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The 'F-Word': Awareness and Perceptions in Fin-Fish Farming and Aquaculture Policies

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**The 'F-Word': Awareness and Perceptions in
Fin-Fish Farming and Aquaculture Policies**

By

Jordan Wrigley

Accepted in Partial Completion
of the Requirements for the Degree
Master of Arts

Kathleen L. Kitto, Dean of the Graduate School

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MASTER'S THESIS

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Jordan Wrigley
May 5, 2017

**The 'F-Word': Awareness and Perceptions
In Fin-Fish Farming and Aquaculture Policies**

A Thesis
Presented to
The Faculty of
Western Washington University

In Partial Fulfillment Of
the Requirements for the
Degree Master of Arts

By
Jordan Wrigley
May 2017

Abstract

Fin-fish aquaculture and farming is a disputed and controversial issue in the United States. These controversies and disputes may occur in part because of perceptions of fin-fish aquaculture as threatening to local and regional environments, traditional lifeways, and occupations. These perceptions are complicated by the positive role aquaculture might play in addressing U.S. dependence on seafood imports, as well as issues of socio-economic access to fish and the associated health benefits. Further, how issues of fin-fish aquaculture are perceived as well as what level of awareness and knowledge perceptions are based on as may impact policy decisions through public support and discourses. Yet, there are few comprehensive studies of perceptions of aquaculture in the U.S. or the implications for food systems and environments through policy decisions. The following thesis is an exploration of fin-fish aquaculture perceptions, awareness, and knowledge at three scales: national, regional, and individual. I have added to current social-aquaculture research by characterizing elements and aspects of perceptions at each scale in three discrete manuscript-style studies. Key findings in this research include correlation between awareness and perception among coastal stakeholders, emphasis on impacts to the natural environment and local food production in perceptions, and the changeability of perceptions in a learning context. Based on the collected findings from all three studies, I give recommendations for approaching fin-fish aquaculture in public policy and planning processes to reduce conflict and increase consensus in context-based goals for fin-fish aquaculture.

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Acronym List

APA	American Planning Association
ARCScale	Aquaculture Regulatory Climate Scale
CSA	Community Supported Agriculture
CSAqua	Community Supported Aquaculture
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
eNGO	Environmental Non-Government Organization
ESA	Endangered Species Act
GIS	Geographic Information Systems
GM	Genetically Modified
IMTA	Integrated Multi-Trophic Aquaculture
IRB	Internal Review Board
JARPA	Joint Aquatic Resource Permit Application
KALPHA	Krippendorff's Alpha
LISA	Lummi Indian School of Aquaculture
MSC	Marine Stewardship Council
NGO	Non-Government Organization
NIH	National Institute of Health
NIMBY	“Not-In-My-Backyard”
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWIC	Northwest Indian College
PGIS	Participatory Geographic Information Systems
RCW	Revised Code of Washington
SEPA	State Environmental Policy Act
SMA	Shoreline Management Act
SMP	Shoreline Management Program
SPSS	Statistical Package for the Social Sciences
USDA	United States Department of Agriculture
UW	University of Washington
WAC	Washington Administrative Code
WWU	Western Washington University

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Chapter 1

Introduction

In 2002, a group of activists broke into and damaged machinery and structures at an Atlantic salmon farm in British Columbia, Canada (Young and Matthews 2011). This event is indicative of the social clashes that have been and are occurring across North America over the use and practice of fin-fish farming and aquaculture. Controversies, protests, and political maneuvering to ban fin-fish aquaculture have occurred in nearly every coastal region of the United States, as well as Canada, in both freshwater and marine contexts (Mosness 2017; Payette 2015; Winter 2009; Young and Matthews 2011). Events such as the 2002 actions to remove a fish farm from the regional waters in B.C. may occur in part because of perceptions of fin-fish aquaculture as threatening to local and regional environments, traditional lifeways, and occupations (e.g., fishers) (Natale et al. 2013; Sanchez-Jerez et al. 2016). However, this is complicated by the positive role aquaculture might play in addressing U.S. dependence on seafood imports, as well as issues of socio-economic access to fish and the associated health benefits (Helvey et al. 2017; Gutiérrez and Morgan 2015; Kite-Powell, Rubino, and Morehead 2013; Delgado et al. 2003).

The possible role of perception in policy is problematic when perceptions are based on generalized and vague information such as that found in media characterizations of aquaculture (Froehlich et al. 2017; Hall and Amberg 2013). Additionally, there are questions about how aware or knowledgeable stakeholders and the general public are of both negative and positive impacts of fish-farm, or even that they exist (Mazur and Curtis 2006). Further, media characterizations and political discourses often do not include discussion of the impacts of fin-fish aquaculture and fin-fish aquaculture policies on regional food systems and access to

produced seafood (Froehlich et al. 2017; Costa-Pierce 2015; Knapp and Rubino 2016).

Understanding public and stakeholder awareness and perceptions aids in addressing current and possible future conflicts by locating the common social goals and concerns that underpin differing views of aquaculture and encourage consensus in policy decisions defining the future of aquaculture (Dryzek 2013; Cheung and Sumaila 2008; Kaiser and Stead 2002).

Through exploration of aquaculture at three scales, national, regional, and individual, I seek to add to current social-aquaculture research by characterizing elements and aspects of awareness and perceptions at each scale. Each of these scales is encapsulated in its own study. The resulting studies form the core of this thesis. To this I add policy recommendations based in the collective findings of all three studies. These recommendations emphasize engaging regional stakeholders and the general public in decision-making based on holistic awareness and fully informed perceptions of aquaculture types, practices, impacts, and outcomes relevant to contextual environmental, economic, and social goals for aquaculture.

In this research, I use food systems as my predominant lens with acknowledgment that these systems are often inseparable from the environment and regional ecosystems (Gutiérrez and Morgan 2015). This is, in part, due to my own experiences and observations in moving to the coastal city of Bellingham, Washington. Moving from a land-locked state I had envisioned the Washington coast as a never-ending seafood feast. But, sadly, I found there were limits to seafood access including mobility (e.g., getting to the harbor to buy off a boat) and price. It turned out I was not alone in the latter as a graduate student on a tight budget (Owens 2012).



Figure 1: Photo of the salmon options at a local grocery store in Bellingham, Washington (photo by researcher)

Within Washington, and as of 2016, just under one million people were on food assistance with \$118 being the average level of assistance per month (Kaiser Foundation 2016). When wild caught salmon costs approximately \$14 per pound (Figure 1) (roughly 11% of a \$118 a month budget) it and its associated health benefits such as increased brain function (a necessity for a graduate student) and heart health, among others, become inaccessible to low-income individuals (Loring, Gerlach, and Harrison 2016; Delgado et al. 2003).

This does not include those who simply cannot find fish due to rural contexts or transport. When I could find it, I noticed farmed Atlantic salmon was significantly cheaper than fresh and

“wild”¹. Yet, people throughout the Northwest and the wider West often react to farmed fish and fish farms with knee-jerk disdain or even disgust. This was particularly true in the case of salmon farming in my new home (Pers. Obs.). Despite this, individuals were often unaware of the eight Atlantic salmon net-pen sites operation in Washington waters (Bouta and Payne 2015). The combination of observed lack of regional accessibility and observed strong perceptions that were likely indicative of the feelings held by the B.C. activists in 2002, led me to an investigation of fin-fish aquaculture awareness and perceptions from a policy perspective. Specifically, I ask the broad question: How do people perceive aquaculture? To answer this question, I completed the three studies at the core of this thesis. Each of these studies answered sub-questions or hypothesis designed to add to knowledge and conversations that currently form the basis of knowledge addressing how and what people think of aquaculture and to tease apart some of the details and specifics of perceptions as well as awareness and knowledge as they relate to one another.

¹ The term “wild” is questionable. 80-90% of salmon caught in Pacific Northwestern waters and 50% in Alaskan waters are hatchery originated (National Marine Fisheries Service 2014). Hatcheries themselves are a type of aquaculture according to definitions by the National Oceanic and Atmospheric Administration (NOAA) (Blackhart, Stanton, and Shimada 2006). Hatcheries also have some of the same impacts on native salmon species as fish-farms (Araki and Schmid 2010). This has led researchers and seafood sustainability programs such as Monterey Bay Aquarium’s *Seafood Watch* to question not only how “wild” is defined but if hatchery produced fish should be subject to examination in terms of sustainability (Charron 2014; Lackey 2003).

Before moving to these studies, I give a brief overview of the literature and theory guiding their design as encapsulated in the conceptual framework in Figure 2. It should be noted that my own Washington context has led me to pull heavily from the marine salmon net-pen farming literature.

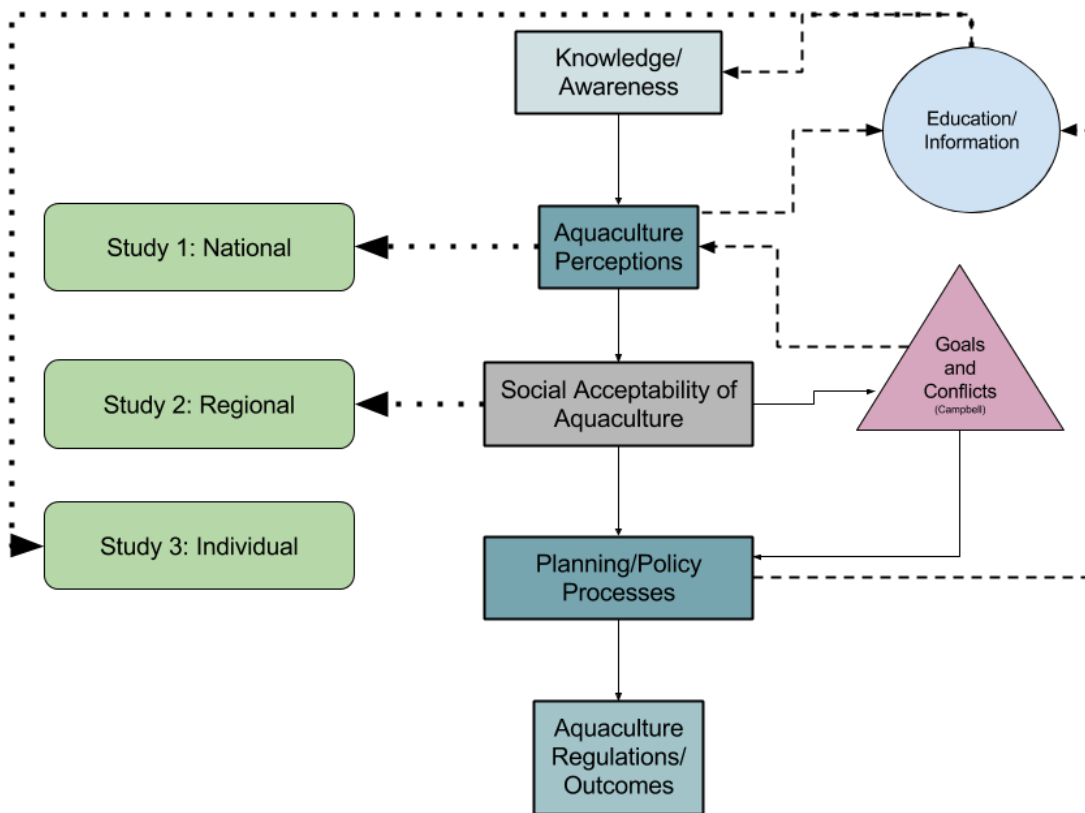


Figure 2: Conceptual Framework

There are a variety of aquaculture species, structures, practices, and geographic locations in a seemingly infinite number of combinations. Each of these combinations will have different impacts and meaning for individual region's environments and food systems.

Therefore, it should also be acknowledged that any given form of fin-fish aquaculture may not suit the environmental, economic, or social character of a region regardless of increased awareness or changed perceptions. This is to say, although this research may be engaged with increasing awareness and initiating perception change, the intent is not to ensure all stakeholders and the general public accept and/or actively support aquaculture development. Rather, the intent of this research and the subsequent recommendations is to provide insights that may contribute to strengthening policy decisions for fin-fish aquaculture in Washington state.

Literature

Although under-examined in scholarly literature, seafood as a part of local and sustainable food movements has entered popular literature. Popular authors note that the U.S. is dependent on imported seafood to meet continuously growing demand (Voo 2016; Greenberg 2014, 2011). Presently, 90% of seafood consumed in the U.S. is imported. Of imported seafood, 50% is produced through aquaculture. This has led to a \$11.2 billion annual deficit in seafood trade (National Marine Fisheries Service 2014). Domestic fin-fish aquaculture offers a possibility of reducing U.S. dependence on imported fin-fish by producing what is currently being imported from international operations (Helvey et al. 2017). Additionally, aquaculture operations in Asia and South America are often less regulated for social and environmental damages. Therefore, U.S. dependence on imported aquaculture products, in addition to creating a deficit, also shifts negative impacts on both natural and human environments to vulnerable regions and populations (Campbell 1999; Helvey et al. 2017; Naylor et al. 2009, 2000). This is not to say communities in these regions are unaware of the impacts of aquaculture operations. Rather, in a complex series of environmental, economic, and social trade-offs, as well as other considerations and pressures,

communities or individuals have elected to incorporate aquaculture as best as possible within their respective contexts. Further, Hugues-Dit-Ciles (2000) suggests there may be an optimal equilibrium to be struck between the environmental, economic, and social aspects of aquaculture practices and development where contextual goals for its installment are incorporated into planning. This may also be the case for the U.S.

Within the U.S., few fin-fish aquaculture perception studies have been completed despite the potential implications of its development for domestic economics, food systems, and environments, both natural and human. A consistent theme in previous studies has been the perception of aquaculture as ecologically and environmentally harmful, but of the socio-economic benefits as desirable (Chu et al. 2010; Whitmarsh and Palmieri 2009; Mazur and Curtis 2008, 2006; Katranidis, Nitsi, and Vakrou 2003). Robertson, Carlsen, and Bright (2002), in a New England study, found the nature of information and previous knowledge of the individual both played roles in the formation and change in perceptions of off-shore aquaculture. In a comparative study between Norway and the U.S., Chu et al. (2010) found several factors impact perceptions of aquaculture with a key finding that the more stakeholders agree with the benefits and disagree with the detriments, the more likely they are to support development. The authors also suggest perceptions of aquaculture among stakeholders has significance for policies by determining the support for development.

Analysts of aquaculture policy note that regulatory policies “are developed over time in response to a society’s desire to provide oversight” and congressional officials “do so in response to interests of society as expressed by each member’s constituents”(Engle and Stone 2013, 253).

Expressed interests are likely to be created through perceptions of the subject or issue under consideration (Sudarmadi et al. 2001). In this case, perceptions of fin-fish aquaculture are likely to inform the interests and stances expressed as a part of and through political processes. Presently, fin-fish aquaculture policy discourses have been dominated by two stakeholder groups: environmentalist, who tend to focus on the negative impacts of aquaculture sites on natural environments (e.g., disease transfer to native populations of fish)², and aquaculturist, who emphasize the economic benefits (e.g., increased domestic production) of aquaculture (Knapp and Rubino 2016; Costa-Pierce 2010). Although it is tempting to reduce aquaculture debates to environment versus economy, perceptions of aquaculture are far more complicated and nuanced particularly when considered at the regional and state scales where most aquaculture regulation through policy takes place (Engle and Stone 2013).

In a study of aquaculture regulatory stringency, Wirth and Luzar (2000) illustrated the variety of aquaculture policy approaches taken by states and between aquaculture types including species, purposes, and practices. It has also been noted that some regions of the U.S., such as the

² It is important to make a distinction between the natural and human or built environments particularly in policies, because they are often distinguished in frequently used policy tool such as environmental impacts assessments (EIA) and statements (EIS) (DiMento and Ingram 2005). For example in Washington Administrative Code (WAC) and the Revised Code of Washington (RCW), "natural environment" means those aspects of the environment contained in WAC 197-11-444(1), frequently referred to as "natural elements, or resources, such as earth, air, water, wildlife, and energy"(WAC 197-11-770) and "built environment" refers to the elements of the environment as specified by RCW 43.21C.110 (1)(f) and WAC 197-11-444(2), which are generally "built or made by people as contrasted with natural processes"(WAC 197-11-718). For the purposes of this research, environment or environmental (e.g., environmental impacts) is used to refer to both environments simultaneously with "natural" and "human" or "built" used to refer to one or the other specifically.

Northwest and New England, were more stringent than others (Zhu and Chu 2013; Pillay 1992). This variation in policy regulation suggests there are differing perceptions being expressed through political processes within each state and in reference to different modes of aquaculture. Researchers also suggest conflict and, perhaps, regulation may be more controversial where current or potential fin-fish farms and aquaculture overlap with traditional catch fisheries as well as where environmental groups work with fishers to advocate its banning (Sanchez-Jerez et al. 2016; Natale et al. 2013; J. L. Anderson 1985). This echoes findings in previous studies in Australia and Greece wherein perceptions of aquaculture were found to vary by region (Mazur and Curtis 2006; Katranidis, Nitsi, and Vakrou 2003). Whitmarsh and Palmieri (2009) further found the socio-economic character of a region (e.g., income levels) may play a role in perception and support for aquaculture development. The authors specifically note regions of affluence were more likely to place greater weight and importance on aquaculture's impacts on natural environments whereas regions of low-income placed more weight on the economic impacts and benefits of development. This illustrates that nuance in the social aspects of aquaculture and aquaculture perceptions is likely to exist at the regional scale and in relation to different types of aquaculture. Costa-Pierce (2010) emphasizes context in designing approaches and goals for aquaculture development. Before approaches and goals can be addressed there should be an understanding of regional public and stakeholder awareness and knowledge of current or potential aquaculture as well as the types, impacts (positive and negative), and implications for contextual environments, economies, and life-ways (Hugues-Dit-Ciles 2000; Sudarmadi et al. 2001).

Sudarmadi et al. (2001) define awareness as the “attention, concern (mindful or heedful) and sensitivity” to environmental issues, whereas knowledge is defined as “a body of facts and principles” (172). As an example, consumer studies have noted the Pacific Northwest and Washington may be more likely to be “sensitized” (Cline 2012, 392) to aquaculture issues as a region (Wessells and Holland 1998). Yet, it has also been shown consumers in the same region may not be knowledgeable of current and potential fin-fish aquaculture (Hall and Amberg 2013). In another example, Mazur and Curtis (2006) found in a survey of Australian perceptions of aquaculture that individuals had low awareness and knowledge of existing and developing aquaculture sites despite proximity. Therefore, awareness and knowledge of aquaculture within a given context cannot be assumed. This would seemingly contrast with other studies and researchers who suggest conflict is more intense and frequent in closer physical proximity to aquaculture (Sanchez-Jerez et al. 2016; Hamouda et al. 2005; Hoagland, Jin, and Kite-Powell 2003). These conflicting findings may indicate that an individual or group does not necessarily need to be aware of or be knowledgeable about aquaculture (regardless of proximity) to form strong perceptions and often opinions of or stances on its use and development. For the purposes of this research, I will be addressing specifically perceptions of aquaculture which underlie opinions and stances on aquaculture issues. Perceptions underlie opinions and stances on environmental problems because perceptions are where the problems are framed or understood in terms of personal and contextual experiences in both individuals and the public (Mazur and Curtis 2008). It is good to note that opinions are not consistently synonymous with perceptions yet both can be impacted by media (Amberg and Hall 2010).

Media and media representations of aquaculture may also affect perceptions and vicariously behavior including consumer choices and political support by impacting knowledge and awareness (Rickard and Feldpausch-Parker 2016; Hall and Amberg 2013; Schlag 2010). Research has also found that perceptions can change when new knowledge is acquired (Leach et al. 2014; Kaiser and Stead 2002). This is counter to most previous research suggesting that more information, and scientific information specifically, further ingrains previously held beliefs (Leach et al. 2014). It is, perhaps, in the social aspect of aquaculture perceptions where researchers and decision-makers can reach beyond initial environment versus economy dialogues to include contextual social impacts into aquaculture approaches and goals. In so doing, it may be possible to locate the common social goals and concerns that underpin differing views of aquaculture and encourage consensus in policy decisions defining the future of aquaculture and its impact on natural and human environments and food systems (Krause et al. 2015; Barrington et al. 2010; Whitmarsh and Palmieri 2009).

Theory

There are several theoretical paradigms that might explain the strong opinions and reactions toward aquaculture. For this research, I selected three key theoretical frameworks. In the following section, I give a brief overview of the selected and supporting theories. Theories overviewed in this section will be reiterated, as relevant, in each study. First, I pull from the work of Yi-Fu Tuan's *Topophilia* (1974) to conceptualize and define perception, where the importance of context is emphasized. To this I add participatory policy process theory to expand on the relationship of perception to policy formation (Wesselink et al. 2013; Dietz and Stern 2008). To further explore the context of aquaculture perceptions, I use bioregional planning

theory as described by Robert Thayer in his work *LifePlace* (2003). Thayer defines the concept of bioregions or places that “can be variously defined by the geography of watersheds, similar plant and animal ecosystems, and related, identifiable landforms (e.g., particular mountain ranges, prairies, or coastal zones) and by unique human cultures that grow from natural limits and potentials of the region” (3). I use this to emphasize the context of aquaculture perceptions in relation socially enculturated value trends. To give form to the underexplored and often wicked issues surrounding aquaculture (Jentoft and Chuenpagdee 2013, 2009), I incorporate the Planner’s Triangle created and revised by Scott Campbell (1999, 2016). Lastly, I briefly summarize the theoretical basis of the methodological approach of using key-informants to gather data. The tool was developed in cultural anthropology research, to locate and streamline qualitative data gathering of perceptions (Tremblay 1957; Marshall 1996).

Tuan (1974) defines perception as “the response of the senses to external stimuli and purposeful activity in which certain phenomena are clearly registered while others recede in the shade or are blocked out.”(4) Based on Tuan’s theory of environmental perceptions, it is likely that awareness and perceptions of aquaculture will vary based on individual and group characteristics. In participatory policy formation, when one perception or voice is stronger than others, it affects the attitudes of the wider group and can dominate subsequent environmental discourses (Wesselink et al. 2013). This can lead to favored perceptions or definitions of sustainability that preference some priorities and solutions over others in policy (Wesselink et al. 2013). This is in keeping with Costa-Pierce's (2010) call for regional goal-making for aquaculture and the state-scale nature of current aquaculture policy-making (Engle and Stone 2013; Zhu and Chu 2013; Wirth and Luzar 2000; Pillay 1992). It is important here to note that the dominant perception is not

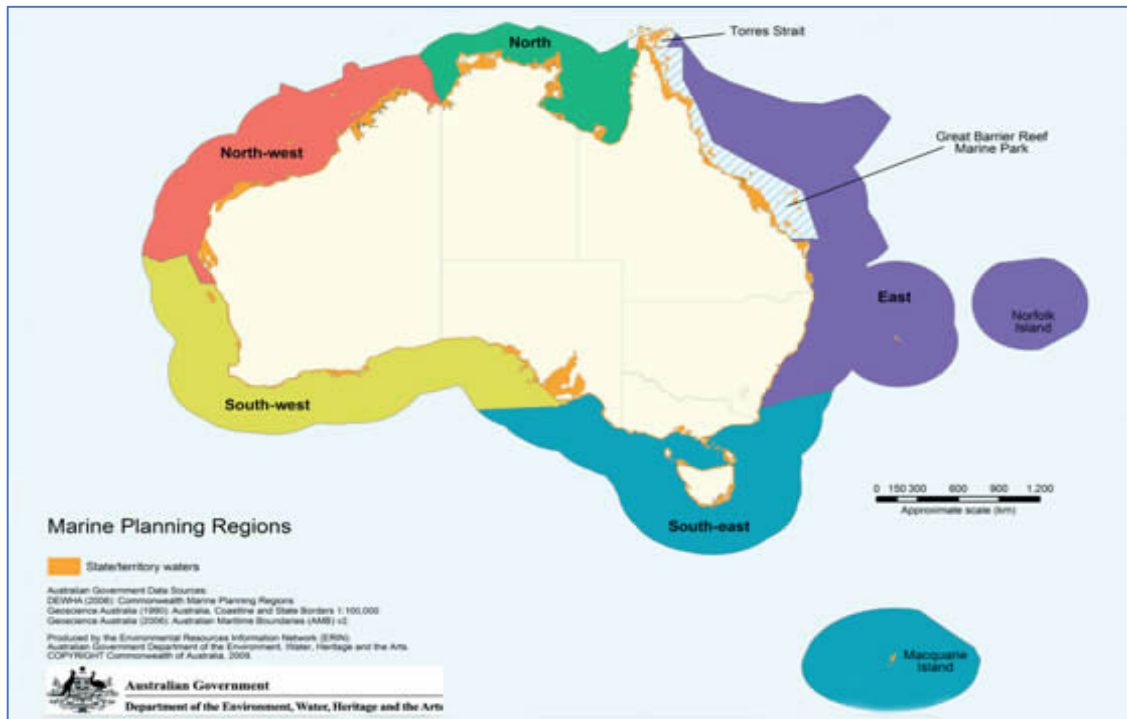


Figure 3: Australian Marine Bioregions (Department of Sustainability, Environment, Water, Population, and Communities, 2011)

synonymous with the most common perception or the perception of the majority (Neumann 2014). Participatory planning and engagement literature notes those stakeholders who participate in policy formation often hold extreme opinions of policy issues not holistically representative of the stakeholder population (Dietz and Stern 2008). However, the perceptions, awareness, and knowledge of aquaculture are not homogenous across scale or geography (Mazur and Curtis 2008; Katranidis, Nitsi, and Vakrou 2003; Robertson, Carlsen, and Bright 2002).

Bioregional planning approaches have made addressing the environmental, economic, and social complexities of place key in developing planning and resource management solutions (Thayer 2003). In this planning paradigm, management and design are place-based with boundaries being

defined through ecological and cultural characteristics rather than political. These nature-bounded areas are bioregions; in Australia, bioregions have been defined for marine planning areas through research, planning, and policy processes (Figure 3) (Department of the Environment and Energy 2012; Department of Sustainability, Environment, Water, Population, and Communities 2011). Like Tuan (1974), Thayer (2003) contends that ‘place’ is reflected in the perceptions of a given region. Therefore, sustainability is an issue best addressed and defined with context-specific environmental perceptions and values in mind. Thayer also points out that awareness of place creates and changes the “mental-maps” (259) of people and what is included in them in terms of environments and food systems (Thayer 2003). Therefore, to form a place-based use for aquaculture that fits with regional environmental, economic, and social goals and reduces conflicts awareness and knowledge of aquaculture is required.

The Planner’s Triangle can help address the unstructured nature of wicked problems (Campbell 1999; Berke 2016; Australian Public Service Commission 2016; Hisschemöller and Hoppe 1995). Within a policy context, the structuring of problems is essential to creating effective solutions and accurate use of policy tools such as EIAs (DiMento and Ingram 2005). The Planner’s Triangle provides a tool to find and structure planning priorities and conflicts in a way that avoids “vague idealism”(296) (e.g., “a romanticized view of pre-industrial, indigenous, sustainable cultures”(297)) while pursuing sustainability (Campbell 1999). Planning priorities are shown in the points (environment, economy, society) of the Triangle and conflicts between these priorities as the sides of the Triangle with the ideal of fair, sustainable, growth at the center (Figure 4) (Campbell 1999). Bioregional planners have taken this simple diagram and further described it as a ‘three-legged stool’ of planning with each priority constituting a leg and

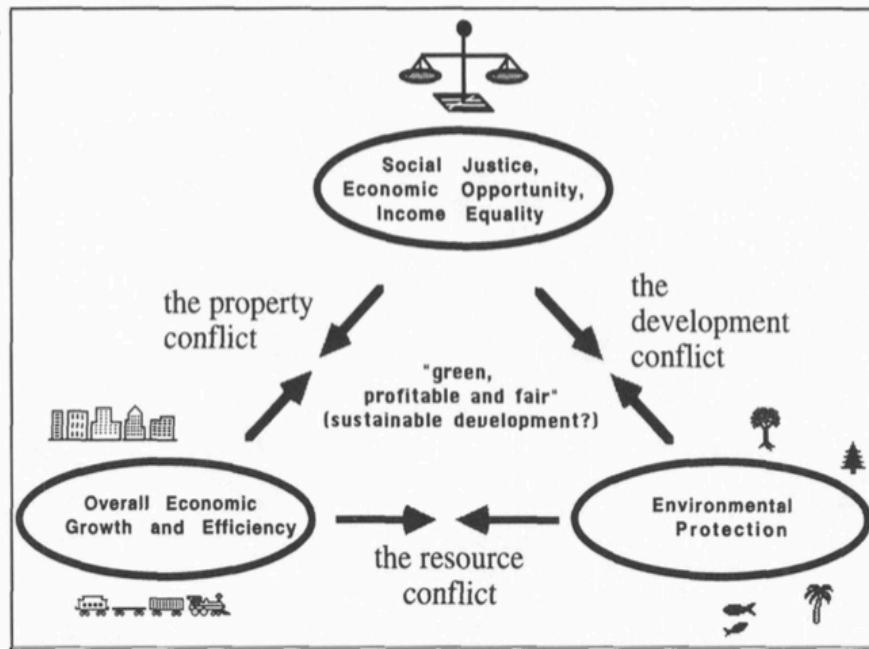


Figure 4: *The Planner's Triangle* (Campbell 1999)

sustainability balanced atop the seat (Tanzer and Longoria 2007). The Triangle in any form allows planners to give structure to ill-structured and intractable problems by locating community priorities and identifying tensions in seeking sustainable outcomes (Campbell 2016, 1999; Hisschemöller and Hoppe 1995). Critics of the Triangle have described it as static, simplistic, and weak in its representation of social complexities (Berke 2016). Nonetheless, Campbell's Triangle has been and continues to be a key diagrammatic tool in planning paradigms and solution-finding (Moore 2016).

Perceptions among stakeholder populations could not be surveyed directly due to limited time and geographic extensiveness of the population. To address this, a key-informant technique was operationalized for this research (Marshall 1996; Tremblay 1957). In this approach, individuals are selected as informants for their knowledge of a community or issue (Marshall 1996). Key-

informants in this research were chosen for their connections and expertise relating to aquaculture. Of interest were informant observations of general and specific regional perceptions and awareness of aquaculture. Informants were asked about their observations of the level of awareness and nature of perceptions of aquaculture among stakeholders and the general public in their regions. Heberlein et al. (2005) posit that perceptions can only be taken from the source individual and cannot be observed. However, previous studies in community health have found knowledgeable key-informant viewpoints of community perceptions helpful in assessing health priorities (Yadrick et al. 2001). A very similar approach using key-informant methodology was applied to the present research.

Thesis Format

The structure of this thesis uses three studies, written in manuscript form, as the core of the text. Each article includes a brief introduction, study design or methods, findings, discussion, and conclusion sections specific to the individual study. These studies are as follows:

1. *“Fin-Fish Aquaculture in the United States: Awareness, Perception, and Regulation”*

In this study, three hypotheses were used to test aspects of aquaculture perceptions along U.S. coastlines. Data was gathered via key-informant observations of stakeholder perceptions regarding aquaculture. Sea Grant Program professionals were solicited to complete online surveys as key-informants for their respective regions. A relationship between observed awareness and perceptions was found. The most frequently reported stakeholder concern was impacts to the natural environment, while the most frequently reported benefit was increased seafood production. Each of these was frequently reported in connection with specific stakeholder groups: fishers in connection to impacts

on the natural environment and vicariously on native species and ecosystems, and low-income groups who may have increased access to local seafood through aquaculture production. Although tested, there was no significant relationship between regional perceptions and regulatory stringency.

2. *“The ‘F-word’: Fin-fish farming in Washington State”*

The second study examined and explored regional perceptions of a highly controversial type of aquaculture, Atlantic salmon net-pen farming. Semi-structured interviews with key-informants such as government officials, retailers, and aquaculturists were conducted. Like the first study, informants emphasized negative impacts on the natural environment and acknowledged the role net-pens might play in addressing regional salmon access issues. Interestingly, informants consistently characterized public awareness of current and potential aquaculture to be low and perceptions to be negative with few exceptions. This indicates that while the public might be aware of aquaculture as a practice, they are likely not aware of specific aquaculture sites within regional marine waters. Lastly, all informants involved with aquaculture permitting and regulation expressed dissatisfaction or frustration with the current regulatory frameworks.

3. *“Aquaculture Perception and Knowledge Acquisition Among Students: a hands-on learning scenario to measure change”*

The final study examines the change that may occur in awareness and perception when new knowledge of aquaculture is acquired. Knowledge acquisition was measured in a

sample of Western Washington University undergraduate students during an environmental impact assessment (EIS) writing class using pre- and post-surveys. Students were exposed to information about fin-fish aquaculture through presentations by a student team examining a hypothetical aquaculture proposal for Bellingham Bay. Results of the study show a distinct change in knowledge and, to a lesser extent, awareness and perception among survey respondents. Focus on ecological concerns remained consistent. Rather, than suggesting perceptions moved positively, I suggest student perceptions predisposed to be negative (based on regional attitudes toward aquaculture described in the second study) shifted neutrally in consideration of the new information and knowledge with regards to aquaculture.

After the studies, I summarize the three studies' findings and discuss the relationship between them. Based on findings, recommendations intended for use during aquaculture policy and planning processes are given. These recommendations are targeted at creating understanding of shared social goals for aquaculture among stakeholders and the general public to reduce conflicts and increase consensus as well as to strengthen the foundation of policy decisions to include considerations of aquaculture's non-environmental aspects. As a disclaimer, this research and these recommendations are not intended as a silver-bullet for advocating and engineering aquaculture development. There is every possibility that a community unwilling to accept the inclusion of fin-fish aquaculture in their area may remain unwilling regardless of increased awareness, knowledge, or improved perception. However, by including all aspects and outcomes of aquaculture in the decision to support or ban aquaculture, the decision itself will become even more secure.

All methods, interviews, and surveys executed and completed during this research were approved by Western Washington University (WWU) Internal Review Board (IRB) officer as required by the National Institutes of Health (NIH). A WWU Libraries Heritage Resources agent approved use of archival materials referenced in this thesis.

Chapter 2

“Fin-Fish Aquaculture in the United States: Awareness, Perception, and Regulation”

Introduction

Aquaculture as a mode of producing seafood has grown globally in relation to increases in human population and demand for seafood (Helvey et al. 2017; Thurstan and Roberts 2014; Goldberg and Naylor 2005). Recently, aquaculture outpaced traditional catch fisheries in production (Moffitt and Cajas-Cano 2014). The majority of aquaculture development has taken place in developing countries which currently provide the majority of seafood (91%) consumed in the United States resulting in a \$11.2 billion deficit and the shifting of impacts to less regulated regions of the world (National Marine Fisheries Service 2014). Although the U.S. has great potential for domestic aquaculture, it remains a minimal contributor to national and regional food systems (Knapp and Rubino 2016; Costa-Pierce 2010). In addition to closing the seafood trade deficit gap, some stakeholders and the general public often perceive and are supportive of aquaculture’s benefits such as increased local seafood production and socio-economic factors including access to seafood and associated health benefits, increased employment, and reduced pressure on wild and hatchery stocks (Chu et al. 2010; Whitmarsh and Palmieri 2009; Mazur and Curtis 2008). However, there are impacts natural and human environments that arise from aquaculture including habitat degradation, impacts to local species, and spatial conflicts with other coastal space users. These often result in vicarious impacts on stakeholder groups such as catch fishers and landowners (Krkošek et al. 2006; Naylor et al. 2005; Black 2001; Volpe et al. 2000). These impacts, negative and positive, vary across ecosystems and regions and exist as trade-offs (Gichuki et al. 2009; Galland and McDaniels

2008). The lack of aquaculture growth is attributed to a combination of negative public perceptions and media depictions; lack of awareness and knowledge of aquaculture practices; impacts and advancements; and stringent regulatory frameworks (Knapp and Rubino 2016; Hall and Amberg 2013; Zhu and Chu 2013; Culver and Castle 2008). Rather than being separate issues, aquaculture perception and policy are interconnected by democratic processes wherein stakeholders and the public express views and perceptions to policy-makers who use regulatory structures to provide oversight and reflect the environmental, economic, and social values of constituents (Engle and Stone 2013; Chu et al. 2010; Kaiser and Stead 2002). It should be noted here that current policy discourses are typically dominated by environmentalist and conservation groups working with commercial catch fishers and aquaculture and fish-farmer groups in a contentious dichotomy (Knapp and Rubino 2016; Natale et al. 2013; Young and Matthews 2011). As is the case in many contentious and dichotomous environmental policy debates, sides often select the scientific and academic literature that best supports their stances and perceptions (Sarewitz 2004; Sudarmadi et al. 2001). This can lead to a privileging of how problems are framed and also subsequent solutions with little to no inclusion of non-dichotomous stakeholders and voices relevant to and impacted by policy decisions (Wesselink et al. 2013).

Current aquaculture policies in the U.S. are geographically varied and range from excluding aquaculture entirely to encouraging them (Wirth and Luzar 2000). This is in part due to the majority of regulation existing in state jurisdictions including permitting, siting, and environmental impact management and complicated by overlapping national, regional, and local jurisdictions and policies (Engle and Stone 2013). Variation is due to diverse public perceptions that inform regulatory policies through expressed values and views constructed in differing

environmental contexts and therefore differing cultural and economic contexts as well as individual experience and demographic factors such as age or income (Whitmarsh and Palmieri 2009; Mazur and Curtis 2006; Thayer 2003; Tuan 1974). This becomes problematic when policies reflecting public perceptions in overlapping local, state, regional, and national jurisdictions vary substantially. This may cause frameworks and processes (particularly permitting and licensing) to be fractured and inefficient, slowing the growth of sustainable aquaculture innovation and effectively excluding the creation and growth of small regional aquaculture (Engle and Stone 2013; Zhu and Chu 2013). Additional issues of social justice are created when policy discourses are based on a dominant perception of a privileged minority rather than inclusive of a diversity of values and goals (Wesselink et al. 2013). Dietz and Stern (2008) note those mostly likely and able to participate in the democratic process of public policy engagement are also those who have the most extreme opinions and, likely, perceptions. In aquaculture policies, this frequently presents a consistent prioritization of the environmental impacts that are typically the predominant concern behind negative perceptions of aquaculture and precludes discussion of socio-economic (and possible environmental) benefits as well as aquaculture innovation (Knapp and Rubino 2016). Knowledge and awareness of the benefits of aquaculture as well as innovative forms of aquaculture practices such as integrated multi-trophic aquaculture (IMTA), or coupled with other marine uses, have been shown to improve public perceptions of aquaculture (Wever, Krause, and Buck 2015; Barrington et al. 2010). However, previous perception studies have noted lack of public trust in government and regulatory agencies and frameworks to balance negative and positive impacts (Schlag 2010; Mazur and Curtis 2006). These conflicts can result in or include place-protective actions also known as ‘not-in-my-backyard’ or NIMBY-ism if perceptions of aquaculture are strongly negative and

viewed as detrimental to coastal regional character and life-ways (Shafer, Inglis, and Martin 2010; Devine-Wright 2009).

The following study was designed to begin exploring and describing national perceptions for the purpose of creating sound and effective aquaculture policies that focus on the observed contextual awareness, perceptions, concerns, and desired outcomes of stakeholders in NOAA defined Coastal Counties.³ Through this exploration I seek to begin answering questions about what people perceive of aquaculture as a way of adding to conversations guiding the future of its use and impacts on environments and food systems. To begin this exploration, three hypotheses were developed and tested based on *a priori* assumptions derived from theory and previous studies. Based on the results derived from hypothesis testing and incorporated literature conclusions, policy recommendations are discussed.

Awareness, Perception, and Regulation

Theory developed by Tuan (1974) posits that contextual cultural values condition environmental perceptions. Therefore, an individual's view and perception of an environmental issue, such as aquaculture and its associated benefits and concerns, will be inextricably tied to place as well as personal characteristics (e.g., sex, gender, age, employment). Thayer (2003) echoes this in advocating greater awareness of place through bioregional planning approaches inclusive of the environmental, economic, and social aspects found in the Planner's Triangle (Campbell

³ Coastal counties are those that have 15% or greater land area in a coastal watershed or comprise at least 15% of a coastal cataloging unit's land area. This definition was developed by NOAA for the Bureau of the Census *Statistical Abstract* series (https://www.census.gov/geo/landview/lv6help/coastal_cty.html).

1999). With this theory in mind the following hypotheses were developed with supporting literature.

H1: Awareness of aquaculture can statistically predict aquaculture perceptions.

Awareness or knowledge of aquaculture is often discussed in tandem with attitudes or perceptions of aquaculture (Whitmarsh and Palmieri 2009; Mazur and Curtis 2008; Katranidis, Nitsi, and Vakrou 2003; Hugues-Dit-Ciles 2000). However, the public is not always aware of the details of fin-fish aquaculture and is more often exposed to highly generalized negative environmental impacts through the media (Froehlich et al. 2017; Hall and Amberg 2013; Amberg and Hall 2010). Nonetheless, general and specific knowledge of aquaculture gained in educational or informational settings has been illustrated to move perceptions or attitudes toward neutrality if not positivity (Leach et al. 2014; Kaiser and Stead 2002; Robertson, Carlsen, and Bright 2002; Simonneaux 2001).

H2: Environmental impacts will be perceived as the largest concern, while increased food production will be perceived as the greatest benefit.

Multiple perception and attitude studies of aquaculture have found that concerns of environmental impacts are typically the dominant concern and a major factor in negative perceptions (Hall and Amberg 2013; Whitmarsh and Palmieri 2009). In contrast, increased food production has been noted as a benefit perceived as valuable and desirable by the public and stakeholders (Chu et al. 2010). For example, in a Bay of Fundy stakeholder study examining

knowledge and opinions, 100% of participants believed IMTA had the potential to increase food production (Barrington et al. 2010). I hypothesize that this trend will also be apparent in the collected data upon analysis of categorization of stakeholder concerns and specific examples of observed concerns, conflicts, and benefits given through open-ended questions. Further, I hypothesize that most concerns related to environment will be pertain to impacts on natural environments (e.g., disease, habitat degradation, etc.) rather than extending to include both the natural and human environments.

H3: Perception of aquaculture will have an inverse relationship with regulatory stringency.

Several researchers have noted that growth of aquaculture practices has an inverse relationship with regulatory intensity (Knapp and Rubino 2016; Engle and Stone 2013; Zhu and Chu 2013). This is particularly the case in areas where traditional modes of catch fishing and aquaculture would interact and possibly conflict (Sanchez-Jerez et al. 2016; Natale et al. 2013). The connectivity of perception and regulatory policies, suggests a similar inverse relationship between perceptions and regulatory stringency. Wirth and Luzar (2000) created a scale, Aquaculture Regulatory Climate Scale (ARCScale), measure of stringency to estimate the regulatory policy climate toward aquaculture in states based on various factors, including number of regulatory items impacting aquaculture practices.

Study Design

The study design used to collect data and test the hypotheses mimicked the approaches used by past perception studies. Several aquaculture studies include mixed-question surveys to glean information on stakeholder and public perceptions (Chu et al. 2010; Verbeke et al. 2007; Mazur and Curtis 2006; Katranidis, Nitsi, and Vakrou 2003). The key-informant approach was also used to create a viable national population for data sampling (Marshall 1996; Tremblay 1957). Yadrick et al. (2001) used key-informant technique to acquire perceptual health data from rural communities from professionals and lay individuals. Following the example of previous perception research, online surveys combining qualitative and quantitative questions were used to gather awareness and perceptions data from a key-informant population. Three stages characterized the study: data collection, data processing, and analysis (Figure 5).

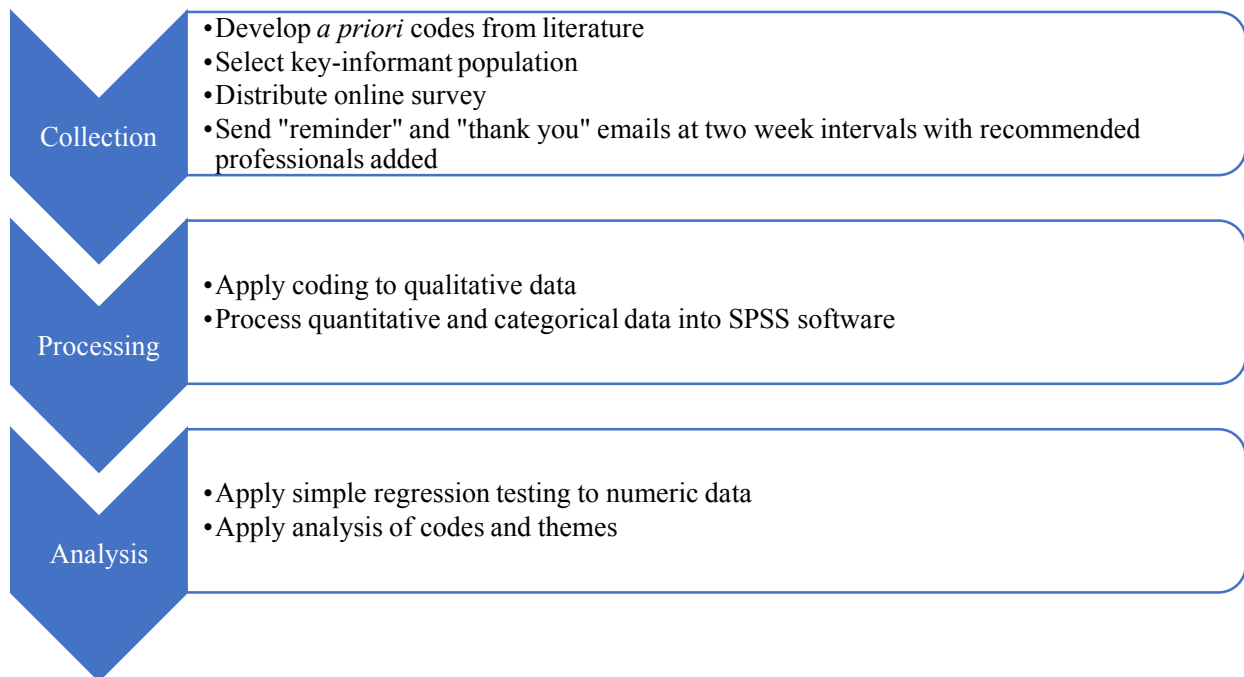


Figure 5: National Study Design Flow

During the collection stage, an online survey was distributed to the key-informant population, which contained Likert-scale, categorization, and open-ended questions. During processing, qualitative data were coded using a hybrid approach with deductive *a priori* coding terms from previous studies and literature as well as inductive codes to recognize emergent phenomenon in the data (Fereday and Muir-Cochrane 2006).⁴ Quantitative and categorical data were processed in SPSS. Data analysis consisted of statistical and content analysis to test the hypotheses.

Literature, key-informant answers, and researcher coding were triangulated to increase reliability (Miles and Huberman 1994).

Key-Informants

The key-informant population consisted of Sea Grant Program professionals from 33 national programs located in NOAA-defined coastal counties. Sea Grant professionals operate as a resource and information provider role and typically avoid advocacy as they may be called on to mediate among conflicting stakeholder groups (National Sea Grant College Program 2013). Sea Grant professionals also often have a broad geographical knowledge of their respective states or regions covering many counties or perhaps whole states (National Sea Grant Advisory Board 2016). This status enabled them to offer a holistic view of stakeholder and public perceptions based on professional experience. Sea Grant professionals' emails were selected from program staff pages using job titles, bios, or focus descriptions containing "aquaculture," "seafood," or

⁴ The codes used in this study were tested for agreement using a KALPHA test in SPSS as part of the second study in this thesis (See Appendix A and Chapter 3).

“fisheries.” If no descriptions contained any of these terms, the program director or individual with a focus most closely related to aquaculture was selected. Professionals were also asked to recommend Sea Grant colleagues they considered knowledgeable about aquaculture and aquaculture issues at the end of the survey. Recommended professionals were added to the subsequent week’s distribution.

Survey

An online survey was created and distributed through Qualtrics online platform via an email invitation containing a link. Surveys were distributed with a reminder email every two weeks from the initial distribution based on Dillman, Smyth, and Christian (2014), a combination of Likert scale, categorical, and open-ended questions were used (See Appendix B). Likert scale questions with a 1-10 range were used to quantify awareness and perceptions observed by key-informants, where 1 was unaware or negative, and 10 was very aware or positive. Key-informants were also asked to categorize stakeholder’s perceived environmental, economic, and social concerns and benefits of aquaculture based on the Planner’s Triangle (Campbell 1999). Open-ended questions were used to identify greater details of perceived concerns and benefits.

Survey respondents were not asked to distinguish between pro- and anti-aquaculture stakeholders; the survey was intended to be an aggregated characterization of all regional stakeholder perceptions related to fin-fish aquaculture. However, Sea Grant program staff biographical pages did not always distinguish between different types or species of aquaculture and shellfish aquaculture specialists may have received emails soliciting a survey. Additionally, in some smaller programs, there were a small pool professionals. In these cases, a professional

deemed by the researcher to be most likely to interact with fin-fish aquaculture was selected. The survey solicitation, title, and questions specified fin-fish rather than general (including shellfish and seaweed) aquaculture as the topic of investigation to reduce responses not relating to fin-fish.

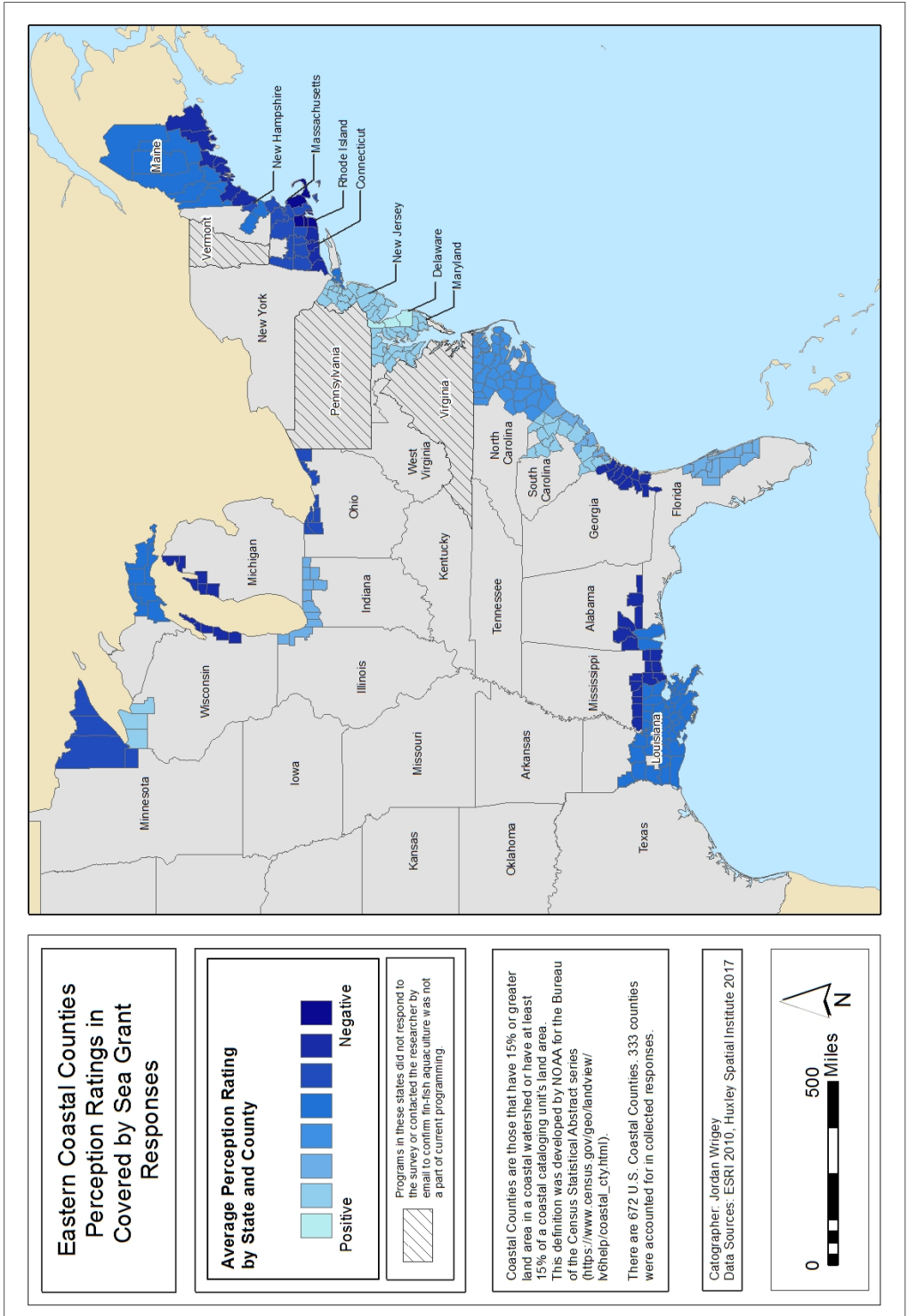
Data Processing and Analysis

Open-ended answers were coded using terms pulled from theory, previous aquaculture perception studies, and literature to create a deeper illustration of specific tensions found around aquaculture. Likert-scale and categorical question responses were processed and analyzed in SPSS. Where multiple key-informants from the same or different programs reported for a given coastal county, responses were averaged.

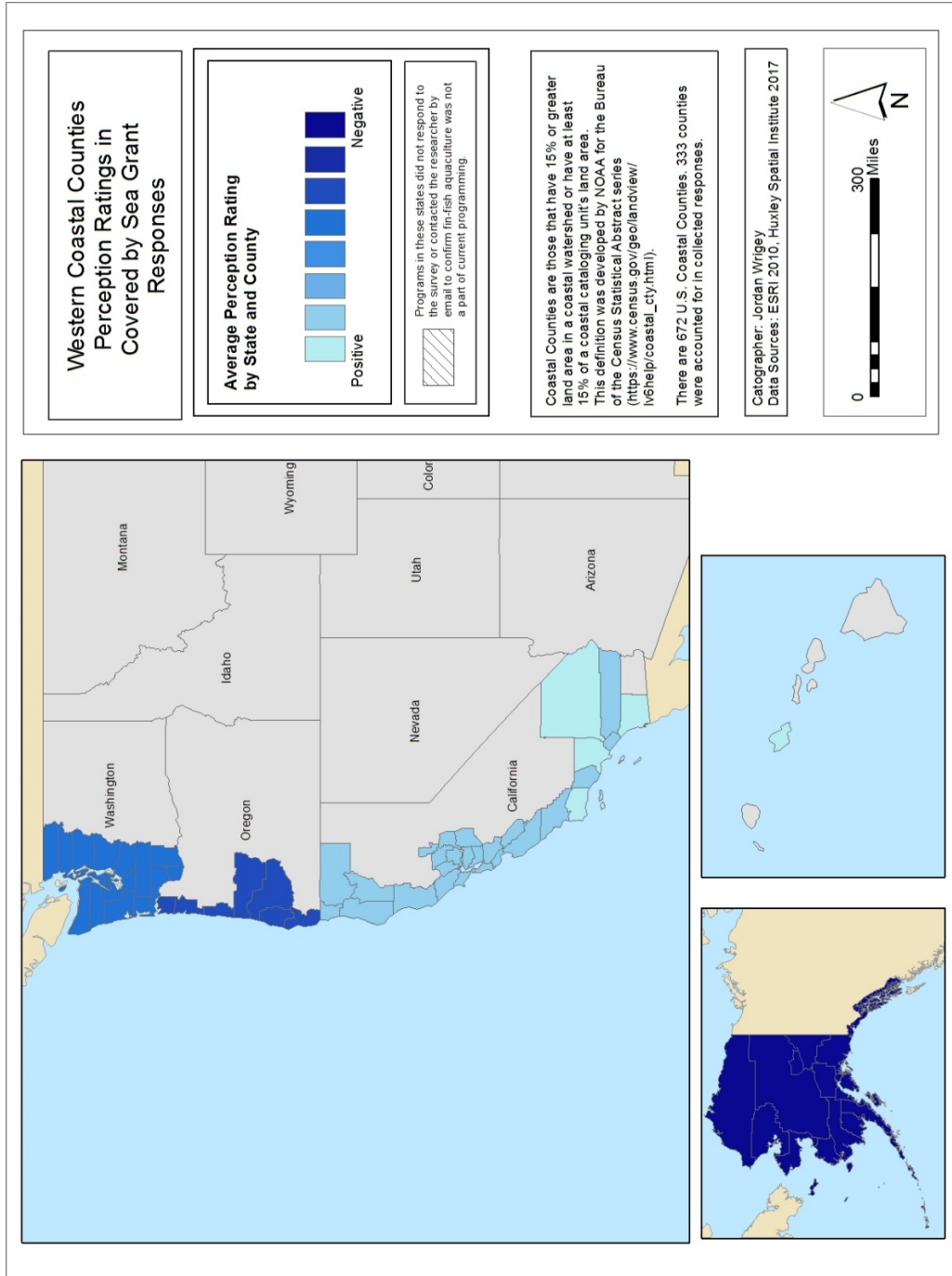
Results

A total of 107 surveys were distributed; 44 surveys (41%) were completed. Twenty-nine out of 33 (88%) programs were included in the completed sample. Responses covered 333 of 672 NOAA Coastal Counties (Maps 1 and 2).

Some surveys contained partial responses. These were retained for use in qualitative analyses, but removed from statistical tests. This is reflected in accompanying statistical tables. Two non-reporting programs responded by email to convey their program was minimally or not involved in fin-fish or general aquaculture practices.



Map 1: Eastern, Southern, and Great Lakes Coastal Counties Covered by Responses by County and State



Map 2: Western Coastal Counties Covered by Responses by County and State

Sea Grant program focus categories most often selected by survey participants when asked “How would you describe your focus in the Sea Grant program?” (more than one category could be selected) were aquaculture (31%) and catch-fisheries (24%), indicating accurate participant selection. Hatchery (10%), mariculture (11%), and agriculture (1%) were the least selected. Twenty-two percent of choices included a selection of ‘Other’ with an open-ended option: habitat, disaster mitigation and adaptation, seafood safety and technology, education, recreation, invasive species, marine safety, and ecology (Figure 6).

Sea Grant Professional Focus Categories (% of Choice)

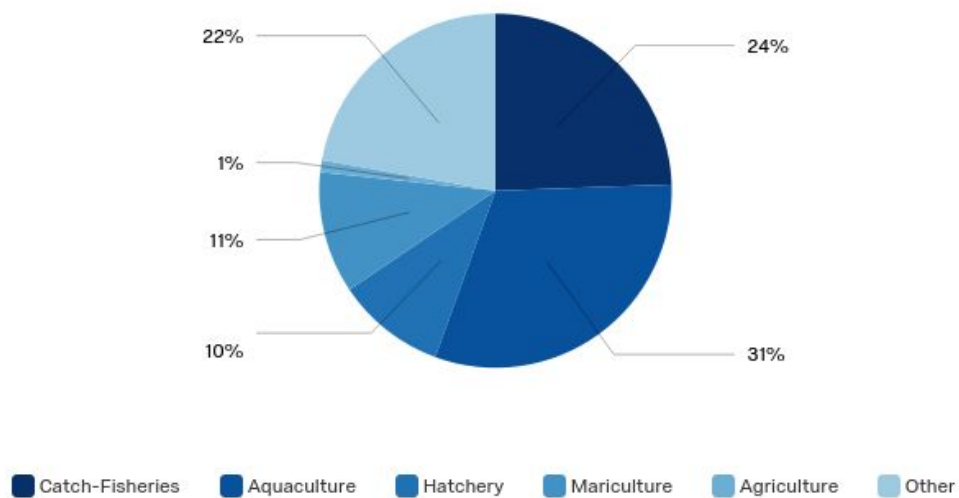


Figure 6: Responding Sea Grant Professional Focus Categories (n=44)

When asked “How would you categorize the majority of stakeholders you work with?” (more than one category could be selected), respondents selected catch-fisheries (29%) and aquaculture (27%) most frequently. Hatchery (12%), mariculture (10%), and agriculture (2%) were selected

less often (Figure 7). ‘Other’ formed 20% of choices with open-ended responses including educators, researchers, government agencies, industry groups, consumers, small businesses, non-governmental organizations, coastal residents and landowners, and scientists.

Sea Grant Professional Stakeholder Categorization (% of Choice)

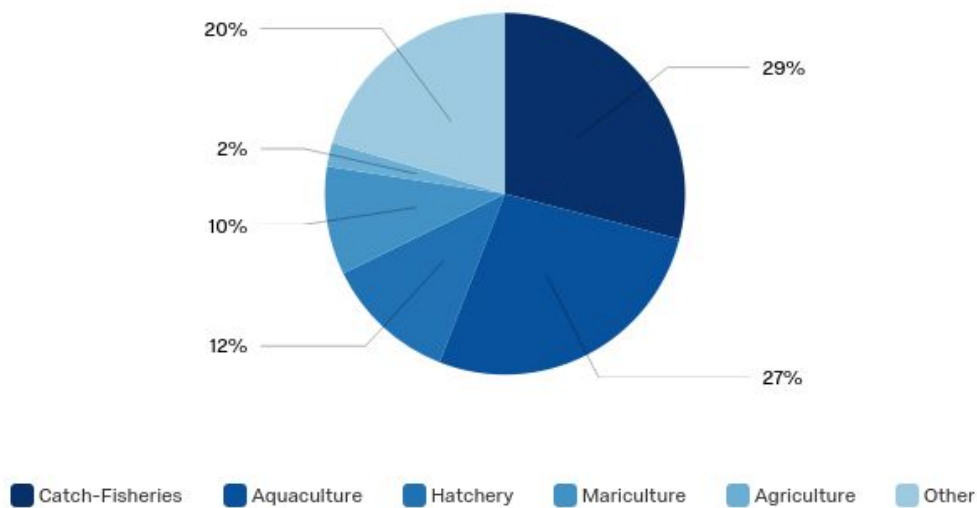


Figure 7: Sea Grant Professional Stakeholder Categorization (n=44)

Awareness and Perception

Informants were asked to rate the awareness and perception of worked-with stakeholders in their respective regions. To measure awareness, a 1-10 scale, with 1 being unaware and 10 being very aware was used to answer the question, “On a scale of 1 to 10, how would you describe the awareness of fin-fish aquaculture practices and policies among stakeholders you work with?” A 1-10 rating scale was also used to measure perception with 1 being the most negative and 10 being the most positive in answering the question, “On a scale of 1 -10, how would you describe

perceptions of fin-fish aquaculture among stakeholders you work with?” In counties covered by Sea Grant informant responses, the mean score of awareness ratings of was 5.51 and the mean reported perception score was 5.17. A test of significance comparing the means for awareness and perception indicated the relationship between the two means was significant at the .05 level. The findings suggest awareness correlates with perception to some extent. For example, where there is an increase in awareness, it’s likely that perceptions will move toward positivity or toward neutrality if perceptions have started toward the negative end of the scale (e.g., a rating of 1 or 2). A simple linear regression was calculated to predict reported perception of aquaculture based on reported awareness of aquaculture practices and policies. A weak but significant relationship was found ($F(1, 39) = 11.89, p = .001$), with $R^2 = .233$ (Figure 8 and Table 1).

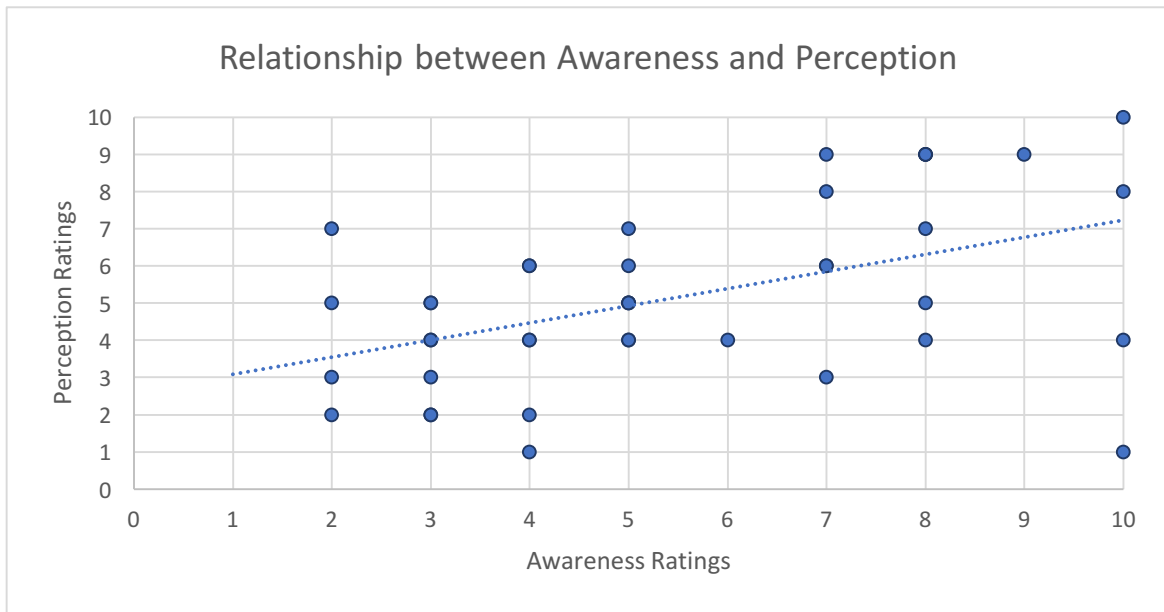


Figure 8: Relationship between Awareness and Perception (n=44)

Simple Regression Testing^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	53.230	1	53.230	11.892	.001 ^b
	Residual	174.575	39	4.476		
	Total	227.805	40			

a. Dependent Variable: Perceptions Rating

b. Predictor: Awareness Rating

Table 1: Simple Regression Testing of Awareness and Perception Ratings (n=44)

Key-informant ratings of stakeholder perception rating moved positively with higher awareness ratings. This indicates positive perception of aquaculture can increase with greater awareness, however this may be impacted by the how of the increased awareness (see the study in Chapter 4).⁵ However, the increase is slight. Nonetheless, 61% of sampled Sea Grant professionals believed greater awareness of practices, science, and possible benefits would impact perceptions of aquaculture positively (Figure 9). A further 20% viewed change as possible. Five percent did not believe awareness would impact perceptions positively and 14% were unsure.

⁵ At the end of this thesis process, by committee suggestion, these ratings were recoded as a -4 to 5 scale, with -4 being the most negative or unaware, 5 being the most positive or most aware, and 0 suggesting neutrality or apathy. Both scales were retested using logistic regression rather than simple to account for abnormal distribution. No differences in *R* were detected, but significance lower minimally ($p=.006$).

Belief in Positive Perception Impact through Increased Awareness

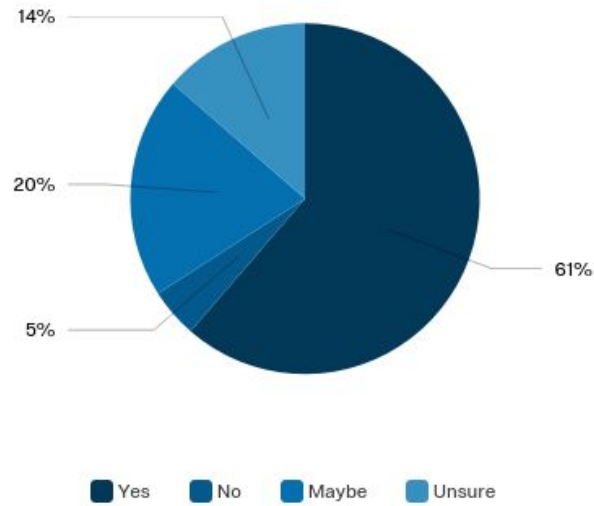


Figure 9: Belief in Positive Perception Change (n=44)

Impacts on the Natural Environment and Food Production

Informants were asked to following questions:

- “Do stakeholders in your region have specific concerns regarding fin-fish aquaculture?”
- “Have disagreements or conflicts based on these concerns with fin-fish aquaculture occurred in your region?”
- “Are there specific benefits perceived by stakeholders in your region regarding fin-fish aquaculture?”

To all three above questions, informants largely responded with “yes” or “unsure” rather than “no” (Figure 10).

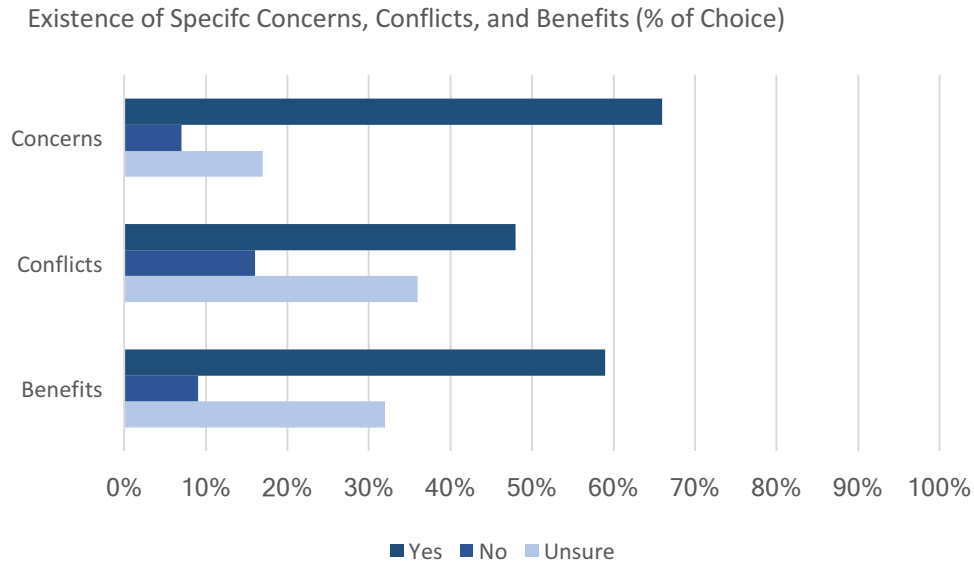


Figure 10: Specific Concerns, Conflicts, Benefits (n=33)

Six-six percent of respondents indicated there were specific concerns held by stakeholders regarding aquaculture. Open-ended responses ($n = 33$) of concerns about fin-fish aquaculture showed most concerns (82%) included natural environment impacts such as disease, escapism, habitat degradation, water quality, and negative impacts on wild stocks. Looking more closely at references to negative impacts on catch fishers and traditional shellfish aquaculture, 33% of environmental issues referenced to degradation of natural environments. Responses that included references to human or built environments such as recreation areas, views and aesthetics, or interruption of non-commercial fishing marine uses collectively formed 60% of coded responses. Thirty-six percent of responses included references that were concerned with the economic viability, social equity, food safety, ownership of aquatic spaces, and regulatory and policy issues. A few of these responses deviated from those typical by alluding to concerns

likely held by entrepreneurial aquaculturists such as “feed and labor costs” and “regulatory obstacles.”

Forty-eight percent of professionals had observed specific conflicts over aquaculture. Open-ended examples of specific conflicts were fewer ($n = 21$). Ten responses contained references to natural environmental bases for conflict with five of these also referencing conflicts between catch fisheries and aquaculture. Nineteen of 21 responses referenced conflicts between stakeholder groups that had occurred or were occurring in relation to policy issues including regulation, permitting, and siting of aquaculture. These included objections to aquaculture siting and expansion as well as difficulty obtaining permits. Most responses indicated that conflicts around fin-fish aquaculture continue or have receded from lack of new aquaculture development. A few noted IMTA had provided an acceptable form of aquaculture by combining fin and shellfish species with seaweed and minimizing negative impacts on the surrounding natural environments. Two responses noted fin-fish aquaculture was illegal in their respective states.

Forty-four responses indicated most professionals identified perceived benefits among stakeholders (59%). Out of 29 benefits comments, 15 included increased food production with *local* increased food production the most frequently mentioned example. Increased employment and access to seafood were mentioned in 12 and 6 of the responses respectively. Other socio-economic and cultural benefits such as maintaining working waterfronts and economic diversification were also mentioned. Reduced pressure and stock enhancement were cited in six responses as perceived benefits. However, it may be that this is related more to hatchery aquaculture than farming aquaculture.

Perception and Regulation

In the third hypothesis, a relationship between perception ratings and regulatory stringency measured by the ARCScale was not confirmed. Statistical analysis of the relationship between perception and regulation of aquaculture using ARCScale data developed by Wirth and Luzar (2000) yielded no significant results indicating little to no relationship based on the collected data. However, it is worth noting most specific conflict examples provided in the open-ended responses happened or are happening in the political context where regulatory events such as permitting and licensing of aquaculture sites or development occur. This indicates that regulatory events may exist in a vacuum for strong perceptions on which subsequent outcomes of political processes are based. Trust in government and regulatory frameworks to manage and balance aquaculture's negative and positive impacts equitability among stakeholders.

Discussion

Before beginning discussion of study results, it is important to reiterate that survey participants were not asked to distinguish between pro- and anti-aquaculture stakeholders when answering survey questions. Therefore, responses are assumed to account for both groups if they are distinguishable.

In this study, two of three developed hypotheses were confirmed. Results of generalized awareness ratings including awareness of policies and concerns in addition to benefits had a positive relationship with perceptions of aquaculture. Previous studies have linked awareness of aquaculture benefits to positive perceptions (Hugues-Dit-Ciles 2000). Study findings indicate a

weak but significant positive relationship between awareness and perception with increased awareness creating movement toward positive perceptions of aquaculture. An interesting point of discussion occurs in the literature's focus on awareness of *benefits*, specifically as factor in positive perceptions movement. In this study, awareness was generalized to include knowledge of policies and concerns as well as benefits. This aggregation of awareness factors may have contributed to the weakness of the relationship found between awareness and perceptions ratings if respondents placed greater weight on awareness of policies and/or concerns in selection of their ratings. However, "Yes" was equally the most common response when asked if there were specific benefits perceived by stakeholders. This was also the case when asked if there were "specific concerns" indicating respondents had noted and taken into equal consideration perceived benefits and concerns of stakeholders. Therefore, it is possible increased awareness may correlate with change in perceptions toward positivity or, at least, neutrality but to a lesser extent than increased awareness of benefits as a singular factor.

Open-ended questions confirmed environmental, and more specifically concerns with impacts on the natural environment, to be predominant in stakeholder concerns. This reflected findings in previous aquaculture perceptions studies (Whitmarsh and Palmieri 2009; Mazur and Curtis 2006; Katranidis, Nitsi, and Vakrou 2003). I distinguish between generalized environmental (those including both human and natural environments) impacts and those specifically on the natural *or* human environment rather than aggregating them. The importance of this is that impacts on the natural environment can often be increasingly minimized using scientific and technological solutions, but, in so doing, leaves little room for considerations of socio-economic aspects of aquaculture of often creates deeper socio-ecological issues that stem from the solutions

themselves (Krause et al. 2015; Sarewitz 2004). Increased food production was confirmed as the most common perceived benefit with secondary emphasis placed on increased access to fish and its associated health benefits.

Responses indicated a greater number of stakeholders held greater concerns regarding aquaculture than benefits. Specific examples of concerns focus heavily on natural environment impacts and aspects such as disease and habitat degradation with emphasis also placed on subsequent negative impacts on catch fisheries. These findings show generalized environmental concerns are more specifically concerns with impacts on the natural environment in part motivated by social concerns for fishers. Findings also indicate stakeholders as being highly aware of aquaculture benefits with increased food production (particularly in local contexts) and subsequent increased socio-economic access being predominant in examples. A social need to look out for the rights and livelihoods of fishers as a traditional occupation is motivating concerns with natural environment impacts. This echoes stakeholder concerns by suggesting an economic benefit (increased food production) motivated by social desires for equitable access to seafood and associated health benefits. It is interesting to note here that emphasis on increased food production and access could be tacit acknowledgement (if not confirmation) by many stakeholders of awareness of current inequities in seafood accessibility. Combined theory by Tuan (1974) and Campbell (1999) predicts the inseparability of environmental, economic, and social aspects of aquaculture perceptions.

The inclusion of aquaculture can change the environmental and economic character of a region through impacts on the natural and human environments and diversifying economies. Tuan

(1974) notes the contextual nature of perception as being formed by cultural norms of place. Respondents noted conflicts as involving catch fishers, an occupation that frequently has deep meaning and historical value to communities based in it (Wiber, Young, and Wilson 2012). This may, in part, explain the frequency of conflicts around fisher-aquaculture if fishery-based community culture identifies its integration as changing traditional ways of life and communal identity. Fisher-aquaculture conflicts as well as others were found to play out on a political stage. This may be due to the vacuum of strong opinion (opinions most opposed or in favor of aquaculture development) created by aquaculture when it is perceived as being allowed by regulatory agencies and frameworks to change regional character without limitation. While change may not be perceived negatively in and of itself, a lack of public trust in current regulatory frameworks and agencies to manage aquaculture's negative impacts and enhance its benefits equitably may contribute to conflict on the political stage.

Conclusion and Limitations

The data collected for this study is a relatively small set and relies on the observations of key-informants, an approach noted to have issues when asking for observation of perceptions. It also remains unlikely that the collected data are completely indicative of the nuances of regional aquaculture awareness, perceptions, and regulatory issues surrounding aquaculture. Attempts were made to compare and analyze the regional differences and commonalities in the data, but the dataset proved too small and qualitative to apply useful statistical tools. A study creating visual mapped representation of perceptions with analysis would be an excellent in furthering U.S. aquaculture perception research. I have also attempted to increase the validity of qualitative findings by using statistical testing and reporting on quantitative data where appropriate. Despite

limitations, I believe these data and analyses offer interesting and valuable insight into the details of public perceptions of aquaculture at a national scale.

The conflicts that occur on political stages may be a result of contextualized weighting of aquaculture benefit versus concerns. Increased awareness of aquaculture in general, and of its benefits specifically, may aid in making explicit decisions most relevant to a given region. This includes understanding what aspects of aquaculture people perceive as beneficial (social equity through access to seafood) and detrimental (negative impacts on natural environments and native species and displacement of traditional fisheries). By distinguishing details such as the difference between impacts on the natural and human environments, localizing benefit values, and contextualizing balanced trade-offs, solutions to aquaculture conflicts can be found.

Chapter 3

“The ‘F-word’: Fin-fish farming in Washington State”

Introduction

At the 2015 American Planning Association (APA) conference, a presenter from outside the Northwest remarked, “People in the Northwest talk about salmon in the same way people elsewhere talk about the weather”(“Infrastructure Planning and Climate Adaptation” 2015). This observation is remarkably salient. Cultures and people of the Pacific Northwest and Washington are intrinsically tied to our environment through experience and perceptions, which overlap with attitudes, values, and define how we respond to environmental problems and conflicts (Lichatowich 2013; Sudarmadi et al. 2001; Tuan 1974). Policies and approaches to managing the environment are no exception and in part are driven by expressed perceptions of environmental issues and operate within the constraints of regional environments, economies, and socio-cultural norms (Thayer 2003). Salmon is an icon and significant resource in Northwestern lifeways and is integrated into everyday lives as observed by the APA presenter (Smith et al. 1998). As a new version of salmon – a farmed version – makes its way into conversation it often triggers a “place-protective” reaction to protect what is perceived to be threatened fin-fish farming(Devine-Wright 2009).

When discussing the subject of farmed seafood there is frequently a knee-jerk, “It’s bad” response with a facial expression suggesting having heard something offensive (Koch 2013; Goldberg 1999). During my research in coastal Washington, this was often the reaction to descriptions of my research into perceptions of fin-fish farming. Though not unanimous, the consistency of this response provided an interesting question: how have people in this region

come to perceive salmon aquaculture in this way? And, what elements and aspects of salmon aquaculture underpin these perceptions? When asked for specifics as to why fish farming, and more typically, why salmon net-pen farming is bad, responses were vague and consisted mostly of concerns such as habitat degradation and disease. Public attitudes and perceptions such as these have implications for policy by motivating support for or against management trade-offs and approaches (Knapp and Rubino 2016; Abroms and Maibach 2008; Chu et al. 2010). Further, how fish production is managed through policy decisions vicariously impacts regional seafood systems (Olson, Clay, and Silva 2014). Therefore, voiced public perceptions play a significant role in defining whether salmon farming could be integrated into or excluded from regional human environments and seafood systems.

Discourses around salmon farming are dominated by environmentalist and industry groups (including fishers and salmon farmers, often on opposing sides) (Young and Matthews 2011). At face value, this dichotomy can create a perception of farming debates as ones only concerned with environmental and economic aspects. However, not all stakeholder perceptions fit into one of these two groups and there are often deeper social motivators for these arguments (Young and Matthews 2011). Yet, by prioritizing the perceptions of these dichotomous groups, their presented discourses and solutions may also be favored (Wesselink et al. 2013). Perceptions missing from discourses on salmon farming may provide different, more complex, and less polarized perspectives and values regarding the social benefits and detriments of its use. This is not to suggest integration of all voices can lead to increased acceptability of salmon farming in regional policies or food-ways, but it may aid in creation of management goals that are relevant

to diverse stakeholders and in achieving balanced and contextualized evaluation of salmon farming's value to the same (Krause et al. 2015; Costa-Pierce 2010).

Literature Review

Perceptions of salmon farming in the Pacific Northwest are “not receptive” to fin-fish farming in part due to views of Northwest coastlines as “pristine” (J. Anderson and Forster 2009, 8).

Changes to regional land and water environments can often invoke place-protective behavior. Place-protective behaviors stem from place-based experience and culture (Thayer 2003; Tuan 1974). This may result in some stakeholder groups being more aware of salmon aquaculture over others. Research illustrates that conflicts and regulatory restrictions are most common in areas where farming and fishing interact in economic markets (Natale et al. 2013; Sanchez-Jerez et al. 2016; Engle and Stone 2013). Previous research has found conflict to be greater both in areas nearer to aquaculture and where catch fisheries and aquaculture do or would overlap (Shafer, Inglis, and Martin 2010; Hoagland, Jin, and Kite-Powell 2003). However, greater conflict does not necessarily mean greater awareness as Mazur and Curtis (2006) found, but may result in greater place-protective behavior and actions (Devine-Wright 2009).

Consumer studies also note the sensitivity of Northwest seafood consumers to issues related to farmed versus wild products particularly when compared to other regions of the United States (Cline 2012; Wessells and Holland 1998). Schlag (2010) pointed to this as part of a broader conversation about depictions of risks of farmed fish in the media. The possibility of using farming to address food shortages and the involved trade-offs are rarely discussed in media (Knapp and Rubino 2016). More often, media stories are related to food safety scares without

full expansion on the nature of the findings such as the antibiotics in farmed fish (Amberg and Hall 2010; Hall and Amberg 2013). Comparisons of national salmon farming policies by Zhu and Chu (2013) showed the impacts of salmon farming increase substantially where development of sites and practices are under-regulated. Literature also suggests salmon farming practices and science continues to improve with respect to reducing or mitigating negative impacts (Lekang, Salas-Bringas, and Bostock 2016; Klinger and Naylor 2012). Integrated multi-trophic aquaculture (IMTA) and combining farms with other uses led to lower impacts and higher public acceptability than standalone mono-culture salmon farming (Wever, Krause, and Buck 2015; Barrington et al. 2010). Yet, concerns with impacts on the natural environment continue despite scientific minimization of impacts as predominate discourses around farming in the Pacific Northwest region (J. Anderson and Forster 2009).

A key discussion in literature examining perceptions of salmon farming and aquaculture is the awareness of fish farming (Hall and Amberg 2013; Hugues-Dit-Ciles 2000). Proximity to salmon farming, media representation, and information all have impacts on perceptions of farms and farming practices (Schlag 2010; Shafer, Inglis, and Martin 2010). Most stakeholders likely recognize the sustainability of regional salmon stocks are becoming threatened due to shrinking populations (Eagle, Naylor, and Smith 2004). In addition, hatcheries present challenges including economic sustainability and impacts on true wild populations. Despite these, hatcheries seem to be perceived as more acceptable than farming but no research comparing perceptions of these different forms of aquaculture was located at the time of this research. Nonetheless, if fishable stocks continue to shrink, it is likely that access to salmon as seafood and protein will as well, whether by scarcity or increased prices or both; the search for more consistent production

may lead to aquaculture (Loring, Gerlach, and Harrison 2016). Although the consistency of aquaculture production is a definite benefit brought up by proponents, it means very little if there is not a robust market for farmed salmon due to environmental values and perceptions acted out through consumer behaviors (Fernández-Polanco and Luna 2012). As an example, the Bellingham Costco location is typically stocked with farmed salmon that has been found to be preferable in mainstream media taste-tests, it is unclear if the salmon in local Costco's are locally farmed or imported (Haspel 2013; Ho 2013).

Regional stakeholders and the public may not have awareness or knowledge of past, current, or future salmon farm sites as well as practices and impacts (Mazur and Curtis 2006). Nonetheless, strong opinions and perceptions indicate a high rate of awareness of salmon farming among the regional public. Mazur and Curtis (2006) found relative proximity to farm sites was not consistent with greater awareness or specific knowledge about salmon farming sites or practices. Therefore, type and extent of awareness and knowledge of salmon farming is likely to be defined by place-based context *and* experience as theorized by Tuan (1974) and Thayer (2003). For example, Knapp and Rubino (2016) note, regulatory structures enacted through public support tend to be stronger in areas where fishers and environmental groups work together to protect respective interests. The combined approaches of these stakeholders groups tend to focus on the minimization or negation of impacts on the natural environment based on shared values of the safety and continuation of native and traditionally fished stocks rather than broad environmental impacts (Bostick 2008). Distinguishing between natural and built environmental impacts is important in the case of environmental impact statements (EIS), a major decision-making tool in environmental policy formation (DiMento and Ingram 2005; Waas et al. 2014). The Washington

State Environmental Policy Act (1971), as outlined in the Washington Administrative Code (WAC), defines elements of the natural environment to include items such as habitats, air quality, and water quality. Elements of the built environment are defined as human structures or environments including fishing areas and shipping lanes (WAC 197-11-718; WAC 197-11-444). For the purposes of this research, and to more accurately assess perceptions of salmon farming based on current policy tools, these definitions will be used to differentiate between impacts on natural environments and built or human environments in collected data.

Researchers have commented on the intensity and strictness with which salmon farming is regulated in the Northwest. Washington and New England have the most rigorous processes for farm permitting in the U.S. (Zhu and Chu 2013). Washington frameworks and processes for acquiring a permit and license to farm fish are extensive, involving several federal, state, tribal, and local agencies each with different requirements and fees. Although efforts have been made to streamline the process in the “one-stop shop” Joint Aquatic Resource Permit Application (JARPA), the process is still resource consuming and may be inefficient in executing appropriate protective measures for natural environments and native species due to redundancies (Figure 11). The figure below is used to illustrate the complexity and breadth of governing bodies involved in shellfish as well as fin-fish farming. There are further considerations and permits specific to net-pen aquaculture included in Appendix C (National Marine Fisheries Service and Washington Department of Ecology 2017).⁶

⁶ The document and information located in Appendix C is part of an ongoing process to clarify net-pen permitting structures and is not yet available as a public resource. For more information or to locate this

Existing Permitting Processes

9/2014

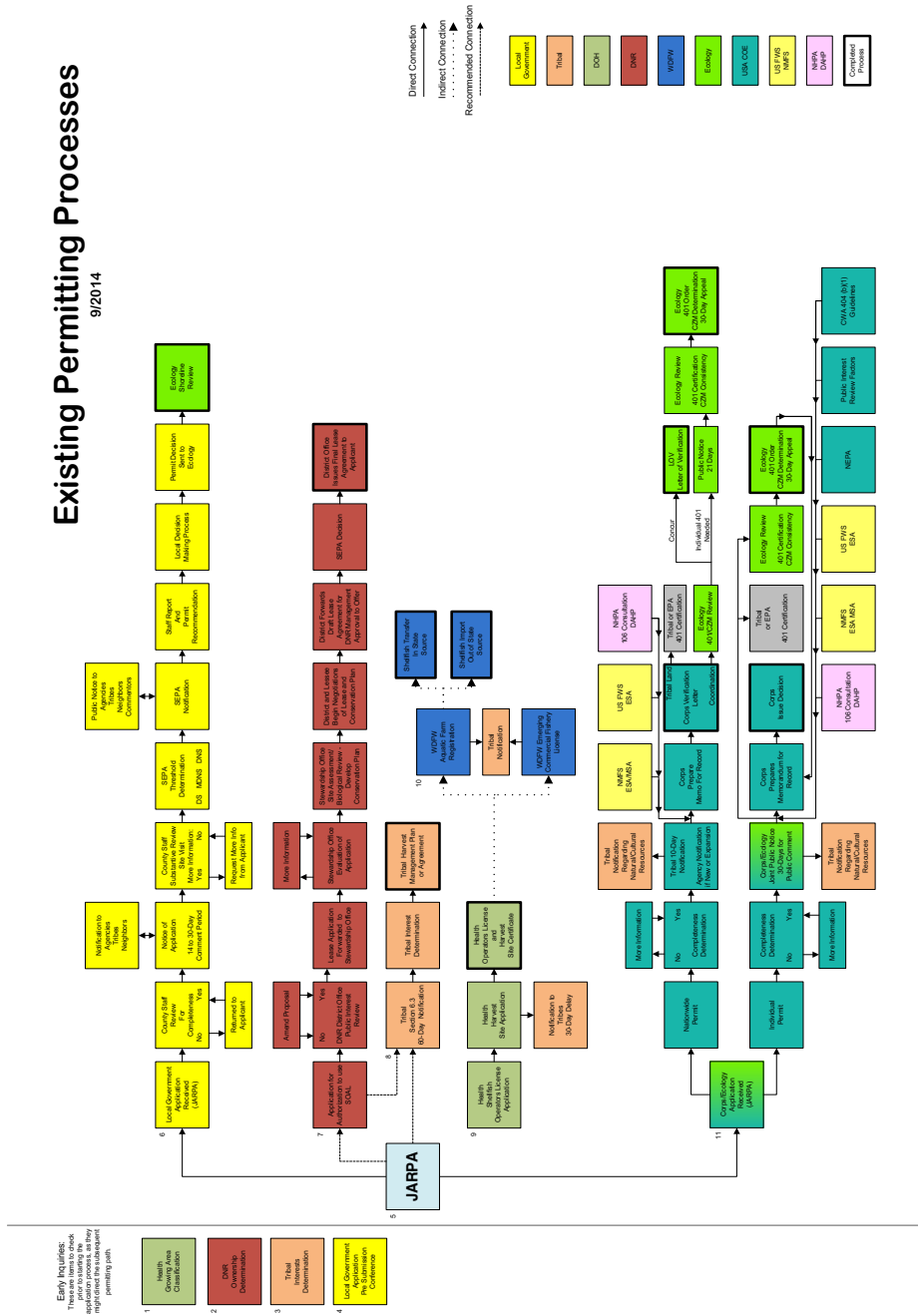


Figure 11: JARPA Shellfish Permitting Flow Chart

document see the contact information at the following web address for the Washington Department of Ecology: <http://www.ecy.wa.gov/programs/sea/aquaculture/netpen.html>.

Despite the intended streamlining of JARPA, Washington's current salmon farming regulatory policies and frameworks are an example of a generalized approach applied indiscriminately to all current and potential forms of aquaculture including shellfish and seaweed, and innovative technological advances as well as all impacts negative and positive (Gillespie 1992; Pillay 1992). Additionally, the substantial resource and financial commitment to complete such regulatory maneuvers is typically found only in multi-national corporations removing the possibility of locally-owned fin-fish farming similar to regional shellfish farms (Engle and Stone 2013; Zhu and Chu 2013; Menzies 2010).

It is likely that these policies and frameworks are in part motivated by strong perceptions of the environmental concerns associated with fish farming as far outweighing the benefits. Place-protective behavior often stems from key stakeholder groups, including environmentalists and fishers, with mutual goals and concerns regarding aquaculture (Knapp and Rubino 2016).

Threats perceived by these groups are not unfounded according to some literature (Thurstan and Roberts 2014; Natale et al. 2013). There is a possibility that uncontrolled growth of farming, in addition to possible damages to native stocks, could force traditional fishers and products out of the market (Eagle, Naylor, and Smith 2004). According to some studies, impacts on native stocks also occur because of hatchery aquaculture, including reduction of fitness in true wild populations due to competition with cultured fish (Araki and Schmid 2010).

Currently, hatchery-based stocks compose 80-90% of caught salmon in the Northwest, and 50% of Alaskan salmon catch (National Marine Fisheries Service 2014; Taylor et al. 2013; Araki and Schmid 2010). Lackey (2003) points out paradoxes in the production of salmon through

government and tax subsidized hatcheries for the purpose of stock enhancement. The author notes this results in taxpayers to have to pay for fish again as consumers. Lackey also points out hatchery impacts on true “wild” stocks may be counter-intuitive to conservationist policy noting that some salmon species listed under the Endangered Species Act (ESA) are still fished regardless of their status (Lackey 2003).

When viewed holistically, the decisions to include or exclude aquaculture become more complicated than addressing only impacts to natural environments. The following research is based on the following research questions: how have people in this region come to perceive salmon aquaculture in this way? And, what elements and aspects of salmon aquaculture underpin these perceptions? These questions are explored with the goal to push current understandings of the debates and conflicts around salmon farming beyond an ‘environment versus industry’ platform and recognize deeper social values and motivators in regional perceptions as well as characterize regional public awareness and views toward current regulatory policies among stakeholders. Using findings derived from interview data, I characterize regional awareness, perceptions, and conflicts around salmon aquaculture. These social aspects of aquaculture will give insight into policy formation processes to more explicitly define the trade-offs and options involved in evaluation of incorporating salmon net-pen farming into local and regional contexts.

Historical Context

There is a long history of using salmon as a natural resource for consumption and commercial harvest. Tribes from across the Northwest caught, traded, and consumed salmon and other marine and river species since time immemorial (Krohn and Segrest 2010). The commercial

fishery began and boomed with the rise of canneries and packing companies in Northern Washington in the 1890's (Radke and Radke 2002). As early as 1919, the University of Washington (UW) began to study salmon farming with experimentation and research beginning in the 1950's and 1960's (Gillespie 1992). At that time, hatchery releases and net-pen farms included Pacific salmon (*Oncorhynchus*) and Atlantic salmon (*Salmo salar*) (Amos et al. 1999). A 1974 article in the *Bellingham Herald* touted Puget Sound salmon aquaculture's ability to contribute food and economic vitality to Bellingham stating the "future of fish farming in Puget Sound is bright" and asked the reader to image the brand new coliseum that would be built with the economic influx brought by aquaculture (*Bellingham Herald* 1974). About the same time there was significant growth and investment in an aquaculture training school by the Lummi Nation⁷ and the federal government (Morris 1973). Tribal water and land use rights had played a part in past decisions regarding aquaculture siting (Gillespie 1992). In a guest appearance on *The Dick Cavett Show*, tribal leadership felt aquaculture and salmon farming were "compatible with [Lummi] culture" (Sam Cagey qtd. in "Hollywood Greats: Marlon Brando" 1973). A three-mile dyke was built in the tribal waters west of the Lummi Reservation to create a sea pond for farmed species ("Hollywood Greats: Marlon Brando" 1973). A part of this aquaculture training was intended to educate employees for an inter-tribal salmon and seafood producing program (*Akwesasne Notes* 1975). The program and school was eventually named Lummi Indian School

⁷ The Lummi Nation was one of several Northwest tribes to be a part of The Treaty of Point Elliott in 1855 as a broader set of treaties enacted by territorial Governor Isaac Stevens. The treaty included language stating signatory tribes were to "retain the right of fishing at their accustomed fishing-places" (Northwest Indian Fisheries Commission 2015).

of Aquaculture (LISA) and is today Northwest Indian College (NWIC) (“Northwest Indian College: Our Story” 2017).

At some point in the 1970’s, following these assessments, perceptions of salmon farming in the region changed, eventually being described in recent literature as “unreceptive” (J. Anderson and Forster 2009). Although the exact reason and point in time this change occurred is unclear, the 1980’s and 1990’s were formative years for net-pen policies. Lummi Tribal aquaculture has reoriented to hatchery and shellfish aquaculture with no sign of returning to salmon farming in the future and new net-pen permits have become difficult and expensive to acquire (Engle and Stone 2013). Literature from this period suggests managers and the public became aware of impacts on natural and human environments as farms established and were quick to set policy structures to limit both farms and impacts (Mahnken 1975). The Washington legislature sought to increase oversight of impacts on natural and human environments through a more robust framework and so initiated the complex interagency processes we see today (Weston 1986; Inveen 1987; Boyce 1988; “Lummi Island Salmon Net-Pens” 1988). A 1992 graduate thesis speculates environmental impact evaluations had already begun to develop due to upland land owner’s concerns regarding the negative impacts of fish farms on water quality, recreational spaces, and the “degradation of scenic views” (Gillespie 1992, 31). The author also found the most common reason for farm permit denial was aesthetics and posited the reason for this emphasis was the inability of the opposition to prove net-pen’s deleterious nature especially when compared to other regional industries, such as the pulp industry or a mercury refinery also located in Bellingham Bay.

Currently, eight salmon pen sites operate in Washington waters (Bouta and Payne 2015). Although small, these operations are producing historic amounts of seafood (Knapp and Rubino 2016). Efforts to expand these operations, or get permits for new sites, have been curtailed thus far according to aquaculturists interviewed in past studies (Engle and Stone 2013). Specifically, Whatcom County in 2007, Jefferson County in 2009, and Island County in 2012 each sought to include amendments to local Shoreline Master Programs (SMPs) prohibiting the installation or development of net-pen aquaculture (Washington Department of Ecology 2016). However, the counties of Clallam, Kitsap, and Skagit continue to maintain net-pens (Bouta and Payne 2015). Due to issues raised during SMP updates, the Washington State Department of Ecology has initiated a review and update of its 30-year old management recommendations for commercial marine fin-fish aquaculture (Bouta 2017). This update, which started in the fall of 2016, should result in revised recommendations by the spring of 2019, which should create more efficient and effective regulatory frameworks and processes.

Local SMPs created in accordance with the Shoreline Management Act of 1971 (SMA) and approved by the Department of Ecology as lead agency, define aquaculture, including net-pens, as a “preferred”, “water-dependent” use of “statewide interest” as per the Revised Code of Washington (RCW) and WAC (RCW 90.58.020; WAC 173-26-241(3)(b); WAC 173-26-020 (39)). The Department of Ecology has stated it “cannot approve SMP provisions that are inconsistent” with these definitions (Washington Department of Ecology 2016). Within the SMA, provisions are made for local governments to modify or amend programs according to changing information and circumstances using policy tools including moratoria (RCW 90.58.060; RCW 90.58.590). Whatcom County, Washington enacted a moratorium affecting a

ban in 2002 in support of salmon capture fisheries, effectively eliminating the installation or development of net-pens in jurisdictional waters (McShane 2002).

These events in historical context have created the current socio-political climate in which aquaculture perceptions and policies are made. Tuan (1974) posits perceptions come from experiences and are not always attached to rational truths despite consistent reliance on positivistic, science-based approaches (Wesselink et al. 2013). It is highly important and beneficial for policy-makers to consider these perceptions, particularly at the state and regional scales where most aquaculture policies are created and enacted (Zhu and Chu 2013; Engle and Stone 2013). It is also important to ensure that the many voices and perspectives based on differing perceptions are heard in formation of policies that impact everyday systems such as access to salmon as a part of regional food ways (Dietz and Stern 2008; Thayer 2003). Thayer (2003) advises a bioregional approach to policy to ensure the regional relevancy and effectiveness of frameworks and actions in social, economic, and environmental contexts. To get at this relevancy, I used semi-structured interviews with regional key-informants to characterize nuances and complexities of perceptions of a contextually relevant form of fin-fish aquaculture, Atlantic salmon net-pens.

Methods

Semi-structured interviews ($n = 10$) were conducted with researcher-identified and participant recommended individuals considered to be knowledgeable about Washington's fish farming conflicts, policies, and stakeholders. This method is known as key-informant technique and is frequently used by social scientists to gain broad knowledge of a group through highly connected

and knowledgeable individuals (Tremblay 1957; Marshall 1996). Maboubi et al. (2015) similarly used this method to locate geospatial ‘hot-spots’ of overlapping environmental, economic, and cultural values in coastal British Columbia, Canada.

Selected and recommended key-informants included state and federal government, salmon farming, retail, and environmental or conservation organization professionals and individuals. Initial interviewees were selected for their direct relationship to salmon farming as farmers, regulators, or opponents in local public forums. Further interviews were gained by asking initial participants to recommend individuals who might agree and disagree with their given observations of regional perceptions and attitudes (Miles and Huberman 1994).

Open- and close-ended questions designed to gain observations of regional stakeholders, conflicts, and perceptions guided the interviews (Miles and Huberman 1994). A copy of the interview guide is included in Appendix D. Although theory exists suggesting perceptions cannot be collected through observational reporting (Heberlein et al. 2005), this method has been used successfully by community health investigators using healthcare stakeholders and professionals as key-informants (Yadrick et al. 2001).

During interview solicitation and collection, I encountered the challenge of finding willing interviewees. The regional salmon farming stakeholder community was found to be relatively small with a handful of key actors largely operating at the state level rather than county or regional scale. Although, interviews were completed with stakeholders at these scales, very few

local or county government, environmental groups, or other stakeholders were willing to participate. The reasons for this are explored in the discussion section.

Ten interviews were completed. Nine interviews were voice-recorded in-person or through cellphone conversations. One interview was not voice recorded at the behest of the participant. However, answers and key-points were taken in writing. Interviews were collected from key-informants employed by federal, state, and tribal government, environmental and conservation groups, salmon farming industry and trade, and fisheries trade organizations. Key-informants were not split into pro- and anti-fish farming categories. Rather, each set of observations was taken individually to increase focus on shared concerns and commonalities. Interviews included a range of opinions on salmon farming but were focused on observations of regional awareness, perceptions, concerns, and perceived benefits. These were remarkably similar despite varying personal opinions.

Two stakeholder groups were not included in this sample: fishers and county or local government. During the time of data collection, regional fishers had largely left the area to fish Alaskan stocks. Fishers that could be located during the data collection period did not return solicitations for interviews. Eight local and county officials, planners, and managers related to marine environments were also solicited for interviews. Although all responded to email and phone calls, none were willing to participate in interviews. The reasons cited included a lack of knowledge about practices and/or lack of relevance to aquaculture and salmon net-pens due to prohibition or non-existence of practices and sites in respective counties.

Analysis

To create an organized analysis structure for collected interview data, inductive data-driven codes and deductive theory-driven codes were used as part of a “grounded approach” to content analysis (Fereday and Muir-Cochrane 2006; Miles and Huberman 1994). An initial codebook was developed from *a priori* themes selected from WAC Title 197-11 “SEPA Rules” and theory (Campbell 1999, 2016; Thayer 2003; Tuan 1974) (Appendix A). The first themes (environment, economy, and social) were pulled from the Planner’s Triangle developed by Campbell (1999). Although “environment” and “ecology” are often used interchangeably in research literature, they are different (Mazzotti 2001). In environmental impact statements (EIS), impacts on the “natural environment” and the “built environment” are distinguished. To explore this difference in the data, definitions taken from the WAC for built and natural environment were applied to interview quotes. As data were collected and examined, *a posteriori* terms were added to the codebook. Inductively located terms were organized under identified and emergent themes found in theory and perception literature.

Several terms identified before and during data can overlap and fit into multiple thematic categories. For example, “catch” can refer to the economic aspect of fisheries as well as the social group of fishers. The goal of this research and broader thesis is to provide perception findings and approaches to avoid conflict and inequity among social groups; therefore, I have organized terms such as catch under the “social” theme as a social group. After completion of interviews, quotes and excerpts were transcribed and coded using codebook terms and themes. Multiple codes were applied where relevant.

Inter-coder Reliability

To increase validity of applied codes, inter-coder reliability was used (Lombard, Snyder-Duch, and Bracken 2010). Three independent researchers were given access to the same 10% of transcribed interview experts and a code list. Completed code sheets including that of the original researcher were input into SPSS software and re-coded to numeric values. Values were summed and tested for user agreement by applying Krippendorff's ALPHA (KALPHA) (Krippendorff 2011, 2007). KALPHA operates as a measure of the reliability of selected terms and concepts and to assure commonality in applying codes to content. A KALPHA or coder agreement of .80 is considered good (Krippendorff 2007). When applied to the researchers and independent-coder data, a KALPHA of .79 was returned. This is well within the bounds of substantial agreement and indicates high agreement between independent and original researchers in application of codes (Krippendorff 2011).

Results

Findings are provided using excerpts from interviews to explore and expand on ideas and findings of previous perceptions literature. I have also attempted to connect the perceptions in the current research to the historical context of the local region where salmon farming went from the "bright" and promising way to get a new coliseum to a "stain upon the sea" (Hume 2004). Discussion topics have been organized according to major themes. First, I relate key-informant observations of regional awareness of salmon farms. Second, I have combined discussion of environmental, economic, and social aspects of salmon farming to illustrate the tensions described in current perceptions literature and planning theory (Chu et al. 2010; Hugues-Dit-Ciles 2000; Katranidis, Nitsi, and Vakrou 2003; Mazur and Curtis 2006; Campbell 1999). This is

followed by a brief conclusion section. Of the *a priori* and *posteriori* codes, the themes below presented the greatest relevance in analysis of interview data (Table 2).

	Themes	Quotation Examples
Awareness	Knowledge	<i>The majority of the public is completely unaware that it is occurring in Puget Sound. (Conservation NGO)</i>
	Education	<i>I'm interested in getting everyone moving along so that we're talking about what is and looking at facts and real risks and addressing those risks. (State Government 2)</i>
Socio-Economic	Natural Environment	<i>The fish have the opportunity to get out the pens, interbreed with the native stocks, introducing like the Atlantic Salmon, non-native species to the coast. (Private)</i>
	Built Environment	<i>...the residents, the neighbors along the shore began to object to the visual impact of facilities in their view. the residents, the neighbors along the shore began to object to the visual impact of facilities in their view. (Farming Industry 1)</i>
	Economic	<i>It presented some competition to the wild fisheries as far as the product that was being put on the market that was in direct competition for their product. (Private)</i>
	Social	<i>The other side of the social aspect people do want to have access to good quality inexpensive fish... (Private)</i>

Governance	Permitting	<i>You're going to clear the land, put in a concrete foundation, follow this wiring code, this plumbing code. When you go to the same person and ask to put a net-pen out here, they look at you like you're from Mars. (Farming Industry 2)</i>
	Regulation	<i>It's an environmental planning challenge. It is a challenge because legislature has made it very clear that we are to plan for and foster a lot of dependent uses but to do that in a way that also protects our valuable shorelines. (State Government 1)</i>

Table 2: Themes Found in Regional Key-informant Interviews

Awareness

Consistent with findings by Mazur and Curtis (2006), salmon farm industry and conservation informants observed the regional and state public have been and continue to be largely unaware of current farming operations despite its proximity. As one conservation informant stated, “The majority of the public is completely unaware that it is occurring in Puget Sound” (Conservation). One industry informant noted that awareness of net-pens had not increased until it had impacted other stakeholders.

It went along undetected for 10 years. When people wanted to apply for permits to do aquaculture in salt water, the residents, the neighbors along the shore began to object to the visual impact of facilities in their view. (Farming Industry 1)

This assessment aligns with the trends found by Gillespie (1992). Another informant made note that it was fishers who were originally aware and brought awareness of farms to the public.

Initially it was the commercial fishing industry promoted anti-aquaculture information because they were concerned that aquaculture would compete with them and they were threatened by it. (Farming Industry 2)

The lack of awareness was a continuous theme in informant observation. An environmental informant posited this may be because of a lack of economic production stating, “Since it is not a major production in this state, I think not, but as time goes on it could be.” A Conservationist informant estimated that low awareness is likely the case for 90% of the public.

But, locally, in Washington, I think if you asked 100 people if there were Atlantic Salmon being raised in net-pens for marketing in Puget Sound, 90 of them might say no way. (Conservation NGO)

State government informants also observed current awareness and subsequent perceptions are often based on “out dated” or non-contextual information with regards to the science and practice of salmon farming, stating “Part of it is that the regional perceptions are dated.”(State Government 2) and “A lot of people are still looking backwards and thinking net pens are either what they hear about overseas or they hear of issues in B.C.” (State Government 1)

These observations were largely related to natural environmental impacts and echoed by farming industry informants following findings by Chu et al. (2010) and Katranidis, Nitsi, and Vakrou (2003). As one farming informant noted, “There’s a lot of outdated information that keeps

coming out from 20 years ago.” (Farming Industry 2) Another farming informant noted a similar timeline stating, “There’s a lot of changes in 30 years of the industry.” (Farming Industry 1)

Informants also observed specific aspects and impacts under-developed in public awareness. A conservationist informant noted a lack of awareness regarding specific species, specifically steelhead as the state fish.

This is another thing that the public is just willfully unaware of...Puget Sound steelhead are listed as threatened under the ESA. A lot of people don’t realize is that Puget Sound steelhead are the state fish. (Conservation)

The informant went on to observe a lack of public awareness regarding the economics of impacts to the natural environment, native species, and their repercussions for tax-payers.

If the public understood that not only has it been understood that this industry can cause the outbreaks of these viruses because of the inescapable high-density in net-pens, when it does happen, that we, citizens, will be footing the bill. (Conservation)

This observation runs parallel to observations of the tenuous economic sustainability of hatchery aquaculture by Lackey (2003).

State government informants observed the public as also being unaware of the value of farming’s food production. One state informant made broad reference to a food crisis related to aquaculture, saying, "There’s a looming food crisis so it is a little more complicated and nuanced

than most people understand" (State Government 1). Another state informant noted the changes in farming as a mode of food production in relationship to awareness and perception of risks.

The process is different. The food is different. The use of antibiotics is different than what gets talked about a lot. I'm interested in getting everyone moving along so that we're talking about what is and looking at facts and real risks and addressing those risks. (State Government 2)

Like awareness of environmental and economic factors, awareness of the social aspects such as access and food safety may alter perceptions. However, there is a question as to how and to what degree perceptions might change given various types of information in different contexts. As suggested by a farming informant observation, there are stakeholder groups more likely to object to farms than others, indicating possible higher awareness of farm existence, if not all aspects of salmon farming practices and production.

I think most people are fairly uninformed and typically don't have strong opinions one way or the other on aquaculture. I think there are certain categories of folks who have taken a lot of information and do have opinions. Typically, the closer you get to the coast the more controversial aquaculture is. (Farming Industry 1)

Despite an "uninformed" public, place-protective behavior arising from perceptions of aquaculture was also observed by informants (Devine-Wright 2009). An employee in seafood retail observed this behavior in customers regarding farmed fish in the seafood case stating, "I think people automatically assume since they've grown up here and people have told them it's

bad. They just don't want it, no real description of why" (Retail). Like land-owners and fishers, the customers in this observation see the farmed fish as offensive or threatening (Fernández-Polanco and Luna 2012). However, the knee-jerk reaction suggests perception born from collective enculturation as theorized by Tuan (1974). Yet, it is unclear based on collected observations what impact increased knowledge and awareness of various aspects of salmon farming would have on diverse regional stakeholder groups. A private sector informant observed that education would make support less likely saying, "Those who are educated on the pros and cons of aquaculture and salmon aquaculture, specifically, probably would lean towards a little less in support of it." (Private)

This type of observation typically related to awareness of the science of farming impacts rather than a holistic education or knowledge. A federal government informant observed scientific knowledge can serve all sides and all arguments of the salmon farming debate.

There's the pro- group, the anti- group, the I don't care group and the science-based group. Not that the pro- and anti- groups aren't science-based. Both of those sides have their science, but they tend to cherry-pick a bit. (Federal Government)

Each of these groups uses selected scientific knowledge to support their stances on aquaculture. As Wesselink et al. (2013) and Krause et al. (2015) point out this can privilege some actors and solutions such as an emphasis on impacts to the natural environment in political discourses. The recent arrival of social science to aquaculture and salmon farming studies has placed impacts on

the natural environment in conversation with socio-economic issues such as food systems and access. It is this conversation that I examine in terms of perceptions in the following section.

Natural Environment and Socio-economic

Consistent with literature by Chu et al. (2010) and Hugues-Dit-Ciles (2000) perceptions of salmon aquaculture bounce between natural environmental impacts and socio-economic impacts. One farming informant noted salmon aquaculture policies and practices had been shaped by environmental perceptions and culture.

The industry had to evolve during a time of very increased environmental awareness and had to make a lot of rapid changes during its development. So, we've been under the scrutiny of regulators and environmentalists during the last 30, 40 years and has had to make changes. In the time, I've been in this industry, it's not what it was. It is completely different than what it was 30 years ago. (Farming Industry 2)

Another informant succinctly summarizes primary concerns typically listed in social-aquaculture literature (Chu et al. 2010; Costa-Pierce 2010; Schlag 2010).

The negative side comes with a lot of the environmental concerns. The fish have the opportunity to get out the pens, interbreed with the native stocks, introducing like the Atlantic Salmon, non-native species to the coast. A lot of the water quality issues. Primarily related to inputs of large amounts of food into the system and waste products from the fish. Those are more negative side. (Private)

In the study region, concerns with impacts on the natural environment often focused on native salmon species and ecosystems (Hall and Amberg 2013). An eNGO informant emphasized impacts on native salmon species, saying “That's an issue. Being a carrier for a disease that could affect Pacific salmon” (eNGO). A state informant observed that asking the public to consider salmon aquaculture and salmon conservation as simultaneous entities in the region can be counter-intuitive.

We've asked citizens and state agencies to make a huge investment in salmon recovery of Pacific salmon. It is hard for people to understand how net-pens would fit in that effort. It is a challenge to think out of the box and find a way to make them sustainable. (State Government 1)

A conservation informant attached this to Washington in particular.

Especially because, within public perception, it would conflict with the huge public investment in PR machine that is underway to protect and restore water quality and the health of Puget Sound. You can't escape it in Western Washington. (Conservation)

These observations focus on the impacts to native salmon species. A State Government informant also observed this trend in regional media depictions when asked to characterize regional perceptions.

Fairly negative. Perceptions at least with the media that I keep track of, anything that could potentially harm native salmon in the Pacific Northwest are going to be viewed very negatively. So, the public perceptions around net-pen

rearing have really gotten a lot of negative publicity particularly in the northern five counties. (State Government 2)

Such impacts are not desirable to farmers either according to one environmental informant stating, “With respect to disease in net-pens, that's an economic issue, they don't want mortalities; they don't want escapes. They have escapes, but don't want them” (eNGO). This provides an interesting dynamic in that impacts on the natural environment are more likely to be scientific issues and inherently solvable through scientific solutions. However, this is not always beneficial. Scientific solutions tend to focus on the minimization of impacts on the natural environment as observed by a conservation informant.

There is no easy solution. I get frustrated in the meetings like the one we were in yesterday because there's so much talk of minimization and I feel like we, as a society, can justify just about anything if we talk about minimizing its impacts on the environment from our perspective. (Conservation NGO)

A farming informant pointed out salmon farming has moved forward substantially in relation to impacts on natural and human environments, to an extent that they are negligible.

The industry has matured dramatically since it was originally started. Some of the individual criticism of the industry was probably warranted. Some of the environmental impacts were too excessive or some of the quality of the product was less than satisfactory. But in time it has matured to the point, none of those objections to the industry are valid—proven to be wrong. Nevertheless,

you continue to hear all kinds of things about the product particularly in the environmental impact that are negative but not true. (Farming Industry 1)

This maturation was echoed by a Conservation informant's tongue-in-cheek assessment of conservationist standards.

But at the same time, because there is no pleasing a conservationist, we see the impacts in B.C. [British Columbia] and throughout the world where net-pen aquaculture had been well established. We see impacts from that industry on wild fish health and abundance. (Conservation NGO)

Conflicts around salmon farming are not simple issues of reducing impacts on natural environments, but have broader socio-economic impacts attached to its use and development. All informants acknowledged (most without prompt) the benefits of increased regional salmon production through farming. A conservation informant briefly noted growing demand for salmon but also observed hatchery aquaculture, despite having its own impacts, was the current mode of addressing this.

We acknowledge a demand and arguably a need for fish protein. We certainly understand that our wild fish stocks in the Northwest are a fraction of what they used to be. We understand that one of the ways that the state agencies are trying to bolster natural native fishing opportunities, commercial, recreational, tribal, is through the use of hatcheries, which have their own substantial sweep of impacts on wild fish, unfortunately. (Conservation NGO)

A farming informant connected this demand to growing populations.

Supplying food for a growing population. I think we're going to have to, that's what got me into this business. If we're going to eat these fish, we're going to have to learn how to grow them. (Farming Industry 2)

Another informant succinctly observed that growing demand but shrinking supply leads to some consumers not having access to salmon, and further illustrates the way in which it is produced may be less off-putting to some.

The other side of the social aspect people do want to have access to good quality inexpensive fish and that level would be your more typical consumer who goes to the grocery store and doesn't realize that they're eating an Atlantic salmon when it just says fresh salmon or doesn't care, frankly. (Private)

It is unclear how much of the knowledge and sentiment expressed in these excerpts affects public awareness and perceptions. Based on the ubiquitous and ready acknowledgement of this benefit of farming by informants, it's assumed some has reached the public. The three observations mentioned previously characterize some of the key tensions in farming discourses. These tensions are found within governing groups as well as in public perceptions. An environmental informant also observed why farmed salmon might be perceived to increased access to salmon as seafood.

The amount of wild salmon available and fresh salmon is seasonal. That's been the advantage for this farmed salmon, they can provide it or scale their production to provide it year round. That's especially important to the western industry as well as the fish market. (eNGO)

Although the consistency is a definite benefit brought up by proponents, it means very little if there is not market for farmed salmon do to environmental values and perceptions acted out through consumer behaviors (Fernández-Polanco and Luna 2012). Consumers holding negative perceptions of farmed salmon tend to be highly visible and vocal based on observations by informants. One informant noted the commonality of opposition in bumper stickers on cars.

There are bumper stickers on cars throughout [Washington] that say “skull and crossbones sign DON’T EAT FARMED SALMON” in orange on black background. There’s just a log of negative associated with anything that isn’t wild caught salmon. (State Government 2)

Informants also observed the perceptions of people they worked with and public perceptions would not make most people likely to buy or eat farmed salmon.

I think people here know if it is Atlantic salmon, it is farm raised at the market, they'd probably resist buying it; but if it's their only choice, they probably would buy it. (eNGO)

Another informant connects this to place-based culture and perceptions stating, “Frankly there’s, with us Pacific Northwest salmon snobs who are used to our good fish, a perception that it isn’t as good or as valuable as other stocks” (Private). Counter to this, a farming informant used a frank example of the dissidence in this perception in comparison to land-based agriculture.

That’s another thing to advocate, farmed fish, bleh. Look at your plate and tell me what didn’t come from a farm. Go to a grocery store and tell me what

didn't come from some sort of agriculture. We're not going to survive without farms. Your chickens aren't wild; your cows aren't wild. (Farming Industry 2)

The informant theorized further on why this dissidence exists in perceptions with regards to salmon.

We're used to looking at agricultural land and forget that was a forest. It's been around so long; farms and cows are beautiful now because they've been around so long. We've changed the landscape so significantly that we're used to it. It's normalized by now. Everyone is used to looking at water right now. The occasional sailboat goes by. But if you put a net-pen out there, everyone starts to freak out. You can't do that. It's an eyesore. No, it's farming. It is getting people to see the water differently. That's been the challenge. (Farming Industry 2)

This observation would fit into Thayer's (2003) theories of place and how they are formed over time through a mix of culture and economics. Nonetheless, farmed salmon is observably absent from most regional grocery stores likely because of consumer preference for "wild" salmon. An informant in retail provided several examples of this behavior in salmon consumers. In one example, a retail informant connected consumer perceptions to place-based experiences once again observing, "They usually say they've been spoiled with their access to wild so they prefer it" (Retail). Regarding consumer reactions to farmed fish for sale, the informant noted two groups saying "Some of them are okay with it. And some let me talk to them about it. But people just see that "farmed" they stick up their nose at it" (Retail). When asked what perceptions these behaviors were based on, they connected observed behaviors to environmental concerns as well

as place enculturation. “People have a bias against farmed raised fish. They feel like it’s a bad process. They think it’s bad for the environment.” (Retail)

In addition to consumers, there are also producers to consider. In the case of the salmon, fishers. Goldberg and Naylor (2005) suggest there is a chance salmon farming could replace catch fisheries as the main mode of salmon production, meaning the loss of a highly defining traditional occupation in Washington. Observations by informants indicate this aspect of farm development has been included in regional perceptions. As one informant asks, “The issue is related to ‘can you have an increasing salmon farming industry (multinational, of course) and have wild salmon production occurring in the same area?’” (eNGO)

A farming informant observed the integration of salmon aquaculture is perceived to have implications for fishers who have maintained salmon supplies for a considerable amount of time.

It presented some competition to the wild fisheries as far as the product that was being put on the market that was in direct competition for their product. They had had a monopoly for these whatever hundred years so there was a lot of fears that were put out there of things that could potentially happen.

(Farming Industry 2)

The conflict between fishers and farms is one of many to be addressed by policy. However, the lack of full incorporation of social elements has left a gap where contention and division can occur (Krause et al. 2015; Schlag 2010). As one informant observed:

It is a really mixed equation. I don't feel that there's a uniform consensus on whether it is good or not on a social level because you're going to find people on both sides. (Private)

Governance

All informants noted a gap in knowledge and process among aquaculture stakeholders and expressed the need to know more and have greater knowledge of important events, findings, and facts, both for their own stakeholder groups and for the public. A Federal Government informant pointed out efforts to increase knowledge and outreach with respect to net-pen regulation is already underway stating, "Mostly it's a lot of education outreach and trying to help on the regulatory side whether that is this agency, the state agencies or local government level" (Federal Government).

A farming informant observed a lack of detailed knowledge about net-pen practices, requirements, and regulations presented issues for farmers as well as regulators.

It is a very confusing regulatory environment. It isn't straightforward. It is so small in Washington State. Not all the regulators are up to snuff. When you go to build a home, you go to the planning department and they know exactly what they're going to ask and what you're going to do. You're going to clear the land, put in a concrete foundation, follow this wiring code, this plumbing code. When you go to the same person and ask to put a net-pen out here, they look at you like you're from Mars. (Farming Industry 2)

A state informant also observed the legislature related to net-pens presents a challenge particularly where it is defined as a preferred, water-dependent use of statewide interest, but legislature simultaneously dictates the need to protect shorelines.

It's an environmental planning challenge. It is a challenge because legislature has made it very clear that we are to plan for and foster a lot of dependent uses but to do that in a way that also protects our valuable shorelines. (State Government 1)

The importance and authority of tribal policies was also acknowledged.

The tribes own harvest areas and any new aquaculture, net-pens could be viewed as having an impact on their ability to do the more traditional fishing and harvesting. Those protections and laws and treaties have been very powerful, clearly give them a lot of say in what goes on in the marine environment. Without tribal support, it would be very difficult for anyone to be able to start something like that in today's climate. (Private).

It was also observed tribal perceptions and policies regarding may vary among tribes as they do among states and counties "There are some tribes who are very supportive of this and there are some that are not" (Federal Government). This follows findings in aquaculture perception and policy literature (Whitmarsh and Palmieri 2009; Wirth and Luzar 2000). The history of regional tribal involvement with salmon farming may or may not be impactful in current tribal positions on aquaculture. New information as well as non-tribal actions in developing net-pens may have caused a change in position from the 1970s. Regional tribal members spoken to during data

collection observed diseases stemming from net-pen use could substantially impact tribally fished stocks (Tribal Member).

Informants also pointed out frustrations when systems of communication are ineffective and not inclusive of all knowledge and voices. A conservation informant stated, “There’s a real need for transparency” (Conservation NGO). The informant went on to give an example saying, “The meeting yesterday, there was really no public notice for it. We were invited because we have shown an interest in this issue.” (Conservation NGO). It was also observed that a relatively small group of stakeholders could impose their perceptions on policy processes, “The way our system is set up, even if it is a very small group that is opposed, if they’re vocal enough they can put a stop to things”. (Federal Government)

A federal informant noted the importance of inclusivity in formation of policies by identifying all concerns as important in creating effective net-pen policies and are far more effective when concerns are based in common knowledge.

The main thing I would say is social acceptance or social license, and that goes back to those concerns people have that are all important to consider. We don’t want to blow off any of those concerns or not pay attention to those concerns, but most are unfounded or unjustified or haven’t played out in a way that people think that they have. (Federal Government)

Simultaneously, informants point out the importance of considering avenues other than salmon farming to answering food production and access issues. A conservation informant advised the use of the Precautionary Principle to avoid impacts occurring in other regions.

In a nutshell, while we see a need, we need to be very smart, very careful - certainly following a precautionary principle especially regarding the experiences of Chile or B.C. (Conservation NGO)

The informant goes on to emphasize “investment [and] focus on close-containment aquaculture opportunities inland or otherwise that have the potential to have much reduced impacts on the environment including wild fish”. The informant also drew parallels between salmon aquaculture and other regional environmental issues to encourage consideration of alternative salmon production methods.

I feel like that these efforts to expand [Atlantic salmon farming in] Puget Sound are a lot like the interest to expand new opportunities to mine coal. Where we’re sort of missing the big picture. Instead of focusing on solar or wind or less impactful solutions to the problem, we’re continuing on the path that we started because it works. It works. We can make energy with coal but there are better ways to do it now and the economics aren’t quite there but they will be soon and if we could be directing the energy and these resources this way [toward closed containment] instead of expanding the open water net-pen industry, we could be using them in more creative, innovative and responsible direction, we’d be much better off. (Conservation NGO)

These observations get to the crux of issues facing net-pens and aquaculture in general. It is not the only solution, but it is the solution expanding globally as well as nationally. These forces are arguably economic and have impacts on natural environments and native species that are not desirable or acceptable for many. This presents a difficult challenge to policy-makers and managers seeking to maintain the valuable environmental, economic, and cultural resources of shorelines and native salmon species whilst ensuring access and opportunity for aquaculture as a preferred use.

Discussion

Many of the themes and phenomena found in this study align with previous findings in the literature. For example, informants observed (despite strong negative perceptions toward salmon farming) public awareness and knowledge of practices, nuances, and impacts were underdeveloped and outdated. The media informing awareness, and vicariously perceptions, were also noted to be skewed toward negative perceptions and depictions of farming. This is a substantial change from the perceived “bright” future depicted in the regional newspaper and other media in the 1970’s. A Farming Industry informant related the growth of aquaculture occurred within the culture context of heightened environmental awareness and inferred this had set the course for the industry’s quest for reduced impacts on local natural environments. This is one possible explanation for changes in regional and state perceptions in the 1980’s. This also supports the applied theory of Tuan (1974) in that experiences and culture in place create and change perceptions of environments and environmental issues. In the case of salmon farming, its establishment at a time of intensive regional environmental perceptions induced pressure to create strict regulatory policies containing and minimalizing impacts on the natural environment

resulting from industry development. It is unclear if policy have resulted in the minimization of impacts. It is plausible that through the lack of development has arguably caused impact to remain static in type if not cumulative magnitude. However, the nature and severity of net-pen impacts is subject to debate among researchers (Young and Matthews 2011). The implications of this have reverberated through the decades and may have be the basis for observed knee-jerk and negative perceptions of salmon farming despite observed low knowledge of local farm sites. These perceptions have incited place-protective behaviors including political action, stringent regulatory policies, complex frameworks, and refusal to participate in farmed salmon markets (Young and Matthews 2011; Devine-Wright 2009).

Observations of perceptions regarding concerns were related to impacts on native salmon species and salmon habitats. By definitions used in decision-making tools such as EIS's, these impacts are defined as impacts on the natural environments and therefore would receive different and likely more scientific mitigation measures and solutions than impacts on built or human environments. Despite maturation of farming practices to reduce impacts using science, they continue to be the focal point of negative perceptions. While this is not necessarily problematic by itself, decisions regarding aquaculture also have impacts for food systems regional and, collectively, nationally.

Historically, there are objections to aquaculture development for impacts on the built environment as well. Land-owner stakeholder groups would likely be some of farms most staid opposition with little reason to support its growth or siting due to direct and unbalanced economic detriments; possible reduction in real-estate value and aesthetics for land-owners and

direct market competition and possible negative impacts on capture stocks for fishers. Any change in perception or position on salmon farming would have to come from acknowledgement of farms having benefits for broader communities. Rather than being offset by scientific improvement, negative perceptions based in impacts on the natural environment (and to a lesser extent, built environment) are part of a trade-off to gain the socio-economic benefits of increased access through increased and consistent supply as well as lower prices. Although informants observed there were and are “people on both sides” of these trade-offs, it might be more accurate to say people can be found on *every side* as there are (as demonstrated by informants) several perceptions, paradoxes, and tensions at work in fish aquaculture conflicts. It is in policy where these are acted out and structured as regulations and frameworks to manage the undesirable impacts on native stocks and occupations while growing the desirable socio-economic benefits of increased production and access. Finding a balance in policy and regulation that allow for this has been problematic on all sides in formation and enactment processes. Permitting of net-pens has been, and continues to be, a major regional issue that has recently begun to be addressed by the Washington Department of Ecology (Bouta 2017). This value may mean little if there is no regional market for farmed salmon. However, the extent to which individuals currently unable to access salmon produced through catch fisheries would purchase or participate in creation of a consumer base for farmed salmon is unknown. Nonetheless, this socio-economic aspect of farmed salmon (despite its ubiquity among the informants) has remained relatively underexplored and under addressed in public perceptions and formation of farming regulatory policies within Washington (Engle and Stone 2013).

It should be noted here that most informants in this sample are likely to have access to the salmon (farmed or capture) of their choice. As observed by some informants, not all consumers have the choice of how their salmon is produced or simply, as one private informant observed “won’t care”. Whitmarsh and Palmieri (2009) found income to be a factor in how stakeholders weighted the concerns versus the benefits of farm development with greater emphasis being placed on environmental impacts by more affluent communities and on socio-economic benefits by low-income communities. It may be that a sample of informants with less access to salmon would indicate a larger potential market than this sample shows.

The governance of fish farms is changing in consideration of trade-offs and policy dynamics. Fishing Industry informants observed Washington’s salmon farms past, present, and future are governed by a complex framework and a resource-intensive permitting process that is perceived to be inefficient on all side of net-pen debates. This complexity reduces innovation opportunities in farming approaches and the ability of small, local farm ownership and other innovative opportunities as well as create ineffective policy pathways to seek impact mitigation on native species (Zhu and Chu 2013; Washington Fish Conservancy 2017). The restrictive nature of current processes may be part of place-protective behaviors enacted by collective stakeholder groups such as fishers, environmentalists, and land-owners. As a water-dependent use under the state SMP, governing agencies are compelled to foster sustainable aquaculture of various types including net-pens. However, this fostering can cause clashes in perceptions between and within stakeholder groups and creates divisive policy discourses based on dichotomous rather collective voices and values (Wesselink et al. 2013). Further, the privileging of a few loud voices over many in formation of policies that may lead to the exclusion or inclusion of farmed salmon in

regional environments and seafood systems. One informant made note that salmon farms are not the only approach to addressing declining salmon supply in the face of increasing demand. Yet, few if any alternatives have been presented and explored.

Conclusion

This study began with an observation by a planner who noted the comfort with which Northwesterners discussed salmon was akin to the way other regional peoples discussed the weather. When the subject of salmon farming is brought into conversations in the Northwest and Washington the conversations typically become less comfortable and more tense. In the past, this may not have been the case when perceptions of salmon farms were included as the source of new civic structures and opportunities for economic growth. Overtime, regional perceptions placed greater emphasis on farms as threats to traditional life-ways and native species. In the present, perceptions are shifting again and subsequently policies are shifting to incorporate new trade-offs and values with substantial conflict and clashes in the process. Nonetheless, salmon farms should be fully considered in policy processes with full awareness of impacts on essential and iconic regional salmon species as well as impacts on access to salmon as part of regional food culture. Both should be considered, as the planner observed, an equitably accessible part of every Northwesterners and Washingtonian's place-based experience.

Chapter 4

“Aquaculture Perception and Knowledge Acquisition among Students: a hands-on learning scenario to measure change”

Introduction

Learning and knowledge acquisition in public policy contexts can be key factors in creating consensus among stakeholders particularly where experts and advocates disagree based on differing perceptions of issues and solutions (Leach et al. 2014). In a time of uncertain fish stocks and supply and increasing demand for seafood, the regulation of fin-fish aquaculture has created consternation and conflict among policy-makers and stakeholders (Hamouda et al. 2005). At the core of aquaculture perceptions and policy conflicts is a trade-off between negative impacts on native species and habitats (and vicariously traditional fishers) and socio-economic benefits of increased domestic seafood production and access (Chu et al. 2010; Gichuki et al. 2009; Mazur and Curtis 2006). This trade-off is one that is being addressed in policy processes throughout the U.S. on a state and local basis (Knapp and Rubino 2016; Engle and Stone 2013; Wirth and Luzar 2000). However, people and publics have been prone to knee-jerk, negative reactions to aquaculture (Koch 2013; Goldberg 1999). This reaction can occur despite having little to no detailed knowledge of aquaculture practices, policies, impacts, or broader implications of its regional inclusion or exclusion in domestic seafood production (Naylor, Eagle, and Smith 2003; Kaiser and Stead 2002; Robertson, Carlsen, and Bright 2002). Social research has found perceptions of aquaculture can and do change in light of new information, increased awareness, and knowledge acquisition (Leach et al. 2014;

Robertson, Carlsen, and Bright 2002; Hugues-Dit-Ciles 2000). This is not to say people can be taught to support aquaculture by being exposed to greater amounts or more detailed information. Rather, learning as part of aquaculture policy dialogues will increase mutual understandings of seemingly dichotomous stances to enhance opportunities for consensus and explicit trade-off decision-making (Dietz and Stern 2008; Riege and Lindsay 2006). This research was aimed at creating an analogous scenario this learning through university students as a proxy for aquaculture stakeholders.

Two research questions guide the following study: 1) what knowledge of aquaculture, if any, would be acquired during a learning scenario? and 2) what change might occur in student's awareness and perception when knowledge was acquired? I answer these questions by measuring and examining knowledge acquisition, awareness, and perception change among upper-class undergraduate environmental studies and science students ($n = 17$) over the course of an environmental impact statement (EIS) writing class. During the class, it was the task of student groups to research and write a professional EIS for presentation to the class and a relevant professional group. A group of instructor-chosen undergraduate students ($n = 5$) was selected to create an EIS for a hypothetical salmon net-pen site to be located in Bellingham Bay, Whatcom County, Washington, with the study author as group leader. During the class, the selected group of students learned various information and facts necessary to write the EIS, including negative and positive impacts of salmon net-pen development in local waters. Near the end of the class the group presented its findings to the larger class exposing all students to the information. Pre- and post-surveys consisting of Likert scale, closed-, and open-ended questions were

used to measure change in self-assessed awareness and perception and identify acquired knowledge, respectively.

Theory and Literature

In the United States, aquaculture is a broad term that is applied to a complex diversity of species, practices, and applications often without geographic context (Knapp and Rubino 2016; Costa-Pierce 2010; Blackhart, Stanton, and Shimada 2006). U.S. aquaculture policy is equally complex and geographically disparate in stringency and application (Wirth and Luzar 2000). Policy-makers and researchers have noted the Pacific Northwest is an area where people are particularly sensitive toward and have overwhelmingly negative perceptions of aquaculture and farmed seafood products, specifically salmon net-pen farming (J. Anderson and Forster 2009; Cline 2012; Wessells and Holland 1998). These perceptions likely play a part in the creation of highly stringent and resource intensive aquaculture regulations and frameworks (Engle and Stone 2013; Pillay 1992). Simply, how people perceive salmon aquaculture impacts how salmon is managed and regulated (Olson, Clay, and Silva 2014).

In theory, perceptions arise from personal experiences as well as place-based or contextual culture (Tuan 1974). Thayer (2003) uses this concept in bioregional planning theory to illustrate the value and necessity of place-based approaches to management policies. Likewise, Campbell (Campbell 2016, 1999) emphasizes the importance of contextualization in the structuring and solution-finding of conflicting environmental, economic, and social planning goals for sustainable and equitable growth. Based on this

theory, learning in aquaculture policy processes should be contextually grounded in regional and local questions, concerns, wants, and needs (Whitmarsh and Palmieri 2009). Therefore, forms, species, and impacts of aquaculture most relevant to regional public perceptions of place-character should be the focus of knowledge acquisition and efforts to increase awareness (Costa-Pierce 2010). This is particularly important where proximity to aquaculture does not correlate with awareness or knowledge of aquaculture (Shafer, Inglis, and Martin 2010; Mazur and Curtis 2006).

Perceptions and awareness are also based on personal experiences that may vary because of demographic characteristics (Tuan 1974). Different people of differing circumstances will have differing views of aquaculture. Whitmarsh and Palmieri (2009) found individuals in affluent regions placed greater importance on avoiding negative impacts (e.g., habitat destruction) than low-income regions where greater importance was placed on aquaculture's socio-economic benefits (e.g., increased employment). Fernández-Polanco and Luna (2012) found younger and more highly educated individuals were more likely to have positive beliefs regarding aquaculture. Studies have also shown conflicts over aquaculture siting to be greater in areas where it would or does interact with traditional catch fisheries (Sanchez-Jerez et al. 2016; Natale et al. 2013). Many of these conflicts are a result of place-protective behavior by fishers and other stakeholder groups perceiving aquaculture as a threat to traditional lifeways (Devine-Wright 2009; Young and Matthews 2011). This indicates it is not spatial proximity alone that defines awareness and perception, but the directness of aquaculture's impact on a given stakeholder group. Therefore, it is not only what is being learned that is important but

who is learning it (Leach et al. 2014). This illustrates the importance of structuring learning to engage stakeholders and fill gaps in knowledge to encourage growth in awareness, which may then lead to less negative perceptions of aquaculture.

Previous studies have shown greater awareness of aquaculture can alter perceptions of aquaculture (Barrington et al. 2010; Kaiser and Stead 2002; Robertson, Carlsen, and Bright 2002; Simonneaux 2001). Information that increases awareness and alters perceptions occurs in a variety of ways, under different circumstances, and in different contexts (Leach et al. 2014). For example, increased awareness of different forms of aquaculture such as integrated multi-trophic aquaculture (IMTA) or coupled with other marine uses such as wind farms has been shown to increase acceptability (Wever, Krause, and Buck 2015; Barrington et al. 2010). Increased awareness of socio-economic benefits has also been shown to act as a counter-balance to environmental concerns bringing stakeholders closer to understanding aquaculture as a policy trade-off (Mazur and Curtis 2008; Krause et al. 2015).

Media messaging is also a factor in development of awareness and perception of aquaculture (Schlag 2010; Chu et al. 2010). Olson, Clay, and Silva (2014) note mixed messaging regarding aquaculture can be perplexing for the public as consumers and as stakeholders. Media messaging simultaneously extols the health benefits of eating salmon but also contains dire warnings of health risks (Amberg and Hall 2010). Additionally, health warnings are particularly dire in relationship to farmed salmon despite its affordability in comparison to most fished salmon (Hall and Amberg 2013). Stakeholders

and the public are also submitted to frequent news headlines regarding aquaculture, which are generally negative, but are broad and ambiguous in reasoning and subject matter and mostly related to environmental impacts (Froehlich et al. 2017). Knapp and Rubino (2016) noted a substantial amount of anti-aquaculture media emphasizing impacts on the natural environment originates from fisher and environmentalist groups seeking to limit detrimental aspects of aquaculture on ecosystems and traditional lifeways. However, in a survey of the public in British Columbia, Canada (less than 100 miles from the study area) individuals reported the dominance of this messaging made them feel “manipulated and uninformed”(Schlag 2010, 838). This informational ‘cherry-picking’ may cause problems in political contexts where acquired information may only serve to more deeply ingrain previously held perceptions and increase polarization of views thereby reducing the opportunity for consensus (Leach et al. 2014; Young and Matthews 2011). Therefore, in addition to what and who is learning, it is also important to consider how information aimed at increasing awareness of aquaculture is presented.

Based on literature and previous studies, three key factors were considered for this study:

1. Place-based context: what types, modes, and species of aquaculture are most relevant based on the questions, concerns, wants, and needs of a given region or locality?
2. Stakeholder diversity: who is learning and what is their previous knowledge and awareness of aquaculture?
3. Presentation: how is the knowledge and learning being communicated?

Several researchers have suggested similar elements be integrated into aquaculture policy processes to help alleviate contention and conflicts in policy formation. Kaiser and Stead (2002) recommend open and transparent forums where panels of citizen-learners can request presentations by specialists to answer questions regarding aquaculture. Krause et al. (2015) advocated for the integration of context with equitable consideration of environmental, economic, and social aspects and impacts in consideration of aquaculture goals. And, Leach et al. (2014) conclude that knowledge acquisition primes individuals for belief change in collaborative aquaculture partnerships. However, Leach et al. also note the intent of the partners and partnership may impact the factors listed above in the learning process. This was taken into consideration as well in study design.

Study Design

The study context (a college EIS writing class) provided an opportunity to add an educational element to the other research in this thesis. To answer the research questions, the study design needed to measure knowledge acquisition, change in awareness, and change in perceptions of aquaculture among enrolled students and those on the aquaculture EIS project team. The conceptual framework (Figure 12) used in this design is based on the work of Leach et al. (2014).



Figure 12: Knowledge Acquisition - Conceptual Framework

This framework operates on the findings of Leach et al. that knowledge acquisition primes individuals for belief change. The framework was operationalized to measure change in awareness and perception through self-assessed ratings as a result of acquired knowledge. During study design and analysis of data, the three key factors that may impact policy-learning scenarios were considered: place-based context, stakeholder diversity and presentation.

Environmental Impact Statement

According to State Environmental Policy Act (SEPA) guidelines in the Washington Administrative Code (WAC), an environmental impact assessment (EIA) is required where a project or action is determined to have significant environmental impacts (197-11 WAC). The purpose of an EIA is to 1) analyze a proposed action's environmental impacts, 2) consider mitigation measures and alternative actions, and 3) recommend a preferred action (WAC 197-11-400(2)). The final Draft EIS (DEIS) must include analysis of impacts on the natural and built environments and may include socio-economic impacts (WAC 197-11-444; WAC 197-11-448(2)). This led most research to focus on the negative environmental impacts of aquaculture rather than the positive socio-economic benefits. However, a small portion of the EIS document was given to discussion of such impacts (e.g., increased employment and increased access to salmon as seafood).

Place-based Context

Salmon net-pen aquaculture is a highly contentious issue in Washington State and the Pacific Northwest and several counties have attempted to adopt or adopted policies to

prohibit its development (Washington Department of Ecology 2016; Hume 2004). This is due, in part, to poor perceptions of practices and siting options (J. Anderson and Forster 2009). Despite this, eight salmon net-pens operate in Washington waters (Bouta and Payne 2015). Thus, salmon aquaculture provided an excellent focus for knowledge acquisition. Writing an EIS for a hypothetical salmon net-pen site in Bellingham Bay presented a prime way to address the first consideration of place-based context. Students were expected to complete a professional draft EIS (DEIS) over the course of the class. The aquaculture group extensively researched and analyzed the impacts of the hypothetical proposal. This provided a regionally relevant type and mode of aquaculture to be learned about as part the class.

Stakeholder Diversity

The EIS writing class functioned as a sample of the regional population and a facsimile of a multi-stakeholder learning group that would be found in policy processes. The class included environmental science and environmental studies students of various tracks including planning, geographic information systems, and policy. These tracks involve a variety of classes in science, ecology, policy, and social science. However, no required or offered classes at the time of this thesis integrated salmon net-pen aquaculture of any form as an element of the curriculum. Despite little to no formal education in salmon aquaculture, it is likely students had been exposed to some amount of awareness through local and regional media and social dialogues (Burger and Gochfeld 2008). The results of a pre-survey indicated students' awareness and perceptions followed some trends found in previous research but not others. Overall, student knowledge regarding aquaculture

was undetailed and indicated low awareness of existing regional aquaculture. I go over this in greater detail in the results section.

Presentation

The presentation of aquaculture knowledge and information was integrated into a reoccurring class curriculum. The goals of the class were as follows:

1. Enhance secondary and primary data collection methods
2. Improve written and oral communication skills
3. Support effective and productive student team experiences
4. Build bridges between academic learning and professional experience

These aims were to be achieved through creation of a professional DEIS document (Laninga 2016). Within the aquaculture project group, collection and interpretation of knowledge was largely student directed. Pre-chosen roles and self-selected assigned sections of the document gave some direction, however the sources and nature of knowledge were based on individual decision-making. At the completion of the DEIS and class, findings and recommendations were presented to the class allowing for a learning situation similar to the learner panels suggested by Kaiser and Stead (2002) to take place. Figure 13 shows the intended learning flow.



Figure 13: Knowledge Acquisition, Information Flow

Role of Instructor and Researcher

The role of the class instructor and myself as the research and aquaculture group leader was to provide resources and ensure timely completion of tasks by set deadlines.

Although many aspects of aquaculture were discussed as part of the EIS development, both the instructor and myself refrained from overtly influencing student perceptions.

However, the direct involvement of the researcher and instructor may have impacted perceptions regardless of best intentions and should be taken into account when considering the results of this research.

Surveys

To measure knowledge acquisition and change in awareness and perception a pre- post-survey was used. Pre- post-surveys are a common form of evaluation for learning outcomes because it offers a measure of pre-learning knowledge in comparison to post-learning knowledge (Barge 2007). Surveys contained a mix of quantitative close-ended and Likert-scale (1-10, 1 being negative and 10 being positive) questions and qualitative open-ended questions (Dillman, Smyth, and Christian 2014). Copies of the pre-survey and post-survey are found in Appendix E and Appendix F respectively. Surveys were created in Qualtrics, an online survey platform, and shared as a link. The instructor distributed the survey to the class through announcements and messages on the university learning platform, CANVAS. This online platform is the basis for most forms of communication and material distribution for course at Western Washington University (Western Washington University 2017). No delineation was made between group

members and other students in the class in terms of survey content. The pre-survey was distributed in the first week of the class with a reminder email sent out a week later by research and instructor. To preserve the integrity of given answers the pre-survey was closed two weeks from the first distribution. The post-survey was distributed in the final week of the course after the group had presented to the class (Dillman, Smyth, and Christian 2014). Analysis of survey data consisted of exploratory content analysis and narrative building to create an image of what knowledge was acquired and how it changed awareness and perception among students.

Results

Pre-Survey Results

Results for both pre- and post-surveys are organized into three sections to create continuity in findings regarding changes that occurred in students' knowledge and perceptions of aquaculture. These sections are "Knowledge" (general and detailed knowledge of aquaculture), "Awareness and Perceptions" (awareness and perception of regional aquaculture sites and conflicts), and "Concerns and Benefits" (changes in the basis for perceptions in terms of negative and positive impacts).

Knowledge

Ten out of seventeen students took the pre-survey. On a scale of 1 to 10, where 1 was "low" and 10 was "high", eight rated their knowledge of aquaculture as 5 or less. One student rated their knowledge as 6 and another as 7. The average knowledge rating was 3.1. When asked "Are you aware of any current fin-fish aquaculture operations in the

Washington Salish Sea or Puget Sound?” nine of ten said “no.” When asked “If yes, can you name the approximate areas in which they operate?”, the respondent named Taylor Shellfish Farms, which is a shellfish growing company rather than fin-fish farming.

Awareness and Perceptions

When asked “Do you believe greater awareness of aquaculture practices, science, and possible benefits would affect stakeholder perceptions positively?” seven students replied “yes,” two replied “maybe” and one was “unsure.” Lastly, students were asked if there was any information they felt should be considered in aquaculture social research and policy making. Students felt equal consideration of benefits and concerns to be important. One student mentioned the importance of tribes and tribal land in consideration of policies and impacts. Students were also asked “On a scale of 1 -10, how would you describe your perceptions of fin-fish aquaculture?” where 1 was negative and 10 was positive, four students rated their perceptions as 4 or lower, two as 5, three as 6, and one as 8. The average perception rating was 4.6.

Concerns and Benefits

When asked “Do you have specific concerns regarding fin-fish aquaculture?”, five students responded “yes,” one “no,” and four were “unsure.” When asked for specific examples of these concerns, students consistently referenced impacts on wild stocks and regional habitats. Students were also asked if they perceived benefits coming from aquaculture. Six said “yes” and four were “unsure.” Examples of perceived benefits included “Fin-fish aquaculture can take the

pressure off of wild stocks”, “A greater availability to the public for cheaper”, and “decreases our reliance on off-shore fishing.”

Post-Survey Results

Knowledge

The post-survey was taken by eleven out of seventeen students. However, one was incomplete and removed from the sample. Average knowledge rating rose from 3.1 to 7 with all students rating their knowledge as a 5 or higher. The average perception rating rose from 4.6 to 6 (Figure 14).

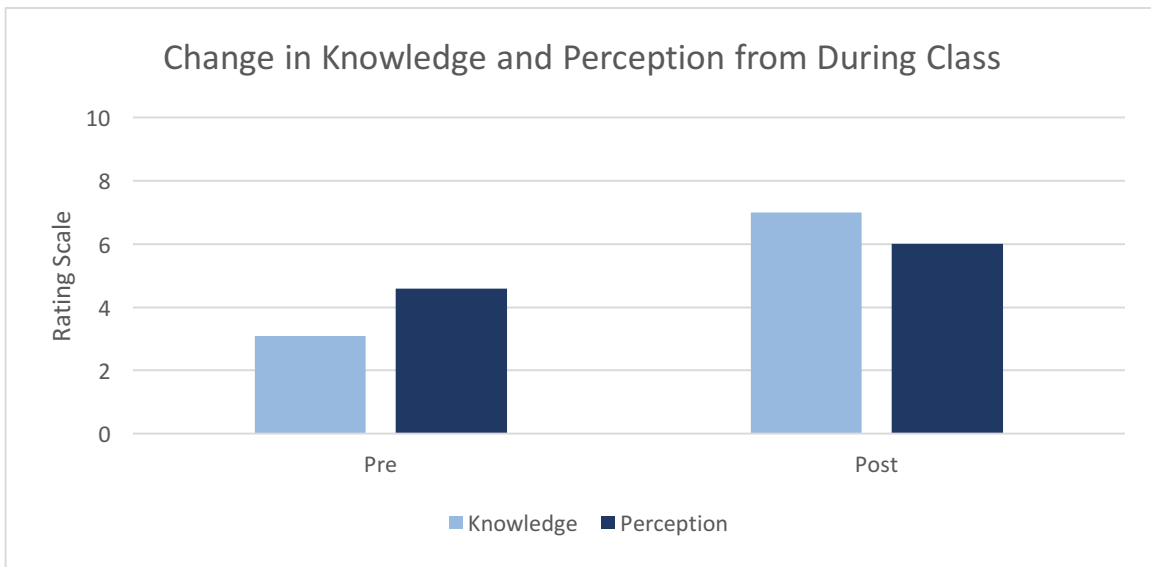


Figure 14: Change in Student Knowledge and Perception during EIS Class (n=10)

Awareness and Perceptions

In addition, students were asked if they believed their awareness and perception had changed because of the class. In response to awareness, eight students believed their awareness had

increased. One did not and one was unsure. Belief in perception change during the class was more mixed. Six student believed their perceptions had changed as a result of the class and four believed there was no change in their perception. Students were also asked to assess on a scale of 1-10 how much they believed their awareness had increased (1 being no increase and 10 substantially increased) and their perception had changed (1 being no change and 10 being substantially changed). Average reported change in knowledge (5.9) and perception (4.9) was higher than actual change in knowledge (3.9) and perception (1.4) during the class (Figure 15). Although these are different scales the discrepancy between change in knowledge and

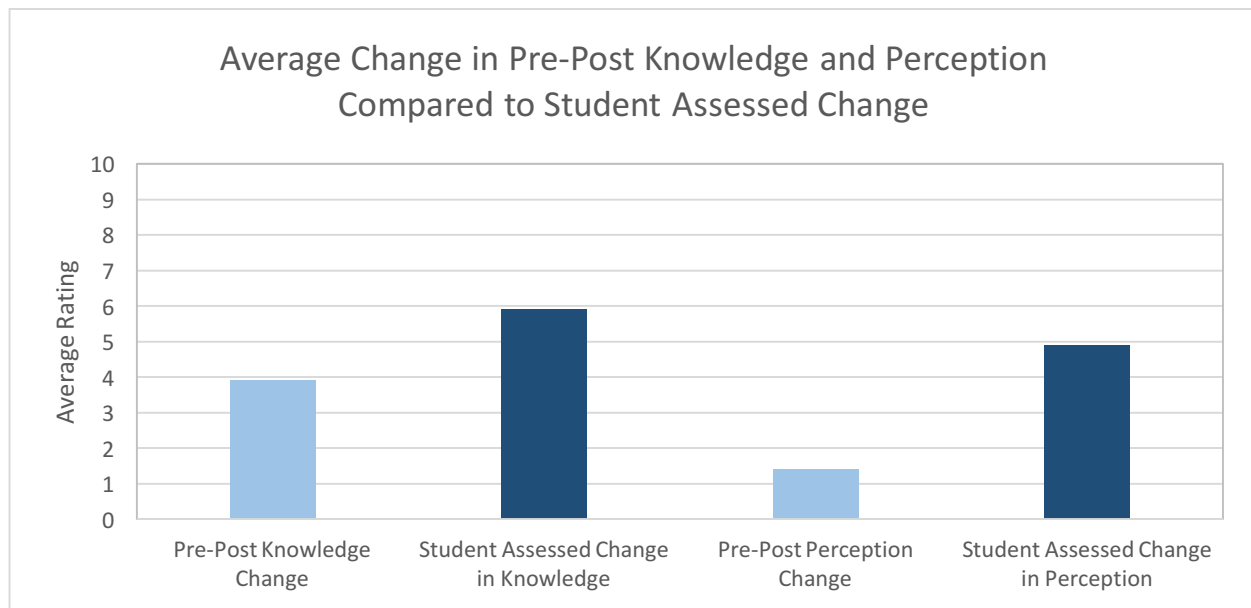


Figure 15: Knowledge, Perception Change during EIS Class (n =10)

perceptions measured from pre-survey to post-survey and the amount of change felt to have occurred by the students provides an interesting aspect of these findings.

Concerns and Benefits

Five students were aware of specific sites and five were not. All five who were aware of sites correctly listed aquaculture site locations. Nine students said they had specific concerns and all ten students said they were aware of specific benefits (Figure 16).

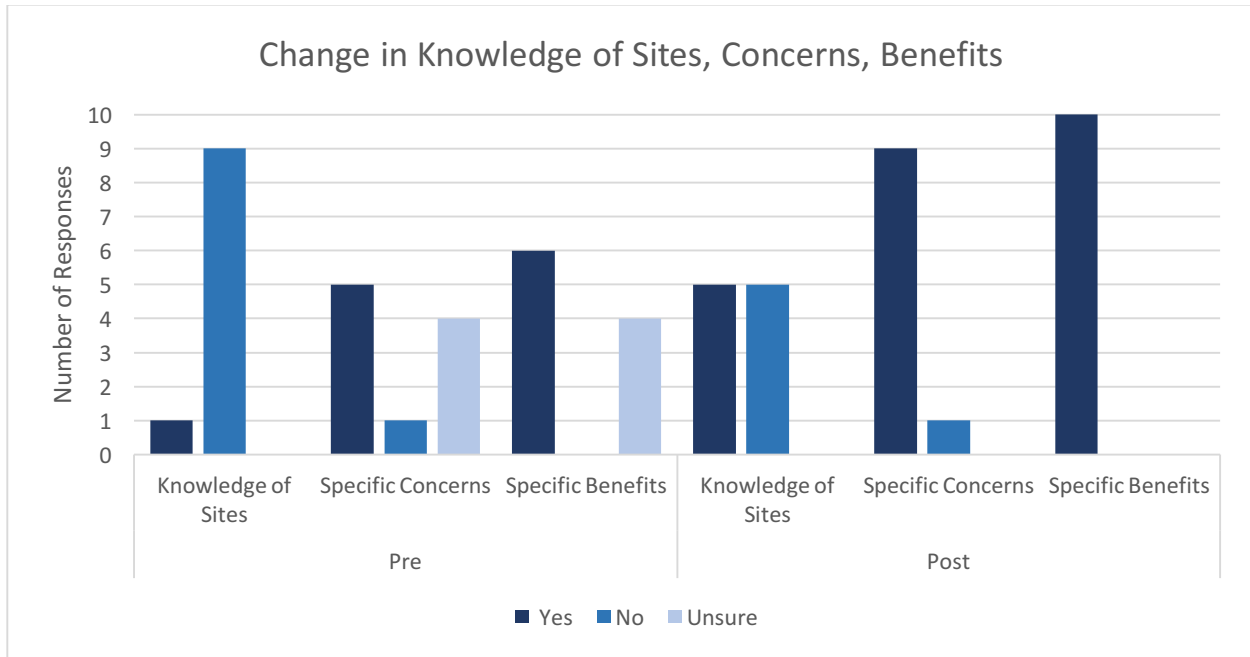


Figure 16: Change in Aquaculture Sites, Perceived Concerns, and Perceived Benefits (n =10)

Further, students exhibited greater detail in response to open-ended questions regarding concerns and benefits. For example, in the comparison below, the pre-survey concern example is broad listing only impacts whereas the second example references specific outcomes of escaped farm stock interbreeding with native stocks.

Pre-Survey Example: “Impact on wild stocks.”

Post-survey Example: “Possibility of genetic divergence in wild salmon as a result of

interactions/breeding with aquaculture species.”

This was also the case in examples of beneficial outcomes of aquaculture. A pre-survey example made a hesitant assessment of environmental benefits.

Pre-Survey Example: “Possibly less environmental degradation from harvesting.”

In comparison, a post-survey example illustrates knowledge regarding the broader aspects and socio-economic considerations of aquaculture comparatively and in relationship to personal values.

Post-Survey Example: “We need more food production and this is a great way to do that, that isn't inhumane when compared to the meat or dairy industry. I also like the idea that less affluent people would be able to afford fish.”

The accuracy of these assessments of benefits and detriments is subject to interpretation as part of larger debates about the science and economics of aquaculture that continues among experts and advocates (Young and Matthews 2011). Nonetheless, growth in detail and nuance in responses indicates a change in knowledge and awareness.

EIS

In completion of the EIS, the aquaculture student group concluded the hypothetical net-pen site and structure would have significant impacts on the natural environment (wildlife, habitats, and water quality) with moderate impacts on built environments (other marine uses, fisheries, aesthetics). However, it was found the impacts at the selected site would be minimal due to previous degradation and remaining impacts could be mitigated through technical and policy

solutions. It was also posited there could be positive secondary environmental impacts through use of IMTA and relief on capture fishery stocks. In addition, a socio-economic impact section contained predominantly positive impacts for the public, with specific stakeholder groups such as fishers and land-owners benefiting less or being negatively impacted. The action recommended by the group was the installation of a single salmon net-pen with regular reassessment of impacts to more exactly determine the site-specific impacts on the natural environment and better estimate socio-economic impacts over time.

Discussion

This study was based on two research questions:

1. What knowledge of aquaculture, if any, was acquired during the class?
2. What change occurs in student's awareness and perception when knowledge was acquired?

In answering these questions, three factors pulled from literature were considered: place-based context and relevancy of aquaculture type and species (salmon net-pens), stakeholder diversity (students with low awareness), and presentation (a hypothetical EIS research and writing project and presentation).

Based on qualitative and quantitative answers to survey questions, knowledge of aquaculture was acquired. Student knowledge of the environmental and socio-economic benefits of salmon net-pen farming increased substantially. Further, most students believed their knowledge and awareness had increased. Half of students responding to the post-survey continued to be unaware of current net-pen sites in Washington. This is assumed to a signifier of the difference between

project group and non-project group students. Impacts of the hypothetical proposed site were the focus of the EIS presentation and current sites were only briefly touched on. In comparison, group members would have had greater exposure to current sites as a way of assessing impacts of the hypothetical proposed net-pen site. Thus, group members were more likely to have been able to answer questions regarding current sites. This indicates greater knowledge acquisition occurred for group members who actively participated in the EIS process, than in relationship to those who only heard the presentations. Therefore, approaches such as the learning panels suggested by Kaiser and Stead (2002), wherein active participation is required, are more likely to facilitate increased knowledge and awareness than information presented in more passive forms.

Change in awareness and perceptions did occur during the class. However, knowledge acquisition and increased awareness was greater than perception change both during the class and as assessed by students in the post-survey. Although it was not the intention of this class or study to move perception one way or the other, this may be a result of the information and learning being attained by a group of individuals who started with low awareness. Despite student's regional proximity and relatively ubiquitous discourses in state and local policies, awareness was low, mimicking the findings of Mazur and Curtis (2006) wherein nearness to sites did not correlate with awareness. Beginning the class with low knowledge and awareness necessarily left room for growth within the educational context of the class. Robertson, Carlsen, and Bright (2002) and Leach et al. (2014) pointed out learning context as well as the learner's previous knowledge of aquaculture will play a role in how information impacts perceptions. Findings by Robertson, Carlsen, and Bright (2002) showed individuals less knowledgeable about aquaculture would show relatively substantial change in attitude or perception when exposed to

information regarding aquaculture impacts. Leach et al. (2014) found knowledge acquisition “primes” belief change. In this study, acquired knowledge and increased awareness brought average perceptions closer to a neutral mid-point between negative and positive from a more negative original perception. These findings align more closely with Leach et al. (2014) more so than Robertson, Carlson, and Bright (2014) by showing far greater knowledge acquisition than perceptual change. Findings also lend to characterizations that young, educated, and (generally) less affluent individuals being more likely to be open to knowledge acquisition and change their perceptions of aquaculture positively (Fernández-Polanco and Luna 2012; Whitmarsh and Palmieri 2009).

An additional interesting aspect of this research is in the result of the self-directed nature of the acquired knowledge among group members. As independent researchers and through the environmentally oriented nature of an EIS, students within the group were given ample room to select and use only literature describing the negative impacts of salmon net-pen aquaculture. Thus, effectively ‘cherry-picking’ the science and literature due to knee-jerk negative perceptions thereby also transferring only knowledge of negative impacts to the class (Leach et al. 2014; Koch 2013). However, students also sought literature regarding new and possibly positive impacts and forms of aquaculture indicating openness to holistic knowledge gain and room for, if not, perceptual change.

Limitations and Conclusions

This study was intended as an experimental form of policy-process learning to measure knowledge acquisition, change in awareness, and change in perception of salmon aquaculture.

The sample of students who took the survey is relatively small in comparison to the class size. However, the response size ($n = 10$) is reasonable for stakeholder focus groups or citizen learner panels. It is unknown why more students did not complete the survey. Additionally, the history and origin of students was not considered as part of the survey. As noted by Tuan (1974), personal experiences as a result of place-based culture and socio-demographic character can impact perceptions. To address this, broad characterizations of regional and socio-demographic perceptions were taken from previous literature and studies. Findings indicate awareness increases and perception change occurs in relationship to knowledge acquisition. Post-survey open-ended questions showed greater detail regarding aquaculture impacts. Greater learning occurred among active learners involved in an EIS process as opposed to passive presentation learners. Low knowledge and awareness of students at the beginning of the class likely contributed to substantial increases in knowledge and awareness during the class that may not be the case in a group already knowledgeable about aquaculture. Lastly, student's openness and independent research of positive impacts of aquaculture were counter to literature characterizations of regional perceptions and theories of selective, new knowledge reinforcing polarized stances and perceptions.

Chapter 5

Summary of Findings

Findings from all three studies focused on the relationship between awareness and perception of aquaculture as well as the major concerns and perceived benefits. In the first study, average Sea Grant professional reported ratings showed national awareness (5.51) and perception (5.17) to be middling. Reported ratings also showed a weak but significant positive relationship with perceptions moving positively with increased awareness. Most professionals (61%) believed increased awareness would result in increased positive perceptions of aquaculture. This study also showed substantial emphasis on concerns with impacts to the natural environment rather than the human environment when defined by SEPA EIS language. Increased food production with a strong emphasis on local production was the most reported benefit identified by regional stakeholders. Although tested, no significant relationship was found between perceptions and the ARCScale developed by Wirth and Luzar (2000).

In the second study, interviews with regional key-informants showed the current salmon aquaculture perceptions in Washington to have changed substantially from those of the 1970's. Informants also consistently observed public knowledge and awareness of current salmon aquaculture sites, impacts, and practices was low or outdated. Several informants also observed negative perceptions of farms and farmed salmon to be place-based and common among individuals in the region as a learned knee-jerk reaction. However, observations also indicated this may be only one group of stakeholders who are active and vocal in the case of policy. Like observations in the national study, informants noted most concern with salmon aquaculture centered on its negative impacts to native salmon species. Nonetheless, all informant observed

shortages in capture fisheries and the possibility of aquaculture contributing to filling the gap between supply and demand for regional salmon. It was also observed that encouraging the development of salmon aquaculture with simultaneous salmon conservation messaging might be mutually exclusive in public perceptions when aquaculture is associated with degradation of the natural environment and threats to native species of salmon. Several informants also indicated frustration with current policy frameworks and processes for various reasons including lack of communication, over emphasis on minimizing impacts, resource intensive nature, absence of voice diversity, and lack of knowledge among stakeholders and the public.

Acquired knowledge, increased awareness, and change in perception was the focus of the third study. During an EIS writing class, students showed substantially increased knowledge and awareness of salmon aquaculture as well as slightly more positive perceptions. Students within the active writing group are hypothesized gain greater knowledge then compared to non-group students due to more in depth exposure, indicating learning and likely perception change is greater in an active context.

Discussion

In approaching the subject of perceptions of fin-fish aquaculture, I asked the broad question: How and what do people perceive of aquaculture? To answer this question, I created and completed the three studies at the core of this thesis. Each of these studies answered sub-questions or hypothesis designed to add to knowledge and conversations that currently form the basis of knowledge addressing how and what people think of aquaculture and to tease apart some

of the details and specific of perceptions as well as awareness and knowledge as they relate to one another.

Researchers acknowledge public perceptions play a role in policy formation and that awareness and knowledge of aquaculture's different aspects impact the character of perceptions (Knapp and Rubino 2016; Leach et al. 2014; Olson, Clay, and Silva 2014; Engle and Stone 2013; Chu et al. 2010; Costa-Pierce 2010; Mazur and Curtis 2006; Hugues-Dit-Ciles 2000). Further, theory tells us that perceptions of environments are based in place and context as well as personal experience (Campbell 2016; Thayer 2003; Campbell 1999; Tuan 1974). Therefore, perceptions of aquaculture as well as what is wanted from aquaculture originates from a combination of place culture, socio-demographics, and new knowledge and typically are most strongly related to specific types, species, or modes of practice. This social aspect of aquaculture unpin and complicate the structuralist theory presented by Costa-Pierce (2010) wherein fish farming will occur where fisheries cannot meet demand.

Nationally, U.S. awareness and perceptions are somewhat neutral and yet exist in a positive relationship indicating greater awareness leads to more positive perceptions of aquaculture. However, given the wide diversity of aquaculture types as well as regional values, it seems unlikely that this relationship is as straightforward and homogeneous as it implies. Instead, I characterize greater knowledge and awareness of aquaculture as bringing the public and stakeholders closer to understanding aquaculture development as a trade-off between negative and positive impacts, neither of which can be easily dismissed. Both are observed by informants to have subsequent impacts on stakeholder groups. Possible damage to fisheries stocks could

likewise impact the traditional livelihoods of fishers and otherwise change place-character in aesthetics and space. Aquaculture's ability to increase domestic production is a possible solution to a massive shortfall in supply to meet increasing demand and accessibility. The tension between the goals of maintaining place-character and environments and ensuring equitable access to seafood as well as other socio-economic benefits is well founded in previous research (Mazur and Curtis 2006; Katranidis, Nitsi, and Vakrou 2003; Hugues-Dit-Ciles 2000). However, contrary to dominant discourse often locked between environmental and industrial perceptions focusing on the impacts to the natural environment, aquaculture is a social issue that plays out on a political stage (Hugues-Dit-Ciles 2000). This is exemplified in consistent undertones of *who* aquaculture impacts positively or negatively within observations and responses. But, perceptual emphasis on problems with impacts to the natural environment solved with scientific solutions risks exclusion of the social aspects of aquaculture despite acknowledgement of social impacts (Wesselink et al. 2013). This is particularly the case where those who are or would be impacted by aquaculture, but are outside of the dominant voices, such as low-income communities, are not involved in creating aquaculture policies. Therefore, aquaculture, rather than being 'man versus nature' or 'environment versus economy' are better described with the Planner's Triangle where environmental, economic, and social goals pull at one another and create conflicts between stakeholder groups, public values, and aquaculture policies (Campbell 2016, 1999). In using the Triangle, policy-makers may give structure to aquaculture's otherwise unstructured socio-economic problems so that conflicts can be addressed through explicit goal-setting.

Ultimately, the decision to use aquaculture lies with states and localities and the policies that are created to include or exclude aquaculture in their waters. Whereas most policy governing aquaculture exists at the state and local scales, it is not surprising that policies might take on the characteristics of regional perceptions (Engle and Stone 2013; Zhu and Chu 2013; Wirth and Luzar 2000). This is problematic where 90% of the public is observed to be unaware of current aquaculture operations in regional waters (Interview: Conservation NGO). As one informant pointed out a relatively small group of people can alter the path of policies therefore impacting environments as well as food systems. Tuan (1974) and Thayer (2003) both theorize environmental perceptions are made in place. Therefore, perceptions of aquaculture will be characterized by place-based culture. This, in tandem with the place-based nature of many aquaculture species and types, leads to the necessity of addressing conflicts within individual contexts and in consideration of relevant aquaculture types (Costa-Pierce 2010). In Washington State, salmon net-pen aquaculture is contentious despite evidence of positive perceptions in the 1970's. The consistency of regional informant references connecting perceptions of aquaculture to place-based experiences and enculturation also suggest a cultural bioregion. This is one factor that has been integrated into Australian national approaches to marine planning as a way of addressing the often 'wicked' social problems associated with aquaculture development by considering place-based culture similar to regional ecosystems (Australian Public Service Commission 2016). Because, while certain trends were consistent between the national and regional studies, distinctions existed in informant characterizations of regional awareness and perceptions. For example, knee-jerk reactions to salmon aquaculture occurring despite low awareness and relatively recent positive social history. Washington (and perhaps the Northwest) also presents an interesting perceptual paradox in hatchery aquaculture. Informants noted, for

taxpayers, there is economic unsustainability that occurs when tax money pays for clean-up in the event of farm salmon escape. This is like the economic unsustainability of hatcheries posited by Lackey (2003). Yet, despite similar impacts to salmon aquaculture on true wild salmon population, hatcheries are perceived as more acceptable. However, this may be an issue of awareness. Based on informant reporting, it is likely the regional public is unaware of the comparative costs of maintaining hatcheries versus farm escape clean-up, therefore perceptions of this trade-off are incomplete. Subsequent decisions made based on public support born from such perceptions are equally incomplete. However, increased knowledge as a part of policy creation processes may change perceptions (Leach et al. 2014).

In the third study of this thesis, students in an EIS writing class showed substantial increases in their knowledge of aquaculture and positive change in their perceptions. Rather than suggesting that increased awareness is directly correlated to the positive perceptions, I argue holistic knowledge and awareness of all aspects of regionally relevant aquaculture types brought students to more neutral perceptions where they forewent knee-jerk reactions and could weigh multiple types of impacts for different groups of stakeholders. This does not mean that all students or stakeholders would support regional aquaculture development. It is entirely possible that neutral perceptions may result in decisions to not support or allow for development to occur. However, these perceptions and decisions will be made with full knowledge and awareness rather than predicated on only a portion or a single aspect of aquaculture. It should also be noted that media representations of aquaculture may impact perception. Although media was not prominent in this research, literature indicates much of the media representation of aquaculture and aquaculture products is negative or confusing to the public (Froehlich et al. 2017; Hall and Amberg 2013;

Young and Matthews 2011). An informant in the regional study observed this trend in regional media and it is unlikely that media depictions of aquaculture are holistic leading to biased and lopsided views including knee-jerk reactions (Rickard and Feldpausch-Parker 2016). By using a learning approach during policy processes policy-makers would have the opportunity to ensure perceptions and decision are balanced. According to literature, creating an active learning process would increase inclusion of stakeholder voices, reduce conflict through mutual learning, and increase opportunities for consensus in aquaculture issues and decision-making (Krause et al. 2015; Kaiser and Stead 2002). This would help stakeholders and decision-makers better answer the question “what do people want from aquaculture?” (Whitmarsh and Palmieri 2009, 452)

Implications and Recommendations

To find what people want from aquaculture and execute these wants in policy contexts, decision-makers must first understand what people know or are aware of about aquaculture and how they perceive it as a part of their regional water-scape. To do this there are four key implications to consider based on this study’s findings.

1. *The relationship between awareness and perception of aquaculture.* All three study findings included connections between awareness and perceptions. Informants in the studies also indicated values and the culture of place are strong factors in deciding if the public and stakeholders will support aquaculture development or advocate for banning it. Therefore, it is important to consider the awareness of stakeholders in aquaculture policy.

2. *Perceptions are contextual.* Environmental perceptions arise, in part, from place-based enculturation of values. This is indicated in theory and literature as well as the regional study in this research. Informant observations closely connected regional values to perceptions of salmon aquaculture and aquaculture products.

3. *Perceptions can be formed without full awareness of impacts or implications.* Current aquaculture discourses in media and policy tend to be confusing and heavily focused on generalized negative impacts on natural environments. When this messaging is the sole basis for awareness of aquaculture it is also the basis for perceptions on which support and policy decisions are made. Emphasizing holistic awareness of aquaculture could lead to different perceptions, if not policy outcomes.

4. *Perceptions can change given new knowledge.* Most participants in this research indicated they believed increased knowledge and awareness would change perceptions of aquaculture. In the student study, perceptions did move positively. However, this does not mean all knowledge would consistently create more positive perceptions. Although, perceptions moved positively in these studies perceptions among other stakeholder populations may change in different ways based on more holistic information.

Based on these findings, I recommend the following actions on the part of policy- and decision-makers as well as stakeholders during aquaculture policy creation processes. Each recommendation is accompanied by questions that might form the basis for outreach and

engagement efforts. These actions are in a chronological order. However, they are also modular and usable as individual elements in approaching policy formation and stakeholders, as well as the public, where aquaculture is contentious.

1. *Understand and engage current awareness and knowledge in stakeholder populations.*

The relationship between awareness and perceptions shown in this research indicates increased awareness and change perceptions. By identifying what stakeholders know and understand regarding aquaculture and on what information current aquaculture perceptions one based, decision-makers can address any gaps or outdated information through learning approaches. Measuring knowledge of various forms of aquaculture such as coupled-use or IMTA could be part of these instruments (Wever, Krause, and Buck 2015; Barrington et al. 2010). This might take the form of surveys, focus groups, or interviews with stakeholders. Commenters on previous aquaculture policies and public issues would be an excellent initial population. Further, with a moderate amount of outreach, this action could be used to engage with stakeholder groups less heard in aquaculture discourses (e.g., such as low income) by acknowledging impacts for them (e.g., increased access to seafood). Integrating such information into learning approaches will also allow for learning to be modular and address multiple stakeholder groups that may each have different knowledge levels and knowledge of different aspects of aquaculture's impacts. With holistic awareness of who and how a given type of aquaculture may have implications, stakeholders and decision-makers can consider and create policy structures that avoid knee-jerk opinions and create inclusion leading to

greater opportunities for consensus based on interests rather than positions. The following questions might characterize or act as objectives for such inquiries:

- Who is impacted and aware or unaware of aquaculture?
- What is known and unknown about aquaculture among stakeholders?
- What is the source of stakeholders' information?
- What is the nature of those sources?
- How might the nature of those sources impact perceptions?
- What forms of learning or information might best be used to create holistic awareness of aquaculture for individual stakeholder groups?

2. *Explicitly address aquaculture in terms of regional or local goals.* The contextual nature of aquaculture necessitates the couching of aquaculture issues and impacts in terms of regional values and socio-demographic values that arise from place-character and perception (Costa-Pierce 2015; Krause et al. 2015; Thayer 2003; Hugues-Dit-Ciles 2000; Tuan 1974). Therefore, aquaculture should fulfill goals created from these values. For example, in the regional study based in Washington, not all individuals have access to salmon as a part of regional food culture. Thus, increased salmon production and access would be perceived as a desirable outcome of aquaculture. Informants also observed impacts on native species and negative impacts for fishers as a part of place-character would be undesirable. Thus, aquaculture policies and processes in Washington need to address both impacts. By addressing only one set of impacts, typically those on the natural environment, existent policies risk limited foundations without inclusion of socio-economic elements leading to inequitable distribution of resources and abilities. For

example, the price and expense of catch salmon may limit its consumption and health benefits to a higher income bracket. In another example, overdevelopment of aquaculture may negatively impact traditional lifeways and occupations such as fishing. In a final example, resource intensive regulatory frameworks may encourage only intensive industrial aquaculture and suffocate regional innovation and ownership of aquaculture. Each of these examples fit into a side of the Planner's Triangle where environmental, economic, and equity goals pull against one another to create conflicts and tensions (Campbell 2016, 2016). Policy-makers currently use the Planner's Triangle in addressing aquaculture goals (Australian Public Service Commission 2016). However, goals can be made more explicit by attaching them directly to the question posited by Whitmarsh and Palmieri (2009), "What do people want from aquaculture?" This should be further clarified by asking "What do people NOT want from aquaculture?" and "What do people of a specific region want and not want from a specific type of aquaculture?" By asking these questions, decision-makers will be able to increase the accuracy of policy goals and outcomes. Further, by asking these questions of stakeholders who are fully aware of aquaculture impacts will require trade-offs, but also allow for the creation of mutual value-based goals that can be addressed with specific forms of aquaculture or non-aquaculture options.

3. *Engage stakeholders in processes through active learning to encourage balanced perceptions through knowledge acquisition.* The student study in this research found perceptions of aquaculture change where new knowledge of aquaculture impacts was acquired. I found that the positive movement in student perception signified movement

toward neutrality from an initial negative stance. This neutrality may create an ideal situation for students and stakeholders to consider aquaculture's multiple types of impacts without knee-jerk reactions. Therefore, stakeholders in a similar situation may also move perceptions toward neutral consideration of aquaculture with full knowledge of associated trade-offs. Previous research has suggested similar scenarios. Kaiser and Stead (2002) recommend a stakeholder-learner panel where the panel may select as a group expert to come and present to the panel regarding various aspects of aquaculture impacts. Leach et al. (2014) showed aquaculture partnerships led to acquired knowledge and changes in attitudes toward aquaculture through collaboration. In the student study, the approach included active learning for group members through participation and passive learning for non-group student. I found active learners acquired greater knowledge in terms of detail and robustness through the research and writing process. In regional processes, these might be mimicked as part of document creation to increase mutual understanding of goals and values. In creating learning scenarios, who is learning and how the knowledge and learning is to occur should be explicitly decided to create clear outcomes for the exercise. This is where the first step in this sequence may be useful in identifying best practices for learning scenarios and outcomes through analysis of questions answered?. Further, learning should focus on regionally significant aquaculture types if there is not already a single type of aquaculture (e.g., salmon net-pen). It is also important to note in all examples, those of previous research and my own function largely on self-directed learning and resource selection. Although this may lead to scientific cherry-picking it also provides increased validity where it encourages bi-partisan research and learning.

Conclusions and Future Research

The goal of this research and thesis was to push beyond surface conflicts to access the deeper social aspects of perceptions around fin-fish aquaculture. By using multi-scalar studies, I have demonstrated the relationship between and character of awareness and perceptions of aquaculture as well as hypothesized deeper social drivers that may underpin surface environmental-economic debates at the national scale. I have also shown the nuances of contextual social history and culture that create perceptions at the regional scale in a study of Washington State perceptions of salmon net-pen aquaculture. Lastly, I have confirmed that knowledge acquisition and increased awareness can change perceptions of aquaculture.

The research and findings in this thesis are intended to act as tools in encouraging holistic awareness of aquaculture to create fully informed perceptions, reduce knee-jerk reactions and conflicts, increase consensus, and create effective and sustainable policies for multiple stakeholder groups. To achieve this, we must recognize, perceptions of aquaculture are decided by several factors and have implications for the future of environments and food systems as well as place-character and stakeholders when acted out in policy processes. Informed perceptions will create more secure policies that incorporate all aspects, acknowledge all trade-offs implicit in development, and better answer what people want from aquaculture.

I would also like to reiterate that aquaculture is not the only solution in addressing food shortages or the only entity contributing to negative environmental (natural and human) impacts. It is likely that aquaculture will be more appropriate for some regions than for others dependent on a

multitude of factors. There are also a seemingly infinite number of combinations for different environments, structures, and species of aquaculture each of which would have its own impacts in specific context. The recommendations in this thesis may provide useful for identifying at least the social aspects of this as well by leading to explicit goal making. Nonetheless, this demonstrates there is a significant amount of research and work to be achieved to fully understand aquaculture awareness and perceptions. Nationally, in the U.S., very little is understood of public perceptions of aquaculture despite its ability to address a major trade deficit and persistent conflicts. A national study examining the geo-social patterns that may emerge in perceptions may aid in creating national frameworks that can be adjusted to regional goals, types, and needs for aquaculture. This may also provide data for case comparison at a regional scale. It would be very interesting to compare regional awareness, perceptions, and conflicts to identify if there are homogenous factors that result in analogous policymaking. There are also several questions regarding the political-economics of aquaculture that need to be answered. Would substantially increasing aquaculture remove the trade deficit and dependence on unsustainable imports? How much aquaculture and of what type and where would it occur? Although, many of these questions may be answered by using offshore aquaculture in federal waters a substantial amount of the future of U.S. aquaculture will be decided at the regional scale.

In Washington state, salmon are an integral part of regional place-character and lifeways. A question this research was only able to touch was why is the “wildness” of salmon so important to regional consumers and stakeholders? Findings in this research imply that only “wild” salmon may be considered central to Washington place-identity and farmed salmon antithetical. In terms of food systems and access, this may war, on personal and public levels, with the idea of wild

salmon a bourgeois commodity only available to higher income and intimately connected individuals and groups. Deeper research into this may create a useful narrative in identifying the role of salmon in cultural and social identity as well as the tension that may exist between social and environmental values in terms of access to salmon. This may be similar for other regions where the concept of domestication competes with “wild” in a regional icon. However, I suspect this attitude may be unique to the West and possibly Alaska. Regional research might also include more in-depth examination of the exact impacts of perceptions on policies. Literature theorizes and suggests perceptions have implications for policies, but it would be highly valuable to know exactly how and to what extent personal and public perceptions as well as place-based culture shape aquaculture policies. Lastly, regarding personal perceptions, theorists provide that individual perceptions are created out of personal experiences. It is these perceptions that are change through awareness and knowledge and people who create policies that govern aquaculture. At a very small scale, but with highly valuable detail, research might create a series of personal narratives regarding aquaculture. Because, although fin-fish aquaculture is a relatively new venture in the U.S., it is growing and will likely soon become a way of life for many regardless of impacts.

Appendix A: Codebook

Codebook				
	Theme	Code	Definition	Definition Source
<i>A priori</i> Codes (deductive)	Environmental	Natural Environment	Natural environmental issues such as disease, interbreeding causing reduced fitness, negative impacts on local flora/fauna.	(Campbell 2016, 1999; WAC 197-11-770; WAC 197-11-718)
		Built Environment	Interference with human built or organized uses or spaces such as shipping lanes, recreation areas, or transportation.	
	Economic		Economic benefits or detriments of aquaculture. This includes job creation, economic diversity, sector growth, or industry growth, etc. or impacts such as market competition with catch fisheries, prices increase or decreases, or negative secondary impacts from natural environmental impacts on stocks, etc.	(Campbell 2016, 2016)
	Social		Social benefits or detriment of aquaculture including increased access to seafood, job creation, increased local production or concerns related to negative or positive impacts on other stakeholder groups or people.	(Campbell 2016, 2016)
<i>A posteriori</i> Codes (inductive)	Governance	Permitting	Permitting processes, permits, or permitting bodies.	
		Regulation	Regulation of aquaculture or fisheries such as frameworks, governing bodies, and requirements.	
		Ownership	Ownership including public ownership of aquatic resources or privatization of aquatic areas.	
	Awareness	Knowledge	Public or stakeholder awareness of aquaculture practices, policies, or information.	
		Education	Education or outreach, or suggesting a lack of it regarding aquaculture.	
	Social	Catch	Catch fisheries, fishers, or markets.	
		Aesthetics	Smell, view sheds, or other visual aspects.	
Food		Seafood access, availability, increase, or decrease, and quality.		

Appendix B: Sea Grant Professional Key-Informant Survey Questions

Q1. Which Sea Grant program do you work with?

- Alaska Sea Grant
- California Sea Grant
- Connecticut Sea Grant
- Delaware Sea Grant College Program
- Florida Sea Grant
- Georgia Sea Grant
- Illinois-Indiana Sea Grant
- Lake Champlain Sea Grant
- Louisiana Sea Grant
- Maine Sea Grant
- Maryland Sea Grant
- Michigan Sea Grant
- Minnesota Sea Grant
- Mississippi-Alabama Sea Grant Consortium
- MIT Sea Grant College Program
- New Hampshire Sea Grant
- New Jersey Sea Grant Consortium
- New York Sea Grant
- North Carolina Sea Grant
- Ohio Sea Grant College Program
- Oregon Sea Grant
- Pennsylvania Sea Grant
- Puerto Rico Sea Grant
- Rhode Island Sea Grant
- South Carolina Sea Grant Consortium
- Texas Sea Grant
- University of Guam Sea Grant
- University of Hawai'i Sea Grant
- University of Southern California Sea Grant
- University of Wisconsin Sea Grant Institute
- Virginia Sea Grant
- Washington Sea Grant
- Woods Hole Sea Grant

Q2. What zip codes (or counties) do you work in?

Q3. How would you describe your focus in the Sea Grant program? (Select all applicable options and/or select Other and write your own)

- Catch-Fisheries
- Hatchery
- Mariculture
- Aquaculture
- Agriculture
- Other _____

Q4. How long have you been in your current position?

- Less than 1 year
- 2-5 years
- 6-10 years
- 10 + years

Q5. How would you categorize the majority of stakeholders you work with? (Select all that apply and/or select Other and write your own)

- Catch-Fisheries
- Hatchery
- Mariculture
- Aquaculture
- Agriculture
- Other _____

Q6. On a scale of 1 to 10, how would you describe the awareness of fin-fish aquaculture practices and policies among stakeholders you work with? (1 = Unaware, 10 = Very Aware)

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

Q7. Do you believe greater awareness of aquaculture practices, science, and possible benefits would affect stakeholder perceptions positively?

- Yes
- No
- Maybe
- Unsure

Q8. On a scale of 1 -10, how would you describe perceptions of fin-fish aquaculture among stakeholders you work with? (1 = Negative, 10 = Positive)

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

Q9. Among stakeholders in your region, would any negative perceptions of fin-fish aquaculture fall into any or all of the following categories? (Select all that apply and/or select Other and write your own)

- Economic
- Environmental
- Social
- Other _____
- None. Stakeholder perceptions of fin-fish aquaculture are positive in my region.

Q10. Do stakeholders in your region have specific concerns regarding fin-fish aquaculture?

- Yes
- No
- Unsure

Q11. If yes, please use the space below to give some examples of these concerns (ex. water quality).

Q12. Have disagreements or conflicts based on these concerns with fin-fish aquaculture occurred in your region?

- Yes
- No
- Unsure

Q13. If yes, please use the space below to give an example of disagreements/conflicts over fin-fish aquaculture in your region.

Q14. Are there specific benefits perceived by stakeholders in your region regarding fin-fish aquaculture?

- Yes
- No
- Unsure

Q15. If yes, please use the space below to give some examples of the benefits perceived by stakeholders.

Q16. Is there any other information you feel should be added or taken into consideration on this topic?

Q17. Are there Sea Grant colleagues you believe would add to this research survey? If yes, please write in their names, programs, and emails in the space below.

Appendix C: Further Considerations in Net-pen Permitting

A brief overview of the regulatory structure for marine finfish rearing facilities follows:

- *Washington State Department of Fish and Wildlife (WDFW)*: manages regulatory authority for commercial aquaculture disease control, escapement and stocks of fish reared in netpens.
- *Washington State Department of Agriculture*: develops regulations with WDFW for commercial aquaculture.
- *Washington State Department of Ecology*: regulates discharges from netpens by issuing NPDES permits that contain operational conditions to protect water quality and sediment standards. *Ecology reviews and approves local shoreline programs and associated shoreline permits.*
- *Environmental Protection Agency*: approves or disapproves Ecology's water quality and sediment standards.
- *Washington State Department of Natural Resources*: leases aquatic lands for netpen facilities.
- *Counties and Cities in Washington State (local government)*: issues shoreline permits (Conditional Use Permits or Shoreline Substantial Development Permits)
- *Tribes of Washington State*: co-manages natural resources in Washington State and have input into aquaculture disease control regulations adopted by WDFW.
- *National Marine Fisheries Service (NMFS)*: administers Endangered Species Act for anadromous salmonids and marine mammals.
- *U.S. Department of Fish and Wildlife (USFWS)*: administers Endangered Species Act for bull trout in Puget Sound.
- *Army Corps*: issues Department of Army Permits under section 10 of the Rivers and Harbors Act (for structure or work in navigable waters of the US) and/or section 404 of the Clean Water Act (for discharge of dredged or fill material).

State, Local, and Federal Regulatory Controls for Finfish Net Pen Aquaculture in Washington State

The following is a brief summary of the regulatory regime governing fin fish net-pen operations in Washington State prepared by Kevin Bright of American Gold Seafoods. This summary is not intended to be exhaustive, but is intended to provide an overview of the various programs in place to ensure net-pen operations do not interfere with other beneficial uses of Washington State's waters and shorelines.

1) Shoreline Substantial Development Permit / Conditional Use Permit (Local Counties/Cities)

- The local county or city in which a new net-pen facility plans to operate is responsible for issuing a Shoreline Substantial Development Permit (SSDP) under the *Shoreline Management Act*. The SSDP allows for the construction of the net-pen facility and any associated structures.
- The local jurisdiction also *may issue* a Conditional Use Permit, which allows site-specific issues to be mitigated and minimized through the placement of specific conditions on the issuance of the SSDP/CUP. For example,

conditions on a SSDP/CUP may address lighting or noise limitations to ensure compatibility with nearby upland uses.

- The SSDP/CUP must be consistent with the local jurisdictions Shoreline Master Program (SMP). The SMP addresses the public's right to visual and physical access to the shoreline, as well as the natural character, resources and ecology of shorelines and water bodies. SMP's are also required to make provisions for the reasonable commercial use of state shorelines for public commerce and benefit of the public welfare, such as food production.
- The Department of Ecology ("Ecology") performs the final review of Conditional use permits issued by the local agency to ensure any environmental concerns are adequately addressed.
- State Environmental Policy Act (SEPA) review and determination. A proposed new net pen aquaculture facility also requires a SEPA threshold determination and, if necessary, a full environmental analysis to evaluate impacts and identify required mitigation.

2) **Joint Aquatic Resource Permit Application (Various Agencies).** A new finfish aquaculture facility is required to submit a Joint Aquatic Resources Permit Application (JARPA) to all agencies involved in the permit process related to the use of state or federal waters.

- This process allows for agency coordination in addressing the overall potential impacts of a development. The JARPA creates a public process, numerous agency notifications and a permit review process by state, local and federal agencies, Tribal natural resource agencies, and interested groups or citizens.

3) **U.S. Army Corps of Engineers Permit: Section 10 Rivers and Harbors Act and section 404 Clean Water Act (Various Agencies)**

- Any federal permit approval requires an Endangered Species Act (ESA) review and consultation with the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS) and tribal governments with respect to potential impacts on endangered species in the project area. Depending on the potential effects of the project on listed species, a Biological Assessment/ Biological Evaluation (BA/BE) of the proposed project must be performed by an approved consulting firm with expertise in the fisheries, aquatic biology and/or habitat conservation fields. The BA/BE analyzes the project with a specific focus on the potential impacts of the project on ESA listed species in the area. The applicable expert agency (USFWS and/or NMFS) reviews and approves the BA/BE.
- The federal *Coastal Zone Management Act* requires that all projects in the coastal zone be certified by the Department of Ecology before a federal agency such as the Corps of Engineers grants its permits. This certification ensures that federally-permitted projects are consistent with the state Coastal

Zone Management Program, which has federal approval. This applies to all shoreline activities in or affecting Washington's 15 coastal counties.

- National Environmental Policy Act (NEPA): The NEPA process consists of an evaluation of relevant environmental effects of a federal project or action undertaking, including a series of pertinent alternatives. The NEPA process begins when an agency develops a proposal to address a need to take an action. Once a determination of whether or not the proposed action is covered under NEPA there are three levels of analysis that a federal agency may undertake to comply with the law. These three levels include: preparation of a Categorical Exclusion (CE), preparation of an Environmental Assessment (EA) and Finding of No Significant Impact (FONSI); or preparation and drafting of an Environmental Impact Statement (EIS).

4) Washington Department of Fish and Wildlife (WDFW) Aquatic Farm Permit and Registration.

\$150 (from

http://wdfw.wa.gov/licensing/commercial/forms/aquatic_farm_application.pdf)

- Registration is required with WDFW for each individual aquatic farm location and the type of species being reared within the State. The registration requires annual renewal and quarterly reports on the production from the facility.

5) Aquaculture Finfish Permit (Operational Permit) (WDFW).

- WDFW has the statutory authority to approve, deny or condition the type of aquaculture finfish species being reared in a facility. WDFW considers the specific facility location, the type of species reared, the rearing methods, the potential biological risks, the best available science and the best available technology in rendering its decision.
- The permit requires the development of a facility operations plan that addresses Best Management Practices (BMP's), Best Available Technologies (BAT's), and the development of Employee Fish Escape Prevention Plans, Fish Escape Reporting Procedures, Accidental Fish Escape Rapid Recapture Plans and Regulated Finfish Pathogen Reporting Plan.

6) Fish Transport Permit (WDFW).

- WDFW is responsible for enforcing the fish health laws and disease control regulations within the State. Private finfish aquaculture facilities are subject to the same laws and regulations that state public finfish hatcheries and enhancement facilities are subject to.
- WDFW requires annual facility certification and periodic fish health screening of brood stock and smolts.

- There are regulations and requirements on the importation or interstate transport of live finfish and/or gametes. Additionally, the importation or interstate transfer of live finfish falls under federal USFWS jurisdiction, regulation and permitting.

7) National Pollutant Discharge Elimination System (NPDES) Permit. (Ecology)

- The Dept. of Ecology is responsible for issuing and regulating the NPDES Waste Discharge Permit under the authority of the federal *Clean Water Act* and Washington State equivalent. An NPDES permit is required for each individual net-pen site.
- The NPDES Permit sets limits on the allowable discharges from a finfish aquaculture operation in State waters.
- The NPDES Permit prohibits discharge of unauthorized chemicals.
- The NPDES Permit requires that a sampling plan complying with specific permit requirements be developed, including a sediment monitoring cycle to be carried out by a third party consultant. All sediment monitoring reports are submitted to Ecology and the Dept. of Natural Resources.
- Sediment monitoring of benthic impacts are carried out around a 100' perimeter from the farm sites. Impact limits are set for the organic enrichment of sediments to distinct threshold values. Mandatory mitigation and monitoring is required if sediment standards exceed the limits. Closure monitoring is required of any monitoring stations that exceeded the threshold limits until the sediments are returned to the allowable levels by mitigation.
- The NPDES Permit calls for the mandatory reporting of approved chemical use, reporting incidence of sea lice infestations, reporting of emergency disease occurrences and the reporting of accidental fish escapes.
- The NPDES Permit requires the development and use of Best Management Practices and Best Available Technology.
- The NPDES permit requires the development and use of site-specific Pollution Prevention Plans, Accidental Fish Escape Prevention Plans, Fish Escape Reporting Procedures and Accidental Fish Escape Recovery Plans in coordination with WDFW.

8) Aquatic Use Permit Application and Aquatic Lands Lease (DNR).

- The State owns most aquatic lands, including tidelands, shorelands, harbor areas and the beds of navigable waters. An Aquatic Lands Lease is required for a finfish net pen facility operating in State waters. Aquatic Lands Leases are issued and regulated by DNR.

- Aquatic Lands Leases have guidelines, rules and allowable use activities on the facility operations within the lease area. Leases are written to protect State resources, including ecological resources.
- Any vacated lease sites must have all physical improvements completely removed from them and require any contaminants be removed from them.
- Quarterly lease payments are based on a flat annual rate (regardless of production) plus an additional royalty amount based on the production from the facility.

9) U.S. Coast Guard Private Aids to Navigation (PATON) Permit.

- Floating structures permanently moored in the navigable waters of the U.S. must obtain a PATON permit to operate navigational lights. Exact locations and instructions on operating a Private Aid to Navigation are registered with the U.S. Coast Guard and checked annually.

10) Marine Mammal Protection Act/Predator Deterrence

- Non-lethal predator deterrence methods are approved by NOAA Fisheries (included in consultations with EPA and ACOE):
Each farm site has installed an external marine mammal predation barrier net that is tied to a heavy and semi-rigid pipe frame that is suspended below the fish containment nets. This system has been developed and improved upon over the past 15 years as an effective means of passive predator control for marine mammals. The pipe frame creates an underwater “weighting” grid made out of Schedule 80 steel well-casing pipes. Each 40’ piece of pipe is linked to the next using a combination of chain and polypropylene line. The steel pipe is 6” to 8” in diameter and when linked together the grid-work frame creates a support structure that keeps the barrier nets tight at all times. The side panels and the bottom panels of the nylon barrier net are “sewn” to the pipe frame below the surface and to the outer perimeter of the fish pen walkways at the surface. The frame work below the surface helps maintain the shape of the nets and creates a physical separation between the exterior barrier net and the interior fish containment nets. An above surface barrier net is also deployed around the entire perimeter of the farm. This netting material is lashed to the walkway and suspended approximately 6 feet vertically by metal poles. This “jump netting” prohibits the marine mammals from jumping up onto the cage walkways and gaining access to the fish containment nets inside of the barrier nets.

Appendix D: Regional Key-Informant Interview Guide

[Introduction and Disclosure. Describe study purposes, interview outline, and intended uses. Describe confidentiality procedures. Ask for participant to sign consent. If consent is refused thank participant and leave contact information. If consent form is signed proceed with interview.]

- Can you please describe your work or profession?
- Do you consider yourself a stakeholder in policies related to salmon aquaculture development or restriction?
- Can you describe your past or current contact or experiences related to salmon aquaculture?
- Do you seek out information or research on salmon aquaculture?
- If yes, please describe the types and sources of information (e.g. Web resources, trade journals, fellow professionals, etc.)?
 - How would you characterize regional perceptions of aquaculture among people you work with or your own perceptions?
 - Do you believe salmon aquaculture is plausible in Washington's Salish Sea region?
 - Why or why not?
 - If yes, what benefits and deficits do you perceive in developing salmon aquaculture?
- What challenges do you see for stakeholders and decision-makers? [Wrap up exercise.]

[Thank participant.]

Appendix E: EIS Student Pre-Survey

Q1. On a scale of 1 to 10, how would you describe your knowledge of fin-fish aquaculture practices and policies? (1 = low, 10 = high)

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

Q2. Are you aware of any current fin-fish aquaculture operations in the Washington Salish Sea or Puget Sound?

- Yes
- No

Q3. If yes, can you name the approximate areas in which they operate?

Q4. On a scale of 1 -10, how would you describe your perceptions of fin-fish aquaculture? (1 = Negative, 10 = Positive)

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

Q5. Do you have specific concerns regarding fin-fish aquaculture?

- Yes
- No
- Unsure

Q6. If yes, please use the space below to give some examples of these concerns (ex. water quality).

Q7. Do you perceive any benefits coming from fin-fish aquaculture?

- Yes
- No
- Unsure

Q8. If yes, please use the space below to give some examples of this benefits.

Q9. Do you believe greater awareness of aquaculture practices, science, and possible benefits would affect stakeholder perceptions positively?

- Yes
- No
- Maybe
- Unsure

Q10. Is there any other information you feel should be added or taken into consideration on this topic?

Appendix F: EIS Student Post-Survey

Q1. On a scale of 1 to 10, how would you describe your knowledge of fin-fish aquaculture practices and policies?

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

Q2. Are you aware of any current fin-fish aquaculture operations in the Washington Salish Sea or Puget Sound?

- Yes
- No

Q3. If yes, can you name the approximate areas in which they operate?

Q4. On a scale of 1 -10, how would you describe your perceptions of fin-fish aquaculture? (1 = Negative, 10 = Positive)

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

Q5. Do you have specific concerns regarding fin-fish aquaculture?

- Yes
- No
- Unsure

Q6. If yes, please use the space below to give some examples of these concerns (ex. water quality).

Q7. Do you perceive any benefits coming from fin-fish aquaculture?

- Yes
- No
- Unsure

Q8. If yes, please use the space below to give some examples of this benefits.

Q9. Do you believe greater awareness of aquaculture practices, science, and possible benefits would affect stakeholder perceptions positively?

- Yes
- No
- Maybe
- Unsure

Q10. Has your awareness of aquaculture has increased as a result of the information you have seen your EIS class?

- Yes
- No
- Unsure

Q11. On a scale of 1 to 10, how much would you say your awareness of aquaculture have changed? (1 = no change, 10 = greatly changed)

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

Q12. Do you believe your perceptions of aquaculture have changed as a result of the information you have seen your EIS class?

- Yes
- No
- Not sure

Q13. On a scale of 1 to 10, how much would you say your perceptions of aquaculture have changed? (1 = no change, 10 = greatly changed)

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

Q14. Is there any other information you feel should be added or taken into consideration on this topic?

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