

EVALUATING SOCIOECONOMIC DIMENSIONS FOR A RESILIENT
SHELLFISH MARICULTURE INDUSTRY IN HUMBOLDT BAY: ASSESSING
THE STRENGTHS, VULNERABILITIES, AND POTENTIAL OF HUMBOLDT'S
EXPANDING INDUSTRY

By

Wyatt G. Smith

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Committee Membership

Dr. Laurie Richmond, Committee Chair

Dr. Yvonne Everett, Committee Member

Dr. Joe Tyburczy, Committee Member

Dr. Yvonne Everett, Program Graduate Coordinator

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ABSTRACT

EVALUATING SOCIOECONOMIC DIMENSIONS FOR A RESILIENT SHELLFISH MARICULTURE INDUSTRY IN HUMBOLDT BAY: ASSESSING THE STRENGTHS, VULNERABILITIES, AND POTENTIALS OF HUMBOLDT'S EXPANDING INDUSTRY

Wyatt G. Smith

For nearly 90 years the shellfish mariculture industry in Humboldt Bay has coexisted with various stakeholder groups and the Bay's delicate ecology. Presently, the shellfish mariculture industry in Humboldt Bay is composed of six shellfish producing businesses ranging in operational size from small-scale to large-scale. Commercial shellfish production from Humboldt Bay yields over 70 percent of California's mature, market-sized, Pacific oysters (*Crassostrea gigas*) and Kumamoto oysters (*C. sikamea*). Shellfish growers in the Bay also produce seed from Pacific oysters, Kumamoto oysters, and Manila clams (*Tapes semidecussata*).

As the mariculture industry in Humboldt Bay is poised to expand its footprint, very limited data about the industry have been made available for planners and decision makers. The purposes of this thesis were to: (1) Gather reliable socioeconomic data about the state of the mariculture industry in Humboldt Bay. (2) Evaluate the industry's strengths and vulnerabilities. (3) Assess the priorities for the industry moving forward. (4) Provide an objective, accurate picture of the mariculture industry in the Bay for the purpose of clarifying how the mariculture industry operates and showing the industry's

economic contribution to the region. To achieve these goals, I used a mixed-methods approach consisting of semi-structured interviews with mariculture participants and other Bay stakeholders, a socioeconomic survey of mariculture businesses, document analysis, participant observation, and public workshops. Analysis of collected data showed that the mariculture industry in Humboldt Bay has many strengths. In 2016, the mariculture industry employed 101 people. These participants harvested over 9.5 million mature oysters and brought in \$9.8 million in revenue. In addition to the mariculture industry's strengths, mariculture participants were met with specific challenges that represent vulnerability for the future resilience of the industry. Challenges or vulnerabilities expressed by the mariculture participants included: obtaining permits, procuring seed, and the opposition from non-mariculture community members regarding expansion in Humboldt Bay.

Seed production is an important and growing part of the mariculture industry in Humboldt Bay and an area for future development. The burden of permitting and the conflict between stakeholders of Humboldt Bay should be addressed in order to expand the industry's grow out grounds. In addition, it would also benefit the mariculture participants to work to address concerns from the environmental and scientific community about the impacts of oyster cultivation on the environment -- particularly eelgrass. Until concerns about eelgrass are studied and addressed in proposals for mariculture operations, permitting and expansion may continue to be challenges for the industry. Overall, the Humboldt Bay mariculture industry has many strengths and

improvements in some areas can increase the resilience and sustainability of the industry over time.

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1.0 INTRODUCTION AND RESEARCH QUESTIONS

1.1 INTRODUCTION

Marine aquaculture in the United States provides jobs, contributes to the seafood supply, restores habitat, and maintains economic activity in communities in every coastal state (NOAA Aquaculture, 2016). While there are many different types of marine aquaculture, the National Oceanic and Atmospheric Administration (NOAA) has recently prioritized shellfish mariculture¹ above all other forms of aquaculture in order to grow more shellfish for food, jobs, and ecosystem services (NOAA Aquaculture, 2016). With over 300 commercial shellfish farms producing two-thirds of all mussel, clam, and oyster aquaculture sales in the United States and employing more than 3,800 people directly, the West Coast shellfish industry is a major source of employment in many economically depressed coastal communities (Pacific Shellfish Institute, 2013).

The U.S. West Coast oyster industry produces approximately \$87 million worth of Pacific oysters annually (National Aquaculture Association, 2018). Oysters and other shellfish species are cultivated in bays and estuaries along the West Coast, but Humboldt Bay in California has become a focal point of oyster mariculture in the last decade (Driscoll, 2015; Humboldt Bay Harbor District, 2017).

With the decline of commercial fishing, the oyster mariculture industry in Humboldt Bay has been growing substantially in terms of cultural identity and as a

¹ Aquaculture refers to both freshwater and saltwater-farmed aquatic species. Mariculture refers specifically to the farming of marine saltwater seafood species.

source of seafood (Pomeroy et al. 2010). In 2009, the California state legislature recognized the Humboldt Bay mariculture industry's economic and cultural importance and designated Humboldt Bay as the Oyster Capital of California (National Working Waterfront Network, 2015). Currently over 70 percent of California's oysters are produced in Humboldt Bay (Walters, 2012; Driscoll, 2015, Humboldt Bay Harbor District, 2017). The Humboldt Bay Harbor District estimated that the mariculture industry brought in approximately six million dollars to the state economy in 2012 and over nine million dollars in 2016 (California Department of Fish and Wildlife, 2016; Humboldt Bay Harbor District, 2017). While these numbers highlight the mariculture industry as an important economic contributor to the region, they are based on preliminary estimates gathered by the California Department of Fish and Wildlife and not on scientifically supported quantitative research.

The mariculture industry in Humboldt Bay is currently in a state of transition. There are two projects underway that could increase the industry's footprint within the Bay. These expansion plans included the Humboldt Bay Mariculture Pre-permitting Project and Coast Seafoods' expansion and permit renewal. In addition to these projects, knowledge of Humboldt Bay's idyllic growing conditions for shellfish mariculture production is increasing and the potential for new businesses to set up land-based hatcheries for seed and larvae production is also growing.

While the development and expansion of oyster, mussel, and clam culture can provide different types of economic benefits to the region, the operational process of shellfish farming can also be seen as competing with environmental values and different

stakeholders on the Bay. Therefore the expansion of mariculture in the Bay may reduce overall biodiversity and hinder other economically viable activities (Mitchell, 2006; Forrest and Creese, 2006; Forrest et. al, 2007; Humboldt Bay Harbor District, 2017).

There have been disputes over the mariculture industry in Humboldt Bay since mariculture production began in the 1930's, however a significant escalation in conflict with different stakeholder groups has been observed over the last decade. Stakeholder groups that have expressed concerns about Humboldt Bay's mariculture activities included the Wiyot Tribe, North Coast fishermen, waterfowl hunters, recreational Bay users, and environmental groups such as the Audubon Society and the California Waterfowl Association (Simms, 2017).

Policy makers in the Humboldt Bay Harbor District and the California Coastal Commission are poised to make important decisions about the future of the mariculture industry in Humboldt Bay. However, at present there are limited reliable socioeconomic data available about the industry. As a result, this represents a critical time to provide socioeconomic information that can assist in the sustainable development of Humboldt Bay's shellfish mariculture industry.

The purpose of this thesis is to: (1) Gather reliable socioeconomic data about the state of the mariculture industry in Humboldt Bay. (2) Evaluate the industry's strengths and vulnerabilities. (3) Assess the priorities for the industry moving forward. (4) Provide an objective, accurate picture of the mariculture industry in the Bay for the purpose of clarifying how the mariculture industry operates and showing the industry's economic

contribution to the region. It is my hope that industry participants, community members, and other researchers can use this data to inform coastal planners and policy makers in order to effectively manage the industry and avoid conflict.

During the summer and fall of 2017, I conducted over 40 semi-structured interviews with residents, recreational users, and stakeholders, with linkages to Humboldt Bay, as well as Humboldt Bay's mariculture industry participants. I also surveyed the six mariculture businesses operating on Humboldt Bay. These methods were applied with the intention of answering the following research questions:

1.2: RESEARCH QUESTIONS

1. What do participants working within the Humboldt Bay shellfish mariculture industry see as strengths and vulnerabilities of the mariculture industry?
2. How do participants in the shellfish mariculture industry relate to other users of Humboldt Bay? What are the potentials for conflicts and, or synergies with other bay stakeholders (e.g. commercial fishermen, recreational fishermen, boaters, hunters, and environmental groups)?
3. What are the baseline socioeconomic conditions of the current Humboldt Bay shellfish mariculture industry (e.g. the number of businesses, employment, landings, business strategies, suppliers, market channels) and how are those projected to change in the near-term?

2.0 STUDY SITE AND INDUSTRY BACKGROUND

2.1: STUDY SITE

Humboldt Bay is located along the North Coast of California (Figure 1). With an area of 24.1 square miles at mean high tide, it is the second largest coastal estuary in the state (California Department of Health Services, 2007). The average depth of the Bay is roughly 11 feet and it is described as a well-mixed and tidally driven estuary (Shaughnessy, 2016). Humboldt Bay is surrounded by the cities of Arcata (population 17,974 in 2017) and Eureka (population 27,226 in 2017), as well as unincorporated land within the County of Humboldt, and Wiyot Tribal Territory (US Census Bureau, 2017).

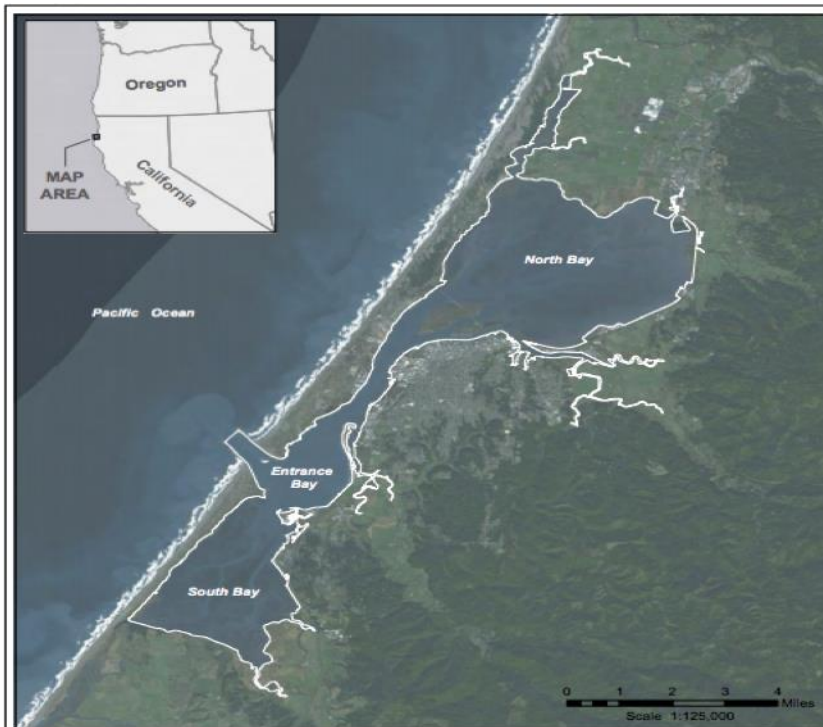


Figure 1. Humboldt Bay, California. (Merkel & Associates, Humboldt Bay Eelgrass Management Plan, 2017)

Fishing and waterfront activities in Humboldt Bay are a central part of the community's economic, social, and cultural fabric (Pomeroy et al. 2010). Between the years of 2000 and 2015, nearly 206 million pounds of fish were landed from commercial fishing operators in the port of Eureka, estimated to be worth over 200 million dollars (Hackett et al., 2017). Humboldt Bay offers a myriad of recreational uses that include, but are not limited to kayaking, hiking, swimming, birding, surfing, hunting, and recreational and charter fishing. All of these uses contribute to the local economy and community (Humboldt Bay Harbor District, 2017).

There are six shellfish mariculture businesses operating in Humboldt Bay. Four of the companies are commercial shellfish harvesters and two of the companies operate as shellfish seed nurseries. Coast Seafoods Company, Humboldt Bay Oyster Company, Aqua Rodeo Farms, and North Bay Shellfish Company cultivate mature, market-sized, single, clutchless oysters and small numbers of mussels. Taylor Mariculture produces both oyster and clam seed. Hog Island Oyster Company produces both oyster and clam seed, and also plans to produce oyster and clam larvae in a hatchery setting by 2019. It is also possible that there could be a seventh mariculture entity active on the Bay in the near future, as there is currently one applicant, known as Yeung Oyster Company attempting to permit shellfish culture in Humboldt Bay (Humboldt Bay Harbor District, 2017). The existing permitted shellfish growing areas are located in the northernmost segment of Humboldt Bay, known as “North Bay”, or “Arcata Bay” (Figure 2). Hog Island Oyster Company has only a small area near their dock and their footprint is not represented in this figure.

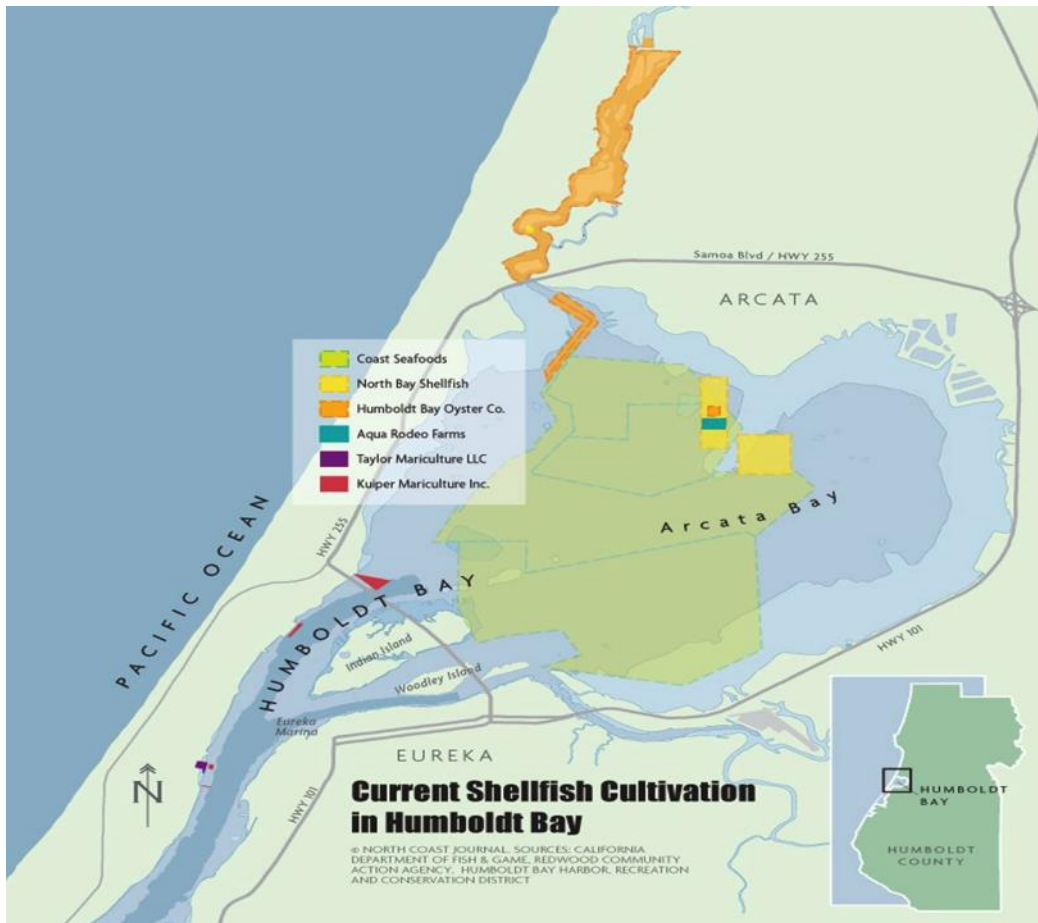


Figure 2. 2012 Mariculture Footprint in North Bay (H. Walters, 2012)

All of the adult shellfish produced in Humboldt Bay are typically grown while suspended in the water column on horizontal long-lines or on the substrate in mesh bags. Commercial shellfish production in North Bay is primarily Pacific oysters (*Crassostrea gigas*) and Kumamoto oysters (*C. sikamea*). Some cultivators also produce small numbers of Mediterranean or “southern” bay mussels (*Mytilus galloprovincialis*) (Humboldt Harbor District, 2017).

2.2: HISTORICAL BACKGROUND AND CONTEXT: THE HUMBOLDT BAY SHELLFISH MARICULTURE INDUSTRY

The history of shellfish mariculture in Humboldt Bay dates back hundreds of years. Long before the arrival of Europeans, the North Coast of California provided the members of the Wiyot Tribe with an abundance of shellfish (Coy, 1975). People have harvested oysters from Humboldt Bay since Native Americans first coexisted with the estuary (Walters, 2012). However, it wasn't until the 1850's that shellfish were found to be profitable in Humboldt Bay by colonial settlers. In 1854 L.K. Wood discovered high quality clams on the shores of his ranch near Union (Arcata) and sold them locally (Coy, 1975). Nearly 20 years later in 1873, hundreds of sacks of clams were being exported from Humboldt Bay to San Francisco at two dollars per sack (Coy, 1975). The oldest record indicates that the first attempt at oyster mariculture in Humboldt Bay was in 1897 when, "several carloads of oysters" were planted in the Bay, but many of the oysters were lost because, "they did not prepare beds, merely placing them (oysters) in soft mud, consequently over half of the oysters were smothered" (Coy, 1975). Data suggest that there have been attempts to cultivate four different species of oyster in Humboldt Bay since the turn of the 20th century. They included Humboldt Bay's native oyster, known as the Olympia oyster (*Ostrea lurida*), the Eastern, or Atlantic oyster (*Crassostrea virginica*), the Japanese, or Pacific oyster (*Crassostrea gigas*), and the Kumamoto oyster (*Crassostrea sikamea*) (Barrett, 1963).

The mariculture industry, as we know it today, began in 1931, when committee members of the North Coast Council of the State Chamber of Commerce in Humboldt

and Sonoma counties, as well as an “oyster expert” and biologist by the name of Harvey C. McMillian reported that, “conditions were found to be very favorable for the cultivation of Native oysters” (Humboldt Standard, 1931). Within a few days of the published report that declared “over 1000 acres of tideland suitable for native oyster cultivation”, two companies (Eureka Oyster Company and Humboldt County Growers Association) began scouting out areas in Humboldt Bay, “preparing to operate on an extensive scale” (Humboldt Standard, 1931).

Efforts to raise Pacific oysters in Humboldt Bay began in 1953 when 20 cases of oyster seed were planted on a lease in northern Arcata Bay (Barrett, 1963). The initial planting experiment was successful and in 1954 over 100 cases of Pacific oyster seed was planted in the same allotment. The commercial oyster farming industry in Humboldt Bay was then developed the following year in 1955 by what is now known as *Coast Seafoods Company* (formerly known as Coast Oyster Company) (Barrett, 1963). Large-scale plantings were initiated in Arcata Bay in 1955 when “8200 cases of oyster seed imported from Japan was spread out in Humboldt Bay” (Humboldt Standard, no date) and today, Coast Seafoods has achieved a scale of operations and a level of production far greater than any other California based oyster grower (Wagshal, 2016).

The first of many controversial issues surrounding the present day shellfish mariculture industry took place in the early 1960’s. The complications stemmed from the methods used to cultivate oysters in the mid-1900s. Though its environmental impact is still one of the most controversial aspects of shellfish mariculture in Humboldt Bay, current practices have far lower environmental impact than those used historically. Historically, the most

common means of growing oysters in Humboldt Bay was ground culture – spreading juvenile oysters directly on the mudflats (Barrett, 1963). Practices involved in this method of growing oysters had numerous environmental impacts. Empty shell and rock was spread on the mudflats to harden them prevent the oysters from sinking into and being smothered by the mud, but this inhibited eelgrass growth in these areas. Bottom-feeding predators, especially bat rays, were killed in large numbers to reduce their consumption of cultivated oysters (Humboldt Standard, 1960; Barrett, 1963; Walters, 2012). Starting in 1956, growers in Humboldt Bay began using a suction dredge to reduce the labor required to pick up juvenile and adult oysters from the mudflats (Barrett, 1963), however this caused major disturbance to eelgrass. The dredge was run in a spiral pattern and the resultant circular plots with little eelgrass were still visible in aerial imagery years after this practice was ceased. To make matters worse, ground culture also made it very easy for poachers to steal oysters (Humboldt Standard, 1960), though this remains an issue for the current industry.

By the end of 2003, regulators including the Army Corps of Engineers and the California Department of Fish and Wildlife required shellfish growers to change their operational methods in the Bay (Walters, 2012). Growers were no longer allowed to use ground culture, and were instead required to grow them suspended or contained off the bottom using long-lines, rack-and-bag, or other methods (Walters, 2012). Suspending oysters off the bottom had the important advantage that “the oysters (were) able to feed freely on the plankton, not endangered by the creeping silt that might choke them on the sea’s floor” (Humboldt Standard, 1960). Further, these new methods make it significantly

harder for bat rays and other predators to prey on cultivated oysters and they do not require hardening or dredging in the eelgrass beds (Humboldt Bay Harbor District, 2017). While these off-bottom techniques had been introduced from Japan and Korea previously (Humboldt Standard, 1944) they were not the major means of production in Humboldt Bay until after regulations were changed starting in 2003. Along with these new regulations came increased scrutiny of environmental impacts and a more involved permitting process, which has led to concerns within the industry about affordability (Walters, 2012).

In 1944 Will Speegle, a writer for the Humboldt Times wrote, “Who can tell now, even though so many ventures have seemingly failed, but that oil and oysters may be developed to a very large extent in the future and become among our very best commercial operations” (Humboldt Times, 1944). Today, oysters from Humboldt Bay are served in restaurants all over the world, which is in stark contrast to oyster sales in the 1940’s, when the only market outlets were in San Francisco, or found locally in Eureka and Arcata. In 2009 Humboldt Bay was named the “Oyster Capital of California” by the state legislature (Harbor District, 2017).

Presently, the mariculture industry is in a state of transition with two expansion projects currently under consideration. Under the first expansion project, the Humboldt Bay Mariculture Pre-permitting Project, the Humboldt Bay Harbor District would obtain permits in Humboldt Bay’s intertidal zone and sublease the pre-permitted tidelands to shellfish growers. This project would benefit small-scale shellfish growers, as the process of permitting and the current regulatory climate within the shellfish mariculture industry

continues to be a primary constraint to the industry's expansion (Lavoie, 2009). The Humboldt Bay Harbor District will assume all regulatory risk associated with the pre-permitted grounds. At this time, the only part of this pre-permitting project that has been approved are three sub tidal grounds and these sites are currently occupied by Floating Upwelling Systems (FLUPSYs). The remaining sites that were intended for mature oyster cultivation have yet to be approved and the process has been held up for various reasons (National Working Waterfront Network, 2015).

The second mariculture expansion project currently happening in Humboldt Bay is Coast Seafoods' lease extension and expansion *permit No. 14-03*. After an arduous process that resulted in the reduction of Coast Seafoods grow-out grounds, the permit was approved by the California Coastal Commission in August of 2017. This coastal development permit allows Coast Seafoods to increase their shellfish cultivation effort under multiple stipulations; including a requirement that the company create monitoring plans for eelgrass, black brant, and herring (Houston, 2017). The permit also requires Coast Seafoods Company to limit operations during brant hunting season, monitor and cleanup their equipment, and create a plan for transit lanes to reduce potential impacts of boats and barges on wildlife (Houston, 2017). Most importantly, Coast Seafoods' permit specifies that the company mitigate their spatial use in the Bay and submit an annual report on the status of their oyster beds and harvest records (Humboldt Bay Harbor District, 2017). The permit requirements are a result of the opposition and dissatisfaction that stakeholders and other community members expressed for this expansion project during the spring of 2017.

This conflict over Coast Seafoods' expansion is rooted in the environmental setting of mariculture operations happening in conjunction with the eelgrass ecosystem of Humboldt Bay. Eelgrass is a critical component to any estuary, but has been declining globally (Gilkerson, 2008; Wiseheart et. al, 2007). One of the biggest threats to eelgrass function in Humboldt Bay is reduced or absence of light due to suspended sediment and shading from structure (Dennison and Alberte, 1982). There are concerns that shading from structures and equipment used in the mariculture could negatively affect eelgrass populations in Humboldt Bay. Equipment from the current method being used by mariculture operators in the Bay -- cultch and basket long line – could reduce the quality of light reaching the eelgrass below (Shaughnessy et al., 2015). Due to scientific uncertainty about the impact of mariculture operations (and shading from those operations) on eel grass populations, scientists and environmental groups have expressed grave concerns about expanding the footprint of mariculture operations, particularly in parts of the Bay with eelgrass (Shaughnessy et al., 2015). Conflict related to this project became rather significant in the summer of 2017 and will be explored in the vulnerabilities and challenges section of my discussion chapter in this thesis.

3.0 LITERATURE REVIEW

Overall, this thesis draws from three different bodies of literature, which include: coastal resilience, shellfish mariculture production in the United States, and marine spatial planning to avoid conflict in the coastal zone.

3.1 COASTAL RESILIENCE

The word "resilience" is increasingly being used as a way of attempting to understand the ever changing and dynamic nature of ecosystems (Walker and Salt, 2006; Folke et al, 2010). The term "ecosystem goods and services" has become linked with resilience and the term is used to define the benefits that people obtain from ecosystems. In the case of the marine ecosystem, its associated goods and services provide tremendous economic value and human well being (Vollstedt and Graterol, 2009).

Ecosystem resilience is defined as the amount of disturbance that an ecosystem can withstand without changing self-organized processes and structures, and can be considered as a return time to a stable state following disturbance or perturbation (Gunderson, 2000; Walker and Salt, 2006; Folke et al, 2010). Patrice Guillotreau asserts that the concept of resilience must be understood in several dimensions (static and dynamic and ecological and social), which has proven to be rather complex (Guillotreau et al, 2017).

Timothy Beatley applies the concept of resilience to coastal communities as a way of helping planners and coastal community members anticipate and prepare for the uncertain future. The author asserts that there are four different components of coastal resilience. They include (1) social; (2) economic; (3) ecological; (4) the built environment (Beatley, 2014). Guillotreau et al. (2017) conceives that a coastal communities' resilience is best understood as a function of its social systems and networks and its levels of social and community support.

Beatley's components of coastal resiliency can be applied to the Humboldt Bay shellfish mariculture industry. The social component of coastal resilience of the mariculture industry is observed in the relationships and interdependency among the shellfish growers themselves, as well as with the relationships with other stakeholders on Humboldt Bay, and the industry's policy makers. The economic component of coastal resilience of the mariculture industry is seen through the industry's contributions of shellfish production, revenue, and market penetration. The ecological component of coastal resilience of the mariculture industry is observed in the overall ecological health of Humboldt Bay and its water quality. The ecological component of resilience within the mariculture industry also appears in the conflict surrounding eelgrass function. The built environment component of coastal resilience of the mariculture industry is seen as the facilities in which shellfish farmers depend on for storage, shellfish seed and larvae production, and refrigeration. In addition the component of the built environment can be seen in the industry's grow out grounds, equipment, and zoning issues.

The coastal community surrounding Humboldt Bay, and its shellfish mariculture industry could benefit from the application of resilience planning and a resilience based framework. Carl Folke et al. (2010) addresses resilience and vulnerability in social-ecological systems. The author asserts that vulnerability is the opposite of resilience and states that when a community is vulnerable, there are consequences for both the social and ecological components of the system.

Research regarding resilience and vulnerability in the mariculture industry from a social science standpoint is lacking. There have been very few studies that encompass mariculture participant needs and concerns in relation to coastal and community resilience. Using the data collected from mariculture participant interviews regarding their perceived industry challenges and vulnerabilities, coupled with data from socioeconomic surveys about future concerns and threats, I aim to address the needs of research on the vulnerability that has been observed by social-ecological change in Humboldt Bay (Beatley, 2014).

Applying the concept of coastal resilience as the primary design and planning principle to guide all future development and all future social, economic, ecological, and infrastructure decisions within Humboldt Bay's shellfish mariculture industry will not only benefit the human-dominated systems, but also Humboldt Bay's delicate ecosystems (Beatley, 2014; Guillotreau et al, 2017).

3.2 MARICULTURE IN THE UNITED STATES

The majority of the literature related to the socioeconomic dimensions of the mariculture industry fall into three categories: (1) Documentation of the economic impact of the industry; (2) ecological impacts of the industry; (3) stakeholder analysis of the industry.

3.2.1 Economic Impact

The literature related to the socioeconomic dimensions of the mariculture industry is dominated by reports and articles that highlight the economic impact of the mariculture industry as a whole (Yang, 2016; Northern Economics Inc., 2013).

Scholars like Yang (2016) and the preparers at Northern Economics Inc., (2013) rely primarily on general business surveys and interviews with key industry informants from mariculture regions along the West Coast to gather data. One of the most important categories in the aquaculture industry globally is the production of molluscan shellfish species, which make up roughly 25% of all farmed production and 60% of marine aquaculture production globally (Yang et. al., 2016; FAO, 2014). The Food and Agriculture Organization of the United Nations (FAO) estimates that over 60 percent of the total annual production from molluscan mariculture is made up of clams and oysters (FAO, 2014).

In 2013, mollusks ranked second behind food fish in the largest category of aquaculture in the United States by sales revenue at \$328 million (USDA, 2014). Molluscan shellfish production signified one of the largest growth categories in

aquaculture, growing by 62 percent from 2005 to 2013 (USDA, 2014). The largest revenue source within the molluscan shellfish sector was from oyster sales, with the Eastern oyster dominating Atlantic Ocean production at 20.8 percent and the Pacific Ocean oyster dominating Pacific Ocean production at 26.4 percent (Yang et. al., 2016; FAO 2014). Revenue from producing Pacific oysters through mariculture methods generated \$87 million in total sales in 2014 (Yang et. al., 2016; FAO, 2014; PCSGA, 2018).

Washington State is the leading producer of maricultured shellfish in the U.S. with nearly half of total sales. California ranks fifth in production behind Connecticut, Florida, and Virginia (Yang et. al., 2016). Regarding oysters; Bays and estuaries are being utilized along both coasts in the United States for cultivation, but Humboldt Bay located along the North Coast of California has become increasingly important for oyster mariculture in the last decade (PCSGA, 2018; Humboldt Bay Harbor District, 2017).

According to data provided by the California Department of Fish and Wildlife (CDFW), total revenues for California's oyster mariculture industry in 2016 amounted \$15.8 million. The two largest regions for mariculture production in California are Humboldt Bay and Tomales Bay (Lavoie, 2009), with Humboldt Bay accounting for roughly \$10 million of the total revenue for the state (CDFW, 2016).

However, while researching socioeconomic literature on mariculture in Humboldt Bay, it has become apparent that this region is understudied. Not only is there very little data on Humboldt Bay's mariculture industry, but the existing economic data gathered by

the California Department of Fish and Wildlife are based on shellfish harvest estimates and are unreliable (CDFW, 2016).

3.2.2 Ecological Impacts

Ecological effects from shellfish farming operations have been documented (Mitchell, 2006; Gibbs, 2007). The literature on shellfish farming impacts is dominated by accounts of effects on the sea floor, directly below active maturation grow-out and culture areas (Mitchell, 2006; Forrest and Creese, 2006; Forrest et. al, 2007). The literature describing the ecological effects of mariculture production on the marine environment on the East Coast of the United States is dominated by reports about ecological carrying capacity (Mitchell, 2006; Gibbs, 2007; Forrest et al, 2007; Newell and Richardson, 2014). Studies on the ecological impacts of mariculture along the West Coast primarily recognize potential industry effects on seagrass function (Rumrill and Poulton, 2004; Wischart et. al, 2007; Dumbauld et. al, 2009; Dumbauld and McCoy, 2015). While these scientific studies acknowledge that shellfish mariculture production can have benefits and drawbacks for the marine environment, they fall far short of providing a comprehensive understanding of environmental effects of the industry, as well as providing epistemic accounts from the mariculture participants.

Furthermore, the literature does not address potential ecological issues specific to seed and larvae expansion. Land-based hatcheries use cultured marine algal species as the principal food supply during the early conditioning stages, and larval process for molluscan shellfish seed production (FAO, 2018). The second stage of conditional grow-

out for molluscan shellfish occurs in Floating Upwelling Systems (FLUPSYs), usually conducted in the water directly adjacent to the hatchery site.

In the FLUPSY stage, molluscan shellfish seed derive their nutrition by filtering and processing suspended particulate matter (SPM), including detritus, inorganic particles (e.g., fine sediment), and phytoplankton and zooplankton from the water column (Forrest et. al, 2007). Therefore it is possible that shellfish seed and larvae hatcheries, no matter the scale, can contribute to the depletion of naturally occurring food sources. Large-scale cultivation levels of SPM filtration may affect not only shellfish crops, but also natural populations of filter feeders and the wider ecosystem (Forrest et.al, 2007).

However, while diminution of zooplankton are documented as ways in which oyster mariculture may affect the food web in estuarine or coastal ecosystems, there is no conclusive evidence of this in relation to seed and larvae production (Forrest et. al, 2007). Gathering robust scientific data about the effects of seed and larvae production and carrying capacity is beyond the scope of this study, but merits further research to contribute to understanding the impacts of Humboldt Bay's expanding industry.

3.2.3 Stakeholder Analysis of the Industry

Few scholars (Hansen, 2016; Mabardy et al., 2015; Conway et al. 2010; Guillotreau et al., 2017) address the shellfish mariculture industry's strengths and weaknesses from the perspective of mariculture participants and other stakeholders.

Mabardy et. al, (2015) studied the West Coast oyster industry in relation to how shellfish farmers perceive climate change, ocean acidification, and management. The author asserts that there has been a shift in marine resource management toward a holistic approach that integrates stakeholder insight with the implementation of coastal policy (Mabardy et. al 2015).

There are very few studies that focus on how mariculture participants perceive their place. Documenting the perspectives of the participants in their own words about what is working and what is not working can provide planners with valuable information based on local knowledge to improve the industry. The Humboldt Bay shellfish mariculture industry merits a study that encompasses stakeholder input about the mariculture industry's strengths and vulnerabilities coupled with concrete economic data. This thesis is intended to help managers and shellfish business owners to anticipate opportunities and threats to their expanding industry and plan accordingly for the future of shellfish culture in Humboldt Bay.

Using quantitative survey data with qualitative interviews gathered from Humboldt Bay's mariculture participants I aim to provide a holistic picture of the shellfish mariculture industry in Humboldt Bay. This approach is unique in that it takes into account the needs and concerns of the mariculture participants, with non-mariculture related stakeholder input. This study addresses what it is like to participate in Humboldt Bay's understudied mariculture industry. In addition, this study attempts to understand where conflict and tension exist and focuses on shellfish farmer's perceived challenges and threats going forward.

3.3 MARINE SPATIAL PLANNING AND POTENTIAL FOR CONFLICTS IN THE COASTAL ZONE

There is a large body of literature on various uses and conflicts over uses of the coastal zone called marine spatial planning (MSP). According to Flannery et al. (2018), MSP offers a way of communizing the coastal zone. Through active stakeholder participation, local knowledge about a circumstance can be integrated into the planning process (Flannery et al. 2018). Other scholars like Sanchez-Jerez et al. (2016) and Filgueira et. al, (2014) assert that MSP pursues rational decisions that seek to reconcile the concerns of multiple users of the marine environment with management goals in a sustainable fashion (Sanchez-Jerez et al. 2016; Filgueira et. al, 2014; Flannery et. al, 2018).

The coastal zone in any given area, is subject to competing claims between its different users and stakeholders (Tiller et al. 2012; Le Tissier et al. 2010). According to Sanchez-Jerez et al. (2016) usable space for mariculture activities in coastal zones is now becoming increasingly limited. Tiller et al. (2012) stated that the expansion of aquaculture into coastal areas represents the reallocation of common pool resources into private hands, which excludes others and creates a potential for conflict in the coastal zone. Tiller et. al, (2012) examined aquaculture expansion in Norway. The authors asserted that the local government lacked the knowledge to make informed decisions because they did not use a participatory approach that included stakeholder input during their planning process (Tiller et. al, 2012). While this is just one example of how

ineffective management of the coastal zone can lead to conflict, there are many more articles that show that a participatory approach is necessary for planning in order to reduce conflict in the coastal zone (Tiller et. al, 2012; Filgueira et, al. 2014; Sanchez-Jerez et al. 2016).

In order to plan for a resilient mariculture industry in Humboldt Bay, conflict must be reduced between the mariculture participants and those who oppose mariculture. While dominant narratives surrounding planning are often closely tied to notions of objective scientific processes (Chuck and Dhanju, 2013), there is a growing body of literature suggesting that understanding stakeholder's perceptions is critical to the success of planning, and that a participatory process can bring together competing interests and values and assist management in making informed decisions (Collie et al. 2013; Filgueria et. al, 2014; Sanchez-Jerez et. al, 2016).

The potential ecological effects from the shellfish mariculture industry on eelgrass beds (Rumrill and Poulton, 2004; Wisheart et. al, 2007), as well as the industry's effect on hunting activity and recreational mobility within the Bay have become a spatial conflict in Humboldt Bay.

Sanchez-Jerez et al. (2016) and Flannery et al. (2018) view MSP as a participatory approach that involves a variety of stakeholders including state and local planners and managers. Adding the perceived needs and concerns from the shellfish mariculture participants to the MSP process creates a planning approach in the form of a public process aimed at achieving ecological, economic, and social objectives to assist in

achieving community and coastal resilience (Tiller et al. 2012; Le Tissier et al. 2010; Sanchez-Jerez et al. 2016; Flannery et al. 2018).

The MSP planning and marine spatial conflict literature can help inform research into Humboldt Bay's mariculture industry. The industry is currently undergoing discussions and conflicts related to its spatial presence in the bay. Waterfowl hunters are concerned that mariculture operations impinge upon their hunting grounds and many have opposed spatial expansion of the industry. Additionally, environmentalists, scientists, and fishermen have expressed concerns about mariculture operations expanding into areas with eelgrass. The MSP planning literature can provide insights into the nature of these spatial processes as well as planning processes that might be effective for managing the industry along with other uses of the bay into the future. In doing so, priorities can be assessed and used to inform coastal planners and policy makers for the purpose of effectively managing the industry moving forward, avoiding conflict, and contributing to coastal resilience.

4.0 METHODS

I utilized a mixed-methods approach in this research. These methods were implemented in order to seek potential solutions that could contribute to additional resilience within the mariculture industry. I analyzed data through qualitative and quantitative methodologies, with an aim to identify key conflicts, vulnerabilities, and needs that are specific to individuals within the mariculture industry. The following methods were applied in my research between December 2016 and December 2017: A business survey of businesses, semi-structured interviews, planning workshops, participant observation (public meetings, dock visits, conversations, industry operation visits), and document analysis.

4.1 BUSINESS SURVEY

I distributed a survey to the six shellfish mariculture companies that currently operate in Humboldt Bay. This business survey was designed to collect rigorous data about the baseline socioeconomic conditions of the shellfish mariculture industry in Humboldt Bay. The goal of the survey was to provide a rough outline of the economic contributions of the mariculture industry to the region and to gather data that could speak to the economic realities of operating an aquaculture business in the region. I also used this survey to gather baseline socioeconomic data about the industry that could be used to monitor change in the industry over time and that could possibly be used to predict the economic impact of future proposed changes to the industry. We chose to collect socioeconomic information from the 2016 shellfish mariculture season because the

industry participants all agreed that the 2016 season was an average year in terms of production. It is also important to note that the year 2016 was significant because it was Coast Seafoods' final full season before their permit expired in August of 2017 and the ensuing conflict surrounding Humboldt Bay's mariculture industry during the summer of 2017.

One hundred percent of the surveys distributed were returned with 2016 data, however not all businesses answered every question on the survey. In the business survey we asked questions about employment, expenses, production, sales, equipment, and other aspects of running a mariculture operation. A full list of the survey questions is contained in Appendix A. The Humboldt Bay shellfish mariculture business survey was adapted from the Pacific Shellfish Institute's Economic Impact of Shellfish Aquaculture in Washington, Oregon, and California in April 2013; and from the Virginia Marine Resources Commission 2013 Aquaculture Survey. The results of the survey have been aggregated to describe the conditions of three or more businesses combined, meaning that we did not report out data from returned survey answers that contain information from fewer than three businesses.

4.2 SEMI-STRUCTURED INTERVIEWS

I completed 40 semi-structured interviews with stakeholders connected to the Humboldt Bay mariculture industry. The goal of the interviews was to develop a comprehensive understanding of the socioeconomic and political dimensions of Humboldt Bay's mariculture industry (Table 1). These interviews were completed as part

of an ongoing project that I was involved with at Humboldt State University. As a research associate for the Fishing Community Sustainability Plan for the Port of Eureka, I, along with two other colleagues conducted these interviews.

Of these 40 interviews, 21 were conducted with mariculture participants. These interviews were done with the owners, managers, and operators from the six mariculture operations in Humboldt Bay, as well as with shellfish buyers and distributors in Eureka, a support business owner in Samoa, and a consultant representing a potential new mariculture business. I also interviewed government officials responsible for overseeing the mariculture industry. These interviewees included members of Eureka's City Council and commissioners of the Humboldt Bay Harbor District.

I also interviewed 19 stakeholders of Humboldt Bay with no affiliation to the mariculture industry. These interviews were completed with the purpose of developing an understanding of how these individuals relate to the local mariculture industry and to identify current and potential vulnerabilities and conflicts within the mariculture industry. The non-mariculture participants that I interviewed were members of the following stakeholder groups: North Coast commercial fishermen, Humboldt Bay recreational fishermen, members of different Humboldt Bay affiliated environmental groups, and representatives of the Wiyot Tribal Council. I also interviewed two waterfront property owners on Humboldt Bay and a local sea-level rise expert, who are represented in (Table 1) by the stakeholder group "other".

Table 1. Number of Semi-structured Interviews by Stakeholder Type

Type of Stakeholder:	Number of Interviews:
Mariculture Industry Participants	14
Local Government/Regulatory Body	7
Environmental Group	3
Commercial/Recreational Fishermen	11
Tribal	2
Other	3

These interviews loosely followed a set of five questions about the mariculture industry in Humboldt Bay and the working waterfront on the Port of Eureka. A few examples of the interview questions that we asked are; “In your opinion, what are the strengths of the Humboldt Bay mariculture industry?”, and “In your opinion, what are the particular difficulties, or challenges that participants in the mariculture industry face in Humboldt Bay?” A full list of the semi-structured interview questions is included in Appendix A. With the exception of two phone interviews, all of the interviews were conducted at neutral locations in Arcata, Eureka, Trinidad, and Table Bluff. Each interview typically lasted between one and two hours.

4.3 PARTICIPANT OBSERVATION: SITE VISITS TO MARICULTURE FARMS, SEAFOOD BUYERS, AND PUBLIC MEETINGS

I conducted ethnographic site visits to key industry locations. I visited four of the mariculture companies that currently operate in Humboldt Bay. These site visits helped to

provide socioeconomic information, along with details on the current method and processes used for oyster cultivation in Humboldt Bay. These site visits highlighted the major differences between seed producing and market-sized oyster producing entities. They also helped me to understand the major differences between small- scale and large-scale mariculture operations in Humboldt Bay.

In addition to touring the oyster farms, I visited two fish processors, Pacific Choice Seafood and Wild Planet, to gain a sense of the non-local market channels for Humboldt Bay produced seafood and to better understand the economic contributions of the mariculture industry in Humboldt Bay.

I also attended public meetings throughout the progression of my research. I attended Humboldt County Board of Supervisors meetings, Humboldt Bay Harbor District meetings, and one Coastal Commission meeting in which mariculture was on the agenda. I attended these public meetings in order to listen to public comments made by various users and stakeholders of Humboldt Bay that addressed the current issues surrounding the mariculture industry.

4.4 DOCUMENT ANALYSIS

Document analysis was also implemented for this research. Through the collection of secondary data related to the industry, I was able to establish a baseline to build upon and assess historical conflicts that surrounded the mariculture industry. This historical data was also helpful in measuring past, present, and future growth within the industry. Through archival research completed at the Humboldt Historical Society in

Eureka, I found multiple Humboldt Bay oyster related newspaper articles, dating back to the 1930's. I also collected over ten present day newspaper articles about the oyster industry in Humboldt Bay. In addition to the archival research and newspaper article analysis, I also read mariculture expansion and permit renewal environmental impact reports, initial impact reports, Coastal Commission reports, and contemporary policy documents. I also read oyster mariculture related theses and collected information from environmental agency websites, and regulatory/ government agency websites in order to gauge the current regulatory climate around mariculture. This research also required me to draw on my personal experience from oyster farming in the Chesapeake Bay, as well as other literature and documents about oyster mariculture around the United States and Canada.

4.5 MEETINGS AND WORKSHOPS

As stated in the semi-structured interview section, my research benefited from the Fishing Community Sustainability Plan (FCSP) for the Port of Eureka. During the data collection process, the FCSP team hosted two advisory committee meetings and one public workshop in Eureka. Humboldt Bay mariculture industry participants attended all three of these meetings and provided valuable input about their specific needs and solutions to their challenges.

4.6 DATA ANALYSIS

We analyzed the data from returned business surveys by using an excel spreadsheet to aggregate the answers under “the rule of three” in order to present the

findings anonymously. Using the economic impact multiplier developed by Northern Economics Inc. (2013) for California (1.97) we were able to estimate the total economic impact of the industry.

Analyzing the qualitative data required a detailed coding process. I took all of the data from the semi-structured interviews and coded it for strengths, weaknesses, and areas to invest in. I then counted the number of times each participant mentioned something new, or something similar to another participant's statements. I was then able to search for key themes in the data and pull relevant quotes to support my findings.

5.0 RESULTS

This section draws from gathered qualitative and quantitative data. First I describe the results from the business survey, followed by the findings from the semi-structured interviews, participant observation, and document analysis.

5.1 Business Survey Results

5.1.1 Employment

In 2016, the Humboldt Bay shellfish mariculture industry directly employed 98 full-time individuals and three part-time individuals for a total of 101 employees. The employees in Humboldt Bay's mariculture industry fell into a variety of categories (Table 2).

Table 2. Humboldt Bay Shellfish Mariculture Industry Employees by Type in 2016

Employee Type	Number of Employees
Owner/Operator	4
Manager/Supervisor	14
Laborers/ Farm Hands	79
Maintenance	3
Other (Farmers Market Sales Person)	1
Total	101

When asked to provide comments on anticipated change in employment over the next five years, four out of six survey respondents estimated that their established mariculture operations in Humboldt Bay would require a total of at least 32 additional full time employees and seven part time employees by 2021. Respondents specified that the potential for additional growth, production, and employment within the local industry is closely tied to the implementation of the Harbor District's pre-permitting project. Respondents also noted that hatchery and nursery operations are also likely to expand, requiring more staff. It is also probable that administrative and sales/delivery positions will increase within the industry, bringing more paid employees to the area than previously identified.

5.1.2 Tidelands

In 2016, participants of the Humboldt Bay shellfish mariculture industry reported that they collectively used 386 acres Humboldt Bay for their private shellfish grow-out grounds. Each company reported a different number for their lease rate per-acre. The industry controlled an additional 3,659 acres of Humboldt Bay that were not under cultivation.

When asked to provide comments on the anticipated changes with tidal tenure over the next five years, some mariculture respondents estimated that their operations' footprints will increase and that they will lease more acreage in Humboldt Bay for cultivation purposes by 2021. Other respondents said their operations will get smaller, or stay the same by 2021.

Data from the survey showed that the participants of the Humboldt Bay shellfish mariculture industry are expected to utilize an estimated 518 acres of Humboldt Bay in 2021. Some mariculture participants noted that eelgrass encroachment on existing grounds is going to become a bigger problem for them over the next five years. Other participants specified that some of their leased acreage could be used as mitigation, however not all the acreage that is currently leased in the tidelands is usable for farming shellfish with the currently mandated grow-out techniques. One mariculture participant indicated that interest and market demand are increasing, which will lead them, as well as other cultivators to want to expand their grow-out grounds to meet the demand.

5.1.3 Facilities and Equipment

In 2016, the participants of Humboldt Bay shellfish mariculture industry owned or leased 15 land-based buildings/facilities, totaling 77,300 square feet. Participants used 5,054 square feet of cold storage space.

When asked if their operation had sufficient cold storage space; some respondents said no, and others said yes. The managers or owners of the companies who said that their entities do not have sufficient cold storage would prefer an additional 2,200 square feet between their businesses.

In 2016, the participants of Humboldt Bay shellfish mariculture industry owned major pieces of mariculture related equipment (Table 3). When asked how often their individual operation lends major equipment to another Humboldt Bay mariculture participant, four of the six respondents said that they lend major equipment to another

entity once a year. One of the six respondents said that they lend major equipment to another entity once a month, and one of the six respondents said that they never lend major equipment to another entity.

Table 3. Total Number of Pieces of Mariculture Related Equipment in Humboldt Bay Mariculture Industry in 2016

Equipment Type	Number of Pieces
Boats/ Vessels	18
Floating Upwelling Systems (FLUPSYs)	13
Land-based Upwellers/ Downwellers	89
Tumbling/ Sorting Machines	15

It is important to note that that both FLUPSYs and land-based upwelling systems are vital pieces of equipment and there are many different types of systems ranging in materials and price. It also important to note that participants in the industry use different materials for their sorting machines and utilize different types of structures such as; sheds, warehouses, lean-to's, and garages. Therefore, one respondent may not consider what another respondent considers to be a structure; or a tumbling/sorting machine.

5.1.4 Expenses

The participants of Humboldt Bay shellfish mariculture industry had major expenses throughout the 2016 calendar year (Table 4).

Table 4. Amount of Money Spent On Expense by Type in the Humboldt Bay Shellfish Mariculture Industry in 2016

Expense Type	Estimated Expenses
Payroll	\$3,000,000

Non-wage Benefits	\$280,347
Federal Taxes	Less than three mariculture participants reported their federal taxes, therefore data from this question was not released.
State Taxes	Less than three mariculture participants reported their federal taxes, therefore data from this question was not released.
Permitting Fees	\$32,992
Environmental Monitoring Fees	\$22,520
Health Compliance Fees	Less than three mariculture participants reported their federal taxes, therefore data from this question was not released.
Facility Leases and Mortgages Fees	\$381,882
Capital Expenditures	\$2,310,866 (This number does not include debt service)
Seed and Larvae	\$4,289,767
Repairs and Maintenance	\$529,139
Insurance	\$281,448
Ice	\$42,898
Freight	\$201,883
Gas and Fuel	\$88,828
Utilities	\$217,642
Total Expenses	\$10,243,878

5.1.5 Production

In 2016, participants of Humboldt Bay shellfish mariculture industry produced mature, whole Pacific and Kumamoto oysters, as well as a very small amount of Southern Bay mussels. Participants in the industry also produced seed for Pacific and Kumamoto oysters and Manila clams but I was not able to get a full estimate of seed production across the industry (Table 5).

Table 5. 2016 Humboldt Bay Shellfish Mariculture Production

Shellfish Type	Number of Individual Pieces
Pacific Oysters (Market Size)	656,562
Kumamoto Oysters (Market Size)	9,299,170

In 2016, five of the six participants in the Humboldt Bay shellfish mariculture industry commented on how their company's oyster seed was allocated. The five companies sourced 1% of their seed from their company's operations in Humboldt Bay, 53% of their seed was produced by their company's operations outside of Humboldt Bay, and sold 46% of the seed they produced to other mariculture businesses in and outside of the Humboldt Bay region.

When asked to provide comments on the anticipated changes with seed and larvae production over the next five years, the participant's responses varied. Some respondents said they believed that their operations will likely increase their seed production and some respondents indicated that their seed production will stay fairly constant. Other respondents said they expected that there will be fluctuations in the percentages for

internal and external seed sales. One respondent noted that the consistent availability of seed and the allowable expansion of businesses in Humboldt Bay must be addressed by the regulatory agencies in the state of California.

5.1.6 Revenue

In 2016, participants of Humboldt Bay shellfish mariculture industry received revenue from sales of mature, whole Pacific and Kumamoto oysters and Southern Bay mussels. Participants in the industry also received revenue from seed sales of Pacific and Kumamoto oysters and Manila clams (Table 6).

Table 6. 2016 Humboldt Bay Shellfish Mariculture Revenue

Shellfish Type	2016 Gross Sales Value in the Humboldt Bay Mariculture Industry
Pacific Oysters (Market Size)	\$342,276
Kumamoto Oysters (Market Size)	\$6,114,231
Larvae and Seed	\$3,373,271

In 2016, three of the six participants in the Humboldt Bay mariculture industry stated that one hundred percent of their Humboldt Bay related business revenue came from activities in the Humboldt Bay region. When asked to list non-shellfish sales sources of revenue that their company generates in the Humboldt Bay region, participants stated that they engage in farm tours, company merchandise sales, subleasing acreage, and renting space on land.

When asked to provide comments on anticipated changes with revenue over the next five years, three of the six mariculture participants said they plan on attempting different mariculture goods such as; seaweed, scallops, and mussels if there is seed available. Three of the six respondents did not provide comments. One respondent noted that in order for the mariculture industry's revenue to expand, the participants would need to develop better market channels outside the local area.

5.1.7 Markets/Marketing

In 2016, only three of the six participants in the Humboldt Bay shellfish mariculture industry commented on their marketing channels. The three companies sold 42% of their Humboldt Bay produced market shellfish to restaurants, 32% to retail outlets, 6% to wholesalers, 16% directly to a customer, and 4% of their Humboldt Bay produced market shellfish to Arcata Oysterfest.

In 2016, participants in the Humboldt Bay shellfish mariculture industry purchased seed from the states of California, Washington, Hawaii, and Alaska. Five out of six participants in the Humboldt Bay shellfish mariculture industry experienced challenges in procuring shellfish seed and larvae over the last five years. Four of the six respondents stated that their major hurdle in procuring seed was the limited amount of seed made available from suppliers. One of the six respondents found that their company's major challenge with seed over the past five years had to do with the inconsistencies found in the quality of the seed and the scale of hatchery production.

Four of the six participants in the Humboldt Bay shellfish mariculture industry reported plans to get into, or increase shellfish seed and larvae production. These participants want to attempt, or increase their shellfish seed and larvae production because of the need for seed and the ability to stay relevant in the industry. Two of the six respondents did not comment.

In 2016, only three of the six participants in the Humboldt Bay shellfish mariculture industry commented on their sales and outlets. The three companies collectively sold 79% of their Humboldt Bay produced market shellfish to locations in Humboldt County and the other 21% to locations in California outside of Humboldt County. These three companies did not sell any shellfish to locations outside the state of California, or outside the United States.

5.1.8 Collaborations/Community Work

In 2016, participants in the Humboldt Bay shellfish mariculture industry were a part of various community collaborations including: the Humboldt Bay Harbor District's Pre Permitting Project, Coast Seafoods expansion project, Humboldt Bay Keeper's beach cleanup efforts, high school projects, Adopt a Highway programs, a raft culture study, a shellfish growth study, the eelgrass monitoring study, the black brandt monitoring study, a CDPH water quality and shellfish health study, a master's study at Humboldt State University, and a CSU Agriculture study.

In 2016, participants in Humboldt Bay shellfish mariculture industry collectively spent 267 employee hours per month assisting with Humboldt Bay related scientific

studies, community work, and agency and industry initiatives. It is important to note that certain companies spent much more time than other companies in assisting with non-company related initiatives.

5.1.9 Future

We asked the participants in the Humboldt Bay shellfish mariculture industry to rank (in numbered order) their top five concerns/threats related to the sustainability of their mariculture business (Figure 3).

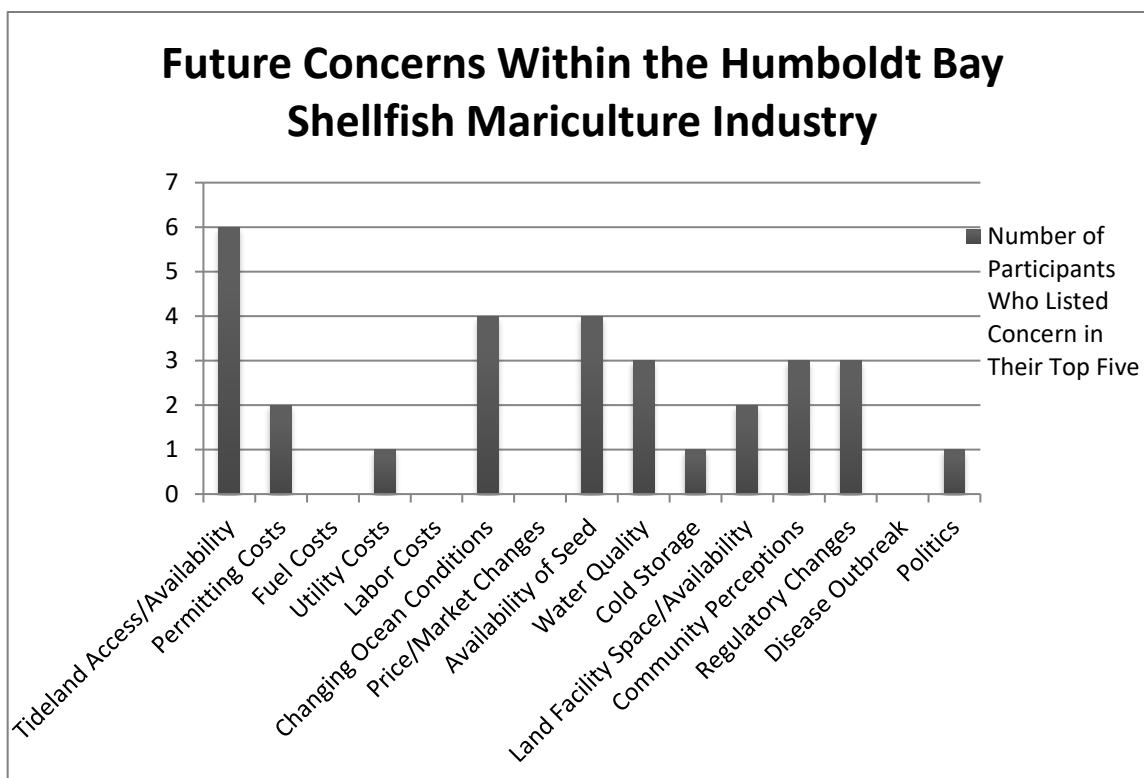


Figure 3. How Mariculture Participants Prioritized Their Top Five Concerns and Threats Related to the Sustainability of Their Businesses

When asked to provide any additional comments about anticipated and future changes over the next five years, two out of six survey respondents did not provide any

comments. One mariculture participant stated that community and regulatory changes can happen very quickly and potentially put you out of business depending on their results.

Another participant voiced their concerns about changing ocean conditions and acidification and the potential for this to be catastrophic.

5.1.10 Economic Impact/Multiplier

The shellfish mariculture industry in Humboldt Bay had estimated revenues of \$9.8 million in 2016. Utilizing the economic impact multiplier developed by Northern Economics Inc. (2013) for California (1.97) it is estimated that the 2016 total economic impact of the industry in the Humboldt Bay region is \$19.3 million.

5.2 Qualitative Results (Interviews, Participant Observation, and Document Analysis)

5.2.1 Strengths within the Humboldt Bay Shellfish Mariculture Industry

Analysis of documents, participant observation, and stakeholder interviews with mariculture participants and non-mariculture participants showed that the shellfish mariculture industry in Humboldt Bay has many strengths.

During the interview process we asked both mariculture participants and non-mariculture participants, “What is working well within the mariculture industry in Humboldt Bay”? Coding and analysis revealed that the mariculture participants mentioned eight themes in response to the interview question. Figure 4 shows the results from this question. Most notably, mariculture participants mentioned three major strengths within Humboldt Bay’s mariculture industry:

1. The relationships amongst one another within the mariculture industry.
2. Water quality within Humboldt Bay.
3. The surrounding communities' perceptions of the mariculture industry.

Coding and analysis revealed that the mariculture participants mentioned five other themes that are working well within Humboldt Bay's mariculture industry. These themes were not explored either because the interviewees chose not to expand in detail about the theme, or because I could not find information about the theme during document analysis. These themes included; business co-ops, available land-based infrastructure for seed production, family owned businesses, Arcata Oyster Festival, and the mariculture industry's economic impact in general.

The theme, "Business co-ops" refers to more than one business, or shellfish grower participating in the selling of shellfish together. "Available land-based infrastructure for seed production" refers to the surrounding land on Humboldt Bay as being valuable for future seed production. "Family owned businesses" refers to the small-scale shellfish businesses that operate in Humboldt Bay. "Arcata Oyster Festival" refers to an annual summer festival on the plaza in Arcata. "The mariculture industry's economic impact in general" refers to the annual amount of revenue that shellfish mariculture in Humboldt Bay contributes to Humboldt County.

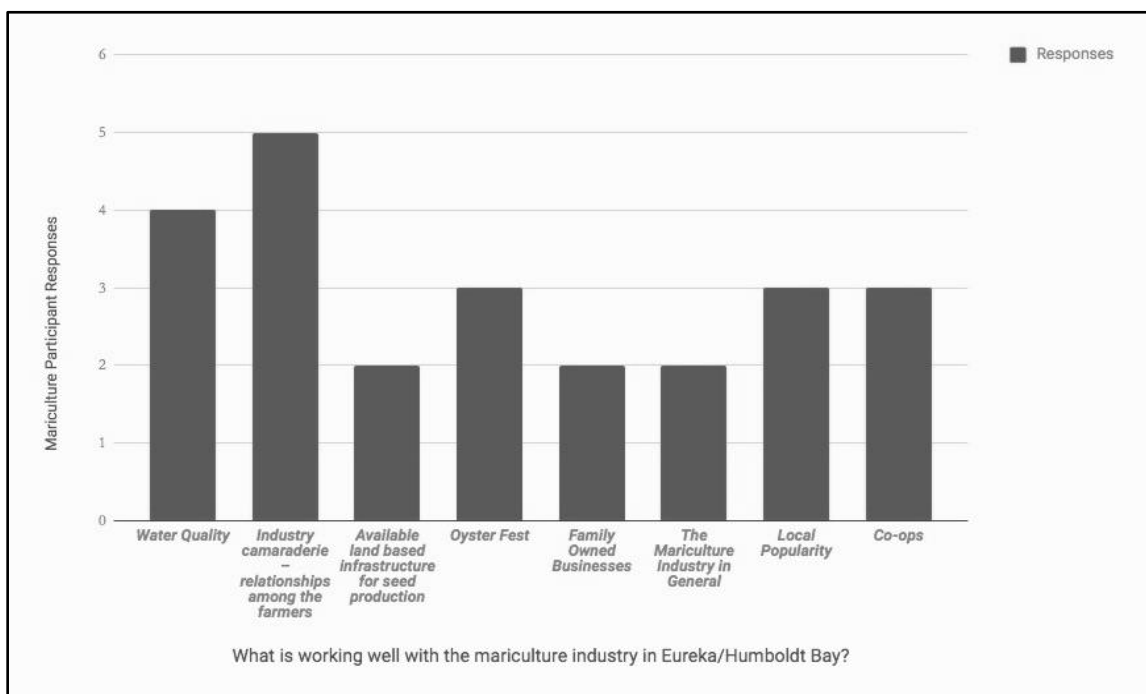


Figure 4. Mariculture Participants Responses to the Question, “What is working well within the Mariculture Industry in Humboldt Bay?”

A major strength within the Humboldt Bay mariculture industry is Humboldt Bay’s healthy water quality and ability to remain resilient. Four respondents noted that Humboldt Bay’s water quality is beneficial to the mariculture industry. One respondent said, “Humboldt Bay is a gem and more and more players are starting to figure that out. It has a clean bill of health. It is disease free and resilient.” (Interview, Shellfish Grower, 2017). Another mariculture participant pointed out that the bay’s healthy water quality was directly related to the presence of the shellfish mariculture industry. The respondent stated that, “water quality here has drastically improved because of shellfish culture” (Interview, Shellfish Grower, 2017).

In an article published in the Times Standard, the owner and operator of Humboldt Bay Oyster Company, Todd Van Herpe spoke of the environmental benefits of

shellfish mariculture. He said, "oysters serve a beneficial ecological purpose by filtering water (as much as 50 gallons a day per oyster), battling eutrophication and providing structure to the bay" (Poor, 2011).

In terms of providing ecosystem goods and services and benefiting the marine ecosystem's ability to remain resilient, shellfish farming, and particularly oyster farming, is of the highest value. Oyster mariculture is so essential to the health of some parts of the marine ecosystem that NOAA has recently prioritized it above all other forms of aquaculture in order to grow more oysters for food, jobs, and ecosystem services (NOAA Aquaculture, 2016).

Oyster farmers were not the only ones to mention Humboldt Bay's healthy water quality. John Driscoll, a writer for the Times Standard said in an article in July of 2015, "Humboldt Bay's clean water, its tides and its moderate climate make it the biggest producer of oysters in the state" (Driscoll, 2015).

Greg Dale, the manager of Coast Seafoods Company, was interviewed in the same Time Standard newspaper article and spoke of the importance of the mariculture industry and the benefits of shellfish culture on water quality. Dale said, "We are huge on water quality, we are a good industry. We are smart, resourceful with a real net positive influence" (Driscoll, 2015). In another article published in the Daily Journal in 2011, Greg Dale spoke of the importance of Humboldt Bay's shellfish mariculture industry. He said, "Humboldt Bay is extremely important to the oyster industry worldwide, the Kumamotos (oysters) are highly prized, they don't grow everywhere" (Molina, 2011).

Humboldt-grown oysters were considered to be "best-choice" by Monterey Bay Aquarium's Seafood Watch program (Monterey Bay Aquarium Seafood Watch, 2012). This designation, along with Humboldt Bay being "the oyster capital of California" has helped the mariculture industry to gain global recognition. The national popularity of oysters grown in Humboldt Bay is economically important for mariculture participants and other Bay businesses. However, for most of the mariculture participants, it is much more important to be revered by the community that surrounds their operations. One of the biggest strengths that stakeholders within the Humboldt Bay mariculture industry reported is the industry's popularity among local Humboldt County residents.

Three mariculture participants mentioned that the community's perception of the shellfish mariculture industry was something that was working well within the mariculture industry. One respondent made the following statement about their industry's popularity among Humboldt Bay's community, "The community is real receptive to oysters and the growers" (Interview, Shellfish Grower, 2017).

Another mariculture participant explained why he believed that the industry was important to local residents. He added, "Oysters and the growers are really celebrated here, I think because we do so much for the community and are good environmental stewards" (Interview, Shellfish Grower, 2017).

Non-mariculture participants also voiced support for the mariculture industry. During the Coastal Commission meeting to review Coast Seafoods' expansion permit on June 7th, 2017, Dr. Thomas Torma, the cultural director for the Wiyot Tribe said during the time allotted for public comment, "It should be noted, that the Wiyot Tribal Council

has expressed its support for sustainable mariculture in the bay. We see it as both an important part of the local economy in which the Wiyot tribe depends on and also the ecology of the bay”.

During the interview process, another non-mariculture participant noted that they supported the mariculture industry and its participants because of the positive influence and recognition of Humboldt Bay that the shellfish growers’ have contributed. The interviewee stated, “There is more and more recognition of Humboldt Bay because of oyster growers. I like the oyster guys here, they are really great and science based” (Interview, Environmental Advocate, 2017).

The interview process with mariculture participants revealed that the top strength perceived by stakeholders within the mariculture industry in Humboldt Bay; is their relationships with one another. Five shellfish growers in Humboldt Bay mentioned that their relationships with other shellfish growers in Humboldt Bay was something that worked well. One respondent made the following statement about the camaraderie within the industry, “The oyster growing community works really well together here. Tighter than anywhere I have ever been or worked” (Interview, Shellfish Grower, 2017). Another respondent said, “I love the community inside the mariculture industry” (Interview, Shellfish Grower, 2017).

While all mariculture participants compete with one another for market penetration and shellfish sales, in interviews, participants mentioned that they get along well and support each other, whether or not the business is a large-scale, or small-scale

operation. This result is made apparent through the following response, “The oyster community has worked together on so many projects in the area. There isn’t any closed competition, it is all open between us” (Interview, Shellfish Grower, 2017).

On February 28th, 2017, the Board of Commissioners for the Humboldt Bay Harbor District called a special meeting to discuss the policy decision involving the ruling on *permit 14-03*, Coast Seafoods’ proposed plan for oyster culture expansion in Humboldt Bay. Among the many residents in attendance for the meeting were the owners and managers of all six operations of Humboldt Bay’s mariculture industry, with exception of recused commissioner and manager of Coast Seafoods, Greg Dale. During time set aside for public comment, five mariculture participants from four different, and much smaller entities came up to the podium in full support of Coast Seafoods’ expansion plan.

Grace Sterner of North Bay Shellfish spoke in full support of the plan. She said,

I think I speak on behalf of our communities’ small growers that we completely support this expansion of Coast Seafoods. They (Coast Seafoods) are an amazing company. They don’t just do a lot for Humboldt Bay, but they do a lot for the community...

We (North Bay Shellfish) could simply not exist without Coast Seafoods Company because they (Coast Seafoods) are the ones who have the resources to study the eelgrass, the brant, and all that’s in Humboldt Bay. So thank you Coast, for all that you do for us (Harbor District, 2017).

5.2.2 Vulnerabilities and Challenges within the Humboldt Bay Shellfish Mariculture Industry

Analysis of documents, participant observation, and stakeholder interviews with mariculture participants and non-mariculture participants shows that industry participants see several challenges and vulnerabilities within the shellfish mariculture industry in Humboldt Bay.

During the interview process we asked both mariculture participants and non-mariculture participants, “What are the particular challenges/difficulties within the mariculture industry in Humboldt Bay?” Coding and analysis revealed that the mariculture participants mentioned 12 themes in response to the interview question (Figure 5). Most notably, respondents mentioned three major vulnerabilities that presented the biggest challenges to the future and sustainability of the mariculture industry in Humboldt Bay. These were:

- (1) Permitting and regulations within the industry.
- (2) Procuring seed and larvae.
- (3) Community opposition to expansion.

Coding and analysis revealed that the mariculture participants mentioned nine other themes in response to the question, “What are the particular challenges/difficulties within the mariculture industry in Humboldt Bay”? These themes were not explored either because the interviewees chose not to expand in detail about the theme, or because I could not find information about the theme during document analysis. These themes include; gear storage, shipping, ice/cold storage, Harbor District management, poachers,

environmental variables, operational overhead costs, not enough processors, and lack of growth in the industry.

The theme, “gear storage” refers to the challenge of being able to safely and efficiently store the large amount of gear that is required to farm shellfish. “Shipping” refers to the difficulty with shipping shellfish out of Humboldt County. “Ice/ cold storage” refers to the limited amount of available ice/cold storage in Eureka’s working waterfront. “Harbor District management” refers to the notion that the Harbor District is doing an ineffective job at managing the mariculture industry. “Poachers” refers to people stealing maricultured shellfish out of grow out grounds. “Environmental variables” refers to the challenge of working outside in an uncontrolled climate. “Operational overhead costs” refers to the amount of money business owners have to spend annually to participate in the industry. “Not enough processors” refers to the

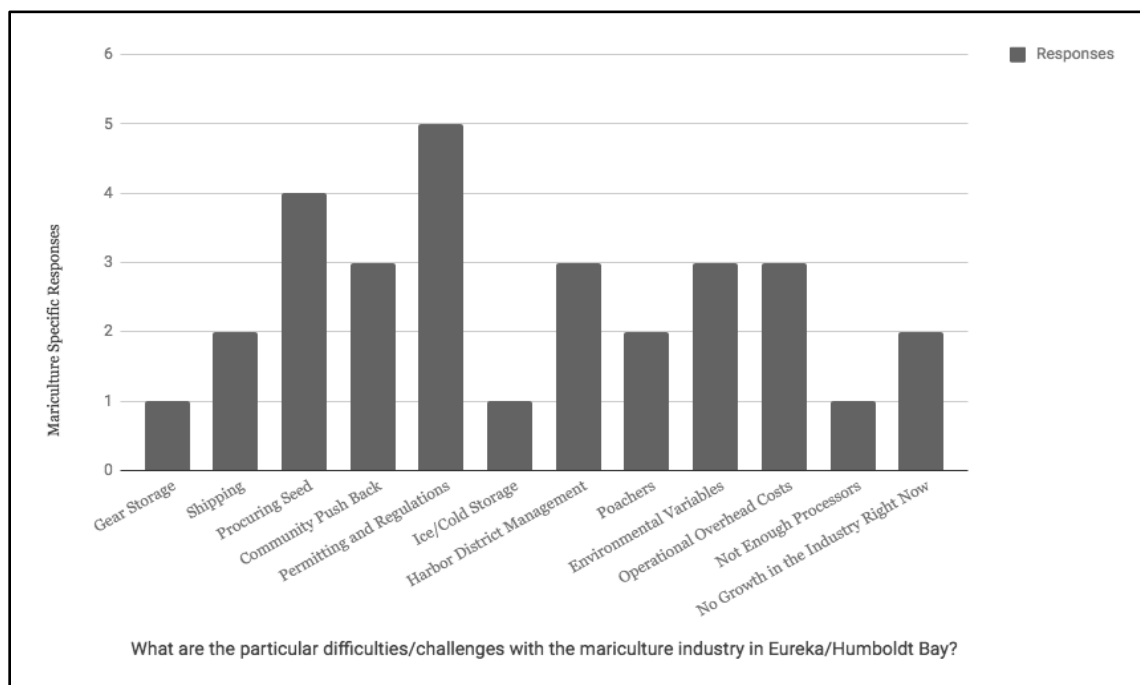


Figure 5. Top 12 Categorized Responses to the question, “What are the particular difficulties/challenges with the mariculture industry in Eureka/Humboldt Bay?”

challenge of selling maricultured shellfish products because of the lack of businesses that specialize in the selling of these products. “Lack of growth in the industry” refers to the absence permits being given out to new shellfish mariculture businesses in Humboldt Bay.

During the interview process, five mariculture participants mentioned the challenges gaining permits for shellfish mariculture in the state of California and the redundant regulations within the industry. One mariculture participant said, “It is so frustrating to go through the permitting process. My job would be easier elsewhere, it is so overwhelming in California” (Interview, Shellfish Grower, 2017).

Another mariculture participants noted that the challenge of permitting and subsequent regulations within Humboldt Bay’s mariculture industry is particularly difficult for the owners and managers of smaller entities. The participant noted that, “California is not friendly to small, family shellfish farmers” (Interview, Shellfish Grower, 2017).

According to the Aquaculture portal on the California Department of Fish and Wildlife website, permitting shellfish mariculture is “an extremely complex process” (CDFW, 2018). An article published in the Eureka Times Standard in 2011 echoes the CDFW statement. The author describes the process of permitting shellfish mariculture in Humboldt Bay as “rigorous” (Poor, 2011).

In 2012, the North Coast Journal published an article about oyster farming in Humboldt Bay. The author interviewed multiple shellfish farmers including Coast

Seafoods' manager Greg Dale. According to Walters (2012), Coast Seafoods Company spent more than \$1 million on permits and environmental reviews from at least nine local, state and federal agencies over a period of ten years. The author added that, "Coast could weather the expense, but smaller operators generally can't" (Walters, 2012).

One shellfish grower summed up the burden of permitting shellfish mariculture in Humboldt Bay in his letter to the Humboldt Bay Harbor District. The mariculture participant said,

If you want to set up a new oyster farm on the bay – or expand an existing one – you'll need buckets of money and the perseverance of a gull choking down a starfish to complete the slow-going, complex multi-agency permitting and environmental review process (National Working Waterfront Network, 2018).

Many of the participants' concerns with the permitting process were related to how complex it is, how difficult it is to navigate, how expensive it is, and how uncertain it is. In the California system, mariculture operators must hire experienced environmental consulting firms to help them navigate the permitting process which is expensive and can make entrance into the industry prohibitive for small businesses. To start, or continue a mariculture operations, business must get at least ten different permits and every permit application is an opportunity for the project to be stopped.

It is important to note that many of the challenges in permitting or expanding mariculture operations in Humboldt Bay are also linked to legitimate environmental

concerns about the impacts of mariculture activities on eelgrass populations in the bay. Scientists and stakeholders have concerns that the mariculture industry's current grow out method may have negative impacts on the eelgrass ecosystem. In a letter sent from three professors from Humboldt State University's Department of Biological Sciences to the Harbor District regarding Coast Seafoods' Permit Draft Initial Study, the concerned party wrote, "Based on the best available science inside and outside Humboldt Bay, we feel that the proposal will negatively affect functions of the eelgrass bed" (Shaughnessy et. al, 2015). The letter went on to suggest that a monitoring study be conducted to assess the impacts of mariculture activities on eelgrass in the bay before any expansion of the industry is improved. When the Coastal Commission voted not to approve Coast Seafoods' permit and expansion project, Commissioners who voted no, cited the uncertainty about impacts to eelgrass in their decision. Until concerns about eelgrass are studied and addressed in proposals for mariculture operations, permitting and expansion may continue to be challenges for the industry.

Another major vulnerability within Humboldt Bay's shellfish mariculture industry is the challenge of procuring shellfish seed and larvae. During the interview process, four mariculture participants noted that procuring seed is a major difficulty, either because of Humboldt Bay's location or because of the lack of seed producers in the area. One respondent said, "It's very difficult to get seed here, it just is not available" (Interview, Shellfish Grower, 2017).

Two interviewees suggested that procuring seed is much more difficult for the small- scale growers and noted that the larger operators are actually buying up most of the available seed. One respondent said, “These big players are really clamping down on the seed availability, making it hard for smaller players to procure seed (Interview, Shellfish Grower, 2017).

Whether or not the challenge of procuring shellfish seed stems from Humboldt Bay’s geographic isolation, or simply the insufficient production of seed and larvae stocks, the lack of availability of seed and larvae creates a major vulnerability within the mariculture industry in Humboldt Bay.

A third challenge and vulnerability perceived by the participants of Humboldt Bay’s shellfish mariculture industry is the opposition from the surrounding community of non-mariculture participants to shellfish mariculture expansion. During the interview process, four mariculture participants noted this challenge.

One mariculture participant spoke of the challenges of expanding his grow-out grounds in Humboldt Bay. He said, “Finding common ground with all the users and the participants in Humboldt Bay is very hard. It is a bummer because I feel like we can, and should all be working together to promote commerce on the bay and should be able to expand, but this place is full of pessimistic, intolerant, change fearing people” (Interview, Shellfish Grower, 2017).

Another mariculture participant expressed his concerns with the community's opposition to mariculture expansion by recounting his experiences at public meetings regarding the Pre-permitting project and Coast Seafoods’ expansion. He noted, “There

are lots of accepting people of the mariculture industry here and they want to see it grow and succeed, but they are not the ones standing up in public meetings. The people who stand up are the ones who are disgruntled and upset with our industry” (Interview, Shellfish Grower, 2017).

The opposition from non-mariculture participants regarding mariculture expansion represents a significant vulnerability within Humboldt Bay’s mariculture industry because of the subsequent conflict that has become associated with it.

While there are six companies that participate in the Humboldt Bay mariculture industry, most non-mariculture participants and stakeholders that I interviewed expressed negative perceptions of Coast Seafoods because of the way that [Coast] moved forward with their expansion permit and application process.

Commercial and recreational fishermen both contributed negative opinions about Coast Seafoods and the EIR process for their expansion. One respondent noted that, “The EIR for Coast Seafoods’ expansion blew off the hunters, the recreational fisherman, and the herring guys. That is terrible” (Interview, Recreational Fisherman, 2017). Another fisherman noted that Coast Seafoods’ expansion project tarnished Humboldt Bay’s reputation by stating, “I am disappointed about the big oyster company moving around and this pissing match, it doesn’t put Humboldt Bay in a good light. I hear people talk about their concerns about loss of jobs and not so much about the expansion, it’s all bad” (Interview, Commercial Fisherman, 2017).

Members of two other stakeholder groups, environmental advocates and agency representatives, were critical of Coast Seafoods and their EIR process during their

interviews. They stated that, “Coast messed up. There was litigation written all over that EIR, they wanted more and more until they got less and less” (Interview, Environmental Advocate, 2017). An agency representative stated, “The regulatory environment surrounding mariculture in Humboldt Bay has become brutal, I have become extremely negative about the whole thing. There was some pretty good local support for oyster growers and production in Humboldt Bay, until Coast blew it up. Now people are pissed” (Interview, Agency Representative, 2017).

Throughout the interview process with non-mariculture participants, there were two Humboldt Bay business owners that expressed empathy and positive perceptions toward Coast Seafoods and their expansion process. Both business representatives expressed similar sentiments, saying, “Coast, man that was a blow. I hope everyone in the fishing and oyster community steps up to help them, the bay needs them, I only have positive things to say about them” (Interview, Bay Business Owner, 2017).

Other statements from the stakeholder interview process revealed that most non-mariculture participants felt neutral, or positive about the presence of the five other, smaller companies in Humboldt Bay, but still viewed Coast Seafoods negatively. One respondent stated, “Oysters, they are a big deal on the bay and if the small farmers needed support, I would be on their side. Oyster people were taking it for granted that they could do what they wanted, now because of [Coast] there is a shift and it’s all a mess” (Interview, Commercial Fisherman, 2017).

5.2.3 Recommendations and Priorities for Future Investment

When asked, “what have you seen in other communities that helped to strengthen the mariculture industry?”, three of the participants in the Humboldt Bay shellfish mariculture industry said they believed that external support from non-mariculture participants in the states of Washington and Virginia strengthen the shellfish mariculture community.

One respondent said, “In Washington and on the East Coast, there are people with different types of jobs at all the trade shows and at the aquaculture conferences. There are people there from the scientific community with positive results and grants are written in support of our industry, not just from government hands, but with people’s private money. There is something to be said for that. That goes a long way in an oyster community” (Interview, Shellfish Grower, 2017). Another respondent said, “Shellfish growers are treated better by the government and outside community elsewhere” (Interview, Shellfish Grower, 2017).

Coding and analysis revealed that the mariculture participants mentioned three other themes in response to the question “what have you seen in other communities that help to strengthen the mariculture industry?” These themes included better mariculture related infrastructure, more reasonable permit fees elsewhere, and that there is a demand for water quality monitoring elsewhere.

During the interview process we asked the participants from the six shellfish mariculture companies, “If you had five million dollars to make economic, environmental, or social improvements to the local mariculture community, what would

you do”? The mariculture participants mentioned eight themes (Figure 6). Most notably, the respondents mentioned:

- (1) Prioritizing the Pre-permitting project.
- (2) Developing a mariculture special use property.
- (3) Permit and regulation streamlining and fee assistance.
- (4) Water quality monitoring and assurance to maintain the bay’s healthy water quality.

Coding and analysis revealed that the mariculture participants mentioned four other themes in response to the question, “if you had five million dollars to make economic, environmental, or social improvements to the local mariculture community, what would you do?” These themes were not explored either because the interviewees chose not to expand in detail about the theme, or because I could not find information about the theme during document analysis. These themes include; ocean acidification research, cold and gear storage facilities, improving city sewage infrastructure, and fixing the docks and pilings around Woodley Island.

The theme, “ocean acidification research” refers to investing more research to determine the effects of ocean acidification on shellfish in Humboldt Bay. “Cold and gear storage facilities” refers to investing more money into ice/cold and gear storage in Eureka’s working waterfront. “Improving city sewage infrastructure” refers to investing more money in improving the cities’ of Eureka and Arcata’s sewage infrastructure to avoid a catastrophic sewage leak into Humboldt Bay. “Fixing the docks and pilings around Woodley Island” refers to investing money into improving the docks and pilings

that mariculture participants and other stakeholders depend on at Woodley Island Marina, for the sustainability of their businesses.

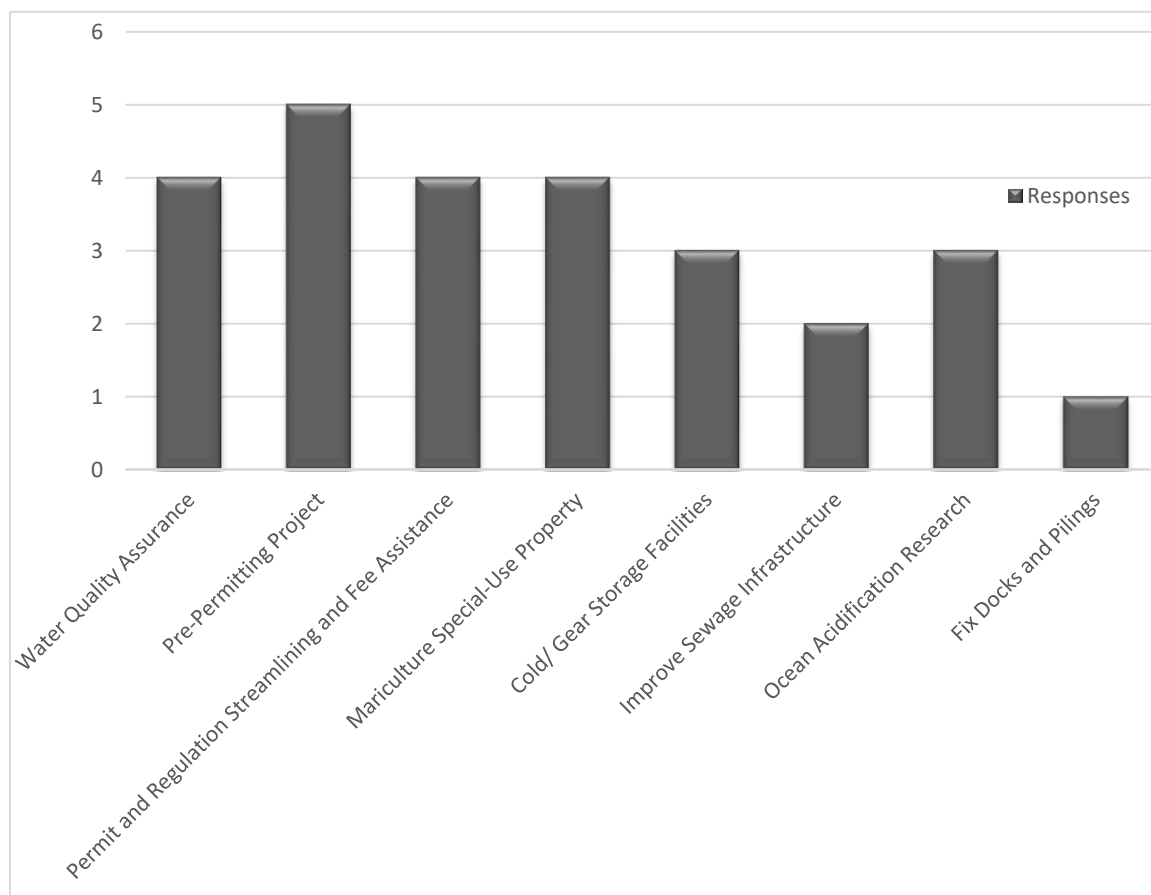


Figure 6. Top 8 Categorized Responses to the question, “If you had five million dollars to make economic, environmental, or social improvements to the local mariculture community, what would you do”?

During the interview process, four mariculture participants recommended that the development of a land-based mariculture special use property would be a good investment to help alleviate some of the challenges within their industry. One respondent noted, “The facilities are pretty decent on the bay, but they aren’t helping us oyster guys

too much. We could use a facility, or a piece of property specifically for us to help keep things organized” (Interview, Shellfish Grower, 2017).

Another recommendation that was made during the interview process with mariculture participants was a water quality monitoring and protection plan to help to maintain the bay’s current, healthy water quality. One participant said,

The presence of oysters stimulates wetlands. That is why we have eelgrass here, which is why the bay’s water quality is excellent. There have been frightening spills in this bay and despite it all we have good water quality. It’s no secret that the bay’s good water quality is directly related to the presence of oysters. We need a plan and some assurance to keep it that way. Investment in a water quality-monitoring plan could show stakeholders over time that oyster culture is a good thing (Interview, Shellfish Grower, 2017).

During the interview process, four mariculture participants recommended investing in permit and regulation streamlining, as well as fee assistance. This recommendation goes hand in hand with the Pre-permitting Project. The Humboldt Bay Mariculture Pre-permitting Project allows the commissioners of the Humboldt Bay Harbor District to obtain permits in Humboldt Bay’s intertidal zone and sublease the pre-permitted tidelands to shellfish growers. This project, once accepted will streamline the permitting process and alleviate redundant regulations within the industry. One mariculture participant said, “Farming oysters is tough. You gotta enjoy bleeding, sweating, hurting, and worrying. Then you gotta do it again the next day. It would be nice to worry about one less thing, like permitting” (Interview, Shellfish Grower, 2017).

Shellfish farming takes place on public land that is held in trust by the state of California. Locally, three entities -- the cities of Eureka and Arcata, and the Harbor District -- authorize the leasing of this trust land to shellfish farmers. The farmers are required to get permits from their leasing authority, as well as from the U.S. Army Corps of Engineers, the California Coastal Commission, the California Water Quality Control Board and Humboldt County. In addition, their operations are under assessment and review from local, state and federal entities, from the California Department of Fish and Game to the National Marine Fisheries Service. More often than not, small-scale cultivators expressed disdain towards the regulatory structure in California. One respondent noted that, “The idea of being able to increase the mariculture footprint and make some more money here is a tricky situation. Certain people in the government make certain things a real burden for us” (Interview, Shellfish Grower, 2017).

Another shellfish cultivator’s testament to the shellfish mariculture management structure in California highlights the uncertainties and troubles that shellfish growers face regarding tenure in Humboldt Bay, as they discussed the tribulations that Coast Seafoods was dealing with in the summer of 2017. The respondent stated that,

The level of awareness on mariculture, from a non-local, or on a state level is worrisome. We need better support from higher up and this pre-permitting project needs to happen. The outlook on jobs in the area is a little bleak. Why take away good, local jobs and important resources? That’s what is happening when you shut down a place like Coast Seafoods. We are really vulnerable. As far as I know

all the shellfish growers in this bay are all on a month-to-month lease after this Coastal Commission nonsense (Interview, Shellfish Grower, 2017).

6.0 DISCUSSION

6.1 OVERALL DISCUSSION

Analysis of the qualitative data from interviews with mariculture participants and the quantitative data from returned socioeconomic business surveys showed that the mariculture industry in Humboldt Bay has many strengths. These strengths however, were met with several challenges and vulnerabilities that make the future of the shellfish mariculture industry uncertain. Discussion of the mariculture participants' recommendations will help clarify their concerns and provide the foundation for a more resilient planning approach (Beatley, 2014).

6.2 ECONOMIC IMPACT OF THE MARICULTURE INDUSTRY

The results from the survey revealed that the mariculture industry in Humboldt Bay provides jobs, contributes positively to the local economy, and produces large numbers of both shellfish seed and mature shellfish (Table 7). In addition to the money that is earned in the mariculture industry, there is also money spent and disbursed throughout Humboldt County by the industry participants. Not only do participants spend money on gas, ice, and repairs that are done locally, the participants also spend earnings from their paychecks throughout the community. To account for the total economic activity that mariculture industry creates for Humboldt County, we used an economic impact multiplier developed by Northern Economics Inc. The economic multiplier developed for the state of California is 1.97 (Northern Economics Inc., 2003). After applying the multiplier effect to the mariculture industries' generated revenue of \$9.8

million in 2016, we estimate that the industry provides \$19.3 million worth of economic activity to the region. A priority for the future should include gathering reliable economic data from Arcata Oysterfest to show how important the event is to both the economy and the community.

Table 7. Contributions of the Humboldt Bay Shellfish Mariculture Industry

Businesses	6
Jobs	101
Payroll	\$3,000,000
Revenue	\$9,800,000
Economic Impact (Multiplier Effect)	\$19,300,000
Mature Kumamoto and Pacific Oyster Production (Pieces)	9,995,732

6.3 PERMITTING

After significant investment of time and money into their operations and facilities in Humboldt Bay, mariculture participants still do not have a clear picture of the accessibility and potential permitting costs of intertidal lands to grow market size oysters for human consumption. This lack of predictability makes planning extremely difficult. In addition, the lack of clarity has a significant effect on the revenue stream and the ability of participants to pursue growth opportunities for their businesses and employees. Results indicated that further investment and actual implementation of the mariculture pre-permitting plan will help to address the mariculture participant's top

recommendations and alleviate a major challenge and vulnerability within the industry. Regarding the Pre-permitting project, the Humboldt Bay Harbor District pays for and leads the effort to get areas permitted for shellfish use. The Harbor District then leases these grounds to qualified businesses. This takes the risk and cost associated with permitting away from the businesses and could make room for smaller businesses to enter the industry.

According to Yang et al. (2016) and Lavoie (2009), the process of permitting marine shellfish mariculture continues to be a primary constraint to its expansion. Obtaining the proper permits and authorization to grow shellfish is complicated and characterized by layers of regulations and complex application review and approval processes (NOAA Shellfish, 2016). Permitting is also constrained by the potential environmental impacts of mariculture operations. In the survey responses about future growth in the mariculture industry in Humboldt Bay participants expressed very similar concerns about the challenges of permitting for expansion.

Results from both the surveys and the interviews revealed that the future growth of the mariculture industry in Humboldt Bay will be greatly aided by the implementation of the Pre-permitting Project. The Humboldt Bay mariculture Pre-permitting Project will likely help to strengthen the mariculture industry in Humboldt Bay and ensure jobs and economic benefits that will have a ripple effect on the surrounding community and thereby contributing to coastal resilience. Expansion and maintenance of the industry will

also require understanding the environmental impacts of mariculture operations – particularly on eelgrass – and devising methods to limit those impacts.

6.4 CONFLICT OVER MARICULTURE EXPANSION

Compared to Humboldt County’s historic mariculture industry, Coast Seafoods’ expansion and the mariculture pre-permitting project represent the largest requests for expanding acreage for cultivation of mature oysters in Humboldt Bay. According to Sanchez-Jerez et al. (2016), usable space for mariculture activities in coastal zones is now becoming increasingly limited. The expansion of aquaculture into coastal areas represents the reallocation of common pool resources into private hands, which excludes others and creates a potential for conflict in the coastal zone (Tiller et. al, 2012; Filgueira et al. 2014; Sanchez-Jerez et al. 2016). Because nearly all of the remaining intertidal habitat suitable for mature oyster production is inhabited by Humboldt Bay’s extensive eelgrass beds, conflict has escalated between the oyster industry and various stakeholders over protecting the eelgrass and encroaching upon it.

Analysis of the semi-structured interviews shows that Humboldt Bay’s stakeholders have different attitudes towards mariculture expansion (Table 8). While most stakeholder groups have both pro and competing attitudes towards expansion, document analysis shows that the waterfowl hunters are the only stakeholder group directly opposed to mariculture expansion into eelgrass because of their concerns about impacts to eelgrass and its availability to migratory game birds (Harbor District, 2017). In addition, waterfowl hunters are against the encroachment of oyster farming equipment into hunting grounds (Harbor District, 2017).

Table 8. Stakeholder Group and Attitude towards Mariculture Expansion

General Stakeholder Group on Humboldt Bay	Attitude Towards Mariculture Expansion (Pro or Competing)
Wiyot Tribal Affiliates	Both Pro and Competing
Shellfish Mariculture Participants	Pro
North Coast Fishermen	Both Pro and Competing
Recreational Boaters	Both Pro and Competing
Waterfowl Hunters	Competing
Environmental Advocates	Both Pro and Competing

In 2017 the California Coastal Commission rejected Coast Seafoods' proposed expansion in a 6-5 vote, finding the expansion unjustified based on uncertainty of its impact on the ecosystem (Houston 2017). As seen in the results from both interviews and returned surveys, mariculture participants view the opposition from non-mariculture community members regarding expansion in Humboldt Bay as one of the greatest threats to their industry.

Until further research is undertaken to address the limitations of existing data on the impacts of mature oyster cultivation on eelgrass, regulators are unlikely to permit expansion into areas with eelgrass. This is an important avenue for future research, but even once it commences, it will require years of work before reliable conclusions can be drawn.

In addition to the uncertainty of permitting and tideland availability, it has also become apparent that there are significant misconceptions about shellfish producers and the role they play in the environmental, social, and economic health and sustainability of Humboldt Bay and its stakeholders. These perceptions add to the uncertainty of tideland accessibility and potential costs of permitting of those tidelands.

6.5 DYNAMIC BETWEEN LARGE AND SMALL BUSINESS

The shellfish growing community in Humboldt Bay is highly celebrated by both mariculture and non-mariculture participants. There are, however, a few stakeholder groups whose interests compete with mariculture activities (Table 8). While most non-mariculture participants support the growth of small-scale mariculture business, some oppose Coast Seafood's expansion. Opposition from non-mariculture participants to the expansion of Humboldt Bay's mariculture footprint has resulted in subsequent conflict. The conflict surrounding Humboldt Bay's mariculture industry in relation to other bay stakeholders is not a recent controversy, but has become more intense recently. Interview results show that non-mariculture participants fear that the expansion of large-scale mariculture will reduce resource values, which would further marginalize their groups and degrade Humboldt Bay's ecosystem in the process.

Furthermore, the way that non-mariculture participants view the division between the two scales of shellfish operations in Humboldt Bay has vilified Coast Seafoods. According to interview results, most non-mariculture participants supported the small-scale mariculture businesses, but had negative perceptions of Coast Seafoods, however

all of the mariculture participants in Humboldt Bay fully support Coast Seafoods, as well as further expansion of mariculture on the bay.

According to the survey and interview results, mariculture participants noted that in most cases, local officials and non-mariculture participants lack the knowledge of the positive effects that Coast Seafoods Company has had on their smaller businesses. Mariculture participants also said that lack of awareness that certain members of the outside community had, about the positive and stimulating effects that oysters have for the Humboldt Bay ecosystem was worrisome. As discussed below, the industry has long been a champion of for environmental health and water quality of the bay.

Analysis of the surveys and interview results with both mariculture and non-mariculture participants highlighted the importance of using a marine spatial planning approach to address the interests, goals, and values of all of Humboldt Bay's stakeholders. In doing so, further conflict in Humboldt Bay can potentially be minimized (Tiller et al. 2012; Filgueira et, al. 2014; Sanchez-Jerez et al. 2016).

Data from monitoring the mariculture industry's effects on Humboldt Bay's ecosystems and water quality needs to be made easily available for Humboldt County's residents and planners (Sanchez-Jerez et al. 2016). It would also serve the mariculture participants well to educate the public on the interdependence among the mariculture businesses. Making the public aware of how supportive small-scale shellfish growers are of Coast Seafood's Company, as well as Coast Seafood's support of all the other mariculture participants can only make the shellfish mariculture industry in Humboldt Bay stronger and more resilient (Beatley, 2014).

6.6 SHELLFISH SEED AND LARVAE

Similar to other shellfish mariculture producing regions along the West Coast, shellfish seed and larvae production, and availability continues to be a primary bottleneck for the mariculture industry operating in Humboldt Bay (Mabardy et al. 2015; PCSGA, 2018).

According to the survey and interviews results, Humboldt Bay's mariculture participants procured most of their seed from out of state and expressed a desire to alleviate this challenge by either supporting a local hatchery or starting their own. In addition to this, the results also indicated that at least four of Humboldt Bay's six mariculture businesses had plans to increase their seed production over the next five years.

Production of seed currently accounts for approximately 1/3 of shellfish sales in the region. Further investment in Hog Island Oyster Company's local hatchery and nursery should help alleviate this bottleneck, boost shellfish production, contribute to the seafood supply, and create economic opportunities in Humboldt County. As seen from the interview results with non-mariculture participants and in the literature, the conflict surrounding mariculture expansion exists only within the footprint of Humboldt Bay itself and not on adjacent lands where seed and larvae hatcheries could be sited (Mabardy et al. 2015). This being said, land surrounding Humboldt Bay should be considered for selective breeding labs and hatcheries due to Humboldt Bay's disease free designation and its healthy water quality.

6.7 WATER QUALITY

According to Mabardy et al. (2015), the West Coast oyster industry is threatened by decreasing water quality and ocean acidification. Changing ocean conditions and the water quality of the bay need to be monitored constantly to insure the health and viability of growing shellfish in Humboldt Bay. Without a healthy marine environment in Humboldt Bay (including the uplands, whose runoff via watersheds directly affects the overall health of the bay) growing safe and healthy shellfish would not be possible and any diminishing quality of the environment could have significant impacts on shellfish farmers' business. Like most mariculture regions in the United States, the Humboldt Bay mariculture industry relies on healthy water quality in the bay for the sustainability of their industry. The interview and survey results show that participants in the mariculture industry view changing ocean conditions and declining water quality as some of the biggest threats to their industry. Industry participants also said they believe that Humboldt Bay's water quality and resiliency against ocean acidification is one of the mariculture industry's biggest strengths. Other Humboldt Bay stakeholders, such as fishermen, Wiyot Tribal members, and government officials view the shellfish mariculture industry's effect on Humboldt Bay's water quality in a positive manner. They note that the oyster industry was what kept the pulp mill from dumping their waste into the bay. Not only can one oyster filter up to 50 gallons of water per day (NOAA Shellfish, 2016; Yang et al. 2016; PCSGA, 2018), but also having a mariculture industry in the bay means that there is vested economic interest directly tied to keeping the bay clean and healthy. Other stakeholder groups such as hunters and environmental advocates

must be made aware that the Humboldt Bay shellfish mariculture industry will be highly vulnerable if the water quality in the bay diminishes. In this way, the presence of a shellfish mariculture industry contributes positively to the resiliency of Humboldt Bay.

7.0 RECOMMENDATIONS AND CONCLUSIONS

7.1 RECOMMENDATIONS FOR A RESILIENT MARICULTURE INDUSTRY IN HUMBOLDT BAY

As the mariculture industry in Humboldt Bay continues to expand, enacting a planning policy centered on the concept of coastal resilience may be able to bridge the gap between the social and ecological domains of the ecosystem and surrounding community. Using the socioeconomic data that I collected about the state of the mariculture industry in Humboldt Bay, I evaluated the industries strengths and vulnerabilities in order to provide a list of recommendations for our community of mariculture participants, managers, and planners. It is my hope that these recommendations can be applied towards a more resilient mariculture industry that addresses the conflict between Humboldt Bay's mariculture participants and non-mariculture stakeholders. These recommendations include:

1. Educate the Humboldt Bay area community of non-mariculture participants and political leaders about the economic and ecological benefits of the Humboldt Bay shellfish mariculture industry and the interdependence and relationships between all of the industry's participants. While the relationships between the mariculture participants are good, it is important to also build upon the social component of coastal resilience for a resilient mariculture industry by improving the relationships between the mariculture participants and other stakeholders, as well

as with scientists and industry policy makers. In addition, publicize the mariculture business's involvement in community service. Participants in the Humboldt Bay shellfish mariculture industry collectively spent 267 employee hours per month assisting with Humboldt Bay related scientific studies, community work, and agency and industry initiatives. Showing the stakeholders that the mariculture participants all work well together, depend on, and support one another to provide economic and environmental contributions to the region will help quiet dissonant voices within the community. Furthermore, it will improve relationships and reduce conflict with other Bay stakeholders and policy makers.

2. Highly consider implementing the mariculture pre-permitting project. In doing so will contribute to the economic component of coastal resilience within the mariculture industry. This plan, when brought into action, will help to alleviate a major vulnerability within the industry, as it will streamline the traditional permitting process, transfer the regulatory risk from the growers to the Harbor District while still ensuring environmental compliance by growers, and provide a reasonable investment cost for new growers. As the results of this thesis indicate, industry participants said that the pre-permitting project will stimulate the local economy by providing more jobs, investments, and new revenue to the region. Also, it could be a long-term source of revenue for the Harbor District through lease payments.

3. Invest in a land-based mariculture specific use property, such as a mariculture business park, for gear storage and a place to expand the capacity for seed and larvae production Humboldt Bay. This recommendation will contribute to both the built environment and the economic component of resiliency within the mariculture industry, as it will help to alleviate major challenges that create conflict. Relieving the bottleneck of seed and larvae production in Humboldt Bay is not only vital for the local mariculture industry, but for the U.S mariculture industry as whole. In addition, a special use property for mariculture participants will provide space to store gear in an area where it cannot be stolen or lost in the bay, as well as a space to work on damaged gear.
4. Continue to monitor the changing ocean conditions, eelgrass bed abundance and distribution, and water quality of Humboldt Bay closely. In doing so, the mariculture participants, scientists, and policy makers can develop techniques that limit environmental impacts and contribute to the ecological component of coastal resiliency. In addition, publicize the positive results that the presence of shellfish has on water quality and set up a database where this information can be easily accessed by the public. This data will be integral to further understanding the changes taking place in our oceans and informing state and local policy. Since encroachment on eelgrass beds is one of the biggest inhibitors to mariculture expansion, a study that looks at the interactions between mariculture and eel grass ecosystem success should be used to explore future mariculture techniques that can limit impacts to eel grass ecosystems.

5. As operations expand in Humboldt Bay, focusing on producing and procuring oyster seed locally is important. Further investment in local hatchery and nursery capacity will boost shellfish production, contribute to the seafood supply, and create economic opportunities in Humboldt County. This recommendation will contribute to both the economic and built environment components of coastal resiliency. Surrounding land on Humboldt Bay should be considered for potential locations for selective breeding labs and hatcheries due to Humboldt Bay's disease free designation and its healthy water quality.
6. Create the role of a Humboldt Bay shellfish mariculture coordinator to be staffed by a representative of small-scale operations. By contributing to the social component of coastal resilience, a shellfish grower can represent the local industry in order to provide interagency and mariculture participant coordination and develop consistent, practical, and sustainable management practices.

7.2 CONCLUSIONS

Mother Nature tests the resilience of the mariculture participants, their shellfish, and Humboldt Bay daily. Howling winds, severe rains, pulling currents, polluted and shallowing waterways, changing ocean conditions, and temperature fluctuations are just a few of the environmental stresses that shellfish and their cultivators experience during the grow out process in Humboldt Bay. In addition to these environmental variables, Humboldt Bay's mariculture participants are also burdened with a redundant permitting process and unclear regulations. While these variables present unique challenges for the mariculture industries' participants, the negative perceptions of the mariculture industry

from competing stakeholders on Humboldt Bay represents the greatest vulnerability for the shellfish mariculture industry. This became obvious after watching the public meetings and listening to all the stakeholders involved in this project and emerged as one of the greater challenges for the industry going forward.

However, despite these persistent challenges and vulnerabilities, throughout the past 90 years the participants of Humboldt Bay's shellfish mariculture industry have worked together to succeed and thrive and have continued to remain relevant on a global mariculture scale, as the largest producer of oysters in the state of California. By the time the sun rises over the horizon each morning, oyster farmers in Humboldt Bay are already on the water organizing oyster nets and bags (some up to 200 pounds when full), fixing equipment, cleaning their boats and bags, sorting and transporting shellfish seed to different areas, and harvesting oysters that are ready for market. After a full day on the water they head back to the dock, where the job of cleaning the freshly-harvested oysters begins, along with packing the oysters for transport and delivery, and making time for more, seemingly endless paperwork (Morgan, 2016). While there is one large-scale shellfish mariculture company on Humboldt Bay, the other operations are small, multi-generational family-owned businesses; for many, the oyster farmer is also the boat mechanic, delivery person, accountant, marketer, seed-nursery manager, and owner of the company. Endless planning and prepping is a constant extended-day routine as they cover all the bases to ensure their livelihood and the quality of their shellfish (Morgan, 2016). With an early wakeup call, intensive labor on the water, often in challenging wet and cold conditions, cleaning and packaging oysters, driving all over the state California to deliver

fresh shellfish to restaurants and markets, and a late night return home for more paperwork. A day in the life of the mariculture participants in Humboldt Bay is a long one and their pains taking efforts to produce a commodity that has provided important economic and ecosystem benefits since the 1930's have contributed positively to the resilience of Humboldt Bay and its surrounding community.

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APPENDICES

Appendix A

Interview Questions

Semi Structured Interview Questions for Mariculture Participants

- 1.) What is the name of the mariculture company you work for?
- 2.) What is your employment role in the mariculture company that you work for?
- 3.) What types of products do you produce?
- 4.) To whom do you sell your products to?
- 5.) From the perspective of the mariculture industry, what is working well in Humboldt Bay and with Eureka's working waterfront?
- 6.) In your opinion, what are the particular difficulties/ challenges that the mariculture industry faces in Humboldt Bay?
- 7.) What have you seen in other ports, or shellfish farms that help to strengthen the industry?
- 8.) If you had \$5 million to make improvements to the local mariculture industry, how would you invest it?

Semi Structured Interview Questions For Non- Mariculture Participants

1. From your perspective of the fishing and mariculture industries and working waterfront, what is working well?

2. In your opinion, what are the particular difficulties/ challenges that the working waterfront and fishing industry face in Eureka?
3. What have you seen in other ports that help to strengthen the fishing and mariculture industries?
4. If you had \$5 million to make improvements to the local fishing and mariculture industries, how would you invest it?
5. What is your agency's/entity's role in waterfront activities in Humboldt Bay, or in Eureka?
6. Is there anything you would like to add?

Appendix B

Business Survey

SECTION A. EMPLOYMENT:

- 1.) Number of employees (where employees *live* and work)

	Humboldt Bay Region		Outside Region	
	Full Time	Part Time	Full Time	Part Time
2016				
5-years out (est.)				

- 2.) Number of different types of employees in Humboldt Bay region: one employee can only be on one category; select the most appropriate
 - a. Owner/Operators: # _____
 - b. Managers/ Supervisors: # _____
 - c. Laborers/Farm Hands: # _____

- d. Marketing/Sales: # _____
- e. Maintenance/Safety: # _____
- f. Delivery: # _____
- g. Other (list category) _____: # _____
- h. Other (list category) _____: # _____
- i. Other (list category) _____: # _____
- j. Other (list category) _____: # _____
- k. Other (list category) _____: # _____

Comments on employees and anticipated change in employment in the next 5 years:

SECTION B. TIDELANDS:

3.) Tide Lands (grow-out grounds) permitted for aquaculture and under your control

	2016 acres	Lease Rate: Dollars Per Acre Per Year you pay	Estimated number of acres- 5-years out
Number of Acres in Humboldt Bay			
Number of Acres outside of Humboldt Bay			

4.) How many Humboldt Bay acres (grow-out grounds) do you have control over that are not under cultivation? _____

5.) Does your company sublease acreage to another company in Humboldt Bay? Y / N

If yes, then how many acres does your company sublease and at what rate?

	2016	Lease Rate: Dollars Per Acre Per Year you charge
Number of Acres <u>Subleased</u> in Humboldt Bay		

Comments on tidelands and anticipated change over the next 5 years:

SECTION C. FACILITIES AND EQUIPMENT: (Humboldt Bay ONLY)

6.) Number of building/facilities/structures in Humboldt Bay your operation owned or leased in 2016:

2016-Building/Facilities Owned or Leased	
#:	SqFt:

7.) Equipment in Humboldt Bay your operation owned in 2016:

a. # of boats/vessels your business owns: _____

b. # of FLUPSYs your business owns: _____

c. # of land-based upwellers/downwellers your business owns:

d. # of tumblers/sorters your business owns: _____

e. Estimated amount of cold storage space _____ sq. ft. (not including insulated totes)

8.) Do you feel that your business has sufficient cold storage? Y/N

If no, how much more cold storage space would you prefer to have?

_____ Sq. ft.

	2016	Est. 5 yrs. out
TOTAL EXPENSES	\$	
Labor Expenses		
Total payroll	\$	
Total non-wage benefits	\$	
Taxes		
Federal	\$	
State & Local	\$	
Environmental Monitoring/Permitting		
Permit fees	\$	
Monitoring fees	\$	
Health Compliance/Permitting		
Permit fees	\$	
Compliance fees	\$	
Other Expenses		
Facility leases/mortgage	\$	
Capital expenditures (NOT debt service)	\$	

Includes gear purchases

Seed & shellfish	\$	
Repair & Maintenance	\$	
Ice	\$	
Insurance carriers	\$	
Freight	\$	
Gas/Fuel	\$	
Utilities	\$	

9.) About how often does your business borrow major equipment from other businesses on the bay?

Never Once a year Once a month Once a week

Daily

10.) About how often does your business lend major equipment to other businesses on the bay?

Never Once a year Once a month Once a week

Daily

Comments on facilities and equipment and anticipated change over the next 5 years:

SECTION D. EXPENSES:

11.) Approximate Expenses for 2016 calendar year related to Humboldt Bay operations:

Comment on expenses and also the extent to which you believe these will change in the next 5 years

SECTION E. 2016 PRODUCTION:

12.) Shellfish Production (Humboldt Bay ONLY). Please specify units for each category

	Fresh Whole	Shucked/Jarred	Frozen	Other	Seed or Larvae
UNITS:					
Pacific Oysters					
Kumamoto Oysters					
Manila Clams					
Other 1:					
Other 2:					

13.) If you produce (or grow-out) seed and larvae what percentage goes to these various outlets:

- a. Use in your own company's operations in Humboldt Bay _____ %
- b. Use in your own company's operations outside of Humboldt Bay _____ %
- c. Sold to other businesses/entities _____ %

Comment the extent to which you believe these categories will change in the next 5 years and why:

SECTION F. 2016 REVENUE:

14.) Shellfish sales revenue (Humboldt Bay ONLY)

	Gross Sales Value
Pacific Oysters (Market Size)	\$
Kumamoto Oysters (Market Size)	\$
Manila Clams (Market Size)	\$
Seed or Larvae	\$
Other	\$

15.) Approximately what percentage of your Humboldt Bay related business revenue comes from shellfish sales? _____% (non-shellfish sales revenue could include tours, restaurants, merchandise, subleasing, etc.)

Please list non-shellfish sales sources of revenue your company generates in the Humboldt Bay region:

16.) Does your company (both within and outside Humboldt Bay):

a. Operate another tourist attraction, such as farm tours offered on a regular basis? Y/N

If yes _____ % revenue

b. Operate a restaurant, oyster bar, or retail store? Y / N

If yes _____ % revenue

c. Sell branded merchandise related to your company? Y / N

If yes _____ % revenue

d. Have 3rd party eco label certifications? Y / N

If yes, which certifications do you have?

17.) Approximately what percentage of your total business revenue comes from activities in the Humboldt Bay region? _____%

Comments on sources of revenue and anticipated changes in the next 5 years:

SECTION G. MARKETS/MARKETING:

18.) Approximately what percentage of your Humboldt Bay produced market shellfish (not including seed & larvae) goes to these various types of outlets?

	2016	Est. 5 yrs. out
Restaurants	%	%

Retail outlets	%	%
Wholesalers	%	%
Direct to customer	%	%
Arcata Oysterfest	%	%
Other: _____	%	%
Other: _____	%	%

19.) What US state(s) or country(s) do you purchase seed from? _____

20.) Have you experienced challenges getting oyster seed in the past 5 years? Y/N

What challenges? _____

21.) Do you have plans to get into or increase seed production in Humboldt Bay in the next 5 years?

Y / N

Why? _____

22.) Approximately what percentage of your Humboldt Bay produced market shellfish (not including seed & larvae) is sold to these various locations?

	2016	Est. 5 yrs. out
Humboldt County	%	%
California (not HUMCO)	%	%
United States (not California)	%	%
Outside US	%	%

SECTION H. COLLABORATIONS/COMMUNITY WORK:

In 2016, how many Humboldt Bay-related scientific studies, community/ industry initiatives, surveys, or other engagement activities did your business participate in?

In 2016, approximately how many employee hours per month were spent on collaborative/engagement activities? _____

If comfortable, can you list the agencies, initiatives, or studies that you were/are a part of?

SECTION I. FUTURE:

23.) Rank (in numbered order) your top five concerns/threats related to the sustainability of your mariculture business (1= top concern):

- | | |
|----------------------------------|--------------------|
| Tideland access/availability | Regulatory changes |
| Permitting costs | Disease outbreak |
| Fuel costs | Other 1: |
| Utility costs | Other 2: |
| Labor costs | |
| Changing ocean conditions | |
| Price/market changes | |
| Availability of seed | |
| Water quality | |
| Cold storage | |
| Land facility space/availability | |
| Community perceptions | |

Why did you prioritize the threats that you did?

ADDITIONAL COMMENTS ABOUT YOUR BUSINESS AND ANTICIPATED FUTURE

CHANGES: