the contextualisation and definition of ES would enable more social learning and better incorporation of local and contextual values into this framework. Feedback from study participants suggests that an additional hour allocated to each workshop, or an additional workshop of two hours duration, would have improved the integration of social values, further enhanced social learning and capacity building, and increased transparency associated with this research.
- 6) Participants reported that they learned about new activities and values associated with the study area, discovered areas where their activities and values overlapped with those of other participants, and gained a new appreciation for how all of these activities and values might interact with one another and the environment of the study area. Participants also improved their ability to use the scenarios to consider trade-offs associated with ES over time. However, there was insufficient time allocated in the workshops for participants to effectively engage with one another in a productive discourse about ES trade-offs.

7.3.2 Objective 2: Generation of social qualities

A second objective of this research was to determine to what extent and under what conditions the utilisation of a PM method could integrate social values into an ES framework and generate elements of social capital that contribute to resolving wicked governance and management problems associated with coastal areas. An assessment of the capacity of the research in this regard was undertaken in Chapter 6 using the analytical framework illustrated in Figure 6.1. A brief summary of the assessment findings is provided in the two sections that follow.

7.3.2.1 Process conditions

Five central messages were drawn from the results and discussion of the process conditions that support ES approaches and PM methods applied within a constrained timeframe to resolve wicked coastal problems:

- 1) *Collaborative goals and outcomes:* Project goals and outcomes should ideally be established in collaboration with a diverse group of participants. In this regard, it might be useful in future similar projects to establish an advisory group early on in the process that includes participants particularly troubled by historical conflicts. This could help to improve the legitimacy and impact of the research by creating ongoing opportunities for social learning and trust building. The development of goals and outcomes should aim for relevance to a diverse group of stakeholders and be clearly and frequently relayed to all study participants.
- 2) *Adaptive and participatory approaches:* Research approaches should be adaptive and responsive to participant feedback, which should be invited early and often.
- 3) *Good facilitation:* Good workshop facilitation is critical to positive project outcomes, especially if small group discourse is planned. Facilitation should be perceived by participants to be as neutral as possible to ensure that participants are comfortable sharing information and values.
- 4) *Diverse representation from relevant scales and domains:* Potential participants should be identified with the input of a working group if possible. Representation from all relevant scales and domains of interest should be encouraged. Previously excluded or underrepresented stakeholders should be included, as this builds trust and facilitates the incorporation of new knowledge into the research.
- 5) *Time considerations:* Time allocation should be considered carefully in the process design phase in connection with the social qualities that are important to project aims. It is likely that social values, social learning and capacity, and transparency can all be enhanced with the addition of a small amount of time, possibly as little as an hour per workshop. However, mediating power and building trust are likely to require a greater investment of time, particularly to address the concerns of mistrustful individuals. Including individuals who are likely to be mistrustful in a working group may help to build trust and resolve wicked problems.

7.3.2.2 Social qualities

The extent to which the five social qualities considered in this research were generated was assessed in Chapter 6 and the findings are summarised in Figure 6.2 using a scale of Low-Medium-High. A brief review of these findings is provided below.

1) Integrating social values (Medium)

Despite some challenges associated with scale and missing stakeholder representatives, the findings from this research indicate that through the application of the PM method, a holistic and spatially explicit perspective of the social values of the ES associated with the study area was compiled. Regarding the examination and negotiation of values and trade-offs, there were some difficulties associated with accounting for the complexities of Māori identity and experience, but the method employed in this study provided a mechanism through which the cultural and historic values associated with any cultural group could be explicitly considered. The inclusion of a diverse set of participants in the study provided a much needed opportunity to represent missing values, and the data indicates that in general participants were able to examine and negotiate values and trade-offs using the method.

2) Enhancing social learning and capacity building (Medium-High)

The majority of the participants in this study described the learning opportunities provided by the workshops as the biggest gain from being involved in the research. In particular, participants reported that the mapping process enabled them to learn about new activities and values associated with the study area; discover areas where their activities and values overlapped with those of other participants; and consider how all of these activities and values might be interacting with one another and the environment of the study area. Participants also learned about the values of others through the scenario planning discourse, and although there were some concerns expressed by several participants in relation to this approach, other participants described how the scenarios encouraged them to think about the future of the study area in new and more holistic ways. Many participants described feeling rushed by the workshops, but there is evidence that social learning occurred for most participants despite constrained time frames.

3) Increasing transparency (Low)

The group mapping method utilised in the first workshop was associated with some complexity and confusion, and the scenario planning method utilised in the second workshop was associated with high levels of complexity and a lack of user-friendliness. Overall these findings indicate low levels of transparency. This lack of transparency may also have reduced the capacity of the method to enhance social learning and capacity building among the participant group. However, feedback from participants suggests that more time for scenario planning and/or preparation in advance of the workshops would help to alleviate these problems.

4) Mediating power (Medium)

Participants in the first workshop were generally happy with the mediation of power. In particular, previously excluded participants expressed pleasure at being included in the group mapping process, indicating that the process built capacity and empowered previously excluded or less powerful individuals. However, the second workshop struggled to mediate power relationships and enable the open and easy participation of all present due to a discourse-based structure that relied heavily on good facilitation to manage power relationships. To offset this problem, participants could contribute their views in writing on the worksheets, or discuss their ideas in follow up interviews, but neither of these approaches entirely made up for the losses in social learning opportunities that resulted from the inability of all participants to contribute equally to the workshop process. An important contribution of this research lies in its ability to incorporate a diverse set of opinions about the social value of ES in the study area, rather than to present a single correct perspective. Some participants expressed discomfort and dissatisfaction with this concept; they did not seem to like that it reduced their perspective to one of many. While this dissatisfaction is unfortunate, it suggests that within the confines of the process, the study may have successfully redistributed some power toward the less powerful.

5) Building trust (Medium-Low)

This research indicates that although it is unlikely that a great deal of trust can be generated by a short term project, short time frames may be enough to generate good will among participants who are not pre-disposed to suspicion, and may build some trust among these individuals. However, among stakeholder groups where a history of suspicion exists, a longer time frame and methods more specifically designed in respect to trust, transparency,

and power, are likely to be needed to build trust among participants. This research also suggests that it may not be ideal to utilise this method in short time frames or in areas where long-term mistrust between participant groups exists, as the application of the method may expose or even exacerbate distrust among these groups.

7.3.3 Objective 3: Develop and test a novel method

The final objective of this research was to develop and test a novel method for PM and the identification and valuation of ES that could be utilised to address similar issues in other areas. The study has concluded that the PM methods, including the scoring, group mapping, and scenario planning methods, were somewhat confusing for some participants, a situation that was emphasized by the limited time frames in which to complete the activities. Despite these challenges, participants with no prior ES experience were able to complete the required activities, and many participants reported learning important information about the study area and its associated values and services from the workshop proceedings.

The local context of this study may place some limitations on the applicability of the research elsewhere because of the strong feelings of many participants about specific issues such as MWTP. However, most areas where ES approaches are needed to address wicked problems are likely to have similar ‘hot spots’ associated with passionate disagreement. Local scale stakeholders in any context may also have strong opinions associated with historical problems and mistrust that are likely to create conflict and dispute at a later decision-making stage if valuation processes do not include these participants in an open and transparent participatory manner in the early stages of ES identification and valuation. Nevertheless, this research supports the growing body of work indicating that contextualised social values need to be considered explicitly when attempting to use ES to improve EBM and adaptive governance frameworks. Including a diverse group of stakeholders in the approach used in this research contributed some important social values to the ES list and highlighted how local values may be focused on quite different problems than the values of decision makers operating at higher scales. In particular, the study revealed that any process of ES identification and valuation should incorporate a cultural services category that assesses customary and historical values of the study area.

7.4 Balancing benefits and limitations of the research

This study was developed with the intention of addressing several key gaps in current ES approaches. First, ES approaches will benefit from the integration of social values (Daniel

et al., 2012). Second, there is growing recognition of the need to involve a diverse group of stakeholders in the identification and valuation of ES, but ways to incorporate, value, and reconcile diverse knowledge sets and interests have so far proven to be unsatisfactory (Reyers et al., 2013). Finally, existing ES approaches generally require long term, large scale, and costly methods to produce outcomes (e.g. Costanza et al., 1997; Guerry et al., 2012; Tallis & Polasky, 2011; Videira et al., 2011), which puts decision makers with limited budgets and timeframes at a disadvantage. In response to this mismatch, this study aimed to include a diverse group of stakeholders in a PM approach to identifying and valuing ES in a purposefully limited timeframe. Several limitations that arose because of this approach are described in this section.

Participatory approaches to research are notoriously difficult to manage because of issues associated with representation, trust, power, capacity, and time (Irvin & Stansbury, 2004; Muro & Jeffrey, 2008; Reed, 2008). Who participates and who does not, the extent to which participants trust one another and the researchers, how well power is managed within the group so that all participants are able to participate openly and honestly, and whether or not participants are capable of answering the research questions, can have significant ramifications for study findings (Lynam et al., 2007). The way I approached possible participants, arranged workshop processes, settings, and facilitation, and established and encouraged communication with participants demonstrates an awareness of potential issues with representation, trust, power, capacity, and time, and a willingness to adapt the research based on participant needs and interests. Despite careful process design and management, however, working with a diverse group of participants is inherently tricky, and outcomes associated with these engagement processes are not entirely predictable. But as described in Chapter 3, the point of participatory modelling is not to achieve narrowly optimised solutions to wicked problems, but rather to establish a process through which participants can explore new ideas and in the process, develop resolutions to these problems.

ES approaches are associated with several important limitations. Time and practice are needed to ensure that all participants are as comfortable as possible with the concept and language of ES. This research set up processes that encouraged participants to work through the complex concepts of ES in open and participatory ways, which, over the course of two short workshops, allowed most of the participants to find commonalities and see value in ecosystem function. Nevertheless, ES terminology can be a significant hindrance for any study that aims to include a diverse group of participants because extensive explanation and interpretation may be required to ensure that all participants are utilising the terms in an

appropriate manner. Frustrations can arise because ES approaches may be initially perceived as divorced from outcomes which can improve local community welfare. Time is required to ensure that key services valued by participants are included in the study, but even ample time does not ensure that all participants will be comfortable allocating their values according to ES categories, as some values cannot be ranked or prioritised because they are central to worldviews. This problem can be identified and negotiated prior to considering value trade-offs (Chan et al., 2012), but this process requires time and good facilitation to navigate. The ES mapping method and associated worksheets encouraged participants to link their memories, stories, data sets, and other knowledge of the study area to ES and underlying ecosystem functions, but supporting services, which represent the bulk of the ecosystem functions, were valued lowest of all of the service categories. This result suggests that there is still work to be done to clarify the connection between supporting and other services.

Scale can also be a problem for ES approaches, as stakeholder values can be linked to a range of scales, and this variety can be difficult to capture in a spatially defined process of ES identification. These limitations were addressed by establishing a collaborative and adaptive approach to the research, which aimed to ensure that all participants were comfortable with the language, concept, and applicability of ES and if not, felt comfortable asking questions and posing alternatives. The ES mapping method and associated worksheets therefore included the option to discuss large scale services, even if they could not be spatially located, which enabled participants to reflect on their values in a more detailed manner than has been possible in any previous studies. Additionally, the scenario planning approach included in this study enabled participants to examine and negotiate their values and make trade-offs, which is a critical component of ES decision making. Because of these adjustments, this study managed to capture and integrate a large amount of social value data related to the ES of Manukau Harbour that has never been captured before.

Modelling approaches, such as the mapping of ES, are useful because they can clarify important variables and key spatial interactions associated with wicked problems, but they must carefully account for the cross-scale dynamics of SES (Cash et al., 2006). The spatial scale chosen for this research limited the integration of social values into an ES framework to a particular scale, but the method encouraged participants to consider how their values interacted with other scales through discussion, worksheets, and the inclusion of a “large scale” box located on the map. In this manner, the research developed an effective multi-scalar approach to the identification and valuation of ES. The inclusion of a diverse group of participants in the group mapping, whose values are likely to be associated with a range of

scales and subsequent networks of power, allowed for the deconstruction of traditional scalar hierarchies and the creation of new configurations and arrangements. This method was not capable of capturing temporal changes in system dynamics, but this limitation was partly addressed using scenario planning in Workshop 2.

The strict time constraints placed on the participatory activities undertaken during this research were designed intentionally so that outcomes from the research could be compared with other processes involving considerably larger project budgets and timeframes. This approach was chosen in recognition of the mismatch between the demands placed on many decision-making organisations, the resources that they have available, and the scale of most ES projects to date, which commonly require significant investments of time, money, and skills to succeed. Trade-offs resulting from the emphasis on short timeframes included making it difficult for participants to become comfortable with a large amount of complex data and to form extensive trusting relationships as a group, although efforts were made to reduce information complexity and encourage relationship building where possible. Despite these challenges, participants reported high levels of social learning and capacity building, and the study was able to integrate social values into an ES framework. I would expect these benefits to continue to accumulate with the allocation of slightly more time.

Determining the extent to which the research achieved its stated goals of integrating social values into ES frameworks and generating important elements of social capital needed to address wicked problems requires an evaluation of the research results and how well they adhere to certain guidelines and outcomes that have been derived from the literature review. The five key characteristics developed through an extensive literature review can be used to evaluate the efficacy of the methods applied in this research by associating them with participant praise and criticism. In particular, outcomes associated with long-term social learning and capacity building, increased trust among participants, and the empowerment of communities, are likely to take more time to emerge than a dissertation takes to complete (Johnson et al., 2012). Ongoing collaboration with research participants could enhance the benefits to participants as well as provide further opportunities to evaluate research outcomes.

Finally, there can be epistemological and ontological difficulties associated with integrating participatory research products into existing institutional structures (Bammer, 2005). These issues arise, at least in part, because participatory methods and methodologies are often connected to interpretive, rather than positivist, traditions, and are therefore generally at odds with conventional scientific research frameworks. There is also a tendency to equate interpretivism with less credible research results and therefore reduced legitimacy

(Hesse-Biber, 2010). This paradigm is shifting (Morgan, 2007) however, with an increasing emphasis in political and institutional frameworks on engaged, participatory, co-produced knowledge (Pahl-Wostl et al., 2007). In developing this research I made a strategic decision to divorce the project from any actual decision-making processes to try to avoid tackling all of these problems at once. Instead, I aimed to develop a study that was “real enough” to explore wicked problems, without being tied to a statutory process, framework, or timescale. The results of this research contribute important lessons regarding how participatory processes should, and should not, be undertaken.

7.5 Future research directions

This study was not directly linked to any formal decision-making process, but was designed with the intention that successful methods and lessons learned could be incorporated into more formal environmental management processes. This was achieved in large part by involving participants who are currently or are likely to be involved in such processes in the study area and around New Zealand. Ideally, any future activities based on this study would be deployed by a management agency or agencies that were committed to developing and then adhering to a collaborative or co-management process. However, to best facilitate opportunities for sharing and learning by the assembled participant group, and to allow some time for trust building to occur, activities should be undertaken initially without formal statutory outcomes being tied to the process. Taking three to four hours per workshop instead of limiting the timeframe to a mere two would provide a more comfortable timescale for participants to complete the activities. The methods trialled in this study could be used to accommodate approximately 30 participants if needed.

It is best to undertake participatory activities at the earliest possible stages of a process, but it might be possible to utilise these methods at a later stage in a project if the intention was to change the approach from a previously top-down one to a collaborative model. The establishment of an advisory stakeholder group that could assist in all stages of the process, including being involved in future statutory decision making, would enhance the likelihood of the success of the proceedings. This approach would be particularly relevant for areas with a long history of conflict.

This research took a qualitative/mixed methods approach to considering the usefulness of PM in terms of its capacity to integrate social values into ES and resolve wicked coastal problems. While the approach has been extensive, it was not exhaustive, and has highlighted several viable opportunities for future research directions. In particular, the

social qualities described throughout this thesis need further study, particularly the elements of power, transparency, and trust and the interactions among these characteristics and their ability to contribute to or withhold social learning and capacity building. Further research is also needed into the integration of social values at a variety of scales, in particular local, regional, and national focal scales of interest and how these loose boundaries may contribute to the definition of ES and the designation of the value associated with ES. In particular, further work is needed to consider ways to connect the underlying supporting services and ecosystem functions with the cultural values that are recognised across all stakeholder groups and scales. A more overt focus on social learning in ES processes is a promising direction for further exploration.

The methods utilised for capturing missing contextual social values, including outreach to more user groups, particularly those that are typically underrepresented in decision making processes (such as Pasifika communities and other immigrants), also need consideration in further research. Excluding or underrepresenting these perspectives in decision making can lead to poor choices related to the distribution, allocation, or access to resources. Problems of power can also contribute to long-term grudges or the establishment of subversive and damaging practices. Including previously underrepresented perspectives in decision making, on the other hand, may generate novel solutions to old problems, build trust and understanding among previously disparate social networks, and enhance social capacity to respond to wicked problems that impact coastal SES at every scale. Finally, ongoing research related activities that focus on co-learning and their interactions with governance actions and positive welfare outcomes for the community are needed to encourage the development of connections between research and enhanced welfare for participants and other stakeholders.

7.6 Epilogue

On 4 December 2014, a group of study participants, academics, decision makers, and interested locals gathered together at the Onehunga Community Hall for an evening of presentations on the past, present, and future of the Manukau Harbour. Almost forty people attended the event that evening, which I called “Many Voices of the Manukau” to represent the participatory work that we did, and that we were continuing to do, by showing up and being willing to share our ideas, and listen to those of others. Some attendees were angry, tired of all the talking, and hungry for change. Others were interested to discover new ways of considering an area where they spend so much of their time. Still others were just happy to

realise that they were not the only ones who cared about this place. Afterwards, an undergraduate student who attended asked me if we could have coffee sometime to discuss my research, and ways that she could incorporate it into her own study. She told me that she lives in the area and would like her work to make a difference.

By the time everyone left that evening it was dark, but from the parking lot outside I could just see the lights from the Onehunga Foreshore construction site reflecting on the waters of the harbour. They are building new beaches there, new parks, new bike paths, new places for people to gather and get onto, and into, the water. An emergency overflow discharge pipe from Mangere Wastewater Treatment Plant is positioned at the far end of one of the new beaches, waiting quietly for a rainy day. No amount of fighting in the council offices or the courts could get it removed, though Manukau Harbour Restoration Society and others tried their best. And the noise from the South-Western Motorway, which runs right past the spot, will always disrupt the quiet lapping of waves against the newly installed sand beaches. Maybe visitors will imagine that the roar of the motorway is just the sound of many, many birds, welcoming them to the shores of the Manukau. It is not perfect, but it is a place to start a story.



View from Ambury Park across Mangere Inlet towards One Tree Hill, 9 February 2013.

Appendix A: Participant Information Sheet and Consent Forms

Participant Information Sheet

Stakeholder

Project title Coastal Ecosystem Services: A participatory approach to modelling, management, and governance in Manukau Harbour

Researcher Kathryn K. Davies

I am a postgraduate student at the University of Auckland undertaking research for a PhD in Geography at the School of Environment. As a part of this degree I am carrying out a research project leading to a doctoral thesis.

Project overview

I would like to invite you to participate in my study of coastal ecosystem services in Mangere Inlet. Participation in this study is voluntary. Participants may withdraw from the project at any time.

Mangere Inlet, located in the urbanised north-eastern corner of Manukau Harbour, has been plagued by pollution throughout the last century and although many improvements have been made to control the discharge of contaminants in recent decades, unauthorized discharges of industrial waste and stormwater still regularly occur. Despite this history of contamination, the inlet continues to offer a wide range of important services to humans; food provision, hazard protection, waste disposal, and cultural services are just a few examples. The area is also home to a diversity of fish and bird species, including several endangered birds. The land area surrounding the inlet is an important mixed commercial/light industrial/residential area. The multiplicity of uses associated with Mangere Inlet, its prominence as one of three major estuaries in Manukau Harbour, and the likelihood that significant impacts will be felt in the area as Auckland's population continues to swell, make this area an ideal location for a study of coastal governance and management in the complex and uncertain times characterised by the 21st century.

This project will involve key stakeholders in two participatory modelling workshops (workshops) that aim to address current and future governance and management problems associated with Mangere Inlet and Manukau Harbour by identifying and estimating the value of ecosystem services provided by the area, and discussing possible future scenarios associated with these services. Participatory modelling is the use of modelling in support of a decision-making process that involves stakeholders. Ecosystem services are the goods and services provided to humans by ecosystems. A mapping exercise focused on identifying and valuing ecosystem services in Mangere Inlet and the surrounding areas of Manukau Harbour will be a central feature of the workshop, but other kinds of modelling may also be conducted. The usefulness and efficiency of different kinds of modelling, valuation, and weighting may be explored during this project, as will the ability of these methods to contribute to the development of an adaptive governance and ecosystem-based management framework for the area.

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This research will benefit participants by involving a diverse group of stakeholders, rather than just key decision-makers, in identifying and valuing the ecosystem services provided by Mangere Inlet and the Manukau Harbour. This method of identifying and valuing ecosystem services may contribute to the development of a Marine Spatial Plan or to the re-prioritisation of governance and management activities in the area. The research also aims to improve stakeholder communication about, understanding of, and actions related to social-ecological problems confronting Mangere Inlet and Manukau Harbour both now and in the future through the use of participatory modelling exercises. The project will leave a legacy of participatory methods that can be utilised to identify and value ecosystem services and therefore provide guidance for governance and management actions. These methods may be applicable to other areas around the Auckland Region or New Zealand.

Study objectives

The objectives of this project are:

- 1) To involve stakeholders key to the governance and management of Mangere Inlet and Manukau Harbour in a participatory modelling process;
- 2) To identify and estimate the relative value of ecosystem services provided by Mangere Inlet and Manukau Harbour;
- 3) To determine to what extent and under what conditions the utilisation of a participatory modelling method can resolve wicked governance and management problems associated with coastal areas; and
- 4) To develop and test a framework for participatory modelling and the identification and valuation of ecosystem services that could be utilised to address similar issues in other areas in the Auckland Region.

Your participation is needed

As a stakeholder with an interest in the governance and management of Mangere Inlet, your participation in this research project is essential. I would like to invite you to participate in two workshops that aim to identify and value the ecosystem services associated with Mangere Inlet and some nearby areas of the Manukau Harbour. Participation in this exercise will require a time commitment of approximately four hours for the two workshops and one hour for a follow up interview.

Your manager/CEO/employer has given me permission to discuss this project with you and has agreed to participate in the research. I have gained his/her assurance in writing that the decision of staff members to participate or not in this research will not affect your relationship with your manager/CEO/employer or your employment status.

This research project is intended to be a collaborative learning experience; participants will have the opportunity to both share and learn information about the ecosystem services provided by Mangere Inlet and Manukau Harbour and the current and future governance and management of this area. To fulfil this goal, I will hold a public forum after the publication of the thesis to present the research findings. All participants will receive an executive summary of the thesis following publication.

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- 1) You may leave the workshops at any time.
- 2) If the information that you provide is reported or published, this will be done in a way that does not identify you as its source unless you give your permission to be identified on the Consent Form.
- 3) If you do not wish to be identified you may choose to have your data attributed either to a pseudonym or to your role/job/position title, but nonetheless you may be identifiable.
- 4) Participation in the study will require a total time commitment of approximately five hours; four hours for the two workshops and one hour for a follow-up interview.
- 5) Because the workshops will involve multiple participants, confidentiality cannot be guaranteed but will be strongly encouraged. Participation in these workshops is contingent upon your agreement not to disclose anything discussed during the workshops.
- 6) The workshops will be facilitated by a suitably neutral and experienced facilitator who will manage any conflicts that may arise among participants, and who will be required to sign a confidentiality agreement before becoming involved with the project.
- 7) The workshops will be held at a convenient and neutral or otherwise appropriate location and at a time that is as convenient as possible for participants, probably a mid-week evening.
- 8) Workshops will be video recorded. Participation in the workshops is contingent upon your willingness to be video recorded, as the recording of this event is required for the purposes of analysis and evaluation.
- 9) Workshops will be observed for the purposes of analysis and evaluation.
- 10) Because contributions cannot be withdrawn from workshop video recordings, documents summarising workshop proceedings will be released to you following each workshop, and you will be given the opportunity to amend these summary documents. If you wish to make clarifications regarding your contributions to these documents, you have up to one month after the date of the workshop to do so.
- 11) A follow up interview will be conducted after the completion of the workshop (see the next section for more on how interviews will be conducted).

The interview will be conducted as follows:

- 1) You may leave the interview at any time.
 - 2) If the information that you provide is reported or published, this will be done in a way that does not identify you as its source unless you give your permission to be identified on the Consent Form.
 - 3) If you do not wish to be identified you may choose to have your data attributed either to a pseudonym or to your role/job/position title, but nonetheless you may be identifiable.
 - 4) The interview will be conducted at a time and location of your choosing.
 - 5) The interview will take approximately one hour.
 - 6) The interview will be semi-structured, involving a predetermined list of open-ended questions.
 - 7) With your permission, the interview will be recorded to allow for transcription by a third party. Even if you agree to be recorded, you may request that the recorder be turned off at any time.
 - 8) Notes will be taken during interviews to aid in the retention of information.
 - 9) In circumstances where interviews are recorded and transcribed, the transcriber will be required to sign a confidentiality agreement.
 - 10) In circumstances where translation is needed, the translator will be required to sign a confidentiality agreement.
 - 11) The interview transcript will be released to you upon completion to allow for
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The data collected during this research project will be used to complete doctoral thesis research and for the production of the thesis. Data and information will be used in seminar presentations undertaken as part of or related to the PhD program of study. Data may also be used in publications or presentations arising from this thesis. The data collected during this research project will be kept in storage in a locked cabinet at the University of Auckland for six years and will then be destroyed. In the case of electronic data such as digital video, digital audio, digital photographs, and emails, data will initially be safeguarded by passwords and then deleted from all computerised storage spaces and hard drives after six years. Transcripts and other hard copies of data will be shredded after six years. Consent forms will be kept separate from data in a locked cabinet on University premises and kept for six years before being destroyed.

This Participant Information Sheet provides you with information that enables you to make an informed decision about whether or not you wish to participate in this research. It is recommended that you keep a copy of this document for future reference.

Further information

Funding for this research has been obtained through NIWA. If you have any questions or concerns about this study, please feel free to contact me (the researcher) or my supervisor at any time. Important contact details are provided below.

Contact details		
<i>Researcher:</i> Kathryn Davies k.davies@auckland.ac.nz 0210 757 061 School of Environment The University of Auckland Private Bag 92019 Auckland New Zealand	<i>Supervisor:</i> Dr. Karen Fisher k.fisher@auckland.ac.nz +64 9 373 7599 x 88410 School of Environment The University of Auckland Private Bag 92019 Auckland New Zealand	<i>Head of SOE:</i> Professor Glen McGregor g.mcgregor@auckland.ac.nz +64 9 373 7599 x 85284 School of Environment The University of Auckland Private Bag 92019 Auckland New Zealand

Ethical concerns

For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Office of the Vice Chancellor, Private Bag 92019, Auckland 1142. Telephone (09) 373-7599 x. 83711.

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Consent Form

Stakeholder

THIS FORM WILL BE HELD FOR A PERIOD OF SIX YEARS

Project title Coastal Ecosystem Services: A participatory approach to modelling, management, and governance in Manukau Harbour

Researcher Kathryn K. Davies

My role in this research

- I am aware that my participation in this research is voluntary.
- I have read the Participant Information Sheet and have understood the nature of the research and why I have been selected to take part.
- I have had the opportunity to ask questions and any questions have been answered to my satisfaction.
- I understand that I may withdraw from this study at any time without explanation, and that I may leave the workshop or the interview at any time without explanation.
- I understand that I will have the opportunity to review and clarify my contributions to the summary documents resulting from the participatory workshops up to one month after my participation in the workshops, and that I will have the opportunity to review, clarify, and withdraw the transcript of my interview up to one month after the interview is conducted.
- I understand that I will not be identified in any presentations or publications resulting from this research unless I give my permission and that if I do not wish to be identified I may choose to have the data that I provide attributed to either my role/job/position title or to a pseudonym.
- *I agree/do not agree* to be identified in any presentations or publications resulting from this research.
- *I agree/do not agree* to my role/job title/position being used in this research. I understand that although I will only be identified by my role/job title/position, I may still be identifiable.
- I understand that data will be kept for 6 years, after which time it will be destroyed.
- *I agree/do not agree* to take part in this research.

The role of my employer in this research

- I understand that my manager/CEO/employer has given approval for me to participate in this research and assurances that my decision to participate or not in this research will not affect our relationship or my employment status.

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The workshops

- I understand that I will be video recorded during the workshops, and that my participation in the workshops is contingent upon my willingness to be video recorded, as the recording of this event is required for the purposes of analysis and evaluation.
- I understand that observations of the workshop proceedings will be made for the purposes of analysis and evaluation.
- I understand that my participation in these workshops is contingent upon my agreement to not disclose anything discussed during the workshops.
- I understand that participation in the two workshops will take approximately four hours in total.
- I understand that summary documents of workshop proceedings will be made available to me and that I will be given the opportunity to clarify points that I made during the workshops up to one month after the workshops are held.
- I understand that a neutral and experienced facilitator who has signed a confidentiality agreement will facilitate the workshop.

The interview

- *I agree/do not agree* to be audiotaped.
- I understand that if I agree to be audiotaped I may request that recording be stopped at any time.
- I understand that participation in an interview will take approximately one hour.
- I understand that a transcribed copy of their completed interview will be made available to me and that I will be given the opportunity to withdraw my data or clarify points made in this interview up to one month after the interview has been conducted.
- I understand that a third party who has signed a confidentiality agreement will transcribe/translate the interviews.

Name _____

Signature _____ **Date** _____

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS
COMMITTEE ON 14 March 2012 FOR THREE (3) YEARS, REFERENCE NUMBER 2012/7956.

Consent Form

Manager/Chief Executive Officer/Employer

THIS FORM WILL BE HELD FOR A PERIOD OF SIX YEARS

Project title Coastal Ecosystem Services: A participatory approach to modelling, management, and governance in Manukau Harbour

Researcher Kathryn K. Davies

My role in this research

- I am aware that my participation in this research is voluntary.
- I have read the Participant Information Sheet and have understood the nature of the research and why I and my staff have been selected to take part.
- I have had the opportunity to ask questions and any questions I have asked have been answered to my satisfaction.
- I give my assurance that the decision of my staff to participate or not in this research will not affect my relationship with them or their employment status.
- *I agree/do not agree* to allow my staff to take part in this study during work hours. I understand that participation in the two workshops will take approximately four hours in total and that participation in an interview will take approximately one hour.
- I understand that data will be kept for 6 years, after which time it will be destroyed.
- *I agree/do not agree* that the researcher can approach my staff to ask them if they wish to participate in this research.
- *I agree/do not agree* to take part in this research.

The role of my staff in this research

- I am aware that the participation of my staff in this research is voluntary.
- I understand that participants may withdraw from this study at any time without explanation, and that participants may leave the workshops or the interview at any time without explanation.
- I understand that participants will have the opportunity to review and clarify their contributions to the summary documents resulting from the participatory workshops up to one month after their participation in the workshops, and that participants will have the opportunity to review, clarify, and withdraw the transcripts of their interviews up to one month after the interview is conducted.
- I understand that participants will not be identified in any presentations or publications resulting from this research unless they give their permission, and if they do not wish to be identified they may choose to have information attributed either to a pseudonym or to their role/job/position title, but that nonetheless they may be identifiable.

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 14 March 2012 FOR THREE (3) YEARS, REFERENCE NUMBER 2012/7956.

The workshops

- I understand that my staff will be video recorded during the workshops, and that their participation in these workshops is contingent upon their willingness to be video recorded, as the recording of this event is required for the purposes of analysis and evaluation.
- I understand that observations of the workshop proceedings will be made for the purposes of analysis and evaluation.
- I understand that the participation of my staff in this workshop is contingent upon their agreement to not disclose anything discussed during the workshops.
- I understand that summary documents of workshop proceedings will be made available to my staff and that they will be given the opportunity to clarify points made during the workshops up to one month after the workshops are held.
- I understand that a neutral and experienced facilitator who has signed a confidentiality agreement will facilitate the workshop.

The interview

- I support my staff's preference to be or not to be audiotaped and understand that my staff may request that recording be stopped at any time.
- I understand that a transcribed copy of their completed interview will be made available to my staff and that they will be given the opportunity to withdraw their data or clarify points made in this interview up to one month after the interview has been conducted.
- I understand that a third party who has signed a confidentiality agreement will transcribe/translate the interviews.

Name _____

Signature _____ **Date** _____

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 14 March 2012 FOR THREE (3) YEARS, REFERENCE NUMBER 2012/7956.

FACILITATOR CONFIDENTIALITY AGREEMENT

Project Title Coastal Ecosystem Services: A participatory approach to modelling, management, and governance in Manukau Harbour

Researcher Kathryn K. Davies

Supervisor Dr. Karen Fisher

Facilitator

I agree to facilitate participatory modelling workshops for the above research project. I understand that the information shared during these activities is confidential and must not be disclosed to, or discussed with, anyone other than the researcher and her supervisor.

Name _____

Signature _____

Date _____

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 14 March 2012 FOR THREE (3) YEARS, REFERENCE NUMBER 2012/7956.

RESEARCH ASSISTANT CONFIDENTIALITY AGREEMENT

Project Title Coastal Ecosystem Services: A participatory approach to modelling, management, and governance in Manukau Harbour

Researcher Kathryn K. Davies

Supervisor Dr. Karen Fisher

Research Assistant

I agree to assist with the research for the above research project. I understand that the information learned from my participation in this project is confidential and must not be disclosed to, or discussed with, anyone other than the researcher and her supervisor.

Name _____

Signature _____

Date _____

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 14 March 2012 FOR THREE (3) YEARS, REFERENCE NUMBER 2012/7956.

TRANSCRIBER CONFIDENTIALITY AGREEMENT

Project Title Coastal Ecosystem Services: A participatory approach to modelling, management, and governance in Manukau Harbour

Researcher Kathryn K. Davies

Supervisor Dr. Karen Fisher

Transcriber

I agree to transcribe the audiotapes/videotapes for the above research project. I understand that the information contained within them is confidential and must not be disclosed to, or discussed with, anyone other than the researcher and her supervisor.

Name _____

Signature _____

Date _____

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 14 March 2012 FOR THREE (3) YEARS, REFERENCE NUMBER 2012/7956.

Appendix B: Information for potential participants

Information for Potential Participants

Research project title

Coastal Ecosystem Services: A participatory approach to modelling, management, and governance in Manukau Harbour

Researcher background

My name is Kathryn Davies. I am a postgraduate student at the University of Auckland undertaking research for a PhD in Geography at the School of Environment. As a part of this degree I am carrying out a research project leading to a doctoral thesis.

Study area

Mangere Inlet, located in the urbanised north-eastern corner of Manukau Harbour, has been plagued by pollution throughout the last century and although many improvements have been made to control the discharge of contaminants in recent decades, unauthorized discharges of industrial waste and stormwater still regularly occur. Despite this history of contamination, the inlet continues to offer a wide range of important services to humans; food provision, hazard protection, waste treatment, and cultural services are just a few examples. The area is also home to a diversity of fish and bird species, including several endangered birds. The land area surrounding the inlet is an important mixed commercial/light industrial/residential area. The multiplicity of uses associated with Mangere Inlet, its prominence as one of three major estuaries in Manukau Harbour, and the likelihood that significant impacts will be felt in the area as Auckland's population continues to swell, make this area an ideal location for a study of coastal governance and management in the complex and uncertain times characterised by the 21st century (see Figure 1 for a map of the area included in the study).

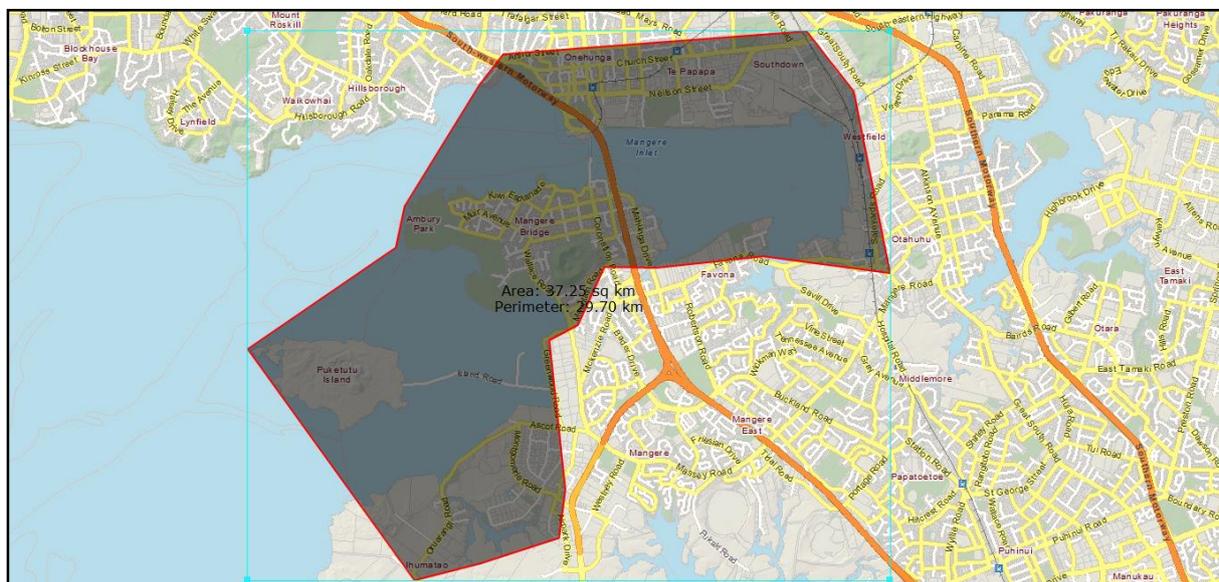


Figure 1: Approximate area in and around Mangere Inlet to be included in the case study.

Study background

This project will involve key stakeholders in a participatory modelling process that aims to address current and future governance and management problems associated with Mangere Inlet and Manukau Harbour by identifying and estimating the value of ecosystem services provided by the area. Participatory modelling is the use of modelling

in support of a decision-making process that involves stakeholders; this work will rely on mapping as a key feature of the participatory modelling process, but other kinds of modelling may also be conducted. Ecosystem services are the goods and services provided to humans by ecosystems. The usefulness and efficiency of different kinds of modelling, valuation, and weighting may be explored during this project, as will the ability of these methods to contribute to the development of an adaptive governance and ecosystem-based management framework for the area.

The objectives of this study are:

- 1) To involve stakeholders key to the governance and management of Mangere Inlet and Manukau Harbour in a participatory modelling process;
- 2) To identify and estimate the relative value of ecosystem services provided by Mangere Inlet and Manukau Harbour;
- 3) To determine to what extent and under what conditions the utilisation of a participatory modelling method can resolve wicked governance and management problems associated with coastal areas; and
- 4) To develop and test a framework for participatory modelling and the identification and valuation of ecosystem services that could be utilised to address similar issues in other areas in the Auckland Region.

Table 1: Mangere Inlet participatory modelling project timeline, tasks, and methods

Date	Task(s)	Associated method(s)	Details
Sep 2011-Apr 2012	Identification of and consultation with key stakeholders	Secondary literature review, snowball technique	N/A
Feb 2012	Seek appropriate neutral location(s) to hold workshops	Consultation with stakeholders	N/A
Mar 2012	Engage appropriate facilitator	N/A	N/A
Mar 2012	Invite stakeholders to participatory modelling workshop	Letter of invitation with RSVP	Aim for the involvement of at least 12 key stakeholders representative of a diverse group of stakeholder interests.
May 2012	Participatory modelling workshop: Discuss ecosystem services background, definition, and list. Mapping activity to define ecosystem services.	Mapping, discourse-based valuation	Max 2 hrs: mid-week evening.
Jul 2012	Discuss value of ecosystem services. Develop future scenarios and discuss possible management regimes.	Possible reliance on discourse-based valuation, scoring, willingness-to-pay, scenarios.	Max 2 hrs: mid-week evening.
Jul-Sep 2012	Follow-up interviews with participants	Semi-structured interviews with individuals	Max 1 hr.
Sep-Dec 2012	Transcription and analysis of interviews	Coding using Nvivo software	N/A
Jul 2014	Present final results to community	N/A	N/A

Benefits of this study

This research will benefit participants by involving a diverse group of stakeholders, rather than just key decision-makers, in identifying and valuing the ecosystem services provided by Mangere Inlet and the Manukau Harbour. This method of identifying and valuing ecosystem services may contribute to the development of a Marine Spatial Plan or to the re-prioritisation of governance and management activities in the area. The

research also aims to improve stakeholder communication about, understanding of, and actions related to social-ecological problems confronting Mangere Inlet and Manukau Harbour both now and in the future through the use of participatory modelling exercises. The project will leave a legacy of participatory methods that can be utilised to identify and value ecosystem services and therefore provide guidance for governance and management actions. The hope is that these methods might then be applicable to other areas around the Auckland Region or New Zealand.

This research project is intended to be a collaborative learning experience; participants will have the opportunity to both share and learn information about the ecosystem services provided by Mangere Inlet and Manukau Harbour and the current and future governance and management of this area. To fulfil this goal, a public forum will be held by the researcher after the publication of the thesis to present the research findings. All participants will receive an executive summary of the thesis following publication.

Your involvement is needed

As a stakeholder with an interest in the governance and management of Mangere Inlet, your organisation's participation and input into this research project is essential. Ideally, at least one representative from your organisation would participate in a participatory modelling exercise that will aim to identify and value the ecosystem services associated with Mangere Inlet and some nearby areas of the Manukau Harbour. Participation in this exercise will require a time commitment of approximately five hours in total; four hours for two workshops which will take two hours each and be held on a mid-week evening, and one hour for a follow up interview, which will be conducted after the workshops at a time and place convenient for participants. The first workshop is to be held on 29th May 2012, and the second will likely be held in July 2012.

This information sheet is intended to be a starting point for consultation and discussion regarding this research. Any questions, concerns, or other feedback that you have regarding this research would be greatly appreciated, as would some indication of your interest in participating or not in the project. Even if you do agree to participate in the project, you can withdraw from participation at any time.

Thank you very much for your time and consideration. I look forward to hearing from you and would be pleased to discuss the project further at your convenience.

Thank you

Kathryn Davies
k.davies@auckland.ac.nz
0210 757 061
School of Environment
The University of Auckland
Private Bag 92019
Auckland

Appendix C: Workshop 1 Agenda

Participatory Workshop Agenda 21 May 2012

Workshop 1 of 2:

Modelling, mapping, and valuing the ecosystem services of Mangere Inlet, Manukau Harbour

Tuesday 29th May 2012, 6-8pm

Ambury Regional Park

Coffee, tea, and snacks will be provided.

Participants

Workshop participants will include representatives from user groups and experts with knowledge and experience related to coastal ecosystem services.

Overview schedule

6:00-6:15pm	Welcome and introductions over coffee, tea, and snacks
6:15-6:30pm	Welcome presentation including research overview and ecosystem services background information
6:30-6:45pm	Discussion of ecosystem services list
6:45-7:15pm	Mapping ecosystem services, completing associated worksheets
7:15-7:45pm	Group tally of ecosystem service values and reporting back on reasoning
7:45-8:00pm	Conclusions, next workshop, and thank you

Set up (1 hour prior to workshop: 5-6pm)

- A welcome table with name badges, Participant Information Sheets, Consent Forms, a list of participants who have already signed a consent form, and a welcome folder, should be placed at the entrance to the room.
- The welcome folder should contain a University branded pen and note paper, some background information on ecosystem services (?), a list of the coastal ecosystem services that we will be discussing, and a small map of the study area.
- The room should be arranged so that participants sit in a U shape around the projector so that they can both see the presentation, and each other.
- The room should be set up with coffee, tea, and snacks so that participants can help themselves when they arrive.
- The large map of the study area should be placed on a table or set of tables to one side of the room but with access all the way around it.
- A camera should be set up so that it will take a picture of the map each minute over the two hour period (or at least for the last hour and a half).
- A video camera should be arranged so that it can capture the map and the majority of the rest of the room. The video camera does not need to capture the presentation.

- A second camera should be utilised to take pictures of whatever seems interesting and important as the evening progresses.

Welcome and introductions (15 minutes: 6:00-6:15pm)

- Each participant should be checked in at the welcome table, where they should receive a name badge and a welcome folder.
- Most importantly, each participant should have their names checked against a list to see if they have already signed a consent form (and if their form needs further clarification regarding issues such as anonymity and videotaping). If further clarification is needed, they should sign a new consent form, taking care to respond to all of the italicised sections on the form.
- If they have not yet turned in a properly completed consent form, then they should do so at this time, taking care to respond to all of the italicised sections on the form.
- Once participants have checked in at the welcome table, they should be directed to help themselves to the coffee, tea, and snacks provided, and to make themselves comfortable at the tables provided.
- After the majority of participants are checked in, participants should be encouraged to sit down at the tables provided, and introductions should begin.
- Kate should give a brief welcome/mihi(?) and remind participants that by signing the consent form they have agreed to keep the information shared during this workshop confidential, and that all of the facilitators have signed confidentiality agreements as well.
- Everyone should briefly introduce themselves and describe their connection to Mangere Inlet/Manukau Harbour (?).

Welcome presentation (15 minutes: 6:15-6:30pm)

- Kate will give the welcome presentation. This presentation aims to provide a brief overview of the research and some background information about ecosystem services.

Discussion of ecosystem services list (15 minutes MAX: 6:30-6:45pm)

- David will facilitate the ecosystem services list discussion (or possibly Kate?). The aim of this discussion is to familiarise all of the participants with the language of ecosystem services so that they become comfortable connecting the things that they value about the study area to the common vocabulary of ecosystem services.

Mapping activity (30 minutes: 6:45-7:15pm)

- Kate will give instructions regarding the mapping activity.
- All facilitators will assist with this activity.
- Each participant will be given 22 counters (one for each ecosystem service listed) and a worksheet. The counters will be numbered (for example: 1-22) and the number set associated with each participant should be recorded on their worksheet along with their name when they are given the worksheets.
- Participants will be instructed to use the ES list and small maps to determine which ecosystem services are most important to them, spatial extents within the study area that are associated with these services, and then to complete the worksheets provided with information about these services and why they are important. Participants should think

about: what are the natural assets of the area, the ES associated with these natural assets, and why do they as a stakeholder representative value it?

- Participants will then be asked to use the counters and the worksheets provided to associate a relative value with each ecosystem service. All 22 counters must be utilised, but no more than 22 may be utilised.
- Once participants have had a chance to brainstorm using their individual lists and maps and to complete their worksheets, they should take their 22 counters up to the large map and place them on it, marking out the areas and services that are the most valuable to them. Markers will be provided so that spatial extents and other notes can also be added to the large map.

Group tally and reporting back (30 minutes: 7:15-7:45pm)

- David will facilitate the group tally and reporting back, with assistance from the other facilitators as needed to write on the board, etc.
- A list of all 22 ES should be written up on the board in advance of stakeholder reporting.
- After all of the participants have placed all of their counters on the map, each individual should briefly report back on what s/he felt were the most important ES and why. Each individual should also provide a tally of the total number of counters that they allocated to each of these services.
- The number of counters assigned to each service by each participant should be compiled on the board in a group tally so that in the end a large list of ranked ecosystem services appears.

Conclusions, next workshop, and thank you (15 minutes: 7:45-8pm)

- David will briefly summarise obvious learnings from the workshop.
- Kate will give an overview of what will occur between now and the next workshop, and say a big thank you to all of the participants.

Appendix D: Workshop 1 Worksheet

Ecosystem services mapping and tracking worksheet

Name:

Number:

Instructions

You have been given a small map of the study area, a list of 22 ecosystem services to consider, and a collection of 22 counters (beads). Using your knowledge of the study area and emphasising your interests as a representative of a stakeholder group, locate assets or areas on the map that provide important ecosystem services. Put this information into the space provided below, and assign counters to each **service** based on how much you value it **relative to the other services** provided by the study area. At the end of the activity, exactly 22 counters must be assigned to the ecosystem services that you feel are important (no more, no less!). The small map of the study area can be used for making notes and for organising your counters. Once you have used the small map and this worksheet to organise your thoughts, you will be asked to place your counters on the large map provided using tailor pins.

Some important things to note:

- You may only include one asset/area and one ecosystem service per row. However, you may value the same asset/area more than once using different associated ecosystem services, and you may value the same ecosystem services more than once in different areas.
- Some services may not be easily mapped to a particular spatial location because they occur at a larger scale than what is provided by the map. These can be noted in one corner of the map and assigned counters in this way.
- Be as specific as possible when describing the associated services, so instead of writing “Cultural Services”, which is an overarching category of services, choose the most appropriate category and subcategory of services that you feel an area provides.
- Be sure to complete all four sections of the worksheet for each of the assets/services that you value.
- Do not feel obligated to assign value to all 22 services! If you are tempted to assign all of your counters to only one or two services, first consider the ways in which the services that you value are connected to other services, and remember that you must provide reasonable justifications for your preferences.

Asset/area (Be specific!)	Number of counters assigned	Associated Ecosystem Service	Why is this asset/area and service important to you?
<i>Old Mangere Bridge</i>	<i>4</i>	<i>Recreation and ecotourism (consumptive)</i>	<i>I have been fishing off of Old Mangere Bridge with my Dad since I was 8 years old.</i>

Appendix E: Workshop 2 Scenario Document

Scenarios, management, and the ecosystem services of Mangere Inlet, Manukau Harbour
24 July 2012

I. Background information for consideration with all scenarios

Spatial Scale

Study Area (approximately 100 square kilometres) in and around Mangere Inlet/Manukau Harbour/Auckland Region

Temporal Scale

The Auckland Plan, which was adopted on 29 March 2012 by Auckland Council, is a 30 year strategy document developed to address changes that are likely to occur in the Auckland Region. A major focus of this document is how to accommodate an estimated one million new residents by 2040. This dramatic increase over three decades will place new pressures the ability of coastal ecosystems to continue to provide essential goods and services to the people living in Auckland.

This research will consider a scenario horizon of 30 years in accordance with the planning and visioning timeframes designated in the Auckland Plan.

Population projections

In the Auckland Plan (Auckland Council, 2012c), Statistics New Zealand and Auckland Council developed three scenarios for the future of Auckland's population – high, medium and low growth. The history of rapid population growth experienced in Auckland indicates that it is safest to base future planning on the high-growth scenario, which is what Auckland Council has done throughout the Auckland Plan.

In an attempt to minimise error and risk, and to best align the scenarios developed for the study area with the planning documents designed for the entire Auckland Region, this research will utilise the high-growth population scenario unless otherwise specified.

Climate change

We know that the climate is changing, and that these changes will impact on coastal communities in a variety of ways, but primarily through sea level rise and the increasing frequency and severity of storms. An overall rise in temperature will also have an impact on coastal communities, although the effects of this particular aspect of climate change are likely to impact more directly on the ecology of coastal communities than the human residents and related infrastructure. What we do not know is at what rate these changes will occur, or how dramatic these changes will be. Although this research does not focus on climate change, it would be negligent to ignore this important driver and its potential impacts on the study area over the next 30 years.

Very few studies have been undertaken that can provide robust evidence as to the specific effects that climate change might have on the Manukau Harbour and Mangere Inlet in particular. However, based on a great deal of sound global science, this research assumes that in the next 30 years, the median projected sea level rise of 15cm will occur, storms will increase in frequency and severity, and the median projected temperature rise of approximately 1°C will occur.

Key variables and associated uncertainties

Some key variables that will affect the future of the focal system are associated with a high level of certainty and/or are beyond our ability to control, and are therefore beyond the scope of this research to address. Examples of this kind of key variable are population growth and climate change.

Other key variables that will affect the future of the focal system are associated with a low degree of certainty and a high degree of choice. Different governance and management approaches to these key variables may produce very different outcomes in the future.

The following list of key uncertainties (key variables associated with a high degree of uncertainty) associated with this particular focal system were developed from the data from workshop 1 and several interviews conducted with key stakeholders who could not attend workshop 1. The range of options associated with these key variables will be explored throughout the four scenarios and in the discussion that follows.

Demographic composition

- Local character
- Property values
- Infrastructure
- Health and well-being

Economic structure

- Industrial/commercial
- Residential (commuter economy)
- Ecotourism/recreation

Infrastructure

- Transportation
- Emergency services and risk management
- Access

Water quality

- Wastewater treatment
- Stormwater
- Unauthorised discharges

Ecological quality

- Fish
- Wild foods
- Birds
- Algal blooms/invasive species

Cultural heritage

- Governance and management regimes (co-management?)
- Preservation vs. Development
- Access and opportunity

Landscape amenity

- Access
- View sheds
- Property values
- Mangroves and oysters

II. Scenarios

Scenario 1: Eco-community

1

The area is characterised by village centres, good access to the harbour, an eco-tourism and recreation-based economy, and good environmental quality.

- Some gentrification, slow rate
- Ecotourism/recreation/commercial/light industrial
- Ferry, Harbourmaster, general improvements to roads/walkways/bikepaths
- Upgrades to MWTP, installation of wetlands and other natural stormwater management
- Improved ecological quality/species abundance/biodiversity
- Preservation of cultural and historic sites highly valued
- Mangroves spread, harbour access limited

In 2041, the population of Auckland is 2.5 million residents. Suburbs surrounding Mangere Inlet such as Hillsborough, Onehunga, Mangere Bridge, Otahuhu, and Favona, are all densely populated areas due to their relatively easy distance from both the CBD and the airport. The suburbs are increasingly expensive areas to live because they have maintained a village structure through intensification of development, improvements in traffic management and slightly increased access to the harbour. These changes have driven up property values, leading to some gentrification of the area. Low income residents are increasingly obliged to look further south for affordable housing, as middle and upper class families take over properties near the waterfront and with easy access to the city and the airport.

Careful management of many historic and cultural sites has led to the preservation of these areas but squeezes property values further. However, limited beach access in the area and the proliferation of mangroves due to a lack of active management, caps the property value increases to a certain extent.

The proliferation of the mangrove forests has led to increased contaminant sequestration in the inner harbour (water and erosion regulation). The installation of several large tracts of wetlands at reclaimed sites to assist with water, erosion, and natural hazard regulation, has also contributed to improvements in overall water quality in the inner harbour as well as in the harbour beyond, which have increased the capacity of supporting and pollination services. Discharges from increased road traffic and residential stormwater runoff are largely treated by these natural areas.

The wastewater purification and treatment services provided by the study area are improved by shifting more of the treatment to land, but this comes with an increased cost to ratepayers – in fact, rates have doubled in the last 30 years. Other side effects of these upgrades include an increase in landfill contamination of groundwater, and increased reliance on costly (and CO₂ producing) transport options. Landfill space is quickly running out.

The improvements made to the wastewater treatment system and the stormwater management systems in the area (both regulating services), lead to benefits such as improvements in water quality and ecological quality, which increase bird and other wildlife populations (existence values) and improve many of the supporting ecosystem services and pollination services. But while there are increases in population densities of many species, there are also dramatic increases in the number of people seeking to harvest food from the area, and it is difficult to maintain the provisioning services in the area because of this increase in demand for goods.

The area is well known for its bird watching and abundant marine life, and a healthy ecotourism culture is built up around these activities. Some areas around the harbour are utilised for swimming and boating (recreation), and food harvesting and fishing (provisioning services), but while water quality is good, access is limited due to mangrove proliferation and areas designated as cultural and ecological sanctuaries.

A harbourmaster is installed in the harbour to meet the needs of the burgeoning and increasingly marine oriented population. A ferry service is put in place to service the airport, Waiuku, and Titirangi, with a dock at Onehunga Wharf. The installation of this service has improved tourism in the area as well as opened up employment options throughout the region. Problems have arisen with regular dredging being required to keep the ferry routes open, however.

Although climate change has led to a slight sea level rise and an increase in the frequency and severity of storms that is often associated with flooding in low-lying areas, the precautionary approach taken by the Council towards climate change which has allowed the proliferation of mangroves, the reclamation of low lying areas for the installation of wetlands, and the active control of stormwater discharge, has insulated the area from many of the problems experienced in other similar low-lying harbours around New Zealand and the world.

Scenario 2: Beach chic

2

The area is characterised by boutique-based town centres, excellent access to the harbour, a recreation-based economy, and good environmental quality.

- Rapid and extensive gentrification
- Recreation/commuter-based economy
- Hovercraft ferry, Harbourmaster, vast improvements to roads/walkways/bikepaths, removal of working port
- Upgrades to MWTP
- Water quality improves but ecological quality declines due to substrate changes/noise/loss of habitat
- Development prioritised over preservation
- Mangroves removed, harbour access abundant

In 2041, the population of Auckland is 2.5 million residents. Suburbs surrounding Mangere Inlet such as Hillsborough, Onehunga, Mangere Bridge, Otahuhu, and Favona, are all densely populated areas due to their relatively easy distance from both the CBD and the airport. The suburbs are expensive areas to live because they have developed into boutique-based town centres through intensification of development, improvements in traffic management and vastly increased access to the harbour. These changes have driven up property values, leading to rapid and extensive gentrification of the area. Low income families and even many long term residents have been obliged to look further south for more affordable housing, as wealthy property owners buy up properties near the waterfront with easy access to the city and the airport. Many historic and cultural sites have been reduced or removed in favour of more cost effective development projects.

The wastewater purification and treatment services provided by the study area are improved by shifting the treatment to land, but this comes with an increased cost to ratepayers, an increase in landfill contamination of groundwater in other areas, and increased reliance on costly (and CO₂ producing) transport options.

Discharges from increased road traffic and residential stormwater runoff cause occasional problems in terms of water quality in the inner harbour, although an expensive stormwater drainage upgrade (water and erosion regulation) was made in the area in the early 2020s.

The improvements made to the wastewater treatment system and the stormwater management systems in the area (both regulating services), lead to benefits such as improvements in water quality and ecological quality. These improvements are taken advantage of by installing sandy beaches around the inner harbour. The cost of these upgrades has led to rates increases of more than three times the rates of 2011. Maintaining the area in 'beach chic' form has also led to wide scale erosion problems in sand supply areas such as Pakiri. Although these beaches are often crowded on fine weather days and cost a great deal to ratepayers to maintain due to the need for regular sand inputs, the installation of the beaches has led to a boom in water recreation activities and a thriving café culture (recreation). The change in substrate impacts on the ecology of the harbour, however, and many of the fish and bird populations that previously thrived in the area due to the muddy shoals that abounded in the harbour are now declining or even extinct in the harbour (existence values, provisioning services). Dramatic increases in the number of people seeking to harvest food from the area due to an abundance of marine recreation opportunities place further pressure on the provisioning services provided by the area.

The port at Onehunga ceases operations due to increasing pressure from locals to utilise the area solely for recreational use. A harbourmaster is installed in the harbour to help regulate the marine activities of the burgeoning population. A hovercraft ferry service is also put in place to service the airport, Waiuku, and Titirangi, with a dock at Onehunga Wharf. The installation of this service improved tourism in the area as well as opened up employment options throughout the region. Problems have arisen with birds being disturbed by the noise of the hovercraft, however.

Although access to the harbour is greatly improved, the use of the harbour for traditional cultural activities (cultural and historic values) declines because of the change in the local population dynamics and the decline in wild foods access (provisioning services) due to overharvesting.

Climate change has led to a slight sea level rise, which does not generally affect waterfront properties or beaches, but the increasing frequency and severity of storms in the area has led to some severe damages and has made insuring waterfront properties increasingly difficult. It is likely that these problems will continue to be exacerbated in the second half of the century.

Scenario 3: Industrial integration

3

The area is characterised by sprawling town centres, an industrial-based economy, limited access to the harbour, and severely damaged environmental quality.

- Expansion of local working class
- Industrial economy
- Expansion of working port, increased frequency of dredging
- Water quality and ecological quality decline
- Cultural and historic sites neglected
- Mangroves managed unevenly, harbour access limited

In 2041, the population of Auckland is 2.5 million residents. Suburbs surrounding Mangere Inlet such as Hillsborough, Onehunga, Mangere Bridge, Otahuhu, and Favona, are densely populated areas due to their easy distance from both the industrial sites around Mangere Inlet and the airport, as well as their relatively easy distance from the CBD. Sprawling town centres supported by a largely industrial

economy are characteristic of the area. Low income housing is available and a large population of low-income earners live in the area and work at nearby industrial sites.

Greater Auckland utilises the Manukau Harbour for regulating services such as wastewater purification and treatment. This use keeps the cost of treatment down by using existing pipelines and limiting the ecological impacts of moving this treatment to other, less impacted parts of Auckland. To deal with the population growth within the catchment area, the Mangere Wastewater Treatment Plant has been upgraded and some of the catchment area is cut off and inputs are directed to the treatment plant at Rosedale. The continued use of the study area for wastewater purification and treatment leads to slight declines in the quality of other ecosystem services provided by the area such as provisioning (capture fisheries) and cultural services (ecotourism and recreation). Overloads of the system during wet weather occasionally occur.

No significant upgrades are made to the water and erosion management (regulating services) in the inner harbour, and as industrial development and road use in the area intensifies to match the increasing population, contaminant discharges from stormwater increase significantly. Rates are maintained at a low level, as no major improvements to the area are made.

The declining quality of regulating and supporting services pushes the ecological system in the inner harbour towards a critical threshold. One day a container ship carrying an invasive algae arrives at the increasingly active port at Onehunga. Although in years past the ecology of the harbour might not have been so threatened by this particular species of algae, the system is particularly vulnerable to invasive species, and a dangerous algal bloom occurs that dramatically changes the ecology of the inner harbour. The algae is not directly dangerous to humans, but smells terrible when it washes up onshore, and is toxic to many species that live in the harbour. Provisioning services such as wild food and fish harvesting from the inner harbour can no longer be safely carried out. Many birds living in the inner harbour die from eating fish from the area, dramatically effecting existence and recreation values.

Due to poor water quality and algal blooms, beaches installed around the Onehunga Foreshore area prior to 2020 are increasingly neglected, along with many areas around the harbour previously utilised for swimming and boating (recreation), and food harvesting and fishing (provisioning).

Cultural and historic values in the inner harbour decline due to industrial development on important sites and the impact of declining regulating, supporting, and provisioning services. The increasingly limited use of the harbour for recreation means that although interest in having a local harbourmaster and a public water transport mode installed was once strong, the ideas never come to fruition.

Mangroves spread in protected inner harbour areas that experience high sediment inputs from runoff. Mangroves are occasionally removed from specific locations around the inner harbour with consent from the council, but in general the area that they cover has increased significantly in the last 30 years.

Appendix F: Interview schedule

STAKEHOLDER INTERVIEW SCHEDULE

Project Title Coastal Ecosystem Services: A participatory approach to modelling, management, and governance in Manukau Harbour

Researcher Kathryn K. Davies

Interview questions

Purpose of this interview:

To determine to what extent and under what conditions the utilisation of an ecosystem services-based participatory modelling method can resolve wicked governance and management problems associated with coastal areas.

Introduction

1. What has your involvement/interest in Mangere Inlet and the Manukau Harbour been?

Workshop 1

2. A range of ecosystem goods and services are provided by Mangere Inlet and Manukau Harbour. In the first workshop, the group ranked several of these services more highly than others. How comfortable are you with this ranking?
3. Of all of these services, which five do you feel are the most important? What kinds of trade-offs would you be willing to make in order to prioritise these services over others?
4. Talk about the mapping activity in workshop 1. Did you find it difficult? Do you feel that you were able to portray your values and/or the important ecosystem services of the area accurately and efficiently through this process? Why or why not? How might the mapping be improved? Did you learn anything new about the area from the mapping process? [Feel free to elaborate and draw on the blank maps provided] How useful do you think the maps that we have developed are? Who will use them and for what purpose? How could these maps be made to be more effective in the future?
5. What did you like/dislike about the first workshop? What, if anything, did you learn from the first workshop?

Workshop 2

6. In the second workshop we discussed possible future scenarios for the area. What management and/or governance programmes do you think would lead to the best possible outcomes for the area in the future? What outcomes might these

management/governance regimes have on the ecosystem services that you are the most interested in?

7. What did you like/dislike about the second workshop? What, if anything, did you learn from the second workshop?

General questions

8. Do you feel that your relationship with other stakeholder groups in general or participants specifically, has changed in any way as a result of the participatory modelling workshop? Describe how it has changed or if not, describe why you feel it has not changed.
9. Do you think that you will have a continued relationship with any of the other stakeholder groups/participants as a result of the workshop?
10. Has your conception of Mangere Inlet and the Manukau Harbour changed as a result of these workshops? If so, how?
11. Was there anything that you felt you were not able to express during either of the workshops that you would like to discuss now?
12. How do you feel the participatory modelling process could be improved in future attempts?
13. Do you feel that the participatory modelling process would be useful if applied to other areas?
14. Based on your experience at the workshop, would you be willing to be involved in future exercises of a related nature?

Appendix G: Anonymous participant

Participant Information Sheet *Anonymous stakeholder*

Project title Coastal Ecosystem Services: A participatory approach to modelling, management, and governance in Manukau Harbour

Researcher Kathryn K. Davies

Researcher background

I am a postgraduate student at the University of Auckland undertaking research for a PhD in Geography at the School of Environment. As a part of this degree I am carrying out a research project leading to a doctoral thesis.

Project overview

I would like to invite you to participate in my study of coastal ecosystem services in Mangere Inlet. Participation in this study is voluntary.

Despite a long history of contamination, Mangere Inlet and the surrounding areas of Manukau Harbour offers a wide range of important services to humans; food provision, hazard protection, waste disposal, and opportunities for recreation and relaxation are just a few examples. The area is also home to a diversity of fish and bird species, including several endangered birds. The land area surrounding the inlet is an important mixed commercial/light industrial/residential area. The multiplicity of uses associated with Mangere Inlet and the likelihood that significant impacts will be felt in the area as Auckland's population continues to swell, make this area an ideal location for a study of coastal governance and management in the complex and uncertain times characterised by the 21st century.

This project will collect data that aims to address current and future governance and management problems associated with Mangere Inlet and Manukau Harbour by identifying and estimating the value of ecosystem services provided by the area, and considering possible future scenarios associated with these services. Ecosystem services are the goods and services provided to humans by ecosystems.

This research will benefit participants by involving a diverse group of stakeholders, rather than just key decision-makers, in identifying and valuing the ecosystem services provided by Mangere Inlet and Manukau Harbour. This method of identifying and valuing ecosystem services may contribute to the development of a Marine Spatial Plan or to the re-prioritisation of governance and management activities in the area.

Your participation is needed

As a person who utilises the resources provided by the study area, your participation in this research project is essential. I would like to invite you to complete an anonymous questionnaire that aims to identify and value the ecosystem services associated with Mangere Inlet and some nearby areas of Manukau Harbour. This questionnaire will take approximately ten minutes to complete.

The data collected during this research project will be used to complete doctoral thesis research and for the production of the thesis. Data and information will be used in seminar presentations undertaken as part of or related to the PhD program of study. Data may also be used in publications or presentations arising from this thesis. The data

collected during this research project will be kept in storage in a locked cabinet at the University of Auckland for six years and will then be destroyed.

This Participant Information Sheet provides you with information that enables you to make an informed decision about whether or not you wish to participate in this research. By completing the associated questionnaire, you imply that you consent to participate in this study. You will not be able to withdraw your information once you have completed this questionnaire because it is anonymous and I will be unable to trace the questionnaire you have completed. It is recommended that you keep a copy of this document for future reference.

Further information

Funding for this research has been obtained through NIWA. If you have any questions or concerns about this study, please feel free to contact me (the researcher) or my supervisor at any time. Important contact details are provided below.

Contact details

<i>Researcher:</i> Kathryn Davies k.davies@auckland.ac.nz 0210 757 061 School of Environment The University of Auckland Private Bag 92019 Auckland New Zealand	
<i>Supervisor:</i> Dr. Karen Fisher k.fisher@auckland.ac.nz +64 9 373 7599 x 88410 School of Environment The University of Auckland Private Bag 92019 Auckland New Zealand	<i>Head of SOE:</i> Professor Glen McGregor g.mcgregor@auckland.ac.nz +64 9 373 7599 x 85284 School of Environment The University of Auckland Private Bag 92019 Auckland New Zealand

Ethical concerns

For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Office of the Vice Chancellor, Private Bag 92019, Auckland 1142. Telephone (09) 373-7599 x. 83711.

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 14 March 2012 FOR THREE (3) YEARS, REFERENCE NUMBER 2012/7956.

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