RISK AND OPPORTUNITY IN BRITISH COLUMBIA SHELLFISHERIES: THE ROLE OF LIMITED PROPERTY RIGHTS IN AQUACULTURE DEVELOPMENT

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ABSTRACT

Marine governance in the 20th century has increasingly moved away from centralized state regulation of fisheries resources as common property towards the use of private property rights for regulation of marine resources. Aquaculture leaseholds, by allocating private property rights to former common property resources, have the potential to redistribute access to marine habitat and resources within that habitat. In British Columbia, Canada, shellfish aquaculture has been proposed as an attractive alternative or complement to wild shellfisheries, notably for its ability to improve the quality and volume of seafood produced with relatively few detrimental environmental effects. Shellfish aquaculture thus has the potential to provide significant economic benefits for coastal communities, though conflicts may emerge if aquaculture leaseholds impinge upon formerly productive wild shellfisheries or impede access to other key coastal resources.

In this dissertation, Geographic Information Systems (GIS) are used to analyze spatial and temporal changes in the distribution of aquaculture leaseholds (tenures) for five coastal study sites in British Columbia. Interviews referencing GIS-produced maps, conducted between 2004 and 2007, examine the effects of aquaculture leaseholds on harvesting patterns in wild clam and oyster fisheries across five study sites, and explore local perceptions of the social, economic and environmental risks and benefits of shellfish aquaculture development. Using GIS analysis and interviews, the dissertation provides quantitative and qualitative information about the risks and benefits of changing access rights, while examining the theoretical implications of developing private property rights for aquaculture. Results indicate that the economic efficiencies of aquaculture development often outweigh - but do not displace or eliminate – coastal stakeholders' concerns about changing resource uses and potential losses of access to wild fisheries and habitat. Results also suggest a disconnect between patterns of aquaculture development and reported perceptions of its risks and benefits. Interviewees' perceptions of the risks of industry growth are therefore examined for potential determinants of whether political and legal resistance to the shellfish aquaculture industry is liable to intensify in British Columbia. Results are discussed in relation to policies aimed at improving environmental and social sustainability of the aquaculture industry and planning for coastal management.

TABLE OF CONTENTS

ABSTRACT ii

TABLE OF CONTENTS iii

LIST OF TABLES iv

LIST OF FIGURES v

PREFACE vi

ACKNOWLEDGEMENTS xi

CO-AUTHORSHIP STATEMENT xii

1. INTRODUCTION 1

1.1 THE RIGHTS-BASED CONTEXT: WHY PROPERTY RIGHTS HAVE BEEN CONTROVERSIAL IN MARINE GOVERNANCE ... 7
1.2 RIGHTS-BASED MANAGEMENT IN BRITISH COLUMBIA: THE BC CASE STUDY ... 12
1.2.1 Wild intertidal clam fisheries ... *13*
1.2.2 Aquaculture leases in British Columbia ... *17*
1.3 RESEARCH OBJECTIVES ... 21
1.4 METHODS ... 22
1.5 BIBLIOGRAPHY ... 29

2. A COMPARISON OF PRIVATE PROPERTY RIGHTS IN FISHERIES MANAGEMENT: ITQS AND SHELLFISH LEASES ... 36

2.1 INTRODUCTION ... 36
IMPLICATIONS OF RIGHTS BASED MANAGEMENT FOR THE BRITISH COLUMBIA SHELLFISH INDUSTRY: CAN THE ITQ EXPERIENCE INFORM? ... 38
2.2 PROPERTY RIGHTS IN MARINE GOVERNANCE: CONCEPTS AND EXPERIENCE ... 40
2.2.1 The shellfish case ... *40*
2.2.2 Defining property rights ... *40*
2.2.3 Economic considerations for rights-based management ... *42*
2.2.4 Transitions from the commons to private property ... *44*
2.3 ENVIRONMENTAL CONSIDERATIONS FOR RIGHTS-BASED MANAGEMENT ... 47
2.3.2 The salmon aquaculture case in British Columbia: a comparative position ... *48*
2.4 PRIVATIZATION OF THE SHELLFISH COMMONS IN BRITISH COLUMBIA: EXPERIENCE AND EXPECTATIONS IN COASTAL COMMUNITIES ... 50
2.4.1 Benefits of shellfish aquaculture ... *52*
2.4.2 Consolidation of ownership ... *54*
2.4.3 Social and cultural implications of shellfish aquaculture ... *54*
2.5 LESSONS LEARNED FROM ITQS: IMPLICATIONS FOR SHELLFISH AQUACULTURE DEVELOPMENT ... 58
2.6 CONCLUSION: FUTURE OF THE INDUSTRY ... 61
2.7 BIBLIOGRAPHY ... 63

3. A GIS-BASED APPROACH TO SPATIAL AND TEMPORAL CHANGES IN ACCESS RIGHTS TO SHELLFISH RESOURCES IN BRITISH COLUMBIA ... 68

3.1 INTRODUCTION ... 68
3.2 STATUS AND MANAGEMENT OF THE AQUACULTURE INDUSTRY IN BRITISH COLUMBIA ... 72
3.2.1 Shellfish aquaculture leaseholds ... *76*
3.2.2 Salmon aquaculture leaseholds ... *77*
3.3 GIS IN PARTICIPATORY MAPPING AND SPATIAL ANALYSIS ... 78

3.4 METHODS 80
3.4.1 Site selection, data sources and approach *80*
3.4.2 Analysis *82*
3.5 RESULTS 86
3.5.1 Shellfish aquaculture leases and wild fisheries habitat *86*
3.5.2 Perceptions of changing access rights *88*
3.5.2.1 Economic and social considerations related to changing access rights 89
3.5.2.2 Political implications for access to wild resources 90
3.5.2.3 Implications for traditional or subsistence harvesting 91
3.5.3 Salmon aquaculture leases and wild shellfish habitat *92*
3.5.4 Perceptions of salmon aquaculture *93*
3.6 DISCUSSION 96
3.6.1 Spatial overlap of wild habitat and aquaculture leaseholds: implications for access *96*
3.6.2 Benefits of participatory involvement *99*
3.6.3 Controversy over aquaculture development *100*
3.7 CONCLUSION 103
3.8 BIBLIOGRAPHY 105

4. CONTESTED SEA SPACE: PERCEPTIONS OF RISK AND OPPORTUNITY IN THE DEVELOPMENT OF PRIVATE PROPERTY RIGHTS FOR SHELLFISH AQUACULTURE IN BRITISH COLUMBIA 111

4.1 INTRODUCTION 111
4.2 CONTEXT 115
4.2.1 Shellfish aquaculture production *115*
4.2.2 Perceptions of Risk *118*
4.2.3 Property rights considerations *122*
4.2.3.1 Potential conflicts with wild fisheries 123
4.3 METHODS 126
4.3.1 Study sites *126*
4.3.2 Interviews *127*
4.3.3 Interview protocol *129*
4.4 RESULTS 129
4.4(a) Perceived economic benefits *130*
4.4(b) Perceived economic risks *131*
4.4.2 Risks to culture and way of life *134*
4.4.3 Political implications: perceived threats to First Nations' territorial sovereignty *138*
4.4.4 Resistance to salmon farming *142*
4.5 DISCUSSION 143
4.5.1 Stakeholder values and perceptions *144*
4.6 CONCLUSIONS 149
4.7 BIBLIOGRAPHY 154

5. CONCLUSION 160

5.1 THEORETICAL CONTEXT: RATIONALE FOR RIGHTS-BASED MANAGEMENT 161
5.2 METHODOLOGICAL ASSESSMENT 166
5.2.1 Limitation and benefits of a participatory GIS analysis *166*
5.2.2 Participatory interviews: evaluating stakeholders' perceptions of aquaculture *168*
5.2.3 Future directions for application of participatory GIS *170*
5.2.4 Future directions: mapping perceptions of risk and culture *174*
5.3 THEORETICAL AND POLICY IMPLICATIONS 175
5.3.1 Implications for fisheries management *175*
5.3.2 Political and legal implications *177*
5.4 FUTURE OF SHELLFISH AQUACULTURE PRODUCTION IN BRITISH COLUMBIA 178
5.5 BIBLIOGRAPHY 181

APPENDIX 1 INTERVIEW SCHEDULES 187
APPENDIX 2 BEHAVIORAL RESEARCH ETHICS REVIEW BOARD CONSENT FORMS 194
APPENDIX 3 BEHAVIORAL RESEARCH ETHICS REVIEW BOARD CERTIFICATE OF APPROVAL 196

LIST OF TABLES

TABLE 2.1 – NUMBER OF INDIVIDUALS INTERVIEWED AT EACH OF THE STUDY SITES 51

TABLE 2.2 – SOCIAL AND ENVIRONMENTAL RISKS AND BENEFITS ASSOCIATED WITH ITQS AND SHELLFISH AQUACULTURE DEVELOPMENT 59

TABLE 3.1 – CHANGE IN SHELLFISH AQUACULTURE TENURES (BY NUMBER AND AREA 1995-2005) FOR FIVE STUDY SITES 88

TABLE 3.2 – REPORTED FORESHORE AREA FOR SHELLFISH HARVESTING AFFECTED BY THE PRESENCE OF SALMON FARMS.....94

TABLE 3.3 – REPORTED DISPLACEMENT OF SHELLFISH HARVESTING AREAS BY SALMON AND SHELLFISH AQUACULTURE LEASES (2005) 95

TABLE 4.1 – ECONOMIC PROFILE OF THE BEACH SHELLFISH AQUACULTURE INDUSTRY IN BC (2001).....120

LIST OF FIGURES

FIGURE 1.1 – COMPARATIVE VOLUME OF AQUACULTURE PRODUCED SALMON AND SHELLFISH IN BRITISH COLUMBIA 1986-2006 5

FIGURE 1.2 – PER POUND MARKET VALUE OF SEAFOOD PRODUCTS FROM BRITISH COLUMBIA 1986-2006 5

FIGURE 1.3 – COMPARISON OF SALMON AQUACULTURE PRICES AND PRODUCTION VOLUMES IN BC 1986-2006 6

FIGURE 1.4 - LOCATION OF STUDY SITES 23

FIGURE 3.1 - PRODUCTION AND VALUE OF INTERTIDAL SHELLFISH SPECIES FROM AQUACULTURE IN BRITISH COLUMBIA 1986-2006 75

FIGURE 3.2 – SHELLFISH AS PERCENTAGE VALUE OF TOTAL BRITISH COLUMBIA AQUACULTURE PRODUCTS (2006) 75

FIGURE 3.3 – PERCENTAGE OF LEASED AREA IN BRITISH COLUMBIA OCCUPIED BY SHELLFISH FARMS (2006) 76

FIGURE 3.4 - SAMPLE CHART OF CLAYOQUOT SOUND STUDY SITE 84

FIGURE 3.5 – ANNOTATED MAPS WILD HARVESTING AND SHELLFISH AQUACULTURE 84

FIGURE 3.6 – ANNOTATED MAP, WILD HARVESTING AND SALMON SITES 95

FIGURE 4.1 – AREA OCCUPIED BY AQUACULTURE LEASES FOR FIVE STUDY SITES 1995–2005 118

PREFACE

I have spent much of my life in fishing communities – in New Brunswick, Nova Scotia, British Columbia and Alaska – and have had an opportunity to witness the effects of downturns in the fishing industry on the socioeconomic fabric of coastal communities. I lived in the Maritimes during the collapse of the Grand Banks cod fishery, and after moving to British Columbia in 1989, observed the effects of the Mifflin Plan and introduction of Individual Transferable Quotas (ITQs) on British Columbia groundfisheries. More recently as a resident of Alaska, I have observed plummeting salmon prices lead to consolidation of the salmon fleets, and as a biologist, I have had the opportunity to observe first-hand the unsustainable fisheries practices of increasingly large offshore fishing fleets targeting dwindling stocks using gear that results in destructive bycatch and damage to the benthic marine environment.

Currently, only about 6% of the global wild fish catch is considered sustainable, and aquaculture therefore may offer a positive alternative to wild fisheries by increasing production without habitat damage or wasteful bycatch. However, the current emphasis in British Columbia on the culturing of high trophic-level finfish has generated significant controversy in relation to its arguably negative impacts on the marine environment. The environmental impact of net-pen finfish aquaculture has in some cases been considered to be more damaging than the potentially unsustainable practices of many wild fisheries; significant research has shown detrimental environmental impacts to include destruction of wild fisheries and marine habitats through the introduction of contaminants, parasites or exotic species (Brooks et al., 2002; Haya et al., 2001; Naylor et al., 2005). In British Columbia, complaints have also been raised about the social sustainability of salmon aquaculture, as it requires large capital investment and generally employs a corporate labor organization that has not necessarily provided direct economic benefits for local communities (Cox, 2004; Lindbergh, 1999).

In contrast, the culturing of lower-trophic level species such as shellfish is generally considered to be a more environmentally sustainable form of aquaculture that presents viable opportunities for increasing resource productivity and employment in coastal communities. Shellfish aquaculture is often considered to be environmentally sustainable as filter-feeders such as mussels, clams and oysters do not require feed inputs, nor do they produce significant waste by-products; shellfish aquaculture is also often considered socially sustainable, as it offers seasonal, resource-based employment that draws on existing skill-sets among fishers, requires only a small capital investment and overhead, and thus is potentially accessible as an investment opportunity for small, locally-owned businesses in coastal communities. Shellfish aquaculture may also have broad social and environmental benefits because it has the potential to increase the diversity of shellfish products available to consumers, while providing an alternative to overexploited wild resources. As an environmentally-friendly consumer product, aquaculture-produced shellfish have the potential to aid in closing the gap between increasing demand for high-quality seafood products and dwindling marine fisheries resources.

In spite of its economic potential, shellfish aquaculture has received much less research attention than has finfish aquaculture, and there is relatively little work to date documenting potential social and environmental risks or benefits. Although there has been increasing emphasis on developing sustainability standards for all types of aquaculture, the preponderance of research has dealt with finfish, while similar research funds have not been allocated to investigate viable complements or alternatives such as shellfish or seaweed farming.

Research on shellfish aquaculture is a logical extension of my previous work as an invertebrate biologist, wherein I had a particular interest in investigating the potential of new and underutilized species, especially those conducive to production by small subsistence and artisanal fisheries. In 1998, as a Cornell-Pew summer scholar studying octopus reproduction and feeding habits in Prince William Sound, I became interested in the possibility of culturing octopus for export markets. *Octopus dofleini* is widely husbanded in Japan, but an octopus market has not to date been developed in Alaska. Octopus is primarily a Native subsistence fishery, but has the potential to become a sustainable commercial fishery and aquaculture industry. The octopus aquaculture (sea-ranching) industry appears to have considerable potential based on the experience with clams and oyster production in Alaska;

the Alaskan shellfish industry has grown rapidly over the last fifteen years, and has been particularly effective at providing start-up opportunities for small businesses in coastal communities. When I returned to British Columbia in 2003, I was curious to know whether shellfish aquaculture was also gaining popularity on the West Coast of Canada, and whether it had similar potential to provide new sources of employment in rural communities.

My former role as a biologist has often involved balancing scientific research with an interest in marine policy. In my prior work for the US National Marine Fisheries Service (NOAA-NMFS) in Alaska, I was involved for several years in research on the effects of bottom trawling on cold-water coral habitat. As the results of this research emerged for public scrutiny, our benthic habitat studies of cold-water reefs grew to be highly politicized in light of an impending ban on bottom trawling in the Bering Sea and Gulf of Alaska. As such, I increasingly found that my scientific relevance required interface with policy-makers, media, and stakeholder groups. My interest in shellfish aquaculture therefore not only connected to my training as an invertebrate biologist, but also directly to this emerging interest in public policy, including a strong desire to explore how fisheries policies can promote social and economic sustainability, while still benefiting resource-dependent communities. By 2004, I had become increasingly curious about the intense controversy over salmon aquaculture in British Columbia (Alaska does not support salmon aquaculture), and I wondered why the same debate had not emerged over the burgeoning shellfish industry. I therefore began preliminary research for this dissertation by visiting coastal communities in both Alaska and British Columbia to observe shellfish aquaculture operations and talk with growers.

When I first began this research, I was surprised at the paucity of prior studies in the common property and fisheries economics literature on aquaculture as a form of privatization (c.f. Anderson, 2007; Anderson, 2002). I had often observed social and economic losses in coastal communities following the introduction of Individual Transferable Quotas (ITQs), and was interested to know whether similar reallocations of common property resources were causing controversies over aquaculture. I therefore began by framing aquaculture as a form of rights-based fisheries management and began delving into the social science literature on common property to examine potential effects of both ITQs and aquaculture policies on access rights to resources in coastal communities. From preliminary investigations, it appeared that a transition to rights-based management had the

potential to induce similarly negative public reactions as a result of both ITQs and aquaculture.

Worldwide, the implementation of private property rights for aquaculture development has in many cases met with resistance in coastal communities, and considerable controversy has arisen where aquaculture and wild harvest fisheries vie for physical space or impose external costs on each other (Hoagland et al., 2003). In British Columbia, resistance to salmon aquaculture has emerged in part due to environmental concerns, but also as a result of risks from the effects of aquaculture development on coastal communities, including a perceived loss of control over local resources. The controversy over salmon aquaculture relates both directly and indirectly to the exclusion of coastal resource users from access to key marine habitats and to competition with wild fisheries for those habitats.

Based on my experience with development of new and underutilized fisheries resources in Alaska, several First Nations councils and their fisheries managers in British Columbia were interested to know whether I thought aquaculture was a positive development, and wondered whether their bands were making good choices by getting involved with government initiatives promoting shellfish leasing. In 2004 and 2005, I worked as a consultant to the Department of Fisheries and Oceans – a position which generally didn't endear me to either fishers or First Nations – so it was not always clear whether my speculative responses on the subject of shellfish development were met with genuine interest. However, the shellfish industry was growing rapidly and it appeared that many fishers, band leaders, and industry representatives were very interested in the changes occurring in shellfish production. I began to attend shellfish industry meetings and conferences, and read widely government reports, industry trade journals and newspaper articles to develop a broad overview of the shellfish industry in British Columbia. A research project began to emerge through which I would use participatory input (through collaboration with interested communities and First Nations band leaders) to develop a comprehensive picture of the potential risks and benefits of shellfish production in coastal British Columbia. My goals were to help communities decide how to better manage coastal ecosystems for multiple, conflicting uses, and to provide insights which would help resolve questions that had emerged within these communities about shellfish aquaculture development.

It was not my primary intent to conduct an ethnographic survey of shellfish harvesting practices in British Columbia. Indeed, this would have been one approach, but would have been better accomplished by an anthropologist who likely would have employed different methods and produced a very different end result. Nor would it have been appropriate to take an entirely scientific perspective, such as conducting a risk assessment or a GIS siting analysis. Instead, it was my intent not to switch research fields entirely, but to begin to learn about relevant social science literature, while relying on my fisheries modelling background to develop an interdisciplinary and collaborative project that would bring both researchers and industry stakeholders into the learning process.

From my background training in geomatics engineering and marine biology, I knew that GIS could be a useful tool for examining spatially-defined habitats and resources. Preliminary research on social science applications of GIS technology also led me to believe that GIS could be a valuable means for examining resource conflicts and prioritizing resource uses. In order to examine stakeholders' perspectives on shellfish production (both farmed and wild), I therefore began developing maps in ArcGIS analyzing shellfish habitat and aquaculture development in BC over a ten-year period from 1995-2005. The maps produced from this analysis, however, were only telling part of the story about aquaculture development and land-use practices. The maps were therefore taken into participatory settings (interviews, meetings, community forums) to generate discussion with a wide range of stakeholders in the BC shellfish industry. Interviewees ranged from aquaculture producers and wild clam harvesters to scientists, fish processors, fisheries managers, government policy-makers and industry trade-representatives, all of whom lent their particular knowledge and perspectives to the questions that we posed.

Preliminary interviews in three coastal communities eventually grew to include interviews with fifty-six stakeholders in sixteen different communities. My approach was based on the premise that participatory research not only provides fisheries stakeholders with an avenue to explore issues affecting them, but also that information gathered through a participatory process can help stakeholders make more informed decisions when presented with different management options (see Neis et al., 2000). It is my hope that the communities who requested this work, and have contributed to it, will benefit from their involvement through political mobilization aimed at creating an equitable distribution of resources and a sustainable shellfish industry.

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CO-AUTHORSHIP STATEMENT

This manuscript-based (not monograph form) dissertation is the combination of three submitted papers on which I, Alyssa Joyce, am the lead author, and introductory and concluding chapters on which I am the sole author. The research proposal, interview schedules, and data analysis are the work of Alyssa Joyce, with input from Drs. Satterfield and Canessa, who provided advice on methodology and made editorial comments on my proposal and drafts of the papers. Final drafts of the dissertation incorporate the suggestions of Drs. McDaniels, Canessa, and Satterfield.

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1. INTRODUCTION

Aquaculture production worldwide has been increasing 9% annually since the early 1990s, such that by 2005, aquaculture comprised more than 40% of global fisheries production (Naylor and Burke, 2005). Finfish account for approximately half of all aquaculture yields, while aquatic plants and invertebrates account for a quarter each (FAO, 2005). Within the wide array of species produced through aquaculture, only a few are considered to have sustainable ecological footprints at current production levels, including some species of plant-consuming finfish, some prawns and crabs, as well as bivalves such as clams, oysters and mussels, and seaweeds (Wolowicz, 2005).

The emphasis of much current aquaculture research is on shrimp and salmon production, yet both the shrimp and salmon farming industries have been widely criticized as socially unsustainable and employing environmentally damaging production methods (Naylor et al., 2000). There are significant opportunities for improving the social and environmental sustainability of aquaculture practices by focusing on cultivation of lower trophic-level species (e.g., bivalve shellfish or seaweeds) that do not require exogenous feed inputs and are thus much less expensive to cultivate, generate fewer waste by-products, and require significantly less energy per unit of biomass produced. Relative to salmon aquaculture, shellfish aquaculture requires only minimal capital investment and no ongoing costs related to feed inputs, and therefore offers opportunities for diversification of the aquaculture industry into species and aquaculture methods that are favorable for small-scale growers in coastal communities (Kingzett and Tillapaugh, 1999).

In British Columbia (BC), shellfish farming is a promising option for increasing fisheries production as a complement or alternative to wild harvesting. Since 1999, the number of shellfish aquaculture tenures in the province has doubled as a result of government policies

promoting leasing of nearshore and foreshore waters. Approximately 35% of the clam harvest and 45% of the scallop harvest in BC now comes from shellfish aquaculture. For many government regulators and fisheries users, this has been a positive development, as shellfish aquaculture has significantly increased production revenues. However, the long-term effects of leasing policies aimed at facilitating shellfish aquaculture production have not been well assessed, in part because aquaculture leasing policies are relatively recent in BC and few studies have examined the social and environmental implications of similar policies elsewhere. Indeed, leaseholds, concessions, and tenures as forms of property rights have received only passing consideration in the common property and fisheries economics literature (Bowden, 1981; Hersoug, 2005; Jentoft and McCay, 2003; McCay, 2004; Pearse, 1994). A lack of research on aquaculture leaseholds as a form of private property rights is surprising given the political importance and complexity of current discussions of other forms of property rights in fisheries management, including significant prior work on quantitative use-rights (quota systems) for the management of fish stocks. A number of case studies have documented the impacts of rights-based management on coastal communities and fishing fleets following the introduction of Individual Transferable Quotas (ITQs) (Brandt, 2005; Copes, 1999; McCay, 2004; McCay and Jentoft, 1998; Palsson et al., 1997). Similar studies are needed on the social and environmental effects of property rights for shellfish aquaculture, in order to effectively address potential conflicts over industry development. In BC, stakeholders in the fishing industry have reported significant redistributions of access rights among fishing fleets and communities following the introduction of ITQs (Ecotrust, 2004), and there is a need for empirical evidence to determine whether shellfish aquaculture development may result in a similar redistribution of access to resources.

Although aquaculture leases do not explicitly grant property rights to fisheries resources (as do ITQs), they in many ways function like private land-based property systems by granting access to, and use rights for a specified area of sea space or foreshore habitat. In some cases, leases also allocate existing resources within a habitat (e.g., standing shellfish stocks on beaches), as well as access to physical capital required to exploit those

resources.[1] As will be explored in subsequent chapters, shellfish aquaculture leases in BC are similar to ITQs in that they grant *dejure* access to wild habitat, including access and withdrawal rights, as well as the right to sell or transfer access rights (e.g., rights of disposition and rights to capital gains). In other aspects, such as environmental risks, they differ significantly insomuch as leaseholds allocate access to habitat while quotas allocate rights to a portion of a fugitive resource.

Two key motivations guided this dissertation. The first was a desire to conceptualize aquaculture as a form of rights-based management in order to understand the effects of this type of management on existing resource users in coastal communities. A second motivation was to understand how stakeholders in the BC shellfish industry weigh tradeoffs between the risks and benefits of shellfish aquaculture development, and to explore more broadly how public perceptions about risks and benefits influence industry growth and shape public discourse about aquaculture policies and practices.

In British Columbia, where there is an existing wild shellfishery, local communities and wild harvesters have not responded uniformly to policies for aquaculture development. A transition from a predominantly wild fishery to shellfish aquaculture production depends, in part, on the ability of existing industry stakeholders engaged in the wild fisheries to adopt new methods and technologies; it also depends on the willingness of those stakeholders to engage with new forms of production, and on the availability of social or economic capital to either constrain or promote a mobilization of resources. A number of feasibility studies have been completed for shellfish aquaculture in BC, and all of these studies highlight favorable cost-benefit analyses under a variety of economic conditions and management systems (Blewett & Associates; Nelson, 2003; Coopers and Lybrand, 1997; Gislason, 2002; Kingzett, 2002b; Pinfold, 2001; Vancouver Island Economic Development Association, 2002). The findings of these reports consistently suggest that aquaculture leaseholds can increase the productivity of existing resources and create

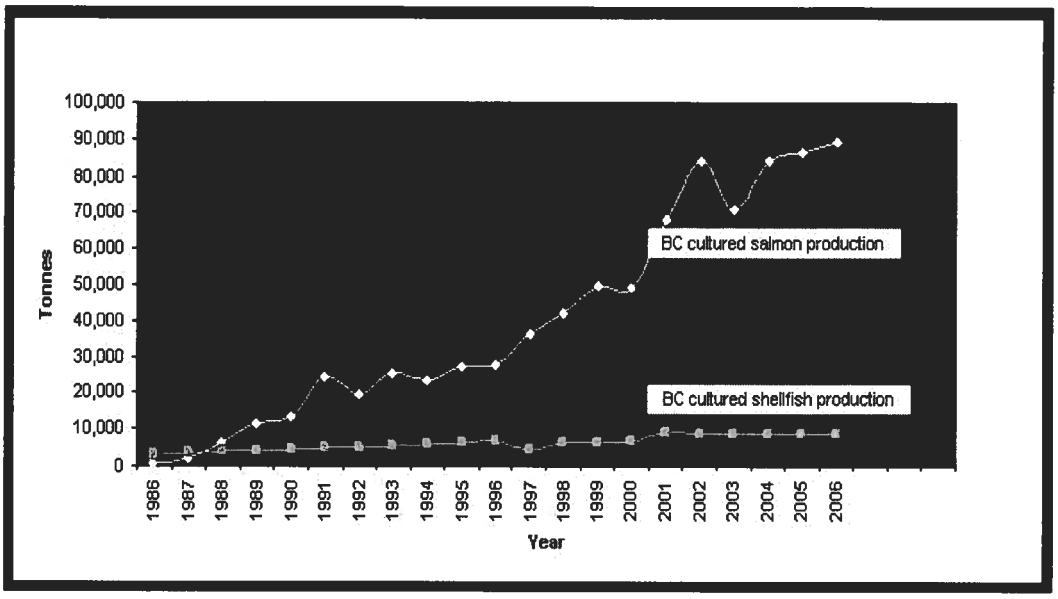
[1] Physical capital may include right to cross government lands to build roads, floats, docks, moorage, underwater anchors; to access fresh water supplies and build cabins/floats for site caretakers; or to drive trucks on beaches to harvest product.

opportunity for coastal communities in ways that lead to new employment opportunities, skill development, and investment in infrastructure. Yet, assessments of economic costs and benefits and investigations of capacity among existing industry stakeholders to adopt new policies and practices do not adequately explain why the rate of expansion in the shellfish industry remains slow relative to the salmon aquaculture industry (Figure 1.1). Farmed salmon is currently BC's primary agricultural export, yet the value of salmon is decreasing in world markets, while shellfish prices remain relatively constant (Figure 1.2). In the salmon industry, the volume of production at each farm site in BC is increasing to take advantage of economies of scale and to recoup per-pound price losses (Figure 1.3). Despite production increases, the number of salmon farms in BC has actually decreased from 126 in 1986 to 114 in 2004. In 2002, a five-year moratorium on salmon leases was lifted, yet site approvals have not increased significantly since that time, and future industry expansion may also be unlikely due to increasing social pressure against the industry and pending First Nations territorial claims.

In contrast, BC remains a relatively small player in world shellfish production. The export of BC oysters, for instance, currently represents less than 5% of the US oyster market. Per pound market prices for shellfish are low and fluctuating, but do not show the same downward price trends as prices for aquaculture-produced salmon. Indeed, some shellfish have higher per pound market values than farmed salmon. BC shellfish are potentially competitive on world markets, and there is unknown development potential for a range of species that are not currently in commercial production (e.g., abalone, geoducks).

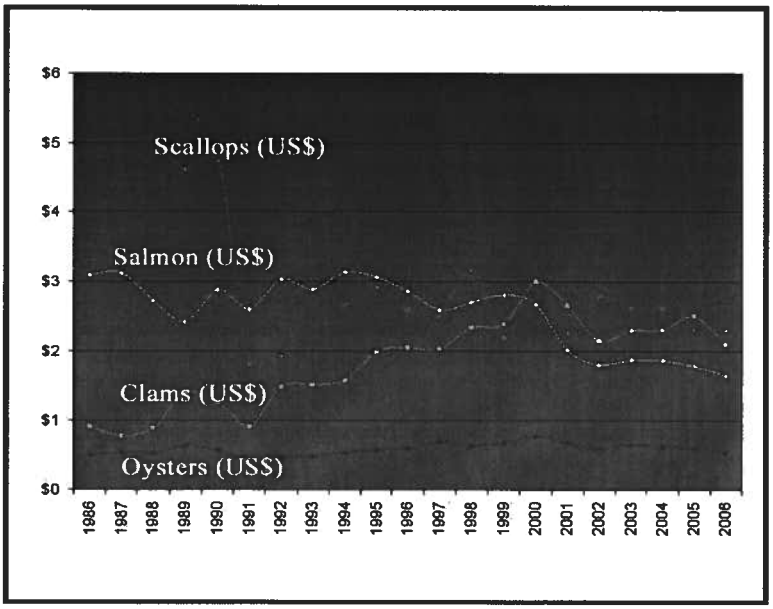
When comparing salmon and shellfish aquaculture, neither market prices nor economic cost-benefit analyses adequately explain why certain coastal communities have been favorable towards shellfish or salmon aquaculture, while others ignore or actively resist aquaculture development incentives. There is a tendency to overlook important social and cultural factors influencing community choices, thus limiting the value of studies based exclusively on investigations of cost-benefits or capacity, because such feasibility studies seldom address local perceptions of the industry.

Figure 1.1 Comparative volume of aquaculture-produced salmon and shellfish in BC 1986-2006 (tonnes)



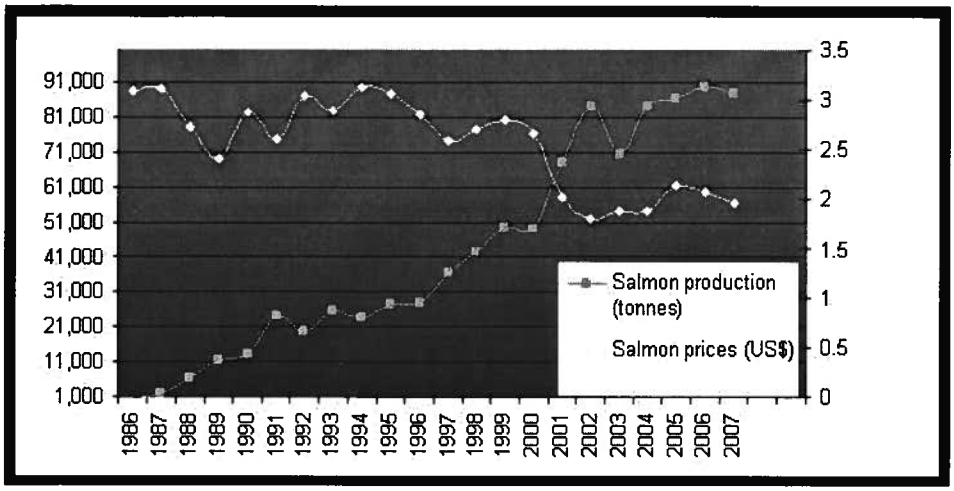
Source: 1986 to 1990 shellfish data from the Department of Fisheries and Oceans; salmon data and shellfish values 1991 onwards from Statistics Canada, Agriculture Division database.

Figure 1.2 Per pound market value of seafood products from British Columbia 1986-2006



Source: Ministry of Agriculture, Food and Fisheries – Aquaculture Statistics

Figure 1.3 Comparison of salmon aquaculture prices and production volumes in BC 1986-2007



Source: Ministry of Environment, Oceans and Marine Fisheries Division, Aquaculture Statistics

Research shows that perceptions of risks strongly influence decisions about products produced and purchased, irrespective of objective assessments of their risks and benefits (Leiss, 2001; Pidgeon et al., 2003; Slovic, 1997, 1999, 2000; Fischhoff, 1978). Perceptions of environmental or social risk may also be important factors in determining which industries are deemed acceptable (Flynn et al., 1994; 2001; Gregory et al., 1995; Poortinga et al., 2003; Walls et al., 2004). In addition, cultural and place-based values are crucial determinants in how individuals perceive and act upon risks (Stern et al., 1994). With regard to aquaculture development, Katranidis et al. (2003) found greater social acceptance was linked to perceptions of higher socioeconomic benefits and lower environmental impacts for local communities. Mazur and Curtis (2006) have also shown that underlying values and cultural understandings strongly shape public perceptions of the risks of aquaculture, and such perceptions have the power to influence local decisions to accept or resist industry growth.

An understanding of how stakeholders weigh the risks and benefits of shellfish aquaculture may therefore explain why, despite significant government incentives, some British Columbia communities, who have both the capacity and economic infrastructure, have not developed shellfish aquaculture sites. As will be discussed in Chapter 2 of this dissertation, prior work on ITQs has shown that a transition from common to private property systems

may displace local resource users with customary access to fisheries resources, and may disadvantage certain sectors of the fishing industry. Such sectors are most likely to resist a change of governance if they perceive the risks of new governance systems to outweigh the benefits. I suggest that diverse cultural experiences, values, and political agendas shape responses to aquaculture development; I also propose that social groups who experience heightened perceptions of risk with regard to aquaculture development are potentially those who are most likely to be negatively affected by this development, and are as a result, most likely to actively resist leasehold policies.

1.1 The rights-based context: why property rights have been controversial in marine governance

Historically, agrarian societies have developed complex private property systems for land-based territories. Although in some cases, *de facto* territorial use-rights existed to govern fisheries resources[2], broad state-level strategies for delimiting territorial and use-rights have emerged only recently, and in limited form, for regulation of fisheries resources (Schlager, 1994; Wilson, 2004). In state-managed fisheries, marine fish (as fugitive resources) have generally been considered public property until caught (Bowden, 1981). During the last two decades, however, access rights to fisheries resources have been increasingly allocated as private property, while the resources themselves (i.e., fish stocks) are still said to be publicly owned and are managed by the state.

In the 1950s, several political scientists began connecting the term *common property* to problems of open access in fisheries management (Gordon, 1954; Scott, 1955). These political scientists proposed that unless management controls were implemented, users of

[2] Shellfish leases, at first glance, appear to be more similar to spatially-delimited Territorial Use-Rights Fisheries (TURFs) than to quota systems; indeed, aquaculture leases may be confounded with TURFs because of the territorial nature (e.g., delimited area) of the access rights. However, the property rights inherent in traditional TURFs are *de facto* allocations of fishing territory among existing resource users (see Acheson, 2003; Christy, 1982, Cordell, 1980; Johannes, 1998). The rights inherent in TURFs therefore differ in two key ways from the type of rights granted by the private property rights inherent to ITQs or aquaculture leases. First, rights of access, withdrawal and exclusion in traditional TURFs were governed by customary rules and social obligations, and employed some form of community-based management for allocation of these rights. Second, use-rights in TURFs were not subject to alienation, and thus management and exclusion rights were unlikely to be transferred outside the purview of the community. As such, TURFs did not convey the wide array of rights seen in leasing policies.

commonly held natural resources would seek to maximize their individual gain at the expense of other users, and that ultimately this natural desire to maximize individual welfare would result in reduced rents, overexploitation, and the inevitable destruction of common-pool resources. As popularized in Garrett Hardin's article, "the tragedy of the commons," the word tragedy suggests that open access to common resources leads to competitive behavior whereby conservation incentives are offset or ignored by an urgency to exploit as much of the resource as possible before rivals do (Hardin, 1968). In the absence of regulation or self-regulation, political economists argued that the race to catch fish would be limited only by the availability of fish and the technology and capital available to exploit the resource, such that fishing pressure would increase until stocks were depleted. Within the tragedy of the commons model, two distinct problems were identified with open-access systems. First, a first-order free-rider problem existed because individuals were driven to exploit resources before a rival could, and thus conservation served only to leave more resources for competitors. A second-order free-rider problem existed because users of common property resources had no incentive to find solutions to the first problem, as solutions would benefit both the individual users and their competitors equally (McCay, 2004).

Political economists suggested several approaches to alleviate the tragedy of the commons, including (1) limiting access through 'command and control' regulation imposed by license restrictions or gear limitations, and (2) conversion of limited-access fisheries to private property through allocation of tradable permits (e.g., quota systems) that set limits on total catch and allocate that catch to specific resource users.

Historically, limiting entry and effort have been the most frequently advocated approaches to restricting fisheries access; such measures have included gear restrictions, time-limited openings, constraints on minimum legal size, or limits on the total number of licenses issued. By limiting fishing rights to a small pool of license holders, limited-entry fisheries restrict access to resources, yet do not restrict the total amount of a resource that is harvested. In a limited-entry system, rents are unassigned, and the pressure to catch fish

will increase until it is no longer feasible to build the larger or faster boats needed to participate in a derby-style fishery, or until the resource becomes so overexploited that there are few incentives left to remain in the fishery (Hilborn et al., 2005; McCay, 2004). Limited-entry programs thus run the risk of converting the problem of an open access fishery, in which there are too many fishermen chasing too few fish, into a problem of too much gear chasing too few fish. In this scenario, neo-liberal economic approaches have suggested that limiting entry (through time or licensing restrictions) merely transforms a dilemma of overexploitation into a dilemma of overcapitalization in vessels and gear (Tietenberg, 2002). Political economists contend that limited-entry systems have a number of inherent inefficiencies, and have therefore advocated for quota-based approaches in order to overcome what they perceive as the rent dissipation and high transaction costs of such systems (NRC, 1999b; Shotton, 2000).

In the latter half of the 20th century, neoclassical economists began addressing the tragedy of the commons by defining open-access to common property[3] as a form of market failure, wherein the logical economic solution was to restrict access rights by developing private property rights (Alchian, 1950, Coase, 1960; Hayek 1967). Specifically, economists suggested that resources governed by limited licensing were costing more to manage than they yielded in user revenues, and that the development of fully specified property rights could increase efficiency for both users and regulatory agencies (Neher et al., 1989; Pearse, 1980). Such approaches considered multiple allocations to small-scale users to be inefficient and suggested that private property rights, and transferability of these rights, could facilitate economies of scale and hence, the full efficiencies of a market-based system (Pearse et al., 2004).

The widespread adoption of property rights for marine governance is rooted in tenets of neoclassical economics and population ecology ("bioeconomic models"), which assume that good control of stock inventory via stock assessment and quota allocations will result in positive social and environmental outcomes. In response to the widespread dominance

[3] Few examples actually existed of open access, as most fisheries had some form of customary or defacto allocation process.

of these models, marine governance practices in recent decades have increasingly shifted from centralized state regulation of fisheries, managed as common property through limited licensing, to fisheries managed via the use of private property rights. Specifically, the regulatory focus in fisheries management has shifted towards development of quantitative use rights, including the use of ITQs in most large scale, developed-world fisheries (Pearse, 1980; Schmid, 1978; Townsend et al., 1987; Welch, 1983). ITQs assign specific shares of the harvest to individual fishers or groups of fishers by dividing the total allowable catch (TAC), or a percentage of the TAC, among quota holders. Quotas are tradable, and quota holders can choose to harvest their quota or transfer it, much as stocks are traded on the stock market. Economic theory underpinning the use of transferable quotas holds that, in the absence of transaction costs, assigning tradable shares to individual fishers or groups of fishers will lead to a situation in which shares will be purchased by those users best able to maximize efficient use of them. ITQ systems can thus be said to rationalize the fishery through market forces, which, in theory, reduces competition and thus the overcapitalization in gear and vessels typical of 'derby-type,' limited-entry fisheries. Economists have argued that the more defined the property rights allocated by a quota system, the greater the economic benefits. For government, the development of private property rights may decrease management costs as regulatory functions are transferred to fisheries stakeholders, while increasing revenue through collection of property taxes from resource users (Neher, 1983).

Neoclassical economists have argued that property rights are the most efficient way to regulate common property resources, and that the overall economic efficiencies achieved through privatization of these resources are advantageous because property rights will accrue to those actors most able to gain utility from them (Coase, 1960). In practice, former common property resources are privatized through an initial giveaway or sale of resources (e.g., often based on historical use rights or auction by the state), followed by trade in a secondary market. Early economic perspectives on the emergence of property rights, including theories of negotiated allocation (Coase, 1959, 1960) and subsequent extensions of Coase's work (e.g., Alchian and Demetz., 1972) believed externalities (e.g.,

social and environmental costs) to be problems of market failure. Critics of such approaches suggested that while efficient market-based allocation of rights could occur through simple Coasian bargaining if there were a small number of parties, in practice, state intervention was generally required to facilitate transactions among the many possible holders of the rights, and transaction costs would negate many of the market-based incentives of such systems. Eggertson (1990), in a broad theoretical review of new institutional economics, suggests that early theories of property rights were limited in their applicability because they did not adequately account for institutional factors such as transaction costs. Referring to Demsetz's (1967) work on the emergence of property rights as "a naive theory of property rights," Eggertson argued that early approaches focused solely on economic efficiency and encouraged the development of exclusive property rights, without explicitly modelling the consequences for social and political institutions.

Economists such as Nelson (1983), who developed early models of property rights in marine fisheries, argued that there is a "natural evolution" from common proptertysystems to private property use-rights. Critics have disputed this viewpoint by questioning the assumptions of bioeconomic models and their sociopolitical bases and imperatives (Ostrom, 2000). In particular, critics have questioned the premise that market-based systems ensure efficient outcomes, as they fail to account for potentially detrimental social and environmental effects (i.e., what economists would define as significant transaction costs and externalities) (Bromley, 2005; Ostrom et al., 2002). Although new institutional economic approaches have shifted the focus of earlier theories of property rights to consider the dynamics of institutions and their role in mitigating transaction costs, critics of rights-based approaches believe these theories fail to account for a broad range of externalities (Rose, 2002).

The assertion that ITQs are a desirable way to control stocks is highly debated on the basis of both efficiency and equity. ITQs, as a rationalization measure, generally exclude a certain percentage of existing harvesters, thus resulting in redistributions of access rights to fisheries resources (Brandt, 2005; Copes, 1999; McCay, 2004; Palsson et al., 1997). The

privatization of fisheries resources through use of ITQs has been highly controversial and has been resisted by many resource users from different sectors of the fishing industry (Copes and Palsson, 2000; Holm et al., 2000). Critics of tradable permits such as ITQs, which allocate limited property rights to resources,[4] view rights-based management as a proliferation of the free market into public domain and point to the negative impacts of such policies upon local peoples and environments as reasons why private property rights should be avoided (Mansfield, 2004). Instead, they advocate for policies that are environmentally and community-driven and specifically provide for distributive justice and equitable outcomes among resource users. Many social scientists for instance, have suggested that fisheries management should reflect multiple objectives, including social or environmental goals such as maintaining rural fishing employment or preserving way of life in coastal communities, which may directly conflict with efficiency (Dengbol, 2003; Jentoft and McCay, 2003; Pinkerton, 2003; Wilson, 2003).

On first glance, few economists appear to find significant interest in the use of property rights for aquaculture leasing, as unlike ITQs, property rights for aquaculture leases are well defined (Anderson, 2002). However, as I will explore in subsequent chapters of this dissertation, there remain challenging policy issues associated with rights-based management of marine space that are worthy of further research.

1.2 Rights-based Management in British Columbia: The BC case study

Since the 1980s, both the BC Provincial government and Canadian Federal government have moved from centralized state regulation of fisheries to the use of private property rights in marine governance. In BC, policies promoting private property rights have resulted in the introduction of ITQs in several key fisheries, including halibut, sablefish, and other groundfisheries. In addition, limited property rights have increasingly been used in the development of leaseholds or "tenures" for finfish and shellfish aquaculture.

[4] Tradable permits are not limited to fisheries applications and have also been used to allocate environmental allowances for air and water pollution, and are increasingly being advocated in 'cap and trade' approaches for addressing climate change (Tietenberg, 2007).

Policies in BC for rights-based management have met with resistance in the groundfish trawl fisheries, and similar controversy has also emerged over the environmental, social, and health impacts of salmon farming (BCSAR, 1995). Although legal conflicts over aquaculture in BC are currently restricted to salmon farming, similar conflicts may emerge over shellfish aquaculture as the industry develops, and conflicts over access to sea space intensify.

1.2.1 Wild intertidal clam fisheries in BC

British Columbia has approximately 27,000 km of shoreline, much of which is rocky headland interspersed with sand and cobble beaches. Shellfish habitat generally occurs in sheltered bays and estuaries, on gentle gradient deltas, where there is suitable substrate (sand or cobble) and adequate nutrient sources from currents and tidal fluxes. Manila clams (*Tapes philippinarum)*, and to a lesser degree, littleneck clams (*Protothaca staminea*), are the primary intertidal bivalve species harvested commercially in BC, although smaller-production fisheries include razor clams (*Siliqua patula*) and butter clams (*Saxidomus giganteus*) (Kingzett et al., 1999). Intertidal bivalve species can be harvested using rakes and shovels at low tide, while subtidal bivalves such as scallops or geoducks are harvested by divers.

In this dissertation, I focus primarily on bivalve manila and littleneck clam harvests, as they occur in the intertidal, and are the largest bivalve fisheries by volume (more than 75% of the total wild shellfish harvest). Further, they are important fisheries to the economic well-being of coastal communities, as they have historically provided employment, although often seasonal and part-time, to significant numbers of people in rural communities.[5] By contrast, butter and razor clam fisheries, as well as scallop harvests, are

[5] In this dissertation, we concentrate on littleneck and manila clam fisheries primarily, as geoducks are a specialized ITQ based dive fishery. Wild geoduck fisheries were transferred to a quota management system in 1989, and despite total revenues, only a very limited number of harvesters are licensed in this fishery. Revenue derived from geoduck fisheries therefore accrues to a small number of individuals, and profits are not widely distributed among a wide range of coastal stakeholders. Geoduck aquaculture leases were also first issued in British Columbia in 2006 (interviews for this dissertation were completed prior to this time). Furthermore, we do not consider to any extent the razor or butter clam fisheries, or the gooseneck barnacle

small in both production values and volume and are highly localized to specific enclaves of the coast. Subtidal geoduck fisheries have had high production values, but have not been as historically significant in either volume or harvester involvement. There is also a small recreational oyster and mussel harvest, primarily on Vancouver Island and the Sunshine Coast (Mitchell, 1997), but there is no commercial wild harvest of oysters or mussels in BC (oysters and mussels are produced largely through aquaculture).

It is worth noting that the majority of wild shellfish harvests by volume are taken by the commercial manila and littleneck clam fisheries (hereafter 'wild clam fisheries'). Few statistics are available on recreational or subsistence harvest volumes, but approximately 1200 to 1600 tonnes of clams are collected annually during the commercial seasonal clam openings regulated by the Department of Fisheries and Oceans[6] (DFO, 2007). Wild clam 'openings' occur primarily in the winter (during low-tides from December until March), as bacterial water counts are lowest in the coldest months. In many cases, clams are harvested from beaches at some distance from communities in relatively remote, roadless areas,[7] and thus access to the fishery generally requires a small boat or skiff. However, unlike other gear-intensive offshore fisheries, clam fisheries do not require significant capital investment to enable participation.

The number of commercial clam licenses issued since 1990 has been relatively stable, ranging between 700 and 1000 licenses per year, although reported catches have declined from an all-time high in 1988 (DFO, 2007). A number of problems have affected commercial clam fisheries in the past few decades, including threats to the health and productivity of stocks due to habitat loss and habitat degradation. Increasingly, the clam fishery has been affected by potential contaminants from mining, forestry, finfish aquaculture, and other coastal industries. Runoff of agricultural effluent, septic and sewage

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fishery, as income derived from these fisheries is limited to very specific coastal areas, and thus does not lend itself to a coast-wide analysis.

[6] Openings average 10-15 days each winter, spread over low tide cycles between December-March.

[7] Although remote beaches are more likely to be open to harvest (fewer contaminants from nearby communities, industry or boat traffic), harvestable beaches are in some cases directly adjacent to communities, and thus a boat is not required. In practice however, harvesting on these accessible beaches often occurs for subsistence use, with defacto rights allocated among local users.

outflows, boat discharges, and hinterland drainage from logging operations have all contributed to an increase in bacterial contaminant closures, which also compound other closures due to naturally occurring paralytic shellfish poisoning (PSP) or pollution from industrial effluent (EC, 2003b). The wild clam fishery has also been affected by increased predation following reintroduction of sea otters to coastal waters. In some locations, localized habitat degradation has increased fishing pressure on remaining wild resources to such a degree that standing stocks have been depleted, and wild fisheries have become variable depending on yearly recruitment.

In response to fishing pressure, management of the fishery has changed significantly since the initial development of commercial clam harvests in the late 1960s. The wild fishery was historically open access, wherein anyone possessing a Personal Commercial Fishing License (PCFL) was permitted to harvest clams. Since 1989, the wild clam fishery has been managed through limits on the total number of licenses issued as well as time-limited fisheries openings and controls on minimum legal harvestable size. Licenses are allocated to qualified harvesters in one of seven regional clam management areas (Z2 licenses), and Aboriginal Community Licenses (ACL licenses) are allocated to First Nations bands based on demographic data for eligible on-reserve populations. In 2007, First Nations ACL's represented approximately 53% of all total licenses in the wild clam fisheries.

As such, the wild clam fisheries have the highest First Nations participation rate of any large-scale fishery on the BC coast (DFO, 2007; James, 2003). In addition to licenses in the wild fisheries, First Nations also retain constitutionally protected rights to harvest fish and shellfish for food, social, and ceremonial purposes. Over the past century, the importance of clam harvesting has declined for some coastal First Nations, as bands were relocated to landlocked reserves or developed other economic livelihoods. However, the ability to access marine resources and participate in their management remains important to coastal First Nations peoples in BC (Newell 1999; Newell and Schreiber; 2006; Harris

2008). Although many First Nations bands in BC do not currently have treaty settlements,[8] various Provincial and Federal protections exist for First Nations fishing rights, and Aboriginal management of fisheries resources is increasingly being explicitly implemented under a number of First Nations interim agreements (Copes, 1999; Harris, 2001). However, there is a long history of strife between First Nations and the Federal and Provincial government over access to fisheries resources. Thus, the importance of clam harvesting as a cultural and economic activity in many First Nations communities renders any changes in management or access rights to the fishery highly contentious.

The primary purpose of this study is not to provide an ethnographic study of First Nations shellfish harvesting practices, nor is it to provide a detailed analysis of the effects of colonial occupation on Aboriginal fisheries in BC, and the subsequent struggle for a livelihood and way of life on Native reserves in coastal communities. A significant body of important work already exists on this subject. However, it is relevant to mention a few details about the social organization and cultural importance of shellfish harvesting practices to First Nations in BC. The high proportional First Nations representation in the clam fisheries, and the existence of unresolved Aboriginal claims to land and resources in BC, distinguishes this case from other similar fisheries aquaculture cases presented in prior studies, including Marshall (2001), Walters (2007), and Mazur and Curtis (2007). In First Nations communities, the majority of licensed commercial clam harvesters are male (as is typical in the wild fishery generally), but in practice, both subsistence and commercial wild clam harvesting is often conducted by families, and there are high levels of community participation in local management of clam resources (Pinkerton, 2008).[9] Unlike other fisheries in which licenses are fully transferable, clam licenses are entirely non-transferable, and thus license ownership can be directly equated with employment in rural communities. In other fisheries, such as halibut or salmon, where licenses are transferable,

[8] Aside from the few bands on Vancouver Island who signed the Douglas Treaties between 1850 and 1854, most of the First Nations bands at our study sites were moved onto to reserves without treaties, and treaty negotiations are thus ongoing to the present; most are unresolved.

[9] In addition to band-level management, there is also an Area F clam board regulating most of the West Coast Vancouver Island clam fisheries; the Helsiuk also have proactive clam management programs, as do the Kwakwaka'wakw and several other mid-coast bands.

Aboriginal license holdings do not necessarily translate into First Nations participation in these fisheries as Aboriginal licenses are frequently leased out, thus providing income but not necessarily employment to reserve communities.[10] In contrast, the clam fishery remains one of the few coastal fisheries in which First Nations retain a strong occupational and management presence, with a significant number of individuals benefiting directly from employment in the fishery (Pinkerton 2008; Heaslip, 2008; James, 2003).[11]

The coastal areas considered as part of this study are primarily rural. In some cases communities are isolated, and accessible only by boat or floatplane, while other communities are accessed from paved and gravel road systems. The majority of coastal communities considered had a high dependence on primary industries, and the majority of wild clam harvesters and aquaculturalists were currently employed, or were previously employed, in other fisheries and resource extraction industries. Many coastal communities in BC have high unemployment rates due to significant declines over the past twenty years in seasonal resource sector industries such as fishing and forestry. Winter employment from both wild clam fisheries and shellfish aquaculture is thus very attractive in rural areas, where seasonal unemployment rates may be as high as 65% (Statistics Canada, 2005b).

1.2.2 Aquaculture leases in British Columbia

Aquaculture leases (tenures) can be divided into four categories based on the sea space they occupy: beach (foreshore), nearshore, deep water, and subtidal. In the foreshore, beaches are tenured for culturing of manila and littleneck clams. Oysters may also be grown in the foreshore, though oysters and mussels are more often cultured in the nearshore, suspended from rafts in 'socks' or longlines within the water column. Clams may also be grown in trays at nearshore leases, while abalone and scallops are grown on

[10] According to James (2003), the Aboriginal owned or operated fleet in 2003 consisted of 595 vessels (of which 564 were owned, and 31 operated), out of a total of 2885 vessels licensed for commercial fishing, which is 21% of the commercial fleet. A rough estimate of 31% percent of all jobs in commercial fishing are held by First Nations, a percentage that is much higher than the percentage of value or vessel ownership largely because Native participants are concentrated in labor intensive fisheries such as salmon and clam fisheries.

[11] In 2006, more than 650 First Nations individuals held ACLs or presented Indian Status cards as identification when applying for Z2 licenses.

similar longline or cage structures in deeper subtidal waters[12]. Suspended cultures are subject to marine mammal predation and thus are designed to exclude sea otters and other marine mammals; fencing or cages may surround suspended cultures, while foreshore (intertidal) areas are subject to both marine and avian predation, and are thus frequently protected by nets spread over the beaches.

Aquaculture leases are issued by the government, and may be applied for by an individual or representative entity for a group of individuals (e.g., First Nations band or a corporation). Potentially desirable lease sites have been identified on coast-wide maps by government-funded biophysical capability studies; in some areas, local residents have also developed shellfish suitability studies which, unlike capability studies, take into account socioeconomic factors and local environmental preferences in the siting of shellfish lease sites (Osborne, 2000). When tenure holders apply for leases, socioeconomic and political factors play an important role in tenure siting.[13] Biophysical habitat characteristics are clearly also important in determining locations of shellfish farms, while proximity to infrastructure (i.e., transportation, labor, processing plants and hatcheries) may also be relevant considerations.

All forms of shellfish culture–foreshore, nearshore, deep-water, and subtidal–grant some form of private property rights to sea space, and thus potentially compete for sea space with wild fisheries and other uses of coastal waters. For instance, nearshore raft culturing may present hazards to navigation or potential competition with other industrial activities such as salmon farming, even though such uses do not directly impact access to wild shellfish habitat. Where foreshore tenures (beaches) are seeded for clam and oyster culturing, there is direct spatial competition between wild and cultured shellfisheries. However, most nearshore lease applications also include foreshore access or associated tenures, and if leasehold applicants are able to secure and develop tenures on (or in close

[12] Benthic subtidal leasing has recently emerged for geoduck culturing. In 2005, Alaska began leasing subtidal tracts for geoduck culture, and the Underwater Harvesters Association in British Columbia lobbied for similar rights in British Columbia. Subsequent to the completion of fieldwork for this research, the first tenures were issued in 2006 for geoduck aquaculture.

[13] See Bornik, 2005 for an examination of suitability and capability siting studies of salmon aquaculture leases; similar political factors also apply to shellfish leasing.

proximity to former wild-harvest beaches), shellfish aquaculture sites reduce the viability of the wild fishery through direct competition for habitat.[14] If shellfish aquaculture development redistributes access to harvestable foreshore areas, it also provides a relatively explicit spatial measure of how tenures alter existing resource use patterns in wild fisheries. If the leasing process is construed to be direct privatization of wild habitat and stocks, foreshore (beach) clam and oyster aquaculture leases are an ideal case study for examining the use of property rights in the control of sea space. Tenures not only privatize beach access, but they also potentially privatize a formerly public fisheries resource and future rights to this resource. As the wild clam fishery in BC is an inshore fishery where place-based users are closely tied to the resource, the shellfish case poses a distinct contrast with other rights-based management schemes like ITQs in groundfisheries, where the effects of privatization have historically been harder to quantify because the resource is fugitive, and fish and fishers in these industries are generally more mobile, vertically integrated, and segregated by fleet sector.

The existence of a direct spatial overlap between foreshore leases and wild fisheries is also important in distinguishing this case study from other recent work on aquaculture-fisheries interactions, for example, Walters' (2007) study of salmon farms and lobster fishery interactions on Grand Manan, New Brunswick. In the BC shellfish case, the effects of spatial displacement are important, as both wild and cultured clams and oysters share the same habitat requirements in the foreshore, and there is spatial overlap between competing wild and cultured uses. Because of this, there is potential for direct conflict between aquaculture leaseholders and wild fishers as foreshore aquaculture leases may preclude the continued existence of a wild fishery in a bay or estuary. Similar conditions did not prevail in the East Coast case presented in Walters (2007), where salmon aquaculture tenures had

[14] Prior to reseeding the beach with spat from a single age-class or developing other infrastructure at the tenure site, standing stocks on wild beaches may be harvested and sold by the tenure holder. The conveyance of standing stocks – implicit in the leasehold agreement - does not occur in all cases as tenure applications will not necessarily be awarded, even if applied for, on highly productive wild beaches, as the cost of such applications are significant, and thus if public opposition is expected, applicants may choose less desirable beaches, such as beaches that have been overharvested, or are already subject to depuration fisheries. However, it remains that any benefits from the ownership of former wild habitat, and future benefits that accrue from the sale of naturally-recruited stocks within that habitat, belong to the tenure holder.

far more limited impact on lobster fishing practices, as lobsters actually preferred habitat near salmon farms in response to readily available nutrients from excess feed and excreted feces. Lobsters also existed in higher abundance near the farms, potentially due to a reserve effect, as fishers could not trap lobster directly under the farms and thus abundance appeared to be greater at the edges of the 'reserve'. Lobsters were not excluded from habitat under and around the farms as the pens were suspended in the water column, and being motile, lobsters could still be harvested adjacent to salmon netpens. Thus, Walters' findings indicate that lobster fishers may in fact benefit from salmon farming, and the effects of salmon farms on productivity in the lobster fishing were relatively diffuse. Further, salmon farms in Walters' case study did not have any impact on Aboriginal fishing rights or unresolved First Nations' rights and title claims such as exist in BC. As a result, lobster fisheries and salmon farms on Grand Manan appear to coexist without undue acrimony.

The BC shellfish case is far more contentious (Hamouda, 2003). Although resistance to shellfish aquaculture development has not manifested in the types of overt protest observed with salmon farms in BC, it is clear that awarding desirable wild shellfish habitat to leaseholders in the form of foreshore tenures–and to some degree associated nearshore tenures–leads to a situation in which farm boundaries and infrastructure (e.g., rafts, docks, fences, netting, moorings) occupy sea space or beaches in ways that compete with access to wild shellfish habitat. Therefore, there is significant potential for displacement of existing subsistence or wild clam commercial fisheries at leasehold sites, as it is no longer legal to harvest wild stocks in these locations. In BC, the aquaculture tenuring system is also a potential threat to First Nations territorial sovereignty, as contention arises over the possibility for transfer of access and management rights away from wild fisheries and First Nations communities (Schreiber, 2003; Leggatt Enquiry, 2001; Page, 2007). Pending resolution of First Nations treaties, the development of private property rights for aquaculture development in First Nations traditional territories has generated, and will continue to generate conflict about ownership of land and resources.

In subsequent chapters, I discuss in more detail specific considerations for siting of shellfish farms, as well as a range of economic, social and environmental risks and benefits of leasing arrangements. The shellfish case in BC is interesting not only as an examination of competition between wild and cultured fisheries, but also as a study of the complex cultural and political issues associated with sovereignty of Aboriginal peoples in British Columbia.

1.3 Research objectives

Several key objectives guide this research:

(1) *To explore the role of property rights in shellfish aquaculture development:*

(a) To examine potential similarities between quantitative use rights for allocation of fisheries resources (e.g., ITQs) and aquaculture leaseholds for allocation of sea space or foreshore habitat; (b) to determine whether lessons from the use of ITQs in marine fisheries can inform problems and conflicts that may arise from other forms of rights-based management such as aquaculture leasing, and specifically, (c) to investigate whether the effects observed with ITQs and salmon aquaculture in British Columbia have any parallels with the observed effects of introducing property rights for shellfish leases;

(2) *To assess potential spatial re-distributions of access rights to coastal marine habitat as a result of shellfish aquaculture development:*

(a) To determine how a transition from primary dependence on wild fisheries to aquaculture production affects access to shellfish resources among existing stakeholders in coastal communities who have historically participated in wild commercial and subsistence shellfisheries; (b) to test quantitatively whether policies promoting shellfish aquaculture have altered access to wild shellfish habitat; and (c) to explore the implications of potential redistributions on access to coastal resources in British Columbia, including potential spatial conflicts with other resource uses;

(3) *To understand stakeholders' responses to shellfish aquaculture development:*

(a) To examine cultural, social, and political factors influencing stakeholders' perceptions of the risks and benefits of aquaculture development; and (b) to examine how stakeholder perceptions of the risks and benefits of aquaculture are shaping acceptance of, or resistance to, leasing policies in British Columbia.

These objectives led to three interrelated areas of research: (1) a review of property rights in marine governance in an effort to understand leasing policies in the context of other types of property rights-based management of fisheries and coastal resources; (2) a spatial and temporal assessment of changing patterns of coastal resource use and access to shellfish resources based on a GIS analysis of wild and cultured shellfisheries; and (3) interviews with stakeholders involved in and affected by changes in the shellfish industry, to explore local responses to changing governance practices.

1.4 Methods

Five study sites were selected for comparative research: the Sunshine Coast, Barkley Sound, Clayoquot Sound, Quatsino Sound, and Kyuquot-Chekleset (Figure 1.1). These sites were chosen to highlight regional variation, including differences in fishing histories and dominant industries, as well as wild harvesting patterns and development of aquaculture tenures. Several basic criteria were required of the study sites for interviews to be productive: (1) both First Nations and non-First Nations stakeholders received appropriate representation across the study sites; (2) local leaders, fisheries managers, and fisheries stakeholders at the study sites expressed interest in the research and a willingness to participate; (3) there were shellfish aquaculture leases or an active wild clam fishery at the study site; (4) there were potentially other influences on sea space in the area, which could provide a comparative with the shellfish case, including the existence of salmon aquaculture leases or other industrial development.

In the first part of the analysis, maps based on GIS data were used to examine whether a spatial redistribution of access rights had occurred as a result of aquaculture development in British Columbia. GIS spatial data - including shellfish aquaculture suitability studies, locations of shellfish aquaculture leases, salmon leases, and spatial extent of water quality

closures - were extracted from government databases held by the Ministry of Agriculture, Food and Fisheries (MAFF), Department of Fisheries and Oceans (DFO), Environment Canada (EC) and Land and Water British Columbia (LWBC). Data was compiled for a ten-year period (1995- 2005) and analysed using GIS software (ESRI ArcGIS 9.0)

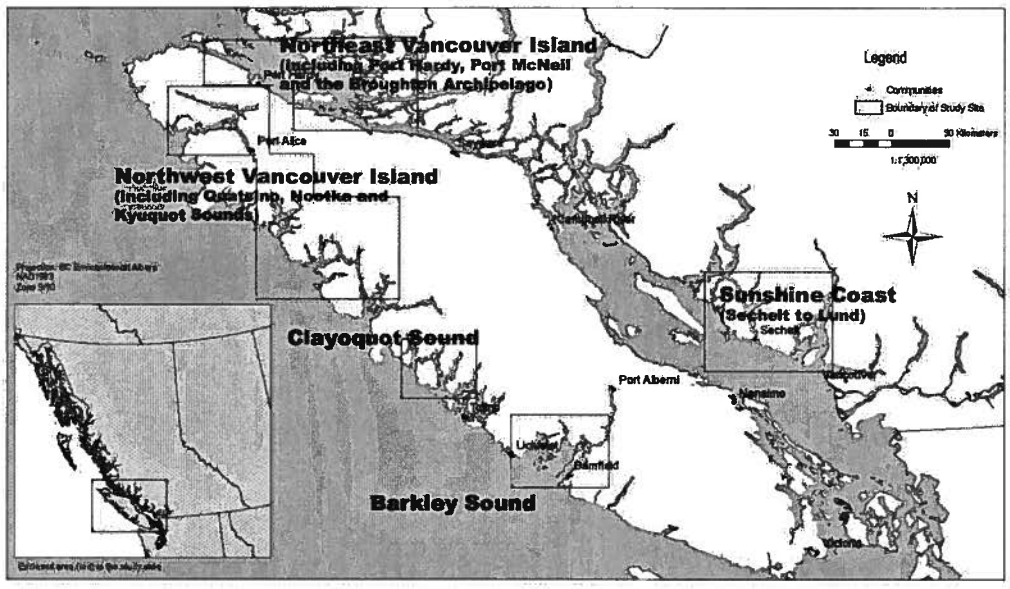

Figure 1.4 - Location of study sites

The maps produced from the GIS analysis were subsequently used during interviews with stakeholders to examine whether private property rights for aquaculture development had altered the distribution patterns of wild clam fisheries, and if so, how this redistribution was affecting resource use patterns and employment opportunities in coastal communities.

Between 2004 and 2007, 56 interviews were conducted with wild clam harvesters, aquaculture producers, fisheries managers, shellfish processors, research scientists, trade association representatives, and policy makers in order to get broad perspectives on changes in the shellfish industry. Interviewees were drawn from a wide range of user-groups, government agencies and regulatory bodies involved with both the aquaculture industry and wild shellfish harvesting. Participants were selected based on their knowledge of shellfish resources and to provide a broad demographic cross section within each community (e.g., age, gender, ethnicity, number of years working in the industry, primary

occupation). The objectives in selecting interviewees were to provide a broad representation of interest groups, in order to develop a coherent understanding of a wide range of perspectives on the shellfish industry across a diversity of locations and cultural contexts.

Several methodological approaches were considered within which to conduct the research and structure the analysis. Within the context of an interdisciplinary and manuscript-based dissertation, I did not employ a strictly ethnographic approach, nor would a scientific approach based purely on risk analysis have been able to capture the complexity of local beliefs about industry development. As such, we developed a series of open-ended questions that would allow interviewees to talk about their experiences and opinions, and tested these questions in a series of preliminary interviews to determine directions for further research. The final script of eighty possible interview questions (Appendix 1) was designed to identify factors influencing stakeholders' perceptions of the risks and benefits of aquaculture development, their policy-relevant knowledge and cultural context, as well as their prior experiences with private property rights in the management of marine resources.

The choice to use semi-structured interviews was important to the type of work being conducted, but posed a number of difficulties for analyzing patterns within interviewees' responses. In order to present a broad overview of the interview results, it was necessary to be able to categorize and generalize responses; we therefore selected fifteen key questions that were posed to all fifty-six interviewees. These questions were relevant across all study site locations and were potentially useful in generating a wide range of perspectives about the state of shellfish production in British Columbia. In theory, transcripts of the interviews could be analyzed for responses to these broad questions, and the results tabulated in a spreadsheet to determine frequency and type of response. In practice, however, this often meant conducting an interview or field visit, subsequently reviewing the transcripts in order to identify initial patterns or contradictions in the data, and then organizing responses to the fifteen broad questions into structured categories for further examination. As the questions we posed were open-ended, and the type of responses varied significantly

between interviewees and groups of interviewees, it was necessary to develop a system for categorizing the responses in order to find patterns in the data. However, rigidly following such a system for categorizing data during the interview process would have been limiting, and would have resulted in a loss of nuance from the original interview transcripts. Further, as our primary goal was to determine which issues and ideas were most relevant to respondents (and not to presume that we knew which issues interviewees' wanted to discuss), the tabulation and categorization of data became secondary to the need to explore the data in detail, and in some cases, to show participants the summary of our analysis to ensure that our interpretations were accurate and that our categorization of responses reflected the issues they had raised.

All interviews were coded according to key themes and analytical categories for the fifteen primary questions. In addition to these fifteen key questions, we were also interested in the analysis of highly detailed responses to 65 additional questions, of which only some of these questions were posed to each group of interviewees (e.g., they appropriate only to specific stakeholder groups or interview locations). As the results to these questions were subject to regional interpretations or were not applicable to all interviewees, it was not relevant to quantify the results. Tabulations of responses to such questions would not have aided in the broader analysis, and in many cases, the total number of responses to these questions was not large enough to generalize. Thus, in response to the fifteen key questions we decided to report overall percentages, while in response to more specific questions we concluded it would be adequate to report data in terms of 'many,' 'most,' 'several,' 'few' or other descriptors, as appropriate to describing trends in responses that were not appropriate for tabulation.

It was not our intent at any point to use a participatory approach to determine the validity of the claims of participants, nor to evaluate the validity of those claims as legitimate or not, but rather to understand the various range of perspectives presented, and to understand those perspectives in relation to a variety of cultural contexts and worldviews. The wide body of social science literature on risk perception has consistently shown that public perceptions, not 'real' risk (as presumably measurable through risk assessment), account

for public response to risk-based controversies (Bickerstaff, 2003; Gregory, 1996; Slovic, 2001; Renn, 1990; Wildavsky and Dake, 1990). When considering domains of potential controversy, one of the central points of the risk perception literature is a critique of the premise inherent in risk analysis that lay judgments can, and should be, compared against a baseline of expert ones in order to assess or communicate 'real' risk. Rather, the risk perception literature suggests that it is important to understand the consistently patterned logic within people's risk perceptions, in order to better understand the role perceptions play in determining public responses to different policies and technologies (Flynn, 2001; Gregory, 1995).[15] Towards this end, one of the central goals of this dissertation was not to speculate on what constitutes legitimate concern or 'real' risk as opposed to the areas of concern expressed by interviewees, but instead to assess perceptions in relation to the socioeconomic, political and cultural contexts in which risks are introduced. [16] Thus, interviewees were asked to participate in an iterative process through which questions were designed to gather information and input to the study, and also to explore and reflect on interviewees' beliefs and values about aquaculture development. In no instance were responses evaluated in order to determine whether stakeholders concerns were 'real', as such a state of mind presumes that it is both possible and relevant to determine the validity of the claims of participants against some form of 'objective' measure of 'real' risk.[17]

As manuscript-based theses are not common in the social sciences, it is also important to clarify at this juncture the differing goals of manuscript-based and conventional monographic theses. First, the challenge of a manuscript-based thesis is that each chapter must be a publishable journal article that contains either empirical or theoretical research.

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[15] One of the basic premises of this literature is that risk perceptions are influenced by heuristics and biases, culture, and worldview as well as a variety of other factors, including gender and socioeconomic status. The risk perception literature therefore focuses on an examination of these variables, wherein the goal is to understand the patterned logic of how people characterize risks (see for instance Flynn et al., 2004; Gregory et al., 1995; Slovic, 2000).

[16] The social science literature on risk perception has emerged, in part, as a critique of risk analysis. The concept of risk analysis implies that an objective analysis of 'riskiness' can be constituted by those who define the attributes of specific risks. Danger is real, but definitions of risk and what matters vary. As will be explored in subsequent chapters, the central question for one group of interviewees may be health-related or ecological risks, whereas for another group the central concern might be threats to territorial sovereignty or cultural practices.

[17] Much has already been written on the dangers of thinking solely in reference to 'real' versus 'perceived' risk (see for example Freudenberg, 1988; Freudenberg and Pastor, 1992).

As such, the chapters are of an acceptable length for publishable paper, but each chapter in the dissertation may employ a different methodological or conceptual approach that fits together to form a comprehensive whole. I therefore begin this dissertation with an article that contains both a literature review of economic theories of property rights, and a subsequent analogy between the private property rights inherent in finfish quota systems and those required for aquaculture leases in order to examine whether there are parallels between the effects of ITQs and aquaculture leases on resource distributions in coastal communities. Although the paper in Chapter 2 also stands separately from the dissertation as an independent journal article, it provides some of the contextual background on property rights for the articles that follow. In Chapter 3, I employ interviews and participatory mapping exercises (using GIS-produced maps) to elicit discussion about interviewees' perceptions of the risks and benefits of aquaculture development. In Chapter 4, I examine these perceptions for their relevance in predicting conflict, based on what is already known within the wide of body of social science literature about the relationship between culture, values, risk perceptions and public controversy. In the chapters that follow, I discuss in more detail the specific methodological approaches, implications of my findings, and limitations of the analysis. The following provides a brief overview of the chapters:

Chapter 2, ***"Private Property Rights in Shellfish Management: A Comparative Analysis of the Environmental, Economic, and Social Effects of Individual Transferable Quotas and Aquaculture Leaseholds in British Columbia"***, begins with a review of relevant literature in economics and common property for important historic perspectives on the emergence of rights-based management. The impacts of rights-based management are then discussed in relation to quota-based allocation of fisheries resources (i.e., ITQs), and case studies of ITQ fisheries are highlighted in order to better understand the effects of ITQs on resource users in coastal communities. Parallels between ITQs and the development of private property rights for shellfish aquaculture development are explored in order to determine whether aquaculture leases in British Columbia have had re-distributional effects on access to fisheries resources by potentially reallocating rights to resources in ways that are detrimental to existing fishers in coastal communities. I examine how current

aquaculture leasing policies in British Columbia are driving a transition from a primarily wild fishery towards aquaculture production, and examine the implications of this transition for coastal stakeholders in the shellfish industry.

Chapter 3, ***"Implementing Property Rights for Shellfish Aquaculture Development: A GIS-based Examination of Spatial and Temporal Changes in Access Rights to Shellfish in British Columbia,"*** analyzes spatial trends in the distribution of wild and cultured shellfisheries to determine whether government policies for aquaculture development in British Columbia have resulted in a redistribution of access to shellfish resources among existing wild shellfish harvesters. Salmon aquaculture has been highly controversial, and shellfish aquaculture may increasingly generate controversy if it is viewed as competing for sea space with wild fisheries or other established coastal resource uses. Using a GIS analysis of spatial foreshore and nearshore habitat in British Columbia, and interviews with coastal stakeholders to interpret the results of the GIS analysis, I examine whether aquaculture policies are altering or complementing wild fisheries production. I also report interviewees' perspectives about the implication of changing management practices, in order to determine whether spatial conflicts between wild fisheries and aquaculture are liable to escalate, and if so, what type of conflict may be anticipated.

Chapter 4, ***"Perceptions of Risk and Opportunity in the Development of Private Property Rights for Shellfish Aquaculture in British Columbia,"*** focuses on interviewees' responses to aquaculture policies in order to assess how attitudes, values, and beliefs are influencing specific choices to engage with, or resist, government leasing policies for aquaculture development. The paper examines the role of interviewees' perceptions about risks and benefits of shellfish aquaculture in relation to the social and political context in which these perceptions are liable to generate conflict between aquaculture leases and other resource uses.

Chapter 5, ***"Conclusion"*** provides an overview of findings, while suggesting implications of the research and future directions.

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2. A COMPARISON OF PRIVATE PROPERTY RIGHTS IN FISHERIES MANAGEMENT: ITQS AND SHELLFISH LEASES[18]

2.1 Introduction

Property rights have increasingly been used in fisheries and coastal management in much of the developed world through fleet rationalization measures such as Individual Transferable Quotas (ITQs), or through the leasing of sea space aquaculture. Since the 1980s, for example, the British Columbia (BC) Provincial government and the Canadian Federal government have adopted quota-based management in many key ground fisheries, while also allocating property rights to coastal habitat through leaseholds for finfish and shellfish aquaculture development.

There is a long history of apportioning common property into private holdings and of the resultant conflict that follows in response to the privatization of resources (Black, 1997; McCay, 2002; McCay, 2004). In marine contexts, wide ranges of resource users have resisted the increased use of property rights in fisheries management (Bromley, 1991; Hersoug, 2005). In BC, for instance, the use of ITQs has met with resistance in several groundfisheries based on concerns about redistribution of harvest rights away from place-based and small scale fishers, as well as potential environmental impacts on fish stocks and habitat (Ecotrust, 2004). Similar resistance has also emerged over aquaculture development, with contestation over the BC salmon aquaculture industry a notable case in point (Noakes et al., 2003). Since 1986, the volume of salmon production in BC has grown tenfold (MOE, 2007), and in the wake of this expansion, conflict has escalated over the environmental, social and health impacts of salmon farming, with resistance manifesting in

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protests against fish farming activities, vandalism to farm sites, consumer boycotts of farmed salmon, and lawsuits (BCSAR, 1997; Gardner et al., 2003). In response to these concerns, the BC government imposed a moratorium from 1995-2002 on new salmon fish farm licenses, thereby effectively limiting expansion of the finfish aquaculture industry for almost seven years (MAFF, 2003). Similarly polarized public controversy has not to-date been observed with regard to the BC shellfish industry, although it is reasonable to suggest that similar controversy and political resistance could emerge if the shellfish aquaculture industry were to expand with similar growth rates to those observed with salmon farming over the past two decades (Figure 1.1).

Shellfish aquaculture leases function in much the same way as land-based property rights by allocating access to a specific area of sea space or foreshore as part of a long-term leasing agreement. Tenure holders pay annual tenure fees to the government for the privilege of the lease, and leases can be bought and sold in much the same way as land-based real estate (e.g., by real estate agents). In many ways, these leases are a prerequisite to aquaculture development in that they ensure the property rights necessary to justify capital expenditure for site development. For government regulators, shellfish producers, and consumers, these property rights confer a number of advantages that may make cultured shellfish production an attractive alternative or complement to wild fisheries. Shellfish aquaculture production is arguably an environmentally sustainable industry, as shellfish require no exogenous feed inputs, produce few waste by-products, and may in fact be prescribed for environmental remediation of contaminated or degraded coastal areas (Crawford, 2002; Howlett et al., 2004; Kaiser et al., 1998). Shellfish aquaculture is also often considered socially sustainable, because it can provide economic opportunities for small-scale resource users in coastal communities who may already have relevant skill-sets from wild harvest commercial shellfisheries. Shellfish production does not require significant capital for entry to the industry, nor does it require significant ongoing capital for feed inputs, and thus is viewed as an accessible opportunity for small start-up companies. Many growers and processors also view it positively because supply-side control of production can be tailored to meet the year-round fluctuations in market demand. Proponents of shellfish development suggest shellfish aquaculture can lower

management costs, increase product safety and increase overall productivity of resources (MAFF, 2003, 2007d; Pinfold, 2001).

However, not all BC fisheries stakeholders perceive benefits from the quasi-privatized property rights of shellfish aquaculture leases, particularly if shellfish aquaculture development competes with wild fisheries for markets and access to habitat. Conflict over foreshore aquaculture is particularly likely, as beach tenures may restrict access to habitat for commercial wild shellfish harvesting or affect existing coastal resource uses such as waterfront housing, beach recreation, or subsistence shellfish collection. In BC, the majority of wild shellfish harvesters are small-scale fishers in rural communities who rely on wild shellfish for seasonal incomes; many are also First Nations band members with historic access to resources. While a management transition from common property to private property may present economic opportunity for some, others may view leaseholds as an unwanted change with potentially detrimental social and environmental outcomes.

Implications of rights based management for the British Columbia shellfish industry

Much of the existing work on resistance to rights-based management has focused on the use of ITQs for the management of fish stocks (Copes et al., 2000; McCay, 1995; McCay and Jentoft, 1998; Tietenberg, 2002). The risks and benefits of ITQs for fishers, their communities, and government agencies have received considerable attention and analysis, however, there has, as yet, been relatively little research in the fisheries management and common property literatures about the arguably similar processes that occur when property rights are used to control access to sea space for aquaculture development (Walters, 2007; Anderson, 2002). Both ITQs and leaseholds confer ownership over fisheries resources, with implied economic benefits. However, the social and environmental consequences may differ significantly, given that quotas are quantitative use-rights allocating a portion of a fugitive resource, while leaseholds allocate access to habitat. Similarities however, may be adequate to justify a comparative analysis of their respective risks and benefits.

Shellfish aquaculture in British Columbia is a relatively new industry, and in the absence of prior work on the social effects of shellfish aquaculture leasing for coastal communities in British Columbia, we began this research by asking whether similar forms of marine governance, namely quota-based allocations of fisheries resources or salmon aquaculture leasing, might serve as analogous case studies from which to examine potential risks and benefits. In the sections that follow, we examine whether the resistance observed in relation to ITQs and salmon aquaculture in BC is relevant for predicting possible conflicts over expansion of the shellfish aquaculture industry BC. This paper takes two approaches to examining the implications for resource users of a transition from common-property to rights-based management of shellfish resources. First, we conduct a comparative analysis of the literature on both aquaculture leaseholds and individual transferable quotas (ITQs), with the goal of determining whether or not the implied economic benefits of property rights can be secured without introducing potentially detrimental social, cultural, and environmental consequences. We ask whether there are similarities between ITQs and aquaculture leaseholds as forms of rights-based management for governance of habitat and fish stocks, and ask what lessons can be drawn from the history of ITQs in order to better understand potential effects of shellfish aquaculture development on coastal resource users. Second, as an illustrative case study, we present interview findings summarizing the experiences and expectations of BC stakeholders with regard to shellfish aquaculture development, and examine parallels between interviewees' experiences with shellfish aquaculture and literature documenting ITQ experiences. We aim to determine whether this literature is useful for predicting the effects of rights-based management on coastal communities, and our findings inform a discussion of the potential for mitigating potentially negative social and environmental impacts of a transition to rights-based management, while recognizing and facilitating the potential economic benefits of these systems.

2.2 Property rights in marine governance: concepts and experience

2.2.1 The shellfish case

Several characteristics of shellfish aquaculture make it an ideal case study to explore changing coastal resource use patterns following implementation of rights-based management policies. First, aquaculture tenures have the potential to affect BC's wild clam fishery by introducing spatial competition for habitat between wild harvesting areas and foreshore shellfish aquaculture leaseholds. If applicants are able to secure and develop foreshore leases on former wild harvest beaches, shellfish aquaculture sites can reduce viability of the wild fishery through direct competition for access to habitat. In cases where wild harvesting sites are converted to shellfish aquaculture leaseholdings, leases can thus be viewed as *de facto* privatizing access to wild fish resources and effectively alter patterns of wild clam harvesting. Therefore, tenures associated with shellfish aquaculture development provide a relatively explicit spatial measure of how aquaculture development has the potential to alter wild harvesting patterns, and thus how the introduction of property rights affects access to existing coastal resources. Second, the wild clam fishery in BC is an inshore fishery where place-based users are closely tied to the resource. In offshore ground fisheries, the effects on resource users and communities of other forms of rights-based management such as ITQs have historically been harder to quantify, as the resource is fugitive, and fish and fishers in these industries are generally more mobile, vertically integrated, and segregated by fleet sector.

2.2.2 Defining property rights

Whether the implied economic benefits of rights-based fisheries management can be reconciled with social and environmental goals first requires a specification of what constitutes private property in the marine domain, and the extent to which ITQs and aquaculture leases should be considered fully developed private property rights. In seminal work on property rights, Ostrom and Schlager (1996) identify two classes of property rights related to control of resources: operational rights for access and withdrawal and

collective-choice rights of management, exclusion and alienation.[19] They also differentiate between owners, proprietors, claimants, authorized users, and authorized entrants, based on the bundles and types of operational or collective-choice rights and responsibilities exercised by resource users. Pearse (1988) similarly outlines a framework for classifying property rights according to their degree of exclusivity by placing property rights along a continuum, with sole ownership or private property at one end and no ownership (*res nullius*), where all users have open access, at the other. Between the two extremes, political economists and economic theorists have proposed several fisheries strategies that provide varying degrees of exclusivity with regard to property rights. Open-access fisheries can be partially controlled by limiting access, fishing areas, or types of permissible harvesting gear (Christy, 1996; Homans et al., 1997). With increasing exclusivity of access, fisheries can also be controlled by granting property rights to a fixed amount or proportion of available resources, and the right to sell or transfer portions of the resource (Johnson et al., 1982; Neher et al., 1989; Scott, 1999; Welch, 1983). Pearse (1994) argues that private property rights exist when users achieve enforceable, transferable rights of exclusion that are perpetual and divisible. This definition fits with what may be described as specified private property rights, wherein private ownership rights are granted to individuals or enterprises, and the market then allocates these rights as tradable commodities. Lesser specified rights, which either do not allocate a full spectrum of rights or restrict the scope of those rights through regulatory frameworks, are considered to be limited property rights.

In natural resource management, there are few examples of fully specified property rights, although there are many examples of limited private property rights. In fisheries, for example, both ITQs and aquaculture leaseholds arguably grant limited property rights: ITQs allocate a portion of the total allowable catch (TAC) to specific users, either individual or group quota-holders, while aquaculture leaseholds grant access to habitat. By Schlager and Ostrom's (Ostrom et al., 1996; Schlager, 1993) definition, ITQs are limited property rights, in that they grant use-rights of access and withdrawal as well as exclusion.

[19] Alienation, according to Schlager and Ostrom (1993) is defined as the right to sell or lease both management and exclusion rights; they distinguish between operational and collective-choice rights as the difference between exercising those rights, and participating in decisions about future rights.

Leaseholds for shellfish aquaculture development are arguably similar limited property rights, as they render access to habitat; the security and exclusivity of such systems are not found in the temporary use-rights afforded by limited licensing systems.

There is considerable ongoing academic and legal debate about private property rights associated with ITQs. Although ITQs are designed to establish a market-based system of property rights, legal definitions of ITQs frequently use the term 'privileges', not rights, purportedly to reduce government liability and diminish the need to compensate rights-holders if the value of a quota changes with fluctuations in fish stocks or regulatory practices (McCay et al., 1998). In contrast, the relationship between aquaculture leaseholdings and private property is somewhat better defined, as BC shellfish aquaculture leases are allocated and transferred in the same way as land-based property, and leases grant access to a spatially bounded location of seabed and shoreline. Shellfish leases are traded and sold by the same agents selling land-based real estate and can be used as collateral for bank loans. The fully specified property rights for aquaculture tenures grant a spectrum of access and withdrawal rights, and depending on the situation in which the tenure is developed, may also confer a loss of management rights to former common property rights and alienation of the resource.[20]

2.2.3 Economic considerations for rights-based management

Increased revenue and lower administration costs provide government regulators with incentives to create private property arrangements, particularly if these property rights are designed to generate property taxes, and delegate formerly public management responsibilities to private owners. Shellfish aquaculture users in British Columbia, for instance, pay annual leasing fees to the Provincial government to obtain tenure rights to shorelines and coastal waters for aquaculture production. In comparison, wild clam

[20] In some cases where co-management agreements exist in the wild fisheries (e.g., between First Nations bands and the Department of Fisheries and Oceans), the development of tenures implies a loss of management control over resources, particularly if former common-property resources, and access and withdrawal rights to those resources, are now managed unilaterally by government (e.g., as non-First Nations and non-communally owned property).

fisheries generally have nominal licensing fees and generate considerable expense in the form of health and safety monitoring. The remote harvesting locations of many wild fisheries, including BC shellfisheries, make regulation and enforcement expensive and difficult, and government agencies are thus highly motivated to devolve costly management duties to the private sector. Shellfish aquaculture leases, for example, may reduce the need for government-sponsored water quality testing, as it becomes possible to shift the onus for testing onto aquaculturalists. Leases also make product easier to track from source to market, reducing the need to monitor activities such as poaching from closed harvest areas, illegal relaying of product, or over-harvesting.

Similarly, quota systems are a more efficient way of controlling access to fisheries resources than limited licensing systems. Quota systems are predicated on the belief that market-based management will increase self-governance among users with vested property rights, thus reducing the need for state intervention in management (Bromley, 1991; Hannesson, 1991; Maloney et al., 1979; Morgan, 1995; Townsend et al., 1987). Yet studies of ITQ implementation have demonstrated that a transfer of regulatory functions away from government licensing systems to fisheries stakeholders does not always decrease management costs (Annala, 1996; Eythórsson, 2000). In some quota fisheries, quota busting and poaching necessitate strict, state-enforced dockside monitoring, thereby eliminating many potential management advantages over the limited-entry fisheries that these quota systems were designed to replace (Eythórsson, 1996; Jensen et al., 2002). Although ITQs are adopted to encourage more efficient and less costly free-market regulation, ITQs may not in fact decrease the costs of managing wild fisheries, as landing fees collected may not be adequate to recover management costs.

There is currently insufficient evidence to assess whether the same hopes and failures associated with ITQs hold true for aquaculture tenures. In the case of shellfish, Pearse (1994) noted the ease with which exclusive rights over relatively immobile resources such as shellfish can be assigned to defined areas and specific owners through the creation of formal or informal tenures. He also points out the inefficiencies of open-access or limited-

entry fisheries, and suggests that limited licensing is a particularly inefficient way of managing non-motile resources such as shellfish, which arguably lend themselves to easier management through delimited private holdings similar to land-based agricultural resources (Pearse, 1982). Although empirical research is as yet lacking, it seems likely that assigning property rights for aquaculture leasing may offer similar economic efficiencies for producers and regulators.

2.2.4 Transitions from the commons to private property

Transitions from common property to private property are often fraught with conflict between regulators and resource users. Concerns are often articulated over policies to privatize fisheries access, which in the case of quota systems have included concerns about perceptions of inequities in redistributions of access rights as well as potentially detrimental effects of quota-based management on fisheries habitat and ecosystems (Dubbink et al., 1996; Rieser, 1999).

A primary concern that arises in response to ITQs is the loss of public trust that occurs when formerly public resources are transferred to private owners (Hersoug, 2005). Deeply ingrained beliefs that common property resources should be held for public use, including the right of access to government-titled lands, have often led to considerable resistance to privatization policies (McCay et al., 1998). In the case of both finfish and shellfish aquaculture leases, for instance, the move to establish property rights in coastal areas held as public commons defies historical and cultural precedents for access to navigable waters and beaches. Stakeholders may perceive injustice if such a move results in an 'unfair' loss of communal access or redistribution of access rights among current fishing regions, particularly if this redistribution disproportionately favors specific fisheries users (e.g., with ITQs, these may include a preference for specific gear types, fleet sectors or relationships with processors (McCay, 1995). Resistance to such policies has been shown to be especially acute if public losses clearly benefit only a few users who will subsequently achieve significant windfall gains, thus influencing the balance of power among industry sectors in ways that result in exclusion of some users and significant profit

for others. In such cases, private property arrangements will be resisted on the basis of perceived inequities in response to re-allocations of access rights (Helgason et al., 1998). In order to pre-empt resistance, public policies are generally designed to transfer rights based on eligibility criteria that offer preferential allocations to existing stakeholders. The logic of eligibility in these cases is often based on a grandfathering system in order to reduce perceived inequities and ensure continuity of access from prior management systems (e.g., quotas are allocated to existing fisheries license holders) (Tietenberg, 2002).

In a transition to a market-based management system, economic approaches often assume that granting formal property rights in fisheries simply makes official the *de facto* use-rights already granted to users under limited licensing structures. Yet, subtle differences exist between the use-rights granted in limited-entry systems and the increasingly exclusive property-type rights granted by ITQs or aquaculture leaseholds. In the case of ITQs for example, increased exclusivity of access is, by definition, designed to increase the efficiency of limited-entry systems by reducing entrants and overcapitalization of a fishery. Such a move to create exclusive access rights generally requires that a substantial percentage of existing users be excluded from the fishery (Brandt, 2005; McCay, 1995).

Over time, a number of problems may emerge with property rights-based systems. First, while a number of case studies have shown that property rights make some users in the first generation wealthy inheritors of a public good, these economic benefits may not be evenly distributed among classes of resource users and may not be transferred to future generations (Mansfield, 2004). In the case of ITQs, even if windfall gains go to a select few owners in the first generation, the value of exclusive property rights in subsequent generations results in a rise in the cost of quota, thereby significantly increasing the costs of entry to the fishery. When quota is traded on an open market, inflationary trends in quota prices may render the cost of quota so prohibitive in the second generation that entry to the fishery is no longer affordable by small-scale users in fishing communities (Copes, 1996).

A second risk is the possibility that increased costs of entry into the fishery may lead to quota accruing to only a handful of users. Economists generally consider multiple allocations to small-scale users to be inefficient, and in the long term, fully developed property rights – including rights to buy and sell the resource, as implied by the transferable nature of ITQs – are thought to be necessary in order to achieve the full efficiencies of a market-based system (Apostle et al., 1998; McCay et al., 1998; NRC, 1999b). The increased cost of purchasing quota will inherently lead to greater pressure to achieve economies of scale, with the effect that tradable quotas quickly accrue to only a handful of people (often corporate entities). This system often eliminates small-scale owner-operators, and favors non-owner-operators who have the capital to control large vessels or fleets (McCay et al., 1998; Palsson et al., 1997; Vestergaard, 1997).

Overall, consolidation of a fishery may be beneficial in reducing operating costs by optimizing level of effort. However, the social costs may be high, particularly in communities with historic dependence on fisheries for economic livelihood and way of life. Fleet rationalization inevitably leads to a reduction in the number of vessels and operators, which may lead to overall loss of employment and access to the resource among place-based users in fishing communities (Copes, 1986; Copes, 1998). Although compensation programs are sometimes designed to reduce these impacts during an initial transition to an ITQ system, further consolidation following the introduction of ITQs may lead to a transfer of resource to urban-based corporations, which will further alienate remaining fishers. As those who historically worked in the fisheries find themselves increasingly able to do so only through remote owners, local knowledge and local control of fisheries becomes less valued, and the social capital, resource knowledge, and relationships between owner-operators and their crews is lost (Jensen et al., 2002; Wingard, 2000).

Since the introduction of quota-based fisheries management to BC in the late 1970s, dramatic trends towards urbanization and consolidation have been observed in most ITQ fisheries (Ecotrust, 2004). In 1979, before fleet rationalization plans were introduced,

many vessels in BC groundfisheries were owned by residents of coastal communities. By 1993, residents of resource-dependent rural areas of Vancouver Island owned only 2% of all individual fishing quotas in BC, while residents of metropolitan areas (Vancouver and Victoria) owned 44% of quotas (Ecotrust, 2004). Further, few of these urban-based quota holders were owner-operators, and the loss of rural ownership and access rights has resulted in high unemployment rates among former fishers in coastal communities (Ecotrust, 2004). Similar consolidation and concentration of quota has been observed in ITQ fisheries in Iceland and Norway (Copes et al., 2000; Eythórsson, 1996; Hersoug, 2005; Palsson, 1996), New Zealand, as well as the United States and eastern Canada (NRC, 1999b; Shotton, 2000).

In order to understand the shellfish case, it is also useful to look at recent trends towards consolidation, urbanization and corporate ownership evident in the BC salmon aquaculture industry. In the late 1980s and early 1990s, salmon farms in BC were owned and operated primarily by small-scale producers in coastal communities. During the 1980s, consolidation occurred such that by 1995, three principal companies owned the majority of salmon leases (Cox, 2004). Similar impacts have been seen on the east coast of Canada (Walters, 2007), and in other countries such as Norway following the restructuring and deregulation of their salmon farming industry in the early 1990s (Aarset, 1998).

A critical concern with all forms of property rights is the irreversibility of such systems; once property rights are allocated, the management system is difficult to alter or dismantle, leaving little flexibility for adaptive management. Further, as the value of quota share or leases becomes prohibitively expensive to buy back, finding alternative solutions becomes largely impossible, even if the rights-based system no longer appears beneficial.

2.3 Environmental considerations for rights-based management

Heretofore, many of the social concerns observed with ITQs and salmon aquaculture appear relevant to the shellfish case. There may also be potential for controversy within

some classes of environmental concern. Critics of ITQs suggest that quota systems have detrimental effects both on the marine environment and the very fisheries that such systems are meant to protect. Critics believe that rights-based management provides few incentives for conservation or ecosystem-based management, and that stocks in many ITQ fisheries, due to high discount rates and perverse incentives, will decline through loss of biodiversity and habitat degradation (Bromley, 1991; Bromley, 2005; McCay, 2004; McCay and Jentoft, 1998; Palsson et al., 1997; Tietenberg, 2002; Vestergaard, 1997). Several functions of ITQs contribute to these criticisms. First, consolidation of quota towards economies of scale may promote efficiencies that encourage loss of targeted small-scale species-specific fishing techniques in favour of less-targeted industrial gear practices (e.g., large-fleet bottom-trawling) (Copes, 1986; Jensen et al., 2002). The changes in gear-type that accompany this shift may cause habitat damage and result in wasteful bycatch (Copes, 1996; NRC, 1999b; Tietenberg, 2002). Further, ITQ fisheries with base-catch or size restrictions have been shown to encourage unreported high-grading (favoring of specific species, age classes or quality of product), as well as legal and illegal discards of bycatch (Townsend, 1995; Turner, 1997). Due to high mortality rates among discards, considerable damage to smaller or less desirable fish of the target species, or to other bycatch species, may result from these practices (Apostle et al., 1998; Boyce, 1996; McCay, 2004; NRC, 1999b; Tietenberg, 2002). There are also inherent incentives for quota holders to cheat in catch reporting, leading to inaccuracies in stock estimates and inflated calculations of total allowable catch (TAC) (Copes, 1998; Grafton et al., 2006). Inaccuracies in stock estimates may, in turn, lead to future quotas that are too large, thereby encouraging further overfishing. As the discount rate is high and ecosystem impacts of unreported practices delayed, market-based systems may lead to long-term degradation of the resource.

2.3.2 The salmon aquaculture case in British Columbia: a comparative position

An examination of salmon aquaculture reveals similar controversy, although the points of contention are somewhat different. From 1995 to 2002, the BC government maintained a moratorium on the issuance of new leases for finfish tenures due to concerns about the spread of disease, sea lice and other parasites, competition among escaped fish and

endemic species, and aquatic pollution caused by fish farm effluent. Conflicts have also escalated unresolved claims over territorial rights between First Nations, salmon farming companies, and the BC government over unresolved rights and title claims (BCSAR, 1997; Noakes et al., 2003).

Environmental controversy in BC over aquaculture has to-date, focused largely on salmon farming and not on shellfish. However, a recent moratorium on shellfish aquaculture in New Zealand suggests that shellfish farming may also become controversial in British Columbia as the industry develops. A dramatic increase of coastal leaseholds for shellfish culturing in New Zealand during the late 1980s and 1990s led to considerable concern about potential environmental and social risks of increased mussel production, which ultimately led to a six year moratorium on shellfish aquaculture expansion. The moratorium was lifted in 2005, when policies were altered to include better environmental regulation and a guarantee that the Aboriginal Maori population would be entitled to a percentage share in shellfish operations (Tollefson and Scott, 2004). Court-based challenges to shellfish farming have also been documented in the United States, Australia, and Chile, and similar resistance could potentially emerge in BC as the shellfish industry becomes more developed, and conflicts over access to sea space become more acute.

The relatively modest environmental impacts of shellfish aquaculture may nonetheless help mitigate the resistance that has been mounted against ITQs and salmon farming in BC. Currently, there is some controversy over the benthic impacts of shellfish farming, as well as risks of losing genetic diversity as a result of monocultures with lack of age-class differentiation. Concern has also been expressed over potential introductions of exotics with shellfish seedstock, as well as damage to other cohabiting species (Bendell-Young, 2006; Kaiser, 2001). However, most studies have found that shellfish aquaculture, even under conditions of high volume production, has fewer negative environmental effects than other forms of aquaculture production, and that shellfish production has an overall relatively small environmental footprint (Buschmann et al., 1996; Crawford, 2002; Kaiser et al., 1998).

In addition, many of the environmental problems associated with salmon aquaculture and regulatory frameworks for ITQs, (e.g., tendencies towards destructive gear-types, excessive bycatch, and data fouling) do not apply to shellfish aquaculture. On the contrary, the right of exclusion afforded by secure property rights appears to produce strong incentives for owners to invest in the resource, and in the shellfish case, this investment leads to increased productivity of the resource through habitat enhancement and development of infrastructure. Clearly delineated and enforceable property rights ensure that owners can secure the benefits of future profits, thereby providing the necessary incentives to invest in predator nets or establish raft cultures, both of which result in a direct increase in production values. Where a wild fishery has been decimated by over-harvesting, the development of foreshore aquaculture tenures also provides incentives to reseed beaches. Beaches that are tilled and maintained are more productive than wild beaches, and the development of raft culture can reduce grow-out times for mussels, oysters, clams and scallops. Overall productivity and total yields of shellfish in British Columbia have increased with aquaculture development, allowing for an increase in the total value of shellfish resources and employment in the shellfish industry (MAFF, 2007). In addition, few conflicts over loss of access to resources or environmental concerns have to-date emerged in the BC shellfish industry, although such concerns could accompany future expansion.

2.4 Privatization of the shellfish commons in British Columbia: Experience and expectations in coastal communities

In order to anticipate the potential for social or environmental controversy, we queried stakeholders in coastal British Columbia about their experiences and expectations. Fifty-six interviews were conducted with stakeholders involved in shellfish harvesting, processing, and management. Interviews were conducted between 2003 and 2006 at five study sites that were chosen to include coastal communities with different fishing histories and local industries, as well as regional variation in wild harvesting patterns and diverse experiences with aquaculture leases (Figure 1.4). A total of 34 interviews were conducted

at the study sites with wild shellfish harvesters and aquaculture leaseholders; 22 additional interviews were conducted with shellfish aquaculture producers, processors, and fisheries managers not associated with specific study sites or overseeing multiple jurisdictions (Table 1). Stakeholders were selected to represent a broad demographic, including a wide

TABLE 2.1 - NUMBER OF INDIVIDUALS INTERVIEWED AT EACH OF THE STUDY SITES

	Wild harvesters	**Aquaculture leaseholders[1]**	**First Nations[2]**	**Managers, buyers/processors, regulators**
Barkley Sound	4	5	6	2
Quatsino Sound/Kyuoquot Sound/Gold River/Port Hardy	6	1	5	5
Clayoquot Sound	5	1	6	5
Broughton Archipelago	3	1	3	3
Sunshine Coast (Sechelt to Powell River)	4	4	3	3
Regulators, buyers or shellfish processors not affiliated with a specific study site				4
TOTAL	**22**	**12**	**23**	**22**

[1] Wild harvesters may also own or work on aquaculture leases, and therefore note overlap between individuals in this category and interviewees in column 1.
[2] Note also overlap between this category and columns 1 and 2, as interviewees who self-identified as First Nations were wild harvesters, aquaculture leasesholders, or both.

range of ages, ethnicities and occupations. Thirty-four interviews were conducted with individuals whose primary livelihood derived from shellfish production, processing or management at the five study sites in southwestern British Columbia. All five study sites included both First Nations and non-First Nations communities; of the 34

harvesters/producers interviewed at the study sites, 23 self-identified as First Nations, and 11 as non-First Nations. Self-identified First Nations had significant representation among these interviewees (41%), as First Nations were key stakeholders representing approximately half of commercial (wild) clam fishery license holders; many First Nations bands had also acquired tenures for shellfish aquaculture. Twenty-two additional interviews were conducted with First Nations and non-First Nations regulators, shellfish buyers, processors, biologists and fisheries managers who were either located outside the primary study sites, or whose jurisdiction extended across one or more of the communities within the five study areas.

Interview questions were designed to assess stakeholders' perspectives on aquaculture development, including specific beliefs about potential conflicts between wild and cultured fisheries, beliefs about social and environmental risks of aquaculture development, and suggestions for maximizing future benefit from the shellfish industry. Questions were also designed to elicit views on: (i) subsistence and commercial livelihoods from wild shellfish harvests; (ii) environmental and economic priorities for shellfish management and beliefs about the social and environmental effects of different management strategies; (iii) prior experience with fisheries governance, including policy-relevant knowledge or previous experience with other types of privatization of fisheries resources; (iv) priorities for the shellfish industry, including priorities for employment and development; (v) responsibilities of current users to be stewards or guardians of resources and to preserve access to those resources for future generations. Wild harvesters were also asked about their fishing practices and the value of their product, and how these had changed over time. They were also prompted to annotate maps showing wild fisheries and aquaculture locations, and to note any user conflicts between wild fisheries and other uses of marine space.

2.4.1 Benefits of shellfish aquaculture

Of the 56 individuals interviewed, 52 indicated that shellfish aquaculture had improved biological productivity and economic viability of the shellfish industry. All government

officials and industry representatives supported increased aquaculture production in British Columbia. Processors and inspectors from seafood companies also generally supported aquaculture production (84%), reporting that they routinely bought shellfish products from wild harvesters but preferred aquaculture sources, because supplies were predictable and buyers had more control at all points of production (e.g., quality control, the ability to project harvests in relation to market demand, and the ability to determine pre-negotiated prices/volume of product). Most interviewees also stated that shellfish aquaculture provided economic opportunity by increasing the value of total shellfish production in BC. Several cases were cited of rural communities where shellfish aquaculture development had led to new employment opportunities, skill development, and investment in infrastructure. By tilling and seeding beaches or developing raft cultures to supplement existing wild resources, aquaculture was also reported to create new opportunities where no previous fishery existed, thus reducing fishing pressure on standing wild stocks. Further, many proponents of aquaculture development confirmed that aquaculture leases improved supply-side management to match year-round market demand, unlike the wild fishery which allowed only for short seasonal openings. Aquaculture leasing was also reported to avoid many of the problems that characterize limited-entry fisheries, including short open seasons and intense competition for resources, wherein there are product gluts and potentially dangerous working conditions for fishers. The wild clam fishery, for example, is primarily a winter fishery, and openings are timed to coincide with tidal cycles, such that openings may occur at night and in potentially dangerous stormy conditions. Harvesters in a wild fishery are subject to buyers' prices, and processors can simply stop buying product or drop prices significantly when they reach capacity, thus leaving harvesters with an excess of unmarketable product.

Aquaculture, in comparison, spreads harvests over a much longer season and allows for harvesting on demand. In several communities, interviewees also observed that leases had allowed harvesters to secure financing, leading to investment in infrastructure and marketing. Whether or not aquaculture has led to higher prices for product was less clear. Economic perspectives on ITQs support a position that supply-side management through

quotas can increase harvesters' negotiating power with buyers and processors, leading to higher prices for product, higher quality products, and consistent supply (Macgillivray, 1997; Tietenberg, 2002). However, no interviewees reported that they thought aquaculture had led to higher prices for shellfish products. Indeed, a small percentage of interviewees (14%) were concerned that prices for wild product were being negatively affected by the increased availability of shellfish produced from aquaculture leases. These individuals believed that leases had only made producers more dependent on processors (captive to buyers' prices and terms of sale). One grower suggested that reduced prices at point of sale were not making BC shellfish more competitive on world markets due to regulatory restrictions on exports, and the increased amount of product available was simply reducing profits for harvesters, as there was increased supply but not similarly increased demand for BC product.

2.4.2 Consolidation of ownership

It was unclear from interviews whether the social equity concerns raised in the literature on ITQs were also likely to manifest themselves with expansion of aquaculture leases. Few interviewees (less than 10%) directly identified shellfish leasing as a form of property rights-based management, and fewer still characterized shellfish aquaculture development as a form of privatization. As a result, only three of fifty-six interviewees (5%) identified overt parallels between shellfish leasing policies and other uses of property rights for control of access to resources (e.g., ITQs). Yet the majority of interviewees (83%) expressed strong resistance both to the development of property rights for finfish leases and to ITQs for the management of inshore fisheries. In relation to these policies, there was a generalized distrust of state-driven fisheries policies, and beliefs that previous government policies have led to environmental degradation and a significant redistribution of access to fisheries resources away from coastal communities. For example, the majority of First Nations interviewees clearly articulated that the development of salmon farms was impeding First Nations self-determination and the right to control and manage marine resources. Fourteen interviewees (25%) also pointed specifically to the use of ITQs in groundfisheries as resulting in consolidation of ownership by large corporations, with

significant economic losses for resource-dependent communities and Aboriginal peoples in British Columbia. Many interviewees also identified previous poor experiences with government fisheries policies, such as the license buybacks and policy reforms for salmon management initiated under the Mifflin Plan. However, only five interviewees (8%) expressed - without prompting - a fear that shellfish aquaculture might some day follow the trends towards consolidation observed with quota systems or finfish aquaculture. However, when prompted about whether shellfish aquaculture leases were private property rights, the majority of interviewees stated they had not thought about this question, but went on to identify generalized concerns about other trends towards privatization of natural resources in BC (e.g., forest-timber licensing agreements).

2.4.3 Social and cultural implications of shellfish aquaculture

First Nations in British Columbia have historically been involved in wild shellfish harvesting, and represent the largest group of licensed users in the wild clam fisheries. Since government leasing policies for shellfish aquaculture were introduced in the early 1990s, many First Nations bands[21] have also acquired tenures for shellfish aquaculture. Where bands have acquired shellfish leases, the nature of access to resources has changed from limited licensing of common property resources to leaseholds. However, all of the leases owned by First Nations in this study were band-owned and communally-operated. As a result, many former wild harvesters also worked on band-owned aquaculture tenures, and access to resources had not changed significantly (e.g., employment opportunities have remained equitably distributed among band-members). Some interviewees even stated that shellfish aquaculture had provided more consistent and lucrative employment than wild fisheries. However, the increased cost of paying leasing fees to the government, as well as the potential for loss of access to wild resources, made it relatively unattractive as an economic development strategy for some First Nations interviewees.

[21] Bands are the governmentally assigned administrative unit for First Nations people. Among other civic responsibilities, the elected band chief and council make most economic development decisions for the tribal group.

Across the five study sites, cultural and economic interest in shellfish varied considerably depending in part on historical ties to wild shellfish resources, and the availability of alternative economic opportunities. The majority of interviewees (76%) clearly believed there were potential environmental, social and cultural risks related to shellfish aquaculture leasing policies in British Columbia. Several First Nations fishers and fisheries managers expressed uncertainty about whether bands should engage with tenuring policies. In some communities, bands had chosen to develop tenures, but resisted paying for access to those tenures, especially if the tenures were on reserve-front or "home-use" beaches. Two reasons were cited for this: first, a belief that tenures were providing the Provincial government with fee revenues but were largely unnecessary in communities where First Nations already had *de facto* use-rights to beaches that were customarily harvested only by First Nations people; and second, that First Nations should not have to pay leasing fees for access to resources in traditional territories, since customary use-rights should be assured under Aboriginal fisheries policies and treaties. Further, many band leaders believed leasing fees were placing an additional burden of debt on bands that had previously enjoyed relatively free access to the commons; they believed tenures not only had the potential to exclude existing resource-dependent users who could not afford the initial cost of leasing fees but would place a burden of debt on bands or individuals who would then have to pay the government in perpetuity for access to resources.

At several study sites, and especially at those sites characterized as resource-dependent communities with a strong history of wild shellfish harvesting, interviewees also expressed significant concern about the effects of aquaculture development on their way of life and livelihood. Such concerns were particularly pronounced among those First Nations harvesters who expressed strong traditional and place-based dependence on wild resources, as well as cultural identification with wild fisheries as a way of life. In Ahousaht for instance, as one wild harvester reported:

> "When there is an opening [a wild harvest fishery] there are lots of people out on the beaches... some of the others [bands] don't care if there are lots of farms because they don't dig clams anymore. Maybe a long time ago they were fishing

> salmon, but now they work in town. The salmon farm gave us some floats and rafts they didn't want anymore so we could make a shellfish farm — but we don't need that because we have [wild] clams — and that is what people want."

Interviewees who preferred to maintain access to wild fisheries did not necessarily view economic efficiency of production as the only, or even an important, management goal, and instead favoured policies emphasizing preservation of traditional social and cultural values[22], including part-time livelihoods from commercial fisheries or the right to access shellfish for subsistence purposes. For many First Nations interviewees, these concerns were also compounded by unresolved conflicts between governments and First Nations over territorial sovereignty; aquaculture was not only viewed as a threat to unresolved rights and title disputes but as a direct loss of control over customary access to benthic and foreshore areas, pending resolution of land-claims settlements. Many First Nations interviewees were concerned about the increased prevalence of private, non-First Nations tenures in traditional harvesting areas; at the study sites, there had been an estimated 30% increase in non-First Nations tenures since 1995. Even band-owned aquaculture leases were cited by some interviewees as potentially restricting traditional and communal access to foreshore habitat for commercial, recreational and subsistence wild shellfish harvesting. The right to manage fisheries as communal resources is explicitly recognized and implemented under a number of First Nations interim measures agreements and treaty settlements, and there was a strongly held belief among many harvesters that aquaculture development could reduce access to common shellfish resources in ways that might threaten traditional, encoded rights and practices.

As one interviewee in Gold River described:

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[22] There is significant controversy over appropriate nomenclature. In this context, we use the word traditional, as it does not exclude long-term coastal residents who are not of indigenous descent, nor does use of this term imply that all people of Aboriginal descent share these values. As Berkes (1999) suggests however, the use of the word traditional has a connotation of being static, and use of this term suggests an inflexible approach that ignores the dynamic realities of culture. We therefore clarify that use of the term recognizes the historical continuity of practice and place-specific nature of local values and knowledge, but does not imply that 'traditional' implies values, practices, institutions, or conventions of behavior that are to be protected from change (e.g., such that tradition and change could be construed as contradictory concepts).

> "I have been digging clams for thirty-five years... my brothers and I dug those beaches. Now they [company from across the island] want to put a shellfish farm up there. There aren't many good beaches left, and those beaches belong to our people. I told the [band] council I don't want leases for us and don't want anybody else taking leases either."

2.5 Lessons learned from ITQs and their implications for shellfish aquaculture development

Since the introduction of ITQs in the 1990s, several modifications have been incorporated into the design of quota systems to offset the social inequities and potentially detrimental environmental outcomes experienced in earlier implementations of such systems (McCay, 2004; NRC, 1999b; Wingard, 2000; Young et al., 1995). In some cases, policies have been enacted to limit concentration of quota. For instance, some fleet rationalization programs have been designed with limits on transferability, owner-operator clauses, or caps on consolidation of ownership by processing firms (e.g., such as have been instituted in the Pacific halibut fishery) (Dawson, 2006; Knapp, 1997). However, in many other cases where ITQs have been adopted, such regulations have not been incorporated, perhaps because they were seen to interfere with free-market functioning, or perhaps because a need for modifications of this kind was not anticipated. Even in cases where such regulations were implemented, the pressure for transferability of quota in second and subsequent generations has often led to the demise of equity-related policies, as wealthy first-generation owners demand increased free-market transferability in order to sell out of the industry (Apostle et al., 1998; Copes, 1986, 1996).

Lessons learned from the development of ITQs over the past twenty years may aid in understanding how property rights for shellfish aquaculture leaseholds can be implemented in such a way as to avoid potentially harmful impacts on small-scale resource users. It might be possible to draw from the example of community quota systems to examine how rights-based systems have been modified to protect the economic viability of fishing communities. A variety of community quota programs exist wherein "communities" of

TABLE 2.2 – POTENTIAL SOCIAL AND ENVIRONMENTAL RISKS AND BENEFITS ASSOCIATED WITH ITQS AND SHELLFISH AQUACULTURE DEVELOPMENT

ITQs	**Shellfish aquaculture**
Expected benefits	*Expected benefits*
1. Reduction in fleet size	1. Reduction in inefficiencies as a result of competition in wild harvests
2. Reduction in overcapitalization of the fleet	2. Investment in infrastructure
3. Reduction in management and enforcement costs	3. Reduction in management and enforcement costs
4. Increased value of product	4. Increased productivity of the resource and increased value of product
Expected risks	*Expected risks*
Social risks	*Social risks*
1. Redistribution of access rights	1. Redistribution of access rights
Owner-operators in the fleet are potentially displaced	Small-scale owners may not be able to afford leases or will have high indebtedness for leasing fees
a. Fairness in initial allocation of quotas when windfall profits benefit a select few users b. Reduction in employment opportunities (and/or displacement of owner operators) as a result of fleet rationalization	a. Fairness in allocation of leaseholds when windfall profits benefit a select few users b. As production increases, increased employment opportunities should become available as harvesters and laborers required to maintain aquaculture sites
2. Consolidation to urban centers and/or corporate control of industry	2. Consolidation to urban centers and/or corporate control of industry
3. Loss of livelihood, way of life in coastal communities, including specific First Nations concerns over loss of First Nations fishing access rights	3. Loss of livelihood, way of life in coastal communities including specific First Nations concerns over loss of territorial sovereignty, loss of wild subsistence or cultural fishery, and the ability to control access to resources in traditional territories
Note: Owner-operator clauses or CFQs have arguably reduced some of these impacts	Note: impacts may be overcome by community leases or Band-ownership
Environmental risks	*Environmental risks*
Increased risks of highgrading and bycatch discarding	1. Reduction in species-diversity and age-class structures
Incentives to engage in inaccurate reporting and subsequent inaccuracies in stock estimates; potential overfishing	2. Potential impacts on eel-grass habitat, or impacts on foreshore habitat (increased intensity of farming that involves tilling, predator netting, driving trucks on beaches, increased boat traffic at raft-based aquaculture sites)

fisheries users, often loosely defined as geographic communities or fleet-sectors, hold harvesting quota and decide how it should be allocated (Apostle et al., 1998; McCay, 2004; NRC, 1999b).

Community fishing quotas (CFQs) can direct the flow of economic and social benefits of a fishery back to coastal communities. For example, they have been used in Alaska to redirect profit from the offshore Bering Sea pollock fishery to adjacent Native Alaskan communities (Ginter, 1995), and have been used similarly in New Zealand to redirect a flow of benefits to Maori in the Chatham Islands (NRC, 1999a; Wingard, 2000). Similar arrangements were observed during this research for community-based shellfish aquaculture leases, wherein several examples existed of band-owned tenures (e.g., Kyuquot First Nation) or community tenures (e.g., Village of Tahsis). The design of these leases can potentially mimic CFQs, by redirecting profits towards fishery-based economic opportunities in the form of processing jobs, or profits for the band. Where concern exists that aquaculture may lead to displacement of small-scale fishers or part-time harvesters, community leases reduce the risk of concentrating access by providing opportunities for small-scale, place-based users to invest in aquaculture development by purchasing shares in leaseholds or an already developed aquaculture site. Market based allocation of access to a community tenure, wherein community members can purchase shares in a larger communal tenure and farm a specific small section of that tenure, encourages investment in infrastructure, while individual property rights secure future returns against that investment. In such cases, the initial costs of the lease application and infrastructure development are borne across a wide range of users, and initial capital requirements become less of an impediment to access, while labor and ongoing commitment to cooperative strategies become more important for longevity of the project. Most of the band-owned tenures we observed did not operate on a share-basis, but rather the tenures were communally held as band property, and community members were hired by the band to work on these tenures. However, in other parts of the world cooperative ownership arrangements have proven successful for promoting shellfish ventures, as such arrangements allow local investors some of the benefit of scale, while retaining all the

advantages of owner-operators who have a stake in success of an operation.[23] In some cases, where communities or First Nations bands showed little interest in cooperative efforts, the leasing of community-owned tenure sites to outside investors was also a viable economic option, if sub-leasing fees could be used to generate direct revenue for the community. Such arrangements may work well in situations where the primary leaseholder does not have an interest, requisite capital, or know-how to develop infrastructure at the tenure site. Sub-leasing agreements, while primarily becoming a source of 'rental' revenue, can also still also potentially generate opportunities for employment, particularly if sub-leasing of tenures can incorporate institutional designs to ensure that some profits and social benefits, including jobs in both harvesting and processing, devolve to the community. Further work is needed on the social and economic benefits of such arrangements to fully assess their potential.

2.6 Conclusion: Future of the industry

For many interviewees, the benefits of private property rights for shellfish aquaculture – including ease of monitoring and enforcement, improved regulation of product safety, increased harvester incomes and productivity of the resource – render rights-based management systems for shellfish aquaculture relatively attractive as a complement or alternative to wild shellfisheries in British Columbia. In the short term, property rights appear to result in an efficient means of improving productivity of shellfish resources while providing economic development opportunities for coastal communities. As such, the development of property rights for shellfish aquaculture may hold greater potential than existing regulatory frameworks, such as limited licensing of the wild harvest clam fisheries.

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[23] Japanese fishery co-operatives or Chinese fei-wen are traditional examples of such cooperative ownership arrangements, but many other examples also exist in the shellfish industry of share-based farms (e.g., in Ireland, Prince Edward Island, and New Zealand). Large commercial producers are generally better organized, are often vertically integrated along the supply chain, and use capital-intensive production systems that render significant scale advantages, while small growers are subject to buyers' and suppliers' prices, are detrimentally affected by fluctuations in supply, and are unable to invest in research, thereby lowering overall profitability and reducing access to foreign markets. In Asia, producers cooperatives and processors organizations have been particularly successful at overcoming scale barriers, as the FAO estimates that 80 % of Asian aquaculture production is derived from small-scale producers, but more than 60% of this production is also exported to foreign markets.

However, the economic benefits of rights-based systems for aquaculture development must be carefully weighed against the potential risks. Overall, we observed a number of parallels between ITQs and shellfish aquaculture, including concerns among interviewees about potential industry consolidation. In the long term, the benefits of economies of scale may result in consolidation and transfer of access rights to urban-based entities and corporations, as has been observed with the salmon farming industry in BC. Interviewees expressed concern over a variety of possible losses if aquaculture increasingly displaces wild fisheries, included a perceived loss of way of life or loss of access to subsistence resources among small scale resource users. Such concerns may also be exacerbated due to perceptions that leases are infringing on resolution of Aboriginal territorial claims, and conflicts are liable escalate if the industry moves from a primarily local employment base to outside ownership through consolidation. Although the British Columbia government clearly benefits (or at least achieves cost-recovery) through the leasing fees collected on aquaculture tenures, the tenuring system may place an additional burden on small-scale users or exclude them entirely from access to resources if they cannot afford leasing fees, or do not have access to the capital required to establish infrastructure at tenure sites. Such a shift has the potential result in a loss of wild commercial harvests or loss of subsistence fishing rights among resource users in coastal communities. The social cost of this loss, in conjunction with the largely irreversible nature of property rights-based systems, requires careful consideration of management options before coastal communities and First Nations can be expected to fully embrace aquaculture development. The increased prevalence of both shellfish and finfish aquaculture worldwide, and the intense conflicts often associated with the regulatory frameworks fostering this development, point to a clear need for further research on the implications of developing private property rights for regulating access to sea space.

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3. A GIS-BASED APPROACH TO SPATIAL AND TEMPORAL CHANGES IN ACCESS RIGHTS TO SHELLFISH RESOURCES IN BRITISH COLUMBIA[24]

3.1 Introduction

Global demand for seafood products is growing exponentially, yet the productivity of wild fisheries is declining rapidly due to overfishing and other anthropogenic stresses on the marine environment (Pauly et al., 2001; Worm et al., 2004). In what has been referred to as a 'blue revolution,' farmed fisheries products are increasingly being developed to satisfy market demand for seafood (Lubchenco, 2003). Worldwide, aquaculture has increased 9% annually since the early 1990s and currently provides about 40% of all seafood eaten by consumers (Naylor et al., 2005). Despite promising developments in aquaculture technology and techniques, the environmental footprint or 'fishprint' of current aquaculture practices is considered significant, and much of world aquaculture production is not believed to be environmentally or socially sustainable (Folke et al., 1989, 1992; Folke et al., 1998). The intensive farming practices required for culturing of shrimp and salmon, for example, have been associated with habitat degradation, water pollution, parasitic infections of wild stock, and unintentional introductions of non-native species. Much of the world's shrimp and salmon aquaculture is also often considered socially unsustainable, as it can lead to redistributions of access rights away from existing coastal resource users, many of whom depend on inshore fisheries for food and livelihood (Bailey, 1997, 2003; Naylor, 2000; Skladany et al., 1995).

There are significant opportunities to improve the social and environmental sustainability of aquaculture practices by focusing on cultivation of lower trophic-level species such as

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bivalve shellfish, which do not require exogenous feed inputs, generate fewer waste by-products, and require significantly less energy per unit of biomass than higher-trophic level species such as finfish. As filter feeders, shellfish extract available nutrients from the water column; shellfish culturing is therefore considered to be non-polluting and suitable for environmental remediation of contaminated or degraded coastal areas (Crawford, 2002; Howlett et al., 2004; Kaiser et al., 1998). Cultivation of lower trophic-level species such as shellfish is also less capital intensive than finfish production, making it possible for the aquaculture industry to diversify into species and methods favorable for small-scale growers. In many coastal areas, shellfish aquaculture is viewed as a profitable and environmentally-sustainable form of seafood production which can both increase employment for local residents and improve the quality of coastal waters (Shumway et al., 2003).

In British Columbia (BC), shellfish aquaculture has been promoted by industry lobby groups and government agencies as an economic development strategy for coastal communities that is capable of increasing employment and economic infrastructure in areas that have been affected by declining opportunities in other resource industries, such as fishing and forestry sectors (BCSGA, 2005; Kingzett et al., 1999; Osborne, 2000). Proponents of shellfish aquaculture suggest that aquaculture development can provide a number of direct and indirect economic benefits to communities and government agencies, by increasing production and decreasing regulatory costs. Existing BC wild shellfisheries, especially commercial wild clam harvests, face a number of problems, ranging from overfishing to the need for expensive testing programs to regulate contaminants and enforce fishery openings. Not only can aquaculture reduce government expenditures for monitoring and enforcing wild fisheries regulations, it also provides a revenue stream from leasing fees collected from tenure holders.[25] Another benefit for both producers and consumers may include increased product quality and supply-side control of production, which can be tailored to meet the year-round demand of existing seafood markets.

[25] The total costs of leasing fees significantly exceed total revenue of license fees collected in the wild fisheries. However, the jurisdiction of wild fisheries licensing falls within the mandate of the Federal Department of Fisheries and Oceans, while aquaculture leasing fees are paid to the Provincial government.

The leasing of BC sea space for aquaculture allows for publicly-owned beaches and nearshore habitat to be 'tenured' for a finite period of time. Increased permits for shellfish aquaculture resulted in a doubling of leases for clam and oyster farms[26] between 2000 and 2005, and the Provincial government estimates the number of leases will again double between 2005 and 2010 (LWBC, 2004). Similarly, the volume of production from BC finfish aquaculture leases has increased exponentially over the past fifteen years, at even more rapid rates than shellfish. However, unlike shellfish where total leases and physical area occupied by those leases has increased, the number of salmon farm leases has remained relatively constant, although stocking densities and production efficiency of farms has increased (Figure 1.1) (MAL, 2006). In the wake of rapid finfish industry expansion over the past twenty years, controversy over salmon aquaculture in BC has escalated, resulting in political and legal conflicts, consumer boycotts, and a seven-year moratorium from 1997-2002 which limited farm expansion (BCSAR, 1997; Noakes et al., 2003). Similarly polarized public controversy has not to-date been observed with the BC shellfish industry. However, it is reasonable to suggest that similar controversy and political resistance may emerge if the shellfish industry were to expand volume of production at the rates observed over the past two decades with salmon farming.

In some areas of the coast, harvesters in the wild shellfisheries are concerned about the effects of converting common fishing grounds—areas that once supported subsistence, recreational, and commercial shellfish harvesting—to private aquaculture leases. The case of foreshore (beach) tenures for shellfish aquaculture development is unique in many ways, because of the potentially direct competition for habitat between shellfish leaseholds and other uses of the foreshore. This type of direct spatial displacement does not occur with salmon farms, as wild stocks and farm-raised salmon may impact on one another, but are not mutually exclusive in their habitat requirements.[27] There is thus fear among some wild

[26] Although the majority of leases in BC are for clam and oyster farming, some farm leases also include permission to cultivate mussels, cockles, abalone or scallops, but production of these other species is as yet, still minimal relative to total volume of clam and oysters that are produced in BC.

[27] There is some evidence for instance that wild salmon migrating past salmon farms may transfer sea lice or disease between the wild and farmed populations, or that escapes of Atlantic salmon from salmon farms in

harvesters that conversion of foreshore habitat to private leaseholds may exclude commercial wild fishers from accessing key beaches, and will ultimately exclude wild harvesters from the industry entirely if they cannot afford to develop aquaculture sites. Further, there is concern that shellfish farming may follow the same route as salmon farming in the province, insomuch as the industry will consolidate to achieve economies of scale,[28] and local communities will lose access to resources if large corporations or other non-local interests that can afford leasing fees and infrastructure costs come to own the majority of tenure sites on local beaches and nearshore waters. Where salmon aquaculture sites are located close to shellfish beaches, many wild shellfish harvesters also believe that waste by-products from salmon farms are contaminating wild shellfish stocks, thus resulting in further losses for wild shellfish harvesters (BCAFC, 2003; Leggatt Inquiry, 2001).

In this paper, we examine the transition from wild to cultured shellfisheries from 1995 through 2005 across five study sites in coastal BC. Specifically, we examine spatial and temporal trends in distributions of wild shellfisheries in response to increasing shellfish and salmon aquaculture development. Using both quantitative and qualitative approaches, we examine whether the introduction of shellfish and salmon leases are affecting access rights to existing coastal shellfish resources. In the first part of the analysis, we use quantitative GIS techniques to examine changing distributions of wild shellfish harvests relative to aquaculture sites. In the second part of our analysis, we conduct interviews referencing these GIS-produced maps to record local perspectives on three broad topics: a) potential spatial conflicts as a result of aquaculture leasing policies, including disputes between government and coastal interviewees over siting of shellfish and finfish farms; b) losses or gains in economic opportunities among existing shellfish harvesters as a result of

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BC may compete with wild salmon for spawning grounds, but the existence of salmon farms does not directly exclude a wild salmon fishery.

[28] The majority of salmon leases were initially developed by small owner-operators (MAFF, 2007c) but have largely been bought out; the salmon farming industry in BC has consolidated such that by 2004, the majority of tenures supporting the $13 billion dollar industry were owned by only three companies (Cox, 2004; MAFF, 2008). Although Cox reports five companies in 2004, further consolidation through mergers and buyouts has resulted in two principal companies – by 2008 - owning 96% of the BC salmon farming industry.

aquaculture development and, c) the relationship between changing access rights and First Nations' concerns about unresolved issues of territorial sovereignty in BC.

In subsequent context sections, we focus on the effects of introducing private property rights in foreshore and nearshore habitat, and the effects of property rights in fostering a transition from a predominantly wild fishery to aquaculture production. In the background section, we provide an overview of the salmon and shellfish aquaculture industry in BC, and examine the relevance of participatory GIS methods for examining potential spatial conflicts and changing access to resources. We then report our methods, and in the findings section, consider interviewees' perspectives in an attempt to gauge a) the perceived social and economic effects of aquaculture development on coastal stakeholders in the shellfish industry; b) whether aquaculture development has affected wild fisheries shellfish harvesting practices, and if so; c) what interviewees perceive the effects of this change to be. In the final sections, we examine our findings to determine whether further industry expansion is likely to lead to controversy over rights-based access to resources, and if so, what type of controversy can be expected.

3.2 Status and management of the aquaculture industry in British Columbia

The majority of finfish leases in the province are for salmon production, although the government has also recently begun issuing tenures for black cod and halibut farms (MAL, 2006). Farmed salmon is currently BC's largest agricultural export, yet over the past decade, the value of salmon has decreased significantly on world markets (Figure 1.3). As British Columbia's primary aquaculture industry, salmon production produced CAD $407 million in revenues in 2006 (MOE, 2006). The volume of production at each farm site in BC has increased over the past decade, although the number of salmon farms in BC actually decreased from 126 in 1986 to 114 in 2004. In 2002, a five-year moratorium on salmon leases was lifted, yet site approvals have not increased significantly since that time, while future expansion to new sites and locations seems unlikely, due to increased social pressure against the industry and pending First Nations territorial claims.

When comparing production growth rates for the BC salmon and shellfish aquaculture industries, salmon production has grown exponentially, while shellfish development has been much slower. BC remains a relatively small player in world shellfish production, with the export of BC oysters, for example, supplying less than 5% of the US oyster market. In 2006, total shellfish production from both wild and cultured sources in BC had a landed value of CAD $127 million, representing 16% of total BC seafood exports. Bivalve shellfish, such as clams, mussels, geoducks, oysters, and scallops, accounted for about 40% of total shellfish value in 2006, with farmed sources of bivalve shellfish accounting for about 8% of total provincial fisheries revenues (MAFF, 2007a). Per pound prices for shellfish are low and fluctuate on a yearly basis, but overall do not show the same downward price trends as prices for aquaculture-produced salmon. BC shellfish may be viewed, then, as potentially competitive on world markets, with unknown production potential for a range of species that are not currently in commercial production in BC (e.g., geoducks, abalone).

Historically, shellfish production in BC derived entirely from wild fisheries, but an increasing percentage of clam, oyster, and scallop production is now derived from cultured sources (MOA, 2004). Although growth rates for the shellfish aquaculture industry have been slow relative to salmon production, growth has nonetheless increased substantially in recent years. Volumes produced by the cultured shellfish industry have doubled since 1999, and continued growth is expected in both volume of production from aquaculture sites and geographic extent of leases (LWBC, 2004).

The importance of the wild shellfish fishery is changing as shellfish aquaculture production increases. In 2005, the total value produced by clam aquaculture surpassed that of the wild stock clam fisheries (LWBC, 2005). In coastal areas, salmon leases, shellfish leases, wild fisheries and other industrial activities all require access to estuarine or foreshore habitat. Shellfish aquaculture is a space-intensive venture, and there is concern that growth of the aquaculture industry will increasingly result in spatial conflicts between

wild and cultured fisheries if shellfish aquaculture expands at similar rates to those observed in the salmon aquaculture industry (Figure 1.3). Shellfish leases currently occupy 66% of the leased sea space in British Columbia (as compared to salmon which occupies only 32% of leased area), even though shellfish production generates only 12% of all aquaculture revenues (MAFF, 2007b) (Figure 3.3).

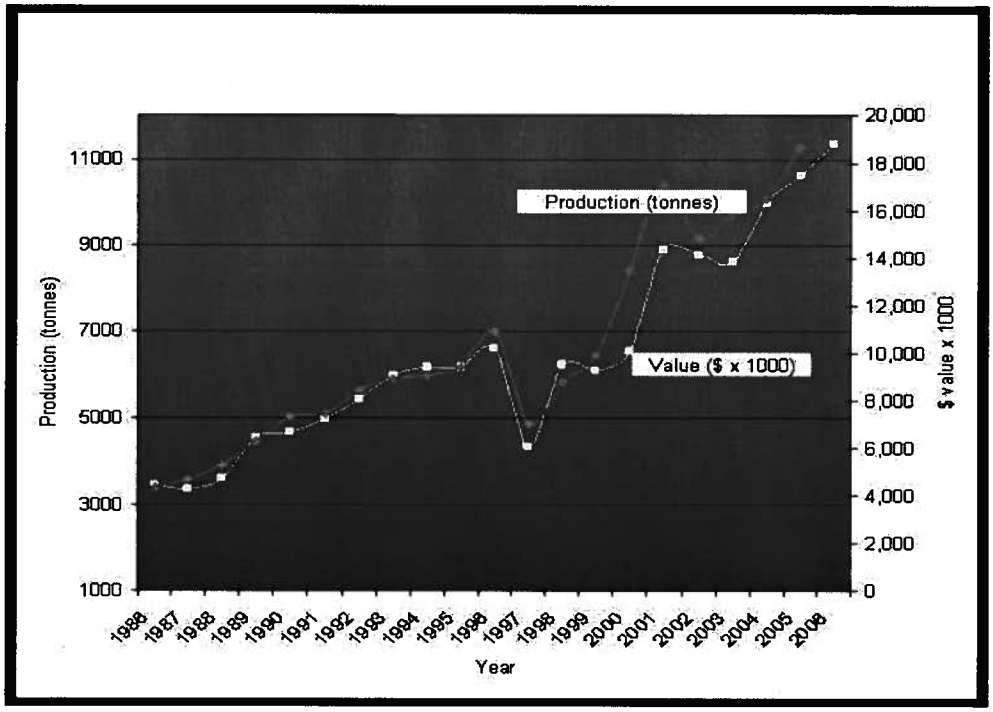
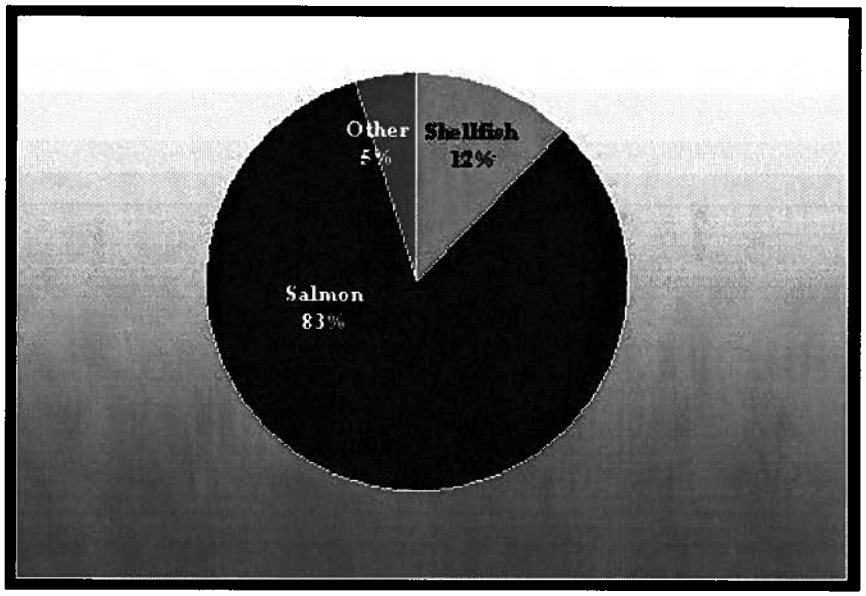


Figure 3.1 - Production and value of intertidal shellfish species from aquaculture in British Columbia. (1986-2006). Source: Statistics Canada, Agriculture Division Database

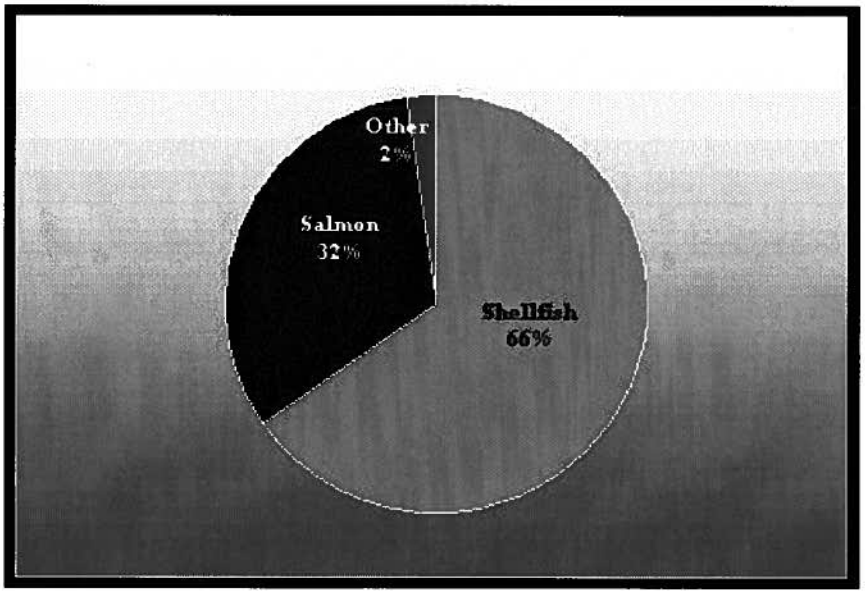
Concerns over sea space and foreshore conflicts between aquaculture and wild fisheries have increasingly surfaced because wild harvesting of Manila clams *(Tapes philippinarum)* and littleneck clams (*Protothaca staminea*) is an important commercial fishery that provides seasonal and part-time employment in coastal communities. In many parts of coastal BC, the wild clam fishery is a reliable source of winter income in rural communities, where there are high unemployment rates as a result of declining opportunities in other resource sectors (FOC, 2003; Mitchell, 1997). The clam fishery is

Figure 3.2 Shellfish as percentage value of British Columbia aquaculture products (2006)



Source: Ministry of Environment, Oceans and Marine Fisheries Division Aquaculture Statistics

Figure 3.3 Percentage of leased area in British Columbia occupied by shellfish farms (2006)



Source: Ministry of Agriculture, Food and Fisheries Aquaculture Licensing Statistics

currently managed as a common property resource through limited licensing and seasonal openings, with wild harvest licenses owned primarily by small-scale users in rural communities; approximately 50% of wild clam licenses are allocated to First Nations users. First Nations also exercise subsistence harvest rights to shellfish (DFO, 2007). Any effects of aquaculture on wild clam fisheries, therefore, will be readily apparent to coastal stakeholders, as the clam fishery is an inshore fishery, with traditional and cultural ties to Aboriginal peoples and a coastal way of life. Negative impacts on the fishery are likely to induce conflict, as place-based users are closely tied to the resource.

3.2.1 Shellfish aquaculture leaseholds

Shellfish leases (tenures) can be divided into three categories based on the sea space they occupy: beach (foreshore), nearshore, or deepwater culturing. All three types of shellfish aquaculture leases grant private property rights to sea space, but their potential spatial effects on access to wild shellfisheries vary. At nearshore or deepwater sites, oysters, mussels and clams are suspended in cages, rafts or on longlines in shallow waters (<10 m); at deepwater sites (>10m), while abalone or scallops are cultured on similar longline or cage structures. Nearshore or deepwater leases may present hazards to navigation or potential competition with other resource uses, such as salmon farming, but do not directly affect access to wild shellfish habitat. Foreshore shellfish leases and wild clam and oyster beds are located on beaches, and thus foreshore aquaculture leases may present direct competition with wild fisheries for habitat. If a leaseholder applicant has the option of developing an unproductive beach or a naturally productive one for an aquaculture tenure, a leaseholder will generally prefer a location that has proven biophysical capability. The presence of wild standing stock is indicative of good habitat and natural recruitment, and the sale of former wild stock from a newly tenured beach also generates income that may give a leaseholder enough of an initial profit to offset start-up costs for the tenure. It is logical, then, to hypothesize that shellfish leases will displace wild harvests if tenure applicants are able to secure beaches for aquaculture development that were formerly productive habitat for wild fisheries. In areas where potential spatial overlap occurs between wild and cultured fisheries, the development of aquaculture leases effectively transfers resources away from wild fisheries harvesters by restricting access to formerly

common-pool resources. The leasing of beaches for shellfish aquaculture may therefore be viewed as a *de facto* form of privatization, if habitat for wild fisheries, once regulated through limited licensing of common-pool resources, is increasingly transferred to private owners.

In this paper, we focus primarily on examining potential conflicts between foreshore shellfish aquaculture leases and wild clam harvesting. As the clam fishery occurs on beaches that may increasingly be developed as aquaculture leases, a spatial and temporal analysis of overlap between the clam fishery and shellfish leases provides a relatively direct spatial measure of any changes in access rights as a result of expansion of aquaculture sites in BC. We also examine potential effects of salmon leases on wild shellfish harvests, as finfish aquaculture production may also have spatial displacement effects – both direct spatial effects and indirect environmental effects - on wild shellfish harvests.

3.2.2 Salmon aquaculture leaseholds

Salmon aquaculture leases may result in conflicts between salmon farms and shellfish farm sites, as well as between salmon farms and wild shellfish harvesting areas. The site qualities desirable for salmon aquaculture facilities are nearly identical to those for raft-based shellfish aquaculture, including adequate water flow, an accessible shoreline, safe moorage and proximity to transportation and population centers (Congleton et al., 1999). As a result, salmon aquaculture may present direct competition for sea space with shellfish aquaculture. In addition, waste by-products of salmon aquaculture may alter the quality of wild shellfish harvests if shellfish beds near salmon farms are exposed to a variety of chemicals or antibiotics introduced at the farm site through feed, paints on farm cages, or medications administered to the fish (Brooks et al., 2003; Burridge, 2003).

Bivalve molluscs will concentrate contaminants, and government leasing guidelines therefore suggest that salmon farms with pens be located at least 300 m from intertidal shellfish beds used for First Nations traditional harvesting or at least 125 m from all other wild shellfish beds or commercial shellfish-growing operations (EAO, 1997).

Considerable literature exists related to environmental effects of fish farms on benthic habitats and wild fisheries (Naylor et al., 2005; Volpe et al., 2000), but there is little agreement about the specific environmental effects of salmon farms on wild shellfisheries. Studies in Atlantic Canada, including hydrodynamic studies of effluent transport, have found that fish farm chemicals can travel up to 3 km from a farm site (Janowicz et al., 2001). Although some studies in BC have found organic wastes from aquaculture sites to be limited to within 50 m of net pens (Hargrave et al, 1997), a recent study found that contaminants from salmon farms extended from 90 m to 225 m outside the farm site (Brooks and Mahnken, 2003). Hydrodynamic cycling will differ for each study site, but a perception exists that shellfish sites are susceptible to contamination from salmon farms at distances even greater than 300 m, and in practice, this perception may be sufficient to alter shellfish harvesting patterns (BCAFC, 2003; Leggatt Inquiry, 2001).

3.3 GIS in participatory mapping and spatial analysis

Spatial conflicts, such as siting conflicts over aquaculture leases, lend themselves well to spatial analysis using Geographic Information Systems (GIS), as the GIS provides computerized tools for integrating spatially referenced information from multiple sources, while allowing for statistical analyses and graphical outputs, including maps and charts (Beck et al., 2002). GIS technology has been widely used for exploring relationships between the distribution of resources and their users, for prioritizing resource uses, and for including stakeholders in decision-making about preferred resource uses (Carver, 2003; Goodchild et al., 2004). As GIS tools have become increasingly user-friendly and digital mapping has become more commonplace and accessible through the Internet (e.g., Google Earth and web-mapping applications), GIS technologies have also become well-suited for collaborative projects with stakeholders (Elwood et al., 2001; Niles et al., 2003; Rugg, 2003; Sieber, 2006). Technological advances in GIS, as well as increased stakeholder participation in planning processes, have led to the emergence of a number of Participatory GIS (PGIS) methods to support collaboration between researchers and the public (Abbot et al., 1998; Leitner et al., 2002; NCGIA, 1996; Obermeyer, 1998). Participatory GIS methodologies, as a means of collecting, disseminating, and using stakeholders'

information about resources and their use have been adopted in a wide variety of research contexts for reconciling multi-stakeholder perspectives in collaborative decision-making or increasing the diversity of representation and participation in planning (Al-Kodmany, 1999; Ball, 2002; Drew, 2003; Shiffer, 2002). Several notable studies have used GIS as a tool to engage community involvement in research through participatory mapping of local knowledge and resources (Craig et al., 1998; Duerden et al., 1996; Elwood et al., 1998). Within a subfield of local mapping, studies have also focused on mapping Aboriginal resources to support land-claims, secure indigenous land tenure, and strengthen cultural ties to traditional territories (Chapin et al., 2005; Marozas, 1995; Olive et al., 1998). As a tool, GIS is particularly well suited to this type of research because it can integrate both resource- and socially-based data, and its flexibility allows a GIS database to incorporate varied data sources, including both local and scientific knowledge into spatial models (Convis, 2001; Poole, 1995a, 1995b). Although some critics of participatory GIS do not believe the inclusion of local knowledge within hierarchical data-structures of GIS studies can support more inclusive multi-stakeholder processes (Morain, 1999; Rundstrom, 1995), many researchers have argued that participatory GIS can provide disenfranchised voices with opportunities to contribute more directly to environmental planning and management (Clark, 1998; Craig, 1994; Pickles, 1995; Sheppard, 1995; Varanka, 1996). In particular, the mapping of Aboriginal ecological knowledge has increasingly become a focus of participatory GIS research (Flavelle, 2000; Ghose, 2001; Looney, 1998; Poole, 1995b).

GIS has been widely used for modeling in terrestrial resource management and has been recently adopted for marine applications in both fisheries modelling and coastal zone planning (Green et al., 2003; St. Martin, 2004; Wright et al., 1999). A number of books have been published in the last fifteen years on applications of GIS to examine fisheries habitat, and fishing practices within that habitat (Fisher et al., 2004; Meaden, 1999; Meaden et al., 1996). GIS studies investigating social relationships to the marine environment have proliferated to examine broad aspects of coastal change, for example, changes in local resource use patterns of inshore fishing grounds (Macnab, 1998) or fishing access to reef habitat (Nietschmann, 1995). Currently, the majority of GIS-based

studies of aquaculture focus on preferential siting of fish farms (Nath et al., 2000; Pérez et al., 2003; Salam et al., 2003), though a handful of social researchers have also used GIS to examine aquaculture-induced social and ecosystem changes (e.g., resulting from shrimp farming; Stonich, 2002). Increasingly, researchers have examined potential displacement effects of aquaculture on existing resource uses (see Walters, 2007). Although GIS is a useful tool for examining relationships between common-pool resources and resource users (see Fox, 1998, 2002; Giordano, 2003; St. Martin, 2004), spatial relationships between property rights for aquaculture development and coastal resource uses remain largely unexplored.

In this study, GIS proved particularly useful for examining spatial competition for sea space between wild and cultured fisheries, as both wild shellfish habitat and aquaculture leases are spatially delimited and their extent of overlap is easily visualized and analyzed within a GIS. Unlike motile, offshore stocks, shellfish exist in visible foreshore and nearshore areas that can easily be represented in the two-dimensional space of printed maps. Maps produced from our GIS analyses allowed for an examination of local knowledge of selected habitats and locations of cultural and social importance, as well as incorporation of industry stakeholders' broad knowledge of fisheries practices and interpretations of potential conflicts over competing resource uses. Further, a participatory GIS approach involved stakeholders in an assessment of different forms of management for local resources; these perspectives were important in establishing comparative analyses of harvesting patterns between study sites, assessing changes in shellfish habitat and harvest patterns, and providing a means to reflect on personal beliefs and constructed meanings about these changes.

3.4 Methods

3.4.1 Site selection, data sources and approach

In this research, a preliminary GIS-based analysis allowed for quantitative analysis of spatial and temporal trends in the distribution of wild and cultured resources, while outputs

of the GIS analysis, in the form of printed maps, were used during interviews to elicit input about conflicts related to potentially competing resource uses.

Five study sites in coastal British Columbia were selected for comparative research: the Sunshine Coast (Sechelt to Lund), Barkley Sound, Clayoquot Sound, Northeast Vancouver Island (Port Hardy and Broughton Archipelago), and Northwest Vancouver Island (Kyuquot and Quatsino Sounds) (Figure 1.4). Study sites were selected to highlight regional variation, including different fishing histories and dominant industries; all sites selected had shellfish tenures, finfish tenures and active wild clam shellfisheries. The majority of communities derived primary income from resource extraction industries such as fishing, forestry and mining, although some communities also had other forms of industrial development (smelters or refineries) or income derived from tourism. Communities represented at each of the study sites included a broad demographic of interviewees representing a wide range of ages, ethnicities, and primary occupations.

In a preliminary analysis, GIS-compatible spatial data for the five study sites were extracted from a number of government databases to represent five two-year time intervals from 1995 to 2005. Spatial data layers were developed in ESRI ArcGIS 9.0 software, using data available from the Ministry of Agriculture, Food and Fisheries (MAFF), Ministry of the Environment (formerly Ministry of Water, Land and Air Protection); Land and Water British Columbia (LWBC), the former Ministry of Sustainable Resource Management (MSRM) and Environment Canada (EC). Data layers included marine charts and locations of shellfish aquaculture tenures, finfish aquaculture tenures, and water quality closures, as well as shellfish aquaculture biophysical capability surveys.

Locations of shellfish aquaculture tenure sites were clearly delineated in government geospatial datasets, but no spatially explicit data on wild clam harvesting locations or stock assessments for the wild clam fishery were available from the Department of Fisheries and Oceans. Thus, biophysical capability assessments, compiled from shellfish aquaculture capability studies (2003), were used as a proxy to define potential wild shellfish harvesting

areas.[29] Sites rated as having 'good' biophysical capability (e.g., substrate, slope), were used to delineate wild shellfish habitat, and a new data layer was extracted for potential wild shellfish harvesting areas. Preliminary interviews confirmed that this proxy provided a reasonable estimate of productive wild shellfish habitat, but the proxy data did not contain adequate information on natural recruitment and productivity of standing stocks at specific beaches. Furthermore, demographic factors, such as proximity to population centers, made it difficult to estimate actively harvested areas, as did the fact that many beaches with high shellfish aquaculture capability ratings were closed to the wild fishery as a result of contaminants (bacterial water quality closures). An additional georeferenced data layer, derived from water quality closure information provided by Environment Canada, was used to adjust shellfish aquaculture capability to account for water quality closures. No spatial data on water quality closures was available for years prior to 2003; locations of wild clam harvesting areas for 2004 and 2005 were therefore based on estimates from 2003 shellfish aquaculture capability surveys. New datasets, incorporating water quality closures, were re-evaluated during interviews for accuracy and relevance and found to improve the accuracy of original maps, which lacked closure data.

3.4.2 Analysis

Spatial and temporal trends in the distribution of wild and cultured shellfish resources were investigated for the five study sites using time-sequenced data to examine: 1) changes in spatial relationships between shellfish aquaculture tenures and wild fisheries; 2) spatial proximity of finfish aquaculture tenure sites to shellfish aquaculture tenure sites and wild shellfish harvesting areas and, 3) temporal changes in (1) and (2).

In the first analysis, we aimed to quantify the extent of spatial overlap between wild shellfish habitat and shellfish tenure areas by overlaying the two georeferenced datasets over a ten-year time period. The resulting maps were then compared, at two-year time intervals, for changes in the total foreshore occupied by shellfish tenures. In the second

[29] Shellfish capability is the biophysical capacity to support aquaculture. Suitability studies, which were not available for the study sites, also take into account socioeconomic factors.

part of our analysis, we examined the extent of spatial overlap (relative proximity) between wild shellfish habitat and salmon aquaculture sites for the same timeframe. For each two-year interval, buffers of 125 m and 300 m around finfish farms were created, and overlap between buffers and shellfish habitat was used to delimit areas of potential spatial competition between wild fisheries and salmon aquaculture sites. The effect of a 500 m buffer was also examined, as some harvesters considered 125m and 300 m buffers to be inadequate. Finally, a third analysis examined total spatial displacement of wild shellfish habitat and harvests as a result of both shellfish and salmon aquaculture development over time. GIS-produced maps of this analysis were then overlaid on coastal marine charts for readability, and printed for two-year time intervals from 1995 to 2005.

Maps generated from the analysis were presented to stakeholders during interviews to examine their local experiences with aquaculture development (Figure 3.4). In order to determine whether significant spatial redistributions of wild shellfish habitat had occurred as a result of aquaculture development, interviewees were asked to comment on the maps.

From January 2004 to July 2006, 56 interviews were conducted with wild harvesters, aquaculture producers, industry representatives, shellfish processors, scientists, fisheries managers, and government regulators who had a stake in the future of shellfish production in BC (Table 2.1). Thirty-four interviews were conducted with individuals whose primary livelihood derived from shellfish production, processing or management at the five study sites in southwestern British Columbia. All five study sites included both First Nations and non-First Nations communities; of the 34 harvesters/producers interviewed at the study sites, 23 self-identified as First Nations, and 11 as non-First Nations. Self-identified First Nations had significant representation among these interviewees (41%), as First Nations were key stakeholders representing approximately half of commercial (wild) clam fishery license holders; many First Nations bands had also acquired tenures for shellfish aquaculture. Twenty-two additional interviews were conducted with First Nations and non-First Nations regulators, shellfish buyers, processors, biologists and fisheries managers

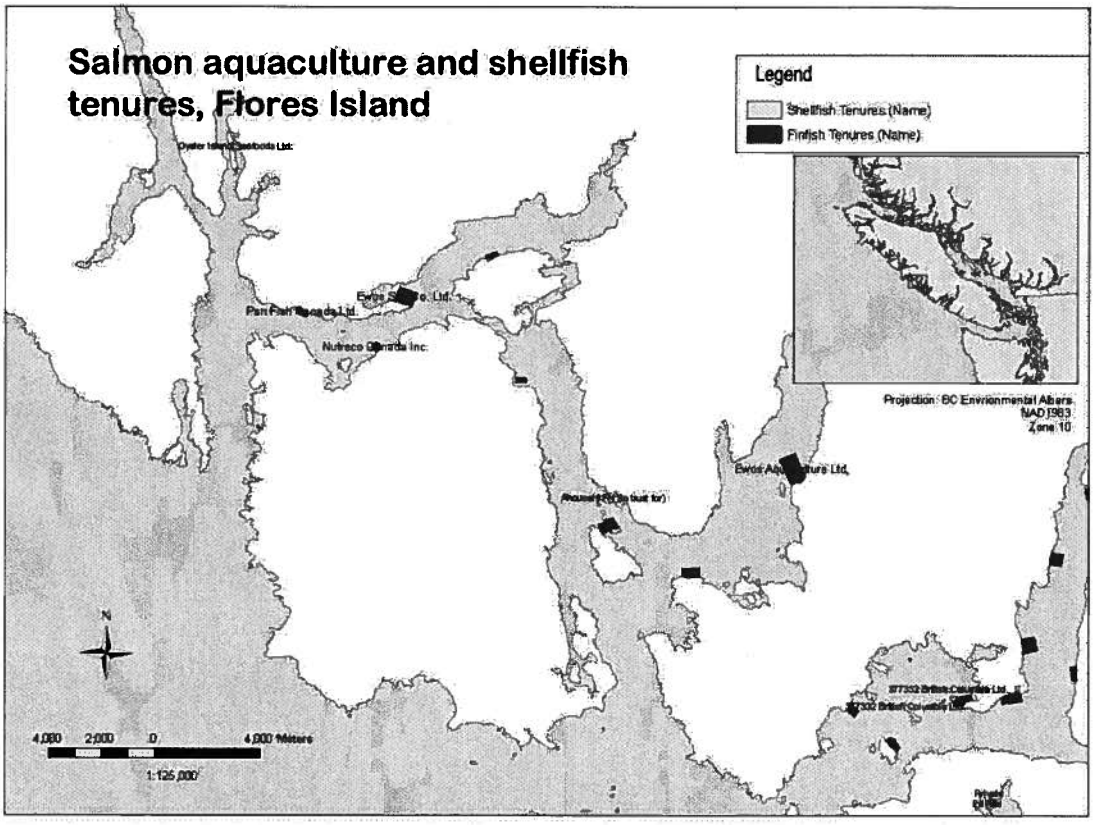
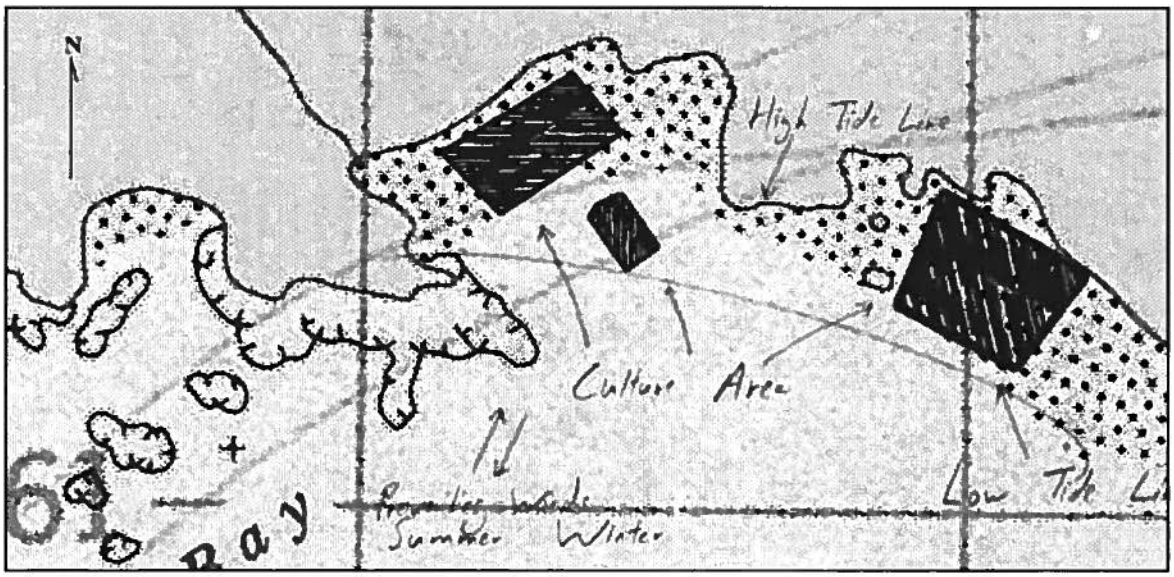


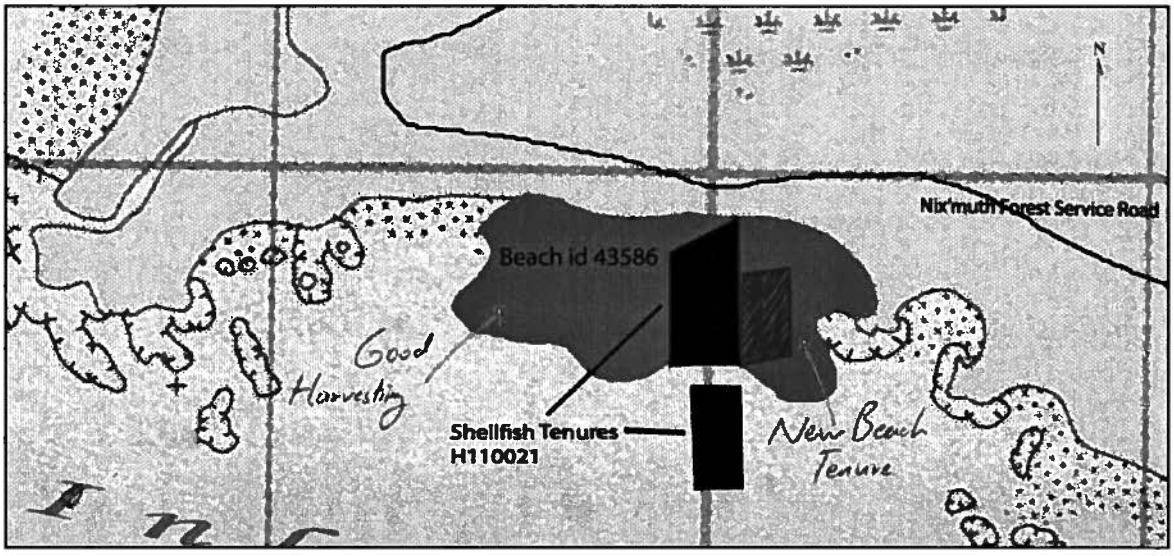
Figure 3.4 - Sample chart of Clayoquot Sound study site, as presented to interviewees. Chart shows shellfish and finfish aquaculture tenures. Separate charts were provided with overlays of biophysical capability (potential wild harvest sites) and water quality closures.

who were either located outside the primary study sites, or whose jurisdiction extended across one or more of the communities within the five study areas.

Semi-structured interviews focused on three broad categories of questions: 1) competition between aquaculture and existing resource uses; 2) current regulation of wild fisheries and aquaculture lease sites; and 3) historic access patterns and changes over time in opportunities for traditional or subsistence harvesting. Interview questions were designed to identify policy-relevant knowledge, local knowledge of resources, and information about place-based and cultural contexts relevant to understanding interviewees' relationships to resources. Maps created from the GIS analysis were presented during interviews to prompt discussion about user conflicts, environmental impacts, and socioeconomic risks and benefits related to the development of shellfish and salmon

Figure 3.5 – Annotated map of wild harvesting and shellfish aquaculture (tenure sites). Maps show interviewees' diagrams of tenure sites relative to wild clam harvesting beaches. As noted, not all harvesting beaches or aquaculture tenure sites appeared on GIS produced maps, as new applications did not appear in geospatial databases, nor did some of the smaller potential wild shellfish harvesting beaches.





aquaculture. During interviews, stakeholders were encouraged to annotate maps of GIS-derived thematic overlays in order to add descriptions of variables, such as shellfish

abundance or perceptions about the distribution of contaminants (Figure 3.5). Specifically, interviewees were asked to record on printed copies of the maps information that would:

a) corroborate or refute the existence of spatial conflicts between wild harvest areas and aquaculture sites (i.e., indicate overlap/potential competition for habitat);
b) plot changes over time in patterns of resource use for commercial (wild) shellfisheries and aquaculture development;
c) indicate priority-use areas for wild fisheries or areas where interviewees believed aquaculture expansion should or shouldn't occur;
d) identify how interviewees believed wild harvesting practices had been altered by contaminants or perceptions of contaminants, including water quality closures (e.g., due to high faecal coliform counts for bacterial contaminants), salmon farms, and other point and non-point sources such as mines, pulp mills, forestry, and agriculture; information provided in this final category was necessary to contextualize the effects of spatial conflicts itemized in (a) and (b).

3.5 Results

3.5.1 Shellfish aquaculture leases and wild fisheries habitat

Coast-wide across BC in 2001, there were a total of 423 shellfish aquaculture tenures covering 1750 ha. By 2005, these figures had increased to 537 tenures occupying 2800 ha. Although 2800 ha only represents about 0.67% of the total foreshore in BC[30], not all foreshore in BC is suitable habitat for wild shellfish harvesting. Total area of suitable foreshore was harder to quantify, as only a small percentage of total available foreshore in BC is biologically productive shellfish habitat.[31] Further, not all areas that are biologically productive are also accessible for wild harvesting (e.g., areas that are too far from population centers, or are closed due to contaminants). Quantitative, coast-wide data therefore served as an important backdrop against which to assess the relevance of findings

[30] Total foreshore as measured by Natural Resources Canada (2000), Canada Centre for Remote Sensing, GeoAccess Division.
[31] Clams do not generally grow on rocky headlands, and also require specific substrate or tidal conditions, thus rendering a large portion of the total coastline unsuitable for shellfish production.

for the five study sites, as inteviewees were asked to comment on specific changes at the five study sites relative to these broader coast-wide trends. However, coast-wide statistics, as collected in this study from available GIS data, were useful primarily as a discussion and reference point in relation to specific local perspectives on tenure development, as opposed to being useful in their own right for determining the effects of aquaculture expansion on use of sea space in BC.[32]

For the five study sites, the number of total shellfish aquaculture tenures increased 54% from 2000 to 2005 (Table 4.1). Using 2003 values, biophysically capable shellfish beaches for all study areas (used as a proxy for wild fisheries habitat) showed that in total, wild fisheries had a potential extent of 220,500ha. GIS analysis showed that by 2003, 7.8% (172 ha) of that foreshore area had been converted to private aquaculture leaseholds. From 1995 values, this represented a 37.6% increase in foreshore habitat occupied by aquaculture leaseholds. At the Barkley and Clayoquot Sound study sites, the increase in tenures was most dramatic, with an 84% increase in total area of tenures from 1995 to 2005, to include 49% of the estimated total available wild shellfish habitat area at those study sites. From 1995 to 2005 on the North Island (Northwest and Northeast Vancouver Island Study sites), harvesters noted that an increase in foreshore tenure area (from 19 ha to 42 ha) or a nearly 200% increase in beach tenure area had resulted in a loss of harvestable area in wild fisheries of potentially 38 ha, or 17% of total available harvestable area.[33]

In 2005, for the five study sites, 98% of the shellfish aquaculture tenures were coincident with potentially productive wild clam habitat, as identified by biophysical capability data. Such a high rate of coincidence was not surprising, given that biophysical capability studies were undertaken to direct developers to productive shellfish habitat and were used in this study as proxy values to identify wild fisheries habitat. However, after accounting

[32] To some degree, these figures were useful in determining whether local patterns for the five study sites were reflective of broader coastwide trends. However, a number of data limitations (as will be discussed), make it difficult to draw broad conclusions from a quantitative analysis of the government-derived GIS datasets.

[33] Extrapolated based on 2003 shellfish capabilities studies, and adjusted for water quality closures. These figures should be considered rough estimates, while interviews provided more detailed data for specific study sites.

for water quality closures, only 57% of these locations were confirmed in interviews to have been productive wild harvesting areas. Participants reported that some potentially productive beaches had been overharvested and had few standing stocks, while other beaches were too far from population centers to be economical for harvesting. Interviews were important in differentiating between potential shellfish habitat and actually productive harvest areas.

Table 3.1 Change in shellfish aquaculture tenures (by number and area 1995-2005) for five study sites. Locations of five study sites are shown in Figure 1.4.

Year	Number of shellfish aquaculture tenures	Total area of aquaculture tenure sites (deepwater, foreshore and nearshore leases) (ha)	Foreshore area occupied by aquaculture tenures (ha)	Foreshore wild clam habitat area (ha)	Foreshore wild clam habitat adjusted for water quality closures (ha)
1995	31	113	65	-	-
1996	34	132	78	-	-
1997	46	187	102	-	-
1998	46	187	102	-	-
1999	51	220	128	-	-
2000	59	265	140		
2001	66	317	156	-	-
2002	75	362	167	-	-
2003	81	398	172	2205	1774 (80.4%)[2]
2004	89	437	192	Est 2205[1]	1261 (57.2%)
2005	91	446	198	Est 2205	1145 (51.9%)

[1] Estimates for 2004 and 2005 are based on 2003 shellfish aquaculture capability surveys for wild harvesting areas (no data available for prior years).
[2] Beach area was adjusted for bacterial water quality closures reported for 2003, 2004, 2005 (no data available for prior years).

3.5.2 Perceptions of changing access rights

As discussed in relation to the GIS analysis, the majority of wild shellfish harvesters interviewed were concerned that increased aquaculture development had resulted in an estimated 17% loss of wild habitat which, as a result, resulted in loss of subsistence access to wild clam beds or seasonal income from wild harvesting. The majority of commercial clam harvesters stated that seasonal income from winter shellfish openings was important

for maintaining livelihood and way of life in rural communities; few believed that aquaculture could replace wild fisheries as a source of winter employment. Many stated they could not afford the cost of a lease application, ongoing tenures fees, or the infrastructure to develop an aquaculture lease site. For some interviewees, there was particular concern that those community members who had the lowest average incomes and highest rates of unemployment, typically older members of the community or those with the least formal education, were most likely to be excluded by a transition away from wild fisheries towards aquaculture production. As one harvester stated:

> "I've been digging clams since 1964, and I can't afford a lease. If I can't afford a lease, someone else will take one (a lease) – and then what will I have left? What will become of the old people who dig clams... who don't know about aquaculture? They don't have any money to do that (aquaculture) but they don't have other options, because everything is becoming tenures now."

Even though the small increase in total area for shellfish aquaculture development since 2000 appears relatively insignificant when compared to the total area of foreshore beach habitat, the loss of access to formerly harvested wild harvest beaches was considered significant by interviewees in some areas, particularly when this loss occurred on productive beaches in proximity to communities with historic access to wild fisheries (Table 3.4). In Clayoquot Sound, for example, where there is a strong history of wild harvesting, 86% of respondents believed that aquaculture represented a risk to future productivity of wild fisheries, whereas only 24% of respondents throughout all of the study sites felt that way. As one interviewee in Clayoquot Sound described, "If things continue like this (more leases), every beach here is going to be a shellfish farm."

3.5.2.1 Economic and social considerations related to changing access rights

Cultural and economic interest in shellfish varied considerably among interviewees and across the five study sites. While some interviewees embraced the economic benefits of shellfish aquaculture development, others perceived considerable risk. Many were conflicted as they considered shellfish aquaculture development to hold potential for economic development and employment, but they also felt it held significant risks if it

resulted in a loss of access to wild fisheries and risks to livelihood and way of life in coastal communities. In particular, all First Nations interviewees expressed some concern and uncertainty about increased shellfish aquaculture development. As place-based and traditional users of coastal waters, some First Nations expressed strong historical dependence on access to shellfish resources for social and ceremonial purposes, subsistence use, and economic livelihood. As such, many First Nations participants in both wild and cultured fisheries had a strong interest in weighing the risks and benefits of policies influencing access to shellfish resources. Moreover, property rights vis-à-vis shellfish aquaculture intersect with, and cannot be considered independently of, unresolved conflicts between the government and First Nations over territorial sovereignty and unresolved First Nations' rights and title cases. Even within bands that were endorsing and actively pursuing opportunities for shellfish aquaculture, non-First Nations aquaculture development was seen as a potential risk to territorial sovereignty and First Nations rights to access traditional resources.

The majority of interviewees (65%) believed that tenures had provided secure jobs and improved the saleability of product through guaranteed contracts from processors. The remaining interviewees—many of whom were wild harvesters—argued that aquaculture tenures were increasingly replacing wild fisheries, and this transition had not been economically beneficial for their communities. These interviewees believed aquaculture had merely increased debt as a result of the high cost of leasing fees, as compared with wild fisheries. Leasing fees are substantially greater than the cost of wild fisheries licenses, with leases averaging approximately $600/hectare/year, while wild fisheries licenses are available at only a nominal cost. While such fees are not necessarily prohibitive for larger corporations who could benefit from economies of scale, they were cited as prohibitive for many small-scale harvesters.

Across the five study sites, 72% of interviewees believed that shellfish aquaculture was economically risky for small-scale producers, and 54% believed aquaculture was not currently more lucrative than maintaining wild fisheries. Many of the interviewees in

remote communities stated that the cost of establishing tenures exceeded potential profits, while wild fisheries had high profit margins relative to costs of labor (e.g., a harvester's time) and capital inputs (e.g., gas for boats). Although shellfish aquaculture requires significantly less capital to develop than finfish aquaculture, many small-scale harvesters nonetheless pointed out that shellfish aquaculture still requires significantly more capital investment and infrastructure than wild harvesting, and wild fisheries therefore remain the preferred choice for part-time employment in winter months.

3.5.2.2 Political implications for access to wild resources

In some areas, particularly Clayoquot and Barkley Sounds, and the Broughton Archipelago, the majority of First Nations interviewees were either indifferent to, or in some cases, directly opposed to all aquaculture leases, stating that they preferred instead to maintain access to wild fisheries. Yet, surprisingly at these same study sites, significant overlap existed between interviewees who reported they worked on aquaculture leases, and those who also reported income from wild fisheries. To explain this, several former wild harvesters indicated that they (often through their band) had felt pressured to buy leases in order to preclude other investors from applying for exclusive access to key harvest sites; they also reported that their band councils had chosen to purchase leases since they deemed it important to preempt applications for non-First Nations aquaculture leases in traditional territories. They suggested that if First Nations did not apply for leases, increased non-First Nations leases were more liable to limit the ability of First Nations to control foreshore and benthic fisheries habitat pending resolution of land-claims settlements. Aquaculture leases, as a form of private property within First Nations territories, were identified as risky in light of ongoing legal struggles between First Nations and the Federal and Provincial government over rights and title.

Across the five study sites, 83% of First Nations interviewees strongly believed bands should not have to pay leasing fees for access to shellfish beaches adjoining reserves. In particular, several First Nations groups who had acquired tenures expressed dissatisfaction that they were paying leasing fees for aquaculture tenures for which they either lacked interest in developing, or lacked capital or know-how to do so. At one of the study sites,

the local First Nations band had applied for and been granted several leases adjacent to their reserves. However, the band had ceased paying for the tenures because they decided they should not have to pay the government to seed and harvest beaches to which they had formerly had exclusive customary access (e.g., "home-use" harvesting areas). Although the government had attempted to collect leasing fees, the band had asserted their right not to pay, and conflict over the ownership of these beaches, and payments on the leases, was unresolved.

3.5.2.3 Implications for traditional or subsistence harvesting

Subsistence and recreational harvesters represented a small subset of all interviewees; furthermore, the majority of harvesters who reported subsistence use were also active in the commercial fishery. However, for some First Nations interviewees who reported that access to clams for cultural or ceremonial reasons was important, there was a strong perception that any aquaculture on foreshore beaches discriminated against traditional fishing rights and way of life. As shellfish aquaculture requires significantly more capital investment and infrastructure than wild fisheries, the majority of interviewees did not consider tenures relevant for subsistence use. In fact, some wild harvesters perceived aquaculture development to be discrimination against existing resource users who lacked the necessary capital to develop a tenure site.

3.5.3 Salmon aquaculture leases and wild shellfish habitat

In two of the five study sites (Barkley Sound and Northeast Vancouver Island), the total number of finfish aquaculture tenures had increased since the BC moratorium on finfish aquaculture leasing was lifted in 2002. In the remaining three sites (Clayoquot Sound, the Sunshine Coast, and Kyuquot/Quatsino), the number of leases decreased slightly. Overall, for the five study sites the number of total finfish aquaculture tenures decreased slightly between 2001 and 2005, but this decrease was relevant only to the five study sites as, on a coast-wide basis, the total number of finfish aquaculture leases had increased since 2002 (DFO, 2005).

Although government guidelines suggest that salmon farms should not be sited within 125 m of known shellfish habitat and within 300 m of shellfish beds that are actively harvested, we found that the suggested siting criteria for salmon farms had not always been followed. In terms of areal extent for a 125m buffer zone, there was little overlap between salmon aquaculture sites and wild shellfish harvesting areas. However, data from 2005 indicate that out of a total of 55 salmon farms at the five study sites, 21% (n=20) were within 300 m of a formerly harvested shellfish beach and 29% (n=27) within a 500 m buffer (Table 3.3). During interviews, harvesters identified only fourteen of these sites to be wild clam beds that had been actively harvested within the past ten years. Harvesters reported in all cases that they no longer dug clams on those beaches, and in response to the figures presented, estimated that 7-15% of wild shellfish habitat available at the five study sites was no longer being harvested as a result of salmon farm leases. Although this is a relatively small percentage, it nonetheless represents a loss of foreshore for wild fisheries that many interviewees perceived to be significant.

Interviewees at all five study sites reported that a loss of wild habitat as a result of shellfish aquaculture development was compounded by other losses, including those resulting from increased finfish aquaculture, water quality closures, or other marine industrial development. The result was a perception among some interviewees that communities were losing, or risked losing, access to shellfish resources entirely. On the Sunshine Coast (Lund to Sechelt), for instance, 30 beaches identified as former wild harvesting sites had either been converted to tenures, were located in proximity to a salmon farm, or were closed due to faecal coliforms. The total loss was approximately 80% of the area of formerly productive wild habitat.

3.5.4 Perceptions of salmon aquaculture

As with shellfish aquaculture, many wild harvesters expressed concerns over loss of access to shellfish resources as a result of finfish aquaculture development. Of the 22 wild harvesters interviewed, 58% indicated that salmon aquaculture was altering customary wild harvesting patterns (Table 3.4). Many of these harvesters reported that they no longer

harvested clams or collected oysters on beaches at distances much greater than government suggested guidelines (300 m), as they believed these shellfish were contaminated. These harvesters believed that fish farm contaminants travelled considerable distances and degraded the quality of nearby shellfish beds. Other wild harvesters reported that they did not harvest shellfish in areas that were perceived to be visually close to a salmon farm because of conflicts between local fishers and salmon farming companies. Fourteen of twenty-two wild harvesters indicated that beaches well over 500 m (or in some cases even within 1 km of a salmon farm) were no longer harvested, in part due to spatial occupancy

TABLE 3.2. REPORTED FORESHORE AREA FOR SHELLFISH HARVESTING AFFECTED BY THE PRESENCE OF SALMON FARMS

	Number of salmon tenures	Area of salmon farm leases + 125m buffer (ha)[1]	Number of wild beaches reported to be within 300m of a salmon farm[2]	Number of wild beaches reported to be within 500m of a salmon farm[3]	Wild shellfish harvesting area reported to be affected by salmon farming (ha)[4]
Barkley Sound	9	43.7	3	5	10.7
Quatsino Sound/Kyuoquot Sound/Nootka Sound	8	35.6	1	1	4.6
Clayoquot Sound	11	56.1	5	7	19.1
Broughton Archipelago/ Port McNeill/ Port Hardy	14	58.8	9	10	26.8
Sunshine Coast (Sechelt to Powell River)	13	41.6	2	4	15.4
Total	55	235.8	20	27	76.6

[1] 125m is minimum suggested siting distance between salmon farms and wild shellfish harvesting areas
[2] Reported by interviewees referencing GIS-produced maps
[3] Estimated using values provided by interviewees, and adjusted for areas already restricted due to bacterial water quality closures (source data for bacterial water quality: Environment Canada, 2003)

issues (e.g., "We don't go there since the salmon farm took over the bay.") or due to perceptions of contaminants. According to both wild shellfish harvesters and shellfish aquaculture producers interviewed, perceived risks due to increased finfish aquaculture tenures also included direct conflicts over sea space with shellfish aquaculture sites.

TABLE 3.3. REPORTED DISPLACEMENT OF SHELLFISH HARVESTING AREAS BY SALMON AND SHELLFISH AQUACULTURE LEASES (2005)

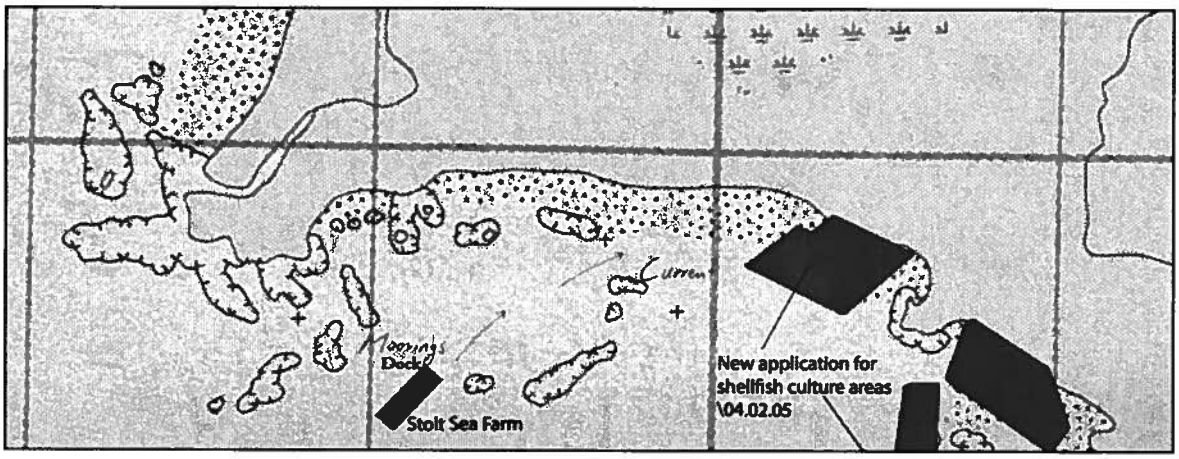
	Number of wild harvesters interviewed	Number of harvesters who indicated shellfish aquaculture had displaced wild harvests	Number of harvesters who indicated salmon aquaculture was altering wild harvesting patterns
Barkley Sound	4	3 (75%)	3 (75%)
Quatsino Sound/Kyuoquot Sound/Nootka Sound	6	4 (66%)	2 (33%)
Clayoquot Sound	5	5 (100%)	4 (80%)
Broughton Archipelago/ Port McNeill/ Port Hardy	3	3 (100%)	2 (66%)
Sunshine Coast (Sechelt to Powell River)	4	3 (75%)	2 (50%)
TOTAL	22	18 (82%)	13 (58%)

In several locations, First Nations participants were vocal in their opposition to the inadequacy of current management regulations for protecting traditional harvest beaches from salmon farm contaminants. These respondents also clearly articulated beliefs that the development of salmon farms in First Nations' territories was an infringement on First Nations' territorial sovereignty and represented impediments both to self-determination and the right to control and manage marine habitats and the biological resources in those

habitats. Many published reports also share these findings (BCAFC, 2002, 2003; EAO, 1997).

Study sites where concerns about finfish aquaculture were particularly pronounced (e.g., Clayoquot Sound and Northeast Vancouver Island) were areas with high densities of salmon aquaculture sites in proximity to actively harvested wild shellfish beaches. In Alert Bay, where there were high densities of salmon farms and significant community

Figure 3.6 – Annotated map showing proximity of wild shellfish beaches (wild harvesting areas), and new shellfish tenure applications to a salmon farm site.



involvement in wild shellfish harvesting, one fisher succinctly summarized what appeared to be a community-wide sentiment when he stated, "We've been harvesting clams here long before the salmon farms decided to move into our waters, and we don't want salmon farms here. Salmon farms are an insult to our people."

Fuelling the concerns over contamination were observations of altered health and appearance of the shellfish grown in proximity to salmon farms, including changes in distribution and characteristics of the flesh and shell (color, size, and meat texture). Across five study sites, 53% of interviewees reported changes in substrate composition and altered species composition on beaches in proximity to salmon farms. In addition to changes in the health of benthic and littoral organisms, many also reported increased organic enrichment

of the water and sedimentation around the farm area ("Nothing grows there anymore, except slime."). Several harvesters and growers expressed health-related concerns about the uptake of antibiotics and heavy metals by clams and other bivalves in proximity to salmon farms. Regardless of scientific evidence for or against evidence for contaminants in proximity to salmon farms, the perception of contamination or even just the presence of a salmon farm (visual line of sight to a beach), was reported as sufficient to alter harvesting practices for the majority of harvesters interviewed.

3.6 Discussion

3.6.1 Spatial overlap of wild habitat and aquaculture leaseholds: implications for access

The GIS analysis, in conjunction with interviews, indicated that total foreshore area of habitat available to wild clam fisheries had decreased as a result of aquaculture development across five study sites from 1995 to 2005. However, the extent to which these changing patterns altered *who* had access to shellfish resources was more difficult to determine. Attribute tables in government datasets for shellfish aquaculture were inadequate to directly address this question, as datasets did not contain adequate information about ownership of lease sites. For example, there was not adequate information to determine which wild harvesters, or groups of harvesters, had acquired shellfish tenures, since the category "private leasehold" was used in many cases to denote both band-owned and non-First Nations' tenures. As such, it was difficult to ascertain whether a transfer of access rights was occurring away from or in favour of First Nations communities, or whether First Nations bands were taking out tenures on former wild harvest sites, thereby transferring access rights into community or band-run tenures.

During interviews, it was possible to determine who owned specific leases and thus assign attributes to data for lease sites. We found that distribution of ownership varied significantly across study sites. In the Clayoquot and Barkley Sound study areas, for instance, interviewees reported that shellfish aquaculture sites included a significant

number of non-First Nations leaseholds, while in more remote areas such as Quatsino Sound or Kyuquot, interviewees reported only a few leases that were not owned by First Nations. On the East Coast of Vancouver Island and on the Sunshine Coast, large processing companies owned many of the tenures, while on the West and Northwest coasts of Vancouver Island, tenures were generally owned by private individuals or First Nations bands.

First Nations governance rights played an important role in disputes over access to and ownership of resources. First Nations' concerns over loss of access to shellfish resources were particularly pronounced because aquaculture tenures constituted a superimposition of property rights onto accepted, traditional and communal resource uses. As noted, the majority of First Nations interviewees viewed shellfish aquaculture as socially and economically risky if it resulted in a transfer of rights away from local communities, but also viewed it as an infringement of Aboriginal sovereignty. Some interviewees viewed non-First Nations shellfish farms in traditional territories as serious risks to territorial sovereignty, because government siting of these farms posed direct challenges to First Nations rights to self-governance. Distrust of government aquaculture policies was not surprising in light of the strained relationship between many First Nations and government agencies over land claims and treaty settlements. In BC, First Nations rights and title cases dispute ownership of coastal areas and fishing rights, and any form of property rights introduced into First Nations' territories are a potential threat to the resolution of these cases. First Nations' beliefs about ownership are, as a result, often in direct conflict with government policies regulating access to resources.

For both First Nations and non-First Nations interviewees, a loss of wild harvesting area was deemed risky if they believed access rights to aquaculture sites would eventually be transferred out of the purview of local communities. Interviewees suggested that the sale of a community- or band-held lease, or a defaulted payment on a lease, could trigger the reallocation of tenures that would result in permanent loss of access by the community. In several cases, where bands had chosen not to acquire tenures (in part due to cost), there

was significant regret that access rights to key beaches had been lost. Several non-First Nations interviewees also echoed this sentiment, insomuch as they believed that by not acquiring leases, they risked losing access to resources in perpetuity, particularly if tenures on productive wild beaches were claimed by non-community based interests.

Despite concerns about leasing policies, and perhaps because of them, many former wild harvesters have chosen to acquire leases for aquaculture development. Many First Nations interviewees who formerly participated in wild shellfisheries also worked on band-owned tenures. In cases where bands had acquired tenures on key wild beaches, the nature of access had changed from common property to private ownership, but access had remained communally distributed among former harvesters. Employment opportunities had not been lost because former wild harvesters from the band now worked at the aquaculture sites. In these cases, access to shellfish resources was not, in fact, being impeded or significantly altered by aquaculture development, even though the nature of access rights had changed considerably. In some communities, the cost of leasing fees, as well as seedstock, infrastructure and labor required to enhance beaches was the only immediate economic differences between wild shellfisheries and tenures.

Despite the increased cost of leasing fees, some interviewees indicated that they had directly benefited from the changing rules of access under leasehold policies. Interviewees who acquired leaseholds on former wild harvest beaches reported that they had increased the biological productivity of overharvested or 'dug out' beaches (i.e., beaches in the wild fishery that no longer had harvestable stocks). Furthermore, First Nations harvesters who had acquired preferential[34] leaseholds on key beaches stated that they no longer competed with non-First Nations interviewees for access to these beaches. Several interviewees also noted that aquaculture has significantly increased total shellfish production values in BC over the past decade and suggested that employment in their communities had increased as

[34] First Nations were given priority in selecting leasehold sites, and non-First Nations leases in First Nations territories were submitted through a referral process for review by First Nations bands. Therefore First Nations had some degree of control in how leases were allocated, but were not always satisfied with the outcome of the process, as final decisions were made by Provincial government officials.

a result. In these cases employment was seen as highly beneficial, even in situations where shellfish farms were not producing large profits.

3.6.2 Benefits of participatory involvement

GIS analysis proved to be a valuable tool for examining competition for sea space between wild and cultured fisheries. It was also useful for examining the temporal nature of changing access rights, as changes in harvesting patterns were reflected in the locations of both wild shellfisheries and aquaculture sites over time (1995-2005). Feedback from interviewees on the GIS data was also crucial for identifying gaps in the government datasets and guiding the analysis. We found that a participatory approach yielded benefits that flowed in two directions: 1) participatory input helped provide quality control and ground-truthing for the formal geospatial analyses; while 2) map-based discussions and sharing of study results helped interviewees situate local observations within the broader geographic context of aquaculture development across BC.

In three of the five study sites, preliminary interviews identified inaccuracies or errors in locations of salmon and shellfish tenures (farms had been relocated, or data was inaccurately digitized). We also found that the GIS information available from government sources was not complete for all years. For example, data on water quality closure areas was only available for 2003, which required extrapolation in order to estimate the effects of closures on current harvesting patterns in wild fisheries. Preliminary interviews identified significant inaccuracies in the initial extrapolation process used to identify locations of water quality closures and, based on this feedback, we were able revise the analysis. However, interpretation remained limited by data constraints, as a result of unavailable datasets and known inaccuracies in those that were available.

Input from interviewees was useful in determining the validity of the proxy values used for wild shellfish sites. A lack of detailed information about wild harvesting locations was not surprising, given that such information is unlikely to be shared with regulatory agencies or even among harvesters due to the competitive nature of the wild shellfishery. The use of

shellfish aquaculture capability surveys was a reasonable proxy, as locations of wild harvest beaches were not available as a spatial data set, and available stock assessment data was limited to a few beaches. Interviews confirmed that the proxy data derived from shellfish aquaculture capability studies, as adjusted for water quality closures, provided a reasonable approximation of wild shellfishery sites. Local knowledge was useful in determining which beaches in the wild shellfishery had been recently harvested, and was invaluable for determining how wild harvesting patterns had changed over time. In this way, interviews remained a critical component in determining the productivity of wild harvests, and the data derived from interviews was necessary to annotate datasets for each of the study sites.

We found that participatory mapping exercises also held considerable potential for exploring the human dimensions of coastal management and, in particular, found mapping to be particularly useful in examining interviewees' perspectives on, and priorities for, future resource use. Initially, before looking at coast-wide maps, interviewees expressed views on changing access rights that were specific to their community. Many assumed that increased development of shellfish and salmon aquaculture tenures (and water quality closures) were occurring in only a few localized areas. After examining maps of other study sites, and coast-wide data of shellfish and finfish aquaculture development across BC, however, many interviewees made connections between local trends and changes that were occurring at a much larger scale. After examining province-wide data on shellfish aquaculture development and water quality closures, many interviewees revised their opinions about local circumstances to include a broader geographic and political context. After examining the maps, some interviewees also commented about the rate at which aquaculture had expanded across the southern half of the province. From the maps and data presented, they were able to speculate about future developments and commented on what aquaculture development may portend for their communities. In some cases, this growth was viewed positively, though in other cases, interviewees suggested priorities for resource use that did not include aquaculture expansion.

3.6.3 Controversy over aquaculture development

In BC, we found that resistance to finfish aquaculture was more politically entrenched and clearly defined than resistance to shellfish aquaculture. From 1995 to 2002, the Provincial government established a moratorium on new finfish tenures based on concerns surrounding the spread of disease and parasites, competition among escaped fish and endemic species, aquatic pollution caused by fish farm effluent, and unresolved disputes over territorial sovereignty between First Nations and government (Noakes et al., 2003). Considerable pressure against salmon farms has been exerted by lobby groups and fisheries unions over damage to wild stocks, as well as over the effects of price competition between wild and farmed fish (BCSAR, 2005).

Many studies have explored the health and environmental effects of salmon aquaculture (Cabello, 2006; Hites et al., 2004; Howgate, 1998; Janowicz et al., 2001; Levings, 1994; Naylor et al., 2005). Only a few studies have directly addressed how policies promoting leasing of sea space for salmon aquaculture result in direct conflicts over access to sea space with competing resource uses. If a spatial displacement of competing marine uses (e.g., wild shellfisheries) occurs when property rights are introduced for aquaculture leasing, this displacement may result in perceptions that local communities are losing control over resources. Further, it may alter relationships among existing resource users by displacing customary rights. For example, if interviewees believed that prescribed buffers around salmon farms were not adequate to preclude contamination of nearby shellfish, they reported altered harvesting patterns, regardless of scientific risk assessments. In some cases, salmon farm leases had been relocated to accommodate environmental concerns about proximity of fish farms to shellfish stocks. However, even these relocations were not deemed adequate by some interviewees to protect shellfish beds. We noted a strong disconnect between public perceptions and scientific estimates of risk from salmon farms, and noted that perceptions of contamination, not siting guidelines, were most likely to alter behavioral customs.

Despite considerable evidence that aquaculture development alters resource use patterns in coastal communities, there has been very little research on how displacement of local access rights accompanying the introduction of property rights for aquaculture affects the economic well-being of local resource users (Anderson, 1985, 2002). Clearly, there are supply-side advantages to aquaculture, but there is a lack of research in the common property and fisheries management literatures on the economic benefits and risks for coastal resource users who are affected by transitions from wild fisheries to rights-based management for aquaculture. Values which favor protection of sea space and beaches as common property also play a role in determining conflicts. In particular, interviewees who had customary access under common property arrangements reported significant concern that aquaculture was infringing on their existing public access rights. A study of salmon aquaculture in Norway reported that local residents who found access rights to coastal areas affected by salmon aquaculture, pursued infringements on use-rights as a basis for legal action (Aarset, 1998). In Canada, legal actions have emerged against salmon farms in BC, and against large-scale industrial blue mussel farming in Nova Scotia (Environmental Law Briefings, 2003). By contrast, a recent study in New Brunswick found competition for sea space between salmon farms and other coastal resource uses such as lobster farming to be relatively uncontroversial (Walters, 2007). Unlike the BC shellfish farming case, Walters found introduction of private leases for salmon farms had not negatively impacted lobster fishing, as the two resource uses were generally considered overlapping rather than exclusionary. Even though lobster traps could be set in proximity to salmon farms, few concerns were reported about contaminants from the salmon farms affecting lobster harvests.

Unresolved First Nations rights and title cases may account for the differences between our findings in BC and the relative lack of controversy between salmon farming and lobster fishing on the East Coast of Canada. On the East Coast of Canada, there is significantly less controversy about infringements on Aboriginal territorial sovereignty as a result of salmon or shellfish aquaculture leases. In BC, treaty negotiations remain unresolved, and conflicts over First Nations' territorial rights are the basis of a number of legal cases

between First Nations and the salmon farming industry.[35] Legal cases over loss of access to traditional fisheries in response to salmon aquaculture development do not currently extend to shellfish aquaculture, but the potential for controversy is clear if industrial shellfish projects emerge in BC.

Although very few interviewees in this study suggested that a moratorium, akin to the BC salmon moratorium of the 1990s, was warranted for shellfish aquaculture, it remains to be seen whether conflicts will escalate if competition for sea space increases and issues of First Nations' territorial sovereignty are not satisfactorily resolved. In New Zealand, a moratorium was invoked in the late 1980s and 1990s on shellfish culturing in response to both environmental and Maori concerns about Aboriginal access to resources. A dramatic increase in leases for green mussel farms in New Zealand in the 1980s promoted strong reactions from Maori groups, and the moratorium was only lifted in 2005, when policies were altered to guarantee the Maoris a 20% stake in all shellfish operations (Tollefson and Scott, 2004). Legal resistance to shellfish farming has also been documented in the United States, Australia, Chile and Norway, and increased legal action in BC over shellfish farms may be imminent if conflicts over allocation of sea space are not adequately addressed.

3.7 Conclusion

Total production of farmed shellfish has increased significantly in BC from 1995 to 2005. At the same time, overall wild shellfish production has remained relatively constant but could potentially decline as marine space is reallocated to aquaculture production and other recreational or industrial uses. We found that interviewees expressed ambivalence about aquaculture development, as they considered it to provide significant economic opportunity but also believed such development to be risky for a variety of economic, cultural and political reasons. All twenty-four of the First Nations interviewees identified at least one of the following risks arising directly from increased aquaculture development:

[35] Cases include Homathco vs. Marine Harvest; Sierra Legal Defence Fund (now called Ecojustice) on behalf of MTTC and Gwawaenuk vs. Stolt Sea Farms, Heritage Salmon Ltd.

a) potential loss of existing rights to subsistence harvest or part-time income from wild shellfish harvests;
b) loss of cultural identity and way of life, based on traditional relationships to wild resources; and
c) risks to territorial sovereignty, pending resolution of land-claims settlements and rights and title cases.

For First Nations, the specific risks articulated in relation to aquaculture development were more acute in locations where access rights to wild shellfish harvesting had been transferred to non-First Nations shellfish leaseholders, or where there was a high percentage of salmon aquaculture sites located in proximity to shellfish harvesting areas. With regard to the siting of finfish aquaculture leases, a distrust of regulatory frameworks, a lack of control over placement of salmon farms in proximity to shellfish harvesting areas, and differing perceptions of the impacts of salmon farm contaminants on shellfish beds all contributed in generating controversy.

Regarding shellfish aquaculture tenures, many interviewees indicated that leases had resulted in an overall reduction of productive beach area available to wild fisheries. The direct competition for habitat between wild fisheries and foreshore aquaculture sites had resulted, to some degree, in a displacement of access among small-scale and traditional harvesters, yet the long-term effects of this transition were not clear. In some cases, coastal communities and First Nations who historically depended on wild shellfish resources for way of life and livelihood had adopted shellfish aquaculture tenures, thereby transitioning former access rights from wild shellfisheries to aquaculture production. In other instances, access to wild shellfisheries was perceived as constrained by the presence of salmon and shellfish farms, and consequently stakeholder groups resisted further development.

To date, the long-term environmental and socioeconomic impacts of shellfish aquaculture development as a form of rights-based management have not been adequately assessed in BC or elsewhere. The increased allocation of private property rights as a prerequisite for

both shellfish and finfish aquaculture development, and the potential conflicts associated with the regulatory frameworks fostering this development, indicate a need for further research on the use of private property rights in leasing of sea space for aquaculture development.

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4. PERCEPTIONS OF RISK AND OPPORTUNITY IN THE DEVELOPMENT OF PRIVATE PROPERTY RIGHTS FOR SHELLFISH AQUACULTURE IN BRITISH COLUMBIA[36]

4.1 Introduction

Global demand for seafood is growing exponentially, yet more than 75% of the world's wild fisheries have been exploited at or beyond capacity (Worm et al., 2006). Aquaculture, which currently produces over one-third of the world's seafood, has been proposed as a solution to the problem of increasing demand in the face of wild stock depletion. Despite promising developments in aquaculture technology and techniques, however, the aquaculture industry has been increasingly beset by controversy, largely in response to environmental and health risks associated with fish and shrimp farming.

In contrast to the shrimp and salmon farming industries, the cultivation of lower trophic level species such as bivalve shellfish or seaweeds generates relatively little controversy, as bivalve molluscs (e.g., clams, mussels, and oysters) are filter feeders that extract nutrients from the water column, and their culture therefore requires no feed inputs and produces few polluting waste by-products (Crawford, 2002; Howlett et al., 2004; Kaiser et al., 1998). Although some environmental concerns have been raised in regard to shellfish farming (Bendell-Young, 2006; Kaiser, 2001), the environmental risks from mollusc

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farming are generally considered to be much less than those of finfish farming (e.g., salmon) or crustaceans (e.g., shrimp) (Folke et al., 1989, 1992; Folke et al., 1998).[37]

In response to the fewer environmental impacts, and the potential social and economic benefits of shellfish aquaculture, industry lobby groups, NGOs and government agencies in British Columbia (BC) have increasingly promoted shellfish production as an environmentally-friendly economic development strategy for coastal communities (Kingzett et al., 1999). Biophysical capability studies of coastline suitability for shellfish production have shown significant opportunity for industry expansion on the West Coast of Canada (MAFF, 2002), and economic feasibility reports have consistently highlighted the advantages of shellfish aquaculture as an alternative or complement to wild shellfisheries (Blewett & Associates; Nelson, 2003; Coopers and Lybrand, 1997).[38] Favorable projections for the industry have led the BC Provincial government to support aquaculture development by issuing new foreshore and nearshore tenures (leases). As a result, the number of clam and oyster tenures granted between 1999 and 2005 doubled, with overall production rates for the past ten years increasing at more than 10% per year. Government projections predict that the number of shellfish tenures will double again by 2010, resulting in a tripling of production within the decade (LWBC, 2004). Currently, shellfish tenures are located primarily in the southern regions of BC (Sunshine Coast and Vancouver Island), although in recent years the industry is expanding to include North Coast regions.

To date, controversy over shellfish aquaculture is muted, as compared to finfish aquaculture in BC, or to political resistance to shellfish farming in other parts of the world (e.g., New Zealand; see Tollefson and Scott, 2004). However, increased growth of the

[37] Although the overall impact of shellfish aquaculture is generally considered to be less significant than salmon farming, environmental concerns have been raised in relation to potential introduction of exotic species in seed stock, losses of genetic diversity, and lack of age-class differentiation, as well as damage to cohabiting species when beaches are tilled and seeded for shellfish aquaculture production.
[38] Several other studies have drawn similar conclusions, see also Gislason, 2002; Kingzett, 2002b; Pinfold, 2001; Vancouver Island Economic Development Association, 2002.

industry in BC is likely, and experience elsewhere suggests that future conflict may be anticipated if exponential growth of the industry continues.

Currently, favorable cost-benefit assessments of shellfish leasing potential, or investigations of fishers' capacity to adapt to new policies and practices, do not explain why certain individuals or communities engage in shellfish aquaculture, while others remain ambivalent or resistant to this development. For some communities, a lack of requisite skills or financial capital to enter the shellfish aquaculture industry may be limiting industry expansion, but few studies have addressed other potentially limiting factors, including an investigation of how stakeholders weigh the perceived risks and benefits of this development. An investigation of beliefs among coastal stakeholders already involved with the industry can potentially predict what concerns are likely to emerge as the industry develops, and also explain why, despite significant government-sponsored initiatives, some communities with both the infrastructure and capacity to develop shellfish leases have not done so.

This paper is based on a series of interviews with a range of coastal stakeholders involved in or affected by the shellfish aquaculture industry, including commercial wild shellfish harvesters, aquaculture growers, fish processors, fisheries managers, biologists, government regulators, and trade representatives. Interviews explore observed patterns of shellfish aquaculture development in BC, as well as attitudes toward this development. In particular, we examine interviewees' beliefs about employment and the regulatory benefits of aquaculture development, their perceptions of potential social and economic risks, and other related factors that explain their interest in, or concerns about aquaculture expansion. For example, we investigate the role of public trust in government agencies as a potential factor influencing the uptake of government-sponsored economic development initiatives for shellfish production. We also examine how interviewees' employment histories and cultural identity may influence their beliefs about the acceptability of aquaculture policies and practices; in this regard, we pay particular attention to a discussion of First Nations cultural and territorial sovereignty, including issues relevant to unresolved rights and title

disputes in BC. Finally, we focus our attention on the role of property rights in defining access to coastal resources and interviewees' perceptions about the role of property rights in shaping coastal resource uses.

In this article, we begin by exploring the current and historical context of the BC shellfish industry and observed patterns of engagement with shellfish farming. We then provide a theoretical justification for our exploration of risk perceptions among industry stakeholders in order to provide a framework for how beliefs about the economic and social risks of aquaculture may be influencing local engagement with shellfish farming in BC's coastal communities. We use the concept of risk perception broadly, as being relevant not only to the study of hazards, but also to perceptions of risk related to loss of access to resources and fears of environmental, economic, and cultural loss caused by changing policies and industry practices. Using a risk-based framework, we identify a number of important differences between finfish and shellfish farming, and discuss how these differences may play a role in garnering public support for growth of the shellfish sector. In BC, the allocation of property rights for aquaculture development often conflicts with First Nations territorial sovereignty issues, and we present results describing how First Nations bands engage with government agency efforts to promote shellfish aquaculture as an economic development strategy. By exploring a variety of stakeholders' perceptions about risk and opportunity in the BC shellfish aquaculture industry, we also investigate the role of private property rights in aquaculture development and the potential for conflict over these rights in the context of broader discourses about privatization of marine space in coastal management and marine governance. Much of the existing literature on marine governance does not address in any detail the ways in which aquaculture leasing policies — by creating property rights within the coastal commons — create conflicts over sea space with competing uses of foreshore and nearshore habitat. This paper is organized around two key themes. The first is a desire to conceptualize aquaculture as a form of rights-based management in order to understand the effects of this type of management on existing resource users in coastal communities. The second is to understand how stakeholders in the BC shellfish industry weigh tradeoffs between the risks and benefits of shellfish

aquaculture development, and to explore more broadly how public perceptions about risks and benefits influence industry growth and shape public discourse about aquaculture policies and practices. The following sections explore these themes in more detail, while grounding the discussion in a case study of the British Columbia shellfish industry.

4.2 Context

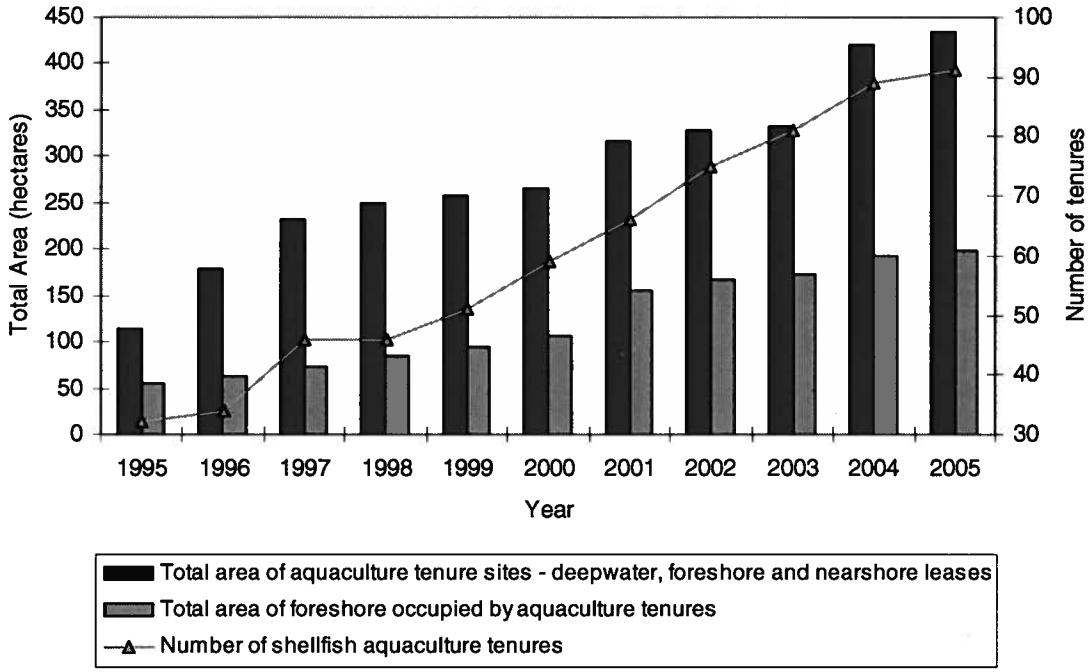
4.2.1 Shellfish aquaculture production

The majority of shellfish aquaculture leases in British Columbia are currently issued for clam and oyster production, although leases are also available for other species, including scallops, geoducks, abalone, cockles and mussels (and many sites co-culture several species under the same lease permit). Bivalve aquaculture production in BC has increased steadily, such that, in 2005, all BC commercial grade oysters (*Crassostrea gigas*) were cultivated (BCSGA, 2005), and by 2006, the total volume of manila clams produced through aquaculture exceeded the volume harvested in wild capture fisheries (MOE, 2006b). Shellfish farming, particularly for clams and oysters, is a space-intensive venture requiring access to tracts of intertidal and estuarine habitat. Over a ten-year period from 1995 to 2005, the total area of sea space in BC devoted to shellfish aquaculture increased by 42% (MOE, 2006a) (Figure 4.1). In 2005, this included a 3% increase in foreshore area (approximately 55% of leased area) and a 5% increase in nearshore habitat (approximately 45% of leased area) devoted to shellfish aquaculture. In 2005, shellfish leases encompassed a total of 3033 hectares of nearshore and foreshore area in BC (MAFF, 2007a). Even though shellfish accounted for only a small percentage (approximately 12%) of total aquaculture production values, shellfish tenure sites occupied about half the total area of all aquaculture leases in the province, while salmon aquaculture and other finfish sites occupied the remainder (MOE, 2007). Farmed shellfish production volumes per unit area are relatively low compared to other types of aquaculture operations (e.g., salmon farming), yet still higher than per unit area yields for wild shellfish beds.

Shellfish aquaculture development in BC is currently predicated on a tenure system that grants access to sea space or beach habitat. Tenures function in much the same way as do

land-based property rights, which can be bought and sold (e.g., by real estate agencies). Growers can apply for leases or purchase existing leases to cultivate three distinct types of habitat: foreshore (beach), nearshore, and deepwater. Nearshore and deepwater leases have

Figure 4.1 Area occupied by aquaculture leases for five study sites 1995-2005



very few effects on naturally occurring shellfish habitat, as shellfish are grown in cages, trays, or longlines at some distance from shore, while shellfish beds in the wild fisheries (e.g., for clams and oysters) are exclusively located in intertidal or estuarine areas. Foreshore lease applicants may apply for tenure on naturally productive wild clam and oyster beaches. Although leases are not always granted at these sites,[39] it is generally advantageous for a leaseholder to apply for a site with good natural habitat and natural recruitment (e.g., productive wild fisheries sites are most likely to be equally productive if

[39] Tenure applications will not necessarily be awarded, even if applied for, on highly productive wild beaches, as the cost of such applications are significant, and thus if public opposition is expected, applicants may choose less desirable beaches, such as beaches that have been overharvested or beaches that are already subject to depuration fisheries. However, it remains that any benefits from the ownership of former wild habitat, and future benefits that accrue from the sale of naturally-recruited stocks within that habitat, belong to the tenure holder.

developed as aquaculture sites). If wild harvest beaches are redesignated as aquaculture sites through tenure applications, foreshore shellfish leases have the potential to limit access to public beaches by reassigning them to private owners, and to effectively displace wild harvesters who formerly fished on those beaches. The effects of the introduction of property rights in the foreshore — and the subsequent conversion of some publicly-owned beaches to private seafood farms — thus has the potential to exclude existing uses of the foreshore, including displacement of subsistence, recreational and commercial wild shellfish harvests. Displacement effects may not be felt as keenly if former wild harvesters or their representatives (e.g., First Nations bands) are the tenure applicants for a band-owned or communal lease. In that case, a transition from a wild fishery to aquaculture implies a change from public to private ownership, but access rights to the resource often remain distributed among former fishers.

Shellfish aquaculture in BC has the potential to provide important economic opportunities in coastal communities by increasing employment in otherwise declining fisheries and fish processing sectors (Table 4.1). In 2005, the unemployment rate for rural Vancouver Island and the North Coast of BC was 12%, while for some First Nations communities, that rate was more than 65% (Statistics Canada, 2005b). High unemployment rates have led many former workers in resource industries to seek employment in urban centers, with subsequent population losses in rural areas. Proponents of shellfish aquaculture argue that, relative to salmon aquaculture, the low cost of entry into the shellfish aquaculture industry makes it advantageous as an economic opportunity for small-scale entrepreneurs, especially among fishers in rural communities who may have access to boats and the relevant skills to build and maintain shellfish aquaculture sites (Osborne, 2000). In addition, once the infrastructure for a shellfish farm is in place, production is relatively inexpensive compared to more intensive finfish farming methods where there is a continuous need to supply feed from external sources (Shumway et al., 2003).

4.2.2 Perceptions of Risk

Theories of social construction of risk may provide a context for examining public perceptions about the shellfish aquaculture industry. Considerable psychometric research,

Table 4.1 - Economic Profile of the Beach Shellfish Aquaculture Industry in BC (2001)

	Total industry - 2001	**Average per operation**	**Production returns per hectare**	**Tonnes of production**
Number of tenures	275	1	.18	.05
Tenure area	1,500 hectares	5.5	1.00	.26
Production				
Clams	1,400 tonnes	5	.9	.25
Oysters	4,300 tonnes	16	2.9	.75
Total	5,700 tonnes	21	3.8	1.00
Product value				
Farm gate	$11.7 million	$43,000	$8,000	$2,100
Processing margin	$8.1 million	$29,000	$5,000	$1,400
Wholesale value	$19.8 million	$72,000	$13,000	$3,500
Wages & benefits				
Farm level	$6.0 million	$20,000	$4,000	$1,050
Processing	$3.0 million	$10,000	$2,000	$550
Total	$9.0 million	$30,000	$6,000	$1,600
Employment (person years)				
Farm level	240	.9	.16	.04
Processing	120	.4	.08	.02
Total	360	1.3	.24	.06
Investment	$40 million	$150,000	$25,000	$7,000
Government revenues				
Provincial				
One time fees	$.2 million	$700	$130	$35
Annual rent	$.2 million	$700	$130	$35
Local property tax	$.04 million	$150	$25	$7

Source: GSGislason & Associates Ltd., 2002 http://srmwww.gov.bc.ca/rmd/srdb/docs/BB-BeachShellfish.pdf

has examined how perceptions of risk influence consumer decisions about products and industries (Gregory et al., 1995; Pidgeon et al., 2003; Yeung et al., 2001). Social approaches to risk research have shown that aversion to particular industries is influenced not only by objective, probabilistic assessments of technological hazards associated with those industries, but also by characteristics of the risk object itself, and by the sociocultural contexts into which risks are introduced (Lupton, 1999; Slovic, 2000). Psychometric studies have shown, for example, that resistance to specific industries or public policies such as toxic waste disposal or nuclear energy is largely unrelated to the measurable risk of potential health hazards. Instead, such studies show stronger correlations with socioeconomic and cultural factors such as gender, race, and cultural identity (Flynn et al., 1994 Satterfield et al., 2004; Slovic, 1993), as well as trust in agencies responsible for mitigating risks associated with these industries (Poortinga et al., 2003; Slovic, 1999; Walls et al., 2004). Psychometric models have been particularly effective at explaining how dread associated with risks or hazards relates to characteristics of the risk itself. For example, heightened perceptions of risk are influenced by a variety of predictable factors, such as whether the risk is viewed as lethal or catastrophic, imposed or involuntary, uncontrollable, unknown, or unfamiliar (Fischhoff et al., 1978; Slovic, 2000).

Studies of risk communication failures have attempted to address the consistent disconnect between scientific estimates of risk and levels of public concern through better integration of people's mental models into risk communication programs (Morgan et al., 2001). Explanations for public amplification of risk and subsequent industry stigmatization indicate that controversies intensify when signal risk events occur and responsible parties fail public expectations (Flynn et al., 2001; Kasperson, 1992). In situations in which there is a lack of public confidence in scientific competency, or in cases in which regulatory capability is deemed inadequate, a risk communication vacuum is said to occur and entrenched oppositional positions prevail (Leiss, 2001; Powell et al., 1997). Theories of social amplification of risk also posit that risk incidents may have secondary 'ripple' effects set off via 'amplification stations' (e.g., government agencies, social groups, the

media, or scientific institutions) that can ultimately result in widespread stigmatization of people, industries, or products with which they are associated (Gregory et al., 1995).

In relation to aquaculture, Katranidis et al. (2003) found that greater social acceptance of aquaculture is linked to perceptions of higher socioeconomic benefits and lower environmental impacts for local communities. Similarly, Mazur and Curtis (2006) have shown that public perceptions of the environmental and health risks of shellfish and finfish aquaculture in Australia are linked to negative local responses to aquaculture development; they also suggest that planning and management designed to address public concerns about aquaculture risks can improve acceptability of the industry. Studies reporting heightened public perceptions of potential harm from aquaculture find that consumers' perceptions of social, health, and environmental risk derive primarily from information about shrimp and salmon farming, and that risks associated with these industries are frequently conflated to include other types of aquaculture production (Kaiser et al., 2002). Public perceptions of the negative impacts of shrimp and finfish culturing are shaped largely by health and environmental risks, including risks from contaminants, habitat destruction, parasitic infections of wild stocks, and unintentional introductions of non-native species. The shrimp and salmon farming industries have also been heavily criticized in response to public perceptions of their potentially detrimental social and economic impacts on food security and local resource use (Naylor, 2000; Naylor et al., 2005; Pauly et al., 2001).

Stigmatization of the salmon farming industry in response to these concerns has been costly to the industry, with public resistance manifesting in protests against fish farming activities, vandalism to farm sites, consumer boycotts of farmed salmon, and lawsuits (Gardner et al., 2003). In response to these concerns, the BC government imposed a moratorium from 1995-2002 on new salmon fish farm licenses, thereby effectively limiting expansion of the finfish aquaculture industry for almost seven years (MAFF, 2003). Similar to the BC case with salmon aquaculture, a substantial body of research in the developing world has shown shrimp aquaculture to have considerable detrimental effects on inshore fisheries habitat and traditional land uses (e.g., agriculture or hunting-

gathering). Shrimp farming, for example, has been linked with marine pollution, and a redistribution of resources away from the rural poor through degradation of coastal habitat (Bailey, 2003; Barraclough, 1996; Stonich et al., 1997). Studies have shown that when access rights to wild fisheries resources are constrained by aquaculture development, it is rural, resource-dependent peoples involved in subsistence activities for their livelihood who are most likely to be affected. In many cases, shrimp aquaculture has been shown to displace existing coastal resource uses, particularly if the transformation of common property or tenant land arrangements leads to consolidation of private corporate holdings or land-estates (Bailey, 1997; Primavera, 1991).

Many coastal stakeholders in BC who are involved in shellfish production share characteristics of rural subsistence harvesters in other parts of the world, including livelihoods that include occupational diversity, seasonal employment, and dependence on natural resources for their way of life. If existing coastal resource users depend on wild fisheries, we anticipate that they will have heightened worries about risks from aquaculture development. This is particularly so if aquaculture is liable to (a) alter coastal resource use patterns through degradation or exclusion from wild habitat held as common property; (b) provide limited employment opportunities for local people or, (c) if employment opportunities for local people are not as desirable or lucrative as existing coastal resource uses. Many of the above social risks of aquaculture development are also tied to the redistribution effects of access rights, when private property is introduced to manage what were formerly commonly held public resources. Despite potential benefits from aquaculture development, the effect of changing access rights — including potential displacement of existing resource uses — has led coastal stakeholders in some parts of the world to conclude that the risks of aquaculture outweigh its benefits (Stonich, 1995; 2000). In addition to possible environmental degradation associated with certain types of aquaculture production (e.g., shrimp and salmon farming), losses associated with privatization of public lands have generated significant opposition to aquaculture development insomuch as the privatization of waters for aquaculture development have led to redistributions of access rights away from existing coastal resource users, many of

whom depend on inshore fisheries for food and livelihood (Bailey, 1997, 2003; Naylor, 2000; Skladany et al., 1995).

4.2.3 Property rights considerations

Private property rights are generally viewed as a prerequisite for the development of an aquaculture industry, as the exclusive access rights associated with tenures provide a necessary incentive for producers to invest in infrastructure (Anderson, 2002; Bowden, 1981). Aquaculture tenures can not only reduce costs of production and facilitate management functions, but the increased self-interest of growers implied by private property rights may also decrease production inefficiencies of limited or open access systems (e.g., intense competition for limited resources leading to overharvesting), with implied benefits for both consumers and producers. Further anticipated benefits may include improved product quality, supply and safety, as aquaculture products can be grown to meet specific, year-round demands of seafood markets. Private property rights confer predictability, and the right of exclusion afforded by these property rights produces strong incentives for owners to invest in site development. Shellfish growers can use leases as collateral on loans to develop infrastructure (e.g., rafts, boats, seedstock). Delineated and enforceable property rights also allow producers to increase product quality and value by investing in more efficient forms of production (e.g., using predator-exclusion nets, seeding beaches). Aquaculture may also be particularly attractive to producers where wild shellfish beds have been depleted by overharvesting because foreshore leases can be used to reseed damaged beaches, or nearshore leases can be used supplement natural foreshore production (e.g., through raft-based culturing). Culturing of shellfish also allows for standardization of age classes, which simplifies harvesting and allows producers supply-side control over their markets. Furthermore, overall productivity and total yields increase with aquaculture development, as beaches that are tilled and maintained as aquaculture sites produce significantly more product per unit area than do wild beaches, while raft-culturing techniques (growing shellfish on trays or longlines) can also significantly reduce grow-out times for mussels, oysters, clams, and scallops (Becker et al., 2008).

The private property rights associated with aquaculture development are also attractive to government agencies. In BC, the government benefits directly from aquaculture in the form of revenue derived from tenuring (leasing) fees, as shellfish growers pay annual leasing fees to the government for the privilege of obtaining tenure rights to shorelines and coastal waters (Ministry of Agriculture and Lands, 2005). If shellfish production can be contained in a few privately-owned leaseholds, as opposed to wild fisheries which are distributed over large, unpopulated sections of coastline, aquaculture also has the potential to simplify administrative practices, largely because it can make seafood products easier to track from source to market, and reduces regulatory costs associated with wild fisheries, such as monitoring for illegal harvesting (e.g., enforcing anti-poaching laws). Private leaseholds also have the potential to reduce the administrative costs associated with environmental testing of shellfish growing waters, as monitoring can be transferred from the public sector (e.g., in wild fisheries) to the private lease owners. Proponents of aquaculture have suggested that a number of other regulatory benefits can be expected, including possible cost recovery for management.

4.2.3.1 Potential conflicts with wild fisheries

Conflicts over aquaculture development may occur if aquaculture leases are viewed as directly competing with wild fisheries. Wild shellfish harvesting is an important industry in coastal BC; in 2006, shellfish production in BC from both farmed and aquaculture sources had a landed value of CAD $127 million, representing 16% of total seafood production in the province (MAFF, 2007a). Although revenue from aquaculture production is increasing, wild harvest fisheries remain important sources of seafood revenues. Wild-caught bivalve species of molluscs, including clams, mussels, geoducks, oysters, and scallops, accounted for 40% of total shellfish values in BC, while crustaceans (e.g., shrimp, crabs, and lobster) constituted the remainder (MAFF, 2003).[40] Clams, including geoducks, were the most important of the bivalve molluscs in both wild capture and cultured fisheries. The wild

[40] The term shellfish generally refers to shelled molluscs and does not include crustaceans such as shrimp, prawns, or crabs. Some government statistics will include crustaceans as shellfish, though the majority of definitions consider shellfish to be molluscs only.

harvest of geoduck clams (*Panopea abrupta*) generated the largest percentage of total shellfish revenues ($33 million in 2006),[41] while the wild harvests of manila clams *(Tapes philippinarum)* and littleneck clams *(Protothaca staminea)* are the largest mollusc capture fisheries by volume (MAFF, 2007b).

The intertidal wild clam fisheries (e.g., manila and littleneck clams) on British Columbia's southwest coast are of particular interest in this paper because they are important sources of part-time and seasonal work in coastal communities that regionally employ a significant number of harvesters.[42] More than 80% of the license holders legally entitled to harvest manila and littleneck clams in wild commercial fisheries are small-scale harvesters in rural communities (Mitchell, 1997). In the 1998-99 season, for instance, approximately 990 clam licenses were issued (Dunlop, 2000). Although revenues in this fishery are small (the average declared earning per license was only $2,685 on the West Coast of Vancouver Island in 2005), the fishery provides important income during winter months when other employment in remote communities is scarce. The wild clam fishery has significant representation from Aboriginal groups, with approximately 50% of wild-harvest clam licenses being allocated to bands (in the form of Aboriginal Community Clam Licenses – ACLs) or to individual users (as Z-2 licenses) in First Nations communities (James, 2003).

A number of problems have increasingly beleaguered wild shellfisheries- — problems that in some cases make aquaculture an attractive alternative. The wild manila/littleneck clam fishery is currently managed as common property, and harvests are controlled through limits on the total number of harvesters' licenses, time-delimited fisheries openings, and

[41] Geoduck aquaculture was first licensed in British Columbia in 2006, and therefore is not reflected in these statistics.

[42] For the purposes of this paper, we concentrate on littleneck and manila clam fisheries only. There is a small recreational oyster fishery (non-commercial), but almost all oysters in BC are grown through aquaculture. Wild geoduck fisheries were transferred to a quota management system in 1989, and despite high overall revenues from this fishery, the proceeds are divided among a very limited number of harvesters licensed in this fishery. Revenue derived from geoduck fisheries therefore accrues to a small number of individuals, and profits are not broadly distributed among a wide range of coastal stakeholders. In contrast, the number of intertidal manila clam licenses issued ranges between 700 and 1000 licenses per year, and the fishery therefore plays an important role in employment for coastal communities (Department of Fisheries and Oceans, 2007). We do not consider the razor clam fishery or the gooseneck barnacle fishery, as income derived from these fisheries is limited to very specific coastal areas, and thus did not lend itself to a coast-wide analysis.

specification of minimum legal clam sizes. However, these measures do not control the total take of the fishery, nor do they impose conditions on the amount of the resource that is harvested. The average 10-year wild clam harvest has remained relatively constant (approximately 1200 to 1600 tonnes annually), though in recent years, total catch has declined slightly (MAFF, 2007b). One explanation may be that, despite a relatively stable volume of harvest, increased fishing pressure in some locations — either through legal catches and/or poaching — has resulted in increased fishing pressure, intensified competition, and potential overharvesting of wild clam stocks. Such problems are clearly also compounded by increased sea otter predation, increased water quality closures due to bacterial contaminants (e.g., elevated faecal coliform levels (EC, 2003a, 2003b; Kingzett, 2002a), and contaminants from industrial effluent including pulp mills, mines, and smelters (BCAFC, 2003; BCSGA, 2005). Property rights associated with foreshore shellfish aquaculture may also reduce the beaches available to wild clam fisheries, but could theoretically increase volume of production using less sea space, and allow for seeding, predator control (netting), and improved quality of product and monitoring of shellfish sites. In locations where increased fishing pressure has depleted standing stocks,[43] seeding a beach (e.g., by first converting it to a tenure for aquaculture production) can increase productivity by halving grow-out times, while raft culturing can increase production volumes without competing with wild stocks (Becker, 2008). Aquaculture, thus, may be a favorable alternative or complement to wild clam fisheries for increasing overall production values, and has already been shown to be very effective in developing a commercial oyster industry.

Despite government encouragement and economic incentives, there remains reluctance among some BC coastal inhabitants to purchase or develop aquaculture leases. Growth of shellfish aquaculture in BC has prompted concern among some coastal stakeholders who believe that this development may have significant detrimental effects on access to resources, while not proving to be particularly lucrative or creating significant employment opportunities in coastal communities. Concern exists that aquaculture development is

[43] Wild stocks will regenerate naturally over time, based on natural recruitment, but seeding a beach for aquaculture can decrease the time to next harvest.

reducing access to habitat for the subsistence or commercial harvest of wild shellfish, and that leaseholds are infringing on First Nations' customary rights to resources and territorial sovereignty. In order to examine the basis of such concerns, we conducted interviews over a period of two years (2003-2005) with individuals involved with shellfish harvesting, aquaculture development, the shellfish processing industry, or fisheries regulation in BC. We selected a range of coastal resource users involved in the BC shellfish industry to determine how estimations of the tradeoffs between the risks and benefits of aquaculture are influencing decisions to engage with, or resist government shellfish leasing policies.

4.3 Methods

4.3.1 Study sites

Interviews were conducted with 56 individuals across five study sites chosen to represent a diversity of experiences with both wild fisheries and aquaculture leases. Study sites included communities with varied fishing histories and local industries (Figure 1.4). The nature of leasehold ownership and degree of aquaculture development diverged considerably among study sites. In the Clayoquot study area (area 1), for instance, there were many shellfish aquaculture sites which were owned primarily by non-First Nations, while in Nootka, Kyuquot, and Quatsino Sounds (area 2), there were fewer leases and the majority of these leases were owned communally by local First Nations bands. On the Sunshine Coast (Sechelt to Lund; area 3), there was limited aquaculture development, but a near-equal distribution of First Nations and non-First Nations leases. At the Sunshine Coast study site, some band members and a few non-First Nations also still participated in wild harvest shellfisheries away from the major population centers, though many of the wild beaches in this study area were permanently closed to shellfish harvesting due to faecal coliform contaminants or overharvesting. In contrast, all of the First Nations and non-First Nations interviewees at the Northeast Island (area 4) had participated in wild shellfish harvests in the previous five years. At the Northeast Island study site, there were a large number of salmon farms but only one active shellfish farm. In contrast, in Barkley Sound (area 5), shellfish aquaculture predominated over wild fisheries, as only a few

interviewees, both First Nations and non-First Nations, reported having held licenses in wild fisheries within the past five years.

4.3.2 Interviews

Thirty-four interviews were conducted at the five study sites with wild shellfish harvesters and aquaculture leaseholders; twenty-two additional interviews were conducted with shellfish aquaculture producers, processors, and fisheries managers not associated with the five specific study sites, but who had a stake in the industry or affiliations across multiple jurisdictions (Table 2.1). Interviewees were also selected at each study site to represent a broad demographic cross-section that included a diversity of ages, varied employment histories, and both First Nations and non-First Nations wild harvesters and aquaculture operators.

Interviewees were organized into four key groups: leaseholders actively involved in developing aquaculture farm sites (group 1); individuals holding shellfish leases (either directly as leaseholders or through band leaseholds) but not directly participating in growing shellfish at those sites (group 2);[44] policy makers, shellfish processors, managers, biologists, and industry representatives (e.g., from growers' associations, or the Clam Board) not associated with specific study sites but involved in managing wild fisheries or aquaculture resources (group 3); and wild harvesters who participated in commercial clam fisheries (group 4). Although we found these categories useful for identifying interviewees and classifying their responses, we also found significant overlap between categories. For example, nine out of twenty-two (40%) wild harvesters also owned aquaculture leases, and thirteen out of twenty-two (59%) of managers, processors, and industry representatives also owned aquaculture sites.

[44] Leaseholders in this second group were not actively seeding beaches or developing infrastructure, but were either taking a minimal shellfish harvest based on natural wild recruitment from leased beaches, or were holding leases for future use.

Aquaculture owners/operators (group 1, n=12): Aquaculturalists were, in general, small owner-operators (production values < $200,000/year) and included both First Nations and Non-First Nations leaseholders. Approximately 73% of the twelve aquaculture leaseholders interviewed were from First Nations bands. Eighty-seven percent of the aquaculturalists interviewed had been active in wild clam fisheries in the past five years; 42% continued to participate in wild fisheries but also owned (either individually or as a member of a band or cooperative) at least one shellfish aquaculture tenure.

Non-farming tenure-holders (group 2; n=6): More than a quarter (26%) of the tenure-holders who had acquired and were paying for leases did not actively farm them; within this group, most (87%) belonged to First Nations bands who acquired leases under preferential siting agreements. In the 1990s, First Nations bands were given a finite period of time (e.g., ten years) during which they would have preferential access to leases, after which date other users were entitled to apply for unclaimed tenures. In some cases, leases were being held speculatively, in the hope of developing the site at a future date, or to preclude other applicants who might otherwise compete for lease sites and maintain access to key harvesting areas.

Regulators, managers, processors, and industry representatives (group 3, n=22): A third group of interviewees included government regulators, fisheries managers, and biologists, as well as shellfish processors and industry/trade representatives. Interviewees in this group were not necessarily associated with specific study-site communities, but were directly involved in shellfish production (both wild and cultured fisheries), and derived their primary livelihood from shellfish processing, marketing or management.

Wild harvesters (group 4; n=22): Wild commercial harvesters (e.g., clam diggers) included interviewees who held ACL or Z-2 clam harvesting licenses for more than five of the previous ten years. We also included individuals (e.g., some First Nations elders) who did not actively harvest in the commercial fisheries, but who reported consistent subsistence harvesting or a history of more than ten years of total harvesting in the wild

fisheries. Among the wild-shellfish harvesters interviewed, 85% lived in rural areas with less than 2000 inhabitants; approximately 45% of wild shellfish harvesters were self-identified members of local First Nations bands (as was appropriate given that First Nations are more than 50% of licensed wild harvesters in the commercial clam fisheries).[45]

4.3.3 Interview protocol

Interview questions fell into six primary categories of inquiry relative to interviewees': (1) historical access to and use of local shellfish beds; (2) perceptions of economic risks and benefits associated with local development of shellfish aquaculture; (3) attitudes towards government regulation of shellfish and other local natural resources; (4) knowledge of and experience with current fisheries policies and regulations; (5) perceptions of the cultural implications of shellfish development; and (6) reflections on beliefs about the benefits or risks of the move toward tenuring of beaches and foreshore. In order to better identify factors influencing perceptions of aquaculture development, questions also focused on beliefs about (i) the right to derive subsistence and commercial livelihoods from wild shellfish harvests; (ii) place-based or cultural identification with shellfish resources; (iii) stewardship of resources and responsibility to preserve resource access for future generations; (iv) trust in experts and government authorities and management systems (including policy-relevant knowledge or previous experience with other types of privatization of fisheries resources) (v) status of Aboriginal rights and title claims; and, (vi) environmental and economic priorities for nearshore and foreshore areas.

4.4 Results

Overall, we found that respondents identified three distinct categories of concern associated with shellfish farming: (1) uncertainty over economic benefits and risks; (2) perceptions of risks to culture and way of life in coastal communities, primarily resulting from loss of access to wild fisheries (or the symbolic power of 'wild' fisheries more broadly); and. (3) political considerations specific to First Nations peoples about the

[45] In 2006, more than 650 First Nations individuals held Aboriginal Clam Licenses or presented Indian Status cards as identification when applying for Z2 licenses (out of approximately 1200 total available licenses).

tenuring process, including potential risks to territorial sovereignty as a result of unresolved rights and title cases, and loss of access rights to traditional subsistence and commercial fishing rights.

4.4(a) Perceived economic benefits

Interviewees reported that the economic benefits of aquaculture had accrued in two main arenas: increased production values and long-term employment opportunities. All of the government officials and industry representatives whom we interviewed supported increased aquaculture production in BC. Processors and inspectors from seafood companies also generally supported aquaculture production (84%; *n=6*). All processors routinely bought shellfish products from wild harvesters, but preferred aquaculture sources because supplies were predictable and buyers had more control at all points of production (e.g., quality control, the ability to project harvests in relation to market demand, and the ability to determine pre-negotiated prices/volume of product). The majority (78%, *n=56*) of all interviewees, including wild fishers, also stated that shellfish aquaculture could provide economic opportunity by increasing the value of total shellfish production.

Reported expectations for economic development were consistent with data showing a tripling in shellfish production values in BC since 1995 (Statistics Canada, 2005a). However, interviews revealed important nuances in interviewees' experiences with economic development that did not correspond directly with statistical increases in production values. Surprisingly, several aquaculture site managers reported that increased production had not translated directly into revenue for their communities, yet the employment benefits of aquaculture (not infrastructure or capital investment) were nonetheless meeting important goals for economic development. As one First Nations fisheries and aquaculture manager described:

> "Shellfish aquaculture is one of the few economic development projects that has provided consistent employment in this community. Returns on our tenures are marginal, or even negative, but I can't name another project around here that has led to long-term jobs for the people of this community… "

Aquaculture was viewed particularly favorably at study sites where leases were not in competition with wild resources for foreshore habitat (e.g., nearshore raft culturing for oysters), or where leases were granted to wild harvesters that effectively restored or supplemented already over-exploited wild resources:

> "A lot of (clam) beaches up here have been dug out, and legally, DFO won't let us seed or net a wild beach, so putting an aquaculture site up there can't be a bad thing... lots of people in our community want to harvest clams, but with all these closures, there are only a few good beaches... it is the only way I know to increase production [through aquaculture]."

In Kyuquot Sound, for instance, wild harvesters had obtained additional employment on band-owned tenures, and raft culturing had increased production without significantly affecting wild harvests. Thus, aquaculture was considered to complement, rather than displace, wild fisheries. Furthermore, beaches that were tenured and therefore no longer available to the wild fishery were not subject to competition for access by harvesters outside the band. In this case, the band council had actually acquired sole ownership of former wild resources, albeit at significant additional cost (e.g., leasing fees and loan payments on infrastructure).

4.4(b) Perceived economic risks

Interviewees stated that low profit margins associated with shellfish farming (i.e., high initial and ongoing costs with relatively low return on investment) was the primary reason why aquaculture was not providing more economic benefits for rural communities. In comparison to wild fisheries, where investment is nonexistent, shellfish farms compared unfavorably in this respect, as they required initial capital investment for infrastructure, as well as significant ongoing operating costs to cover labor, seed stock, and annual leasing fees paid to the government. The majority of aquaculturalists (group 1) stated that their tenures had not been as lucrative as anticipated. The overall return on investment was cited

as 'poor' for 67% of sites considered.[46] Only two of the First Nations communities had consistently sold product from their band-owned tenures, and neither had achieved more than a negative return on their investment.[47] Although aquaculture was considered to be economically viable for larger producers who could benefit from economies of scale, interview data suggest that aquaculture is much less lucrative for the type of small-scale operators who would benefit the most from increased employment opportunities. Nearly three-quarters (72%) of all interviewees, for instance, stated that shellfish aquaculture production did not currently have significant economic advantages over wild fisheries for small-scale producers in coastal communities. This result was surprising in light of the oft-reported economic benefits of shellfish aquaculture production, particularly for generating rural employment (AMB, 2000; Gislason, 2002).

Unforeseen capital expenditures and difficulty in marketing products accounted in part for lack of profitability for small-scale farmers. Several aquaculture site managers said they believed that aquaculture production should improve the saleability of product through guaranteed contracts from processors, but these benefits were not observed in practice. These managers reported that they felt 'captive to' or 'forced to accept' buyers' offered prices, as they did not have the capacity to transport, process, and market their products competitively. Several site managers stated that they believed aquaculture could only become profitable if developed by cooperatives or by larger corporations capable of vertical integration for processing and marketing. For instance:

> "Many of us feel that shellfish start-up is too expensive [for the band]. We want to provide employment for the community, but we don't have the capital to invest for unknown returns..."

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[46] Several large oyster producers reported significant profit margins on their investment. It appeared that sites reporting greater revenues generally benefited from economies of scale and were well-established within specialty or niche markets.

[47] Much of the initial investment for these tenures was provided through government grants (e.g., employment initiatives, Indian Affairs grants, interim treaty measures), and thus total investment was hard to calculate, as it came from a variety of sources over longer time-periods. Overall negative returns were reported to researchers during interviews, but the researchers did not access the original data on investment or profits in order to assess returns or operating margins.

In Quatsino, an innovative proposal was suggested in order to overcome the potentially prohibitive costs of acquiring and maintaining leases. Plans had been developed for a large-scale industrial shellfish farm that included the subleasing of large tracts of nearshore habitat to established shellfish companies and processors. Under the terms of subleasing agreements, the Quatsino band council would only assume liability for leasehold payments, without the direct financial risk of developing the tenures and marketing final products. The proposal was designed to attract outside investors, who would also agree to provide local employment to Band members as part of the leasing agreement. A subleasing agreement was viewed as having the potential to generate income without imposing the liability of investment in infrastructure. However, we found that this type of potential subleasing agreements did not appeal to all interviewees. As one interviewee stated:

> "There are environmental concerns with that kind of large-scale industrial aquaculture; also you got some big corporations in there running everything. Owning the tenure gives you some control, but what if the band gets greedy and wants the money tomorrow, and they sell that tenure? Then what will you have left ten years from now?"

Several interviewees expressed concern that defaults on leasehold contracts, or the increased sale of leases, could eventually lead to industry consolidation. They commented that consolidation, with implied movement of access rights away from communities, had occurred in other commercial groundfisheries when small owner-operators sold their wild salmon licenses or defaulted on boat payments. Many interviewees also pointed out that salmon aquaculture in BC was now owned by only a handful of companies and expressed a fear that similar displacement and consolidation could occur with shellfish aquaculture. The majority of salmon leases were initially developed by small owner-operators (MAFF, 2007c) but had been bought out; the salmon farming industry in BC had increasingly consolidated such that by 2007, the majority of tenures supporting the $13 billion dollar industry were owned by only three companies (Cox, 2004; MAFF, 2008).[48]

[48] Cox reports five companies in 2004; further consolidation through mergers and buyouts has resulted in two principal companies owning 96% of the BC salmon farming industry (if Stolt and Marine Harvest are now considered to be the same entity).

4.4.2 Perceptions of risks to culture and way of life

Approximately half of all interviewees (54%) lived in rural communities, which we defined as communities with populations of less than 2000 individuals. The majority of wild harvesters (76%; group 1; $n=22$) were rural inhabitants. Eighty-two percent of wild harvesters stated that aquaculture was affecting wild fisheries, and in some cases expressed concern that shellfish aquaculture would eventually displace wild harvests and/or reduce the ability to maintain a part-time or subsistence lifestyle based on access to wild shellfish. Even wild harvesters who also owned aquaculture sites, or who participated in aquaculture through band-owned tenures, were conflicted about increased shellfish aquaculture development in BC. Of particular note, all First Nations wild harvesters that we interviewed expressed some degree of concern and uncertainty about the tenuring process, even within bands that were endorsing and actively pursuing shellfish aquaculture.

A primary concern reported by wild harvesters was a concern that shellfish aquaculture was resulting in formerly wild, open-access clam harvesting sites being converted to private farm sites. Although displacement effects were still minimal (Joyce and Canessa, 2008), a history of increasingly restricted access to wild shellfish beds, in part due to aquaculture development, led to a generally pessimistic view among wild harvesters of likely future access. Seventeen out of twenty-two (77%) wild harvesters interviewed said they anticipated losing access to wild shellfish resources in the next ten years. Only four (18%) of these harvesters specifically stated that they believed shellfish aquaculture tenures would entirely replace wild fisheries in the future; many, however, were concerned that the loss of access to wild fisheries would continue and increase. The majority of those interviewed (66%) also believed that a transition away from wild fisheries towards increased aquaculture development would not necessarily be beneficial for coastal communities, if small-scale harvesters risked losing control over local resources. Even among those interviewees who had developed aquaculture sites, many were conflicted as to whether the benefits of aquaculture outweighed its risks. A loss of wild shellfish habitat was of particular concern when it occurred on productive beaches in close proximity to communities that had historic access to wild fisheries:

> "Why should we be taking out leases, when we have the wild beaches? We have already lost so many of our fisheries here – we don't have licenses anymore [for salmon], and now they want to give the beaches to companies from down-island to grow oysters...what is left for us? Those beaches belong to this community. How can [the company] apply for a tenure on a beach that my grandfather harvested. No one should let that happen."

Interviewees were more likely to deem shellfish aquaculture risky at study sites where there were already many competing industrial uses for sea space. In areas where water-quality closures, finfish aquaculture sites, or other industrial activities had already limited wild shellfish harvests, observations about prior loss of access to fisheries resources were often recounted in conjunction with strong perceptions about the risky nature of aquaculture development. In locations such as Clayoquot Sound or Sointula (Northeast Vancouver Island study site), there was intense competition for sea space among multiple conflicting uses of foreshore; beaches for wild harvests were in close proximity to salmon farms, and there were significant beach closures in proximity to marinas, houseboat sites or boat traffic. In rural areas such as these, where there were few employment opportunities, a history of wild fishing, and competing demands on coastal foreshore, shellfish aquaculture was generally viewed unfavorably, in part because competing uses of sea space were already significant, but also because interviewees reported negative experiences with prior government fisheries policies and aquaculture development. Several interviewees in Sointula, for instance, reported that the band had lost more than 80% of former fisheries and fish processing jobs over the past decade, and that salmon farms, which were the only new fisheries opportunity in the region, did not employ significant numbers of local people. Prior experience with salmon farms led these interviewees in some cases to discount employment possibilities from shellfish production, and to favor instead uses of sea space that were more likely to preserve existing access to limited, valuable wild shellfish beds. A distrust of government agencies responsible for regulating the salmon aquaculture industry, and a belief that communities had little control over growth of the industry, were reported as reasons interviewees' beliefs about the potential risks of shellfish aquaculture development.

In comparison, in regions such as Nootka and Quatsino Sounds — both remote areas where there were limited wild fisheries, few competing claims for sea space, but also few employment opportunities — there was considerably more interest in shellfish aquaculture as an economic development strategy. Indeed, in areas where there were few wild harvesters and nearshore habitat was largely undeveloped, proposals for industrial-scale aquaculture were mostly unopposed:

> "Since the [timber company] left, there are no jobs here, and we have lots of beaches; why not turn some of them into farms? I can understand why people don't want salmon farms here because they bring people up [from Victoria] to work on the farms; but shellfish farms mean jobs, and I need to work."

In contrast, interviewees in remote communities with historic ties to the wild fishery expressed the strongest concerns about aquaculture development. Many wild harvesters expressed values favoring a rural, subsistence lifestyle, and had limited economic opportunities in their current place of residence, but also had limited geographic mobility that precluded seeking out employment opportunities elsewhere for a variety of cultural and socioeconomic reasons. Many First Nations interviewees living on designated reserves had strong place-based affiliations (and incentives to stay on reserve) that made it unlikely that they would relocate in search of other opportunities. Several interviewees in this category identified specific wild beaches as 'belonging to' the community, and expressed beliefs that traditionally harvested beaches should be preserved in perpetuity as public resources for local residents. At the Ahousaht (Clayoquot Sound) study site, for instance, we interviewed several individuals who expressed a belief that leaseholds were overriding First Nations' subsistence and commercial harvesting rights; they also believed the leasing process could have significant implications for land claims settlements. Interviewees emphasized the importance of preserving wild clams as key cultural assets of First Nations peoples and supported maintaining traditional access rights to shellfish for subsistence or cultural purposes (e.g., home use, way of life). Interviewees in Sointula (one of the communities where we conducted interviews for the Northeast Vancouver Island study site) also emphasized the importance of maintaining communal access to wild resources and preserving access to wild resources for future generations. Articulated risks included

beliefs about losing control of foreshore and nearshore areas currently available for wild and subsistence harvest, and concomitant losses of culture, way of life, and livelihood. In contrast, concerns about losing access to wild harvest sites were less prevalent in communities such as Quatsino, where there were few wild harvesters and very little reported dependence on the wild shellfishery. In Quatsino, for example, the band had been primarily salmon and whale hunters whose ties to marine resources had been lost after band members were relocated to a central reservation in the 1950s. Quatsino had not actively participated in the wild clam fishery for eight of the ten previous years, and, because the band had little prior economic dependence on wild shellfish resources, band leaders appeared much less resistant to proposed industrial-scale aquaculture leasing than were other communities that had historically derived significant income from wild shellfish harvesting.

A common factor among all interviewees who perceived heightened risk related to shellfish aquaculture development was a history of previous poor experiences with government fisheries policies, including prior loss of access to other coastal fisheries (e.g., salmon, halibut, sablefish). The majority of wild harvesters and aquaculturalists interviewed (29 of 56 total, or 79%) had been involved with other commercial fisheries in the past ten years. Sixty four percent (64%) of all interviewees expressed distrust of state-driven fisheries policies, and many commented generally on the increased lack of opportunity in coastal communities as a result of these policies. Among interviewees in communities or bands who reported that they had lost most, if not all, of their salmon and other groundfish licenses over the past two decades, distrust of regulatory agencies and government policy was particularly pronounced.

Although the majority of interviewees expressed some form of distrust of government fisheries policies, few (<15 %) explicitly suggested that this distrust was related to the privatization of resources. Surprisingly, without prompting about whether or not aquaculture leases were a form of rights-based management, only three interviewees (5%) suggested shellfish leases were a form of private property rights, and fewer still

characterized shellfish aquaculture development as a form of privatization of sea space *per se*; however, 71% of those interviewed identified overarching concerns about an increasing trend towards privatization of natural resources in BC. When questioned about their views, respondents stated that a number of previous government policies had led to the redistribution of access to resources away from rural communities. When asked which specific policies had led to a loss of access to resources, they referred to previous poor experiences with timber leases, as well as various government fisheries policies, such as the license buybacks and policy reforms under the Mifflin Plan for salmon management. In addition, several interviewees referred to the loss of access that had occurred as a result of the introduction of Individual Transferable Quotas (ITQs) in groundfisheries. It was interesting to note that, prior to interviewees being prompted to comment directly on the question, "Are aquaculture leases private property?" only a few interviewees suggested that conflicts over aquaculture might be related to property rights. We nonetheless found that access to coastal resources was an important issue for many coastal residents, and that concern was particularly pronounced among First Nations respondents.

4.4.3 Political implications and First Nations' territorial sovereignty

A loss of access to shellfish beds was frequently cited as a risk to way of life for small-scale harvesters, but among First Nations, these concerns were often compounded by specific concerns about traditional entitlement to, and dependence on, place-based resources, as well as unresolved conflicts over Aboriginal rights and title. Almost all (95%; $n=22$) of First Nations interviewees had historically participated in wild shellfisheries, but thirteen (59%) had also acquired access to aquaculture sites, either through individual or band-owned leases. The effects of aquaculture on existing First Nations wild harvesters varied considerably among study sites. In many communities, First Nations harvesters reported that they were involved in aquaculture through band-owned leases, wherein access rights to important wild beaches had changed from common access for wild fisheries to private property (e.g., exclusive band ownership for aquaculture), but the rights to resources remained communally distributed. At study sites with band-owned leases (e.g., Kyuquot or Barkley Sound), many former wild harvesters now worked on tenures,

but there was no observed displacement of First-Nations access rights as a result of aquaculture development.

A unique situation occurred when bands were not actively cultivating shellfish but had acquired leases to ensure that they would continue to have future access to shellfish beds in their traditional territories. Eight of the ten First Nations bands included in this study had acquired at least one tenure which was undeveloped; in cases where the Band was paying for these tenures, many First Nations band members expressed considerable dissatisfaction that the band was paying leasing fees to the government for tenures in areas formerly open to the wild fishery. In some cases, preferential 'in-trust' siting agreements between First Nations and government made it advantageous for First Nations to hold leases which they were not actively farming, in order to protect future rights to resources (e.g., for ten years, the band did not have to pay to maintain priority access to these sites). The Tseshaht band, for example, had acquired tenures on beaches which they had historically harvested, but had not established aquaculture infrastructure at these sites. In contrast, only one non-First Nation stakeholder interviewed held an undeveloped holding, since the cost of leasing fees generally encouraged leaseholders to actively invest in production or sell/default on their lease.

At three of the five study sites where First Nations bands reported holding undeveloped tenures, band leaders reported acquiring leases in order to maintain access to traditional harvesting areas, but stated they did not currently have the interest or capital available to develop their leases. As one fisheries manager explained, the band council was concerned that if they were not willing to pay for the tenures, they risked losing access to key harvesting areas in perpetuity. At another study location, the band council had applied for and been granted large tenures, but subsequently decided not to pay tenuring fees on beach tenures adjacent to their reserves because they regarded it as inappropriate to have to pay for the right to seed and harvest beaches to which they had traditional or customary access. Dissatisfaction over tenure costs was particularly acute as the aquaculture leases were on former community harvesting areas. Overall, nearly three-quarters (73%) of First Nations

interviewees were uncertain about whether bands should engage with tenure policies in traditional territories, and most (86%) strongly believed that First Nations should not have to pay leasing fees to the government for access to resources in traditional territories, and especially, on beaches adjoining reserves.

The majority (73%) of First Nations interviewees were concerned that a transition to cultured fisheries might exclude current wild harvesters who could not afford the initial cost of leasing fees, or place a burden of debt on bands or individuals who would then have to pay the government for access to formerly public resources in perpetuity. Several interviewees in Quatsino for instance, observed that several former wild harvesters in their community had tried to raise funds to start an aquaculture site, but were not able to raise the necessary capital and resources required to develop an aquaculture site. In this case, and several other study sites, community members could only participate in aquaculture through band-owned tenures (as the band was willing to accept the cost of leasing fees as a trade-off for increased employment in the community).

Although six (26%) First Nations interviewees stated that they, or their band council, did not have the know-how or available capital to develop tenure sites, the remainder of First Nations interviewees reported that they or their band had both the necessary ability and capital to develop aquaculture sites, but had not done so. A striking example occurred in Ahousaht (Clayoquot Sound) where the band had been provided with infrastructure (rafts, floats, lines) from a decommissioned salmon farm that was suitable for establishing a nearshore shellfish aquaculture site. The band had also applied for grants to subsidize the operation yet, in the end, the equipment had not been used. Fisheries managers and shellfish harvesters in the community expressed considerable scepticism about the potential benefits of shellfish aquaculture development, and when prompted, several reasons were provided for the decision not to develop shellfish tenures, including beliefs about lack of profitability in the enterprise, as well as cultural and political resistance within the community:

> "Why should we pay for aquaculture sites? We don't want them, and we don't want anyone else applying for them. Those are our beaches, and we don't need aquaculture here. We have a wild fishery here... and that [wild fishery] is what the community wants."

Ongoing negotiation and litigation with Federal and Provincial governments over First Nations sovereignty lent an additional element of risk for some bands. In light of unresolved treaty negotiations, nearly all (95%) of First Nations interviewed perceived any form of aquaculture development (i.e., both finfish and shellfish aquaculture) to be a direct threat to unresolved land claims, as it potentially allowed non-First Nations exclusive access to resources in First Nations territories. First Nations interviewees in Barkley Sound for example, reported that increases in non-First Nations leaseholds had resulted in loss of access to some beaches that were formerly open to the wild fisheries. The Huuayaht band had developed their own tenures in Barkley Sound, including several on formerly harvested wild shellfish sites. Overall, the Huuayaht band had lost access to some wild harvesting sites as a result of non-First Nations tenures, but had increased the value of their shellfish resources by developing beach and raft-based aquaculture of their own. Nonetheless, several Huuayaht band leaders still viewed tenure development as risky in light of unresolved conflicts over Aboriginal rights and title.

Maintaining communal access to traditional resources was also cited as significant for 22% of First Nations respondents. The right to manage fisheries as common band resources is explicitly recognized and implemented under a number of First Nations interim agreements and treaty settlements (Copes, 1999; Harris, 2001). At both the Clayoquot and Northern Vancouver Island sites, individuals or small groups of First Nations harvesters had attempted to develop proposals for private joint ventures, but the proposals for private tenures were eventually abandoned, in part due to a reported lack of capital. However, several interviewees suggested that community opposition to the proposals may also have accounted for the lack of progress on private tenures. When prompted, fisheries managers and band leaders suggested that the council did not support this development, as they did not believe the community's interests were being served by encouraging private tenures, even among band members.

4.4.4 Resistance to salmon farming

Interviewees' comparatively optimistic — or at least dispassionate — beliefs about the environmental impacts of shellfish aquaculture contrasted sharply with generally negative attitudes towards salmon aquaculture. For many interviewees, salmon aquaculture evoked strong responses regarding its environment risks, but in contrast, all interviewees reported that shellfish aquaculture was not a threat to coastal waters. Many wild harvesters neverthless, were concerned about the effects of contaminants from salmon farms on nearby wild shellfish beaches. Although government siting guidelines suggest a buffer around finfish aquaculture sites, salmon farms are on occasion located in proximity to wild clam beds. More than half of the wild harvesters interviewed (57%) reported that they perceived risks associated with the toxic accumulation of chemicals in shellfish as a result of effluent from salmon farms. Forty-eight out of fifty-six interviewees (85%) also voiced generalized environmental concerns about salmon aquaculture, including introduction of parasites and exotic species to the marine environment. Further, several interviewees also expressed concern about the social sustainability of salmon aquaculture, observing that salmon aquaculture was owned predominantly by multinational corporations, and as such, pursued corporate labor practices that did not provide a significant number of jobs to local communities.

In all study site communities, salmon aquaculture was reported as a source of significant controversy; in three study-site communities, disputes over salmon farms had led to a series of unresolved and largely intractable conflicts between First Nations and the Federal and Provincial governments.[49] However, all interviewees reported that they had not observed similar political resistance to shellfish farming in BC (e.g., in the form of lawsuits, vandalism, or protests).

[49] Geoduck farm leases also generated significant controversy during public consultation processes in 2006. However, geoduck aquaculture had not been introduced when interviews for this research were being conducted from 2003-2005, and therefore no data was collected on potential resistance to geoduck farming.

4.5 Discussion

Biophysical capability studies whick consider factors such as presence of favorable growing waters, or studies of a community's social or economic capacity to raise financial capital or provide know-how, have consistently found aquaculture to be both feasible and beneficial for most coastal communities in BC. However, biophysical, economic, or demographic factors considered in government and industry reports have not been able to explain why some communities or individuals embrace shellfish aquaculture development, while others oppose or are uninterested in it. High unemployment rates, for example, which might otherwise imply a desire to generate employment and economic opportunities, did not explain reluctance in some rural communities to purchase leases or develop those already held. We found that in some cases, aquaculture was limited by a lack of capital or know-how, but in many cases, interviewees' suggested that cultural identity and place-based values also played a significant role in their decision to engage with shellfish aquaculture. Interviewees' estimations of the risks and benefits of shellfish aquaculture were related to tradeoffs between scarcity of available resources or opportunities, and the potential for conflict between aquaculture and other established resource uses. Surprisingly, we found that many wild shellfish harvesters who had limited economic opportunity in rural communities –and in many cases, the least geographic mobility to seek out more lucrative opportunities–were also most likely to perceive significant risks from aquaculture. Many wild harvesters in remote communities were opposed to shellfish leases because they perceived them as unnecessary if wild fisheries were productive; further, leases were viewed as infringing on local access rights and were perceived as threatening to the future of wild harvesting, which was not only a source of income, but an identity and way of life. If harvesters believed that aquaculture would increasingly displace wild fisheries, those interviewees whose livelihoods were most likely to be affected also expressed the greatest perception of risk regarding shellfish aquaculture expansion.

Even though operational costs, such as fuel for boats, transportation, or processing of product, are higher in remote areas, those inhabitants of rural areas where there was little

prior dependence on wild fisheries and almost no competition for sea space with existing industries held the most favorable beliefs about the economic benefits of shellfish aquaculture. In contrast, many inhabitants of communities closer to urban centers did not view shellfish aquaculture to be relevant as an economic development strategy. A number of geographic and demographic factors may explain this difference. First, favorable growing waters for shellfish are generally far from urban centers due to decreased risks of pollution, and therefore aquaculture in remote locations is likely to be a more profitable venture, provided these remote areas have few competing claims on sea space and adequate infrastructure to support the industry. Second, in remote locations, aquaculture leases are much less likely to infringe on use-rights by competing with existing, and potentially more lucrative claims for scarce sea space such as marinas, light industry, or sale of waterfront real estate. Third, interviewees in urban areas (>2000 people) were likely to have access to more diverse and potentially more lucrative employment opportunities, thus rendering aquaculture less desirable or significant as an economic opportunity.

Overall, we found that heightened perceptions of the risk of aquaculture development were closely linked to a number of factors, including interviewees' historic and place-based ties to a maritime way of life or dependence on fisheries income for livelihood. We found that a scarcity of wild resources, competing claims for sea space, as well as the availability of alternative economic opportunities also influenced their interest in shellfish aquaculture development. Interviewees' weighing of the tradeoffs between potential economic risks and benefits were also closely linked to a distrust of government agencies based on prior losses of access to, or control over local resources as a result of government aquaculture policies. First Nations' political concerns about territorial sovereignty also generated heightened perceptions of the risks of shellfish aquaculture as an economic development strategy for coastal communities.

4.5.1 Stakeholder values and perceptions

The factors that predisposed interviewees to perceive greater risks from aquaculture development were consistent with factors in other risk-based studies showing that cultural

and place-based values are crucial determinants of how risks are perceived and acted upon (Masuda et al., 2006; Norton et al., 1997; Stern, 2000). It was not surprising that a lack of trust in agencies and institutions responsible for managing the aquaculture industry led to heightened perceptions of risk regarding government policies and practices originating within those institutions (Pidgeon et al., 2003; Slovic, 1997). Similarly, our findings confirm considerable prior work showing that political and economic marginality are implicated in how people perceive risks (Johnson, 2005; Mohai et al., 1998; Satterfield, 2000). Political ecologists have consistently found that groups perceiving discrimination or vulnerability to exploitation are more likely to express heightened risk perceptions in relation to public policies affecting them, sensing that they bear the brunt of risks while benefiting little from the risk-producing activity (Satterfield et al., 2004; Tilt, 2006). If leasing policies are liable to create inequities among existing resource users, the vulnerability of particular groups to these inequities may help explain why some interviewees perceived risks from aquaculture development, while others did not.

In particular, the introduction of private property rights for aquaculture development in BC is complicated by the fact that coastal fishing rights and coastal areas are disputed as part of unresolved First Nations rights and title cases. As a result, aquaculture leases introduced into First Nations' territories were frequently perceived as a potential threat to Aboriginal access to resources. Government policies, which allow for the privatization of common property in ways that transfer lands and resources out of the purview of local First Nations communities, were generally viewed as infringements on First Nations sovereignty and challenges to self-determination and self-governance. Conflicts over territorial sovereignty have already resulted in several lawsuits against salmon farming companies, including a 2003 lawsuit filed on behalf of the First Nations in the Broughton Archipelago (MTTC and Gwawaenuk) by the Sierra Legal Defence Fund (SLDC, now called Ecojustice) against two salmon farming companies, Stolt Sea Farm, Inc. and Heritage Salmon Limited. The lawsuit alleges that in promoting the aquaculture industry, the Provincial and Federal governments are not upholding their constitutional duty to protect Aboriginal rights (SLDF 2003). A subsequent case, with similar allegations, was filed in Provincial Court by the

Homathco (Chief Blaney of the Xwemalhkwu v. Marine Harvest, 2005) and is still unresolved. No similar cases had been filed against shellfish farming activities, but if the shellfish industry develops in the future at similar growth rates to the salmon industry, there is clearly potential for conflict. Legal resistance to shellfish farming has already been documented in other countries, such as New Zealand, where the dramatic increase in shellfish aquaculture leaseholds during the late 1980s and early 1990s led to intense conflicts over aboriginal rights and preservation of nearshore environment, which prompted a seven-year moratorium on expansion of the blue mussel industry. The moratorium, similar to the five-year moratorium on salmon farming in BC, was lifted only in 2005 with the implementation of policies to guarantee the Maoris rights to shellfish sites, and a share in all proceeds of shellfish aquaculture operations (Tollefson and Scott, 2004).

We found that aquaculture policies privatizing communal resources were deemed to be risky if these policies resulted in cultural losses as a result of displacement from traditional lands and resources. This was not surprising in light of prior work in marine governance on Individual Transferable Quotas (ITQs), wherein the imposition of a property rights regime on previously common property resources has been shown to engender significant controversy, particularly over beliefs about fairness in allocation of resources (McCay et al., 1998; Palsson et al., 1997; Vestergaard, 1997). Overall, we found that in the case of shellfish aquaculture, debates over how risk is regulated were guided less by perceptions of the risk object itself (e.g., health or environmental risks of aquaculture), and more by perceptions of redistributions of access rights as a result of public policies that were perceived to be unfair or potentially discriminatory towards specific stakeholder groups. In the case of salmon aquaculture, a perceived lack of economic benefit for local communities and heightened perceptions of environmental risks resulted in strong perceptions of the risks of finfish farming for many First Nations interviewees. In contrast, there was much greater variation in the perceived risks and benefits of shellfish farms, and hence public response to industry development was generally more positive. Among those individuals, groups or communities where shellfish farming was resisted, aquaculture leasing was

primarily seen as risky because obtaining a lease was a political and economic event that changed the use of the foreshore in ways that challenged cultural identities and local control of resources.

Wild harvesters' objections to aquaculture leases as risks to culture and infringements on territorial sovereignty gave voice to refrains often heard in discussions about environmental justice.[50] To date, very little research on environmental justice has been conducted in Canada, but a relevant body of research on environmental justice has emerged from the US over the past twenty years, largely focused on the vulnerability of marginalized populations in relation to the discriminatory siting of hazardous wastes or contaminants (Bryant et al., 1992; Bullard, 1993; Cole and Foster, 2001; Hofrichter, 1993). A number of studies have examined how power imbalances between regulators and affected populations influence stakeholders' perceptions of the environmental risks of hazards of industrial development. Studies have shown that environmental justice is not only relevant when examining the impacts of contaminants on cultural practices (O'Neill, 2003; Schlosberg, 2004) but can be useful when examining disproportionate inequities in distribution of resources, and the effects of these inequities on vulnerable populations (Cole et al., 2001; Krakoff, 2002).[51]

In BC, an environmental justice lens has previously been used to examine the disproportionate effects of salmon farms on coastal First Nations in comparison to other Canadians (Page, 2007). Prior research in BC has shown that First Nations believe salmon aquaculture tenures displace traditional access to resources, resulting in restrictions on economic, social, and cultural activities integral to community well-being (Richmond et al., 2005). Similar studies have argued that First Nations face disproportionate risks from

[50] The literature on environmental justice merges both social and environmental movements aimed at addressing inequitable environmental burdens born by groups such as racial minorities, women, or residents of developing nations. Environmental justice has been legislatively recognized in the United States, but as a nomenclature, has not been widely used in a Canadian context. In relation to unresolved Aboriginal rights and title, environmental justice may be applied as Schlosberg (2004) describes to "policies which undermine Aboriginal peoples' jurisdiction over land and sea, or that compromise attempts to negotiate jurisdiction."
[51] Increasingly, research is also focusing on social vulnerability to hazards and how stakeholders' perceptions of risk relate to that vulnerability. See for instance Adger, 2000; Norton et al., 2002; Oliver-Smith, 2003.

salmon farms because they limit access to key cultural resources, or affect traditional ways of life or means of deriving a livelihood (Heaslip, 2008). An environmental justice approach may be relevant when examining our findings about shellfish leases, particularly in light of fact that interviewees' objections to aquaculture leases were based primarily on risks to culture and territorial sovereignty. It is not necessary for a policy to deliberately discriminate against specific marginalized populations for that policy to render inequities in its distributional effects. An environmental justice argument therefore is not based on policy-driven discrimination, as a wide range of potential stakeholders have been targeted and supported to adopt aquaculture leases, but rather on the conclusion that even well-intended policies can create losses for wild shellfish harvesters (many of whom are First Nations).

In summary, it is interesting to note that despite significant public controversy surrounding the health and environmental risks of salmon aquaculture in BC, we found that perceptions of risk from expansion of shellfish aquaculture resulted not from the types of health or environmental concerns typical of salmon farm controversy, but rather from social controversy over rights-based access to resources for specific user groups. However, in light of prior experience with case studies of shellfish farming in New Zealand and Australia, it would not be surprising if scientific debates over the environmental and health risks of shellfish aquaculture become more prevalent, in part to legitimize or reinforce social or value-based concerns about rights-based access to resources. Fifteen years ago, few environmental concerns were voiced about salmon farm development in BC. The small-scale emerging salmon farm industry was seen as a potential to contribute to the 'blue revolution' that would increase world food production, and in so doing, provide employment and opportunity for BC coastal communities. Today, public opinion has shifted, and significant resistance has emerged to the BC salmon farming industry (Leggatt Enquiry, 2001).

4.6 Conclusions

In BC, the transition from a wild fishery to shellfish aquaculture will depend not only on the availability of social and economic capital to adopt new methods and technologies, but also on the willingness of coastal stakeholders to mobilize resources towards aquaculture development. We found that local responses to shellfish leasing policies were shaped not only by a range of perceived risks and benefits related to economic considerations, but also to diverse cultural experiences, values, and political agendas. Wild shellfish harvesters were likely to express resistance to changes in the *status quo*; furthermore, they were less likely to perceive benefits from obtaining property rights for aquaculture if they believed the cost of those rights was greater than retaining existing informal rights to the wild fishery. For resource users who already had access to wild fisheries, or who did not have the capital to develop aquaculture sites, risks of aquaculture development were often reported to outweigh benefits. For example, there was considerable dissatisfaction expressed by some First Nations interviewees who were paying leasing fees to the government for aquaculture tenures in traditional harvest areas formerly used in the wild fishery. Other interviewees expressed disinterest in developing aquaculture leaseholds because such development conflicted with their existing way of life, including their rights to traditional shellfish harvesting or infringed on territorial sovereignty and rights to local governance of resources pending resolution of First Nations rights and title.

In light of heightened risk perceptions among some groups of interviewees, we were interested to know why resistance in BC to shellfish farming had not become more acute, as compared for instance to the highly politicized controversy which exists over salmon aquaculture in BC or mussel farming in New Zealand. It was not clear why certain groups of BC stakeholders, who did not perceive a shift from wild to cultured fisheries to be in their best interest, had not taken a stronger stance on shellfish leaseholds or at least refrained in greater numbers from acquiring lease sites. Instead, the data indicated increases in both numbers and extent of leaseholds, including tenures owned by First Nations.

The limited amount of environmental concern about shellfish aquaculture may have been one reason for the lack of resistance to shellfish farming. The high proportional representation of First Nations in the shellfish aquaculture industry, as compared to the salmon industry, may be another reason that the type of overt resistance observed with salmon farming in BC has not emerged with shellfish. No salmon farms in BC were reported to be solely owned by First Nations leaseholders, and only a very small percentage of First Nations people were employed on salmon farms (BCAFC, 2002). In contrast, as we discovered in this research, approximately a third of all shellfish aquaculture leaseholds are held by First Nations, and communities may therefore benefit directly from the development, thus improving local perceptions of the acceptability of the industry.

From this research, it did not appear that shellfish aquaculture has been explicitly discriminatory against First Nations peoples (indeed the opposite may be true in terms of employment and economic opportunity). From the results of our interviews, however, we found that shellfish aquaculture was not viewed favorably by some First Nations. Conventional market-based approaches such as tenure systems, which advocate for economic growth and development, were viewed skeptically, as such approaches were not deemed to be particularly important to way of life in coastal communities, nor were they desirable from the perspective of maintaining local control over resources. As Marshall (2001) suggests, the adoption of rights-based management for aquaculture represents a significant change in all aspects of governance that may have far-reaching implications for fisheries and the fishing communities that depend on coastal resources for way of life and livelihood. The introduction of rights-based management has been often been resisted by small-scale resource users in coastal communities, and we found that many interviewees were extremely negative about the private property rights inherent in salmon aquaculture leases, in quota systems for groundfisheries, or for timber leasing policies in BC. In spite of overt resistance to these other forms of rights-based management, I observed that many interviewees (or their bands) had acquired shellfish leaseholds, even when they perceived the benefits of existing management systems (e.g., wild fisheries) to outweigh purported advantages of the new, rights-based systems.

In light of these findings, is was necessary to speculate why some user groups, such as specific First Nations bands who expressed largely indifferent or even negative perceptions about shellfish aquaculture development, were nonetheless defying the cultural and economic status quo to engage with policies which they believed were not in their long-term best interests.

The decision to adopt rights-based management can be regarded as a public-policy choice, rather than a *de facto* response to the failure of common property systems. If there is no reason for resource users to diverge from the status quo (e.g., an existing management system), specific conditions and incentives, as well as socially and legally sanctioned rules, must be embedded within policies to facilitate privatization of natural resources and ensure stakeholder compliance with these policies. In the case of shellfish aquaculture, such conditions and incentives potentially included regulations that made it illegal (or at least prohibitively difficult) to seed an overharvested beach without a tenure.[52] A fear of exclusion was also adequate to convince some reluctant stakeholders to acquire leaseholds, as evidenced by one long-time fisher who succinctly stated, "If I don't apply for a tenure on this beach, someone else will." A primary incentive to shift from common property to rights-based management is also aided by the windfall gains that accrue to the first generation of owners, such that certain groups perceived significant short-term advantages to adopting leaseholds (Tietenberg, 2002; Welch, 1983). In some cases, First Nations bands were offered preferential selection of aquaculture site and in order to maintain access to key harvesting sites, many also took out leases to preclude other potential investors. Yet some of these bands were troubled that they paid large yearly sums to the government, even though they were not able to, or were uninterested in, developing aquaculture facilities at these sites. Others refused to pay while continuing to exercise tenure rights.

[52] Some First Nations bands, particularly in remote areas where there was no likelihood of other non-local First Nations' users benefiting from the harvest of seeded beaches, had circumvented this situation by applying for pilot project test sites instead of tenures, thus making it legal to seed local beaches without paying tenuring fees.

Several important insights emerged from these observations, observations that could potentially be applied more generally to other common property systems, such as water or timber resources, in order to explain how public policies create conditions and incentives for privatization of resources. Further research is needed to examine how specific conditions and incentives aid in creating stakeholder compliance with rights-based policies, to explore whose interests are represented by these policies, and to determine how resistance to such policies plays out in power relationships between stakeholders or industry lobby groups or regulatory bodies. As in any rulemaking process, the incentives and conditions embedded within regulatory frameworks have the potential to benefit some, while potentially disadvantaging others. In fisheries management over the last two decades, access rights to fisheries resources have become increasingly allocated as private property, while the resources themselves (i.e., fish stocks) are still claimed to be publicly owned. The implications of such a contradictory situation are unclear.

If establishing property rights is one of the fundamental requirements for economically viable aquaculture and other marine industries, there is a need for further research on benthic and marine zoning policies in order to understand how property rights are allocated in the marine environment, as well as to recognize the potential implications of this allocation process on resource users in coastal communities. Marine zoning policies not only create legal frameworks within which industrial development such as aquaculture can occur, but also provide frameworks for fisheries and ecosystem protection, including the development of marine protected areas, area-based fishing rights, and no-take zones (Farrow, 1996; NRC, 2000). Equally, these policies provide the framework for benthic and subsurface rights for mineral, oil, and gas development (see Firestone et al., 2004; Skladany et al., 2007). Much of the seafloor and the oceans are still considered to be part of the "tragic commons," and currently, a lack of clear policy related to marine property rights in Canada is impeding the resolution of major Aboriginal rights and title cases, and in some cases, conservation efforts towards development of marine protected areas or other coastal zone planning initiatives. Although this study focused specifically on shellfish resources on the coast of British Columbia, there is a need to extend this work to other resource uses and locations, as debates over private property rights are relevant not only to

aquaculture development, but also to resource production and extraction in other industries.

4.7 Bibliography

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5. CONCLUSION

As explored in this dissertation, much of the economics literature on fisheries governance assumes that privatization of marine resources is advantageous for economic and regulatory efficiency and also assumes that, under appropriate policy conditions and with suitable incentives, stakeholders will choose to adopt private property rights for fisheries management (Hannesson, 1991; Maloney et al., 1979). Indeed, the development of property rights has commonly been viewed among economists as progress toward growth and development in a transition from older, common propterty institutions to modern, private property ones (Anderson et al., 1977). Economists espousing such perspectives also generally believe that contemporary examples of common property will inevitably disappear or disintegrate.

In direct contrast to this approach, I have drawn on a significant body of social science research on common property systems to suggest that private property rights do not evolve naturally, nor do they necessarily emerge in response to the tragedy of the commons. Rather, I suggest that rights-based management can be regarded as emerging only in the context of socially and legally sanctioned rules created and enforced by public policy, and thus must be regarded as a value-based choice with the potential to serve the interest of some social groups, while potentially disadvantaging others (see Bromley, 1991; Schmid, 1978).

Empirical evidence presented in this dissertation has shown that policy choices are increasingly supporting a move from common to private property rights for shellfish production in British Columbia. Yet, despite significant theoretical and empirical research literature on reasons for resistance to rights-based management in fishing communities worldwide, there is relatively little research on the specific policy processes by which rights-based management systems are implemented to replace common property

arrangements. If property rights are created by rules, and enforced by agencies responsible for enacting those rules, several questions arise: Whose interests are being represented by current policies for aquaculture development in BC? What values and power relationships are embedded within these policy choices? How are such policies creating the conditions and incentives to facilitate a transition to rights-based management, despite evidence that some stakeholders are uninterested or even resistant to these policies?

In previous chapters, I explored ways in which public policies can potentially increase production values and efficiencies through transition from a predominantly wild fishery to an aquaculture industry; I then explored the potential risks and benefits of this transition from the perspective of representative stakeholders in the BC shellfish industry. In this concluding chapter, I suggest possible contributions of this research to discussions about rights-based management and examine potential methodological implications of the work, while also reiterating some of the limitations of the approach and proposing directions for future work.

5.1 Theoretical context: rationale for rights-based management

As explored in Chapter 2, the property rights inherent to aquaculture development are arguably similar to other types of private property rights in marine governance such as ITQs, and the development of quasi-privatized access rights for aquaculture development may hold a number of potentially comparable risks and benefits for existing fisheries users. Although many interviewees reported highly negative effects from ITQ policies, there was considerably more variation in beliefs about the risks and benefits of shellfish aquaculture development. In many situations, interviewees were conflicted, finding it difficult to weigh the risks and benefits, as the shellfish industry is still relatively new in British Columbia.

For many interviewees, shellfish aquaculture was reported as, in theory, being a potentially promising sustainable alternative or complement to wild fisheries. More specific responses did not always reflect these types of broad statements, however, the majority of

interviewees did report that shellfish had few if any negative environmental impacts, and even interviewees concerned about environmental effects, suggested that in comparison with salmon farms, shellfish farms had minimal environmental risks. When asked broad questions about the potential for economic development of shellfish farming, interviewees also reported that it was one of the more viable economic development strategies available, and was, in many cases compatible with existing expertise; many interviewees believed shellfish aquaculture could boost employment in communities affected by downturns in other resource industries. In practice, these statements were not always reflected in reported profits or employment opportunities, but the low initial capital investment, low overhead and minimal operating costs were nonetheless reported to be attractive incentives for small-scale harvesters to get involved in shellfish production.[53] Industry representatives consistently pointed out that aquaculture could relieve pressure on wild stocks, while diversifying production and increasing production values. Government administrators and policy-makers also generally favored a transition to aquaculture, expressing views that shellfish aquaculture was both beneficial for both cost-recovery and ease of management.

Despite these purported benefits, some interviewees identified significant concerns in acquiring leases and developing shellfish farms. In communities where there had been a shift from primary dependence on wild fisheries to aquaculture production, a transition towards aquaculture development was perceived as risky if it was believed to have altered culture, way of life, and ability to derive a livelihood, particularly in coastal communities with historical access to, and dependence on wild fisheries. Even in locations where shellfish aquaculture appeared to have significant economic benefits and few negative environmental effects, stakeholders who relied on the wild fishery for their way of life or livelihood were more likely to perceive aquaculture development as negative if they believed it would alter the distribution of rights to resources within their community. Protected values about the conservation of wild fisheries, and maintenance of foreshore habitat as a public or commonly held resource, also led to heightened perceptions of the

[53] Such statements were often related to the inaccessibility of opportunities to benefit from the salmon farming industry, where few local jobs and no local owner-operators were reported.

risks from aquaculture development for some interviewees, regardless of their beliefs about the relative magnitude of accompanying benefits.

Such results were not surprising, as it has been clearly demonstrated in the context of ITQs that existing users with access to common property are likely to resist change to the status quo and will likely see few benefits from obtaining private property rights if they believe the cost is greater than that of retaining existing common property access (McCay, 2004). A number of important differences were found to exist between the risks and benefits of other marine property rights structures (e.g., ITQs) and shellfish aquaculture leases. Yet a transition to exclusive access rights still generally requires that a substantial percentage of existing users be excluded from the fishery, and thus economic losses may be anticipated that will not necessarily be equally distributed among existing resource users (Christy et al., 2000; Copes et al., 2000; Eythórsson, 1996; Tietenberg, 2002). Hence, it is not surprising that opposition to rights-based policies will emerge, particularly if there is perceived injustice when overall public losses result in benefits to only a few users who can potentially realize significant profits. Unless other existing users are compensated (e.g., through buy-outs), those users who are excluded can be expected to strongly resist a change in governance (Brandt, 2005; McCay, 1995).

A number of additional factors – examined in detail in Chapter 2 – may also deter existing users from entering into private property arrangements, particularly if such arrangements are believed to result in distributional inequities or to have potentially detrimental social and environmental outcomes. In the case of ITQ fisheries, resistance to rights-based systems has been linked not only to concerns about fairness of allocation, but also to potential environmental and economic losses. As described in Chapter 2, it is not uncommon for existing resource users to perceive injustice when they believe the establishment of property rights defies historical and cultural precedents for communal ownership, or may result in industry consolidation and buy-outs by non-local owners. The transfer of access rights away from communities is likely to generate concern, as it is

perceived to be inequitable, and to violate the public trust by allocating public resources to private enterprise.

Shellfish aquaculture development in BC presents an interesting case with which to examine a transition from a common property system in a wild fishery, to a primarily aquaculture-based industry that relies on private property rights to delimit access to sea space and resources. The case presented in this research was unique because of the potentially direct spatial competition between the wild fishery and aquaculture sites for both access to habitat and markets. The property rights in salmon farming are similar to the rights inherent in shellfish leases, but spatial conflicts over property rights are not as visible in the salmon farm case, because there is no direct competition for habitat.

Many First Nations people have indicated that policies for salmon farming, and to some degree shellfish aquaculture, are unacceptable, yet in the salmon farming case, political mobilization (e.g., through lawsuits and protests) has not always been adequate to mount effective resistance. Although shellfish aquaculture has not yet generated significant legal or public resistance in BC, it is clear that where there is a perception of injustice, conflict is liable to escalate. Although I do not argue in this dissertation that shellfish aquaculture has been explicitly discriminatory against First Nations peoples (indeed the opposite may be true in terms of employment and economic opportunity), it is clear from the results of our interviews that shellfish aquaculture was not viewed as desirable by some of the First Nations peoples. Conventional market-based approaches, which advocate for economic growth and development, were viewed skeptically by some interviewees, as such approaches were not deemed to be particularly important to way of life in coastal communities, nor were they desirable from the perspective of maintaining local control over resources.

Both ITQs and aquaculture leaseholds grant users exclusive access and withdrawal rights. The difference between such systems and *de facto* territorial use-rights (TURFs), or even owner-specific licenses, is that such systems go further than just granting rights to access,

withdrawal and in some cases, exclusion[54]; the owners of rights under such systems also benefit from disposition of property and capital gains. The transferability of ITQs and aquaculture leaseholds, with possible increases in value, can lead to industry consolidation in ways that preclude future acquisition of property rights by owner-operators, especially if such rights become prohibitively expensive. Rights-based management thus not only results in an initial redistribution of resources, but also can foster economic barriers to future entry, or re-entry into the industry by future resource users. The negative impacts of such systems are largely felt by the first generation of resource users who may be excluded from a fishery, but impacts can be compounded in subsequent generations, since rights-based management has the potential to irrevocably limit future entry to the industry and determine who profits from the resource. As Huppert (2005) describes, "property rights systems are largely irreversible, and once introduced, endogenous changes in the fisheries tend to work in support of strengthening and expanding rights-based management...over time, rights-based management tends to erode the political influence of those who stand to lose the most from this type of management (394)."

As discussed in previous chapters, the introduction of rights-based management through ITQs has been widely resisted by many resource users from different sectors of the fishing industry (Copes et al., 2000; Holm et al., 2000). Although economic studies of property rights generally assume efficiency to be an overriding management goal, many stakeholders I interviewed did not perceive economic efficiency as the only, or even the most important, management goal. This finding was not surprising given that critiques of rights-based management have shown that efficiency in resource allocation can be detrimental to social considerations such as equity among resource users, and that social equity is often the most sought-after goal of fisheries stakeholders (Palsson et al., 1997). Indeed, the results of this research showed that some interviewees saw few reasons to

[54] Exclusion is, according to Schlager and Ostrom (1993), the right to determine who will have access rights, and how those rights may be transferred. In some cases, transition to a property rights system for aquaculture also implies a transfer of management as well as access rights. I would also clarify here that while economists would describe private property rights as conveying access and withdrawal rights, as well as rights of exclusion (e.g., alienation in Schlager and Ostrom's schema), First Nations consider the concept of alienation of traditional property rights impossible, as these rights belong to their people and can only be passed to subsequent generations through inheritance (Pinkerton and Weinstein 1995).

transition to a rights-based management scheme, and instead, favoured policies that maintained access to wild fisheries. Despite the potential economic advantages of aquaculture, they preferred access to wild fisheries for preserving part-time employment or traditional livelihoods, including the right to harvest shellfish for cultural, ceremonial, and subsistence purposes.

5.2 Methodological assessment

5.2.1 Limitation and benefits of a participatory GIS analysis

As explored in Chapter 3, a GIS-based spatial analysis was useful in determining how wild shellfish harvesting patterns were changing relative to aquaculture development. However, using only GIS data, it was difficult to determine the implications of these changes for coastal stakeholders. Interviews were necessary to determine whether aquaculture had improved their overall situation (e.g., through increased production and employment), or whether they had experienced social and economic losses as a result of aquaculture development. It was unclear from the GIS data whether there were significant changes in existing access rights to shellfish resources and, if so, whether changing access rights were likely to alter way of life and the ability to derive a livelihood in coastal communities.

The results of the GIS analysis, based on ten years of available government data and ancillary sources, indicated that areas occupied by wild clam fisheries were to some degree being constrained by aquaculture leases. As yet, however, the displacement was not reported to be particularly disruptive to existing resource uses. However, stakeholder comments during interviews suggested that as aquaculture expanded, aquaculture leases could increasingly displace wild commercial shellfish harvesting activities, and would progressively limit access to subsistence harvests at traditional use sites. In the GIS analysis, the total area of coastal foreshore occupied by shellfish aquaculture sites was small, although during interviews, displacement effects were reported to be more widespread than simply areal extent of lease boundaries.[55] Even when accounting for

[55] As noted in Chapter 3, displacement effects were not limited to leasehold boundaries, but generally excluded the entire beach where a tenure was located. As such, the effects were reported to be greater than the figures shown by the GIS data.

displacement effects, the total area of productive foreshore that had been converted to lease sites was not substantial, as compared for example, to total available foreshore in BC. Some of this foreshore is clearly not suitable for aquaculture development given biophysical constraints, but there were nonetheless large expanses of potentially suitable coastline that are currently undeveloped. Whether such areas were not only capable of being productive shellfish farms, but also suitable given that they may be distant from transportation and processing facilities, is unclear. However, in some of these undeveloped areas, interviewees reported few wild fisheries or other possible resource uses that would compete with aquaculture development. Closer to population centers, interviewees at some of the study sites considered the loss of wild-harvesting habitat significant, particularly when this loss occurred on beaches in proximity to communities with historic access to, and dependence on, wild fisheries. When this loss of access to wild fisheries habitat was compounded by water-quality closures due to bacterial contaminants or pollution from other marine activities (e.g., salmon aquaculture, marinas, log sort/wood processing), the effect was a perception among many wild harvesters that coastal communities and traditional resource users were losing access to shellfish resources at an alarming rate. More than 85% of First Nations interviewed were concerned that access rights to shellfish resources would be transferred to private, non-First Nations leaseholders within ten years. In addition, there was significant concern about potential contamination of shellfish beds in proximity to finfish farm sites. Similar environmental risks were not mentioned in relation to shellfish farms, but significant risks were cited with regard to loss of access to wild harvesting areas and losses to way of life and livelihood for small-scale harvesters.

As discussed in Chapter 3, important limitations within the available GIS data made it difficult to empirically determine whether users were losing access to resources as a result of aquaculture development, or whether they had simply transitioned to new forms of production by acquiring aquaculture leases. First, a lack of available GIS information about the exact location of wild fisheries made it difficult to determine with confidence how aquaculture sites were affecting wild harvesting. In the absence of geographically referenced stock-assessment data for wild harvest areas, biophysical capability data for shellfish aquaculture was used as a proxy for wild fisheries locations. The decision to use

shellfish biophysical capability data limited, to some degree, confidence in the results of the GIS analysis. Furthermore, in many cases, former wild harvesters interviewed – both First Nations and non-First Nations – had acquired shellfish aquaculture tenures, yet the information available within the available GIS datasets was not adequate to determine ownership of tenure sites. In most cases, interviewees were able to clarify ownership of aquaculture sites and the GIS database could be modified to include relevant attributes (e.g., whether a lease was band-owned, whether it was a fallow or active production site). In many cases, we found the nature of access rights had changed, but tenures had not necessarily displaced former wild harvesters. Instead, wild harvesters had acquired aquaculture leases and cultivated these in lieu of, or in addition to, wild harvesting. However, as a result of the GIS data limitations, the empirical findings of the GIS analysis were limited in scope, and a participatory approach was necessary to provide a more detailed and explicit exploration of the effects of changing access rights.

5.2.2 Participatory interviews: evaluating stakeholders' perceptions of aquaculture

During interviews, maps produced from GIS analyses were used to examine local knowledge of selected habitats and locations of cultural and social importance, as well as to examine conflicts over potentially competing resource uses. These maps were also used to explore historic patterns of resource use, perceptions about the risks and benefits of aquaculture development, and priorities for resource use. Interviewees were encouraged to annotate maps of GIS-derived thematic overlays and to add descriptions of variables such as shellfish abundance. Participatory GIS techniques involved interviewees in an assessment of their beliefs about different forms of management for local resources, and also allowed for the incorporation of their input for groundtruthing of available government data sources. Interviewees' perspectives were important for establishing comparative analyses of harvesting patterns between study sites. A participatory approach was also beneficial because it provided a means of collecting local knowledge to supplement existing government-derived GIS data. Furthermore, a participatory approach generated considerable interest among stakeholders because it provided a means by which to assess complex changes in shellfish habitat and harvesting patterns, and within the

context of interviews, provided a means to reflect on personal beliefs and constructed meanings about these changes.

Several unexpected results emerged from this work. For instance, many interviewees' responses highlighted the value in preserving access to wild resources for subsistence harvests and expressed risks related to a loss of access to subsistence ('home-use') resources. Concerns about these types of risks would not have emerged had the selected methodology relied on more conventional approaches (e.g., use of GIS-based data only or stakeholder surveys consisting of rankings of risks compiled *a priori* by the researcher). The use of semi-structured interviews and participatory mapping exercises allowed for a nuanced understanding of stakeholders' perspectives to emerge; such an approach also allowed for solicitations of opinions about current forms of shellfish production, as well as priorities for future development of the industry.

In several cases, participants were deliberately asked about conceptual issues such as 'privatization' or 'environmental risk' at a level of abstract generality. Subsequent interview questions were directed towards exploring specific but related questions that allowed for a more detailed contextualization of responses. The goal was to differentiate between broad opinions and explicit local data and experience. In many cases, the specific local data did not support broad perceptions, yet opinions and perceptions were adequate to shape public discourse on a variety of controversial topics.

In other cases, it was difficult to generalize from the findings of our work, as responses to the interviews were specific to local experience and reflective of current local events (e.g., treaty negotiations, or outcome of a recent lawsuit). Thus responses to some of the questions posed during interviews could not be extrapolated as relevant to all shellfish development *per se,* and generalizations from the study should be made carefully. However, we found that overall, the maps was useful in grounding the interviews, and steering responses towards explicit substantiated data, rather than opinion or simply a desire to get the 'right response' (e.g., a response that interviewees thought was 'politically correct' or a response that interviewees thought the researchers were seeking).

The birds-eye view afforded by large-scale maps was useful, and in some cases altered stakeholders' perceptions of coastal resource use. For example, when GIS-derived maps showing locations of aquaculture sites were compared with maps of shellfish aquaculture capability (as a proxy for wild shellfish harvesting locations), the resulting analysis revealed a number of interesting trends in resource distributions. Before examining coast-wide maps, interviewees' views on changing access rights were generally informed by their own local circumstances. Most interviewees assumed that both increased shellfish aquaculture and increased water-quality closures of shellfish-harvesting beds occurred as localized, independent, and dissociated events. However, after examining coast-wide maps, they made connections between local trends and the effects of policy changes at a much larger scale, and some revised their opinions to comment on a larger political context in which aquaculture development is occurring.

5.2.3 Future directions for application of participatory GIS

GIS analysis has powerful capabilities for analyzing spatial data about the physical environment, but has not been as successful in capturing cultural interpretations or perceptions about that environment. Indeed, where culture has been incorporated into mapmaking, it has traditionally been represented by anthropologists through its physical manifestations, such as traditional locations of resource use, rather than through abstract expressions about these locations (i.e., how perceptions, beliefs, and values influence interpretations about 'sense of place') (Feinberg, 2003). Researchers are increasingly experimenting with methodologies to incorporate cognitive mapping into GIS frameworks in order to integrate intangible information related to values and beliefs into a spatial data environment. This type of research is highly experimental, but an increasing number of studies have established precedents for integrating cognitive or mental-mapping methodologies within GIS models. For instance, spatial mental mapping has attempted to represent factors that contribute to stakeholders' sense of place, including how residents value their homes, public resources, or wildlife habitats (Craig et al., 1998; Elwood et al., 1998; Harris et al., 2002; Talen, 2000). Participatory risk perception mapping, a subfield of participatory GIS, has also attempted to capture values and beliefs about contaminants

risks using GIS frameworks. Although this area of research has not yet attracted much attention in either the GIS or risk perception literature, it has considerable potential to apply spatial methodologies towards an understanding of public risk perceptions. In particular, risk perception mapping may be important for exploring risk-based environmental and social justice issues (c.f. Smith et al., 2000; Stoffle et al., 1991; Stone, 2002).

The risk perception literature is largely aspatial, and most risk perception models are based on survey data or on interviews using mental models. Studies such as this, in which participatory mapping exercises were used to facilitate communication about stakeholders' perceptions of the risks and benefits of specific policies and political choices, are a starting point for engaging stakeholder participation in resolving spatially-based resource-management conflicts (e.g., conflicts over land-use practices or, in this case, allocation of sea space). In this study, GIS-produced maps helped stakeholders articulate their visions for the future of the shellfish industry, and also revealed tacit beliefs about the importance of particular harvesting locations and practices. In order to interpret interviewees' beliefs and experiences, perspectives from the literature on risk perception were used to illuminate responses to changing patterns of resource allocation, and to better understand perceptions of environmental, economic and social risk in response to these changing patterns.

Participatory research, such as undertaken here, may be applied to other spatially defined problems that have been explored in the risk perception and environmental justice literatures. For example, environmental justice researchers in the United States were initially interested in how marginalized populations were vulnerable to discriminatory practices in the siting of facilities that process or store hazardous wastes and other contaminants (Bryant et al., 1992; Bullard, 1993). Environmental justice frameworks have also increasingly been used to explore the cultural effects of these discriminatory practices (Satterfield et al., 2004), or the effects of specific management practices on potentially discriminatory access to resources (O'Neill, 2003; Schlosberg, 2004). As observed in the wide range of issues that are increasingly being addressed, environmental justice frameworks are no longer being applied only to discriminatory practices in the placement

of hazardous wastes sites, but also to the effects of contaminants on cultural practices of vulnerable populations, or inequities in distribution of risks in relation to culture or tribal sovereignty (Cole et al., 2001; Krakoff, 2002).[56] In BC for instance, prior research has shown that First Nations believe salmon aquaculture tenures have displaced traditional access to marine resources, resulting in restrictions on economic, social, and cultural activities integral to community well-being (Richmond et al., 2005). Several recent articles have reported salmon aquaculture in BC as a threat to First Nations peoples if such development limits access to key cultural resources such as shellfish, or affects traditional ways of life or means of deriving a livelihood (Heaslip, 2008). An environmental justice lens has also been used to examine the disproportionate impacts of environmental risks from salmon farms on coastal First Nations in comparison to other Canadians (Page, 2007).

Although the salmon farm case differs in important ways from the shellfish case in BC, we found some similarities, including objections to both shellfish and salmon aquaculture leases on the basis of First Nations territorial sovereignty. As in the New Zealand case, we may find the in the future that conflicts over shellfish farming will increasingly be framed within an environmental justice context, in much the same way as arguments about local control of resources have been used to articulate resistance to the siting of salmon farms in First Nations territories. While shellfish aquaculture development policies might be ostensibly aimed at economic benefits for rural communities, there existed concern that such policies may also discriminate against specific marginalized populations to the extent that they have the power to irrevocably alter local access to resources. Resistance to such policies may be compounded if there is perceived cultural discrimination in the reallocation of resources, such that First Nations cultural preferences or practices are disproportionately affected by these changes.

[56] English (2004) provides a comprehensive overview of literature on risk and environmental justice. Critics of the environmental justice movement have argued that it dilutes the environmental movement with strictly anthropocentric concerns such as racism, classism, and sexism. In response to such criticisms, English argues for a broader conception of environmental justice that would include non-anthropocentric values within environmental justice approaches to risk.

With regard to salmon farming, we observed that First Nations perceived disproportionate health risks from salmon farms due to their higher consumption levels of shellfish and other locally harvested marine species, as well as their geographic vulnerability to salmon farm sites (BCAFC, 2003). A key area of further research, using data derived in this study, may be the application of a GIS-based examination of government siting practices for salmon farming leases, including a study of the discrepancies between government policies and stakeholders' perceptions of the impacts of contaminants from salmon farms on wild shellfish harvests.

Maantay (2002) has argued that spatial vulnerability and environmental justice are not to-date well explored in the geographic literature, and considers spatial models for analysis of place-based links between vulnerability and risk perception to be an important new area of research. In the early 1990s, researchers began discussing how spatial information analysis using GIS technologies might be used to empower underprivileged social groups and offer representation to a broad range of marginalized voices (Clark, 1998; Craig, 1994; Obermeyer, 1998; Pickles, 1995; Sheppard, 1995; Varanka, 1996). Prior to this in the late 1980s, before participatory GIS developed as an academic field, a number of grassroots groups had begun experimenting with mapping for reclaiming indigenous resources (Aberley, 1993; Convis, 2001; Poole, 1995a, 1995b). Early applications, developed largely by non-profit agencies in support of indigenous land claims, focused on how GIS technology could be used to map indigenous knowledge to secure land tenure, manage natural resources, and strengthen cultural ties to traditional territory (Chapin et al., 2005; Denniston, 1994; Marozas, 1995; Olive et al., 1998). Since then, many GIS studies have attempted to address perceptions of inequity that may result from environmental injustice or racism (Esnard et al., 2002; Harmsworth, 1998; Harris et al., 1998; Louis et al., 2002; Maantay, 2002; Poole, 1995a). Few such studies, however, draw on the risk perceptions of affected stakeholders as sources of data for examining the cultural impacts of hazards or environmental contaminants. More detailed work on mapping of risk perceptions associated with contaminants in shellfish (e.g., contaminants from salmon farms potentially affecting shellfish), may offer a tool by which to define how perceptions of

exposure, and beliefs about the severity of that exposure, are related to demographic factors, such as cultural or ethnic background, geographic proximity of residents to farm sites, rural or urban residency, or the dependency of local economies on primary industries such as agriculture or resource extraction.

5.2.4 Future directions: mapping perceptions of risk and culture

When examining perceptions of environmental risks, political ecologists have found that marginalized groups who feel discriminated against, or vulnerable to exploitation, are more likely to express heightened perceptions of risk. This finding is not surprising given that marginalized groups frequently bear the brunt of risks while benefiting little from the risk-producing activity (Satterfield et al., 2004; Tilt, 2006). Prior studies of risk perception have shown that political and economic marginality are clearly implicated in how people perceive risks, and that risk perceptions cannot be dissociated from their social and cultural contexts. As a result, such perceptions are never politically neutral (Satterfield, 2000).

As explored in Chapter 4, the introduction of private property rights for aquaculture leasing has the potential to affect First Nations cultural practices insomuch as it can alter or limit customary access to resources. Environmental justice arguments suggest that First Nations groups who depend on shellfish resources are particularly vulnerable under privatization policies due to their insecure legal and political status as a result of unresolved rights and title to traditional lands and resources. Thus, it was not surprising to observe heightened perceptions of risk about aquaculture among First Nations interviewees, as aquaculture development policies were perceived as threatening to First Nations peoples in resource-dependent coastal communities if such policies had the potential to limit access to key cultural resources, infringe on territorial sovereignty, or alter traditional harvesting patterns, ways of life, or means of deriving a livelihood.

To date, very little environmental justice research has been conducted in Canada. Future research using an environmental justice framework could allow First Nations to frame their needs for control of access to shellfish resources, or beliefs about contaminants from salmon farms to those resources, in a similar way that the environmental justice argument

has been used in the United States to demonstrate how specific environmental policies have disproportionately affected minority populations. Considerable prior work on environmental justice has attempted to establish links between policies that lead to heightened vulnerability to contaminants and stakeholder risks from exposure to these contaminants (Bullard et al., 2000; Mohai et al., 1998). Similar frameworks could be applied to the results of this research on aquaculture, in order to determine potential cultural impacts on First Nations stakeholders who have stated that salmon farm contaminants are disproportionately affecting First Nations' shellfish harvesting, or who believe that bacterial water quality testing protocols are unfairly discriminatory against wild fisheries and rural communities. Although I have not proposed that there is overt policy-driven discrimination against First Nations vis-à-vis shellfish aquaculture development, I would suggest that even well-intended policies can create losses for local wild shellfish harvesters as side effects of the pursuit of investment, and that such policies may be viewed by affected groups, including First Nations, as infringements on existing use-rights or territorial sovereignty.

5.3 Theoretical and policy implications

5.3.1 Implications for fisheries management

Considerable research has documented the effects of assigning property rights to fisheries resources through the use of ITQs; similar processes have allocated habitat for aquaculture development, but these processes have been largely overlooked in the fisheries management and common property literatures. A guiding objective of my research has therefore been to investigate how limited property rights are a prerequisite for aquaculture development in coastal waters, and how these property rights can provide economic advantages for producers, consumers and regulators. I also investigate why such rights may result in public controversy if they disrupt historical patterns of resource use by reallocating access to former common property resources to private owners.

In light of the many options available for governing marine resources, it is important to ask why economic approaches advocating private property rights have come to predominate in

fisheries management. As many social scientists have argued, fisheries management practices must adapt to work at a responsive scale with fishers and their communities, using approaches that consider the relationships of fishers to the ecosystems and resources that they depend on for way of life and livelihood. Yet the ubiquity of economic models for growth, and the path dependence on such models, makes the introduction of alternative approaches difficult. As observed during this study, economic growth was not the only priority of coastal communities, and social scientists working on community-based approaches to management have suggested there is a strong need to broaden fisheries analysis, in ways that will include not only quantitative approaches, but also spatial, habitat-based and community-based analyses that will focus not solely on maximizing productivity and economic returns, but will also account for a variety of environmental and social objectives.

Further research might include a closer examination of policies to encourage community-based aquaculture development (e.g., possibilities for community licensing or share-based aquaculture). Community-based quotas have been incorporated into several ITQ fisheries to reallocate the benefits of rents derived from resource extraction back to fishing communities. In these cases, communities themselves allocate quotas or fishing licenses managed as private property, and hence are able to incorporate some of the social and environmental benefits of community-based management. Under community quota programs, fishing "communities" (often loosely defined as geographic communities or fleet-sectors) hold harvesting quotas and decide how they are to be used (Apostle et al., 1998; McCay, 2004; NRC, 1999b; Wingard, 2000). Proponents of community quotas believe that such programs may be able to accomplish some of the economic and management goals of private property regimes, but are better suited to addressing social equity, particularly in cases where development of private property rights have the potential to displace small-scale fishers or part-time harvesters (NRC, 1999a; Wingard, 2000). Similar practices may exist for share-based aquaculture (e.g., band-owned or community tenures), but interest in these practices has not yet been documented in the literature on common property and co-management. Further work is needed to document

and develop the possibilities for this type of community-based management in relation to aquaculture sites.

5.3.2 Political and legal implications

In Chapter 4, I identified a need for further research on the political and legal implications of property rights and their relationship to First Nations rights and title cases. In 2005, in a case commonly known as the Delgamuuk decision (Hereditary Chiefs of the Gitksan and Wet'suwet'en Nations v. Government of Canada), the Supreme Court explicitly stated that Aboriginal rights and title had never been extinguished in British Columbia, and that the Crown had a duty to consult First Nations in all matters regarding lands and resources in contested territories; this duty could only be satisfied by the involvement of First Nations in decisions taken with respect to projects undertaken on traditional lands (WCEL, 2005). Subsequent to the Delgamuuk decision, further cases have asserted First Nations' rights to ensure consultation relevant to lands and resources.[57] In the marine environment, for instance, several lawsuits have been filed against salmon farming companies on the basis of infringements of First Nations territorial sovereignty and failure to adequately consult First Nations on siting plans. In March 2003, a lawsuit was filed on behalf of the First Nations in the Broughton Archipelago (MTTC and Gwawaenuk) by the Sierra Legal Defence Fund (SLDF) against two salmon farming companies, Stolt Sea Farm Inc. and Heritage Salmon Limited. The lawsuit alleged that, by promoting the aquaculture industry, the provincial and Federal governments were not upholding their constitutional duty to protect Aboriginal rights (SLDF 2003). A subsequent case, involving similar claims by the Homathco (Chief Blaney of the Xwemalhkwu v. Marine Harvest, 2005) is still unresolved. In 2005, the Haida First Nations Council in northern BC filed a rights-and-title claim, which included a request for jurisdiction over foreshore and offshore marine resources (all seafloor surrounding their traditional territory to 200 miles of the Exclusive Economic Zone). The outcome of the Haida case could set a precedent for claims to benthic rights that would have profound effects on jurisdictional boundaries of all Canadian waters, including the ability to establish property rights for aquaculture and other industries, such

[57] Subsequent cases since 2005 include *Haida Nation v. British Columbia Minister of Forests* and *Taku River Tlingit First Nation v. Tulsequah Chief Mine Project.*

as offshore oil and gas extraction. A resolution of the Haida rights and title case in favor of the Haida peoples' right to benthic and marine resources would grant a type of First Nations rights which have never formerly been recognized in Canadian courts, with profound effects on existing rights to offshore and nearshore development.

5.4 Future of shellfish aquaculture production in British Columbia

The current volume of production from wild stocks in British Columbia has been relatively constant over the past ten years[58], and thus it is not possible to increase production of shellfish in BC without the benefits of property rights conferred by a tenuring system. Without these rights, aquaculture development will not proceed, as the rights inherent in leaseholds are necessary to secure the benefits of investment. Thus, it was not the intention of this dissertation to dismiss the importance of the tenuring system as a means of supporting and encouraging the aquaculture industry. Rather, it was important to explore how shellfish development was similar to, or differed from other forms of rights-based management, in order to assess potential risks or benefits and thus suggest directions for industry growth, or predict impediments to growth that include potential conflicts with other resource uses or territorial claims.

Understanding local perceptions of risk can help anticipate the controversy that has emerged over both finfish and shellfish aquaculture. In BC, salmon aquaculture has already led to a series of unresolved and largely intractable conflicts between First Nations and the Federal and Provincial government over territorial rights and control of fisheries resources and habitat. While shellfish aquaculture development has to date generated comparatively little controversy, sea space conflicts between wild harvesters and shellfish aquaculture operators may escalate if beaches and nearshore waters are increasingly converted to shellfish leases. As discussed in Chapter 3, legal resistance to shellfish farming has already been documented in other countries such as New Zealand, where the dramatic increase in shellfish aquaculture leaseholds during the late 1980s and early 1990s led to a seven-year moratorium on expansion of the shellfish industry. The moratorium, similar to the

[58] As noted in Chapter 2, reported catches have declined slightly.

moratorium on salmon farming in BC, was lifted only in 2005 with the implementation of policies that guarantee the Maoris rights to shellfish sites, and a share in all proceeds of shellfish aquaculture operations (Tollefson and Scott, 2004).

To date in New Zealand, only some of the recommendations for protection of Aboriginal rights and mitigation of environmental risks have been implemented by the shellfish industry. However, much could be learned from New Zealand and other countries through a comparative, cross-cultural study of shellfish and salmon aquaculture policies. As the shellfish industry develops in BC, policy frameworks elsewhere are worthy of further research before conflicts over sea space and environmental concerns intensify.

The majority of growth in the world's fish supply over the past two decades has been the result of aquaculture development (FAO, 2007). As world population increases and wild stocks decrease, market growth of aquaculture will be driven by a need for new protein sources and rising prices for seafood. Shellfish, as lower-trophic level species, are highly efficient to produce and have a relatively small environmental footprint. Although the developed world has to-date focused primarily on cultivation of high-trophic level species, world aquaculture production is still dominated by species at the lower end of the food chain. Of the total world production of fish and shellfish in 2007 (14.9 million tones), molluscs accounted for more than 30% of total aquaculture production (FAO, 2007). Most molluscs are currently grown in Asia, but there is clearly room for expansion of production in North America for both domestic and export markets.[59] The benefits of expanding the shellfish aquaculture industry should not be underestimated, both in terms of economic development for BC, and also in a larger social and ecological context of sustainable world food production. Yet the increased prevalence of aquaculture worldwide, and the conflicts often associated with the regulatory frameworks that foster it, are not likely to be resolved without increased attention to the implementation of rights-based management systems that are a prerequisite for aquaculture development. As rights-based systems increasingly become customary governance practices in the coastal zone, and growth predicated on these systems increases, it will be necessary to place more research emphasis on

[59] Asia accounts for more than 80% of world production of molluscs, and 90% of all aquaculture production.

governance structures, both for aquaculture development and rights-based management of other marine industries.

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APPENDIX A

Interview Questions

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1. General questions

How long have you had a wild clam license? Or how long have you been operating your tenure?

How long have you been living in this community? Were you born/grow up here?

How many (wild) harvesters do you estimate are in the area? How many shellfish aquaculture leases in the area?

Who is digging clams or operating shellfish farms (e.g.,First Nations band tenures, ACL or Z-2 license holders, other) in this area?

Are there a lot more people who want to dig than there are openings? Or, for aquaculture leases, how easy is it to develop tenures?

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2. Questions on economic status of the resource

How many people are working in (a) wild fishery (b) tenures?

Is the fishery profitable? Are aquaculture tenures profitable?

How important is the clam fishery to the community economically? Is it getting more or less important?

Who is buying the product? How much are buyers paying? Do you know how much clams are selling for on US markets? Other markets? [probe for profit margins, relationships with buyers, difficulties in shipping from remote locations, knowledge of markets]

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3. Questions on regulation and management of the wild fishery

Who pays for clam management?

Is there local management here that has the authority to decide when to harvest, or how much to take?

How do you feel about the band's fishery management? [if relevant]

How do you feel about DFO and other government agencies' management of the wild clam fishery? About their management of other fisheries? What has been your experience? What do you think is the community's experience overall? [probe for knowledge and experience of prior experiences with fisheries management]

How successful is management of the wild fishery? [e.g., relationships with firms, government, individuals; problems with overharvesting, enforcement, agree/disagree with regulatory decisions]

Is it getting worse, better, or the same?

If you think it is getting worse, what is the problem?

Are there closures? What are the reasons for these closures? If closures are for

Overharvesting → questions follow

Contamination/water quality → see below

Maps were used by interviewees to document locations of beaches closed/impacted due to over-harvesting or contamination/water quality. In the next two sections, several questions ask for

further descriptions of these locations in reference to the maps. NOTE: Not all questions were relevant in all cases. Sections 4-8 are case specific, and questions are based on relevance to known site criteria.

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4. WILD FISHERY - OVERHARVESTING CLOSURES

By and large, do you think the resource is in health or unhealthy condition? Is there overharvesting?

Which beaches are dug on the "wildcats"? Have some of these beaches been "dug out"? [map these]

How many people have licenses in this community?

How many harvesters are licensed vs unlicensed?

Has overharvesting contributed to closures by the Department of Fisheries and Oceans (DFO)?

Do you think the closures are fair, justified?

What level of support is there currently for DFO clam harvesting regulations? [probe for explanation of why support/no support]

Do you think there is an over-harvesting problem that justifies closures? (i.e. do you think conservation closures are necessary?) What is the attitude in the community generally about conservation closures?

Do you worry about abundance? At what point of abundance do harvesters chose not to dig, move on to other beaches? Which beaches are abundant, which have been dug-out? [map these]

What makes clams more or less abundant? [probe for knowledge of stock assessment or traditional/local knowledge of recruitment]

5.WILD FISHERY - WATER QUALITY CLOSURES

Do you think water quality is a problem? Do people in the community generally think water quality is a problem?

What do you think is the source of the water quality problem? [probe for knowledge of causes of water quality issues including PSP, bacterial contaminants, beliefs about other sources of contamination]

Do you know which agency is responsible for the water quality closures? [probe for knowledge of regulatory frameworks, relationships between Environment Canada and Department of Fisheries and Oceans]

Do you think the closures are justified? What level of support in the community is there currently for the water quality closures? (i.e. do people agree or disagree with the reasons for the closures?)

Which beaches are impacted by water quality closures? [map these and code reasons for closures]

How long have these beaches been closed? [record approximate dates]

What is the prior history of water quality closures in this area? (i.e. frequency of closures, dates of historical closures, former frequency of sampling, prior relationships with regulatory agencies)

6.WILD FISHERY - OTHER CONTAMINANTS

Are there contamination problems that aren't associated with closures? If so, what are they?
Which beaches are impacted by contamination? [map locations]
Do you harvest off these (perceived as contaminated) beaches for personal (e.g.,subsistence) use? Do you harvest off of these (perceived as contaminated) beaches commercially?
How long have you been aware of this contamination?
Is there a visible difference between clams from contaminated beaches and non-contaminated ones? [probe for local knowledge, beliefs about the source and type of contaminants]
If contaminants are from salmon farms, how dispersed are the impacts? (i.e. at what distances are impacts from salmon farms perceived to impact clam beaches? [plot locations of salmon farms adjacent or in vicinity of clam beaches]

7.If contaminants are perceived from salmon aquaculture, then ask for brief explanation of the history of salmon aquaculture in the area, including number of farms, time these farms have been in these locations, and interviewees perceptions of relationships between salmon farms and the local community:

How long has the salmon farm been here? [note date on the chart]
How long has there been salmon aquaculture in this area?
How long have salmon farms been in these locations?
Does the band have rights/agreement/relationship with the salmon aquaculture company?
Do you have any feelings about the salmon aquaculture operations here?

8.Questions on regulation and management of the shellfish aquaculture industry

How many shellfish tenures in this area? [plot locations]
Who owns the tenures? Who operates the shellfish tenures? [code ownership]
How much employment created by these tenures?
Do you know much are the tenuring ("leasing") fees per year? Who pays for these tenuring ("leasing") fees?
Were the beaches that are now tenured previously in the wild fishery? How long ago? [record any known times for conversions to tenures]
How many of these beaches were converted to tenures in the past five years? [plot locations and count totals]
How do you feel about shellfish tenures? (i.e. if in favor, what is your vision for future of shellfish tenures? If against, probe for reasons.)

9.Questions on traditional use and subsistence harvest

How often do you harvest clams for personal use? Can you show me where? [plot locations]
Have you heard stories about the clam gardens? Are there traditional clam gardens here? [plot locations of traditional and historical harvest sites]
How important is the clam fishery generally in the community for subsistence harvest ("home" or "traditional" use)? Which beaches? [plot frequented locations]

Who are the "beachkeepers"? Are they hereditary chiefs? Do they have control of specific beaches? [probe to see if beachkeepers must give permission to harvest on certain beaches, impose "tax" on commercial harvesters]

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10. Questions about perceived risks and benefits

General questions

What are there other major threats to shellfish production (wild fishery and shellfish aquaculture) in this area?

What are the conditions in the wild clam fishery here now? Is it viable? Dangerous? Why?

What are the conditions for aquaculture here now? Is it viable? Risky? Why?

What is the greatest risk to the wild clam fishery? What is the greatest risk to the aquaculture industry?

What do you envision in the future: more benefit from the wild fishery and/or shellfish aquaculture tenures?

Do you want more shellfish aquaculture here?

Are there any beaches where you wouldn't want to see shellfish tenures? [plot locations] Why not?

Economic futures

How stable is the wild fishery currently (market price for product, income earned, consistency of employment)? How stable is the aquaculture industry currently (market price for product, income earned, consistency of employment)? How is this different from five years ago?

Is the status of the wild fishery improving or getting worse? Is aquaculture becoming more or less economically viable?

How do you feel about the economic future of the wild fishery? How do you feel about the economic future of aquaculture operations?

What would make the wild fishery more economically viable? What would make aquaculture more economically viable?

Livelihood and identity

How long have you harvested clams here? Did you fish other species before?

Do other members of your family harvest clams? Do other members of your family fish? [probe for types of licenses held, types and level of subsistence use]

Is there a future for the next generation to fish in the wild clam fishery? Is there a future in aquaculture?

Do you see clam harvesting as an important part of the future of this community? Do you see aquaculture tenures as an important part of the future of this community?

What would you like to see happen to the wild clam fishery? Do you think this can happen? What would you like to see happen to the shellfish aquaculture industry? Do you think this can happen?

Health and environment

Are there health risks from eating shellfish in this area? What are the greatest risks?
Are there environmental risks? What are the greatest risks?
What could be done to reduce these risks? Is this possible? [probe for sense of control over risk]

→ Health/environmental risks from salmon farm contaminants?

→ Health risks from bacterial and PSP contaminants?

Environmental risks from shellfish farming?

→ Risks to political futures

How do you feel about non-First Nations tenures in this territory?

Are there risks to territory/treaty negotiations from the tenuring system?

Do you feel tenures are infringing on treaty rights? [probe for beliefs about non First Nations shellfish tenures or salmon farm tenures in First Nations territories]

11. Questions on access rights to the resource

Have you ever had a problem getting access to shellfish resources? Do you feel that you should have access when you want for subsistence use? For commercial use? What is preventing people who want access from getting it?

Who should have rights to harvest here?

Do you feel there is discrimination in access to the wild fishery? To tenures?

How could you increase or limit access to the wild fishery (court/legal action, licenses, authorizing fishing on beaches that are currently closed?) Would this increase your ability to harvest or do you think more restrictions should be placed on resources to preserve stocks?

How could you increase or preclude access to tenures? [probe for information on referrals] Are there cases of tenures being issued that the band did not approve? That you don't approve of?

What happens when someone gets a tenure on a beach that you/the community doesn't approve of (e.g.,is there conflict?)?

Are tenures private property?

12. Questions on access to markets / economic opportunity

Would more investment in tenures increase access (increase production or jobs)?

Could investment in the wild fishery increase access? What would this investment look like?

Could investment in tenures improve economic opportunity in this community?

Do you make more money from tenures or the wild fishery? Which do you think is more cost-effective?

Do you worry about getting a fair price for your clams? Could you get a better price? How? [probe for relationships with buyers, beliefs about opportunities to develop marketing strategies, interest in entrepreneurial ventures for smoking, packing, processing product]

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13. Questions for follow up

Can you tell me the names of some other harvesters/tenures in other locations? (or, are you in any way connected to other communities/bands/operators involved with shellfish?)

In what ways are you connected with outside agencies? [probe for knowledge of Clam Board, Shellfish Aquaculture Growers Association, DFO or Provincial Government regulatory agencies for shellfish, etc]

Would you want to talk to other harvesters in other areas of the coast if there were an easy way to establish communication? What would work for you? (phone, meetings, visits?)

Who is someone you talk to regularly about clams that you think is very knowledgeable? Whose opinion do you respect? Who else should we talk to?

Institute for Resources, Environment and Sustainability
Room 462 – 2206 East Mall
University of British Columbia

Participant
City, Province

May 26, 2005

Dear [redacted],

I am writing to you regarding a research project being conducted by myself, Alyssa Joyce, and Professor Terre Satterfield from The University of British Columbia (UBC) and Professor Rosaline Canessa from the University of Victoria. The research project is entitled "Risk and Opportunity in British Columbia Clam Fisheries." We are currently working with communities and First Nations band councils on Vancouver Island and the Sunshine Coast to investigate changing conditions in the shellfisheries. We are very interested in hearing from community leaders, clam harvesters, as well as people who are involved in shellfish aquaculture, in order to get a coherent picture of the variety of opportunities and/or problems facing wild clam harvesters and shellfish aquaculture operators in British Columbia. This research is being undertaken towards my Doctoral degree at UBC.

If you agree to participate, I would like to arrange for an interview at a time and place that is convenient for you. The interview will include questions about current challenges and opportunities in the wild clam fishery and in shellfish aquaculture operations, as well as any thoughts you may have about your use of and access to shellfish resources. We would very much like to hear from you about what kind of things might help you avoid or manage problems that you face, including those that will help us better understand how communities and harvesters are responding to changing government policies and to determine how these policies may help or hinder your access to shellfish for personal or commercial use. The interview should take approximately one hour of your time. Participation is wholly voluntary, and your name will never be associated with any information that you choose to share. At the time of the interview, we will present you with a consent form and ask for permission to quote your responses in any subsequent publications.

Thank you for considering our request. I will be contacting you in the next few weeks to see if you are interested in participating. In the meanwhile, if you have any questions you can telephone me at 604-xxx or call Professor Terre Satterfield at (604) xxx. If you have any questions about your rights as a research participant, please feel free to contact The University of British Columbia Research Subject Information Line at 604-822-8598.

APPENDIX B - CONSENT FORM

Project: *Risk and Opportunity in the British Columbia Clam Fisheries*

Principal Investigator: Dr. Terre Satterfield
Institute of Resources, Environment and Sustainability
The University of British Columbia
604- xxx

Co-investigator: Alyssa Joyce, PhD student
Dept. of Resource Management and Environmental Studies
The University of British Columbia
604- xxx

Purpose: Researchers Terre Satterfield, Rosaline Canessa and Alyssa Joyce are conducting a study investigating the distribution of fishery access rights along the BC Coast, focusing specifically on changing resource use patterns in wild shellfish harvesting and shellfish aquaculture.

You have been invited to participate in this research because of your knowledge about local issues influencing the shellfish industry. Your voluntary participation in this study will help researchers better understand any economic and practical barriers that you might face, including problems and opportunities that are linked to Federal and Provincial government policies (fisheries laws, water quality monitoring and land tenuring practices), as well as a range of risks and opportunities in management of shellfish. We are interested in investigating both wild clam fisheries and shellfish aquaculture as part of this study. Your voluntary participation in the research will aid in understanding the future of shellfish harvesting in coastal communities. This research will contribute to the Doctoral thesis of co-investigator Alyssa Joyce, and the results will be shared with the communities and individuals choosing to participate in this study.

Study Procedures: Interviews are being conducted with clam and oyster growers, clam harvesters, fisheries managers, fisheries biologists, band leaders. Completion of an interview should take sixty to ninety minutes of your time. Please feel free to ask questions about procedures at any time during the interviews.

Confidentiality: The researchers commit to keeping your identity in strict confidence. Your name will be removed from our research materials, and you will never be identified in any publications or other research material without your explicit written permission. Hard copies of our data will be remain locked at UBC, and electronic copies will be password protected. The only persons who will have access to this data are Dr. Terre Satterfield and Alyssa Joyce.

Contact Information about the study: You may contact Terre Satterfield or Alyssa Joyce with any further questions in respect to this study.

Contact Information about the Rights of Research Subjects: You may contact The University of British Columbia Research Subject Information Line (604-822-8598) with any questions or concerns about my treatment or rights as a research participant.

Consent: Everyone who is interviewed is asked to either sign an informed consent release. You understand that your participation in this study is entirely voluntary and that you may refuse to participate or withdraw from participation at any time without penalty or offence. By giving consent you ***do not*** waive any legal rights.

Your signature below indicates that you have received a copy of this consent form.

Your signature below indicates that you consent to participate in this study.

_____

Name of Participant (Please Print)

_____

Signature of Participant Date

The University of British Columbia
Office of Research Services and Administration
Behavioural Research Ethics Board

Certificate of Approval

PRINCIPAL INVESTIGATOR	DEPARTMENT	NUMBER
Satterfield, T.A.	Resources, Envir & Sustain	**B05-0512**

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT

UBC Campus ,

CO-INVESTIGATORS:

Canessa, Rosaline, Geography; Joyce, Alyssa, Graduate Studies

SPONSORING AGENCIES

TITLE:

Risk and Opportunity in British Columbia Clam Fisheries

APPROVAL RENEWED DATE	TERM (YEARS)	
AUG 1 6 2006	1	

CERTIFICATION:

The request for continuing review of the above-named project has been reviewed and the procedures were found to be acceptable on ethical grounds for research involving human subjects.

Approved on behalf of the Behavioural Research Ethics Board
by one of the following:
Dr. Peter Suedfeld, Chair,
Dr. Jim Rupert, Associate Chair
Dr. Arminee Kazanjian, Associate Chair

This Certificate of Approval is valid for the above term provided there is no change in the experimental procedures