A REGIONAL ECOLOGICAL RISK ASSESSMENT AND MULTIJURISDICTIONAL INSTITUTIONAL ANALYSIS OF THE KAIPARA HARBOUR IN NEW ZEALAND

A Dissertation Presented

by

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ABSTRACT

The Kaipara Harbour is the largest enclosed harbour in the Southern Hemisphere, providing resources for several growing industries including agriculture, fisheries and renewable energy. Despite the wide array of political, environmental, and cultural stresses adversely impacting its resources and ecosystems, it presently lacks a comprehensive management plan and the need to prioritize management efforts has become more evident with the declining harbour health.

This research project examines the complexity of the Kaipara Harbour region through a mixed-methodological, case-study approach. An institutional governance analysis explores the network configuration of the Kaipara system, recognizing the capital flows exchanged amongst actors, action arenas where decision-making occurs, and the system's adaptive capacity. A semi-quantitative, stakeholder-driven, relative regional risk assessment prioritizes land use stressors and ecological habitats of concern. Finally, a cultural policy analysis investigates the integration of Māori values in multiscalar regulating documents of the Harbour, addressing resource management conflicts and integrated indigenous governance opportunities.

Results of the risk assessment reveal that from the sources of stress and habitats of concern identified, fisheries pose the greatest risk to the harbour, shellfish habitats are at greatest risk, and the Kaipara and Rodney ecological districts are characterized with the highest levels of risk in the basin. The institutional findings emphasize the importance of informal action-arenas in effective management of the harbour and its resources. The policy analysis concludes the integration of Māori values at the national level is strong in guidance to district and regional councils although sparse in language in policy documents, while successfully integrated at the district level of regulation. This three-fold dissertation research results in a set of management recommendations for the Kaipara Harbour decision-makers and those recommendations are summarized below.

To achieve improved management of the Kaipara Harbour and its resources, the Integrated Kaipara Harbour Management Group (IKHMG) needs regulatory influence in decision-making processes at the regional level of the system to represent the interests of the Harbour. To better understand the impacts of the fishing industry, further investigation of the commercial, recreational, and customary fishing industries, their respective impacts on fish stocks, and the role of the Quota Management System is needed. A subcommittee with members from both Northland Regional Council and Auckland Council jurisdictions is required as an effort to instigate comprehensive management for the ecological areas of the Kaipara catchment. The National Policy Statement for Freshwater Management should provide increased national guidance for freshwater use in the country, and encourage holistic management of freshwater resources by incorporating significant Māori values that relate to freshwater, including *Kaitiakitang*a. Finally, the incorporation of *Manaakitanga* in local and regional planning documents would better address the limitations presented in cultural integration, land use pressures, and habitat protection with regards to fisheries management and shellfish conservation.

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Dissertation Overview

The Kaipara Harbour is the largest enclosed harbour in the southern hemisphere, providing resources for a number of growing industries such as agriculture, fisheries, aquaculture, tourism and renewable energy. Presently, the Kaipara Harbour lacks a comprehensive management plan despite the wide array of environmental, social, cultural and political issues posing threat its resources and ecosystems. These pressures include sedimentation, a large scale tidal energy project, divergence amongst governing councils, opposing resource management objectives among groups, including Māori, and the intensification of agriculture, to name a few.

One of the most compelling challenges in the Kaipara Harbour catchment is to identify the problems that influence effective environmental decision-making. To better understand the contextual conditions of the Kaipara system, in particular the institutional, ecological and policy impacts on natural resource management, I examined the complexities of the Kaipara Harbour region through a three-pronged, mixed methodological approach. First I conducted an institutional governance analysis (*sensu* Ostrom 2005, Koliba 2010, Folke 2005) to examine the social-ecological network components of the Kaipara Harbour system, recognizing the capital flow interactions amongst actors, the action arenas where decision-making occurs, and the system's adaptive capacity. I then did a semi-quantitative, stakeholder-driven relative regional risk assessment (*sensu* Landis, 2005) to identify and prioritize stressors and habitats of

concern in the Kaipara catchment. Finally, I did a cultural policy analysis to evaluate indigenous co-management through the integration of Māori values in the current governing documents that manage the resources of the Kaipara Harbour. These documents address resource management conflicts and opportunities for integrated governance. The results of my research offer a set of management recommendations for the decision-makers of the Kaipara Harbour.

The organization of this dissertation follows the *journal article format* as defined by the University of Vermont's Graduate College. First, in this introductory chapter I frame my dissertation research questions and offer some background information about the Kaipara Harbour. Second, I present a comprehensive literature review (Chapter 2) to provide an integrated perspective to the body of research and literature encompassed in the dissertation. Next, I prepared three papers structured to be submitted for publication and are formatted according to the specific style requirements of the anticipated scholarly journals. The first paper (Chapter 3) is entitled "An Institutional Analysis of the Kaipara Harbour Governance Network in New Zealand" and will be submitted to Environmental Management. The second paper (Chapter 4) is entitled "A Regional Ecological Risk Assessment of the Kaipara Harbour using the Relative Risk Model" and will be submitted to Human and Ecological Risk Assessment. The final paper (Chapter 5) is entitled "An Evaluation of Māori Values in Multiscalar Environmental Policies Governing the Kaipara Harbour in New Zealand" and will be submitted to The Journal of Natural Resources Policy Research. The policy

recommendations from the three papers are summarized in the Dissertation Conclusions (Chapter 6).

Introduction

The Kaipara Harbour is the largest enclosed harbour in the southern hemisphere, providing resources for a number of growing industries such as agriculture, fisheries, aquaculture, tourism and renewable energy. A wide array of environmental, social, cultural and political issues pose threat to the ecosystems of the Kaipara Harbour, including: sedimentation, the world's largest approved tidal energy project, divergence amongst governing councils, opposition with the indigenous *Māori*[1] tribes, and the intensification of agriculture, to name a few.

The competing demands on the resources of the Kaipara Harbour necessitate prioritizing the management of critical habitats. The Kaipara Harbour is a multijurisdictional body of water, with the regulating and political authority held at a number of scales varying from district and regional councils, national regulations, to local Māori customary rights. This fragmentation of power and financial instability, alongside with political, economic and cultural divergence has led to the inconsistent management of the Kaipara Harbour and its resources.

The Integrated Kaipara Harbour Management Group (IKHMG) completed Phase 1 of the "Information Review and Gap Analysis" of the Kaipara Harbour in 2010. This report is the most comprehensive data set available to date. The IKHMG compiled spatial data, literature and occurrence data to construct both an extensive Geographical

[1] All italicized words in this introductory chapter will be defined in Appendix A:The Glossary of Māori Terms, at the end of this chapter.

Information Systems (GIS) database and a non-spatial data and literature database. The report documents, reviews and identifies gaps in three knowledge bases: biophysical, *Mātauranga Māori,* and socio-economic.

The review is extensive including spatial layers of biophysical and economic data, however there are data limitations. Not only were some of the data collected over a decade ago now outdated, there are also gaps and uncertainties among the different categories in the analysis. Additionally, the IKHMG is a Māori-led initiative and thus data could arguably stem from a biased viewpoint. Therefore, incorporating the diversity of stakeholder perspectives in conjunction with a thorough ecological analysis of existing data, relevant policies and changes in governance networks will fill some of the missing information in terms of temporal changes and subjective disparities involved in the management of the harbour.

Objectives

Building on pioneering work in semi-quantitative ecological risk assessment (Landis 2005), this research conducts a stakeholder-driven ecological risk assessment and multijurisdictional analysis for the Kaipara Harbour. Specifically, major sources of threat to the harbour and the habitats of greatest concern are identified through stakeholder perspectives and a relative risk model, evaluating the efficacy in addressing those ecological issues by policies and governance configuration in the Kaipara system. Through a mixed methodological approach combining semi-structured interviews, content analysis, ecological risk assessment, and institutional, governance and policy analyses, I will address the following research questions:

1) How do the governance network configuration and resource flows exchanged in the Kaipara catchment impact the management of the harbour and its adaptive capacity as a social-ecological system?
2) Where are the decision-making arenas in the Kaipara Harbour governance network?
3) What are the principal sources of environmental pressures the Kaipara Harbour?
4) What are the critical habitats that need to be protected in the Kaipara Harbour?
5) To what extent do the existing policies governing the Kaipara Harbour include Māori values?
6) What are the challenges and opportunities presented in the representation of Māori values in existing policies?

These research questions will provide the framework for three publishable works, described in detail in the research methods and scope section. The first paper addresses questions 1 and 2 through an institutional framework and governance network analysis of the regulating agencies and decision-making actors of the Kaipara Harbour. The second paper examines questions 3 and 4 by means of a stakeholder-driven ecological risk assessment. Finally, the third paper focuses on questions 5 and 6 by exploring the inclusion of Māori values in the policies and regulations governing the Kaipara catchment.

Results from this study will contribute to the sparse body of literature and research on the Kaipara Harbour, and offer policy recommendations to the decision-makers in the catchment. A comprehensive management plan for the Kaipara Harbour region is necessary to respond to the needs of an increasingly ecologically compromised area. The multiplicity of stressors from a range of industries at varying scales highlights the need for a qualitative ecological risk assessment, as a substantial amount of environmental, indigenous, and institutional information is not included in the scientific databases currently available. The results of this case study will inform future

investigations to further examine the effectiveness of management plans for multijurisdictional waters.

Background: The Kaipara Harbour

The Kaipara Harbour is situated on west coast of Northland on the North Island in New Zealand, approximately 80 km north of Auckland and open to the Tasman Sea, (Figure 1-1); it is the largest enclosed harbour on the Southern Hemisphere and one of the largest estuaries in the world.

Figure 1-1. Location of the Kaipara Harbour (Integrated Mapping, 2011)

The harbour was formed by a system of drowned river valleys thus is broad and mostly shallow and covers a total of 947 km^2 (Makey 2013). The harbour spans 60 km from north to south, containing over 400 km^2 of intertidal zones and mudflats and includes more than 900 km of shoreline (Hay and Grant 2003; Haggitt et al. 2008). The Kaipara

has an extensive drainage catchment, feeding a number of main river systems such as the Wairoa, Arapaoa, Otamatea, Oruawharo, Tauhoa, Kaipara and Hoteo Rivers. The entry of large rivers and hundreds of streams contributes to the vast watershed area (Figure 1-2) containing close to 640 km^2 of land (Wilson et al. 2006; Makey 2013).

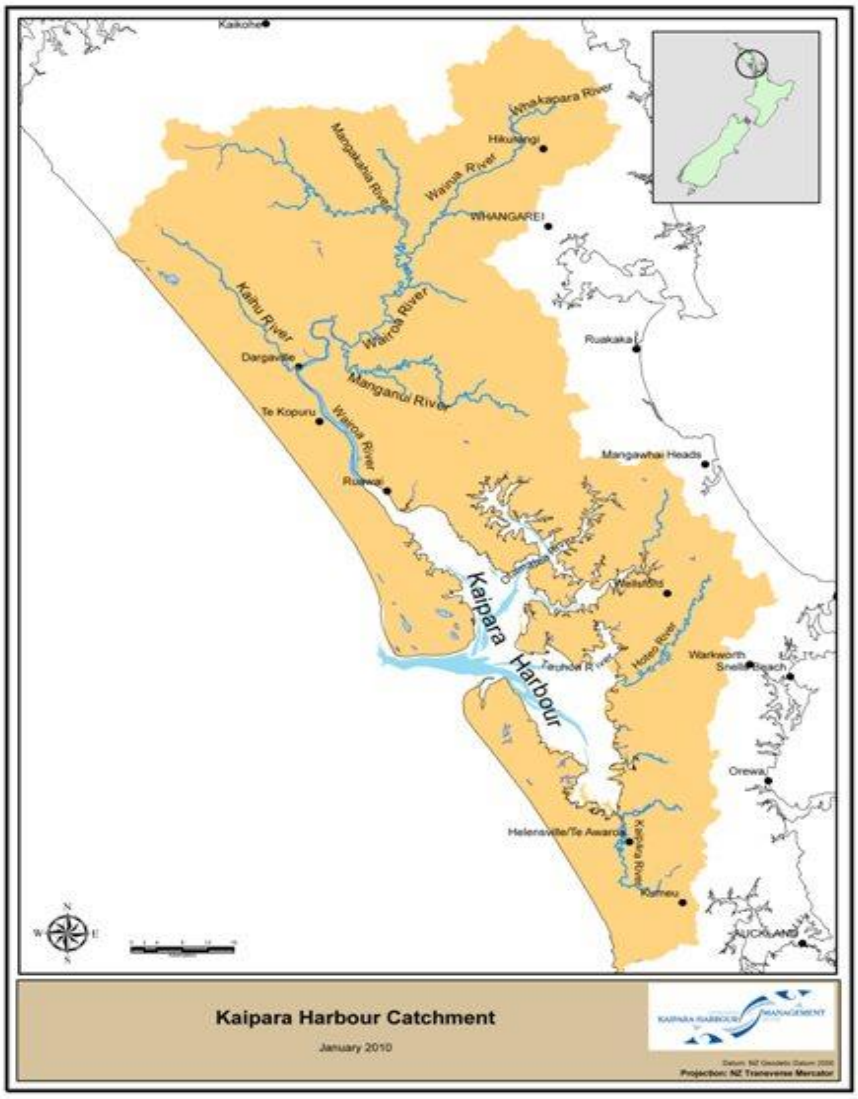

Figure 1-2. Map of the Kaipara Harbour Catchment (Makey, 2011)

The harbour entrance is only seven kilometers wide, and has a dangerous bar which historically became the burial ground of numbers of ships in the early years of trade and settlement around the New Zealand coast (Helensville & District Historical Society Inc. 2011). The Kaipara was an important waterway for trade, war parties, communication, and travel to Helensville for Māori Land Court hearings. The rich stands of the *kauri* tree lured in many European traders and settlers until the timber stocks plummeted in the 1890's. The harbour was then primarily used to transport logs, creating competition amongst steamboat companies (Helensville & District Historical Society Inc. 2011).

The Kaipara region has geographical and natural advantages such as highly productive and fertile soils, generative waters, aesthetic natural beauty, and the close proximity to the largest market in New Zealand, Auckland (Wilson et al. 2006). These traits make the Kaipara Harbour highly valued for a number of industries and stakeholders dependent on the resources of the harbour and its surrounding catchment.

Agriculture:

Land use in the Kaipara Harbour catchment is dominated by agriculture. Beef and dairy farming covers the primary pastoral land use. The Northland region provides nearly 20% of New Zealand's beef output, dairy farming in the region supplies 9.5% of New Zealand's entire dairy herd, and the catchment is also scattered with clusters of specialized agriculture such as *kumara* (sweet potatoes) and capsicum (Wilson et al. 2006; Haggitt et al. 2008; Makey 2010; Makey 2013). The agricultural sector provides employment and economic revenue for the region, while land use intensification and

agricultural runoff is threatening the health of the freshwater and coastal waterways. A current agricultural challenge in the region is relaxed farming regulations and monitoring in the northern portion of the catchment. It is speculated that district and regional councils consciously turn a blind eye to unfavorable agricultural management practices and given their economic significance, farmers in the region maintain political power over regulating authorities (Bellingham 2011; Greene 2011; Makey 2011; Ramsey 2011).

Fisheries

The Kaipara Harbour has always been a *marae* (sacred place) for customary and recreational fishing, and commercial fishing has been widespread in the region since European settlement. The Kaipara Harbour is the nursery grounds to nearly all of snapper on the west coast of the North Island, and provides habitat for a number of other fin and shellfish stocks (Yardley and Yardley 2011). Concerns with the state of the harbour's fisheries have been increasing and include the depletion of fish and shellfish stocks, sedimentation, poor water quality, resource use and development pressure, and the lack of integrated fisheries management (The New Zealand Herald 2011). The current Quota Management System does not manage or limit catch at a local level, creating a number of conflicts between: recreational, customary and commercial fishers, between fishing and aquaculture, between fishing and transportation in the harbour and with conservation initiatives (Wilson et al. 2006). Several stakeholders contend the current centralized fisheries management system favors large scale commercial fisheries, is ineffective for local fishing communities and isolates sustainable local knowledge, and

the current model that intends to regulate fish stocks will not work (Makey 2011; Miru and Harding 2011; Yardley and Yardley 2011).

Tidal Energy

Crest Energy Limited has been granted consent for a marine tidal turbine power station at the mouth of the Kaipara Harbour. The project involves 200 submerged tidal turbines with a maximum generating capacity of around 200 megawatt (Crest Energy Limited 2013). From a renewable energy point of view, the Kaipara has many factors that are appealing for the project: Up to 8,000 million cubic meters of water pass in and out of the harbour daily, the harbour is rarely used for commercial shipping anymore due to the treacherous tides and unstable sand bars at its mouth, and the project continues New Zealand's tradition of harnessing energy from renewable sources (Crest Energy Limited 2013). However, there is considerable opposition to this project from environmental non-profits, Māori, local farmers and fisherman as well as from Crown research institutes, politicians and regional councils. The objections to the project range from skepticism of turbine infrastructure, adverse impacts to marine ecosystems, and instability of the turbulent seabed. While the Environmental Court has approved the 200 turbines, incremental environmental monitoring conditions are required in the upcoming years of the project.

Tourism

The Kaipara Harbour encompasses a diverse set of landscapes that draws in a variety of tourists. From the Kaipara flats to the fertile farmland, up the windy Kaipara hills down to the bottom of the saltmarsh wetlands and along the rugged coast lined with

beautiful beaches, the Kaipara region is one of international significance (Department of Conservation 2013). It contains a large migratory bird habitat, housing many threatened and endangered species, and is one of the key distribution ranges for the Maui Dolphin, one of the world's rarest. The harbour meets many of the criteria set by the Ramsar Convention including 'Criterion Six' that states a wetland is considered internationally significant if it regularly supports one percent of the individuals in a population of one species of water bird, and the Kaipara Harbour supports 18% of Bar-tailed Godwirs, 16% of Knots, and more than one percent of several other water bird species including Turnstones, Pacific Golden Plover, Far-eastern Curlew, Whimrl, New Zealand endemic Fairy Tern, Wrybill, Peid Oystercatchter, Banded Dotteral, Peid Stilt, and Caspian Tern (Bellingham 2011; Department of Conservation 2013; Forest and Bird 2013).

Forestry

Forestry is one of the most intensive land uses in the Kaipara Harbour region and the timber industry removed most of the native kauri and *kahikatea* forest, replacing them with agricultural and urban areas. This has led to rapidly increasing soil erosion on land and consequently amplified sedimentation in the harbour. Shellfish abundance has dropped and finfish populations such as mullet, snapper, and school shark are quickly diminishing (Makey 2010). Conversely, the increased sedimentation has resulted in the reclamation of coastal mangrove forests in the Kaipara due to increases in the elevation of intertidal areas and establishment of suitable nutrient needs for mangroves habitat. Given that 80% of the commercial fisheries and specifically juvenile fish are dependent on the coastal mangrove wetlands as breeding, sedmimentation can be considered an

ecological benefit for some fishery industries (Integrated Kaipara Management Group, 2010).

Culture

The indigenous Māori populations of New Zealand have settlements and *marae* (communal, sacred place) distributed around the harbour. The *iwi* (tribe) Ngāti Whatua have held *mana* (rights) over both land and water *taonga* (treasured possessions) through numerous ancestral generations in Kaipara Harbour and catchment region (Figure 1-3). Since European settlement in the 1840s Māori endured impacts of colonization including the loss of their ancestral land, the destruction and depletion of their natural world through western development, and loss of governance and management of resources they once used (Makey 2010). The cultural conflict occurring in the Kaipara region is highly controversial amongst iwi and Pākehā (New Zealander of European descent), as Māori and the British Crown have had long term disagreements regarding Māori customary rights for land and resources.

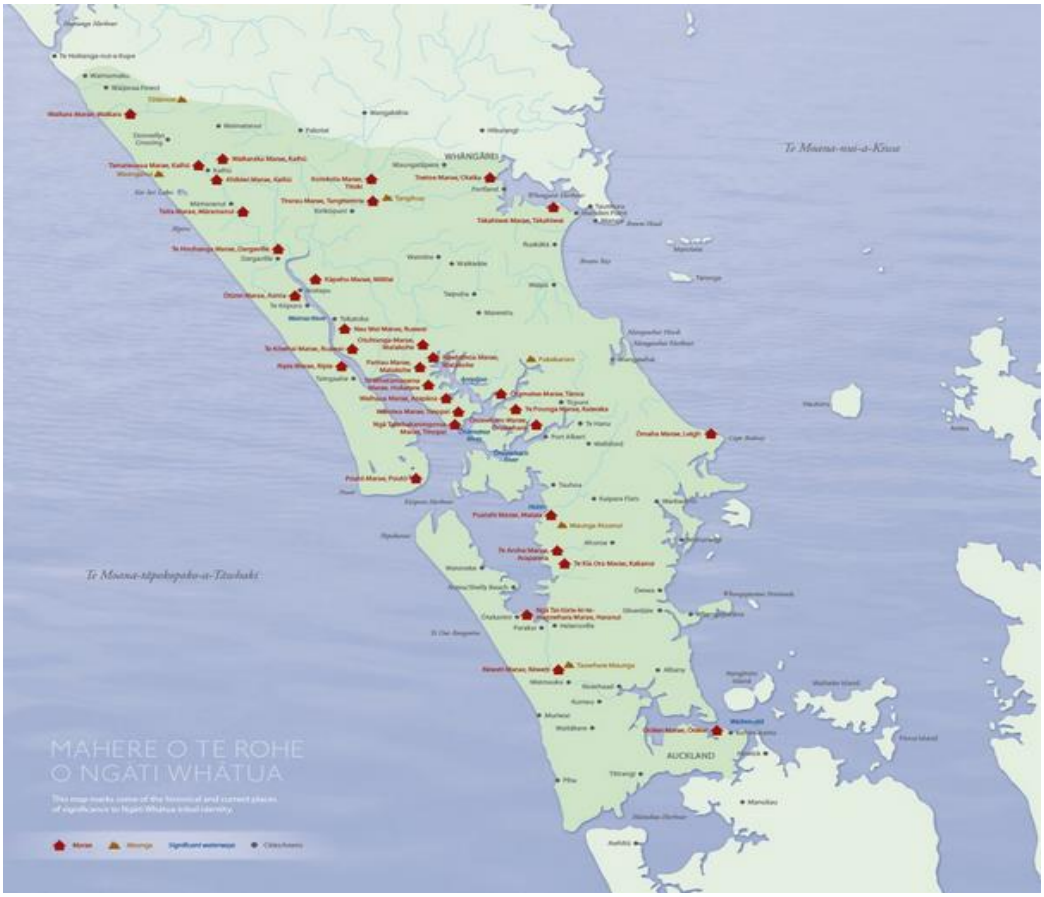

Figure 1-3. Location of Ngāti Whatua settlements in Kaipara Harbour catchment

The Kaipara Harbour: Policy and Governance

The divided governance and fragmented policies in the management of the Kaipara Harbour presents many regulatory challenges. The fluctuating political, knowledge, cultural and financial exchanges amongst significant actors in the basin present issues that stress the environmental battles being fought in the Kaipara Harbour today. Understanding the existing policy and governance of the Kaipara Harbour is necessary to obtain insight into the intricacy behind the institutional framework and its mechanisms for environmental management.

Policy

New Zealand policy can be traced to the common law of Britain. Environmental awareness during the 1960s led to a specific body of environmental law that developed in many Western countries including New Zealand. Environmental law increasingly was integrated in the 1980s with the passing of the Environment Act 1986 and the Conservation Act 1987. These acts set up the Ministry for the Environment, Parliamentary Commissioner for the Environment, and the New Zealand Department of Conservation (DoC) (King 2003). The most significant acts of the Parliament concerning environmental management are the passing of Resource Management Act in 1991 and the Local Governments Act in 2002. Issues under these Acts are adjudicated by the Environment Court of New Zealand.

Resource Management Act of 1991

The Resource Management Act (RMA), passed in 1991in New Zealand, is the principal legislation for environmental management in the country. The RMA regulates access to natural and physical resources such as land, air and water, with sustainable use of these resources being the overriding goal (Gunningham 2008). The RMA invokes an ecosystem based process by mandating that regulation be established on the management of the effects of resource use according to the "life supporting capacity" of the natural environment (Snelder and Hughey 2005). The national government provides the overarching goals and policies for the nation, and then devolves decision making to the lower tiers of government. The RMA is a non-prescriptive act and provides guidance for the implementing councils with high-level national goals. Thus, the regional-scale

environmental planning (regions include water catchments and extend to the edge of the territorial sea) and localized policy development are critical to its implementation (Snelder and Hughey 2005).

The RMA is an ambitious act, striving to manage air, fresh and marine water, and land in one piece of relatively broad legislation. One of the key functions for regional councils, as stated in section 30(1)(a) of the RMA, includes the preparation of objectives, policies, and methods to achieve *integrated management* of the natural and physical resources of the region (Environmental Defense Society 2011). District councils focus specifically on the integrated management of land use effects, as stated in section 31(1)(a) of the RMA (Environmental Defense Society 2011).

A pyramid of policies and plans that are prepared at the national, regional and district levels help promote this integration (Figure 1-4). The national environmental standards developed under the RMA can mandate the adoption of consistent standards at the regional and district levels (Environmental Defense Society 2011). Integration between decision makers is facilitated through the requirement for joint hearings, in most cases, where an activity requires resource consents, similar to a permit in the United States, from more than one agency. Joint policies and plans can also be prepared by two or more councils.

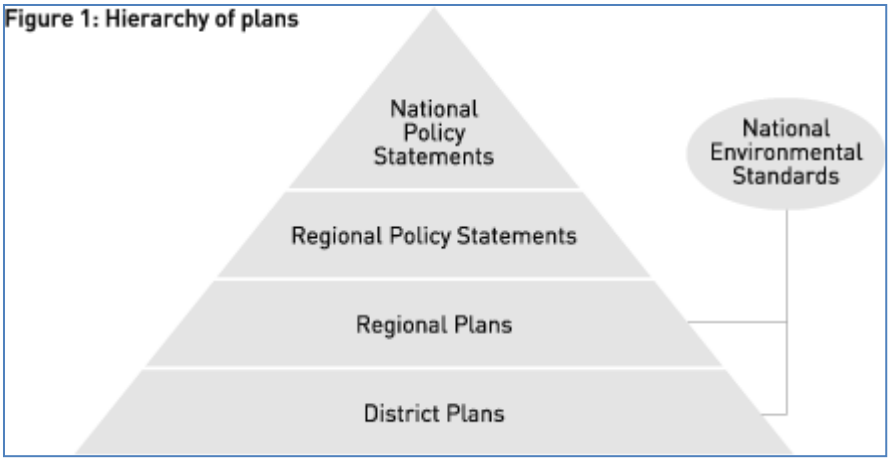

Figure 1-4. Hierarchy of policies and plans under the Resource Management Act (Environmental Defense Society 2011)

Based on the principle that decision-making is best executed at the level closest to the resources affected, decision-making under the RMA is decentralized to local and regional levels (Environmental Defense Society 2011). Typically decisions regarding land use are made at the district level; decisions about fresh water, soil conservation and air pollution at the regional council level; and decisions involving the management of the coastal marine areas are shared between the national and regional levels through coastal plans (Environmental Defense Society 2011). These jurisdictional bodies will be further examined in the next section on Governance. In instances where there are proposals of national significance, central government can directly intervene in local decisions either through a call-in procedure or on the recommendation of the Environmental Protection Authority.

Local Governments Act of 2002

The Local Government Act of 2002 (LGA) defines local governments and districts in New Zealand. Similar to the RMA, this act also includes a focus on

sustainability, specifically in terms of resource management defined by the 'four well-beings': social, economic, environmental and cultural resources (New Zealand Legislation 2011). The purpose of the act is to facilitate democratic decision-making and action by and on behalf of localized communities. The LGA divides New Zealand into 11 regional authorities and 5 territorial (or unitary) authorities, which are further separated into 73 local districts or territorial authorities, each with an elected Mayor and elected Councilors (New Zealand Legislation 2011).

Regional authorities are responsible for several environmental management issues: water, contaminant discharge, coastal management, river and lake management, flood and drainage control, regional land management, regional and public harbours, and biosecurity or pest management. Territorial authorities are responsible for: local-level land use management, network utility services such as water, sewerage, stormwater and solid waste management, local roads, libraries, parks and reserves, and community development (New Zealand Legislation 2011). Property rates are used to fund both regional and territorial governments and there is often overlap between regional and territorial councils responsibilities because of their complementary roles.

Managing the Kaipara Harbour

The Kaipara Harbour does not have a comprehensive management plan. There are a number of policies that play an important role in the management of the harbour at varying scales of implementation. Aside from the broader goals of the RMA and LGA, and the localized district and regional plans, the significant policies and documents affecting the management of the Kaipara Harbour and its resources are described below.

New Zealand Policy Statement for Freshwater Management

National policy statements (NPS) are instruments under the RMA to help local governments determine how competing national benefits and local costs should be balanced (Ministry for the Environment 2013). The New Zealand Policy Statement for Freshwater Management (NPSFM) is one of several policies in a larger national reform called the Fresh Start for Freshwater reforms of 2011, which aims to collaboratively address waterway restoration, pollution cleanup, and irrigation issues. The freshwater statement is an effort to improve freshwater management at a national level, setting out objectives and policies that direct local governments to manage water sustainably while providing for economic growth within set water quality and quantity limits (Ministry for the Environment 2013). Based on RMA requirements, any provisions to the NPS must be reflected in district and regional plans, thus the freshwater NPSFM strives to drive national consistency in local RMA planning and decision-making, while allowing for some level of regional flexibility (Ministry for the Environment 2013). Resource consents are required for taking, damming, discharging and diverting water, and any more than *minor potential adverse* effects of activities are carefully considered and actively managed by the pending inclusion of limits in plans. The key purpose of the NPSFM is to improve freshwater management through setting enforceable water quality and water quantity limits through an integrated management approach (Ministry for the Environment 2013).

New Zealand Coastal Policy Statement

The Minister of Conservation is responsible for the New Zealand Coastal Policy Statement (NZCPS) that was originally issued in 1994, then revoked and reissued in

2010. The NZCPS is a requirement under Section 56 the Resource Management Act 1991 to promote the sustainable management of the natural and physical resources of the coastal environment, including coastal land, foreshore and seabed, and coastal waters from the high tide mark to the 12 nautical mile limit (Department of Conservation 2011). The coastal management regime was established by the RMA of 1991, and required the NZCPS to guide regional and district authorities in managing their regional and district policies and plans (Department of Conservation 2010). Similar to the NPSFM, any provisions to the NZCPS must be reflected in the local governing documents. The implementation is a joint effort between local authorities and the Department of Conservation, offering explicit and specific direction to councils on strategic and spatial planning as well as addresses several environmental value domains: the preservation of natural character, protection of natural landscapes, protection of indigenous biodiversity, and the adoption of precautionary approaches where appropriate (Department of Conservation 2010).

New Zealand's Quota Management System

The former Ministry of Fisheries (MfF), now part of the Ministry of Primary Industries (MPI) is responsible for the Quota Management System (QMS) that helps with sustainable utilization of fisheries resources through the direct control of harvest levels for each species in a specified geographical area. Each fish species in the QMS is subdivided into separate fish stocks defined by Quota Management Areas (QMAs), and presently there are 100 different fish species managed in 636 different stocks (Ministry of Fisheries 2011).

Treaty of Waitangi

The Treaty of Waitangi is the founding document of New Zealand was written only a few days before it was signed in the Bay of Islands in 1840. The Treaty is a broad statement of principles on which the British and Māori made a political compact to found a nation state and build a government in New Zealand. The three components of the treaty are of regular debate between the British Crown and Māori tribes: 1) Māori surrender the sovereignty of New Zealand to Britain; 2) Māori give the Crown a chance to buy lands they wish to sell, in return Māori are guaranteed rights of ownership of their lands, forests and fisheries; 3) Māori are given the rights and privileges of British subjects (King 2003)

Governance

The institutional framework of New Zealand is important to understand for a thorough governance and policy analysis. New Zealand is a constitutional monarchy with a parliamentary democracy with Queen Elizabeth II as the head of state and her elected Prime Minister is currently John Key. The environmental actors in New Zealand and regulating bodies for the Kaipara Harbor will be described in detail in this section.

Actors

There are many critical actors under order of the Parliament involved in the management of water, or any natural resource, in New Zealand. The Ministry for the Environment provides RMA advice to parties in need of legislative assistance. They also initiate the preparation of NPSs and environmental standards, and are responsible for the compilation and distribution of information on environmental matters. The DoC manages New Zealand's conservation estates, oversees the management of the coastal

environment, and more generally promotes the conservation of natural and historic resources. The Ministry of Primary Industries (MPI) recently merged the Ministry of Fisheries and Agriculture, and is responsible for fisheries management within New Zealand's 200-nautical-mile (400 km) Exclusive Economic Zone, with a mandate to ensure that fisheries are sustainably used within a healthy aquatic ecosystem, predominantly through monitoring fisheries compliance with the conservation and access/allocation rules. More recently, on October 1, 2009, an office within the Ministry for the Environment (MfE) was created and called the Environmental Protection Authority (EPA). The powers of the EPA are exercised by the Secretary for the Environment and the EPA's role is focused on a 'call in' procedure which applies to proposals of national significance. The Parliamentary Commissioner for the Environment reviews and provides advice on environmental issues and the government's existing environmental management systems.

Regional councils are the equivalent of state government in the United States and one of the more important actors involved in the Kaipara system. They are responsible for the integrated management of natural and physical resources of their region including the coastal marine area, the preparation of regional policy statements and plans, and the determination of applications for water and discharge permits (Ministry for the Environment 2011). The regional council is the level at which the implementation of authority occurs through the use of consents (or permits) and regional plans. An important issue to note here is that the RMA does not restrict water use or take unless restricted in a rule of a regional plan. The territorial authorities, or district

councils, are responsible for controlling the impacts of land use within their district, including the preparation of district plans, and the determination of applications for land use and subdivision consents. The implementation measures at this tier is mainly through planning for district specific economic development and land use tools for decision makers (Gunningham 2008). Finally, the Environment Court hears and determines a wide range of legal matters under the LGA and RMA (Ministry for the Environment 2011).

Historically the Kaipara's resources were managed by Rodney District Council (RDC) and Auckland Regional Council (ARC) to the south, and the Kaipara District Council (KDC) and Northland Regional Council (NRC) to the north (Left, Figure 1-5).

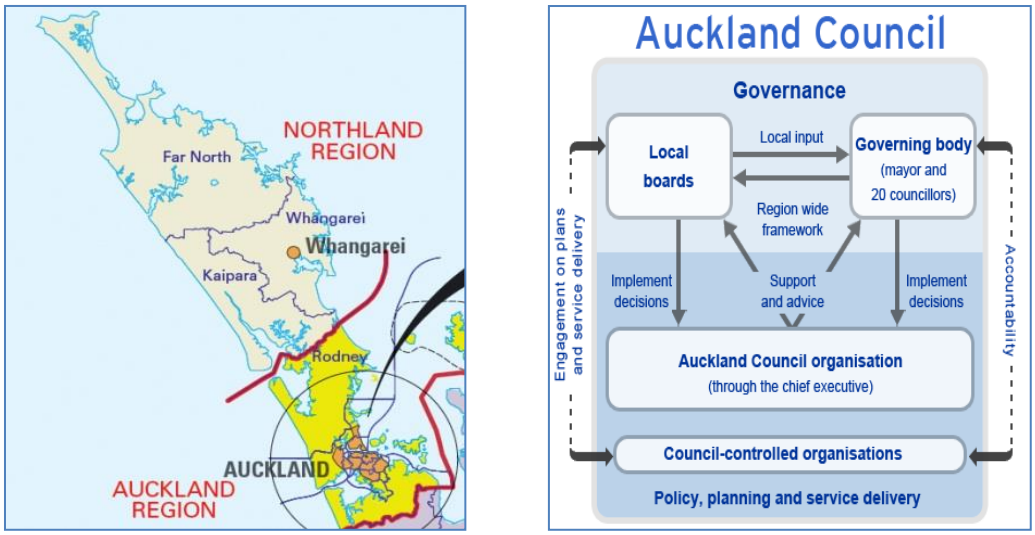

Figure 1-5. (Left) Former governing councils of the Kaipara Harbour (Local Governments New Zealand, 2011), (Right) Structure of the new unitary authority: Auckland Council (Auckland Council, 2011)

The ARC and RDC endured numerous pleas to form a unitary authority, and since 2011 the southern portion of the Kaipara has been administered by the merged

unitary authority the Auckland Council (AC) (Right, Figure 1-5), combining the powers and functions of the existing regional council and the region's seven previous city and district councils, including the Rodney district (Makey 2011). AC is the largest council in Australasia, with a $3 billion annual budget, $29 billion of assets and staffing of approximately 8,000 people (Orsman 2010). The AC has adopted a new model of local government designed to strengthen regional leadership while providing local and community democracy (Auckland Council 2011). The decision making responsibilities are now divided between the governing body (elected mayor and 20 councilors) and 21 local boards (Figure 2-5): the governing body focuses on the broader picture and on region-wide strategic decision-making, while local boards represent the local communities and facilitate policymaking on local issues, activities and facilities (Auckland Council 2011). Services from the AC are delivered through council-controlled organizations. Much of the decision-making from the AC involves issues regarding urbanization and sprawl.

There is a clear distinction between the southern management of the harbour versus the northern management of the Kaipara, particularly because there is more financial and human capital available to the AC therefore the southern part of the harbor is managed very differently. NRC is made up of 8 elected councilors, an appointed chief executive officer and 140 supporting staff, and reported a $7.8 million deficit for the 2010 fiscal year (Northland Regional Council 2010). NRC and the KDC are not as financially sound as the AC, struggling to employ critical staff roles and fund most environmental protection projects, let alone those involving the Kaipara Harbour.

Additionally, NRC has eleven other natural harbours to protect, from Parengarenga close to the region's northern tip, past the vacation hot spot of the Bay of Islands down, to Whangarei Harbour, where region's largest population center is situated. The Kaipara Harbour has always been of lower priority in terms of management than the economic hub of the Whangerei Harbour or the tourist attraction of the Bay of Islands. As mentioned earlier, this has been evidenced by reduced water quality, altered marine life, declining biodiversity but also from the cloudy physical appearance of the major rivers that feed into the Kaipara Harbour in Northland (Figure 1-6).

Figure 1-6. Upper Hoteo River (left) and the Wairoa River in Dargaville (Makey, 2013)

NRC attributes the intensification of farming as the main source of threat to the Kaipara Harbour (Reed et al. 2011). The size and number of beef and dairy farms are increasing, thus depleting increased amounts of forest land and yielding more sediment

and agricultural runoff into the harbour. NRC affirms that landowners need to manage their properties more sustainably, and the council does offer consultation through a consents program to provide one on one assistance to farmers, although this program's funding ended in 2012 (Reed et al. 2011). Many other Kaipara stakeholders speculate that the farmers in the area truly hold the political reign, given agriculture is the largest source of income in the catchment and that regulatory agencies possibly turn their heads when they see adverse impacts from undesirable farming practices (Awatere 2011; Bellingham 2011; Brandenberg 2011; Greene 2011; Hopkins 2011; Yardley and Yardley 2011).

Both regional councils have integrated Māori relations in their policymaking processes. The AC works closely with the Māori Statutory Board, who aims to make sure the council takes the views of Māori into account when making decisions by addressing the cultural, economic, environmental and social issues that are significant for the *mana whenua* group and *Mātāwaka* in *Tāmaki Makaurau;* and to make sure that the council complies with statutory provisions that refer to the *Treaty of Waitangi* (Auckland Council 2011). NRC has an *iwi* representative on their Environmental Management Committee and Regional Transport Committee, works closely with *iwi* and *hapō* on specific issues as they arise, and by involving Māori in the consent process by sending *iwi* and *hapō* copies of applications that are publicly notified (Reed et al. 2011).

Integrated Kaipara Harbour Management Group

The largest effort to include Māori in the management of the Kaipara Harbour to date is the Integrated Kaipara Harbour Management Group (IKHMG). The IKHMG is an initiative led by *Te Uri o Hau* and its stakeholders to support the management of the harbour by providing leadership to coordinate the various resource management agencies in a united vision for the management of the Kaipara Harbour and its catchments (2010). This would assist IKHMG in meeting their obligations under the Te Uri o Hau Settlement Act and be consistent with many Memoranda of Understanding (MOU) and protocols established between Te Uri o Hau Settlement Trust and key stakeholders (Makey 2013). The group started as a result of Te Uri o Hau and the Crown Research Institute 'Landcare Research' initiating two *hui* in 2005, the outcomes with iwi and stakeholders on the following issues were identified, as stated on the Integrated Kaipara Harbour Management Group website:

- The harbour is in environmental decline.
- The vision is for the creation of "A healthy and productive Harbour".
- The vehicle for achieving this vision is a Sustainable Kaipara Catchment Plan.

An Interim Kaipara Management Group was formed to undertake a 6 month program, appoint a Project Coordinator and oversee research and co-ordination with the aim of scoping an agreed approach to achieve a Sustainable Kaipara Catchment Plan. The first report back to the wider group was in March 2006. The IKHMG works with common interests and does not aim to challenge the management processes led by the decision-

making agencies holding statutory authority in the catchment; rather, it explores the means by which all interests (public and private, cultural and social, commercial and recreational) can focus on a common vision (Makey 2013)

Collaborative efforts with the AC and NRC have instigated an interregional plan called the 'Kaipara Harbour Scoping Study'. The project was broken down into phases due to the complexity of issues involved. The initial consultation phase carried out in 2005 was considered Phase 1. Phase 2 was the scoping project and preparation of the Project Brief. Phase 3 is anticipated to produce a Plan Outline with the eventual implementation being Phase 4 (2010; Makey 2013).

IKHMG receives financial contributions by several governmental, nongovernmental and private organizations in the network on a donation basis (Makey 2011). The group applies for funding through Te Uri o Hau subsidary Environs Holdings Trust, which provides them with operational funding. The set of MOU's and protocols that Te Uri o Hau have with the government organizations provides leverage to see that contributions are made annually, however, the group rarely meets their budget requirements and typically fall short of their needs by 30-40% annually (Makey 2011) The project coordinator of the IKHMG is Leane Makey, a PhD student at Auckland University, who assists in all project correspondence, implementation and evaluation within the Kaipara Harbour.

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APPENDIX

Glossary of Maori Terminology

Iwi: Māori tribe, or largest social unit in Māori culture. Means "people" or "folk"
Hapū: Subtribe of Iwi, basic political unit in Māori culture. Means "subtribe" or "clan"
Hui: term for a social gathering or assembly.
Kauri: *Agathis australis,* a heavily logged coniferous tree found in the northern district of New Zealand's North Island. Pre 1840 kauri occupied 12,000 sq. km, after 1950 this reduced to 1400 sq. km
Kahikatea: *Dacrycarpus dacrydioides,* coniferous tree endemic to New Zealand. European settlers used as timber to make butter boxes, Māori used as a food source and for bird spears. Before extensive logging the tallest kahikatea recorded was 80m, now the tallest recorded is 50m.
Kumara: Sweet potato
Mana: A person or organization of people of great personal prestige and character
Mana Whenua: A tribe that has demonstrated their authority over a piece of land or territory
Marae: A communal or sacred place which serves religious and social purposes
Māori: Members of the aboriginal people of New Zealand, and their Polynesian language
Mātāwaka: Māori who live in the Auckland council boundaries
Mātauranga Māori: Traditional concepts of knowledge and knowing. The term takes many forms, including language, traditional environmental, traditional knowledge of cultural practice, such as healing and medicines, fishing and cultivation.
Nga Kaitiaki Tai Ao o Kaipara: Māori hapu (or sub tribe) of Ngāti Whātua, on the northern side of the Kaipara Harbour
Ngāti Whatua: Māori tribe of New Zealand. It consists of four sub tribes (hapus): Te Uri-o-Hau, Te Roroa, Te Taoū, and Ngāti Whātua-o-Ōrākei. Territory (Rohe) covers the Kaipara regions
Pākehā: New Zealanders who are not of Māori blood line, mostly British and Irish settlers though also includes Dutch, Scandinavian, German, Yugoslav or other Caucasian ethnicities. Some find this term very offensive, others are indifferent.
Rohe: Territory or boundaries of tribal groups

Tāmaki Makaurau: New Zealand Parliamentary Māori electorate returning one Member of Parliament to the New Zealand House of Representatives
Taonga: A treasured tangible or intangible thing, such as heirlooms, artifacts, land, fisheries, etc.
Te Uri o Hau: Māori hapu (or sub tribe) of Ngāti Whātua, on the northern side of the Kaipara Harbour
Treaty of Waitangi: Treaty established and signed in 1840 by the British governor of New Zealand and various Māori chiefs that recognized Māori ownership of their lands and other properties, and gave the Māori the rights of British subjects. Considered the founding document of New Zealand as a nation, highly contested by the British Crown, New Zealanders and Māori.

Chapter 2 Literature Review

Introduction

The environmental, institutional and political complexity in the Kaipara Harbour region presents management challenges to the policy and decision-makers in the region. No single research approach can address the breadth of issues within the catchment. This research examines these complexities through integrating both qualitative and quantitative data to provide a better understanding of the Kaipara Harbour system. Mixed methods approaches are increasingly used in interdisciplinary research to examine complex environmental, social and economic issues. Researchers that converge methodological analyses tend to base knowledge claims on pragmatic grounds, and use strategies of inquiry that involve sequential or simultaneous data collection to best understand research problems (Creswell 2013). The results of one method can inform another approach, one method can be nested within another to offer insight into different levels of analysis, or methods can serve a broader and transformative purpose to change or advocate a current public perspective or stance (Creswell 2013).

This dissertation research examines the Kaipara Harbour through a mixed methodological approach. First, an exploratory case study approach of the Kaipara Harbour governance network collects and analyzes qualitative institutional data, nesting methods to evaluate different units of analysis. Next, a stakeholder-informed semi-quantitative ecological risk assessment codes interview data, processes geospatial information and synthesizes source documentation to prioritize ecological areas and land

use in the region. Finally, a cultural values and policy analysis quantifies the integration of Māori values in current regulating policies of the Kaipara Harbour catchment.

The purpose of this chapter is to provide the scientific framework that guided the development of this dissertation research project. The following sections will provide an overview of social ecological systems and the development governance and institutional research to study these systems, review the ecological risk assessment literature, and offer insight into integrated watershed management and policy analysis.

Social-Ecological Systems

Academic interest to integrate social and ecological science is rising, particularly in the field of coupled human and environmental systems, often defined as social ecological systems (SES). SES are ecological systems intricately linked and impacted by at least one social system. 'Ecological systems' are lightly defined as an inter-reliant system of organisms or biological units, and 'Social systems' are loosely described as interdependent systems that tend to form cooperative relationships (Anderies et al. 2004). The SES framework examines resource systems (i.e. forestry or fishery), resource units (pine trees or snapper), users (loggers or fisherman), and governance systems (organizations and their rules that regulate forestry or fisheries) that are separable though interact with one another to produce outcomes at the SES level (Figure 2-1) (Ostrom 2009). The success or collapse of SESs can be explored through the identification and analyses of relationships among multiple spatial and temporal scales and perspectives, hence understanding the complexities of the whole system requires knowledge about the interconnectedness of the component parts (Ostrom 2009).

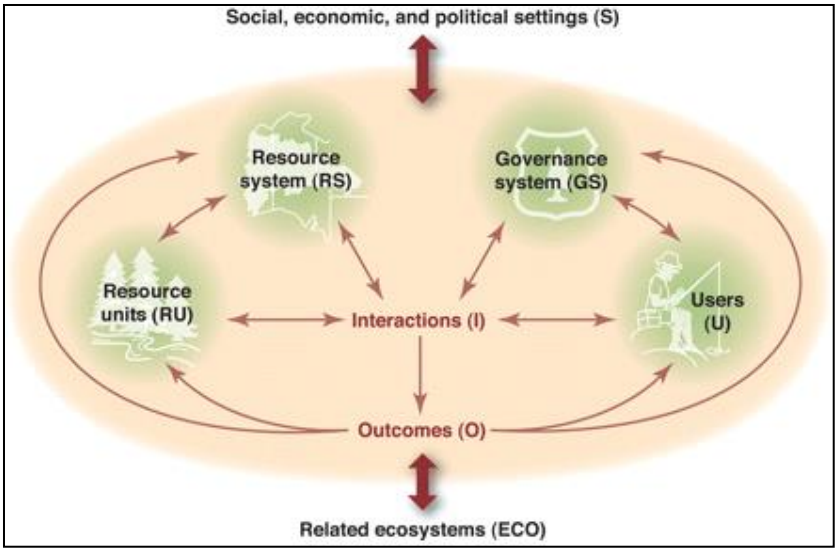

Figure 2-1. The core subsystems in a framework for analyzing SES (Ostrom 2009)

SES are analogous to the anatomy of organisms and can be described as an interdependent system of biological units; living creatures are composed of organs, those organs of tissues, the tissues of cells, the cells of proteins, and so on (Brondizio et al. 2009; Ostrom 2009). In terms of an ecosystem, the subsystems of a governance network are divided into resource systems, resource users and governance systems. These separate social and ecological units can be observed individually, or by examination of the linkages between the interactive subsystems embedded within SES (Anderies et al. 2004; Brondizio et al. 2009; Ostrom 2009). Studies often overlook the key interactions between agents, the rules constraining the actions of the agents, and the collective choice processes used to inform decision-making (Brondizio et al. 2009)

Institutional Analysis and Development

Prior to the bounty of SES literature, Elinor Ostrom's pioneering work on common pool resources and institutional choice challenged government regulation of

public resources by asserting that formal regulatory authorities are not the only means for successful decision-making. Her research addressed the complexities in evaluating relationships between the interactive subsystems within SES and her pivotal contributions to the emerging SES field resulted in the Institutional Analysis and Development Framework (IAD). The IAD is a multi-tier framework that identifies actors, resources and rules in a system, and the resulting 'action situations' and 'action arenas' to evaluate outcomes of common pool resource management (Ostrom et al. 1994; Ostrom 2005). Interest in the highly adaptable IAD framework expanded with researchers determining what *type* of organizational structure promoted social and political productivity for its surrounding system. The IAD model has been modified, separating the traditional framework into four main subcomponents: the *context* (attributes of resources, resource users, and governance arrangements) that influences the *action arenas* (actors, resources, rules, and patterns of conflict/cooperation), in which important patterns of *interaction* are established, leading to specific *outcomes* (Ratner D. et al. 2013).

Social and environmental scientists are increasingly combining the IAD and SES framework to address context specific complexities in coupled human-natural research (Ostrom and Cox 2010; Ostrom 2011). With regard to patterns of interaction, studies of institution analysis in ecosystem-based management conclude that the efficacy of applied natural resources management is dependent on proper institutional design (Imperial 1999). In particular, an emphasis on the balance between the federal (vertical) and local (horizontal) controls, recognizing that the capacity (knowledge, power, resources) of the institutional actors and scales of governance are often variable when

solving complex environmental problems (Imperial 1999). Support for multijurisdictional research argues that the dynamics of cross-scale and cross-level interactions are affected by the multiscalar interplay between institutions, and that conscious co-management incorporating knowledge across multijurisdictional boundaries may facilitate solutions to the complicated problems that common-pool decision-makers are faced with (Cash et al. 2006).

Governance Networks

Through a combination of SES and IAD frameworks, we can identify the broader subsystems within a coupled natural-environmental system. The relationships and interaction within the subsystems, however, require an interorganizational assessment. Interorganizational network studies are prevalent across public administration, economic, sociological, and governance literature and include applications to policy and decion-making networks, cross sectoral collaborations, public-private partnerships, and public management (Whetten 1981; Koliba et al. 2011). Although natural resources research has broadened its interdisciplinarity in SES studies, with particular emphasis in social networks, interorganizational research remains relatively sparse in the body of environmental management literature. A few of the existing studies evaluate stakeholder participation in integrated rural development (Honadle and Cooper 1989), eco-system based management evaluation (Imperial 1999), the robustness of institutional relationships and public infrastructure in SES (Anderies et al. 2004), and exchanges of social, political, natural, intellectual, physical and cultural capital flows (Costanza et al. 1997; Brondizio et al. 2009; Koliba et al. 2010).

Recently, Christopher Koliba and his research team introduced a diagnostic toolkit to understand interorganizational connections in what they define as *governance networks*, or "relatively stable patterns of coordinated action and resource exchanges; involving policy actors crossing different social scales, drawn from the public, private or nonprofit sectors and across geographic levels; who interact though a variety of competitive, command and control, cooperative, and negotiated arrangements; for purposes anchored in one or more facets of the policy stream" (Koliba et al. 2010). Koliba et al. (2010) provide a systematic method which can be applied to a diverse set of applications to distinguish important characteristics of a governance network. Critical features regarding the individual network actors that are relevant in describing governance network structures are identified. These are the social scale of actors, the goal orientation of actors, the social sector from which the actors originate, the resources actors contribute to the network, and the roles they may assume.

Ostrom argued to effectively conduct the social-ecological research our present day needs it is necessary to move beyond simplistic models and blueprint frameworks, and will require a novel integration of methodologies to understand complex systems and processes (Ostrom and Cox 2010). The governance network analysis in combination with IAD and SES frameworks will allow for an in-depth, methodologically-pluralistic insitutional analysis for the Kaipara Harbour case study.

Ecological Risk Assessment

Risk can be defined in a number of ways however a common concept in most definitions is uncertainty, particularly the uncertainty that surrounds events and outcomes

(Berg 2010). Risk is present in all human situations; therefore risk assessment can be applied in several fields including organizational risk management, financial risk management, safety risk assessment, health risk assessment, and toxicology and chemical risk assessment (Thoeye et al. 2003; Berg 2010). The focus of this section is on ecological risk assessment (ERA), and its meaning has evolved over time. In general, ERA is an evaluation tool to examine potential adverse effects that human activities have on organisms and their ecosystems. The process itself provides a means to develop, organize and present data so that it is useful to policy and decision makers (Environmental Protection Agency 2013). When conducted for a particular place, such as a watershed or catchment, the ERA process can identify vulnerable resources, prioritize data collection activity, and link human activities to their resulting impacts. The results of an assessment provide a basis for comparing various management options, allowing decision and policy makers, and the public, to make better informed decisions regarding the management of ecosystems and their resources (Environmental Protection Agency 2013).

The United States Environmental Protection Agency (EPA) has been involved in risk assessment practices since the 1970s, though it did not formalize a process until 1983 when the National Academy of Science published the ground breaking report "Risk Assessment in the Federal Government: Managing the Process", commonly known as the Red Book (Environmental Protection Agency 2013). Since then the EPA has incorporated principles from this document into their practices today conducting risk assessments that typically deal with single chemicals in pesticides, herbicides, organic

solvents, metals, and dioxins; evaluating health impacts such as mortality, reproduction and chronic physiological effects (Landis 2005; Environmental Protection Agency 2013).

Shortly after the release of the 'Red Book' there was a push to broaden the field of ecological risk beyond human health impacts to deal with plants, animals and whole ecosystem risks. In the early 1990s there was yet another effort to further expand the field of risk assessment to evaluate flora and fauna but also to reflect the reality of the structure, functionality, and complexity of ecosystems at a landscape scale (Landis 2005). One of the most important criticisms of the EPA paradigm is that the assessment was originally designed for single chemicals and single receptors; thus its applicability into a spatial environment with the inherent persistence of multiple stressors had many limitations (Wiegers et al. 1998; Landis 2005).

Landis and Wiegers (1997) outlined a new framework that incorporated multiple stressors, spatial structure, historical events and multiple assessment endpoints (Figure 2-8). Traditionally, ERA's evaluate interactions amongst three environmental components (Figure 2-8a): stressors released in the environment, receptors living in the environment and receptors response to the stressors (Landis and Wiegers 1997). This classic framework tends to focus on a single stressor, thus the interaction of the exposure and effects measurements tend to be simple and straightforward. Conversely, in a regional multiple stressor assessment (Figure 2-8b), the quantity of possible interactions increases sharply since sources can release a number of stressors into the environment, and those stressors can impact many habitats, potentially with synergistic effects clouding results (Landis 2005). The two approaches are similar in composition, though the regional risk

model emphasizes location and the idea that *groups* of stressors, receptors and effects should be considered and that a receptor for one stressor might also be a stressor for another receptor.

Landis and Wiegers (1997) developed a definition for regional-scale risk assessment that utilizes nontraditional methods to estimate risk; this definition will be used for the scope of this dissertation research: "A risk assessment deals at a spatial scale that contains multiple habitats with multiple sources of multiple stressors affecting multiple endpoints and the characteristics of the landscape affect the risk climate. Although there may only be one stressor of concern, at a regional scale the other stressors acting upon the assessment endpoints are to be considered" (Landis 2005).

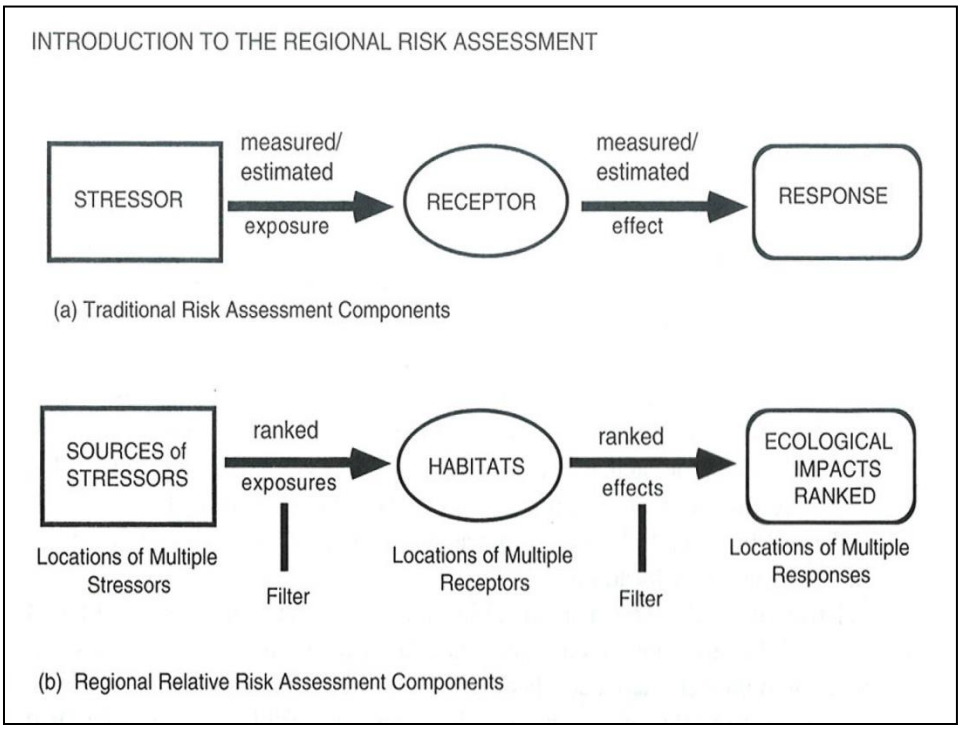

Figure 2-8 (a) Traditional Risk Assessment Components and (b) Regional Relative Risk Assessment Components (Landis 2005)

The regional framework described identifies combinations of risk pathways to environmental hazards. If a source generates stressors that affect critical habitats to an ecosystem, ecological risk is high. On the other hand, a minimal interaction between stressor and habitat components result in a lower risk while no interactions amongst components expose no risk (Landis and Wiegers 1997; Landis 2005).

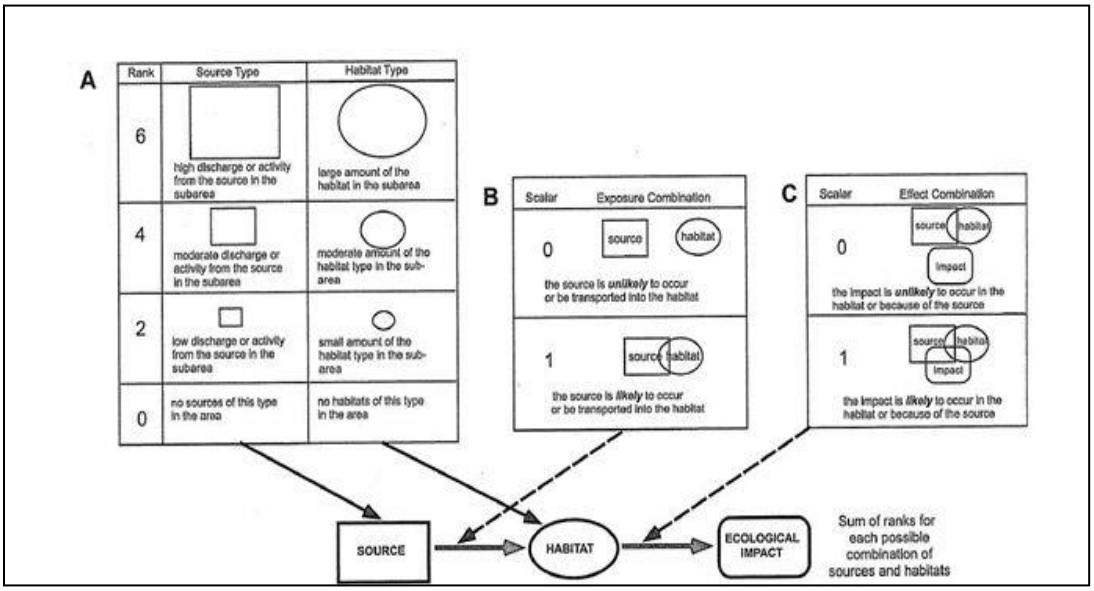

Figure 2-9. The regional risk model approach and its system of numerical ranks and weighting factors (Landis and Wiegers 1997)

The regional risk model (RRM) calculates risk through a semi-quantitative ranking and filter approach (Figure 2-9). A system of numerical ranks and scalars are developed to tackle conflicts encountered when combining different types of risks in complex systems where various stressors and effects are rarely linear (Landis and Wiegers 1997). This semi-quantitative methodology that identifies intersecting risk components; the idea being risk is proportional to the overlap between sources, habitats and impacts in the environment. Rather than isolating acute measurements of

contaminants, chemicals or other pressures in the environment, the RRM determines whether a region may have, for example, an *abundance* of a pollutant, the *most* introduced invasive species or potentially both; highlighting isolated areas of greater impacts in the region (Figure 2-10). The risk assessment than determines whether a region is at a high, medium, or low level of risk resulting from a combination of sources that are capable of impacting various habitats.

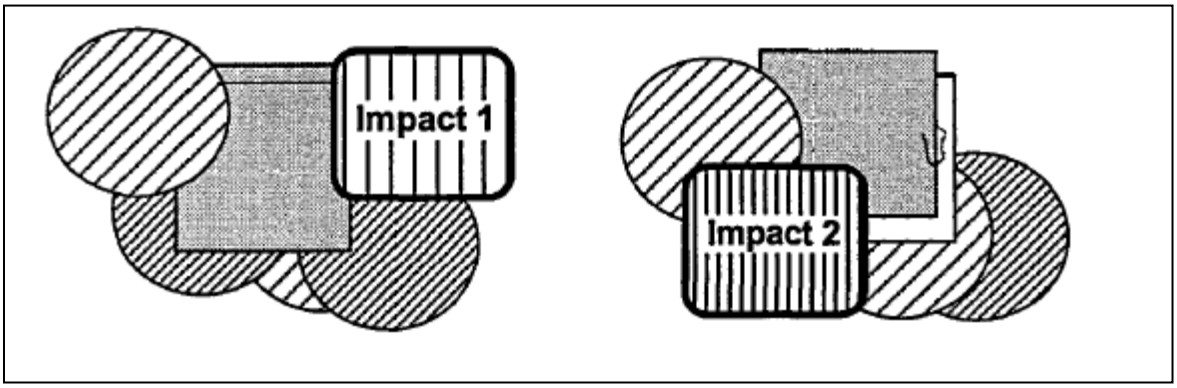

Figure 2-10 . Two risk pathway combinations of two sources and two habitat types that can influence the risk of impacts on a region (Landis and Wiegers 1997)

The regional risk model is advantageous to areas where a number of stressors impact a range of habitats. Often it is difficult to determine what stressors are of greatest concern and which of the habitats are facing the most threat, particularly when various stakeholders have differing perspectives on these issues. Another key benefit is that the RRM allows metrics that are inherently dissimilar to be compared with one another (i.e. invasive species count, nutrient levels, eco-tourism, etc). Moreover, the RRM allows for these diverse inputs (sources/habitats) to be compared to one another using an objective numerical ranking system, helping stakeholders of divergent expertise communicate about the relevant issues, regardless of their background.

The Kaipara Harbour on the North Island of New Zealand provides a good case study and application of RRM in an area where there are competing and conflicting demands for a range of natural resources. This project conducts a stakeholder driven ecological risk assessment for the Kaipara Harbor to assess the risk from principal sources of threat to the Kaipara Harbour and their impacts on critical habitats in the catchment.

Policy and Indigenous Integrated Management

The field of water resources management is increasingly adopting ecosystem and landscape based approaches, incorporating collaborative and multijurisdictional contexts for governance, and in particular transferring the water management responsibilities from centralized governments to a number of important stakeholders (Sabatier 2005; Durette and Barcham 2009; Huitema et al. 2009; Memon et al. 2010). Several studies on collaborative watershed management conclude that the top-down, agency dominated approach in governing water has come to an end, and are more commonly being replaced with the bottom-up, collaborative approaches that are better adapted to diffuse complex watershed problems (Koontz et al. 2004; Sabatier 2005; Huitema et al. 2009). The interactions between government agencies, nongovernmental actors and citizen participation in collaborative watershed partnerships often determine whether or not integrated, science-based planning can address resource management conflicts successfully among stakeholders and decision-makers (Moore and Koontz 2003; Koontz et al. 2004; Koehler and Koontz 2008; Durette and Barcham 2009).

Studies in management literature suggest that knowledge from all diverse groups within society can inform resource management, and there has been an increased recognition to include values and beliefs of indigenous communities (Berkes et al. 2000; Tipa and Welch 2006; Panelli and Tipa 2007). Studies of traditional ecological knowledge (TEK) indicate there is a level of local observational information in environmental systems, and is loosely defined as a 'cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmissions about the relationship of living beings (including humans) with one another and with their environment' (Berkes et al. 2000). Globally, integrated water resources management approaches that transfer the water management responsibilities from centralized governments to a number of important stakeholders is also shifting to include indigenous communities (Durette and Barcham 2009). Indigenous water governance examples exist internationally, with cases involving peasant irrigation with Bolivia's Campesino population, Aboriginal water rights and collaborative governance in Australia, and the integration of First Nations, Metis and Inuit environmental movements in federal regulation in Canada (Ramin 2004; Perreault 2005; Durette and Barcham 2009).

For Māori in New Zealand, survival was historically contingent on the natural resource knowledge and sustainable resource gathering from land, water, and sea. This long history of occupation in the country contributed to a rich ecological knowledge of sustainable management practices for water and land resources (Tipa and Tierney 2003; Tipa and Welch 2006; Panelli and Tipa 2007). Following European settlement,

traditional land uses became restricted with development and urbanization, and Māori communities witnessed changes (often destruction) to their valued environments, alienating them from resources from which their cultural beliefs and identities are derived (Tipa and Welch 2006). Over the course of the past few decades, and particularly with the passing of the Resource Management Act in 1991, incorporating Māori viewpoints and values in natural resources management is more prevalent. New Zealand has several examples of indigenous integrated watershed management seeing as Māori have cultural connections to water and land, and take on the role of *kaitiaki*, or guardian of the environment, in managing those resources sustainably (Durette and Barcham 2009). Māori traditionally believe that the waters, surrounding land, and all the life supported by them possess *mauri*, or life force; and the primary resource management principle is, therefore, protecting the mauri of a resource from sacrilege (Tipa and Tierney 2003).

A policy analysis evaluating the integration of Māori values in current documents regulating resource use in the Kaipara Harbour catchment will identify cultural and environmental challenges, and opportunites, in the region.

Conclusion

The Kaipara Harbour has a number of environmental, social and institutional issues that need to be explored in detail to mitigate the further deterioration of the economic, cultural, and ecological life support services in the catchment. My research will examine the complexity of the issues described in the background section through a

stakeholder driven ecological risk assessment, an institutional governance analysis and a multi-jurisdictional policy analysis of Māori values integration.

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Chapter 3 An Institutional Analysis of the Kaipara Harbour Governance Network in New Zealand

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Abstract: Common pool resources present complex management challenges that historically have been investigated through traditional scientific studies and governed through regulatory mechanisms. The literature suggests a shift towards applied scientific approaches and collaborative governance structures in natural resource management. Increasingly, social ecological systems (SES) perspectives are used to understand multifaceted issues through mixed-methodological approaches and to better comprehend the components of a larger system. Using the theoretical concepts grounded in environmental governance we examine the multijurisdictional SES of the Kaipara Harbour in New Zealand in two different policy regimes through a synthesis of network, institutional and adaptive governance analyses. We find that a conventional form of regulatory management has persisted through these eras. However, the network configuration has been modified dramatically and the emergence of informal subsystems has proven to be vital in the successful management of the harbour and its resources. Our findings reveal the greatest limitation in the present day network is legislative accountability to the informal actors. We argue that recognizing governance and institutional relationships at the micro-level network, the network configurations at the macro-level and the adaptive capacities of a SES are critical in understanding the challenges and opportunities in complex environmental systems. Studies of this nature will help inform the interorganizational arrangement of the decision-making and collaborative actors in governance networks to promote ecological, social, cultural, and political efficacy for SES.

Keywords: Kaipara Harbour, multijurisdictional governance networks, integrated watershed management, social-ecological systems, adaptive governance

INTRODUCTION

The field of environmental governance has transformed the approach to how natural resources and ecosystems are studied. The localized scale of site specific assessments are moving towards a broader evaluation of ecosystems at the landscape scale. Traditional scientific research investigates ecological systems biophysically, while increasingly more holistic, or systems-based, approaches are recognizing the role of human and social dimensions. The conventional top down, command and control authority in natural resources management is branching out to collaborative partnerships incorporating stakeholder engagement in decision making processes (Koontz et al. 2004; Sabatier 2005).

Social Ecological Systems

Academic interest in the paradigm shift from basic scientific conduct to an applied sciences perspective is rising and the literature is extensive, particularly in the field of coupled human and environmental systems, often defined as social ecological systems (SES). Elinor Ostrom's pioneering work on common pool resources and institutional choice challenged the prevailing perspective concerning government regulation of public resources by asserting that formal regulatory authorities are not the only means for successful decision-making. This pivotal contribution to the SES field resulted in the Institutional Analysis and Development Framework (IAD), a multi-tier framework that identifies actors, resources and rules in a system, and the emerging 'action situations' and 'action arenas' to evaluate outcomes of common pool resource management (Ostrom et al. 1994; Ostrom 2005). Ostrom described SES through an analogy that dissect the anatomy of organisms; living creatures are composed of organs,

those organs of tissues, the tissues of cells, the cells of proteins, and so on (Ostrom 2009). In terms of an ecosystem, the subsystems of a governance network are divided into resource systems, resource users and governance systems. These separate units can be observed individually, or by examination of the linkages between one another to better understand the complexities of SES (Anderies et al. 2004; Ostrom 2009).

Interest in the highly adaptable IAD framework expanded with researchers determining what *type* of organizational structure promoted social and political productivity for its surrounding system. The IAD model has been modified, separating the traditional framework into four main subcomponents: the *context* (attributes of resources, resource users, and governance arrangements) that influences the *action arenas* (actors, resources, rules, and patterns of conflict/cooperation), in which important patterns of *interaction* are established, leading to specific *outcomes* (Ratner D. et al. 2013). Building on the patterns of interaction, studies of institution analysis in ecosystem based management conclude that the efficacy of applied natural resources management was dependent on proper institutional design (Imperial 1999). In particular, an emphasis on the balance between the federal (vertical) and local (horizontal) controls, recognizing that the capacity (knowledge, power, resources) of the institutional actors and scales of governance are often variable when solving complex problems (Imperial 1999). Support for multijurisdictional research argues that the dynamics of cross-scale and cross-level interactions are affected by the multiscalar interplay between institutions, and that conscious co-management incorporating knowledge across multijurisdictional

boundaries may facilitate solutions to the complicated problems that decision-makers are faced with (Cash et al. 2006).

The literature clearly emphasizes that it is critical to understand the interactions between organizations to address complex governance issues. Christopher Koliba and his team offer a diagnostic toolkit to understand these connections in what they define as *governance networks*, or "relatively stable patterns of coordinated action and resource exchanges; involving policy actors crossing different social scales, drawn from the public, private or nonprofit sectors and across geographic levels; who interact though a variety of competitive, command and control, cooperative, and negotiated arrangements; for purposes anchored in one or more facets of the policy stream" (Koliba et al. 2010). There are several approaches to network analyses that evaluate macro- and micro-level configurations, however of particular interest to this study are resource exchanges amongst the network actors. These system inputs are called *capital flows* and take on a variety of forms from financial, physical, cultural, natural, social, intellectual, human and political interchanges (Costanza et al. 1997; Brondizio et al. 2009; Koliba et al. 2010).

Adaptive Governance and Management

After the configurations of the governance network and the cross-scale interactions are better understood, we can than assess the *adaptive governance* of the SES. Theoretically, the field of adaptive governance is grounded in resilience theory, or the extent to which systems withstand natural and human disturbances without degrading or slipping into less desirable states (Bellamy et al. 2001; Dietz et al. 2003; Anderies et al. 2004; Folke et al. 2005; Gunderson and Light 2006; Plummer and Armitage 2007;

Parkes et al. 2010; Cosens and Williams 2011; Clark and Semmahasak 2013; Ratner D. et al. 2013). Resiliency studies can be challenging when applied to human-constructed systems versus those from the biological and ecological sciences, and the focus on adaptive governance and management has generated feasible institutional measures that are an integral component in the management of complex environmental issues.

The seminal work by Carl Folke, *Adaptive Governance of Social-Ecological Systems,* include four critical, interacting aspects in assessing adaptive governance: 1) building understanding of the resource and ecological dynamics, 2) incorporating that knowledge into adaptive management practices, 3) supporting flexible institutions and multi-level governance for management, and 4) adaptive capacity in dealing with perturbations, uncertainty, and surprise (Folke et al. 2005). Folke contends that polycentric design of institutional arrangements are essential for managing ecosystems with multijurisdictional boundary issues, such as oceans and climate, particularly when operating in scientific circumstances where knowledge is incomplete, multiple pathways of knowledge are present, and decision-making is both top-down and bottom-up (Dietz et al. 2003; Folke et al. 2005; Gunderson and Light 2006; Olsson et al. 2006).

Adaptive governance aims to integrate policy, science and decision-making assuming that system players are willing to embrace dynamic change and eager to deal with multifaceted human interactions and obstacles that historically may have impeded management progress (Gunderson and Light 2006). *Adaptive management*, a critical component of adaptive governance, focuses on multi-scalar, community-based systems of resource management tailored to specific places and situations that allow for ongoing

learning by means of testing institutional arrangements and ecological knowledge in a dynamic, self-organized process (Folke et al. 2005; Gunderson and Light 2006; Huitema et al. 2009). Adaptive management implies several institutional prescriptions including collaboration, experimentation, and bioregional approaches to resource management (Huitema et al. 2009). This concept is dependent on relationships of stakeholders operating with local, municipal, regional, national and global networks, and the strength or weakness of the linkages between these entities in theory reflect the overall adaptive governance capacity of the system (Folke et al. 2005).

Integrated Watershed Governance

Increasingly, adaptive management is mentioned frequently in the watershed governance literature. Watersheds (or catchments, river basins, water systems, etc.) provide a model context for integrated governance, where systems actors can prioritize issues from coalescing environmental, social and economic boundaries. Several studies on collaborative water management projects in the United States conclude that the top-down, agency dominated approach to governing water has come to an end, and is more commonly being replaced with bottom-up, collaborative approaches that are better adapted to diffuse complex watershed problems (Sabatier 2005; Huitema et al. 2009). Specifically, the concept of *adaptive co-management* has emerged, emphasizing the sharing of rights, responsibilities, and power between sectors of government and civil society (Koontz et al. 2004; Folke et al. 2005; Koehler and Koontz 2008; Huitema et al. 2009).

Tomas Koontz has been examining collaborative watershed partnerships and the theoretical frameworks that evaluate partnership success, specifically the role of governmental agencies, nongovernmental actors and citizen participation, determining whether integrated, science-based planning can address conflicts among stakeholders and decision-makers (Moore and Koontz 2003; Koontz et al. 2004; Koehler and Koontz 2008). His study of the Albermarle and Pamlico Sounds in North Carolina, the second-largest estuarine ecosystem in the United States, reveals that collaborative watershed management amongst a wide array of actors and institutions did improve the general understanding of the estuary, although did not address major barriers in management of the water system (Koontz et al. 2004). Research in the loss of ecological resilience in The Everglades wetland system in Florida also suggests that adaptive approaches in management and governance are critical for the recovery of the critical areas, arguing that the current restoration of the ecosystem is stagnant and withstanding, as well as resisting, change (Gunderson and Light 2006).

The number of adaptive watershed governance studies outside of the United States are growing and have stressed attributes of flexibility, intermediary functions, and social learning (Gunderson and Light 2006; Parkes et al. 2010; Clark and Semmahasak 2013). Recent work in British Columbia, Canada is promoting a shift towards integrated watershed governance through a new conceptual device called *The Watershed Governance Prism* (Parkes et al. 2010). The prism is a heuristic framework to help in decision-making for policy makers, researchers, practitioners, and educators, encouraging the notion to move beyond disciplinary approaches by linking human health to the health

of the watershed. Ecosystems, social systems, and human health/wellbeing are the three vertices forming the triangular base of the prism, and the watershed represents the peak of the prism (Parkes et al. 2010). The researchers conclude that the integral inclusion of these determinants, described as an ecohealth approach, contribute to building social-ecological resilience and advance in communicating the logic of integrated watershed governance (Parkes et al. 2010).

Indigenous integrated watershed governance

One aspect of these integrated water resources management approaches transfers water management responsibilities from centralized governments to a number of important stakeholders, including indigenous communities (Durette and Barcham 2009). Indigenous water governance examples exist globally, with cases involving peasant irrigation with Bolivia's Campesino population, Aboriginal water rights and collaborative governance Australia, and the integration of First Nations, Metis and Inuit environmental movements in federal regulation in Canada (Ramin 2004; Perreault 2005; Durette and Barcham 2009).

New Zealand, of particular interest to this study, has several examples of indigenous integrated water management. The Montueka Integrated Catchment Management Programme is an example that supported multi-disciplinary, multi-stakeholder research to provide information to improve the management of land, freshwater, and near-coastal environments in catchments with multiple, interacting, and potentially conflicting land uses (Landcare Research 2013). Another case includes tribe Ngāti Hori (*iwi* that reside in the Hawkes Bay region) who were deeply involved in the

revival of the Karamu Stream, an ancestral waterway that was degrading rapidly. The *iwi* obtained a small grant and formed a committee and water management plan, using at first only indigenous knowledge and participation although eventually branched out to the wider community to ensure the plan was a meaningful document for all stakeholders of the water body (Durette and Barcham 2009).

Māori communities are clearly engaged in water and land management issues, and are increasingly apart of the co-management and watershed governance decision-making processes. Of most recent legislative significance, the Waikato-Tainu Raupatu Claims Settlement Act 2010 established the Waikato River Authority which set the primary direction for the management of the Waikato River, the longest river in New Zealand. The authority is a single co-governance comprised of 10 appointed members, half of those being iwi, and the other half appointed by the Crown (Pikia 2011). This example of co-governance is one of the first in New Zealand where the vision and strategies of integrated watershed management are developed by both iwi and governmental agencies and approved by local authorities (Environmental Defense Society 2013).

A New Zealand Case Study

Approaches in integrated natural resources management strive to improve the knowledge of holistic system dynamics, rather than meticulous understanding of its discrete parts. This research contributes to this body of literature through an evaluative and descriptive case study of the governance structure in the Kaipara Harbour system in New Zealand. The Kaipara Harbour provides resources for a number of growing

industries such as agriculture, fisheries, aquaculture, tourism and renewable energy, presenting a classic example of common-pool resources. A wide array of environmental, social, cultural, and political issues pose threats to the ecosystems of the Kaipara Harbour, including: sedimentation, one of the world's largest approved tidal energy projects, divergence amongst governing councils, opposition from indigenous Māori tribes regarding land use and resource management, and the intensification of agriculture, to name a few.

Presently there is no comprehensive management plan for the Kaipara Harbour. The competing demands on the resources of the Kaipara Harbour necessitate prioritizing the management of vulnerable habitats and areas experiencing adverse environmental impacts. This has been challenging to accomplish given the multijurisdictional governance the of body of water, with regulating and political authority held at a number of scales varying from district and regional councils rules, national regulations, to local Māori customary rights. This fragmentation of power and financial stability, alongside with political, economic and cultural divergence has led to the inconsistent management of the resources in the Kaipara Harbour region and the urgency to remedy this is apparent with the deteriorating water quality and increasing habitat loss.

This SES case study will explore the institutional arrangements of the Kaipara Harbour under two policy regimes and assess how the system has adapted after a significant policy change. One at the time the Resource Management Act (RMA) was passed on October 1, 1991, and the other in it's the present day configuration in October of 2013. The intention of this comparison is to determine how the governance network

has changed over time in terms of actors, resource flows, action arenas and adaptive governance; and if these changes influence management in the system. The introduction of the RMA is a significant environmental milestone for the country of New Zealand with efforts of integrated and decentralized management. The analyses of the governance networks are before and after the influence of this important policy, investigating the success or failure of effectively employing integrated management by guidance of the RMA in the Kaipara network and determining if the system has experienced institutionally alterations and if so, how it has adapted to those changes over the course of the past few decades.

In particular, the objective of this research is to identify the important decision-making arenas of the Kaipara Harbour governance network through the examination of the network configuration, the resource flows exchanged, and its adaptive capacity. This study draws on the seminal, multilevel-diagnostic approaches and concepts reflected in the *Institutional Analysis and Development Framework, Governance Network Analysis;* and *Adaptive Governance of SES*. The purpose of this mixed-methodological approach is to recognize the role of individual actors in the Kaipara Harbour governance network, understand their relationships with one another, and identify how their configurations serve the adaptive governance capacity of the system.

The remainder of this paper is organized as follows. First, the data collection and methodologies supporting the case study are described. Through the analytical approaches an overview of the study area and background of the competing resource users will be explained. Next, we describe the governance networks of the Kaipara

Harbour in two time periods. The first of two in 1991, prior to the passing of the influential Resource Management Act, and the second being in the present in 2013 to examine organizational and management alterations as a result of the policy changes. To illustrate these variations, systems network visuals will be presented during each era and compared in the discussion section. Finally, we review the findings in the context of our analysis methodologies, highlighting the challenges that have emerged in the governance network of the Kaipara Harbour.

METHODOLOGY

This study integrates a mixed-methodological approach. We use three different analytical methodologies in a case study approach to improve the understanding of institutional arrangements in the social-ecological system of the Kaipara Harbour, these approaches are: 1) Governance network analysis, 2) Institutional Analysis and Development Framework and, 3) Adaptive Governance.

An exploratory and descriptive single-case study design is employed to evaluate the contextual conditions unique to the SES of the Kaipara Harbour (Yin 2003). Twenty-five semi-structured interviews were conducted with stakeholders in the Kaipara Harbour network to determine the institutional structure of each actor and their perspectives on the current management of the region's resources. Interviewees were selected based on either: their use of resources in the Kaipara (e.g. fisheries, tidal energy, farming), their role in the management of resources in the harbour (e.g. councils, conservation groups, scientists), or their involvement in resource management issues in the region (e.g. Māori

groups, non-governmental organizations). A detailed list of the interviewees and their affiliations can be found in the dissertation Appendix (pp. 208).

Five different participant groups were identified: governmental agencies, the nongovernmental groups, private practitioners, scientific researchers, and Māori tribes (Table 3-1). *National* refers to the countrywide or federal level actors, *regional* indicates those organizations focusing on the Kaipara Harbour region including state or public sectors by New Zealand definition, and *local* actors fall either exclusively under the Auckland Council or Northland Regional Council jurisdictions, including the smaller districts within.

Table 3-1. Total number of participants in each group and their jurisdictions

Participant Groups	National	Regional	Local	Interviews
Government	1	1	8	10
Non-governmental	1	1		2
Private	2	1	2	5
Scientific	4			4
Indigenous	1	3		4
Totals	9	6	10	25

Source documentation analysis of the organizational actors, regional and district plans, gap analysis reports, websites, informational pamphlets, press releases and relevant policies supplement the interview data. The construction of the Kaipara Harbour institutional case study utilizes methodologies from the Governance Network Analysis (Koliba et al. 2010) and the IAD framework (Ostrom et al. 1994) to organize and investigate the data categories, and the analysis is rendered through the tenets of Adaptive Governance.

Governance Network Analysis

The governance network analysis of the Kaipara Harbour is investigated by methods presented in Koliba et al. 2010. This adaptable model of analysis has been used in a wide range of applications including emergency management post-hurricane Katrina (Koliba et al. 2011), energy and natural resources management (Poocharoen and Sovacool 2012), public administration and policy studies (Koliba et al. 2011), and the business and urban governance literature (Morçöl et al. 2013), to name a few. The framework explores governance network functions through both macro-level and micro-level scales. A few of the micro-level components of the framework included in this methodology are characteristics (social scale, sector, geographic scale) of network actors, or nodes, and the relationships with other actors in the system (Koliba et al. 2010).

The network can further be described by the type of capital resources exchanged within those ties, the strength or formality of the tie (the relationship between actors) and the type of administrative authority the actor configuration represents (Koliba et al. 2010). The micro-level components selected for the context and applicability of the New Zealand case study (Table 3-2) will detail the actors and their attributes in the governance network as needed by the IAD framework.

Table 3-2. Micro-level characteristics selected for Kaipara Harbour governance analysis, adapted from (Brondizio et al. 2009; Koliba et al. 2010)

Network Characteristic	Types	Definition
Geographic Scale	National	Countrywide or federal level actors
	Regional	Multijurisdictional actors regional and multistate scale
	Local	Specific jurisdictional association, similar to statewide actors in the U.S. context
Social Sector	Public	Formal governmental institutions
	Private	Profit driven institutions
	Non-Governmental (NGO)	Mission driven organizations typically founded to serve social or public needs
	Indigenous	Māori led organizations serving Māori needs
Resources Exchanged	Financial	Any medium or mechanism that represents wealth, typically money available for the production or purchasing of goods and services
	Knowledge	The information, intellectual property and experience that facilitate the transfer of knowledge
	Cultural	The knowledge of social norms, customs, traditions and other cultural characteristics that ascribe to an organizational setting
	Political	The accumulation and use of influence and power built on the premise of representation, and representing other's interests

The macro-level characteristics examined (Table 3-3) are the formality of the relationships between nodes, the social power of the authorities represented, and the governance network configurations (Koliba et al. 2010). Macro-level systems visualizations will be rendered from the analysis described.

Table 3-3. Macro-level characteristics selected for Kaipara Harbour governance analysis, adapted from (Imperial 1999; Koliba et al. 2010)

Network Characteristic	Type	Definition
Formality or Strength	Strong/Formal	Frequent contact, abundant resources exchanged/official goals and rules to operate
	Weak/Informal	Infrequent contact, few resources exchanged/ varying coordination and limited resources
Social Power	Command & Control	Vertical ties, authority *over*, federal control, hierarchical structure
	Compromise	Diagonal ties, authority *negotiated*, mixed structure
	Collaboration	Horizontal ties, authority *with*, localized, cooperative structure
	Competition	No ties, authority *against*, market structure
Governance Configuration	Shared	Balance of authority and strength of ties, high trust
	Lead Organization	Authority concentrated in lead organization, low trust
	Network Administrative organization	Coordinating body administers activities of network, established for exclusive purpose of network governance, moderate trust

Institutional Analysis and Development Framework

Drawing from Elinor Ostrom's IAD framework (Figure 3-1) we then begin to populate data components into our analysis to ascertain contextual conditions in the Kaipara Harbour case study. We dissect the investigation into the components that ultimately influence the patterns of interactions and management outcomes in the Kaipara Harbour network. The three main inputs for this framework are the exogenous variables: the attributes of the physical world, attributes of the community and the rules-in-use. These clustered variables in turn influence the action arenas which sequentially result in the patterns of interactions and outcomes for the system.

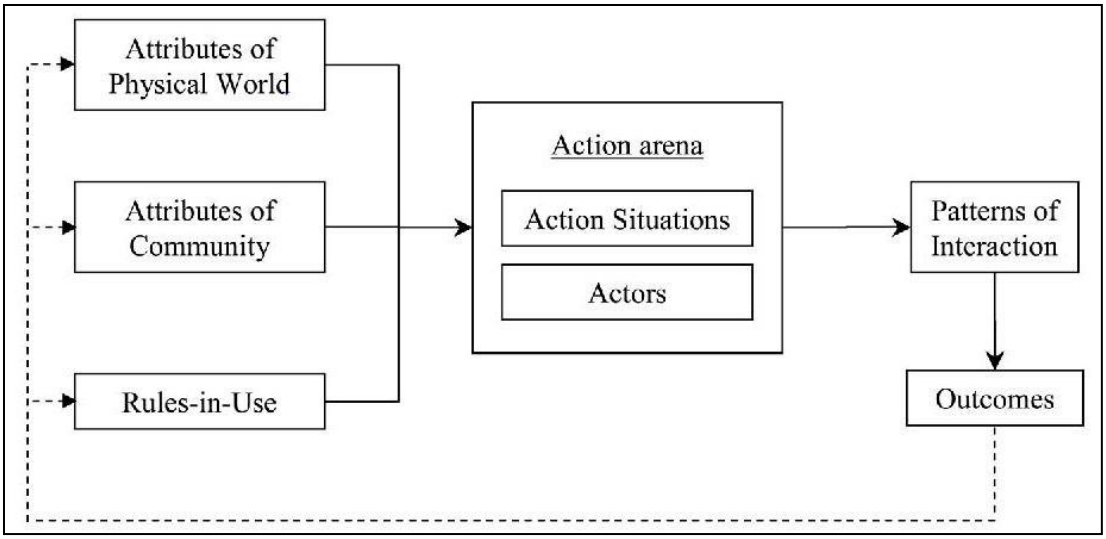

Figure 3-1. Conceptual Framework of the IAD Framework (Ostrom et al. 1994; Ostrom 2005)

Physical attributes

The Kaipara Harbour is situated on west coast of Northland on the North Island in New Zealand (Figure 3-2). Approximately 80 km north of Auckland and open to the Tasman Sea, it is the largest enclosed harbour on the Southern Hemisphere and one of the largest estuaries in the world. The harbour is broad and mostly shallow, formed by a system of drowned river valleys covering a total of 947 km^2, it has more than 900 km of shoreline and spans over 60 km from north to south (Hay and Grant 2003; Haggitt et al. 2008). The Kaipara has an extensive drainage catchment, feeding a number of main river systems such as the Wairoa, Arapaoa, Otamatea, Oruawharo, Tauhoa, Kaipara and Hoteo Rivers. The entry of large rivers and hundreds of streams contributes to the vast watershed area containing close to 640 km^2 of land (Wilson et al. 2006; Makey 2013). The northern and southern portions of the harbour are different. The southern portion features extensive intertidal mud flats, sand flats, and mangrove stands; the north has

much deeper river and tidal tributaries (National Institute of Water and Atmospheric Research 2013).

Figure 3-2. The Kaipara Harbour catchment (Makey 2013)

The harbour entrance is only seven kilometers wide, although it contains dangerous bars which historically confirmed the burial ground of numbers of ships in the early years of trade and settlement around the New Zealand coast. The Kaipara was an

important waterway for trade, war parties, communication, and travel to Helensville for Māori Land Court hearings. The rich stands of the native *kauri* tree lured many European traders and settlers until the timber stocks plummeted in the 1890's with the extensive felling of these trees. The harbour was then primarily used to transport logs, creating competition amongst steamboat companies (Helensville & District Historical Society Inc. 2011).

Presently, the Kaipara region maintains geographical and natural advantages such as highly productive and fertile soils, unique marine and terrestrial ecosystems, aesthetic natural beauty, and the close proximity to the largest market in New Zealand, Auckland (Wilson et al. 2006). These traits make the Kaipara Harbour of high value for a number of industries and stakeholders dependent on the resources of the harbour and its surrounding catchment. Several scientific documents report a decline in the harbour ecosystem including habitat loss, decline in fisheries and shellfisheries and the accumulation of sediment (Haggitt et al. 2008; Makey 2010; National Institute of Water and Atmospheric Research 2013). A few of the significant land uses and their tradeoffs are briefly summarized as follows.

Agriculture

Land use in the Kaipara Harbour catchment is dominated by agriculture. Beef and dairy farming covers the primary pastoral land use. The Northland region provides nearly 20% of New Zealand's beef output, dairy farming in the region supplies 9.5% of New Zealand's entire dairy herd, and the catchment is also scattered with clusters of specialized agriculture such as *kumara* (sweet potatoes) and capsicum (Wilson et al.

2006; Haggitt et al. 2008; Makey 2010; Makey 2013). The agricultural sector provides employment and economic revenue for the region, though land use intensification and agricultural runoff is threatening the health of the freshwater and coastal waterways.

Fisheries

The Kaipara Harbour has always been a *marae* (sacred place) for customary and recreational fishing, while commercial fishing has been widespread in the region since European settlement. The Kaipara Harbour is the nursery grounds to nearly all of snapper on the west coast of the North Island, and provides habitat for a number of other fin and shellfish stocks (Yardley and Yardley 2011). Concerns with the state of the harbour's fisheries have been increasing and include the depletion of fish and shellfish stocks, sedimentation, poor water quality, resource use and development pressure, and the lack of integrated fisheries management (The New Zealand Herald 2011).

Tidal Energy

Crest Energy Limited has been granted consent for a marine tidal turbine power station at the mouth of the Kaipara Harbour containing 200 submerged tidal turbines (Crest Energy Limited 2013). There is considerable opposition to this project from the rest of the Kaipara network ranging from skepticism of the turbines infrastructure, adverse impacts to marine ecosystems, and the instability of the turbulent seabed.

Tourism

The Kaipara Harbour encompasses a diverse set of landscapes that draws in a variety of tourists. From the Kaipara flats to the fertile farmland, up the windy Kaipara hills down to the bottom of the saltmarsh wetlands and along the rugged coast lined with beautiful beaches, the Kaipara region is one of international significance (Department of

Conservation 2013). It contains a large migratory bird habitat, housing many threatened and endangered species, and is one of the key distribution ranges for the one of the Maui Dolphin, one of the world's rarest. Although there are many tourist attractions in the area, organized tourism infrastructure is lacking.

Forestry

Forestry is another significant land use in the Kaipara Harbour region. Much of the native forest cleared by the timber industry has now been replaced by agricultural and urban areas. This has led to increased soil erosion and consequently amplified sedimentation in the harbour. As a result shellfish abundance has dropped and finfish populations such as mullet, snapper, and school shark are quickly diminishing (Makey 2010).

Culture

The indigenous Māori populations of New Zealand have settlements and *marae* (communal, sacred place) distributed around the harbour. The *iwi* (tribe) *Ngāti Whatua* have held *mana* (rights) over both land and water *taonga (*treasured possessions) through numerous ancestral generations in Kaipara Harbour and catchment region (Figure 3-3). Since European settlement in the 1840s Māori endured impacts of colonization including the loss of their ancestral land, the destruction and depletion of their natural world through western development, and loss of governance and management of resources they once used (Makey 2010). The cultural conflict occurring in the Kaipara region is highly controversial amongst *iwi* and *Pākehā* (New Zealander of European descent), as Māori and the British Crown have had long term disagreements regarding Māori customary rights for land and resources (Harmsworth 2005).

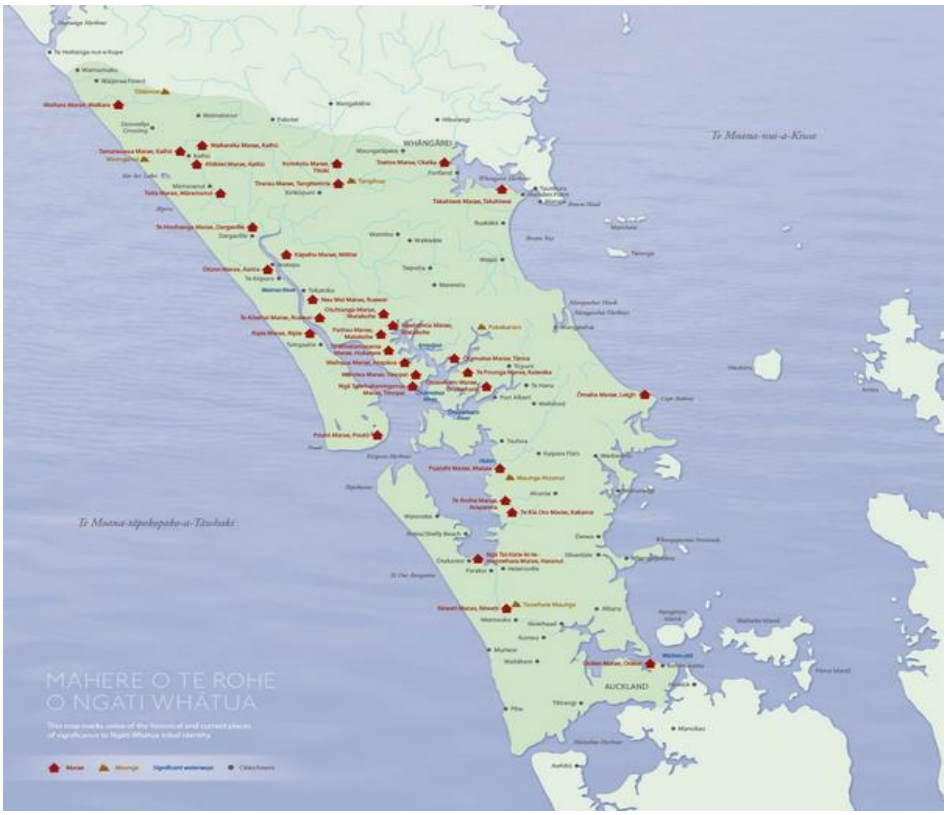

Figure 3-3. The tribal settlements and marae of Ngāti Whātua (Ngati Whatua 2013)

Attributes of the community

The attributes of the greater New Zealand community (Figure 3-4) reveals over 2/3's of New Zealand's 4.43 million in population is of European descent, while Māori are the second most predominant ethnicity comprising approximately 15% of the total population and mostly residing in the larger metropolitan centers (Statistics New Zealand 2013). In the Kaipara Harbour catchment, at the time of the 2006 census approximately 48% of the Ngāti Whatua descendants lived in the Auckland region versus the 22.6% in the Northland region; and the *iwi/hapū* comprised between 14% - 25% of the total population (Makey 2010).

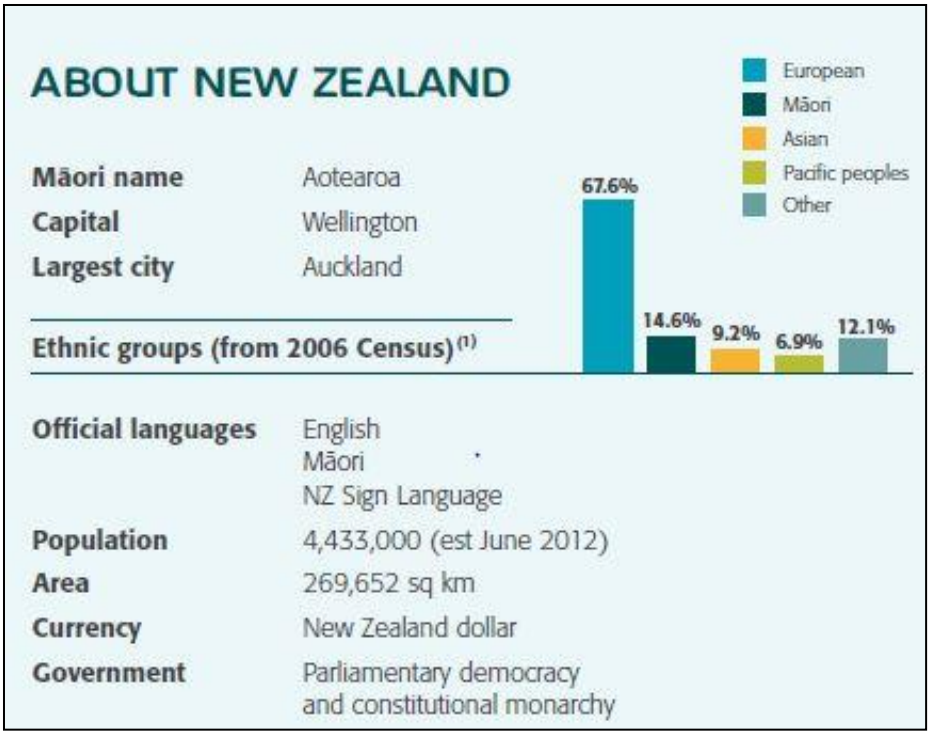

Figure 3-4. Community attributes and demographic information about New Zealand (Statistics New Zealand 2013)

There is tension between the European and Māori populations, largely as a result of historical natural resource guarantees that have not been upheld. However, in recent years the government has reached agreements with many tribes, this will be described in more detail in the following section. With over half a million Māori in the country, and close to 30,000 in the Kaipara catchment, there has been a major revival of the Māori customary rights, as well as language, art, and culture in the past few decades (Makey 2010; Statistics New Zealand 2013). The Auckland Council and Northland Regional Council are specifically under increasing public and political pressure to improve management of the Kaipara catchment and harbour, balancing the tradeoffs amongst the competing resource users (National Institute of Water and Atmospheric Research 2013)

Rules-in-use

The concept of rules is quite diverse and can range from everyday rules to moral principles in society. This research study will refer to rules-in-use as it applies to natural resources management in the Kaipara Harbour, focusing on the historical Treaty of Waitangi and the more recent Resource Management Act 1991. These two pieces of national legislation are the overarching rules[2] to which regional jurisdictions, national policies, and district and regional must adhere.

The Treaty of Waitangi

The Treaty of Waitangi, the founding document of European Settlement in New Zealand signed in 1840, is a broad statement of the principles on which the British and Māori tribes made a political compact (in both languages) to found a nation state and build government in New Zealand. The treaty gave Māori the right to keep their lands, forests, fisheries and sacred establishments although they would hand sovereignty and governorship to the Crown while also only being able to sell land to the Crown (New Zealand History Online 2013). Three components of the treaty translations are of regular debate between the English and Māori versions of the Treaty: 1) Māori surrender the sovereignty of New Zealand to Britain; 2) Māori give the Crown a chance to buy lands they wish to sell, in return are guaranteed rights of ownership of their lands, forests; and fisheries and, 3) Māori are given the rights and privileges of British subjects (King 2003).

Over the past few decades, legal and political opportunities for Māori to seek redress for breaches by the Crown have increased through the treaty claims process.

[2]Several of the finer scale rules-in-use operating on the Kaipara Catchment are described in the Māori values and policy research by Kanwar et al, 2014.

Claims are complaints that the Crown has violated the Treaty of Waitangi by particular actions, inactions, laws, or policies and as a result Māori have suffered prejudice (Waitangi Tribunal 2013). This process represents efforts in returning sacred land and water to the Māori people, and other means of seeking amends for Māori involve cogovernance and management powers in land and water decision-making. The Land and Water Forum is one example of a group that *iwi* and other primary industry representatives, and environmental and recreational NGOs were a part of as a stakeholder-led, collaborative process to provide recommendations on the of governance and management of freshwater resources in New Zealand (Land and Water Forum 2013; Ministry for the Environment 2013).

Resource Management Act (RMA)

The RMA passed in 1991 is the principal legislation for environmental and resource management in New Zealand. The RMA's approach to regulate access to natural and physical resources such as land, air and water is firmly rooted in the concepts of sustainable and integrated resources management (Gunningham 2008; Environmental Defense Society 2011). The national government provides the guidance, overarching goals, and policies for the nation while devolving decision-making to the district and regional councils.

The adoption of the RMA is significant for several reasons. First, the integrated ecosystem approach to managing New Zealand's resources consolidated or replaced many resource specific pieces of legislation (69 Acts were amended and repealed, 19 regulations were revoked) that were fragmented across agencies and governmental

sectors (Fisher 1991). Additionally, the RMA was the first legislative bill to incorporate the concept of sustainability in New Zealand. This intention of sustainability was decidedly placed at the heart of a regulatory framework that decentralized decision-making to lower tiers of government, a new framework for the entire country. The RMA requires almost all developments to avoid, mitigate or remedy adverse environmental effects by mandating that consents for use of water, air, soil and land resources are obtained from the relevant regional, city or district councils, with provision for public participation in the decision-making process (Pawson 2010). The RMA has been seen as controversial by several sectors who view it has a hindrance to development, inefficient to economic growth, expensive, and an unfair waste of time given the added level of bureaucracy with the consent process (Harmsworth 2005).

Action arenas

Action arenas are stable subassemblies of a larger network and are composed of actors and action situations, or the social space where actors with diverse preferences establish their patterns of interaction (Ostrom 2005). Action arenas are defined by the context of the network (Figure 3-1, pp. 66), which, as previous described, includes the biophysical attribute of the resources, and the attributes of the community of resource users, as well as the governance configuration and rules-in-use (Ostrom 2005; Ratner D. et al. 2013). Using these definitions and methods extracted from the IAD, *the patterns and efficacy of stakeholder interactions* in two different political eras of the Kaipara Harbour can be evaluated, paying particular attention to shifts in the actors and the actions situations of the network. For the scope of this study the action arenas in the Kaipara Harbour system will refer to the decision-making actors who influence resource

use in the harbour. The *actors* includes the organizational network actors and organizations that have a significant role in the resource management of Kaipara Harbour catchment, and the *action situation* will include the resources they contribute to the system. The attributes of the actors will be described using the micro-level characteristics outlined in the governance network analysis, while the action situations, and in particular the patterns of interactions they yield, will be investigated by the macro-level characteristics identified (Table 3-3).

RESULTS: THE KAIPARA HARBOUR GOVERNANCE NETWORK, 1991

The first governance network examined is the Kaipara Harbour system at the time the RMA was passed and became law on October 1, 1991. The comprehensive list of actors and their attributes during this era are detailed below (Table 3-4) and their abbreviations will be used for the remaining of the paper.

Table 3-4**.** List of actors in the Kaipara Harbour governance network at the time the RMA was passed, October 1 1991

Actor	Abbreviation	Scale	Sector	Resources Contributed
Department of Scientific and Industrial Research	DSIR	National	Public	K
Ministry of Agriculture and Fisheries	MAF	National	Public	K, F, P
Ministry of the Environment	MfE	National	Public	K, F, P
Department of Conservation	DoC	Regional	Public	K, P
Forest and Bird	F&B	Regional	NGO	K, P
Ngāti Whātua	NW	Regional	Indigen-ous	K, C
Northland Regional Council	NRC	Local	Public	K, F
Auckland Regional Council	ARC	Local	Public	K, F
Kaipara District Council	KDC	Local	Public	K, F
Rodney District Council	RDC	Local	Public	K, F

Resource Flows: K: Knowledge, F: Financial, P: Political, C: Cultural

The governance network of the Kaipara Harbour on October 1, 1991 is illustrated below (Figure 3-5). During this time the New Zealand government was generally configured to a top down, command and control arrangement. The policy tools were set at the national level and enforced throughout the regulatory system. The MAF and MfE provided the overarching management protocol at the national level of the

system and enforced this down through the regulatory public sector through financial, knowledge and political capital flows.

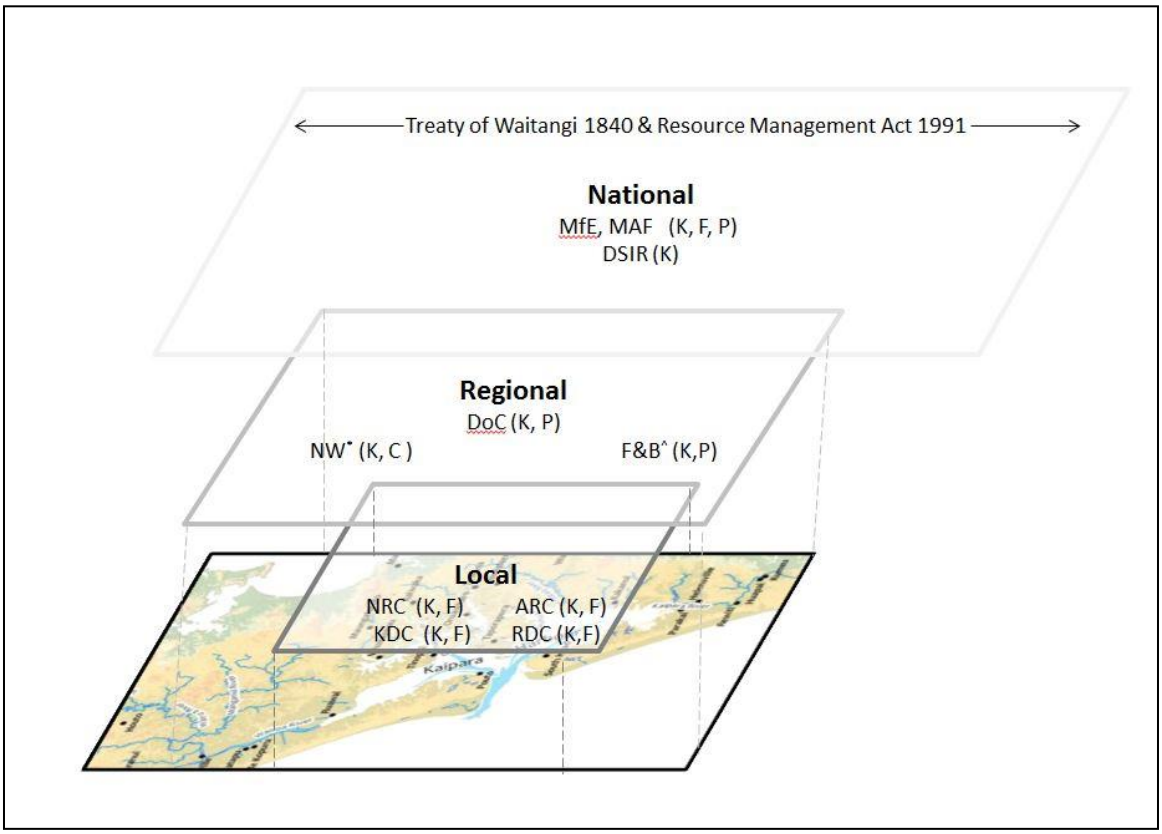

Figure 3-5. The Kaipara Harbour governance network and resource flows in 1991. (K: Knowledge , P: Political, C: Cultural, F: Financial. Actors denoted with * are Indigenous, with ^ are NGOs, and with # are Private; all others are public sector governmental entities.

The DSIR coordinated research proposals and conducted scientific research for the country by directing efforts in private industries and research facilities.

The DoC by New Zealand definition is a state or public sector entity whose mission is to protect New Zealand's natural and historic heritage. The DoC falls under

the national actors though jurisdictionally operates on a regional basis with divisions of authority dispersed amongst the defined regional areas of New Zealand. The final level of the regulatory chain are the local governments and include the ARC and RDC who govern the southern portion of the Kaipara Harbour, and NRC and the KDC who oversee the northern portion of the region. The regional councils in New Zealand operate similar to state governments in the United States, while the district councils are equivalent to city or town municipalities.

Outside of the top-down, public sector governments there are two more groups of actors included in this governance regime, NGOs and Indigenous groups. The NGO sector for the Kaipara region in 1991 only included F&B. The society was founded in 1923 and has over 50 branches all over New Zealand that are engaged in conservation and advocacy projects on a community, regional, and national basis (Forest and Bird 2013). The Indigenous sector included the group NW, the *iwi* that covers the entire Kaipara Region (Figure 3-3, pp. 71). NW is comprised of 4 *hapū* (subtribes) which are: Te Uri O Hau, Te Roroa, Te Taoū, and Ngāti Whātua O Ōrākei. Te Uri O Hau and Te Roroa are the two most politically active hapū as far as natural resource management issues are concerned in the northern and southern portions of the harbour, respectively. Historically, the waterways of the Kaipara Harbour offered Māori populations with resources and a ready means of moving between the sacred settlements scattered throughout the region (Figure 3-3, pp. 71).

In summary, the governmental sectors from the national level down to the local levels exclusively contain the financial capital of the entire network while the cultural

capital is exclusively maintained in the Indigenous group. Political influence resides at the national level with policy and top-down planning controls, and also with the NGO sector through an environmental advocacy lens. The knowledge resource flows are contributed by every actor in the system, validating their inclusion in the governance network analysis. Through these resource exchanges we conclude that the national, regional, and local authorities in this governance regime hold the decision-making power; while the NGO and Indigenous actors provide supplementary resources that influence the network.

THE KAIPARA HARBOUR GOVERNANCE NETWORK: 2013

The other governance network examined is the Kaipara Harbour system during its present day configuration in October of 2013, after over 20 years of the RMA implementation. The comprehensive list of actors and their attributes during this era are detailed in Table 3-5 and their abbreviations will be used for the remaining of the paper. The governance network of the Kaipara Harbour in 2013 (Figure 3-6) has experienced a number of changes and additions since 1991. Undoubtedly, the conventional top-down arrangement has been modified.

Table 3-5. List of actors in the Kaipara Harbour governance network in the present day, October 2013. Note: Those actors or sectors denoted with * are new to the network since the 1991 analysis

Actor	Abbreviat-ion	Scale	Sector	Resources Contributed
Ministry of Primary Industries*	MPI	National	Public	K, F, P
Ministry of the Environment	MfE	National	Public	K, F, P
Department of Conservation	DoC	Regional	Public	K, P
Environmental Protection Authority*	EPA	National	Public	K, P
National Institute of Water and Atmospheric Research*	NIWA	National	Private: CRI*	K
Landcare Research*	LCR	National	Private: CRI*	K
Crest Energy*	CE	National	Private	K, F
Waitangi Tribunal*	WT	National	Indigen-ous	P, C
Forest and Bird	F&B	Regional	NGO	K, P
Kaipara Harbour Sustainable Fisheries Management Group*	KHSFMG	Regional	NGO	K, P, C
Integrated Kaipara Harbour Management Group*	IKHMG	Regional	NGO	K, P, C
Ngāti Whātua	NW	Regional	Indigen-ous	K, C
Te Ure o Hau Settlement* Trust	TUoHST	Local	Indigen-ous	C, P
Nga Rima O Kaipara Trust*	NRoKT	Local	Indigen-ous	C, P
Northland Regional Council	NRC	Local	Public	K, F
Auckland Council*	AC	Local	Public	K, F
Kaipara District Council	KDC	Local	Public	K

Resource Flows: K: Knowledge, F: Financial, P: Political, C: Cultural

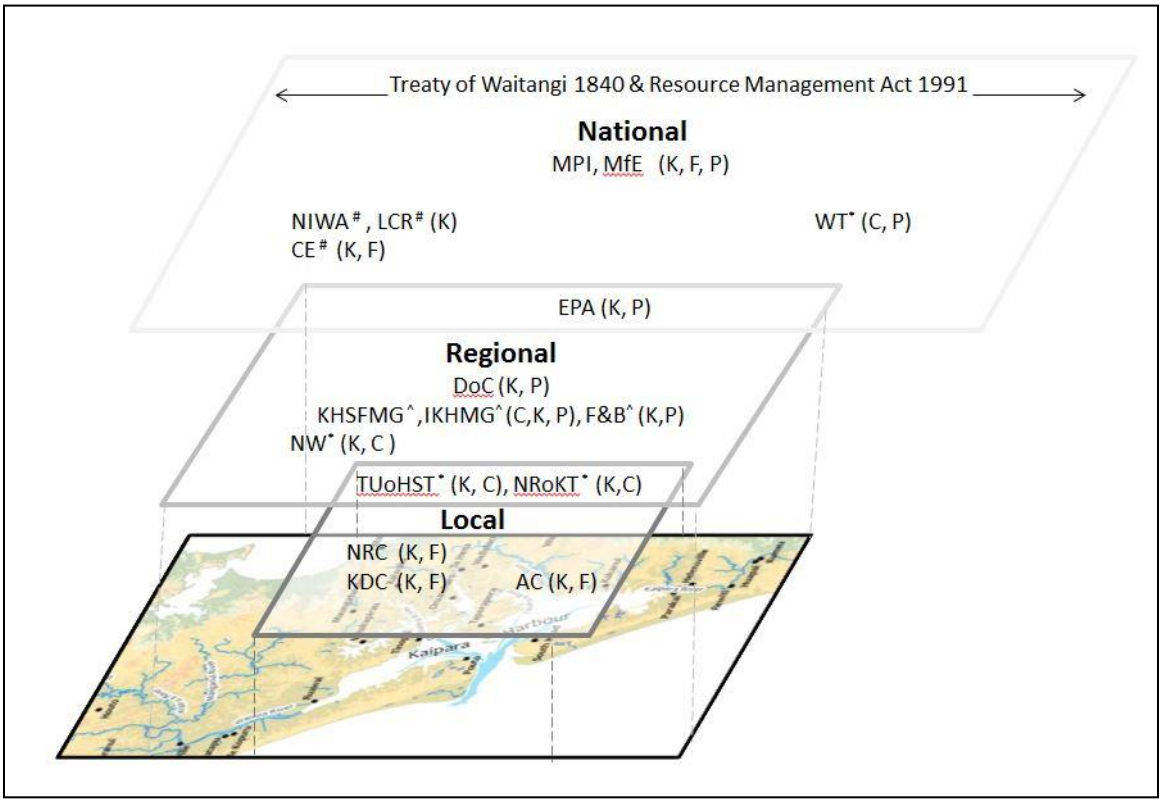

Figure 3-6. Kaipara Harbour governance network and resource flows in 2013. (K: Knowledge , P: Political, C: Cultural, F: Financial. Actors denoted with * are Indigenous, with ^ are NGOs, and with # are Private; all others are public sector governmental entities.

Starting at the national level, the most substantial change is that the DSIR as a government entity dissolved in 1992. The DSIR along with various other parts of government departments (e.g., Department of Works) was replaced by CRI's, or privatized Crown entities charged to conduct scientific research for the country of New Zealand with an expectation that the CRIs had to provide a return on investment to government. This resulted in the addition of a new Private sector node, including two large organizations who conduct research projects on the Kaipara Harbour, and hence added knowledge capital to the system, and includes NIWA and LRC. Both CRIs work

at the national level as well as at local and regional levels in a variety of capacities related to the environment. The other large difference at the national level includes the MPI actor, who consolidated a history of various governmental ministries including: MAF in 1991, which became the Ministry of Fisheries, and merged with the Ministry of Agriculture and Forestry before MPI was formed in 2012.

Outside of the formation of the CRI's another addition to the Private sector includes CE. As mentioned earlier, CE has invested capital towards a large renewable energy project in the basin, and was granted consent for a marine tidal turbine power station at the mouth of the Kaipara Harbour in 2008. The project involves 200 submerged tidal turbines with a maximum generating capacity of around 200 megawatt (Crest Energy Limited 2013). From a renewable energy point of view, the Kaipara Harbour has many factors that are appealing for the project: up to 8,000 million cubic meters of water pass in and out of the harbour daily, the harbour is rarely used for commercial shipping anymore due to the treacherous tides and unstable sand bars at its mouth, and the project continues New Zealand's tradition of harnessing energy from renewable sources (Crest Energy Limited 2013). On the other hand, there is considerable opposition to this project from NGOs, Māori, local farmers and fisherman as well as from CRIs, politicians and regional councils. The objections to the project range from skepticism of the turbines infrastructure, adverse impacts on marine ecosystems, instability of the turbulent seabed, and impacts on local communities. The project was original impacting both NRC and AC jurisdictions; however, Crest Energy changed the consent application and project execution to be within only the NRC regime (Hopkins

2011). While the NRC approved the 200 turbines to be built in stages in the near future, there were substantial appeals to the project and monitoring conditions are required under the consent approval.

Moving down to the regulatory actors at the regional level of government, it should be noted that along with the DoC, who was also present in the 1991 regime, a new national actor affects this group. The EPA was introduced into the New Zealand governance system in 2011 and its primary responsibilities involve taking over the consent (or permit) decision-making processes for those activities of national importance, relinquishing that responsibility from regional councils and expediting the time taken to grant or deny the consent. The EPA works between the national and local governments, assisting in the decision-making processes that straddle their jurisdictional extent with national scale projects.

Continuing to the local government, the 1991 visual illustrates that the Kaipara's resources were managed by RDC and ARC to the south, the KDC and NRC to the north. Since 2011, the southern portion of the Kaipara Harbour is now administered by the merged unitary authority the AC, combining the powers and functions of the existing regional council and the region's seven previous city and district councils, including the RDC. Often described as a "Super Council" or "Super City", AC is the largest council in Australasia, with a $3 billion annual budget, $29 billion of assets and staffing approximately 8,000 people (Orsman 2010). The AC has adopted a new model of local government designed to strengthen regional leadership while providing local and community democracy (Auckland Council 2011). The decision making responsibilities

are now divided between the governing body (elected mayor and 20 councilors), who focus on broader picture and region-wide strategic decision-making, and the 21 local boards, who represent the local communities and facilitate policymaking on local issues, activities and facilities (Auckland Council 2011). Conversely, NRC on the northern end of the harbour, is made up of only 8 elected councilors, one appointed chief executive officer and 140 supporting staff, and reported a $7.8 million deficit for the 2010 fiscal year (Northland Regional Council 2010). NRC and the KDC are not as financially sound as the AC and struggle to fund critical staff roles and environmental protection projects, including project in the Kaipara Harbour.

Finally, the Indigenous group of actors and the NGO sector experienced considerable changes since the 1991 governance network. In the 1991 network, the Indigenous node contained the *iwi* of NW, based predominantly on the geographic extent of the Māori tribes in the Kaipara region (Figure 3- 3). By 2013, three more actors in this group emerged: The WT, TUoHST and the NRoK. Since the Treaty of Waitangi has limited legal standing in itself, the primary means of registering settlement claims is through the WT, who then offers the national government recommendations in how to settle the individual claims. The two trusts were established from Treaty of Waitangi settlement and grievance claims.

It should also be noted that in this network Māori people gained voting and representation rights with passage of the Local Government Act of 2002[3] (LGA). The

[3] It should be noted that there are several other national policies, or National Policy Statements (NPS) that have recently been issued in this network to better manage land and water resources since the passing of the RMA. Local plans and policies must adhere to these regulations and the current NPS guide regional and local councils on electricity, freshwater,

purpose of the act is to facilitate a democratic decision-making practice, by and on behalf, of localized communities. Structurally, the LGA divides New Zealand into 11 regional authorities and five territorial (or unitary) authorities, which are further separated into 73 local districts or territorial authorities, each with an elected Mayor and elected Councilors (New Zealand Legislation 2011). The LGA states that after each triennial election, local authorities must issue a local governance statement describing the representation of their jurisdictional arrangements, including the option of establishing Māori wards or constituencies. The idea is to foster the development of Māori capacity in governance, and to provide opportunities for Māori to contribute to the local decision-making processes (New Zealand Legislation 2011). The passing of LGA gave indigenous populations of New Zealand with more political power and social influence than they had in the 1991 network.

The Māori communities in the Kaipara region have a valuable role in the present day NGO. However, other groups have become important as well. The KHSFMG is a collective research group composed of local, recreational, and cultural fisheries promoting a collaborative stakeholder approach to fisheries management. The IKHMG is an *iwi* led organization formed by NW in 2005 and is an initiative spearheaded by TUoST to support the management of the harbour and its catchment by providing coordinated leadership with the some of the key resource management agencies (Makey 2011). The goals of the group were initially discussed at a *hui* (public forum) with *iwi*

coastal management, and renewables (Ministry of the Environment 2013). The policy research conducted by Kanwar, et al explores the national level documents that influence the Kaipara Harbour in greater depth.

members, a variety of harbour stakeholders, and the LCR determined that the harbour is in environmental decline, they then created visions for "A healthy and productive Harbour", and identified the vehicle for achieving this vision is a Sustainable Kaipara Catchment Plan (Makey 2013).

The IKHMG works with common interests and does not aim to challenge the management processes led by the decision-making agencies holding statutory authority in the catchment. Rather, it explores the means by which all interests (public and private, cultural and social, commercial and recreational) can focus on a common vision (Makey 2013). Collaborative efforts with the AC and NRC have instigated a study called the 'Kaipara Harbour Scoping Study', the first step in effort towards compiling the data to underpin a comprehensive management plan of the harbour catchment. IKHMG is funded on a donation basis by all of the other actors in the network, less the Private sector MPI, DoC, NIWA, LCR, NRC, AC, KDC, NRoKT, TUoST, F&B, as well as others outside of the network including Auckland University and Whangarei District Council (Makey 2011). The collaborative role, the social connectivity, and the mission of the IKHMG situate this NGO in the center of the 2013 Kaipara Harbour governance network. It is the lack of financial capital and regulatory authority, on the other hand, which stations this group on the periphery as an informal actor.

In summary, the resource flows in the 2013 network reveal that once again, all actors contribute intellectual flows in the system. The monetary resources exchanged in this network still predominantly reside at the governmental level with the regional councils and their localized jurisdictional extent have the most direct financial influence

on the resources of the Kaipara Harbour. The addition of the Private sector with the CRIs and corporatized scientific research, and the private interest group CE through the renewable energy investments also contributes increased financial flows into the system. The cultural capital has strengthened immensely in the Indigenous group as a result of the local settlement groups in the catchment and the WT assisting with grievance claims at the national level. Similarly, the NGO sector has bolstered with the addition of the IKHMG and KHSFMG, overlapping with the Indigenous groups due to cultural connections embedded in the NGOs. This collaboration adds social and potentially decision-making leverage to these actors. This will be explored more in the following section.

DISCUSSION

The governance network of the Kaipara Harbour has fundamentally changed in the past few decades (Figure 3-7). The modifications of the network are a function of both macro-level changes that occurred to New Zealand's governance structure as a nation, as well as micro-level changes to the interorganizational structure of the Kaipara network. In summary, the major factors that triggered these adaptations and reforms in the 2013 network include, first, the reorganization of regulatory authorities at the national and local level. This specifically refers to the dissolution of DSIR and the aggregate ministry of MPI at the national scale, and ARC and RDC merging into the AC unitary

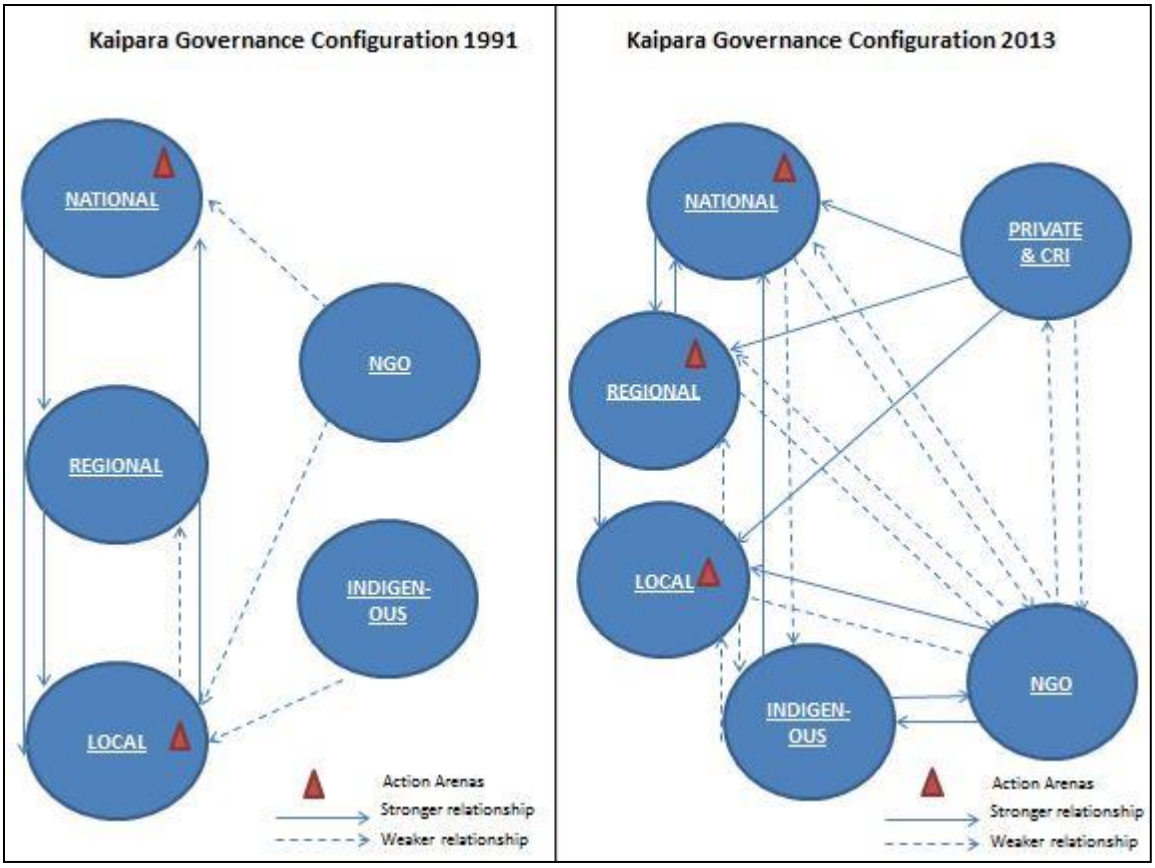

Figure 3-7. Comparison of the Kaipara Harbour Governance Network Configuration at the time the RMA was passed in 1991(right) and in its present day configuration in 2013 (left).

authority at the local scale. Second, a greater concentration of network accountability is at the regional scale of governance with the EPA acting as a consent liaison between national and local governments. Prior to the EPA, the DoC was the only other main actor in this node, with environmental preservation issues as its focus. The EPA adds regulatory weight by administering nationally significant infrastructure projects and regulating new organisms, chemicals and hazardous materials (Environmental Protection Authority 2013). This regional addition is likely a result of the RMAs effort to decentralize management in New Zealand. Next, the introduction of the Private sector in

the Kaipara Harbour network, including the CRI groups and CE, adds financial interest in the science and resources of the catchment. Finally, the amplified capacity of Māori representation in governance and the NGO sector strengthens relationships to the WT at the national level, increases collaborations with IKHMG, and enlarges political leverage in decision-making processes with regional councils.

Governance Network Structure

There were substantial changes in macro-level configurations between the 1991 and 2013 network (Figure 3-7). We can evaluate the characteristics of each configuration based on the methodologies selected (Table 3-3, pp. 65). The 1991 network displays the strongest relationships on the left-hand side of the network, or the regulatory governmental chain starting from the national government down to the localized. This top-down, command and control configuration exclusively reveals vertical lines, while the NGO and Indigenous groups display weaker and informal diagonal linkages, representing groups in the system that compromise or negotiate issues with the regulatory agencies.

The network configuration closely represents that of *a lead organization*, where the decision-making power is predominantly at the national and local levels, and the lead organizations are specifically the regional councils governing the northern (NRC) and southern (ARC) halves of the harbour. The other actors in the network exchanges capital flows with these regional councils, and the authority and power are most concentrated with them despite the overarching role of the national level actors. In lead organization networks, most major undertakings and decision-making are coordinated by a single

member acting as a principal actor, and in the case where they are within regulatory systems, such as the 1991 Kaipara network, concessions and compromises are often provided to the regulating entities (Koliba et al. 2010). This translates to a potential bias favoring the public sector and the regulatory authorities, offering less attention to the NGO and Indigenous nodes in the 1991 governance network.

The lead organization network had shifted to a new arrangement in the 2013 network. We see on the left-hand side of the 2013 network (Figure 3-7) that the top-down, regulatory chain from the national level down to the local level of government remained largely unchanged, with the exception of an added regional actor (EPA) liaison between the national and local regulatory entities on consent issues. The primary changes in this system stem from the growth of the Private and Indigenous groups, though predominantly from the connectivity and network linkages provided by the NGO sector. The strongest relationships are found from those with the most financial contributions, or Private and Public sectors; however the NGO group provides impressive influences in terms of negotiating (diagonal lines) and collaborative (horizontal lines) relationships.

This governance configuration is described as a *network administrative organization*, where a coordinating group administers the critical role and functions of the system, which in this case is the successful management of the Kaipara Harbour and its resources (Koliba et al. 2010). Within this new network it is the IKHMG that acts as this informal coordinating body that is informally connected to every actor in the network and exclusively exists to coordinate projects and management efforts in the Kaipara

Harbour catchment. The combination of resources flowing horizontally, vertically, and diagonally (Figure 3-7) respectively illustrate the collaborative, command and control, and negotiating relationships throughout the multiscalar network.

The changes from the 1991 and 2013 network stem from the influence of the RMA operating over the country. The RMA mandates for an integrated approach that includes centralized governmental roles in local decision-making process, and this is reflected in the role of the regional councils. Despite the fact that potential for collaborative and participatory processes in the current network is extremely high and is currently making progress in a cooperative direction, it is presently not successful in doing so. Leane Makey from the IKHMG contended "We need co-governance and effect based management for the Kaipara Harbour, and thus far the iwi capacity is merely tokenism." (Makey 2011). The NGO and Indigenous capacities of the system offer a wealth of unique and valuable knowledge from Māori groups, local stakeholders, and community members. The present interorganizational arrangement enables a collaborative system, however the NGO and Indigenous groups are not yet mobilized in the decision-making processes.

The IKHMG is truly at the center of the 2013 network as a result of their connectedness in the system and the number of cooperative opportunities they provide to the network, although, it does not have the financial capital or decision-making ability to make regulatory or management changes so remains on the periphery. Despite the polycentric changes to the physical configuration of this system; the regulatory power (regional councils and national crown agencies), and hence ultimate decision-making

function, of this governance arrangement essentially remains unchanged. The Kaipara Harbour is presently managed by several multijurisdictional governmental entities in a top-down arrangement. Conversely, the IKHMG offers advice and strategies for comprehensive management and their role is essential in the collective communication and collaborative success of the network. Functionally, the group is challenged by their dependency on voluntary external financial supplies, and their influential or leveraging powers can only informally affect and impact governance outcomes.

Presently none of the actors contribute all resource flows (financial, knowledge, cultural, and political) to the system, and if the IKHMG had formal involvement in the decision-making process and stable funding, the group *would* contribute to all flows to the system. The mission of the group, the social, political and cultural connectivity, the existing initiatives towards a Sustainable Kaipara Catchment Plan, and the intellectual knowledge all presently exists and would support the comprehensive management of the harbour; the only piece lacking, albeit the most significant, is the regulatory clout. Similar to the Māori groups obtaining statutory representation in the local decision-making process, we suggest that for effective governance of the Kaipara Harbour, the IKHMG should have legislative influence on the management of the Kaipara Harbour. This could be in a variety of forms: a partnership with regional councils, representation on behalf of the iwi community and the IKHMG in regional and national decision-making process, or collaborations with more than one agency or group. The intention behind this suggestion is simply to formalize the IKHMG group, even if partially or in combination with other groups, to better inform management decisions regarding the Kaipara Harbour.

Patterns of Interactions: Formal and Informal Action Arenas

One of the research goals of this study was to identify the action arenas in both governance eras to better understand the patterns of interaction in the system. Unlike the dramatic visual changes in network structure, the action arenas did not experience considerable physical change (Figure 3-7). The management decision-making areas in the 1991 network occur at the national level, using overarching policies and regulations to guide the centralized arenas at the local level. These actors are both essential in making decisions and implementing policy that affect governance of the Kaipara Harbour's resources, although, it is within the authority of the local governments to make the hands-on decisions regarding land use and consent permitting in both the ARC and NRC regions. The action arenas in 2013 remain identical to that of the 1991 network; persistent at the national and local levels with the addition of the EPA actor at the regional level (Figure 3-7). While the EPA is a national level actor, it does work with regional councils as a conduit to the national government on projects of national significance. The marine turbine project would have likely qualified as a project where the consent process was determined by the EPA; however, the EPA had not yet formed during the project's consent process which took place in 2002.

Even though the action arenas experienced minor changes since the 1991 network, these decision-making assemblies are essential in making policy changes in the Kaipara catchment. To truly embrace the integrated approach the RMA strives to achieve, an action arena would ideally be placed within the nodes found on the right-hand portion of the 2013 network (Figure3-7). Introducing a decision-making arena in the Private, NGO or Indigenous node would balance the abundance of weaker relationships

on that side of the system with stronger, authoritative ties that can influence and shape policy choices. This would facilitate more diagonal and horizontal linkages in the governance network, increasing negotiations in management decisions across the system, as well as enabling a more collaborative and cooperative network.

Nonetheless, the interorganizational changes in the Kaipara governance network did result in the emergence of *informal* action arenas, where social ties, political linkages and scientific connections between actors serve as the conduit for resources to flow between nodes. These informal arenas are self-organized multilevel networks that bridge organizational boundaries, build trust within their sub-network, and collaborate intellectual capacities for novelty and innovative management solutions, all of which tend to be subdued in a bureaucratic arrangement (Folke et al. 2005). They are mechanisms of adaptation which, through their network linkages, provide information and facilitate collaborative actions fulfilling the broader network objective of managing the Kaipara's resources. The groups share interests about specifics topic, and deepen their knowledge through the exchange of social and intellectual capital.

These informal arenas are found between three sets of actors in the network. First the Indigenous and National nodes interact through the formation of the WT, to assist Māori groups with grievance claims. Second, the Indigenous and NGO nodes interact through the IKHMG and KHSFMG who work closely with local community and *iwi* to resolve fisheries and natural resources management issues in the harbor. Third, the NGO and the Private nodes – specifically the CRIs - increase scientific, political and cultural leverage in the system, outside of the public sector chain of command." The

addition of the CRIs and NGOs to the Kaipara network increases scientific, political and cultural leverage in the system, outside of the public sectoral chain of command. Although the informal arenas may not have regulatory responsibilities in the network, the capacities of these groups transcend the conventional boundaries that the action arenas are confined to and allow for valuable information to be transferred amongst significant stakeholders in the system. We determine these informal action arenas serve vital knowledge, cultural, political and social functions that are essential to the Kaipara network.

Adaptive Governance Capacity

The literature on governance networks contends that the polycentric design of institutional arrangements is essential to manage ecosystems that have multijurisdictional boundaries, such as this case study of the Kaipara Harbour (Dietz et al. 2003; Folke et al. 2005; Gunderson and Light 2006; Olsson et al. 2006). However it is necessary to evaluate whether the polycentric design is the most effective means to management Kaipara Harbour A useful framework for this evaluation is to examine four critical components associated with adaptive governance: 1) building understanding of the resource and ecological dynamics, 2) incorporating that knowledge into adaptive management practices, 3)supporting flexible institutions and multi-level governance for management, and 4) adaptive capacity in dealing with perturbations, uncertainty, and surprise (Folke et al. 2005).

Building understanding of the resource and ecological dynamics

Through the examination of resource flows it is evident that the intellectual capacity of the Kaipara Harbour system is not a limitation. The issue to consider is whether all of the actors who contribute knowledge resources to the network are effectively mobilized and collaborate with one another in a proactive combination of knowledge subsystems (Folke et al. 2005). For example, the NGO and Indigenous groups have informal action arenas and thus exchange their understandings of the Kaipara catchment with one another; however, if these groups were mobilized with incentives to exchange that understanding with the formalized operating action arenas at the governmental sector, the potential for a feedback of knowledge through the network would be higher. The opportunity does exist to combine and integrate the knowledge streams horizontally across the network and social incentives would facilitate this mobilization. Some sound incentives examples we offer are: council requested participation of NGOs, community stakeholders, and Indigenous groups in local planning; NGO and Indigenous groups working together as a nested function of governmental decision-making, or mandated inclusion in the problem formulation stages of environmental impact assessments.

Incorporating knowledge into adaptive management practices

To obtain the appropriate knowledge base in a SES requires a feedback of information into adaptive management processes through continuous tests, monitoring and evaluation. Presently, the studies and research about the Kaipara Harbour's ecosystem dynamics, land use challenges and social oppositions are multiscalar, across several jurisdictions, sectors, and organizations (Folke et al. 2005). Adaptive

management processes in the Kaipara SES will require first, a comprehensive management plan to test, and second, a learning environment that sponsors leadership and dynamic social norms within management organizations. Presently, the IKHMG is best positioned to assume this leadership role since they have spearheaded a comprehensive database and scoping studies for a comprehensive management plan; yet the adaptive management influence they have on decision-makers is negligible until they have legislative influence to support their efforts.

Supporting flexible institutions and multi-level governance for management

Adaptive management systems are multi-scalar, community-based systems of resource management dependent on the collaborative nature of stakeholders operating with local, municipal, regional, national and global networks; and the strength or weakness of the linkages among these entities reflect the overall adaptive governance capacity of the system (Folke et al. 2005). In the present day Kaipara Harbour system, there are strong ties among the autonomous decision-making units, or the action arenas, at a variety of geographical scales improving the institutional strength of the regulatory authorities. The imbalanced configuration isolates the other groups in the governance system that do not have decision-making power and inhibits the collaborative capacity of the remainder of the interorganizational, community-based network. The role of the Indigenous and NGO nodes are not formally incorporated into the decision-making processes, distancing them from holding leverage in the Kaipara system. The configuration of the local and regional capacity of the network supports shared management and power responsibilities, although, the cross-level, collaborative governance structures have yet to surface. The diverse set of stakeholders operating at

various scales in the network have proven their ability to generate, transfer and develop resource flows necessary for flexible institutional infrastructure. Including these external groups in the legal and authoritative processes that occur in action arenas will increase the functionality of the multi-level governance in the Kaipara system. The Waikato River Authority provides an excellent example of including iwi into integrated watershed management and formal decision-making processes.

Dealing with perturbations, uncertainty and surprise

Currently, the informal action arenas in the Kaipara Harbour governance network have the most comprehensive knowledge base regarding the catchment area and are best situated with social connections necessary to respond to climate uncertainties, ecological disasters, or economic surprises in the system. The national levels of government in the Kaipara system provide the operational protocols for the local council to follow, yet governmental procedures do not encompass the knowledge, experiences, and skillsets from the informal sectors that will support and complement the system needs when it is disrupted. To be used most effectively informal action arenas would ideally be nested within the local, regional and national level governments so these valuable information flows are accessible and integrated into the regulatory system, supported authoritatively, and utilized effectively in times of urgency.

CONCLUSION

This case study analysis explores the direct causes of institutional change and the mechanisms of adaptation, including the organization arrangement of the governance system, the role of informal action arenas, and the adaptive capacity, in the Kaipara

Harbour governance network between 1991 and 2013. We used three different approaches to improve the understanding of institutional arrangements in the social-ecological system of the Kaipara Harbour. These approaches are: 1) Governance network analysis, 2) Institutional Analysis and Development Framework and, 3) Adaptive Governance. Adaptive governance in multilevel systems, such as the Kaipara, experience different power structures, motivations and resource exchanges at each scale, thus benefit from this methodological approach evaluating temporal, micro-level, and macro-level characteristics to determine how alterations to the network may affect the adaptive capacity of the system.

Under the influence of the RMA and its integrated resource management approach, the configuration of the Kaipara Harbour governance network has changed from a network predominantly lead by one command and control organization to a polycentric arrangement of governance. This new configuration may look like an integrated watershed governance system from afar, however, despite the increased number of actors contributing valuable cultural, social, intellectual and political resources to the system, the legislative authority is not present in these new organizations to influence or alter management decisions. The decision-making entities in the network have ultimately remained static with increased centralization of authority in the governmental sector. Informal, self-organized, action arenas have emerged and we have determined that these bridging sub-networks are assets in the sustainable management of the Kaipara Harbour. In particular, our analysis suggests that if an organization like the IKHMG had appropriate authority it would be in a better position to instigate positive

change. Legislative involvement for the IKHMG would contribute to adaptive co-management and indigenous integrated watershed governance in the Kaipara Harbour network, emphasizing the sharing of rights, responsibilities, and power between varying sectors of government and civil society. The Kaipara Harbour network is making progress towards adaptive governance with its stable knowledge capacity and multiscalar institutional infrastructure, although a comprehensive management plan, as well as interorganizational collaborations between the decision-making and informal arenas is essential in implementing adaptive management practices.

This study provides an institutional analysis template that encourages case study comparisons of multijurisdictional social-ecological systems, ranging from forests, water bodies, renewable energy projects, and other common-pool ecosystems experiencing conflicting uses from network stakeholders. Through increased institutional research on context sensitive social-ecological systems similar to the Kaipara Harbour, we can learn from the constraints, challenges, and opportunities that emerge over time. This information will help inform the successful interorganizational arrangement of decision-making and collaborative actors in watershed governance networks and institutional structures to promote ecological, social, cultural, and political efficacy for an entire environmental system.

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Chapter 4 A Regional Ecological Risk Assessment of the Kaipara Harbour using the Relative Risk Model

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ABSTRACT
A regional ecological risk assessment was conducted for the Kaipara Harbour catchment in New Zealand. The Relative Risk Model (*sensu* Landis 2005) was used to prioritize management of the sources of stress and habitats of concern in the basin. Semi-structured interviews with 25 representative stakeholders were conducted to obtain the resource-users perspectives, develop assessment goals and identify the regional source stressors and habitats inputs for the model. The risk analysis divided the catchment into nine ecological districts. Mixed-methodological approaches including content analysis, geospatial analysis, and source documentation were used to categorize source and habitat rankings, based on the relative abundance of each in respective ecological districts. Risk characterization revealed that fisheries and tidal energy pose the largest source of risk to the catchment; shellfish and Maui dolphin habitats are at most risk in the basin; and that Kaipara and Rodney ecological districts exhibit the highest risk across the ecological districts. Monte Carlo analyses addressed the uncertainties associated with the RRM source and habitat inputs. The results of this assessment can be used by policy makers, conservation groups, and municipalities to help inform future management efforts in the harbour catchment.

Key Words: Kaipara Harbour, ecological risk assessment, relative risk model, watershed management

INTRODUCTION

Ecological risk assessment (ERA) has evolved over time. In general, ERA is an evaluation tool to examine potential adverse effects that human activities have on organisms and their ecosystems. The process provides the means to develop, organize and present data for more transparent and efficient use by decision makers

(Environmental Protection Agency 2013). When conducted for a particular place, such as a watershed or catchment, the ERA process can identify vulnerable resources and prioritize data collection activity, linking human activities to their consequential impacts. The results of an assessment create objective and transparent comparisons that can inform management alternatives, allowing stakeholders and policymakers to make informed decisions regarding the use of the subject ecosystems and their resources (Environmental Protection Agency 2013).

Traditional approaches to ERA have focused on specific chemicals, assessing exposure and effect levels and estimating the likelihood of their occurrence. The U.S. Environmental Protection Agency (EPA) has led the development of risk assessment practices since the 1970s, although it did not formalize a process until 1983 when the National Academy of Science published the ground breaking report "Risk Assessment in the Federal Government: Managing the Process" (National Research Council 1983), also commonly known as the Red Book (Environmental Protection Agency 2013). The EPA has incorporated principles from this pivotal document into their recommended practices today, typically conducting risk assessments that isolate single chemicals in pesticides, herbicides, organic solvents, metals, and dioxins and evaluating their human health impacts on mortality, reproduction and chronic physiological effects (Landis 2005; Environmental Protection Agency 2013).

Critics of this methodology argue that the EPA assessment approach was designed for specific chemicals and single receptors. Thus, its applicability to complex environments that have multiple interacting stressors that impinge on multiple,

interacting receptors that include non-human targets of concern, has limitations (Wiegers et al. 1998; Landis 2005). Consequently, shortly after the release of the 'Red Book' there was a push to broaden the field of ecological risk to deal with landscape and ecosystem-wide threats. The focus of regional ecological risk assessment (RERA) has been to extend the field of ERA to evaluate multiple flora and fauna within the true structure, functionality and complexity of ecosystems at a landscape scale (Hayes and Landis 2004; Landis 2005).

There are several variations on RERA in the ERA literature. One of the earliest models of RERA was a five-step approach developed in 1983 that included 1) qualitative and quantitative descriptions of the sources of concern, 2) identification of the environment within effects that are expected, 3) selection of endpoint indicators, 4) estimations of spatiotemporal patterns of exposure, and 5) quantification of the relationship between the exposure and the modified environment (Hunsaker et al. 1990). A few years later in 1987 a group of senior officials at the EPA surveyed 31 types of environmental problems within the agency's jurisdiction to estimate how much risk was posed by each type of problem, and concluded with there was a need to reorganize its process toward environmental protection by shifting priority from those problems that ranked lower on the risk index to those that ranked higher (Hornstein 1992). This launched an initiative to use Comparative Risk Analysis (CRA) as a technique to anchor the agency with a more scientific understanding of risk in policy and decision-making. Unique to the CRA framework is the construction of a two-dimensional matrix that offers

policy alternatives and their scores based on a number of chosen criteria for decision-makers to evaluate (Linkov et al. 2006).

The CRA lacks a structured methodology to combine the functionality of specific criteria, which is an integral component of another methodology that can be used to evaluate risk, the Multi-Criteria Decision Analysis (MCDA). MCDA traces back to the 1960s and is used in a number of different disciplines, and increasingly in the environmental field. MCDA allows decision-makers to assess policy and decision-making alternatives based on multiple criteria and synthesizes the range of alternatives through a ranking scheme that helps overcome some of the limitations of an individual or multi-institutional policymaking (Linkov et al. 2006). One of the advantages of using MCDA in the decision-making processes is the capacity to call attention to similarities or potential areas of conflict between stakeholders' perspectives, which results in a more complete understanding of the values held by others in any given study. Engaging stakeholders in MCDA can bring useful and relevant knowledge to the decision-making process, and, stakeholder acceptance of the decisions is more likely, even if those decisions do not necessarily reflect individuals' desired outcomes and may alter community and sectoral expectations (Gilmour and Beilin 2007)

In 1997, Landis and Wiegers presented an alternative model to the chemical-receptor assessment that is central to this study, one that incorporates many of the elements already described in existing ERAs including stakeholder perspectives, multiple stressors, geophysical spatial structure, and assessment endpoints. Traditionally, ERAs evaluate interactions among three environmental components (Figure 4-1a): stressors

released into the environment, the receptors living within the environment, and the receptors' responses to the stressors (Landis and Wiegers 1997). This traditional framework tends to focus on a single stressor that has acute effects on a limited number of receptors. Thus, the interaction of the exposure and effects measurements tends to be simple and straightforward. Conversely, in a regional multiple stressor assessment, as found in the Regional Risk Model (RRM) (Figure 4-1b) the number of possible interactions is much greater with sources imposing a large number of stressors into the environment that affect multiple receptors (habitats), potentially creating synergistic effects that can compound the results (Landis 2005).

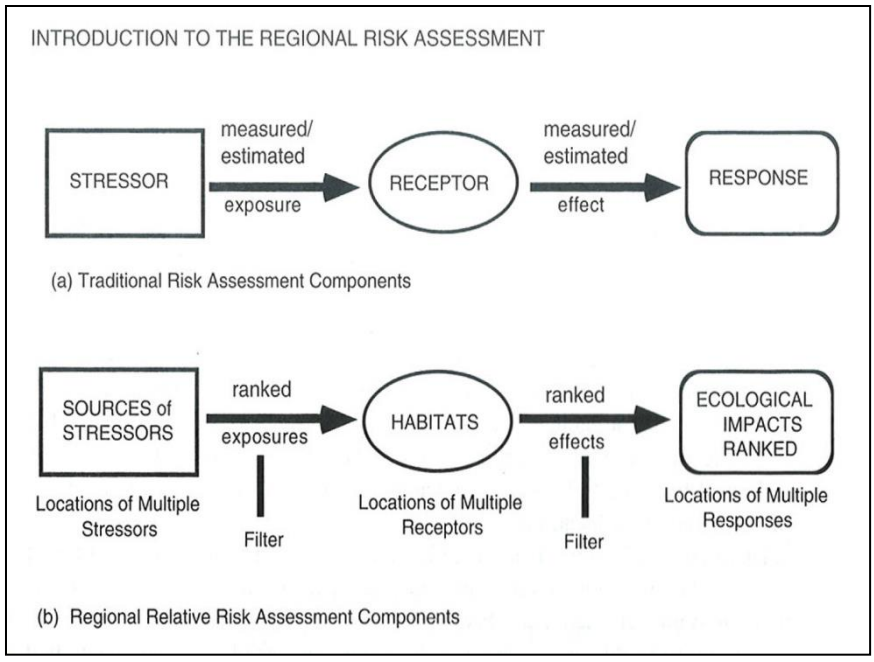

Figure 4-1 (a) Traditional Risk Assessment and (b) Relative Risk Assessment Components (Landis 2005)

The two approaches are contextually similar, although the RRM is modified in scale since it expands to cover a region and focuses on a large, explicit region,

emphasizing the idea that *groups* of stressors, receptors and effects at the landscape scale should be considered. Rather than a general spatial extent of the environment, the RRM is place-based and encompasses the contextual conditions of a specific region.

For the scope of this study, we adopt a definition for regional-scale risk assessment that utilizes nontraditional methods to estimate risk that states: "A risk assessment deals at a spatial scale that contains multiple habitats with multiple sources of multiple stressors affecting multiple endpoints and the characteristics of the landscape affect the risk climate. Although there may only be one stressor of concern, at a regional scale the other stressors acting upon the environment are to be considered" (Landis 2005). The methodology of the RRM integrates ranks of sources and habitats for subregions within a study area to quantitatively determine their interactions and the relative risk contribution from identified sources into indicated habitats (Hayes and Landis 2004). Rather than isolating measurements of contaminants, chemicals or other pressures in the environment, the RRM determines whether a region may have, for example, a *high* source of nitrogen contamination that is likely to impact a *large* freshwater system; highlighting isolated areas of *greater relative risk* in the region.

The RRM mirrors traditional risk assessment in carrying out three similar phases: problem formulation, analysis, and risk characterization (Walker et al. 2001; Chen and Landis 2005; Landis 2005). In the *problem formulation* phase, the scope of the assessment is defined and the values of the stakeholders are determined. The background of the region is explained, goals of the risk assessment are made, and the regional stressors and habitats are identified (Walker et al. 2001; Hayes and Landis 2004; Landis

2005). In *the risk analysis phase*, the stressors and habitats are ranked based on the likelihood of occurrence and the regional framework calculates combinations of risk pathways to environmental threats (Figure 4-2). If the stressor sources in a region are abundant, and there is a reasonable expectation that these stressors could impact habitats in that area, then the ecological risk is high. On the other hand, minimal interactions between source and habitat components result in a lower risk, while the likelihood of no interactions amongst components expose no risk (Landis and Wiegers 1997; Landis 2005).

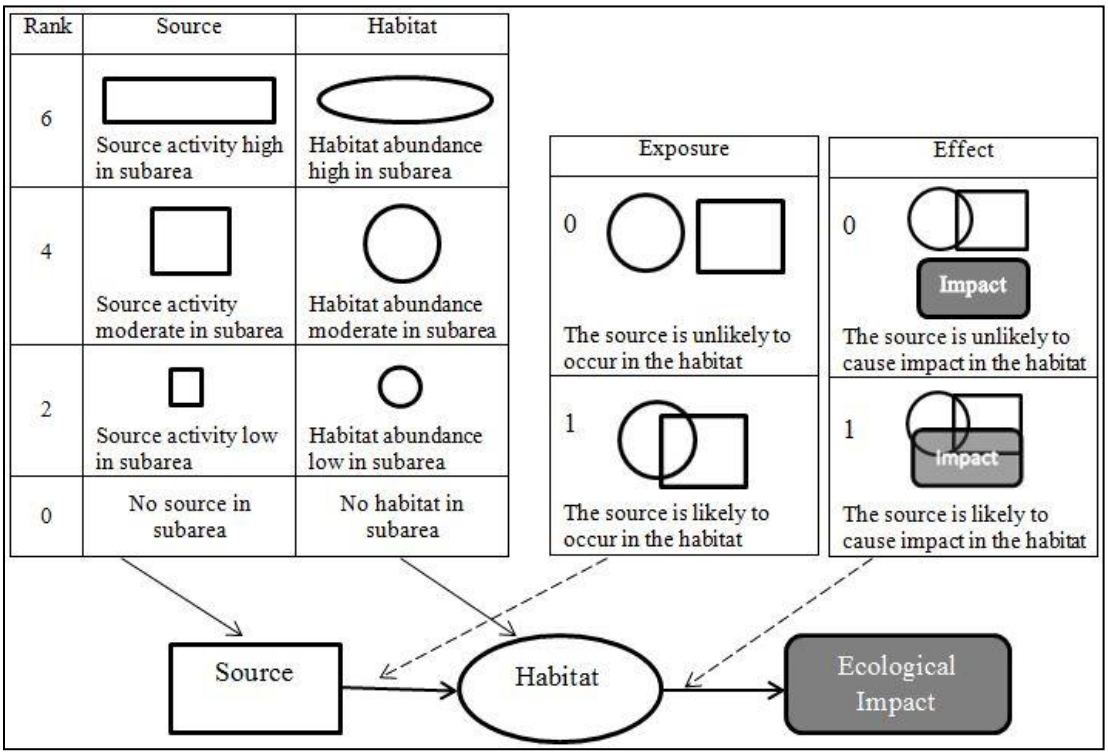

Figure 4-2. The regional risk model and its system of numeric ranks and weighting factors, adapted from Landis and Weigers 1997

In the *risk characterization phase* the risks for the stressors and habitats are compared, and the relative risks of sub regions can be examined providing a basis for discussion regarding management and decision-making in the area (Walker et al. 2001; Landis 2005). This framework ultimately determines whether a region is at a high, medium, or low-level of risk resulting from a combination of sources that are capable of impacting various habitats. The RRM is advantageous to studies at the ecosystem and landscape scale for a number of reasons. From a management viewpoint, it is often difficult to determine which stressors and habitats are of most concern, especially if an ecosystem may have numerous adverse impacts and multiple stakeholders have divergent perspectives on these issues. The RRM offers a starting point to compare these tradeoffs and levels of risk. The RRM also creates metrics that allow inherently dissimilar characteristics to be compared (e.g. invasive species count, nutrient levels, eco-tourism, acres of wetlands, etc.). The relative risk model allows these diverse inputs (sources/habitats) to be compared using an objective, unit-less ranking system, assisting stakeholders who have different levels or types of expertise to communicate about the relative risks in an ecosystem regardless of their individual backgrounds.

The RRM was originally developed for an assessment for the Fjord of Port Valdez in Alaska and since then has been applied to several catchments in Pennsylvania, Mississippi and Washington as well as international watersheds in Brazil, Tasmania , Australia, and Chile (The Institute of Environmental Toxicology 2013). This paper reports the application of the RRM at the regional scale for the Kaipara Harbour in New Zealand. This catchment is an exemplar case study of how the regional risk framework

can be applied to an area where there are competing and conflicting demands for a range of natural resources, intending to put the catchment issues in context and highlight management opportunities. The assessment methodologies are modified to include the unique examples of magnitude in the Kaipara catchment, and will be described in the Risk Analysis section. The purpose of this assessment is to provide estimates of relative contributions of risk in the Kaipara region, offering a starting point for management recommendations to the policy makers in the area and to contribute to the body of relative risk assessment literature employing the RRM.

Presently, the Kaipara Harbour in New Zealand does not have a comprehensive management plan. There are several stakeholders, non-governmental organizations (NGOs), and governmental agencies increasingly expressing concerns about the environmental issues and the tradeoffs between the competing users in the catchment. There are a number of valuable ecological habitats for seashore and migratory birds, marine ecosystems, shellfish, and wetlands in the Kaipara catchment. The region is economically important for the entire country in terms of fisheries, tourism and a tidal energy project. Additionally, the cultural significance of land and resources for the indigenous Māori populations contributes added spiritual meaning to ecosystems of the area. With intensifying adverse impacts from sources such as agriculture, sedimentation, runoff and deforestation, to name a few, the need to prioritize management efforts has become more evident. This assessment provides a foundation in that prioritization process, incorporating the perspectives of the users of the harbour and offer management and policy recommendations to the decision-makers of the Kaipara Harbour. The RRM

(Landis 2005) is used for this assessment, with modifications to the filter structure of the assessment. Both filters were altered through arithmetic additions to incorporate unique magnitude issues in the basin. Therefore, this study contributes a new case study on the Kaipara Harbour and an important modification to the RRM approach.

SITE DESCRIPTION

The Kaipara Harbour is situated on west coast of Northland on the North Island in New Zealand (Figure 4-3). Approximately 80 km north of Auckland and open to the Tasman Sea, it is the largest enclosed harbour on the Southern Hemisphere and one of the largest estuaries in the world. The harbour is broad and mostly shallow, formed by a system of drowned river valleys and covering a total of 947 km^2, it has more than 900 km of shoreline and spans over 60 km from north to south (Hay and Grant 2003; Haggitt et al. 2008). The Kaipara has an extensive drainage catchment, feeding a number of main river systems such as the Wairoa, Arapaoa, Otamatea, Oruawharo, Tauhoa, Kaipara and Hoteo Rivers. The entry of large rivers and hundreds of streams contributes to the vast watershed area containing close to 640 km^2 of land (Wilson et al. 2006; Makey 2013).

Figure 4-3. The Kaipara Harbour catchment (Makey 2013)

Presently, the Kaipara region maintains geographical and natural advantages such as highly productive and fertile soils, unique marine and terrestrial ecosystems, aesthetic natural beauty, and the close proximity to the largest metropolitan market in New

Zealand, Auckland (Wilson et al. 2006). These traits make the Kaipara Harbour of high value for a number of industries and stakeholders dependent on the resources of the harbour and its surrounding catchment. A few of the significant land uses and their tradeoffs are briefly summarized as follows.

Agriculture

Land use in the Kaipara Harbour catchment is dominated by agriculture with beef and dairy farming comprising the primary pastoral land use. The Northland region provides nearly 20% of New Zealand's beef supply, the dairy farming sector in the region contains 9.5% of New Zealand's entire dairy herd, while the catchment is also scattered with clusters of specialized agriculture such as *kumara* (sweet potatoes) and capsicum (Wilson et al. 2006; Haggitt et al. 2008; Makey 2010; Makey 2013). Agriculture provides employment and economic income for the region, while on the contrary land use intensification and nutrient runoff from the industry is threatening the health of the freshwater and coastal waterways.

Fisheries

The Kaipara Harbour has always been a *marae*, or sacred place, for customary and recreational fishing, and the commercial fishing industry has been widespread in the region since European settlement. The Kaipara Harbour is the nursery grounds to 98% of all of snapper on the west coast of the North Island, and provides habitat for a number of other fin and shellfish stocks (Yardley and Yardley 2011). Concerns with the state of the harbour's fisheries have been increasing regarding the depletion of fish and shellfish

stocks, sedimentation, poor water quality, resource use and development pressure, and the lack of integrated fisheries management (The New Zealand Herald 2011).

Tidal Energy

Crest Energy Limited has been granted consent for a marine tidal turbine power station at the mouth of the Kaipara Harbour containing 200 submerged tidal turbines (Crest Energy Limited 2013). There is considerable opposition to this project from the rest of the Kaipara network ranging from skepticism of the turbines infrastructure, adverse impacts to marine ecosystems, and the instability of the turbulent seabed.

Tourism

The Kaipara Harbour embraces a diverse set of landscapes that draws in a variety of tourists. From the Kaipara flats to the fertile farmland, up the windy Kaipara hills down to the bottom of the saltmarsh wetlands and along the rugged coast lined with beautiful beaches, the Kaipara region is one of international significance (Department of Conservation 2013). It contains a large migratory bird habitat, houses many threatened and endangered species, and is one of the key distribution ranges for the one of the Maui Dolphin, one of the world's rarest. Although there are many tourist attractions in the area, organized tourism infrastructure is lacking.

Forestry

Forestry is another major land use in the Kaipara Harbour region and the timber industry removed most of the native forest in the catchment, replacing them with agricultural and urban areas. This has led to rapidly increasing soil erosion on land and consequently amplified sedimentation in the harbour. The adverse impacts of

sedimentation are concerning for the fisheries industry, as the shellfish abundance has dropped and finfish populations such as mullet, snapper, and school shark are quickly diminishing (Makey 2010).

Culture

The *iwi* (tribe) *Ngāti Whatua* have held *mana* (indigenous rights) over both land and water *taonga (*treasured possessions) through numerous ancestral generations in Kaipara Harbour and catchment region. Substantial concern came from the European settlement in the Kaipara in the 1840's. Through the period of 1860 and 1960, Māori endured impacts of colonization including losing most of their land, observing the destruction and depletion of their natural world through western development, and lost management and control of resources they were once permitted to use (Makey 2010). The cultural conflict occurring in the Kaipara region is highly controversial amongst *iwi* and *Pākehā* (New Zealanders of European descent), as Māori and the British Crown have had long term disagreements regarding Māori customary rights for land and resources.

METHODS

The RRM calculates risk through a semi-quantitative ranking and filter equation. A system of numerical ranks and weighting factors are developed to tackle conflicts encountered when combining different types of risks in complex systems where various stressors and effects are rarely linear (Landis and Wiegers 1997). This methodology identifies intersecting risk components (Figure 4-2), the idea being that risk is proportional to the overlapping relationships between sources, habitats and impacts in the environment.

The Problem Formulation Phase

Through understanding stakeholder interests, the three basic components of a risk assessment (Figure 4-1) were identified. Information was gathered from regulatory agencies, researchers, resource users, and other stakeholders in the Kaipara Harbour catchment at the national, regional and local scale (Table 4-1). Twenty-five interviews were conducted to identify public concerns, values and knowledge about the harbour and its surrounding area. Interviewees were selected based on either: their use of resources in the Kaipara (e.g. fisheries, tidal energy, farming), their role in the management of resources in the harbour (e.g. councils, conservation groups, scientists), or their involvement in resource management issues in the region (e.g. Māori groups, non-governmental organizations). A detailed list of the interviewees and their affiliations can be found in the dissertation Appendix (pp. 208).

Table 4-1. Total number of stakeholders interviewed in each group and their jurisdictional extent

Participant Groups	National	Regional	Local	Interviews
Government	1	1	8	10
NGO	1	1	0	2
Private	2	1	2	5
Scientific	4	0	0	4
Indigenous	1	3	0	4
Totals	9	6	10	25

The interviewees were asked a series of semi-structured, conversational questions about the history of the harbour, the policies in place, the actors involved, and the issues they

felt were most important regarding the current state of the area. The two questions asked that directly applied to the risk assessment were:

1) What are the largest sources of threat causing the most impacts in the harbor?
2) Which habitats in the harbour and the surrounding catchment area are of most pressing concern?

Data collected from these interviews provided the risk assessment goals through a content analysis. The interview data were first structurally coded by question, regarding the significant stressor sources and habitat types of stakeholder concern, and then coded by frequencies of thematic mention by participant, or the specific source and habitat types identified (Namey et al. 2007). The results of the content analysis were categorized into three groups of high, medium, and low dependent on the total thematic frequencies across all participants, and those ranked highest were included in the RRM. The community's concerns were chiefly influenced by the environmental impacts of the fishing, agriculture and forestry industries, and towards efforts for the protection and enhancement of natural habitats in the area. Thus, the endpoint goals of assessing risk were focused on the following areas reflected by the source and habitat groups (Table 4-2) in the relative risk methodology:

1) Finfish and shellfish populations used by both recreational and commercial fishermen
2) Wildlife populations such as shark, dolphins and birds that use the harbour seasonally or on a year round basis
3) Endangered and valued ecosystems or habitats such as wetlands and sand dunes
4) Water and sediment quality in the harbour

These assessment goals were chosen to carefully reflect the wide array of interests and concerns raised by the stakeholders interviewed. There were several additional issues that were expressed and noted, however to narrow the breadth of the assessment a content analysis of the topics identified the most common issues from all interviewees. This was used to prioritize those consistently significant issues from all stakeholder perspectives.

Identification of ecological districts

The boundaries of the study area were divided into nine ecological districts as defined by the New Zealand Department of Conservation Protected Natural Areas Programme (PNAP) (Department of Conservation 1987).

Table 4-2. Sources and habitats defined for the Kaipara Harbour Risk Assessment

Sources	Description	Source
Agriculture	Primary pastoral areas with high producing exotic grassland for dairy, sheep, and beef farming	MfE
Tidal Energy	Marine tidal turbine station power station at the mouth of the Kaipara Harbour	Crest Energy Limited
Fishing	Commercial, recreational and customary fishing causing pressure on specified fish stocks	IKHMG, TP354
Sedimentation	Long term accumulation of fine sediment on tidal rivers/creeks, vegetated intertidal areas, and tidal flats	PNAP, TP354, NIWA
Deforestation	Harvested forest areas showing canopy opening, skidder tracking, new roading or log landings	MfE
Runoff	Nutrient runoff and fecal pathogens from pastoral agricultural farming	PNAP, TP354, NRC report
Sand mining	Sand extraction and dredging for manufacturing and ready-mix commercial concrete	PNAP, IKHMG
Urbanization	The expansion of residential and commercial urban areas	PNAP, TP354

Habitats	Definition	Source
Red Snapper Habitat	*Pagras auratus,* nursery grounds habitat and commercial, recreational, and customary fishing	MPI, PNAP, TP354,
Grey Mullet Habitat	*Mugil cephalus*, commercial and customary fishing	IKHMG, PNAP
Flounder Habitat	*Rhombosolea leporina* (yellow-belly flounder) and *Rhombosolea plebeian* (sand flounder), commercially, recreationally, and customary fishing	IKHMG, PNAP, TP354
Shark Habitat	Rig Shark, Spotted Dogfish and School Shark species	TP354, IKHMG
Maui Dolphin Habitat	*Cephalorhynchus hectori maui*, world's smallest and rarest dolphin, critically endangered	IKHMG, TP354
Shellfish Habitat	Scallops, Oysters, Mussels, Prawns, commercial, recreational, and customary fishing.	IKHMG, PNAP, TP354
Sand Dunes	Large dune peninsulas north and south of the harbour mouth, only 2% of original dunes remaining, important for water quality, culture, aesthetic	PNAP, IKHMG
Sea Grass	*Zostera capricorni*, critical intertidal habitat and juvenile nursing grounds for red snapper	NIWA, TP354, IKHMG
Wetlands	Open water classified as lakes/ponds, herbaceous freshwater vegetation, flaxland, low producing grass	MfE
Water Fowl Habitat	Migratory/endemic wading birds, breeding grounds for significant species including Dotterel, NZ Ferry-tern, Wrybill, Black Stilt	PNAP, TP354, Forest & Bird

The ecological districts are geographical regions (Figure 4-4) that have similar landscapes and biological communities (Table 4-3) (Department of Conservation 2013).

Table 4-3. Ecological districts in the Kaipara Harbour catchment

Ecological District	Description
Whangaruru	Known for its nationally rare coastal forest and also includes important habitats such as swamp forest, freshwater wetlands, dunelands, and estuarine systems (115,782 ha)
Whangarei	One of the most predominant features includes the nationally rare volcanic broadleaf forest, and as well as important habitats such as riverine forests, freshwater wetlands, estuarine systems and kiwi habitats (81,000 ha)
Tangihua	The area is mostly forested with native forest vegetation and includes some freshwater wetlands (167,024 ha)
Tutamoe	The area is nationally and internationally significant for some of the largest remaining indigenous forest cover in the country, and also includes important coastal habitats (31,934 ha)
Tokatoka	Most habitats remain small and fragmented. Most notably is the Manganui River Complex which contains substantial areas of original floodplain acting as a natural wetland (74,610 ha)
Waipu	Important habitats to note include indigenous forestland, beaches and dunelands, estuarine areas that include important bird habitat and several small wetlands (49,413 ha)
Kaipara	Estuarine habitats dominant this area, and native/migratory birds, wetlands and sand dunes are of significant importance in the area and protected. The district falls under both the Northland Regional Council and Auckland Council jurisdictions (311,400 ha)
Otamatea	3 major tidal saltwater rivers, extensive mangroves, mudflats and sand flats which include important habitats of native and migratory birds, The district straddles the Northland Regional Council and Auckland Council jurisdiction (101,727 ha)
Rodney	Duneland, sand fields, estuarine habitats, and inland forests are the dominant vegetation types. 22,000 ha are governed by the Northland Regional Council's jurisdiction, while the majority of the district to the south is governed by the Auckland Council (247,000 ha)

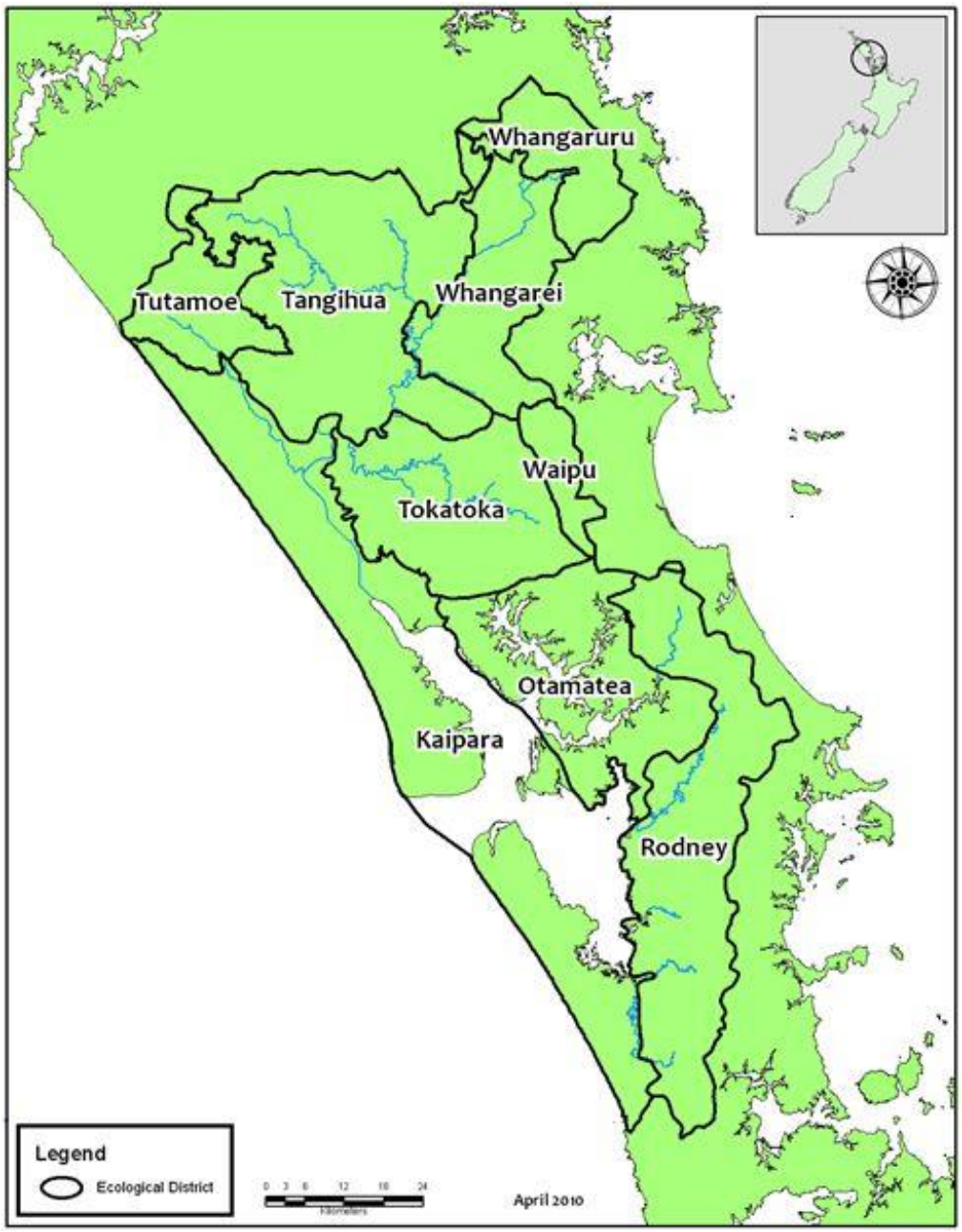

Figure 4-4. The ecological districts of the Kaipara Harbour catchment (Department of Conservation 1987; Makey 2013)

Using geospatial processing, specifically the raster calculator in ArcMap 10.2, we calculated the percentage of area of the risk input (source, habitat) contained in each

ecological district. For variables that are explicitly based on geography, a presence or absence criteria was applied, or a proxy that estimated the source and habitat abundance was used.

The Relative Risk Model

The RRM of the Kaipara Harbour catchment compares the 9 ecological districts to determine the relative risk of contributing sources and the habitats impacted as guided by the stakeholder values and concerns addressed in the problem formulation phase. The model analysis and risk calculations methods are similar to those used in regional RRM literature (Wiegers et al. 1998; Walker et al. 2001; Obery and Landis 2002; Hayes and Landis 2004; Chen and Landis 2005; Colnar and Landis 2007) and the characterization of risk in the Kaipara Harbour is founded on the following assumptions (Landis and Wiegers 1997): (1) the greater the size or abundance of a source of stress in an ecological district, the greater potential for exposure to stressors, (2) the type and density of receptors correspond to the specified available habitat, and (3) the sensitivity of receptors in habitats varies and the severity of impacts in the ecological districts depends on exposure, effects, magnitude of impacts, and characteristics specific to each habitat. The application of the RRM (Figure 4-2) in the Kaipara Harbour uses a ranking scheme to categorize sources of stressors and habit input components and filters each possible combination into an estimate of relative risk.

Ranking

The sources and habitats identified in each ecological district through the problem formulation phase were ranked to convey a relative probability of low, medium, high or

none; indicating how the habitats identified within the assessment goals would be impacted. The criteria were assigned based on the *size and frequency* of the source in an ecological district, and the *abundance and use* of specified habitat(Landis and Wiegers 1997; Wiegers et al. 1998). The ranking criteria and points assigned for the source and habitat groups identified in the problem formulation phase are as follows:

- 6: High, Likely to occur
- 4: Medium, Possibly could occur
- 2: Low, Unlikely to occur
- 0: None, Not likely to occur

Filter design

Two filters were designed in this assessment to characterize the relationship or pathways between the sources and habitats risk components. Because every source will not impact every habitat, the use of filters ensures that only the relevant risk interactions were included in the assessment. The RRM literature uses exposure and effect filters. The purpose of the traditional filters used by Landis and Weigers (1997) was to simply identify that a link did (or could) exist between a source and a habitat category. In this study we modified the filters to incorporate the concepts of exposure and magnitude, defined as *effects* and *impacts* filter (Figure 4-5). The modification describes the relationship between the source and habitat, or what this study defines as *magnitude*. We also altered the traditional binary (0 and 1) coding used in several previous studies (Wiegers et al. 1998; Walker et al. 2001; Obery and Landis 2002; Hayes and Landis 2004; Chen and Landis 2005) to include middle-scale and higher-scale values to detail the *potential* for interactions and effects, and integrating the *magnitude* of interactions in the catchment.

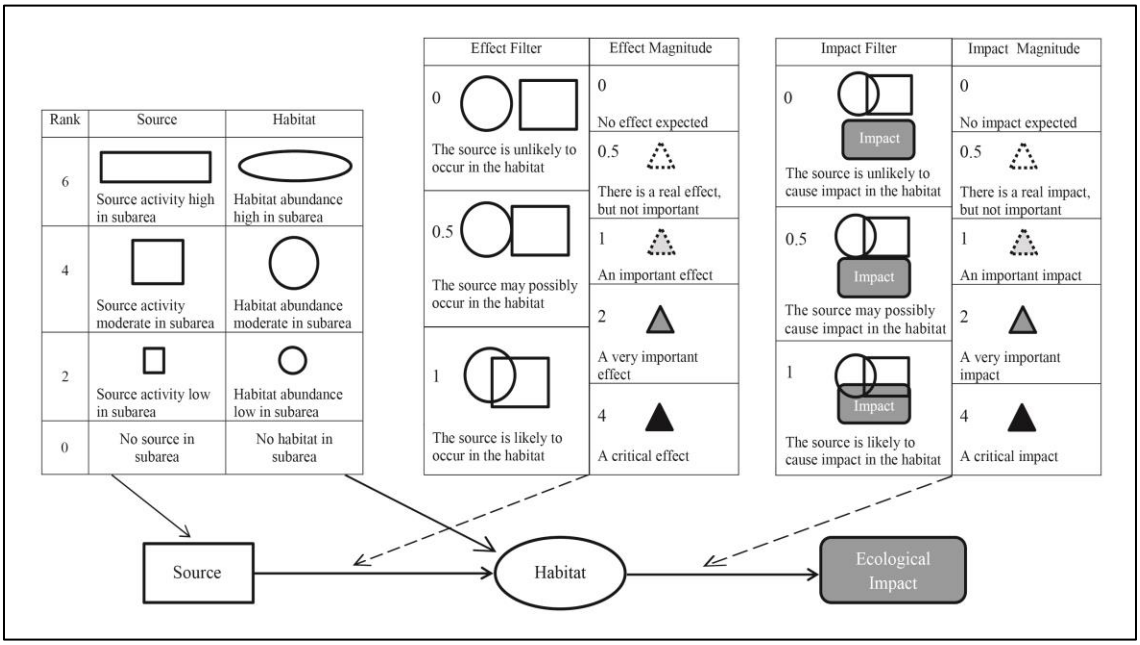

Figure 4-5. Modified RRM for the Kaipara Harbour risk assessment

The effect filter examines the occurrence and presence of sources in the Kaipara Harbour catchment. Specifically, the modified filter assesses the exposure and potential effects the sources may have, and consists of a two-part calculation between the source and the habitat combinations. The first part of the calculation investigates the 'sources exposure' in a habitat, and asks *is the source is likely to occur in the habitat*, and the numerical weights assigned are:

- 0: No source is expected to be present in the habitat
- 0.5: The source may possibly occur in the habitat
- 1: The source is definitely present in the habitat.

The value of 1 was reduced to 0.5 if the data indicated that the stressor occurred in small amounts or had the potential to be even marginally exposed to the habitat. The second part of the effect filter examines the magnitude of the anticipated interactions, and asks

how important is the source's exposure in the habitat, and the numerical weights assigned are:

- 0: No effect expected
- 0.5: There is a real effect, although not that important
- 1: An important effect
- 2: A very important effect
- 4: A critical effect

The higher weighted values (2, 4) added to the second portion of the effect filter signify greater magnitudes of effect outside of standard source-habitat linkages reflected by a score of1. For example, an effect filter of 4 was assigned to the tidal project source and the Maui dolphin since the critically endangered Maui dolphin is the world's rarest dolphin found only in the Kaipara Harbour and the turbine project could have critical effects on the extremely valuable habitat. The product of these two parts (exposure and importance) adds more detail and hence a refined total effect of the sources on the habitats.

The impact filter examines the interaction of sources within habitats in the Kaipara catchment, and operates similarly to the effect filter through a two-part calculation. The sources that were identified to cause an effect through the previous filter are further examined to assess the anticipated impacts on the designated habitats in the system. The first part of this filter investigates whether any impact is anticipated from the sources by asking, *is the source likely to cause an impact in the habitat,* and the numerical weights assigned are the same as those used in the effects filter:

- 0: The source is not expected cause an impact in the habitat
- 0.5: The source may possibly cause an impact in the habitat
- 1: The source is definitely likely to cause an impact in the habitat.

The second part of the impact filter determines the magnitude of those impacts by asking, *how important is the impact caused by the source in each specific habitat,* and utilizes the same numerical weights in the second portion of the effects filter:

- 0: No impact expected
- 0.5: There is a real impact, although not that important
- 1: An important impact
- 2: A very important impact
- 4: A critical impact

The product of these two parts (impact and importance) calculated the total impact of the sources on the habitats. All calculations for both filter types were computed by individually assessing each source and habitat relationship by questioning the likelihood of their interactions and the strength of their connection given the specific characteristics of both risk components. The effect and impact filter weighting calculations and Tables are detailed in Tables A-3 through A-8 in Appendix A.

Integrating ranks and filters

The source and habitat ranks, and filter factors were combined through multiplication. The original mathematical methodology described by Landis and Wiegers (1997) was used with the modified ranks and filters described above to generate risk scores following this general equation:

$$RS = \Sigma(S_{ij} \times H_{ik} \times W_{jk})$$

Where:

RS = final risk score
i = the ecological district series
j = the source series
k = the habitat series
S_{ij} = rank chosen for sources in each ecological district
H_{ik} = rank chosen for the habitats in each ecological districts
W_{jk} = weighting factor established by product of effect and impact filters

Equation 1. Relative Risk Model equation for integrating ranks and filters (Landis 2005)

The analyses are briefly described below and further detailed in equations 2- 4 in Appendix B.

Source risk scores

The source risk scores represent the relative risks contributed by each of the source types across all ecological districts. The risk score of each source is the summation of all of the risk scores in each district, or the risk contributed by all sources across all ecological districts in the study area (equation 2, Appendix B).

Habitat risk scores

The habitat risk scores represent the relative risks occurring within particular habitats in the Kaipara Harbour catchment. Each habitat risk score is the summation of all of the risk scores occurring in each district, thus the total risk contributed by all sources to each habitat across in the study area (equation 3, Appendix B).

Ecological district risk score

The ecological district risk scores represent the relative risks to each ecological district. Each ecological district risk score is a summation of all of the risk scores contributing from all sources in the study area (equation 4, Appendix B).

Monte Carlo Evaluation

The RRM is based on a combination of site specific data, general knowledge about interconnectedness between risk components, and approximations of source and habitat occurrences. Uncertainty from this assessment arose from limited data availability for site-specific sources of stress and species-specific data in some or all of the ecological districts within the catchment study area. Therefore, risk predictions produced in the RRM are estimates based on ranks and filters derived from imperfect data. To address and communicate the uncertainty associated with the estimates, we conducted a Monte Carlo analysis (Warren-Hicks and Moore 1998; Hayes and Landis 2004) to generate risk predictions for risk assessment inputs by combining assigned probability distributions based on the uncertainty associated with source and habitat ranking inputs.

Monte Carlo analysis is a statistical technique used to derive the probabilities of possible solutions for mathematical equations and models (Hayse 2000). Developed in the 1940's, it is often used in deterministic ERAs, or those risk assessments where the determined risk values adequately represent the risks to organisms and little to no information is provided about the probability that a particular value will result from a stressor exposure (Hayse 2000). A fundamental reason to use a Monte Carlo analysis is to examine the effect of uncertainty in risk estimations. Given the variability of data sources and uncertainty in assigning source and habitat ranks for the Kaipara Harbour ERA, the Monte Carlo analysis were applicable for this application of the RRM.

To accomplish this, we applied assigned designations of discrete probability of low, medium and high uncertainty to each source and habitat rank based on data quality, availability and approximations employed in each ranking scheme. Ranks with high uncertainty, the estimate rank were assigned a 0.6 probability, with adjacent ranks receiving probabilities of 0.2. For the ranking inputs with medium uncertainty, we assigned probabilities of 0.8 and 0.1 respectively, and left ranks with low uncertainty was the original estimate designated. Creating a macro in Microsoft® Excel 2010, Monte Carlo simulations were run for 1000 iterations for each source and habitat estimate, and derived output estimates for the sources and habitats across all ecological districts.

RESULTS

Problem Formulation

The ranking criteria assigned for the source and habitat groups (Table 4-4 and 4-5) determine the RRM inputs.

Table 4-4. Ranking criteria for sources of stress for the Kaipara Harbour catchment

Sources	Criteria		Rank
Agriculture	54% - 67%	Pastoral areas with high producing exotic grassland	6
	38% - 52%		4
	23% - 37%		2
Tidal Energy	Presence		6
	Absence		0
Fishing[4]	Commercial Industry		6
	Customary/Recreational		4
	Freshwater Presence		2
Sedimentation[5]	Mouth of Rivers		6
	Primary rivers		4
	Tributaries		2
Deforestation	1.54% - 2.21%	Harvested forest areas showing canopy opening, skidder tracking, new roading or log landings	6
	0.77% - 1.53%		4
	0.09% - 0.76%		2
Runoff[6]	High Priority		6
	Outstanding water bodies		4
	Rivers		2
Sand mining	Presence		6
	Absence		0
Urbanization[1]	Commercial Urban		6
	Residential Urban		4
	Rural		2

[4] Source validation for fishing, urbanization, sand dunes, grey mullet habitat, flounder habitat, shellfish habitat, sand mining, and sea grass criteria from biophysical data sets through: Makey, L. (2010). The World of the Kaipara. Information Review and Gap Analysis: Phase One. J. Chetham, S. Awatere, M. Morrisonet al, Integrated Kaipara Harbour Management Group**:** 592.

[5] Source validation for sedimentation criteria: Swales, A., Gibbs, M., Ovenden, R., Costley, K., Hermanspahn, N., Budd, R., Rendle, D., Hart, C., Wadhwha, S. (2011). Patterns and rates of recent sedimentation and intertidal vegetation changes in the Kaipara Harbour. NIWA, National Institute of Water and Atmospheric Research.

[6] Source validation for runoff criteria: Phipps, T. (2013). Kaipara Harbour: Work Programmes. Report to the Kaipara Harbour Joint Political Committee, Northland Regional Council.

Table 4-5. Ranking criteria for habitats in the Kaipara Harbour catchment

Habitats	Criteria		Rank
Red Snapper[7] Habitat	Marine		6
	Freshwater		2
Grey Mullet Habitat[1]	Marine		6
	Brackish/Mangrove		4
	Freshwater		2
Flounder Habitat[1]	Inshore mud/sand flats		6
	Marine		4
	Fresh		2
Shark Habitat	Presence		6
	Absence		0
Maui Dolphin Habitat	Presence		6
	Absence		0
Shellfish Habitat[1,4]	River Mouth		6
	Inshore		4
	Intertidal		2
Sand Dunes[1]	Extraction Site		6
	Coastal Sand Presence		4
	Coastal Sand Absence		0
Sea Grass Habitat[1]	Presence		6
	Absence		0
Wetlands	1.16% - 1.73%	Open water classified as lakes/ponds, herbaceous freshwater vegetation, flaxland, low producing grass	6
	0.54% - 1.15%		4
	0.00% - 0.57%		2
Water Fowl Habitat	Coastal		6
	Intertidal areas		4
	Land		2

The sources and habitat ranking assignments for the risk assessment inputs are detailed in tables A-1 and A-2 in Appendix A.

[7] Source validation for red snapper habitat, shark habitat, shellfish habitat and waterfowl habitat are found in: Haggitt, T., S. Mead, et al. (2008). Review of Environmental Information on the Kaipara Harbour Marine Environment. G. Barnes. Auckland, Auckland Regional Council.

Relative Risk Model

The risk characterization phases yields final risk scores for each source, habitat and ecological district. The risk estimates were compared to reveal:

- the ecological districts where most risk occurs
- the sources contributing the most risk, and
- the habitats where the most risk occurs

The risk scores (Tables 4-6 and 4-7, Figure 4-6 through 4- 8) are unit-less numbers that evaluate the relative severity of environmental risk based on the stakeholder-informed problem formulation phase.

Risk characterization of ecological districts

The ecological districts that are closer to coastal, marine and intertidal sources (Kaipara, Rodney) generally are exposed to more risk based on both the stressor sources exposed as well the amount of vulnerable habitat impacted in the region (Figure 4-6). The Whangarei and Otamatea districts, both coastal and intertidal environments also seems to contribute moderate levels of risk given its proximity of water sources. Those districts upstream or located higher in the Kaipara catchment (Tokatoka, Tutamoe, Waipu) are generally associated with lower levels of risk.

	Sources								
	Agriculture	Tidal Project	Fishing	Sediment-ation	Deforest-ation	Run-off	Sand-mining	Urbaniz-ation	Total Relative Risk
Tutamoe	14.5	0	64	72	14	92	0	18	274.5
Tangihua	16.5	0	40	88	14	54	0	20	232.5
Whangaruru	4	0	32	20	6	60	0	20	142
Whangarei	36	0	276	52	28	216	0	60	668
Waipu	7	0	64	20	8	32	0	42	173
Otamatea	22	0	72	126	24	60	140	44	488
Rodney	9.5	0	212	84	16	70	148	90	629.5
Kaipara	19.5	900	594	198	36	216	324	60	2347.5
Tokatoka	39	0	48	38	12	52	0	40	229
Total Relative Risk	168	900	1402	698	158	852	612	394	(5184)

Table 4-6. Ranked relative risk output of relative risk model by source and ecological district

	Habitats										
	Red Snapper	Sea Grass	Sand Dunes	Shark	Grey Mullet	Shellfish	Maui Dolphin	Floun-der	Wet-lands	Water Fowl	Total Relative Risk
Tutamoe	24	0	0	0	28	52	0	28	132	10.5	132
Tangihua	12	0	0	0	16	72	0	16	108	8.5	116
Whangaruru	16	0	0	0	18	36	0	18	40	14	88
Whangarei	36	72	0	12	38	198	96	76	120	20	528
Waipu	20	0	0	0	22	40	0	22	36	33	104
Otamatea	12	0	136	0	36	156	0	54	60	34	394
Rodney	20	60	140	4	72	104	64	72	44	49.5	536
Kaipara	168	84	300	162	150	264	864	150	180	25.5	2142
Tokatoka	12	0	0	0	28	68	0	14	80	27	122
Total Relative Risk	320	216	576	178	408	990	1024	450	800	222	(4162)

Table 4-7. Ranked relative risk output of relative risk model by habitat and ecological district

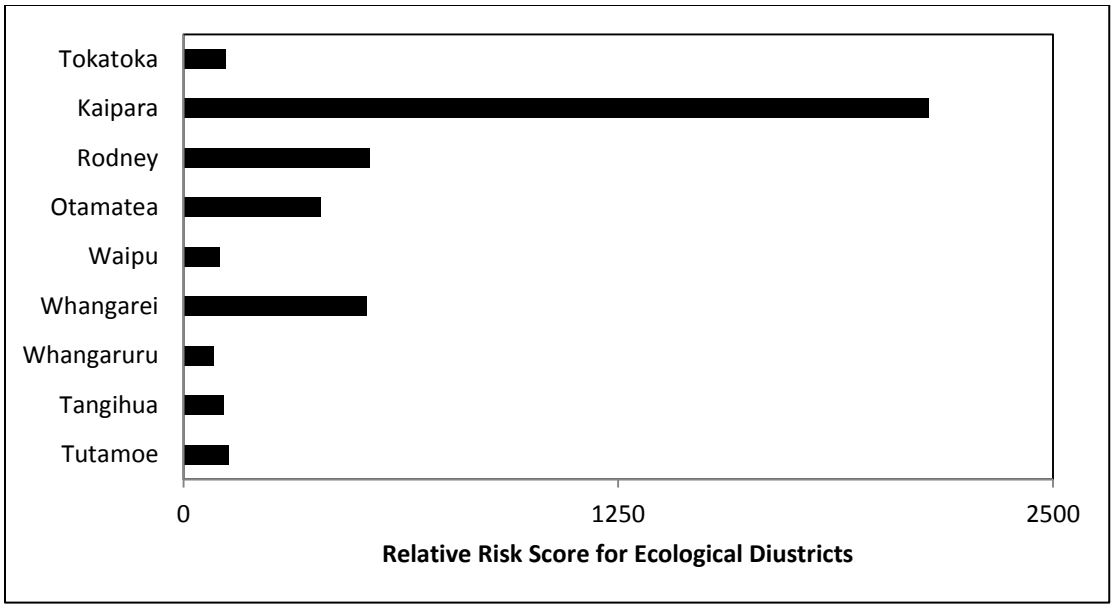

Figure 4-6. Total relative risk scores obtained for each ecological district

Risk characterization of sources

The risk assessment indicates that fishing (commercial, recreational and customary) contributes the most risk to the watershed (Table 4-5, Figure 4-7). Runoff, the tidal energy project and sand mining are sources contributing the next highest levels of risk, while the RRM indicated that deforestation, agriculture and sedimentation contribute relatively less risk to the Kaipara watershed. In the two ecological districts experiencing the most risk, the Rodney and Kaipara, fishing and sand mining are the two predominant sources contributing the large proportions of relative risk to, in particular, the shellfish and sand dune habitats. The tidal energy project that is unique to the Kaipara ecological district has a large impact on marine habitats used by sharks, and the rare and critically endangered condition of the Maui Dolphin species (see Table A-1 in Appendix A).

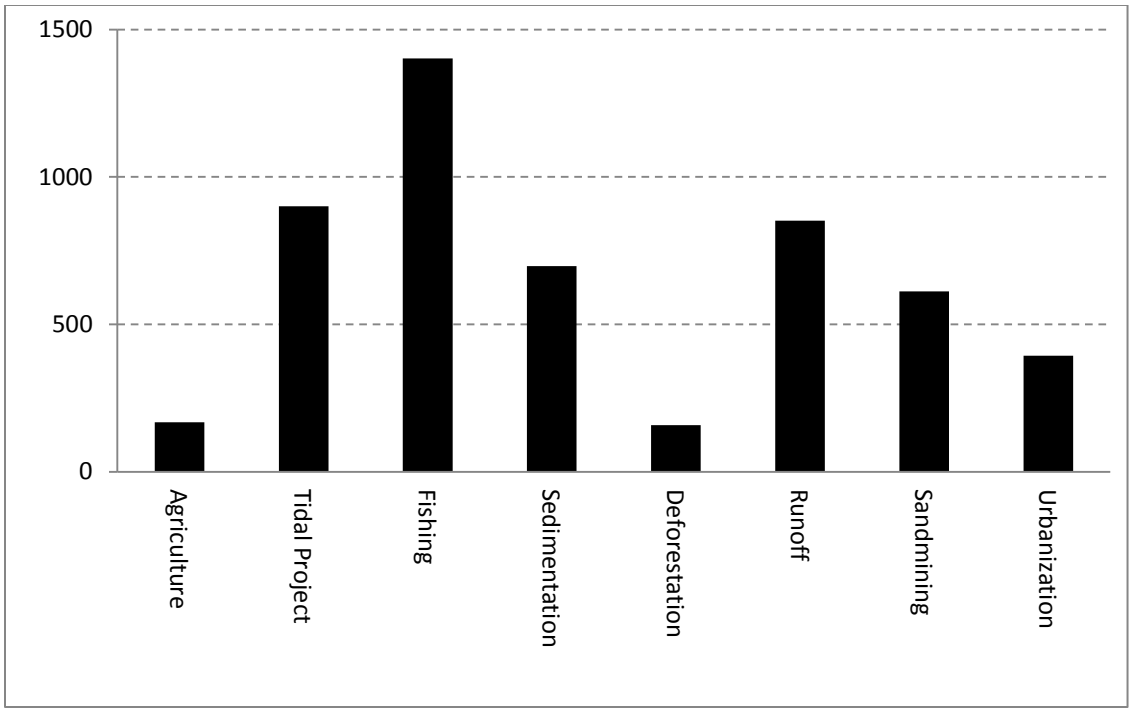

Figure 4-7. Total relative risk scores calculated for sources in the Kaipara Harbour catchment

Risk characterization of habitats

Shellfish, Maui Dolphin and wetland habitats are exposed to the greatest relative risk in the Kaipara Harbour catchment (Figure 4-8). Conversely, the finfish, sea grass, shark, and bird habitats are at relatively lower risk. No observable patterns emerged in terms of marine, coastal, intertidal, or terrestrial trends in habitat risk. However, once again given the value and significance of the threatened Maui Dolphin and sand dune habitat, the magnitude of risk is amplified.

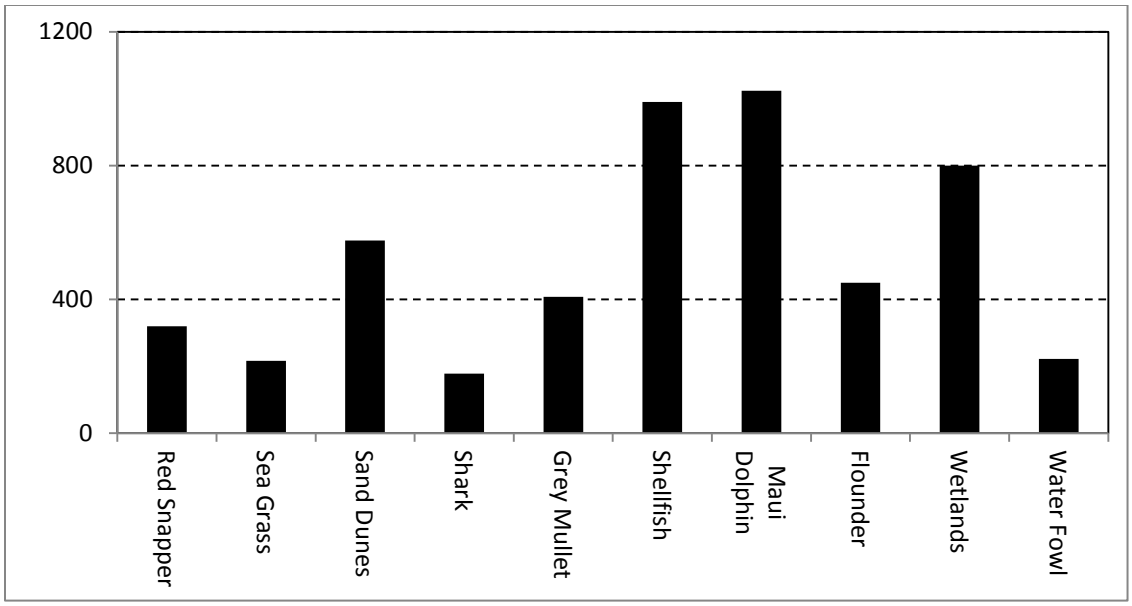

Figure 4-8. Total relative risk scores calculated for habitats in the Kaipara Harbour catchment

Relative risk in the Kaipara Harbour catchment

This risk assessment determined that the fishing industry source contributes the greatest risk across the ecological districts in the watershed. The assessment also identified sand extraction, the tidal turbines approved in the mouth of the Kaipara Harbour, and agricultural runoff as additional stressors of concern. The majority of these sources are a result of increased exposure pathways reflected in the effects filter (Tables A3-A5, Appendix A) in comparison to other sources, excluding sand mining and tidal energy sources that are magnified as a result of the intensified impacts (Tables A7-A8, Appendix A) they have in the ecological district they are found in. The risk assessment also identifies that shellfish, Maui Dolphin and wetland habitats exhibit the most relative risk in the Kaipara Harbour catchment. Aside from the Maui Dolphin's critically endangered status, these findings result from increased exposure pathways across all

ecological districts. Habitats across the range of marine, coastal and intertidal environments exhibit both high and low levels of relative risk, posing a challenge to discern habitat vulnerability in relation to spatial and topographical conditions. Thus, the most significant assessment goal identified during the problem formulation phase based on the results of this study are the *valued and endangered ecosystems or habitats* such as wetlands, sand dunes and the Maui Dolphin.

This risk assessment also revealed that there is a risk gradient associated with the relative risk of ecological districts and their proximity to water sources. The ecological districts that are closer to marine, intertidal and freshwater sources (Kaipara, Rodney) generally are exposed to more risk based on both the stressor sources exposed as well the amount of vulnerable habitat impacted in the region. Those districts upstream or located higher in the Kaipara catchment (Tokatoka, Tutamoe, Waipu) are generally associated with lower levels of risk. This predicted trend of increasing risk from upstream districts to downstream regions is expected because of the greater combination of stakeholder-identified habitat and sources of stress in those ecological districts lower and downstream in the catchment.

Monte Carlo Analysis

Source estimate risk scores (Figure 4-9) and the habitat estimate risk scores (Figure 4-10) of the Monte Carlo simulations reveal the increased variability in source rank inputs used for the RRM. The Kaipara ecological district maintains high risk (Table 4-5) however Tokatoka and Waipu districts reveal increased risk estimates in the Monte Carlo analysis, despite their minimal influence in the RRM ranking assignments.

The results of the habitat simulations concur with the RRMA rankings (Table 4-6), maintaining the Kaipara, Rodney and Whangarei ecological districts with high risk characterizations.

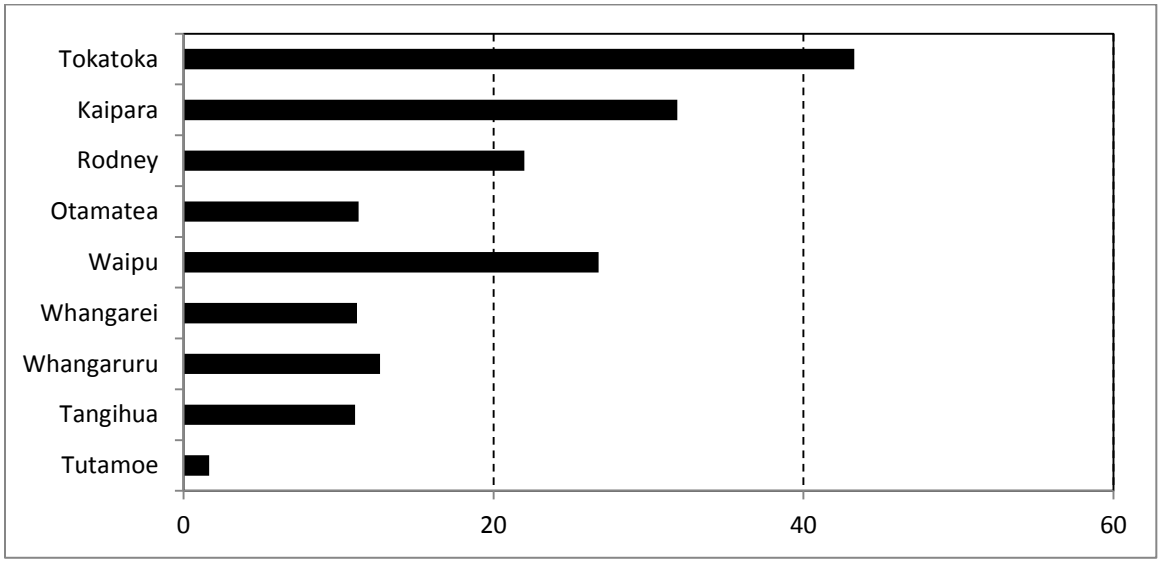

Figure 4-9. Monte Carlo analysis source risk scores derived and averaged from 1000 iterations.

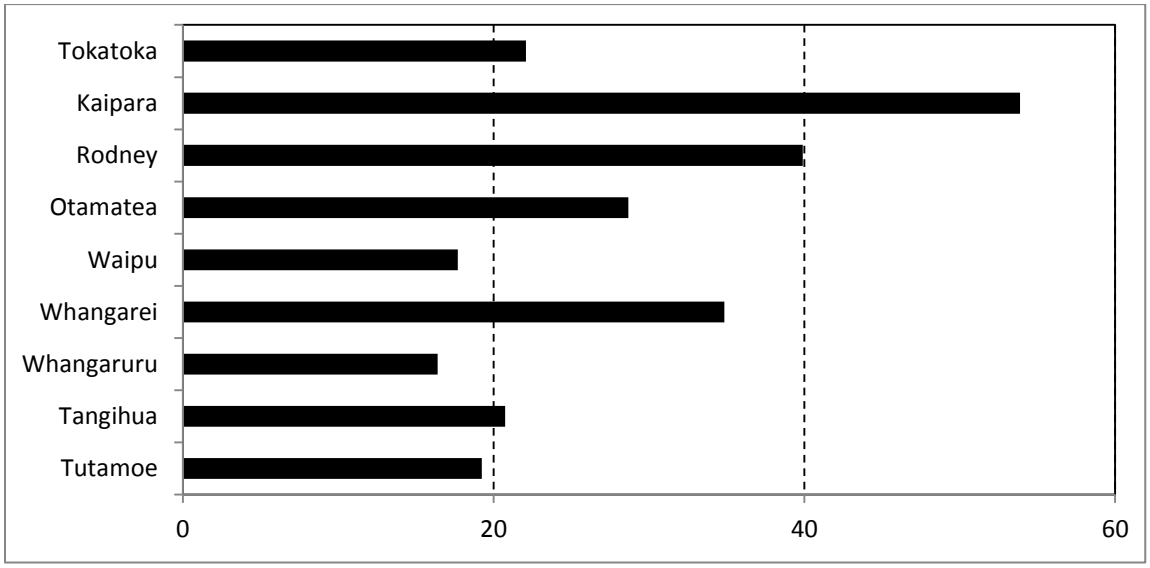

Figure 4-10.. Monte Carlo analysis habitat risk scores derived and averaged from 1000 iterations.

DISCUSSION

The level of concern for the Kaipara Harbour has elevated over the past few years due to the increase in adverse impact from several anthropogenic activities. A variety of governmental, nongovernmental, scientific and private groups have conducted studies that assess individual activities or habitats in the watershed. The data from existing literature is robust, although is not coordinated since it is fragmented in a variety of perspectives: environmental groups, indigenous groups, crown research entities, regional councils and local users in the catchment, to name a few. The resource users of the harbour are represented by these stakeholders and decision-makers, providing much of the knowledge about the harbour; however, their perspectives are often conflicting with one another making it difficult to understand the competing tradeoffs. Congruently, there is presently no comprehensive management plan of the Kaipara Harbour. Through the application of the RRM this research project fills some of the information gaps amongst the diverse stakeholder opinions and offers an integration of the representative perspectives to assess the threats to highly valued resources in the Kaipara Harbour catchment.

Risk Management Recommendations in the Kaipara Harbour Catchment

The comprehensiveness in scope is pivotal to this study, including stakeholder and resource user engagement, along with the existing biophysical science and current political and cultural regime. The result is a new and inclusive ecological perspective for the management of the resources in the Kaipara catchment. The design of the RRM allows for the multiplicity of environmental interactions to be considered and the combined results and conclusions are now left to the discretion and interpretation of the

resource managers in the system. The weighted filters were modified from the traditional RRM to better reflect the sensitivities of sources and habitats in the Kaipara Catchment by incorporating magnitude in both the exposure effects and the resulting impacts. The findings of the risk assessment process offer preliminary management recommendations for those decision-makers of the watershed, synthesizing and prioritizing the concerns expressed by stakeholders in the watershed. Given the multijurisdictional governance of the Kaipara Harbour's district, regional, and unitary authority, the recommendations could be used to guide future conversations on managing the following environmental issues, as highlighted by the higher relative risk values in RRM application to the Kaipara Harbour catchment.

Based on the representative stakeholder perspectives interviewed in the problem formulation phase, relative risk values revealed that the fishing industry source exhibits the most relative risk in the RRM. The commercial, recreational and customary fishing industries span a wide array of habitats, geographical extents, and fishing technologies. Although there are several data limitations and gaps on the fisheries information , it is recommended that further investigations and a separate risk assessment solely on the fishing industry and the impacts of specific fish stocks is conducted to better manage specific fish stocks. Interviews with recreational, customary and most importantly, commercial fisheries offer a starting point to understand the complexities between each resource user, obtaining information about their concerns from specific stressors and towards individual species or habitats. The decision-makers could then supplement this data from the Quota Management System as a starting point for a conceptual model,

detailing the current management and technologies used of specific fish stocks in the Kaipara Harbour catchment.

Out of the relative risk values occurring in each habitat (Table 4-6) all of the finfish species impacted indicate similar levels of low relative risk, while the shellfish habitat reveals substantially higher levels. Important to note is the shellfish category includes oysters, scallops, mussels and prawns; if environmental managers preferred to examine the risk of each type of shellfish populations separately, it is recommended that these individual species are separated into another risk assessment about shellfish only.

Aside from the shellfish habitats, the risk assessment results also suggest that Maui Dolphin and wetland habitats exhibit the most relative risk in the Kaipara Harbour catchment. The Maui Dolphin's high relative risk scores are not surprising considering they are extraordinarily rare worldwide with a population of 55 and their critically endangered status. The freshwater wetlands habitat, however, may not presently be a priority for management in the Kaipara Catchment where often the marine, coastal, and intertidal habitats take precedence. Each ecological district has varying amounts of freshwater wetlands remaining and the resource managers in each regional or district council should survey the current wetland status to determine whether wetlands should be prioritized in specific ecological districts. The wetland geospatial and PNAP report data would also be updated in the process.

In general, the Kaipara district is characterized as having by far the most risk, and the Whangarei and Rodney ecological districts are exposed to the next highest levels of

risk based on both the stressor sources exposed as well the amount of vulnerable habitat impacted in the region. As expected, the total risk incorporating both exposure effect and total impact of sources and habitats across the districts (Figure 4-5) reveals the Kaipara ecological district, including the marine harbour environment, contains the most risk.

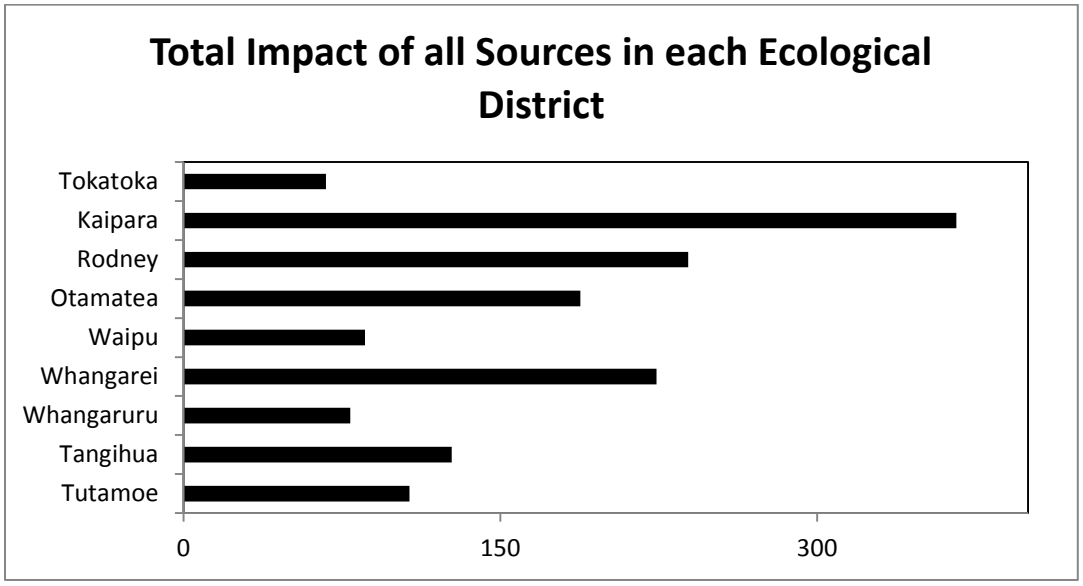

Figure 4-11. Total impact of sources across all ecological districts

The *total impact* of the sources in each district (Figure 4-11), again indicates the Kaipara district with the highest risk characterization, detailing the ecological districts that are contributing high impacts from sources of concern in the catchment. However, examining the impacts from the sources illustrates that not only are the Kaipara, Rodney, and Whangarei districts at high levels of risk in the catchment, they are also contributing the largest proportion of the adverse impacts to the habitats identified.

Noteworthy, is that the Kaipara and Rodney ecological districts are multijurisdictional with the Northland Regional Council and Auckland Council governing a portion of each area. The Kaipara ecological district is divided almost equally in half with each jurisdiction overseeing the northern (Northland Regional Council) or southern (Auckland Council) portion of the harbour, while the Rodney ecological district predominantly lies within the Auckland Council's administration. Seeing as these two ecological districts have dramatically higher relative risk in comparison to the rest of the ecological districts, we recommend that the regional councils create a subcommittee with members from both jurisdictions come together as an effort to instigate comprehensive management for these ecological areas. These two ecological districts are adjacent to or contain the harbour itself; creating such a committee could offer a powerful starting point in the broader picture of integrated catchment management.

The Regional Risk Model: Limitations, Implications and Importance

This model was framed based on the problem formulation phase with the stakeholders interviewed and the available knowledge at the present time. It is possible, that different risk assessments will yield different results based on the type of assessment goals determined in the early stages of the analysis. For example, a separate ecological risk assessment could be conducted solely on agriculture and terrestrial habitats, changing the entire scope and breadth of the study. Despite the possibility of different conceptual

models, the RRM framework will always offer a mechanism of prioritization and inherently the basis of discussion for environmental prioritization.

This particular application of this RRM was intentionally broad in scope in an effort to provide overarching guidance for initial management decisions specifically directed to the regional councils. Thus, this study did not focus on specific chemical or biological stressors in the system but rather the breadth was kept broad to identify those *larger* sources of concern that impact the *wider* range of habitats. In the future, further investigations could isolate specific stressors released by individual sources, evaluating detailed interactions with species and habitats types. However, the data resources to execute such a study are currently not available.

The literature and data on the Kaipara Harbour, its surrounding catchment, land cover and land uses, and habitats are growing, although it is fragmented depending on the source, region, and jurisdictional governance. The regional examination is widespread and includes a multiplicity of stressors and several habitats with the tradeoff is the finer resolution of details are inevitably compromised. Future investigations could be refined in scale and narrowed in scope if preferred from stakeholders and resource managers, time and funding were substantial, and the data needs were met.

The application of the RRM was valuable for a number of reasons. First, the assessment assisted in the organization of available data and pointed to where gaps exist in the literature. Second, stakeholder engagement was essential in the problem formulation phase and set the goals and objectives of the ecological risk assessment. The

model inputs from regulators, informed community members and scientists, who had empirical knowledge and experience in the harbour, filled many gaps in conceptual and quantitative data. Finally, the unit-less results and semi-quantitative scale of low, medium and high are simple for a wide array of audiences to use and understand. The final risk scores allow for follow-up investigations and discussion to continue making progress in the eventual comprehensive management of the Kaipara Harbour.

CONCLUSION

This ecological risk assessment of the Kaipara Harbour catchment evaluated numerous sources of stress in a system and the impacts they have on multiple habitats in nine ecological districts of the watershed. The RRM provides a methodology that is well suited for the regional and watershed applications, and this preliminary risk assessment has proved that the framework is a useful tool for synthesizing several types of data ranging from stakeholder perspectives, and data on sources of stress, habitats types, and competing environmental tradeoffs into one cohesive study. This conceptual model underpinning the RRM framework was derived from stakeholder interests, and the results were calculated using the interactions between source and habitat groups in the catchment. The RRM of the Kaipara Harbour catchment provides a starting point to compare the competing environmental tradeoffs and levels of risk associated with the various resource users in the watershed. This research was conducted with the intention to offer the resource managers and decision-makers of the Kaipara Harbour with management recommendations and to provide insight for future investigations.

ACKNOWLEDGEMENTS

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APPENDIX A

Ecological Districts	What is the extent, size, number of each source in each ecological district?							
	Agriculture	Tidal Project	Fishing	Sedimentation	Deforestation	Runoff	Sand mining	Urbanization
Tutamoe	2	0	4	4	2	4	0	2
Tangihua	2	0	2	4	2	2	0	2
Whangaruru	2	0	2	2	2	4	0	4
Whangarei	4	0	6	2	4	6	0	6
Waipu	2	0	4	2	2	2	0	6
Otamatea	4	0	2	6	6	2	4	4
Rodney	2	0	4	4	2	2	4	6
Kaipara	2	6	6	6	4	4	6	4
Tokatoka	6	0	2	2	2	2	0	4

Table A-1. Source ranking assignment for the ecological districts in the Kaipara Harbour catchment

Ecological Districts	What is the extent, size, number of each Habitat in each ecological district?									
	Red Snapper	Sea Grass	Sand Dunes	Shark	Grey Mullet	Shellfish	Maui Dolphin	Flounder	Wetlands	Water Fowl
Tutamoe	2	0	0	0	2	2	0	2	6	2
Tangihua	2	0	0	0	2	4	0	2	6	2
Whangaruru	2	0	0	0	2	2	0	2	2	2
Whangarei	2	6	0	4	2	6	2	4	4	4
Waipu	2	0	0	0	2	2	0	2	2	4
Otamatea	2	0	4	0	4	6	0	6	2	4
Rodney	2	6	4	2	6	4	2	6	2	6
Kaipara	6	6	6	6	6	6	6	6	6	6
Tokatoka	2	0	0	0	4	4	0	2	4	4

Table A 2. Habitat ranking assignment for the ecological districts in the Kaipara Harbour catchment

Effect Link	Is the source likely to occur in the habitat?									
Source	Red Snapper	Sea Grass	Sand Dunes	Shark	Grey Mullet	Shellfish	Maui Dolphin	Flounder	Wetlands	Water Fowl
Agriculture	0	0	0	0	0	0.5	0	0	1	0.5
Tidal Project	1	0	0	1	1	1	1	1	0	0
Fishing	1	1	1	1	1	1	1	1	0.5	1
Sedimentation	1	1	1	0	1	1	0	1	1	1
Deforestation	0	1	0.5	0	0	1	0	0	1	1
Runoff	1	1	1	0	1	1	0	1	1	1
Sand mining	1	1	1	0	1	1	0	1	1	1
Urbanization	0	1	1	0	0	1	0	0	1	1

Table A-3. Source exposure filter for RRM in Kaipara Catchment

Effect Importance	How important is the source's exposure in the habitat?									
Source	Red Snapper	Sea Grass	Sand Dunes	Shark	Grey Mullet	Shellfish	Maui Dolphin	Flounder	Wetlands	Water Fowl
Agriculture	1	1	1	0.5	1	1	0.5	1	1	0.5
Tidal Project	1	0	0.5	2	1	1	4	1	0	0
Fishing	1	0	0	1	1	1	4	1	0	0
Sedimentation	0	0.5	0	0	0.5	1	0	0.5	1	0
Deforestation	0	1	0	0	0	0	0	0	1	0.5
Runoff	1	1	0	0	1	1	0	1	1	0.5
Sand mining	0	0.5	2	0	0	0.5	0	0	0	0
Urbanization	0	0.5	0.5	0	0	0.5	0	0	1	1

Table A-4. Source effect importance filter for RRM in Kaipara Catchment

Total Source Effect	What is the total effect of each source on each habitat?									
Source	Red Snapper	Sea Grass	Sand Dunes	Shark	Grey Mullet	Shellfish	Maui Dolphin	Flounder	Wetlands	Water Fowl
Agriculture	0	0	0	0	0	0.5	0	0	1	0.25
Tidal Project	1	0	0	2	1	1	4	1	0	0
Fishing	1	0	0	1	1	1	4	1	0	0
Sedimentation	0	0.5	0	0	0.5	1	0	0.5	1	0
Deforestation	0	1	0	0	0	0	0	0	1	0.5
Runoff	1	1	0	0	1	1	0	1	1	0.5
Sand mining	0	0.5	2	0	0	0.5	0	0	0	0
Urbanization	0	0.5	0.5	0	0	0.5	0	0	1	1

Table A-5. Total effect of source (exposure and importance) filter in RRM in KaiparaCatchment

Impact Link	Is the source likely to cause an impact in the habitat?									
Source	Red Snapper	Sea Grass	Sand Dunes	Shark	Grey Mullet	Shellfish	Maui Dolphin	Flounder	Wetlands	**Water Fowl**
Agriculture	1	1	1	0.5	1	1	0.5	1	1	1
Tidal Project	1	0	0.5	1	1	1	1	1	0	0
Fishing	1	0	0	0.5	1	1	1	1	0	0
Sedimentation	0	1	0	0	1	1	0	1	1	0
Deforestation	0	0.5	0	0	0	0	0	0	1	1
Runoff	1	1	0	0	1	1	0	1	1	1
Sand mining	0	1	1	0	0	1	0	0	0	0
Urbanization	0	1	1	0	0	1	0	0	1	1

Table A-6. Impact link between source and habitat filter in RRM in Kaipara Catchment

Impact Importance	How important is the impact caused by the source in each specific habitat?									
Source	Red Snapper	Sea Grass	Sand Dunes	Shark	Grey Mullet	Shellfish	Maui Dolphin	Flounder	Wetlands	Water Fowl
Agriculture	2	1	1	1	1	1	1	1	1	0.5
Tidal Project	2	0	1	2	1	1	4	1	0	0
Fishing	2	0	0	1	2	2	2	2	0	0
Sedimentation	0	1	0	0	1	2	0	1	2	0
Deforestation	0	1	0	0	0	0	0	0	1	1
Runoff	1	1	0	0	1	2	0	1	2	1
Sand mining	0	1	4	0	0	1	0	0	0	0
Urbanization	0	1	1	0	0	1	0	0	1	1

Table A-7. Impact importance filter for RRM in Kaipara catchment

Impact filter	What is the total impact of the source on each habitat?									
Source	Red Snapper	Sea Grass	Sand Dunes	Shark	Grey Mullet	Shellfish	Maui Dolphin	Flounder	Wetlands	Water Fowl
Agriculture	2	1	1	0.5	1	1	0.5	1	1	0.5
Tidal Project	2	0	0.5	2	1	1	4	1	0	0
Fishing	2	0	0	0.5	2	2	2	2	0	0
Sedimentation	0	1	0	0	1	2	0	1	2	0
Deforestation	0	0.5	0	0	0	0	0	0	1	1
Runoff	1	1	0	0	1	2	0	1	2	1
Sand mining	0	1	4	0	0	1	0	0	0	0
Urbanization	0	1	1	0	0	1	0	0	1	1

Table A-8. Total impact of source on habitat (link, importance) filter in RRM of Kaipara catchment

APPENDIX B

Equation 2: $RS_{sources\ j} = \Sigma(S_{ij} \times H_{ik} \times W_{jk})$ for source *j* = agriculture … urbanization

Equation 3: $RS_{habitats\ k} = \Sigma(S_{ij} \times H_{ik} \times W_{jk})$ for habitat *k* = red snapper … water fowl

Equation 4: $RS_{ecologicaldistricts\ i} = \Sigma(S_{ij} \times H_{ik} \times W_{jk})$

for ecological district *i* = Tutamoe … Tokatoka

Chapter 5 An Evaluation of Māori Values in Multiscalar Environmental Policies Governing the Kaipara Harbour in New Zealand

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Abstract: Integrated indigenous management is increasingly found in watershed governance to engage important stakeholders and incorporate traditional ecological knowledge. This paper explores the integration of Māori values in water and land policies Kaipara Harbour in New Zealand. Multijurisdictional documents were analyzed for the inclusion of nine Māori values. The results of the study indicate the most commonly mentioned values in the policy documents are *Whakakotahitanga, Mana Whenua*, and *Arohatang*a; while *Manaakitanga* and *Whakapono* are the least commonly represented. A scalar trend was also identified, with increased Māori values integration as the geographic scale of policies decreases.

Key Words: Kaipara Harbour, integrated indigenous management, policy analysis, multijurisdictional watershed governance

Introduction

The field of water resources management is increasingly adopting ecosystem and landscape based approaches, incorporating collaborative and multijurisdictional contexts for adaptive governance (Sabatier 2005; Huitema et al. 2009; Memon et al. 2010). Watersheds (or catchments, river basins, water systems, etc.) provide a model context for integrated management, aiming to prioritize issues from the coalescing environmental, social and economic boundaries. Several studies on collaborative watershed management projects conclude that the top-down, agency dominated approach in governing water has come to an end, and are more commonly being replaced with the bottom-up, collaborative approaches that are better adapted to diffuse complex watershed problems (Koontz et al. 2004; Sabatier 2005; Huitema et al. 2009). The interactions between government agencies, nongovernmental actors and citizen participation in collaborative

watershed partnerships often determine whether or not integrated, science-based planning can address resource management conflicts successfully among stakeholders and decision-makers (Moore and Koontz 2003; Koontz et al. 2004; Koehler and Koontz 2008; Durette and Barcham 2009).

Studies in management literature suggest that knowledge from all diverse groups within society can inform resource management, and there has been an increased recognition to include values and beliefs of indigenous communities (Berkes et al. 2000; Tipa and Welch 2006; Panelli and Tipa 2007). Studies of traditional ecological knowledge (TEK) indicate there is a level of local observational information in environmental systems, and is loosely defined as a 'cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmissions about the relationship of living beings (including humans) with one another and with their environment' (Berkes et al. 2000). Globally integrated water resources management approaches that transfer the water management responsibilities from centralized governments to a number of important stakeholders is shifting to include indigenous communities (Durette and Barcham 2009). Indigenous water governance examples exist internationally, with cases involving peasant irrigation with Bolivia's Campesino population, Aboriginal water rights and collaborative governance in Australia, and the integration of First Nations, Metis and Inuit environmental movements in federal regulation in Canada (Ramin 2004; Perreault 2005; Durette and Barcham 2009).

For Māori in New Zealand, survival was traditionally contingent on the natural resource knowledge and sustainable resource gathering from land, water, and sea. This long history of occupation in the country contributed to a rich ecological knowledge of sustainable management practices for water and land resources (Tipa and Tierney 2003; Tipa and Welch 2006; Panelli and Tipa 2007). Following European settlement, traditional land uses became restricted with development and urbanization, and Māori communities witnessed changes (often destruction) to their valued environments, alienating them from resources from which their cultural beliefs and identities are derived (Tipa and Welch 2006). Over the course of the past few decades, and particularly with the passing of the Resource Management Act in 1991, incorporating Māori viewpoints and values in natural resources management is more prevalent. New Zealand has several examples of indigenous integrated watershed management seeing as Māori have cultural connections to water and land, and take on the role of *kaitiaki*, or guardian of the environment, in managing those resources sustainably (Durette and Barcham 2009). Māori traditionally believe that the waters, surrounding land, and all the life supported by them possess *mauri*, or life force; and the primary resource management principle is, therefore, protecting the mauri of a resource from sacrilege (Tipa and Tierney 2003).

The Montueka Integrated Catchment Management Programme for the Montueka River on the South Island of New Zealand, is one example that supported multi-disciplinary, multi-stakeholder research to provide information and knowledge that will improve the management of land, freshwater, and near-coastal environments in catchments with multiple, interacting, and potentially conflicting land uses (Landcare

Research 2013). The *iwi* (tribe) Ngāti Hori that reside in the Hawkes Bay region, on the North Island of New Zealand, were also deeply involved in the revival of the Karamu Stream, an ancestral waterway that was degrading rapidly. The *iwi* obtained a small grant, formed a committee and water management plan for the water body, using at first only indigenous knowledge, and eventually branched to the wider community to ensure the plan had meaning for the stakeholders involved (Durette and Barcham 2009). Another example is the integration of Māori knowledge in management for the Taieri catchment in the South Island. A collaborative research project between Ngai Tahu (iwi) and ecologists developed a cultural health index for assessing stream health, using the iwi values to inform freshwater management processes and categorize stream health indicators (Tipa and Tierney 2003).

Māori communities are clearly engaged in water and land management issues, and are increasingly apart of the co-management and watershed governance decision-making processes. Of most recent legislative significance, the Waikato-Tainu Raupatu Claims Settlement Act 2010 established the Waikato River Authority which set the primary direction for the management of the Waikato River, the longest river in New Zealand. The authority is a single co-governance comprised of 10 appointed members, half of those being iwi, and the other half appointed by the Crown (Pikia 2011). This example of co-governance is one of the first in New Zealand where the vision and strategies of integrated watershed management are developed by both iwi and governmental agencies and approved by local authorities (Environmental Defense Society 2013).

Over the past few years the New Zealand Ministry for the Environment (MfE) has been encouraging integrated and consensus-based approaches for freshwater management and this has resulted in increased Māori engagement in water and land management decisions. The cabinet strategy 'Fresh Start for Freshwater' affirms that rights and cultural interests of Māori in natural resources management remains undefined and unresolved, and this needs to be addressed for successful water management in the country (Durette and Barcham 2009; Ministry for the Environment 2013). However, a recent study of Māori perspectives in water allocation processes reveal that Māori participants have called for a more holistic approach that better reflect their values in protecting the environment. The study further suggests that one of the greatest challenges to successful resource management is the incorporation of Māori values in multiscalar planning ,policy development, and implementation (Durette and Barcham 2009). Despite the New Zealand policy environment increasingly recognizing the need to incorporate Māori viewpoints in water management, some authors argue that the Māori have not yet seen this implementation (Tipa and Tierney 2003; Harmsworth 2005; Durette and Barcham 2009).

This paper explores the integration of Māori values in multiscalar water management policies in the Kaipara Harbour in New Zealand. The Kaipara Harbour is a multijurisdictional body of water that is suffering from declining ecosystem health, and presently has no comprehensive management plan. Local Māori iwi and hapū have several settlements in the Kaipara catchment, and offer TEK in sustainable management

efforts within the region. Several multiscalar policy documents govern the resources of the harbour, and the focus of this paper is to determine the extent to which these documents include Māori values. This paper is organized as follows. First, an overview of the broad context of New Zealand environmental policy is discussed. Then, the methodology is presented, including descriptions of the policies and values selected for analysis. Finally, the results of the analysis are reported and discussed in terms of challenges and opportunities to improve the integrated and indigenous management of the Kaipara Harbour catchment.

Background: New Zealand Environmental Policy

Treaty of Waitangi

The Treaty of Waitangi, the founding document of European Settlement in New Zealand signed in 1840, is a broad statement of principles on which the British and Māori made a political compact to found a nation state and build government in New Zealand. The principles of the treaty include (1) sovereignty to the crown with a conditional requirement to include Māori interests, (2) self-management for sustainable tribal development so iwi can manage their own resources, (3) the principle of equality among all New Zealanders, (4) reasonable cooperation between government and iwi on issues of major concern, and (5) redress principles where the government is responsible for providing effective resolution of the Māori's grievances in expectation of reconciliations (Harmsworth 2005). The treaty gave Māori the right to keep their lands, forests, fisheries and sacred establishments although they would hand sovereignty and

governorship to the Crown. They were also authorized to sell their land to the Crown (New Zealand History Online 2013).

There are two versions, one translation in Māori and one in English, and for the past 170 years the meaning of the Treaty of Waitangi has been debated. The Treaty of Waitangi is a valid, internationally significant document that is valued in the history of New Zealand, and is considered a visionary document that acknowledged Māori customary rights, established the British government in New Zealand, and provided equal rights to all individuals in New Zealand (Harmsworth 2005). However, the lack of statutory authority has influenced the interpretations of the language in both translations, and has been controversial with the failure by the Crown in upholding its commitments to the articles of the Treaty and consequently the adverse impact on Māori and their sacred resources (Harmsworth 2005).

Over the past few decades, legal and political opportunities for Māori to seek redress for breaches by the Crown have increased through the treaty claims process. Maori claims allege that the Crown has violated the Treaty of Waitangi by particular actions, inactions, laws, or policies and as a result Māori have suffered prejudice (Waitangi Tribunal 2013). This process considers grievance claims and offers treaty settlements. This represents an effort to return sacred land and water to the Māori people, and other means of seeking amends for Māori involve co-governance and management powers in land and water decision-making. The Land and Water Forum is one example of a stakeholder-led group that *iwi* and other primary industry representatives, environmentalists, and NGOs are a part of as a collaborative initiative in governing and

managing natural resources in New Zealand (Land and Water Forum 2013; Ministry for the Environment 2013).

Resource Management Act 1991 (RMA)

The Resource Management Act (RMA) passed in 1991 is the principal legislation for environmental and resource management in New Zealand. The RMA's approach to regulate access to natural and physical resources such as land, air and water is firmly rooted in the concepts of sustainable and integrated resources management (Gunningham 2008; Environmental Defense Society 2011). The national government provides the guidance, overarching goals, and policies for the nation while devolving decision-making to the district and regional councils.

The adoption of the RMA is significant for several reasons. First, the RMA's integrated ecosystem approach to managing New Zealand's resources consolidated or replaced many resource specific regimes that were fragmented across agencies and governmental sectors (Fisher 1991). Sixty-nine Acts were amended and repealed and 19 regulations were revoked. Additionally, the RMA was the first legislative bill to incorporate the concept of sustainability in New Zealand. This intention of sustainability was deliberately placed at the heart of a regulatory framework decentralizing decision-making to lower tiers of government, a new framework for the entire country. The RMA requires almost all developments to avoid, mitigate or remedy adverse environmental effects by mandating that consents for use of water, air, soil and land resources be obtained from the relevant regional, city or district councils and include public participation in the decision-making process (Pawson 2010). The RMA has been

controversial from several sectors who view it has a hindrance to development, inefficient to economic growth, expensive, and an unfair waste of time given the added level of bureaucracy with the consent process (Harmsworth 2005). Several portions of the RMA make reference to the role and need for iwi interests and values integration in management plans, and in essence give practical recognition to Māori values in environmental regulations. These sections are 6(e), 7(a) and 8 and are described as (Harmsworth 2005):

- Section 6(e): Matters of national importance need to "recognize and provide for the relationship of Māori and their culture and traditions with ancestral lands, water, sacred sites, and other *taonga*, having regard to *kaitiakitanga* (stewardship) and Treaty of Waitangi principles."
- Section 7(a): Refers to "having regard to the exercise of kaitiakitanga," acknowledging the role of *tangata whenua* (Māori or people of the land) as *kaitiaki* over resources.
- Section (8): Include principles of partnership and participation, stating "all persons exercising functions and powers under the RMA in relation to managing the use, development, and protection of natural and physical resources shall take into account the principles of the Treaty of Waitangi."

Local Government Act 2002

The Local Government Act of 2002 (LGA) defines local governments and districts in New Zealand. Similar to the RMA, this act also includes a focus on sustainability, specifically in terms of resource management defined by the 'four well-beings': social, economic, environmental and cultural resources (New Zealand Legislation 2011). The philosophy behind the act is that the sustainable development for communities stems from the local government, with leadership and coordination from the communities themselves (Harmsworth 2005). The purpose of the Act is to facilitate democratic decision-making and action by and on behalf of localized communities. The LGA divides New Zealand into 11 regional authorities and five territorial (or unitary)

authorities, which are further separated into 73 local districts or territorial authorities, each with an elected Mayor and elected Councilors (New Zealand Legislation 2011). In the case of the Kaipara Harbour, the northern half of the harbour is governed by the Northland Regional Council and the Kaipara District Council, while the southern portion is governed by the recently merged unitary authority of Auckland Council.

Regional authorities are responsible for a wide range of environmental management issues: water, contaminant discharge, coastal management, river and lake management, flood and drainage control, regional land management, regional and public harbours, and biosecurity or pest management. Territorial authorities are responsible for: local-level land use management, network utility services such as water, sewerage, stormwater and solid waste management, local roads, libraries, parks and reserves, and community development (New Zealand Legislation 2011). Property rates are used to fund both regional and territorial governments and there is often overlap between regional and territorial council responsibilities because of their complementary roles. LGA recommends that local governments develop collaborative strategies with iwi communities through a ‘treaty approach' to provide commitments, specific guidance, and reporting functions for increased participation with Maori iwi and/or hapū Legislation would encourage collaboration between local and regional governments, and Māori (Harmsworth 2005; New Zealand Legislation 2011).

New Zealand’s Quota Management System

The former Ministry for Fisheries (MfF), now included in the Ministry of Primary Industries (MPI), is responsible for the Quota Management System (QMS) that

helps with sustainable utilization of fisheries resources through the direct control of harvest levels for each species in specified geographical area. Each fish species in the QMS is subdivided into separate fish stocks defined by the Quota Management Areas (QMAs). Presently there are 100 different fish species managed in 636 different stocks (Ministry of Fisheries 2011). To follow the customary fishing regulations, iwi determine who has *tangata whenua* status over a fishery or *rohe moana* (coastal marine area): The iwi and hapū choose people to act as guardians for the *rohe moana* and the Ministry of Primary Industries then officially appoints them as guardians (Ministry of Fisheries 2011). Māori can request customary fishing grounds to be protected as special management areas for non-commercial designations, coastal protection, for those fish stocks that are declining, and for cultural events (Ministry of Fisheries 2011).

Methods

This study investigates the major environmental policies that govern the resources of the Kaipara Harbour in order to evaluate the degree of incorporation of Māori values. Results are based on a content analysis of the policy language integrating Māori concepts and themes. The selection process of the chosen policies and values is described below. It is important to note that the interpretation and understanding of the data under study inevitably reflect the researcher's own knowledge, understanding and world view. Because the analysis requires data to be read and interpreted by the researcher who is not of Māori background, it is necessary to acknowledge the language limitations of the researcher and how these biases may affect the findings of the research.

Policies of the Kaipara Harbour

Materials used for analysis were national, regional and district level policies that govern the resources of the Kaipara Harbour. There were a total of nine different policies that had relevance to the management of the Kaipara Harbour. However, the policies that were included in the analysis focus on water resource management aspects unique to the Kaipara Harbour including coastal, freshwater and land regulations within the harbour and in the adjacent regional jurisdictions. The policies under review (Table 5-1) are described below and abbreviations will be used through the remainder of this paper. The overarching Resource Management Act (1991) and The Treaty of Waitangi were excluded from analysis due to their broad national context and the overarching guidelines that are devolved to regional governments.

Table 5-1. Summary table of the analyzed policies and plans governing the resources of the Kaipara Harbour

Policy	Year	Scale	Description
National Policy Statement for Freshwater Management (NPSFM)	2011	National	Manages freshwater bodies by water quality and quantity limits
New Zealand Coastal Policy Statement (NZCPS)	2010	National	Coastal spatial planning, and coastal environmental protection
Northland Regional Council Water and Soil Plan (NRCWSP)	2004	Regional	Discharges, construction, surface and ground water use, vegetation
Auckland Council Regional Plan: Air, Land and Water (ACRP)	2010	Regional	Air, soil, rivers, streams, lakes, groundwater, wetlands, geothermal
Kaipara District Plan (KDC)	2013	District	Subdivision, development and landuse change in the in the district

Similarly, the Quota Management System was excluded from analysis because of its emphasis on fisheries and specific fish stock. The Rodney District Plan was excluded from the district level analysis to avoid redundancies in the Auckland Council Regional Plan, as stated on page 11 of the Air, Land and Water plan, "Territorial authorities were consulted about their District plans in the development this Plan. This was to avoid inconsistencies between different plans. It also ensures that wherever possible there are complementary provisions between district plans and this Plan which promote integrated management of land use activities and their associated impacts in terms of soil conservation, air quality, water quality and quantity, and the management of activities on the beds of lakes and rivers." (Auckland Council 2012)

National Policy Statement for Freshwater Management (NPSFM)

National policy statements (NPS) are MfE instruments working under RMA guidelines to assist local governments determine how competing national benefits and local costs should be balanced (Ministry for the Environment 2013). The NPSFM is one of several policies in a larger national reform called the Fresh Start for Freshwater reforms of 2011, which aims to collaboratively address waterway restorations, pollution cleanup, and irrigation issues. The freshwater statement is an effort to improve freshwater management at a national level, setting out objectives and policies that direct local governments to manage water sustainably while providing for economic growth within set water quality and quantity limits (Ministry for the Environment 2013). Resource consents are required for the use of freshwater, and the key purpose of the NPS is to improved freshwater management through setting enforceable water quality and

water quantity limits through an integrated management approach (Ministry for the Environment 2013).

To Māori, water is an essential ingredient of life both physically and spiritually. It therefore gives *mana*, or authority, to people and is considered to be a *taonga,* or treasure, left by the ancestors for the life sustaining use of their descendants (Tipa and Welch 2006). A review conducted by the MfE found that all regional policy statements and regional plans (affecting fresh water) identify and explain relationships between Māori and freshwater resources, emphasizing the issues of concern to Māori (Ministry for the Environment 2011). There are some regional policy statements and regional plans that stand out, these being reflective of high levels of input from iwi authorities, particularly those who are post-settlement governance entities.

New Zealand Coastal Policy Statement (NZCPS)

The coastal management regime is another NPS instrument under the MfE that follows similar protocol in terms of RMA guidelines to assist local governments. The implementation is a joint effort between local authorities and the Department of Conservation, offering explicit and specific direction to councils on strategic and spatial planning as well as addressing several environmental value domains: the preservation of natural character, protection of natural landscapes, protection of indigenous biodiversity, and the adoption of precautionary approaches where appropriate (Department of Conservation 2010). The NZCPS applies to the coastal environment; the seaward limit is 12 nautical miles offshore from roughly the high tide line, while the inland limit is not

defined and varies from region to region according to respective geographies (Department of Conservation 2010).

Coastal resources are significant to Māori for a number of reasons as they provide sustenance and spiritual identity for coastal iwi. Harbours and estuarine areas are important breeding, nursery and feeding grounds for culturally important fish and birds habitats (Forest and Bird 2013; Waikato Regional Council 2013). Maori regard the coastal environment as 'baskets of food' providing *kaimoana*, or seafood, for the coastal community. The sand dunes on coastal ranges often grow *pingao*, a rare weaving material and the also contain many important cultural sites including *middens*, or archeological sites that are domestic dump sites containing refuse from human occupation; historic remains of general living areas often including stained sands from ovens; and *urupa* sites, or burial grounds (Waikato Regional Council 2013).

Northland Regional Council Water and Soil Plan (NRCWSP)

The NRC has a few regional plans active under its jurisdiction to regionally fulfill the purposes of the national RMA guidelines, including an Air Quality Plan and the regional Coastal Plan. This study evaluates the NRC Water and Soil Plan, which covers the effects of land use activities on water and soil specifically in the Northland region. The NRCWSP addresses important water and soil issues in the area, including any discharges to land and water (sewage, stormwater, agricultural, industrial, and trade), surface and groundwater use, construction and earthworks in river and lake beds, and vegetation clearance and activities within the riparian areas along rivers, lakes, and the coastal marine area (Northland Regional Council 2004). Minor activities that do not have

large effects on land and water are permitted, although larger activities either require a resource activity or are prohibited (Northland Regional Council 2004).

Māori have a strong presence in Northland with several major iwi in the region (Ngāpuhi, Te Aupōuri, Te Rarawa, Ngāti Kahu, Ngāti Kurī and Ngāti Whātua) and comprise 31.7% of the population (Te Ara 2013). NRC works closely with Māori and has iwi representation on the Environmental Management and Transportation committees, maintains an open door policy to work as a liason with iwi on important cultural issues, and includes Māori in consent process to incorporate any concerns or feedback they may have (Northland Regional Council 2011; Reed et al. 2011).

Auckland Council Regional Plan: Air, Land and Water (ACRP)

Similar to the NRC, the Auckland Council has several Auckland Council Regional Plans (ACRPs) that assist in carrying out the purpose of the RMA including coastal, dairy farm discharge and sediment plans. To be consistent with the scale and content of the other regional (NRC) plan evaluated, this analysis includes the ACRP: Air, Land and Water (which was prepared by the former ARC, but now administered by the AC). The plan clearly focuses on the management of air, soil, rivers and streams, lakes, groundwater, wetlands and geothermal water (Auckland Council 2012). Specifically, the plan details management areas under the ACRP governance, and the regulations of air quality hindrances, discharges to land and water, water allocations, cross boundary issues and integrated management, and applications for resource consents (Auckland Council 2012).

Māori have a strong presence in the Auckland, comprising 11% of the population which is substantially less than in the Northland region (Statistics New Zealand 2011). AC has three units within their council that focus on Māori relations, strategies and protocols in terms of regional planning (Auckland Council 2013). The Independent Māori Statutory Board was established in 2010, independent of the AC but working closely with them on important regional planning issues in the Auckland region. The Māori Plan focuses on cultural, social, economic and environmental wellbeing of *Mana Whenua*, Māori with tribal affiliations within the Auckland region, and those with tribal affiliations outside of the Auckland region, *Mataawaka* (Independent Maori Statutory Board 2011). The plan has three layers of influence-- Aspirations, Actions and Accountability-- and an opportunity for Māori to further strengthen partnerships, in particular with the AC and their planning processes.

Kaipara District Plan (KDP)

The Kaipara District falls within the NRC jurisdiction, although it is through the management included in the Kaipara District Plan (KDP) that changes or sub-divisional development in the district are addressed. The plan examined is current as of August, 2013. A new version was available in October, 2013, however it was not publicly available at the time of this study (Kaipara District Council 2012). The KDP is divided into 24 detailed chapters under broader topics including the district wide strategy that covers ecological areas, natural hazards and development; the land use section that categorizes zones into rural, residential, industrial and cultural uses, and other notable chapters include sites, features and units as well as methods, monitoring, and funding

(Kaipara District Council 2012). The specific chapters analyzed were selected based on applicability to natural resources management and Māori values and include: Chapter 1 - Structure and Tools of the Plan, Chapter 2 - District Wide Resource Management Issues, Chapter 3 - Land Use and Development Strategies, Chapter 5 - Tangata Whenua Strategies, Chapter 6 - Ecological Areas, Chapter 15 (a & b) Māori Purposes, and Chapter 17 - Heritage (Kaipara District Council 2012).

The Kaipara District has a moderately strong Māori presence within its jurisdiction, comprising 22.3% of its total population (Statistics New Zealand 2011). From an organizational viewpoint, unlike the regional councils, the KDC does not make any special reference to Māori in the district, or include Māori in their regulatory authority.

Māori Values

A literature review of Māori values in broad application of natural resources was conducted to identify key values for the analysis (Barlow 1991; Kawharu 2000; Tipa and Tierney 2003; Zygadlo et al. 2003; Harmsworth 2005; Harmsworth 2013; Landcare Research 2013). Subsets of values in governance, cultural practices, environmental sustainability, spirituality, and social values categories were identified. Influenced by the similarities in multijurisdictional management, the diverse set of natural features, and the land use applicability at a watershed scale; the finalized list of values selected for analysis builds on the existing values framework highlighted in the Integrated Catchment Management for the Motueka River program (Landcare Research 2013). The selected values (Table 5-2) are described below.

Table 5-2. Summary table of Māori values selected for analysis

Value Name	Definition
Whakapapa	Genealogical descent, ancestral linkages, connections, bonds
Tino rangatiratanga	Self-determination, sovereignty, power, rule, independence
Whakakotahitanga	Respect for individual differences and participatory inclusion for decision-making
Mana Whenua	Self-governance, territorial rights over tribal land and resources
Whakapono	Faith, creed, belief, trust, honesty, integrity
Kaitiakitanga	Guardianship, protection, conservation of the environment
Awhinatanga	Support, interpersonal relationships, being of service
Arohatanga	To care for, love, or respect, to have compassion or sympathy for
Manaakitanga	Hospitality, kindness, reciprocal and unqualified acts of giving and sharing

Whakapapa

Whakapapa is the genealogical descent, ancestral lineage or cultural identity of all living things from gods to the present time(Barlow 1991; Zygadlo et al. 2003; Harmsworth 2005). The term "papa" is anything broad, flat and hard such as a flat rock, a slab or a board, and "whakapapa" is to place in layers, and lay one upon another and is used to describe both the recitation in proper order of genealogies, and also to name the genealogies (Barlow 1991; Himona 2001). Whakapapa includes a spiritual dimension that stretches back to the beginning of time, explaining humankind's inanimate and animate relationship with the universe, earth and matter (Zygadlo et al. 2003). This can be translated to imply a holistic connection and relationship with the surrounding land.

Tino rangatiratanga

Tino rangatiratanga describes Māori sovereignty and independence as it appeared in the Māori version of the Treaty of the Waitangi (Barlow 1991; Zygadlo et al. 2003; Harmsworth 2005). The verbatim of the phrase breaks down into "rangatira" which are Māori chiefs, the suffix "tanga" transforms the word to an abstract noun referring to the quality or attributes of the chieftainship, and the preceding term "Tino" intensifies the term to a the highest level of chieftainship. The closest English translation would be absolute sovereignty, self-determination or autonomy of land, values and resources (Barlow 1991; Zygadlo et al. 2003; Harmsworth 2005). It should be noted that this term has some contention associated with it since it was created by the European colonists, or the *Pākeha*, who often are viewed to have ultimately suppressed Māori rights (Barlow 1991).

Whakakotahitanga

Whakakotahitanga is the Māori term for unity (Poutama 2013). It is a governance term that reflects multiple accountabilities and relationships in congressional activity or policy-making, specifically translating to the respect for individual differences and participatory inclusion for decision-making (Harmsworth 2013; Landcare Research 2013).

Mana Whenua

Mana Whenua are the self-governance and territorial rights over tribal land and resources (Poutama 2013). The term translates to "Mana", the power, authority, and prestige, over "Whenua", land or grounds (Barlow 1991; Poutama 2013). The phrase

typically describes the power associated with the possession of lands, but can also be associated with the power or capacity of the land to produce (Barlow 1991).

Whakapono

Whakapono was first introduced by missionaries to communicate the concept of religion and it means to believe, or have faith, creed, trust, honesty or integrity (Poutama 2013; Te Ara 2013). In terms of natural resources management, the idea connects spirituality to the guardianship and the management of the environment, or *Kaitiakitanga* described below. *E whakapono ana ia ki te Atua kaha rawa./*She believes in God Almighty (Poutama 2013).

Kaitiakitanga

Kaitiakitanga is the stewardship, guardianship and wise protection and care of the environment, natural resources and sacred areas (Barlow 1991; Zygadlo et al. 2003; Harmsworth 2005; Poutama 2013). The word translates to "Kaitiaki" a guardian, or a person or group that cares for an environmental area (Te Ara 2013). The concept follows the notion that humans and nature are not separate, and Kaitiakitanga is a responsibility to maintaining this life force.

Awhinatanga

Awhinatanga means to support, to be of service, or to assist for (Harmsworth 2013; Landcare Research 2013). This phrase has broad applications from education, to health, and to the environment. *Awhina katoa atu mātau i ō mātau mātua ki te parau, ki te rumaki i ngā kai* / We all helped our parents plough and plant the crops (Poutama 2013). This example refers to domestic assistance in a pastoral setting.

Arohatanga

Arohatanga is the state of being sympathetic (Zygadlo et al. 2003). "Aroha" is defined as love, sympathy and charity. Often a person who possesses aroha demonstrates so by sharing it with everyone, and without discrimination (Barlow 1991). This notion of care and compassion to the environment falls under the tenets of Kaitiakitanga, and includes respect for the areas, resources and treasures that are important to Māori.

Manaakitanga

Manaakitanga is a cultural practice about the respect given to visitors, and includes notions of hospitality, and reciprocal and unqualified acts of giving and sharing (Barlow 1991; Zygadlo et al. 2003). "Manaaki" means to express love and ethical care towards people, often translating to the way Māori engage with tourists, fostering the sharing of knowledge, beliefs and hospitality with those outside of their culture (Barlow 1991; Zygadlo et al. 2003; Te Ara 2013). Food and rest are emphasized in this hospitality, with a particular emphasis on feeding or gifting guests with local delicacies of the area (Zygadlo et al. 2003)

Results

The selected policy documents of the Kaipara Harbour (Table 5-1) were analyzed for the presence of identified Māori values (Table 5-2). The language of each document was coded for the existence and frequency of the identified Māori values, carefully isolating the value representation in any Māori contextual conditions embodied in the texts (Table 5-3). Document glossaries, tables of contents, indices, and appendices were omitted from all analyses to avoid redundancy and the duplication of results. A total of

383 mentions of the selected values were present across the five policy documents examined (Table 5-4).

Table 5-3. Examples of contextual language representing Maori values in policy documents

Value	Examples of language content in policies
Whakapapa	Ancestral lineages, genealogic heritage, ancestral customs and traditions
Tino rangatiratanga	Treaty of Waitangi, Māori settlements, independence, colonization, rangatiratanga
Whakakotahitanga	Māori consultation and inclusion in decision-making, consent and planning processes, committed to working together including iwi, collaborate with Māori
Mana Whenua	Tangata Whenua (Māori people of a specific locality), Rohe (territorial boundaries of tribal groups)
Whakapono	Spiritual ideas and values, religious and cultural customs, practices, and rituals, faith, mythologies, god, universe, cosmic forces supporting kaitiakitanga
Kaitiakitanga	Explicit use of term "Kaitiaki", conservation, preservation, management of land and water resources
Awhinatanga	Identify needs, providing, applications, resource consents, monitoring, remedying in relationship to environment, community housing
Arohatanga	cultural and historic heritage, cultural understanding, care for cultural sites and special values, traditional relationships with nature, interests, sacred sites
Manaakitanga	Sharing of local knowledge, foods, and housing, food basket and physical sustenance

The summarized results (Figure 5-1) indicate the most commonly mentioned values in the policies analyzed are *Whakakotahitanga*, *Mana Whenua*, and *Arohatang*a; while *Manaakitanga* and *Whakapono* are the least commonly represented.

Table 5-4. Results of policy content analysis for Maori values

	POLICY					
VALUE	NPSFM	NZCPS	NRCWSP	ACRCP	KDP	Total
Whakapapa	0	4	7	7	14	32
Tino rangatiratanga	1	0	6	8	21	36
Whakakotahitanga	4	5	21	15	19	64
Mana Whenua	2	13	22	7	22	66
Whakapono	0	1	9	7	5	22
Kaitiakitanga	0	12	9	14	14	49
Awhinatanga	1	6	11	8	10	36
Arohatanga	3	8	20	12	18	61
Manaakitanga	1	1	5	6	4	17
Total	12	50	110	84	127	383

The percentage and distribution of the values across the 5 policy documents (Figure 5-2) reveal the district plan contributed the largest number of values (33%) to the analysis. The two regional districts combined contained over half of the identified values (51%), with the broader, unitary regional authority including approximately 1/3 less in values than the traditional regional council (22% versus 29%). The two national documents included the least number of concepts (16%), with the coastal plan containing the majority of those nationally mentioned values (13%).

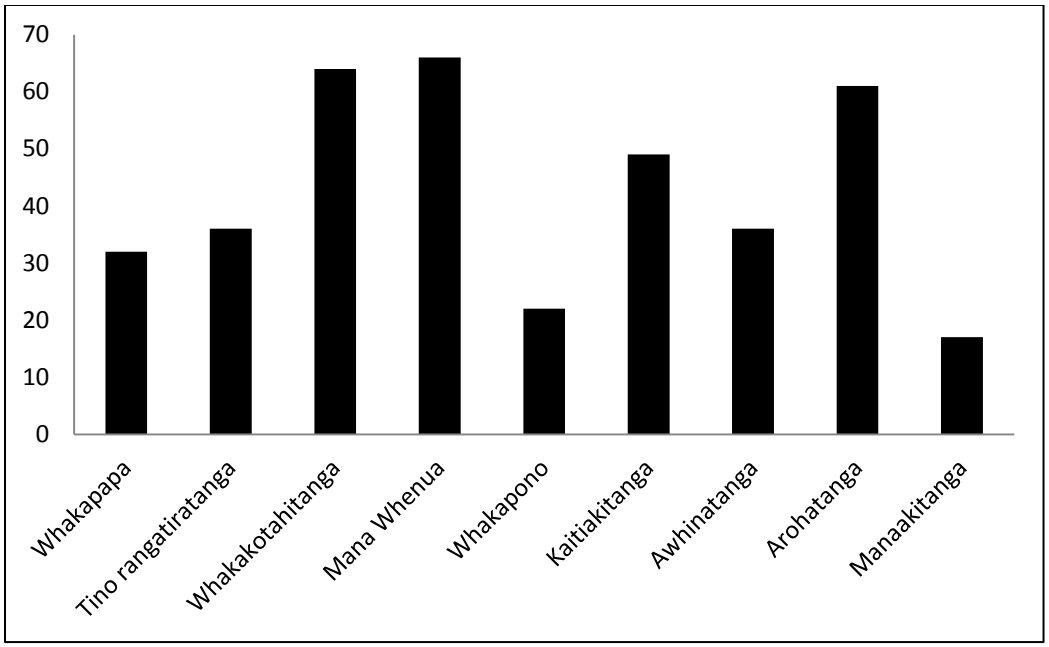

Figure 5-1. Summary of values represented across policy documents governing the Kaipara Harbour

As a result, we determine a scalar trend with the national, regional, and district-level policies displaying increased contextual Māori values as the geographic scale decreases (Figure 5-3).

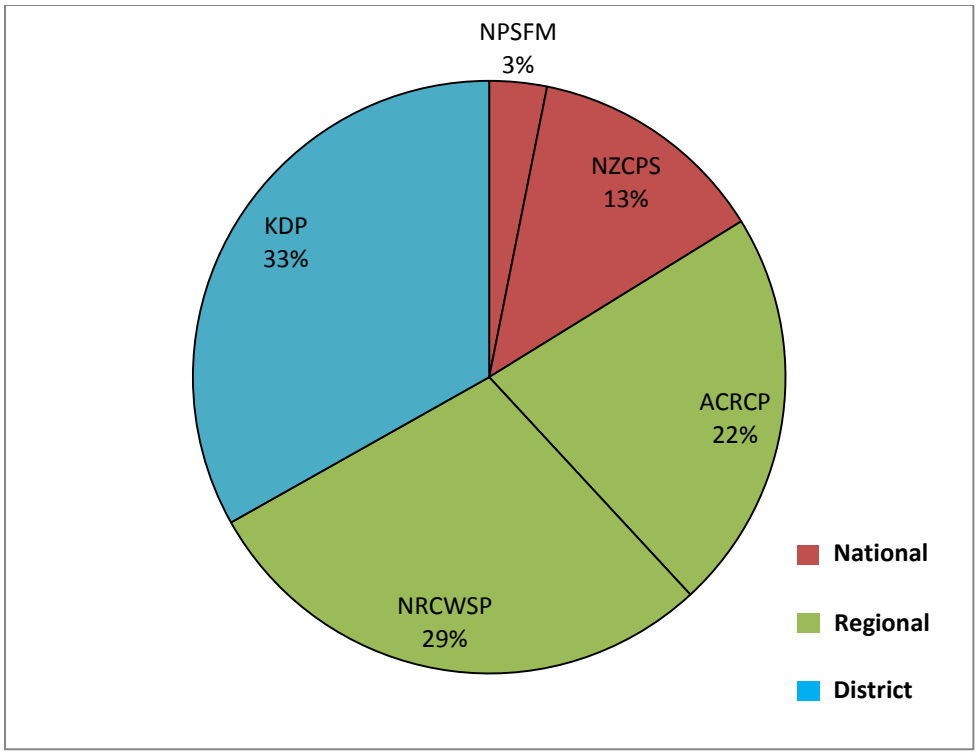

Figure 5-2. Percentage of value distribution across the governing policies of the Kaipara Harbour

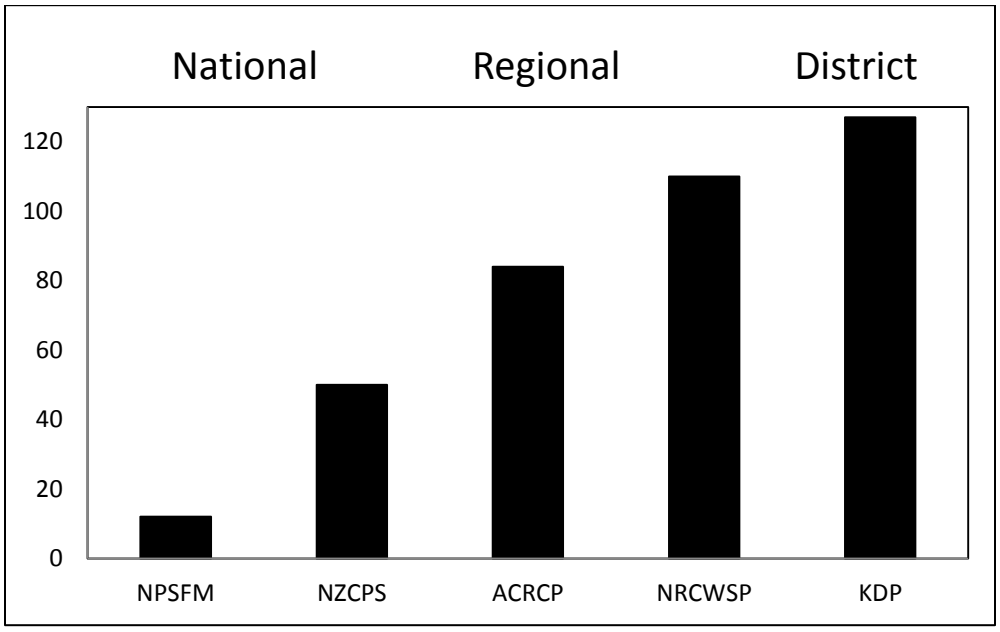

Figure 5-3. Geographical scalar trend of policies incorporating Māori values

The degree of variation of Māori values inclusion in the policies is diverse. The Northland council and the Kaipara District Council plans designated specific Māori chapters including chapter titles such as "Values", "*Tangata Whenua*" (translates to people of the land), and "Māori Purposes: Treaty Settlement Land." Conversely, the national documents sparsely dispersed the value concepts in introduction, background and objective sections. The level of detail regarding the values was substantially higher in the northern jurisdictions documents, with entire subsections assigned to values in the KDC and NRC plans.

A unique example rendered from the analysis is from the NRC plan, offering a Māori blessing at the beginning of their document translating in both native script as well as in English (Northland Regional Council 2004): "MAN WILL PASS, BUT THE EARTH REMAINS

Greetings to all people of the Northland Region.
Firstly, we acknowledge those who have gone before us,
From whom we derive our heritage, Farewell.
To us who remain, Greetings.
We present here the Regional Water and Soil Plan for Northland
In setting it down we look to you, the people of Northland,
For the mandate to carry it out,
So that together we may achieve the wise management of the environment.
May we be blessed in doing so,
Greetings to you all"

In this introductory passage we find *Whakapapa* values in the second and third sentences, acknowledging genealogical descent and ancestral linkages through the words "those who have gone before us" and "derive from our heritage". *Kaitiakitan*ga is also present in the phrase "wise management of the environment".

Kaitiakitanga is present in almost all of the policies and often mentioned in conjunction with other values. For example, the Values chapter of the ACRP under the section 'Tangata Whenua World View'states "Kaikitanga is an integral part of the expression of Rangatiratanga, or authority whereby it is often impossible to protect resources without also exercising a degree of authority or control over them" (2012, 2.3.11, pp. 2-27). This statement includes both *Kaikitanga*, explicitly in this mention, as well as *Tino Rangatiratanga* values. Similarly in the KDC in the Māori Land Issues chapter under section 15A.4.4, it asserts "For Te Uri o Hau and Te Roroa the exercise of *rangatiratanga* and *kaitiaki* through the ability to manage and care for their own lands and waters and their treasures, ecosystems, *waahi tapu* and other *taonga* using their own practices and customs is paramount." Again, the explicit reference to *Kaikitanga* and *Tino Rangatiratanga*, and the religious value of *Whakapono* is represented through the mention of tribal customs and practices (Kaipara District Council 2012). The only document that did not include *kaikitanga* was the NPSFM. This is surprising since the significant value is included in the RMA which openly mandates its inclusion in all resource management policies in New Zealand.

As noted in Table 5-4, the top three most commonly mentioned values are *Whakakohitanga, Mana Whenua,* and *Arohatanga*. *Whakakohitanga* and *Mana Whenua* frequently were mentioned with one another. In the NZCPS, policy 2b (taking account the principles of the Treaty of Waitangi and *kaitikitanga*, in relation to the coastal environment), declares "with the consent of *tangata whenua* and as far as practicable in accordance with *tikanga* Māori, incorporate *mātauranga* Māori in regional policy

statements, in plans, and in the consideration of applications for resource consents, notices of requirement for designation and private plan changes" (2010, pp. 11). This not only includes Māori in the policy and decision-making changes, it specifies the inclusion of the iwi with territorial rights over the designated territory of land. Likewise, in the NPSFM section D (Tāngata whenua roles and interests), objective D1 states "To provide for the involvement of iwi and hapū, and to ensure that tāngata whenua values and interests are identified and reflected in the management of fresh water including associated ecosystems, and decision-making regarding freshwater planning, including on how all other objectives of this national policy statement are given effect to". This broader application includes all three of the top values with the inclusion of Māori in decision-making, and not only local iwi and hapū acknowledged but also their values and interests which incorporate the *Arohatanga* value.

Although this analysis focused initially on the values identified in Table 5- 2, a few additional values emerged throughout the policy documents and are worth mentioning. Knowledge was included frequently, particularly *pukenga*, and *mātauranga* which mean knowledge from ancestral values, world views and cultural practices; and being versed in heritage skills or practices. These concepts of knowledge were typically categorized in the genealogical value of *Whakapap*a. Recreational values were noted, including *waka ama* and *mahinga kai* that are translated to canoes and gardening, and were represented in this analysis by *Arohatanga* values. The concept of *Papakainga*, or land use subdivisions and dwellings for Māori communities, mostly appeared in the local and regional documents in land use planning sections and were tallied in the

Awhinatanga value. Finally, sacred and valuable possessions of Māori were presented evenly amongst the policies, most commonly the term *taonga,* which translates to treasured properties and possessions (Poutama 2013). Yet again, these were included in the *Arohatanga* value, in the context that there is respect and compassion for treasured possessions of Māori people.

Discussion

The integration of Māori values in policies governing the Kaipara Harbour provides insight into the degree of integrated indigenous management occurring in the catchment. The multiscalar national, regional and district regulations are varied in the level of values inclusion. Contrary to the RMA instruction to incorporate Māori interests into decision-making process, the NPSFM surprisingly only contributes 3% of the value occurrences across all policies displaying a low representation of Māori values. The freshwater policy is young and brief, passing only two years ago and including Māori values only sparsely in headings or at the end of subsections. However, the coastal policy statement was also passed recently and incorporates almost five times as many values, is three times the length, and addresses specific policies on a coastal level and interlaces Māori values throughout relevant policy topics. The emphasis on integrated coastal management is clearly important in New Zealand, although several studies indicate freshwater bodies and estuarine habitats are declining in health as a result of adverse impacts from the intensification of agriculture, among other land uses (Wilson et al. 2006; Haggitt et al. 2008; Makey 2010; Swales 2011; The New Zealand Herald 2011). This research argues the NPSFM should not only provide increased national guidance for

freshwater use in the country, but also encourage a holistic management of freshwater resources by incorporating at minimum the significant Māori values that relate to freshwater, including *kaitiakitang*a.

Conversely, the district council plan does not promote or announce Māori integration on their website, in council documents, or through the interviews conducted. Ironically, the KDC contributed over 1/3 of the total Māori values in the policy analysis. The values are not differentiated from the regulatory language in the plan and are consistently distributed in every chapter, focusing largely on the inclusion of the rights of territorial iwi in decision-making, and respecting their culture and traditional norms. The attention and integration to Māori interests in localized regulations offers communities in the Kaipara district to not only respect traditional ecological knowledge, but also contribute to the planning and conservation efforts in the area.

In general, iwi inclusion (*Whakakotahitanga, Mana Whenua*) of designated jurisdictional extents in decision-making processes is strong across all scales of policies examined. This is likely a result of the Māori recognition in the national guidance of the RMA, however is prominently less (by 25%) in national policies compared to the regional and district regulations. The intention behind the substantial values integration in lower tiers of governance may reflect community consideration for Māori interests and iwi recognition, rather than a mandatory or required policy strategy, potentially the case in the national documents. We recognize that the frequency of mentioned values does not necessarily translate to influence or power within legislation; however, it is a transparent indicator of Māori acknowledgment in these regulating documents.

The analysis of *Arohatanga* scrutinized policy language for concepts of care, love, respect, compassion and sympathy. Given the broad and subjective nature of this value, the results conceptually blended many different values that are not included in the analysis and situated the value as one of the prominent in the policy documents. Several of the values that emerged in the analytical process were categorized as an *Arohatanga* value; however, these values could easily have been assigned a unique value category in the initial methodological approach rather than being generalized into *Arohantanga*. For example, knowledge, recreation and sacred possessions all materialized significantly in the policy analysis. These values contributing to the total number of *Arohatanga* mentions, influencing its ranking as the value with the third highest occurrences across the documents examined.

On the contrary the hospitality value *Manaakitanga* was the least mentioned in the document analysis. In environmental contexts *Manaakitanga* often refers to iwi 'food baskets', or the indigenous physical sustenance of tribal groups in different geographical areas that often include shellfish and shellfish. Drawing from recent stakeholder-driven ecological risk research conducted on the Kaipara Harbour, the results revealed the fishery industry being the largest source of stress to the catchment and shellfish habitats of most critical concern for protection (Kanwar et al, 2014). Based on the lack of *Manaakitanga* values across the Kaipara regulatory documents, and the apprehension with fisheries and in particular shellfish habitats, this study recommends increasing the incorporation of *Manaakitanga* into local and regional planning documents, as well as in quota management protocols and ecological conservation documents. This would help

address the limitations presented in cultural integration, land use pressures, and habitat protection with regards to fisheries management and shellfish conservation.

UPDATE (December 18, 2013): Since this research was undertaken there have been significant changes in how Māori rights in New Zealand are being exercised, primarily because of the more recent Treaty settlement claims and through the National Policy Statement on Freshwater Management (NPSFM) 2011 which explicitly specify co-governance rights over freshwater resources. The government is now proposing amendments to the NPSFM and they are substantial, adding approximately 70 pages of text to the document and in many instances strengthens the language in the NPSFM. The proposed amendments require regional councils to account for all water takes and discharges, includes a national framework to support freshwater objectives, provides explicit Māori recognition and involvement, and establishes ecosystem and human health as values in regional planning (Ministry for the Environment 2013). In addition, the Treaty settlement process is the driving force, e.g. Waikato-Tainu Raupatu Claims Settlement Act 2010 which established the Waikato River Authority, by which these amendments are being formalized. These changes could influence the results of this study and the future management of the Kaipara Harbour basin. The proposed amendments opened to the public on November 7th, 2013 and public feedback submissions will close on February, 4 2014.

Conclusion

Māori have thousands of years of historical habitation in New Zealand and have developed exhaustive knowledge of their environment, ecosystems, resources and their sustainable management. This unique knowledge contributes valuable perspective for planning, decision-making and policy implementation for complex resource management issues. Scientific information plays a key role in integrated resource management, however it is the local indigenous knowledge that can contribute data and fill in gaps that conventional scientific approaches may not have been aware of (Bowden et al. 2004).

Presently, the national government is making a strong effort to include Māori in water resources management in New Zealand, and this is clear in the policy analysis for the Kaipara Harbour and the abundant presence of Whakakotahitanga values. However, the current language is gentle and implicit; using phrases such as "recognize", "have regard to", "take account" and "give effect to" in relation to Māori values, interests and inclusion in resource management. Building on the conclusions from the Taieri study of indigenous co-management (Tipa and Welch 2006) , this study recommends that policy and regulatory documents at all scales deliver specific outcomes, from both ecological, economic, and indigenous perspectives that include the preservation of cultural identity and ecological resources, and use a balance of scientific and indigenous knowledge. In the case of the Kaipara Harbour, a direct translation of this recommendation is the inclusion of *Manaakitang*a in multiscalar policy documents, incorporating the traditional ecological knowledge of customary and small scale fishery practices in combination with the existing quota management system, to address cultural, economic and ecological interests. In conclusion, we offer a quote from a document on good practice guidelines

when working with Māori that encapsulates the iwi perspective and intent behind integrated indigenous management (Harmsworth 2005):

"As descendants, many Māori, feel they have a responsibility to their ancestors to uphold, express, and articulate Māori culture and values in modern society."

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Chapter 6 Dissertation Conclusions

This dissertation research explores the complexities of environmental management and decision-making in the Kaipara Harbour in New Zealand. The results of the studies support the intricate relationships between the institutional organization of the actors in the Kaipara network, resource management concerns in the basin and the cultural integration of the acting policies in the catchment. The network governance and adaptive capacities of the Kaipara social-ecological system influence the integration of indigenous co-governance in policies acting on the basin; and both of these factors inherently inform resource management in the Kaipara Harbour catchment (Figure 6-1).

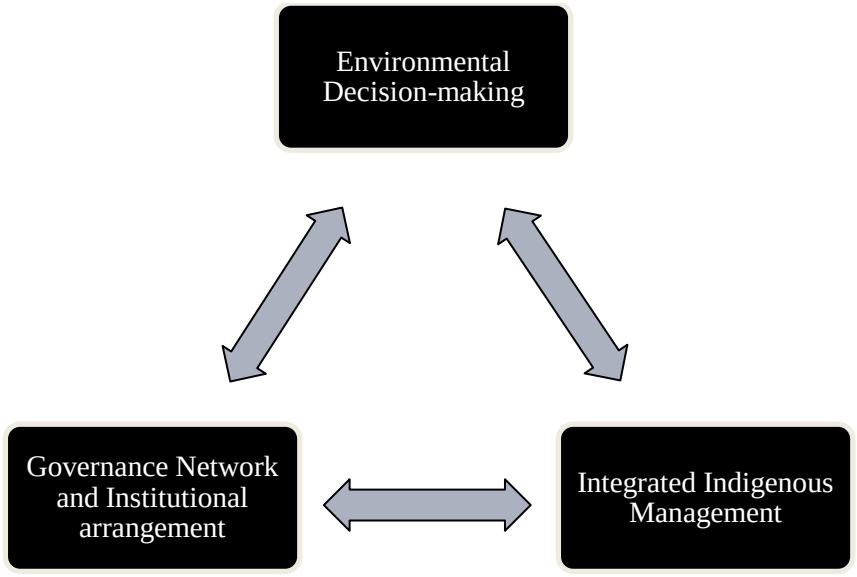

Figure 6-1. The relationship between governance, policy and natural resources management in the Kaipara Harbour catchment.

The objective of this research is to provide recommendations for the policy and decision-makers of the Kaipara Harbour catchment. These recommendations are summarized below.

Institutional Recommendations

- To achieve improved management of the Kaipara Harbour and its resources, the Integrated Kaipara Harbour Management Group (IKHMG) needs regulatory influence in decision-making process at the regional level of the system to represent the interests of the Harbour
- For effective governance of the Kaipara Harbour, the IKHMG requires legislative involvement in making management decisions with respect to the harbour use for the region, creating an action arena outside of the regulatory system

Ecological Recommendations

- To better understand the impacts of the fishing industry, further investigation of the commercial, recreational, and customary fishing industries, their respective impacts on fish stocks, and the role of the Quota Management System is needed
- To isolate the risk characterization of specific shellfish habitats, a follow-up ecological risk assessment focusing on individual shellfish species (oysters, scallops, mussels and prawns) is recommended
- A subcommittee needs to be formed with members from both Northland Regional Council and Auckland Council jurisdictions as an effort to instigate comprehensive management for the ecological areas of the Kaipara catchment

Policy Recommendations

- National Policy Statement for Freshwater Management needs to provide increased national guidance for freshwater use in the country, and encourage holistic management of freshwater resources by incorporating significant Māori values that relate to freshwater, including *Kaitiakitang*a
- The incorporation of *Manaakitanga* in local and regional planning documents, as well as in quota management protocols and ecological conservation documents, would better address the limitations presented in cultural integration, land use pressures, and habitat protection with regards to fisheries management and shellfish conservation

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APPENDIX

Kaipara Harbour Interviews				
Name	**Title**	**Affiliation**	**Date**	**Location**
Leanne Makey	Project Coordinator	Integrated Kaipara Harbour Management Group	May 31, 2011	Helensville
Malcom Green	Freshwater and Estuaries Scientist	National Institute of Water and Atmospheric Research	June 7, 2011	Auckland
Shaun Awatere	Sustainability and Society Staff	Landcare Research	June 7, 2011	Auckland
Ned Norton	Freshwater and Estuaries Modeler	National Institute of Water and Atmospheric Research	Fog Delay	Auckland
Mal Green	Freshwater and Estuaries Scientist	National Institute of Water and Atmospheric Research	June 9, 2011	Auckland
Shaw Mead	Technical Director	LTD. Consulting Firm	June 9, 2011	Ranglan
Jarrod Walker	Marine Scientist	Auckland Council	June 10, 2011	Auckland
Paul and Charm Hauraki	Dairy Farmers	Local family operation, all milk goes to Fonterra Co-op	June 12, 2011	NE Kaipara
Jacquie Reed	Monitoring Specialist	Northland Regional Council	June 13, 2011	Whangarei
Wayne Teal	Land Management Advisor	Northland Regional Council	June 13, 2011	Whangarei
Dan Evans	Land Management Advisor	Northland Regional Council	June 13, 2011	Whangarei
Paul Maxwell	Consents Officer	Northland Regional Council	June 13, 2011	Whangarei
Keri Webster	Land Management Advisor	Northland Regional Council	June 13, 2011	Whangarei
Pete and Christine Yardley	Fishermen	Local	June 13, 2011	Whangarei
Jane Sherard	CEO	Nga Rima o Kaipara Trust	June 16, 2011	Auckland
Ian Boisvert	Axford Fellow/Lawyer	Fulbright/Blue Sky Mediation and Law	June 17, 2011	Auckland
Anthony Hopkins	Director	Crest Energy, Ltd.	June 19, 2011	Auckland
Chrissy Henley	Sustainable Catchments Coordinator	Auckland Council	June 20, 2011	Orewa
Tim Brandenburg	Area Manager	Department of Conservation	June 20, 2011	Warkworth
Graeme Ramsey	Councillor/Former Mayor	Northland Regional Council/Kaipara District Council	June 20, 2011	Dargaville
Mikaera Miru	Cultural Heritage Project Leader	Te Uri o Hau Settlement Trust	June 21, 2011	Whangarei
Deborah Harding	Chief Executive Officer	Te Uri o Hau Settlement Trust	June 21, 2011	Whangarei
Mark Bellingham	North Island Conservation Manager	Forest and Bird	June 22, 2011	Auckland