What is the relationship between science and spatial conflict in aquaculture?

A New Zealand case study in environmental controversy

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ABSTRACT

Aquaculture development in New Zealand (NZ) is a politically controversial topic that is reliant on science for decision-making. Aquaculture causes conflict over use of marine space because the ecosystem is rich with overlapping values and uses, such as recreation, fishing and biodiversity. Science helps decision-makers understand aquaculture's effects on other stakeholders and the environment. This case study investigates the role that science and scientists have in addressing spatial conflict in NZ aquaculture. This is approached from three angles: policy frameworks, scientific knowledge, and the challenges to utilising scientific knowledge in policy frameworks. Data were drawn from documentary analysis and fifty-two semi-structured interviews with members of the aquaculture policy community, marine scientists, and stakeholders in the marine ecosystem.

The results of this case study are as follows. First, the Resource Management Act 1991 (RMA) framework employs science to make normative planning decisions. Where there is controversy over planning decisions, science represents different interests in debates over spatial allocation. Second, regarding scientific knowledge, beliefs and policy goals for aquaculture science appear to be oriented towards commercial, civic and Māori epistemologies. Commercial science is the narrowest of the three for considering the full range of values in the debate over aquaculture. Third, when science is used in policy debates, interviewees perceive it to be politicized, revealing the assumption that science should be neutral and objective. Misinformation and mistrust of scientists are barriers to using science effectively to address spatial conflict.

This research suggests that science politicization of science may be a natural part of aquaculture development, which implies that the links between science and values must be made transparent to allow debate. It is necessary to ensure appropriate and adequate opportunity for deliberation about the principles and values for use and non-use of space. This removes the focus from employing 'right' and 'wrong' scientific facts to influence the political process. This type of debate is supported by civic-oriented science.

ACKNOWLEDGEMENTS

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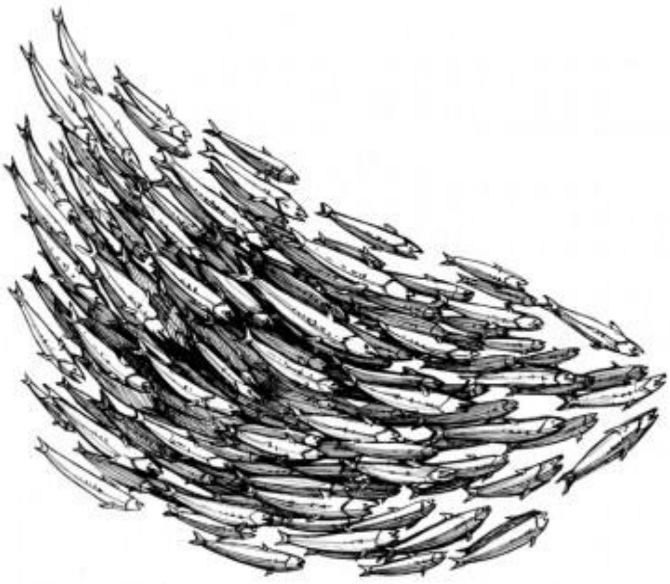
A research assistantship with the Emerging Issues Programme: Oceans Governance project supported this project and provided me with a way to contribute to broader marine issues, which is my ultimate goal in undertaking this degree. My practicum placement at the Ministry for the Environment gave me the chance to experience marine policy development first-hand.



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Salmon farm on the West Coast near Bruce Bay, NZ. It is advertised as the "world's smallest salmon farm". (Collins 2010)

Chapter 1. Introduction

The Blue Revolution is upon us. Aquaculture is the fastest growing food production sector worldwide, having increased from 5% of seafood consumed globally in 1975 to 42% in 2006 (FAO 2008). Marine farming is expected to provide over 50% of global seafood consumption in 2012 (FAO 2011). Decision-makers in both the public and private sectors are increasingly turning to aquaculture to augment fish supply and stimulate economic growth in less developed countries and regions (Rennie et al. 2009). New Zealand (NZ) follows these patterns of global aquaculture growth. From 1985 to 2005, the average annual growth rate of the industry was 13% (NZ Govt 2007) and continues to show growth potential. Principal species farmed are in NZ the Greenshell mussel, Pacific oyster, and king salmon, occupying approximately 15,800 hectares (AQNZ 2010). The principal areas of production are shown in Figure 1.

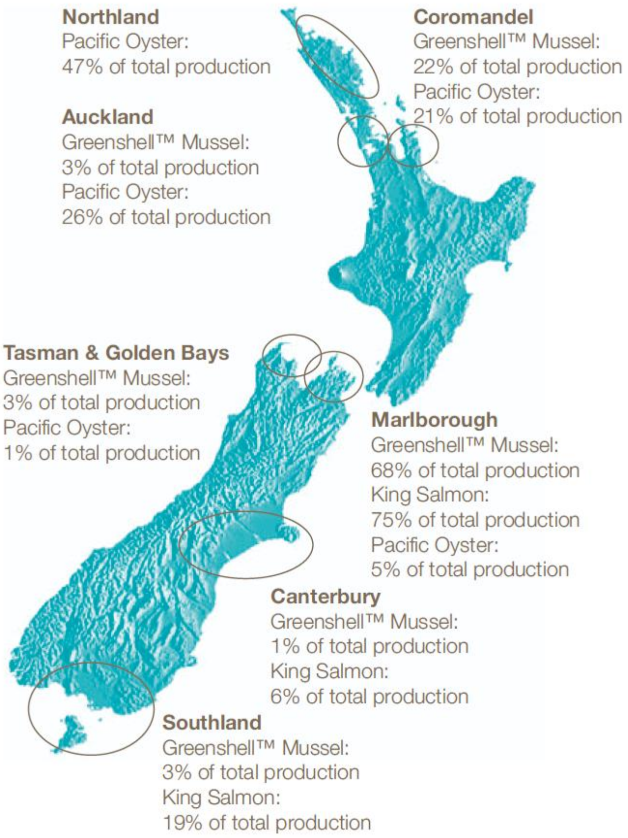


Figure 1. Principal species farmed in NZ marine aquaculture. Source: NZAC 2010.

As aquaculture becomes a significant part of the NZ seascape, objections to aquaculture's exclusive use of space arise among marine stakeholders. Occupation of marine space causes conflict because the coastal marine ecosystem is rich with overlapping values and uses. This research explores how spatial conflict around aquaculture is addressed through science and policy systems. Science and scientists are key parts of understanding the debate, as debate relies on information about the effects of aquaculture on the ecosystem and on other users. This case study explores three aspects of the role that science and scientists have in addressing aquaculture spatial conflict: policy frameworks, scientific knowledge, and the challenges to utilising scientific knowledge in policy frameworks.

The NZ case has implications for how planning and policy deal with multiple use conflict in marine ecosystems, particularly how existing scientific information can be used more effectively to ameliorate environmental controversy. Understanding the interactions between producers and users of science for marine management can support participatory decision-making with respect to ecological goals (Weber et al. 2010). Research into the social aspects of science, including the political factors influencing science and democratization of science, has aided fisheries management to define what is “the best available information” (Sullivan et al. 2006). For other issues of NZ marine space occupation, such as renewable energy, analysis of the Resource Management Act 1991 (RMA) provided valuable insight into the ways that sustainable energy sources can be developed while not frustrating existing interests (Boisvert 2011). The gap in knowledge in this area for aquaculture is discussed in chapter 3.

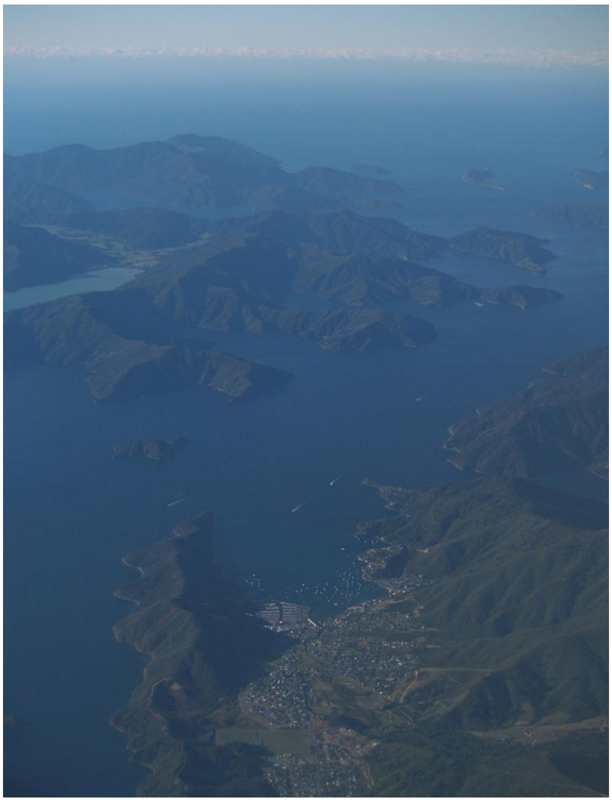
1.1 AQUACULTURE AND SPATIAL CONFLICT

The need to negotiate among multiple, conflicting values for space is a strong theme in NZ aquaculture. Values are defined as relating to ethical, moral, philosophical, cultural or economic importance (MEA 2005), which demonstrate a preference towards a particular outcome. The prominent value sets for the NZ coastal marine ecosystem are reviewed in section 3.1. The definition of aquaculture used in the Resource Management Amendment Act (No. 2) 2004 is “the breeding, hatching, cultivating, rearing, or ongrowing of fish, aquatic life, or seaweed for harvest if … [it] involves *occupation of a coastal marine area*” (emphasis by author). Coastal marine space is multi-functional both in the sense of ecological functions and anthropogenic use. Aquaculture operations claim an exclusive use of marine space, which conflicts with other uses and use values. Broad stakeholders groups in the NZ territorial sea include, but are not limited to: commercial, recreational, environmental, Māori, conservation, and users of ecosystem goods and services.

The definition of spatial conflict used for this case study has three dimensions: conflict that results from spatial and temporal overlaps in use, conflict over legal rights, and conflicts on the principle of occupying marine space. This definition is derived from literature on marine spatial conflict in NZ and internationally. First, in a functional sense, spatial conflict is "spatial and temporal overlap of human activities and their objectives, causing conflicts" (Douvere 2008: 762). Second, conflict extends beyond uses to involve legal rights. Bess and Radamudi (2007) explain NZ marine spatial conflict as the clash between the need for environmental protection and the legislative duty to uphold rights that have been assigned in the legal system (e.g., commercial, customary, recreational). There may also be conflicts between the rights assigned to two or more user groups (e.g., aquaculture and commercial fishing). Lastly, social opposition to aquaculture occurs because there are contrasting use and non-use values. Non-use values support ecosystem protection and are a priority under international obligations such as the United Nations Convention on the Law of the Sea. Section 3.1 elaborates on the conflicting values for use and non-use in the NZ marine ecosystem.

Box 1. "The future expansion of the aquaculture industry in New Zealand will largely depend on the degree to which marine farms are perceived to interfere with or detract from natural character, landscape and amenity values, access to public space, recreational use, and navigation" (Gibbs 2010: 86).

The following is a review of research into NZ aquaculture spatial conflict to date. Public perception of aquaculture in NZ is generally negative (NZAC 2006, Shafer et al. 2010). Spatial conflict occurs in social debate over uses of space (Rennie 2009, Shafer et al. 2010), natural character (Gibbs 2010, Box 1), ecological effects (Rennie et al. 2009, Gibbs 2010), contention over property rights (Rennie et al. 2009, Gibbs 2010), and conflict with local residents, recreational users and environmentalists (PCE 1999). In an analysis by Banta and Gibbs (2009) of aquaculture permits that were declined in the Marlborough District between 1995-2004, 95% were declined in part due to social reasons. Until the 1990s, conflict over space mainly occurred with the commercial fishing sector, but in that decade, conflict broadened to a greater number of user groups (Hickman 1997). In general, public involvement in spatial conflict became more active during



A marina in the Marlborough Region, showing the density of recreational users in the Sounds (Collins 2011).

the 1990s. There was an increase in participation from the recreational sector, and tensions with the commercial sector increased (Gibbs 2010). Thus social aspects of conflict are a central aspect of aquaculture development and of reconciling multiple use conflict in the marine ecosystem.

The legal underpinnings of conflict over aquaculture begin with the public access rights that are granted in the coastal marine area (CMA), which is underscored in the RMA. Occupation rights are taken very seriously, and the RMA takes a precautionary approach to consenting marine space (Makgill and Rennie 2011). Prior to debates over title to the Foreshore and Seabed, the Crown assumed responsibility and title for the CMA. Following the Marine and Coastal Area (Takutai Moana) 2011 Act, the title of the CMA and common law rights were decided to be for the public. This means that there is a strong tendency to maintain public access to the CMA and avoid alienation of the space. Because aquaculture excludes other uses, it is not particularly favoured under the RMA. This is because section 6(a) and (d) provide for “the preservation of the natural character of the coastal environment (including the coastal marine area) and its protection from inappropriate subdivision, use and development” and “the maintenance and enhancement of public access to and along the coastal marine area”. The tendency towards public access, multiple uses and amenity value are key to understanding the social expectations for spatial use (including *non-use*) and for marine ecosystem protection. Further background on the policy institutions for aquaculture is provided in Appendix 9.

1.2 SCIENCE, POLICY AND POLITICS

There is a need to address spatial conflict through effective, democratic and efficient tools that are transparent and accountable to stakeholders in multi-use space, which play a significant role in coastal planning (Kay and Alder 1999, Bennett and Lawrence 2002). Science and scientists play an important role in addressing spatial conflict. Policy makers rely on information about the ecosystem and societal uses for it. According to Pielke (2007), the role of science in environmental decision-making is growing due to the conception that scientists support evidence-based decisions consistently and reliably. He says that science can inform expectations, lay out alternatives and suggest possible outcomes for decision-making.

For politically controversial decisions, this role becomes complicated. Science and policy have very distinct norms and procedural structures for reaching decisions. One aspect of this are the differing goals of science and policy: the goals of science are to increase knowledge, reduce uncertainty, and prevent against being wrong, while the goals of policy are to respond to problems in society and avoid political and social costs (Kinzing et al. 2003). Likewise, scientific problems by nature of the scientific method must be clearly bounded, whereas political problems are not (Herrick and Sarewitz 2000). For NZ aquaculture, the interface between science and politics is particularly complicated due to low levels of baseline marine information (PCE 1999, Banta and Gibbs 2009).

The following paragraphs define science, policy, and politics. The definition of science used in this case study is the systematic pursuit of knowledge and expertise (Pielke 2007), as a way of generating and organising knowledge by testing explanations of how the world operates (Popper 1959). This definition is broad and may include information in areas such as ecology, social sciences, cultural studies, or economics. This study also considers traditional ecological knowledge (TEK) as science knowledge (Berkes 1999). This definition is consistent, yet slightly more broad, than the sciences listed under the Crown Research Institute (CRI) Act 1992 section 2, which include the physical sciences, biological sciences, social sciences, and technology. The wide definition of science is chosen to include many different and difficult-to-compare types of information, which underscore the challenges of using science in political debate.

New Zealand is a liberal democracy that operates under a parliamentary system. Liberal democracy is founded on the principles of liberalism, which are equal rights and freedom of speech (Song 2006). For controversial issues, this relies on the political process and public participation to reach fair outcomes. A liberal democracy provides a structure for pluralist political viewpoints to be incorporated in the democratic process, acknowledging a diversity of interests in society (Hampshire 1983). Pielke (2007) provides useful definitions of policy and politics (Box 2). Politics deals with competing interests and is a process of deliberating between values and social priorities. Deliberation is a core part of politics, defined as the process of negotiating different positions through

Box 2. Policy: "commitment to a particular course of action" (29)
Politics: "the process of bargaining, negotiation, and compromise" that influence allocation of resources to whom, when and the way of allocating. (29)

exchange of ideas or persuasion (Newig et al. 2010). Key elements of deliberative processes, reviewed in Lebel et al. (2006), are open communication, discussion, alternative political viewpoints, and learning. Democratic deliberation is central to reconciling multi-use needs. As described in Chapter 2, NZ aquaculture policy is an area of decision-making where stakes are high due to social conflict.

1.3 AIM OF THIS CASE STUDY

This aim of this case study is to enquire into **the role that science and scientists have in addressing spatial conflict in NZ aquaculture**. There are three parts to this aim. The first is to understand how the RMA, as the principal policy framework for addressing conflict, uses science in debate over aquaculture. Second, because conflict is a result of social factors, this case study examines the links between scientific knowledge and the NZ social context. These links are examined through the commercial, civic and Māori beliefs and policy goals for science. The third research question synthesizes the themes of the first two. Question three investigates the challenges of utilising scientific knowledge in policy, focusing on the expectations and assumptions about science. The three research questions are:

1. How is science used in spatial allocation **policy frameworks** for aquaculture? ....Chapter 4
2. What characterises the epistemologies for **science knowledge** in NZ aquaculture? ....Chapter 5
3. What are the chief challenges for using **science in policy decisions** in aquaculture? .....Chapter 6

The rationale for pursuing these questions is explained in the literature review in chapter 3. The results for each research question are presented in chapters 4-6 with a discussion at the end of each chapter. Chapter 4 uses documentary analysis to examine the RMA spatial allocation process. Chapter 4 also explains how the RMA uses scientific information in normative decisions and how competing interests are represented by different types of information in the debate over space. Next, chapter 5 uses in-depth interviews to characterise commercial, civic and Māori scientific knowledges. Interviews show how these groups' beliefs and policy goals affect the content and end-uses of science. Finally, chapter 6 uses in-depth interviews to explore the chief challenges for engaging science and scientists in political processes. Chapter 6 describes how science becomes politicized as it enters the debate over aquaculture's use of the marine ecosystem. There were diverse assumptions about neutrality and objectivity of scientific information. Respondents recounted that politicization can lead to misuse of information and mistrust for scientists engaging with policy decisions.

Together, the three chapters characterise the way aquaculture policy processes utilise scientific knowledge to address spatial conflict. Chapter 6 discusses these results and suggests that aquaculture science must be contextualised with an understanding of social priorities, values, and worldviews for the marine ecosystem. This removes the focus from using facts to demonstrate the 'right' answer, towards a focus on debate over the principles and values for occupying marine space. This analysis suggests that clear and explicit linkages between science and values can aid policy processes to address spatial conflict. Dealing with politicization, misinformation and mistrust can address barriers to using existing science more effectively in policy. For planning, this means that science must be able to support multiple values and worldviews. Democracy is never finished, so for more effective use of scientific information, the relationships between science, politics and values need to be brought into aquaculture discussions.

Chapter 2. Methodology

I took a qualitative case study approach to this research (Creswell 1994), limiting the case to NZ marine aquaculture. Qualitative methods require a systematic approach to reduce biases (Berg 2007). The literature review in Chapter 3 provides the framework for collecting and analysing data in the 'theory-before-research' approach (Yin 2003). Table 1 states the research questions, the aspect of the science-policy relationship that each addresses, and the method of investigation.

Table 1. Areas of case study investigation.

Research question	Aspect of science-policy relationship	Method of investigation
1. How is science used in spatial allocation <u>policy frameworks</u> for aquaculture?	Framework for planning and spatial allocation	Documentary analysis
2. What are the characteristics of the epistemologies for <u>science knowledge</u> in NZ aquaculture?	Social aspects of science for NZ aquaculture	Semi-structured interviews
3. What are the chief challenges for using <u>science knowledge in policy frameworks</u> to address spatial conflict in aquaculture?	Stakeholder practical experiences of science for policy	Semi-structured interviews

I present the findings in the third person point of view, consistent with many authors in social studies of science (e.g., Jasanoff 1987, Pielke 2007, Gopnik 2008, Keller 2009, Weber et al. 2010, Wiley 2011). However, I recognise that some authors elect to present results in the first person (e.g., Harraway 1988, Kinzing et al. 2003, Sarewitz 2004) to account for their subjectivity in analysing the issues. I opted to report results in the third person[1] point of view for consistency with the field and for clarity, but I recognise that the third person does not reflect as well my position and subjectivity in the research (Creswell 1994, Love 2003, Berg 2007), which may present limitations for this study. For this reason, I include a positionality statement in section 2.3. I present the results in chapters 3-5 using the descriptive method, and my intention was to describe the situation as it is during a particular period of time (Travers 1978).

Common approaches to sociology of science studies are in-depth, qualitative, and mixed methods approaches, such as Pielke (2007) and Keller (2009). Sociology of science draws in part from post-structural methods and acknowledges that there may be a plurality of ‘truths’ on a particular subject (Harraway 1988). Social constructivism asserts that some “concepts, processes, ideas or entities are not natural or inevitable” (Robbins 2004: 109), but instead are formed as part of the lens through which the world is understood. The constructivist camp also asserts that all knowledge is the result of social interaction (French 2007), which is influential in how I analysed the epistemologies for science in aquaculture. The sociological approach implies that the researcher may bring biases to the research, particularly on controversial topics. Reflexivity means examining “what the researcher knows and how the researcher came to know this” (Matza 1969: 179) and is covered in the statement of positionality in section 2.3.

2.1 DOCUMENTARY ANALYSIS

I used documentary analysis to explore the policy framework for spatial allocation. Documentary analysis is generally useful for uncovering trends (Love 2003). I drew information from peer-reviewed journal articles, policy documents, ‘grey’ literature, legal rulings and theses. Internet search terms included “aquaculture”, “New Zealand”, “planning”, and “spatial allocation”. In addition to fact-gathering, I used documentary analysis to identify underlying themes of debate and values in the policy framework (Tonkiss 1998, Love 2003).

[1] There is an exception to this in chapter 5 where an interviewee provided background knowledge on Māori culture speaking specifically to me.

2.2 INTERVIEWS

A qualitative approach is useful to understand the epistemologies for science in aquaculture and the challenges for using science to address spatial conflict. There are norms and rules-in-use for planning and policy development that are not written into the legislative frameworks. I attempted to reveal these norms and rules-in-use during interviews, because they would otherwise be difficult to characterise. Interviews (n=52) provided a means to understand the social and political realities of how science is used *in practice* in a way that allowed for elaboration and clarification. Ethics approval was granted by the Victoria University Human Ethics Committee on 18 April 2011 (Appendix 2).

The semi-structured interview approach garnered a depth of information from each interviewee. Semi-structured interviews allowed for flexible wording of the interview questions, adjustment in language for clarity and reflexivity, and addition/deletion of questions or probes for greater depth (Berg 2007). Semi-structured interview questions also allowed for evolution and increased depth of interview topics, as the research was a learning process for me. Interview questions, listed in Appendix 5, were open-ended and allowed for prompting. I interviewed respondents for their experience, perceptions, behaviour, and the nuances of practice and process (Clark 2003) along the cross-section of perspectives and expertise types. To confirm relevance of research questions, I undertook exploratory consultation with five individuals from Ministry of Fisheries, World Wildlife Fund, Ministry of Science and Innovation, Te Ohu Kaimoana, and Victoria University. Those interviews were not included in the sample. I used their feedback to make the interview questions more specific to the practical realities of policy and science practice. The question topics were:

- The background and position of the interviewee
- The nature of spatial conflict, including underlying values and principles
- Linkages between science providers, policy-makers and the private sector in aquaculture
- Strategies for using science to promote or oppose aquaculture development
- Links between values and science in aquaculture conflict
- The ways that science has influenced the outcomes of spatial conflict
- Interviewees’ concerns for how science is used in aquaculture governance, including the challenges to using science in addressing spatial conflict

I selected informants by purposive sampling for a diversity of opinion and types of expertise in the subject area (Clark 2003), and drawing from the ten stakeholder group categories (Table 2). My aim in purposive sampling was to capture a range of stakeholder values, expertise types and occupational roles. Because the topic area is controversial, purposive sampling enabled me to take a targeted approach to garnering diverse points of view. However, it is limited in its ability to generalise research results (Berg 2007).

Table 2. Distribution of interviewees by stakeholder group and by location.

Distribution of interviewees by stakeholder group	Abbreviation used in results reporting	
Advocate - environmental	Adv-envr	6
Advocate - recreational	Adv-rec	5
Coastal planner	CP	5
Commercial fishing	CF	2
Māori development	MD	3
Marine farming	MF	8
Policy analyst	PA	7
Scientist - CRO[2]	Sci-CRO	8
Scientist - ministry	Sci-min	2
Scientist - university	Sci-uni	6
Total		**52**

Distribution of interviewees by location	
Auckland	5
Bay of Plenty	3
Christchurch	2
Dunedin	1
Marlborough Sounds	5
Nelson	16
Northland	3
Tasman Bay	3
Waikato	2
Wellington	12
Total	**52**

To identify stakeholder group categories, I researched the history of aquaculture spatial conflict prior to interviews. This took place as I was employed as a research assistant for the Emerging Issues Programme: Oceans Governance project. During this project, I conducted a literature review on the drivers of agenda development in aquaculture policy, which served to identify the major interest groups in the sector. Through this research, I revealed ten general stakeholder groups (Table 2). I classified groups on the basis of the interests that they stated as part of their position (e.g., environmental advocate). I provide names and/or employment information (where respondents elected to release) on respondents in Appendix 7.

There are several important points to note on the stakeholder group classification. Some advocates had multiple areas of expertise or of interest, but I classified these as to the individual's primary role or position. For example, one advocate who comes from a legal background and works for an environmental organisation specialises in policy

[2] Contract Research Organisation.

analysis, but I classified her in the Advocate - environmental group. All coastal planners in the sample are employed by a regional or unitary council. The commercial fishing group contains representatives from fishery interest groups (e.g., Seafood Industry Council), but no quota owners. The Māori development category contains individuals from Te Ohu Kaimoana and Te Puni Kōkiri, and two of these were Pakeha. There were two marine farmers in the sample who are Māori, and on the basis of their interview, where they did not discuss their Māoridom, I classified them in the marine farming category. All policy analysts in the sample are employed by a central government ministry. A contract research organisation (CRO) is a science organisation that is responsible for its own financial viability (Mirowski and van Horne 2005), which included Crown Research Institutes (CRI), Cawthron, and one independent consulting firm. The marine farming group contains marine farmers and representatives of marine farming interests, such as Aquaculture NZ.

After I identified the interviewee categories, I identified individual interviewees through the policy and academic literature. I sought researchers, scientists, advocates and decision-makers who have made contributions to the discourse on spatial conflict and aquaculture science (e.g., in writing or action). I sought their contact through web searches. I identified marine farming and advocate stakeholders through the publicly-available submissions to the 2009 Technical Advisory Group process. Lastly, I took suggestions from interviewees where they were offered. Although I sought a balanced representation among stakeholder groups, this was not possible due to interview acceptance rates (approximately 60%). I informed potential interviewees of the means by which I had found their contact information in the initial email requesting the interview.

Because of the sensitivity of the topic, with the request for the interview, I sent a detailed email of the study rationale and study aims. Five interviewees asked for more detail on the study questions before agreeing to be interviewed. Interview participants clustered in the areas where there is most aquaculture activity (Marlborough, Tasman, Waikato and Northland) and in Wellington as a policy-making hub. I conducted interviews in Wellington, NZ from June-August 2011 and in Nelson, NZ from 25 July - 4 August 2011. Interviews typically lasted one hour, but ranged from 40 minutes to 2.5 hours. I recorded the interviews and transcribed them verbatim. I terminated data collection when interview statements became redundant with what I had previously discussed with other individuals, and when I could make sufficient triangulation of statements among the interviewees to prevent biased interview results to the extent possible. I vetted responses with those participants who indicated that they would like to do so. I present the results as verbatim quotes with a summary of general trends for that theme (e.g., Felt 2008, Gopnik 2008, Wiley 2011). For each research question (chapters 4-6), there is a discussion at the close of each results section (Wiley 2011). The implications and evaluation of all results are synthesized in the discussion chapter 7.

After I identified interviewees, I sent them an individual email with the goals of the project and a specific reason why I sought their particular insight. If the individual agreed to participate, I provided him/her with an information sheet with further detail of the objectives of the project and a description of how their statements would be used to answer the research questions (Appendix 6). Before the time of the interview, which took place in person or by telephone, I sent an information sheet and consent form guaranteeing ethical treatment of data (Appendices 3 and 4). This consent form gave the option of remaining confidential, disclosing his/her name, *or* disclosing the name of his/her organisation. I also gave participants the option of reviewing their statements before a final draft was completed. When interviews were conducted by telephone, I sent the consent form to the researcher electronically or by post. There were certain opinions and statements that required corroboration across interviewees, and I added questions to the interview schedule for verification.

2.3 POSITIONALITY

The controversial nature of aquaculture development in NZ warrants a positionality statement. I am a white US-born transplant to NZ. My initial views on aquaculture were shaped while working as a deckhand in the Alaska salmon commercial fishery. There, I developed the opinion that growth of finfish by our southerly neighbours in British Columbia was an outcome of industrialisation and a driver of change to traditional food production methods and lifestyles. Wild salmon are a culturally significant species, which I regard as an inspiring symbol of how life begets life while allowing for its own dissolution for a new cycle to begin.

My approach to environmental issues is to view human society as dependent on ecological goods and services. My view does not permit overexploitation or lack of foresight, but it respects traditional and contemporary approaches to wise, local, respectful and prudent utilisation of ecosystem goods and services. I have bioregionalist views (Berg 1978), where I find optimism for addressing complex challenges in the marine environment in local action.

This framing I brought with me to NZ, and I proceeded to examine aquaculture growth with (self-acknowledged) criticism. My critiques also stemmed from my adherence to the public trust doctrine for marine ecosystems that is legislated in North America. I soon realised that I needed to have a more open mind about aquaculture growth in NZ and North America as aquaculture history and social context are about as comparable as apples and mushrooms. Through the course of this research, I saw aquaculture as a potential tool to address local demands for protein *if done 'right'*. That is I see aquaculture having the potential to create sustainable regional economies and feed local communities if done from an ecosystem-based management approach (MEA 2005).

There is also a cross-cultural element to this research. There were three interviewees doing Māori development, one Māori environmental advocate, and two Māori marine farmers. My understanding and assimilation in this research of Māori knowledge passes through the lens of my North American cultural and educational background. I have been educated in the western scientific tradition throughout secondary and tertiary school. This research has been a learning process in Māori culture, values, and worldview, as has been my attempt to learn the appropriate approach to representing these results from within the academy. I see myself as fortunate that the Māori interviewees were sympathetic with my desire to learn about Māori culture and about appropriately reporting on it for this thesis, and I thank these individuals for the time spent in coaching me in this area. To address these biases, I attempted to leave quotes integral, letting the statements speak for themselves, refraining where possible from imposing my assumptions about what they imply for western science and planning frameworks.

2.4 LIMITATIONS

I am not able to generalise the results of this case study to other sectors or other regions. Generalizability is typically an issue with the case study approach (Berg 2007). Generalizability within the study – that is, portraying the representativeness of an opinion across the entire sector – is also a point to note. In the interviewee selection, I attempted to capture and accurately portray the range of opinions and values for aquaculture. Sample size and time limitations naturally pose constraints for the generalizability within the study. I expected contradiction among responses, and I attempted to depict the distribution of responses as well as possible. While the sensitivity of the subject matter may have been inhibitive to data collection, my subjective observation was that the free and frank nature of the research was conducive to earnest conversation on the part of many interviewees.

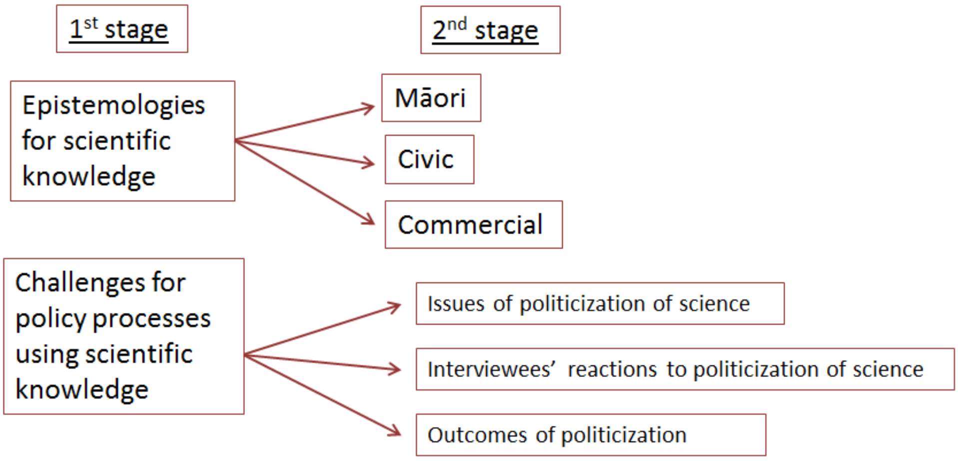
There is inherent subjectivity in qualitative research, where I introduce my opinions and biases. These appear as part of the research orientation itself, i.e., in the topic I elected to research, and through the semi-structured interview style, in which I did not necessarily pose the same questions to each interviewee. I deal with these issues by presenting the research as one snapshot in time, offered from one (my) point of view (Berg 2007). The research is thus open to question and critique by others, and I hope that this will take place. Additionally, there was a significant limitation in the degree of information able to be discussed by some policy analysts and planners due to their involvement with the Aquaculture Amendment (Transitions and Appeals) Act 2011 that was passed in September 2011. Because this Act dealt with many issues of conflict between commercial fisheries and aquaculture, many interview participants were obliged to refrain from discussing issues that pertained to the Act.

2.5 DATA ANALYSIS

The literature in sections 3.2-3.4 is the basis for documentary analysis and the interview approach. According to Miles and Huberman (1984: 28), “A conceptual framework explains, either graphically or in narrative form, the main dimensions to be studied - the key factors, or variables - and the presumed relationships among them”. I used theories to build the framework, where theory was added or modified throughout the study (Creswell 1994). To analyse the epistemologies and challenges for policy using science, I followed systematic data analysis procedures. I transcribed interviews in full. I coded

Figure 2. Data coding categories.

the data in two stages (Figure 2).



I analysed data using content analysis to identify patterns and relationships of meaning (Creswell 1994) using the theoretical basis (sections 3.2-3.4). I took the interpretive approach to content analysis, drawing conclusions about the essence of what was said or done (Berg 2007). I made inferences with respect to theory in 3.21-3.4 (Creswell 1994). I sought internal validity of statements through triangulation of primary data with other sources and convergence between interview responses (where applicable) (Berg 2007). Once the data were coded, I attempted to corroborate statements against each other to a point where sufficient generalisation could be made; otherwise, I reported divergent patterns. I made an effort to portray the degree of agreement or disagreement among respondents on a particular issue.

Chapter 3. Literature Review

Chapter 3 accomplishes two tasks. The first outlines the use and non-use values for NZ marine ecosystems, which is the background upon which documentary analysis and interview analysis takes place. The second task is to explain the rationale for each research question in sections 3.2-3.4.

The aim of this study is to understand the role of science in addressing spatial conflict in aquaculture. The following explains how the three research questions, together, accomplish this aim. The analysis of policy processes in chapter 4 illustrates the role of science in the RMA framework for allocating space from a sociology of science perspective. Chapter 5 builds upon this to demonstrate the links between scientific knowledge and social context, such as worldview and beliefs about the best end-uses for science. The epistemologies for science suggest tight linkages between aquaculture science and social context. From this understanding of science, chapter 6 synthesizes the themes of the first two questions by investigating ways that science knowledge is utilised in policy decisions in aquaculture. In particular, chapter 6 focuses on the challenges for using science in policy and identifies important stakeholder assumptions about how science should be used in policy debate. Chapter 7 synthesises all results from chapters 4-6.

3.1 BACKGROUND ON NZ COASTAL MARINE ECOSYSTEM VALUES

Section 3.1 reviews the marine ecosystem values that are pertinent to NZ spatial conflict, which cluster in three themes: commercial, civic and cultural values. For the NZ marine ecosystem, these are:

- **Commercially-oriented values:**
    - Instrumental values and consumptive values for marine space (MEA 2005, Fox 1990)
- **Civic-oriented values**:
    - Non-consumptive social values (MEA 2005) such as in recreation, amenity and landscape values
    - Ecological values and intrinsic values for ecosystems (Fox 1990)
    - Utility values of ecosystem goods and services (e.g., Costanza et al. 1997, De Groot et al. 2002)
- **Cultural values** (MEA 2005): as part of Māori worldview

These value groupings are obviously not fixed, as would be exemplified by a marine farmer with environmental interests or a marine farmer who is Māori. Nevertheless, this review aims to capture the dominant, overarching value groupings for aquaculture for the purpose of this research. The following paragraphs describe the relevance of each grouping to NZ aquaculture.

First, there are strong commercially-oriented values for oceans in NZ. Central government is promoting aquaculture growth on a national scale (Box 3). The Ministry for Economic Development's (MED) Economic Growth Agenda is one driving force behind the goals for aquaculture's 'economic transformation' (NZAC 2006). Policies support growth by providing commercially-focused science, better regulation around natural resources, and improved education and skills (MED 2010). Economic development was one of the driving forces behind aquaculture legislative reforms in 2002 (Rennie 2002). More recently, the Aquaculture Reform (Repeals and Transitional Provisions) Amendment Act (No. 3) 2011, also promotes economic development by attempting to streamline the consent process and increase investment certainty for farmers. In the science policy area, contestible funds have been made available to support high-quality projects in aquaculture that improve profitability and scale (the total government investment from 2008-2011 is $1.6 million) (Brownlee 2010).

Box 3. "Economic transformation is one of the Government's top priorities for the next decade... The Government views aquaculture as a valuable sustainable industry that has potential to assist economic transformation nationally and regionally." Trevor Mallard, Ministry of Economic Development and Jim Anderton, Minister of Fisheries (NZAC 2006: 5).

Second, civic values encompass social and ecological values. Social surveys demonstrate the inherent pluralism of civic values within NZ society for marine ecosystems. In 2001, the Ministerial Advisory Committee conducted a survey to determine the value of the oceans to New Zealanders. Survey results showed that New Zealanders valued the physical setting of NZ as an island, the importance of a 'healthy sea'; the spiritual and physical connection of Māori to the sea; and the fact that "oceans also support a complex infrastructure that a modern society and economy need to function" (MACOP 2001). Likewise, in 2001, the Marlborough District Council and Corydon Consultants conducted a survey to understand the national importance of the Marlborough Sounds. Scenic beauty, high water quality, peace, tranquillity, and good fishing were high scoring values (Dawber 2004). Social connections to the sea are a core value set that are broached in the conflict over aquaculture development. Both of these surveys indicate a wide range of attitudes towards the marine environment with no obvious priority.

Moreover, there are civic values that deal specifically with the marine ecosystem. Ecological goods and services have utility value, and their public good nature lends itself to conflict when negative effects on other stakeholders are not mitigated (see, for example Royal Society of NZ 2011). Aquaculture can induce ecosystem change, a concern to those with ecological and intrinsic values. Biophysical impacts from finfish farming can occur from nutrient enrichment of the water column and can cause changes to benthic habitat (Forrest et al. 2007). The NZ government compiled a survey of ecological impacts of NZ aquaculture species, summarised in Appendix 8.

Ecological impacts are important because of their inherent value to New Zealanders. Inherent value relates to non-use and amenity values. Ecological values for the ocean are non-consumptive and have been reviewed most extensively in the international literature. This genre of values encompasses concepts such as:

- Ocean ecosystem integrity (Scheiber 1997)
- Conservation values, equity values in distribution of resources (including through time), and aesthetic values (Callicott 1992)
- Public access and protection of coastal resources (Knecht and Cicin-Sain 1997)
- Ecosystem approaches to management and intergenerational values (Scheiber 1995)

There are also non-anthropogenic values for nature, such as the wilderness ethic, preservation values, intrinsic values of nature (Callicott 1992), and biodiversity values (Scheiber 1997).

Third, cultural values held by Māori are significant. According to Henry (2000), drawing lines between the spiritual and physical realms is not intrinsic to a Māori worldview. Instead, she says that interrelationships between humans and the ecosystem dictate protocols and practices, which are related to the workings of the environment and to spiritual beliefs. Creation according to Māori began in the ocean (Douglas 1984). The following Māori concepts illustrate the deep connection between Māori values and the ocean:

- **Kaitiakitanga** – “the act of guardianship” (Roberts et al. 1995: 8)
- **Mauri**: essential life force (EMR 2009), which is destroyed by mixing different types, including water (Douglas 1984)
- **Rāhui**: ban on harvesting due to death at sea or to prevent overexploitation (EMR 2009), which enhances mauri (Kawharu 1998)
- **Rohe**: geographical or spiritual boundary (National Library of NZ 2010), which also applies to ocean space
- **Tapu**: sacred (National Library of NZ 2010)
- **Taniwha**: guardian or protector of a water body (National Library of NZ 2010)

There are obvious connections between Māori values for the ocean and practices for resource utilisation and stewardship. These are the basis for Māori epistemology, described in more detail in section3.3.3.

Values are a huge driver of social conflict over aquaculture. For NZ, there is a gap in research as to how these values relate to marine science. Science has a role in negotiating competing values because it provides information on how different interests are affected by aquaculture. Commercial, civic and Māori values for marine space are point to the central the epistemologies for science in aquaculture, explained in section 3.3.

3.2 LITERATURE REVIEW: QUESTION 1 - POLICY PROCESSES

Because this research deals with social values in spatial conflict, a sociology of science approach is taken to analysing how science is used in the RMA planning processes. This chapter describes the sociology of science analytical lens and why this lens is useful for understanding planning under the RMA.

The first research question examines how science is used in the RMA for aquaculture planning. Planning is "a decision-making process for determining the way in which physical and natural resources are used" (Jay 2010: 49), and for aquaculture, planning deals with competing uses for space. Planning relies on science to understand environmental risks and effects on other users.

The sociology of science literature often frames its analysis in terms of the boundary between science and policy (e.g., Jasanoff 1987, Keller 2009). The boundary is the extent of crossover and role-sharing between science and political decision-making. This literature focuses on the social, institutional and political factors, including those that deal with power and advantages, that affect how actors observe the boundary. Traditional models of decision-making using science maintain a clear divide between science and policy-makers, aiming to keep scientists' advice independent, credible, and employ science in a passive way (Lane 1999, Pielke 2007). Separating science and politics protects the Enlightenment notion that science should not be biased under the influence of political influences (Keller 2009). For NZ aquaculture, planning is a contentious process because of conflicting values for marine space, so it is of interest to investigate the science-policy boundary in planning under high levels of conflict.

In the sociology of science literature, the conventional rationale behind using science to inform policy decisions is that science is a reliable source of objective information to bring clarity to decision-making (Herrick and Sarewitz 2000, Gluckman 2011). Keller (2009) asserts that decision-makers seek a source of information that provides a definitive, 'correct' or 'best answer' to settle debate. The conventional perspective operates under the assumption that facts can help to clarify alternatives (Pielke 2007) or to understand policy outcomes in the future (Sarewitz 2004). Science is used by decision-makers in cases of uncertainty (which may be political, scientific or otherwise), which is "the location where conflicts between competing sets of facts and disciplinary perspectives reside" (Sarewitz 2004: 396). For NZ aquaculture, there is a gap in understanding the role of science and scientists in spatial conflict and planning. Aquaculture planning is a useful means of investigating whether or not science upholds a conventional role in political decisions, or if it deviates from the conventional role. A case study approach is valuable for in-depth knowledge on NZ aquaculture planning because, according to McNie (2007: 29), "it is essential that we develop a more robust understanding of experience and practical experiments regarding how relationships [and institutions] are constructed and managed across the science-society boundary".

The conventional perspective of the role of science in decision-making has been questioned on the basis of the ability of science to provide neutral and unbiased information, particularly for controversial decision-making. Questioning has stemmed in part from the philosophical debate between realist and constructivist camps, which is reviewed in Appendix 10, which demonstrates the extent to which knowledge is given meaning socially. From a sociology of science perspective, for controversial environmental decisions, stating that science portrays objective truth denies that how the natural world is understood is contingent and negotiable (Herrick and Sarewitz 2000). Even the idea of a 'natural' ecosystem is constructed because systems are in constant flux (Shrader-Frechette and McCoy 1993). Based on this perspective, science is a product of social context and can be used as a rhetorical tool to shape decision-making. Marine farm applicants must demonstrate to planners that their proposal is a suitable use of space, and public participation processes use science to argue for or against a particular proposal. The literature on spatial conflict for NZ aquaculture deals mainly with the social aspects (Shafer et al. 2010, Rennie 2009, Gibbs 2010, Banta and Gibbs 2009) and legal aspects (Rennie et al. 2009, Bess and Radamudi 2007) of conflict. There is a gap in the literature as to how science can support or detract from reconciling spatial conflict, and this must be assessed from within the NZ policy framework. Research question 1 attempts to fill this gap by examining the way the RMA uses science in planning.

3.3 LITERATURE REVIEW: QUESTION 2 - EPISTEMOLOGIES FOR SCIENCE

The aim of this research is to understand the role of science in addressing spatial conflict, so understanding what gives science meaning and social authority is useful to understand how science is used in policy decisions. The second research question aims to characterise the epistemologies for science in aquaculture. Epistemology, or the study of knowledge (Harré 1985), structures scientific inquiry and the end-use of science. Appendix 10 shows that knowledge is given meaning socially, so exploring epistemologies is a useful way to understand the relevance of scientific information to spatial conflict. Haas' (1992: 2-3) research into epistemic communities helps to illustrate how epistemologies appear in day-to-day practice. An epistemic community is a "network of knowledge-based experts" with:

1. A shared set of normative and principled beliefs
2. A shared causal beliefs for knowledge
3. Shared notions of validity – "intersubjective, internally defined criteria for weighing and validating knowledge in the domain of their expertise"
4. Common policy goals – "a set of common practices associated with a set of problems to which their professional competence is directed"

Using Haas' characterisation of epistemic communities, which are related to beliefs and policy goals for knowledge, I argue that commercial, civic and Māori interests from section 3.1 help to identify the dominant epistemic communities in aquaculture debate. Groups taking part in debate over aquaculture engage scientific knowledge in different ways. These beliefs are affected by the interest each group has in policy goals, which I argue correspond with the values that the group has for use or non-use of space. The key areas of interest for the epistemologies for aquaculture science are the similarities and divergences of beliefs and policy goals. Beliefs and policy goals demonstrate the inextricable links between science and social context. Beliefs and policy goals for science differ according to beliefs about the demands for science in policy and in society (McNie 2007), the goals for application of science through policy (Weber et al. 2010: 242), and interpretation of science through policy dialogue (Lee 1993).

Haas' various works on epistemic communities suggest a gap in knowledge for NZ. His research points to the need to use *existing* information more effectively and efficiently, where policy systems can 'learn' to improve without substantial investment with new resources. For example, his work on epistemic communities helped address pollution control issues in the Mediterranean through policy learning (Haas 1989), provided direction for policy learning in European collaborative governance (Haas and Haas 1995), and to improve effectiveness of using scientific information in multilateral governance for the United Nations (Haas 2002). This is topical for NZ marine governance, as the new Minister of Science and Innovation, Steven Joyce, has articulated that any science funding in the near future will come from existing sources as opposed to allocating new funds (Joyce 2012). Joyce's statement comes when there are already low levels of baseline knowledge for NZ marine ecosystems (PCE 1999, Marine Think Tank 2011). Thus there is a need to be more innovative, creative and mindful of how scientific information is used to address complex problems, and understanding the links between science, social context and conflict can reduce barriers to using information effectively.

To characterise commercial, civic and Māori science, the focus of this research is not to analyse each *individual* according to epistemology; instead, the research examines the epistemologies for aquaculture science as they appear in policy debates through beliefs, norms and policy goals. The following charts contain the theory on the commercial, civic and Māori epistemologies for science. Following Haas (1992), to bridge theory with practice, Charts 1, 2 and 3 review three traits that define an epistemic community: notions of validity of knowledge, normative and principled beliefs, and policy goals. This theory is the basis for analysing interview statements.

3.3.1 Commercial science

Commercial science has been characterised extensively by Mirowski (2003) and Mirowski and Van Horne (2005). Authors suggest that commercialization is largely a result of social, legal and cultural factors as much as economic ones. This epistemology uses the market as a determinant of research priorities and what is needed from science in society. The commercialised approach corresponds with neoliberal political ideologies. Science can thus be a tool that policy-makers use to achieve other goals (e.g., innovation or economic development). As the market is meant to determine the need for science, focus of research and direction of funding tend to be towards ends that can be valued in the market.

Chart 1. The commercialised epistemology for science.

What makes knowledge valid? ➢ Economic lens for understanding science: using concepts like technology transfer and outputs to describe the scientific process (Mirowski and Van Horne 2005) ➢ The market is an efficient and appropriate determinant of what research is conducted, and it reflects what the public wants (Davies 2001 in Mirowski and van Horne 2005) ➢ Uses neoclassical ideas as the basis for decision-making (Mirowski and van Horne 2005)
Normative and principled beliefs for knowledge: ➢ Scientific information conceptualised as property, with legal status (Mirowski 2003) ➢ Intellectual property brings with it new expectations and institutions for science (Mirowski and van Horne 2005) ➢ Fewer incentives for collaboration among disciplines, leading to narrowing of focus (Mirowski 2003) ➢ Aim to take advantage of the incentives for cost minimization and maximization of convenience to science, but not change how science is produced (Mirowski and van Horne 2005)
Policy goals: ➢ Structurally, science can be client-based, and scientific institutions are 'producers' of a good meeting demands, which has implications for how science is funded (Mirowski 2003) ➢ Competitive, market models, aiming to make research more efficient (Mirowski and Van Horne 2005) ➢ Commercialisation is "transfer [of] research outputs to end-users, either through existing businesses or where necessary through the creation of new commercial entities" (MoRST 2010: 19)

3.3.2 Civic science

Adherents to civic science believe science should be applied to ecological and social policy goals. Knowledge is valid when it is produced based on social and ecological needs, and it aims at making improvements for broader social and environmental good. Civic science does not acknowledge a strict boundary between science and policy; instead, science is seen as supportive of democratic processes, such as deliberation and debate. Because scientific research is embedded within social context, this civic science asserts that the purpose of knowledge should be for integrative and collaborative approach to solving social and environmental issues. Civic science contends that if science is to be part of policy development, cooperation is necessary between scientists and stakeholders (Schmandt 1998). Science is seen as an integral component of democracy. Civic science in policy deals with the communication, institutional context and societal demands to 'supply' science (Pielke and Sarewitz 2005).

Chart 2. The civic epistemology for science.

What makes knowledge valid? ➢ Scientific problems must be embedded within social context; acknowledging social limits and opportunities (Pielke 2007: 236) ➢ "Multidirectional and iterative flow of information among scientists, policymakers, citizens, and other societal stakeholders" (Weber et al. 2010: 236)
Normative and principled beliefs for knowledge: ➢ Whereas conventionally, science and democracy are separated, "civic science seeks to reunite these divided roles and responsibilities", contrasting the notion of upholding its 'objective' place outside of society (Shannon and Antypas 1996: 60) ➢ Relates to the active dimensions of science, such as analysing and taking action (Clark and Illman 2001) ➢ Efforts on the part of scientists to articulate and illuminate science content in the context of social issues (Clark and Illman 2001: 18)
Policy goals: ➢ Proposes that the role of science is to intersect with the goals and needs of society. Rationale is that science and society are interdependent and so must enter into a two-way dialogue about how science is used (Lane 1999) ➢ Civic science is "the process of linking experts and stakeholders in planning social, economic and environmental improvements" (Schmandt 1998: 63) ➢ The aim of science in the policy process is to be integrative, collaborative and participatory (Welp et al. 2005).

3.3.3 Māori knowledge

A commonly-accepted definition for traditional ecological knowledge (TEK) is the cumulative body of knowledge, beliefs and practices that are handed down by cultural transmission about the relationships of living beings and humans to the environment (Berkes 1999). While I cannot assume that the concept of an epistemic community can be directly imposed on Māori knowledge systems, there are aspects of Māori systems that illustrate what makes knowledge valid, the principles for knowledge, and policy goals. Kaupapa Māori exemplifies the intersection between values, knowledge and method, as Kaupapa is both a methodology and a worldview that embodies the beliefs and experiences of Māori (Henry 2000). Māori knowledge is an intersection of experience, history and observations of the environment through mainly oral tradition.

Māori knowledge about the environment is strongly related to the social and ecological contexts in which it arises. Clear boundaries and distinctions between knowledge and the source of knowledge cannot be drawn (Henry 2000); that is, facts cannot be taken independently. Thus, there is an indivisible link between the values, knowledge and practice for engaging Māori knowledge.

Chart 3. Māori knowledge.

What makes knowledge valid? ➢ **Mātauranga Māori** is the knowledge and tradition of Maori, shaped by time and experience. Includes language and the creation of knowledge. It has a large contextual contingency, having changed through time as the environment changed and as European settlers arrived (MoRST 2006) ➢ **Mātauranga Māori** includes language (te reo), traditional environmental knowledge (tāonga tuku iho, Mātauranga o te taiao), traditional knowledge of cultural practice, fishing (kai moana) and cultivation (mahinga kai) (National Library of NZ 2010)
Normative and principled beliefs for knowledge: ➢ **Kaupapa Māori** is the oral tradition and conceptualisation of Māori knowledge. Kaupapa Māori knowledge has a strong link to culture and value systems (Reid 1998) ➢ Kaupapa Māori shapes how the "Māori mind receives, internalises, differentiates, and formulates ideas" (Nepe 1991: 34)
Policy goals: ➢ Kaitiakitanga guides resource management practices. It is the responsibility and obligation to respect and take care of Tangaroa's places (Te Runanga O Turanganui a Kiwa 1999) ➢ **Kaupapa Māori** principles (Smith 1990): o Tino Rangatiratanga – the principle of self-determination o Tāonga Tuku Iho – the principle of cultural aspiration o Ako Māori – the principle of culturally preferred pedagogy o Whānau – the principle of extended family structure o Kaupapa – the principle of collective philosophy

The theory in Charts 1, 2 and 3 forms the basis for characterising the epistemologies for aquaculture science in chapter 5. Interview data are analysed to identify the similarities and differences among commercial, civic and Māori science. This builds on the first research question which describes how RMA planning enables public debate over aquaculture, and chapter 5 characterises the three science epistemologies to understand how they support democratic debate.

3.4 LITERATURE REVIEW: QUESTION 3 - CHALLENGES FOR USING SCIENCE IN POLICY

The third research question examines the chief challenges for using science in policy decisions in aquaculture. These challenges are a window into the barriers to effectively using scientific information to resolve politically controversial aquaculture issues. There are two philosophies for applying science to policy: rationalism and positivism. Understanding the two philosophical camps helps identify interviewee expectations and assumptions for the purpose of science in controversial decision-making because there are inherent differences to how science and politics utilise information. Two central differences are the way uncertainty is understood and evidentiary standards. Science standards are high and are based on probability, and policy standards may based the perception of being right or wrong (Kinzing et al. 2003). However, it is important to acknowledge the range of decision-making frameworks used in policy decisions, where other times they may be based on criteria costs, benefits and risks of decisions as in some NZ policy ministries. This is most obvious for environmental effects of aquaculture, which can be calibrated empirically but must be debated socially to determine acceptable levels of effect. Scientific data and the way data is represented may not match the "specific contours of political controversy", referring to the specific needs of deliberation and political debate and decision-making (Herrick and Sarewitz 2000: 313). For conflict in aquaculture, this means that controversial issues may be analysed according to different, and possibly contradictory, criteria. Rationalism and positivism are explained in Table 3 and are compared and contrasted below.

Table 3. Comparison between rationalist and positivist schools of thought.

	Rationalism	Positivism
How it works for decision-making	Science informs debate once the goals, issues and options have been outlined through deliberation (Keller 2009) Value of science for politics is to "illuminate policy choices by defining the alternative possibilities and evaluating their costs and benefits"(Price 1979:56)	Scientific theory is able to make predictions for decision-making (Harré 1985) Facts and values are distinctly divided, and scientists do not enter into political rhetoric (Price 1979) Clear boundary between science and policy to avoid politicization of science (Keller 2009)
Purpose	➢ Normative way of proceeding ➢ Helps make difficult moral decisions by deliberating against one another with respect to criteria (e.g., public interest, utilitarianism) (Hamlin 2003) ➢ Science helps achieve a specific outcome, e.g., explain causality (Keller 2009)	➢ Science brings benefit of society by providing true and objective facts (Keller 2009) ➢ Scientific knowledge helps to reduce political uncertainty(Pielke 2007)
Why adhere to this philosophy?	Predicated on the idea that beliefs are arrived at by reason, for moral and virtuous ends (Hamlin 2003)	Presume that science and fact – therefore truth – have answers for policy (Keller 2009)

The rationalist perspective on science for policy is that science can efficiently inform policy questions by offering different alternatives (Keller 2009). The rationalist approach is said to maximise the advantages of a decision within the bounds of the question (Mouffe 1994). Science is brought in after the debate and policy goals are outlined in a democratic arena, and as such rationalism is said to uphold democracy because the options are outlined prior to using science (Keller 2009). In theory, political deliberation would be a part of a public process, so the objective is to prevent domination by an elite majority (experts) in political decisions. Rationalist philosophy underlies many liberal democracies (Mouffe 2000). Rawls (1993) conceptualised a liberal democracy as a political society which structures the social contract for the way that social decisions are made.

In a positivist approach, science has a lot of power and privilege within politics (Price 1979). According to Keller (2009), the positivist approach is technocratic. She asserts that technocracies are less democratic because expertise is not held by everyone, and scientists should not be given priority in decision making. The positivist camp asserts that indeed technocracy is democratic because science is based on objective truth. These philosophical views are important because they form expectations and assumptions for science and scientists as they engage in political debate.

The results of interviews with decision-makers, stakeholders and scientists to understand the challenges for using science in aquaculture policy are presented in chapter 6. This literature review supports analysis of the expectations and assumptions about the objectivity and neutrality of science with respect to political interests. The rationalist and positivist philosophies form the basis of expectations for how science should be brought into political decision-making, which may underlie the challenges for using science in policy. These philosophies also are the basis for assumptions about how scientists should observe the science-policy boundary in planning, policy development and in the Environment Court.

3.5 SUMMARY OF LITERATURE REVIEW

For NZ policy, this research informs broader questions of improving democratic processes and integrating oceans governance. The Parliamentary Commissioner for the Environment (1999: 46) argued that NZ marine governance must focus on mitigating strategic risks with regard to oceans management, including myopia of priorities and perspectives and failure to address wider social-ecological contexts. This case study investigates the different social and epistemological perspectives on aquaculture to understand social conflicts in greater depth. The study also provides a sociological perspective on conflict to place aquaculture development within the broader context of marine ecosystem values and priorities. Vince and Hayward (2008) assert that integrated planning in NZ coastal management is fragmented and lacking overall. Integration is not only a matter of operational policy, but of integrating values and worldviews for marine space through science. Lastly, this research addresses the ongoing struggle in NZ marine governance to cope with low levels of baseline information. In aquaculture in particular, Banta and Gibbs (2009: 177) describe how "regulators have often been forced to make resource consent decisions on relatively sparse information". By considering the barriers to using science to address spatial conflict, the present case study offers suggestions for better using existing information in aquaculture planning and policy.

With respect to the international literature, this research fills a gap in the sociology of science field for marine ecosystems. Sociology of science is dominated by issues such as climate change (Herrick and Sarewitz 2000, Sarewitz 2004, Pielke 2009), acid rain reduction (Keller 2009), and biomedical policy (Choi et al. 2005, Keller 2009). There are fewer studies in the marine realm, although prominent contributions have been in collaborative management for salmon recovery (Weber et al. 2010), social power of scientific information for conflict over marine reserves in NZ (Wiley 2011) and marine protected area selection (van Haastrecht and Toonen 2011). To my knowledge, there is not a single study on the use of science in aquaculture decisions. Yet, aquaculture conflict is likely to increase in coming decades due to its rapid growth rate described in the introduction.

Chapter 4. Results: Policy processes - the RMA Framework

The first research question examines the Resource Management Act (RMA), which is the central policy framework dealing with spatial conflict. The research question this chapter addresses is:

How is science used in spatial allocation **policy frameworks** for aquaculture?

Science informs planners about aquaculture's effect on the environment and on other users. Many different types of information are submitted as part of public processes, and this information is used to influence the planning process. The policy and planning decision frameworks follow a rationalist approach to using information, which allows for substantial deliberation and permits a range of information types to be used (e.g., quantitative to anecdotal). Determining which effects are acceptable and which are not is a normative process undertaken employing scientific information, following the considerations in the RMA. Another key piece of legislation to note is the Māori Commercial Aquaculture Claims Settlement Act 2004. This is a key policy under which 20% of aquaculture space is allocated to iwi. Also, the Local Government Act 2002 section 14 requires councils to ensure prudent stewardship of resources and maintain and enhance the quality of the environment.

4.1 THE RMA PLANNING FRAMEWORK

The RMA establishes several important principles that affect the way coastal planning and permitting take place. Part 2 sets out the purpose and principles of the Act, which include sustainable management in section 5 (Box 7, next page). Section 6 sets out matters of national importance, including natural character of the coastal environment, protection of outstanding natural features, maintenance and enhancement of public access to and along coastal marine area. Section 7 establishes that planning shall have particular regard to kaitiakitanga, ethic of stewardship, efficient use and development of natural and physical resources, maintenance and enhancement of amenity values, intrinsic values of ecosystems, maintenance and enhancement of the quality of the environment, and finite characteristics of natural and physical resources.

Box 7. **The RMA is based on sustainable management principles**. Sustainable management under section 5(2) means "managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural wellbeing and for their health and safety while- (a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and (b) Safeguarding the life-supporting capacity of air, water, soil and ecosystems; and (c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment".

The RMA sets out the structure for coastal planning. Coastal planning is the responsibility of regional councils under the RMA s30(1)(d). The RMA pertains to planning and the rights granted for terrestrial and coastal marine ecosystems up to 12 nautical miles from shore. The RMA defines the coastal marine area (CMA) from mean high water springs to the boundary of the territorial sea at 12 nm (s2). The CMA is accessible by the public as a matter of national importance, following RMA s6(a) and (d). There are two processes that apply to aquaculture: coastal planning and coastal permitting (consenting). Coastal planning involves allocating space among different uses, including aquaculture. Most activities that occupy an exclusive use of space, such as aquaculture, are prohibited. Use and occupation of the CMA is allowed only when stated in a plan or when resource consent is granted (s12(1) and (2)), so marine farmers must apply for a consent. Regional councils have responsibility for managing the marine environment, which under the RMA is treated like a common property resource (Makgill and Rennie 2011).

With regard to planning, the RMA is the basic framework to reconcile public access and private rights to the environment (Makgill 2011). In the RMA, there are statutory requirements in ss56-58for the Department of Conservation to prepare a National Coastal Policy Statement (NZCPS), which must be signed off by the Minister of Conservation. The NZCPS guides regional councils to create regional coastal plans. Regional coastal plans support sustainable management processes by outlining objectives, policies and rules about what is allowed in the coastal marine area (CMA). The section on duties and restrictions, in Part 3 of the RMA, states that occupation may not take place unless stated in a rule, regional coastal plan, proposed plan, or consent. Section 12A establishes that aquaculture may not occur unless stated in a plan or a consent. Local councils are responsible for processing resource consents for cases of unpermitted activities. In general, the RMA is enabling legislation with the obligation to provide for environmental, social, cultural, and economic wellbeing in section 5(2)(a), (c). However, in the CMA, it is more precautionary than enabling because the ocean is considered in the public domain (Makgill and Rennie 2011). This arrangement leans towards a 'command and control' approach as opposed to the neo-liberal approach to terrestrial systems (Makgill 2011).

For coastal permitting for aquaculture, a potential marine farmer must be authorised to occupy space, erect structures, and undertake aquaculture activities. Under Part 7A of the RMA, applications are processed on a 'first in, first served' basis, unless otherwise stated in a regional coastal plan. The role of science in consenting is to inform planners about the effects of aquaculture on the environment and on other uses. An assessment of environmental effects (AEE) is provided with each marine farming application, and judgement is used to determine if adverse environmental effects are acceptable. As for effects on other uses, planners must consider social, cultural, economic and other effects, listed in section 32, when assessing consent applications. The RMA allows for public participation and debate in an appeal over a consent application. Submissions contain different types of information to demonstrate support or disapproval for proposed projects. These may contain opinions, empirical data, arguments based on principles, legal arguments, or anecdotal evidence. Again, planners must use their judgement to compare and contrast these different types of information in a spatial allocation decision.

Lastly, there is a process for addressing conflict between aquaculture and commercial fishing. It is called the undue adverse effects (UAE) test on fishing, and it looks at effects on commercial, customary and recreational fisheries. The UAE test draws from councils' assessment of effects on *fisheries resources* which includes ecology, social science and economics information. According to a ministry scientist who was interviewed for this research, commercial fishing tends to receive the most attention due to data availability, as there is much less quantitative data for recreational and customary fishing, according to respondent 43 in the interview for this research. The *effects on fishing* test looks at how aquaculture may affect fishers' ability to harvest. The UAE test also follows a rationalist approach to using science. Science measures the extent of the impact, and then a judgment must be made as to whether or not that is 'undue'. Overall, scientific evidence is a core part of assessing impact on the environment and addressing conflict between resource uses.

Table 4 lists the different policy processes that shape aquaculture decision-making. Listed in the order that they appear in the table, these policy processes are: coastal planning, coastal permitting (consenting), monitoring and evaluation, judicial processes, and allocation of rights between aquaculture and fisheries. It is important to remember that the RMA is the overarching framework, as described above, under which the following policy processes take place. The exceptions to this are where the Fisheries Act 1996 and the Aquaculture Amendment (Repeals and Transitions) Act 2011 apply, which have statutory binding alongside the RMA (not under it). Following a description of the policy processes, the table describes how science is used in each. Recalling the definition of science from chapter 1, the types of information used in aquaculture policy processes may range widely. The contents of the table are sourced from NZCPS 2010, RMA 1991, and MAF Fisheries 2011.

Table 4. Policy processes for aquaculture.

slation	Purpose	Functions	Planning mechanisms using science
tal Planning: ew Zealand Coastal olicy Statement (NZCPS) 010	Achieve the purpose of the RMA in the coastal marine area. Define parameters and considerations for regional coastal plans (RMA 1991 s60)	Coastal management, including providing for aquaculture in appropriate places (NZCPS Policy 8)	Coastal development should consider effects that would make water quality unfit for aquaculture (NZCPS Policy 8)
tal planning: Regional oastal plans	Define parameters and considerations for regional coastal resource management	Carry out specifications in NZCPS and address regionally-specific issues	Specific to region
tal Permitting: onsenting under the MA 1991	Allocating space to different users by consenting (s12(1) and (2)) Consents granted on a case-by-case basis following effects-based planning (s9) Avoid, remedy or mitigate adverse effects (s9) Establish public process for submitting on consent applications	Evaluate effects of aquaculture on other users where conflict arises (determined by submissions and by assessment on fishing and fisheries resources) Assess effects of aquaculture on the coastal environment, requiring an Assessment of Environmental Effects (AEE) before consents are granted (s88 and s92)	Must consider sustainable management implications, actual and potential effects, and consequences for NZCPS and regional/district plans (s104) using the best available information (s10) 'Environmental effect' can be positive or negative, temporary or permanent, cumulative, high probability or low probability with high impact (s3) Consider landscape, natural character, amenity, visual, economic, ecosystem, social, health, cultural, spiritual or historic factors in AEE and strategic assessments (Schedule 4) Receive submissions from stakeholders in the coastal marine area
toring and evaluation: MA 1991	Oversee ongoing effects to environment Avoid, remedy or mitigate adverse effects (s9)	Establish consent conditions for monitoring and evaluation	Receive monitoring datasets and assess effects Enforce standards established in consent conditions In cases of uncertainty over effects, councils collect information to adaptively manage environmental effects
ial processes: MA 1991 the nvironment Court	Specialist court for RMA and planning issues	Enables stakeholders to appeal a council decision (RMA Schedule 1)	Draws on scientific expertise through expert witnesses / Friends of the Court
ation of rights between sheries and aquaculture: sheries Act 1996 AND quaculture Reform Repeals and Transitional rovisions) No. 3 Act 2011	Address spatial conflict between aquaculture and fishing	Assess impact of aquaculture on fisheries (commercial, recreational and customary)	Regional coastal planners now assess impacts of aquaculture on fishing and fisheries resources under the Reform No. 3 2011 MAF Fisheries oversees the undue adverse effects (UAE) test on fishing under Fisheries Act. MAF can make consent conditions pertaining to fishing.

4.2 DISCUSSION OF THE PLANNING FRAMEWORK

As shown in chapter 3, conflict arises when there is overlap of use of space or conflict of values and principles over space. The policy framework outlined in Table 4 addresses conflict from several angles: establishing background policy, considering effects on different values (Schedule 4), providing for public process, and directly mitigating conflict. The following analysis presents three points about the planning framework: planning is a normative process; planning uses science to represent different interests; and there are values as part of the planning framework that shape outcomes.

First, spatial allocation decisions are made based on the assessment of effects, submissions and consideration of the NZCPS and regional coastal plans. From a sociological point of view, scientific data informs planners, and then a normative decision is made on what levels of effect are acceptable. Planners are to consider landscape, natural character, amenity, visual, economic, ecosystem, social, health, cultural, spiritual or historical factors (Schedule 4). This range of considerations may call for a large range of types of scientific information whose nature differs quite distinctly from one another. It may be difficult to compare different types of information for planning decisions as part of the consenting process. The RMA does not explicitly prioritise these considerations (although some indication may be given in regional coastal plans), because, for instance it may be difficult to weigh economic information about the benefits of a farm versus past uses. Furthermore, anecdotal accounts and local ecological knowledge that may be included with submissions are not directly comparable to quantifiable data that uses economic or biological statistics. This requires individual judgement calls, which inevitably are normative. This case study argues that these decisions are normative even if they involve quantitative data because there is a subjective judgement as to which type of information is given more weight for decision-making.

Second, scientific information is used to influence RMA planning by different interest groups. This is a deliberative process where stakeholders submit information to influence the outcomes of planning. For example, planners must compare expected economic benefits of a marine farm, historical cultural uses of an area, and concerns about the view from a property owner’s house. Effects on other users are considered through the AEE, UAE test, through the public submissions process, and sometimes through the Environment Court. When controversial cases are unable to be resolved through the submission and appeals process, they go to the Environment Court. Scientific experts are called to back claims made by different parties. Competing interests are represented by different types of information, and they vie to influence planning outcomes. Rationalist deliberation uses science as a tool in debate, and science helps decision-makers once the alternatives have been outlined (Keller 2009) to compare choices against one another (Hamlin 2003). Decisions about what levels of effect are acceptable and appropriate are normative decisions that draw on societal values and norms.

Third, from a sociological point of view, there are values inherent in the planning framework itself. Regional coastal plans may define certain values that localities would like to protect. The RMA framework includes sustainable management principles, protects the natural character of the coastal marine area, and outlines considerations in section 32 which explicitly link to different value sets. These considerations range widely and at times may contradict one another, as in the case of economic and ecological values. Furthermore, inherent to the framework are neoliberal values about resource use. Effects-based planning implies that the marine farmer bears the onus of proof to deal with environmental effects of aquaculture, including costs of processing consent applications and environmental monitoring (Rennie 2002). This is a neoliberal approach to use rights, where the privilege to promote well-being is accompanied by responsibility to maintain the resource (Makgill 2011). In this way, the market has a role in determining which activities move forward within the framework. The values and priorities as part of this framework give decision-makers a guide for prioritising different interests in the deliberative process.

In sum, the aim of understanding how science is used in the RMA planning framework has been fulfilled from three angles: that of how decisions are made, how science is used in debate, and how values structure use of information. Planning involves normative decisions to allocate space among competing interests. Decisions require a large range of information types that are compared as part of a rationalist process. Public processes allow for deliberation, and scientific information represents different interests in this process. It may be difficult for planners to compare different types of information, and it may require normative judgement calls as to what is an acceptable level of effect or which type of information is privileged in this process. Research question 2 builds upon these results by examining the links between scientific knowledge and beliefs, norms and policy goals. RMA planning enables public debate over aquaculture, and chapter 5 characterises the three science epistemologies to understand how they support democratic debate.

Mussel farm in Tasman Bay, NZ. The farm can be viewed from a local beach, permanent and holiday homes and a small marina (Collins 2011).

Chapter 5. Results: Aquaculture science epistemologies

The research question pursued in this section is:

What characterises the epistemologies for **science knowledge** in NZ aquaculture?

The literature review in section 3.2 showed that epistemology of science is important because it reveals the links between scientific knowledge and social context. To characterise each epistemology for aquaculture science, it is necessary to explore the beliefs and policy goals that are part of the scientific knowledge community. Chapter 5 describes commercial, civic and Māori science by examining interview data gleaned from semi-structured interviews with key informants. Interviewee statements contain evidence that there is tension among the epistemic communities in aquaculture. Because aquaculture science is heavily linked to social factors, and because the process of allocating space is ultimately a normative one, there is evidence that the civic and Māori epistemologies support deliberative processes better than commercial science.

Key respondents in this chapter include scientists, policy makers, coastal planners and advocates in aquaculture. The findings presented here do not attempt to classify individuals into respective epistemologies, as this is not consistent with the goals set out in section 3.2. Rather, interview statements are classified according to the beliefs and policy goals on which they recommended science be focused. The ten stakeholder groups are listed below, and abbreviations are used to identify interview statements (Table 5). This chapter concludes with a discussion on these epistemologies.

Table 5. Stakeholder group abbreviations.

Stakeholder group	Abbreviation used in results reporting
Advocate - environmental	Adv-envr
Advocate - recreational	Adv-rec
Coastal planner	CP
Commercial fishing	CF
Māori development	MD
Marine farming	MF
Policy analyst	PA
Scientist - CRO[3]	Sci-CRO
Scientist - ministry	Sci-min
Scientist - university	Sci-uni

5.1 COMMERCIAL SCIENCE

The dominant epistemology in this sample is commercialised science. Commercial science was discussed by 13 of the 25 interviewees who made reference to their epistemic orientation[4]. These interviewees were from the science, policy analyst and marine farming groups. A prominent theme was that these respondents see the science sector as responsible for its own financial viability, and a large focus of science production was technology transfer to enhance aquaculture production.

Six scientists in this sample described how they believe science should help promote growth of the aquaculture sector. These scientists recounted that growth is achieved through product research (Sci-CRO 35)[5], education (Sci-uni 22), and best practice (Sci-CRO 1). Interviewees discussed at length the factors that distinguish applied science from 'pure' science. Respondents noted that applied science for NZ marine farming is characterised by well-defined questions (Sci-CRO 1) aimed at up-scaling research (MF 20) to make it commercially viable (MF 14). Where applied science is used to enhance production, it was seen as useful when it answers a question that arose from an industry problem (Sci-CRO 35). Interviewees placed a large emphasis on valuation of science, and one respondent explained that applied science for NZ aquaculture should have a monetary value (Sci-uni 22).

[3] Contract Research Organisation, which includes Crown Research Institutes, Cawthron and independent consulting firms.
[4] Some interviewees did not provide sufficient indication of their beliefs and policy goals to be considered in this section.
[5] The references are identified by stakeholder group, followed by the interview number.

Under this epistemology, several interviewees characteristically believed that science should support industry capacity. The following quote explains that capacity is enhanced through public good science for industry:

> The way I see public good research is about building capability, capacity in NZ, whatever the area in NZ. You've got that knowledge and that capacity, and people are able to then do the specific projects that companies want done. (MF 43)

When asked to characterise the 'public good', this scientist explained that:

> The public good, really in this context means export earnings. That just sort of goes away to 'happy economy, happy people'... It's all a bit unclear with the transition from the Foundation to the MSI and they still don't know what their guiding principles are. But if you look at the people in there, then you know that dollars is paramount. (Sci-CRO 40)

The following researcher explained how the commercial system affects research funding:

> But the thing is that it would be very difficult for me to attract any funding to do any interesting evolutionary studies on [a species with few industrial applications]. So in my strategy, I am very open about it, I work on fisheries and aquaculture species because I know I stand more chance of attracting money to work on those species to sequence a whole genome than I will in any other species. So I am in this area because I want to address some basic science questions, and this is the best way I know to do that. (Sci-uni 2)

This statement characterizes how the commercial epistemology influences science funding and priorities.

Some interviewees were critical of commercial science and offered their critiques on where it is deficient. These included an inability to build baseline knowledge (PA 3), in areas such as basic ecological studies (Sci-CRO 39), integrative projects incorporating social concerns (Adv-envr 21), and collaborative projects between sectors (Sci-CRO 46). This was explained by one ecologist:

> A lot of what I'm doing is commercially oriented, but there is not the ability to study basic ecology of individual critters to great detail. You just don't have the time and the money to spend… That hasn't been put together, partly because it is expensive, and partly because there hasn't been a real commercial need for it. It would be really nice to do. (Sci-CRO 39)

This account clearly highlights the tension that exists between commercial applications of science and fundamental ecology, which he implies is sidelined due to lack of demand. Overall, beliefs in the strengths of commercial science were science for adding value to industry, basing research decisions following the market, technology transfer, and acknowledgement that the dominance of commercial science is narrow in its approach to non-financial research needs.

5.1.1 Discussion of commercial science

Commercial science reflects neoclassical economic ideas such as utility maximisation and incentivization for efficiency of science production (Mirowski 2003). Incentives are built into the system of science provision that shape the way science is produced and scientific research results, such as through contestible funding and through funding aimed at primary growth partnerships. The policy goals behind commercialised science go beyond the sole aim of maximising the *profits* from science, as explained by Sarewitz and Pielke (2007). Commercial science aims to optimise scarce resource allocation to science. Decision-makers attempt to maximise the *outcomes of research* funding by comparing research portfolios and competing projects. Science provision is thus seen as the 'supply' and the outcomes in society as the 'demand', and the aim is to 'reconcile' the two (McNie 2007). This was illustrated in the comment that public good science means bringing economic benefits to society.

The commercial epistemology affects policy goals for science, such as in building capacity in the sector. The value orientation of science is evident where science focuses on adding value to industry. The commercial rationale for determining research outputs, shown in the quote by the ecologist, is optimised mainly through the economy (Mirowski and van Horne 2005). A very important point here is how commercialised science shapes focus areas of research. The deregulated system leaves the market to determine where the most viable areas of science production are, which results in science production that will in turn generate a return for the investor. Several respondents noted how non-market goods, such as social concerns or ecological research, are lacking in this system. Understanding the pressures on science to focus on commercial values aids the discussion in chapter 7 on the ways that scientific knowledge can support fair deliberation to address spatial conflict.

5.2 CIVIC SCIENCE

A small group of interviewees held civic-oriented beliefs for science. Nine interviewees made reference to civic science out of 25 who discussed their epistemology. One theme that emerged was the need for science that is focused on social and ecological improvements, and there were several calls for the science system to consider a wider range of end-goals beyond those that are economically-focused.

One respondent provided an example of a civic-oriented science project. The Motueka Integrated Catchment Management (ICM) programme, spanning the years 2000-2010, had as part of its mandate to look at the environmental conflicts within the Motueka River catchment. Its goal was to conduct multi-disciplinary, multi-stakeholder research as an input into environmental management and interacting or conflicting uses (Landcare 2011). This scientist described this project as focusing on "real questions and real problems":

> One of the ways that we've found the best approach is to look at conflict because with the Motueka ICM programme, we had a strong social component, and the idea was to provide a framework that all stakeholders could be involved… The most important, to me, was getting the marine stakeholders involved, because previously, they pretty much hadn't. They were just accepting what came down the pipe… It was really important, and to do it in a non-threatening way, so it didn't end up being a them-and-us situation, which it had been previously when the problem developed. There was no input prior to that development. (Sci-CRO 48)

The calls for civic science took many forms. This coastal planner explained that science for planning should be about understanding the relationships between different parts of the community and the environment through science:

> The scientists can range from people going out to looking at the benthos and coastal processes but also dealing with the communities and the communities' experiences and their views on things. If you are taking a broad view on things, it's a pretty constant process. It's about going out to the community and getting their views on things... that the community's views are included in that way of incorporating science [into planning]. (CP 9)

Interviewees called for a number of other focuses for civic science, including science that considers a wider range of social factors in research (Adv-envr 21), contributes to collaborative management (Adv-envr 38), and that is more closely aligned with non-consumptive values (Adv-envr 28). The focus on commercial science in competition with other needs was an issue for this policy analyst:

> There's been a real disconnect between the government and the stakeholders and the institutes to actually develop science and skills that are needed to fill the gaps. I don't think the science funding is based around 'what don't we know and what do we need to know.' It's been driven by other motives. (PA 3)

One advocate expressed concern that monitoring efforts and impact studies in aquaculture are too small-scale to understand larger ecosystem effects. His recommendation was for 'deeper' science to increase confidence about the ecological effects of aquaculture (Adv-envr 28). In a similar way, this interviewee would like to see science in service to the social good:

> There's been a lack of marine scientists involved in looking at the environmental issues… I have now over the many years realised that science is recognised as a tool which unfortunately or fortunately we have to use in our society... We have now ended up in a position where the public good science is not being done. This is the trouble with science. Science focuses on the *subject*… So it's not that I'm deadly against aquaculture; I'm deadly against science that focuses on leveraging benefits for the industry rather than science that's looking at the litter base under it. (Adv-envr 21)

The term 'public good' in this context is interpreted to be for the social good, distinct from the usage in section 4.1 linked to economic benefits. On the whole, the themes that arose in discussions about civic science were: science that links different stakeholder groups and interests, science that considers non-consumptive values for the environment, science that is integrative across different study areas, and knowledge that addresses topical social-ecological problems for aquaculture.

5.2.1 Discussion of civic science

This group of the sample seeks social and environmental improvements, as part of a broader orientation towards democratization, public dialogue and interpretation (Lee 1993). The unique case of the Integrated Catchment Management Project serves as an example for how science aims at addressing system-wide environmental problems and friction between user groups. This approach to producing science reflects interdependence between science and society (Lane 1999). Lane asserts that two-way dialogue with community and collaboration across different fields yields the most benefits for wider society in a democratic manner. Proponents of civic science advocate for a strong relationship between science and policy development. This necessitates cooperation between scientists and stakeholders, "marrying expert knowledge to decision-making" (Schmandt 1998: 68). Civic science for NZ aquaculture was described as linking many values for marine space through science, where science is the connecting factor between ecological protection, conflict resolution and the social good.

The above calls for civic science came from a small but clearly articulate group of interviewees. They demonstrate the tension between the epistemologies for science, particularly between science associated with consumptive and non-consumptive values, which is representative of the broader value debates over aquaculture's use of space. Understanding the distinct focuses of science among these epistemologies informs the discussion in chapter 7 on how commercial, civic and Māori science support debate in different ways.

5.3 MĀORI KNOWLEDGE

The results to this point have dealt mainly with the dominant planning, policy and industry practices, which are based in the western scientific tradition. There are members of the sector who operate with different cultural paradigms, such as with Kaupapa Māori knowledge of the environment and of utilisation of resources. There were five interviewees who discussed Māori knowledge, making this a minority epistemology in aquaculture science. These interviewees were not all Māori (there were two Pakeha working in Māori development), and there were Māori interviewees who made no reference to their epistemic orientation.

There is neither one Māori voice nor one Māori approach to aquaculture. The essence of these discussions is that Mātauranga Māori – just like western science – is an indicator for the state of the environment and guides resource use. The following quote illustrates the fact that the Māori worldview is a framework for understanding the environment, and the respondent suggested that it is underrepresented in the system for aquaculture science.

> Māori have a whole tradition that is not based in western science, but it is equally valid. That is something scientists easily forget. Science as a philosophy is really new, 4-500 years old! In terms of a system for understanding our environment and our world, it's very, very new. It's very important, but it's not unique or the only means by which we can comprehend the natural environment. The Māori system is called Mātauranga Māori. And it describes things in terms of relationships to each other. It doesn't differentiate relationships from human relationships and relationships between non-human. (MD 5)

The next respondent described how some iwi engage in aquaculture as a livelihood, employing knowledge of the environment garnered through kaitiakitanga, a concept depicted here as:

> Kaitiakitanga is the local version of more internationally recognised traditional environmental knowledge. It operates locally within communities, within specific environments. It has to do with two things. One is maintenance and sustainability of the

> resource, but also it is about utilisation… It is the underpinning of Māori environmental management. (MD 27)

From the point of view of an analyst at Te Puni Kōkiri, the Māori worldview plays a similar role to science in how the ecosystem is understood, and it also relates to uptake of development opportunities:

> The primary objectives for [Māori who invest in] aquaculture are social and economic. That is within the exercise of the framework of kaitiakitanga, which is an appreciation for the interlinked nature of life and non-life. It accords closely to ecology. Ecological principles can be found within the Māori framework, which is known as Mātauranga Māori. (MD 5)

The above quote articulated the links between resource use and resource stewardship. One respondent was kind to provide a greater depth of Māori culture to me as an aspect of this epistemology:

> I suppose it's difficult to get into these sorts of esoteric discussions with you, but in Māori, if you go into an area of the sea, that is the domain of the Atua Tangaroa (god of the sea). Tangaroa is assigned the duty to make decisions on what, where and how things happen in the sea. Tangaroa knew where to place scallops, mussels or shellfish. Human kind comes, makes all these mistakes, tries to do science about it. Science is so singularly focused on the content of what they are doing that they are not taking a holistic approach. (Adv-envr 21)

The boundary between western science and Māori epistemologies was a common theme in the discussions on Māori ecological knowledge. Three respondents argued that there are difficulties integrating the Māori worldview into aquaculture policy. This respondent described the challenges of uniting Māori and western epistemologies for science in policy:

> If there is a different epistemological knowledge system for kaitiakitanga from mainstream environmental science, which there could very well be, and there are certainly operationally very big differences… [*What are some of the challenges at working at the interface of those epistemologies? For instance, in policy*?] You end up thinking you are making sense, and you end up talking to yourself... You say things from a kaitiaki perspective but they are heard in terms of a mainstream perspective. So you've got to spend a lot of time and a big effort to retain the essence of kaitaikatanga and articulate it in that other world. (MD 27)

The suggestion made in this quote is that it is difficult to integrate Māori science in the same way that it is difficult to integrate culturally distinct views on society and politics. Although the Māori viewpoint did not dominate the interviews[6], more involvement and leadership in research by Māori can hopefully yield a clearer picture of how Kaupapa

[6] This also may be an artefact of the research questions pursued.

Māori is used across the aquaculture seascape. Overall themes in the discussions on Māori knowledge were the inherent connections between worldview and practice for resource stewardship, the indivisible link between resource stewardship and utilisation, and the challenge of integrating Māori knowledge with western science for marine management.

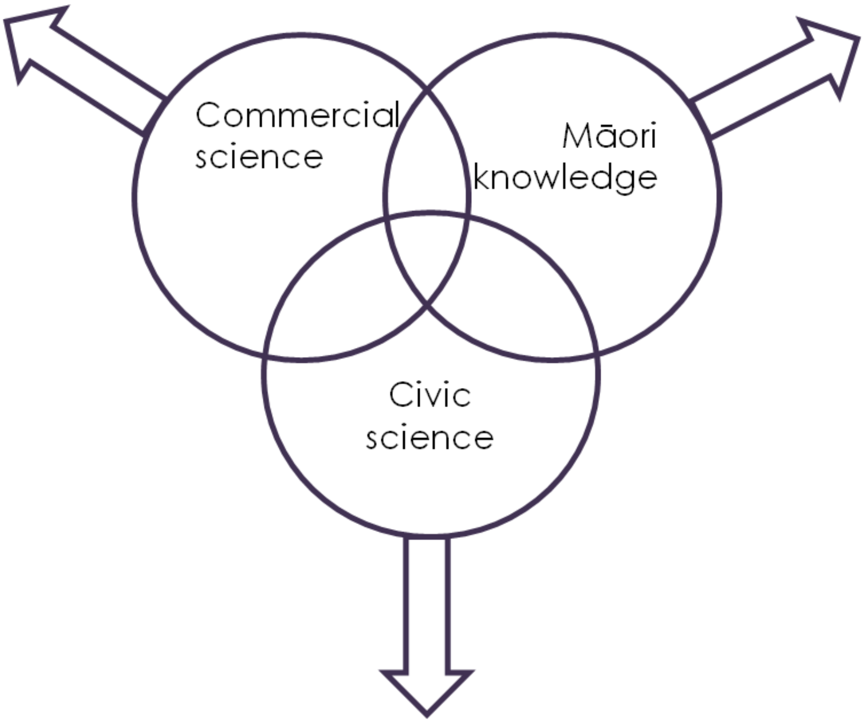
5.3.1 Discussion of Māori knowledge

It is argued in the academic literature that the Māori worldview reflects relationships with the environment where resources are both utilised and responsibility upheld for their maintenance (e.g., Moller et al. 2010). In this way, understanding of the environment is tied very closely to resource use (Henry 2000). In these interviews, this mingled with western scientific knowledge to differing degrees among the respondents. Given that the aims of this study are to address conflict, it is significant that the individuals who work in Māori development strongly assert that there is little recognition of the Māori worldview in aquaculture policy. Different respondents underscored different aspects of Māori epistemology in this study, with no obvious dominant theme: ecological protection, resource utilisation, spiritual relationships, and political struggle for recognition. The sample of Māori participants in this study was too small to draw firm conclusions about the degree to which Māori knowledge is integrated into wider aquaculture policy and science, yet it does reflect frustration by those respondents. The statements regarding the struggle to gain recognition for the Māori worldview in policy frameworks are broached again in the discussion on social contextualisation of science and the importance of linking scientific facts to values.

5.4 DISCUSSION OF THE THREE EPISTEMOLOGIES

In sum, most statements in this sample subscribed to commercial science, where science is client-based and focuses on economic implications. A small group of respondents describe civic science, asserting that the best uses of science are towards social or environmental improvements. The Māori worldview is also a minority in this sample. The three epistemologies were distinguished by the policy goals of science, and interviewees described friction between the policy goals addressed by each orientation of science. For example, proponents of civic science claimed that there is insufficient science researching ecological and social issues in aquaculture. Advocates of Māori development reported that the Māori worldview is not present in aquaculture science and management frameworks. Although there is some overlap, the differing goals for science lead to tension among the epistemologies, represented in Figure 3. These typologies support deliberative processes addressing spatial conflict in different ways, a point which is elaborated in the discussion chapter 7.

Figure 3. Epistemologies for NZ aquaculture science.



The beliefs and policy goals of the three epistemologies have implications for the role of science in conflict deliberation. Section 3.1 showed that values help to define conflict, and chapter 4 demonstrated that science supports different interests in planning debates. It is not uncommon for scientists to have differing and contradictory views about what science is and how it operates (French 2007). This chapter has depicted the strong links between science and beliefs and goals for science. For each epistemic group, knowledge can point the way for action and informs outcomes-based decisions to address spatial conflict.

With regard to science and policy outcomes, these interviews suggest that there is a degree of 'competition' among commercial, civic and Māori science. Commercial science, using the market to determine research needs, does not mesh well with the RMA's approach to public space, which maintains public ownership and non-market values. Civic and Māori epistemologies appear to be more consistent with the RMA's approach to public space, including ecological protection. The expressions of frustration by proponents of civic science that the social and environmental considerations are under-represented in aquaculture science are significant. The calls for civic science mirror the debate between instrumental and non-consumptive values for the ocean ecosystem.

Commercial, civic and Māori science are compared in Table 6. Because civic science and Māori knowledge incorporate social, cultural, ecological and utilisation values for the ocean, they are a more useful platform for discussion and debate over how space is used than the narrow commercial view. Māori are in an interesting position because the worldview for environmental management is closely linked to historical and cultural knowledge, particularly in the case of the interviewee who described how it is difficult to mesh Mātauranga Māori with the western scientific tradition, which is empirical and narrowly focused. Civic science does not necessarily privilege any particular value set, but aims to democratically represent different values through science (Shannon and Antypas 1996).

Table 6. Comparison of the epistemologies for NZ aquaculture science.

	Commercial x Civic	Civic x Māori	Māori x Commercial
Similarities	Emphasis on expert-based knowledge Quantitative/ empirical Enlightenment views	Resource stewardship Holistic Links between of social and environmental ends	Resource utilisation
Divergences	*Differing scope of focus:* Commercial is narrow Civic is wide	*End-use of knowledge:* Māori knowledge links to culture and history Civic science links to present-day issues	*Relative prioritisation of values:* Commercial prioritises economic interests Māori encompasses ecological, spiritual, economic, social interests with no set priority

These results illustrate how science can be a medium through which different values influence policy. With respect to the research aim of this chapter, there were common themes that emerged from the discussions on commercial and civic science.

These results are significant because they show that spatial conflict cannot be viewed purely in terms of scientific measurements of effects- conflict must be contextualised with beliefs and policy goals in the marine ecosystem. The epistemologies for science build upon the analysis of the RMA policy framework in chapter 4, underscoring the links between science and social context. Chapter 4 showed that science is used to influence the consenting and submission processes, and chapter 5 shows that science is linked to commercial, civic and Māori beliefs and policy priorities in distinct ways. This suggests the need for deeper investigation of the way that science is used in a political space, which is the theme of chapter 6. Future research in NZ aquaculture should be mindful of the most effective and appropriate methods that will support the Māori voice in aquaculture policy and science. Understanding how different interests and policy goals influence science is of principal importance to examine the challenges for using science in policy to address spatial conflict in chapter 6.

Chapter 6. Results: Challenges for using science in policy

Thus far, the chapters 4 and 5 have described aquaculture policy processes under the RMA and the epistemologies for scientific knowledge in NZ aquaculture. Chapter 6 builds upon these by exploring the ways that policy processes utilise scientific knowledge. The research question pursued through chapter 6 is:

What are the chief challenges for using **science in policy decisions** in aquaculture?

Interviewees described how science becomes politicized when it enters debate over aquaculture. Politicization of science occurs as science is used as a persuasive tool to influence decision-making. Interviewees reacted differently to politicization in different stages of the policy process and revealed different expectations and assumptions for how scientists should behave in the political sphere. Some interviewees perceived politicization to affect the quality and reliability of science, while others saw science as a rhetorical tool.

There are three parts to chapter 6. Section 6.1 explores politicization of science through different stages of the policy process: planning, policy development and the Environment Court. There were diverse assumptions about the level of independence science should have from politics through the different stages. Sections 6.2 and 6.3 explore misuse of information and mistrust of scientists as aspects of politicization. This chapter sets up the discussion in chapter 7 by concluding that fact alone cannot form the basis of controversial decisions. Politics is a normative, political process – so the links between science, values and controversy are of primary importance to addressing spatial conflict for NZ aquaculture.

6.1 POLITICIZED SCIENCE

This subsection describes interviewee perceptions of science politicization through three stages of the policy process: planning, policy development and the Environment Court. Semi-structured interviews reveal different assumptions about science at each stage.

6.1.1 Politicization in planning

Regional and unitary councils are responsible for coastal planning in the territorial sea. As described in chapter 4, science is part of the AEE, submission process, UAE test and Environment Court. The objectives of planning are to consider the range of interests affected by an application for consent and to optimise the use of space accordingly. Among stakeholders from Māori development, marine farming, policy analysis, and coastal planning, many were aware that science can become politicized as parties try to assert their influence over the planning process. For example, this analyst at Te Puni Kōkiri implies that some stakeholders ‘buy’ science to influence the way an issue is interpreted:

> Science tries to state that it is strictly neutral, just strictly factual observation. I believe that scientists perform that function to their very best of ability. What people do with the science they buy is another matter entirely. They try to relate it to relationships, either positive or negative. (MD 5)

Where decision stakes are high, stakeholders may look for the rhetorical tools that will best help achieve their objectives. This is portrayed clearly in this marine farming stakeholder’s quote on ways that science can be used to oppose aquaculture development:

> The reality is that it's things like landscape, navigation, amenity, that tend to derail things... And the ecology is a means to an end. It's another rock to throw, another lever or obstacle. (MF 38)

Science is not only part of the opposition to aquaculture, but helps demonstrate to planners that a consent should be granted, as explained by this coastal planner:

> [Under the RMA,] the whole onus is actually on the applicant to prove that their sites are suitable. So they must be able to prove to either a council hearing committee or commissioners, whoever is hearing those consents, that the sites that they are applying for are suitable. So they must then work with the science providers to provide evidence that it is satisfactory. (CP 49)

Chapter 4 explained that planners receive submissions on a consent decision, and they must compare quantitative, qualitative, cultural and anecdotal information for spatial allocation decisions. Comparing quantifiable and non-quantifiable information presents another dimension to the challenge of deliberating over interests in spatial conflict. One planner said that she simply must use her best judgment to compare across existing uses and values (CP 50), implying that it is a subjective judgment. In a highly contentious and political atmosphere:

> [Councils sometimes] solve things based on politics. There's a lot of gaming out there, and it is something that you cannot get around. People have their views, and they try to work towards those views as best they can. (PA 34)

The complexity of the consent process is explained by this marine farming stakeholder:

> There is very little that is hard, fast and exact. But yeah, [consent decisions are] a game. This whole thing is a juggle between ethics, morals, emotion, science, regulation. It's a continuous game. (MF 35)

The pattern among these accounts is that in a contentious, deliberative space, politicization of science is not an unexpected phenomenon. There was comparatively less criticism of politicization of science in planning than in policy development or Environment Court.

6.1.2 Politicization in policy development

Policy development for aquaculture was a prominent topic during interviews because the research took place when the Aquaculture Amendment (Repeals and Transitions) Act 2011 was in Parliament. One central aim of this Act was to address conflict between aquaculture and other stakeholders such as commercial fishers. The following statements by policy analysts illustrate the contention they observed as part of working on this legislation. This quote attributed politicization of science to high decision stakes:

> It's really about the competing uses of the same area or the lack of use of that area… that is what the conflict is about. The science is just a tool to whack other arguments with, quite frankly. The science itself doesn't do a lot. It just sits there. People *use* it for or against doing something to an area, for an area... Science is just part of it. Part of the argument... is 'how can people use science'. (PA 29)

This policy analyst described how, in controversial decision-making, it is difficult to compare types of information:

> The heart of what is the issue around aquaculture development is that spatial conflict. Also, there is a whole range of players in there and science information is really relevant in terms of assessing conservation values of the areas and impact on ecosystems and so on. Also relevant is social science information in terms of impact on communities in terms of visual impacts and all those sort of things, and the spatial conflict arises on all those sort of spectrums. Some of those we find easier to take account of than others. (PA 30)

There were discussions on this topic with three aquaculture analysts deeply involved in aquaculture policy development. These policy analysts (PA 3, PA 29, PA 34) explained that evidence-based policy is seen to strengthen the policy case and protect the policy-maker from accusations that decisions are biased or politically motivated. This analyst explained that there is a clear role for scientific fact in the political decision-making, where the boundary between the two is clear:

> We rely on the experts to tell us what is the fact, the science fact. Do we interpret that fact correctly without distorting it? …We have all these different perspectives that go into an advice paper for a decision-maker... So there's a ground truthing through the peer-review process, for whatever, natural science information, or social science information. (29)

The reasons for relying on scientific fact in decision-making are described by this policy analyst, where information is an antidote to politics:

> The reality of policy as anywhere is that a lot of the time it is driven by politics rather than facts. I guess if you're making decisions which are in relation to managing natural resources, if you can hook that into an understanding of the facts, than you can strengthen the understanding of the science and outcomes. (PA 3)

According to one analyst (PA 34), better information can depoliticize controversial calls by bringing a 'clear answer' to the debate. For policy development, science is one input alongside many others in a package of policy advice, which is then sent to final decision-makers (e.g., the Minister) (PA 29). In cases of conflict, scientific evidence can provide empirical backing to a decision or as an antidote to political pressure and lobbying. This opinion of politicization is clearly distinct from those discussed as part of planning, because scientific information is assumed to be neutral or objective, reflecting positivist epistemologies.

6.1.3 Politicization of science in the Environment Court

The third stage of the policy process that is considered here is the Environment Court. When controversial consent decisions are unable to be resolved through the submission and hearings process, they are appealed to the Environment Court. The quotes below explained that Courts rely heavily on empirical, scientific data. These quotes also portrayed scientists' role in Environment Court proceedings as providing objective and technical advice so the court may make a good decision. One respondent underscored the important role of the code of conduct for expert witnesses to follow, which establishes that information should be factual and not interpreted according to opinion (Sci-CRO 46). Another scientist asserted that scientists have a special role within the Environment Court because technical expertise is highly regarded:

> A lot of lay people try to use science to press a particular point. When it comes to hearings or the Environment Court, their evidence isn't given as much weight as expert witnesses because they haven't got the training and expertise. (Sci-CRO 19)

This environmental advocate corroborated the above opinion:

> Over the many years I've been involved with the RMA, the Environment court cases, is that scientists have been to the fore in that discussion. It's their science that a lot of decisions are hinged on. And unfortunately some of those scientists consider they are the priests of truth. Just because science says something, doesn't mean to say that everything they say is truthful. Science is just a mini-programme or a snapshot of the issues. It's very limited. Quite often the hearing committee takes their view over and above other evidence just because they are scientists. (Adv-envr 21)

The following interviewees stated that science in the Environment Court also often becomes politicized. This interviewee remarked how the Environment Court process lends itself to adversarial uses of science:

> So [the intention of] the Environment Court could winnow out the facts and evidence surrounding aquaculture generally... Science can be manipulated, and that's an unfortunate circumstance. Science gives itself to the adversarial nature of our consent process. Two scientists provide competing views, and the judge tries to sort out which one is more believable. So in that sense, the reductionist approach supports that kind of adversarial nature. (MD 5)

In Court, parties use science to elucidate or legitimate their claims. The following quote by a policy analyst explains that scientists may interpret the same datasets in different ways. He observed that this depended on which "side of the bench" the science was provided by:

> Conflicts will be used in any way possible, depending on what the competing interests are. They all do that. They all try to game the process of decision-making in one form or another. So it is sometimes alarming how pretty much the same information can be used for different arguments... Science information, like any information, is dependent on whose side of the bench you are talking to. (PA 29)

This scientist argued that interest groups try to influence the judicial process against aquaculture with sensational information about ecological impact:

> Because then they go to court, and they've got a judge or somebody that doesn't know any better, and they say, 'look at this! This place is a cesspit! It's a septic tank! It's killing everything!' How does [the judge] know any better? And they know how to sensationalise it and drag it out. (Sci-CRO 35)

While these interviewees implicitly expect scientists in court to provide objective and neutral advice, many perceived science to be politicized. The discussion in chapter 7 examines these contradictions in more detail and suggests that the scientific tools engaged by the political process cannot be separated from the politics themselves.

6.1.4 Discussion of politicization

In short, for planning, both planners and scientists were aware of the tendency for science to become politicized, and there was acknowledgement that it is an ordinary aspect of politics. In contrast, three analysts in policy development explained how they use science to justify and de-politicize decisions, protecting them from the appearance that decisions are political. Lastly, in the Environment Court, interviewees asserted that science information in court can also be politicized.

Politicization of science in planning, policy development and the Environment Court is significant for understanding how science and scientists address spatial conflict. Politics are rhetorical and competitive among different values and interests (Herrick and Sarewitz 2000). Science is an important tool to influence political decision-making in spatial allocation by both opponents and proponents of aquaculture. The difference in opinion over politicization may reflect positivist versus rationalist divides in thinking about how science should be used in political decisions. Decision-makers are not isolated from political pressure, and when decision stakes are high, they face the dual challenge of reaching a robust decision under political uncertainty while dealing with pressure from various stakeholder groups to influence the political process. There may even be incentives for scientists to frame their work in terms of truth and falsity, away from framings that acknowledge complexity and ambiguity (Price 1979). The results of this case study corroborate those of Keller (2009), where she points out that the norms for science may contradict one another throughout the political process: while the conventional perspective demands that scientists act as idealized neutral advisors during legislation, in agenda-setting, the scientist may be asked to make political interpretations of facts.

Politicization takes place because most difficult political decisions ultimately are made by committing to values and goals (Herrick and Sarewitz 2000). Chapter 5 showed that science for aquaculture is embedded with different beliefs and policy goals for science. In a highly politicized process, different interests and values shape the way science is used. The results of this case study challenge the assumption that scientific information is always objective. This case study suggests that there is no ‘good’ or ‘bad’ way to engage science in policy, but instead that science for policy is based deeply in norms, expectations and beliefs for science. Next, section 6.2 discusses how perceptions of misinformation and mistrust for science and scientists in the political process exemplify the negative aspects of politicization, representing major barriers to using scientific information appropriately to address spatial conflict.

6.2 PERCEPTIONS OF MISINFORMATION

Taking a deeper look at politicization of science, respondents perceived that opponents and proponents of aquaculture at times use misinformation that is selective or misleading. Misinformation refers to science that is used for political persuasion that does not represent all evidence that is available. Two respondents suggested that misinformation is incentivised because there may be rewards that come from influencing the political process, such as achieving a favourable outcome. The following policy analyst remarked that misinformation can be strategic, which he attributed to the structure and incentives of the legal framework:

> Most of the misinformation is around ecological effects... It may be driven not that people have ecological concerns, but because they are concerned about the view from their bach, and then they raise all the ecological stuff to go with that. It’s very difficult; I mean that’s basically game-playing… The difficulty is, how do you remove the incentive on people to use misinformation? It’s really, really, really tricky. If someone is affected by something, like they’ve got a value that they want their view unobstructed by aquaculture, their incentives are to try and use every mechanism that they can to try and do it. (PA 34)

One university scientist observed that an opposition group:

> ...had a message which was very reasonable, but [they] layered on top of it all these misconceptions and facts that were wrong. (Sci-uni 2)

One scientist explained that technical expertise has a great deal of weight under the RMA, so there is an incentive to use empirical information to support one's case (Sci-CRO 19). This analyst also suggested that science is privileged in debate over privatisation over public space:

> The RMA means that if you are concerned around privatisation around public space, the RMA has very weak mechanisms for you to win that argument. It is around sort of social and recreational amenity. Contrast that with the amount of coastal space and the amount of aquaculture development... So your natural opposition is on that basis, but the best way you can actually win the RMA fight so-to-speak is to prove that it is ecologically or environmentally degrading. (PA 44)

This respondent suggested that it is difficult to substantiate social or cultural values through science to influence the planning process.

Importantly for this research, one interviewee pointed out that the real problem is when scientific information is used *in place of debate over principles themselves*:

> What often happens is that people look for every piece of evidence they can use to oppose something, even though the evidence might be weak... People will look for all sorts of things to try and demonstrate adverse ecological impacts, when they are really opposed in principle. (Sci-CRO 19)

The above quotes are interviewee *perceptions* of misinformation, and this thesis does not attempt to verify each and every interviewee statement. Importantly, however, there were a variety of explanations suggested as to why misinformation is used and what it means for aquaculture conflict. Four respondents noted that misinformation was not necessarily used with malicious intent, but that it could be an uninformed misapplication of science from overseas (MD 5, CP 9, MD 27) or due to already high uncertainty about environmental effects of aquaculture (Sci-min 23). Likewise, from the point of view of two aquaculture opponents, using ecological information strategically is necessary to be successful in opposing site development (Adv-envr 28, Adv-envr 42). These perceptions open important questions about whether debate processes should focus on scientific fact, or on creating space to directly debate values and principles over use and non-use values.

6.2.1 Discussion of misinformation

These perceptions suggest that misinformation may be a strategic way of influencing aquaculture politics. Two policy analysts in this sample explained that the elevated position of science in decision-making may incentivise misinformation in aquaculture conflict. Science for advocacy and science as a persuasive tool are well-documented phenomena (e.g., Stone 1997, Keller 2009). According to Stone (1997), science can change the way the opposition sees the issue by way of science narratives. These stories have a causal element, explaining how the way the world works, to be persuasive in the political process. As explained in section 6.1 above, this may be a natural aspect of politics. Keller (2009) proposes that the users of science may manipulate the information to support a particular outcome, such as through biasing the science or its representation in policy discussions. She states that heavy reliance on empirical information presents an incentive for participants in politics to stress the idea of 'sound science' for politics and seek information that supports a particular case. The point made by the CRO scientist (19) is significant for this research aim, because it suggests a barrier to better using science to address spatial conflict. While it is possible to distort facts for debate, it is more important to focus on the principles and values that drive aquaculture conflict. This point is elaborated in chapter 7.

6.3 MISTRUST OF SCIENCE AND SCIENTISTS IN POLICY

A salient theme in the interviews on politicization was mistrust of scientists when they appeared to be advocating for a particular policy outcome. This tended to arise when stakeholders perceived science to be advocacy-based, both for opposition and to support aquaculture development. Stakeholders from the policy analyst, marine farming, environmental advocate, and Māori development groups recounted that they perceived the quality or reliability of the information to be lower when scientists attempt to influence the political process.

Several interviewees perceived scientists to advocate for policy outcomes that favoured commercial interests. This policy analyst was mistrustful of the incentives that are part of the contestible funding system:

> In the NZ context, there are a few issues which are starting to bubble up in the contribution of marine science to policy discussions. One of them is the fact that NZ is small and the funding is very limited for the research providers, and therefore a lot of the

> research is actually driven, market-driven rather than driven by what would be best to understand this area. Because someone is always *paying* for the science. (PA 3)

One complaint was that the commercial funding system can affect the way that scientific advice is provided to policy. This quote by a scientist attributes mistrust to the privatised research institution structure:

> There is mistrust around science and scientists, and they think we are just out to get money. So I think the model that we have around funding does create issues. (Sci-CRO 43)

In the following case, the environmental advocate expressed mistrust for scientists that run science institutions like a business:

> In some of these pieces of work, consultants have been justifying the location of an aquaculture farm in a particular place… I think it's a lack of integrity by some of the work as well… There appears to be some people that lack any ethics. The only thing that's driving them and their consulting business is the fact that they are going to get paid. This applies to not only individual researchers but institutional ones as well… There is not a lot of independence there. (Adv-envr 4)

The next two respondents claimed that the commercial system biases scientific results. The first quote explains that the contractual relationship between the science provider and client may be seen as an obligation to fulfil the expectations of the client, which affect scientific integrity:

> The bad qualities are being seen to be tainted by association. Being a scientist for hire. To say only what the person paying you wants you to say. Those are the kinds of qualities that do science a disservice. A scientist has a responsibility to say to people wanting to pay for their research what the constraints of working in the marine environment really are. (MD 5)

The following respondent postulated that some people think that scientists are biased in accordance with their source of funding:

> That's part of the thing that sometimes undermines confidence in the system. So you've got two acknowledged experts in the field saying two different things about the same matter. People just think everyone is a gun for hire. So you have that criticism, you know, even research providers get it. The client paid you, therefore you are in their pocket and you are not objective. (MF 38)

In sum, advocacy-based science and commercial incentives were perceived as biasing science and led to mistrust of scientists.

6.3.1 Discussion of mistrust

Mistrust for science and scientists is important to political deliberation. These results support findings by Wiley (2011) on conflict over marine protected areas in NZ. Wiley found that stakeholders' perceptions of the validity of scientific information was related to how participants perceived the stakeholder group providing the research. Wiley concludes that social aspects of research are a high-order concern, and where there are conflicting goals in marine space, credibility of information is a central aspect in the 'social power' of research. For aquaculture, this underscores the need to consider the social relevance of information as a key factor in resolving spatial conflict. This study suggests that mistrust is a barrier to effectively using scientific information.

6.4 DISCUSSION OF THE CHALLENGES FOR USING SCIENCE IN POLICY

To summarise, the salient challenge of using science in policy was politicization of science. Politicization of science describes the way science is used as a rhetorical tool in deliberation. Stakeholders' reactions to politicization were distinct at each stage of the political process. Underlying these results is the assumption that scientific information should be a neutral tool for understanding and clarifying political controversy.

Stakeholders in this sample did not have a uniform view of the norms for science and scientists' involvement in policy-making. They diverged widely, in that some opined that science should be politically independent and neutral, resounding of positivist epistemologies. Others suggested that science is a rhetorical device like any other, more in line with rationalist epistemologies. Interpretations of scientific information can support a range of political ends (Sarewitz 2000). Under conditions of uncertainty, there may be implicit or explicit institutional pressures on scientists that can affect the way information is interpreted (Haas 1992). Political issues evolve through time, possibly to no resolution, and scientific input to these types of problems must be integrated within the social controversy, not compartmentalized or removed from it. Compartmentalizing science can then lead to selective use of the information to support one position or another (Herrick and Sarewitz 2000), as may be the case in this study.

Chapter 6 aimed to identify the chief challenges to using science in controversial policy decisions in NZ aquaculture. This objective has been achieved by describing politicization in three stages of the planning process and by describing interviewee frustrations over misinformation and mistrust of scientists. The positivist assumption that science is objective and neutral was apparent from interviews. This assumption is a barrier to using scientific information effectively in debates over aquaculture. Considering the results of chapters 4 and 5, it is important to acknowledge the influences that social context have on science. These results suggest that the focus should be on the core principles and values of debate as opposed to the objectivity of science to resolve spatial conflict. Interviewee perceptions that there are incentives for misinformation underscore the necessity of appropriate, effective and accessible channels for participation in debates over spatial use. It is necessary to view aquaculture science from within its social context- which is inherently political- to address spatial conflict.

Chapter 7. Discussion:
The relationship between science & spatial conflict

The aim of this case study is to understand the role of science and scientists in addressing aquaculture spatial conflict. The study helps to fill a gap in knowledge for NZ aquaculture, where much of the literature has focused on the social aspects of conflict without considering the role that science and scientists play in ameliorating or exacerbating it. A civic approach to science is useful to integrate multiple use values and directly address the core issues of debate. The study also offers a contribution to broader NZ marine governance issues, where lack of scientific information is a barrier to integrative decision-making. Reducing incentives for misinformation and decreasing mistrust of scientists can help to use existing information more effectively.

There are several limitations to this study that affect what conclusions may be drawn. First with regard to methodology, the semi-structured interview approach with a very wide range of stakeholder interests yielded a vast amount of interview data. All the data could not be represented in this report. Many of the themes in those interviews, while being related to the topic of science and scientists' role in aquaculture conflict, were left out of the write-up. Specifically, there were very strong opinions, both in support of and critiquing, intellectual property rights, information-sharing initiatives and collaborative science. These issues are all related to the commercial science system, and could have provided more in-depth understanding of the barriers to using existing information to address multiple use conflict. Future research may explore these in more detail.

Furthermore, because there is very limited sociology of science literature for NZ, much of the exploratory research was prepared using overseas examples. Socially, culturally and politically, NZ has a unique context for social studies of science that was revealed quite quickly in the interviews. Thus prior conceptions about the principal issues were reassessed throughout the interview process.

Furthermore, this study offers suggestions as to barriers to better dealing with spatial conflict, but it cannot assert that the politicization of science, mistrust and misinformation are themes common to every region of NZ, nor that the issues have persisted for any length of time. This research portrays the perceptions of interviewees from the snapshot able to be captured over the interview period; however the issues raised by interviewees do share similarities with many of the pressing issues for NZ oceans governance, discussed below. Likewise, the limitations of this study to assess Māori epistemologies were described in section 5.3. While the links between commercial and civic science with policy objectives are clear, the study is not able to draw conclusions about how effective these epistemologies are at influencing policy outcomes. They suggest that the epistemologies drive conflict, but the policy outcomes are not able to be assessed.

The following is a synopsis of the points discussed in this chapter. Firstly in section 7.1, science should not be treated as a source of information that is independent of conflict. Commercial, civic and Māori science play a part in defining the conflict over space between user groups. This means that science for spatial conflict resolution cannot be viewed independently, purely in terms of the empirical measurements alone. This case study argues that politicization is not necessarily detrimental if the interests and values that science represents are disclosed in debate. This is helped by examining assumptions around the objectivity of scientific information.

Secondly in section 7.2, transparent links need to be made between science and values. Because there are multiple stakeholder epistemologies for science, and because there is mistrust for scientists when they are perceived to be advocating for a policy goal, assuming that scientific information is neutral and independent from social factors can limit the potential that science plays in value debates over the use of the marine ecosystem, as seen in the case of mistrust for scientists. To incorporate multiple uses for space, the emphasis in using science to address spatial conflict should be on the arenas to debate values and principles themselves for the marine ecosystem.

Lastly, section 7.3 argues that science can be a tool to support broader democratic processes. Appropriate planning regimes must be developed where values can be debated democratically, recognising and legitimising different epistemological viewpoints. *Democracy is never finished*, so the key is to understand the strengths of commercial, civic and Māori science for supporting effective and efficient democratic deliberation. It is also necessary to understand how commercial science is limiting to support deliberation over multiple use conflict.

7.1 AQUACULTURE SCIENCE IS SOCIAL

This research contributes to a growing body of work that seeks to understand the social influences on science, stemming from policy context, norms, and values (e.g., Jasanoff 1987, Haas 1992, van Kerkoff and Lebel 2006, Pielke 2007, Keller 2009). Social context influences scientific inquiry in what science considers as moral or social priorities, funding and funding politics, and the politics supporting the research question (French 2007). RMA planning for spatial allocation and challenges for using science to address spatial conflict are not 'conventional' applications of science- instead, value judgments, interpretation of risk and uncertainty affect how scientific information is used (Functowitz and Ravetz 1993). The changing problématique in which decision-making takes place must acknowledge that scientific knowledge may not provide whole and complete solutions to complex issues within political fora.

This research also contributes to the dialectic that began decades ago in philosophical circles debating the nature of objective knowledge and whether science can represent reality independently from the observer and from context (beginning with Lakatos 1970, Kuhn 1970, Latour and Woolgar 1986). This is demonstrated clearly in the divergences between commercial, civic and Māori beliefs about what the focus of science should be. The content of scientific beliefs is affected by social factors; thus, what counts as evidence may be socially determined, affecting which explanations of 'how the world works' are accepted (French 2007). This is evidenced in the struggle to integrate Māori epistemologies into the scientific and planning regimes for aquaculture. Māori epistemologies incorporate history, spiritual beliefs and culture, which are incongruent with the reductionist approaches of commercial and civic science. Stating that science is a source of absolute truth denies that how the natural world is understood is contingent and negotiable (Herrick and Sarewitz 2000). The body of work to which this research contributes asserts that science is not value-free, and instead it is shaped by the societal context and can be a rhetorical tool for political deliberation.

In the case of NZ aquaculture, science is given a specific social meaning for conflict when it becomes a tool for measuring effects on the environment and on other values. The way information is understood, applied and assessed is subjective. This places a certain responsibility on the scientist to understand the social implications of his or her work, a point which is unpacked below.

7.1.1 Epistemologies, values, and conflict

The competing epistemologies for science in aquaculture are a window into the root causes of aquaculture conflict. An important point here is that the epistemologies for science, driven by values and worldview, influence how *conflict itself is defined*. Scientific information is an indicator of effects on other users, and it lays the parameters of what is considered important and what is not considered important in conflict. For example, ecology as a discipline is undoubtedly embedded with values. This is illustrated by what Schrader-Frechette and McCoy (1993) term the ‘normative basis for ecology’. The normative basis follows from the land ethic presented by Leopold (1949), which states that “a thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise” (262). Schrader-Frechette and McCoy (1993) argue that this ethical approach is embodied within ecology because, as a discipline, ecology promotes ecological health. Yet it is not problematic that science is embedded with values; what is important is that the links between science and values must be understood.

Furthermore, the rationalist approach to RMA planning is designed to distil inputs from different sources into something that can be compared by planners. Environmental effects must be considered under the RMA, and ecological values are central to the debate over use of space, evidenced in the interviews on misinformation. Civic science and Māori knowledge both support ecological protection because they contain beliefs that science should investigate and ultimately promote ecosystem health. In rationalist approaches to politics, commercial science is less supportive of ecological protection because inherent and existence values cannot (or will not) be measured in the marketplace. Science gives a voice for those interests in debate, so commercial science can be limiting it its ability to support environmental considerations. This means serious consideration of the links between science and values is necessary to appropriately address NZ aquaculture spatial conflict, a point which is elaborated below.

7.1.2 Assumptions about neutrality of information

Social factors also affect assumptions about neutrality of information, which need to be understood as part of this environmental controversy. Respondents argued that politicization of science in planning is a typical strategy for influencing decision-making (although at times an undesirable one). For policy development, the same themes were viewed differently, where policy analysts expected science to de-politicize decision-making and protect from the appearance of bias. These assumptions are imbued with positivist assumptions that may need to be reconsidered in light of aquaculture values debates. These assumptions contradict the results from chapters 5 and 6 where values are interwoven in science epistemologies for aquaculture and into science as a tool for political debate. The results align more closely with a rationalist approach to decision-making, where policy objectives are outlined before considering scientific evidence, alongside other decision-making rationale. The recent era of science and politics has acknowledged that scientific experts are not "unquestioned authoritative sources of objective information", leading to renegotiation of marine scientists' role in policy circles (Weber et al. 2010: 235). The science epistemologies characterised in chapter 5 are multifaceted and relate to views on how the market, ecosystem and communities should be related through aquaculture management. These views are in no way neutral, and they orient the scientific knowledge produced and the end-use applications of science, including for policy. To address politicization and mistrust as barriers using information effectively, the links between science and values must be considered.

7.2 LINKS BETWEEN SCIENCE & VALUES FOR ADDRESSING CONFLICT

The principles and values for multiple use marine ecosystems are a major source of contention in aquaculture. Values and science are linked through the beliefs and policy goals different groups have for science, such as ecological values and commercial values, which compete with one another through the political process. The case at hand supports seminal conclusions in sociology of science made by Jasanoff (1987), who deconstructed claims made by scientists in policy to conclude that the ultimate basis for policy decisions is evidence-based, yet the scientific basis itself is often laden with competition among scientists and policy-makers to influence the political process under high decision stakes. This aquaculture case study argues that it is better to err on the side of transparency of value orientations for the science that is used in spatial conflict, as opposed to concealing values and portraying science as an objective source of information.

The conflict over aquaculture's use of space has parallels with other value conflicts in NZ oceans governance. The tension between ecological sustainability and economic objectives in the long term has been a source of "fundamental tension" for NZ marine managers on the whole (PCE 1999), comparable with the friction between use and non-use values in aquaculture. Coastal planning in general involves decisions between 'shaping' and 'protecting' the natural environment (Makgill and Rennie 2011), yet oceans governance in NZ reflects the utilitarian tradition for use and exploitation of marine resources (PCE 1999).

There is a need to make the links between science and values transparent so that the values underlying the science can be properly debated. This thesis has unpacked the ways that science is perceived to be affected by values and political interests in chapter 6. It also has demonstrated that the focus of science research for different epistemologies is linked to their desired policy outcomes. Willis (2011) discusses the issue of linking science and values for the NZ judicial system. He asserts that agenda-driven interpretation is a normal part of decision-making. He argues that judgements based on values should be made explicit by "marking the vehicle" so that the values can be debated democratically. Linking science to social concerns over space means that the multiple use values as the root causes of conflict can be more easily debated through existing policy frameworks. It may also disincentivize misinformation in debate.

When considering the types of evidence used in decision-making, it is crucial to recognize that certain epistemologies better support integration of contrasting values than others. The term *civic science* emphasises the democratic applications of science. It does not imply that any particular value set be elevated. Instead, “civic science seeks to reunite the divided roles and responsibilities [of science and society]”, explicitly contrasting the notion of upholding its ‘objective’ place outside of society (Shannon and Antypas 1996: 60). Civic-minded science means that scientists have regard to the social context in which information is used. It means interpreting the implications of science within the existing policy frameworks and the values at stake for that decision- which could mean making normative judgments. From the point of view of this research, civic science is as simple as stating the purpose of science and having an awareness of the value orientations to which the science applies. In this way, science can help to support deliberation by fairly allowing for a range of values and interests to be represented in the political sphere, as opposed to being dominated by one value set.

7.3 THE IMPORTANCE OF DEBATING VALUES IN AQUACULTURE

The challenge of linking science and values lies in applying science within a democratic, normative framework. Facts cannot directly inform political debate over values (Kinzing et al. 2003), so the focus must be on the deliberative processes themselves. The assumptions held about the neutrality or objectivity of information reflect the positivist approach to decision-making, where scientific information is meant to direct policy-makers to the ‘right’ decision. Rawls (1993) asserts that a rationalist approach to conflict between values and principles takes place through ‘reasonable pluralism’. Reasonable pluralism provides many reasonable choices from which decision-makers may choose. The choice will be made and accepted on the basis of justice and on reasonable due process. This warrants the need to include multiple epistemologies for science in aquaculture debate.

The challenges of using science in political debate are also related to the ability to compare different types of information. Respondents claimed that misinformation was a strategic tool for opponents of aquaculture because empirical data and expertise have high traction in the RMA consent process and Environment Court process. It is noteworthy that two individuals perceived that ecological (mis)information is used to oppose aquaculture, when in fact the core issues were social or cultural ones, such as the principles and values for using space. The respondent suggested that misinformation is used because quantitative, expert information is privileged in debate in comparison to other forms of participation. This points to the need to legitimize public participation processes that give adequate consideration to different types of information and debate non-use values. As illustrated in Stone's (1997) and Keller's (2009) studies (described in chapter 6), science has a unique authority in policy decisions because it is seen to determine what is reality.

Obviously, quantifiable or empirical information makes it easier for a decision-maker to draw a firm conclusion as compared to non-quantifiable, anecdotal or cultural accounts. However, the coastal marine ecosystem is multiple-use space with multiple value types that are represented by multiple different kinds of information. Chapter 5 demonstrated that aquaculture science is linked to different value sets and policy goals for science. The problems with misinformation lie beyond the fundamental issue of introducing incorrect or skewed information to political debate. The problems with misinformation are that, as suggested by interviewees, it arises from the perception that scientific fact is a more powerful tool than values-based arguments. Interviewees in this case study described how this obscured the debate from its core social factors to one that was more ecologically-focused. Acknowledging and debating a plurality of values is a chief aspect of integration in planning and policy for aquaculture.

This case study argues that politicization becomes detrimental when it is covert- that is, when strategic use of information is not contextualised with the social values that give rise to it. In Pielke's (2007) views, politicization is not inherently negative, but it may have perverse outcomes. Sarewitz and Pielke (2007: 10) use the term "non-pathological" to describe politicization of science that is not detrimental to the political process and that supports democracy. They conclude that "science is always politicized, and that the real-world challenge is to cultivate an inclusive and non-pathological process of politicization".

Open debate of values and science broadens the responsibility of the scientist beyond the immediate effects of research. The civic view is that science is situated within society, combining roles of science and democracy (Shannon and Antypas 1996). This requires effective communication between scientists and the broader community (Lane 1999), which needs to be considered in light of the institutional context that shapes the demands on science (Pielke and Sarewitz 2005). In a system where science is an important input to controversial decision-making, civic-oriented science is a seminal part of deliberation to fairly represent different stakeholder voices in a controversy. Having a strong role for scientists in policy does not mean moving towards technocracy. It means science and scientists become more active in political deliberation: communicating, interpreting science, actively making science relevant to the community, supporting policy cases and innovation, questioning policy rationales, and being open to questions into their assumptions. In contrast to civic science, commercial science is not equally as supportive of democratic deliberation. Because of its narrow focus on economic ends, non-consumptive and inherent value orientations for marine ecosystems are not likely to be considered. The competitive model for science funding may also draw attention away from the social applications for science, such as the conflict resolution approaches of the Motueka ICM Programme, towards those that can be measured in the market.

Integration is needed where contrasting, multiple use values are dealt with in marine governance frameworks. McGinnis (2010, 2012) attributes NZ spatial conflict to a lack of integration in oceans governance. He asserts that integration is needed not only to deal with overlap of activities, but also to connect management and protection functions, create linkages between terrestrial and marine ecosystems and resource use, and address the need to protect ecologically sensitive areas. This case study asserts that one aspect of integration is how a plurality of values is considered in spatial allocation decisions, and incorporating science from a range of viewpoints is a necessary part of integrating a plurality of interests. These issues point to the challenges involved in creating a functioning policy framework that can reconcile a plurality of differing values and principles for using coastal space without quashing opposing epistemological points of view. For aquaculture, if Māori epistemologies are to be integrated into dominant decision-making frameworks, the scope of knowledge considered for oceans management must also include Māori culture and value systems as part of the knowledge base (Reid 1998). While the RMA framework obliges planners to have regard for numerous effects on multiple user groups and ecosystems, this points again to the challenge of integrating different types of information beyond privileging empirical data for fair consideration of the range of values for marine ecosystems. If, as respondents suggested, quantitative information is given more weight in decision-making, this privileges the user groups that can provide quantitative information over those which use qualitative or anecdotal information.

A more effective approach is to consider how science can democratically represent multiple use values with existing information. According to Schmandt (1998: 68), civic science involves “structured and recurrent dialogue” between policy-makers and experts. The two-way process he suggests involves sharing information, and human resources to address problems. This requires collaboration and flexibility in how policy engages science. From the sociological point of view, where scientific information cannot be considered independently from social context, collaboration may be conducive to debating the principles and values for space in aquaculture. This case study argues that politicization of science may be an inevitable aspect of politics. The problem of politicization arises when the values linking to the science are not transparent or able to be debated openly. The key is to understand science within its social context so it can support debate over multiple use values for more effective and efficient decision-making. This can be aided by acknowledging and supporting the diverse epistemologies for marine science.

This research builds on international literature on marine management that advocates for science to support improved ecosystem-based approaches and to address spatial conflict. Douvere (2008) asserts that to address both ecosystem protection and spatial conflict requires a focuses on the processes of planning to integrate uses, human behaviour and science. The epistemologies for science characterised here offer a small contribution towards understanding science as an interface between social factors and multiple uses. Inclusivity in marine planning may be necessary to achieve both ecological and economic outcomes (Gopnik 2008). This case study reinforces the importance of inclusivity for multiple use conflict in the marine environment. In fact, Sanchirico et al. (2010) assert that inclusivity of social and legal aspects of planning can not only support environmental policy goals, but bring ancillary benefits such as improved informal management institutions and a stronger regulatory environment. This is a growing field with much potential for future research.

7.4 CONCLUSIONS - SCIENCE AS A TOOL TO SUPPORT DEMOCRACY

Science is part of democracy, not separate. This research on the barriers and challenges to addressing spatial conflict suggests that science is a tool that can be used to carry out multiple objectives. Multiple values for space call for effective deliberation processes. The aim of this research was to understand how science is used to address spatial conflict in NZ aquaculture. This was evaluated in three ways: analysing the spatial allocation framework for aquaculture, characterising the epistemologies for aquaculture science, and examining the challenges to using science in controversial aquaculture policy decisions. The results of this study show that science is a means of understanding the effect of aquaculture on the marine ecosystem and on other users, and it represents different interests in the spatial allocation process. The epistemologies for science embody numerous social dimensions, being shaped by expectations for the end-use of science, values, worldviews and norms. Politicization of science warrants more explicit links between the science and the value sets that shape it. A key role for science in spatial conflict is to uphold the processes of democratic debate of which it is a part. Understanding social context and the links between science and values helps to address the pitfalls of politicization of science, such as using science as a political 'whacking stick', selective uses of information, and mistrust of science and scientists. This further emphasizes the need to make transparent links between science and values in open debate.

Recommendations for future research stemming from this study are numerous, but two are included here. The first is to assess in more depth the relationship that commercial, civic and Māori science have in policy outcomes. While this study was able to suggest how civic and Māori science may be better able to support deliberation and reconciliation of multiple use conflict, no firm conclusions could be drawn about their ability to achieve policy outcomes. Second, future research into the role of science in political deliberation can focus on public participation processes. This case study explored planning and policy development, but debate over values for marine ecosystems takes many forms: submissions, through the media, in Select Committee, etc. Legitimacy and access to political debate were not examined here. Although this study was able to suggest some general patterns for the role of science in debate, research into a larger cross-section of public participation processes would be valuable.

Finally, the central point of this case study is *not* that objective and neutral sources of information should be sought. Arguments that politicized science always is detrimental ignore the fact that science and information are a result of social context. This means that science is understood to relate to the competing interests in controversial spatial allocation decisions. The key to addressing spatial conflict, then, is to ensure that appropriate and adequate deliberation of the principles and values relating to the activity are given adequate attention in planning and policy. This case study informs the literature on 'non-pathological' politicized science and on international marine planning by suggesting that a greater focus on the principles and values within democratic debate can address the core issues of spatial conflict in NZ aquaculture.

This case study demonstrates that science can be a tool for supporting democratic means of addressing spatial conflict in NZ aquaculture. The ends to which science is applied - including the values and principles that it serves - then can be debated in the appropriate arena. Assuming that all scientific information is an independent source of fact obscures the links that science has to social context, and this limits the potential that science can play in clarifying debates over values in the marine ecosystem.

Source: NZKS 2008

APPENDICES

APPENDIX 1 – REFERENCES

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APPENDIX 2 – ETHICS APPROVAL

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

MEMORANDUM

Phone 0-4-463 5676

Fax 0-4-463 5209

TO	Meghan Collins
COPY TO	Mike McGinnis
FROM	Dr Allison Kirkman, Convener, Human Ethics Committee

DATE	18 April 2011
PAGES	1

SUBJECT	**Ethics Approval: 18389 Cultivating Civic Science in new Zealand Aquaculture Development**

Thank you for your application for ethical approval, which has now been considered by the Standing Committee of the Human Ethics Committee.

Your application has been approved from the above date and this approval continues until 28 February 2012. If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Allison Kirkman

Human Ethics Committee

APPENDIX 3 – INFORMED CONSENT FORM

VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wānanga o te Ūpoko o te Ika a Māui

Consent form for participation in
"What are the models for science used in NZ aquaculture policy and development?"

Meghan Collins
Department of Environmental Studies, School of Geography, Environment and Earth Sciences (SGEES)

Supervisor:
Mike McGinnis, Senior Lecturer, School of Government

I agree to take part in an interview with Meghan Collins, the researcher, as part of her thesis for a Masters of Environmental Studies at Victoria University. I have been informed of the objectives of this research and I understand that the interview will cover topics relating to aquaculture development and the application of science within policy relating to aquaculture.

I understand that I have the option to maintain my statements in confidential and non-attributable form, the option for my opinions to be acknowledged to the organisation for which I work, *OR* the option for my opinions to be acknowledged to my name (see below).

I am free not to answer questions, or to withdraw at any time without consequence. Once the interview has taken place, I have the option to review and provide feedback on any quotes that are attributable to me. I also have the opportunity to alter those quotes (see below). I have the option to withdraw my material from inclusion in the study at any time prior to 15 November 2011.

I am aware that the interview will be recorded and that interview transcripts will only be seen by Meghan and her supervisor, Mike McGinnis, and will be treated confidentially. I can request the recorder to be turned off at any point during the interview. Questions or concerns may be brought to the supervisors' attention at the email addresses and phone numbers below.

Please tick one of the following:

☐ I wish for my name to be acknowledged in the results of this research.

☐ I wish that any opinions not be attributed to my name, but I may be referenced as an employee of my organisation.

☐ I do not want any opinions to be attributed to me or my organisation.

***You have the option* to tick one of the following**:

☐ Before the thesis is submitted, I wish to be sent a summary of the findings to the following electronic address: __________________________________.

□ (*where applicable)* Before the thesis is submitted, I wish to be sent a summary of the findings of the thesis to review, provide feedback upon, or alter the opinions attributed to my name before 15 January 2012 to the following electronic address: ______________________________.

Name: Date:

Signature:

Researcher contact information: Meghan Collins meghan.collins@vuw.ac.nz phone 027 858 0590

Supervisor contact information: Mike McGinnis mike.mcginnis@vuw.ac.nz phone upon request

APPENDIX 4 – INFORMATION SHEET FOR INTERVIEW PARTICIPANTS

VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wānanga o te Ūpoko o te Ika a Māui

Participant Information Sheet for
"What are the models for science used in NZ aquaculture policy and development?"

Meghan Collins
Master's Candidate, Department of Environmental Studies
School of Geography, Environment and Earth Sciences

Supervisor:
Mike McGinnis, Senior Lecturer, School of Government

Duration of research: March 2011 – February 2012
This research is part of the requirements of a Master's in Environmental Studies at Victoria University.

Objectives of the research:
1. Characterise the models for applying science to policy and development in NZ aquaculture
2. Understand the institutional, economic, and social factors that contribute to models used for science in NZ aquaculture
3. Examine the implications of the models for spatial conflict and deliberation, particularly user-ecosystem conflict, and discuss the models strengths and weaknesses.

I am a candidate for a Master's of Science in Environmental Studies at Victoria University. My research explores the way science is applied to aquaculture development and policy in NZ aquaculture. This includes the mode of interaction between producers and users of science, and involvement of science and scientists in policy processes.

Spatial conflict and interference with the ocean's ability to provide ecological goods and services are problems in aquaculture both in NZ and worldwide. It is useful to explore the philosophical, political and normative underpinnings of science for better use in policy arenas. This can then provide insight into resolving conflict, such as with compatible use planning.

To achieve these research objectives, I am using semi-structured interviews with knowledgeable actors in the aquaculture industry, policy and scientific spheres. Interviews generally last 20 minutes to ¾ of an hour. This research has been approved by the Victoria University Human Ethics Committee.

As an interviewee, you have the option to maintain your statements in confidential and non-attributable form, the option for your opinions to be acknowledged to the organisation for which you work, ***OR*** the option for your opinions to be acknowledged to your name. You are free not to answer questions, or to withdraw at any time without consequence (see consent form). You also have the option to withdraw any material from inclusion in the study at any time prior to 15 November 2011.

The interview will be recorded, interview transcripts will only be seen by Meghan Collins and Mike McGinnis, and they will be treated confidentially. You may request the recorder to be turned off at any point during the interview. Recordings will be used solely to transcribe the interviews and will be kept in a passcode-protected location for up to five years after the completion of the project.

The final thesis will be submitted to the School of Geography, Environment and Earth Sciences for marking, and will be deposited in the University Library. Provided the opportunity, I may present my research at an academic or professional conference, and develop a manuscript for submission for publication in a refereed journal. Please feel free to contact me or my supervisor with any questions.

Researcher contact information:
Meghan Collins: email meghan.collins@vuw.ac.nz, phone 027 858 0590

Supervisor contact information:
Mike McGinnis: email mike.mcginnis@vuw.ac.nz, phone number upon request

APPENDIX 5 – INTERVIEW SCHEDULE FOR SEMI-STRUCTURED INTERVIEWS

OPENING QUESTIONS – BACKGROUND

What are your job responsibilities?

What do you consider your specialty areas?

Feel free to disagree with the way the questions are posed, or point out any assumptions I'm making that may be incorrect.

MODELS FOR SCIENCE

What makes 'good science'? What makes a 'good scientist'?

Where do the best questions in science come from? What are they aimed at solving?

Can scientists be value-neutral?

What makes a scientist credible? What makes science credible?

> In your experience, do (scientists/policy-makers) generally agree on these issues, or is there disagreement?

Where is aquaculture industry in it's 'lifecycle' or stage of maturity?

What is the level of optimism for growth in the future?

Norms and values

Are scientists able to be objective? What makes a scientist objective?

Is it appropriate for scientists to be environmental activists? Is it appropriate for environmental activists to be scientists?

Using science in policy

Do you collaborate with scientists / decision-makers in aquaculture?

What are the key areas or concerns in aquaculture policy that use science?

Should scientists offer recommendations for policy based on their work?

In what ways is science persuasive in the policy process?

Are there ways to misuse science in policy?

In your experience, are there issues in aquaculture upon which scientists disagree? What are those issues?

THEORETCAL ISSUES OF SCIENCE AND POLICY PRINCIPLES

Economics

Is science important for aquaculture growth?

What factors threaten or inhibit growth in aquaculture?

Can science be misused in promoting aquaculture development?

What ecological factors in the marine area enhance the value of aquaculture products (list as many as possible)?

Do scientists benefit from growth in aquaculture? Are there disbenefits to science when growth does not occur?

Do stakeholders in aquaculture generally agree about the direction of growth in aquaculture, or is there conflict?

ISSUES OF CONFLICT

What are the most pressing spatial conflicts in aquaculture?

Does science have a role in addressing spatial conflict, or are other means better?

Should scientists advocate for what they believe should be the ‘right’ use of coastal marine ecosystems in aquaculture? How about the ‘right’ ecological standards?

Do you know someone who doesn’t share your point of view?

APPENDIX 6 – SAMPLE EMAIL REQUEST TO INTERIVEW PARTICIPANTS

Hello [name],

I am writing to you as an expert in the area of aquaculture development and reform in NZ. I am a Master's candidate at Victoria University of Wellington, and my thesis is a joint project between the Institute of Policy Studies and the Department of Environmental Studies, supervised by Dr. Mike McGinnis.

Your experience and outlook on aquaculture policy would be a valuable contribution to this research. I am seeking interviewees' perspectives on the following: **How is science integrated into in aquaculture development?** This will help to understand the nature of spatial conflict in the marine coastal ecosystem. Examples of spatial conflict that use science are disputes over terrestrial runoff and water quality, for example from agriculture or sewage contamination.

Interviews are semi-structured and touch on topics such as how science is used in dispute resolution, and the 'demand' for science in aquaculture policy. This research has received Human Ethics Committee approval. Interviews can be as short as 20 minutes but may last up to three quarters of an hour, depending on your willingness to share. I can send an abbreviated or full-length proposal upon request. If you are able to participate, please respond with a day and time convenient to be interviewed that falls between today's date and 15 July 2011.

Best,
Meghan Collins

P.S. If I am mistaken that this is not your area of expertise, please accept my apologies. If you are able to make any recommendations as to experts in this area, please feel free to do so.

APPENDIX 7 – INTERVIEW PARTICIPANTS

There were 52 participants in this study. Interview names and/or affiliation are listed where the interviewee consented to their release.

	Name	Organisation	Stakeholder group	Date interviewed	Interview Type
1	Phil Heath		scientist - CRO	22 June 2011	in person
2	Pete Ritchie	Victoria University of Wellington	scientist - university	22 June 2011	in person
3	Anonymous		policy analyst	24 June 2011	telephone
4	Anonymous		advocate - environmental	24 June 2011	telephone
5	Tony Seymour		Maori development	27 June 2011	in person
6	Anonymous	Te Ohu Kaimoana	Maori development	30 June 2011	in person
7	Lesley Bolton-Ritchie		coastal planner	30 June 2011	telephone
8	Andrew Morgan		scientist - university	1 July 2011	telephone
9	Anonymous	Northland Regional Council	coastal planner	1 July 2011	telephone
10	Anonymous		scientist - university	4 July 2011	telephone
11	Julie Hills		scientist - ministry	5 July 2011	in person
12	Allen Pidwell	Surfbreak Protection Society	advocate - recreational	6 July 2011	telephone
13	Anonymous		marine farming	6 July 2011	telephone
14	Mike Burrell		marine farming	6 July 2011	in person
15	Tony Orman		advocate - recreational	6 July 2011	telephone
16	Anonymous	option4	advocate - recreational	6 July 2011	telephone
17	Anonymous		scientist - university	7 July 2011	in person
18	Raewyn Peart	Environmental Defence Society	advocate - environmental	7 July 2011	telephone
19	Shane Kelly		scientist - CRO	8 July 2011	telephone
20	Mark Allsopp	Wakatu Fisheries	marine farming	8 July 2011	telephone
21	Malibu Hamilton	Te Ngaru Roa Aa Maui, Surfbreak Protection Society	advocate - environmental	8 July 2011	telephone
22	Paul Decker	Mahurangi Technical Institute	scientist - university	8 July 2011	in person
23	Anonymous	Ministry of Fisheries	scientist - ministry	11 July 2011	in person
24	Alastair Macfarlane		commercial fishing	11 July 2011	in person
25	Anonymous		advocate - recreational	12 July 2011	telephone
26	Anonymous		marine farming	12 July 2011	telephone
27	Keir Volkerling		Maori development	12 July 2011	in person
28	Steffan Browning		advocate - environmental	15 July 2011	in person
29	Anonymous	Ministry of Fishieries	policy analyst	15 July 2011	in person
30	Emma Taylor		policy analyst	15 July 2011	in person
31	Anonymous		advocate - recreational	18 July 2011	telephone
32	Anonymous		scientist - university	18 July 2011	telephone
33	Anonymous		commercial fishing	19 July 2011	telephone
34	Dan Lees		policy analyst	25 July 2011	in person
35	Anonymous		scientist - CRO	25 July 2011	in person
36	Anonymous		marine farming	26 July 2011	in person
37	Anonymous	Sealord	marine farming	26 July 2011	in person
38	Mike Mandeno		marine farming	26 July 2011	in person
39	Nigel Keeley		scientist - CRO	27 July 2011	in person
40	Anonymous		scientist - CRO	27 July 2011	in person
41	Barrie Forrest		scientist - CRO	27 July 2011	in person
42	Anonymous	Friends of Golden Bay	advocate - environmental	28 July 2011	in person
43	Anonymous	Cawthron	marine farming	1 August 2011	in person
44	Anonymous	Ministry of Fisheries Aquaculture Unit	policy analyst	2 August 2011	in person
45	Anonymous	Anonymous	policy analyst	1 August 2011	in person
46	Ken Grange		scientist - CRO	1 August 2011	in person
47	Anonymous		advocate - environmental	2 August 2011	in person
48	Paul Gallespie	Cawthron	scientist - CRO	2 August 2011	in person
49	Anonymous		coastal planner	12 August 2011	telephone
50	Anonymous		coastal planner	18 August 2011	telephone
51	Wendy Banta		policy analyst	18 August 2011	in person
52	Anonymous	Tasman District Council	coastal planner	19 August 2011	telephone

APPENDIX 8 – ECOLOGICAL EFFECTS OF NZ FARMED SPECIES

Documented ecological effects of the NZ farmed species.
Source: Farmed Species Ecological Effects (NZ Govt 2007).

Species	Green lipped mussel	Pacific oyster	King salmon
Ecological effects	Seabed effects Organic and inorganic depositions Plankton extraction Potential to improve water quality/clarity Deposition of faeces or pseudo-faeces Changes to local nutrient concentration Water column obstruction Creation of artificial reefs (increase biodiversity) Reduction in seafloor biodiversity Changes to predator-prey interaction Genetic distinctiveness of wild populations	Changes to seabed organic material, Water flows Extraction of plankton Increased microbial activity on seabed Plankton removal Secretion of nutrients that stimulate plankton growth Changes to nutrient cycling, Potential to act as disease vector	Physical, chemical and biological effects of deposition of uneaten feed Organic enrichment to microbial activity and oxygen depletion Algal growth and biotoxins Artificial reef creation Disease Escaped fish Entanglements of marine mammals Zinc and copper additives from feed

APPENDIX 9 – POLICY INSTITUTIONS FOR AQUACULUTRE

There are several public sector institutions that play an active role in aquaculture governance. The overarching mission of central government in aquaculture is stated on the Ministry of Agriculture and Forestry's (MAF Fisheries) homepage as "committed to environmentally sustainable aquaculture development" (NZ Govt 2006). Regional councils have devolved responsibility for managing the marine environment. MAF Fisheries supports regional councils by providing information for regional councils to assess impact of aquaculture activity on fishing and fisheries resources and helping with consent conditions (MAF Fisheries 2011a). Within MAF Fisheries is the recently established Aquaculture Unit, which is Government's principal advisor on aquaculture and is a branded Business Unit. It is accountable for coordinating between stakeholders in aquaculture managing stakeholder relationships. This takes place by collaborating with central government, regions, national groups (NGOs, iwi, industry), and the Aquaculture Forum (Lees 2010). At time of writing, the Unit is developing the National Aquaculture Strategy and Action Plan. MAF Fisheries is also responsible for implementing the Māori Commercial Aquaculture Claims Settlement Act 2004.

APPENDIX 10 – DEBATE BETWEEN REALIST AND CONSTRUCTIVIST PHILOSOPHIES

Conventionally, the scientific method was seen as a rigorous way to maintain the objectivity of science, reduce biases to results, and free it from suppositions. Objectivity is taken to be neutral of values, preferences, beliefs, interests, or culture, and the scientific method is designed to remove these from affecting how scientific theories are shaped (French 2007). This is reflected in the realist perspective, which is fact-seeking and which takes the position that science is successful because it provides an accurate portrayal of reality (French 2007).

The possibility of human objectivity has been termed as 'the myth of the unbiased observer (Godfrey-Smith 2003). Beginning with Merton (1973), Kuhn (1970), the Strong Program, and others, this discourse was deconstructed and the core rationales of science re-examined in a social context. Kuhn's (1970) ideas sprang from observations of history and shifts in patterns of scientific thinking, which he termed paradigms. Scientific paradigms encapsulate a way of thinking that helps define questions, agree to methods, and lay out theory upon which expectations and hypotheses are based. In this way, context and what is accepted as the most plausible set of theories on a topic give way to particular research questions and approaches to answering them. In a more controversial piece of work, Latour and Woolgar (1979) produced *Laboratory Life*, which asserts that the scientific method obscures the fact that there are human processes involved in creating facts. Facts do not appear through the process, but instead, facts are a product of social context because of the process of peer review, critique and debate. In a similar way, Shapin and Schaffer in 1985 wrote *Leviathan and the Air Pump*, whose thesis posited that facts are 'manufactured' as opposed to being found through an independent process.

During the same era, the Strong Program established more credibility for the social constructivist view on science. French (2007) and Godfrey-Smith (2003) explain that the Strong Program asserts that scientific facts are socially constructed in the same manner as any other belief, according to the 'lens' of the observer. Science communities are guided by habits and socially established norms that shape beliefs. This viewpoint proposes that there should not be a distinction made in terms of 'good' and 'bad' between rational beliefs (objective) and irrational beliefs (non-objective), but instead that beliefs should be considered equivalent in light of what gives them credibility. Thus this discipline aims to understand the causes behind scientific beliefs, which are often social. Credibility can be established by social factors, such as social interaction and negotiation of 'what is true', so it is neither the facts nor the experts that are objective. What is determined to be important to observe in answering a question is the presupposition, such as theory and prior knowledge. This point of view on how knowledge and fact come to be is the basis for analysing the debate around aquaculture, using science.