

Shellfish Aquaculture in Puget Sound in Light of Washington's
Coastal Marine Spatial Planning

Kara Mia Cardinal

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David Fluharty
Daniel Huppert

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Abstract

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Kara Mia Cardinal

Chair of the Supervisory Committee:
Associate Professor David Fluharty
School of Marine and Environmental Affairs

The shellfish growing industry in the Puget Sound region of Washington State greatly depends on the health of the marine waters, and is therefore considerably invested in coastal management issues and protection of state waters. The industry has overcome many challenges throughout its existence in Washington, and is currently facing many new and even unknown challenges to growth and sustainability. The purpose of this study is to define and evaluate different tools and strategies from around the world that may be integrated into Washington's proposed coastal and marine spatial planning (CMSP) management framework. There are four main goals of this study. The first is to identify the current major barriers that face the commercial shellfish industry in Puget Sound. Through literature review, workshop attendance, and discussions with stakeholders, the barriers identified include: Regulatory and permitting process, water quality, conflicting uses and public perceptions. The second goal is to investigate,

through various international case studies, how marine policy frameworks from around the world may address these barriers. Evaluated tools include examples from case studies from the European Union, Ireland, France, Sweden, and Australia. The third goal is to explore how CMSP, which has recently been proposed as a marine management strategy for Washington State, and its objectives address these barriers to the Puget Sound shellfish industry and the important user conflicts that come into play. The final goal is to assess opportunities for improvement for how Washington's CMSP framework may integrate these new tools and practices from around the world. It is important to note that the framework used in this study can also be tailored to evaluate management strategies for many different ocean and coastal sectors and uses. Preliminary recommendations for CMSP in Washington include adapting community-based approaches for spatial management, focusing in on a shoreline, bay or watershed scope, increasing stakeholder involvement, improving communication and outreach strategies, and ensuring transparency and legitimacy through the entire implementation process.

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LIST OF ACRONYMS

ACOE:	Army Corps of Engineers
CMSP:	Coastal and Marine Spatial Planning
DNR:	Department of Natural Resources
DOH:	Department of Health (DOH)
Ecology:	Department of Ecology
ECOP:	Environmental Codes of Practice
EFH:	Essential Fish Habitat
EMS:	Environmental Management System
EP:	Environmental Policy
EPA:	Environmental Protection Agency
ESA	Endangered Species Act
FEAP:	Federation of European Aquaculture Producers
GBRMPA:	Great Barrier Reef Marine Park Authority
GIS:	Geographic Information Systems
GMA:	Growth Management Act
HAB:	Harmful Algae Bloom
ICZM:	Integrated Coastal Zone Management
MMPA:	Marine Mammal Protection Act
MRC:	Marine Resources Committees
MSFCMA:	Magnuson-Stevens Fishery Conservation and Management Act
NGO:	Non-governmental organization
NMSA:	National Marine Sanctuaries Act
NOAA:	National Oceanic and Atmospheric Administration
NWIFC:	Northwest Indian Fisheries Commission
PCSGA:	Pacific Coast Shellfish Growers Association
PSI:	Pacific Shellfish Institute
PSP:	Puget Sound Partnership

QPWS	Queensland Parks and Wildlife Service
SAF:	System Approach Framework
SBM:	Single Bay Management
SMA:	Shoreline Management Act
SMP:	Shoreline Management Programs
SOC:	State Ocean Caucus
SPICOSA	Science and Policy Integration for Coastal System Assessment
WDFW:	Washington Department of Fish and Wildlife
WSI:	Washington Shellfish Initiative

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I. Introduction

The production of seafood is fundamental to sustaining our present and future food supply. Seafood, which includes fish, such as salmon, tuna, trout, and tilapia, and shellfish, such as shrimp, crab, and oysters, has many beneficial nutrients for human beings (USDA and HHS 2010). An average citizen in the United States eats roughly 16 pounds of seafood, both fish and shellfish, per year (Lowther 2011). The latest health and nutrition studies recommend increasing our intake of seafood from the current average of 3 ½ ounces per week to about 8 ounces, with pregnant women needing up to 12 ounces per week (USDA and HHS 2010). If we continue to eat this amount of seafood, along with an increasing population, increased aquaculture production in the United States is essential to supporting the recommended increase in seafood consumption (Shumway et al. 2003).

Along with being important to our health, aquaculture also plays an important role in our national and state economies. In 2011, The United States exported about 24.6 million pounds of clams, oysters and mussels¹, which is approximately a \$90.5 million value. However, the United States imported roughly five and a half times by volume the amount of exports, bringing in 135.4 million pounds and a value of \$229.8 million. This is nearly a \$139.3 million deficit of exports to imports in shellfish (USDA 2012), signaling an evident need for increasing United States' production of shellfish aquaculture.

Table 1. Volume and value of U.S. exports of selected shellfish products in 2011 (USDA 2012)

	Volume (lbs.)	Value (\$US)
Oysters	10,369,000	27,043,000
Mussels	1,141,000	1,989,000
Clams	13,104,000	61,514,000
Total Shellfish Exports:	24,614,000	90,546,000

¹ These numbers are calculated for oysters, mussels and clams only, which are the main types of shellfish grown in Washington. These numbers exclude all shrimp and scallops.

Table 2. Volume and value of U.S. imports of selected shellfish products in 2011 (USDA 2012)

	Volume (lbs.)	Value (\$US)
Oysters	26,785,000	73,933,000
Mussels	63,813,000	91,197,000
Clams	44,789,000	64,672,000
Total Shellfish Imports:	135387000	229802000

Shellfish culture is unique compared to other types of aquaculture-reared organisms, and is often perceived as an environmentally sustainable form of aquaculture (Shumway et al. 2003). Filter feeding bivalves have the ability to clean the water, filtering out excess nutrients such as nitrogen and phosphorus, which often lead to eutrophication. Other forms of aquaculture add nutrients to the ecosystem and have been shown to contribute to eutrophication. Joyce and Satterfield (2010) argue that shellfish cultivation is “a sustainable industry with a relatively small environmental footprint that is being promoted by environmental NGOs as an economic development opportunity for rural communities”. An oyster farm of about 1 ha can compensate for the nitrogenous wastes of 40-50 coastal inhabitants (Shumway et al. 2003). Unlike other types of aquaculture, shellfish feed on naturally occurring food sources in the water, such as phytoplankton and other nutrients. In fact, cultured shellfish are one of the few forms of marine aquaculture to receive approval for ecological stewardship from the Audubon Society, Monterey Bay Aquarium’s Seafood Watch and Eco-Fish (Shumway et al. 2003).

The commercial shellfish industry of Washington State plays an important economic, ecological and cultural role in this region and nationwide. According to the Pacific Coast Shellfish Growers Association (PCSGA), 83% of the overall weight of shellfish and 85% of the revenue from shellfish farming operations harvested on the Pacific Coast of the United States (Alaska, Washington, Oregon and California), comes from Washington State (PCSGA 2011). The state is the top producer in the nation of farmed clams, oysters and mussels, with a value of over \$107 million (WSI 2011). The industry is a large provider of state jobs and revenue, as well as supporting many local fishing economies

and communities. With an estimated economic contribution of \$270 million, Washington's shellfish industry directly and indirectly employs over 3,200 people, making it the largest private employer in multiple counties around Puget Sound (WSI 2011). Shellfish culture in Washington reflects two important economic qualities: Sustainability and potential for growth. It presents an important opportunity for economic activity, and for bringing social cohesion to rural coastal areas, providing family wage jobs to these areas that are often otherwise economically depressed (Shumway et al. 2003).

The Commercial Shellfish Industry

The commercial shellfish industry of Washington greatly depends on the health of the Puget Sound and is therefore considerably invested in coastal management issues and protection of state waters. It is in the best interest of the shellfish growers to support clean water, protect marine biodiversity and guard against overstocking their farms, in order to provide the local and national community with safe, healthy and productive shellfish products.

The West Coast shellfish industry has developed an Environmental Management System (EMS), consisting of an Environmental Policy (EP) and an Environmental Code of Practice (ECOP), which were prepared by PCSGA in 2002 and is crucial to the survival and continued prosperity of the shellfish industry. These documents will work to ensure that as the industry develops, it maintains a responsible environmental record (Shumway et al. 2003). The EP states the industry's goal to "strive for environmental stewardship, responsible management, environmental excellence, regulatory compliance, waste management and sharing of resources" (PCSGA 2001).

The industry has overcome many challenges throughout its existence in Washington, and is currently facing many new and even unknown barriers to growth and sustainability. Historical and current challenges potentially include permitting issues, public perceptions, water quality, land-use conflicts, shoreline use conflicts, insufficient science in the policy process, ocean acidification, and the need to document economic

contribution the industry makes (Gleason 2008). Declining coastal water quality and conflicting use issues threaten the future of historic and new commercial shellfish aquaculture operations. These problems are being exacerbated as residential development encroaches on areas with historic shellfish aquaculture, or as shellfish aquaculture expands into new areas with existing residential development. With increasing development of the west coast, particularly in waterfront areas, these conflicts will only increase. Planning is one of the more effective ways to address such conflicts (Dewey et al. 2007).

With increasing pressure on shellfish growing areas brought about by shoreline development and competition for natural resources, shellfish farmers recognize that long-term sustainability depends on the broader overall environmental health of the estuaries in which they work, as well as cooperation with other estuary users (PCSGA 2001).

State and National Initiatives

In 2011, the National Oceanic and Atmospheric Administration (NOAA) supported the National Shellfish Initiative, making it a national goal to increase shellfish aquaculture for commercial and restoration purposes, to promote coastal economic growth and improving ecosystem health. The focus of this initiative is to: Enhance shellfish restoration and farming opportunities; encourage scientific information about the interaction of shellfish and the environment; engage in marine spatial planning to support siting of shellfish farms and restoration projects; improve coordination to facilitate timely permitting; and seek innovative financing and value for ecosystem services (NSI 2011). NOAA strives for stakeholder engagement, working with states, industry groups, environmental NGOs, scientists, and others to shape and implement this initiative.

On December 9, 2011, Governor Gregoire unveiled the Washington Shellfish Initiative (WSI), an agreement among federal and state government, tribes, and the shellfish industry to restore and expand Washington's shellfish resources to promote clean water, commerce and create family wage jobs (Ecology 2011a). The initiative has three main goals, with subsequent objectives. The first goal is to "create a public/private partnership

for shellfish aquaculture.” The objectives of this goal include implementing a federal, state and local model permitting program, continuing vital shellfish aquaculture research, implementing pilot projects, improving guidance for local shoreline master programs, and acknowledging important shellfish ecosystem services. The second goal is to “promote native shellfish restoration and recreational shellfish harvest” by restoring native shellfish populations, enhancing recreational shellfish harvest, and creating public support for shellfish initiative. Lastly, the WSI aims to “ensure clean water to protect and enhance shellfish beds” (WSI 2011). This will be achieved by directing \$4.5 million in Environmental Protection Agency (EPA) funding to protect and improve water quality to meet state standards in commercial, recreational and tribal shellfish growing areas. This money will be directed to projects that work to improve shellfish growing area protection and restoration efforts, work with boaters to address potential pollution impacts, and take steps to address ocean acidification (Ecology 2011a).

Furthermore, the Puget Sound Partnership’s (PSP) Dashboard of Vital Signs highlights shellfish beds as an indicator of Puget Sound's health, in particular as a measure for healthy human populations (PSP 2012). Currently about 36,000 acres out of the estimated 190,000 acres of classified commercial and recreational shellfish beds, approximately 19%, are closed due to pollution sources. PSP set a target for a net increase of 10,800 acres of harvestable shellfish beds, of which 7,000 acres must be from beds presently classified as prohibited, by the year 2020. Achieving this goal will provide more opportunities for commercial and recreational shellfish growing and harvesting in our region. Major sources of the pollution affecting shellfish aquaculture comes from leaking septic systems, runoff from livestock farms, and pet waste which release fecal coliform bacteria into our waters which is an established indicator of potential pollution threat to the areas where oysters, clams and other bivalve shellfish grow. PSP is promoting programs to find and fix failing on-site sewage systems, implement stronger stormwater permits, and effectively address water quality on agricultural lands. It also sponsors education campaigns, such as Puget Sound Starts Here, to educate Puget Sound residents about a number of topics related to stormwater runoff and management (PSP 2012).

These national and state initiatives and programs recognize the beneficial values of shellfish in Washington's local waters, as well as the potential for economic growth. It also brings up the pertinent questions of what are PSP and the state of Washington doing to meet these objectives, and how can other tools address and help to achieve these goals?

Comparing Tools and Frameworks

Frankic and Hershner (2001) pointed out that one of the key issues concerning aquaculture development in the United States is the availability of efficient tools for coastal zone planning. There is a lack of studies that look at how coastal zone planning, such as Integrated Coastal Zone Management (ICZM) and Coastal and Marine Spatial Planning (CMSP), can be used to facilitate and benefit aquaculture development. Many invested stakeholders involved with shellfish aquaculture in the state have expressed a concerned interest in Washington's proposal for CMSP and how it will address these challenges to the industry, as well as other coastal and marine-related user conflicts (Ecology 2011b). The commercial shellfish industry in Puget Sound is greatly concerned about how shellfish aquaculture will be defined, interpreted, and respected in Washington's CMSP proposed plan. The industry calls for more considerations for aquaculture planning, permitting and expansion within the proposal, not just for commercial harvest, but for recreational and subsistence as well (Ecology 2010).

Coastal nations around the world have been practicing aquaculture techniques for centuries, and have been dealing with many of these same issues, such as coastal use conflicts, unclear permitting and legal frameworks, water quality constraints, and public uncertainty of industry expansion. This thesis examines case studies from the European Union, Ireland, France, Sweden, and Australia, to identify some of the alternative tools used to address these present challenges to shellfish aquaculture through Marine Spatial Planning (MSP). It will then be determined if and how these tools may be integrated into the current governance framework of Washington, including CMSP, to alleviate some of the current barriers faced by the shellfish industry of Puget Sound. It is my hope that the government of Washington, with help from the shellfish growers, can learn from

practices and frameworks from around the world, in order to create a more streamlined, productive and positive process for cultivation of shellfish in Washington State. It is also important to note that this thesis strives to evaluate CMSP as a management framework from the perspective of the shellfish industry, but it can be used as a baseline to evaluate management strategies for any type of marine use.

Major Questions and Goals

Burbridge et al. (2001) highlights social and economic policy issues relevant to marine aquaculture. They pose the question of how to better integrate knowledge and skills from different disciplines to create a robust framework for assessing options for marine aquaculture development, and further, how to effectively integrate these tools into the formulation of policy, investment strategies, spatial plans and natural resources management for coastal areas. This thesis examines selected tools and policies in light of the commercial shellfish industry of Puget Sound, to determine how Washington can implement a robust and sustainable shellfish aquaculture framework.

There are four main goals of this study:

- 1) The first is to identify the current major barriers that face the commercial shellfish industry in Puget Sound.
- 2) Once these barriers have been identified, I ask the questions of how marine policy frameworks from around the world have addressed similar barriers, and what has been successful?
- 3) I will then evaluate Washington's proposed CMSP framework, to ask how does the CMSP framework and its objectives address the barriers to the Puget Sound shellfish industry and the important user conflicts that come into play?
- 4) Finally, I present an assessment of opportunities for improvement for the ways we integrate these tools and practices from around the world into Washington's CMSP framework.

Framework for Evaluation

The fundamental purpose of this thesis is to identify tools and techniques that would potentially benefit the management of the shellfish industry, and the overall process of CMSP in Washington. First, I set the historical context of shellfish harvest in Washington State, depicting the importance of the original harvest by Native Americans and the development of the cultivated industry since the mid-1890s. Next, I identify four of the key barriers that have shown to hinder growth, expansion and management of the shellfish industry in Puget Sound. A barrier is defined as something that restricts the ability for new or existing shellfish growers to efficiently develop and grow their tideland farms and economic productivity (Gunderson et al.1995). Gleason (2008) identifies historical challenges and is used here as a stepping stone to discover current barriers. A literature search is conducted to determine the four current key barriers defined in this document. The findings of this literature review are confirmed through communication with industry representatives, and observations from attendance at local shellfish growers' conferences and meetings.²

Next, I conducted a review of alternative coastal and shellfish management tools and strategies that have been used successfully in other countries around the world. The cases for review were selected for their spatial management qualities and for their recognition of shellfish aquaculture as a key use of the marine waters. This review classifies tools and strategies used, key players involved, geographic scope, and the process used in each case. The outcome of this research will ideally form the basis for how successful policies and practices may be integrated into Washington's CMSP framework to better manage our shellfish aquaculture industry, as well as other marine resources and uses.

² These meetings include the 19th Conference for Shellfish Growers, held in Union, WA on March 5-6, 2012; 2012 Penn Cove Mussel Festival field tour; 2012 Sound Waters, hosted by Island County Beach Watchers, presentation by Penn Cove Mussels.

II. Historical Narrative

The roots of shellfish harvest in Washington can be traced back many centuries. Shellfish was a main source of protein in the diet of native coastal tribes throughout Washington. The commercial shellfish industry is greatly intertwined throughout the history of our state and plays a critical role in the future of our culture and economy.

The state of Washington was one of the few states to sell off tidelands for private ownership. This has led to great user conflicts between private tideland owners and the Coastal Treaty Tribes, who were granted access to these marine resources. Fishing treaty issues were addressed in the Boldt trials, although shellfish legislation was postponed to a later date. Judge Rafeedie was assigned to this case in 1994 and ruled that tribes had reserved harvest rights to half of all shellfish from all of the usual and accustomed places. This meant that tribes had the right to half of the shellfish resources, even on privately owned land. This led to many more years of conflict, especially since buyers of these tidelands were not told about the tribal access rights at the time of purchase (Anderson 1999). It wasn't until 2007 that commercial shellfish growers and the tribes sat down together at the same table to cooperatively discuss a beneficial solution.

Native Shellfish Harvest

Shellfish have played an important ceremonial, subsistence, as well as commercial role in the diet and culture of western Washington Indian tribes for thousands of years. Clams, crabs, oysters, shrimp, and many other species were harvested year-round in tribal fisheries. Evidence of abundant native shellfish harvest has been found all throughout the coast in remains of large deposits of shells, known as tribal "kitchens". Shellfish harvest plays, and still does, a central role in tribal gatherings and daily nutrition, including weddings and funerals, as well as everyday subsistence. In fact, an old Salish saying says that "When the tide is out, the table is set" (S'Klallam Tribe 2011).

As settlers moved into the Puget Sound and as tidelands continued to be purchased by non-Indians, tribes slowly became excluded from their traditional shellfish harvest areas.

No-trespassing signs even started appearing, specifically targeting Native American shellfish harvesters (Anderson 1999).

This was very upsetting to the native tribes, since it had already been established that they held the rights to resources harvested within their usual and accustomed fishing grounds. This right was first granted in 1855 through the Treaty of Point No Point. Language pertaining to tribal shellfish harvesting is as follows:

“The right of taking fish at usual and accustomed grounds and stations is further secured to said Indians, in common with all citizens of the United States; and of erecting temporary houses for the purposes of curing; together with the privilege of hunting and gathering roots and berries on open and unclaimed lands. Provided, however, that they *shall not take shellfish from any beds staked or cultivated by citizens.*”

- Treaty of Point No Point, Jan. 26, 1855

As pressure on local fish stocks, such as the wild salmon runs, has led to decreased abundance over the last century, native tribes have increasingly relied on shellfish as part of their commercial income. Commercial shellfish harvesting provides income for the tribes, which are used to help pay for tribal natural resources programs (NWIFC 2011).

Bush and Callow Acts

In order to encourage and assist the growth of the oyster industry, the state of Washington sold many of its tidelands to private landowners under the Bush and Callow acts. The Callow Act, passed in 1891 by the state legislature, acknowledged the importance of the oyster industry to the state economy and allowed oyster growers to purchase the lands they were farming. The law stated that if the lands were used for any purpose other than oyster cultivation, or if they ceased to establish artificial oyster beds, then all sale deeds would be canceled and the land would be reverted back to the state. The Bush Act of 1895 allowed for anyone to purchase lands not already being used for oyster production,

as long as they proceeded to use the land for farming oysters and other shellfish. However, the law did not require the owner to actively engage in oyster harvest in order to maintain the title, as long as the lands remained in their original state and were not used for anything else other than shellfish harvest. (RCW 79.135.010 Bush act/Callow act lands).

Tideland Owners

When the original settlers purchased their tidelands, they were unaware of the tribal rights granted by previous treaty agreements. Their land titles made no such mention of any outstanding claims of access rights to their property by any party, and no claims had ever been declared until tribes filed their lawsuits. Once these third-party rights became recognized, many tideland owners and shoreside residents became very angry and felt that they had been misled over the years. Some tideland owners have even attempted to remove shellfish from their beaches to avoid tribal harvesting (Anderson 1999). The district court eventually did recognize that tideland owners were "innocent purchasers" with respect to tribal shellfish rights affecting their property. However, tension and disagreement over property rights still remains.

Commercial Shellfish Growers

Commercial shellfish growers share a majority of the same issues as tideland owners, although tribal harvesting may have further impacts on the grower's livelihoods. Tribal harvesting may potentially deplete their shellfish beds and their profits. Because growers depend on these shellfish beds as a main source of income, any tribal take may make it increasingly difficult for them to support and maintain their business practices (Anderson 1999).

Boldt Decision

In an attempt to end years of conflict between native tribes and the State of Washington, the Boldt Decision established equal fishing rights between the Washington state commercial fishermen and the treaty tribes (*United States v. Washington*, 384 F. Supp.

312). The tribes had been excluded from traditional fishing grounds by property owners, previous state court decisions, and state regulations. In 1974, Judge George Hugo Boldt of the United States District Court for the Western District of Washington ruled that the tribes are entitled to 50% of each anadromous run of fish that passes through their usual and accustomed fishing areas. Judge Boldt defined anadromous fish, which includes salmon, as "any fish which spawns or is artificially produced in freshwater, reaches mature size while rearing in saltwater and returns to freshwater to reproduce" (*United States v. Washington*, 384 F. Supp. 312). Although this trial made significant progress for tribal treaty rights, the Boldt Decision never mentioned if shellfish were included in this decision or how they should be allocated. However, this decision was very beneficial in establishing the approach for allocating fishing resources among Indians and non-Indians, as well as further defining the locations of the usual and accustomed fishing areas, which was a critical context in the shellfish debate (Combs 1999).

1994 Rafeedie Trial Context

Inheriting jurisdiction from the Boldt trial, Federal District Court Judge Edward Rafeedie was in charge of establishing shellfish allocations between the treaty tribes and the State of Washington. Issues of interpretation and definition remained, including 1) determining if shellfish are to be considered a fish, using the terminology from the Boldt Decision; 2) the debate over shellfish as a stationary resources versus migratory fish as defined in the Boldt Decision; and 3) Interpretation of Shellfish Proviso (Anderson 1999). After hearing testimony from tribal elders, biologists, historians, treaty experts, as well as testimony from private property owners and non-Indian commercial shellfish growers, Judge Rafeedie made his ruling on December 20, 1994. Following in the footsteps of the Boldt Decision, Judge Rafeedie determined that words "in common", used in preceding treaties, meant that the tribes had reserved harvest rights to half of all shellfish from all of the usual and accustomed grounds, except those places "staked or cultivated" by citizens.

In 2007, Puget Sound commercial shellfish growers and 17 Treaty Indian Tribes in western Washington reached an agreement that would hopefully resolve these legal

battles. Rather than turning to the courts, they worked together to determine the amount of monetary loss to the tribes if they were to forgo their access rights. This amount was determined to be \$2 million per year. In order to reach this amount, \$33 million would be put in a trust and the tribes be granted the interest. This money came from both the federal government (\$22 million) and the state (\$11 million), because it was determined by the courts that they were at fault for not notifying the tideland owners of these treaty rights before purchase. The commercial shellfish industry will also provide the tribes with \$500,000 over ten years for shellfish enhancement on public tidelands to which they have access to. This agreement would protect commercial shellfish industries from having to give away 50% of their harvest each year (NWIFC 2011).

III. Identification of Barriers

The idea of overcoming barriers stems from a book on adaptive environmental management by Hollings et al. (1995), which looks at a series of case studies in order to determine possible strategies for transcending barriers and renewing damaged ecosystems. A paper by Gleason (2008) identifies historical challenges to the industry, as well as distinguishes remaining and potential developing barriers. This thesis uses the findings of this paper as a baseline and will attempt to “move forward” from where this paper has left off. Gleason (2008) interviewed representatives from the shellfish industry, asking them to identify the major challenges *historically* faced by the aquaculture industry as a whole. Responses included difficulties relating to permitting for new and existing sites, land-use policies and practices, water quality, lack of viable hatcheries and access to genetically diverse brood-stock, and public perceptions and consumer acceptance of their products. Gleason then asked the representatives why they felt that many of these issues still remain as challenges to the industry. The respondents cited “a lack of resources and lobbying power, conflicts over population growth and uses of land and water, and the fact that the industry has been very reactive rather than proactive when it comes to dealing with issues” (Gleason 2008).

The identification of barriers has been a very prominent topic to industry members and researchers alike. The Pacific Shellfish Institute (PSI) is working on investigating barriers to entry for shellfish aquaculture, including determining the legal, environmental, and socio-economic obstacles (PSI 2012). From the perspective of the growers, “Expansion of shellfish aquaculture, or even maintaining historic operations in the U.S., faces numerous challenges including use conflicts and environmental impacts associated with urbanizing shorelines, permit issues, litigation and lack of comprehensive shoreline planning to protect existing and future shellfish aquaculture opportunities” (Dewey et al. 2007).

With coastal populations on the rise, shellfish growing areas are threatened with degrading water quality from failing on-site sewage systems, storm water runoff, domestic animal waste, and increased recreational use without adequate facilities. Commercial dairy and livestock are frequent sources of pollution to shellfish growing waters (PCSGA 2011). As a result, downgrades in growing area classification have been a matter of course for shellfish growers. Impacts from failing septic systems, increased storm water runoff, hobby and commercial farm runoff are taking their toll. While there has been a recent reversal in the trend, 25% of the commercial shellfish growing areas classified as approved for direct shellfish harvest in Washington State experienced downgrades between 1985 and 2002 (Dewey et al. 2007).

As shellfish aquaculture faces more regulatory scrutiny, both nationally and within our state (brought on by the increase of geoduck farming and its potential to trigger the many environmental statutes, such as Endangered Species Act (ESA) and the Shoreline Management Act (SMA)), there exists the possibility that growers, especially smaller operations, will find it an economic difficulty to remain in business (PCSGA 2007). In addition, many researchers, tribal biologists, and government agency personnel, as well as the general public, have not been completely informed about the many positive effects of shellfish culturing on the marine ecosystem. The recognition that shellfish culture may be good for the environment needs to be expanded. As local, regional and state governments have developed coastal zone management plans in Puget Sound there has

often been limited support for aquaculture development. Competing user groups and waterfront homeowners dominate planning processes or aquaculture siting hearings and frequently prevail (PSCGA 2011).

This thesis asks the question of what are the current barriers that the commercial shellfish industry is facing in Puget Sound. Through literature review, expert panel, meetings, workshops, and press releases, I have attempted to identify the specific challenges for continuing and/or expanding shellfish aquaculture operations and investigate and summarize barriers to entry for shellfish aquaculture in Washington. I have selected four key barriers that the commercial shellfish industry is currently facing within Puget Sound. The key barriers that I have identified are: Regulations and the permitting process; water quality; conflicting uses; and negative public perceptions. Each of these will be further discussed below.

1. Regulations and the permitting process

In order to commercially cultivate and harvest shellfish on private lands, a grower first needs to acquire a shellfish operation license and harvest site certificate from the Department of Health (DOH). They must also register each parcel of land with the Washington Department of Fish and Wildlife (WDFW) as an aquatic farm. A shellfish Operation License and Certificate of Approval can cost between \$263 and \$2,399 and can take from one week to one year to process, depending on the type of operation. These permits must also be renewed annually (ORA 2012). A grower must also apply for a Harvest Site Certificate, which lists all the sites that are approved for your company to harvest. There are three main categories of commercial shellfish licenses issued in Washington. The Harvesters License is for growers who harvest shellstock (live, unshucked product) and sell only to other licensed Washington state shellfish dealers. The Shellstock Shippers License allows growers to grow and harvest shellstock, and buy and sell in or outside Washington. Companies listed as Wholesale Only must have a Shellstock Shipper license. The Shucker-Packer License allows growers to both grow and harvest shellstock, buy and sell in or outside Washington, and shuck product for

packing in jars or similar containers. Commercial shellfish companies are licensed for a period of one year, and licenses must be renewed annually. All companies are regularly inspected and must meet stringent state and federal sanitation standards (DOH 2012).

Before a new farm site is established, affected treaty tribes must be notified. Section 6.3 of the federal court's Revised Shellfish Implementation Plan requires that someone who wants to create an artificial bed of shellfish or to enhance a natural bed of shellfish must first notify the affected treaty Indian tribe(s) at least 60 days beforehand. A grower must work cooperatively with the tribes to resolve treaty right questions, and a harvest plan must be developed if it is determined that natural shellfish is present on the tideland. Tribes have a right to harvest the naturally occurring shellfish, but not to the shellfish that are a product of cultivation.

In order to sell harvested shellfish, a DOH approved tag must be acquired and the harvest must be reported to WDFW. For cultivated shellfish, sales must be reported on a quarterly basis, using an aquaculture production report provided by WDFW. Any shellfish that becomes available for human consumption must be attached with a DOH approved tag containing all of the required information before removing the shellfish from the harvest site, and any shellfish for export must be packed in approved containers using approved markings.

At the federal level, the U.S. Army Corps of Engineers (ACOE) is responsible for issuing permits for shellfish farms under section 404 of the Clean Water Act and under Section 10 of the federal Rivers and Harbors Act (PCSGA 2007). Application for this permit can bring up restrictions and consultations with NOAA under the Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCA), as well as the Endangered Species Act (ESA). The Marine Mammal Protection Act (MMPA), and the National Marine Sanctuaries Act (NMSA) can also come into play (Dewey et al. 2007).

Recently, the ACOE has been working with shellfish farmers to reduce the complexity of the federal permitting process, and improve clarity, consistency and efficiency for the

national permitting of shellfish aquaculture, yet still maintain the environmental responsibilities of the ACOE. They will be developing a Nationwide Permit, Regional General Permits, and potentially, Individual Permits (PCSGA 2007). Effective on March 19, 2007, the ACOE introduced a new Nationwide Permit 48, which will be in effect 5 years until the new Nationwide Permit cycle in 2012. This will allow the ACOE to collect and review information on shellfish aquaculture activities and consider necessary modifications and improvements to the permit (Dewey et al. 2007).

As part of the West Coast shellfish industry Environmental Policy (EP) statement, “The shellfish industry is committed to ensuring these laws and regulations are environmentally effective, based on sound science and do not place an unreasonable financial burden on growers or regulators” (PCSGA 2001). All growers who are members of the PCSGA are aware and knowledgeable of the laws and regulations in their regions and committed to meeting and, where practical, exceeding compliance.

Regulatory obstacles and the permitting process have been identified as current barriers to the shellfish industry, including regulatory hurdles at the federal, state and local levels, costs of permits, time constraints and overall frustration and confusion with the process. A paper by Gleason (2008) identifies permitting of new and existing sites a significant challenge to Washington State shellfish growers. Multiple interviewees expressed that both the state and federal permitting process for new sites was a continuous challenge, and that policy-makers lacked the knowledge about economic contributions the industry brings to the state (Gleason 2008).

A conference proceedings report on the national trends in shellfish aquaculture from the 2007 Coastal Zone Conference in Portland, Oregon states that “Federal regulation of shellfish aquaculture, despite national policies to the contrary, until recently has been inconsistent and in some cases overly burdensome and expensive” (Dewey et al. 2007). In fact, Washington based Taylor Shellfish Company, one of the oldest and largest producers of farmed shellfish in the country, has recently begun expanding operations into Canada. “Taylor has purchased five farms and a processing plant, for a total

Canadian employment of approximately 100 people. These acquisitions were necessary to meet growing market demand for shellfish products" (Dewey et al. 2007).

In 2011, the PCSGA put out a document entitled "West Coast Shellfish Research and Information Needs and Priorities" (PCSGA 2011). Objective 11.5 states that it is a priority to "Maintain and enhance cooperative relationships between industry and regulatory agencies, ensure regulations reflect best available science and that growers understand and implement appropriate conservation measures." The rationale for this goal suggests that many regulatory measures, including the ESA, have resulted in uncertain futures for shellfish farmers. An emerging issue in Washington fisheries management is the potential expansion of commercial geoduck aquaculture along the coasts and tidelands of Puget Sound. This is an important economic opportunity for the commercial shellfish industries, as well as the state economy as whole. However, there is a potential overlap in the areas where geoduck farming would occur and the EFH for wild salmon, which triggers the MSFCMA, as well as the ESA for listed Chinook salmon.

Washington growers are encouraged by the many recent developments in federal and state governments that are aimed at addressing these regulatory constraints, including the National and Washington Shellfish Initiatives, as well as the ACOE improvements. However, these will need to "yield expeditious results if shellfish farming is to remain a viable economic force in rural economies on the west coast" (Dewey et al. 2007).

2. Water Quality

The Washington Shellfish Initiative (WSI) recognizes the fact that "shellfish aquaculture and commercial and tribal harvest of wild shellfish resources are water-dependent uses that rely on excellent water quality." Because of their ability to filter and improve the water quality, the WSI views shellfish as part of the solution to restoring Puget Sound's water quality. "We can have healthy marine waters and productive shellfish beds for a growing industry, Native American tribes and for all the citizens of Washington" (WSI 2011).

However, poor water quality conditions throughout Puget Sound's bays and estuaries poses a major threat to the health and safety of consumption of local shellfish resources. Shellfish are often called the “canaries in the coal mine” for the sea (King and McNeal 2010). Bivalve shellfish filter the seawater, along with all of the phytoplankton, nutrients, bacteria, viruses and other environmental contaminants that may be found in it. These particles accumulate in the tissues of the shellfish, which in turn are ingested for human consumption. Marine water quality standards are more stringent for areas harboring shellfish beds, than for other uses such as swimming beaches. Basically, shellfish harvested in clean water are safe to eat, while shellfish harvested in dirty water are not (King and McNeal 2010).

A major conflict of concern lies between the shellfish farms and the upland uses, particularly cattle/dairy farming, hobby farms, and landowner septic systems. Fecal coliform, bacteria found in the wastes of warm-blooded organisms, can leak into a river system and contaminate the shellfish beds downstream. Shellfish farms have experienced increasing amounts of closure by the DOH because the waters upland of commercial shellfish beds have continuously exceed the State Water Quality Standard of 100 cfu/100mL of water, potentially rendering the shellfish unsafe for consumption (Ecology 2010b). It is critical to address these user conflicts in order to avoid unnecessary economic losses to the commercial shellfish industry.

A prime example of the economic losses posed by poor water quality conditions can be seen in Drayton Harbor in Whatcom County. Drayton Harbor possesses ideal conditions for growing shellfish, once home to a 100 acre shellfish farm run by a Canadian grower, as well as the Lummi Tribal harvest. An estimated value of the commercial harvest ranges from one and two million dollars annually, while the tribal clam harvest is estimated to be approximately \$50,000 annually. In 1988 the harbor was rated a priority for non-point pollution, with inputs from livestock waste from noncommercial agriculture, on-site sewage systems (septic systems), boats and marinas, and the Blaine sanitary sewer system. By 1995, the majority of the harbor was classified as prohibited to shellfish harvesting. Currently, the community has been taking great strides to

improve water quality and reopening a commercially viable shellfish farm, but it is taking millions of dollars worth of community, state, and federal money to make it happen (Burke and Menzies 2010).

Section 3 of the WSI seeks to “ensure clean water to protect and enhance shellfish beds.” The plan is to direct \$4.5 million in EPA funding to “protect and improve water quality to meet state standards in commercial, recreational and tribal shellfish growing areas.” These funds will be used to help reach the Puget Sound Partnership’s shellfish indicator target of upgrading 10,800 acres of harvestable shellfish beds by 2020 (discussed earlier). Managed by both the Washington DOH and the Department of Ecology (Ecology), more than \$2 million will go to local government programs designed to identify and address pathogen and nutrient pollution from a variety of nonpoint sources (pollution identification and correction programs). More than \$1 million will be allocated to county health departments to carry out onsite sewage system management plans. Finally, \$1.5 million will be set aside to fund agricultural best management practices. Other strategies include addressing storm water and wastewater treatment outfalls.

A second objective under Section 3 of the WSI is to “improve shellfish growing area protection and restoration efforts.” This entails forming a “pollution action team” consisting of the EPA, DOH, Ecology and the Washington State Department of Agriculture, which would provide immediate response to water quality problems that threaten shellfish areas, as well as provide pollution identification, inspections, enforcement, flyovers and technical assistance for pollution protection and restoration (WSI 2011).

3. Conflicting Use

With growing populations and increased shoreline development occurring in many coastal and water-dependent communities throughout Washington and the whole West Coast, the challenges of conflicting coastal uses will ever-increasingly come into play. Our shorelines provide space for parks and recreation, residential living, economic and industrial endeavors, as well as pure conservation value. As a valuable and potentially

growing industry, it is critical for shellfish aquaculture to find its niche within this coastal space. Shellfish growers in Puget Sound are very aware of these use issues, and strive to create and maintain positive relationships with other shoreline users through “cooperative and educational efforts and by acknowledging and responding to community concerns” (PCSGA 2001). They also are actively involved in local shoreline, watershed and growth management planning, such as the Shellfish Aquaculture Regulatory Committee (Shellfish Aquaculture Regulatory Committee 2012).

WSI recognizes the need to include shellfish aquaculture in the planning of coastal uses, with aims to improve guidance for local Shoreline Management Programs (SMP). This would include an Ecology published SMP handbook section about geoduck aquaculture, updating aquaculture web resources, and providing technical assistance and training for local governments (WSI 2011). This would include regulatory and technical assistance to protect against habitat impacts and planning to minimize conflicts with adjoining shoreline owners and other marine water users (WSI 2011).

However, in the current state, conflicting use issues may threaten the future of historic and new commercial shellfish aquaculture operations (Dewey et al. 2007). One key conflicting use is increased residential development in areas of historic cultivated shellfish beds, as well as new aquaculture expansion into areas with existing residential homes (Dewey et al. 2007). Dewey et al. (2007) suggest particular planning tools unique to Washington that may be effective in addressing these conflicts. These include: Washington's Shoreline Management Act (SMA), which prioritizes different shoreline uses; state or local zoning laws, which have been applied in upland uses, but can also be used to address these issues in coastal areas; and the Coastal Zone Management Act Section 309, which provides grants to states for adoption of procedures and policies to evaluate and facilitate siting of aquaculture facilities in the coastal zone.

The issue of conflicting coastal uses brings up the concept of public and private ownership of the shorelines and tidelands, which is a particularly unique issue to Washington. As stated earlier, many tidelands are privately owned through the Bush and

Callow Acts. These tidelands can be used for the sole purpose of shellfish harvest, yet still allow for public access (Anderson 1999). Other land can be leased for shellfish farming through the Washington State Department of Natural Resources (DNR) aquatic leasing program (DNR 2012). The issue of public/private use and public right of access stirs up new emotions in the debate over conflicting uses. Joyce and Satterfield (2010) observe that only a small part of the aquaculture literature addresses the issues of property rights in marine governance in regards to aquaculture leasing policies that have led to conflicts over coastal space with competing uses shoreline habitat, or with tribal treaty rights. They go on to suggest that “there is a need for further research on benthic and marine zoning policies to understand how property rights are allocated in the marine environment, as well as to recognize the potential implications of this allocation process on resource users in coastal communities” (p.120).

Objective 11.4 in the PCSGA's West Coast Shellfish Research and Information Needs and Priorities states the need to foster a positive regulatory and social environment which supports environmentally sound shellfish culture (PCSGA 2011). PCSGA (2011) highlights the lack of support for aquaculture development in local, regional and state coastal zone management plans.

4. Public Perceptions

A difficult barrier to overcome is the lack of community understanding of shellfish culture and the public perception of the industry or practice itself. Both the general and informed public may have concerns about the environmental impacts of the shellfish growing and harvesting practices on marine organisms and ecosystems. There may also be concerns about the overall sustainability of the industry. The overall uncertainty of the impacts of shellfish farming to our natural ecosystem and the lack of clarity in the regulations concerning shellfish aquaculture contribute largely to the current public perceptions and community understanding.

As mentioned earlier, an issue that opponents to shellfish aquaculture in Washington are raising is the potential impacts of shellfish farming on the wild salmon nearshore habitat,

particularly the Chinook (or King) salmon. The Pacific Coast Salmon Plan suggests that various methods of shellfish aquaculture and harvest may have adverse impacts to the essential fish habitat for salmon, including dredging of eelgrass beds, habitat alteration through raft and line culture, and the use of chemicals to control unwanted predators. These actions may also alter water quality, modify the physical habitat, and create impediments to passage, as well as create more competition for salmon's food and habitat (Coon 2003).

Many environmental groups in Puget Sound are actively emphasizing the possibility that shellfish aquaculture may not be in compliance with current federal fisheries regulations³. The Case Inlet Shoreline Association claims that shellfish aquaculture (mainly geoduck) damages nearshore salmon habitat, as well as permanently displaces eelgrass beds and sand dollar habitat (Case Inlet Shoreline Association 2011). The South Puget Sound Salmon Recovery Group identified shellfish aquaculture as one of their twelve major human-induced stressors on natural processes specific to South Puget Sound (South Puget Sound Salmon Recovery Group 2005).

Another concern about the potential growth of the shellfish industry is the displacement of wild and naturally occurring shellfish. In a study by Joyce and Satterfield (2010), local perceptions of shellfish aquaculture production in British Columbia included “beliefs about losing control of foreshore and nearshore areas currently available for wild harvest, and the concomitant losses of culture, way of life, and livelihood for future generations.” Another concern from the perspective of wild harvesters was that shellfish aquaculture was converting formerly wild, open-access clam harvesting sites to private farm sites.

Expansion of the industry, along with uncertain environmental impacts and increasing residential development along the shorelines where aquaculture occurs, have pushed the

³ Particularly the Magnuson-Stevens Fishery Conservation Management Act of 2007 (MSA). 2007. P.L. 94-265. U.S. Department of Commerce, NOAA, NMFS.

industry more into the public eye. Many environmental concerns arise, as well as complaints related to marine debris, noise, and aesthetics (Dewey et al 2007).

IV. Review of Alternative Tools and Strategies

Coastal nations around the world have been practicing aquaculture techniques for centuries, and have been dealing with many of the same issues, such as coastal use conflicts, unclear permitting and legal frameworks, water quality constraints, and public uncertainty of industry expansion. This review of alternative tools is based upon the understanding that countries can learn from one another to draw lessons about which policies work best to reach particular goals. This study focuses on industrialized countries that have in-depth experience in shellfish aquaculture practices, so that the lessons learned will have the greatest relevance for Washington's longstanding shellfish industry (Blake and Adolino 2010).

This thesis reviews six cases from around the world, focusing in on a country or region with specific tools for coastal and shellfish management. These cases include: The European Union's COEXIST project; the CLAMS model in Ireland; Australia's Great Barrier Reef Marine Park Zoning Plan; The application of the SPICOSA model in France; Aquamedia, launched by the Federation of European Aquaculture Producers; and the nutrient trading model demonstrated in Sweden. The following review presents an overview of each program or project, describing the key players involved, geographic scope, the design process, and the tools and strategies used in each case. In some cases, the management framework was developed by large agencies, while in other scenarios, a more adaptive and cooperative planning approach was taken. Some cases are very country or region specific, while others involve multinational participants. Once each case is presented, it is evaluated for how and what barrier it may potentially and successfully address.

COEXIST

COEXIST is a broad, multidisciplinary project, bringing together thirteen partners from ten European countries, that will evaluate competing activities and interactions throughout the European coastline (COEXIST 2012). This project brings together a diverse group of stakeholders from various sectors, particularly fisheries, aquaculture, tourism, wind farm operation, and nature conservation in marine protected areas. The goal of this project is to “provide a framework to assist with the resolution of the existing and future conflicts related to interactions between aquaculture, fisheries and other sectors” (COEXIST 2012).

The key players and geographic scope are very broad and diverse. The project is coordinated by the Norwegian Institute of Marine Research, with funding from the European Commission Seventh Framework Programme. Each country (Norway, Finland, Denmark, Germany, the Netherlands, U.K., Ireland, France, Portugal, and Italy) has stakeholder representation. Out of these stakeholders, a General Assembly was created as the main decision-making body, along with a Coordinator who acts as the intermediary to the European Commission, and a Management Support Team who assist the General Assembly and Coordinator (COEXIST 2012).

COEXIST set out specifically to be a “collaborative project,” forming partnerships to provide ecosystem modeling tools to support decision makers on maritime space management choices. The foundations of COEXIST are based on predesignated “work packages” that are carried out through six case study areas. The case studies covered include: Hardangerfjord; Atlantic coast; Algarve Coast; Adriatic Sea Coast; Coastal North Sea; and the Baltic Sea. For each case study, they begin by identifying the baseline interactions, conflicts, and management tools present (Work Package 1). Next, they review and document the current legal, institutional and policy frameworks, and the current governance regimes applicable to the management of fisheries and aquaculture (Work Package 2). The integration of models and processes (Work Package 3) will produce a selection of models that will map interactions between aquaculture, fisheries

and other marine resource uses, based on spatial and temporal overlap of activities. Finally, an evaluation of spatial management will take place (Work Package 4), which will assess the existing spatial management for each selected case study and propose improvements (COEXIST 2012).

Evaluation criteria for implementation of a spatial management framework are defined by Work Package 4. These include: Existence of a functioning coordinating mechanism (task force), stakeholder participation, NGO and community-based activities, availability of human, technical and financial resources, existence and presence of scientific research, educational and training curricula, enabling legislation, conflict resolution mechanism, and a shared vision, prioritization of goals and objectives, and course of action. These criteria are all deemed necessary by Work Package 4 for successful implementation of a spatial management plan (COEXIST 2012). There are many more work packages within this project, but these four pertain the most to this study.

Matrices of interactions

The first tool identified and used in these case studies is the *matrices of interactions*. This tool highlights stakeholder issues and interactions, outlining conflicting relationships between sectors, as well as considers mutually beneficial relationships that exist between stakeholders (Bolman et al. 2011). A conflict refers to “a situation where interaction(s) between a single activity or multiple activities caused concern amongst the actors involved resulting in, for example, competition for space or poor relations.” A beneficial relationship refers to something that “improves or is promoted in relation to the activity concerned” (O’Donnell 2011). Each stakeholder is asked to specifically identify both conflicts and benefits that may occur between sectors in their area.

In the Adriatic model, this multidisciplinary approach analyzes the ecological/biological, spatial, legal, social, economic and nature conservation aspects of the area. Specific attention is given to the interactions between coastal fisheries, aquaculture and other sectors and resource users (Fabi 2012). This model attempts to identify conflicts, while at the same time highlight areas of mutual opportunities (Figure 1).

	Set gears (gillnets, traps, pots)	Hydraulic dredges for baby clam	Trawling	Mussel harvesting on wild banks	Recreational fishery	Tourism	Artificial Reefs
Intensive mussel culture	Conflict for space	Conflict for space	No conflict	Economic conflicts	No conflict	Positive economic interaction	Possible integration and diversification
	Set gears (gillnets, traps, pots)	Conflict for space and resources	Conflict for space and resources	No conflict	Conflict for space and resources	Positive economic interaction/ Development opportunities	Development opportunities
		Hydraulic dredges for baby clam	No conflict	No conflict	Conflict for space	Positive economic interaction	Conflict for space
			Trawling	No conflict	No conflict	Positive economic interaction	Protection against illegal trawling
				Mussel harvesting on wild banks	Conflict for resource	Positive economic interaction	Development opportunities
					Recreational fishery	Development opportunities	Development opportunities
						Tourism	Diving opportunities

Level of interaction/conflict: = Low = Medium = High

Figure 1. Matrices of Interaction. Synthesis of major interactions/conflicts between aquaculture and fisheries (Fabi 2012).

Results from the Hardangerfjord case study showed that aquaculture was cited by 67% of the respondents as being the activity that causes most conflict in this particular area. Reasons for conflict mostly involved spatial disputes. Beneficial relationships were also identified in the form of sector synergies and the results of research being used by a number of sectors. In the German sector of the Coastal North Sea case study, another beneficial relationship was identified between tourism and fisheries and/or aquaculture, with the potential to create local brands and tourist products (O'Donnell 2011).

Site selection plan

Another tool identified through this project is the creation of a *site selection plan*. In the Baltic Sea case study, Finland established a national aquaculture development program with a goal of promoting sustainable aquaculture development throughout the country.

This plan uses a system of permits and designates suitable areas for aquaculture (Mäkinen 2012). Also within Finland, a site selection plan was created to reserve the most suitable sites for aquaculture throughout different regions. The implementation of this plan is conducted by site selection, marking, capacity modeling and environmental impact assessments (Finland Environment Centre 2010).

An assessment of the base line conditions of all the case studies, laid out in Work Package 1, observed that “Only in a few case study areas have spatial management measures that relate directly to the stimulation or development of certain activities been found, such as offshore wind farms and aquaculture.” In the cases that did have these site selection measures already in place, “such activities are further developed in comparison to other areas where these measures are not in place” and a boost of these activities have occurred (Pastoors 2012).

Barriers Addressed: Regulation and permitting process, User Conflicts

The site selection plan used by COEXIST has the potential to anticipate the regulatory and permitting hurdles caused by determining which areas are suitable for growing and harvesting shellfish. Predetermined areas set aside for aquaculture development, which has already been tested for water quality and resolved user conflicts, would streamline the permitting process and encourage cooperative development.

Matrices of interaction essentially provide a chart of where user conflicts occur, depicting which interactions and sectors are causing the conflicting relationships. This can be an extremely useful tool to first identify all the existing and potential uses of a coastal area. Next, it can be determined which uses are in conflict, which have neutral interactions, and which have mutually occurring needs and opportunities. Following this groundwork, a site selection plan can be easily generated to reflect where aquaculture development is best situated and what uses would lead to beneficial relationships.

CLAMS

Under the European Union's recommendations, each member state is asked to develop national guidelines for Integrated Coastal Zone Management (ICZM) which includes all coastal stakeholders. Rooted in the principles of ICZM, a process known as Co-ordinated Local Aquaculture Management Systems (CLAMS) was introduced in 1998 to the coastal communities of Ireland. CLAMS is a “nationwide initiative to manage the development of aquaculture in bays and inshore waters throughout Ireland at a local level” (BIM 1998).

Shellfish farming is practiced throughout almost all coastal counties of Ireland, predominantly rope mussels, bottom mussels, Pacific oysters, native oysters, clams and scallops. Because of the extensive amount of aquaculture development in Ireland, there was a growing need to establish a plan to promote sustainable and environmentally sound aquaculture practices.

While keeping the national EU policies in mind, CLAMS is a very locally-based and community driven process. Key players, including the Ireland Department of Communications, Marine and Natural Resources, the Marine Food Programme Manager, Marine Institute (representing the Minister of State’s Aquaculture Development Forum), and industry representatives, came together to form Irish Forum for Aquaculture Policy Development (BIM 1998).

The CLAMS process allows for the successful integration of aquaculture into the coastal zone through a consultative process, encourages more public interest consultation for the future of their bays, as well as more efficient production of shellfish by optimizing conditions within the bay and laying the foundations for co-operative ventures. It is designed to treat each bay or region as a separate entity with individual, tailored plans drawn up for each area, and requires essential local participation. It also integrates the existing policies of Single Bay Management (SBM) practices, ICZM, County Development plans, and the interests of other groups using the bays and shorelines (BIM

1998). The national standards for ICZM involve all coastal stakeholders, and the establishment of a CLAMS process will ensure that the interests of the aquaculture sector are adequately represented.

Once a CLAMS area is identified, all existing shellfish growers and producers in the area gather together with policy makers to set a plan in place. A CLAMS document contains: Baseline information; integration and local translation of the national codes of practice covering each species farmed in the area; relevant details of the local CLAMS group and liaison officer; a list of future developments in order of priority; and details of potential areas for development (BIM 1998).

Once a plan is set in place, an informational presentation is made to the local community and state agencies. Interpretive signs are constructed, displaying photographs, history of the area, current aquaculture practices in the bay, and other activities occurring in the bay. These signs share information with the local community and visitors about the project and provide a point of contact for further information (BIM 1998).

CLAMS is set up to not just bring aquaculture interests together, but also look outward to other stakeholders and users of the bay. Each CLAM project, local third party consultants are brought in, including regional fisheries boards, potential new entrants, fishing co-ops, county councils, regional development bodies, harbor boards and any other relevant parties. Future meetings are scheduled to keep up an ongoing review to continuously modify the CLAMS plan according to concerns and changing needs. The plan should also incorporate a strategy to enhance further communication and collaboration with fisheries, enhancement and management programs, marine tourism and other interests (BIM 1998).

Barriers Addressed: Regulation and Permitting Process, User Conflicts, Public Perceptions

The CLAMS model addresses the barrier set up by difficult and confusing regulations and permitting processes. CLAMS is set up to incorporate the existing and localized

Single Bay Management practices and the county development plans with principles the nation-wide principles of ICZM. Important to note in the context of CLAMS is that it is not set up to list objections for development, but to promote growth and management of local industry.

The CLAMS model encourages more public consultation in determining where different coastal activities should occur, ensuring potential for cooperative ventures. It brings together all growers in the area and sets in place priorities and future development areas for aquaculture. Establishing these future growing areas provides opportunity to discuss how various activities and uses will interact and sets a foundation for transparency and communication.

The CLAMS model puts a significant focus on engaging interested party participation and consultation from the local community, as well as continuing to educate and share information through presentations, interpretive signs and other activities. Public and stakeholder involvement is a critical component for moving any type of plan along, especially one that concerns public access, operations, and routines.

Great Barrier Reef Marine Park Zoning Plan

The Great Barrier Reef Marine Park Zoning Plan of 2003 is the primary planning tool for ensuring the proper conservation strategies and management of the Great Barrier Reef Marine Park on the east coast of Australia. This Zoning Plan aims to protect and conserve the biodiversity of the Great Barrier Reef ecosystem, preserve the world heritage values and traditional uses, provide ecologically sustainable development, manage for multiple uses, promote scientific research, and ensure acknowledgement of the rights and interests of indigenous Australians, and continued access to the marine park for current and future generations (GBRMPA 2004a).

The Great Barrier Reef Marine Park Zoning Plan is classified by eight zones: General Use Zone; Habitat Protection Zone; Conservation Park Zone; Buffer Zone; Scientific Research Zone; Marine National Park Zone; Preservation Zone; and the Commonwealth

Islands Zone. Regulated activities in each zone are managed by various permits, and include aquaculture, fisheries, tourism, research, education, shipping and aircrafts. The Great Barrier Reef Marine Park Authority (GBRMPA) and the Queensland Parks and Wildlife Service (QPWS) are charged to ensure the conservation of the Great Barrier Reef. The use of permits allows these organizations to reduce impacts on high-use and sensitive areas, separate potentially conflicting activities, encourage responsible behavior in all Marine Parks users, collect data for planning of Marine Parks, and monitor activities which may become damaging to the Marine Parks. A permit is granted for one year, allowing the establishment of the operation. If the operation wishes to continue and have met the assessment requirements, the permit may be renewed for six to 15 years (GBRMPA 2004a).

Aquaculture is becoming an increasingly important activity in the Great Barrier Reef Marine Park, due to developing markets, new technologies, and employment and investment opportunities. The GBRMPA developed a position statement on aquaculture within the GBRMP, which provides a brief background on actual and potential aquaculture operations and a guiding statement of the approach that the park will take in assessing applications for aquaculture operations. It breaks aquaculture up into two types: extensive and intensive. Extensive aquaculture is defined as an aquaculture operation that does not include the addition of feed, such as pearl oyster, oyster, clam and sponge aquaculture. Intensive aquaculture is any type that requires additional feed and other inputs. The permit requirements for extensive aquaculture may be more lenient and allowable in more zones than intensive aquaculture (GBRMPA 2004b).

Spatial zoning allows for different levels of aquaculture to be categorized according to its level of impact. The GBRMP zoning plan allows extensive aquaculture activity (specifically shellfish aquaculture), subject to permits, in the General Use, Habitat Protection and Conservation Park Zones. Intensive aquaculture currently does not take place in the GBRMP and will not likely be permitted for development at the current level of technological advancement. There is a possibility that intensive aquaculture may be permitted only in the General Use Zones, but only if the applicant can demonstrate

sustainable and ecologically acceptable practices. No aquaculture activities are allowed in the Buffer Zones, Scientific Research or Preservation Zones, Marine National Park Zones, Preservation Zones, Special Management Areas, No Structures Sub-Zones and The Whitsundays Plan of Management Area (GBRMPA 2004b).

The GBRMPA used a program called *Marxan* as one of the decision support tools for rezoning of the Great Barrier Reef. *Marxan* is a freely available conservation planning software that has the ability to aid in design of new reserve systems, reporting on the performance of existing reserve systems, and developing multiple-use zoning plans for natural resource management (Ball et al. 2009). In the GBRMP zoning plan, the program was used successfully to identify spatial conflict and zoning issues by gathering stakeholder input.

<i>ACTIVITY</i>	<i>Habitat Protection Zone</i>
Aquaculture	<i>Permit</i>
Bait Netting	✓
Boating, diving, photography	✓
Crabbing (trapping)	✓
Harvest fishing for aquarium fish, coral and beachworm	<i>Permit</i>
Harvest fishing for sea cucumber, trochus, tropical rock lobster	<i>Permit</i>
Limited collecting	✓
Limited impact research	✓
Limited spearfishing (snorkel only)	✓
Line fishing	✓
Netting (other than bait netting)	✓
Research (other than limited impact)	<i>Permit</i>
Shipping (other than a designated shipping area)	<i>Permit</i>
Tourism program	<i>Permit</i>
Traditional use of marine resources	<i>Permit or an accredited TUMRA</i>
Trawling	✗
Trolling	✓

Figure 2. Habitat Protection Zone activity in the Activities Guide for the new GBRMPZ (GBRMPA 2004a).

Barriers Addressed: Regulation and Permitting Process, User Conflicts

This plan considers a range of zones, from highly sensitive conservation areas to areas of general use for growth and development. Aquaculture is allowed, by permit, in specified areas. Stipulating exactly where these practices can and cannot occur can conceivably reduce confusion over permit requirements, and provide more thorough information and communication for growers wishing to expand their operations. The GBRMP also institutes different levels of permit requirements for varying types of aquaculture. This allows for less intrusive aquaculture practices, such as shellfish growing and harvesting, to bypass strict permitting processes set up for more intensive aquaculture practices.

It is important in this process not to forget about conservation and protected areas as a critical use of our marine waters. This is where the GBRMP zoning plan comes into play. This establishes zones for conservation, as well as development. Once the conservation zones have been agreed upon, the general use zones can be scoped out and allocated for various uses.

France: SPICOSA

The Science and Policy Integration for Coastal System Assessment (SPICOSA) program uses the EU ICZM framework to conduct research and achieve sustainable management of coastal areas throughout the EU. From 2007-2011, this project assessed 18 different study sites throughout the EU, including the Pertuis Charentais site in France. A “System Approach Framework” (SAF) was developed which incorporates the ecological, social, and economic sectors of an area into a dynamic model (Mongruel and Pérez Agúndez 2010). The SAF is a methodology that was designed, developed and tested by 54 research institutes and universities across the EU. Multidisciplinary teams analyzed various issues regarding coastal conflicts, environmental problems in the coastal zone, ecological sustainability, economic efficiency, and social equity (SPICOSA 2012).

France is one of the leading countries in Europe for shellfish production. Shellfish production in France mostly relies on natural spat settlement for oyster and mussels,

following traditional culture practices that have been established since the early part of the century (Goulletquer 1998). French oyster farming is well-established, with small family-run companies, an educated farmer population, technical expertise, a seawater quality monitoring program, and innovative new research (Beustel et al. 2009). They also partake in a traditional practice of refining oysters in oyster ponds, known as *claires*. Claires are shallow ponds near the sea which usually have abundant phytoplankton blooms used to fatten the oysters. This refining practice aims to improve product quality and taste by fattening the oysters in winter, before the marketing season (Goulletquer 1998, Beustel et al. 2009).

The main limiting factors against further development of this industry remains access to farming sites, due to increased support for tourism development and the desire to maintain access to offshore waters (FAO 2012). Major environmental management goal for the French oyster farmers are to maintain water quality in rearing areas, improve treatment procedures (purification and detoxification), reduce risks of animal diseases, integrate shellfish production into coastal zone management in order to reduce spatial competition from tourism, fisheries and environmental protection through cooperation and regulation (Beustel et al. 2009).

The Pertuis Charentais region on the Atlantic coast of France (Figure 3) is characterized by shallow waters, intertidal mudflats, strong currents, extended wetlands and three main river discharges. It has a history of conflict concerning environmental protection, space uses and freshwater sharing. It is an area of mixed use and very dependent on freshwater for household water consumption, agriculture, oyster cultivation, tourism and leisure. Despite the implementation of management measures to preserve water quality and use, the Charente river basin still fails the objectives of the European Water Framework Directive, due to agricultural runoff, and water shortage events (Prou 2012).

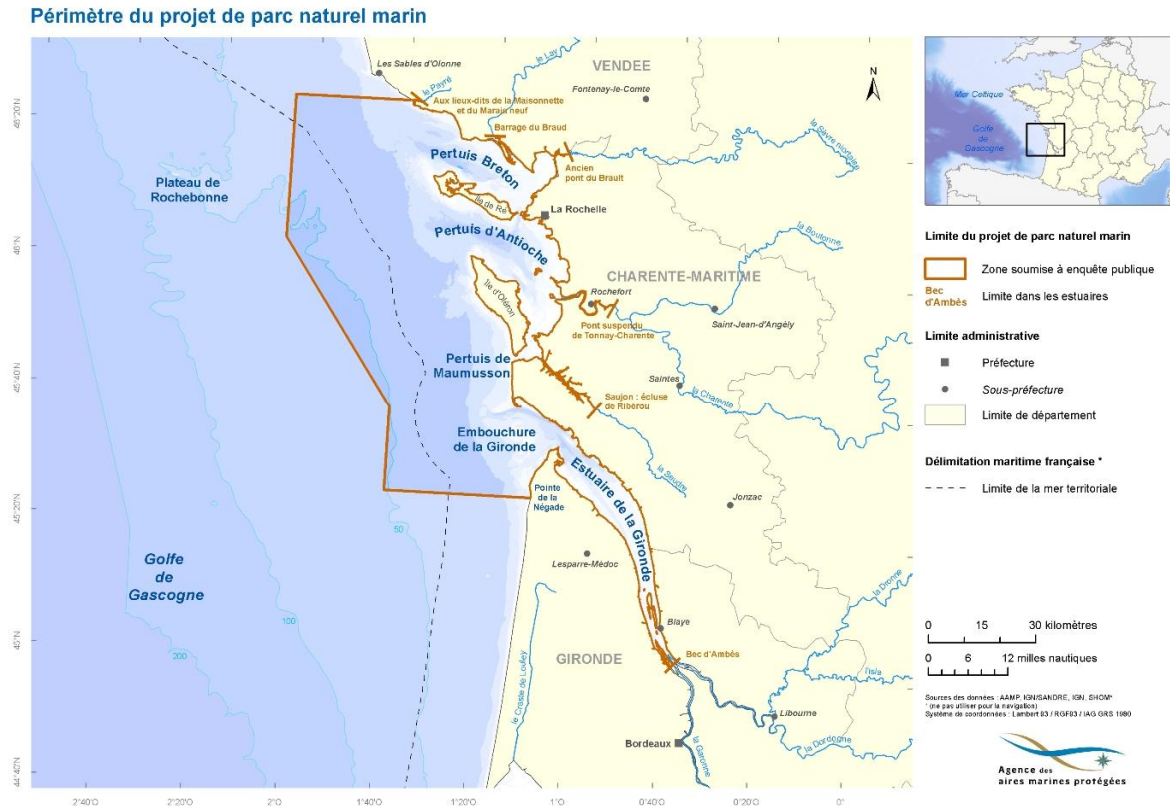


Figure 3. Map of Pertuis Charentais, France, <http://aquaculture-aquablog.blogspot.com/2010/11/la-rochelle-port-des-minimes-2015-la.html>

Participants strive for agreement on freshwater use of the Charente River, for such uses as environmental protection, agriculture, shellfish aquaculture, and drinking water distribution (Prou 2012). The SAF model was used to achieve this goal.

A SAF model application has five steps (SPICOSA 2012):

1. Issue Identification - the problem is diagnosed by stakeholders;
2. System Design - a virtual system is conceived;
3. System Formulation - a simulation model is made;
4. System Appraisal - the model is tested and run for several scenarios;

5. System Output - stakeholders deliberate the scenarios.

SAF also incorporates the simulation of scenarios, such as problem management options, and the engagement of stakeholders at the science-policy interface, as shown in Figure 4.

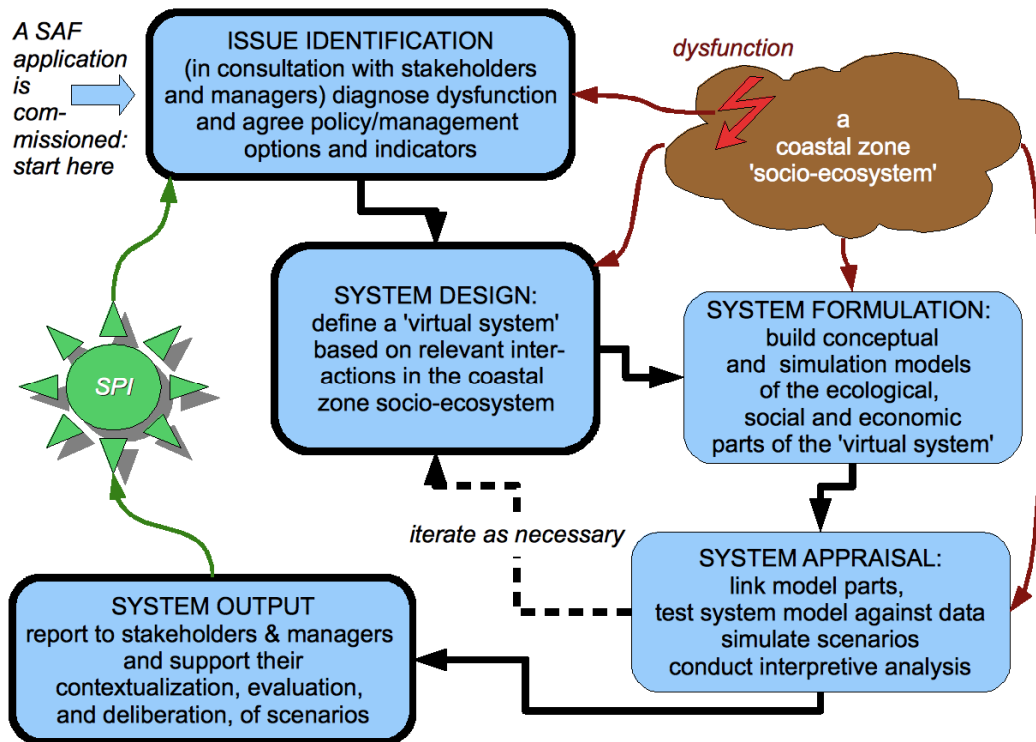


Figure 4. SAF Application Diagram showing the 5 steps. <http://www.coastal-saf.eu/introduction/whatis.shtml>

The SPICOSA website provides a comprehensive step by step manual on how to apply the SAF to a particular coastal area. It uses existing tools already set in place, along with offering essential supporting information, a variety of examples, bibliographies and links to several databases (SPICOSA 2012).

Participants in this process, including the water management agency for the Charente River, expressed positive feedback about the SAF model. They felt that it opened their eyes to different management scenarios and will remain highly involved throughout the continued development of the model. The SAF model opened up many possibilities for communication for future discussions and negotiation with other management bodies and local farmers. Lastly, this model helped to establish common language between scientists, managers and farmers from different backgrounds (Prou 2012).

Barriers Addressed: User Conflicts

The SAF model may be a valuable tool for satisfying conflicting uses. This model looks at the conflicts that may occur between the need for ecological sustainability, economic efficiency, and social equity in the coastal zone. A virtual webtool simulates numerous scenarios of connections, interactions and uses to determine which is most advantageous for a specific area. This process reflects that of the matrices of interactions and CLAMS, yet this model has the ability to make connections that may not be considered or even realized during meetings between stakeholders.

Aquamedia

It is fundamentally important for the shellfish growers to promote a beneficial public image of their industry and the products they supply. Public distrust can be very detrimental to the industry and the markets. Stead et al. (2002) suggest getting the environmental organizations, animal welfare groups, science ethics committees, science museums, and the media on the side of the industry, as vehicles for educating the public. They emphasize that “the aquaculture industry needs to fund and promote its own positive fish stories and be proactive at communicating on the benefits that eating its products can bring.”

Aquamedia is an initiative that has been set up to addresses these types of issues. *Aquamedia* is run by the Federation of European Aquaculture Producers (FEAP), with participation from the local aquaculture sector. FEAP is composed of 31 National

Aquaculture Associations from 22 European Nations. Aquamedia provides a centrally focused arena for accurate and up-to-date information about aquaculture. Its purpose is to “tell the story of aquaculture in an open and transparent way to all those who are interested in what it does” (Aquamedia 2012).

This web-based tool sprung from the desire of the aquaculture farmers to help their consumers understand how their operations work, how the product is grown, and what new developments are occurring. The webpage offers information and links to new and relevant news threads, studies and reports about the state of aquaculture. It also provides detailed information about production, environmental affects, consumer reports and economics of the industry. This go-to page presents a focal point where consumers, researchers and those who are studying the procedures of food production can find the most up-to-date scientific information regarding the truthful production of aquaculture. (Aquamedia 2012).

Barriers Addressed: Public Perceptions

Tools like Aquamedia have the potential to transcend the issues that cause negative public perceptions of the industry and can provide truthful and up-to-date information. Those concerned about shellfish aquaculture, estuary protection, ecosystem services, and other associated issues, would have the weblink on their radar. Emails, tweets, and other posts could reach out to the surrounding community when critical, imminent decisions need to be made. Having this un-biased and timely information easily accessible and available to the public would greatly increase the transparency throughout the entire process. When real opportunities are available for public voices to be heard and truly considered, it often results in wider public acceptance and understanding.

Nutrient Trading System

A contrasting approach to valuing the shellfish resources as a consumer product is to look at the ecosystem services they provide (MEA 2005). Ecosystem services are defined as the benefits that natural systems provide, in terms of resource and processes, to

humankind. They are divided into four broad categories: Provisioning services, which provide needs such as food and water; regulating services, which control processes such as climate and disease; supporting services, such as nutrient cycling and crop pollination; and cultural services which provide spiritual and recreational uses (MEA 2005).

Understanding the trade-offs between these services may present unique opportunities for aquaculture management.

Many studies have analyzed the possibility of developing a market for shellfish ecosystem services, rather than for the good itself. As discussed earlier, shellfish have an incredible service of filtering particles, bacteria and nutrients out of seawater. It has been estimated that it would take roughly 266.4 million kg of dry weight oysters to filter the volume of Puget Sound every 3 days (Feifel 2009). However, it is important to balance the trade-offs between services and to know the carrying capacity for shellfish production for different areas. For example, too many shellfish in one area may take away food and nutrients from other fish and organisms sharing the same resources, leading to lower returns for the ecosystem service of fish production (Brumbaugh and Toropova 2008). Managers need to be aware of these trade-offs between services in order to best manage an area for its full potential.

Developing a new market where shellfish are valued for their ability to filter the water would allow the aquaculture industry to continue to produce shellfish, but in a different capacity (Brumbaugh and Toropova 2008). A paper by Feifel (2009) depicted a scenario where “some shellfish beds would be cultivated for the sole purpose of enhancing the natural filtration capacity within the ecosystem to control phytoplankton populations, thereby reducing the magnitude of HABs, while other beds continue to be used for commercial aquaculture.” This would require the formation of new policies that create a monetary market for shellfish ecosystem services, as well as increased levels of government support (Feifel 2009).

In Sweden, a case study was developed to assess the possibility of improving marine water quality and to reduce eutrophication through mussel farming. One of the greatest

barriers to mussel farming on Sweden's west coast is the poor water quality due to the excessive amount of bio-toxins from local sewage plants and agricultural run-off. The argument for this study is that existing mussel farms already perform this service for free, but the benefits could be far greater by expanding the ecosystem services framework (Lindahl et al 2005). The case study sets up a framework for a nutrient trading system where nutrients are recycled from sea to land through mussel harvesting.

The nutrient trading system is regarded as a management tool. It enables the emitter of the pollution to be financially responsible for what they are discharging. The mussel growers take on the role of "nutrient harvesting enterprise" and seller of the service, while the responsible party for the pollution discharge is the buyer or consumer. Observably, this makes for a simple transaction if it concerns a point source discharge. However, it becomes more complex when non-point sources are contributing to the nutrient discharge. It is very difficult to monitor and document volumes of non-point discharges, and the lack of documentation and record keeping could seriously hinder the market. A monitoring and recording system would need to be set in place to document the amount of nutrient uptake by an expanded shellfish culture, and how that will compensate for the land-based sources.

Currently, the group known as SUBMARINER, which promotes sustainable uses of Baltic marine resources, is lobbying for the adoption of nutrient trading scheme as an environmental measure in the Baltic Sea region (SUBMARINER 2012). A project titled "Mussel Farming for Improving Coastal Water Quality in Kalmarsund, Sweden" uses the concept of Agro-Aqua recycling to recycle nutrients from the sea back to land and agricultural operations. Mussels are cultivated at the mouth of streams and rivers where they can uptake nutrients such as nitrogen and phosphorous that result from pesticide, fertilizer and other agricultural runoff. The mussels are then harvested, removing a known amount of nutrients from the sea, and recycled back to the land. They are mainly used as mussel biomass which is processed into mussel meal to be used in organic feed or composted into a rich organic fertilizer. Participants in this SUBMARINER project are

lobbying for the adoption of this type of nutrient trading system to take place in the Baltic Sea region (SUBMARINER 2012).

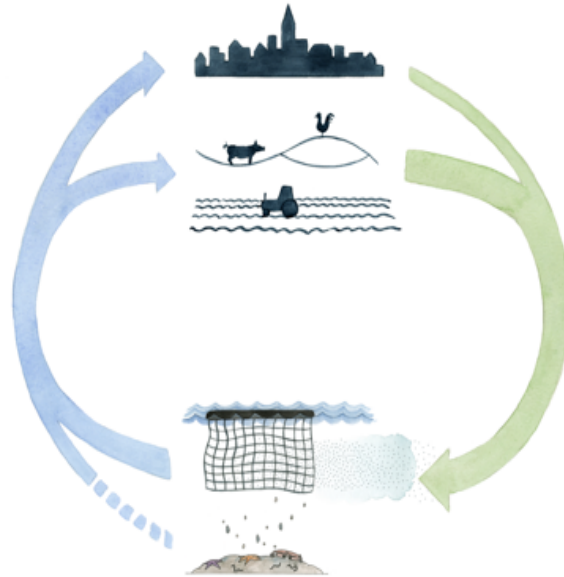


Figure 5. The Agro-Aqua recycling system, SUBMARINER

Brumbaugh and Toropova (2008) argue that, with the great amount of public and private funds that go to reducing nitrogen pollution from land-based sources, it is necessary for managers to look to other ways to combat these issues. They suggest that if a nitrogen trading market existed, which incorporated the ability of shellfish to remove the nitrogen from the water, it might create more incentives to invest in pollution abatement measures through shellfish restoration.

Currently in Puget Sound, filter feeding models are under review that attempt to evaluate the capacity of shellfish to mitigate nitrogen pollution. Ecology is also considering the possibility of implementing a nitrogen credit system that uses shellfish for pollution

reduction. This system could potentially bring more shellfish industry and jobs to the coastal communities of Puget Sound (WSI 2011).

Barriers Addressed: Water Quality, Public Perceptions

In terms of thinking about water quality as an ecosystem service provided by shellfish, the nutrient trading system tool may be valuable for confronting this widespread barrier. As stated earlier, shellfish provide supporting services by cycling nutrients, such as nitrogen, from the water. Generating a market for shellfish nutrient cycling would require both public and private funds, as well new policies to build the foundation of a market and nitrogen credit system.

The nutrient trading system has the potential to totally shift the public view of shellfish aquaculture. It can take the conventional perceptions of shellfish cultivation as an activity of disturbance and reframe the issue to extract new perspectives on the advantages of shellfish as a vessel for improving the quality of our waters.

Table 3 identifies the name of the tool, who it was developed by, what type of tool or strategy it is (model, plan, web tool or economic tool), how it may apply to Puget Sound, and which barriers each tool feasibly addresses.

Table 3. Matrix highlighting name of tool or strategy, who it was developed by, what type of tool or strategy is applied, the effectiveness in Puget Sound, and which barriers may potentially be reduced.

Name	Developed by	Tool/Strategy	Effectiveness in Puget Sound	Key Barriers as identified in Section III			
				Regulations/permitting process	Water quality	Conflicting Uses	Public Perceptions
Matrices of Interactions	EU COEXIST	model	Very effective in providing baseline info for stakeholder interactions			X	
Site selection plan	EU COEXIST	plan	May be difficult with mixed uses and multiple-use zones	X		X	
CLAMS	Ireland government	plan	Would need to be based on local/regional scale (County SMPs)	X		X	X
Spatial Zoning	GBR Marine Park Authority	plan	Zoning may be challenging with set uses and property rights	X		X	
SAF model	SCIPOSA	web tool/model	Scenario-based modeling useful for determining possible outcomes			X	
Aquamedia	FEAP	web tool	Quick set-up, but would need to consistently update				X
Nutrient Trading System	SUB-MARINER the Baltic Sea region countries	Economic tool	Would need to create a market and incentives		X		X

V. Coastal and Marine Spatial Planning framework

As part of the Final Recommendations of the Interagency Ocean Policy Task Force, Coastal and Marine Spatial Planning (CMSP) was introduced as part of a framework to establish a comprehensive, integrated, ecosystem-based approach to address conservation, economic activity, user conflict, and sustainable use of ocean, coastal, and Great Lakes resources (CEQ 2010). In July 2010 President Obama issued Executive Order 13547 adopting the recommendations of the Task Force. NOAA defines CMSP as a process that will help to identify “areas most suitable for various types or classes of activities in order to reduce conflicts among uses, reduce environmental impacts, facilitate compatible uses, and preserve critical ecosystem services to meet economic, environmental, security, and social objectives” (Executive Order 13547). A federal level CMSP program was established involving 24 agencies in a National Ocean Council, which develops regional and national workshops, and establishes regional planning bodies to carry out regional CMSP plans and to develop strategic action plans (Executive Order 13547; NOAA SAB 2011).

In March 2010, Governor Gregoire signed into law Substitute Senate Bill 6350, a new law directing state agencies to address and report on recommendations for marine spatial planning framework in Washington. An interagency team was formed, through the pre-existing State Ocean Caucus (SOC) and a report to the Legislature was submitted on December 15, 2010. This report contains recommendations for how to carry out a marine spatial plan in Washington. However, it is not an actual marine spatial plan, which will be addressed in an established planning process (Hennessey 2010). Authorities involved in Washington's CMSP process are currently focused on attempting to understand and explore issues, needs, and gaps for Washington and West Coast region.

Just recently, on March 19, 2012, new legislation was introduced to Washington regarding marine spatial planning, through House Bill 2SSB 6263. This new legislation will allow continued facilitation of marine management planning, provides direction for

allowable expenditures of a Marine Resources Stewardship Account, and creates the Washington State Coastal Solutions Council (House Bill Report 2SSB 6263).

The purpose of CMSP is very broad, but generally is set up as a process to inform the spatial distribution of ocean and coastal activities in order to sustain these uses for future generations (Foley et al. 2010). CMSP could be a very viable tool to help Washington reach its goals of ecosystem based management. A review by Gilliland and Lafolley (2008) addresses the key basic elements of setting up a CMSP framework, and suggests considerations for the planning process. The following considers these key elements when looking at marine spatial planning recommendations for Washington. Most information was extracted from the 2011 Final Report and Recommendations of the State Ocean Caucus (SOC) to the Washington State Legislature (Hennessey 2011).

Definition

Washington State defines marine spatial planning as:

A public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives. (Hennessey 2010)

Purpose

CMSP encompasses the components of reducing user conflicts, protecting ecosystem health and services, facilitating compatible uses, identifying emerging new uses, expanding existing uses, and aligning management decisions (Hennessey 2011). It is also important to note that balancing multiple objectives most often requires some means of assessing trade-offs among varying uses. This will be important to determine how Washington will balance these multiple uses when outlining specific uses within the plan.

Products

Expected products to be generated by the CMSP process for Puget Sound include: An ecosystem assessment of the Puget Sound; a series of maps, an implementation strategy; and a framework for coordinating review of renewable ocean energy proposals. The development of a marine spatial plan for Puget Sound that allows flexibility and for the ability to consider planning issues unique to this area (Hennessey 2011).

Guiding principles

Guiding principles for CMSP fall into three categories: ecological, social and economic. A study by Foley et al. (2010) proposed four basic ecosystem principles which call for the conservation or restoration of (1) native species diversity, (2) habitat diversity and heterogeneity, (3) key species, and (4) connectivity. It is necessary for Washington's interagency team to define guidance principles for the remaining social and economic sectors. The National Ocean Council's CMSP framework suggests various planning principles, which include public participation, treaty rights, best available science, addressing climate change, adaptive management, and use of the precautionary approach. Washington has looked to these principles for guidance (Hennessey 2011).

Governance scale

At the federal level, NOAA sets forth general goals, planning principles, and a flexible process for establishing regional plans guided by national standards. It expects to link to regional processes in each coastal large marine ecosystem. Washington belongs to the West Coast region, and is a member of the West Coast Governors' Agreement on Ocean Health. This regional partnership was established in 2006 by the governors of Oregon, Washington, and California, and is designed to address critical, shared ocean and coastal protection and management issues facing the West Coast (WCGA 2008). As of now, the Governor's Agreement has not adopted goals or objectives addressing CMSP. However, this framework greatly aligns with the partnership's priorities, and a marine spatial planning component may be a foreseeable next step (Figure 6).

The National Ocean Council also released their Draft National Ocean Policy Implementation Plan, which “provides the framework for all Federal agencies to work together to pursue these goals with cohesive actions across the Federal Government, and for engaging State, Tribal, and local authorities, regional governance structures, non-governmental organizations, the public, and the private sector” (NOC 2012).

The federal framework allows for incorporation of state-level plans, managed by a lead agency and a steering and technical committee. The recommendation from its proposed CMSP is for Washington is to divide the plan into three different spatial regions: Puget Sound, managed by the Puget Sound Partnership; Columbia River basin, managed by the Lower Columbia River Estuary Partnership; and the outer coast, managed by a to-be-determined coast coordinating committee (Hennessey 2010) (Figure 7).

The Final report for Washington (Hennessey 2011) greatly emphasizes the fact that a spatial plan “will not, in itself, institute new regulations.” It will pull from and utilize existing regulations and authorities of agencies across local, state, tribal and federal jurisdictions.

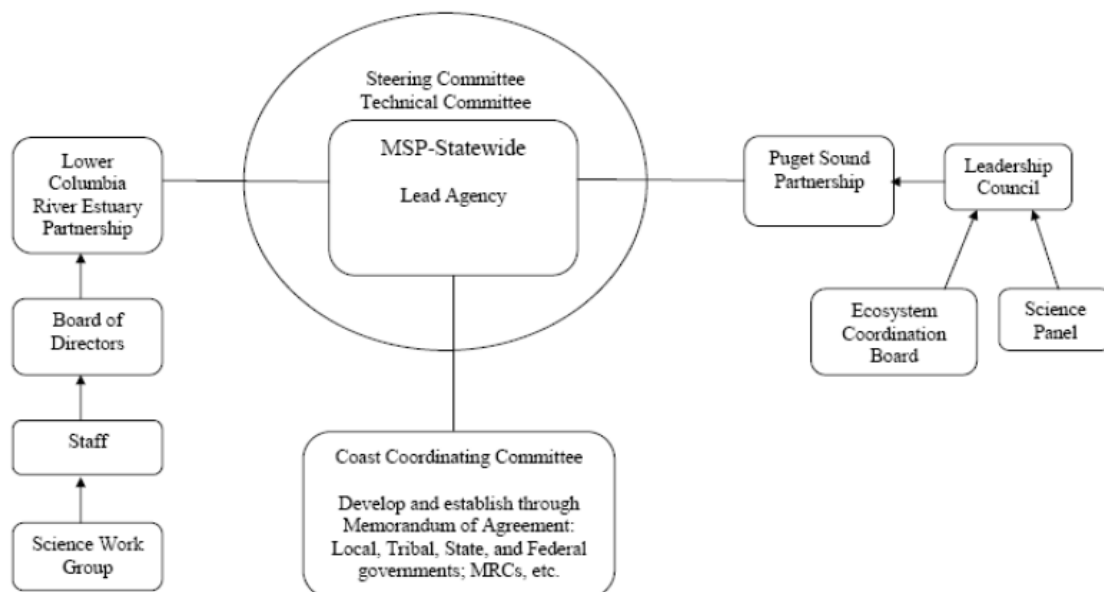


Figure 6. Proposed Governance for Marine Spatial Planning in Washington (Hennessey 2011).

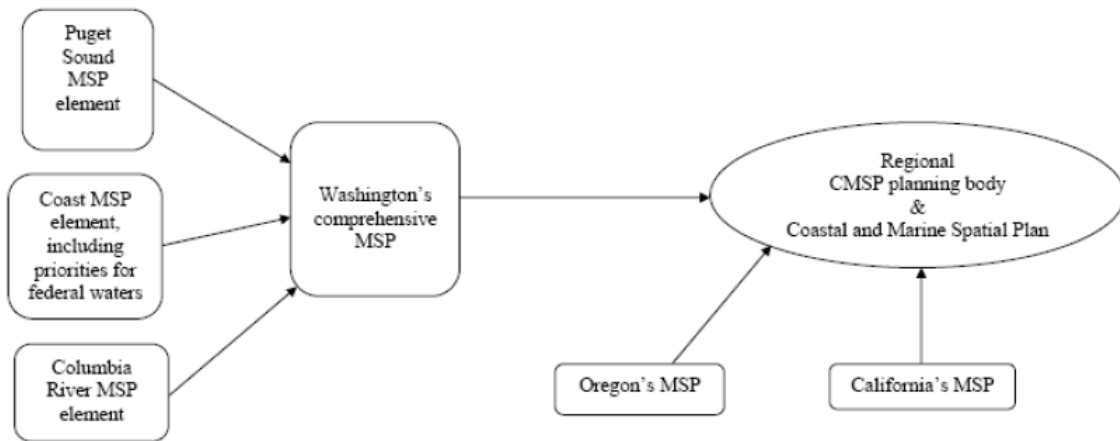


Figure 7. Connection between state and regional efforts (Hennessey 2011).

Planning authorities for Washington

Marine spatial planning in Washington is led by the Department of Ecology (Ecology). The State Ocean Caucus (SOC), coordinated by Ecology, was charged with developing the recommendations and final report, as well as brainstorming possible tools and processes. The SOC team also pulled representatives from coastal Marine Resources Committees (MRCs), federal agencies, and tribal governments (Hennessey 2011).

Once the report was complete, Ecology is responsible for submitting the completed marine spatial plan to the National Ocean Council, according to the National Ocean Policy Implementation Plan, where it will undergo a review and approval for incorporation into the states federally approved coastal zone management program (Hennessey 2011; NOC 2012).

Overall process

In order to establish a process for CMSP in Washington, the SOC team will need to define the area to be managed, determine goals and objectives for a plan, gather and map spatial data, analyze the data, including assessing future scenarios, prepare a plan, and begin to implement, monitor and evaluate the plan. It is also important to consider how this plan can be collaborated with existing plans. The SOC team must consider in its recommendations for Puget Sound:

- a) Including a marine spatial component in the Puget Sound action agenda;
- b) Goals and objectives for a marine spatial plan that integrate with existing policies and regulations, and recommend a schedule to develop marine ecosystem health indicators;
- c) Providing recommendations on achieving a unified approach to database management and delivery that would support marine spatial planning throughout the state.

Goals and Objectives

To create effective management objectives, it is important to identify desired ecological principles, involve stakeholder participation and cooperation throughout the process, ensure real public accountability, independent decision-making, adaptive management, dependable funding, and public transparency, and clearly articulated goals and a means of evaluating whether they are being met (Foley et al. 2010).

The SOC team recommended the following objectives for CMSP in Washington (Hennessey 2011):

- a) Recognize and respect tribal treaty rights through proper government-to-government consultation and co-management.

- b) Recognize and value existing uses, which includes, but are not limited to, recreational, commercial, cultural, and security uses.
- c) Promote protection and restoration of biodiversity and ecosystem processes to a level that will enable long-term sustainable production of ecosystem goods and services.
- d) Address potential impacts of climate change and sea level rise upon current and projected marine water uses and shoreline and coastal impacts.
- e) Foster and encourage sustainable uses that provide economic opportunity and preserve coastal heritage without significant adverse environmental impacts.
- f) Preserve and enhance public access to, commercial and recreational uses of, and other values for marine waters and shorelines.
- g) Protect and encourage working waterfronts and support the infrastructure necessary to sustain water-dependent uses such as marine industry, commercial shipping, commercial, tribal and recreational fisheries, and shellfish aquaculture.
- h) Foster public participation and significant involvement of communities adjacent to the state's marine waters in decision-making.
- i) Integrate existing management plans and authorities and makes recommendations for aligning plans to the extent practicable.
- j) Rely on best available science and create a process to adjust plans to incorporate additional science as it is available.
- k) Improve scientific information about the marine ecosystem to fill data gaps, answer key management questions, and inform planning and decisions through adaptive management processes.
- l) Use the precautionary approach as reflected in Principle 15 of the Rio Declaration.

Priorities

As noted above, CMSP is used to consider emerging new uses, expanding existing uses, and resolving conflicts among existing uses. These uses are very unique and diverse in their needs and practices. They can include: shellfish aquaculture; offshore fish and other such as net pens; bio-prospecting (gathering and use of marine life for research or medicinal purposes); marine transportation; oil and gas, including pipelines and spill prevention and response; protection, conservation, or restoration of sensitive environmental areas for habitats, plants or animals; scientific research and equipment, such as buoys and cables; sediment removal, placement or disposal such as from dredging activities; telecommunication or power cables; military activities; recreation & tourism activities; offshore wind, wave and tidal energy; siting for nuclear power activities; and climate change.

Geographic scope

The recommendation is for the plan to be divided into three different regions. The Puget Sound region will include the marine waters covering from the entrance to the Strait of Juan de Fuca to all marine waters inland of that point. The Columbia River region will include the marine waters and tidally-influenced portion of the Columbia River from the mouth of the river to the eastern boundary of Wahkiakum County. The Coast region will cover the Pacific Ocean, marine waters and estuaries from Cape Flattery south to Cape Disappointment.

Spatial scope

As stated in the legislation, the marine spatial plan for Washington shall cover aquatic lands and waters under tidal influence in Washington State, including: saltwater and estuaries from the ordinary high water mark out to 3 nautical miles; all major estuaries such as Puget Sound, Willapa Bay, and Grays Harbor; Lower Columbia River; and privately-owned tidelands. Although the state's jurisdiction applies only in state waters,

management activities that cross these boundaries should collaborate with federal agencies.

Spatial data

With multiple agencies charged with various objectives, a largely diverse amount of spatial data can be found throughout the state. It is essential to understand what types of data exist, in order to determine what is needed for a state-wide marine spatial plan (Hennessey 2011). The SOC team held a working session to identify spatial needs that would support a new plan. The priority data needs include: bathymetry-topography; fisheries; habitats; conservation/regulated areas; water quality; oceanographic processes; marine fish; geomorphic characterization; and endangered species. The participants also emphasized the need to look at seasonal and temporal variability for all of the data, as well as to understand potential future changes due to climate change (SOC 2011).

A key recommendation from the working session was to create a centralized on-line place to search for, download, and view spatial data and coordinate GIS data in the state with a GIS Council and central library/catalog. According to the outcome of this working session, the SOC team made recommendations for priority data needs, accessing data, data standards, data sharing, and decision tools (SOC 2011).

Stakeholder engagement

Gilliland and Laffoley (2008) suggest that “the nature of MSP is such that stakeholder engagement should be considered intrinsic to it.” They note that it is fundamental to achieving its objectives to engage the public, industry, local government, regulators and stakeholder groups in the planning process.

Stakeholder engagement for Washington involved meetings and briefings with various groups about the process, presentations at coastal Marine Resource Committee meetings, a public meeting on ocean issues in Westport, a meeting of the Olympic Coast Intergovernmental Policy Council, a meeting of the Puget Sound Federal Caucus, and a

briefing to Northwest Indian Fisheries Commission's Environmental Policy Council by their staff. Public input was gained through an online survey, comments on draft goals, and public meetings about the draft report. As mentioned earlier, a working session on spatial data was held, providing input on recommendation for spatial data needs. A website hosted by Ecology was launched which updates stakeholders about the current state of the process (Ecology 2012).

In a workshop to document availability of data on human use of the marine and coastal waters, a major theme that emerged was the importance of stakeholder engagement in the data inventory process, new data collection, and CMSP in general. Participants felt that the CMSP process should be collaborative, bringing in larger data sets and wider outreach throughout the state (Ecology 2011c).

Monitoring

Target indicators are an essential part to monitoring the effectiveness of tools such as marine spatial planning. With the Puget Sound Partnership's and the Lower Columbia River's pre-established indicators, the legislation charges the SOC to develop a set of indicators for measuring the progress for Washington's coast. The SOC recommends for a coastal coordinating body to develop indicators (Recommendation 5) involving tribal, federal, local and state representatives. These indicators should track the status of coastal and marine ecosystem health, as well as social and economic elements of the coastal communities.

Current Status Regarding Aquaculture

When the marine spatial planning legislation was introduced to Washington State last year, many commercial and recreational users, as well as conservationists, became concerned about what this new framework would mean for state coastal and marine management (Grays Harbor MRC 2009). A CMSP forum held in Grays Harbor in 2009 brought together representatives from the general public, sport and commercial fishing, shellfish farming, recreation, tourism, higher education, and local, state, tribal and federal

governments. This forum emphasized many concerns and necessary considerations for this proposed framework. Participants advised the need to prioritize existing uses of our marine waters, such as fishermen and shellfish growers, and to protect these traditional uses from being pushed out by newer uses such as renewable ocean energy (Grays Harbor MRC 2009). Other suggestions included ensuring the essential use of good quality data and maps, improving coordination and communication between resource agencies, and building upon existing authorities and programs, rather than creating a whole new framework (Grays Harbor MRC 2009).

The commercial shellfish industry in Puget Sound is greatly concerned about how shellfish aquaculture will be affected by Washington's MSP proposal. Many suggestions and consideration from the Pacific County Willapa Bay community, a key shellfish aquaculture growing area, were presented through the public comment sessions. The concept of distinguishing the terms “shellfish aquaculture” from general “aquaculture” will separate the “negative implications tied to general aquaculture that should not be drug into shellfish” (Pacific County MRC 2010). Also, shellfish industry representatives suggested adding another category of beneficial uses to the data collection, such as for shellfish aquaculture that recycles nitrogen and other nutrients, cleans the water and provides habitat for other marine species (Ecology 2011c).

The industry calls for more considerations for aquaculture planning, permitting and expansion within the proposal, not just for commercial harvest, but recreational and subsistence as well. The industry would also like to see the conflicts between tideland aquaculture and upland uses be addressed in this proposal (Ecology 2010a).

Next steps

St. Martin and Hall-Arbor (2008) point out that the “human dimensions” of the marine environment is fairly undocumented and remains a “missing layer” in decision-making. The ecological landscape is being mapped in great detail, but the social landscape, including fishing communities, interests, dependencies and human uses have been overlooked. This “missing layer” is vital for implementing marine spatial planning and

requires new methodologies and data collection efforts, such as community research, in-depth map-based interviews, and community workshops (St. Martin and Hall-Arbor 2008). Workshop participants at the human use sessions in Aberdeen (SOC 2011) suggested several possible studies to document economic impacts and private ownership of shellfish aquaculture areas. Suggestions included stitching together county data of tideland ownership to develop regional data sets, and online survey to produce maps of growing areas.

With such a traditional and coastal dependent industry like shellfish aquaculture, CMSP must integrate existing farms, as well as plan for the development of potential new sites and address compatible uses, which will benefit the coastal community and marine environment as a whole.

Now that I have identified the major current barriers to the shellfish aquaculture industry, and examined various tools and strategies from around the world, including Washington's CMSP process, it is important to determine how these tools can actually address these barriers and potentially provide beneficial solutions.

VI. Assessment of Opportunities for Improvement

In order to properly manage an area for multiple competing and synergistic use, you need to pull different tools from your toolbox. CMSP is one of many existing management tools and frameworks that can be used to achieve sustainable management of our coastlines and working water-fronts. However, I believe that the CMSP process has greater potential to overcome the barriers identified in this thesis if alternative tools are simultaneously incorporated. The following discussion touches on each of the four barriers (regulations and permitting process, water quality, conflicting use, and public perceptions) and provides suggestions for how these alternative tools and strategies can be effectively integrated into the CMSP process.

Regulations and permitting process. In order to address the barriers brought upon by regulations and the permitting process, CMSP could benefit greatly by integrating the concepts from COEXIST's site selection plan, the CLAMS framework, and the Great Barrier Reef Marine Park Zoning Plan. Regulation and permitting challenges have made it difficult for shellfish growers to expand their operations. These hurdles include cost, time constraints, confusion over which regulations to follow and at which levels, and an overall frustration with the process.

If CMSP is to address this regulatory barrier, it must consider industry consultation and involvement in the process. The heart of the problem stems from the lack of information and communication, lack of grower consultation and participation through the process, and the translation of regulatory language into that which can be understood by growers. In order to expect the industry to truly support the permitting and regulatory system, they must understand why these laws were created and why they are required to abide by them, and be involved in the decision making.

CLAMS, much like CMSP, strives to integrate existing local policies and codes of practice into a cohesive framework. However, the community based focus of CLAMS allows key stakeholders to tailor local regulations for a particular bay or coastal community. This same process could be emulated in Washington by taking the principles of CMSP, and incorporating them into Shoreline Management Plans (SMPs) or other coastal community based planning programs. As stated earlier, an objective of CMSP is to recognize and value existing uses, and to foster and encourage sustainable uses that provide economic opportunity and preserve coastal heritage (Hennessey 2011). Shellfish aquaculture can be classified as an existing use, a sustainable economic opportunity, and a piece of our coastal heritage. Aquaculture is also a preferred water-dependent use under the Shoreline Management Act and aquaculture activities already have set guidance for management in SMP guidelines. With aquaculture already being managed in the SMPs, integrating these objectives of CMSP would enhance the management structure and provide a good opportunity to promote aquaculture as a sustainable, water-dependent use (Shellfish Aquaculture Regulatory Committee 2012).

Concepts of permit management from the COEXIST and the GBRMP zoning plan can be built into CMSP. Stipulating where aquaculture practices can and cannot occur, and which type should be located where, can conceivably reduce confusion over permit requirements, and provide more thorough information and communication for growers wishing to expand their operations. This must also be generated by a detailed negotiation among stakeholders.

It is a goal of CMSP to utilize existing policies and regulations in its framework. As stated earlier, CMSP will not set out to create new regulations, but pull from existing regulations from federal, state, and local level into one comprehensive framework. This will provide an opportunity to determine which regulations and permits are necessary to make the framework function, and leave out those that have been confusing and overly burdensome. It should be a focus of CMSP to pull all the various federal, state and local programs together that affect Washington's coast lines, and integrate them into one cohesive framework. This will also provide an opportunity to examine where current conflicts in our regulations occur, and how to addresss them (i.e. conflicts between federal requirements and state permitting). These programs could include the recent WSI, with an objective to maintain and enhance cooperative relationships between industry and regulatory agencies and ensuring that the best available science is used for all regulatory requirements.

CMSP has the potential to align federal policies, such as NOAA's emerging aquaculture policy and the Coastal Zone Management Act (CZMA), state policies, such as the Shoreline Management Act (SMA) and Growth Management Act (GMA), and local policies such as Shoreline Management Plans (SMP). It may take time to examine and align each federal policy's goals and objectives, but it would be of great benefit to all coastal and marine uses. If regulation at all levels were consistent with each other, shellfish aquaculture development could transform into a transparent, concise and productive process.

Water Quality. A majority of water-dependent uses rely on excellent water quality conditions, especially shellfish, which can also be seen as a potential solution to restoring the water quality of Puget Sound. Water quality was identified as a priority spatial layer for CMSP. Water data needed includes the quality and the chemistry, pathogens, HABs, dissolved oxygen, acidification, turbidity, temperature, salinity, and areas with significant fecal coliform water quality problems.

Because of its critical importance, many targets have been set to help reach higher water quality standards in the Puget Sound. The Puget Sound Partnership (PSP) set a target to upgrade the number of acres of suitable shellfish growing areas with healthy water conditions, as well as to improve water quality and habitat by managing storm water runoff (PSP 2012). Ecology's Marine Water Condition Index reports changes in water quality, better or worse, to track the overall quality of Puget Sound (Krembs 2012). The SOC team advised to adopt and incorporate these existing targets and objectives into Washington's CMSP framework. The development of the three distinct marine spatial plans for the major geographic areas (Puget Sound, Lower Columbia and outer coast) will allow flexibility and for the ability to consider planning and water quality issues unique to each area, such as farming, storm water runoff, logging, nutrient blooms, and heavy metal inputs.

Although not specifically stated as an objective, CMSP has the potential to indirectly benefit water quality through strategies addressing user conflicts. A direct link between user conflict advances and water quality improvements could be seen by spatially identifying upland uses and areas of input that contribute to water quality downgrades, such as sewage treatment plants, large farms and areas of large urban storm runoff. In fact, water quality could actually be considered a user conflict in itself. Areas of poor water quality, as well as areas potentially sensitive to degraded water quality could also be mapped out. Identifying these areas would allow managers to see the spatially explicit link between upland uses and poor water quality areas. It would also allow managers to better focus their priorities and management techniques on specific areas rather than an entire watershed.

A nutrient trading system as a management tool in CMSP could result in reduced user conflicts between upland pollution sources and water quality issues. We could potentially see investment and capital redirected to a more market-based system rather than merely throwing money at the problem. This might also cause a shift from mechanical water quality fixes to more natural sources of filtration and purification.

Conflicting Uses. Conflicting use issues are the poster child for CMSP. There is a belief that if you map out all uses of the coastal zone, identify where and what uses are in conflict, and change the zoning so these uses are no longer in proximity, everything will fall into place. Although this has worked well in many distinct cases⁴, there is much more that needs to be considered in CMSP. Many times, the existing uses have held claim to a specific area for generations, and will not give up their foothold to be moved to a different zone or use area. In other situations, it may take consultation and communication to realize that, with a few changes in practices for each party, the uses may no longer be in conflict, and may even mutually benefit each other⁵. Other “uses” or stressors may also arise, such as non-point pollution or ocean acidification. Shellfish growing operations cannot simply just pick up and move away from these stressors, since they often affect the entire water column and widespread areas. It will not be enough for CMSP to simply map or zone an area for specific uses. It needs to integrate collaboration and communication strategies, stakeholder involvement opportunities, target indicators and monitoring plans.

A major focus of CMSP is to facilitate compatible uses, identify emerging new uses, allow for expansion and contraction of existing uses, and foster sustainable use of our shorelines. It acknowledges the importance of coordinating diverse uses, such as working waterfronts, economic opportunities, coastal heritage and environmental protection and conservation. Going along with the recommended strategy of

⁴ Such as in the Stellwagen Banks case of redirecting shipping lands to protect whale populations (<http://stellwagen.noaa.gov/welcome.html>)

⁵ New concept combines offshore wind farms, mussel cultivation, M. Brenner, B.H. Buck & A. Koehler (2007)

incorporating existing policies into the CMSP framework, there could be great value gained by incorporating shellfish aquaculture planning into local, shoreline oriented plans like SMPs. However, these plans need to be specific about how shellfish aquaculture should be regulated, how it will address environmental concerns, and how it can fit in with other existing and potential uses. This process could be directed by consistent guidelines, yet still be tailored to the specific region and incorporate stakeholder consultation.

Associated tools for moderating conflicting uses include COEXIST's matrices of interaction and site selection plan, CLAMS, the Great Barrier Reef Marine Park Zoning Plan, and the SAF model by SPICOSA. As set up in the CLAMS model, CMSP in Washington would greatly benefit by bringing together the key uses of the inland uses that generate pollution and coastal waters to hash out what and where shellfish growing activities should occur and where pollution prevention activities should occur. Bringing the SAF model into the CMSP process would create a series of diverse scenarios that could be presented and communicated to key agencies and stakeholders involved in CMSP implementations, providing diverse and unanticipated opportunities at best and at worst better communication of differences.

Negative public perceptions. Finally, public perceptions of shellfish aquaculture can be enhanced by CMSP through increased public involvement in the decision making and implementation process. Providing this opportunity for public involvement is extremely critical. However, often these opportunities go by unnoticed, poorly attended, or do not reach out to the right people. Many times, individuals and groups will become interested in the decisions after they have been made and have protests or specific suggestions to many of the implementation actions. This can be extremely frustrating for those who have put countless hours into the decision making process, discussed options thoroughly, and have already incorporated suggestions and concerns. At this point, they are ready to look forward, not back, and feel blindsided by these new interests.

The CLAMS model, Aquamedia, and the nutrient trading system may all have the potential, when combined with CMSP, to enhance public perceptions and understanding of shellfish aquaculture practices and development. There is a burgeoning need for a change in the representation of the issues themselves. Bardwell (1991) presents a management framework for re-framing an issue, which seeks to encourage rather than undermine community involvement and action. How the community perceives the problem has a profound effect on how solutions are accepted and guides the strategies and actions needed to address the problem. One aspect of the process of re-framing the problem includes personalization (Bardwell 1991). When a person or community feels attached to or part of a problem, they begin to feel ownership for their actions. Further, issues that impact important aspects of everyday life are difficult to ignore. Changing the way a problem is perceived to include more personal and community ownership may lead to more involvement and tangible solutions (Bardwell 1991). Incorporating tools, like Aquamedia, into CMSP from the very beginning can draw attention to the decision making process and bring those interest groups in before decisions have been made.

VII. Conclusion

Shellfish growers in Puget Sound have overcome many challenges throughout the last century, and continue to face barriers to expansion and growth of the industry. CMSP has the potential to be a strong platform for spatial management of our coastlines and marine waters. However, integrating the alternative tools and strategies identified in this thesis may increase the possibility of overcoming the barriers to the shellfish industry and greatly enhance and reinforce the effectiveness of the overall CMSP framework.

An evaluation of these tools and strategies reveals the importance of a locally or regionally-based focus for spatial planning, yet still incorporating state-level policies and consistency with state and federal regulations. A framework for Washington needs to focus on increasing stakeholder involvement, integrating with shoreline management

plans, improving communication and outreach efforts, and ensuring transparency and legitimacy. There should be an attempt to reframe the issue of managing our coastal zone to truly reflect individual community needs and local involvement. With that being said, it is also important to recognize that all of this is not a trivial effort, should not be taken lightly, and will require a lot of work and dedication from government and industry alike. Ideally, these recommendations will be a part of the planning and implementation process, and will lead to greater cooperation and political buy-in. Integrating these concepts into Washington's CMSP framework will open up new opportunities for the shellfish industry, create new partnerships for coastal management, and benefit the industry, economy and health of Washington State.

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