Final Environmental Impact Report for the Humboldt Bay Mariculture Pre-Permitting Project

Volume 1

SCH #2013062068

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Executive Summary

This Environmental Impact Report (EIR) assesses the potential environmental effects of implementing the Humboldt Bay Mariculture Pre-Permitting Project (Project). The Project would increase production of Kumamoto oysters (*Crassostrea sikamea*), Pacific oysters (*C. gigas*) and Manila clams (*Tapes philippinarum*) in Humboldt Bay, California. It would also potentially include culture of native macroalgae (Rhodophyta). Under the Project, approximately 527 acres (ac) of culture would be established in intertidal areas using methods that suspend cultured shellfish off the bay bottom. Approximately 21 ac of culture would be established in subtidal areas using rafts. However, the alternative being considered for adoption is Alternative 1, which is the environmentally superior alternative and only involves establishment and operation of subtidal shellfish nurseries and macroalgae culture. Reasons for considering Alternative 1 for adoption are provided in EIR Volume 2, Master Response 1.

The regulatory structure of the Project is unique for Humboldt Bay, where permits are typically obtained and held by private shellfish growers. Specifically, under the Project, the Humboldt Bay Harbor, Recreation and Conservation District (District) would obtain and hold the permits and lease the "pre-permitted" areas to private shellfish growers ("Lessees"). Table S-1 provides a summary of the Project's impacts, mitigation measures and impact levels of significance.

Table S-1. Summary of the Project's Impacts, Mitigation Measures and Impact Levels of Significance

Impact	Significance Without Mitigation	Mitigation Measure(s)	Significance With Mitigation
Cultural and Archeological Resources			
CR-1: Placement of equipment.	PS	**CR-1**: Inadvertent discovery of cultural or archeological resource protocols. **CR-2**: Inadvertent discovery of Native American remains and grave goods protocols. **CR-3.** Training for Lessees operating at Intertidal ~~Subtidal~~ Sites 3 and 4.	LS
Biological Resources			
BIO-1: Effects of intertidal culture on shorebird species as a result of loss of foraging habitat and alteration of food sources.	LS	None needed	N/A

Impact	Significance Without Mitigation	Mitigation Measure(s)	Significance With Mitigation
BIO-2: Effects of intertidal culture on black brant (*Branta bernicla nigricans*) as a result of loss of foraging habitat and alteration of food sources.	LS	None needed	N/A
BIO-3: Potential impact to marine mammals from the potential loss of foraging habitat and restrictions to movement due to placement of aquaculture equipment in intertidal and subtidal areas.	LS	None needed	N/A
BIO-4: Effects of human disturbance (e.g., boat movement, presence of culture workers) on marine mammals and other wildlife.	PS	**BIO-1**: Educational meetings.	LS
BIO-5: Effects on distribution and abundance of mammalian or avian species that are potential predators of native fish species, and related effects to native fish species.	LS	None needed	N/A
BIO-6: Effects of artificial lighting on wildlife.	PS	**BIO-2:** Shielding of light fixtures.	LS
BIO-7: Effects to green sturgeon (*Acipenser medirostris*) as a result of potential reduction in prey.	LS	None needed	N/A
BIO-8: Effects on abundance of suspended organic matter and related effects to other native species.	LS	None needed	N/A
BIO-9: Effects to green sturgeon as a result of habitat loss or degradation.	LS	None needed	N/A
BIO-10: Effects to green sturgeon due to entanglement.	NI	None needed	N/A
BIO-11: Effects on wetland functions.	LS	None needed	N/A
BIO-12: Effects on eelgrass (*Zostera marina*).	PS	**BIO-3:** Eelgrass avoidance by boats. **BIO-4:** Eelgrass avoidance of culture equipment. **BIO-5**: Deposition of shells.	LS
BIO-13: Potential impacts of overwater structures at subtidal sites on fish species.	LS	None needed	N/A
BIO-14: Potential impacts of water intakes on aquatic species.	PS	**BIO-6**: Screening criteria.	LS

Impact	Significance Without Mitigation	Mitigation Measure(s)	Significance With Mitigation
BIO-15: Potential effect to eelgrass by constraining its expansion into higher elevation areas as a result of sea level rise.	LS	None needed	N/A
BIO-16: Potential impacts on Pacific herring (*Clupea pallasii*) spawning sites.	PS	**BIO-3; BIO-4; BIO-5** **BIO-7**: Spawning herring avoidance.	LS
BIO-17: Effects on the distribution and abundance of fish species that are potential native fish species predators, and related native fish species effects.	NI	None needed	N/A
BIO-18: Potential for cultured shellfish to naturalize or establish self-sustaining populations outside of cultivation and the effects of this naturalization on native marine species and communities.	PS	**BIO-8**: Discard clam culls outside of bay. **BIO-9:** Remove mature clams from bay.	LS
BIO-19: Effect on benthic habitat and communities from the shellfish culture equipment and cultured shellfish, including initial equipment installation activities, anchoring, posts and material staging.	LS	None needed	N/A
BIO-20: Potential impacts to submerged aquatic vegetation and benthic habitat resulting from bottom scour, support vessel operations motor contact and trampling by workers.	LS	None needed	N/A
BIO-21: Potential effects of additional shellfish culture structures due to potential light transmission changes through water column, water flow and sediment transport.	LS	None needed	N/A
BIO-22: Ecological effects during installation of piles at Subtidal Site 3.	PS	**BIO-10:** Sound threshold criteria. **BIO-11**: Biological monitor.	LS
BIO-23: Impact on the distribution and dispersal of non-native invertebrate fouling species.	PS	**BIO-12**: Bio-fouling organism removal.	LS
BIO-24: Conflicts with local policies, particularly those described in the Humboldt Bay Management Plan and County of Humboldt, City of Eureka and City of Arcata Local Coastal Programs.	NI	None needed	N/A

Impact	Significance Without Mitigation	Mitigation Measure(s)	Significance With Mitigation
Aesthetic and Visual Resources			
AV-1: Effect on scenic vistas and visual character from the presence of mariculture workers and vessels.	LS	None needed	N/A
AV-2: Effect on scenic vistas and visual character from the presence of shellfish culture equipment.	LS	None needed	N/A
AV-3: Effects of glare and artificial lighting.	PS	**BIO-2:** Shielding of light fixtures.	LS
Air Quality			
AQ-1: Contribution to micrometers (PM_{10}) levels.	PS	**AQ-1**: Compliance with air quality regulations.	LS
Greenhouse Gas (GHG) Emissions			
GGE-1: Generation of GHGs.	LS	None needed	N/A
GGE-2: Conflict with an applicable plan, policy or regulation adopted for reducing GHG emissions.	NI	None needed	N/A
Hydrology and Water Quality			
WQ-1: Petroleum spills.	PS	**WQ-**1: Minimize fuel and petroleum spill risks.	LS
WQ-2: Pollutant/contaminant remobilization.	LS	None needed	N/A
WQ-3: Alteration of circulation patterns.	LS	None needed	N/A
WQ-4: Changes to the abundance of suspended organic matter.	LS	None needed	N/A
Land Use			
LU-1: Effects on coastal dependent industrial uses.	LS	None needed	N/A
LU-2: Conflict with land use plans or policies.	NI	None needed	N/A

NI=No Impact, LS=Less than Significant, PS=Potentially Significant, N/A=Not Applicable

In accordance with the California Environmental Quality Act §15123(b)(2), the areas of known controversy shall be identified in a EIR. "Controversy" is generally defined as a difference of opinion or dispute. An issue to be resolved, which has had some controversy among local governments and the public, is how many Lessees there will be and the process for identifying the Lessees. This is an issue that is currently being resolved through a request for proposals process being overseen by the City of Eureka, County of Humboldt and the District.

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Section 1.0 Introduction/Project Structure/Use of the Environmental Impact Report

The Humboldt Bay Mariculture Pre-Permitting Project (Project) is an economic development project of the Humboldt Bay Harbor, Recreation and Conservation District (Harbor District or District), primarily funded by the Humboldt County Headwaters Fund. The Project's objective and purpose is to allow for an expansion of commercial mariculture activities in Humboldt Bay, to create jobs and improve the local economy, while also increasing local and sustainable seafood production.

The EIR alternative being considered for adoption is Alternative 1, which is the environmentally superior alternative and involves a smaller spatial footprint and less potential environmental effects than the originally proposed project. Reasons for considering Alternative 1 for adoption are provided in EIR Volume 2 (Master Response 1). Also, as described in Volume 2, there are certain unresolved aspects of the environmental analysis, which are not related to the alternative being considered for adoption.

This Final EIR incorporates changes that resulted from public comments on the Draft EIR (see Volume 2, Response to Comments). Material changes to the EIR are identified by underlining (additions) and strikethrough (deletions). These changes are described in Volume 2.

As part of the Project, the District will obtain all the necessary regulatory approvals to allow mariculture activities at specific sites in Humboldt Bay, California. Once the Project's Environmental Impact Report (EIR) is finalized and all other regulatory approvals are gained, the District will grant leases to private shellfish growers ("Lessees") for discrete portions of the Project's pre-permitted sites. For sites leased through the Project, the Harbor District will issue a standardized tideland lease for mariculture (Hereafter 'Lease'). Leases will be the mechanism by which the District ensures that all activities occurring under the Project are fully compliant with this Environmental Impact Report (EIR) and all other regulatory terms and conditions for the pre-permitted sites. The Leases will:

1. Include a map and legal description of the leased area, and allow the Lessee to conduct specific mariculture activities within that area, and
2. Incorporate the full suite of regulatory requirements that each Lessee must comply with in order to operate under this EIR and other regulatory approvals; and
3. Describe the mechanisms by which the District will oversee culture activities to ensure that operations are consistent with all regulatory requirements including regular reporting by Lessees to the Harbor District; and
4. Describe the process by which the Harbor District will address failures to meet lease requirements, including cancelling leases and requiring the removal of all cultured organisms and related equipment if lease conditions are not met.

As described below, there are three general intertidal culture methods and three general subtidal culture methods that will be allowable at the leased sites. Mariculture activities under the Project must not exceed specific thresholds related to (1) the surface area and volume occupied by culture activities, (2) amount of culture equipment in contact with the bay bottom (benthic footprint), (3) farm worker activities, and (4) biomass of cultured animals. Other terms and conditions to be followed will be identified during the Project's environmental analysis and regulatory approval process.

Prospective Lessees will be required to provide a site specific description of their proposed activities (a "culture description") to the Harbor District for approval. Additionally, if a Lessee plans to alter their culture operations (for example, but not limited to, the culture footprint, equipment type or number of animals) the Lessee must submit a revised culture description to the Harbor District for approval. Culture descriptions must clearly demonstrate that (1) the general methods proposed are consistent with those in the standardized Lease and this EIR, and (2) the thresholds established in this EIR will not be exceeded by the culture activities. These determinations are at the discretion of the District in consultation with other permitting agencies. The following steps will be taken to ensure compliance with lease requirements.

Step 1. The culture descriptions provided by prospective Lessees will be reviewed by Harbor District staff to ensure that they are consistent with Lease requirements (and therefore with this EIR and other associated regulatory requirements).

Step 2. Before, during and immediately after installation of culture equipment, Harbor District staff will visit the culture sites to assess the proposed culture layouts and further ensure consistency with Lease requirements. Staff from all permitting agencies, agencies commenting on this EIR, and any other interested agency will be invited to attend the site visits to provide input.

Step 3. If it is determined that the proposed activity is consistent with Lease requirements, and any other Harbor District requirements, then the District will enter into a Lease with the Lessee, and the Lessee may implement their culture activities as proposed. When a lessee proposes a new culture method or an adaptation of the general culture methods, staff from all permitting agencies, agencies commenting on this EIR, and any other interested agency will be invited to provide input regarding the appropriateness of the method.

Step 4. Harbor District staff will visit the culture sites during and immediately after each site is "planted" and at least annually thereafter to ensure compliance with all Lease requirements. A standard inspection report will be developed and utilized to document these visits.

Step 5. Each Lessee will provide an annual report to the Harbor District. This report will describe the culture site's current status of operations, production, culture methods and relationship to the thresholds described below and all other lease requirements. The reports will include an assessment of the originally proposed culture operations versus existing ("as built") conditions (including a description of location, methods, equipment and any other pertinent information). The reports will also document the state of operations and upkeep on the site, including the presence of discarded, broken or abandoned tools, gear or equipment. Reports will also include representative site photographs. As requested, the Harbor District will provide copies of the annual reports to staff from all permitting agencies, agencies commenting on this EIR, and any other interested agency.

In the event that culture activities are at any point found to be out of compliance with Lease requirements, the Harbor District will require immediate action to achieve compliance with the Lease. The District will reserve the right to revoke the Lease and require the removal of all cultured organisms and related equipment for any failure to comply with lease terms, regardless of the type or magnitude of the non-compliance action.

In the event that a culture site is to be abandoned, all culture equipment, including broken equipment as well as cultured organisms (attached and dislodged) will be removed. To help enforce cleanup of equipment that has become dislodged, it will be required that all culture equipment be labeled with the equipment owner's name, unless this cannot be reasonably done (e.g., it would not be reasonable to label a screw). Surveys for debris (including dislodged shells) will be required within all abandoned culture areas and within 100' of every abandoned culture area and all debris must be removed. An exception will be made for shells that are completely buried. The District (or a District contractor) will conduct a post clean up survey to ensure that cleanup was consistent with the requirements of this EIR, with further cleanup and post clean up surveys implemented as necessary. To ensure there is funding for this to occur, prior to finalization of a lease, potential Lessees will be required to provide financial assurances for removal. Financial assurances can be provided in the form of performance bonds, letters of credit, or other financial instruments. The estimated cost of cleanup will be developed by the lessee and approved by the District. The District will assume the ultimate responsibility for cleanup if financial assurances are not adequate or if the lessee is not otherwise fulfilling their obligation for the cleanup

1.1 Intended Use of this EIR

The District is the California Environmental Quality Act (CEQA) Lead Agency for the Project. This EIR documents the potential environmental effects of the Project and is to be used by the District to satisfy CEQA requirements and to support assessments by other agencies, including responsible and trustee agencies. As described above, The District will be leasing the Project sites to Lessees. The Project conditions described in this EIR (e.g., mitigation measures and thresholds) as well as any other conditions contained in other Project approvals will be required of the Lessees as part of their lease conditions. Table 1 depicts the agencies expected to use the EIR in their decision making processes and the related environmental laws, approvals, permits and/or consultations.

Table 1. Agencies Expected to Use this EIR in their Decision Making Processes and the Related Environmental Laws, Approvals, Permits and/or Consultations

Agency	Law(s)	Type of Approval, Permit or Consultation
U.S. Army Corps of Engineers (USACE)	Clean Water Act (CWA) Section 404, Rivers and Harbors Act Section 10	Likely a Regional General Permit
	National Environmental Policy Act	Likely an Environmental Assessment
North Coast Regional Water Quality Control Board	CWA Section 401	Section 401 Water Quality Certification
Humboldt Bay Harbor, Recreation and Conservation District	State of California Harbor and Navigation Code	General Permit
City of Eureka	City of Eureka Code	Conditional Use Permit
County of Humboldt	County of Humboldt Code	Conditional Use Permit
California Coastal Commission	CA Coastal Act	Coastal Development Permit
National Marine Fisheries Service	Magnuson Stephens Fishery Conservation and Management Act, Endangered Species Act, Marine Mammal Protection Act	Primarily through consultation with USACE
U.S. Fish and Wildlife Service	Endangered Species Act	Primarily through consultation with USACE
California Department of Fish and Wildlife	California Endangered Species Act and California Fish and Game Code Section 1802	Primarily through consultation with the California Coastal Commission
	California Fish and Game Code Macroalgae Harvesting License	For collection of macroalgae for culture at the subtidal sites

Section 2.0 Project Description

2.1 Objective

The Project's objective and purpose is to allow for an expansion of commercial mariculture activities in Humboldt Bay, to create jobs and improve the local economy, while also increasing local and sustainable seafood production.

2.2 Project Sites

The Project consists of four intertidal sites where culture of Kumamoto oysters (*Crassostrea sikamea*) and Pacific oysters (*C. gigas*) could occur and three subtidal sites where culture of Kumamoto oysters, Pacific oysters and Manila clams (*Tapes philippinarum*) could occur. Additionally, at the subtidal sites, culture of native red macroalgae (Rhodophyta) could occur (for example, culture of *Chondracanthus*, *Gracilaria*, *Palmaria* and *Porphyra*). The sites were identified based on the following criteria <u>(further information regarding site selection is provided in Appendix D)</u>:

1. Good potential for successful mariculture based on input from local aquaculturists and assessment of appropriate tidal elevations.
2. Minimize environmental effects:
    a. Avoid marine mammal haul-out areas.
    b. Avoid eelgrass (*Zostera marina*) beds by locating sites at higher elevations where eelgrass is absent or sparse.
3. Avoid existing tidelands leases.
4. To the extent possible, the vertices of each culture site are positioned on full "degree-minute-second" geographic coordinates. This will make it easier to identify site boundaries in the field and to survey the sites.

A regional map depicting the location of Humboldt Bay, California is provided in Figure 1. The proposed sites are depicted in Figures 2-10[1]. Spatial coordinates for each site are provided in Appendix A.

[1] The aerial imagery used in Figures 2-10 was collected by NOAA Coastal Services Center in 2009.

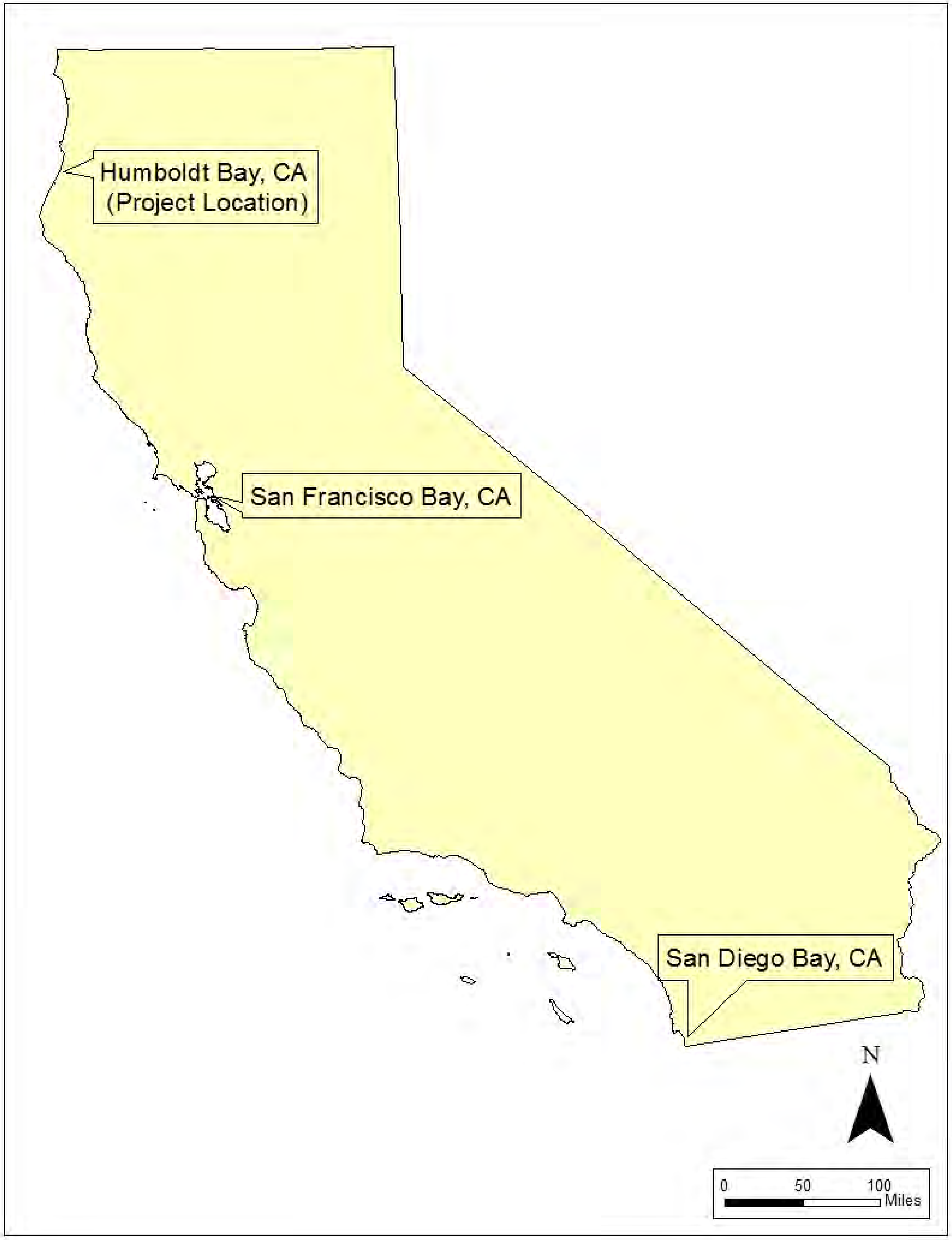

Figure 1. The Project is Located in Humboldt Bay, California

Figure 2. Intertidal Culture Sites

Figure 3. Intertidal Culture Site 1 (Intertidal 1) is 98.5 Acres

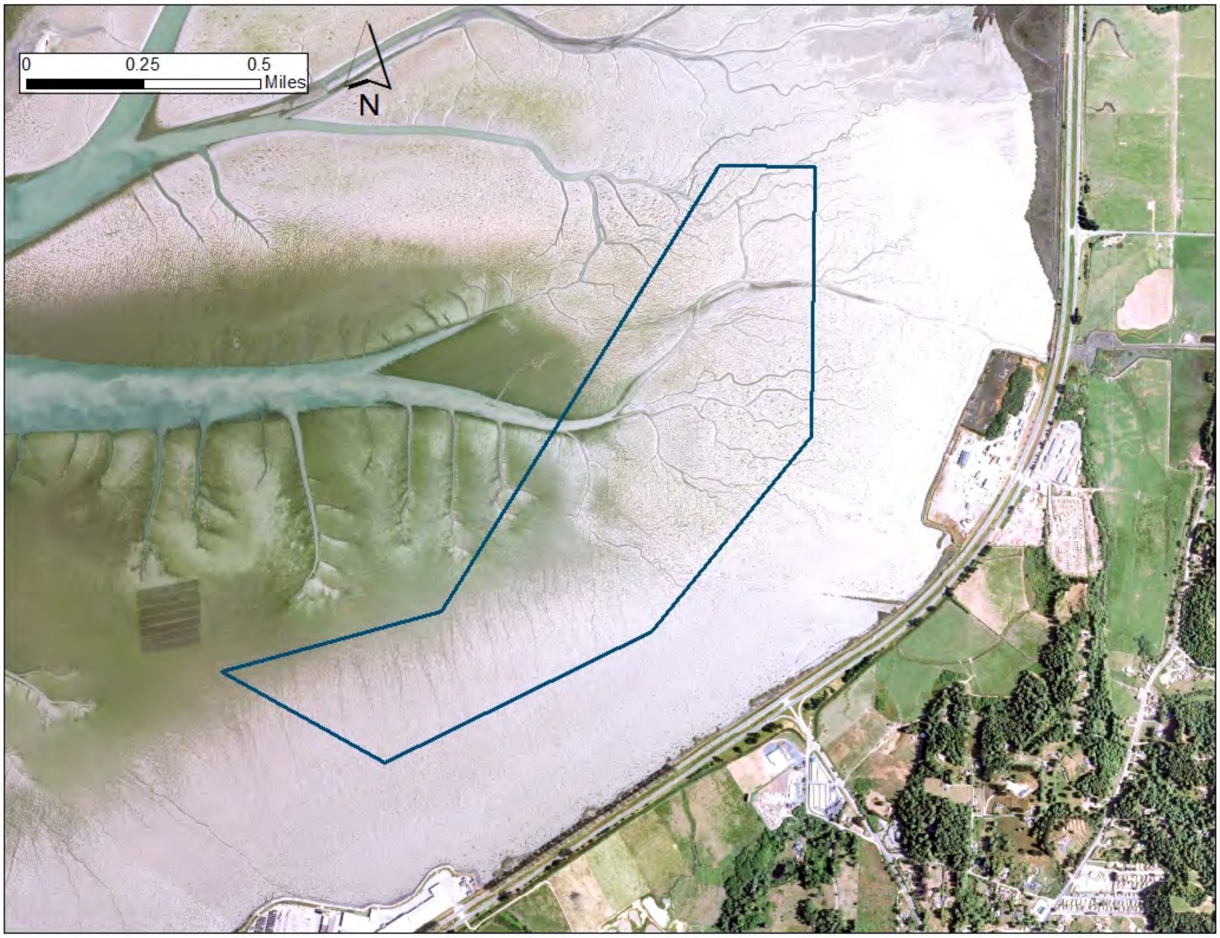

Figure 4. Intertidal Culture Site 2 (Intertidal 2) is 364.0 Acres

Figure 5. Intertidal Culture Site 3 (Intertidal 3) is 13.6 Acres

Figure 6. Intertidal Culture Site 4 (Intertidal 4) is 49.9 Acres

Figure 7. Subtidal Culture Sites

Figure 8. Subtidal Culture Site 1 (Subtidal 1) is 3.9 Acres

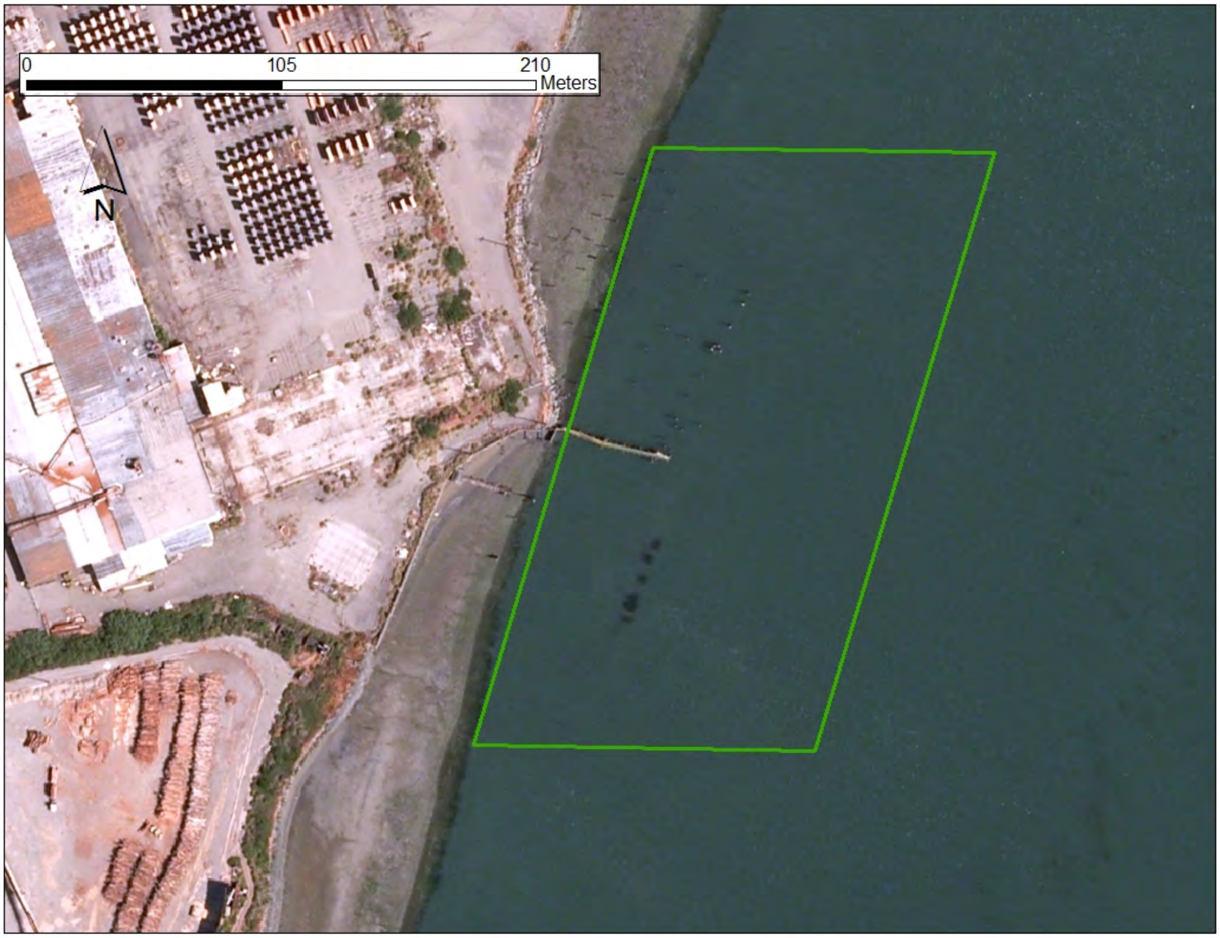

Figure 9. Subtidal Culture Site 2 (Subtidal 2) is 8.6 Acres

Figure 10. Subtidal Culture Site 3 (Subtidal 3) is 8.7 Acres

2.3 Project Description Overview

The continued success of mariculture in Humboldt Bay will require adaptation of culture methods as new technologies are developed. New methods can result in higher production, improved product quality and reduced environmental effects. To allow for adaptation of culture methods, the following process was used to develop the Project description:

1. For each site, a Project layout was developed based on the following culture methods. These methods represent the general types of culture that would occur under the Project.
    a. For intertidal sites:
        i. Rack-and-Bag
        ii. Cultch-on-Longline
        iii. Basket-on-Longline
    b. For subtidal sites:

i. Floating Upwelling Systems (FLUPSYs) or Pump Systems

ii. Rafts

iii. Macroalgae Longline

2. The following culture characteristics were assessed. These culture characteristics are related to specific environmental effects of mariculture (Table 2).

    a. Levels of activity by farm workers

    b. Water surface area occupied by culture equipment and cultured organisms

    c. Volume of culture equipment and cultured organisms

    d. Area of culture equipment in contact with bay bottom (benthic footprint)

    e. Maximum biomass of shellfish soft tissue that could be present at any given time

3. Based on the culture characteristics of each method, thresholds were established for the Project. Under the Project, culture can occur within each site as long as it:

    a. Does not exceed these culture characteristic thresholds,

    b. Follows other terms and conditions established by the Project's regulatory approvals including the EIR, and

    c. Does not result in any environmental effects that were not considered under the Project.

If there are environmental effects that were not considered under the Project, then additional regulatory approvals may be required.

Table 2. Culture Characteristics and Related Potential Environmental Effects

Culture Characteristics	Potential Environmental Effect
Levels of activity by farm workers	Environmental effects by farm workers (e.g., trampling, wildlife disturbance)
Water surface area occupied by culture equipment and cultured organisms	Increased shading and overwater cover
Volume of culture equipment under the water line	Effects on currents and sedimentation
Benthic footprint	Reduction in habitat for benthic organisms
Biomass of cultured shellfish	Reduced particulate organic matter as a result of consumption by cultured shellfish

As described above, this Project description primarily establishes thresholds and criteria for mariculture at the Project sites. However, at Subtidal Site 3 a specific need for infrastructure to support mariculture operations has been identified. Specifically, up to 32 18-inch diameter steel or concrete piles would be installed to allow multiple aquaculturists to safely secure their culture equipment.

2.4 Example Culture Methods

The Project is designed to allow for some flexibility in culture methods. The following culture methods were used to evaluate the potential environmental effects of mariculture and to establish thresholds for certain mariculture characteristics.

2.4.1 Intertidal: Shellfish Culture Rack-and-Bag Method

This description was adapted from Coast Seafoods Company (CSC) (2007). Rack-and-bag culture is used for growing Kumamoto oysters and Pacific oysters. The oysters are grown as "singles", meaning they are not attached to any structure such as shells or to each-other (they are "loose" in the bags). Rack-and-bag culture uses polyethylene mesh bags and rebar frames. Each rebar frame is 3 feet (ft) x 12 ft and supports 3-6 bags attached to the frame via industrial rubber bands (see Appendix B). Each bag is initially seeded with oysters and placed in intertidal areas. It takes 1–2 years for the seed to grow into oysters of market size, depending on tidal height and primary productivity, and then the bags of oysters are harvested by hand (lifted from the racks into a skiff), processed and brought to market.

2.4.2 Intertidal: Shellfish Culture Cultch-on-Longline Method

This description was adapted from CSC (2007). Cultch-on-longline culture is used for growing Kumamoto oysters and Pacific oysters. Prior to planting in the bay, oyster seed is attached to shells, which are attached to longlines. Planting is accomplished by placing seeded longlines on notched PVC stakes that are arranged in rows on the mudflats. The longlines are strung through notches on top of the PVC stakes, suspending the oyster seed approximately one ft above the bay bottom (see Appendix B).

Longline beds are harvested when they have oysters of a harvestable size and market conditions are right. It usually takes 1.5–3 years for oysters to reach a harvestable size. One of two methods is used to harvest longlines. The first, hand picking, involves placing around 20 bushel tubs on the bed at high tide using an oyster scow. The tubs are then filled at low tide by hand. The picking crew cuts the longline into manageable single clusters and places them in the picking tub. A floating ball is attached to each tub, and at high tide an oyster scow is used to pull the tub out of the water. The oysters are dumped on the deck of the scow, and the tub is placed back on the bed to be refilled.

The second method of harvest, the longline harvester, involves positioning a scow over the longline bed at high tide. Individual lines are then pulled onto the floating scow either by hand or by means of a hydraulically operated roller. If the lines are pulled by hand then the lines need to be cut into individual clusters, usually at the plant. If the lines are pulled mechanically they run through a breaker that strips the clusters from the line. The longline harvester does not come in contact with the bottom while harvesting longlines.

2.4.3 Intertidal: Shellfish Culture Basket-on-Longline Method

Basket-on-longline culture is used to grow Kumamoto oysters and Pacific oysters as singles. This method utilizes baskets that hang off a monofilament line suspended off the bottom using 2-inch schedule 80 PVC pipe. The monofilament line is 5mm in diameter and protected by a 3/8-inch polyethylene sleeve that the monofilament is slid inside (see Appendix B). The baskets are approximately 24 inches (in) x 10 in x 6 in and are held on the line with plastic clips. A float, which is approximately 2.5 in diameter and 5.5 in long, is often attached to the baskets so that the baskets float up during high tides. Once the oysters reach a harvestable size, in approximately 1.5–2 years, the baskets are removed from the water, and the oysters are accessed through end caps on the baskets.

2.4.4 Subtidal: Shellfish Culture FLUPSY or Pump System

This description was adapted from CSC (2007) and Taylor Mariculture LLC (2011). The FLUPSY method is used to mature Kumamoto oyster, Pacific oyster and Manila clam seed. A FLUPSY is an in-water, raft-like structure that upwells water through upwelling bins to provide a consistent source of nutrients to growing shellfish. They are moored by chain and line to a pier and adjacent pilings or anchored with concrete or steel anchors. They are constructed of aluminum with poly-encapsulated floats for floatation, and have a submerged trough containing a paddle wheel or propeller. This trough is surrounded by open wells containing the upwelling bins. The paddle wheel or propeller moves the water out of the trough; in order for the trough to refill, water must pass through the upwelling bins containing oyster seed. The bottoms of the upwelling bins are a 1.2–1.8-millimeter mesh screen, which allows water to come up through the upwelling bin and exit the bin at the top (see Appendix B). Alternatively, instead of using a paddle wheel or propeller, water may be pumped to the shellfish seed (a Pump System). The FLUPSYs only contain seed, which is grown to market size using different methods.

2.4.5 Subtidal: Shellfish Culture Raft Method

This description was adapted from CSC (2007). Nursery rafts are anchored to concrete anchors, accessible by skiff. The rafts are about 12 ft wide x 24 ft long constructed from aluminum with polyethylene encapsulated Styrofoam for floatation. Each raft has 24 tray wells, which contain seed nursery trays in stacks of about 8-20 suspended in each well (see Appendix B). The rafts only contain seed, which is grown to market size using different methods.

2.4.6 Subtidal: Macroalgae Longline Method

Longline culture of macroalgae involves an array of single, independent lines (ropes) fixed by removable mooring points or anchors and supported by floats (see Appendix B). The algae would be collected locally from drift or by trimming algae no closer than 2 in from the holdfasts and would be attached to the ropes for culture. Alternatively, spores may be settled onto ropes. A mature culture line would be covered nearly entirely by live holdfast tissue, promoting generation of vegetative growth (thalli) radiating outward from the live line. Periodically, the line would be raised and run over a star wheel assembly on an open work skiff, and through a cutter assembly, removing the mature thalli and leaving the holdfasts intact on the line for further culture. It is expected that algal biomass at harvest density would be approximately 2–3 pounds per ft of culture line.

Maintenance of the line would include periodic changing of leaders and floats to remove epiphytic growth. Lines would likely be arranged parallel to shore to minimize drag with tidal currents. Lines would be spaced to accommodate service and harvesting by a work skiff, likely with a minimum spacing of 20 ft between lines.

Visits to the site would be focused during the increasing photoperiod in spring and summer months, with overwintering visits likely limited to periodic maintenance. Growth rates on site are unknown but during harvest periods, visits may be weekly, with monthly maintenance visits in the offseason. Deployment or removal of lines would be more intensive but less frequent, on the order of two to three weeks of daily visits at the beginning or end of the growing season. Harvested product would be fresh cut seaweed in net bags.

2.5 Determination of Culture Characteristics

The following processes and assumptions were used to develop an understanding of mariculture characteristics, upon which thresholds for mariculture operations were based.

2.5.1 Environmental Effects by Farmworkers

Farmworkers may have environmental effects when they are working at the culture sites, for example by trampling vegetation or disturbing wildlife. Mr. Greg Dale (CSC operations manager) and Mr. Ted Kuiper (retired shellfish culturist) were interviewed to determine the type and number of visits for each method.

2.5.2 Surface Area

Cultured organisms and associated equipment can affect eelgrass and other habitat features by increasing shade over these features. Overwater structure can also provide habitat for organisms, including plants, birds, fish and invertebrates. The water surface area per acre (ac) occupied by culture equipment and cultured organisms was calculated based on the following assumptions (also see Appendix B):

2.5.2.1 Intertidal Culture Methods

For rack-and-bag culture:

- Racks are 12 ft x 3 ft and are elevated by six 5/8-inch rebar posts
- Racks are set in groups of 9, with a distance of 3 ft between subgroups of three racks
- Each group of nine racks is 10 ft apart from each other group of nine racks

For cultch-on-longline culture:

- Area is based on measurements of sampled cultch-on-longlines in 2012
- Lines are in groups of 5, with a distance of 2.5 ft between each line
- Each group of five lines is separated by 5 ft within a given row
- Rows are 10 ft apart
- Lines are a maximum of 100 ft, but areas where a 100 ft line won't fit are filled by partial lines
- Lines are elevated by 2-inch PVC posts every 2.5 ft

For basket-on-longline culture:

- Baskets are 24 in x 10 in
- Basket floats are 2.5 in diameter and 5.5 in long
- Lines are in groups of 3, with a distance of 3 ft between each line
- Each group of three lines is separated by 20 ft on all sides
- Lines are a maximum of 100 ft, but areas where a 100 ft line won't fit are filled by partial lines
- Lines are elevated with 2-inch PVC posts every four baskets and line ends are anchored with 1.5 in x 2 in wide galvanized fence posts

2.5.2.2 Subtidal Culture Methods

For subtidal culture, the thresholds are based on a conceptual layout of rafts, FLUPSYs and floating docks at Subtidal Site 3. These thresholds represent a maximum that would not be exceeded by any subtidal culture method(s) at any subtidal site. The conceptual layout for the 8.7-acre site includes:

- Two floating walkways that are 538 ft x 10 ft each
- One floating walkway that is 214 ft x 10 ft
- 18 FLUPSYs that are 82 ft x 22 ft each
- Six FLUPSYs that are 45 ft x 25 ft each
- 10 culture rafts that are 12 ft x 24 ft each

2.5.3 Volume

Cultured organisms and associated equipment can alter water currents and sedimentation rates. The overall volume of cultured organisms and associated equipment is a reasonable metric for assessing effects on currents and sedimentation. The volume of each culture method per ac was assessed based on the following assumptions (also see Appendix B).

2.5.3.1 Intertidal Culture Methods

For rack-and-bag culture:

- Rack dimensions are 12 ft x 3 ft x 0.7 ft
- Racks are set in groups of 9, with a distance of 3 ft between subgroups of three racks
- Each group of nine racks is 10 ft apart from each other group of nine racks

For cultch-on-longline culture:

- Volume of individual lines and associated shellfish is based on measurements taken in 2012
- Lines are in groups of 5, with a distance of 2.5 ft between each line
- Each group of five lines is separated by 5 ft within a given row
- Rows are 10 ft apart
- Lines are a maximum of 100 ft, but areas where a 100 ft line won't fit are filled by partial lines

For basket-on-longline culture:

- Basket dimensions are 24 in x 10 in x 6 in
- Floats are 2.5 in diameter and 5.5 in long
- Lines are in groups of 3, with a distance of 3 ft between each line
- Each group of three lines is separated by 20 ft
- Lines are a maximum of 100 ft, but areas where a 100 ft line won't fit are filled by partial lines

2.5.3.2 Subtidal Culture Methods

For subtidal culture, the thresholds are based on a conceptual layout of rafts, FLUPSYs and floating docks at Subtidal Site 3. The thresholds represent a maximum that would not be exceeded by any subtidal culture method(s) at any subtidal site. The conceptual layout includes:

- 18 FLUPSYs that are 82 ft x 22 ft x 4 ft each
- Six FLUPSYs that are 45 ft x 25 ft x 4 ft each

- 10 culture rafts that are 12 ft x 24 ft x 4 ft each

2.5.4 Benthic Footprint

The area of culture equipment in contact with the bay bottom was calculated based on the following:

2.5.4.1 Intertidal Culture Methods

For rack-and-bag culture:

- Racks are 12 ft x 3 ft and are elevated by six 5/8-inch diameter rebar posts
- Racks are set in groups of 9, with a distance of 3 ft between subgroups of three racks
- Each group of nine racks is 10 ft apart from each other group of nine racks

For cultch-on-longline culture:

- Lines are elevated by 2-inch PVC posts every 2.5 ft
- Lines are in groups of 5, with a distance of 2.5 ft between each line
- Each group of five lines is separated by 5 ft within a given row
- Rows are 10 ft apart

For basket-on-longline culture:

- Each line holds 40 baskets
- Lines are in groups of 3, with a distance of 3 ft between each line
- Each group of three lines is separated by 20 ft
- Lines are a maximum of 100 ft, but areas where a 100 ft line won't fit are filled by partial lines
- Lines are elevated with 2-inch PVC posts every four baskets and line ends are anchored with 1.5 in x 2 in wide galvanized fence posts

2.5.4.2 Subtidal Culture Methods

For subtidal culture, the thresholds are based on a conceptual layout of rafts, FLUPSYs and floating docks at Subtidal Site 3 and anchoring requirements. The actual number of anchors and overall benthic footprint including piles needed at Subtidal Site 3 may be substantially less than described below if piles can be installed. However, there is a possibility that pile installation won't be funded or permitted and so an environmental analysis of maximum anchoring requirements was conducted. The thresholds developed based on the Subtidal

Site 3 conceptual layout represent a maximum that would not be exceeded by any subtidal culture method(s) at any subtidal site. The conceptual layout includes:

- Three floating walkways each with four anchors that are 6 ft^2
- 24 FLUPSYs each with four anchors that are 6 ft^2
- 10 culture rafts each with four anchors that are 6 ft^2

2.5.5 Biomass of Cultured Shellfish

Phytoplankton consumption by cultured shellfish is proportional to the number of shellfish cultured. The shellfish biomass calculations are based on the following:

2.5.5.1 Intertidal Culture Methods

For rack-and-bag culture:

- Each Rack-and-Bag unit contains six bags per rack, with 2 liters (L) of seed added per bag and periodic subsequent division of that stock into more bags
- Racks are set in groups of 9, with a distance of 3 ft between subgroups of three racks
- Each group of nine racks is 10 ft apart from each other group of nine racks

For cultch-on-longline culture:

- Each 100-ft longline contains 40-100 dozen oysters
- Lines are in groups of 5, with a distance of 2.5 ft between each line
- Each group of five lines is separated by 5 ft within a given row
- Rows are 10 ft apart

For basket-on-longline culture:

- Each basket is planted with 2 L of seed with periodic subsequent division of that stock into more baskets. Each line holds 40 baskets
- Lines are in groups of 3, with a distance of 3 ft between each line
- Each group of three lines is separated by 20 ft
- Lines are a maximum of 100 ft, but areas where a 100 ft line won't fit are filled by partial lines

2.5.5.2 Subtidal Culture Methods

For subtidal culture, the thresholds are based on a conceptual layout of rafts and FLUPSYs at Subtidal Site 3. The thresholds developed based on the Subtidal Site 3 conceptual layout represent a maximum that would not be exceeded by any subtidal culture method(s) at any subtidal site. Thresholds related to the biomass of cultured shellfish are not relevant for macroalgae culture. The conceptual layout includes:

- 18 FLUPSYs that are 82 ft x 22 ft x 4 ft each, with 30 bins per FLUPSY and an average of 15 kilograms (kg) of live weight seed per bin
- Six FLUPSYs that are 45 ft x 25 ft x 4 ft each, with 15 bins per FLUPSY and an average of 15 kg of live weight seed per bin
- 10 culture rafts that are 12 ft x 24 ft x 4 ft each, with 20 trays per module, 24 modules per raft and an average of 1 kg of live weight seed per tray

Section 3.0 Results and Thresholds

Based on the information described above, subtidal and intertidal culture characteristics are depicted in Tables 3–6.

Table 3. Type and Number of Visits by Farmworkers to Different Types of Intertidal Mariculture Operations

Method	Type of Visit	# Visits per Year	Note
Rack-and-Bag	Place racks	0.2	Once every 5 years
	Inspections	104	Range of 1–3 times per week, assumed average of twice per week
	Flip bags	26	Bags flipped on average every two weeks
	Grade oysters	6.4	Every 6–8 weeks in summer (Feb to Oct) and every 8–12 weeks in winter (Nov to Jan)
	Plant and harvest	1	Plant and harvest once per 2 years
Cultch-on-Longline	Staking lines	0.2	Once every 5 years
	Monthly inspection	12	
	Plant and Harvest	1	Plant and harvest once every two years
Basket-on-Longline	Stake lines	0.2	Once every 5 years
	Grade oysters	6.4	Every 6–8 weeks in summer (Feb to Oct) and every 8–12 weeks in winter (Nov to Jan)
	Plant and harvest	1	Plant and harvest once per 2 years

- "Shaded cells" depict the maximum values for each culture characteristic. These values represent the maximum level of effort that generally occurs for the various mariculture methods.

* The information provided is for individual culture units (i.e., a single bag, longline or basket). A group of units would generally be visited more frequently.

Table 4. Type and Number of Visits by Farmworkers to Different Types of Subtidal Mariculture Operations

Method	Type of Visit	# Visits per Year	Note
Floating Upwelling System (FLUPSY) or Pump System*	Place FLUPSY or Pump System	0.1	Once every 10 years
	Rinse and Inspect seed	365	This figure is for Pump Systems, FLUPSY's require less rinsing and inspection.
	Grade seed	36	Every 10 days
Raft Culture*	Place raft	0.1	Once every 10 years
	Inspections	365	Daily visual inspection from nearby docks or land
	Rinse seed	12	Once every month
	Grade seed	8	Once every month between March-October and every other month between November and February
Macroalgae Longline Culture	Deployment or removal of lines	14–21	Two to three people working daily for two to three weeks.
	Harvest	52	Assumed weekly, but this is likely an overestimate because there are times of the year when harvest won't occur.
	Maintenance	12	Once per month.

- "Shaded cells" depict the maximum values for each culture characteristic. These values represent the maximum level of effort that generally occurs for the various mariculture methods.

* The information provided is for individual culture units (i.e., a single raft or FLUPSY). A group of units would generally be visited more frequently.

Table 5. Culture Characteristics of Example Intertidal Culture Methods

Method	Water Surface Area (ft^2) in Culture per Acre	Volume (ft^3) of Shellfish Culture Equipment and Cultured Organisms per Acre	Benthic Footprint (ft^2) per Acre	Biomass (kg) of Shellfish Dry Weight per Acre (6% of Live Weight)
Rack-and-Bag	13,068 (30%)	8,736	4.36	253
Cultch-on-Longline	4,792 (11%)	1,947	118.07	97
Basket-on-Longline	3,484 (8%)	1,623	11.80	207

- "Shaded cells" represent the maximum values for each culture characteristic. Under the Project, these maximum values are the culture characteristic thresholds that cannot be exceeded by shellfish culture operations.

Table 6. Culture Characteristics of Subtidal Culture Methods for Surface Area and Volume of Culture Equipment and Biomass of Shellfish, Based on a Conceptual Culture Layout for Subtidal Site 3, but applicable to all Subtidal Sites

Surface Area (ft^2) in Mariculture Operations Per Acre (Ac)	6,322 (14.5%)
Volume (ft^3) of Mariculture Equipment Per Ac*	19,357
Benthic Footprint (ft^2) of Mariculture Equipment (anchors) per Ac	102
Biomass (kg) of Shellfish Dry Weight Per Ac	98

* Does not include floating docks, because they do not extend far below the water surface. Includes entire volume of FLUPSYs and culture rafts, although a portion of this equipment is above the water surface.

3.1 Site Specific Thresholds

Farmworker activity at the sites must not exceed the general activity levels described for rack-and-bag culture (for intertidal sites) or FLUPSYs (for subtidal sites) (Tables 3 and 4). Additionally, the thresholds identified in Tables 5 and 6 cannot be exceeded. Site specific thresholds were determined by scaling the thresholds to the size of each site (i.e., multiplying each site's area suitable for culture by the relevant threshold values) (Tables 7 and 8).

Table 7. Site Specific Culture Characteristic Thresholds for Intertidal Sites

Site	Acres	Allowed Surface Area (ft^2) of Water that Can be in Mariculture Production	Allowed Volume (ft^3) of Mariculture Equipment and Cultured Organisms	Allowed Benthic Footprint (ft^2)	Allowed Biomass of Shellfish (Dry Weight, kg)
Intertidal 1	99	1,306,800	864,864	11,689	25,047
Intertidal 2	364	4,756,752	3,179,904	42,978	92,029
Intertidal 3	14	182,952	118,810	1,652	3,542
Intertidal 4	50	653,400	435,926	5,904	12,650

Table 8. Site Specific Culture Characteristic Thresholds for Subtidal Sites

Site	Acres	Allowed Surface Area (ft^2) of Water that Can be in Mariculture Production	Allowed Volume (ft^3) of Mariculture Equipment and Cultured Organisms	Allowed Benthic Footprint (ft^2)	Allowed Biomass of Shellfish (Dry weight kg)
Subtidal 1	3.9	24,656	75,493	398	383
Subtidal 2	8.6	54,370	166,472	878	845
Subtidal 3	8.7	55,002	168,408	887	855

Note: Boats or barges that will be moored over night at a site must be included in the calculation of surface area that is in "mariculture production". Such boats or barges must be itemized by size (surface area over water) in the site descriptions and leases described in Section 1. The surface area of boats or barges that are moored overnight combined with the surface area of all other structures cannot exceed the thresholds in this table.

3.1.1 Piles at Subtidal 3

In addition to the information described above, in order for Subtidal Site 3 to be used effectively by multiple aquaculturists, up to 32 18-inch diameter concrete or steel piles will be installed. The piles would reduce the need for numerous anchors, which would occupy more benthic area than the piles, and could create potential conflict between Lessees (e.g., anchor lines could come in contact and "tangle").

Section 4.0 Project Alternatives

The Project as described above is the preferred project or "Project". Three alternatives were considered to the Project. Alternative 1 would only include subtidal culture, Alternative 2 would only include intertidal culture and Alterative 3 is the scenario of not implementing the Project.

4.1 Alternative 1. Subtidal Culture Only

Under Alternative 1, only subtidal culture, as described above and with mitigation measures described below would occur. No intertidal culture would occur. Hence, the potential effects associated with intertidal culture would not occur. Major considerations include the larger footprint of intertidal culture and higher biomass of cultured shellfish.

4.2 Alternative 2. Intertidal Culture Only

Under Alternative 2, only intertidal culture as described above and with mitigation measures described below would occur. No subtidal culture would occur. Hence, the potential effects associated with subtidal culture would not occur. A particularly unique aspect of the proposed subtidal culture is the installation of piles at Subtidal Site 3.

4.3 Alternative 3. No Project

Alternative 3 is the No Project Alternative, which is the scenario of not implementing the Project, Alternative 1 or Alternative 2. Under this scenario, it is expected that existing shellfish culture would continue (see Section 6.0 for a description of existing culture) and culture would be expanded in Humboldt Bay through permitting efforts by private entities. However, the rate of expansion may be slower and the final area of culture may be less. Additionally, planning for locations and types of culture would not happen in the comprehensive manner that is happening through the Project (i.e., different culture activities would be proposed separately by individual private culturists).

Section 5.0 Environmental Setting and Effects of the Alternatives

The environmental setting described in this section reflects physical conditions as they occurred at the time the Notice of Preparation (NOP) was published (May, 2014). Further information regarding the environmental setting is provided within each effects analysis section below.

5.1 Humboldt Bay

Humboldt Bay is approximately 14 miles (mi) (22.5 kilometers [m]) long and its width varies from 0.5 mi (0.8 km) in Entrance Bay to 4.3 mi (6.9 km) across the widest part of the North Bay. At high tide, Humboldt Bay occupies an area of 24.1 mi^2 (62.4 km^2), which is reduced to 10.8 mi^2 (27.97 km^2) at low tide (Proctor et al. 1980). At low tide, extensive intertidal mudflats are exposed, comprising about 2/3 of the Humboldt Bay area (Gast and Skeesick 1964; Proctor et al. 1980). The entrance and shipping channel depths are maintained at 38 to 48 ft (11.6 to 14.6 m) by periodic dredging (HBHRCD 2007).

As California's 2nd largest natural bay and the largest estuary on the Pacific coast between San Francisco Bay and Oregon's Coos Bay, Humboldt Bay is a complex ecosystem and valuable resource for California and the nation because of its natural resources, its aesthetic appeal and recreational opportunities, its ecological services, economic benefits, and its vital transportation links. Visitors and Humboldt County residents value Humboldt Bay for its natural and anthropogenic attributes. Humboldt Bay biota is diverse and ecologically significant at scales ranging from local fisheries, including oyster production to hemispheric ecological patterns such as shorebird and waterfowl migration. The Humboldt Bay area hosts over 400 plant species, 300 invertebrate species, 100 fish species, and 260 bird species, including those that rely on the bay as they travel the Pacific Flyway. Humboldt Bay is important in the life cycles of commercially and recreationally important fish species including shellfish, crustaceans and finfish. Humboldt Bay has a successful oyster culture industry, producing about 70% of the oysters grown in California. Portions of the diked former tidelands around Humboldt Bay, particularly in the Arcata Bottoms, are utilized for agriculture, primarily livestock grazing for dairy and beef production. The largest urban concentrations are in Arcata (population approximately 16,651) and Eureka (population approximately 25,866).

During the late-19th and early 20th centuries, diking and filling reduced Humboldt Bay salt marshes from an estimated 9,000 ac to only 900 ac today. Humboldt Bay habitat has been further disturbed by discharges of agricultural and urban runoff, industrial and recreational activities, excessive sedimentation from the bay's watershed and other sources, colonization by invasive *Spartina*, and other stressors (HBHRCD 2007; Sutula et al. 2008).

5.2 Overview of Effects Analyses

Potential effects are assessed based on the following categories:

- Cultural and Archeological Resources
- Biological resources
- Aesthetics and Visual Resources
- Air Quality
- Greenhouse Gas (GHG) Emissions
- Hydrology and water quality
- Land Use

The general terms used in this EIR to describe the level of significance of impacts are as follows:

- Less than significant with mitigation
- Less than significant without mitigation
- Significant
- No Impact

5.3 Possible Effects Not Analyzed in EIR

Section 15060(d) of the CEQA guidelines requires that that the lead agency "focus the Draft EIR on the significant effects of the Project and indicated briefly its reasons for not determining that other effects would not be significant or potentially significant". Section 15128 of the CEQA Guidelines states that "An EIR shall contain a statement briefly indicating the reasons that various possible significant effects of a project were determined not to be significant and were therefore not discussed in detail in the EIR." This section describes the environmental impacts found not to be significant.

5.3.1 Agriculture Resources

The Project would have a beneficial effect on agricultural resources by increasing the footprint of shellfish culture in Humboldt Bay. There would be no negative impacts on agricultural resources, and the proposed land use is consistent with existing zoning, including zones designated by the City of Eureka Municipal Code (Section 156.065) and County of Humboldt Code (Section 313-5.4). The use is also consistent with policies pertaining to this part of the bay that are described in the Humboldt Bay Management Plan (HBMP) (Section 2.3.2 of HBHRCD 2007). Hence, no impact is expected.

5.3.2 Geology and Soils

5.3.2.1 Risks to People and Structures

There are numerous fault lines near the Project area, as well as the intersection of three tectonic plates. As such, the area is highly susceptible to seismic activity. However, the Project would not add any fixed structures to the landscape that would be susceptible to seismic damage, nor would it put existing structures at greater risk. The Project area is level and lacks structures that could become unstable and injure culturists. The soil could be subject to liquefaction, which would pose a minor risk to culturists; however, the risk is considered very low, given that (1) liquefaction of the type that would be a risk to culturists is uncommon, and there is no historical evidence of liquefaction in Humboldt Bay; (2) culturists would be at the Project sites only temporarily, and no people would inhabit the Project sites; and (3) culturists would be near boats and safety equipment, including personal floatation devices. Hence, impacts related to seismic risks are expected to be less than significant.

5.3.2.2 Erosion

Through a study of sedimentation at shellfish culture sites in Humboldt Bay similar to the Project sites and equipment (Rumrill and Poulton 2004) found that "fine sediments were deposited and eroded in an inconsistent manner." However, based on the study results, there appears to be a net increase in sediment accumulation, not a loss. A minor amount of net sediment deposition, rather than erosion, is expected when shellfish culture equipment is placed in tidelands. Hence, no impact is expected.

5.3.2.3 Instability

The Project would not involve the construction of any permanent structures, and is not expected to affect the potential for onsite or offsite landslides, lateral spreading, subsidence, liquefaction, or collapse. Hence, no impact is expected.

5.3.2.4 Expansive Soils

There may be expansive soils in the Project area; however, the Project would not add enclosed or habitable structures (buildings) to the landscape; therefore, there would be no substantial risk to life or property from Project development. Hence, no impact is expected.

5.3.2.5 Wastewater Disposal

The Project does not involve the development of new waste water disposal systems. Culturists would use existing facilities (restrooms), likely in underutilized industrial areas. Hence, no impact is expected.

5.3.3 Hazards and Hazardous Materials

5.3.3.1 Transport, Use, Release or Emission of Hazardous Materials

The only hazardous materials that would be associated with the Project are fuel and lubricants for boats, including for internal combustion engines on small boats. Use of these materials is common in Humboldt Bay and does not represent a significant hazard to the environment or people. A requirement of the District's leases to Lessees would be that Project personnel would follow all current and standard safety and cleanup protocols for fueling and lubricating engines. No impact is expected.

5.3.3.2 Known Hazardous Sites

The Project area is not known to be on any list of hazardous materials sites compiled pursuant to Government Code Section 65962.5. Because the Project sites are intertidal and subtidal, it is unlikely that they supported historical uses that would have resulted in contamination. There are contaminated sites located on the margins of the bay, but hazardous materials are not expected to reach the Project sites at concentrations that would have any impact on the Project's culturists. Hence, no impact is expected.

5.3.3.3 Aircraft/Airport Related Safety

The only nearby airport is Murray Field, which is a public airport approximately 0.8 mi from the nearest Project boundary. Airplanes landing and departing from this airport are not expected to be a hazard for the Project's culturists. Hence, no impact is expected.

5.3.3.4 Emergency Responses and Fire Hazards

The Project would not have any effect on an adopted emergency response plan or emergency evacuation plan, because it would not impede emergency response or evacuation routes or procedures. Also, because the Project area is in intertidal and subtidal (aquatic) areas, there is no risk of wildfires. Hence, no impacts are expected.

5.3.4 Mineral Resources

The Project would expand mariculture operations in Humboldt Bay. It would have no effect on mineral resources. Hence, no impact is expected.

5.3.5 Noise

The Project would involve expanding mariculture operations on Humboldt Bay. Its primary noise effect would be caused by the addition of approximately 15 small watercraft with internal combustion engines. These would generate noise similar to that generated by other small watercraft on the bay. The Project boats could not be heard from sensitive receptors. Because the Project's noise generation would be typical of what already occurs in Humboldt Bay, no noise impacts are expected.

5.3.6 Population/Housing

The Project would involve expanding mariculture operations on Humboldt Bay. It may create approximately 50 new jobs. Some of these jobs may be filled by people already living in the area and some may be filled by people from out of the area. However, it is expected that there is ample housing and other required infrastructure available to support this negligible potential population increase. Hence, no impacts are anticipated.

5.3.7 Public Services

The Project may create approximately 50 new jobs. Some of these jobs may be filled by people already living in the area and some may be filled by people from out of the area. However, there are ample public services available in the region to support this negligible potential population increase. Hence, no impacts are anticipated.

5.3.8 Recreation

Approximately 50 people would be employed by the Project, some would be from the region and others may move to the region for employment through the Project; however the small increase in population caused by the Project is discountable. Hence, no impacts are expected.

5.3.9 Transportation/Traffic

5.3.9.1 Traffic Levels, Patterns and Hazards

The Project would not substantially increase the local population. Approximately 50 culturists may be employed through the Project. Some of these culturists likely will be from the region and some may relocate to the region for employment through the Project. The culturists are expected to utilize existing parking areas and other facilities; including in underutilized industrial areas on the Samoa Peninsula. They are also expected to utilize existing bay access points. No impact is expected.

5.3.9.2 Alternative Transportation

The Project's mariculture equipment could interfere with the movement of watercraft (e.g., boats, kayaks) in intertidal areas. This interference would occur only when the tides are high enough for watercraft to move through the intertidal areas, but so low that that the vessels can't move readily over the equipment. Empty space among the equipment would allow smaller watercraft (e.g., kayaks) to move about, but in some cases only in two directions (e.g., parallel to rows of equipment). Watercraft movement in subtidal areas, including in the primary navigation channels for watercraft, would not be affected. Because this impact would occur only during certain tide heights and is limited to areas outside of navigation channels (i.e., in intertidal areas where boating activity is limited), the impact is considered less than significant.

5.3.10 Utilities/Service Systems

Project employees would use existing restrooms, likely within underutilized industrial areas. The Project would generate waste that would go to a landfill. This waste may include rope from cultch-on-longline culture operations and other disposable materials. Local landfills would have the capacity to accept this relatively small amount of waste. The Project would maintain compliance with federal, state, and local statutes and regulations related to solid waste. Hence, no impacts are expected.

5.4 Effects to Cultural and Archeological Resources

General information on the cultural and archeological resources in the vicinity of the Project area is found in a number of sources, including:

- Planwest Partners and the Cultural Resources Facility, Center for Indian Community Development, Humboldt State University 2008. Humboldt Bay Historic and Cultural Resource Characterization and Roundtable. October 2008.
- Humboldt County Department of Community Services Development 2008. Humboldt County General Plan November 20, 2008. Chapter 10, Section 10.6 Cultural Resources.
- Humboldt Bay Harbor, Recreation and Conservation District 2006. Humboldt Bay Management Plan Draft EIR. April 2006.
- ESA 2008. Marina Center Mixed Use Development Project Draft Environmental Impact Report. November 2008.

5.4.1 Environmental Setting

Humboldt Bay is the ancestral heartland of the Wiyot Indians, whose native language is affiliated with the Algonquian language family and who had occupied the bay area for at least 2.000 years by the time the first European maritime explorers entered the bay and the first American towns were established in 1850. There are hundreds of known and undiscovered archaeological sites around Humboldt Bay that evidence Wiyot history and prehistory. Today, citizens of Wiyot ancestry are affiliated with three federally-recognized tribes located in the ancestral homeland: Blue Lake Rancheria; Bear River Band of the Rohnerville Rancheria; and the Wiyot Tribe at Table Bluff Reservation.

5.4.2 Pertinent Laws and Regulations

A number of state and federal historic preservation laws, regulations and policies address the need to manage potentially significant and/or sensitive (e.g., human remains) archaeological and Native American resources discovered inadvertently and in "post-review" settings. These include:

- CEQA: Requires analysis by the Lead Agency, to determine if the Project will cause a significant impact to "historical resources" including archaeological and Native American sites.
- Section 106 of the National Historic Preservation Act: Requires analysis by the Lead Federal Agency (that provides funding or a permit for the "undertaking") and consultation with the California State Historic Preservation Officer, Advisory Council on Historic Preservation, culturally affiliated Native American Tribes, and others, as appropriate, to "resolve adverse effects" on "historic properties" including archaeological and Native American sites.

Several laws and their implementing regulations spell out evaluation criteria to determine what constitutes a significant 'site' or a significant 'discovery' during construction:

- California Register of Historical Resources (RHR) criteria (California Code of Regulations, Title 14, Chapter 3, Section 15064.5), for archaeological and Native American resources qualifying for consideration under CEQA.
- National Register of Historic Places criteria (36 CFR 63), qualifying for consideration under Section 106 review and the National Environmental Policy Act.

State laws call for specific procedures and timelines to be followed in cases when human remains are discovered on private or non-federal public land in California. It includes penalties (felony) for violating the rules for reporting discoveries, or for possessing or receiving Native American remains or grave goods:

- Section 7050.5 of the California Health and Safety Code and Section 5097.98 of the Public Resources Code outline requirements for handling inadvertent discoveries of human remains, including those determined to be Native American and associated grave goods found on private or state lands (i.e., the Project area), and Public Resources Code 5097.99 (as amended by SB 447) specifies penalties for illegally possessing or obtaining Native American remains or associated grave goods.

5.4.3 Definition of Significance and Baseline Conditions

Significance criteria are those listed in the CEQA checklist; a project's effects on cultural resources are significant if it will:

1. Cause a substantial adverse change in the significance of a historical resource as defined in CEQA §15064.5.
2. Cause a substantial adverse change in the significance of an archaeological resource pursuant to CEQA §15064.5.
3. Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.
4. Disturb any human remains, including those interred outside of formal cemeteries.

"Substantial adverse change" in the significance of an historical resource means physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of an historical resource would be materially impaired (California Native American Heritage Commission [NAHC] undated). Further, material impairment can happen when a project demolishes or materially adversely alters a historical resource's physical characteristics such that:

- It affects the resource's inclusion or eligibility for the California RHR.

- It affects the resource's inclusion or eligibility for a local RHRs.

Criteria for eligibility include resources that are (California State Parks [CSP] 2010):

- "Associated with events that have made a significant contribution to the broad patterns of local or regional history or the cultural heritage of California or the United States (Criterion 1).
- Associated with the lives of persons important to local, California or national history (Criterion 2).
- Embodies the distinctive characteristics of a type, period, region or method of construction or represents the work of a master or possesses high artistic values (Criterion 3).
- Has yielded, or has the potential to yield, information important to the prehistory or history of the local area, California or the nation (Criterion 4)."

5.4.4 Effects Analyses of the Project

Protection of archeological resources will be based on protocols that would be implemented when resources are inadvertently discovered.

Potentially significant impacts and related mitigation measures are described below.

IMPACT CR-1: Placement of equipment. Posts, anchors and/or stakes placed in the substrate to secure shellfish culture equipment could potentially disturb cultural resources. Mitigations CR-1 and CR-2 provide protocols for actions that will occur if cultural resources are discovered. Mitigation CR-3 provides further assurances for protection of resources at Intertidal Sites 3 and 4. With these mitigation measures this potential impact is less than significant.

MITIGATION CR-1: Protocols for inadvertent discovery of any cultural or archeological resource. The following protocol shall be implemented if a cultural or archeological resource is discovered.

1. The party who made the discovery shall be responsible for immediately contacting by telephone the District.
2. Ground-disturbing activities shall be immediately stopped at the find locality if potentially significant historic or archaeological materials are discovered. Examples include, but are not limited to, concentrations of historic artifacts (e.g., bottles, ceramics) or prehistoric artifacts (chipped chert or obsidian, arrow points, groundstone mortars and pestles), culturally altered ash-stained midden soils associated with pre-contact Native American habitation sites, concentrations of fire-altered rock and/or burned or charred organic materials, and historic structure remains such as stone-lined building foundations, wells or privy pits. Ground-disturbing Project activities may continue in other areas that are outside the discovery locale.

3. An "exclusion zone" where unauthorized equipment and personnel are not permitted shall be established (e.g., taped off) around the discovery area plus a reasonable buffer zone by the District, or party who made the discovery.

4. The discovery locale shall be secured (e.g., 24-hour surveillance) as directed by the District if considered prudent to avoid further disturbances.

5. Upon learning about a discovery, the District shall be responsible for immediately contacting by telephone the contacts listed below to initiate the consultation process for its treatment and disposition:

    a. Tribal Historic Preservation Officers (THPOs) with Blue Lake Rancheria, Bear River Band and Wiyot Tribe; and

    b. Other applicable agencies involved in Project permitting (e.g., U.S. Army Corps of Engineers [USACE], California Coastal Commission, etc.).

6. In cases where a known or suspected Native American burial or human remains are uncovered, the Humboldt County Coroner (707-445-7242) shall <u>also</u> be notified immediately.

7. Ground-disturbing Project work at the find locality shall be suspended temporarily while the District, THPOs, a consulting archaeologist and other applicable parties consult about appropriate treatment and disposition of the find. Ideally, a treatment plan may be decided within three working days of discovery notification and the field phase of a treatment plan may be accomplished within five days after its approval, however, circumstances may require longer periods for data recovery. Where a project can be modified to avoid disturbing the find, this may be the preferred option.

8. Any and all inadvertent discoveries shall be considered strictly confidential, with information about their location and nature being disclosed only to those with a need to know. The District shall be responsible for coordinating any requests by or contacts to the media about a discovery.

9. Ground-disturbing work at a discovery locale may not be resumed until authorized in writing by the District.

10. Final disposition of all collected archaeological materials shall be documented in a data recovery report and its disposition decided in consultation with Tribal representatives.

11. These protocols shall be requirements contained within District leases to Lessees.

MITIGATION CR-2. Protocols for inadvertent discovery of Native American remains and grave goods. In the event of a discovery of Native American remains or grave goods, the following protocol would be followed, in addition to the protocol described under Mitigation CR-1.

1. If human remains are encountered, they shall be treated with dignity and respect. Discovery of Native American remains is a very sensitive issue and serious concern of affiliated Native Americans. Information about such a discovery shall be held in confidence by all Project personnel on a need-to-

know basis. The rights of Native Americans to practice ceremonial observances on sites, in labs and around artifacts shall be upheld. The preference of the Wiyot area tribes is to leave ancestral burials and remains in situ, and that no photographs or analyses will be made.

2. The Coroner has two working days to examine the remains after being notified of the discovery. If the remains are Native American, the Coroner has 24 hours to notify the NAHC at (916) 653-4082.
3. The NAHC is responsible for identifying and immediately notifying the most likely descendant (MLD) of the deceased Native American.
4. Within 48 hours of their notification by the NAHC, the MLD may recommend the means for treating or disposing, with appropriate dignity, the human remains and any associated grave goods. The recommendation may include the scientific removal and non-destructive or destructive analysis of human remains and items associated with Native American burials. Only those osteological analyses (if any) recommended by the MLD may be considered and carried out.
5. Whenever the NAHC is unable to identify a MLD, or the MLD identified fails to make a recommendation, or the District rejects the recommendation of the MLD and mediation between the parties by NAHC fails to provide measures acceptable to the District, the District shall cause the re-burial of the human remains and associated grave offerings with appropriate dignity at an appropriate nearby location not subject to further subsurface disturbance.
6. These protocols shall be requirements contained within District leases to Lessees.

MITIGATION CR-3. Training for Lessees operating at Intertidal ~~Subtidal~~ Sites 3 and 4. Subtidal Sites 3 and 4 have the greatest possibility for inadvertent discovery of archeological and historic resources. Hence, prior to initiating culture at these sites, Lessees will meet with the Wiyot Tribe THPO in order to gain an understanding of the resources that may be disturbed and practical steps for minimizing disturbance.

5.4.5 Effects Analyses of Alternative 1. Subtidal Culture Only

Placement of stakes and posts associated with intertidal culture is more likely to impact archeological resources than placement of anchors and piles associated with subtidal culture. Hence, without intertidal culture, there would be substantially less potential to impact archeological resources. Levels of significance of the impacts of the Project and alternatives are presented in Table 9.

5.4.6 Effects Analyses of Alternative 2. Intertidal Culture Only

Placement of stakes and posts associated with intertidal culture is more likely to impact archeological resources than placement of anchors and piles associated with subtidal culture. Hence, without subtidal culture, there would only be a slight decrease in the Project's potential to impact archeological resources. Levels of significance of the impacts of the Project and alternatives are presented in Table 9.

5.4.7 Effects Analyses of Alternative 3. No Project Alternative

Under the no Project alternative, there would be no potential impact to archeological resources from the Project. Other activities in the bay, including shellfish culture, could still impact archeological resources. Levels of significance of the impacts of the Project and alternatives are presented in Table 9.

Table 9. Levels of Significance of the Project and Alternatives for Potential Cultural and Archeological Resource Impacts

Impact	Project	Alternative 1: Subtidal Culture Only	Alternative 2: Intertidal Culture Only	Alternative 3: No Project
CR-1: Placement of equipment	LSM	LSM	LSM	NI

NI=No Impact, LS=Less than Significant without Mitigation, LSM=Less than Significant with Mitigation, PS=Potentially Significant

5.5 Effects to Biological Resources

5.5.1 Environmental Setting

The Project will occur in and potentially affect intertidal and subtidal habitats in Arcata Bay (Figure 11). Table 10 depicts the types and areas of intertidal habitats in Arcata Bay and the overlapping areas of existing shellfish culture and shellfish culture proposed by the Project. In addition to this intertidal area, the Project proposes subtidal culture within 21.2 ac, which is approximately 1% of the 2,110 ac of subtidal habitat in Arcata Bay.

Table 10. Areas of Intertidal Habitats in Arcata Bay and the Overlapping Areas of Existing Shellfish Culture and Project Shellfish Culture

	Existing Culture				Project Intertidal Sites							
Habitat	Cultch-on-Longline	Rack-and-Bag	Basket-on-Longline	Nursery	Site 1	Site 2	Site 3	Site 4	Existing and Project Culture Total	Area Without Existing Project Culture	Total Habitat	% in Existing or Proposed Culture
Unconsolidated Sediment	0.0	0.0	0.0	0.0	26.0	67.1	5.4	15.5	114.0	2630.9	2744.8	4.2%
Patchy Eelgrass (11-84% Cover)	242.7	5.6	10.4	1.6	60.2	246.1	0.0	0.0	566.6	1313.3	1879.9	30.1%
Eelgrass (84-100% Cover)	24.3	0.0	0.8	1.2	8.1	35.2	0.6	3.6	73.8	1365.0	1438.8	5.1%
Macroalgae	0.0	0.0	0.0	0.4	0.0	0.0	1.9	13.7	16.0	1086.8	1102.9	1.5%
Total	267.0	5.6	11.2	3.3	94.3	348.4	8.0	32.7	770.4	6395.9	7166.3	10.8%

* Habitat types are based on mapping conducted by NOAA Coastal Services in 2009 with corrections made by H. T. Harvey & Associates.

- Table Notes: a) Some of the intertidal sites extend into subtidal habitat, however culture won't occur in subtidal habitat in these areas (the sites are larger than the area that can actually be cultured using intertidal methods); b) Mitigation measures described below will result in avoidance of eelgrass by culture equipment and cultured animals.

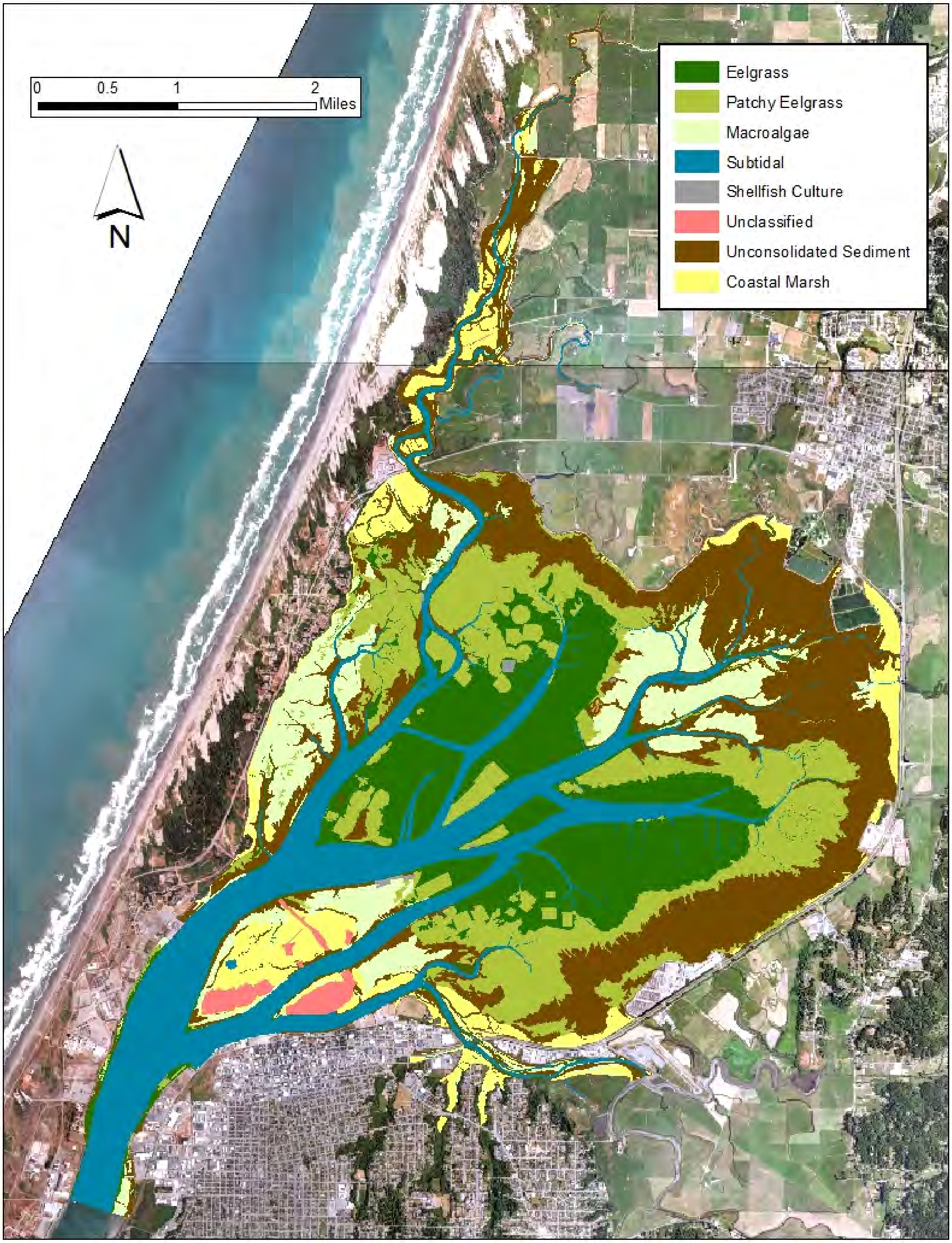

Figure 11. Arcata Bay and Arcata Bay Habitats as Defined by this EIR (These Habitats were Mapped by NOAA Coastal Services in 2009, with Corrections Made by H. T. Harvey & Associates)

5.5.1.1 Subtidal Community

The subtidal community in Humboldt Bay is comprised of plant and animal species that are always inundated by water. Due to the numerous aquatic species that occur in the bay and estuaries, "functionally related" species groups have been defined (HBHRCD 2006). Special status fish in this community include tidewater goby (*Eucyclogobius newberryi)*, coastal cutthroat trout (*Oncorhynchus clarkii clarkia)*, coho salmon (*O. kisutch),* steelhead (*O. mykiss)*, Chinook salmon (*O. tshawytscha)*, longfin smelt (*Spirinchus thaleichthys)*, green sturgeon (*Acipenser medirostris*) and eulachon (*Thaleichthys pacificus)*. Commercially and recreationally important species that utilize subtidal areas include Dungeness crab (*Cancer magister*), Pacific herring (*Clupea pallasii*), rockfish (*Sebastes* spp.) and California halibut (*Paralichthys californicus*). Numerous bird and marine mammal species also utilize subtidal areas. These species are discussed throughout this EIR.

5.5.1.2 Intertidal Community

Intertidal mudflats are exposed during lower tides and are submerged during higher tides. Channels cut across the mudflats. In some areas, eelgrass forms dense beds, and, in other areas, eelgrass is sparsely distributed or absent. Species of algae also occur on mudflats including red alga (*Polysiphonia*), rockweed (*Fucus* spp.) and sea lettuce (*Ulva* spp.). During high tides, fish, including special status fish species described in this EIR, can occur on mudflats and some may utilize them as foraging habitat. Various invertebrate species including the commercially and recreationally important Dungeness crab can occur on mudflats during high tides and low tides. Bird and marine mammal species also utilize intertidal areas. These species are discussed throughout this EIR.

5.5.2 Special Status Species Potentially Affected

This EIR focuses on plant and animal species that:

- Are likely to occur within or adjacent to the Project sites and potentially be effected by the Project, and
- Are listed under the Endangered Species Act (ESA) or California Endangered Species Act (CESA), or
- Are listed as a Species of Special Concern or Fully Protected Species by the State of California, or
- Are a plant species ranked by the California Native Plant Society as Rank 2 or rarer, or
- Are marine mammals (due to their protection under the Marine Mammal Protection Act [MMPA]).

These species are referred to as "special status species".

No special status plant species have been identified that would potentially be affected by the Project.

5.5.3 Animal Species Potentially Affected

Based on the criteria listed in Section 5.5.2, a literature review, and input from experts (including comments on the NOP), the special status and commercially important animal species determined to be potentially affected by the Project are identified in Table 11. Brief descriptions of the species requiring detailed analysis in this EIR are provided below. Other species are described where appropriate in the effects analysis below.

Table 11. Special Status and Commercially Important Animal Species Potentially Affected by the Project

Common Name	Scientific Name	Status
Green sturgeon-southern Distinct Population Segment (DPS)	*Acipenser medirostris*	Federally threatened, State Species of Special Concern
Coho salmon-southern OR/northern CA evolutionary significant unit (ESU)	*Onchorhynchus kisutch*	Federally threatened, State threatened
Northern California steelhead DPS	*Onchorhynchus mykiss*	Federally threatened
California coastal Chinook salmon ESU	*Onchorhynchus tshawytscha*	Federally threatened
Coastal cutthroat trout	*Oncorhynchus clarki clarki*	State species of special concern
Southern eulachon DPS	*Thaleichthys pacificus*	Federally threatened
Longfin smelt	*Spirinchus thaleichthys*	State threatened
Dungeness crab	*Cancer magister*	Commercially important
Pacific herring	*Clupea pallasii*	Commercially important
Rockfish	*Sebastes* spp.	Commercially important
California halibut	*Paralichthys californicus*	Commercially important
Western snowy plover	*Charadrius nivosus nivosus*	Federally threatened
California brown pelican	*Pelecanus occidentalis californicus*	State fully protected species
Marbled Murrelet	*Brachyramphus marmoratus*	Federally threatened, State endangered
California sea lions	*Zalophus californianus*	Protected under the Marine Mammal Protection Act (MMPA)
Harbor seal	*Phoca vitulina*	Protected under the MMPA
Harbor Porpoise	*Phocaena phocaena*	Protected under the MMPA

- This EIR addresses shorebirds and waterfowl collectively, with some discussion of individual species in the potential effects analysis.

5.5.3.1 Green Sturgeon–Southern DPS

Green sturgeon is a long-lived, slow-growing fish species, which is listed as threatened under the Federal ESA, and as a Species of Special Concern under the California ESA. Mature males range from 4.5–6.5 ft (1.4–2 m) fork length and they do not mature until they are at least 15 years old, while mature females range from 5–7 ft

(1.6–2.2 m) fork length and do not mature until they are at least 17 years old (National Marine Fisheries Service [NMFS] 2009). Maximum ages of adult green sturgeon are likely to range from 60–70 years. This species is found along the west coast of Mexico, the United States, and Canada.

The life history of green sturgeon is typical of anadromous fish. They likely spend most of their lives in nearshore oceanic waters, bays (including Humboldt Bay), and estuaries. Spawning occurs in deep pools in "large, turbulent, freshwater river mainstems" (NMFS 2009). Currently, spawning is believed to occur in the Klamath River basin, the Sacramento River, and the South Fork of the Trinity River. Spawning is unlikely to occur in creeks flowing into Humboldt Bay. Green sturgeon adults are regularly observed in channels within Humboldt Bay.

5.5.3.2 Coho and Chinook Salmon, Steelhead Trout and Coastal Cutthroat Trout (Salmonids)

Humboldt Bay supports three salmonid species that are listed as threatened under the Federal ESA: coho salmon, Southern Oregon/Northern Coastal California (SO/NCC) evolutionary significant unit (ESU), the Northern California steelhead trout Distinct Population Segment (DPS), and the California coastal Chinook salmon ESU. The coho salmon SO/NCC ESU is also listed as threatened under CESA. Additionally, Humboldt Bay supports coastal cutthroat trout (*O. clarki clarki*), a California Department of Fish and Wildlife (CDFW) species of special concern.

Salmonid life history is characterized by periods of pelagic conditions, adult upstream migration, spawning and egg development, fry and juvenile development, smolt outmigration, and estuary rearing. Channels within marsh habitats may be of particular importance to subyearling salmonids (*Oncorhynchus spp.*) because of the high insect and invertebrate prey resources and potential refuge from predators (Bottom et al. 2005). Wallace (2006) found significant use of the tidal portions of Freshwater Creek, Elk River, and Salmon Creek (Humboldt Bay tributaries) by juvenile Chinook salmon, coho salmon and steelhead trout. Pinnix et al. (2013) found that in Humboldt Bay, juvenile coho salmon primarily utilize deep channels, channel margins and floating eelgrass mats.

5.5.3.3 Southern Eulachon DPS

The Pacific eulachon is a small anadromous fish from the eastern Pacific Ocean (NMFS 2011). In March 2010, NMFS listed the Southern DPS as threatened under the ESA; the DPS includes populations in Washington, Oregon, and California. Critical habitat was designated in October 2011; in California, critical habitat includes the Mad River (NMFS 2011).

Eulachon spend 3–5 years at sea before returning to freshwater to spawn, from late winter to mid-spring. Eggs are fertilized in the water column, where they then sink and adhere to the river bottom of coarse sand and gravel. Most adults die after spawning. Eggs hatch in 20–40 days, and larvae are carried downstream and "are dispersed by estuarine and ocean currents shortly after hatching" (NMFS 2011).

Eulachon have been documented in Humboldt Bay and nearby coastal rivers such as Redwood Creek and the Mad River. In 1996, the Yurok tribe supported a eulachon sampling effort on the Klamath River of over 110 surveying hours, from early February to early May. No eulachon were observed. Considering the low abundance for over 20 years, CDFW considers the fish to be "nearly extirpated from California" (California Department of Fish and Game [CDFG] 2010).

5.5.3.4 Longfin Smelt

Longfin smelt are estuarine fish listed as threatened under the CESA. Longfin smelt are known to occur in Humboldt Bay, but little is known regarding their distribution, abundance or life history there. It is a short-lived (generally 2 years) species. Adults spawn in low salinity or freshwater areas within the lower reaches of coastal rivers and the buoyant larvae are swept into more brackish waters where they rear and then move to marine waters.

5.5.3.5 Western Snowy Plover

The western snowy plover (*Charadrius nivosus nivosus*) nests along the Pacific Coast from Damon Point, Washington to Bahia Magdalena, Baja California, Mexico (U.S. Fish and Wildlife Service [USFWS] 2007). Degradation and use of habitat for human activities has been largely responsible for the decline in snowy plover breeding population; other important threats to the snowy plover are mammalian and avian predators, and human disturbance (Page et al. 1995). In the Humboldt Bay region, western snowy plovers primarily breed and winter in ocean-fronting beaches (Brindock and Colwell 2011) although small numbers of plovers have been documented nesting in gravel bars of the Eel River (Colwell et al. 2011). Nonbreeding western snowy plovers occasionally occur on the interior of Humboldt Bay (Colwell 1994), but they are expected to occur mainly in the southern portion of the bay on sandier substrates rather than on softer substrates associated with mudflats in the northern portion of the bay. Snowy plovers are expected to occur in the Project area rarely as occasional foragers.

5.5.3.6 Marbled Murrelet

The marbled murrelet (*Brachyramphus marmoratus*) occurs along the Pacific coast from Alaska to California, foraging nearshore in marine subtidal and pelagic habitats for small fish and invertebrates (USFWS 2011). Breeding occurs in mature, coastal coniferous forest with nests built in tall trees. In California, breeding occurs primarily in Del Norte and Humboldt counties. The loss of old-growth forest is a primary reason for this species' decline (USFWS 1992). In California, marbled murrelets nest in redwoods that are older than 200 years (Nelson 1997). They are also vulnerable to oil spills along the coast. Marbled murrelets can occur in Humboldt Bay as foragers, and are expected to primarily occur in the entrance portion of the bay.

5.5.3.7 California Sea Lion

California sea lions (*Zalophus californianus*) are restricted to middle latitudes of the eastern North Pacific. There are three recognized management stocks: (1) the U.S. stock from Canada to Mexico, (2) the western Baja California stock, and (3) the Gulf of California stock (Lowry et al. 2008; Carretta et al. 2009). Breeding colonies only occur on islands off southern California, along the western side of Baja California, and in the Gulf of California (Heath and Perrin 2008). California sea lions feed on fish and cephalopods, some of which are commercially important species such as salmonids, Pacific sardines (*Sardinops sagax*), northern anchovy (*Engraulis mordax*), Pacific mackerel (*Scomber japonicus*), Pacific whiting (*Merluccius productus*), rockfish, and market squid (*Loligo opalescens*) (Lowry et al. 1991; Lowry and Carretta 1999; Weise 2000; Lowry and Forney 2005). California sea lions do not breed along the Humboldt County coast; however non-breeding or migrating individuals may occur in Humboldt Bay.

5.5.3.8 Harbor Seal

Harbor seals (*Phoca vitulina*) are widely distributed throughout the northern Atlantic and Pacific Oceans along coastal waters, river mouths, and bays (Burns 2008; Lowry et al. 2008). Harbor seals consume a variety of prey, but small fishes predominate in their diet (Tallman and Sullivan 2004). In Northern California, pupping peaks in June and lasts about two weeks; pups are weaned in four weeks (Burns 2008). Foraging occurs in a variety of habitats, from streams to bays to the open ocean, and harbor seals can dive to depths of almost 500 meters (m) (Eguchi and Harvey 2005). Harbor seals breed along the Humboldt County coast and inhabit the area throughout the year (Sullivan 1980). Harbor seals use Humboldt Bay as a pupping and haul-out area; other nearby haul-out sites are located in Trinidad Bay and the mouths of the Mad and Eel Rivers.

5.5.3.9 Harbor Porpoise

Harbor porpoises (*Phocaena phocaena*) are distributed throughout the coastal waters of the North Atlantic and North Pacific Oceans, and the Black Sea. In the North Pacific, they range from Point Conception, California, to as far north as Barrow, Alaska, and west to Russia and Japan (Gaskin 1984; Angliss and Allen 2009; Carretta et al. 2009). Harbor porpoises from California to the inland waters of Washington have been divided into six stocks (Carretta et al. 2009), with three additional stocks occurring in Alaskan waters (Angliss and Allen 2009). Porpoises from Humboldt County are included in the SO/NCC stock that extends from Point Arena to Lincoln City, Oregon (Carretta et al. 2009). Harbor porpoises have been observed throughout the year at the entrance to and within Humboldt Bay, usually as single individuals but sometimes in groups, with a maximum size of 12 animals (Goetz 1983). Abundance peaks between May and October, and porpoises are most abundant in Humboldt Bay during the flooding tide.

5.5.4 Plans Protecting Biological Resources

In the vicinity of the Project area, numerous riparian habitats and other sensitive natural communities have been identified by city governments, CDFW, and USFWS. These natural communities provide habitat for year-round and migrant species. Specific areas managed by local, state or federal entities protecting riparian habitats and other sensitive natural communities include:

- The Humboldt Bay National Wildlife Refuge Complex, owned and managed by the USFWS. http://www.fws.gov/humboldtbay/

- The Arcata Marsh and Wildlife Sanctuary, owned and managed by the City of Arcata. http://www.cityofarcata.org/departments/environmental-services/water-wastewater/wildlife-sanctuary
- CDFW Wildlife Areas (WA), at the following locations http://www.dfg.ca.gov/lands/wa/region1/index.html: South Spit WA, Eel River WA, Fay Slough WA, Mad River Slough WA, Elk River WA

Plans protecting biological resources in the vicinity of the Project include Local Coastal Plans, the Open Space Element of the County General Plan (CGP), Habitat Conservation Plans (HCPs), and recovery plans for listed species that are likely to occur within the Management Area.

Local Coastal Plans and other relevant documents include:

- City of Arcata Certified Local Coastal Program (LCP), http://www.cityofarcata.org/departments/building-planning/regulations/certified-local-coastal-program
- Humboldt Bay Area Plan of the Humboldt County LCP, April 1995, http://co.humboldt.ca.us/planning/local_coastal_plans/hbap/hbap.pdf
- Eel River Area Plan of the Humboldt County LCP, May 1995, http://co.humboldt.ca.us/planning/local_coastal_plans/erap/erap.pdf
- Local Coastal Plan Issue Identification Report, September 2003, http://co.humboldt.ca.us/planning/local_coastal_plans/pdf/issueidentificationreport/issue.pdf
- Humboldt Bay National Wildlife Refuge Comprehensive Conservation Plan 2009, http://www.fws.gov/humboldtbay/ccp.html
- HBMP 2007, www.humboldtbay.org

The County's coastal plan policies call for providing maximum public access and recreational use of the coast; protecting wetlands, rare and endangered habitats, environmentally sensitive areas, tidepools, and stream channels; maintaining productive coastal agricultural lands; directing new development to already urbanized areas; protecting scenic beauty, and locating coastal energy facilities such that they have the least impact (County of Humboldt 2003).

The CGP is currently being updated (County of Humboldt 2012). The Biological Resources section of the Conservation and Open Space Elements describes the policies for preservation of natural resources, production of resources, outdoor recreation, and public health and safety.

In the general vicinity of the Project area, HCPs and candidate conservation agreement and assurances plans have been written, but none geographically overlap the Project area.

The HBMP (HBHRDC 2007) which is incorporated by reference to this EIR provides guidance to the District regarding management of the bay. Preferred uses in Arcata Bay identified by the plan include (1) continued or heightened protection of Arcata Bay's environmental resources, (2) continued use for aquaculture or mariculture, and (3) the continuance and enhancement of recreational opportunities. Overall, the plan expresses a need to balance mariculture activities with other legitimate uses of the bay.

5.5.4.1 Clean Water Act Section 404 Wetlands

Under Section 404 of the Clean Water Act (CWA), wetlands are "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas" (USEPA 2011). USACE defines three characteristics of wetlands: hydrology, hydrophytic plants, and hydric soils. An area must exhibit all three characteristics to be considered a "jurisdictional wetland." Some areas may perform the functions of wetlands, yet not be delineated as jurisdictional wetlands if they do not exhibit all three wetland characteristics. All of the Project's Intertidal Sites are likely to be considered jurisdictional wetlands, whereas Subtidal Sites are not.

5.5.4.2 California Coastal Act

The Project area is within the California Coastal Commission's area of retained permitting jurisdiction and the Project will require a Coastal Development Permit. The California Coastal Act (CalCA) contains policies to protect marine resources, coastal waters, estuaries, wetlands, water quality, and environmentally sensitive habitat areas.

5.5.5 Definition of Significance and Baseline Conditions

Baseline conditions are those that have been documented at the time that the NOP was published. These conditions are described above as the present conditions of biological resources within and in the vicinity of the Management Area.

The CEQA Guidelines provide direction in evaluating Project impacts and determining which impacts will be significant (Remy et al. 1999). CEQA defines "significant effect on the environment" as "a substantial adverse change in the physical conditions which exist in the area affected by the proposed project." Under CEQA Guidelines Section 15065 (Mandatory Findings of Significance), a project's effects on biotic resources are deemed significant where the project would:

- "substantially reduce the habitat of a fish or wildlife species"
- "cause a fish or wildlife population to drop below self-sustaining levels"
- "threaten to eliminate a plant or animal community"
- "reduce the number or restrict the range of an endangered, threatened, or rare species"

In addition to the Section 15065 criteria that trigger mandatory findings of significance, Appendix G of the CEQA Guidelines provides a checklist of other potential impacts to consider when analyzing the significance of Project effects. The impacts listed in Appendix G may or may not be significant, depending on the level of the impact. For biological resources, these impacts include whether the Project would:

1. Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by CDFW or USFWS.
2. Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by CDFW or USFWS.
3. Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the CWA (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means.
4. Have a substantial adverse effect on coastal wetlands as defined by the CalCA.
5. Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.
6. Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.
7. Conflict with the provisions of an adopted HCP, Natural Community Conservation Planning (NCCP), or other approved local, regional, or state HCP.

5.5.6 Effects Analyses of the Project

This section evaluates possible impacts that would potentially affect biological resources as related to the thresholds described above.

IMPACT BIO-1: Effects of intertidal culture on shorebird species as a result of loss of foraging habitat and alteration of food sources. Humboldt Bay is an important estuary for migrating and wintering shorebirds in the Pacific flyway, and the bay has been designated as an International site in the Western Hemisphere Shorebird Reserve Network. During bay-wide surveys, as many as 32 shorebird species and over 80,000 individuals have been recorded during spring migration (as observed in April 1991) although shorebird counts conducted during the 1990's reflect a decline relative to historic estimates (Colwell 1994). In Humboldt Bay, a suite of non-breeding shorebird species use intertidal mudflat areas for foraging, although their habitat use is differential based on species' morphology, water depth (and thus tidal cycles), and substrate type. In general, shorebirds are very flexible and opportunistic in their diets, with considerable dietary overlap among species and foraging guilds (Skagen and Oman 1996). They often take prey in accordance with availability, concentrating where prey is most dense (Goss-Custard 1970; 1977; 1979). These birds often concentrate at the edge of the receding tideline, where worms, crustaceans, and bivalves occur close to the surface. Thus, the hydrologic regimes and ecosystem processes that maintain abundant invertebrate populations are more important than the specific invertebrate taxa available. Near the waterline, shorebird microhabitat use typically depends on each species' leg length, as well as the size and shape of their bills. For example, the very shortest-billed semipalmated plovers (*Charadrius semipalmatus*) and black-bellied plovers (*Pluvialis squatarola*) often feed on recently exposed mud, small sandpipers (*Calidris* spp.) such as western sandpiper (*Calidris mauri*) and least sandpipers (*Calidris minutilla*) forage on recently uncovered mud and shallow water, mid-sized birds such as dunlin (*Calidris alpina*), long-billed dowitchers (*Limnodromus scolopaceus*), and short-billed dowitchers (*Limnodromus griseus*) can forage in slightly deeper water, and larger shorebirds such as willets (*Tringa semipalmatus*), long-billed curlews (*Numenius americanus*), and marbled godwits (*Limosa fedoa*) are able to probe in deeper water (although these species will forage in exposed areas as well).

Shorebirds in Humboldt Bay also exploit other habitats, particularly agricultural fields, when intertidal mudflats are inundated (Colwell and Dodd 1997; Long and Ralph 2001). Shorebird use of pastures is correlated with rainfall, as shorebirds likely exploit increased prey availability when pastures are wet, or possibly their use of pastures is related to a decrease in prey availability on mudflats during rainfall (Colwell and Dodd 1997). In addition to bill shape and leg length, sediment type can dictate where shorebird species forage. Sediment particle size influences shorebird distribution in Humboldt Bay, for instance sanderlings (*Calidris alba*) tend to select areas with coarser sediments and American avocets (*Recurvirostra americana*) tend to occur in areas with finer sediments (Danufsky and Colwell 2003).

Aquaculture practices in intertidal areas may have the potential to reduce the amount of available foraging habitat for shorebirds through habitat modification (Colwell 1994) and a study on wintering shorebirds conducted in Tomales Bay suggests that some shorebird species can avoid aquaculture areas (Kelly et al. 1996), although those observed effects are likely related to bottom-culture techniques that are no longer used in Humboldt Bay. Foraging resources for shorebirds are altered in two primary ways by shellfish culture: (1) cultured animals and associated bio-fouling organisms can be a food source to birds (Caldow et al. 2007; Forrest et al. 2009), and (2) habitats, and thus food resources, below culture operations can be altered (Trianni 1996; Quintino et al. 2012). Under the Project, intertidal aquaculture would be permitted to occur on a total of 483 ac in Arcata Bay, with most (306 ac; 63%) occurring over patchy eelgrass habitat (Table 10). Intertidal culture may also occur over 48 ac of dense eelgrass, 16 ac of macroalgae, and 114 ac of unconsolidated sediment (Table 10). Shorebirds may use any of these areas when exposed during lower tides, although they are least likely to use dense eelgrass areas, as those areas are likely inundated more frequently and are less suitable for most shorebirds to use for foraging. Areas classified as patchy eelgrass represent potential foraging habitat for shorebirds because eelgrass in those locations tends to occur in small scattered depressions, and thus most of those areas are mudflats. Thus, a large proportion of the Project area represents potentially suitable foraging habitat for shorebirds.

The placement of cultch-on-longline, basket-on-longline or rack-and-bag infrastructure within intertidal habitats in Arcata Bay could preclude shorebirds from entering all or portions of aquaculture sites, as some species may be wary of objects placed on mudflats. Human disturbance may also preclude shorebirds from using intertidal sites, at least temporarily, as some practices (i.e., rack-and-bag) require approximately two visits per week for maintenance (Table 3). Some birds may avoid aquaculture beds entirely, or avoid walking or foraging only under longlines (particularly if holding baskets) or rack-and-bags. In such cases birds may utilize rows between aquaculture beds. Alternatively, shorebirds may be attracted to aquaculture areas due to an increase in foraging resources associated with cultured oysters or other organisms that grow on the infrastructure. The presence of shells and disturbance of substrate from site access during maintenance and harvest also increases substrate heterogeneity which may attract or deter shorebird species, depending on foraging techniques used.

Due to variation in foraging technique, sensitivity to structures in intertidal habitats, and social structure (e.g., flocking vs. territorial behavior), it is likely shorebird species will be differentially affected by the Project. The relative importance of Humboldt Bay for migration or for extended non-breeding periods (i.e., as a resource for foraging) differs between shorebird species due to variation in migration strategies. For instance, small sandpipers arrive in Humboldt Bay in large flocks and can be observed numbering in the thousands (Colwell 1994), although their residency time in the estuary is short. A study on radio-marked western sandpipers found that the mean length of stay in Humboldt Bay was 3.3 days (Warnock and Bishop 1998), indicating this species uses multiple short flights and stopovers during migration. Contrary to this strategy, long-billed curlews spend long "wintering" periods (i.e., June through March) in Humboldt Bay and establish non-breeding low-tide territories and use agricultural fields, particularly during winter rain periods (Colwell and Dodd 1997; Colwell and Mathis 2001). Thus, territorial birds that reside in the bay longer are likely to be more affected by the Project than birds that reside in the bay for short durations and with little fidelity to specific foraging sites.

To date, one study has been conducted in Humboldt Bay comparing low-tide shorebird use of cultch-on-longline plots to adjacent tidal flats not used for aquaculture (Connolly and Colwell 2005). The results indicate greater bird species diversity on longline oyster plots than on the tidal flats without oyster culture (i.e., control plots), although there was variation in species use of longline and control plots. Where differences occurred, five species (willet, whimbrel [*Numenius phaeopus*], dowitchers, small sandpipers, and black turnstone [*Arenaria melanocephala*]) were more abundant on longline plots than control plots during the study (Connolly and Colwell 2005). The authors suggest that increased abundance of these shorebirds on longline plots was potentially related to increased foraging opportunity or an increase of prey density or diversity. One species (black-bellied plover) was more abundant only on control plots. The authors suggest that greater use of control plots by black-bellied plovers may be a result of greater abundance of their principle prey items occurring on control plots, or factors related to reduced foraging efficiency related to their visual foraging methods. For instance, prey may be less available to black-bellied plovers, due to higher concentrations of shorebirds attracted to the longlines, or prey may be less detectable due to visual obstructions in longline plots.

There are some limitations associated with the Connolly and Colwell (2005) study in terms of its applicability for impact assessment for the Project. First, the study plots were associated with cultch-on-longline beds, but not basket-on-longline or rack-and-bag infrastructure that may be implemented as a result of the Project. Those two aquaculture practices could have the potential to deter shorebirds from using aquaculture beds, more so than cultch-on-longline, as suspended baskets are more likely to obscure visibility and predator detection for shorebirds. Because it is unknown which technique, or combination of techniques, aquaculture operators will utilize on leased intertidal areas, it must be recognized that all methods may be used in leased areas and shorebirds may respond differently (possibly demonstrating partial or complete avoidance) compared to the cultch-on-longline technique. Also, the spatial scale of the Connolly and Colwell (2005) study may have been inadequate to appropriately assess aquaculture practices on long-billed curlews, as many individuals of this species will occupy non-breeding territories in Humboldt Bay (Colwell and Mathis 2001) and the study plots were established irrespective of curlew territories (Colwell pers. comm.). Thus, although long-billed curlews may have shown no preference for longline or control plots in the study, use or avoidance of aquaculture areas is difficult to assess if few territories overlap with study plots (Connolly and Colwell 2005).

Based on the results of the previous study of aquaculture use by shorebirds in Humboldt Bay, some species (and possibly most species) may be unaffected by the Project or could benefit from increased prey abundance under aquaculture beds, while others may tend to avoid aquaculture beds. However, as noted above, no studies have been conducted in regards to shorebird response to the basket-on-longline or rack-and-bag methods, and thus it is possible that some species that would forage under cultch-and-longline may avoid those areas partially or completely. For some species, complete avoidance of aquaculture areas may not result in adverse effects such as increased competition for food and reduced body condition, as many species (e.g., western sandpipers) demonstrate plasticity in selecting stopover sites, thus allowing for them to opportunistically exploit food resources when available and facilitating predator avoidance. This is evidenced by large flocks of small sandpipers that are routinely observed foraging on mudflats throughout Humboldt Bay for brief durations during migration. Because sandpipers are able to forage in various locations throughout the bay, demonstrating low site fidelity, foraging habitat is likely not limited during their brief stopovers. Although up to 435 ac of intertidal mudflats (shown in Table 10 as unconsolidated sediment, patchy eelgrass, and macroalgae), representing 9% of Arcata Bay mudflats, could be used for aquaculture, species exhibiting brief stopovers are unlikely to be affected by loss of habitat (if those areas are avoided).

Other species, long-billed curlews in particular, may be disproportionally affected, as they are large, territorial birds that rely on intertidal foraging areas for extended periods during the non-breeding season. For instance, they are known to occupy territories within proposed intertidal aquaculture areas, particularly the Intertidal 4 site (Figure 2), where approximately 10 curlews maintain foraging territories along the west end of Indian Island (Colwell pers. comm.). It is unknown how long-billed curlews will respond to aquaculture beds, particularly if rack-and-bag or basket-on-longline methods are used, but it is possible that curlews may be displaced from those areas. Although curlews are known to use pastures as alternative habitats during wet periods, their territoriality on mudflats during low tides suggest those areas represent important foraging areas for meeting their energetic needs for migration and reproduction. Loss of available habitat could result in increased competition and reduced foraging efficiency in alternative foraging areas, such as pastures, or altered activity patterns that reduce energy reserves and increase predation risk. Further, if curlews do maintain territories in aquaculture areas, they could be periodically displaced as much as twice per week by the presence of humans.

Large birds, like curlews, experience higher energetic costs when forced to fly than smaller birds, like small sandpipers. Because of this potential habitat loss or degradation, it is possible that the carrying capacity of the bay will be reduced for curlews, such that as many as 10 individuals will no longer be supported as a result of the Project. The wintering population of curlews in Humboldt Bay has been estimated to be approximately 200–300 individuals (Leeman and Colwell 2005), thus the Project could possibly affect up to 5% of the bay-wide population through habitat modification. In the context of their population size, the long-billed curlew range-wide population has been estimated to be 161,181 individuals (Jones et al. 2008). The potential loss of foraging habitat for curlews would not result in habitat or population-level impacts that are sufficient to meet CEQA criteria for a significant impact. As described above, curlews (due to their territoriality) are more likely to be affected by the Project than other shorebirds, particularly small sandpipers that utilize the bay in large numbers but for short durations. Therefore, the Project is expected to have a less than significant impact on foraging habitat for shorebirds and this impact is considered less than significant without mitigation.

IMPACT BIO-2: Effects of intertidal culture on black brant (*Branta bernicla nigricans*) as a result of loss of foraging habitat and alteration of food sources. Humboldt Bay is an important spring staging site for black brant in the Pacific flyway. Brant rely exclusively on eelgrass during the non-breeding season and their distributions are strongly correlated with the distribution of eelgrass (Moore et al. 2004). Humboldt Bay is one of the most important spring staging areas in the Pacific flyway and represents the most important spring staging site in California (Moore et al. 2004), with most (approximately 60%) of the population having been estimated using Humboldt Bay (Lee 2001, as cited in Moore et al. 2004). The southern portion of Humboldt Bay (i.e., South Bay) contains the majority of the eelgrass beds within Humboldt Bay, and that region supports the majority (81%, as determined by surveys between 1931 and 2001) of the brant using the bay during spring migration (Moore et al. 2004). Therefore the distribution of brant in the bay appears to be proportional with eelgrass distribution (Moore et al. 2004). Although a reduction in brant use of Humboldt Bay has been attributed to poor eelgrass quality in the past during specific years, hunting pressure and disturbance has likely had a greater effect on brant use (and declines in abundance) in the bay than the overall quality of eelgrass (Moore and Black 2006).

The Project will expand aquaculture operations in 483 ac of intertidal habitats. Most of the intertidal aquaculture (306 ac) will occur over patchy eelgrass habitat, which represents low-quality habitat for brant because eelgrass in those areas primarily occurs in scattered depressions on mudflats, and thus brant are unlikely to forage in those locations compared to dense eelgrass beds. Areas of dense eelgrass, will largely be avoided by the Project. A small portion of the intertidal aquaculture lease area (48 ac; approximately 3% of intertidal dense eelgrass in Arcata Bay) occurs over areas mapped as dense eelgrass habitat (representing potential high-quality habitat for brant). These areas mainly occur on the borders of tidal channels and on the edge of intertidal sites, rather than on the interior of the aquaculture beds. Off-bottom shellfish culture techniques allow for oyster culture to be held off of the substrate allowing for eelgrass to grow under culture equipment and between rows of culture. The effect of shellfish culture on eelgrass density and quality is unknown, but major habitat degradation is not expected to occur. Impacts to these eelgrass habitats will be avoided to the extent feasible through implementation of mitigation measures, including avoidance of eelgrass areas and routing of boat traffic around eelgrass areas (see Mitigation BIO-3, -4 and -5 below).

Areas under and between aquaculture will continue to be available for foraging brant, but the extent this species will continue to forage in areas with culture and associated human disturbance is unknown. Because they are a hunted species, brant are likely more sensitive to human disturbance than other species, including shorebirds. Although human disturbance is expected to be minimal in most aquaculture areas (e.g., approximately one visit per month for cultch-on-longline and two visits per week for rack-and-bag), brant may avoid areas where aquaculture occurs or use them less. For instance, brant may continue to use culture areas comparably to existing conditions or avoid aquaculture beds because structures impede their ability to take off and land in those areas. Alternatively, brant may only use the more open areas between culture equipment, as those areas may not preclude them from taking off and landing. Brant may also infrequently use the areas between the narrow rows, possibly walking between them and foraging, but they are likely unable to take off or land in narrow spaces between rows of aquaculture equipment. Brant are less likely to use beds with basket-on-longline culture compared to cultch-on-longline, as brant will likely be more wary to forage between those larger structures.

Although it is unknown to what extent brant currently rely on and will continue to use those eelgrass habitats during Project implementation, it must be assumed that brant will avoid using aquaculture areas due to placement of infrastructure and increased human disturbance (in the absence of extensive pre- and post-project monitoring). Nonetheless, the majority of the intertidal aquaculture areas avoid impacts to eelgrass, and at most 3% (48 ac) of high-quality foraging habitat for brant will be impacted. This potential loss of habitat represents a small proportion of foraging habitat available in Arcata Bay and a very small proportion of foraging habitat in the greater Humboldt Bay. Although eelgrass habitat in Arcata Bay represents important spring stopover habitat for the species, the potential loss of a very small proportion of available habitat will not result in a significant impact per the criteria described above for CEQA, and thus the impact is considered less than significant without mitigation.

IMPACT BIO-3: Potential impact to marine mammals from the potential loss of foraging habitat and restrictions to movement due to placement of aquaculture equipment in intertidal and subtidal areas. Harbor seals breed along the Humboldt County coast and inhabit the region throughout the year (Sullivan 1980). Harbor seals will utilize Humboldt Bay as a pupping and haul-out area; other haul-out sites are located in Trinidad Bay and the mouths of the Mad and Eel Rivers. California sea lions do not breed along the Humboldt County coast; however non-breeding or migrating individuals can occur in Humboldt Bay. Harbor porpoises (*Phocoena phocoena*) have been observed throughout the year at the entrance to and within Humboldt Bay, usually as single individuals but sometimes in groups, with a maximum size of 12 animals (Goetz 1983). Abundance peaks between May and October, and porpoises are most abundant in Humboldt Bay during the flooding tide.

When in Humboldt Bay, marine mammals may occasionally move through general areas of Arcata Bay where aquaculture expansion is proposed. These species are expected to move through, and forage in, the relatively deep channels that occur between shallow intertidal areas rather than the shallower areas where intertidal aquaculture beds will be located. If moving through intertidal areas during high tides, longline structures are not expected to restrict movements of marine mammals, as these species would readily navigate the culture equipment and move through spaces between equipment. Floating structures in subtidal areas are not expected to impede the movements of marine mammals or preclude them from foraging; floating structures may occasionally be used for loafing by sea lions if not frequently visited by aquaculture personnel. Harbor seals could haul-out on mudflats near intertidal aquaculture beds, such as on the mudflats near Intertidal Site 2 (Figure 2). The placement of off-bottom aquaculture infrastructure will not limit the species' ability to haul-out in Arcata Bay, as the Project area represents a small proportion of the potential areas that can be used for haul-outs. Therefore, impacts to movement and foraging by marine mammals are considered less than significant and this impact is considered less than significant without mitigation.

IMPACT BIO-4: Effects of human disturbance (e.g., boat movement, presence of culture workers) on marine mammals and other wildlife. Aquaculturists will routinely visit leased areas for installation, inspections, planting and harvesting, product grading, and other activities related to aquaculture practices. The number of visitations to each site will depend on the types of aquaculture operations that are occurring. In intertidal areas for instance, rack-and-bag methods are labor-intensive and require inspections an average of twice per week (Table 3). Other methods are less intensive; cultch-on-longline requires only monthly inspections and basket-on-longline requires only six or seven visits per year (Table 3). Aquaculture activities associated with floating structures installed in subtidal areas will require daily visits for inspections and other activities (Table 4). For all these activities, noise will be generated from small vessels, movement and maintenance of equipment and communication among aquaculture workers. Noise from aquaculture practices will be similar to what occurs from other users of the bay including recreational users (e.g., hunters, fishermen, and paddle and motor boaters) and commercial users (e.g., shippers and commercial fishermen).

Shorebirds and wading birds (i.e., herons and egrets [Ardeidae]) frequently forage in intertidal areas during low tide and may occur within or adjacent to intertidal aquaculture beds. During higher tides, diving ducks and piscivorous birds, like western grebes (*Aechmophorus occidentalis*) and double-crested cormorants (*Phalacrocorax auritus*), will forage in channels near intertidal sites and could occur in open water during any part of the tide cycle near subtidal raft structures. Some birds, including cormorants, elegant terns (*Thalasseus elegans*), or California brown pelicans (*Pelecanus occidentalis californicus*) may roost on rafts or other structures associated with aquaculture. Marine mammals may also occur around raft structures and sea lions may occasionally loaf on structures if no humans are present. Marine mammals may also occur in channels near intertidal aquaculture sites and harbor seals may occasionally haul-out on mudflats in intertidal areas.

Human disturbance associated with visits to aquaculture sites has the potential to flush waterbirds that may be foraging or roosting within or near aquaculture areas. Such disturbance in close proximity to foraging or roosting birds can cause them to flush from the area. It is expected that many birds will become habituated to human disturbance and only flush to nearby sites (and quickly returning after the activity is complete) whereas other individuals may flush greater distances if they are more wary of humans or noise. These disturbances have energetic costs associated with flight while birds search for alternative roosts or foraging sites, with larger birds experiencing higher energetic costs. Disturbance could also result in a reduction in foraging efficiency in nearby foraging areas (or alternative sites), increased movement, or altered activity patterns that reduce energy reserves and increase predation risk. An increase in energetic output to acquire foraging resources could ultimately result in lowered reproductive success for some individuals. It is expected that birds will locate to alternative roost sites when flushed from aquaculture infrastructure and individuals that are more sensitive, potentially including larger species with heavier wing-loads (and thus higher energetic costs associated with flight), may generally avoid areas that receive frequent (e.g., daily) human disturbance. However, foraging areas are not likely limited for most species that use intertidal or subtidal habitats (see Impact BIO-1 above for discussion on impacts to shorebirds). Although some species may experience reduced foraging opportunities and increased energetic costs, activities at aquaculture areas will be similar to those already occurring in Arcata Bay and long-term population-level effects are unlikely to occur even for the most sensitive species. There are numerous roosting sites for birds throughout the bay, including docks, posts, and other structures, indicating roost sites are not limiting for any species bay-wide. Therefore, the effects of human disturbance on waterbirds are considered less than significant.

Human disturbance could cause marine mammals to flush from their loafing sites on floating structures or haul-out sites on mudflats. As described above for avian species, flushing of marine mammals may increase energetic demands on individuals if they are disturbed from resting areas and forced to relocate. However, haul-out sites and other loafing areas are not limited in Arcata Bay and sensitive species will likely utilize alternative sites that receive infrequent human disturbance. Also, because unauthorized harassment of marine mammals is not allowed under the MMPA, Mitigation BIO-1 below will require aquaculture farmers to implement an education program that will inform workers of procedures to avoid flushing marine mammals when using boats in Arcata Bay. These include speed restrictions and other marine mammal avoidance techniques. Impacts to marine mammals associated with human disturbance are considered less than significant with implementation of Mitigation BIO-1.

MITIGATION BIO-1: Educational meetings. The District will require farmers to hold annual educational meetings with their personnel (which will be described in annual reports) where the following procedures relating to marine mammals will be described. These meetings will describe that when marine mammals are encountered, personnel shall:

- Reduce speed and remain at least 100 yards from the animal(s), whether it is on land or in the water.
- Provide a safe path of travel for marine mammals that avoids encirclement or entrapment of the animal(s) between the vessel and the shore.
- If approached closely by a marine mammal while underway, the operator shall reduce speed, place the vessel in neutral and wait until the animal is observed clear of the vessel before making way.

- Avoid sudden direction or speed changes when near marine mammals.
- Never approach, touch or feed a marine mammal.

During these meetings, farmers will also be directed to properly stow any gear and remove any trash or debris from the bay (including on raft structures) so as to avoid potential entanglement of fish or marine mammal species that may be on or near culture equipment.

IMPACT BIO-5: Effects on the distribution and abundance of mammalian or avian species that are potential predators of native fish species, and related effects to native fish species. As discussed in Impact BIO-4 above, piscivorous waterbirds and marine mammals may roost on floating structures associated with aquaculture operations. For instance, elegant terns, California brown pelicans, and double-crested cormorants are frequently observed roosting on docks, pilings, and numerous other structures around Arcata Bay. California sea lions may also loaf on structures, including floating rafts associated with aquaculture. Although these species prey on fish, no significant increase in fish predation is expected to occur as a result of the Project. Piscivorous waterbirds are likely to roost on aquaculture infrastructure, however large congregations are not expected to occur on aquaculture infrastructure because there is an abundance of alternative roost sites (that are often unused by birds) bay-wide. The addition of new roost sites therefore is not expected to result in an increase in fish predators. Similarly, sea lions are not expected to congregate in large numbers on aquaculture rafts, as these structures will not support large numbers of animals, like boat docks and other flat structures, and numerous other (more suitable) loafing areas already occur around the bay. Further, fish are not expected to be attracted to floating rafts, except potentially surfperch (Embiotocidae) and juvenile rockfish; however, no special-status species are expected to be attracted to the equipment. Therefore the impacts to fish species as a result of predatory mammalian or avian species occurring near aquaculture equipment are considered less than significant and this impact is considered less than significant without mitigation.

IMPACT BIO-6: Effects of artificial lighting on wildlife. The adverse effects of artificial night lighting on terrestrial, aquatic, and marine sources such as birds, mammals and plants are well documented (Rich and Longcore 2006). Some of these effects include altered migration patterns and reproductive and development rates, changes in foraging behavior and predator-prey interactions, altered natural community assemblages and phototaxis (attraction and movement towards light). For instance, when birds fly into lighted areas at night, they may lose their visual cues to the horizon and the lights then become the reference, resulting in disorientation (Herbert 1970). Also, there is evidence that floodlights on structures, such as buildings and bridges, will attract and kill migrant birds, especially on misty and cloudy nights during fall and spring (Overing 1938; Lord 1951; Baldwin 1965; Herndon 1973; Jackson et al. 1974). Fish are known to be attracted to lights as well and increased lighting can alter behavior and increase prey risk. For example, salmonid fry have been observed slowing or stopping out-migration, and thus subjected to increased predation when exposed to bright lights from the shoreline (Tabor et al. 2004). However, the installation of additional lighting associated with the Project is expected to occur in limited locations around Arcata Bay. Additionally, an increase in lighting from boat traffic (i.e., from navigation lights) is expected to be insignificant. However, there may be new lighting installed in limited locations on new floating rafts (i.e., up to two lights per raft), and therefore there is potential for increased adverse lighting effects in some areas. To reduce the potential for substantial light pollution to occur at new lighting locations, Mitigation BIO-2 will be implemented. With this mitigation, the impact is less than significant.

MITIGATION BIO-2: Shielding of light fixtures. Only lighting fixtures that are fully shielded and designed to minimize off site glare and avoid on water light spillage will be utilized at night. Motion-sensing lighting will be used to the extent feasible to reduce the amount of time lights are on. Where motion-sensing lighting is not feasible but lights do not need to be on continuously, timers will be installed to reduce the amount of unnecessary lighting.

IMPACT BIO-7: Effects to green sturgeon as a result of potential reduction in prey. Tributaries to Humboldt Bay provide spawning habitat for green sturgeon. However, adult green sturgeon are known to temporarily reside in deeper channels in the bay (Lindley et al. 2011). Beamis and Kynard (1997) suggested that green sturgeon move into the estuaries of non-natal rivers to feed; this is likely true for Humboldt Bay. Likely food sources for green sturgeon are small fishes and benthic invertebrates associated with silty/sandy substrates and benthic fauna (NMFS 2009). There are two potential processes by which the proposed mariculture operations could reduce these prey resources: by displacing prey and by causing ecosystem changes that result in reduced prey populations or availability. The first potential effect is discussed below. The second is discussed assessed in Impact BIO-8, "Effects on the abundance of suspended organic matter and related effects to other native species."

The proposed intertidal mariculture areas are only temporarily inundated with tidal waters. Small fish that may be prey for green sturgeon likely forage in these areas. However, there is ample space for prey fish species to forage among the mariculture equipment and cultured shellfish. Additionally, cultured shellfish and mariculture equipment can benefit small fish by providing habitat and food resources (see review by Dumbauld et al. 2009). Hence, the Project's proposed intertidal shellfish culture is not expected to negatively affect small fish. Additionally, benthic invertebrates have been shown to occur at higher densities in intertidal areas with cultured shellfish than in intertidal areas without cultured shellfish (see review by Dumbauld et al. 2009). Based on available information, there is no reason to conclude that intertidal culture would reduce prey resources for green sturgeon. The proposed subtidal culture floating raft structures would not displace sturgeon prey (small fish and benthic invertebrates) because sturgeon are principally benthic feeders (Billard and Lecointre 2001).

Based on the above, the Project is not expected to have a significant effect on green sturgeon as a result of prey reduction and no mitigation measures are recommended. Hence, this impact is considered less than significant without mitigation.

IMPACT BIO-8: Effects on the abundance of suspended organic matter and related effects to other native species. Cultured shellfish consume natural food sources that are suspended in the water column including phytoplankton and other organic matter and there is potential competition for this food source between cultured shellfish and other filter feeders. This potential impact is evaluated in Appendix A. While the clearance efficiency calculations indicate that shellfish filtration could exceed the bay's flushing rate if the most conservative flushing rate estimate is used, this does not evaluate the impact on phytoplankton within the bay. The filtration pressure and regulation ratio analyses, which take into account the impact on available phytoplankton, indicate that Humboldt Bay is highly productive and this productivity can withstand substantial cultivated shellfish density without affecting food resources available to other organisms in the bay. The results of the study indicate that the Project, when considered with other existing and proposed shellfish culture in the bay, would have some cumulative effect on bay conditions, but that food resources are likely abundant enough that native species would not be significantly affected. Therefore, this potential impact is considered less than significant without mitigation.

IMPACT BIO-9: Effects to green sturgeon as a result of habitat loss or degradation. As described under Impact BIO-7 (Effects to green sturgeon as a result of potential reduction in prey), green sturgeon likely utilize Humboldt Bay for feeding and the Project is unlikely to have a negative effect on prey resources for green sturgeon. Green sturgeon habitat would also be affected by placement of culture equipment on the bottom, which can displace green sturgeon habitat. Current shellfish culture equipment in Humboldt Bay covers approximately 0.76 ac of the bottom (the "benthic footprint") with post, anchors, etc. Structures in the bay not related to shellfish culture (e.g., docks and piles)have not been inventoried well and it is difficult to estimate the benthic footprint of these structures. However, these structures can be characterized as "scattered" along the shoreline and don't appear to occupy a substantial proportion of benthic habitat in the bay. The Project would allow for approximately 0.96 ac of additional benthic footprint, including posts associated with intertidal culture operations, and anchors and piles associated with subtidal operations. Hence, the total benthic footprint of existing and Project shellfish culture equipment would be less than 2 ac (which is in addition to the unknown benthic footprint created by non-culture related structures). This represents less than 0.026% of the 7,795 ac of Arcata Bay. Hence, substantial area for feeding by green sturgeon would remain unaltered. Space between shellfish culture equipment would remain available for use by sturgeon because culture areas are permeable (sturgeon can freely move within the culture areas).

Based on the above, the Project is not expected to have a significant effect on green sturgeon as a result of habitat loss or degradation and this impact is considered less than significant without mitigation.

IMPACT BIO-10: Effects to green sturgeon as a result of entanglement. As an anadromous species, sturgeon swim among diverse structures in rivers, embayments, and the ocean. They have the sensory ability to detect structures and the swimming ability to avoid them. It is expected that green sturgeon would not collide or become entangled with mariculture equipment or cultured shellfish. Shellfish culture has occurred for decades in West Coast embayments where sturgeon occur, and there is no known record (anecdotal or otherwise) of a sturgeon ever becoming entangled in mariculture equipment. No impact is expected.

IMPACT BIO-11: Effects on wetland functions. Wetlands, including in Humboldt Bay, provide numerous functions such as primary production, flood protection, nutrient removal/transformation, wildlife habitat and recreational opportunities. These functions are assessed separately throughout this section. In general, the addition of shellfish culture activities to a wetland does not preclude the functions of that wetland. For example, in areas with shellfish culture; plants grow, flood protection functions continue and nutrients are removed and transformed. As such, the Project is not expected to have a significant effect on wetland functions and this impact is considered less than significant without mitigation.

IMPACT BIO-12: Effects on eelgrass. Humboldt Bay contains approximately 45% of California's eelgrass habitat (Gilkerson 2008) and eelgrass is one of the most abundant habitats in Arcata Bay, densely covering approximately 1,365 ac of Arcata Bay's 7,166 ac of subtidal and intertidal habitats (Table 10). According to Schlosser and Eicher (2012) "Past records suggest that eelgrass distribution in Humboldt Bay has retained the same general footprint over the last 150 years, with some year-to-year fluctuations" and "The year-to-year fluctuations noted by numerous investigators occur primarily at the upper margins of continuous eelgrass beds-i.e., in some years, eelgrass extends higher in the intertidal zone than in other years." Based on data reported in Schlosser and Eicher (2012), mapped eelgrass in North Bay (Arcata Bay) has ranged from a minimum of 840 ac in 1959 to a maximum of 3,577 ac in 2009. However, comparing mapped eelgrass between years may not be very meaningful due to (1) differences in mapping methods, and (2) the fact that eelgrass distribution varies seasonally and mapping was not necessarily done during the same season each year. In Humboldt Bay, eelgrass has critical ecological functions and is important to numerous fish and wildlife species including species listed under the state and federal ESAs. The ecological functions of eelgrass in Humboldt Bay are described well in the HBMP EIR (HBHRCD 2006) which is incorporated by reference to this EIR.

Areas in Humboldt Bay that support eelgrass are considered special aquatic sites under the 404(b)(1) guidelines of the CWA (40 CFR 230.43). Under the Magnuson-Stevens Fishery Conservation and Management Act, eelgrass is designated as Essential Fish Habitat for federally-managed fish species within the Pacific Coast Groundfish and Pacific Coast Salmon Fisheries Management Plans. Also, under the Magnuson-Stevens Fishery Conservation and Management Act eelgrass is considered a Habitat Area of Particular Concern. In 2014, NMFS released a California eelgrass mitigation policy which contains recommendations for managing eelgrass in California (NMFS 2014).

The Project is designed to avoid impacts to eelgrass to the maximum extent possible. The Project sites were identified with specific consideration towards their ability to support shellfish culture without impacting eelgrass. Although eelgrass does occur within some of the sites, it will be largely avoided with implementation of the following mitigation measures.

MITIGATION BIO-3: **Eelgrass avoidance by boats.** Boat traffic will be routed around eelgrass beds to minimize the potential for damage to eelgrass from propellers and hulls. Site descriptions will be prepared for each culture site and will describe boat routes that shellfish farm workers will use to avoid eelgrass.

MITIGATION BIO-4: Eelgrass avoidance of culture equipment. Prior to placement of shellfish culture equipment, eelgrass will be mapped and a 1-meter buffer will be placed around eelgrass plants. Shellfish culture will not occur within these areas. At intertidal sites, aquaculture equipment will only be placed in un-vegetated areas during the months of July and August, when eelgrass is at its maximum extent to ensure avoidance of eelgrass habitat. Equipment placed at the subtidal sites will be placed to ensure eelgrass is not directly impacted or shaded. Designs to avoid eelgrass will be submitted to the Department prior to placing equipment.

MITIGATION BIO-5: **Deposition of shells.** Shellfish farm operators will not intentionally deposit shells or any other material on the bay floor. Natural deposition of shells and other materials will be minimized to the maximum extent feasible.

With incorporation of these mitigation measures, it is expected that most potential impacts to eelgrass will be avoided. However, there may still be some impacts. For example, eelgrass may be trampled by farm workers or accidently come into contact with boat hull and/or propellers. Additionally, the presence of culture equipment and cultured animals may have some effect on circulation patterns and sedimentation, which could have a negative or positive affect on eelgrass distribution. Notably, many areas of Humboldt Bay where eelgrass occurs have been cultured for decades without the avoidance measures described above and these areas retain eelgrass. Overall, Project impacts may result in some minor decrease in the density and/or distribution of eelgrass plants. However, with the mitigation measures described above, a substantial adverse effect to eelgrass is not expected. Hence, this impact is considered less than significant with mitigation.

IMPACT BIO-13: Potential impacts of overwater structures at subtidal sites on fish species. The Raft like structures at the subtidal sites would create a maximum of 1.9 ac (0.35 ac at Subtidal 1; 0.77 ac at Subtidal 2 and 0.78 ac at Subtidal 3) of overwater structure in Humboldt Bay. Toft et al. (2007) researched fish use of overwater structure in Puget Sound Washington and determined that juvenile salmonids avoid swimming beneath overwater structures, whereas surfperch, crabs (Brachyura) and sculpins (Cottidae) were observed beneath or adjacent to pilings. During an acoustic telemetry study in Humboldt Bay, Pinnix et al. (2013) found coho salmon were most often associated with deep channels followed by channel margins, floating eelgrass mats and finally pilings/docks. Hook and line surveys of fish species associated with 30 floating clam rafts in Arcata Bay was conducted in August 2014 (HTH 2014). Species captured included walleye surfperch (*Hyperprosopon agenteum*), topsmelt (*Atherinops affinis*), jacksmelt (*Atherinpsis californiensis*), sardine, northern anchovy, and juvenile rockfish. These species are all native to Humboldt Bay and may benefit from the structural habitat provided by the rafts, though this is uncertain. Regardless, no adverse impact is expected. Juvenile salmonids may avoid the overwater structure, as suggested by Toft et al. (2007) and Pinnix et al. (2013). However, the maximum amount of overwater structure created by the Project in subtidal areas (1.9 ac) only represents 0.09% of the 2,110 ac of Subtidal habitat in Arcata Bay. This amount of new overwater structure in Arcata Bay is not expected to have an adverse effect on fish species and this impact is considered less than significant without mitigation.

IMPACT BIO-14: Potential impacts of water intakes on aquatic species. Water intakes have the potential to impinge and/or entrain small organisms including special status fish species (e.g., salmonids and longfin smelt). Juvenile salmonids and longfin smelt could be in the location of water intakes at Subtidal Sites. Without implementation of the following mitigation measure, these species could be impinged or entrained by these water intakes.

MITIGATION BIO-6: Screening criteria. CDFW has developed screening criteria to protect juvenile longfin smelt in bays and estuaries from impingement or entrainment by water intakes. These criteria also allow for protection of juvenile salmonids, as based on criteria developed by NMFS (2008). These criteria, which all water intakes under the Project will maintain, are as follows:

1. Round or square (measured diagonally) openings in intake screens shall not exceed 2.38 millimeters (mm) (3/32 in).
2. Slotted opening in the screen shall not exceed 1.75 mm (0.0689 in).
3. Approach velocity shall not exceed 0.2 ft per second for self-cleaning screens or 0.05 ft per second for non-self-cleaning screens. Self cleaning screens must achieve full clearance of the entire screen at least once every five minutes.
4. Overall screen porosity shall be a minimum of 27%.

With this mitigation measures, the Project is expected to adequately protect fish species from impingement and/or entrainment and this impact is considered less than significant.

IMPACT BIO-15: Potential effect to eelgrass by constraining its expansion into higher elevation areas as a result of sea level rise. The co-occurrence of eelgrass and off-bottom shellfish culture in Humboldt Bay is documented (Rumrill and Poulton 2004). However, eelgrass can be less dense when it co-occurs with cultured shellfish (Rumrill and Poulton 2004). As described in Mitigation BIO-3, -4 and -5, the Project's policy is to avoid impacts to eelgrass. However, if eelgrass moves into areas where culture occurs, due to sea level rise or other factors, then the eelgrass and shellfish culture will be expected and allowed to co-exist. Based on the above, this impact is considered less than significant without mitigation.

IMPACT BIO-16: Potential impacts on Pacific herring spawning sites. Pacific herring spawn on eelgrass in Humboldt Bay and can spawn on shellfish culture equipment. Maintenance of shellfish culture equipment has the potential to disturb spawning herring and herring eggs. Additionally, there has not been research regarding survival rates of eggs deposited on shellfish culture equipment versus eelgrass or other structure. The following mitigation measures are designed to maximize reproductive success of herring in culture areas.

MITIGATION BIO-3–5: (see above)

MITIGATION BIO-7: Spawning herring avoidance. During the herring spawning season (December, January and February) shellfish farmers will visually inspect shellfish culture equipment to be worked on prior to harvesting, planting or maintenance to determine if herring have spawned. If herring spawning has occurred then the harvesting, planting or maintenance will be postponed for two weeks on the beds where spawning occurred in order to allow for successful reproduction.

With the Mitigations BIO-3–5, the Project is not expected to significantly reduce eelgrass available for spawning herring. Additionally, with Mitigation BIO-7, it is expected that herring will be able to successfully reproduce with eggs deposited on shellfish culture equipment; though the reproductive success rate is unknown. Hence, this impact is considered less than significant with mitigation.

IMPACT BIO-17: Effects on the distribution and abundance of fish species that are potential predators of native fish species, and related effects to native fish species. The Project would create fish habitat consisting of floating in-water structures over sand or silt bottoms at subtidal sites, and various types of off-bottom mariculture equipment over sand or silt bottoms at intertidal sites.

Because the intertidal sites are only temporarily inundated with water, the mariculture equipment at these sites is unlikely to attract predatory fish species. At the subtidal site, the fish that may be attracted are surfperch and juvenile rockfish. Neither of these species preys on longfin smelt, juvenile salmonids, or other special-status fish. According to Fritzsche and Collier (2001):

> the diet of surfperches consists of isopods (e.g., rock lice), of all sizes, and gastropod mollusks (e.g., snails); various amphipods (e.g., skeleton shrimp), polychaete worms, brittle stars, and small crabs, also are included. Surfperches are usually bottom grazers, but apparently will feed mid-water when competitors are absent.

According to Love et al. (1990), newly recruited rockfish eat mostly crustaceans. Rockfish species that shift to substrate-associated prey begin feeding on larger algal-associated gammarid amphipods, shrimps, and isopods. Hook and line surveys of fish species associated with 30 floating clam rafts in Arcata Bay was conducted in August 2014 (HTH 2014). Species captured included walleye surfperch, topsmelt, jacksmelt, sardine, northern anchovy, and juvenile rockfish. These species are not expected to predate on juvenile special status fish species. Based on this information, the Project is unlikely to attract or encourage predators of special-status fish and no impact is expected.

IMPACT BIO-18: Potential for cultured shellfish to naturalize or establish self-sustaining populations outside of cultivation and the effects of this naturalization on native marine species and communities. Successful spawning of Pacific oysters south of Wilapay Bay, WA is believed to be rare (Carlton 1992). This is likely also true for Kumamoto oysters, as neither species has become well established in the Humboldt Bay outside of culture areas. Manila clams are already naturalized in Humboldt Bay (Boyd et al. 2002). The species proposed for culture by the Project have been cultured in Humboldt Bay for decades without evidence of propagation in the bay to the detriment of other species or habitats. Nevertheless, as a precautionary measure to reduce further propagation of this species, Mitigation BIO-8–9 will be implemented. With implementation of these mitigation measures, the impact is less than significant.

MITIGATION BIO-8: Discard clam culls outside of bay. During washing of seed and equipment, screens will be used to contain all clams regardless of size and any culls will be discarded in locations where they cannot reach coastal waters.

MITIGATION BIO-9: Remove mature clams from bay. All clam seed will be removed from Humboldt Bay prior to reaching 12 mm shell size, at which size they are not yet sexually mature.

IMPACT BIO-19: Effect on benthic habitat and communities from the shellfish culture equipment and cultured shellfish, including initial equipment installation activities, anchoring, posts and material staging. Shellfish culture will affect benthic habitat. Hosack et al. (2006) found that structured habitats (both eelgrass and oyster aquaculture) supported more diverse and dense populations of epibenthic and benthic invertebrates. Additionally, anchors, piles and posts will displace benthic habitat used by animals, including polychaetes, crustaceans and mollusks. Benthic habitat that will be displaced by Project equipment is also used for foraging by bird and fish species. Current shellfish culture equipment in Humboldt Bay covers approximately 0.76 ac of the bottom (the "benthic footprint") with post, anchors, etc. Structures in the bay not related to shellfish culture (e.g., docks and piles) have not been inventoried well and it is difficult to estimate the benthic footprint of these structures. However, these structures can be characterized as "scattered" along the shoreline and don't appear to occupy a substantial proportion of benthic area in the bay. The Project would allow for approximately 0.96 ac of additional benthic footprint, including posts associated with intertidal culture operations, and anchors and piles associated with subtidal operations. Hence, the total benthic footprint of existing and Project shellfish culture equipment would be less than 2 ac (which is in addition to the unknown benthic footprint created by non-culture related structures). This represents less than 0.026% of the 7,795 ac of Arcata Bay. Particularly due to the relatively small spatial extent of this benthic footprint, this impact is considered less than significant without mitigation.

IMPACT BIO-20: Potential impacts to submerged aquatic vegetation and benthic habitat resulting from bottom scour and outboard motor contact associated with support vessel operations and trampling by workers. Tables 3 and 4 depict the number of visits per year expected for each method. It is expected that there will be some impacts to submerged aquatic vegetation and benthic habitat resulting from bottom scour and outboard contact associated with support vessels and trampling by workers. However, effects are expected to be temporary (i.e., vegetation and benthic habitats are expected to recover after disturbance) and the spatial extent of the impact is expected to be small relative to the area of submerged aquatic vegetation and benthic habitats in Arcata Bay. It is difficult to estimate the area that will be affected, but is reasonable to assume that it will be less than 1 ac per year. With consideration towards the 7,795 ac of habitat in Arcata Bay, this impact is considered less than significant without mitigation.

IMPACT BIO-21: Potential biological effects of the addition of shellfish culture structures due to potential changes in light transmission through the water column, water flow and sediment transport. To some extent, culture equipment will reduce light transmission through the water column. This could potentially affect primary productivity in the water column as well as benthic productivity. With Mitigations BIO-3–5 the effects to eelgrass are expected to be discountable. Additionally, water clarity in Humboldt Bay is naturally very poor. Measurements by Barnhart et al. (1992) showed that in several areas the maximum depth to which 1% of surface illumination penetrates is less than an average four ft. Culture equipment could also reduce water flow rates and result in changes to sedimentation patterns; sediment may seasonally accumulate and erode. This is not expected to have any significant ecological effects and sea level rise may (or may not) compensate for any net elevation increases by increasing the depth of water in the bay. Existing and Project intertidal culture consists of up to 770 ac (Table 10) of Arcata Bay's 7,795 ac (10.8%). This is a considerable proportion of Arcata Bay. However, as described above, the effects are not expected to be detrimental, consisting of some reduction in light transmission, and potential sediment erosion and accumulation. This is not expected to result in a substantial effect to the ecological value of the bay or biological resources and hence this impact is considered less than significant without mitigation.

IMPACT BIO-22: Ecological effects during installation of piles at Subtidal Site 3. Sound production during installation of piles at Subtidal Site 3 could affect aquatic species. Fish and other aquatic species can be injured or killed by the impact of sounds generated during percussive pile installation. Marine mammal behavior can also be affected. To reduce potential impacts, the following mitigation measures would be implemented:

MITIGATION BIO-10: Sound threshold criteria. This mitigation measure will allow for consistency with noise criteria developed by the Fisheries Hydroacoustic Working Group (FHWG 2008) to protect fish ~~and NMFS (2012) to protect marine mammals from injury~~ from injury. To achieve these criteria, vibratory pile installation, noise attenuation devices, limits on daily activity and other Project components will be used.

Criteria to protect fish from injury are ~~be followed are~~ as follows, these are the thresholds established for fish injury by the Fisheries Hydroacoustic Working Group (FHWG 2008):

- A cumulative sound exposure level of 183 dB re: 1uPa2*sec as measured 10 m from the source shall not be exceeded, and
- Peak sound pressure of ~~180~~ 206 dB re: $1uPa_{peak}$ as measured 10 m from the source shall not be exceeded.

~~If pile installation cannot be reasonably accomplished without exceeding the peak sound pressure of 180 dB re: 1uPa~~$_{peak}$ ~~as measured 10 m from the source then a pile installation shut-down zone equal to the distance where 180 dB re: 1uPa~~$_{peak}$ ~~as exceeded will be established around each pile being installed and pile installation will be shut down if a marine mammal is within that zone.~~

MITIGATION BIO-11: Biological monitor. A biological monitor shall be on-site during pile installation to determine if special status bird and/or marine mammal species are displaying avoidance behavior or other signs of being negatively affected by the pile installation activities. If this occurs then pile installation shall cease until the bird or marine mammal species are no longer in close enough proximity to the operations to be effected.

Additionally, to insure injury or harassment does not occur to marine mammals, hydroacoustic monitoring of the first five piles installed will be conducted to determine the distance from pile installation at which underwater sound levels caused by installation reach 120 dB_{rms} (if vibratory installation methods are used) or 160 dB_{rms} (if driving installation methods are used). These are the thresholds for disturbance to marine mammals established by NMFS (2012). A biological monitor will be onsite and if a marine mammal comes within the distance that would cause disturbance based on these thresholds, then pile installation will cease until the animal moves to a distance where disturbance would not occur.

Also, based on the work of Lucke (2009), harbor porpoises may have higher sensitivity to sound disturbance than other marine mammals. Lucke (2009) suggests that harbor porpoises may swim away from sound at lower levels than the thresholds described above. The implications of moving away from a sound differ depending on site specific information (e.g., location of food sources). For the Project, a precautionary approach will be taken and pile installation activities will not occur while a harbor porpoise is in the line of sight of the biological monitor. However, further analysis is necessary to determine if this is an appropriate or necessary mitigation measure for other pile installation activities.

With these mitigation measures, any impacts to fish, birds or marine mammals are expected to be minimal and this impact is considered less than significant with mitigation.

IMPACT BIO-23: Impact on the distribution and dispersal of non-native invertebrate fouling species. Hard substrate will be added by the Project in the form of shellfish shells, ropes, anchor lines, anchors, piles, posts and stakes. This substrate will attract both non-native and native fouling organisms. During a study by Boyle et al. (2006) of fouling organism composition and succession at Woodley Island, Humboldt Bay, 34% of all species identified were non-native. It is expected that fouling organisms of shellfish and shellfish culture equipment will also be both native and non-native. This effect is considered neutral as it benefits both natives and non-natives in a similar composition as at other hard substrate. However, there is the potential for activities that involve removal of fouling organisms to further disperse non-native fouling organisms. Certain species such as didemnum may disperse with currents, reproduce and further spread their distribution. The extent that this may actually occur is unknown and warrants research. However, as a precautionary approach, Mitigation BIO-12 will substantially reduce opportunities for dispersal and with this mitigation measure the impact is less than significant.

MITIGATION BIO-12: Bio-fouling organism removal. All bio-fouling organism removal operations shall be carried out onshore or on a vessel. All bio-fouling organisms removed during these cleaning operations shall be disposed of at an appropriate upland facility.

IMPACT BIO-24: Conflicts with local policies, particularly those described in the HBMP which is a guidance document for the District and the LCPs of the County of Humboldt, City of Eureka and City of Arcata. The Project is consistent with these policies. This area of Humboldt Bay is identified as suitable for mariculture in the HBMP. Additionally, the Project has many design components that limit its effect on ecological resources, consistent with Local Coastal Plans. Funding for the Project was approved by the County Board of Supervisors and District Commissioners, indicating their support for the Project. Hence, there is not an impact.

5.5.7 Effects Analyses of Alternative 1. Subtidal Culture Only

Without intertidal culture included in the Project, the potential effect of all the impact mechanisms described above would be substantially reduced; including the potential effects to eelgrass, marine mammals, fish, birds and other wildlife. Potential effects to carrying capacity would also be substantially less; because intertidal sites would contain magnitudes more biomass of shellfish than subtidal sites and a substantially higher level of suspended organic matter consumption. Additionally, under this alternative, the spatial extent of the Project would be substantially less. Levels of significance of the impacts of the Project and alternatives are presented in Table 12.

5.5.8 Effects Analyses of Alternative 2. Intertidal Culture Only

Without subtidal culture included in the Project, there would be less potential for ecological effects associated with overwater structures, lighting and benthic effects (from piles and anchors). Levels of significance of the impacts of the Project and alternatives are presented in Table 12.

5.5.9 Effects Analyses of Alternative 3. No Project Alternative

Under the no Project alternative, existing shellfish culture operations would remain and other permitting processes for new culture in the bay would likely continue. Hence, under the no Project alternative, there would be a similar potential for the type of environmental effects described in this EIR, but at a lower magnitude and within a smaller spatial extent. Levels of significance of the impacts of the Project and alternatives are presented in Table 12.

Table 12. Levels of Significance of the Project and Alternatives for Potential Biological Resource Impacts

Impact	Project	Alternative 1: Subtidal Culture Only	Alternative 2: Intertidal Culture Only	Alternative 3: No Project
BIO-1: Effects of intertidal culture on shorebird species as a result of loss of foraging habitat and alteration of food sources.	LS	NI	LS	NI
BIO-2: Effects of intertidal culture on black brant as a result of loss of foraging habitat and alteration of food sources.	LS	NI	LS	NI

Impact	Project	Alternative 1: Subtidal Culture Only	Alternative 2: Intertidal Culture Only	Alternative 3: No Project
BIO-3: Potential impact to marine mammals from the potential loss of foraging habitat and restrictions to movement due to placement of aquaculture equipment in intertidal and subtidal areas.	LS	LS	LS	NI
BIO-4: Effects of human disturbance (e.g., boat movement, presence of culture workers) on marine mammals and other wildlife.	LSM	LSM	LSM	NI
BIO-5: Effects on the distribution and abundance of mammalian or avian species that are potential predators of native fish species, and related effects to native fish species.	LS	LS	LS	NI
BIO-6: Effects of artificial lighting on wildlife.	LSM	LSM	LSM	NI
BIO-7: Effects to green sturgeon as a result of potential reduction in prey.	LS	LS	LS	NI
BIO-8: Effects on the abundance of suspended organic matter and related effects to other native species.	LS	LS	LS	NI
BIO-9: Effects to green sturgeon as a result of habitat loss or degradation.	LS	LS	LS	NI
BIO-10: Effects to green sturgeon as a result of entanglement.	NI	NI	NI	NI
BIO-11: Effects on wetland functions.	LS	LS	LS	NI
BIO-12: Effects on eelgrass.	LSM	LSM	LSM	NI
BIO-13: Potential impacts of overwater structures at subtidal sites on fish species.	LS	LS	NI	NI
BIO-14: Potential impacts of water intakes on aquatic species.	LSM	LSM	NI	NI
BIO-15: Potential effect to eelgrass by constraining its expansion into higher elevation areas as a result of sea level rise.	LS	NI	LS	NI
BIO-16: Potential impacts on Pacific herring spawning sites.	LSM	LSM	LSM	NI

Impact	Project	Alternative 1: Subtidal Culture Only	Alternative 2: Intertidal Culture Only	Alternative 3: No Project
BIO-17: Effects on the distribution and abundance of fish species that are potential predators of native fish species, and related effects to native fish species.	NI	NI	NI	NI
BIO-18: Potential for cultured shellfish to naturalize or establish self-sustaining populations outside of cultivation and the effects of this naturalization on native marine species and communities.	LSM	LSM	LS	NI
BIO-19: Effect on benthic habitat and communities from the shellfish culture equipment and cultured shellfish, including initial equipment installation activities, anchoring, posts and material staging.	LS	LS	LS	NI
BIO-20: Potential impacts to submerged aquatic vegetation and benthic habitat resulting from bottom scour and outboard motor contact associated with support vessel operations and trampling by workers.	LS	LS	LS	NI
BIO-21: Potential biological effects of the addition of shellfish culture structures due to potential changes in light transmission through the water column, water flow and sediment transport.	LS	LS	LS	NI
BIO-22: Ecological effects during installation of piles at Subtidal Site 3.	LSM	LSM	NI	NI
BIO-23: Impact on the distribution and dispersal of non-native invertebrate fouling species.	LSM	LSM	LSM	NI
BIO-24: Conflicts with local policies, particularly those described in the HBMP which is a guidance document for the District and the LCPs of the County of Humboldt, City of Eureka and City of Arcata.	NI	NI	NI	NI

NI=No Impact, LS=Less than Significant without Mitigation, LSM=Less than Significant with Mitigation, PS=Potentially Significant

5.6 Effects to Aesthetic and Visual Resources

This section describes present and possible future conditions of visual resources in the Project area. The significance of effects on visual resources is defined by CEQA "Appendix G" criteria, based on standards found in the CalCA, and on policies within the Humboldt CGP (County of Humboldt 2005) and its supporting documents.

5.6.1 Summary of Present and Possible Future Conditions

Present visual resource conditions are described in numerous documents including:

- The Humboldt CGP, Chapter 10, Section 10.7 Scenic Resources (Humboldt County Planning and Building Department [HCPBD] 2012)
- Local Coastal Plan Issue Identification Report, September 2003 (HCPBD 2003).
- The CGP, Volume II, Humboldt Bay Area Plan of the Humboldt County LCP (County of Humboldt 2005)
- The CGP, Volume II, Eel River Area Plan of the Humboldt County LCP, April 1982, revised May 1995, printed April 2005 (HCPD 1982)

As stated in the Natural Resources and Hazards Report (DBURP 2002), scenic resources include "coastline views, mountains, hills, ridgelines, inland water features, forests, agricultural features, idyllic rural communities", and combinations of these features. These resources are contained within properties such as Humboldt County parks, state parks, open space and wildlife refuge areas, private farmlands and ranches, and private and federal forest. Specific to the Project, scenic resources of interest are coastline views and inland water features.

The Humboldt Bay shoreline is irregular and topographically flat with saltmarsh and mudflats that support both native and non-native vegetation. The many streams and sloughs that empty into Humboldt Bay provide a land/water interface that is generally visually appealing. The built environment that is visible from the Project area includes industrial development, billboards, residential housing, wharfs/marinas, pilings, bridges, mariculture, roads, highways, farmland, and ranch land. Recreational activities that occur in the immediate area include fishing, hunting, boating, kayaking, birding, and hiking.

The future conditions of visual resources are largely dependent on the scenic resources goals and policies defined in the Humboldt CGP (HCPBD 2012), as informed by the Local Coastal Plans of the Humboldt Bay Area. The Humboldt CGP (HCPBD 2012) recognizes scenic area types that are characteristic of Humboldt County. Relevant to the Project are these types:

- Open space and agricultural lands
- Scenic roads (several state highways are eligible for official designation, including Highway 101 for its entire route in Humboldt County)
- Coastal scenic and coastal view areas
- Community separators

Policies and goals in the Humboldt CGP (HCPBD 2012) that will affect and determine future protection of scenic area types include:

SR-G1. Scenic resource protection. Protect high-value forest, agriculture, river, and coastal scenic areas that contribute to the enjoyment of Humboldt County's beauty and abundant natural resources.

SR-G2. Community separators. Visible and aesthetic open space areas between urban development areas that separate and preserve unique identities of the county's cities and communities.

SR-P1. Development in identified scenic viewsheds. In identified scenic areas, new development shall be consistent with and subordinate to natural contours including slopes, visible hilltops and treelines, and bluffs and rock outcroppings. Visible disturbance shall be minimized to the extent feasible.

SR-P2. Heritage landscapes. Protect the scenic quality of mapped heritage landscape areas with appropriate land use designations and design review standards to ensure that new development preserves or enhances the heritage landscape values of the site.

SR-P3. Scenic roadway protection. Protect the scenic quality of designated scenic roadways for the enjoyment of natural and scenic resources, landmarks, or points of historic and cultural interest.

SR-P4. Community separators. Protect the scenic quality of "community separators" from degradation by maintaining adequate open space between communities and cities.

SR-P5. Development within community separators. Retain a rural character and promote low intensities of development in community separators. Avoid annexation or inclusion in spheres of influence for sewer and water services. Provide opportunities for consideration of additional development in community separators in exchange for permanent open space preservation.

Visual effects from the Project will include changes in visual character to the Project area due to:

- The presence of mariculture workers and vessels, and
- The addition of the shellfish culture equipment and cultured shellfish to intertidal and subtidal locations in Humboldt Bay.

5.6.2 Definition of Significance and Baseline Conditions

Baseline conditions are those conditions existing at the time the NOP was circulated. Significance criteria for effects on visual resources are defined in the "CEQA checklist" in combination with the consideration of goals and policies contained within the CGP and its supporting documents.

According to CEQA, effects on visual resources are considered significant if the Project:

- Has a substantial adverse effect on a scenic vista,
- Substantially damages scenic resources, including trees, rock outcroppings, and historical buildings within a state scenic highway,
- Substantially degrades the existing visual character or quality of the site or surroundings, or
- Creates a new source of substantial light or glare.

In the CGP (County of Humboldt 2005) and its supporting documents, additional criteria to determine significance are proposed. According to the CGP, effects on visual resources are considered significant if the Project:

- Disturbs physical scale and visual continuity,
- Does not protect natural landforms and features,
- Is within a Coastal scenic area, is "visible from Highway 101" and causes change that is not "subordinate to the character of the designated area…",
- Results in vegetation clearing that is not minimized,
- Results in development of these resources: Arcata Bottoms, Bottomlands between Eureka and Arcata, South Spit, Bottomlands around South Bay, Ryan and Freshwater Slough, Eel River and associated riparian vegetation, Eel River estuary bottomlands.

5.6.3 Effects Analyses of the Project

Potentially significant Project effects and related mitigation measures are described below.

IMPACT AV-1: Effect on scenic vistas and visual character from the presence of mariculture workers and vessels. The subtidal lease sites are located in close proximity to a developed, historically industrialized part of the bay where there is an established presence of worker and vessel traffic associated with shipping, mariculture and other activities. The increased presence of mariculture workers and vessels at these sites may improve the visual character of the area by demonstrating that the existing infrastructure is being utilized, rather than abandoned. The visual effect of increased worker and vessel traffic would be a minor change from current conditions and no impact is expected.

Human presence and vessel traffic at the intertidal sites primarily consists of recreational users, for example, boaters, fishermen and hunters. The presence of mariculture workers and increased vessel traffic will have temporary effects on the scenic vistas at these sites. Tables 3 and 4 depict the estimated recurrence of visits by shellfish culturists to Project sites. Intertidal Sites 1 and 2 are located between 0.25 and 0.5 mi from transportation corridors; due to the great distance from shore, the appearance of workers at these intertidal sites would be overwhelmed by the extensive saltmarsh, mudflat, and water between observers and subjects, rendering the workers and vessels difficult to see. Intertidal Sites 3 and 4 are near the east end of the westernmost span of the Samoa Bridge (Highway 255), and visible to passing traffic, pedestrians and bicyclists. However, there is also a major navigation channel, with frequent boat use. Other shellfish culture and industrial areas are also viewable from this portion of Highway 255. The presence of vessels and shellfish culture workers is not expected to negatively impact scenic vistas or visual character, because these uses are consistent with what already occurs and is expected in these areas of Humboldt Bay. Hence, the impact is less than significant.

IMPACT AV-2: Effect on scenic vistas and visual character from the presence of shellfish culture equipment. The subtidal lease sites are adjacent to an industrial shoreline and are bordered by numerous wharfs, docks, and pilings. The addition of shellfish culture equipment at these sites would supplement existing marine industry infrastructure and therefore no impact is expected.

The intertidal lease sites do not currently have shellfish culture equipment in place. The shellfish culture equipment to be placed in intertidal lease sites will be similar in scale and materials as the existing equipment in the Bay. Mariculture equipment has a low profile; elevated above the substrate by 1–3 ft. Furthermore, culture equipment is placed at lower intertidal elevations making the equipment visible only during low tides. Intertidal Sites 1 and 2 are located between 0.25 and 0.5 mi from nearby Highways (Highway 101, Highway 255); due to the great distance from shore, the view of shellfish culture equipment at the intertidal sites would be a very small portion of the extensive saltmarsh and mudflat features in the bay thereby rendering them difficult to see from typical vantage points, with minimal visual effect (Figures 12–15).

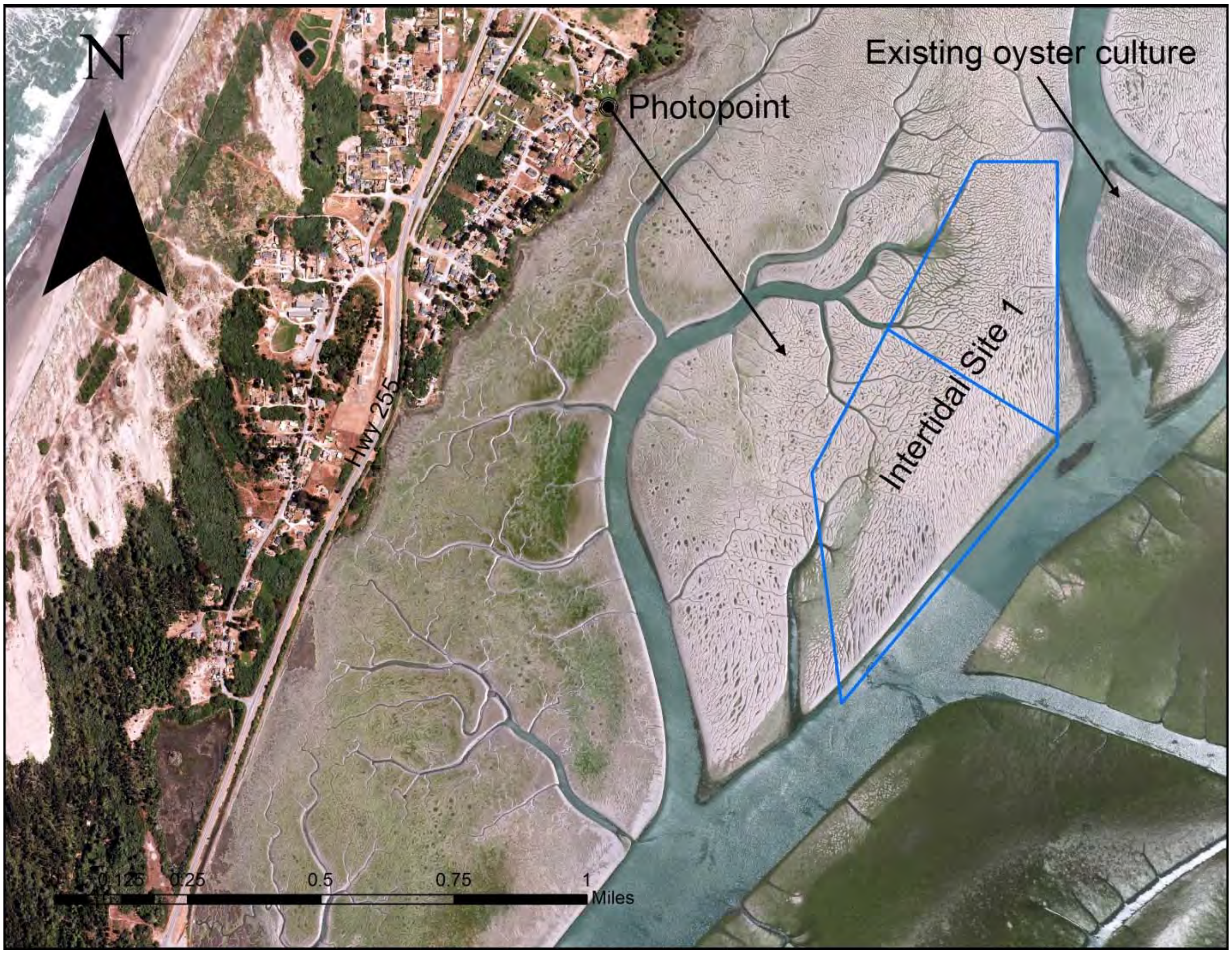

Figure 12. Location and Direction of Photo Depicted in Figure 13, of Intertidal Site 1

Figure 13. View of Intertidal Site 1 from the Location and Direction Depicted in Figure 12

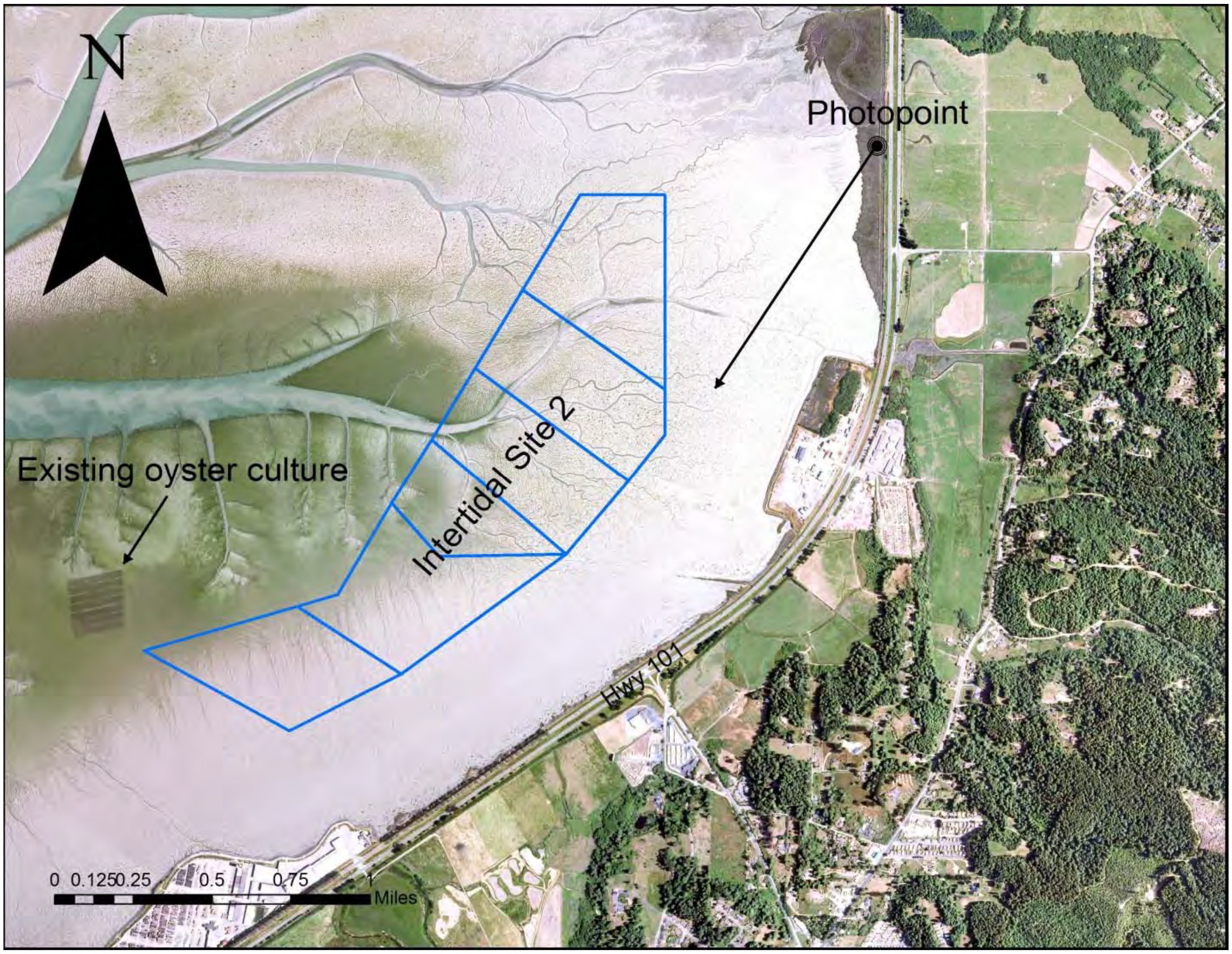

Figure 14. Location and Direction of Photo Depicted in Figure 15, of Intertidal Site 2

Figure 15. View of Intertidal Site 2 from the Location and Direction Depicted in Figure 14

Intertidal Sites 3 and 4 are located on the north and east sides of Indian Island near the westernmost span of the Samoa Bridge (Highway 255). These lease sites are especially visible to eastbound traffic and shellfish culture equipment would be easily observed in Intertidal Site 3 and parts of Intertidal Site 4 (Figures 16–18).

Figure 16. Location and Direction of Photos Depicted in Figures 17 and 18 of Intertidal Sites 3 and 4

Figure 17. View of Intertidal Site 3 from the Location and Direction Depicted in Figure 16

Figure 18. View of Intertidal Site 4 from the Location and Direction Depicted in Figure 16

The addition of shellfish culture equipment will alter the visual characteristics of the Project sites and will add to the visual effect of the existing shellfish culture equipment in Arcata Bay. This impact is considered less than significant without mitigation due to the low profile of the proposed shellfish culture equipment; the historical presence of shellfish culture in Arcata Bay and because these uses are consistent with what already occurs and is expected in these general areas of Humboldt Bay.

IMPACT AV-3: Effects of glare and artificial lighting. The infrastructure proposed for placement in the subtidal lease sites will not be constructed of materials which produce substantial amounts of glare. Due to the location of the subtidal sites, adjacent to an industrial waterfront with existing artificial lighting, additional artificial lighting will not substantially change the vista. With the implementation of Mitigation BIO-2 below, which will reduce off site glare of lighting, the visual effect is considered less than significant.

The infrastructure proposed for placement in the intertidal lease sites will not be constructed of materials which produce substantial amounts of glare. Increased artificial lighting in Intertidal Sites will result from the use of workers using flashlights or headlamps and by navigation lights on vessels. Such lighting would be transient and is considered a less than significant impact.

Based on the above information, this impact is considered less than significant with mitigation.

MITIGATION BIO-2: Shielding of light fixtures. Only lighting fixtures that are fully shielded and designed to minimize off site glare and avoid on water light spillage will be utilized at night. Motion-sensing lighting will be used to the extent feasible to reduce the amount of time lights are on. Where motion-sensing lighting is not feasible but lights do not need to be on continuously, timers will be installed to reduce the amount of unnecessary lighting.

5.6.4 Effects Analyses of Alternative 1. Intertidal Culture Only

Without subtidal culture included in the Project, there would be no potential for visual effects associated with the placement of new mariculture infrastructure, increased vessel traffic and artificial lighting in subtidal areas. Levels of significance of the impacts of the Project and alternatives are presented in Table 13.

5.6.5 Effects Analyses of Alternative 2. Subtidal Culture Only

Without intertidal culture included in the Project, the potential effect of all the impact mechanisms described above would be reduced; including the potential effects to visual resources from Highway 101 and Highway 255. Additionally, under this alternative, the spatial extent of the Project would be substantially less, thereby reducing impacts to aesthetic and visual resources. Levels of significance of the impacts of the Project and alternatives are presented in Table 13.

5.6.6 Effects Analyses of Alternative 3. No Project Alternative

Under the No Project alternative, there would be no effects on aesthetic or visual resources resulting from the expansion of mariculture activities associated with this Project. Levels of significance of the impacts of the Project and alternatives are presented in Table 13.

Table 13. Levels of Significance of the Project and Alternatives for Potential Aesthetic and Visual Resource Impacts

Impact	Project	Alternative 1: Subtidal Culture Only	Alternative 2: Intertidal Culture Only	Alternative 3: No Project
AV-1: Effect on scenic vistas and visual character from the presence of mariculture workers and vessels.	LS	LS	LS	NI
AV-2: Effect on scenic vistas and visual character from the presence of shellfish culture equipment.	LS	LS	LS	NI
AV-3: Effects of glare and artificial lighting.	LSM	LSM	LSM	NI

NI=No Impact, LS=Less than Significant without Mitigation, LSM=Less than Significant with Mitigation, PS=Potentially Significant

5.7 Effects to Air Quality

This section describes the regulatory framework under which air pollutant emissions are controlled and the potential effects of the Project on air quality.

5.7.1 Background and Setting

The Project is located in the North Coast Air Basin (NCAB). Air quality regulation in the NCAB is the responsibility of the North Coast Unified Air Quality Management District (AQMD) pursuant to the Federal Clean Air Act (42 USC § 7401 *et seq*.) and the comparable state law (Health and Safety Code § 39000 *et seq*.). Compliance with air quality standards for criteria pollutants is based on attainment of relevant state or federal standards. If any standard is not met, the pollutant is considered "nonattainment" for that standard. The NCAB is in attainment status for all federal standards for criteria pollutants and in attainment status for all state standards except for suspended particulate matter smaller than 10 micrometers (PM_{10}) (Table 14).

Table 14. Air Quality Status in the North Coast Air Basin

Pollutant	Federal Standard Status	State Standard Status
Carbon Monoxide	Attainment	Attainment
Hydrogen Sulfide	(No Federal Standard)	Attainment
Lead	Attainment	Attainment
Nitrogen Dioxide	Attainment	Attainment
Ozone	Attainment	Attainment
Particulate (PM_{10})	Attainment	***Non-Attainment***
Sulfates	(No Federal Standard)	Attainment
Sulfur Dioxide	Attainment	Attainment
Vinyl Chloride	(No Federal Standard)	Attainment

PM_{10} pollutants may be generated by transportation sources (tire wear, emissions, etc.); by construction-generated dust or smoke; and by smoke from appliances like woodstoves, barbecues, or fireplaces. PM_{10} can be a health hazard, especially for children, the elderly, and people with heart or lung disease. AQMD's Particulate Matter Attainment Plan adopts a number of "control strategies" for achieving particulate matter reductions, including transportation control measures (intended to reduce vehicular pollutant generation from all modes), land use measures, regulation of open burning, and residential burning controls. AQMD has adopted "Regulation 1," which stipulates requirements for air quality management within the NCAB.

5.7.2 Definition of Significance and Baseline Conditions

The thresholds of significance for potential air quality impacts are based on the extent that the Project will (a) directly interfere with the attainment of long-term air quality objectives identified by AQMD; (b) contribute pollutants that would violate an existing air quality standard, or contribute to a non-attainment of air quality objectives in the NCAB; (c) produce pollutants that would contribute as part of a cumulative effect to non-attainment for any priority pollutant; (d) produce pollutant loading near identified sensitive receptors that would cause locally significant air quality impacts; or (e) release odors that would affect a number of receptors.

5.7.3 Effects Analysis of the Project

The Project would create a small amount of emission from up to approximately 15 small boats that are expected to be used for Project operations. It would not create any substantial pollution concentrations or objectionable odors. Additionally, there are no sensitive receptors or a substantial number of people in the vicinity of the Project sites.

IMPACT AQ-1: Contribution to PM_{10} levels. Small boats associated with mariculture operations have combustion engines that generate particulate matter. The Project is expected to involve up to 15 small boats being used in the bay. The vessel engines would contribute to a minor net increase in emissions of particulate matter. Given the small size and limited quantity of vessels, their contribution to PM_{10} levels in Humboldt Bay is likely negligible, even without mitigation.

Moreover, the District lacks direct jurisdiction over air quality, and thus lacks direct authority to require mitigation for potential air quality impacts. However, AQMD regulates vessel engine emissions pursuant to several air quality plans. CEQA addresses circumstances such as this through reliance by lead agencies on the regulatory oversight of responsible agencies carrying out statewide policy. Specifically, State CEQA Guidelines Section 15064(h) establishes a procedure that allows lead agencies, including the District, to rely on the environmental standards promulgated by other regulatory agencies, such as AQMD, with respect to pollutant regulation. AQMD has adopted several air quality management plan elements, including a "PM_{10} Attainment Plan." Mitigation AQ-1 would require Lessees to comply with AQMD regulations and with this mitigation measure this impact is considered less than significant.

MITIGATION AQ-1: Compliance with air quality regulations. Lessees shall consult with AQMD with respect to the requirements of adopted AQMD regulatory plans and shall comply with the requirements of all adopted air quality plans, including plans covering particulate emissions, and shall implement all actions required by AQMD. This mitigation measure will be incorporated into the District's lease requirements for Lessees.

5.7.4 Effects Analyses of Alternative 1. Subtidal Culture Only

Without intertidal culture there would be fewer small boats involved in the Project and hence less impacts to air quality, but the difference is negligible. Levels of significance of the impacts of the Project and alternatives are presented in Table 15.

5.7.5 Effects Analyses of Alternative 2. Intertidal Culture Only

Without subtidal culture there would be fewer small boats involved in the Project and hence less impacts to air quality, but the difference is negligible. Levels of significance of the impacts of the Project and alternatives are presented in Table 15.

5.7.6 Effects Analyses of Alternative 3. No Project Alternative

Under the no Project alternative, there would be no impact on air quality, but existing uses and related impacts to air quality in the bay would continue. Levels of significance of the impacts of the Project and alternatives are presented in Table 15.

Table 15. Levels of Significance of the Project and Alternatives for Potential Air Quality Impacts

Impact	Project	Alternative 1: Subtidal Culture Only	Alternative 2: Intertidal Culture Only	Alternative 3: No Project
AQ-1: Contribution to PM_{10} levels	LSM	LSM	LSM	NI

NI=No Impact, LS=Less than Significant without Mitigation, LSM=Less than Significant with Mitigation, PS=Potentially Significant

5.8 GHG Emissions

Analysis of potential impacts due to the Project, from GHG emissions is now a required section of CEQA EIRs. Three actions, two by the State of California and the other by the U.S. Supreme Court, support the need to include GHG emissions and global climate change in environmental impact analyses (Held et al. 2007). They are:

- California Assembly Bill 32 (AB 32). This AB's title is "The Global Warming Solutions Act of 2006," and it is credited with ending the debate (in California) that global warming is scientific speculation. The legislation also requires the State to reduce carbon emissions by 25% by 2020. In 2005, Govenor Schwarznegger issued EO S-3-05, which proclaimed GHG emission target reductions to 1990 levels by year 2020, and 80% below 1990 levels by 2050.
- The 2007 U.S. Supreme Court decision in Massachusetts vs. EPA. This decision supported the principle that GHG emissions are defined as pollutants and that the EPA must therefore regulate them under the Clean Air Act.
- California Senate Bill 97 (SB 97). In 2007, the California legislature passed SB 97, which amended CEQA to specifically establish that GHG emissions and their impacts are required subjects for CEQA analysis. The Governor's Office of Planning and Research (GOPR) then released guidelines for CEQA analysis and mitigation of GHG emissions or the effects of GHG emissions on April 13, 2009.

5.8.1 Definitions of Significance and Baseline Conditions

Baseline conditions are those at the time the NOP was published. Definitions of significance are available from the CEQA checklist, based on whether the Project would:

1. Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment?
2. Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of GHGs?

In the context of GHG and global climate change, the GOPR recognizes that statewide thresholds of significance for GHG emissions have not been set (GOPR 2008). The GOPR recommends that lead agencies should consider significance in the context of direct, indirect, long and short term, and cumulative impacts. However, "although climate change is ultimately a cumulative impact, not every individual project that emits GHGs must necessarily be found to contribute to a significant cumulative impact on the environment" (GOPR 2008).

5.8.2 Effects Analyses of the Project

The District has not established a threshold of significance for GHG emissions. Consistent with CEQA Guidelines Section 15064.4, the District has opted for a qualitative assessment of GHG emissions and found the following impacts should be assessed.

IMPACT GGE-1: Generation of GHGs. The Project would involve the use of approximately 15 small vessels in Humboldt Bay which would generate GHGs. The Project would also indirectly result in a negligible increase in processing/cleaning, transportation (primarily trucking) and storage of the product (shellfish). Storage is expected to primarily occur at underutilized industrial sites along the Samoa Peninsula in Humboldt Bay. The amount of GHGs generated by these activities is considered low, particularly relative to the amount of food that will be produced and other activities in the region (the existing setting). The effect is considered less than significant without mitigation.

IMPACT GGE-2: Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of GHGs. The Project does not conflict with any known plan, policy or regulation, including AB32 and SB 97 and no impact is expected.

5.8.3 Effects Analyses of Alternative 1. Subtidal Culture Only

Without intertidal culture included, there would be less vessel traffic (approximately three vessels used for the Project rather than 15). Additionally, the indirect aspects of processing/cleaning, transportation and storage of the product (shellfish) would be substantially reduced. Hence, there would only be a small proportion (e.g., 10%) of the GHGs emitted under this alternative as compared to the Project. Levels of significance of the impacts of the Project and alternatives are presented in Table 16.

5.8.4 Effects Analyses of Alternative 2. Intertidal Culture Only

Without subtidal culture included, there would be less vessel traffic (approximately 12 vessels used for the Project rather than 15). Additionally, the indirect aspects of processing/cleaning, transportation and storage of the product (shellfish) would be substantially reduced. However, the bulk of Project activities (e.g., boating, production of shellfish) would occur within intertidal areas and therefore Alternative 2 would represent only marginal decrease in GHG emission compared to the Project. Levels of significance of the impacts of the Project and alternatives are presented in Table 16.

5.8.5 Effects Analyses of Alternative 3. No Project Alternative

Under the no Project alternative, existing shellfish culture operations would remain and other permitting processes for new culture in the bay (i.e., the Coast Seafoods Company Permit Renewal and Amendment Project ["Coast Project"]) would likely continue. Hence, under the no Project alternative, there would be a similar potential for the type of environmental effects described in this EIR, but at a lower magnitude. Levels of significance of the impacts of the Project and alternatives are presented in Table 16.

Table 16. Levels of Significance of the Project and Alternatives for Potential GHG Emission Impacts

Impact	Project	Alternative 1: Subtidal Culture Only	Alternative 2: Intertidal Culture Only	Alternative 3: No Project
GGE-1: Generation of GHGs.	LS	LS	LS	NI
GGE-2: Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of GHGs.	NI	NI	NI	NI

NI=No Impact, LS=Less than Significant without Mitigation, LSM=Less than Significant with Mitigation, PS=Potentially Significant

5.9 Effects to Hydrology and Water Quality

5.9.1 Environmental Setting

Hydrology and water quality in Humboldt Bay are thoroughly described in the HBMP (HBHRCD 2007) and HBMP EIR (HBHRCD 2006) and those documents are incorporated by reference. Key aspects relevant to this EIR are summarized or excerpted below.

"The ambient water quality in Humboldt Bay is generally good, being determined largely by the quality of the water that enters the Bay from the nearshore Pacific. Measured water quality parameters vary through an annual cycle, with water in the Bay being generally warmer than the water in the near-shore Pacific. Water quality parameters vary seasonally and geographically; for example, water in northern Arcata Bay may be both fresher and colder in winter, and warmer and saltier in summer, than in Entrance Bay. Water quality parameters in Entrance Bay, which are significantly influenced by water in the near-shore Pacific, vary in concert with near-shore water quality; during periods of coastal upwelling, for example, Entrance Bay's waters are often colder and saltier than at other times." (HBHRCD 2006)

5.9.2 Regulatory Framework

"The essential water quality requirements for Humboldt Bay are established by the Water Quality Control Plan for the North Coast Region (the 'Basin Plan', North Coast Regional Water Quality Control Board 2011). The Basin Plan establishes 'objectives' for Humboldt Bay, in order to carry out the basic policy that existing 'beneficial uses' be maintained and that existing water quality not be degraded. The Basin Plan includes numerical criteria for a number of pollutants, but the 'narrative criteria' described in the Basin Plan as objectives, together with the basic 'antidegradation policy' and the required maintenance of beneficial uses, constitute the overarching state mandate for water quality in Humboldt Bay. As a general result, most of the ambient water quality parameters that affect biological populations in Humboldt Bay remain favorable throughout the annual cycle. The upwelling that brings colder bottom waters to the surface along the coast is associated with reduced dissolved oxygen concentrations in Bay waters, which may not meet the narrative criteria in the Basin Plan, but this variation is, effectively, a natural phenomenon rather than a Basin Plan violation… an additional level of regulatory review and oversight is provided by the CalCA and the related Federal Coastal Zone Management Act. Both of these laws, and the associated state and federal regulatory programs, include policy guidance that "polluted runoff" shall not degrade the quality of the coastal environment and adversely affect important Coastal Zone resources and uses." (HBHRCD 2006)

"The State of California has developed an integrated regulatory program for nonpoint-source pollution concerns in the Coastal Zone that includes all of the regulatory and trustee agencies exercising jurisdiction there, and that program is directly applicable to the regulation of water quality in Humboldt Bay. However, the explicit authority for regulating water quality in California, including the water quality in the Coastal Zone, remains with the State Water Resources Control Board and the relevant Regional Boards." (HBHRCD 2006) The CGP (County of Humboldt 2005), City of Arcata General Plan (City of Arcata 2008) and City of Eureka General Plan (City of Eureka 1997) contain further goals and policies related to water quality. Additionally, under Section 303(d) of the CWA, Humboldt Bay is listed for PCBs and dioxin/furan compounds. " (HBHRCD 2006)

5.9.3 Definition of Significance and Baseline Conditions

This section considers to what degree the Project would involve:

1. Actions that would violate federal, state, regional or local water quality standards set for water quality and for discharge of waste water;
2. Use of, or interference with, ground water such that the amount of flow of groundwater is adversely impacted;
3. Drainage changes that would alter or cause an increase in amount or flow of tidewater or surface flow that would cause or lead to a substantial increase in erosion or sedimentation either in the Management Area or elsewhere;
4. Alteration of drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner, which would result in flooding on- or off-site;
5. Added runoff from the Management Area that would exceed the capacity of drainage facilities;
6. The creation of polluted runoff or other general adverse water quality impacts that could affect beneficial uses or degrade higher water quality in water of the State;

7. The placement of housing or other structures within the 100-year flood plain, or other area subject to flooding;
8. Place within a 100-year flood hazard area structures, which would impede or redirect flood flows;
9. Expose people or structures to a significant risk or loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam; and
10. Development in such a manner or location that it would be adversely affected by seiche, tsunami or mudflow.

5.9.4 Effects Analyses of the Project

IMPACT WQ-1: Petroleum spills. The Project will result in the addition of approximately 15 small vessels being used in Humboldt Bay. Petroleum products could be leaked to the bay during vessel fueling or operation. Example products that could be leaked include hydraulic fluid, gasoline and diesel. These substances can be toxic and bioaccumulate in marine organisms. Gasoline can also be flammable. In the event of a spill, marine organisms could be affected by the toxicity of these substances. The effect would be local and temporary because toxicity is reduced through time and space, but potentially significant without mitigation. Mitigation WQ-1 will reduce the chances for spills and the impact to less than significant.

MITIGATION WQ-1: Minimize fuel and petroleum spill risks. As part of the District's lease requirements, Lessees will be required ensure equipment is appropriately maintained to minimize the potential for spills and to be prepared to manage spills, including by maintaining cleanup materials (e.g., absorbent pads) on all vessels. The District will reserve the right to inspect the vessels to ensure compliance with this mitigation measure.

IMPACT WQ-2: Pollutant/contaminant remobilization. Project activities will temporarily mobilize a minor amount of sediment and contaminants such as PCBs and dioxins. For example, when stakes are placed or a vessel comes in contact with the bay bottom, sediment may be mobilized. However, the amount of sediment mobilized during mariculture operations is likely very low compared to the quantities of sediment mobilized during stormy conditions (e.g., strong winds). Furthermore, shellfish are filter feeders which have been found to have a positive impact on water quality by filtering pollutants and contaminants from the water column. While it is unknown if culture in Humboldt Bay is beneficial to water quality, the effect of culture on water quality is not adverse. The impact is considered less than significant without mitigation.

IMPACT WQ-3: Alteration of circulation patterns. Oyster culture has a localized effect on sediment distribution and tidal circulation. As water is slowed by frictional effects of the culture structure, sediment deposition and organic content increases (Rumrill and Poulton 2004). A study of sedimentation in Humboldt Bay at locations similar to Project sites, reported that "fine sediments were deposited and eroded in an inconsistent manner at cultch-on-longline sites." The greatest elevation change measured was an increase of 95 mm (Rumrill and Poulton 2004). Localized changes of this magnitude would not have a substantially adverse effect on the environment. Hence, this impact is considered less than significant without mitigation.

IMPACT WQ-4: Changes to the abundance of suspended organic matter. Cultured shellfish consume natural food sources that are suspended in the water column, including phytoplankton and other organic matter and there is potential competition for this food source between cultured shellfish and other filter feeders. An analysis was conducted to assess the potential cumulative effect on organic matter food sources of the Project, existing culture, and other planned culture in Humboldt Bay (Appendix C). The analysis, based on Gibbs' (2007) model, considered the inlet total volume, tidal exchange volume, the mean clearance rate of cultured shellfish, mean phytoplankton biomass, phytoplankton production, and cultured shellfish biomass to determine potential impacts.

The analysis considered three different ways to evaluate the cumulative impact to organic particulate matter food resources: (1) the effectiveness of shellfish in processing bay water during feeding, as compared to tidal flushing (clearance efficiency); (2) consumption of phytoplankton-derived carbon by shellfish as compared to the total carbon generated by phytoplankton in the bay (filtration pressure); and how fast phytoplankton are turning over (doubling time) compared to their consumption by shellfish (regulation ratio).

While the clearance efficiency calculations indicate that shellfish filtration could exceed the bay's flushing rate if a conservative flushing rate estimate is used, this does not evaluate the impact on carbon and phytoplankton within the bay. The filtration pressure and regulation ratio analyses, which take into account the impact on available phytoplankton, indicate that Humboldt Bay is highly productive and this productivity can withstand substantial cultivated shellfish density without significantly affecting food resources available to other organisms in the bay. The results of the study indicate that the Project with other proposed and existing culture, would have some cumulative effect on bay conditions, but that food resources are likely abundant enough that wild species would not be significantly affected. Therefore, this potential impact is considered less than significant.

5.9.5 Effects Analyses of Alternative 1. Subtidal Culture Only

Without intertidal culture included, the potential effects described above would be substantially reduced because intertidal culture represents (1) the greatest area of the Project, (2) the largest amount of equipment, (3) the highest biomass of cultured shellfish and (4) the most vessel use, and each of these variables is proportional to the impacts described above. Levels of significance of the impacts of the Project and alternatives are presented in Table 17.

5.9.6 Effects Analyses of Alternative 2. Intertidal Culture Only

Without subtidal culture included, the potential effects described above only be marginally reduced because intertidal culture represents (1) the greatest area of the Project, (2) the largest amount of equipment, (3) the highest biomass of cultured shellfish and (4) the most vessel use, and each of these variables is proportional to the impacts described above. Levels of significance of the impacts of the Project and alternatives are presented in Table 17.

5.9.7 Effects Analyses of Alternative 3. No Project Alternative

Under the no Project alternative, existing shellfish culture operations would remain and other permitting processes for new culture in the bay (i.e., the Coast Project) would likely continue. Hence, under the no Project alternative, there would be a similar potential for the type of environmental effects described in this EIR, but at a lower magnitude and within a smaller spatial extent. Levels of significance of the impacts of the Project and alternatives are presented in Table 17.

Table 17. Levels of Significance of the Project and Alternatives for Potential Hydrology and Water Quality Impacts

Impact	Project	Alternative 1: Subtidal Culture Only	Alternative 2: Intertidal Culture Only	Alternative 3: No Project
WQ-1: Petroleum spills.	LSM	LSM	LSM	NI
WQ-2: Pollutant/contaminant remobilization.	LS	LS	LS	NI
WQ-3: Alteration of circulation patterns.	LS	LS	LS	NI
WQ-4: Changes to the abundance of suspended organic matter.	LS	LS	LS	NI

NI=No Impact, LS=Less than Significant without Mitigation, LSM=Less than Significant with Mitigation, PS=Potentially Significant

5.10 Effects to Land Use

5.10.1 Summary of Present and Possible Future Conditions

Existing uses in the Project are primarily mariculture and recreational uses, including fishing, boating, hunting and kayaking. There are over 900 ac of underutilized, developed land adjacent to Humboldt Bay that are zoned as Coastal Dependent Industrial (CDI) by the County of Humboldt and City of Eureka. The primary historic use of these lands was in the wood product industry (i.e., processing and shipping of wood products). Local jurisdictions, including the District, County of Humboldt and City of Eureka are continually planning for and implementing projects to revitalize these lands. The Project is expected to result in use of some of these areas, primarily for storage of culture equipment and storage and shipping of shellfish. This is expected to occur within already developed buildings with existing, underutilized utilities and transportation systems. Aquaculture is an allowed use within areas zoned as CDI and the Project is expected to promote the intent of this zoning. It is expected that other uses, in additional aquaculture, will also develop in these industrial areas, particularly through the economic development efforts of the local jurisdictions.

5.10.2 Definition of Significance and Baseline Conditions

The Project would occur in subtidal and intertidal portions of Humboldt Bay.

Definitions of significance are available from the CEQA checklist. Significance criteria are based on whether the Project would:

- Physically divide an established community
- Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the Project (including, but not limited to the general plan, specific plan, LCP, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect
- Conflict with any applicable HCP or NCCP

5.10.3 Effects Analyses of the Project

IMPACT LU-1: Effects on CDI uses. The intertidal sites are not expected to have any effect on industrial uses because industrial uses (including shipping) do not occur within intertidal areas. The subtidal sites are adjacent to parts of the Samoa peninsula that were historically important for shipping, particularly of forest products. The future use of these sites is not known. However, the Project is designed to minimize any potential conflicts with shipping. Specifically, the Subtidal Sites are located away from the shipping channel and from where ships would berth. A review of the sites by the District's Bar Pilots confirmed that the mariculture at the proposed sites will not significantly affect shipping. There could be some impact to non-aquaculture uses due to spatial overlap between the Project and these uses (e.g., the same docks may be used), however, other uses are expected to be compatible with the Project. This impact is considered less than significant without mitigation.

IMPACT LU-2: Conflict with land use plans or policies. The Project area is zoned as follows (Figure 19):

- The Project area within unincorporated Humboldt County jurisdiction is zoned as Natural Resources with Coastal Wetlands and Water Conservation (Figures 19 and 20) (Humboldt County Code §§313-5.4, 313-38). Aquaculture is a conditionally permitted use within this zoning designation and the Project will require a use permit.
- Areas of the Project within the City of Eureka's jurisdiction are zoned Conservation Water and Water Development. Aquaculture is an allowable conditional use within these designations (City of Eureka General Plan, Chapter 6 § 6.A.14). A use permit from the City of Eureka is required for the Project.
- The District's HBMP designates the intertidal portion of the Project area for conservation and mariculture and the subtidal portion for harbor uses (HBMP § 2.2); however, the Project area is also designated as a Mariculture subarea. The Management Plan permits mariculture operations within the entire Project area, noting that the "use of the Bay for aquaculture or mariculture is expected to remain primarily within Arcata Bay, which includes areas that have been leased previously by the District, the cities, or the State of California for mariculture purposes. The combining use designation reflects a determination in this Plan that mariculture activities are generally appropriate within the designated area" (HBHRCD 2007). The Project is also consistent with the plan's goal of supporting

commercial aquaculture and the plan's policy to identify additional aquaculture activities (Policy HFA-5). The plan recognizes the need to balance harbor, recreation, conservation and mariculture uses of the bay.

The Project is consistent with existing zoning and land use plans and no impact is expected.

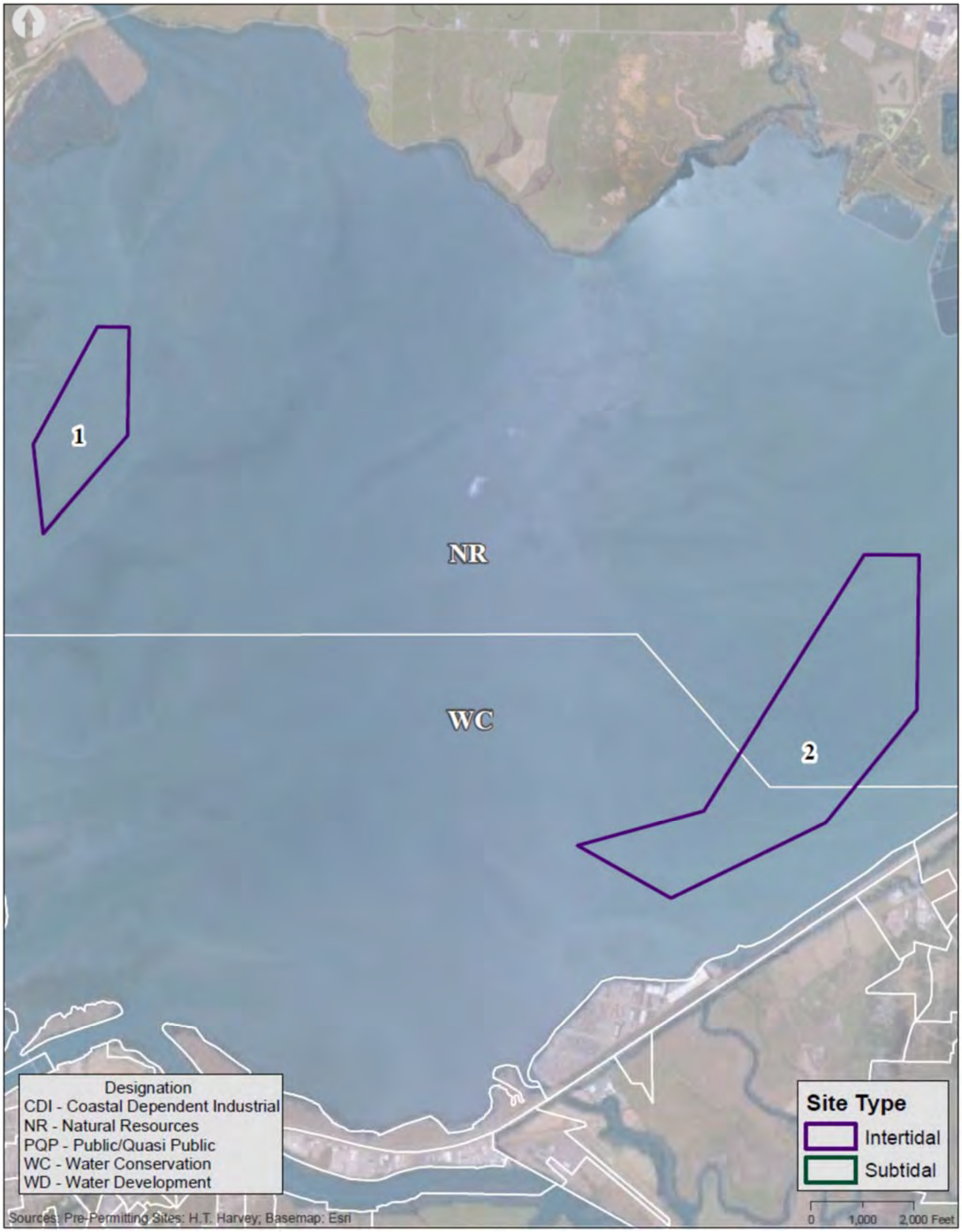

Figure 19. Land Use Zoning of Intertidal Sites 1 and 2

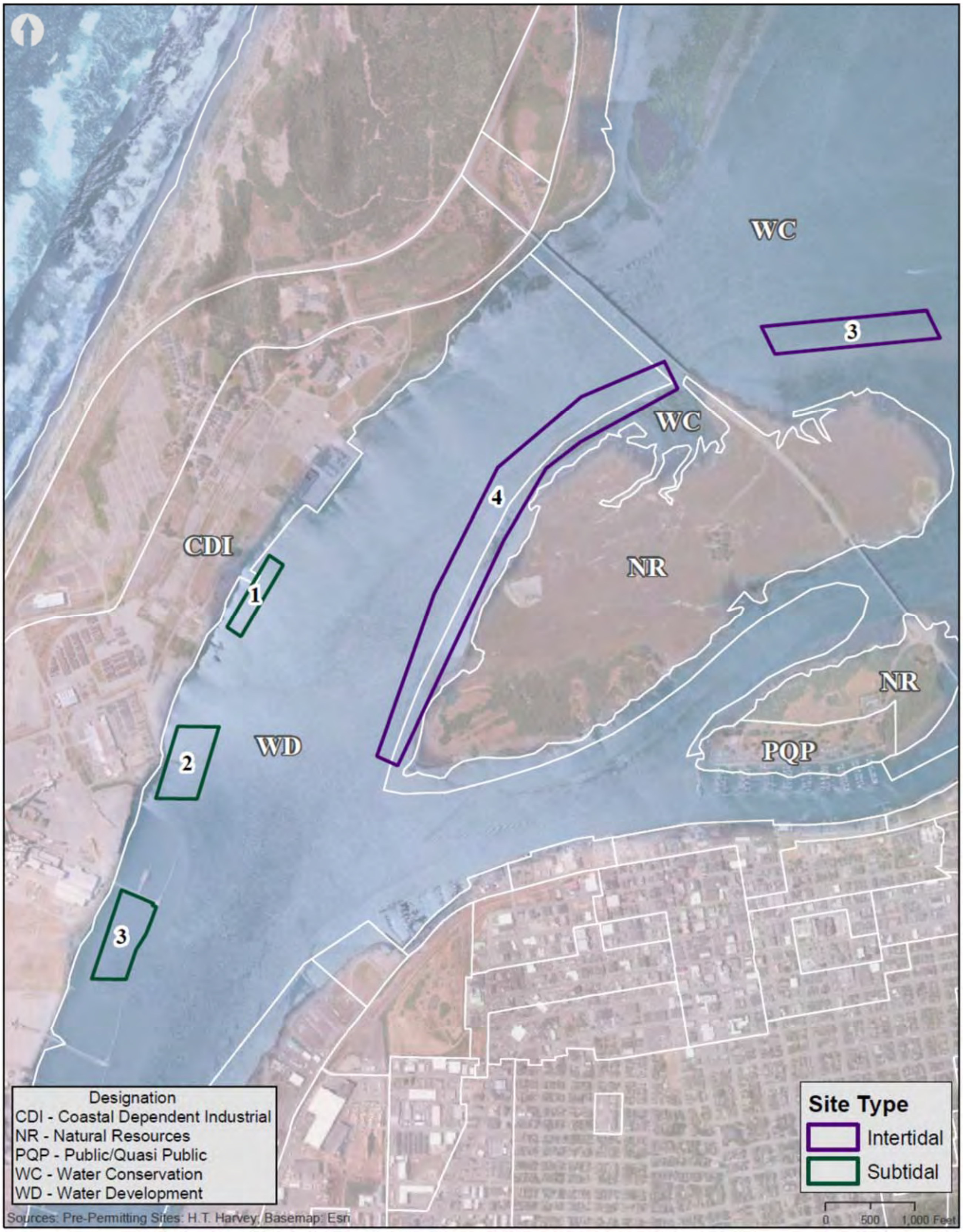

Figure 20. Land Use Zoning of Intertidal Sites 3 and 4 and Subtidal Sites 1, 2 and 3

5.10.4 Effects Analyses of Alternative 1. Subtidal Culture Only

Without the Project's proposed intertidal culture there would be less use of underutilized industrial areas and thus the Project would contribute less to the local jurisdictions' goals to revitalize these areas. Levels of significance of the impacts of the Project and alternatives are presented in Table 18.

5.10.5 Effects Analyses of Alternative 2. Intertidal Culture Only

Without the Project's proposed subtidal culture there would be less use of underutilized industrial areas and thus the Project would contribute less to the local jurisdictions' goals to revitalize these areas. However, there would also not be any potential for the Project to conflict with industrial uses, due to spatial overlap between Project activities and potential future uses of the sites (e.g., docks) at subtidal sites. Levels of significance of the impacts of the Project and alternatives are presented in Table 18.

5.10.6 Effects Analyses of Alternative 3. No Project Alternative

Under the no Project alternative, there would be less use of underutilized industrial areas and thus the Project would contribute less to the local jurisdictions' goals to revitalize these areas. However, there would also not be any potential for the Project to conflict with industrial uses, due to spatial overlap between Project activities and potential future uses of the sites (e.g., docks) at subtidal sites. Levels of significance of the impacts of the Project and alternatives are presented in Table 18.

Table 18. Levels of Significance of the Project and Alternatives for Potential Cultural and Archeological Resource Impacts

Impact	Project	Alternative 1: Subtidal Culture Only	Alternative 2: Intertidal Culture Only	Alternative 3: No Project
LU-1: Effects on coastal dependent industrial uses.	LS	LS	NI	NI
LU-2: Conflict with land use plans or policies.	NI	NI	NI	NI

NI=No Impact, LS=Less than Significant without Mitigation, LSM=Less than Significant with Mitigation, PS=Potentially Significant

Section 6.0 Cumulative Impacts

Cumulative impacts assessed under CEQA are those related to two or more individual impacts that are considerable or that incrementally compound other environmental impacts. Cumulative impact analyses must consider other similar past, present, or reasonably foreseeable future projects. To assess cumulative impacts, other similar aquaculture projects in Humboldt Bay are considered for cumulative impacts analysis.

Potential cumulative impacts would primarily be limited to within Humboldt Bay, a discrete area of shellfish culture and related activities. However, as discussed in Section 5, there are less than significant effects outside of Humboldt Bay; for example, associated with storage and transportation of shellfish. In addition to the Project, there is another proposal to expand intertidal and subtidal shellfish culture operations in Arcata Bay: the Coast Project (CSC 2014). Additionally, Coast operates 293 ac of intertidal shellfish culture in Arcata Bay, along with four other companies that farm an additional 8 ac of shellfish, resulting in a total of 301 ac of existing intertidal shellfish culture. There are also approximately 70 raft type structures culturing shellfish in subtidal areas, 35 of which are managed by Coast. The Coast Project proposes to extend Coast's permits for their existing intertidal and subtidal shellfish culture operations, increase culture within their already permitted FLUPSY, and obtain approvals for intertidal shellfish culture within new areas of Arcata Bay. The proposed Coast Project proposes 622 ac of new intertidal culture areas in Arcata Bay, potentially resulting in a total of 910 cultured areas managed by Coast. Coast also intends to discontinue culture on 6.6 ac where culture now occurs and to add eight culture bins to an existing FLUPSY. Additionally, Hog Island Oyster Company and Taylor Mariculture recently obtained regulatory approvals to add 21 culture rafts in subtidal areas.

When considering current and proposed aquaculture projects in Arcata Bay, without mitigation the Project has the potential to result in significant cumulative effects to the biological resources described above. The following is a description of the potential cumulative effects associated with the Project and proposed mitigation measures to reduce cumulative impacts to less than significant levels. More detail is provided for resource categories that have a higher potential of cumulative impacts (e.g., biological resources).

6.1 Cumulative Impacts: Archeological and Cultural Resources

Existing culture is not expected to impact cultural resources because the equipment is already in place and there will be minimal future ground disturbance. Expansion of culture activities, other than the Project, could have the same potential impacts as the Project. However, other proposed projects (e.g., the Coast Project) are also expected to include mitigation measures or best management practices to reduce potential effects to archeological and cultural resources. As such, cumulative impacts are considered less than significant with the mitigation.

6.2 Cumulative Impacts: Biological Resources

CUMULATIVE IMPACT BIO-1: Effects of intertidal culture on shorebird species as a result of loss of foraging habitat and alteration of food sources. As discussed in Impact BIO-1 above, the expansion of aquaculture in intertidal portions of Arcata Bay has the potential to impact shorebird species through displacement from suitable foraging areas. The placement of aquaculture infrastructure in intertidal habitats could preclude shorebirds from entering all or portions of aquaculture sites, as some species may be wary of objects placed on mudflats. Human disturbance associated with maintenance and other farming activities may also preclude shorebirds from foraging in intertidal sites; in some case, certain species (e.g., long-billed curlews) may be disproportionately affected due to territorial behavior and/or sensitivity to human disturbance. Alternatively, some shorebirds may be attracted to aquaculture areas due to an increase in foraging resources that grow on the infrastructure. Nonetheless even if the most sensitive shorebird species are precluded from foraging in aquaculture areas, the Project's impacts would not meet CEQA criteria for a significant impact, as discussed in Impact BIO-1 above. The Coast Project and existing culture has the potential to result in similar effects to shorebirds, however, the majority of the Coast Project's proposed expansion area (i.e., 531 ac) and existing culture is in areas of dense eelgrass, which occur in relatively low areas within the intertidal zone (i.e., less than approximately 1.5 ft MLLW). Although shorebirds can forage in low-elevation eelgrass beds when tides are sufficiently low enough to expose the substrate, shorebirds are expected to forage primarily on unvegetated mudflats that are exposed for longer periods each tide cycle and provide higher-quality foraging habitat for most shorebirds (compared to vegetated areas). Therefore, this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-2: Effects of intertidal culture on black brant as a result of loss of foraging habitat and alteration of food sources. As described in Impact BIO-2 above, Humboldt Bay is an important spring staging site for black brant because they rely on eelgrass (as well as in other estuaries within the Pacific Flyway) during migration and spring staging. The Project proposes to expand aquaculture in 483 ac of intertidal habitats with the majority of the expansion area occurring in areas that do not provide high-quality foraging habitat for brant (i.e., dense eelgrass beds). Rather, a small proportion (i.e., approximately 3% or 48 ac) will occur in dense eelgrass beds and those areas mainly occur on the borders of tidal channels and on the edge of intertidal aquaculture lease areas, rather than on the interior of the aquaculture beds, suggesting that brant are less likely to be precluded by infrastructure from foraging in those areas. Although it is unknown to what extent brant will be precluded from foraging in suitable eelgrass habitat it must be assumed they will be either partially or fully excluded from accessing up to 47 ac of suitable habitat by the Project. Although eelgrass is important to brant during migration and staging, the potential loss of a small proportion of available eelgrass, which mainly occurs in the South Bay where no aquaculture is proposed, represents a less than significant impact under CEQA.

However, the Coast Project is expected to occur on 622 ac of intertidal habitat in Arcata Bay, with the majority of this expansion involving off-bottom oyster culture on 531 ac of dense eelgrass habitat, representing potentially high-quality foraging habitat for brant. It is unknown whether brant will continue to use culture areas comparably to existing conditions or if they will avoid culture areas entirely due to their potential inability to take off and land around infrastructure (e.g., longlines). Brant could also use only the more open areas between culture equipment. Because it is unknown how brant will respond to aquaculture development, it is assumed that brant may be precluded from using all aquaculture areas within dense eelgrass habitat, resulting in a potentially significant impact to brant. Because this impact is potentially significant, it is expected that the Coast Project will implement mitigation measures to reduce impacts. This may include applied studies and adaptive management strategies to determine if 1) aquaculture expansion areas are important feeding areas for brant, 2) brant are excluded from foraging on eelgrass after off-bottom aquaculture is installed, and 3) adaptive techniques in aquaculture practices to allow brant to forage in culture areas comparable to pre-project conditions (if shown to avoid those areas post-implementation) such that any impacts to foraging brant are minimized or subsequently reversed to avoid significant impacts under CEQA. Because the Project is expected to result in only minor impacts to brant, if any, and because studies and resulting adaptive management practices are expected to be integrated into the Coast Project to minimize impacts to brant. Hence, this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-3: Potential impact to marine mammals from the potential loss of foraging habitat and restrictions to movement due to placement of aquaculture equipment in intertidal and subtidal areas. As discussed in Impact BIO-3 above, harbor seals and California sea lions can occur in Arcata Bay. These species are expected to move through, and forage in, the relatively deep channels that occur between shallow intertidal areas and largely avoid moving through intertidal areas where aquaculture will occur. Even if occasionally moving through intertidal areas at sufficiently high tides, aquaculture infrastructure is not expected to restrict movements of marine mammals, as these species would readily navigate around structures. Floating aquaculture structures positioned in subtidal areas are also not expected to impede the movements of marine mammals or preclude them from foraging in Arcata Bay. Although harbor seals may use portions Arcata Bay for haul-out or pupping sites, intertidal aquaculture is not expected to restrict harbor seals from conducting these activities, as the Project footprint represents a small proportion of the potential areas that can be used for haul-outs and aquaculture personnel will avoid flushing harbor seals when loafing on mudflats or other areas (see Mitigation BIO-1 above). Similarly, the Coast Project is expected to have minimal effects on marine mammals, as that project is not expected to interfere with marine mammal foraging or movements (for the same reasons described above for the Project) and that project will likely incorporate mitigation measures to ensure marine mammal harassment is avoided. Because neither project nor existing culture is expected to result in restricted movements or loss of foraging habitat for marine mammals, this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-4: Effects of human disturbance (e.g., boat movement, presence of culture workers) on marine mammals and other wildlife. Human disturbance associated with shellfish farmer's visits to aquaculture sites has the potential to flush wildlife from those areas. For instance, at low tide shorebirds and wading birds forage in intertidal mudflats and diving ducks and piscivorous waterbirds (e.g., cormorants and grebes) will forage in channels near intertidal sites, as well as in open water during any part of the tide cycle near subtidal raft structures. California sea lions may occasionally loaf on aquaculture structures and harbor seals may occasionally haul-out on mudflats in intertidal areas, and both species may occur in channels near intertidal aquaculture sites. These species may be flushed from aquaculture sites as humans approach, potentially resulting in reduced foraging or loafing opportunities and increased energetic costs.

Existing culture and the Coast Project's aquaculture operations will have similar potential to impact wildlife through human disturbance. However, roost sites for birds are not limited and foraging waterbirds and energetic costs associated with movement away from aquaculture activities are not expected to result detectable population-level effects for even for the most sensitive species. Similarly, haul-out sites and other loafing areas are not expected to be limited in Arcata Bay if all proposed aquaculture activities are implemented. Regardless, because unauthorized harassment of marine mammals is not allowed under the MMPA, the Coast Project is expected to implement education programs to inform workers of procedures to avoid flushing marine mammals when using boats in Arcata Bay. These include speed restrictions, marine mammal avoidance techniques, and notification requirements if an injured marine mammal is observed. Therefore, cumulative impacts to wildlife associated with human disturbance are considered less than significant and this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-5: Effects on the distribution and abundance of mammalian or avian species that are potential predators of native fish species, and related effects to native fish species. In addition to the Project's rafts/FLUPSYs and existing rafts/FLUPSYs, the Coast Project would add eight culture bins and Hog Island Oyster Company and Taylor Mariculture will also add 21 culture rafts to Arcata Bay (some of which may have already been added). As described above, piscivorous waterbirds and marine mammals may roost on floating structures associated with aquaculture operations in Arcata Bay. These floating structures will result in an increase in resting sites for these species. However, although these species prey on fish, no significant increase in fish predation is expected to occur as from installing additional floating structures in the bay. Large predatory species, such as striped bass (*Morone saxatilis*), due not occur in Humboldt Bay and fish that are expected to be attracted to floating structures, such as juvenile rockfish or surfperch, are generally too small and will not congregate in sufficient numbers to significantly reduce numbers of prey species. Therefore cumulative impacts to fish species as a result of predatory mammalian or avian species occurring near aquaculture equipment are not significant and this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-6: Effects of artificial lighting on wildlife. As discussed in Impact BIO-6 above, artificial lights are known to have adverse effects on wildlife species, such as migratory birds when bright lights (e.g., floodlights) are visible from the air or fish when lights shine into the water from nearby infrastructure. The Project is not expected to result in a substantial increase in new lighting, although a small number of lights (i.e., up to two) may be installed on new floating rafts for occasional nighttime or early morning operations. New lighting will be minimal and new fixtures will be shielded to minimize off-site glare and to avoid light from shining in the water (see Mitigation BIO-6 above) to avoid significant impacts to wildlife species. Existing culture and the Coast Project may also result in new artificial lighting in aquaculture areas within Arcata Bay. However, new lighting installation will also be limited to new floating rafts, as no other new facilities are planned for installation. The Coast Project will likely also minimize lighting effects on wildlife by implementing similar measures to reduce glare and off-site light spillage. Because no substantial increase in new artificial lighting is expected to occur from new aquaculture development and existing lighting is minimal, cumulative effects related to artificial lights on wildlife are considered less than significant with the proposed mitigation. Hence, this impact is considered less than significant with mitigation.

CUMULATIVE IMPACT BIO-7: Effects to green sturgeon as a result of potential reduction in prey. As described above for Impact BIO-7 shellfish culture does not have inherent aspects that would result in a reduction of prey for green sturgeon. This remains true when considering other activities in the bay, including existing culture and the Coast Project. Hence, this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-8: Effects on the abundance of suspended organic matter and related effects to other native species. Cultured shellfish consume natural food sources that are suspended in the water column including phytoplankton and other organic matter and there is potential competition for this food source between cultured shellfish and other filter feeders. As described under Impact BIO-8 and in Appendix A, the Project considered with other existing and proposed shellfish culture in the bay would have some cumulative effect on bay conditions, but food resources are likely abundant enough that native species would not be significantly affected. Therefore, this potential cumulative impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-9: Effects to green sturgeon as a result of habitat loss or degradation. As described under Impact BIO-7 (Effects to green sturgeon as a result of potential reduction in prey), green sturgeon likely utilize Humboldt Bay for feeding and the Project is unlikely to have a negative effect on prey resources for green sturgeon. Green sturgeon habitat would also be affected by placement of culture equipment on the bottom, which can displace green sturgeon habitat. Current shellfish culture equipment in Humboldt Bay covers approximately 0.76 ac of the bottom (the "benthic footprint") with post, anchors, etc. Structures in the bay not related to shellfish culture (e.g., docks and piles) have not been inventoried well and it is difficult to estimate the benthic footprint of these structures. However, these structures can be characterized as "scattered" along the shoreline and don't appear to occupy a substantial proportion of benthic habitat in the bay. The benthic footprint of culture equipment could be increased by the Coast Project and Project by up to 1.5 ac and 0.96 ac respectively. Hence, the total benthic footprint of existing culture, the Coast Project and the Project would be up to 3.2 ac (which is in addition to the unknown benthic footprint created by non-culture related structures). This represents less than 0.041% of the 7,795 ac of Arcata Bay. Hence, substantial area for feeding by green sturgeon would remain unaltered. The space between shellfish culture equipment would remain available for use by sturgeon because culture areas are permeable (sturgeon can freely move within the culture areas).

Based on the above, the Project is not expected to have a significant cumulative effect on green sturgeon as a result of habitat loss or degradation. Hence, this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-10: Effects to green sturgeon as a result of entanglement. As described under Impact BIO-10, as an anadromous species, sturgeon swim among diverse structures in rivers, embayments, and the ocean. They have the sensory ability to detect structures and the swimming ability to avoid them. It is expected that green sturgeon would not collide or become entangled with mariculture equipment or cultured shellfish associated with existing culture, the Coast Project or the Project. Shellfish culture has occurred for decades in West Coast embayments where sturgeon occur, and there is no known record (anecdotal or otherwise) of a sturgeon ever becoming entangled in mariculture equipment. Shellfish culture is not expected to result in entanglement of green sturgeon. Hence, there is no impact.

CUMULATIVE IMPACT BIO-11: Effects on wetland functions. Wetlands, including in Humboldt Bay, provide numerous functions such as primary production, flood protection, nutrient removal/transformation, wildlife habitat and recreational opportunities. These functions are assessed separately under different sections of this impact analysis. In general, the addition of shellfish culture activities to a wetland does not preclude the functions of that wetland. For example, in areas with shellfish culture; plants grow, flood protection functions continue and nutrients are removed and transformed. The Project is not expected to have a significant cumulative effect on wetland functions. Hence, this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-12: Effects on eelgrass. As described under Impact BIO-12, in Humboldt Bay, eelgrass has critical ecological functions and is important to numerous fish and wildlife species including species listed under the state and federal ESAs. The ecological functions of eelgrass in Humboldt Bay are described well in the HBMP EIR (HBHRCD 2006) which is incorporated by reference to this EIR.

The Project is designed to avoid impacts to eelgrass to the maximum extent possible. The Project sites were identified with specific consideration towards their ability to support shellfish culture without impacting eelgrass. Although eelgrass does occur within some of the sites, it will be largely avoided with implementation of Mitigation BIO-3–5. Existing culture and the Coast Project would occur in areas with dense eelgrass and therefore those projects would require more detailed assessment of project level and cumulative impacts on eelgrass and it is expected that the Coast Project will incorporate measures to minimize eelgrass impacts.

Because the Project is expected to result in only minor impacts to eelgrass, and because eelgrass impact minimization measures are expected to be integrated into the Coast Project, this impact is considered less than significant with mitigation.

CUMULATIVE IMPACT BIO-13: Potential impacts of overwater structures (including shading) on fish species. As described in Impact BIO-13, certain native fish species may benefit from the presence of overwater structure in subtidal areas while others may avoid it, including salmonids. The maximum amount of overwater structure created by the Project in subtidal areas (1.9 ac) only represents 0.09% of the 2,110 ac of Subtidal habitat in Arcata Bay. The amount of other overwater structure in the bay, related to shellfish culture and other activities, has not been well inventoried. However, these structures can be characterized as "scattered" along the shoreline and they don't appear to create a substantial amount of overwater structure in the bay. Overwater structure in Arcata bay is not expected to have an adverse effect on fish species. Hence, this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-14: Potential impacts of water intakes on aquatic species. As described in Impact BIO-14, water intakes have the potential to impinge and/or entrain small organisms including special status fish species (e.g., salmonids and longfin smelt). With implementation of Mitigation BIO-6, the potential for this to occur is small and other projects involving water intakes (e.g., the Coast Project) are expected to incorporate similar measures to minimize impacts. Hence, this impact is considered less than significant with mitigation.

CUMULATIVE IMPACT BIO-15: Potential effect to eelgrass by constraining its expansion into higher elevation areas as a result of sea level rise. The Project's potential impact is assessed in Impact BIO-15. Because other existing and proposed intertidal culture in the bay is predominantly within areas that maintain dense eelgrass, there is not a cumulative impact to consider. Hence, this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-16: Potential impacts on Pacific herring spawning sites. As described in Impact BIO-16, the Project incorporates mitigation measures to minimize impacts to spawning Pacific herring. It is expected that other projects in the bay will incorporate measures with similar effects and therefore this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-17: Effects on the distribution and abundance of fish species that are potential predators of native fish species, and related effects to native fish species. As described in Impact BIO-17, overwater structures in Humboldt Bay are not expected to attract species that predators of native fish. This applies to the Project and other projects and therefore this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-18: Potential for cultured shellfish to naturalize or establish self-sustaining populations outside of cultivation and the effects of this naturalization on native marine species and communities. As described in Impact BIO-18, successful spawning of Pacific oysters south of Wilapay Bay, WA is believed to be rare (Carlton 1992). This is likely also true for Kumamoto oysters, as neither species has become well established in the bay outside of culture areas. The Project also incorporates Mitigations BIO-8–9 to reduce potential impacts related to propagation of Manila clams. Due to the unlikelihood of successful spawning by Pacific and Kumamoto oysters and the fact that Manila clams are already naturalized in the bay, the Project is considered to have a less than significant impact when considered cumulatively with existing and proposed culture and this impact is considered less than significant with mitigation.

CUMULATIVE IMPACT BIO-19: Effect on benthic habitat and communities from the shellfish culture equipment and cultured shellfish, including initial equipment installation activities,

anchoring, posts and material staging. As described above, the total benthic footprint of existing culture, the Coast Project and the Project would be up to 3.2 ac (which is in addition to the unknown benthic footprint created by non-culture related structures). This represents less than 0.041% of the 7,795 ac of Arcata Bay which is considered insignificant. Hence, this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-20: Potential impacts to submerged aquatic vegetation and benthic habitat resulting from bottom scour and outboard motor contact associated with support vessel operations and trampling by workers. Similar impacts as those described for the Project (Impact BIO-20) would likely result from other culture existing and proposed culture activities in the bay. These impacts would be spread out spatially across culture areas and would not result in any substantial impact in any given area. Hence, this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-21: Potential biological effects of the addition of shellfish culture structures due to potential changes in light transmission through the water column, water flow and sediment transport. Existing and Project intertidal culture consists of up to 770 ac (Table 10) of Arcata Bay's 7,795 ac (10.8%). The Coast Project would add an additional 622 ac for a total of 1,392 ac, or 18% of Arcata Bay's 7,795 ac. This is a considerable proportion of Arcata Bay. However, as described above, the effects are not expected to be detrimental, consisting of some reduction in light transmission, and potential sediment erosion and accumulation. This is not expected to result in a substantial effect to the ecological value of the bay or biological resources. Hence this impact is considered less than significant without mitigation.

CUMULATIVE IMPACT BIO-22: Ecological effects during installation of Piles at Subtidal Site 3. As described under Impact BIO-22, this impact is considered to be less than significant with mitigation. Due to the temporary and local nature of this potential impact, other actions are not expected to increase it. Hence, this impact is considered less than significant with mitigation.

CUMULATIVE IMPACT BIO-23: Impact on the distribution and dispersal of non-native invertebrate fouling species. Hard substrate will be added by the Project in the form of shellfish shells, ropes, anchor lines, anchors, piles, posts and stakes. This substrate will attract both non-native and native fouling organisms. During a study by Boyle et al. (2006) of fouling organism composition and succession at Woodley Island, Humboldt Bay, 34% of all species identified were non-native. It is expected that fouling organisms of shellfish and shellfish culture equipment will also be both native and non-native. This effect is considered neutral as it benefits both natives and non-natives in a similar composition as at other hard substrate. However, there is the potential for activities that involve removal of fouling organisms to further disperse non-native fouling organisms. Certain species such as didemnum may disperse with currents, reproduce and further spread their distribution. The extent that this may actually occur is unknown and warrants research. However, as a precautionary approach, the Project incorporates Mitigation BIO-12, which will substantially reduce opportunities for dispersal. Other aquaculture projects in the bay are expected to incorporate similar measures. With Mitigation BIO-12, this impact is less than significant.

CUMULATIVE IMPACT BIO-24: Conflicts with local policies, particularly those described in the HBMP which is a guidance document for the District and the LCPs of the County of Humboldt, City of Eureka and City of Arcata. The Project, existing culture and other proposed projects (e.g., the Coast Project) are individually and cumulatively consistent with these policies. This area of Humboldt Bay is identified as suitable for mariculture in the HBMP. Additionally, the Project has many design components that limit its effect on ecological resources, consistent with Local Coastal Plans. Funding for the Project was approved by the County Board of Supervisors and District Commissioners, indicating their support for the Project. There is no impact expected.

6.3 Cumulative Impacts: Aesthetics and Visual Resources

Existing and other proposed culture in the Bay (including the Coast Project) will have similar aesthetic impacts as the Project and the effect is cumulative. However, the findings made for the Project's impacts on aesthetics apply similarly when considering cumulative impacts. Particularly, the culture equipment is low profile and produces minimal glare and the use is consistent with the character of Arcata Bay. This cumulative impact is considered less than significant with mitigation.

6.4 Cumulative Impacts: Air Quality

Existing and other proposed culture in the Bay (including the Coast Project) will have similar air quality impacts as the Project and the effect is cumulative. However, particularly because other projects are also expected to comply with AQMD regulations this cumulative impact is considered less than significant with mitigation.

6.5 Cumulative Impacts: GHG Emissions

Existing and other proposed culture in the Bay (including the Coast Project) will have similar GHG emissions as the Project and the effect is cumulative. However, the level of GHG emissions resulting from shellfish culture (i.e., boat use and storage and transportation of shellfish) in Humboldt Bay is considered minor and this impact is considered less than significant.

6.6 Cumulative Impacts: Hydrology and Water Quality

Existing and other proposed culture in the Bay (including the Coast Project) will have similar effects to hydrology and water quality as the Project and the effect is cumulative. However, the findings made for the Project's impacts on hydrology and water quality apply similarly when considering cumulative impacts, particularly because other projects are expected to take similar precautions (i.e., best management practices and mitigation measures) not to impact water quality. Additionally, the assessment of the Project's effects on the abundance of suspended organic matter (Impact WQ-4) is a cumulative analysis and the impact is found to be less than significant. Hence, this cumulative impact is considered less than significant with mitigation.

6.7 Cumulative Impacts: Land Use

Existing and other proposed culture in the Bay (including the Coast Project) has similar considerations regarding land use as the Project. They are also designed not to effect coastal dependent uses and are consistent with land use plans and policies. The cumulative effect on land use is considered less than significant without mitigation.

Section 7.0 Growth Inducing Effects

The purpose of the Project is to allow for an expansion of commercial mariculture activities in Humboldt Bay, to create jobs and improve the local economy, while also increasing local and sustainable seafood production. CEQA Guidelines Section 15126.2 includes fostering economic growth as part of inducing growth. As such, the Project is considered growth inducing. Indeed, a focus of the HBMP (HBHRCD 2007) is to encourage economic activity and an explicit direction to adopt this focus was included by the legislature in the action that created the District.

As noted in other portions of this EIR, there are over 900 ac of underutilized, developed land adjacent to Humboldt Bay that are zoned as CDI by the County of Humboldt and City of Eureka. Underutilization is due to dramatic declines in shipping and wood product industries during the past several decades. The Project would serve to partially revitalize these areas, in some cases potentially removing blight. It would potentially create approximately 50 new jobs in the area. It is likely that these jobs would be filled both by people already living in the region and people relocating to the region. It would also stimulate local economic activity, including for transport of the product and manufacturing of shellfish culture equipment. The growth inducing aspect of the Project (i.e., revitalizing the local economy) is considered to have a less than significant impact on the environment.

Section 8.0 Environmentally Superior Alternative

CEQA guidelines require identification of the environmentally superior alternative. Additionally, CEQA Section 15126 states that "If the environmentally superior alternative is the 'no project' alternative, the EIR shall also identify an environmentally superior alternative among the other alternatives".

Without the Project, the extent that mariculture activities will expand in the bay is unknown. However, it is expected that expansion would be less and therefore potential environmental effects would be less without the Project (although the Project effects are mitigated to less than significant under all alternatives). Hence, Alternative 3, the No Project Alternative, is considered the environmentally superior alternative. The Project, which would include subtidal and intertidal culture, would have the greatest potential for environmental impacts, because it would include all of the culture that would occur under both Alternatives 1 and 2. Alternative 1 (Subtidal Culture Only) would have some potential effects that would not occur under Alternative 2 (Intertidal Culture Only). These effects are primarily related to temporary disturbances during installation of piles. However, Alternative 2 would include a larger footprint than Alternative 1, and would result in more human activity and shellfish biomass in the bay. Hence, among the Project and Alternatives 1 and 2, Alternative 1 is considered the environmentally superior alternative.

Section 9.0 Findings

Detailed mitigation measures have been identified throughout this report that are intended to mitigate Project effects. All of these mitigation measures are identified in Table S-1 (see Executive Summary). After implementation of the proposed mitigation measures, all of the effects associated with the Project would be reduced to a less-than-significant level. The Project would not result in any significant and unavoidable environmental impacts.

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Ted Kuiper (retired mariculturist)

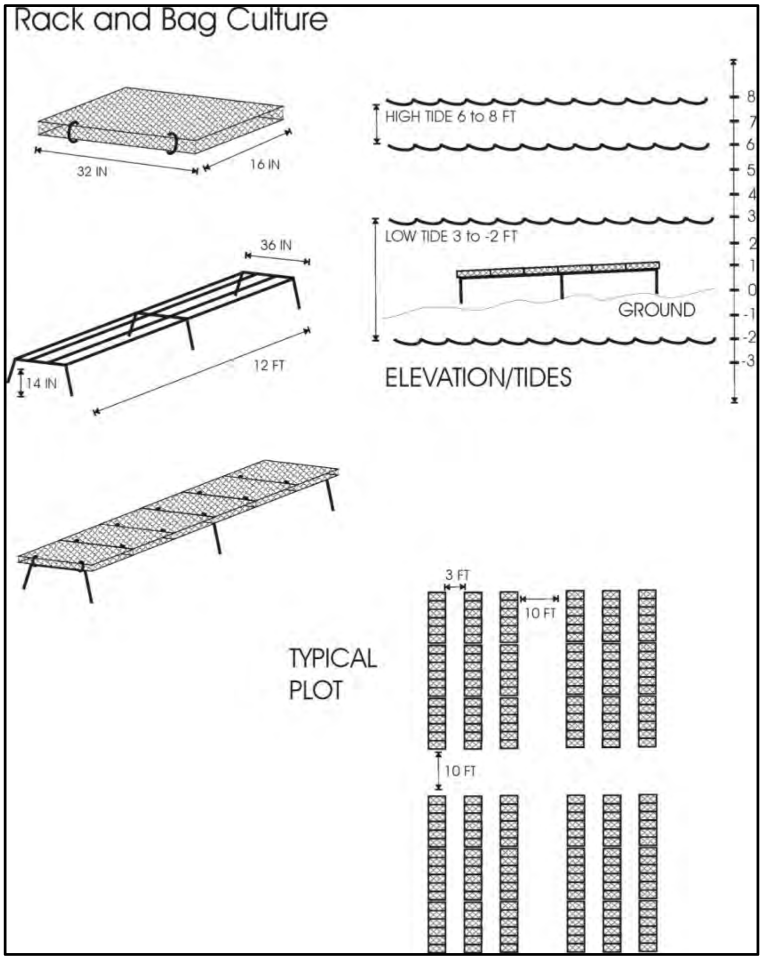
Appendix A. Spatial Coordinates of Culture Sites

	Longitude	Latitude
Intertidal 1	124° 9' 01" W	40° 50' 57" N
	124° 08' 53" W	40° 50' 57" N
	124° 08' 53" W	40° 50' 36" N
	124° 09' 16" W	40° 50' 15" N
	124° 09' 17" W	40° 50' 34" N
Intertidal 2	124° 05' 47" W	40° 50' 13" N
	124° 05' 33" W	40° 50' 13" N
	124° 05' 33" W	40° 49' 43" N
	124° 05' 56" W	40° 49' 21" N
	124° 06' 35" W	40° 49' 06" N
	124° 06' 59" W	41° 49' 16" N
	124° 06' 27" W	40° 49' 23" N
Intertidal 3	124° 09' 52" W	40° 49' 17" N
	124° 09' 28" W	40° 49' 19" N
	124° 09' 26" W	40° 49' 16" N
	124° 09' 50" W	40° 49' 14" N
Intertidal 4	124° 10' 06" W	40° 49' 13" N
	124° 10' 04" W	40° 49' 10" N
	124° 10' 18" W	40° 49' 04" N
	124° 10' 23" W	40° 49' 01" N
	124° 10' 29" W	40° 48' 53" N
	124° 10' 44" W	40° 48' 28" N
	124° 10' 47" W	40° 48' 29" N
	124° 10' 39" W	40° 48' 47" N
	124° 10' 30" W	40° 49' 01" N
	124° 10' 18" W	40° 49' 09" N
Subtidal 1	124° 11' 03" W	40° 48' 51" N
	124° 11' 01" W	40° 48' 50" N
	124° 11' 07" W	40° 48' 42" N
	124° 11' 09" W	40° 48' 43" N
Subtidal 2	124° 11' 16" W	40° 48' 32" N
	124° 11' 10" W	40° 48' 32" N
	124° 11' 13" W	40° 48' 24" N
	124° 11' 19" W	40° 48' 24" N

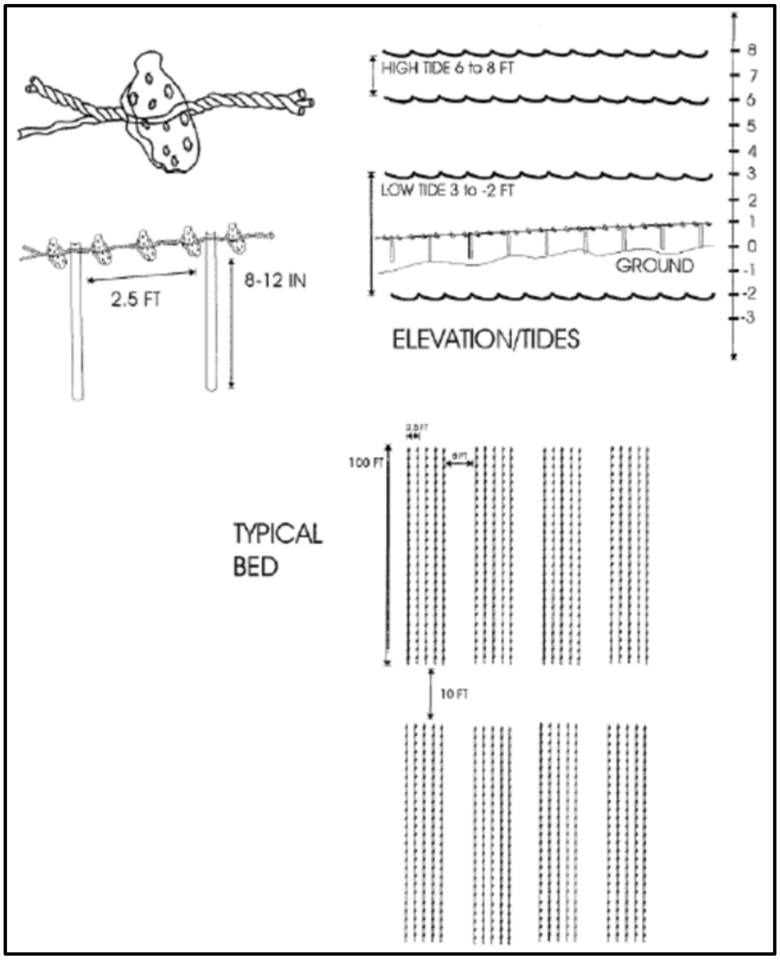
	Longitude	Latitude
Subtidal 3	124° 11’ 23.817” W	40° 48’ 13.793” N
	124° 11’ 21.342” W	40° 48’ 13.034” N
	124° 11’ 19.186” W	40° 48’ 12.359” N
	124° 11’ 19.284” W	40° 48’ 12.149” N
	124° 11’ 18.728” W	40° 48’ 11.979” N
	124° 11’ 19.507” W	40° 48’ 10.331” N
	124° 11’ 20.213” W	40° 48’ 8.999” N
	124° 11’ 21.64” W	40° 48’ 7.216” N
	124° 11’ 23” W	40° 48’ 04” N
	124° 11’ 28” W	40° 48’ 04” N

Appendix B. Example Culture Methods and Pictures

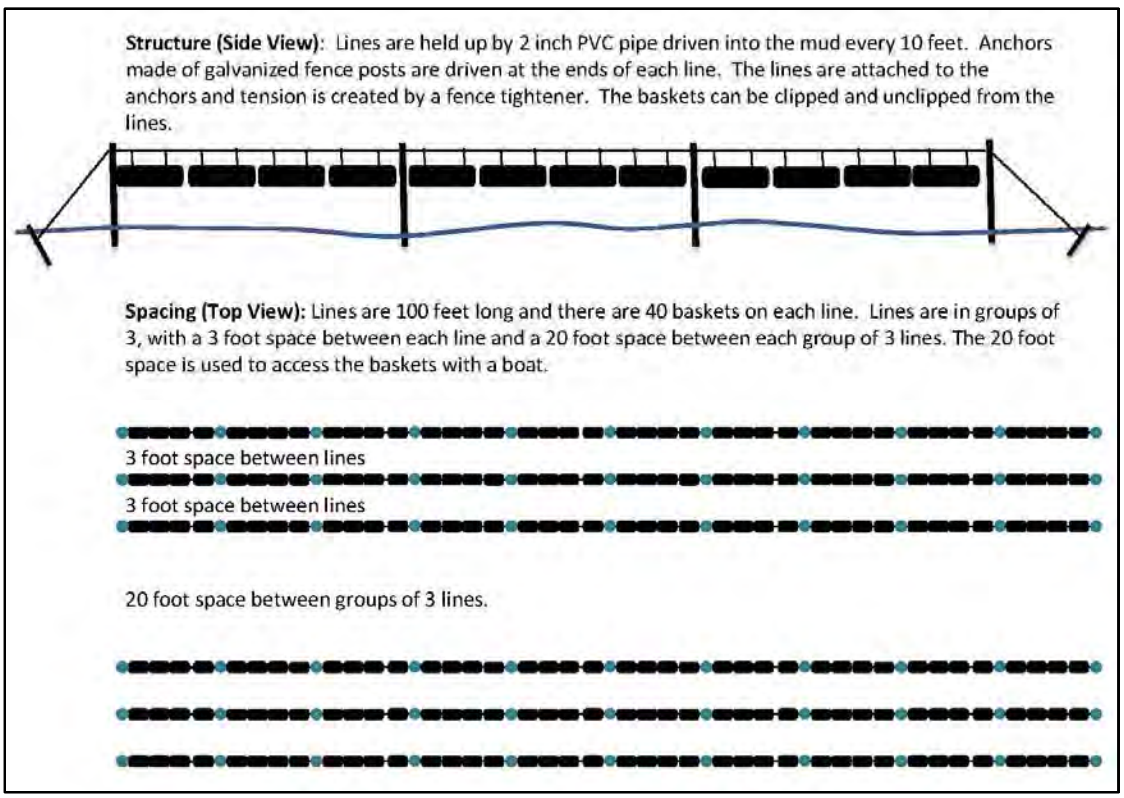
Rack-and-Bag Culture (from CSC 2007)



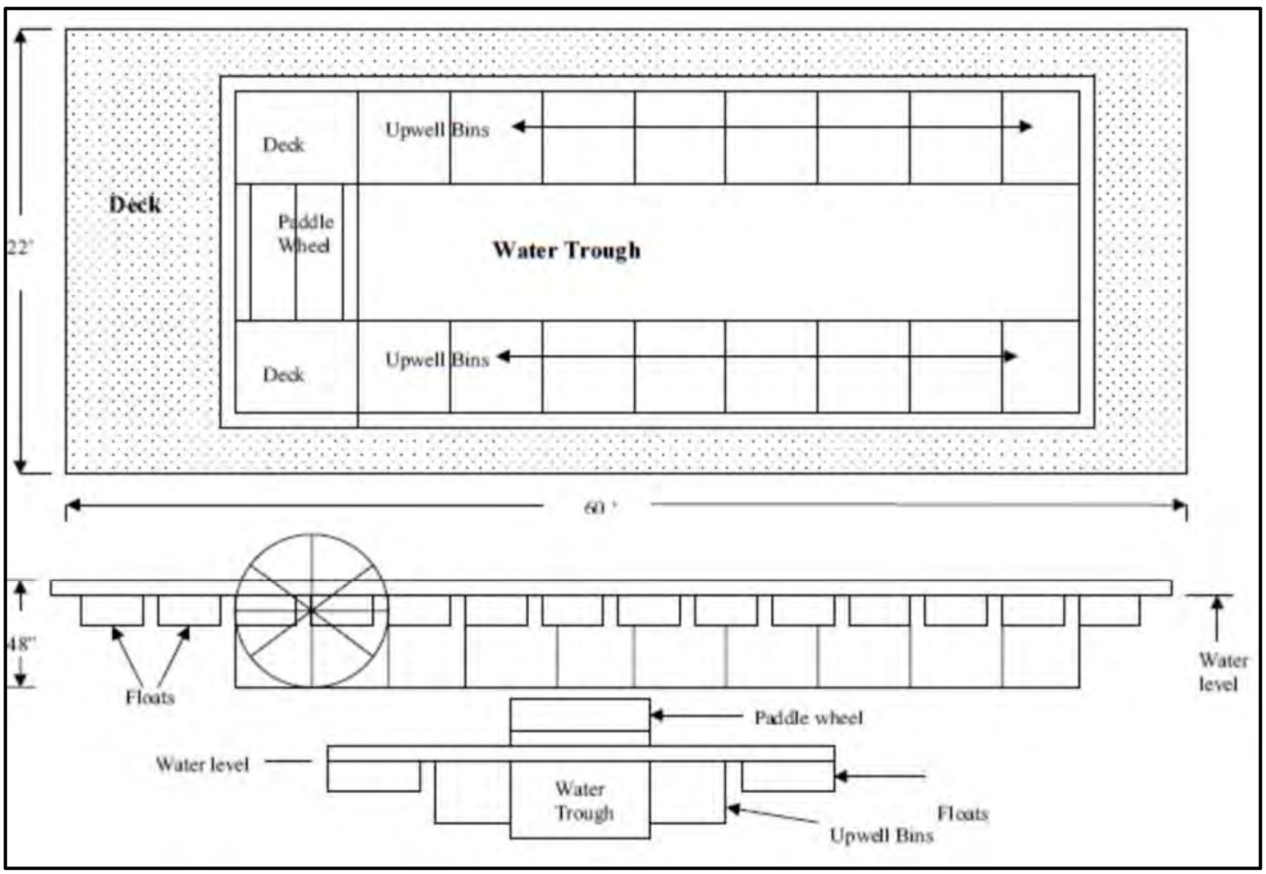
Cultch-on-Longline Culture (from CSC 2007)



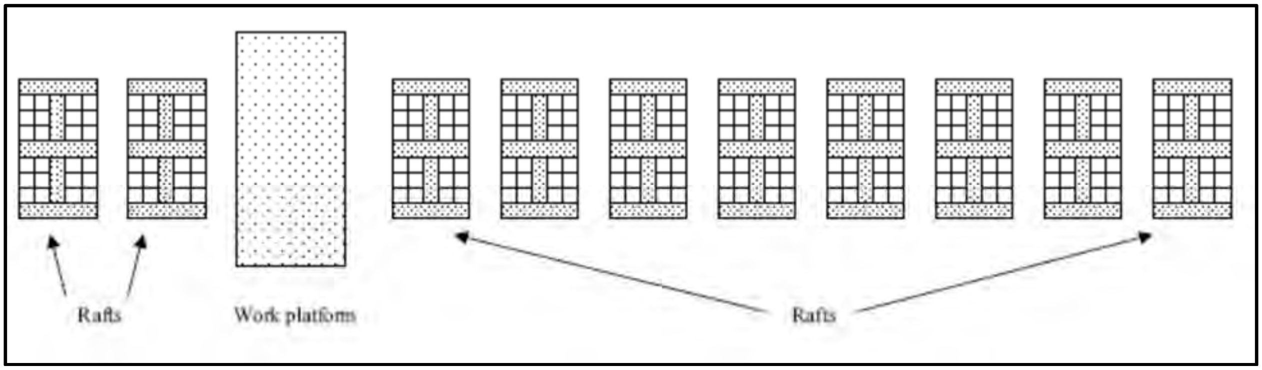
Basket-on-Longline Culture



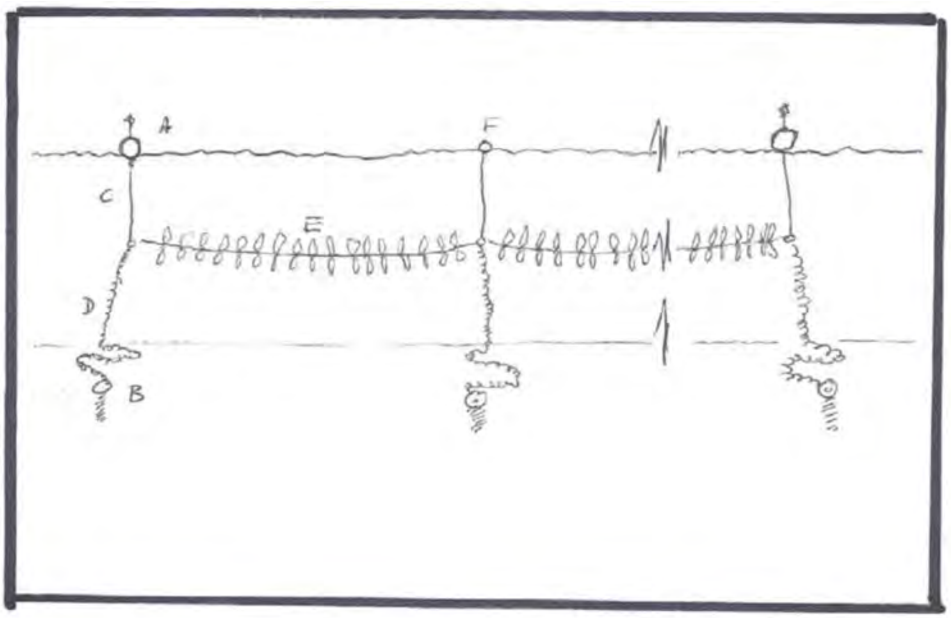
Floating Upwelling System (from CSC 2007)



Culture Rafts and a Work Platform (from CSC 2007)



Macroalgae Longline Culture



A. End marker
B. Helical sand point mooring
C. ½" line leader attached by stainless steel welded ring and thimble
D. 7/16" galvanized chain rode
E. Three stranded culture line
F. Intermediate floats and mooring assemblies occur at 100' spacings until the line terminates

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Appendix C. Humboldt Bay Carrying Capacity Analysis (Note: This analysis was updated since the DEIR version)

Humboldt Bay Mariculture Carrying Capacity Analysis

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Introduction

In Humboldt Bay, California, there are two current proposals to expand intertidal and subtidal shellfish culture operations: the Humboldt Bay Mariculture Pre-permitting Project ("Pre-Permitting Project"), (Humboldt Bay Harbor, Recreation and Conservation District [HBHRCD] 2014) and the Coast Seafoods Company Permit Renewal and Amendment Project ("Coast Project", HBHRCD 2015). Proposed shellfish culture expansion, along with existing culture, could potentially affect food resources and ecosystems in the bay. This document presents an analysis of the effects to food resources of (1) the Pre-Permitting Project, (2) the Coast Project, and (3) other existing shellfish culture in the bay, including culture maintained by Coast Seafoods Company. The specific research question guiding this analysis is "what cumulative impact will the Pre-Permitting Project and Coast Project have on food resources available to filter feeding organisms in Humboldt Bay?" To assess this question, the analysis uses Gibbs' (2007) indicators of how cultured shellfish affect their food sources.

Cultured shellfish consume natural foods suspended in the water column, including phytoplankton and other organic matter, and potentially compete with other filter feeders for this food. Therefore, shellfish farms may affect naturally occurring species and food webs in the growing region. Various approaches can be taken to assess these effects. Gibbs (2007) noted:

> From a technical perspective, an obvious way forward is to develop complex numerical hydrodynamic-NPZ (nutrient, phytoplankton, zooplankton) carrying capacity models with embedded shellfish energetic models to understand these interactions. However, these models are technically complex, are extremely data hungry, and many argue do not have a particularly good performance record (Herman 1993).

In recognition of these challenges, Gibbs (2007) developed a set of "sustainability performance indicators for assessing the environmental performance of shellfish farms." These indicators provide quantitative guidance on answering the following questions (modified from Gibbs [2007]):

- Does the proposed amount of shellfish culture, when considered in connection with existing shellfish culture, significantly change any other ecological processes, species, populations, or communities within the growing region?
- Does the proposed amount of shellfish culture, when considered in connection with existing shellfish culture, represent a quantity that would control phytoplankton dynamics in the growing region?
- Are the current and proposed levels of shellfish culture at the ecological carrying capacity of the region?

Approach/Methods

Gibbs' (2007) indicators use linear combinations and ratios that compare inlet total volume, tidal exchange volume, the mean clearance rate of cultured shellfish, mean phytoplankton biomass, phytoplankton production, and cultured shellfish biomass. Each of these variables, and the data used to describe them, are presented below.

Inlet Total Volume

The volume of water that occupies an inlet is a value used for several calculations in this analysis. Humboldt Bay consists of three sub-basins: Arcata Bay (North Bay), Entrance Bay, and South Bay (Figure 1). Arcata Bay, where aquaculture occurs and is proposed, has an inlet total volume of 48 and 85 million cubic meters (m^3) at mean low water and mean high water, respectively (Table 1) (Barnhart et al. 1992).

Figure 1. Humboldt Bay is Often Described as Three Bays (Arcata Bay, Entrance Bay, and South Bay); Aquaculture Occurs in Arcata Bay.

Table 1. Area and Water Volume of Humboldt Bay and its Subbasins[2]

Characteristic	South Bay	Entrance Bay	Arcata Bay	Humboldt Bay Total
Area (10^7 m^2) at MLLW	0.71	0.73	1.19	2.63
Area (10^7 m^2) at MHW	1.83	0.79	3.45	6.07
Volume (10^7 m^3) at MLLW	1.24	3.21	4.80	9.25
Volume (10^7 m^3) at MHW	3.70	4.44	8.51	16.65

Notes: m^2 = square meters; MLLW = mean lower low water; MHW = mean high water
Source: Barnhart et al. 1992

Tidal Exchange (Rt)

The mixed semidiurnal tides along the coast of Northern California force large amounts of ocean water in and out of Humboldt Bay on a daily basis. There are various descriptions and values for tidal exchange in Humboldt Bay:

- According to Barnhart et al. (1992), tidal exchange of bay waters with the open ocean can transport 74 million m^3 of water in and out of Humboldt Bay each tidal cycle; this large tidal prism extends into Arcata Bay, where 37.1 million m^3 of water can be flushed in one tidal cycle, removing 43.6% of Arcata Bay's water in as little as 8 hours.
- Gast and Skeesick (1964) estimate that 99% of Arcata Bay water is replaced within 14 tidal cycles.
- In a nationwide comparison of estuaries and their potential for eutrophication, Bricker et al. (2007) lists Humboldt Bay's water residence time as three days.
- Efforts to quantify residence time (or water age) over spatial gradients in Arcata Bay using dye studies demonstrated a pigment half-life of 2.5 days (California Department of Health Services [CDHS] 2006).
- A recent model (Anderson 2010) predicts approximately 20% dye reduction in 24 hours and 70% in 2 weeks in parts of Arcata Bay.

The above estimates of flushing rates yield a range of residence times from approximately 3–14 days in the Project area; substantial differences due to the analytical methods used. The range in estimated flushing rates is not unusual, as Gibbs (2007) notes that determining the flushing rates of inlets and estuaries "can also be at times ambiguous", and determined a mean flushing rate was therefore appropriate in his case study. To calculate metrics that include flushing rates, separate calculations were made for the 85 million m^3 of water in Arcata Bay using residence times of 3, 7, and 14 days, acknowledging the range of uncertainty.

[2] Deepening of navigation channels and opening of previously diked areas to saltwater intrusion (e.g., at McDaniel Slough and lower Jacoby Creek) occurred after these estimates were made and likely increased the area and volume of water in Arcata Bay. No estimates for this increase are available and it is not accounted for in this analysis.

Mean Clearance Rate of the Cultured Shellfish (CR)

Shellfish take water in through an inhalant siphon and then filter out particles on their gills for ingestion. After they remove particulates, they release water back into the water column through the exhalent siphon. Clearance rate (CR) is the volume of water processed (cleared) over a period (L of water per gram of dry tissue weight per hour). Filtration rate (FR) is the mass of particulate matter removed during a period (milligrams of solids per hour per gram of dry tissue weight), and is dependent on the animal's ability to process water (CR) and the concentration of suspended particulate matter in the water column during that time. Gibbs (2007) and our analysis use CR rather than FR because the quantity and quality of suspended particulate matter in the water column vary over time at unknown concentrations. The information not captured in CR is accounted for in portions of the analysis below (i.e., for filtration pressure and regulation ratio calculations), primarily based on average chlorophyll concentrations in the bay.

A thorough review and meta-analysis of oyster clearance rates, documented in 25 publications, yielded an average clearance rate of 2.54 L per gram per hour (L/g/h), with a standard error of ±0.24 (Cranford et al. 2011). This value is compared to reported CRs of 4.78 ±0.28 L/g/h for oysters with a seston-based diet (Cranford et al. 2011). Our approach presents a range of performance indicator values based on these CRs (Tables 3 and 4).

Mean Phytoplankton Biomass

Phytoplankton are often considered the main food source for filter feeders, but any organic matter in the water column can be consumed. Organic matter in the bay can be measured by quantifying chlorophyll concentrations. The Central and Northern California Ocean Observing System at Humboldt State University has chlorophyll-a (chl-*a*) fluorescence time series data from Arcata Bay. For data between 2003–2011, we calculated the seasonal mean chlorophyll concentration as 1.96 micrograms per L (μg/L) in winter, 3.18 in spring, 4.11 in summer, and 2.56 in fall. Harding (1973) reported average chl-*a* of 4.1 μg/L for Humboldt Bay during summer months, and found no horizontal trends within the bay. Based on CeNCOOS data, we use the annual mean chl-*a* concentration of 2.96 μg/L for calculations of phytoplankton standing stock.

Phytoplankton Production

Seasonal variations in phytoplankton primary production rates are not available for Humboldt Bay, but local data exist for an annual estimate and production during summer months. Based on the work of Harding (1973), the average primary production rate of phytoplankton in Arcata Bay during summer months is 33.8 milligrams of carbon per cubic meter per hour ($mgC/m^3/hr$). Phytoplankton production measured by Harding (1973) per unit area was 1.05 and 1.50 grams of carbon per square meter per day ($gC/m^2/day$) during low tide and high tide, when accounting for incident light radiation, extinction coefficients, and chl-*a* concentration. The annual rate of phytoplankton production in channel portions of the bay accounted for production of 136 $gC/m^2/year$ (Barnhart et al. 1992).

For calculations that required primary production totals for all of Arcata Bay, we multiplied 136 gC/m^2/year by the area of Arcata Bay at low tide ($1.19 * 10^7$ m^2) for a total annual production of 1,618.4 metric tons of carbon. For calculations that considered finer-scale phytoplankton dynamics (such as turnover rate) and required volumetric estimates, 33.8 mgC/m^3/hr was multiplied by 24 hours, then divided by four to allow for a more conservative estimate based on Barnhart et al.'s (1992) work (note that Harding's (1973) daily per-m^2 production estimates during summer are four times higher than the Barnhart et al. (1992) estimated annual production per m^2 divided by 365 days)[3]. This yielded an average of 203 mgC/m^3/day. A carbon to chl-*a* ratio of 30:1 was used for conversions where needed (Sathyendranath et al. 2009).

Cultured Shellfish Biomass

Dry tissue weight (DTW) is the mass of shellfish tissue after drying at 100°C for 24 hours. DTW is the most accurate way to calculate the total biomass of shellfish in production, and allows comparison of data between species and animal size classes. DTW is also the preferred unit for quantifying CR for shellfish. To calculate the current and proposed biomass of cultured shellfish in Humboldt Bay, we developed shellfish stocking density formulas for each of the culture methods used in the bay (i.e., for each method, we determined the number of shellfish (by size) that would occur in a given area). We then converted the abundance of different-sized animals into DTW using allometric equations that convert shell length to DTW (Kobayashi et al. 1997, Ren et al. 2000). For "seed" production methods (organisms less than 4mm), stocking densities are recorded as kilograms of live weight rather than number of organisms. Therefore, live weight mass was converted to dry tissue weight assuming that DTW is 6% of live weight (Officer et al. 1982, Mann 1979, Spencer et al. 1978). Biomass values per cultivation method were then multiplied by the existing or proposed total area for production (for intertidal sites) or number of raft-type structures (for subtidal sites).

[3] Harding's (1973) primary production estimates for phytoplankton per unit area during summer months are four times greater than Barnhart et al.'s (1992) estimate for average annual phytoplankton production in shallow and deep channels of Humboldt Bay. We apply this 0.25 correction factor to Harding's production estimate per unit volume during summer to reflect what the annual average production rate would be per year.

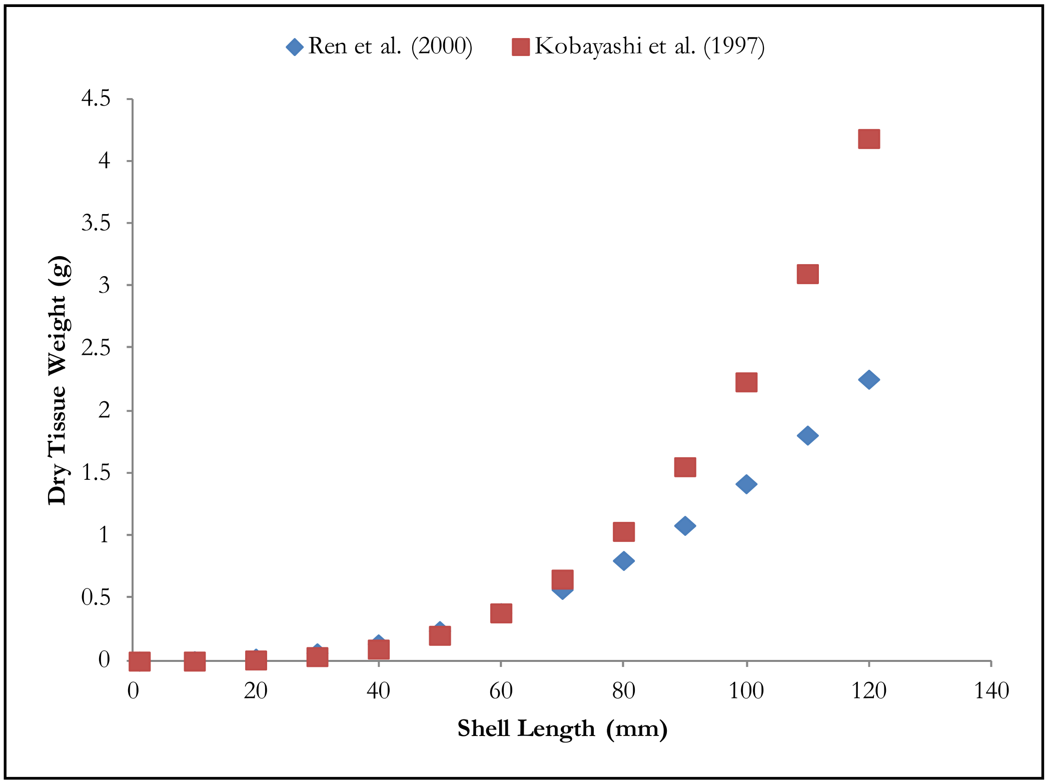

Figure 2. Allometric Relationships between Shell Length and Biomass for Pacific Oysters (Kobayashi et al. 1997, Ren et al. 2000)

The current standing stock of Existing Culture in Humboldt Bay is approximately 13.46 metric tons DTW. This value includes all intertidal locations producing adult oysters as well as subtidal locations producing oyster and clam seed in raft-like structures. Unlike the Coast Project description (HBHRCD 2015), the Pre-Permitting Project description (HBHRCD 2014) does not specify the proportion of specific intertidal culture methods that would be used. For this carrying capacity assessment we assumed 1/3 basket-on-longline, 1/3 cultch-on-longline and 1/3 rack-and-bag methods[4]. The Coast Project and Pre-Permitting Project would add approximately 18.44 and 23.12 metric tons DTW respectively (Table 3). Hence, the total biomass of cultured shellfish in the bay, including from existing culture, the Pre-Permitting Project and the Coast Project would be approximately 55.02 metric tons DTW (Tables 3 and 4)[5].

[4] Also note that the Gibbs model is based on suspended shellfish culture whereas existing and proposed Humboldt Bay culture is elevated off the bottom (not suspended from the water surface) or suspended from rafts. However, the Gibbs model is ultimately based on biomass of cultured bivalves and is applicable to Humboldt Bay culture methods.

[5] Calculations presented in this analysis utilize the shell length to DTW conversion equation presented by Kobayashi et al. (1997). Kobayashi's equation results in a higher total biomass (55.02 metric tons) than the shell length to DTW conversion equation presented by Ren et al. (2000) (39.14 metric tons). Our use of the Kobayashi conversion results in a higher estimate of biomass.

Sustainability Performance Indicators

The following indicators (Gibbs 2007) are used in this assessment, and employ the variables described above within Arcata Bay.

Clearance Efficiency (CE): $CE = R_t/C_t$

CE is a measure of how effectively the shellfish can process bay water during feeding, compared to the efficiency of tidal flushing.

For our analysis:

- R_t is the number of days that it takes Arcata Bay to be flushed by the tide with incoming ocean water. As described above, we used values of 3, 7, and 14 days.
- C_t is the number of days it would take cultured shellfish to clear all the water in Arcata Bay. This value is calculated as the volume of Arcata Bay/volume of water cleared by cultured shellfish each day.

Gibbs (2007) states that CE values less than 0.05 suggest that aquaculture levels "will not be able to induce significant changes to the pelagic functioning" (i.e., connectivity between the embayment and nearby coastal areas). In contrast, CE values greater than 1.0 indicate that water in the bay is flushing slower than the water is being processed by cultured shellfish.

Our approach in calculating C_t considers the percent of time that shellfish cultivation areas are out of the water during low tides (Table 2). Shellfish are not filtering water during that portion of time and, therefore, it was not included in the analysis. The time shellfish are predicted to be out of the water was determined as follows:

- Separately calculated the average ground elevation for the Coast Project, Pre-Permitting Project, Coast's existing culture and other existing culture based on a digital elevation model developed by PWA (2014).
- Added one foot to these averages to account for the approximate height of the shellfish off the bottom.
- Used 1993-2012 NOAA water level data from Humboldt Bay North Spit (https://tidesandcurrents.noaa.gov/) to calculate the percent of time the water level was below the average shellfish elevations (the time a shellfish at the average elevation is in air).

Table 2. Percent of Time Out of Water for Existing and Proposed Shellfish Culture

Condition	Percent of year out of water
Pre-Permitting Project	32%
Coast Expansion	11%
Coast Existing	16%
Other Existing	26%

Filtration Pressure (FP): $FP = B_f/P_p$

FP is an indicator of the consumption of phytoplankton-derived carbon by cultured shellfish compared to the total carbon generated by phytoplankton in the bay. FP also gives an estimate of how much of this energy has been redirected to aquaculture rather than other consumers of this resource. This indicator encompasses the carbon resource flows in a region, but does not account for connectivity with nearby coastal regions, as CE does.

For our analysis:

- B_f is the total carbon extracted from the water column by the shellfish culture every year, and is calculated as follows:

  Total volume cleared per year * amount of carbon in that volume = (total volume cleared per hour * 24 hours * 365 days) * (2.96 μg chl-*a*/L * 30:1 carbon ratio/ 1,000,000 μg per gram)

- P_p is the total carbon fixed by autotrophs in the bay each year, and is calculated as follows:

  Production rate * area = 136 gC/m^2/year * 1.19 * 10^7 m^2 at low tide in Arcata Bay

Gibbs (2007) states that FP values less than 0.05 indicate that very little of the carbon resources generated in the growing region is passing through the culture, suggesting that the culture is having little impact on the system. Values close to 1.0 indicate that the level of culture is nearing the production capacity.

Regulation Ratio (RR): $RR = T_c/T_p$

RR gives a measure of how much control cultured shellfish have on the algal population in the bay by comparing how fast the phytoplankton are turning over (doubling time) to their extraction by cultured shellfish (i.e., finding what percent of phytoplankton is being consumed by shellfish). For our analysis:

- T_c is the ratio of the daily volume of water cleared by the shellfish to the total volume of water in the growing region, and is calculated as follows:

  (CR * biomass * 24 hours)/volume of Arcata Bay

- T_p is the phytoplankton turnover rate, and is calculated from the ratio of the daily mean phytoplankton production (gC/m^3/day) to the daily mean phytoplankton concentration (mg/m^3) converted to carbon (gC/m^3). This is calculated as follows:

Daily mean phytoplankton production/daily mean phytoplankton concentration = (33.88 mgC/m^3/hr * 24 hours * 0.25 [correction factor])[6]/(2.96 mg/m^3 average chl concentration * 30:1 carbon ratio)

Based on Gibbs (2007), values less than 0.05 suggest that cultured shellfish are playing a minor role in phytoplankton dynamics (i.e., growth regulation). Values closer to 1.0 suggest that the cultured shellfish control the phytoplankton dynamics in the growing region, implying that there may be costs to competitors that rely on phytoplankton.

Results and Discussion

The objective of the work presented here is to use Gibbs' (2007) sustainability performance indicators to assess, from three perspectives, the potential impacts of cultured shellfish on their food sources (Tables 3 and 4):

- CE accounts for the percent of the total water volume in an embayment that shellfish filter in comparison to the rate at which it is flushed with the ocean.
- FP accounts for the amount of carbon that is fixed by phytoplankton in the system compared to the amount removed by cultured shellfish through feeding.
- RR accounts for the percent of the bay that is filtered by shellfish each day and the ability of that filtration to regulate phytoplankton growth.

Table 3. Analysis of Cultured Shellfish Biomass and Related Sustainability Performance Indicator Values (Assuming a Clearance Rate of 2.54 L/g/h)

Condition	Biomass (DTW MT)	Clearance Efficiency			Filtration Pressure	Regulation Ratio
		CE_3	CE_7	CE_{14}	FP	RR
Coast Existing	10.09	0.018	0.042	0.085	0.010	0.003
Coast Proposed	18.44	0.035	0.082	0.165	0.020	0.005
Other Existing	3.38	0.005	0.013	0.025	0.003	0.001
Mariculture Pre-Permitting Intertidal	19.83	0.029	0.068	0.135	0.016	0.004
Mariculture Pre-Permitting Subtidal	3.29	0.005	0.011	0.022	0.003	0.001
All Projects	55.02	0.088	0.205	0.410	0.050	0.013

[6] See footnote 2 above for explanation of the 0.25 correction factor.

Table 4. Analysis of Cultured Shellfish Biomass and Related Sustainability Performance Indicator Values (Assuming a Clearance Rate of 4.78 L/g/h)

Condition	Biomass (DTW MT)	Clearance Efficiency			Filtration Pressure	Regulation Ratio
		CE_3	CE_7	CE_{14}	FP	RR
Coast Existing	10.09	0.034	0.080	0.160	0.019	0.005
Coast Proposed	18.44	0.066	0.155	0.310	0.038	0.010
Other Existing	3.38	0.010	0.024	0.047	0.006	0.001
Mariculture Pre-Permitting Intertidal	19.83	0.055	0.127	0.254	0.031	0.008
Mariculture Pre-Permitting Subtidal	3.29	0.009	0.021	0.042	0.005	0.001
All Projects	55.02	0.165	0.386	0.771	0.094	0.024

Clearance Efficiency

CE was calculated three ways, using flushing rates of 3, 7, and 14 days, to address different estimates of flushing rates based on several different flushing estimates (Tables 3 and 4). Total CE values calculated assuming a CR of 2.54 L/g/h range between 0.09 and 0.41, and CE values calculated assuming a CR of 4.78 L/g/h range between 0.17 and 0.77. The highest CE value occurs when including all potential and existing culture, with the assumption of the higher clearance rate and longer residence time of 14 days. Although this maximum value suggests that just over ¾ of Arcata Bay will be filtered by cultivated shellfish each day, it is important to consider that this metric only considers the water itself and does not account for phytoplankton (food) abundance or production in the bay.

Filtration Pressure

Total FP values for proposed and existing culture range between 0.05 and 0.09 when analyzed with 2.54 and 4.78 CRs respectively, indicating that the vast majority of carbon fixed by phytoplankton remains available to non-cultured species. Additionally, the primary production estimates used to calculate FP are conservative, in that they assume that production occurs only in the area of Arcata Bay occupied by water all day (i.e low tide area), and do not account for productivity in waters over mudflats during high tide, a situation which could add 30% more carbon to the system during ideal conditions (Headstrom 1994). Moreover, including other sources of particulate organic matter, such as detritus and benthic microalgae, to the total carbon available in the bay would be appropriate, but a lack of local data prevents us from including these resources in the analysis with reasonable confidence. By not including detritus and benthic microalgae in our analysis, our estimates of FP are likely higher than the actual filtration pressure. Additionally, some resources in the bay are generated in response to the presence of the shellfish, through nutrient recycling in the microbial loop, and a large proportion of the carbon passing through the shellfish culture gets recycled through the ecosystem again (Gibbs 2007) (Figure 3).

To check our estimates of biomass for accuracy, we compared them to estimates made by Gibbs (2007). Gibbs (2007) commented that bivalves consume five times their biomass (5:1). We compared our shellfish carbon-biomass calculations to our calculations of the amount of carbon consumed, resulting in an average 3.8:1 ratio at a CR of 2.54 L/g/h and 7.1:1 at a CE of 4.78. Our estimates correspond well with Gibbs (2007).

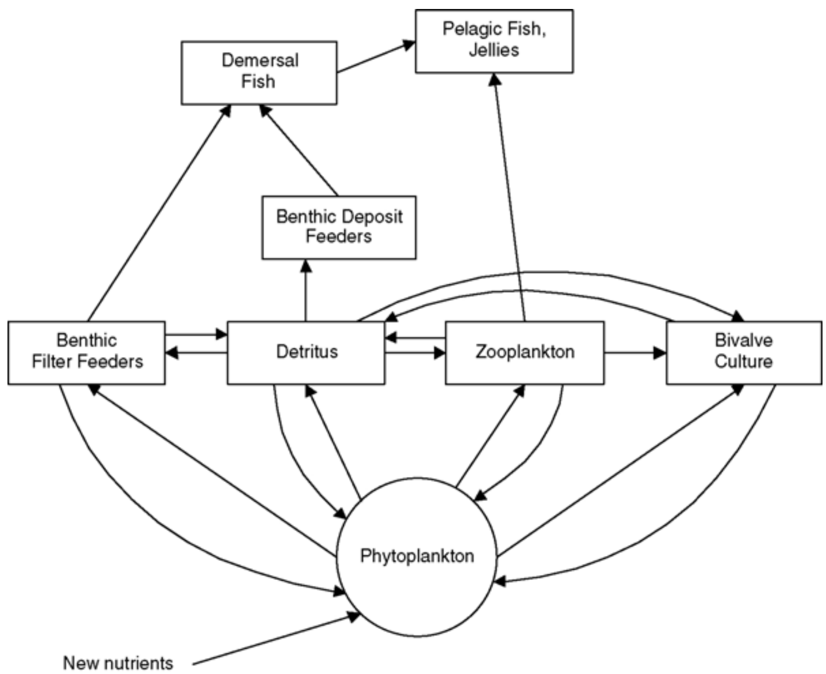

Figure 3. Theoretical Food Web in Aquaculture Area, with Culture Included; Arrows Represent Flow of Energy (Carbon) through the Web; Only the Major Energy Pathways are Shown. Source: Modified from Gibbs 2007

Regulation Ratio

All RR values in this analysis are well below the 0.05 threshold (Tables 3 and 4). The fast phytoplankton turnover rate (T_p=2.28) creates conditions under which the standing stock could replace itself several times per day. RR values suggest that the existing and proposed shellfish culture would have a negligible role in phytoplankton dynamics.

Conclusions

The sustainability performance indicators used in this analysis address the potential effects of current and proposed shellfish culture in Arcata Bay. As described above, where there is data uncertainty, all our assumptions err conservatively towards higher potential effects to phytoplankton abundance (food resources). For example:

- The primary production estimates used to calculate FP do not account for productivity in waters over mudflats during high tide, a situation which could add 30% more carbon to the system during ideal conditions (Headstrom 1994).
- Particulate organic matter types other than phytoplankton, such as detritus and benthic microalgae, are potentially important food sources that are not considered in this analysis due to a lack of local data on which to base the analysis.
- We assume that all shellfish are constantly feeding while submerged under water, which is an overestimate because shellfish particulate consumption varies with sediment concentration. For example, when total particulate matter in the water column is over 5 mg/L, gills start to clog, affecting respiration and triggering a reduction in the clearance rate (Cranford et al. 2011; Galimany et al. 2013).
- Nutrient recycling by the shellfish is not considered, where excreted inorganic nutrients can be taken up by phytoplankton directly or regenerated by bacteria into inorganic nutrients that can stimulate phytoplankton growth.

CE values indicate that the amount of filtration by cultured shellfish in Arcata Bay may already be greater than 5% of the bay's flushing rate with adjacent waters, and that with the quantity of shellfish proposed by the Project and Coast Project, filtration could approach the flushing rate (i.e., CE value of 0.77 assuming a worst-case scenario flushing rate and the higher of the two CRs). However, unlike the other metrics, it is not necessarily detrimental for an ecosystem to have CE values this high. CE does not account for the amount of organic matter in the water, primary production rates, and the ability of the resources being consumed to be rapidly recirculated into the ecosystem though fecal decomposition, the microbial loop, and subsequent new primary production. While a CE value above one indicates that the clearance rate exceeds the flushing rate, it does not answer the more pertinent question of what impact that flushing has on available amounts of carbon and phytoplankton within the ecological system. While all metrics must be considered together, FP and RR are better metrics to specifically address what cumulative impact the projects will have on available food resources in Humboldt Bay.

The FP calculations based on the higher CR indicate that 9% of the carbon fixed by phytoplankton in the bay would be diverted to cultured shellfish and 5% would be diverted assuming the lower CR. It is noteworthy that these calculations do not take into account a large portion of carbon consumed by shellfish that doesn't leave the bay when the shellfish are harvested, but is recycled in the ecosystem[7].

Lastly, the RR value is below 0.05 for all levels of shellfish culture analyzed. This metric directly pertains to the regulation of phytoplankton dynamics and best answers our research question. The phytoplankton turnover rate is too fast to be significantly affected by current and proposed shellfish culture, and therefore the

[7] This includes feces and pseudo-feces produced by shellfish.

cumulative impact from existing culture and the proposed projects appears to be negligible as measured by this metric.

These performance indicator metrics provide useful guidance for assessing the cumulative effects of current and proposed shellfish culture on food resources in Arcata Bay. CE values are relatively high, particularly when employing the conservative assumptions of slow flushing rates and a higher CR. However, CE does not consider the actual food resources (e.g., phytoplankton). Values for the metrics that do consider food resources (i.e., for FP and RR) are substantially lower. This provides an indication that, for its size, Humboldt Bay is highly productive and this productivity can withstand a substantial cultured shellfish density without affecting food resources available to other organisms in the bay. This is likely due to strong upwelling events in nearby ocean waters coupled with rapid phytoplankton turnover rates. Considered together, the performance indicators provide an indication that existing and proposed shellfish culture would have some effect on bay conditions but that food resources are abundant enough that non-cultured (wild) species will not be significantly affected by changes in food availability resulting from the Coast Project and Pre-Permitting Project.

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List of Abbreviations

B_f	carbon extracted (g)
C	carbon
°C	degrees Celsius
CE	clearance efficiency
CR	clearance rate (L/h/g DTW)
C_t	clearance time (days)
DTW	dry tissue weight
FP	filtration pressure
FR	filtration rate (mg/h/g of DTW)
g	gram
h	hour
L	liter
m	meter
Mg	milligram
P_p	carbon fixed (g)
RR	regulation ratio
R_t	flushing rate (days)
T_c	water cleared/water in region
T_p	phytoplankton turnover rate (day^{-1})
µg	microgram

List of Abbreviations (for Appendix C)

B_f	carbon extracted (g)
C	carbon
°C	degrees Celsius
CE	clearance efficiency
CR	clearance rate (L/h/g DW)
C_t	clearance time (days)
DW	dry tissue weight
FP	filtration pressure
FR	filtration rate (mg/h/g of DW)
g	gram
H	hour
L	liter
m	meter
Mg	milligram
P_p	carbon fixed (g)
RR	regulation ratio
R_t	flushing rate (days)
T_c	water cleared/water in region
T_p	phytoplankton turnover rate (day^{-1})
µg	microgram

Appendix D.Site Selection Process

Humboldt Bay Mariculture Pre-Permitting Project
Site Selection Process

The first step in site selection for the Humboldt Bay Mariculture Pre-Permitting Project (Project) was to restrict the Project to north Humboldt Bay, because this is the area of Humboldt Bay envisioned for mariculture activities in the Humboldt Bay Management Plan[1]. Next, within north Humboldt Bay, the following constraints were applied, which substantially reduced the area under consideration. Some of the discussion below is only pertinent to selection of the intertidal culture sites (e.g., elevation and substrate considerations).

[1] Humboldt Bay Harbor, Recreation and Conservation District. 2007. Humboldt Bay Management Plan. Final.

Constraints

Constraint 1: Existing Tidelands

An objective of the Project is to create jobs and improve the local economy. In order not to interfere with existing economic activity, it was determined that existing tideland leases should be avoided. Hence, the 4,671 acres of existing tideland leases in north Humboldt Bay (Figure 1) were not considered for Project siting.

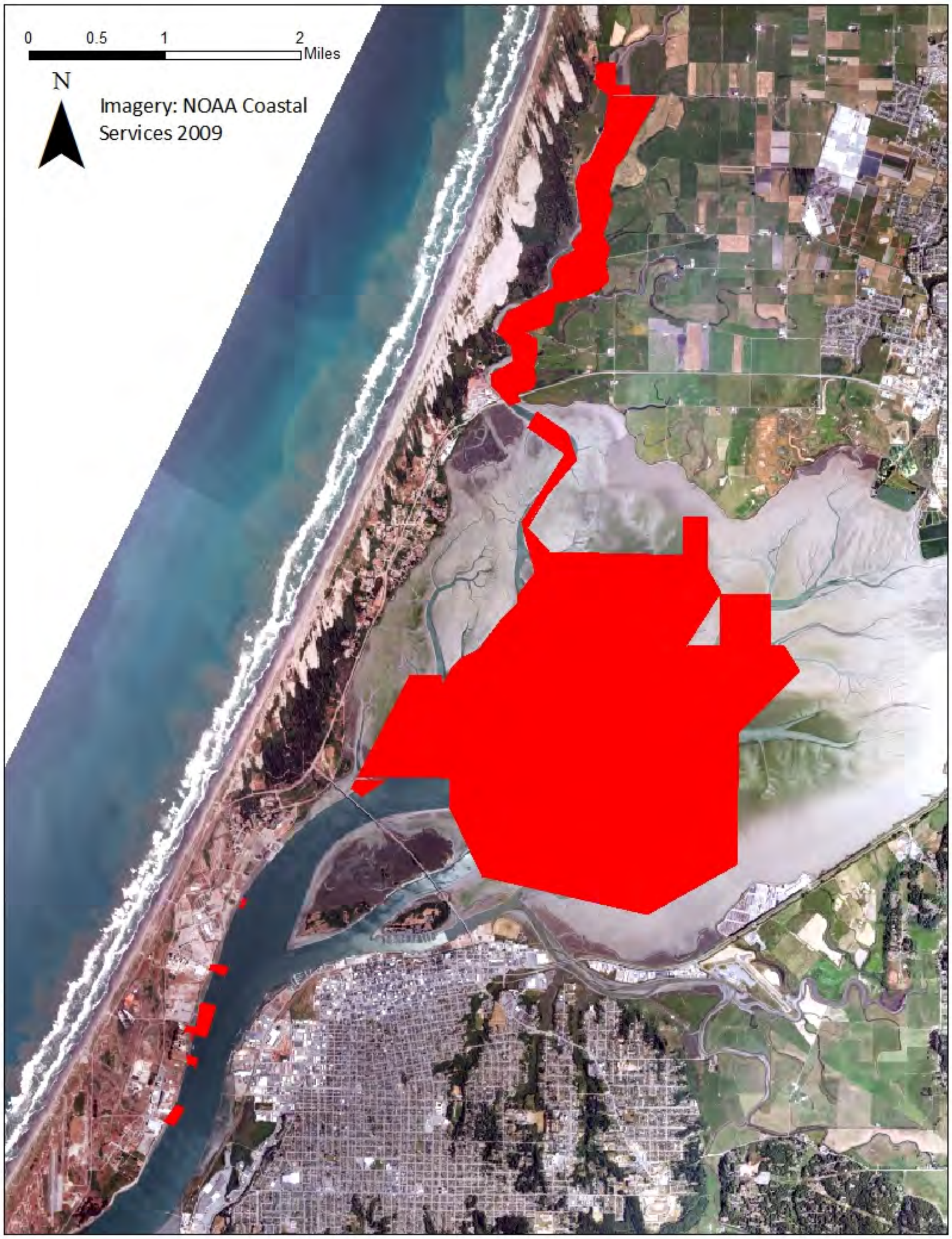

Figure 1. Existing tideland leases avoided by the Mariculture Pre-Permitting Project.

<u>Constraint 2: Dense Eelgrass (*Zostera marina*)</u>

The Project seeks to minimize effects to native eelgrass. This would be achieved through Project siting and mitigation measures. Figure 2 depicts areas mapped by NOAA Coastal Services in 2009 as having dense (>84% cover) eelgrass. These areas were generally avoided, with the exception that some areas were included in order to create site boundaries that can reasonably be surveyed and located (see *Delineation of Site Boundaries* below). A large proportion of the dense eelgrass distribution overlaps with existing tideland leases (Constraint 1). In total, 5,160 acres were avoided due to Constraint 1 (Existing Leases) and Constraint 2 (Dense Eelgrass).

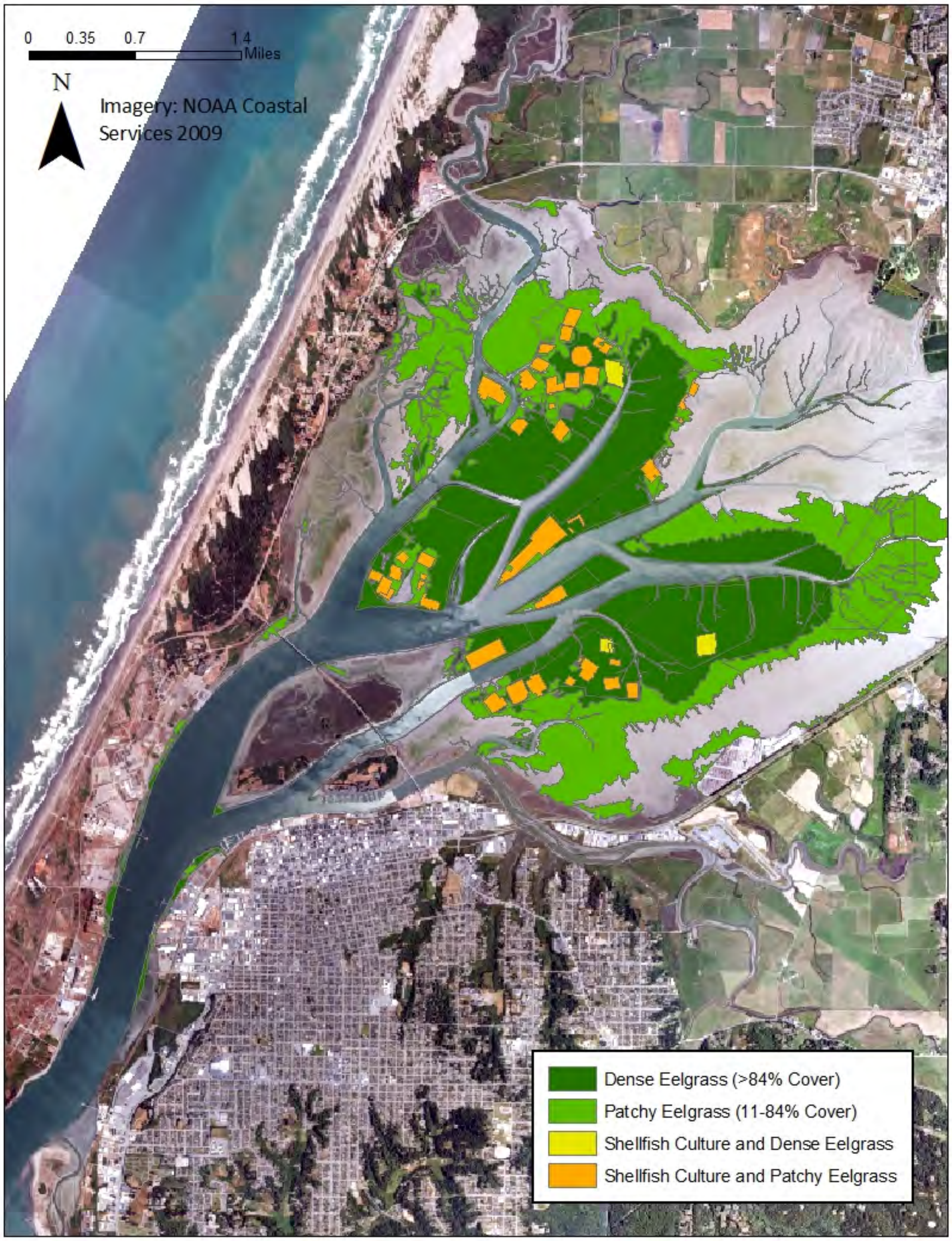

Figure 2. Eelgrass habitats in north Humboldt Bay based on mapping by NOAA Coastal Services in 2009.

Constraint 3: Marine mammal haulout areas.

The Project strives to avoid impacts to marine mammals. Based on our research, there is only one marine mammal haul out outside of existing leases (Constraint 1) and dense eelgrass (Constraint 2) (Figure 3). This site is utilized by harbor seals (*Phoca vitulina*). The Project was designed to avoid this location; the nearest Project Site (Site 1) is approximately 200 meters away.

Figure 3. Identified marine mammal (harbor seal) haul out site.

Constraint 4: Water Quality: Shellfish Culture Prohibition Area

The California Department of Health Services has identified two areas in Humboldt Bay where culture of shellfish for human consumption is prohibited[2] (Figure 4). These areas were avoided.

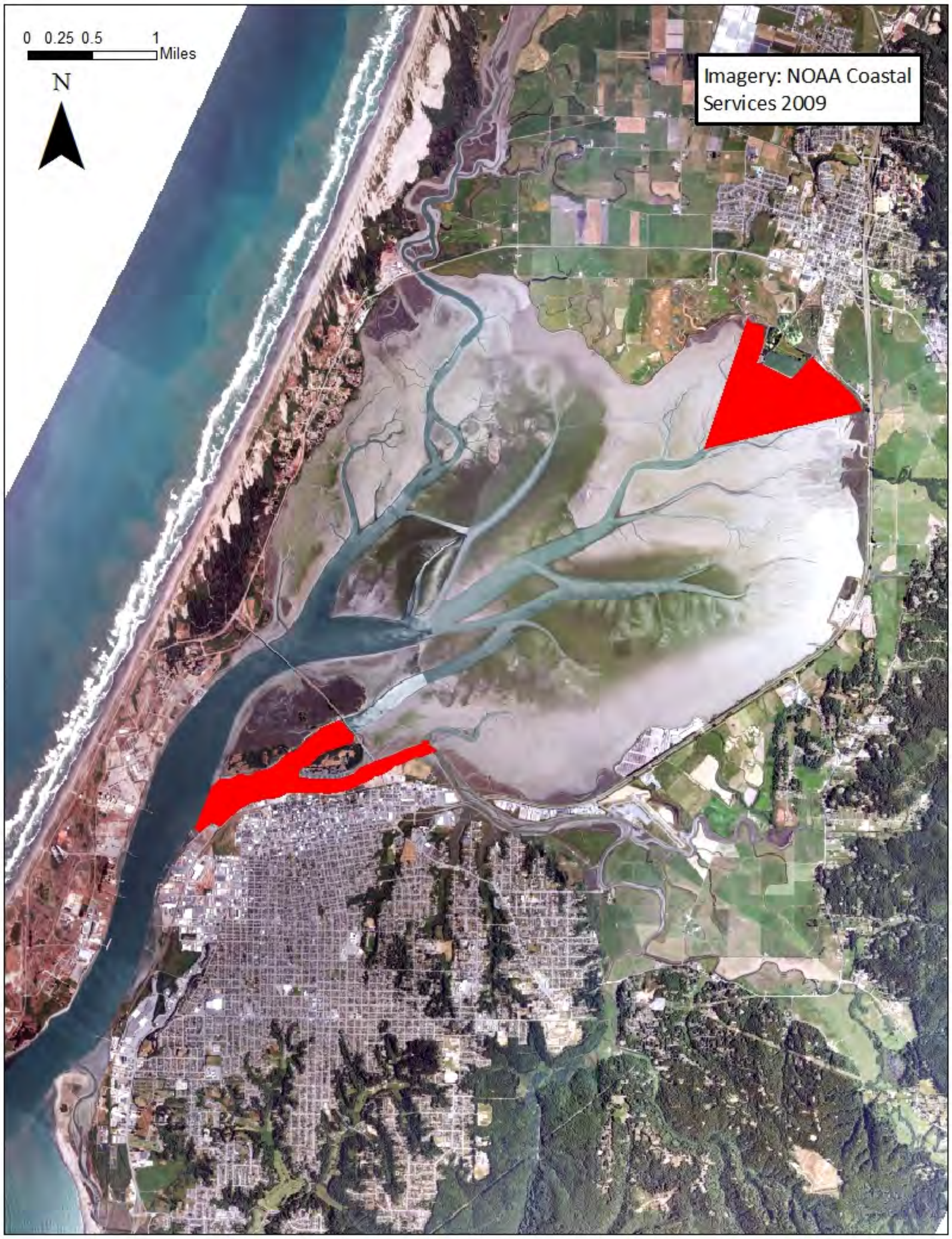

Figure 4. Areas prohibited for culture of shellfish for human consumption by the California Department of Health Services.

[2] California Department of Health Services. 2006. Shellfish growing area classification for Humboldt Bay: twelve-year sanitary survey report. Technical Report #06-11.

Assessment of Suitability for Shellfish Culture

Areas not excluded from consideration due to Constraints 1-4 were evaluated to determine suitability for economically viable shellfish culture. Input was obtained from culturists with experience in Bodega Bay, Tomales Bay, Humboldt Bay and Washington State. Suitability was based primarily on elevation; accessibility at various tide heights; and substrate (i.e., there was a focus on substrate that is firm enough to efficiently walk on). These parameters were assessed in the field by the District and culturists. Based on the assessment, the four intertidal and three subtidal sites described in the EIR were identified.

Delineation of Site Boundaries

Once the general Project areas were identified, as described above, site boundaries were delineated using ArcGIS 10.1. When digitizing the sites, an effort was made to create boundaries that could be reasonable delineated by surveyors and located by shellfish culturists, enforcement officials, biologists and others. As such, an effort was made to locate site vertices on full "degree-minute-second" spatial coordinates and to limit the number of polygon vertices (corners). To achieve this, some areas of dense eelgrass were captured within sites. However, this dense eelgrass will be avoided in order to comply with CEQA mitigation measures. An alternative to including the dense eelgrass in the sites would be to "zig-zag" site boundaries along the edges of dense eelgrass, but this would complicate mapping, surveying and site location efforts and is not considered a good alternative.

Selected Sites

As described above, sites were selected by (1) identifying constraints and avoiding them; and (2) identifying economically viable culture areas outside of the constrained areas, through consultation with experienced culturists. Constraints to siting and identified sites are depicted in Figure 5.

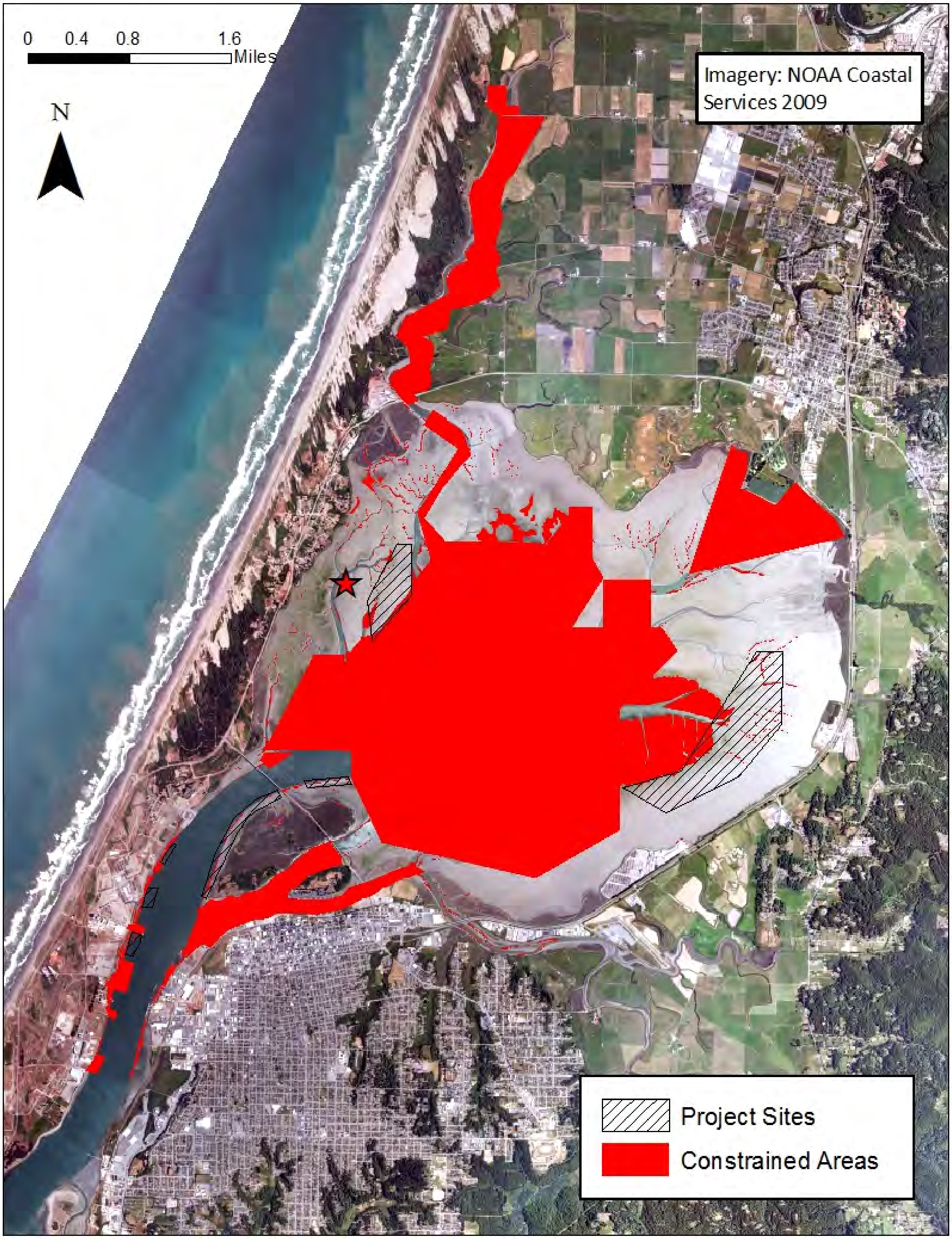

Figure 5. Areas with constraints to Project siting and selected sites.