METHODOLOGY FOR IDENTIFYING AND EVALUATING SHELLFISH MARICULTURE SITE DEVELOPMENT IN CALIFORNIA

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I. INTRODUCTION

Shellfish mariculture is an increasing area of interest for Californians, as project proponents up and down the state pursue permits and approvals for beginning or expanding shellfish mariculture operations. Coastal areas in Northern California are primarily being pursued for oyster farming, while offshore areas in Southern California are, for the most part, being considered for mussel farming. It is important to note that although "shellfish" includes a range of species such as crabs, lobsters, and shrimp, California shellfish mariculture is primarily limited to oyster, mussel, and clam cultivation. Thus, oysters, mussels, and clams are the most pertinent species to consider for California shellfish mariculture, and are the species primarily considered in this article.

After a long and entrenched history, shellfish mariculture in California experienced a steep decline at the turn of the Industrial Revolution. The renewed interest in developing shellfish mariculture is due in part to a recognition of our seafood deficit. In addition, state and federal guidelines have pushed for increased

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domestic shellfish production. The economic benefits to coastal communities and relatively limited environmental effects of shellfish farming on marine ecosystems have also renewed interest in the industry. Each of these will be described in greater detail below.

One of the greatest hurdles in pursuing new or expanded areas for shellfish mariculture in California is where decision-makers start in analyzing an area's suitability for production. Decision-makers must analyze an area's physical ability to grow shellfish in any particular site, or the site's physical feasibility. Decision-makers must also analyze the proximity of these areas to known environmentally sensitive, culturally significant, and economically important regions in deciding whether a chosen site is suitable for initiating or expanding shellfish mariculture operations. As will be discussed in further detail below, there are numerous laws and policies that govern the determination of site suitability based on the aforementioned factors. Decision-makers may in good faith attempt to conform with these laws and policies, and pursue environmentally and economically sound shellfish mariculture operations by choosing an appropriate site based on its physical and environmental constraints. However, this is made difficult by the myriad of possible factors for analysis related to physical feasibility, environmental constraints, cultural and economic considerations. The result can be overwhelming and confusing, and lead to uncertainty for decision-makers as far as where to initiate an analysis for site suitability.

This article provides decision-makers with the tools to undertake an initial review of physical and environmental constraints. An initial review may determine if an area is deemed physically suitable for shellfish mariculture activities, and may take the form of a pre-feasibility study similar to the Humboldt Bay Pre-Feasibility Study, which will be described in greater detail below.

II. SHELLFISH AQUACULTURE IN CALIFORNIA

"Aquaculture" is defined as the propagation and rearing of aquatic organisms for any commercial, recreational, or public purpose.[3] This definition covers all production of finfish, shellfish, plants, algae, and other marine organisms for: 1) food and other commercial products; 2) wild stock replenishment for commercial and recreational fisheries; 3) rebuilding populations of threatened or endangered species under species recovery and conservation plans; and 4) restoration and conservation of marine and Great Lakes habitat.[4] "Mariculture" generally refers to aquaculture operations that take place in the marine environment, typically bays and estuaries, but also offshore in the open ocean.[5] Shellfish mariculture is also often referred to as "shellfish farming."

California has a long and substantial history of shellfish culture, and its oyster industry can be traced back to the 1850s. Settlers associated with the Gold Rush acquired a taste for naturally occurring Olympia oysters from California's coastline, and thus provided a commercial market for oysters.[6] Unfortunately, the naturally occurring populations of oysters declined rapidly because of intensive harvesting, pollution, and increased coastal development.[7] This resulted in the first attempts at oyster mariculture on the West Coast, in which Olympia oysters were transported from Shoalwater Bay, Washington (Willapa Bay), and later from other bays in the Pacific Northwest and Mexico, to San Francisco.[8] The

[3] *Shellfish Aquaculture – Frequently Asked Questions,* NAT'L OCEANIC AND ATMOSPHERIC ADMIN. FISHERIES, http://www.nmfs.noaa.gov/aquaculture/shellfish_portal/shellfish_faqs.html (last visited April 11, 2016).
[4] *What Is Aquaculture,* NAT'L OCEANIC AND ATMOSPHERIC ADMIN. FISHERIES, http://www.nmfs.noaa.gov/aquaculture/what_is_aquaculture.html (last visited April 11, 2016).
[5] MONTEREY BAY NATIONAL MARINE SANCTUARY SITE CHARACTERISTICS, NAT'L OCEAN SERVICE, NAT'L OCEANIC AND ATMOSPHERIC ADMIN. (March 5, 2014), http://montereybay.noaa.gov/sitechar/soci4.html.
[6] *Shellfish Research and Information Services for the U.S. West Coast,* PAC. SHELLFISH INST., http://www.pacshell.org/california.asp (last visited June 1, 2015).
[7] *Id*.
[8] Fred S. Conte, *California Aquaculture: California Oyster Culture*, UNIV. OF CAL. DAVIS DEP'T OF ANIMAL SCI. 1, https://www.extension.org/sites/default/files/California%20Oyster%20Culture.pdf (last visited September 9. 2015).

Shoalwater Bay trade of Olympia oysters dominated the California market from 1850 through 1869.[9]

In 1875, Eastern oyster seed from the Atlantic states was planted and cultured in San Francisco Bay, an operation made possible by the completion of the transcontinental railroad.[10] The Bay reached maximum production in 1899 with an estimated 2.5 million pounds of oyster meat produced.[11] However, by 1908, Eastern oyster production fell by fifty percent in San Francisco Bay, mostly due to degraded water quality and other human-caused stressors. Although oysters are filter feeders and thus can greatly improve water quality, oyster growth is limited in waters that are extremely degraded due to human activity. Thus, "degrading water quality is both a cause and an effect of oyster decline."[12] This is because human stressors cause changing ocean conditions like higher water temperature, changed salinity, low dissolved oxygen, and incoming silt.[13] These stressors make it more difficult for oysters to reproduce, increase disease, and increase predation.[14] This decreases the amount of oysters in the water, which in turn lowers the amount that filtering oysters can provide to the water quality, which further limits oyster growth. By 1939, the last of the San Francisco Bay oysters were commercially harvested.[15]

In 1929, the California Department of Fish and Game (now the California Department of Fish and Wildlife) and commercial companies conducted experimental plantings of Pacific oysters in Tomales Bay just north of San Francisco and Elkhorn Slough in Monterey County.[16] These were the first known

[9] *Id*.
[10] *Id*.
[11] *Id*.
[12] *Oyster Reefs*, NAT'L OCEAN SERVICE, CHESAPEAKE BAY OFFICE, NAT'L OCEANIC AND ATMOSPHERIC ADMIN., http://chesapeakebay.noaa.gov/oysters/oyster-reefs (last visited January 24, 2016).
[13] *Id.*
[14] *Id.*
[15] Conte, *supra* note 8 at 2.
[16] *Id.* (note, some sources disagree and cite this first experimental planting as taking place in 1928. *See* Elinore M. Barrett, *The California Oyster Industry*, RES. AGENCY OF CAL. DEP'T OF FISH & GAME 49 (1963), http://content.cdlib.org/view?docId=kt629004n3&brand=calisphere&doc.view=entire_text (last visited July 1, 2015).

experimental plantings of the Pacific oyster in California, although such plantings had been occurring in Washington for decades.[17] In the 1930s, experimental plantings continued in a number of bays, including Drakes Estero, Bodega Lagoon, and San Francisco Bay in northern California; Morro Bay in central California; and Newport Bay in southern California. Several Pacific oyster plantings proved successful, demonstrating that imported Pacific oyster seed (juvenile oysters about two millimeters in length brought from other water bodies) could be grown commercially in California.[18]

Although Pacific oysters can be grown successfully in California, they have failed to effectively reproduce in California waters.[19] To reproduce, female oysters discharge several millions eggs repeatedly during one spawning period. A small number of these eggs are fertilized by sperm discharged by male oysters into the water. An even smaller number of fertilized eggs, or larvae, survive water hazards in order to attach to a surface and grow out into oyster seed, or very small juvenile oysters.[20] Pacific oysters have failed to effectively reproduce in California coastal waters due to a variety of environmental factors, chiefly water temperature. California oyster growing areas typically are not warm enough for oyster spawning. Occasionally, when water temperatures in California do reach that required for oyster spawning, the larvae do not survive, and "whether they perish because of temperature, salinity, or lack of food is unknown."[21] As such, the oyster industry has turned to the importation of oyster seed. Pacific oyster seed originated from Japan, and thus this importation was disrupted for a time during World War II.[22] Today, most of the oysters grown in California are Pacific oysters produced from seed hatcheries in Washington and Oregon, and from several smaller specialty hatcheries within the state.[23]

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[17] Elinore M. Barrett, *The California Oyster Industry*, RES. AGENCY OF CAL. DEP'T OF FISH & GAME, 48-89 (1963), http://content.cdlib.org/view?docId=kt629004n3&brand=calisphere&doc.view=entire_text (last visited July 1, 2015).
[18] Conte, *supra* note 8, at 1.
[19] Barrett, *supra* note 17, at 50.
[20] *Id.* at 14-16.
[21] *Id.* at 15.
[22] *Id.* at 56-57, 67.
[23] *Id.* at 50-51.

The California Department of Fish and Wildlife initially excluded Humboldt Bay from Pacific oyster plantings, as they were trying to re-establish natural populations of native oysters.[24] Efforts to raise Pacific oyster seed in Humboldt Bay began in 1953, in the northern part of the bay also known as Arcata Bay.[25] The planting was effective, and Coast Oyster Company initiated large-scale plantings in Arcata Bay in 1955.[26] Over the next thirty years, the California industry grew rapidly, centered in Humboldt Bay, Drakes Estero, Tomales Bay, Elkhorn Slough, and Morro Bay.[27]

In addition to oysters, the California coast is home to a number of clam species including the gaper clam, Pacific razor clam, Pismo clam, butter clam, native littleneck, Manila clam, and geoduck clam.[28] The Manila clam, also known as the Japanese littleneck clam, was introduced with imports of Japanese oyster seed in the 1930s.[29] It has since become an important species to the aquaculture industry in California.

The life cycle of a manila clam, and thus the manila clam mariculture operation, begins at hatcheries, where "broodstock animals," or adult clams are conditioned with heated water and food to stimulate the natural breeding season.[30] This can take six to nine weeks, but once desirable conditions are reached, the broodstock animals release eggs and sperm, and thus begin the spawning process.[31] This process is also known as "rearing." California does not have any facilities that rear Manila clam larvae. Instead, California imports Manila clam larvae from Oregon, Washington, and Hawaii, and grows the larvae to clam "seed," or small juvenile clams.

[24] Conte, *supra* note 8, at 1.
[25] Barrett, *supra* note 17, at 70; Conte, *supra* note 8, at 55.
[26] Barrett, *supra* note 17 at 69.
[27] Conte, *supra* note 8, at 1.
[28] PAC. SHELLFISH INST., *supra* note 6.
[29] Kathryn Johnson, *California's Living Marine Resources – A Status Report: Culture of Clams*, CAL. DEP'T OF FISH AND WILDLIFE 19-1 (2008), https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=34426&inline=true.
[30] *Id*. at 19-1.
[31] *Id*.

California mariculture operations specializing in Manilla clams obtain larvae from out of state and culture the larvae in floating upweller systems, otherwise known as "FLUPSYs." These FLUPSYs are "suspended trays covered in mesh netting," and the larvae grow within these trays "until they are between 0.08-0.39 inches (0.2-1.0 centimeters); it is at this point in development that they become clam seed."[32] California shellfish farmers typically do not grow out the clam seed to mature clam size, but supply the seed to other farmers who do so. Although not a large producer compared to Canada and Washington, California is the leading supplier of clam seed worldwide.[33]

Mussels are also a popular and important shellfish source in California. Since the early 1900s, mussels have maintained their commercial and recreational importance as food and fish bait.[34] Despite their popularity, the mariculture industry for mussels did not develop until the late 1970s and 1980s, which brought successful experiments in culturing wild seed stock and in developing hatchery grow out methods.[35]

In 1979, researchers tested the feasibility of harvesting and marketing naturally set Mediterranean mussels from oil platforms in the Santa Barbara Channel.[36] This practice proved feasible, and the harvest of mussels from oil platforms in the Santa Barbara Channel reached its peak in the 1980s. In the fall of 1997, El Nino seawater conditions brought strong storms and warm water, and mussel production fell nearly fifty percent by 1998.[37] In 1999-2000, colder waters improved the growing conditions for mussels, and thus harvest rates increased and mussel production reached a new record high in 2002. From 2002-2009, offshore oil platform harvest reduced by about thirty-three percent, largely due to a major cultivation company ceasing operations.[38]

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[32] *Id.* at 19-2.
[33] *Id*. at 19-1.
[34] Thomas Moore et al., *California's Living Marine Resources – A Status Report: Culture of Mussels*, CAL. DEP'T OF FISH AND WILDLIFE 20-1, (2008) https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=34439&inline=true.
[35] *Id*. at 20-1.
[36] *Id*. at 20-2.
[37] *Id*. at 20-4.
[38] *Id*.

In 1983, in Aqua Hedionda Lagoon near Carlsbad, a shellfish company began experimental mussel cultivation, which turned to commercial cultivation in 1985. The mussel culture followed Italian longline techniques, where mussel seed (or small juvenile mussels) is "placed in a tubular net 'stocking' designed specifically for mussel growing."[39] The stockings are suspended from longlines and supported by small buoys to keep the stockings off the bottom of the ocean. Mussel production in the Carlsbad area peaked in 1989, but production in the area ceased from 1990 to 1992 due to rising coliform counts in the lagoon.

In the mid-1980s, Tomales Bay also began to culture mussels on longlines, and it was common for oyster growers in the Bay to diversify into mussel production.[40] However, most of these Tomales growers ceased all but minimal production of mussels in the mid-1990s to focus mariculture operations on oyster culture. This was mostly due to cheaper, foreign mussel competition.

In 1992, an oyster farmer in Mad River Slough, a tributary to Humboldt Bay, began mussel culture using a floating raft culture method, where seed is "attached to a line inside flexible plastic mesh netting . . . [and] suspended from the raft during grow out."[41] One other operation experimented with mussel grow out in Humboldt Bay in 2001. However, as of 2008, no shellfish farmers in Humboldt Bay were raising mussels.[42]

Recent declines in mussel culture are due to a variety of factors, but the most prominent limiting factor noted by farmers is foreign competition. California growers face strong competition from imported mussels due to low cost air transport and new flash freezing methods of transporting mussels.[43] In other words, local small mussel operations feel they are unlikely to prevail over large, foreign operations providing a cheaper product to consumers. However, a few producers are able to successfully market mussels as locally produced seafood in specialty restaurants and markets.

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[39] *Id*. at 20-3.
[40] *Id*.
[41] *Id*.
[42] *Id*.
[43] *Id*. at 20-4.

Today, a small operation in Tomales Bay supplies mussels to local restaurants, an operator in Santa Barbara provides mussels to local restaurants and markets, and mussels are cultivated from offshore platforms in the Santa Barbara Channel.[44] Growth of mussel mariculture in California that specializes in local markets is likely to continue to develop in the near future, located in offshore waters using the longline technique. This prediction is based on the recent efforts of shellfish producers seeking permits for offshore mussel mariculture operations in Southern California.[45]

Today, the commercial culturing of marine species in California is limited primarily to the production of shellfish such as clams, mussels, and oysters.[46] While the global aquaculture industry is quite large (likely over a $100 billion enterprise), California's $23 million commercial shellfish industry is relatively small.[47] Statewide demand exceeds production, which is constrained by several challenges facing farmers as further described in the following sections.[48]

State and federal governments have recently created several policies to encourage shellfish mariculture in California due to the potential ecosystem benefits, nutritional value of shellfish, and industry's potential to support working waterfronts. However, the expansion of commercial shellfish production has been

[44] *Id*. at 20-3, 20-4.
[45] Catalina Sea Ranch was recently permitted off the coast of southern California, but has not yet been built. For more information, *see About Catalina Sea Ranch*, CATALINA SEA RANCH, http://catalinasearanch.com/Catalinasearanch.com/About_1.html; Santa Barbara Mariculture is seeking to amend permits to continue to cultivate mussels in the Santa Barbara Channel. For more information, *see Santa Barbara Mariculture*, SANTA BARBARA MARICULTURE, http://www.sbmariculture.com/.
[46] CAL. DEP'T OF FISH & GAME, STATUS OF THE FISHERIES REPORT: AN UPDATE THROUGH 2008 17-1 (Traci Larinto ed., 2010).
[47] The National Oceanic and Atmospheric Adminstration states that the industry is $100 billion (*see Basic Questions About Aquaculture*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN. FISHERIES, http://www.nmfs.noaa.gov/aquaculture/faqs/faq_aq_101.html); The Food and Agricultural Organization of the United Nations states states that the industry is valued at $144.4 billion (*see* FOOD AND AGRICULTURAL ORG. OF THE UNITED NATIONS STATES, THE STATE OF WORLD FISHERIES AND AQUACULTURE (2014), *available at* http://www.fao.org/3/a-i3720e.pdf).
[48] CAL. DEP'T OF FISH AND WILDLIFE: *Culture of Clams*, *supra* note 29, at 19-3; CAL. DEP'T OF FISH AND WILDLIFE: *Culture of Mussels*, *supra* note 34, at 20-5; CAL. DEP'T OF FISH & GAME, *supra* note 46, at 17-1.

stunted by a lengthy, complex, and costly regulatory process. To overcome this challenge, entities in some coastal communities with potential for commercial shellfish production growth are turning to innovative permitting approaches.

One such approach is the Humboldt Bay pre-permitting project. Here, the Humboldt Bay Harbor, Recreation and Conservation District (the District), a public agency charged with managing and regulating tidelands in the bay, is seeking to obtain programmatic permits to lease pre-identified tidelands in Humboldt Bay for shellfish mariculture. The District would subsequently lease those pre-permitted tidelands to individual farmers, thus easing the otherwise prohibitively time consuming and expensive permitting process that individual bay farmers would face on their own. (This project will be discussed in more detail in Part V.)

Before pursuing similar permitting or pre-permitting mariculture projects in any additional California coastal water bodies, community and industry leaders should consider conducting pre-feasibility studies at the proposed locations. A pre-feasibility study generally consists of analyzing an area's physical opportunities and constraints for shellfish mariculture. A pre-feasibility study is highly valuable in that it can help to determine if investment in a more extensive review and permitting process is warranted. However, undertaking such an analysis can be daunting, as there are numerous potential physical opportunities and constraints to be studied. This article provides a blueprint and suggests guidelines for developing such a pre-feasibility study.

III. AQUACULTURE EXPANSION: A NATIONAL AND STATEWIDE PRIORITY

The Marine Aquaculture Policy and National Shellfish Initiative's stated reasons for encouraging marine aquaculture development are to provide domestic jobs and healthy, safe, and sustainable seafood products, while protecting marine ecosystems.[49] The Department of Commerce and the National Oceanic and

[49] *National Shellfish Initiative,* NAT'L OCEANIC AND ATMOSPHERIC ADMIN. FISHERIES, http://www.nmfs.noaa.gov/aquaculture/docs/policy/natl_shellfish_init_factsheet_summer_2013.pdf (last visited June 1, 2015).

Atmospheric Administration (NOAA) also encourage marine aquaculture growth in order to support increased U.S. exports of domestically produced marine aquaculture products in response to global demand.[50] These policies encourage sustainable aquaculture innovation and the advancement of improved aquaculture technologies; collaboration between state, local, regional, academic, and business partners; and the exchange of science and insights with other nations to support cooperative research.[51] Lastly, the policies seek to advance public understanding of the environmental, social, and economic benefits and challenges of sustainable marine aquaculture.[52]

Capture fisheries[53] have basically plateaued since the mid-1980s.[54] As such, many regulators and shellfish farmers see mariculture as a viable option to serve growing demand.[55] Commercial fisheries are determined to have plateaued worldwide based on expert assessments from the Marine Fisheries Advisory Committee (MAFAC).[56] In the 2007 MAFAC Final Report, *Vision 2020: The Future of U.S. Marine Fisheries*, experts concluded that:

> Most assessments on the world-wide status of marine fisheries indicate that on a species by species level, most species considered have reached or are near maximum sustainable exploitation levels. Thus, wild marine fisheries harvest which has peaked, at

[50] *Id.*
[51] *Id.*
[52] *Id.*
[53] "Wild capture fisheries" refer to seafood obtained from harvesting or catching naturally occurring species of fish or shellfish (*See What is a Fishery*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN. FISHWATCH, http://www.fishwatch.gov/wild_seafood/what_is_a_fishery.html, last visited July 15, 2015).
[54] *A Milestone for U.S. Aquaculture: 25th Anniversary of the National Aquaculture Act,* NAT'L OCEANIC AND ATMOSPHERIC ADMIN. (September 21, 2015), http://www.fisheries.noaa.gov/aquaculture/homepage_stories/18_35th_anniversary.html.
[55] FOOD AND AGRICULTURAL ORG. OF THE UNITED NATIONS, WORLD REVIEW OF FISHERIES AND AQUACULTURE 83-86 (2010), *available at* http://www.fao.org/docrep/013/i1820e/i1820e01.pdf.
[56] MAFAC, FINAL REPORT OF THE MARINE FISHERIES ADVISORY COMMITTEE, VISION 2020: THE FUTURE OF U.S. MARINE FISHERIES, *available at* http://www.nmfs.noaa.gov/ocs/documents/Vision_2020_FINAL-1.pdf, December 2007.

> approximately 93 million tons per year on a worldwide basis, should not be expected to grow significantly.[57]

The maximum sustainable exploitation level or "maximum sustainable yield," is defined as the "largest, long-term average catch that can be taken under existing conditions."[58] In other words, it is the largest amount of fish and shellfish that can be taken from the ocean without causing long-term deleterious impacts to the population in question. Thus, the MAFAC assessment that fisheries have reached this level worldwide is quite significant. It reveals that we cannot increase the amount of seafood we commercially harvest from the ocean without causing serious adverse impacts to the ocean ecosystem.

In the same report, MAFAC experts determined that on a per capita basis, seafood consumption in the United States is steadily increasing, and is expected to continue growing as the health benefits of seafood are increasingly recognized.[59] Coupled with a growing domestic population and longer average life expectancy, this increase in per capita demand translates into a large overall rise in seafood demand nationwide. Global seafood demand is expected to increase by up to 27 million metric tons by 2030.[60] This predicted increase in demand and the inability to meet such demand from commercially fishing wild stocks is largely the impetus for regulations supporting mariculture development in the United States.

The United States Department of Agriculture (USDA) 2015 Dietary Guidelines Advisory Committee advises moderate intake of seafood to benefit individual health as well as environmental sustainability.[61] The Dietary Guidelines Advisory Committee noted in their report that the collapse of some fisheries due to overfishing in the past decade has raised supply concerns, and that

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[57] *Id*. at 2.
[58] *Annual Catch Limits: Setting an Annual Catch Limit*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN., http://www.nmfs.noaa.gov/sfa/management/acls_ams/setting_acl.html (last visited March 21, 2016).
[59] MAFAC, *supra* note 56, at 2.
[60] *See What is a Fishery*, *supra* note 53, at 69.
[61] U.S. DEP'T OF AGRICULTURE, SCIENTIFIC REPORT OF THE 2015 DIETARY GUIDELINES ADVISORY COMMITTEE 4-8 (Feb. 2015), *available at* http://www.health.gov/dietaryguidelines/2015-scientific-report/PDFs/Scientific-Report-of-the-2015-Dietary-Guidelines-Advisory-Committee.pdf.

"to supply enough seafood to support meeting dietary recommendations, both farm-raised and wild caught seafood will be needed."[62] Thus, the USDA, in addition to the Department of Commerce and NOAA, has national policies encouraging domestic shellfish mariculture growth in the face of ever increasing demand.

While seafood demand in the United States is predicted to increase, current demand already exceeds domestic production. The commercial production of most cultured shellfish in the United States has remained about the same or declined in recent years.[63] To meet consumer demand, the United States imports more than ninety percent of all seafood consumed, as measured by edible weight.[64]

Opponents of domestic shellfish operations cite the seemingly counterintuitive practice of importing ninety percent of American seafood, while exporting the majority of what is caught or cultivated in the United States.[65] Certain fish stocks from the United States are more valuable overseas and thus are immediately exported abroad, while other fish stocks are transported overseas for inexpensive processing, and then brought back into the United States for consumption. In fact, 90% of seafood exported by the United States to China is either reprocessed and exported by China to other countries or sent back to the United States.[66]

U.S. exports of fish and seafood products are led by lobster, Alaskan Pollock, salmon, surimi, and fish roe.[67] Shellfish exports (including lobster and crab) made up thirty-one percent of U.S. fish and seafood exports in FY 2014, and

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[62] *Id*. at 8.
[63] *National Aquaculture Sector Overview: United States of America*, FOOD AND AGRICULTURAL ORG. OF THE UNITED NATIONS, 1 (February 1, 2011), http://www.fao.org/fishery/countrysector/naso_usa/en.
[64] *Global Wild Fisheries*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN. FISHWATCH, http://www.fishwatch.gov/sustainable-seafood/the-global-picture (last visited March 21, 2016).
[65] *See* PAUL GREENBERG, AMERICAN CATCH: THE FIGHT FOR OUR LOCAL SEAFOOD (2014).
[66] Pramod, Nakamura, Pitcher and Delagran, *Estimates of illegal and unreported fish in seafood imports to the USA*, 48 MARINE POL'Y 102-113 (2014).
[67] *U.S. Fish and Seafood Exports Reach Record Levels,* UNITED STATES DEP'T OF AGRICULTURE (Jan. 13, 2015), http://www.fas.usda.gov/data/us-fish-and-seafood-exports-reach-record-levels.

the large majority of these exports consisted of lobster and crab.[68] Many may cite this "seafood swap" as an argument against the need for additional domestic shellfish production, because presumably, any additional shellfish grown domestically will be necessarily exported overseas. However, the vast majority of growing U.S. seafood exports are limited to certain high value products such as lobster, Pacific salmon, and crab sent to China.[69] Contrastingly, shellfish mariculture operations in California are mainly limited to the aforementioned categories of oysters, clams, and mussels.

It is true that as China's population continues to grow, so too will U.S. exports of high value seafood products. Additionally, domestic seafood producers will likely continue to take advantage of inexpensive Chinese labor and process seafood abroad, only to re-import it back to the United States. However, California shellfish mariculture facilities have historically been marketed primarily to local California consumers. This may be due in part to the relatively small size of the California mariculture industry, coupled with the large local demand for oysters, clams, and mussels.

In addition to promoting shellfish mariculture in California to reduce the trade deficit and provide local seafood to consumers, some decision-makers promote California shellfish mariculture for its water quality benefits. Shellfish mariculture can provide vital ecosystem benefits to the marine environment, and this potential is increasingly being recognized by many regulators and scientists who monitor marine and estuarine habitat.[70] Shellfish farms can "improve water quality by filtering out nutrients, suspended sediment, and chlorophyll."[71] Shellfish have the potential to remove phytoplankton, detritus, and particulate material through filtration, thus improving water quality. This can, in turn, improve certain areas of fish habitat in high-turbidity systems. In fact, the

[68] *Id.*
[69] *Id.*
[70] *Aquaculture and Eutrophication in Long Island Sound and Great Bay – Piscataqua Estuary*, NAT'L CTRS. FOR COASTAL OCEAN SCI., http://coastalscience.noaa.gov/projects/detail?key=32 (last visited June 1, 2015).
[71] *Id*.

National Center for Coastal Ocean Science (NCCOS) is currently studying and quantifying the water filtration benefits from shellfish farms.[72]

Additionally, many coastal community leaders and policy makers encourage shellfish mariculture expansion to reinvigorate and support working waterfront economies. Fishing limitations, due to many factors including decreased wild stocks, have led to lost employment and revenues for many coastal communities. Shellfish farming would allow these communities to use existing skills, boats, and infrastructure to boost their income and economies while maintaining traditions of working on the water.[73] Shellfish mariculture operations in these coastal communities can provide jobs for unemployed and underemployed fishermen, as well as unskilled and semi-skilled workers at new seafood processing facilities. The industry even has the potential to generate increased tourism.[74]

According to a 2013 economic report prepared by the Pacific Shellfish Institute, in 2010 California shellfish farmers were responsible for approximately 200 direct jobs and generated an additional 80 jobs through "indirect and induced activity."[75] These shellfish mariculture operations paid approximately $5.4 million in wages and generated additional labor income of $4.6 million, for a total of $10 million in labor income in California. For every dollar spent by the California shellfish mariculture industry, $1.97 worth of economic activity and $0.85 in wages are generated.[76] Because of these potential benefits to working waterfront communities and economies, local governments across the California coast have recently initiated the process of pursuing shellfish mariculture development permits.

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[72] *Id*.
[73] *Shellfish Aquaculture Supports Working Waterfronts—Growing Mussels in Gloucester*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN. FISHERIES (August 6, 2012), http://www.nmfs.noaa.gov/stories/2012/08/08_06_12gloucester_mussels.html.
[74] *Id.*
[75] NORTHERN ECONOMICS, INC., PACIFIC SHELLFISH INSTITUTE, THE ECONOMIC IMPACT OF SHELLFISH AQUACULTURE IN WASHINGTON, OREGON AND CALIFORNIA 29 (2013).
[76] *Id.*

Because of the need to reduce the seafood trade deficit and the potential benefit to coastal communities and ecosystems, state and federal governments have established policies in the past few decades to support shellfish mariculture development. The California Aquaculture Development Act (1983) declared that the growth of aquaculture is in the interest of the people of the state of California in order to augment food supplies, expand employment, promote economic activity, increase native fish stocks, enhance commercial and recreational fishing, and protect and better use the land and water resources of the state.[77]

Additionally, the U.S. Department of Commerce and NOAA, consistent with the National Aquaculture Act of 1980, released a new Marine Aquaculture Policy and a National Shellfish Initiative in June 2011. These policies encourage the growth of a business climate and technological base to foster development of sustainable marine aquaculture in the United States.[78] The goal of the National Shellfish Initiative is to "increase populations of bivalve shellfish in our nation's coastal waters . . . through commercial production and conservation activities."[79]

Inspired by the National Shellfish Initiative, the Pacific Coast Shellfish Growers Association (PCSGA) approached numerous agencies in Washington along with the Washington governor's office to create the Washington Shellfish Initiative (WSI). It met great success, leading PCSGA to also approach the National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW), California Coastal Commission (CCC), and other state and federal agencies in California to develop the California Shellfish Initiative (CSI). To date, the CSI Working Group has held five meetings and developed a working vision, which includes expanding sustainable and legal commercial and restoration shellfish mariculture in California.

[77] CAL. PUB. RES. CODE § 826-828.
[78] U.S. DEP'T OF COMMERCE, AQUACULTURE POLICY (June 2011), available at http://www.nmfs.noaa.gov/aquaculture/docs/policy/doc_aquaculture_policy_2011.pdf.
[79] *National Shellfish Initiative,* NAT'L OCEANIC AND ATMOSPHERIC ADMIN. FISHERIES, http://www.nmfs.noaa.gov/aquaculture/docs/policy/natl_shellfish_init_factsheet_summer_2013.pdf (last visited June 1, 2015).

IV. CONSTRAINTS TO SHELLFISH MARICULTURE EXPANSION

Despite the federal and state policies promoting the growth of the industry, the shellfish mariculture industry in California is not growing. Shellfish farmers, local officials in coastal regions, and other stakeholders contend that the industry's primary constraint is the regulatory permitting process and associated costs that shellfish farmers must pay to obtain mariculture permits.[80]

Shellfish mariculture generally takes place on public lands and in waters held in trust by the state of California. Shellfish farmers must, therefore, obtain leases to grow within these lands, unless the culture is to take place in federal waters.[81] In addition to leases, local shellfish farmers must obtain regulatory approvals. Depending on culture methods and extent, multiple approvals and permits may be required from the U.S. Army Corps of Engineers (USACE) under the Clean Water Act and Rivers and Harbors Act, the CCC under the Coastal Zone Management Act and California Coastal Act, Regional Water Quality Control Boards, the State Department of Health, and local agencies. Further, when a California agency issues a permit or approval, it must comply with the California Environmental Quality Act (CEQA), while federal agencies must follow the National Environmental Policy Act (NEPA).

In turn, permits and approvals usually trigger additional consultation requirements. Consultation, for example, may be required with the CDFW and the National Marine Fisheries Service (NMFS) to ensure compliance with the Endangered Species Act (ESA), California Endangered Species Act (CESA),

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[80] *See* PACIFIC COAST SHELLFISH GROWERS ASSOCIATION (PCSGA), CALIFORNIA SHELLFISH INITIATIVE POSITION PAPER 5-6 (2013), *available at* http://pcsga.org/wprs/wp-content/uploads/2013/08/CA-Shellfish-Initiative-Position-Paper-Aug-2013-.pdf.

[81] *See* THE NATURAL RES. AGENCY OF CALIFORNIA, DEP'T OF FISH AND WILDLIFE, INFORMATION LEAFLET REGULATIONS GOVERNING LEASING OF STATE WATER BOTTOMS FOR AQUACULTURE, *available at* https://nrm.dfg.**ca**.gov/FileHandler.ashx?DocumentID=27450 (describing the general lease application process for aquaculture farmers in California, including the most common process of leasing state water bottoms or the water column from the California Fish and Game Commission).

Marine Mammal Protection Act (MMPA), Magnuson-Stevens Act (MSA), and other laws.[82]

This permitting and review process can take shellfish farmers years and cost tens or hundreds of thousands of dollars to complete. One memorandum recently presented to the CSI Working Group compares the aquaculture project review process in California to that of Maine, New Hampshire, Rhode Island, Connecticut, Maryland, Florida, and Washington. It found that, on average, the permitting process takes four to twelve months and costs $10,000. In comparison, in California it takes two to five years and costs between $75,000 and $200,000, with some reviews costing much more and taking significantly longer.[83] For example, Coast Seafoods Company spent more than $1 million on permits and environmental reviews over a 10-year period for a California shellfish mariculture project.[84] As the largest oyster farmer in California, Coast Seafoods was able to absorb the expense, but the regulatory process and associated costs can be prohibitive barriers for smaller farmers and potential new farmers.[85]

California's environmental laws and regulatory structure are responsible for the increased cost and time for shellfish permitting in California relative to other states. This includes the CEQA, which imposes statutorily mandated guidelines and timelines for environmental review and public participation.[86] Additionally, the CCC is the state agency charged with implementing the Coastal Zone Management Act (CZMA) in California. The CCC has a separate review and approval process for shellfish mariculture projects than that of the State lessor in California (usually the California Fish & Game Commission). This adds a significant layer to the approval process and differs greatly from most states, which either exempt shellfish projects from CZMA review (such as Washington

[82] *Reducing Regulatory Risks for Shellfish Growers in Humboldt Bay, Case Study* 2 (2009-ongoing).
[83] Robert M. Smith, Plauche & Carr, *Memorandum Re. Shellfish Aquaculture Permitting Comparison* 2 (March 27, 2015).
[84] *Reducing Regulatory Risks for Shellfish Growers, supra* note 82 at 2.
[85] *Id*.
[86] *Id.* at 5.

and Maryland), or combine the CZMA consultation process with the state leasing process with no separate approval (such as Rhode Island and Florida).[87]

Another significant barrier to shellfish mariculture development in California is uncertainty as to the extent of environmental effects and the lack of site-specific data. In response to relative uncertainty, many advocate for strict employment of the "precautionary principal," or in other words, prohibit any action if the effects are not known and predictable. Others support an "adaptive management" approach, with strict monitoring of shellfish mariculture sites and the flexibility to respond to environmental impacts that may arise. Extensive environmental review of shellfish mariculture projects is vitally important. Shellfish mariculture expansion has the potential to impact eelgrass and other habitats; marine species that use these habitats; and recreational uses such as kayaking, fishing, and hunting. Given the cumulative impacts of historic and current uses of estuaries and bays, the ecological carrying capacities of water bodies proposed for shellfish expansion must be assessed (see Other Issues for Evaluation below).[88]

V. HUMBOLDT BAY'S "PRE-PERMITTING" APPROACH

Many sites suitable for shellfish mariculture in California are not being used because of the aforementioned regulatory, financial, and environmental hurdles facing shellfish farmers. Despite the State Legislature designating Humboldt Bay as the Oyster Capitol of California in 2009, only a small fraction of tidelands with the potential for shellfish mariculture are being farmed.[89]

In 2010, the Humboldt Bay Harbor, Recreation and Conservation District (District) reached out to local shellfish farmers and environmental groups to explore the idea of increasing sustainable commercial shellfish mariculture activities in Humboldt Bay. The District devised an innovative "pre-permitting" approach, in which it would obtain the necessary permits, and then lease the pre-

[87] *Id.*
[88] *Id.* at 2.
[89] *Id.* at 1.

permitted tidelands to interested farmers through a public bidding process.[90] The District is currently seeking permits and approvals from federal and state regulatory agencies to implement its plan.

The District will incur the costs associated with obtaining permits and regulatory approvals as a one-time expense. They will also incur the risk of investing significant amounts of time and money into the permitting process, with no guarantee of approval. The District decided to pursue this project regardless of these associated costs and risks, based on a pre-feasibility study done by Humboldt State University's Natural Resource Planning Team.[91] This pre-feasibility study determined that some amount of shellfish mariculture expansion and associated economic development in the bay is generally highly feasible.

By seeking all permits and approvals itself, the District will transfer the cost and regulatory risk from individual farmers to the District, and provide a more affordable and overall less risky investment for new farmers. In addition to eliminating high costs faced by individual farmers, the pre-permitting approach could ensure greater environmental compliance and sustainable management than project-by-project reviews, by analyzing all potential sites in a comprehensive environmental review.

The Humboldt Bay Pre-permitting approach is still in the process of development, but its innovative solution to shellfish mariculture development barriers has inspired others in California to look to similar solutions. For example, the Ventura Port District is currently exploring the possibility of a similar venture in offshore waters in southern California. However, before similar projects can be developed in additional California coastal areas, pre-feasibility studies should be completed to assess whether geographic areas under consideration possess the necessary attributes for successful shellfish culturing.

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[90] *Id.*

[91] YVONNE EVERETT WITH CARRIE CARTER-GRIFFIN ET AL., A PRE-FEASIBILITY STUDY EXAMINING OYSTER MARICULTURE EXPANSION IN HUMBOLDT BAY, CA 18 (Humboldt State University 2010).

VI. METHODS TO QUANTIFY PRE-FEASIBILITY OF SHELLFISH MARICULTURE IN CALIFORNIA COASTAL WATER BODIES

Pre-feasibility studies could be conducted for additional California water bodies following the model established by "A Pre-Feasibility Study Examining Oyster Mariculture Expansion in Humboldt Bay, California, 2010." A Humboldt State University Natural Resources Planning Practicum team under the direction of Professor Yvonne Everett performed this pre-feasibility study for the District in order to analyze the area's geographic opportunities and constraints for shellfish mariculture development, and evaluate if moving forward in the permitting process is warranted.

A. *Methodology*

The parameters to determine the feasibility of permitting new shellfish mariculture facilities in coastal water bodies of California include: preliminary evaluation factors; physical boundaries; natural resources; land use; property ownership; and proximity to sensitive natural, cultural, and recreational resources. Decision makers, like the District, may use these parameters for initial screening to determine if a full feasibility assessment is warranted.

In the case of Humboldt Bay, geographic information system (GIS) and light detection and ranging (LIDAR, for bathymetry) data showing existing elevations, property boundaries, land use, and natural resource data was collected from the County of Humboldt and the District. Interviews were conducted with local scientists and shellfish industry experts to identify key physical and resource based constraints on shellfish mariculture sites in Humboldt Bay.

The most essential parameters to review are those related to areas where culture is physically possible based on current and anticipated culture methods. For the Humboldt Bay Pre-feasibility Study, the parameters were depth (based on acceptable depths for cultivation), Humboldt Bay ownership and leases, and sensitive habitats—in this case, existing eelgrass beds and seal haul-outs. These spatial parameters were then digitally mapped and analyzed in GIS to identify areas where expanded shellfish culture would be appropriate.

In all cases, working with, acquiring, and confirming information from existing shellfish farmers was essential. In order for commercial shellfish mariculture operations to have prevailed in this environment, they had to be resourceful, creative, and collaborative. Thus, their knowledge and experience was indispensable for this study—and will be for other pre-feasibility studies in additional coastal areas of the state.

B. *Preliminary Evaluation Factors*

The initial evaluative factor relates to existing shellfish mariculture activities in the water body being examined. Quantifying and reviewing an area's existing mariculture practices and most recent permitting processes will be useful in predicting the outcome of any new shellfish culture activities or expansion of existing operations. It is assumed that if there are currently shellfish culture operations in a given location, additional culture of the same species and methods may be more practical than initiating culture in an entirely new area or with a novel species or method. However, this assumption could be challenged by identifying new areas, shellfish species, and improved culture methods (depending on the analysis of the physical and environmental parameters).

Physical boundaries must also be evaluated to determine if shellfish mariculture operations may be initiated or expanded in any coastal water body. If the proposed activities are based on expansion of existing mariculture locations and methods, the most practical way to define parameters is to review the physical constraints determining the boundaries of the existing culture. In general, the physical boundaries for culture (depending on method) are primarily: (1) elevation (relative to tide); (2) water quality; and (3) proximity to sensitive natural, cultural, and recreational resources. *FLUPSY* culture is further limited to subtidal areas (typically in channels) where floating infrastructure can be adequately secured and maintained and is not a navigational hazard.

Suitable intertidal growing depths are determined by several factors, including sediment build-up, shelter from harsh wave action, and depth of

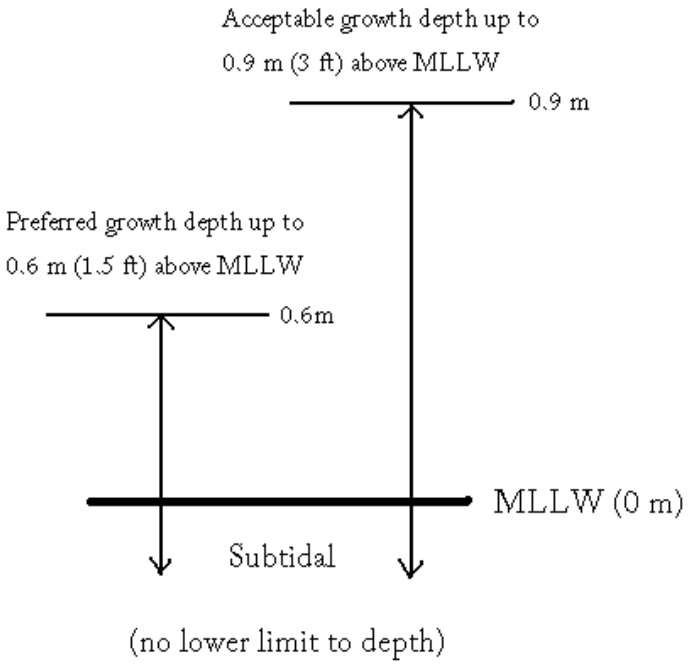
structures to determine ease of servicing.[92] Targeted species in certain areas will only grow at a specified range of elevations.

Figure 1 is an example from the Humboldt Bay study, which focused on the cultch-on-longline method of producing Pacific and Kumamoto oysters. The study established that the typical elevation or depth for growing these oysters in Humboldt Bay was intertidally at 1.5 feet (0.6 meters) Mean Lower Low Water (MLLW), but that oysters could be grown up to 3 feet (0.9 meters) MLLW.[93]

Although Figure 1 is specific to oyster cultch-on-longline culture in intertidal areas of Humboldt Bay, similar studies can suggest preferred elevation parameters for other forms of shellfish culture in additional California water bodies.

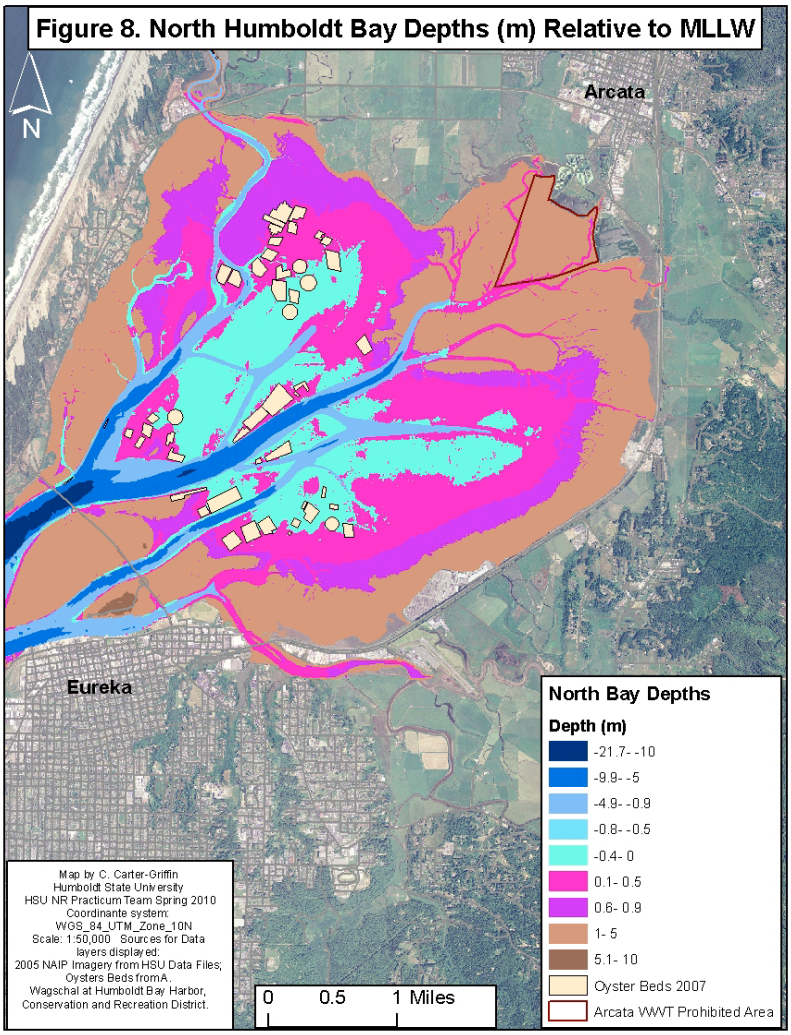
[92] *Id*. at 18.
[93] *Id*. at 18. Mean Lower Low Water, or MLLW, is "the average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch." *Tidal Datums*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN. (2009), https://tidesandcurrents.noaa.gov/datum_options.html).

Figure 4. Depth Ranges Suitable for Oyster Growth



Example of the elevation range for oyster culture for Humboldt Bay, from YVONNE EVERETT WITH CARRIE CARTER-GRIFFIN ET AL., A PRE-FEASIBILITY STUDY EXAMINING OYSTER MARICULTURE EXPANSION IN HUMBOLDT BAY, CA 18 (Humboldt State University 2010).

The Humboldt Bay study also mapped out areas of the Bay to show areas of depth relative to MLLW, as demonstrated in Figure 2. This, along with the figure demonstrating depth suitable for oyster growth in the Bay (Figure 1), helped decision-makers choose ideal areas for permitting, and thus cultivation in the Bay.



Example of the elevation range for oyster culture for Humboldt Bay, from YVONNE EVERETT WITH CARRIE CARTER-GRIFFIN ET AL., A PRE-FEASIBILITY STUDY EXAMINING OYSTER MARICULTURE EXPANSION IN HUMBOLDT BAY, CA 18 (Humboldt State University 2010).

In addressing whether or not existing water quality can successfully support new shellfish culture operations or shellfish expansion, the most important factors to address are: salinity, temperature, pollution (typically e-coli), and disease (relative to shellfish). Salinity and temperature are influenced by

parameters such as location within the water body, depth, tidal flux, freshwater inputs and seasonal changes. Water quality can also be negatively impacted from proximity to point source discharges such as industry and wastewater treatment plants, urban and agricultural runoff, failing septic systems, and other seasonal nonpoint sources. These can produce intermittent pulses of e-coli (an indicator of the presence of other pathogens) that can temporally, sometimes permanently, limit the ability to harvest shellfish from the water body. Also of importance is the potential for diseases that can impact shellfish culture in open water or for hatchery operations (i.e., oyster drills).

Substrate composition and stability is a major physical parameter to consider during the selection of a culture site suitable for shellfish growth, especially where benthic species or bottom culture may be pursued.[94] Substrate composition will determine the suitability of an area for a particular species.[95] This is not an issue for Humboldt Bay, however, where all intertidal shellfish culture is suspended off bottom on long lines or racks or in subtidal areas on rafts.

C. *Natural Resources*

In addition to physical boundaries, a pre-feasibility study using GIS should include mapped areas of known listed or significant natural resource areas such as current and potential essential fish habitat—including eelgrass—under the MSA. Habitat for listed threatened or endangered species under the ESA and habitat for listed species under the MMPA should also be included. Maps should also include the actual presence of any other federal and CESA listed species or significant natural resources. The presence of listed or sensitive species and habitat in areas would not necessarily preclude a project from consideration, but a detailed mapping of natural resources will help inform overall feasibility of shellfish mariculture projects. The Humboldt Bay study included GIS mapping of current and potential eelgrass beds found extensively throughout the Bay, and harbor seal haul out areas (areas where the seals rest on shore). Proximity to migratory bird feeding and gritting sites could have an impact on resources.

[94] Alessandro Lovatelli, *Site Selection for Mollusc Culture,* NETWORK OF AQUACULTURE CENTRES IN ASIA (Nov. 1988), http://www.fao.org/docrep/field/003/AB722E/AB722E00.htm.
[95] *Id.*

D. *Land Use*

A review of current zoning and land use ordinances is important. Many local coastal land use planning documents in California have provisions that address shellfish mariculture and identify it as a coastal dependent use. Designation as a coastal dependent use can give shellfish mariculture priority over certain other types of development, or could present challenges to mariculture operations, depending on the local plan. Potential conflicts with California Local Coastal Plans can create additional challenges to expansion, but these plans can be amended if it is determined by the applicable agency with land use authority that shellfish mariculture is desirable in these areas.

Determining which agency has public trust authority in the water body in question is essential for evaluating the feasibility of mariculture operations. All California tide and submerged lands are subject to the public trust doctrine, requiring that the State of California hold these lands in perpetuity and manage them for the benefit of all Californians for statewide purposes.[96] The California State Lands Commission (SLC) has leasing jurisdiction over much of California's tide and submerged lands, beds of naturally navigable rivers and lakes, and school or proprietary lands.[97] In some areas, permitting and leasing of sovereign state tide and submerged lands for mariculture purposes are under the primary jurisdiction of the California Fish and Game Commission. In some areas, SLC reviews all such permits and leases to ensure that the lands are not used in a way that would violate the public trust doctrine.

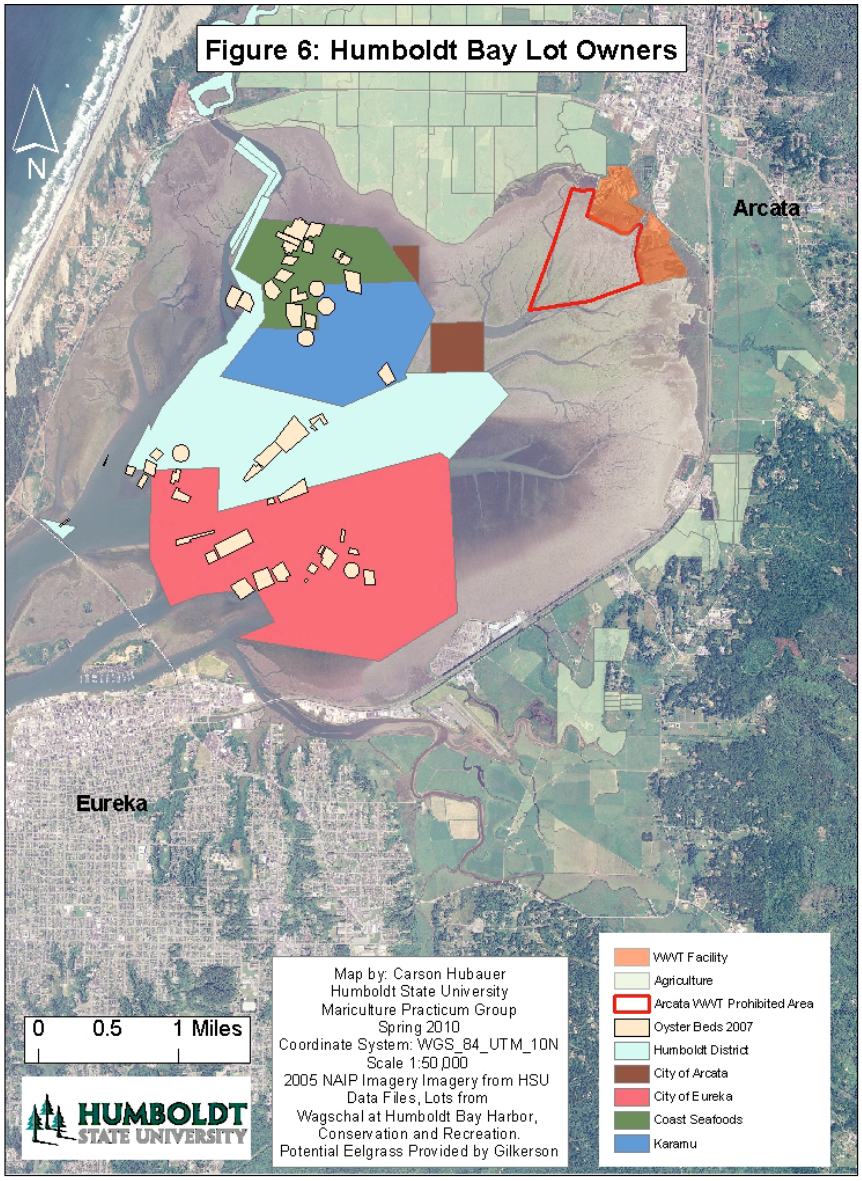
In areas such as Humboldt Bay, trust authority has been delegated to special districts and local agencies such as the District as well as the cities of Arcata and Eureka. All of these entities have the authority to lease state water bottoms or the water column to any person for mariculture, so long as they have determined the lease is in the public interest and the tideland is not privately

[96] *Illinois Central R.R. Co. v. Illinois* 146 U.S. 387, 452 (1892).
[97] *About the California State Lands Commission*, CAL. STATE LANDS COMM'N, http://www.slc.ca.gov/About/About.html (last visited May 13, 2016).

owned.[98] In order to simplify the action of pre-permitting, the number of permittees should be minimized. Ideally, only one permittee would be required.

In places like Humboldt Bay, there is a potential for private property holders to have claim over some tidelands. A review of what is public and privately owned is important, because in some cases, land owner participation may be needed. Figure 3 is an example of how a comprehensive map of public and privately owned areas can be helpful in pursuing a pre-feasibility study.

[98] CAL. FISH & GAME CODE §§ 15400-15415.



Example of Humboldt Bay lot owners from YVONNE EVERETT WITH CARRIE CARTER-GRIFFIN ET AL., A PRE-FEASIBILITY STUDY EXAMINING OYSTER MARICULTURE EXPANSION IN HUMBOLDT BAY, CA 18 (Humboldt State University 2010).

In addition, one should review whether there are any existing tideland trustees, trade cooperatives or associations, natural resource agencies, local government organizations (i.e., Harbor District, County, City, joint powers authority), or local NGOs (i.e., economic development corporation) that have interests in the area. If so, they should be contacted to identify concerns about shellfish mariculture expansion. Significant concerns can be addressed in the spatial analysis of specific areas for consideration.

Additional issues that may be of concern could include:

- *Carrying capacity*: In this context, carrying capacity is the level of shellfish culture that the region could ecologically sustain. It is important to analyze the carrying capacity of the geographic region proposed for shellfish mariculture to ensure that culture level does not surpass the region's ecological carrying capacity. For the Humboldt Bay study, environmental consultants analyzed the carrying capacity of shellfish culture in Humboldt Bay by quantifying the cumulative impact that shellfish mariculture expansion (including proposed projects other than the pre-permitting project) would have on the bay.

- *Existing Habitat Conservation Plan (HCP), Natural Community Conservation Plan (NCCP), or other resource plans*: An HCP is a requirement that may be issued under terms of an Incidental Take Permit pursuant to the ESA. An NCCP is a statewide program and applies to the CESA. Under either plan, land or habitat may be set aside to mitigate or minimize any adverse effects to listed species. It is important that any existing HCP, NCCP, or other resource plan be identified in a proposed area for culture. Such designation may, although not necessarily, preclude the area from development. If such an HCP, NCCP, or other resource plan exists, culture may still be possible so long as the applicant demonstrates that the activity is compatible with the protection of the species or resource.

- *Locations and infrastructure to support processing*: Existing infrastructure that would support shellfish processing near the proposed geographic area

could have significant impacts on project feasibility. If infrastructure support systems currently exist near the proposed geographic location, there may be little or no cost and associated ecological impact required to construct new infrastructure. Similarly, a close, convenient location can have fewer effects on the environment and lower costs than an inconvenient or distant location.

- *Aesthetic impacts*: Possible aesthetic impacts, or the impacts to the visual landscape of mariculture gear on a water body, are also important to evaluate. Possible negative aesthetic impacts on a coastal community should be addressed with community members. These could include impediments to viewing the natural and historical landscape adjacent to and within the bay.

- *Recreational and cultural uses*: Recreational uses such as hunting and boating as well as cultural gathering are possible sources of conflicts.

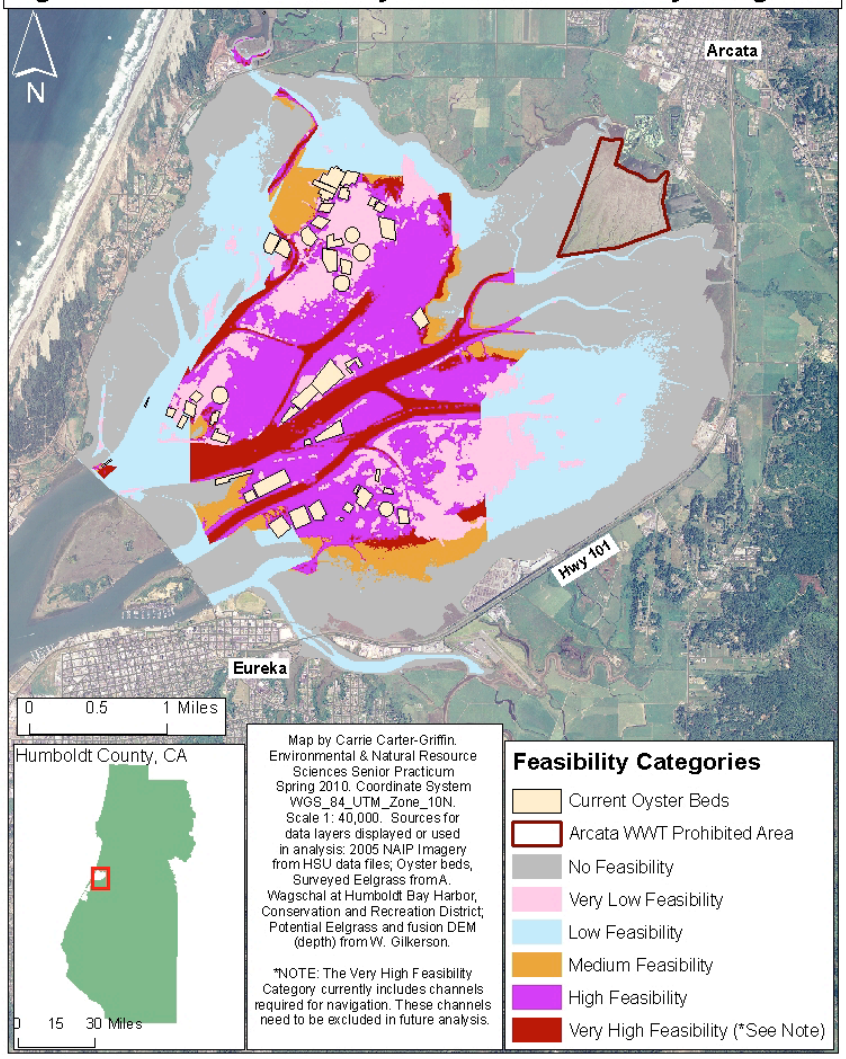
Using GIS, the aggregated data sets from the parameters described above can be evaluated to identify and quantify areas where expanded shellfish mariculture may be appropriate in various California coastal water bodies. Decision makers can then assess if there is sufficient potentially feasible geographic area to justify a more extensive review or permitting effort.

For example, the Humboldt Bay study addressed similar parameters in a GIS based capability and suitability planning exercise to determine the feasibility of mariculture expansion in the North Bay portion of Humboldt Bay (Figure 4). The study established feasibility categories for oyster culture expansion that ranged from "No Feasibility" to "Very High Feasibility," and essentially laid the framework for the Humboldt Bay Pre-Permitting Project full-scale feasibility study for mariculture expansion.[99] In the case of Humboldt Bay, 2,700 acres were identified for culture. It was determined by the District that even if this was ten

[99] Everett et al., *supra* note 97, at 18.

percent accurate, 270 acres of expansion was worth pursuing with extensive study and permitting.[100]

Figure 5. North Humboldt Bay Mariculture Feasibility Categories



Example of Feasibility Areas from YVONNE EVERETT WITH CARRIE CARTER-GRIFFIN ET AL., A PRE-FEASIBILITY STUDY EXAMINING OYSTER MARICULTURE EXPANSION IN HUMBOLDT BAY, CA 18 (Humboldt State University 2010).

[100] *Id.*

Finally, no pre-feasibility cost estimation was done as part of this review. In the case of Humboldt Bay, the bulk of the work was completed by a group of Humboldt State University students with the guidance of their professor, local shellfish farmers, and the District staff and commissioners. Rough estimation of the work product, if done by consultants, would be in the range of $30,000 to $50,000.[101]

Funding is often a limiting factor for an applicant to move forward with necessary studies to obtain permits for shellfish culture. These preliminary reviews can demonstrate the potential for success and thus help to support funding requests for the permitting costs. In the case of Humboldt Bay, it is estimated the cost of permitting will be approximately $400,000, including Humboldt Bay Harbor District staff time working on the project. These types of efforts can be eligible for economic development funding, especially with the current national and state focus on revitalizing working waterfronts.[102] This can include grants from state and federal government programs, private grants, research grants, and other forms of applicable economic development funding.

VII. CONCLUSION

A spatial analysis-based approach to a pre-feasibility study, as discussed above, may be used to quantify a geographic area that would be potentially suitable for shellfish mariculture. This information can then be used to determine if an extensive review effort is worthwhile to expand or introduce shellfish mariculture in specific water bodies along the California coast.

Such a pre-feasibility study assumes that significant spatial data are already available for the study area and can be compiled. Most of the areas under potential consideration for new or expanded shellfish mariculture in California have had some amount of data collection already completed from existing and

[101] This figure was provided by conversations officials from the Humboldt Bay Harbor, Recreation and Conservation District including Mike Wilson and author of the Humboldt Bay Pre-Feasibility Study, Yvonne Everett.
[102] NAT'L WORKING WATERFRONT NETWORK, http://www.wateraccessus.com/toolkit.html (last visited April 12, 2016).

ongoing planning and research activities. Compilation of data related to parameters such as physical boundaries, natural resources, land use, and ownership for the specific potential location is recommended. Feasibility is greater in areas of suitable depth, water quality, and substrate for species to be cultured. It is also greater in areas that do not have projected or surveyed sensitive habitats; in areas that already have leases for shellfish mariculture operations; and in areas with no conflicting recreational, cultural, or land uses.

Specific water bodies in California with the potential for shellfish expansion include Tomales Bay, Morro Bay, and offshore of the Ventura Port District in southern California. Once pre-feasibility studies have been conducted, a pre-permitting approach, such as the Humboldt Bay pre-permitting process, could be considered as a method that is responsive to regulatory and financial challenges to shellfish mariculture development. This approach would also provide a holistic environmental review of a marine ecosystem, rather than a piecemeal approach to environmental permitting.

Californian shellfish mariculture developers (consisting of oyster, mussel, and clam cultivators) will be able to avoid some of the permitting challenges faced by other small shellfish farmers by implementing pre-permitting projects. Addressing regulatory challenges in this holistic way will enable the California shellfish mariculture industry to expand and meet domestic demand for oysters, clams, and mussels, both in California and nationally.