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Coast Seafoods Company, Humboldt Bay Shellfish Aquaculture: Permit Renewal and Expansion Project

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) ADDENDUM

Prepared for:

Coast Seafoods/Pacific Seafood
October 2017

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Confluence Environmental Company

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ACRONYMS AND DEFINITION OF TERMS

Approved Project	The environmentally superior alternative that was selected by the Harbor District through the CEQA process.
culture bed or plot	The area used for shellfish aquaculture activities, including gear, shellfish products, and access locations. The culture bed (also called plot) is the entire acreage for those activities, including space between oyster longlines that do not have any gear or shellfish products.
basket-on-longline	A shellfish aquaculture method that uses SEAPA® baskets that are filled with oysters and placed on a line that is raised above the sediment surface by about 12 inches. The lines are supported by notched polyvinyl chloride (PVC) pipes embedded in rows of 100-foot lines.
CDFW	California Department of Fish and Wildlife
Certified EIR	The Revised R-DEIR and FEIR prepared for the Approved Project that was certified by the Harbor District on February 28, 2017.
CDP	Coastal Development Permit
CEQA	California Environmental Quality Act
Coast	Coast Seafoods/Pacific Seafoods Company
Commission	California Coastal Commission
cultch-on-longline	A shellfish aquaculture method that uses pieces of cultch that are installed on a PVC-supported monofilament line, raised above the sediment surface typically by 12 inches, and placed in rows of 100-foot lines.
DEIR	Draft Environmental Impact Report
double-hung	Double-hung refers to two lines for cultch-on-longline hung at different heights (8inches and 16 inches) attached to PVC tubes.
EBMA	East Bay Management Area
existing footprint	The current amount culture that is part of Coast's existing operations.
FEIR	Final Environmental Impact Report
FLUPSY	Floating Upwelling System
ft	foot or feet
Harbor District	Humboldt Bay Harbor, Recreation and Conservation District
NMFS	National Marine Fisheries Service
off-bottom culture	Shellfish aquaculture methods (e.g., cultch-on-longline, basket-on-longline, rack-and-bag) that raises the shellfish products off the sediment surface.
on-bottom culture	Shellfish aquaculture methods that place shellfish directly on the sediment surface and grow them until harvest.
rack-and-bag	A shellfish aquaculture method that uses elevated metal frames that support plastic mesh bags filled with oysters.
R-DEIR	Revised Draft Environmental Impact Report
Revised Project	The Coast proposed project that was approved by the Commission on September 13, 2017.
single-hung	Single-hung refers to a single line of cultch-on-longline attached to PVC tubes.

EXECUTIVE SUMMARY

The Coast Seafoods Company (Coast), Humboldt Bay Shellfish Aquaculture: Permit Renewal and Expansion Project (Project) has evolved through public and agency feedback. This feedback and evolution has occurred from June 2014 when the original application was submitted to the Humboldt Bay Harbor, Recreation and Conservation District (Harbor District) up until the culmination of the California Coastal Commission (Commission) process in September 2017. This California Environmental Quality Act (CEQA) Addendum evaluates the project proposal approved by the Commission (herein identified as the "Revised Project"), and compares it to the environmentally superior alternative identified in the certified Final Environmental Impact Report (FEIR) and approved by the Harbor District under CEQA (identified herein as the "Approved Project"). The FEIR and Revised Draft Environmental Impact Report (R-DEIR) prepared for the Approved Project are collectively referred to herein as the "Certified EIR."

In February 2017, the Harbor District certified the FEIR that thoroughly evaluated potential environmental impacts from Coast's proposed expansion in Arcata Bay at the north end of Humboldt Bay. The Certified EIR concluded that, upon incorporation of identified conservation and mitigation measures, the Approved Project would not result in any significant adverse environmental impacts. The permit is for an approximate 191-acre expansion of Coast's existing shellfish aquaculture operation, resulting in a total farmed footprint of approximately 490 acres.

The Revised Project reduces Coast's overall farmed footprint by 21 acres compared to existing footprint, resulting in an approved footprint of approximately 279 acres for intertidal oyster culture. As compared to the Approved Project, the Revised Project would reduce Coast's farmed footprint by approximately 212 acres. The Revised Project also reconfigures several existing culture beds within the areas owned or leased by Coast to provide greater spacing between oyster longlines, and relocates culture beds from East Bay into areas of Bird Island and Mad River where there are historical impacts from previous shellfish operations that used cultivation methods that have since been discontinued. The Revised Project proposes the same types of cultivation methods as currently used by Coast on its existing farm, which are also the methods analyzed in the Certified EIR. The culture methods and mechanisms of impact to various resources are unchanged from the prior analyses.

This addendum evaluates each environmental impact analyzed in the Certified EIR, and compares the impacts of the Revised Project to those previously evaluated for the Approved Project. In general, environmental impacts that result from the Revised Project are mostly reduced compared to the Approved Project. This reduction of impacts is primarily due to changes to the areas where culture is proposed or reductions in the total area proposed for shellfish aquaculture activities. Further, for many of the environmental impacts evaluated, the areas where cultivation is proposed under the Revised Project involve fewer ecological concerns as compared to certain areas proposed under the Approved Project. For example, the additional areas proposed for cultivation in the Bird Island and Mad River areas, which were not specifically analyzed in the Certified EIR, include fewer eelgrass beds, fewer impacts to shorebirds due to less overlap between potential shorebird habitat and culture beds, and fewer

areas where green sturgeon have been known to forage. For these reasons, and the other reasons contained in this Addendum, the Revised Project would not result in any new significant environmental impacts, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR. Therefore, the Revised Project does not require preparation of a Supplemental or Subsequent EIR.

1.0 INTRODUCTION

Coast owns or leases approximately 4,313 acres of intertidal and subtidal habitat in Central and North Bay (Arcata Bay) of the Humboldt Bay estuary. Most of the intertidal habitat in Arcata Bay was historically used by Coast, and predecessor companies, to support shellfish aquaculture since at least the 1950s. From 1997 to 2006, Coast reduced its aquaculture footprint from approximately 500 acres to 300 acres, and converted its operations from on-bottom to off-bottom aquaculture.

In June 2014, Coast applied to the Harbor District requesting renewal and amendment of its shellfish farm permit and lease. The Project proposed to maintain 300 acres of existing operations and expand into 622 acres for a total footprint of 922 acres. The potential environmental impacts associated with the project were described in a DEIR that was circulated by the Harbor District for public review on October 26, 2015.

Based on public comments received on the DEIR, several revisions were made to the project and DEIR analysis, including substantial revisions to the DEIR analysis concerning native eelgrass (*Zostera marina*) and other biological resources, phased project implementation, adoption of a "no net loss" standard as the threshold of significance for eelgrass impacts, proposed adaptive management for eelgrass, and a commitment to in-kind, compensatory mitigation for a reduction in eelgrass density. The Harbor District prepared the R-DEIR that included these changes, which was circulated for public review on July 18, 2016.

Additional revisions were included in the FEIR, which included a new alternative identified as the "East Bay Management Area (EBMA) Avoidance Alternative," which reduced the overall acreage of the expansion by more than 60% compared to the project presented in the DEIR. The EBMA Avoidance Alternative proposed to expand culture into 256 acres of fallow habitat in Arcata Bay that had been previously cultivated for oysters, and to remove a total of 64.7 acres of existing culture on Sand Island, Indian Island, and Arcata Channel as in-kind mitigation to support movement of green sturgeon (*Acipenser medirostris*), Pacific herring (*Clupea pallasii*) spawning locations, and use of Arcata Bay by black brant (*Branta bernicla*) and other marine birds. The EBMA Avoidance Alternative proposed a total net expansion of approximately 191.3 acres and a total farmed footprint, including Coast's existing farmed areas, of approximately 491.3 acres. The total acreage is almost equivalent to the amount of area used by oyster aquaculture activities in 1997. On February 28, 2017, the Harbor District selected the EBMA Avoidance Alternative (the Approved Project) as the environmentally superior alternative under CEQA and certified the FEIR.

The project also requires approval from the Commission. On June 7, 2017, the Commission rejected the Approved Project, finding that it did not meet certain Coastal Act requirements.[1] In

[1] The Commission conducts its own environmental analysis that has been determined to be equivalent to CEQA; however, the Commission's determination does not affect the validity of the Certified EIR or the Harbor District's prior evaluation of the Approved Project's environmental impacts.

response, Coast and Commission staff developed several further revisions to the Approved Project, including reducing the overall size of Coast's farmed footprint and consolidation of Coast's growing areas into three geographic locations of the bay (Revised Project). As opposed to the Approved Project, which proposed an expansion of Coast's farmed footprint, the Revised Project proposed an overall reduction in the size of Coast's farming area. The Commission approved a Coastal Development Permit (CDP) authorizing the Revised Project on September 13, 2017 (Commission 2017).

This document is an addendum to the Certified EIR previously certified by the Harbor District. This addendum evaluates the environmental impacts associated with the Revised Project as compared to the Approved Project, including locations approved by the Commission for shellfish aquaculture activities that were not originally covered by the Certified EIR, and demonstrates that all the potential environmental impacts associated with the proposed changes would be within the envelope of impacts already evaluated in the Certified EIR.

1.1 CEQA Authority for Addendum

The CEQA Guidelines provide that an addendum, rather than a supplemental EIR, is appropriate "if some changes are necessary [to the previously certified EIR] but none of the conditions described in Section 15162 . . . have occurred." These circumstances include:

- Substantial changes are proposed in the project which will require major revisions of the Certified EIR due to the involvement of new significant environmental effects or a substantial increase in the severity of previously identified significant effects;
- Substantial changes occur with respect to the circumstances under which the project is undertaken which will require major revisions of the Certified EIR due to the involvement of new significant environmental effects or a substantial increase in the severity of previously identified significant effects; or
- New information of substantial importance, which was not known and could not have been known with the exercise of reasonable diligence at the time the Certified EIR was certified as complete, shows any of the following:
  - The project will have one or more significant effects not discussed in the Certified EIR;
  - Significant effects previously examined will be substantially more severe than shown in the Certified EIR;
  - Mitigation measures or alternatives previously found not to be feasible would in fact be feasible, and would substantially reduce one or more significant effects of the project, but the project proponents decline to adopt the mitigation measure or alternative; or
  - Mitigation measures or alternatives which are considerably different from those analyzed in the Certified EIR would substantially reduce one or more significant

effects on the environment, but the project proponents decline to adopt the mitigation measure or alternative.[2]

1.2 Findings and Determination

As demonstrated by the analysis herein, the Revised Project would not result in any new additional significant impacts, nor would it substantially increase the severity of significant impacts previously identified in the Certified EIR. All the impacts associated with the Revised Project are within the envelope of impacts addressed in the Certified EIR, and do not constitute a new or substantially increased significant impact. In fact, as noted below, most of the environmental impacts associated with the Revised Project are less than those associated with the Approved Project. Further, there are no substantial changes to the circumstances under which the Approved Project analyzed in the Certified EIR would have been undertaken, and no new information of substantial importance which was not known when the EIR was certified has been identified. Therefore, the minor changes resulting from the Revised Project do not meet the standards for a Subsequent or Supplemental EIR, pursuant to CEQA Guidelines Section 15162.

2.0 PROJECT DESCRIPTION

The following information includes the project location, existing conditions, and a comparison of the Approved Project and Revised Project.

2.1 Project Location and Existing Conditions

The project site is in the north and central parts of Humboldt Bay, California. Humboldt Bay encompasses roughly 62.4 square kilometers (about 15,400 acres) at mean high tide in three geographic segments: South Bay, Entrance Bay, and Arcata Bay. Coast leases and/or owns approximately 4,313 acres in Arcata Bay (Figure 1). Coast's leased area includes approximately 1,827 acres owned or held in trust by the City of Eureka, approximately 1,452 acres owned or held in trust by the Harbor District, approximately 515 acres owned by the Karamu Corporation, approximately 5 acres owned by the Manila Community Services District, and approximately 514 acres owned by Coast.

Coast has been culturing shellfish in Humboldt Bay, California, since the early 1950s. Coast's predecessors cultured shellfish in Humboldt Bay since the early 1900s. Historically, there has been as much as 1,000 acres of tidelands used for oyster culture within the current owned and leased footprint. Coast traditionally cultured shellfish using bottom culture methods, which entailed growing oysters directly on the bay bottom and harvesting them with an oyster dredge. In the mid to late 1990s, in response to requests from regulatory agencies, Coast began to transition its operations to more environmentally sustainable off-bottom culture methods.

[2] *See* Pub. Resources Code § 21166; 14 CCR § 15162.

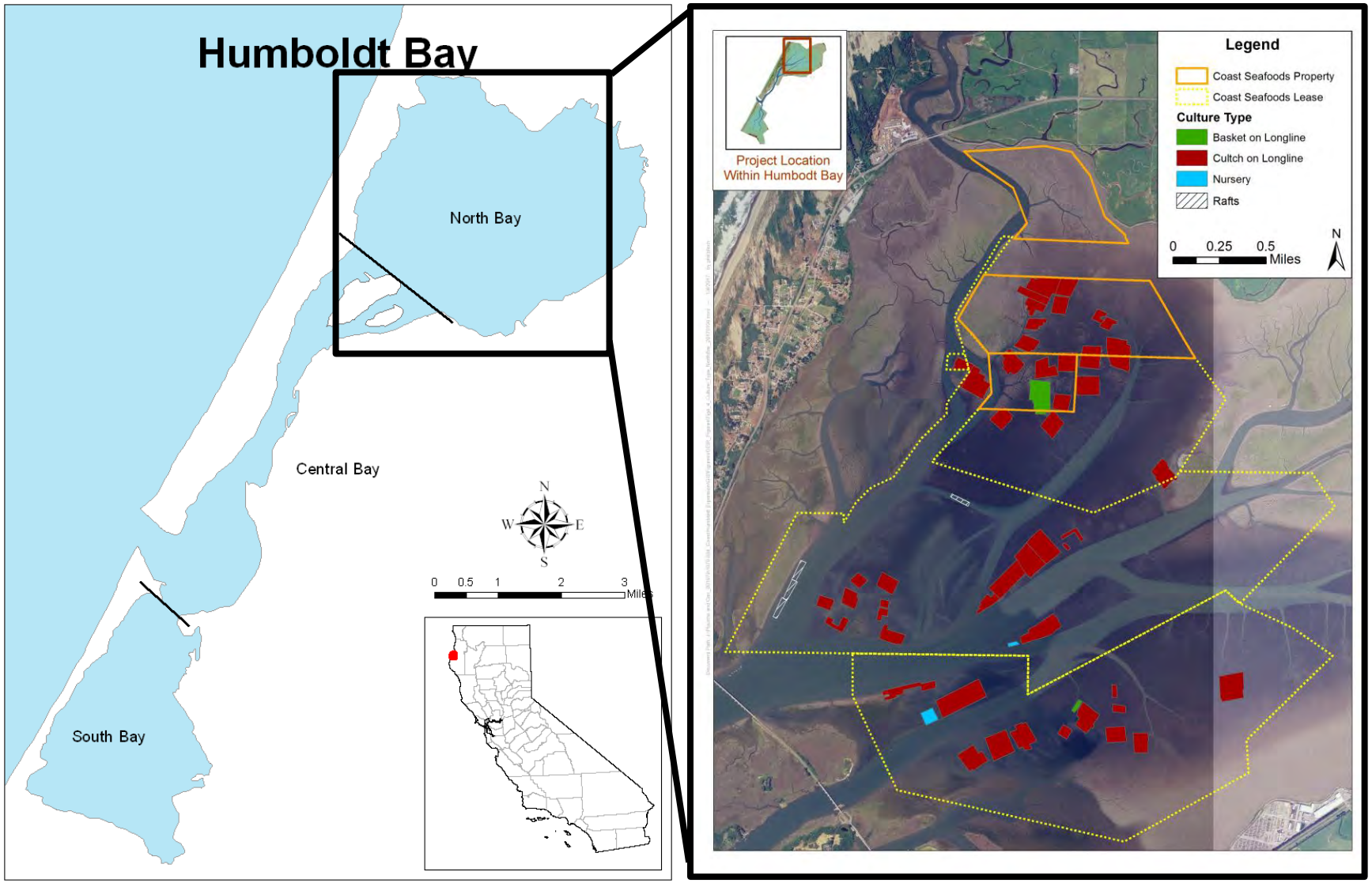

Figure 1 Location of Humboldt Bay, California, and Existing Shellfish Aquaculture in North (Arcata) Bay

Source: GIS layers provided by Wagschal, pers. comm., 2015; *Note*: Habitat and shellfish culture areas based on data from NOAA (2012).

In 2006, Coast reduced its operational farm footprint to 300 acres within Arcata Bay and Central Bay using exclusively off-bottom culture methods within intertidal habitat (cultch-on-longline, basket-on-longline, and rack-and-bag) to grow Pacific (*Crassostrea gigas*) and Kumamoto (*C. sikamea*) oysters. Coast also received approvals for clam rafts, a Floating Upwelling System (FLUPSY), intertidal nursery, and wet storage areas. In 2013, Coast amended its permits to convert to basket-on-longline culture in the portion of its existing footprint dedicated to rack-and-bag culture. Coast currently uses approximately 294 acres of its existing beds to cultivate Pacific and Kumamoto oysters using longline culture (cultch-on-longline and basket-on-longline), although Coast's existing footprint will need to be modified to be consistent with the Commission's approval.

The remaining acreage within the existing operational footprint is apportioned as follows: approximately 4.8 acres utilized as a nursery area; approximately 0.04 acres utilized for the FLUPSY; approximately 0.04 acres utilized for wet storage floats; and approximately 0.93 acres utilized for clam rafts. Coast's existing farm operations were thoroughly discussed in the Certified EIR and Coastal Commission (2017) staff report.

2.2 Approved Project

The Approved Project was proposed to occur in two phases over 8 years with a combination of existing culture, expansion of culture, and mitigation activities for each phase. The Approved Project renewed Coast's permit for its existing shellfish culture activities, and approved a 165.2-acre expansion associated with a Phase I operation (Figure 2) and 90.8-acre expansion associated with a Phase II operation (Figure 3). Cumulatively, the Approved Project included a 256-acre expansion of shellfish aquaculture activities in Arcata Bay. The culture methods included the same as those currently employed by Coast.

In-kind mitigation, through the removal of existing culture, was prioritized in three areas: Sand Island, Arcata Channel, and Indian Island. Mitigation included total removal of existing culture (fallowing) and was based on a 4:1 ratio of expansion acreage to removed existing culture acreage.

Phase I of the Approved Project included the following expansion and mitigation activities:

- Expansion of up to 4.0 acres of rack-and-bag or basket-on-longline culture in areas outside of native eelgrass beds, including a 25-foot (ft) buffer.
- Expansion of 72 acres of 9-ft spaced basket-on-longline culture with 16-ft boat rows between groups of 2 lines.
- Expansion of 89.2 acres of 10-ft spaced double-hung cultch-on-longline culture.
- Removal of 42.0 acres of 2.5-ft spaced single-hung cultch-on-longline culture on Sand Island.

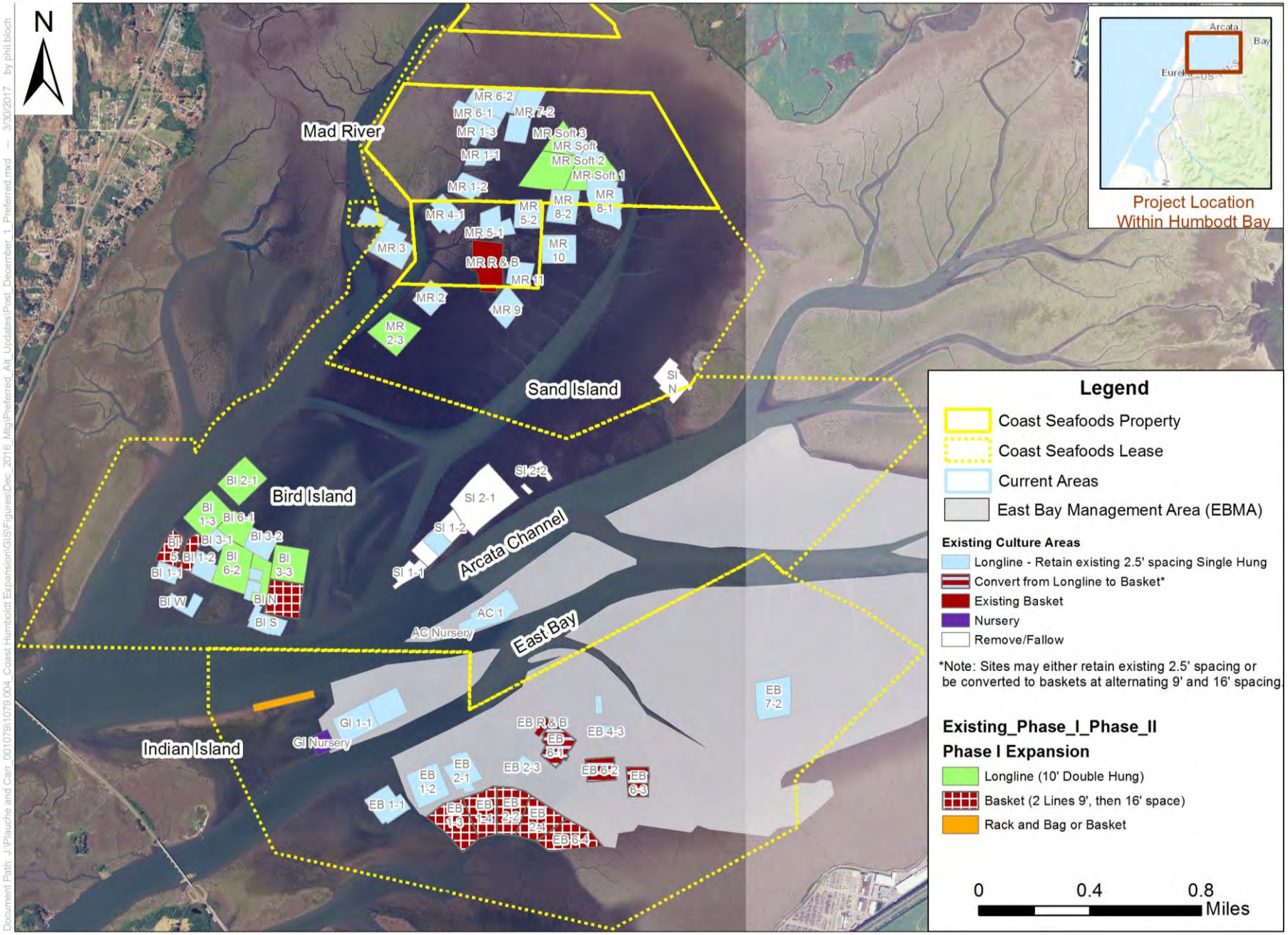

Figure 2 Approved Project Phase I Culture and Mitigation Areas

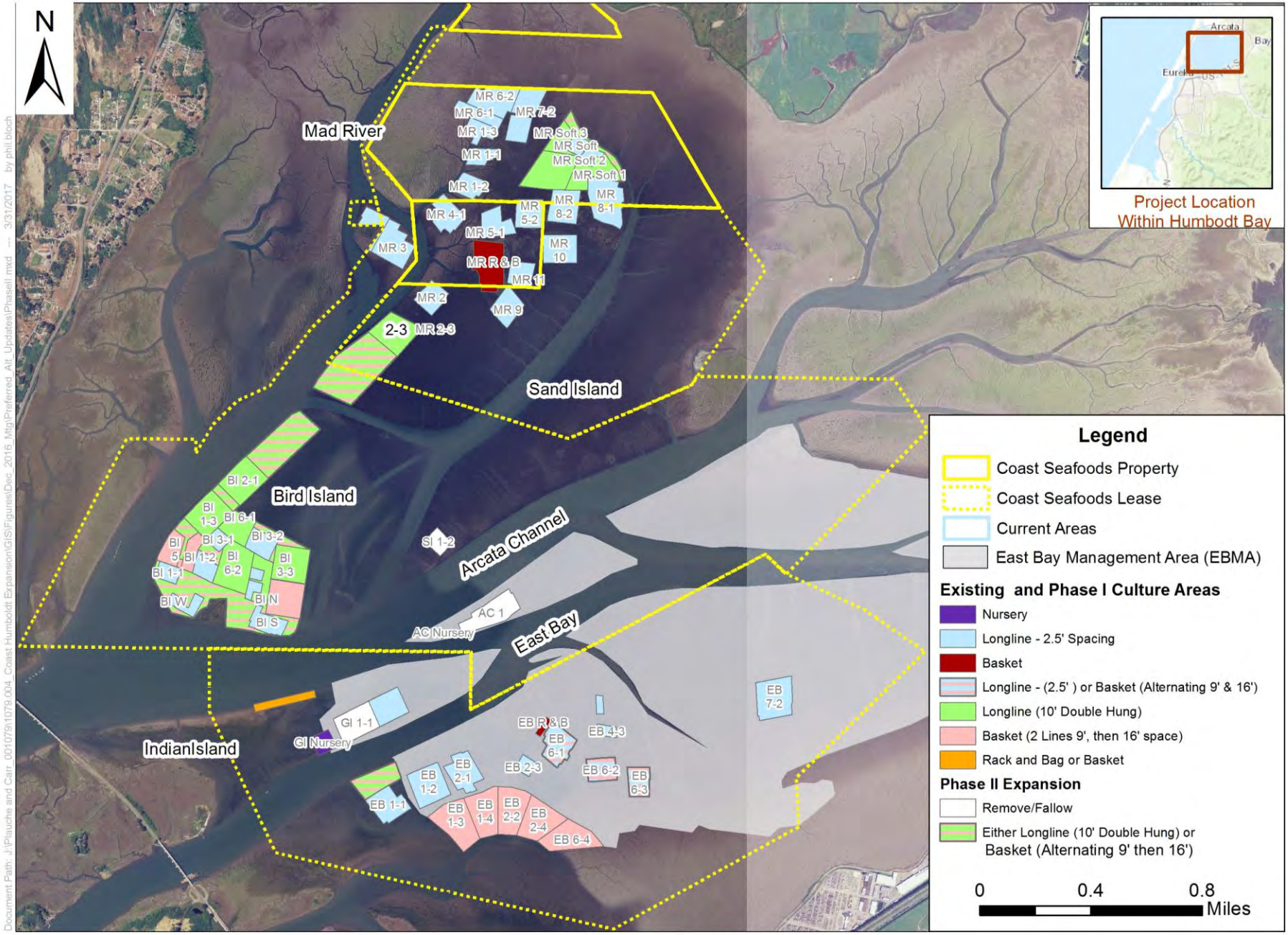

Figure 3 Approved Project Phase II Culture and Mitigation Areas

Phase II of the Approved Project included the following expansion and mitigation activities:

- Expansion of up to 90.8 acres of either 9-ft/16-ft basket-on-longline culture or 10-ft spaced double-hung cultch-on-longline culture.
- Removal of 22.7 acres of 2.5-ft spaced single-hung cultch-on-longline culture on Sand Island, Indian Island, and in Arcata Channel.

The total cumulative Approved Project acreage, including existing culture, removed culture, and expanded culture, was proposed to be 490 acres (11.4%) within the 4,313 acres owned or leased by Coast. As part of the Approved Project, the Harbor District also required Coast to implement an eelgrass monitoring plan and brant monitoring plan to confirm the impact analysis of those impacts described in the Certified EIR.

2.3 Revised Project

The Revised Project will reduce the total acreage operated by Coast from 300 acres to 279 acres over a 2.5-year period. This reduction will occur through complete removal of culture activity on Sand Island and consolidation of culture activities into three primary areas: around Bird Island, Mad River, and the southeastern area of Arcata Bay (Figure 4). Consolidation of culture activities will occur in areas previously used that have historical impacts (e.g., areas of historical dredging and shell deposition in the Mad River and Bird Island areas of the bay) described in the Certified EIR. In addition, Coast will increase its overall production levels by using cultivation techniques (i.e., SEAPA® baskets) that achieve more production per acre. The operational footprint, including cultivation beds and the location of vessel activity, will be reduced by 1/3 from the current operations.

The Revised Project will include the following activities:

- Remove approximately 63.2 acres of existing oyster longlines (spaced 2.5 ft apart) in the central and eastern areas of Humboldt Bay.
- Replant approximately 42.2 acres into areas of historical dredging and shell deposition in the Mad River and Bird Island areas of the bay. Cultivation beds in these relocation areas will be installed with a wider spacing between cultivation gear of either 10 ft spaces between double-hung cultch-on-longlines or alternating 9 ft and 16 ft spaces between basket-on-longlines.
- Convert approximately 20.6 acres of existing culture from densely spaced longlines to 9-ft- and 16-ft-spaced basket lines.

The remaining 215 acres of existing cultch-on-longline and basket-on-longline cultivation beds, as well as Coast's existing FLUPSYs, rafts, storage floats, and nursery operations, would continue as currently permitted. The total cumulative acreage proposed in the Revised Project (existing, replanted, and converted culture) is approximately 279 acres, or approximately 6.5% of the 4,313 acres owned or leased by Coast. Overall, the Revised Project would result in a net reduction of approximately 21 acres compared to Coast's existing footprint.

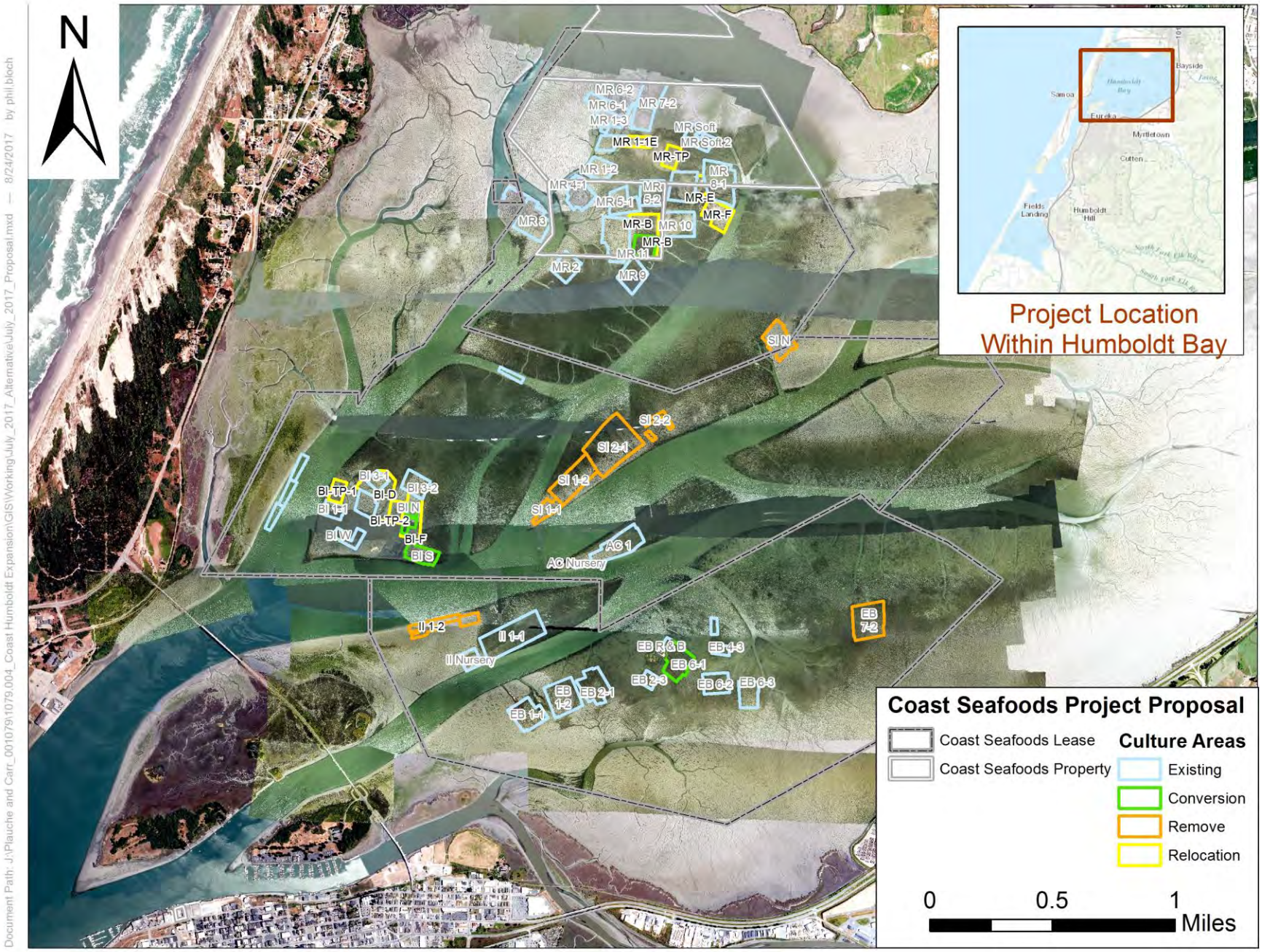

Figure 4 Revised Project Culture and Mitigation Areas

2.4 Project Comparison

As stated above, the Revised Project reduces the overall operational footprint as compared to the Approved Project. Table 1 provides a comparison of the intertidal culture acreage between the Approved Project and Revised Project.

Table 1 Comparison of Intertidal Culture Acreage by Habitat between the Approved Project and Revised Project

Habitat	Approved Project (acre)	Revised Project (acre)	Difference (acre)
Existing Intertidal Culture Area			
Mudflat	11.7	11.7	No Change
Continuous Eelgrass	25.2	25.2	No Change
Patchy Eelgrass	261.8	261.8	No Change
Total Existing Culture	298.7	298.7	No Change
Proposed Removal			
Removal	-64.7	-63.2	↓ 1.5
Existing Culture to Continue			
Mudflat	11.7	5.3	↓ 6.4
Continuous Eelgrass	25.2	18.1	↓ 7.1
Patchy Eelgrass	197.1	212.2	↑ 15.1
Total Continuing Culture	234.0	235.6	↑ 1.6
New Culture Areas (Expansion or Relocation)			
Mudflat	17.3	2.2	↓ 15.1
Continuous Eelgrass	127.0	8.9	↓ 118.1
Patchy Eelgrass	111.7	31.1	↓ 80.6
Total Expansion	256.0	42.2	↓ **213.8**
Total Project	490.0	277.8	↓ **212**.2

Other changes between the Approved Project and the Revised Project not identified above include the following:

- The Revised Project no longer proposes 4 acres of rack-and-bag culture near the northern end of Indian Island that was proposed by the Approved Project.
- The Revised Project includes 218.0 acres of cultch-on-longline culture (199.4 acres at existing spacing), compared to 307.2 acres in the Approved Project (218 acres at existing spacing). A reduction of about 29% of the cultch-on-longline culture proposed.
- The Revised Project includes 56.4 acres of basket-on-longline culture (12.1 acres at existing line spacing), compared to 174.0 acres in the Approved Project (12.1 acres at existing spacing). A reduction of about 68% of the basket-on-longline culture proposed.

- The Revised Project results in a reduction in vessel routes used for access of culture areas due to the increased concentration of culture activity into three primary growing areas – East Bay, Mad River, and Bird Island.
- The Revised Project moves the western boundary of Coast culture activities approximately ½ mile to the west due to the removal of culture areas in East Bay and Sand Island.

3.0 CONSERVATION AND MITIGATION MEASURES

Along with the 19 conservation measures provided in the Certified EIR, the Commission (2017) listed 22 special conditions associated with the CDP. The Certified EIR also proposed 13 mitigation measures to ensure that potential impacts under the Approved Project were reduced to a level that was less than significant. A summary of the final list of conservation measures, mitigation measures, and Commission special conditions applicable for each potential impact identified in the Certified EIR is presented in Appendix A.[3] The Revised Project will incorporate all conservation measures and mitigation measures described in the Certified EIR. No additional conservation and mitigation measures are proposed because the Revised Project would generally result in less impacts as compared to the Approved Project.

4.0 IMPACT ANALYSIS OF THE REVISED PROJECT

This section includes potential impacts associated with the Revised Project compared with the analysis and findings within the Certified EIR to determine if such impacts are within the envelope of impacts documented in the Certified EIR, including whether new significant impacts would result from the Revised Project or whether previously identified significant impacts would be substantially more severe. As set forth by the analysis below, the Revised Project would not result in any new significant environmental impacts or a substantial increase in the severity of a significant impact already identified in the Certified EIR.

Overall, the Revised Project proposes a reduction in acreage associated with Coast's farmed footprint rather than an expansion, includes a consolidation of culture in areas that were previously cultured, and proposes overall fewer lines per acre. There are changes in culture methodology for some of the existing areas (i.e., conversion from cultch-on-longline to basket-on-longline methods), and changes in the location where culture is proposed compared to the Certified EIR. These changes are the focus of the impact analysis for the Revised Project.

Table 2 provides a list of the topics covered in the Certified EIR.

[3] The Commission conditions are provided for informational purposes only. The analysis provided herein does not rely upon the Commission conditions to the extent that they are different than those imposed by the Harbor District in the Certified EIR. While adoption of such conditions is not required to mitigate any identified significant adverse environmental impact, the Addendum notes certain conditions approved by the Commission and accepted by Coast that will further reduce environmental impacts.

Table 2 Summary of Change in Potential Impacts, Conservation Measures, Mitigation Measures, Special Conditions, and Levels of Significance after Conservation/Mitigation for the Revised Project Description for Topics Discussed in the R-DEIR

Certified EIR Potential Impact Number	Certified EIR Topic	Level of Significance in Certified EIR	Change of Potential Impact	Additional Analysis
IMPACT CR-1	Placement of equipment	Less than significant after mitigation	Reduced	See Section 4.1
IMPACT CR-2	Impacts to eelgrass as a tribal cultural landscape	Less than significant after mitigation	Reduced	See Section 4.1
IMPACT CR-3	Impacts to other species with cultural significance	Less than significant after mitigation	Reduced	See Section 4.1
IMPACT BIO-1	Impacts associated with overwater structures	Less than significant	No Change	The Revised Project would include the same amount of overwater structures as the Approved Project.
IMPACT BIO-2	Amount of gear to be installed and changes to unstructured habitat from the addition of shellfish aquaculture gear	Less than significant	Reduced	See Section 4.2.1
IMPACT BIO-3	Eelgrass density reduction analysis	Less than significant after mitigation	Reduced	See Section 4.2.2
IMPACT BIO-4	Potential trampling of eelgrass related to access and activities during shellfish aquaculture operations	Less than significant	Reduced	See Section 4.2.3
IMPACT BIO-5	Potential to contribute to habitat fragmentation by placing oyster longline aquaculture within patchy and continuous eelgrass beds and boat use	Less than significant	Reduced	See Section 4.2.4
IMPACT BIO-6	The potential to affect the development of floating eelgrass rafts and wrack within intertidal habitat of North Bay	Less than significant	Reduced	As noted in Section 4.2.2, the Revised Project would result in fewer impacts to eelgrass as compared to the Approved Project. Additionally, the Revised Project increases longline spacing as compared to Coast's existing footprint, which should reduce the potential for floating eelgrass rafts to become entangled on longlines.
IMPACT BIO-7	The potential to change sediment distribution and tidal circulation	Less than significant	Reduced	The Revised Project would reduce the overall number of PVC pipes installed in the sediment as compared to existing conditions and, therefore, would result in less potential for scour. Further, the Revised Project proposes less basket-on-longline culture and significantly less overall culture as compared to the Approved Project, thereby reducing the potential to affect hydrodynamic conditions or sediment deposition patterns. The Revised Project also increases the spacing of approximately 63.2 acres of existing longlines, which is anticipated to improve hydrodynamic conditions.

Certified EIR Potential Impact Number	Certified EIR Topic	Level of Significance in Certified EIR	Change of Potential Impact	Additional Analysis
IMPACT BIO-8	The potential to change water column nutrients and turbidity conditions within intertidal habitat of North Bay	Less than significant	Reduced	Shellfish provide a benefit to the water column in reducing turbidity and removing nutrients from the water column. Because the Revised Project proposes less shellfish cultivation as compared to the Approved Project, beneficial impacts associated with the project would be slightly less.
IMPACT BIO-9	The potential to exceed carrying capacity in Humboldt Bay	Less than significant	Reduced	The Revised Project would result in approximately 212 acres less shellfish cultivation as compared to the Approved Project. Because fewer shellfish would be produced, impacts associated with carrying capacity would be less than projected in the Certified EIR.
IMPACT BIO-10	The potential to change the presence and persistence of contaminants within North Bay	Less than significant	Reduced	The Revised Project is anticipated to require slightly less boat trips to service Coast's cultivation plots as compared to the Approved Project, which would therefore result in a slight reduction in potential accidental discharge of fuel, lubricants, or hydraulic fluid.
IMPACT BIO-11	The potential to change sediment quality underneath shellfish aquaculture gear due to biodeposits from filter-feeding organism	Less than significant	Reduced	The Revised Project would result in less dense cultivation beds and less planted acreage as compared to Coast's existing plots, which would reduce potential impacts associated with biodeposits.
IMPACT BIO-12	The potential to change benthic invertebrate species composition through the addition of nutrients to the sediment or adding structure	Less than significant	Reduced	The Revised Project would result in less dense culture beds and less planted acreage as compared to Coast's existing footprint, which would reduce potential impacts associated with changes to sediment composition. The Revised Project would also result in less structure (PVC pipes) as compared to the Approved Project.
IMPACT BIO-13	The potential to change benthic species composition through trampling during site access for shellfish aquaculture activities (e.g., planting, harvesting, and maintenance)	Less than significant	Reduced	The Revised Project would eliminate rack-and-bag culture, which would have involved the greatest (although still less than significant) potential of trampling. Further, the Revised Project would result in a significant reduction in cultivated acreage as compared to both the Approved Project and Coast's existing footprint, thereby further reducing potential impacts associated with trampling.
IMPACT BIO-14	The potential to introduce non-indigenous species (NIS) to Humboldt Bay from commercial shellfish aquaculture operations	Less than significant	Reduced	Impacts associated with the Revised Project are anticipated to be less than the Approved Project because the Revised Project includes less structure upon which NIS can colonize.
IMPACT BIO-15	The potential to naturalize cultured oysters (that are NIS) into Humboldt Bay	Less than significant	Reduced	The Revised Project reduces the overall amount of proposed oyster cultivation as compared to the Approved Project, thereby reducing the potential for the naturalization of cultured oysters into Humboldt Bay.

Certified EIR Potential Impact Number	Certified EIR Topic	Level of Significance in Certified EIR	Change of Potential Impact	Additional Analysis
IMPACT BIO-16	Potential impacts to Dungeness crab from the expansion of oyster aquaculture in Humboldt Bay	Less than significant	Reduced	See Section 4.2.5
IMPACT BIO-17	Potential impacts to Pacific lamprey from the expansion of oyster aquaculture in Humboldt Bay	Less than significant	Reduced	Impacts associated with the Revised Project are anticipated to be reduced based on the significant reductions in Coast's planted area.
IMPACT BIO-18	Potential impacts to sturgeon from the expansion of oyster aquaculture in Humboldt Bay	Less than significant	Reduced	See Section 4.2.6
IMPACT BIO-19	Potential impacts to salmonids from the expansion of oyster aquaculture in Humboldt Bay	Less than significant	Reduced	See Section 4.2.7
IMPACT BIO-20	Potential impacts to longfin smelt from the expansion of oyster aquaculture in Humboldt Bay	Less than significant	Reduced	See Section 4.2.8
IMPACT BIO-21	Potential impacts to Pacific herring from the expansion of oyster aquaculture in Humboldt Bay	Less than significant after mitigation	Reduced	See Section 4.2.9
IMPACT BIO-22	Potential impacts to groundfish from the expansion of oyster aquaculture in Humboldt Bay	Less than significant	Reduced	The Revised Project would reduce potential impacts to eelgrass, which is an important habitat for groundfish, as compared to the Approved Project. Further, the Revised Project would have less structured habitat compared to the Approved Project, which could provide a benefit to certain types of groundfish that tend to avoid structure, such as California halibut and bat rays.
IMPACT BIO-23	Potential impacts to marine mammals from the expansion of oyster aquaculture in Humboldt Bay	Less than significant after mitigation	Reduced	While both the Approved Project and Revised Project would remove existing gear near seal haul-out locations on Sand Island and near Arcata Channel, removal would be completed faster with the Revised Project, thereby further reducing potential impacts.
IMPACT BIO-24	Potential impacts to special-status bird species from the expansion of oyster aquaculture in Humboldt Bay	Less than significant	Reduced	The Revised Project reduces the overall amount of proposed oyster cultivation as compared to the Approved Project, thereby reducing the potential for the impacts to marbled murrelets or western snowy plovers.
IMPACT BIO-25	Potential impacts to black brant foraging from the expansion of oyster aquaculture in Humboldt Bay	Less than significant after mitigation	Reduced	See Section 4.2.10

Certified EIR Potential Impact Number	Certified EIR Topic	Level of Significance in Certified EIR	Change of Potential Impact	Additional Analysis
IMPACT BIO-26	Potential impacts to black brant associated with human disturbance from the expansion of oyster aquaculture in Humboldt Bay	Less than significant	Reduced	See Section 4.2.10
IMPACT BIO-27	Potential impacts to black brant associated with loss of grit sites from the expansion of oyster aquaculture in Humboldt Bay	Less than significant	Reduced	The Certified EIR identified one brant grit site in Arcata Bay, located on Sand Island. Both the Revised Project and Approved Project prioritize removal of Coast's existing culture plot located closest to that grit site to minimize potential impacts.
IMPACT BIO-28	Potential impacts to roosting birds from the expansion of oyster aquaculture in Humboldt Bay	Less than significant	Reduced	The Revised Project will involve less boat trips as compared to the Approved Project. Further, the Revised Project would include a vessel management plan, in compliance with California Coastal Commission conditions to further reduce potential disturbances or flushing of birds.
IMPACT BIO-29	Potential impacts to nesting birds from the expansion of oyster aquaculture in Humboldt Bay	Less than significant	Reduced	The Certified EIR identified a nesting colony of Caspian terns and double-crested cormorants located on Sand Island near one of Coast's existing culture areas. Both the Revised Project and Approved Project prioritize removal of Coast's existing culture plot located closest to that nesting site to minimize potential impacts.
IMPACT BIO-30	Potential impacts to birds from artificial lighting	Less than significant	Reduced	The Revised Project reduces the overall amount of proposed oyster cultivation as compared to the Approved Project, thereby reducing the potential for the impacts from artificial lighting used by work boats.
IMPACT BIO-31	Potential impacts to birds from human disturbance	Less than significant	Reduced	Same as IMPACT BIO-28 above.
IMPACT BIO-32	Potential impacts to waterfowl foraging from the expansion of oyster aquaculture in Humboldt Bay	Less than significant	Reduced	See Section 4.2.11
IMPACT BIO-33	Potential impacts to shorebird foraging from the expansion of oyster aquaculture in Humboldt Bay	Less than significant	Reduced	See Section 4.2.12
IMPACT AV-1	Effect on scenic vistas and visual character from worker and vessel presence	Less than significant	Reduced	See Section 4.3
IMPACT AV-2	Effect on scenic vistas and visual character from shellfish culture equipment presence	Less than significant	Reduced	See Section 4.3
IMPACT AV-3	Effects of glare and artificial lighting	Less than significant	Reduced	See Section 4.3
IMPACT AQ-1	Contribution to PM_{10} levels	Less than significant	Reduced	See Section 4.4
IMPACT GHG-1	Generation of GHGs	Less than significant	No Change	See Section 4.5

Certified EIR Potential Impact Number	Certified EIR Topic	Level of Significance in Certified EIR	Change of Potential Impact	Additional Analysis
IMPACT GHG-2	Conflict with an applicable plan, policy, or regulation adopted for reducing the emissions of GHGs	Less than significant	No Change	See Section 4.5
IMPACT WQ-1	Water Quality	Less than significant	No Change	See Section 4.6
IMPACT WQ-2	Sedimentation	Less than significant	Reduced	See Section 4.6
IMPACT HAZ-1	Hazard to people or the environment through the routine transport, use, emission, or release of hazardous materials	Less than significant	Reduced	See Section 4.7
IMPACT HAZ-2	Hazard from the abandonment or loss of marine debris	Less than significant	Reduced	See Section 4.7
IMPACT HAZ-3	Health hazard from bioaccumulation of dioxins in shellfish meat	Less than significant	Reduced	See Section 4.7
IMPACT REC-1	Effects on recreational facilities	Less than significant	No Change	See Section 4.8
IMPACT REC-2	Effects on recreational users of the bay	Less than significant	Reduced	See Section 4.8
IMPACT NOISE-1	Generation of noise levels in excess of established standards	Less than significant	No Change	See Section 4.9
IMPACT TRANS-1	Effects of intertidal culture operations and equipment on watercraft (e.g. boats, kayaks) navigation	Less than significant	Reduced	See Section 4.10

The topics that are not discussed further in this addendum are covered in Table 2 with a summary of potential impacts. These topics result in no changes to the project description presented in the Certified EIR other than either maintaining the same description (i.e., no change in potential impacts) or reducing potential impacts because of the reduction in area used for oyster aquaculture.

4.1 Cultural, Archeological, and Tribal Cultural Resources (IMPACT CR1 to CR-3)

The Certified EIR concluded that there were no known cultural, archaeological, or tribal cultural resources in the project area, and incorporated mitigation measures to address potential resources found during expansion or operational activities (see Appendix A). The Certified EIR also evaluated impacts to native eelgrass as a tribal cultural landscape and other species, such as Dungeness crab (*Cancer magister*) and black brant, that were identified as important to the Wiyot Tribe. The Certified EIR concluded that these impacts would be less than significant based upon the EIR's analysis of project impacts associated with those species and the adoption of mitigation measures identified in the Certified EIR's biological analysis.

The Revised Project would further reduce potential impacts to cultural, archeological, and tribal cultural resources. Based upon further consultation with the Wiyot Tribe, the Revised Project would eliminate 4 acres of rack-and-bag cultivation proposed to be located on Indian Island as part of the Approved Project, and removes 6.6 acres of existing culture on Indian Island near the village of Tuluwat. This location was identified by the Wiyot Tribe as being important to its cultural practices. Consolidating culture activities into areas that were previously disturbed by historical culture activities would further reduce the potential to impact culturally important resources. Further, as described in greater detail below, the Revised Project would result in reduced impacts to eelgrass, Dungeness crab, black brant, and other species that are important to the Wiyot Tribe's cultural practices. Therefore, the Revised Project would not result in any new significant impacts associated with cultural, archaeological, and tribal cultural resources, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.2 Biological Resources (IMPACT BIO-1 through BIO-33)

The Certified EIR analyzed 33 different impact categories associated with biological resources. It concluded that all but four impacts (BIO-3, BIO-21, BIO-23, and BIO-25) would be less than significant without mitigation. The remaining four impacts were determined to be less than significant upon implementation of mitigation measures and that the Approved Project would result in no significant and unavoidable biological impacts. Several of the biological impacts, where there is little or no change to the Certified EIR analysis, are discussed above in Table 2.

Generally, as described in Table 2, the overall biological impacts associated with the Revised Project are anticipated to be less than those described for the Approved Project, because: (1) the Revised Project would reduce Coast's overall farmed footprint, as opposed to the expansion proposed in the Approved Project; (2) the Revised Project would consolidate proposed

operations in the western half of Arcata Bay and avoid portions of the EBMA identified as important to herring and other species; (3) the Revised Project proposes a reduction of nearly 199 acres of cultivation in areas with eelgrass, including approximately 118 fewer acres of cultivation in continuous eelgrass; and (4) the Revised Project converts approximately 62.8 acres of existing longline culture from 2.5-ft spacing to wider spacing. These changes are anticipated to reduce the biological impacts identified below.

4.2.1 Changes to Unstructured Habitat (IMPACT BIO-2)

The Certified EIR discussed impacts associated with changes to unstructured habitat, primarily due to the addition of PVC support posts and aquaculture gear associated with proposed longlines, rack-and-bag, and basket-on-longline culture methods. The Approved Project would result in an additional 0.03 acres of PVC pipes, after mitigation, to unstructured habitat and would occupy approximately 0.8% of the unstructured habitat available in Arcata Bay. Further, the additional gear would not significantly change the habitat type or species use of Arcata Bay because the amount of gear added represented a small proportion of the culture bed itself. The Certified EIR determined that this proposed change is small as compared to the amount of available unstructured habitat in Arcata Bay, and that the Approved Project may provide a minor benefit through increasing food resources within culture areas. Therefore, this impact was considered less than significant.

While the Approved Project would increase the total amount of PVC pipe and aquaculture gear in specific areas of the bay, the Revised Project would decrease the amount of gear overall compared to existing conditions. As shown in Table 3, the number of lines used will be reduced by 29% in the Revised Project compared to Approved Project through a combination of acreage reduction and conversion to different culture methods or wider spaces. The Revised Project also proposes approximately 15 acres less of culture in unstructured mudflats as compared to the Approved Project (see Table 1). The amount of gear, as measured by lines, will also decrease when compared to the existing conditions. The number of potential lines in existing growing areas is 36,850, of which 650 are basket lines. As shown in Table 3, this total will decrease by approximately 10% (3,700 lines). The decrease is due to approximately 5,300 fewer cultch-on-longlines lines. This reduction is partially offset by an increase of 1,600 basket-on-longline lines.

Table 3 Culture Area and Number of Lines by Culture Method between the Approved Project and Revised Project

Culture Method	Approved Project		Revised Project		Difference	
	Culture Area (acre)	Number of Lines	Culture Area (acre)	Number of Lines	Culture Area (acre)	Number of Lines
2.5-ft/5-ft single-hung	218	31,900	199.4	29,200	-18.6	-2700
10-ft double-hung	89.2	7,900	18.7	1,700	-70.5	-6200
3-ft baskets	12.1	650	12.1	650	0	0
9-ft/16-ft baskets	162.8	5,900	44.4	1600	-118.4	-4300
Total Culture	481.2	46,350	274.6	33,150	-206.6	-13,200

Overall, the Revised Project will still result in more unstructured habitat available for use by species in Arcata Bay as compared to existing conditions. Further, consolidation of culture gear near areas already utilized by Coast for aquaculture will result in more areas where shellfish gear is not present in Arcata Bay overall. Most importantly, even though these areas have an increase in shellfish aquaculture gear, that does not mean that species are restricted from these areas, as discussed below. Therefore, the Revised Project would not result in any new significant impacts associated with changes to unstructured habitat, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.2.2 Eelgrass Density Reduction (IMPACT BIO-3)

The Certified EIR discussed impacts associated with reductions in eelgrass density, primarily due to stranding, physical abrasion, trampling (discussed more below), and shading. Based on ground observations and aerial photography within shellfish aquaculture beds in Arcata Bay, eelgrass is present within the longline plots but there is a reduction in the density of eelgrass when longlines are present. The Approved Project was calculated to result in a density reduction between 1.6% and 19% within the culture bed. The reduction in eelgrass density, which is thought to reduce potential ecological functions associated with eelgrass beds (NMFS 2014), was mitigated through removal of existing culture gear on Sand Island, Indian Island, and near Arcata Channel (see Appendix A). This would result in complete removal (or fallowing) of existing culture and existing activity, which would eliminate potential sources of eelgrass suppression. Therefore, eelgrass density reduction impacts were considered less than significant after mitigation.

Generally, the Revised Project would result in less impacts to eelgrass as compared to both the Approved Project and existing conditions. As shown in Table 1, the Revised Project would reduce Coast's overall planted footprint by approximately 21 acres as compared to existing conditions and would result in nearly 199 acres less overlap with eelgrass habitat compared to the Approved Project. Furthermore, the Revised Project reduces the overlap between culture and eelgrass habitat (continuous and patchy) compared to the existing footprint by approximately 16.3 acres (from 286.9 acres of overlap to 270.3 acres of overlap). That said, the Revised Project would involve some changes not analyzed in the Certified EIR, including: (1) consolidation of culture activities around Bird Island, Mad River, and the southeastern area of Arcata Bay, and (2) the increase in basket-on-longline culture methods compared to existing conditions.

The consolidation of culture activities is intended to reduce the potential overlap between shellfish aquaculture activities and eelgrass habitat. The areas proposed for consolidation of culture gear in the Revised Project are primarily located in the Bird Island and Mad River areas, adjacent to areas already used for shellfish cultivation. These areas have exhibited less eelgrass growth than other areas, such as the EBMA, which may be due to historical dredge scarring and shell deposition from previous shellfish culture practices that have not been used by Coast since at least 2006. Further, the Revised Project proposes to increase longline spacing for 62.8 acres of

existing 2.5-ft spaced longline culture, to either 10-ft cultch-on-longline spacing or to basket-on-longline culture with 9-ft and 16-ft spaces between lines (including culture bed EB 6-1 that is surrounded by a continuous eelgrass bed). Additional benefits to eelgrass, as compared to both existing conditions and the Approved Project, are expected due to removal of existing culture bed East Bay 7-2 (11.7 acres) that is located within a continuous eelgrass bed in the EBMA. Therefore, there is less potential for interactions between eelgrass habitat and shellfish aquaculture based on the Revised Project even with the consolidation of culture gear.

In terms of the increased use of basket-on-longline culture methods compared to existing operations, there is a potential to increase the area of potential shading (i.e., 0.3 ft to 0.8 ft for different sizes of cultch vs. 0.8 ft for baskets). However, the area proposed for baskets is a conversion from a higher density of cultch-on-longline methods at lines spaced 2.5-ft apart to wider spaced lines at alternating 9-ft and 16-ft lines. This results in an overall decrease in the amount of potential shading in the culture bed from 26% to 7% of the bed. Further, as compared to the Approved Project, the Revised Project proposes 117.6 acres less of basket-on-longline culture.

Finally, Coast has submitted an eelgrass monitoring plan that will quantify the loss of eelgrass density or percent vegetated cover within three relocated culture beds over a 5-year monitoring term (Appendix B). The results of the eelgrass monitoring plan will provide information on whether the assumptions of eelgrass density reduction in the Certified EIR are accurate. This will then provide an accounting of eelgrass impacts associated with the Revised Project. Therefore, the Revised Project would not result in any new significant impacts associated with eelgrass, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.2.3 Eelgrass Trampling (IMPACT BIO-4)

In addition to the general discussion of impacts to eelgrass density discussed in Section 4.2.2, the Certified EIR also included an analysis of impacts specifically associated with trampling. The potential for trampling impacts is related to the frequency of activities within a culture plot. The Certified EIR determined that cultch-on-longline requires approximately 1 day per month for each 10-acre area to monitor and repair lines, and 2 days per acre every 18 to 36 months to plant and harvest. Basket-on-longline culture is visited more frequently than cultch-on-longline. This culture method is visited on an almost daily basis, but crews are not in the same parts of the bed each day; instead, they work through a bed such that an individual line is visited on average once every 4 months (average rate of 12 days per acre). In addition, maintenance and harvest activities can be done by boat, including approximately 44% of cultch-on-longline operations and 80% for basket-on-longline operations. The Certified EIR determined that, at the proposed density of longline planting and frequency of activity associated with each plot, in general the disturbances from the Approved Project would be infrequent and would allow eelgrass to recover quickly from any trampling effects. Therefore, eelgrass trampling impacts were considered less than significant.

Trampling impacts from the Revised Project are likely reduced as compared to the Approved Project. As described in Table 1, the amount of existing culture in continuous eelgrass would be reduced by 7.1 acres in the Revised Project, and the amount of proposed new or relocated culture in continuous or patchy eelgrass are reduced by 118.1 and 80.6 acres, respectively. These reductions create a reduced potential for eelgrass trampling. The consolidation of culture beds proposed by the Revised Project focused on areas with low eelgrass densities, which further limits the potential for trampling. While the Revised Project includes more proposed basket-on-longlines as compared to existing conditions, it still would represent a significant reduction in the amount of basket-on-longline plots as compared to the Approved Project. Therefore, the Revised Project would not result in any new significant impacts associated with eelgrass trampling, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.2.4 Habitat Fragmentation (IMPACT BIO-5)

The Certified EIR discussed impacts to habitat fragmentation from the addition of oyster longlines into new habitats, especially areas with native eelgrass. The Certified EIR found that placement of longline aquaculture (i.e., basket-on-longlines and cultch-on-longlines) within patchy and continuous eelgrass beds was not expected to contribute to habitat fragmentation or affect epifaunal species richness, total epifauna density or diversity. The three mechanisms that may contribute to habitat fragmentation that were reviewed in the Certified EIR (trampling eelgrass through site access and egress by staff on foot, boat moorage in eelgrass areas, and shading or physical disruption of eelgrass habitat by longline culture gear) were all determined to be minor impacts because of the conservation and mitigation measures used by Coast to reduce or avoid these impacts. Finally, the proposed removal of culture activities on Sand Island, Indian Island, and around Arcata Bay were proposed to allow a larger span of open habitat that could support movement and use by green sturgeon, black brant, Pacific herring, and other important resources. Therefore, habitat fragmentation impacts were considered less than significant.

Potential habitat fragmentation impacts from the Revised Project are likely reduced compared to the Approved Project. As described in Table 1, the total amount of continuous eelgrass habitat overlapping with proposed expanded or relocated aquaculture would be decreased by 118.1 acres (i.e., from 127 acres to 8.9 acres). The amount of patchy eelgrass habitat overlapping with proposed aquaculture would also be decreased by 80.6 acres (i.e., from 111.7 acres to 31.1 acres). These decreases in eelgrass habitat area would decrease the potential for habitat fragmentation. Furthermore, the distribution of proposed culture beds shown in Figure 4 reflects an increased consolidation of culture areas, leaving large portions of Central and Eastern Arcata Bay with no culture activity. The removal of culture bed EB 7-2 creates a large area of continuous eelgrass in the western portion of East Bay where no culture activity will occur. Similar benefits occur on Sand Island where removal existing culture activity, similar to the Approved Project, will open additional undisturbed habitat areas. Therefore, the Revised Project would not result in any new significant impacts associated with habitat fragmentation, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.2.5 Dungeness Crab (IMPACT BIO-16)

The Certified EIR discussed impacts to Dungeness crab from the potential loss of habitat and generation of marine debris. Because of the conclusion, through mitigation, that there would be a no net loss of eelgrass habitat from the Approved Project, potential impacts to Dungeness crab habitat were considered minor. Further, the legacy shell deposition that is present throughout the bay in areas of historical aquaculture activity was considered a benefit to juvenile crab survival (Dumbauld et al. 1993, 2000). While there is potential to disturb these areas during access to the longlines, such disturbances are infrequent. Finally, entanglement or interaction with marine debris was not a concern because Coast's aquaculture gear is not designed with the intention of trapping organisms as compared to fishing gear or crab pots. In addition, Coast would adhere to gear maintenance that would reduce and cleanup potential derelict gear (see Appendix A and Section 4.7). Therefore, impacts to Dungeness crab were considered less than significant.

The Revised Project would potentially result in less impacts to Dungeness crab as compared to both the Approved Project and existing conditions due to the smaller operational footprint. Comparatively, recent studies have reported that Dungeness crab are found in higher abundance associated with oyster longlines compared to the surrounding habitat, including areas in Arcata Bay (Hudson 2016, Dumbauld, pers. comm., 2017), which means that the potential benefits from the presence of longlines would not be provided to the same extent in the Revised Project. Either way, culture operations for the Revised Project are located away from preferred habitat for Dungeness crabs, which is the transition area between subtidal and intertidal habitat adjacent to channels. Overall, the Revised Project results in a 1.8% overlap of North Bay intertidal habitats within 75 m of a main channel, which is a reduction from the 5.3% overlap evaluated in the Approved Project.

In terms of consolidation of culture beds primarily in areas with shell deposition or other areas historically disturbed near Mad River and Bird Island, there would be an increased potential to disturb areas that are important juvenile rearing locations for Dungeness crabs. Consolidation results in more culture in these locations (Figure 5). However, the reduced overlap with channel transition areas, the small percentage of access during the year, and the potential to increase Dungeness crab abundance from the presence of longlines all combine to result in a minor change to Dungeness crab from the Revised Project. In fact, the presence of structured habitat in areas that support juvenile nursery habitat may provide a benefit to Dungeness crab overall. Therefore, the Revised Project would not result in any new significant impacts associated with Dungeness crab, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

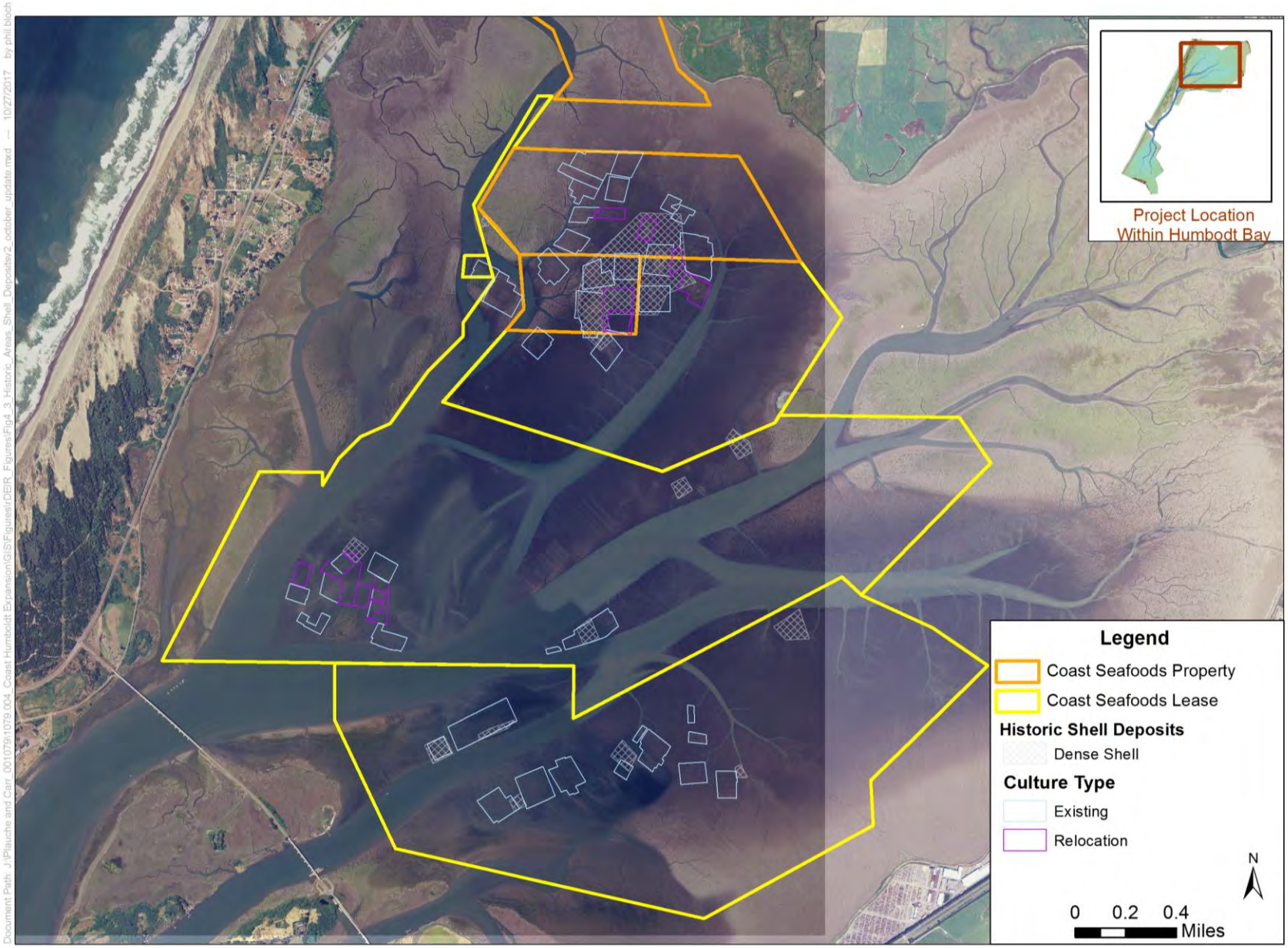

Figure 5 Overlap of Shell Deposition Areas from the Conslidated Culture Beds under the Revised Project

4.2.6 Sturgeon (IMPACT BIO-18)

The Certified EIR discussed impacts to sturgeon from exclusion of feeding areas, disruption to migration, and potential for entanglement in culture gear. The available evidence suggested that sturgeon will encounter, and may feed, in areas containing oyster longline gear, particularly near Sand Island. To account for potential impacts to sturgeon, the Approved Project proposed to remove 45.4 acres of culture beds on Sand Island. Based upon the lack of evidence that oyster longlines impact sturgeon behavior and the reduction of shellfish operations on Sand Island, the Certified EIR concluded that the Approved Project resulted in impacts to sturgeon that were less than significant.

The Revised Project goes even farther at reducing potential impacts to sturgeon by reducing overall acreage and the total number of longlines compared to both the existing culture and the Approved Project. In addition, the Revised Project would convert 62.8 acres with 2.5-ft spaced cultch-on-longline to provide corridors that are at least 10 ft wide that would improve access to these larger fish. Finally, culture would be consolidated into "areas of Arcata Bay that support a lower diversity and abundance of sensitive habitats and wildlife species" (Commission 2017), including areas that are lower quality for sturgeon foraging because of the presence of shell deposition from historical culture operations. Similar to the Approved Project, the Revised Project would remove all existing culture from areas of Sand Island that have been identified as important to sturgeon foraging activity. Therefore, the Revised Project would not result in any new significant impacts associated with sturgeon, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.2.7 Salmonids (IMPACT BIO-19)

The Certified EIR discussed impacts to salmonids from loss of habitat, change in prey resources, and reduction in potential cover habitat (e.g., eelgrass floating mats). Overall, the information reviewed suggested that the ecological functions provided by oyster longlines (e.g., prey resources) show similarities to those of eelgrass, and studies show that juvenile salmonids do not substantially avoid, and are not affected by, the presence of shellfish aquaculture gear. Because of the conclusion, through mitigation, that there would be a no net loss of eelgrass habitat from the Approved Project, potential impacts to salmonid habitat were considered minor. The evidence that salmonids use floating eelgrass mats in Humboldt Bay was minimal, based on a 2% to 9% reported use from tagged coho (*Oncorhynchus kisutch*) salmon smolts (Pinnix et al. 2013), but use of channel margins was more prevalent. As discussed above, the Approved Project incorporated a buffer from channel edges and there was little overlap between the Approved Project's proposed cultivation areas and near-channel habitat. Most culture activities were proposed at higher elevations. The Approved Project also included removal of culture on Sand Island, Indian Island, and near Arcata Channel near salmonid migration routes as they leave the major freshwater sources for Arcata Bay (e.g., Jacoby Creek, McDaniel Slough, Eureka Slough).

The Revised Project would potentially result in less impacts to salmonids as compared to both the Approved Project and existing conditions due to the smaller operational footprint. The reduction of culture, approximately 212 acres less, would result in a reduction of potential impacts to salmonid habitat. On the other hand, shellfish culture gear can potentially increase the amount of prey available for salmonids (Rumrill and Poulton 2004, Hosack et al. 2006, Ferraro and Cole 2007, 2011, 2012), which would be reduced under the Revised Project. The consolidation of culture in the northern and western half of Arcata Bay is outside of typical migration routes for salmonids based on tagging studies for coho salmon (Pinnix et al. 2013), and considered to be of lower quality for sensitive habitats and wildlife species. Therefore, the Revised Project would not result in any new significant impacts associated with salmonids, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.2.8 Longfin Smelt (IMPACT BIO-20)

The Certified EIR discussed impacts to longfin smelt from human disturbance, migration area, and prey resources. Human disturbance would increase in areas with longfin smelt under the Approved Project, but disturbance events were limited to access considerations. When oyster plots are accessed during a low tide event, fish would not be present in the area. When oyster plots are accessed during high tides, fish would be able to easily avoid locations where Coast employees are present. According to data provided by the California Department of Fish and Wildlife (CDFW) to Greg Dale (Dale, pers. comm., 2015), longfin smelt were captured primarily from Freshwater Creek, Eureka Slough, East Bay Channel, and North Bay Main Channel. The proposed culture under the Approved Project both avoided these areas and proposed to remove culture from Sand Island near North Bay Main Channel where longfin smelt were observed. Finally, the potential to impact prey resources was analyzed in the carrying capacity analysis (Harbor District and SHN 2015), which concluded that filtration pressure from cultured shellfish would result in a negligible reduction in the carbon fixed by phytoplankton in Arcata Bay, which is unlikely to significantly affect the prey available to longfin smelt. Therefore, impacts to longfin smelt were considered less than significant.

The Revised Project would potentially result in less impacts to longfin smelt as compared to both the Approved Project and existing conditions due to the smaller operational footprint and consolidating culture into areas not frequented by longfin smelt. Coast has also agreed to additional conditions that further protect longfin smelt, including incorporating fish screens for its wash system associated with its FLUPSY and rafts that have been approved by the National Marine Fisheries Service to be adequately protective of juvenile longfin smelt. Therefore, the Revised Project would not result in any new significant impacts associated with longfin smelt, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.2.9 Pacific Herring (IMPACT BIO-21)

The Certified EIR discussed impacts to Pacific herring from potential disruption in pre-spawning holding areas from boat traffic, removal of gear or harvest activities during spawning when eggs may be present on the gear or surrounding habitat, and survival of eggs on shellfish aquaculture gear and products. Potential disturbance to herring in channels from the Approved Project was anticipated to be minor, given the small increase of approximately 17 boat trips per week (currently at 57 trips per week) throughout the entire bay and no increase in terms of the standard number of hours of human activity in the bay. In addition, boat traffic in East Bay and Arcata channels, where herring are most likely to seasonally occur, was projected to decrease because of removal of culture areas.

Potential interactions with herring was also avoided by the Approved Project by both avoiding core spawning locations in the EBMA and prohibiting the removal of gear or products when herring eggs are present (see Appendix A). The survival of eggs on gear was difficult to predict, but was potentially increased by gear being exposed during low tides compared to natural conditions. This increase in exposure resulted in a weighted average of 13% for Phase I and up to 18% for Phase II for the year, although a fraction of that would be when herring eggs are present (i.e., December to March). Because of the importance of Pacific herring as a prey resource, and the unknowns associated with egg survival on culture gear and products, Coast committed to close coordination with CDFW during the herring spawning season to monitor their culture beds for eggs (Appendix C). Finally, the overall amount of habitat that shellfish aquaculture operations would overlap under the Approved Project was considered a minor portion (3.7%) of the available core spawning habitat in Arcata Bay. Given the low amount of space used by culture activities, and the understanding that only a fraction of the available 1,500 acres in the EMBA is typically used (~10%) during any one spawning event, this overlap did not represent a significant risk to spawning area for Pacific herring. Therefore, impacts to Pacific herring were considered less than significant.

The Revised Project would result in an overall reduction in potential impacts to Pacific herring compared to either the existing operations or Approved Project. In terms of potential disturbance from boat traffic, there would be a slight reduction of trips as compared to the Approved Project. Further, because the Revised Project would result in less cultivation in East Bay, fewer boat trips would occur in Arcata Channel, which was identified in the Certified EIR as a location for pre-spawning holding activities.

The Revised Project would also minimize or avoid potential impacts to Pacific herring core spawning areas in the EBMA through the removal and relocation of existing culture beds. The Revised Project would remove approximately 63.2 acres of existing culture, including culture bed EB 7-2, of which 42 acres of culture beds would be relocated to less sensitive habitat. Culture bed EB 6-1 (approximately 7.8 acres) that is surrounded by dense eelgrass would be converted from dense 2.5-ft spaced cultch-on-longlines to basket-on-longlines spaced 9 ft and 16 ft apart. An additional 12.8 acres of existing culture beds spaced at 2.5 ft apart will increase to wider spacing. The additional space between longlines will provide more eelgrass habitat that

may improve herring egg survival. The remaining amount of existing culture in core herring spawning areas under the Revised Project represents approximately 5.6% of the core spawning area, which is an increase from 3.7% of overlap for the Approved Project. Both the approved and revised project are a reduction from the existing footprint's 5.9% overlap with core spawning areas. This is because Coast is removing less existing culture in herring core spawning habitat, but there is no indication that the existing culture is impacting herring populations. Neither the Approved nor the Revised Project include any expansion or relocation beds in core herring spawning habitat or the East Bay Management Area.

In terms of the potential to disturb eggs after they have adhered to culture gear, products, or the surrounding habitat, Coast would continue to use the same mitigation measure identified in the Certified EIR (see Appendix A). Finally, the Revised Project would result in a weighted average of 19% exposure of gear during the year (Table 4), which is similar to the amount of exposure for the existing culture and an increase in exposure compared to the Approved Project. This is because culture was intentionally consolidated to higher elevations to avoid eelgrass habitat and in areas that had impacts from historical culture operations. However, as stated above, the Commission (2017) and others have identified these areas as supporting a "lower diversity and abundance of sensitive habitats and wildlife species," including Pacific herring habitat. Overall, the Revised Project would not result in any new significant impacts associated with Pacific herring, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

Table 4 Amount of Exposure for Culture Gear Based on Tidal Height and Gear Height.

Project	Culture Method	Culture Height above Bottom (ft)	Average Height of Culture Area (ft MLLW)	Percent of Time Out of Water
Existing Culture	Cultch-on-longline (single-hung)	1.33	0.53	19%
	Basket-on-longline	1.25	0.37	16%
	Weighted Average for Existing Culture	1.33	0.53	19%
Revised Project	Cultch-on-longline (single-hung)	1.33	0.59	20%
	Cultch-on-longline (double-hung; bottom line)	1.00	0.49	15%
	Cultch-on-longline (double-hung; bottom line)	1.67	0.49	22%
	Basket-on-longline	1.25	0.43	17%
	Weighted Average for Revised Project	1.32	0.59	19%

4.2.10 Black Brant (IMPACT BIO-25 and IMPACT BIO-26)

The Certified EIR discussed impacts to black brant that included loss of foraging opportunity due to reductions in eelgrass density and exclusion of brant from eelgrass beds due to the avoidance of culture gear. With the implementation of eelgrass mitigation and achieving a no net loss standard for eelgrass bed ecological function, the Approved Project was calculated to result in a bay-wide reduction of less than 3% in eelgrass available for brant foraging. In addition, brant were observed to forage on shoots taller than the longlines and other structures

when tide height allowed (Demers 2015). It was also observed that brant do not avoid aquaculture structures, even at the narrow 2.5-ft spacing, except when the structures are exposed during a low tide. As reported above, this was a weighted average between 13% and 18% over the year in the Approved Project expansion areas. While effects may occur from the Approved Project to brant or their foraging habitat, the change was considered unlikely to result in additional energetic constraints such that daily mass gain is reduced or stopover duration is increased. A black brant monitoring plan was proposed as part of the Approved Project to verify the conclusion that shellfish aquaculture gear does not impact black brant or their foraging habitat. Finally, removal of culture on Sand Island would support black brant use of the area for foraging, loafing, or at a preferred gritting site. Therefore, impacts to black brant were considered less than significant.

The Revised Project would result in an overall reduction in potential impacts to black brant compared to either the existing operations or Approved Project. Reducing the overlap with eelgrass habitat, the removal of culture on Sand Island, relocation of culture from areas surrounding the EBMA to areas with less eelgrass, and converting 62.8 acres of existing longlines to wider spacing would all minimize or avoid potential impacts to black brant foraging habitat. In addition, relocating culture activities and consolidating culture beds would reduce vessel transit and potential disturbance of birds in high use areas. The Revised Project will result in slightly less boat trips as compared to the Approved Project. A vessel management plan (Appendix D) would be used to ensure that Coast employees use consistent routes to reduce potential flushing or disturbance of birds.

Bird Island, Mad River, and the southeastern area of Arcata Bay, were identified by several groups (e.g., environmental organizations, state and federal agencies, waterfowl experts, local members of the public) as locations that are likely to support limited brant use; therefore, consolidation in these areas is not expected to result in additional impacts to brant. Similar to the Approved Project, the culture areas would be monitored to verify this assumption (Appendix E). The monitoring plan will implement the use of remote wildlife cameras to document brant foraging and use patterns within and outside of culture beds. Therefore, the Revised Project would not result in any new significant impacts associated with black brant, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.2.11 Waterfowl (IMPACT BIO-32)

The Certified EIR identified potential impacts to waterfowl foraging from oyster aquaculture in Humboldt Bay. Potential impacts to waterfowl foraging were associated with potential loss of eelgrass habitat and potential avoidance of shellfish culture sites due to the presence of aquaculture gear. In terms of potential loss of eelgrass habitat, these effects would be controlled through conservation and mitigation measures identified above to result in a no net loss of eelgrass habitat (see Appendix A). In terms of avoidance of culture gear, both brant (Demers 2015) and widgeon (Higerloh et al. 2001) have been observed accessing food resources within, and immediately adjacent to, culture gear when the tide is sufficiently high to allow them to

float over the structures. Both reports indicated that there was no "buffer effect" observed, which indicates that the birds are not avoiding the culture gear within a certain distance. It was anticipated that the greater distance between longlines associated with the expansion areas in the Approved Project may facilitate increased use of these habitats by waterfowl. In addition, removal of culture from Sand Island, Indian Island, and around Arcata Channel was intended to provide more open habitat for waterfowl and other species that use these areas more frequently than other locations in Arcata Bay. Therefore, impacts to waterfowl were considered less than significant.

As described above, the Revised Project would result in reduced impacts to eelgrass. As described in Table 1, the total amount of overlap between proposed new culture areas within eelgrass, as compared to the Approved Project, would be reduced by nearly 199 acres). This reduced overlap between culture gear and eelgrass would result in increased availability of eelgrass habitat for foraging waterfowl. In addition, the Revised Project would convert approximately 62.8 acres of existing longlines to wider spacing. The relocated longlines would be placed in habitat that is considered less suitable for sensitive habitat and wildlife. The Revised Project would also remove existing culture from areas like Sand Island, similar to the Approved Project, where waterfowl forage. These changes would provide increased availability of eelgrass habitat without culture gear present and decrease the total area where culture gear and human activity occur within areas of Arcata Bay that are more frequently used by waterfowl (e.g., East Bay). Therefore, the Revised Project would not result in any new significant impacts associated with waterfowl, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.2.12 Shorebird Foraging (IMPACT BIO-33)

The Certified EIR identified potential impacts to shorebird foraging from oyster aquaculture in Humboldt Bay. Potential impacts were associated with potential reductions in phytoplankton food availability due to competition between shellfish and shorebirds for food resources, affects to habitat accessibility due to the presence of culture gear for feeding, and disturbance to foraging or loafing shorebirds by staff accessing culture sites. Availability of phytoplankton food resources is assessed in IMPACT BIO-9, which was determined to be a less than significant impact under the Approved Project. Shorebird foraging is primarily at higher elevations than oyster aquaculture where tidal flats are exposed for longer periods of time. The most relevant study in assessing whether shorebirds forage in aquaculture longline plots was conducted by Connolly and Colwell (2005) in North Bay. Connolly and Colwell's results indicate greater shorebird species diversity on cultch-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. Incidental observations during the black brant monitoring effort in North Bay (Demers 2015) also suggest that shorebirds readily forage under aquaculture longlines. Finally, removal of culture from Sand Island, Indian Island, and around Arcata Channel was intended to provide more open habitat for shorebird foraging. Therefore, impacts to shorebird foraging were considered less than significant.

The Revised Project would result in either similar or a reduction in potential impacts to shorebird foraging compared to either the existing operations or Approved Project. As shown in Table 4, the Revised Project's area weighted tidal elevation is slightly higher at 0.59 ft MLLW versus 0.53 ft MLLW for the Approved Project. This difference in average elevation is due to reduced acreage at lower elevations and is not a reflection of adding new, higher elevation sites. Therefore, there is no or negligible difference in tidal elevation associated with the Revised Project. Further, the Revised Project would reduce overlap with mudflat habitat by approximately 21 acres as compared to the Approved Project. There is also an approximately 80.6-acre reduction in overlap with patchy eelgrass habitat. Overall, the Revised Project would result in a reduction in overlap of Coast's farmed footprint and potential habitat as compared to existing conditions. These reductions suggest that there will be less potential overlap between culture gear and potential foraging habitat for shorebirds. The Revised Project also concentrates culture areas in three geographic areas of Arcata Bay, which would reduce dispersion of culture areas and create larger areas with no culture gear or staff access. Therefore, the Revised Project would not result in any new significant impacts associated with shorebird foraging, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.3 Aesthetics and Visual Resources (IMPACT AV-1 to AV-3)

The Certified EIR identified potential impacts to aesthetics and visual resources, including effects from the presence of additional workers, vessels, and shellfish culture equipment, and the effects of glare and artificial lighting. In terms of activity, the frequency of site visits to any one culture bed for planting, harvesting, and maintenance activities was considered low (i.e., approximately 12 days/acre every 4 months vs. 2 days/acre every 18 to 36 months). The expansion into new areas would increase activities in specific areas, but the number of labor hours over the year would not increase. In addition, the proposed expansion areas were proposed at least 0.5 miles from the nearest transportation corridor/public viewshed, and the appearance of workers, vessels, or culture equipment would all be subordinate to the extensive saltmarshes, mudflats, and water between observers and subjects. Further, the presence of shellfish operations is consistent with what already occurs and is expected in Arcata Bay. The amount of light/glare during nighttime operations would also be negligible compared to the lights from the bridges, houses, and cars traveling on Highway 101. Finally, the Approved Project included a conservation measure to avoid use of reflective materials and relevant biological mitigation measures to further reduce potential impacts (see Appendix A). Therefore, impacts to aesthetics and visual resources were considered less than significant.

The Revised Project reduces the amount of gear and overall cultivated acreage as compared to both existing conditions and Approved Project. The consolidation of activity and gear for the Revised Project around Bird Island, Mad River, and the southeastern area of Arcata Bay would not result in a significant change to aesthetics and visual resources. The closest culture beds to a transportation corridor/public viewshed are approximately 0.6 miles away, which is further than the distance proposed under the Approved Project. In addition, culture gear is only

present during a tide low enough to expose the gear, which is estimated to occur approximately 19% of the year (see Section 4.2.9 above). Although this is a slight increase compared to the Approved Project, it still represents a minor portion of the year when gear is visible, and significantly overestimates the effect because this estimate includes low tides that occur at night. Finally, the amount of light/glare during nighttime operations would not significantly change compared to the existing operations, although certain areas will be visited more frequently in consolidated culture areas. Therefore, the Revised Project would not result in any new significant impacts associated with aesthetics and visual resources, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.4 Air Quality (IMPACT AQ-1)

The Certified EIR identified one potential impact to air quality associated with the generation of particulate matter from combustion engines. The Approved Project proposed to use two additional small boats (one scow and one skiff), and increased use of the harvest vessels (the Mary Elizabeth and Elusive). In total, the Approved Project would result in 17 additional boat trips throughout the bay per week. There would be a minor net increase in emissions of particulate matter from the increased number and use of vessel engines. In addition, with an increase in potential employees (60-70 personnel), there would also be an increase in particulate matter from additional driving. With the adherence to the suggested mitigation measure for air quality compliance (see Appendix A), the additional contribution of particulate matter was considered negligible. Therefore, impacts to air quality were considered less than significant.

The Revised Project would result in a slight reduction to the proposed vessel activity compared to the Approved Project, although the number of vessels is the same. Eight small vessels (i.e., skiffs and skows) will predominantly be used, which is an increase of 2 vessels compared to existing conditions. Therefore, the Revised Project would not result in any new significant impacts associated with air quality, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.5 Greenhouse Gas Emissions (IMPACT GHG-1 to GHG-2)

The Certified EIR identified one potential impact to greenhouse gas emissions associated with burning gasoline and other fuels from the use of vessels, small generators, and vehicular traffic. The amount of greenhouse gases produced from the proposed increase in operations and employees under the Approved Project was considered negligible, particularly relative to the amount of food produced and compared other the intensive activities in the region. Therefore, impacts to greenhouse gas emissions were considered less than significant.

The Revised Project would result in the same amount of vessel and small generator use, and a potential decrease in the amount of vehicular traffic. This potential impact remains negligible compared to the surrounding activity in the region. Therefore, the Revised Project would not result in any new significant impacts associated with greenhouse gas emissions, and it would

not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.6 Hydrology and Water Quality (IMPACT WQ-1 to WQ-2)

The Certified EIR identified potential impacts to hydrology and water quality associated with water quality changes from filter feeding activities by shellfish, and temporary mobilization of sediment during planting, gear removal, or vessel contact with the seabed. Hydrology was also reviewed under IMPACT BIO-7 in relation to potential sediment distribution around the shellfish aquaculture structures. Changes to water quality from filter feeding would be limited. Humboldt Bay is not characterized as a eutrophic system. Similarly, temporary disturbance of the seabed would not contribute significantly to changes in hydrology or water quality compared to natural storm events. The degree of the effects of culture gear on hydrodynamics and sediment transport is dependent on the porosity of the structures and, therefore, the physical dimensions and spacing of the structures (e.g., height and density). In general, the distance from the seabed (typically 12 inches) would not influence sediment transport, and effects are monitored on a regular basis by Coast to determine if sediment is accumulating or scouring around the structures. These changes are corrected by changing the orientation of the culture beds. Studies in Humboldt Bay and other estuaries with off-bottom culture gear lead to a conclusion that there is limited influence on these structures to sediment transport (Rumrill and Poulton 2004, Forrest et al. 2009). Therefore, impacts to hydrology and water quality were considered less than significant.

In general, the potential impacts discussed for hydrology and water quality remain unchanged between the Approved Project and the Revised Project. Potential changes would be due to the increase in basket-on-longline culture and consolidation of culture areas. Basket-on-longline gear are much less porous than cultch-on-longline gear, and are expected to have the greatest potential disruption to hydrodynamics. However, baskets tend to be located near the upper portion of the bottom boundary layer when fully submerged, which is not likely to cause erosion underneath the structures, but rather deposition adjacent to the structures from flow dampening. As indicated above for the Approved Project, corrective measures can be taken to shift the direction of the structures in a manner than results in insignificant changes to seabed topography. Further, the Revised Project proposes an overall reduction in basket-on-longline cultivation as compared to the Approved Project.

In terms of consolidation of culture operations under the Revised Project, culture gear would be more concentrated in the western portion of Arcata Bay. Sediment transport processes on the west side of Arcata Bay (short fetch) are most affected by tidal currents combined with short waves during low water. In general, current speed is lowest at the seabed, speed increases exponentially with distance away from the bed in the first 1 ft to 2 ft above the bed, and the rate at which the speed increases gradually lessens 1 ft to 2 ft above the bed. Because the majority of culture gear is placed 12 inches from the seabed, with a smaller portion at 8 inches, even a higher concentration of gear will not significantly change the hydrodynamics and sediment transport in these areas. Therefore, the Revised Project would not result in any new significant

impacts associated with hydrology and water quality, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.7 Hazards and Hazardous Materials (IMPACT HAZ-1 to HAZ-3)

The Certified EIR identified potential impacts to hazards and hazardous materials, including potential exposure to fuel and lubricants from boats, generators, and other mechanical equipment, hazards from marine debris, or potential exposure from toxin bioaccumulation in shellfish meat. The Approved Project incorporated conservation and mitigation measures to address these concerns (see Appendix A). In terms of the potential for dioxin to bioaccumulate, dioxin levels in shellfish were well below levels considered by the USFDA and USEPA to be a human health risk. There is no indication that dioxins have increased or changed since 2002 when studies were completed that looked at dioxin levels in shellfish tissue, and have likely decreased since the cessation of dioxin-producing pulp mill activities.

While the Certified EIR identified a potentially significant impact associated with marine debris, the Approved Project incorporated conservation and mitigation measures to address these impacts, including monitoring for loose or escaped gear and regular cleanup events to control any debris in Arcata Bay. Therefore, impacts to hazards and hazardous materials were considered less than significant.

The Revised Project would result in a reduced potential to general hazards or hazardous materials due to a reduction of its operational footprint by approximately 1/3. Further, as noted in Section 4.2.1 above, the Revised Project would result in fewer longlines compared to the Approved Project or the existing footprint. While the Revised Project would increase the total amount of basket-on-longlines as compared to existing conditions, it would result in approximately 117.6 acres less basket-on-longlines cultivation as compared to the Approved Project, which would reduce potential marine debris impacts as compared to the impacts evaluated in the Certified EIR.

In addition to the mitigation measures described in the Certified EIR, Coast agreed to additional measures as part of its CDP permit, identified in Appendix A, to further reduce potential impacts, including: (1) working with the Commission staff to implement enhanced marine debris reduction and recovery efforts, and (2) working with the manufacturer of SEAPA baskets to improve the design of the plastic clasp used to attach baskets to the longlines.

In terms of consolidation of culture around Bird Island, Mad River, and the southeastern area of Arcata Bay, the culture areas will be more frequently monitored due to the increase in visits to the same area, which will improve the efficiency of Coast's monitoring efforts. Overall, the Revised Project would not result in any new significant impacts associated with hazards and hazardous materials, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.8 Recreation (IMPACT REC-1 to REC-2)

The Certified EIR identified potential impacts to recreation, including effects on recreational facilities and effects on recreational users of the bay. Although the Approved Project would expand infrastructure in tidal areas and increase boat traffic and worker presence associated with expanded culture activities, it would not result in physical impacts to recreational facilities or require additional demand on existing facilities. The size of the existing shellfish aquaculture operation is small compared to the area available for recreation in Arcata Bay (300 acres compared to 8,481 acres in Arcata Bay during mean high water). The addition of the expansion of oyster aquaculture activities would create a potential conflict within areas of East Bay that are valued higher for hunters. For example, subtidal channels and deeper intertidal areas are used for access by scullers, and off-bottom culture gear can present a navigation hazard to these smaller boats. Coast agreed to not conduct operations in an identified Hunting Avoidance Area incorporated into the Certified EIR, and presented here in Appendix F, during certain specified hunting times. To address navigational concerns, Coast proposed conservation measures that avoided locations and times when hunting was a predominant activity in Arcata Bay (see Appendix A). In addition, Coast proposed to map each culture bed and post the map on the Harbor District website to improve navigation by recreational users (Appendix G). Therefore, impacts to recreation were considered less than significant.

The Revised Project would result in a reduced potential conflict with recreational users of Arcata Bay. The reduction in overall acreage of the existing operations and consolidation of operations would improve potential navigation by boat-based recreational users during low tides when the longlines are exposed (weighted average of 19% of the year; see Table 4). Consolidation of culture activities is in areas determined by the Commission (2017) and others to be lower quality habitat for sensitive resources and wildlife. The remaining areas where culture is removed provides open access by recreational users for most of the western portion of East Bay, and in areas determined by hunters to be of higher value. Therefore, the Revised Project would not result in any new significant impacts associated with recreation, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.9 Noise (IMPACT NOISE-1)

The Certified EIR identified potential impacts to noise related to use of outboard motors, water pumps, bow thrusters, and mechanical harvesters. Although the Approved Project proposed to increase the number of boats used, the total hours of operation were not proposed to increase above existing conditions. In addition, the types of boats and equipment used was not proposed to change, and noise measurements for the existing operations do not exceed applicable standards for noise restrictions. The noise generating activities in the Approved Project, both during longline installation and normal operating conditions, are consistent with the types of noise commonly experienced on Humboldt Bay and are generally not near sensitive receptors. Therefore, impacts to noise were considered less than significant.

The Revised Project would not result in an increase in potential noise generating activities beyond what was analyzed in the Approved Project. The amount of vessel traffic will increase above existing culture conditions, but not above what was previously analyzed in the Certified EIR. Therefore, the Revised Project would not result in any new significant impacts associated with noise, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

4.10 Transportation/Traffic (IMPACT TRANS-1)

The Certified EIR identified potential impacts to transportation/traffic related to the effects of intertidal culture operations and equipment on watercraft (e.g., vessel, kayaks) navigation. The intertidal areas proposed for expansion of oyster culture under the Approved Project were located outside of the main navigation channels, which are designated water trail routes for recreational vessels. However, culture gear, including PVC pipes used to suspend longlines, and the longlines themselves, may interfere with the movement of shallow draft vessels (e.g., kayaks, canoes, stand-up paddle boards, and skullers) at certain points in the tidal cycle. Shallow boat traffic would be impeded only during tides low enough to exposure culture gear, which ranged from 13% of the year up to 18% of the year, and at the lower range in areas associated with higher use, such as East Bay. The main measures to address this potential impact was to create a cultivation bed mapping and marking plan (Appendix G) and a vessel management plan (Appendix D). Finally, the Approved Project proposed to remove existing culture beds from areas of high recreational use, including Sand Island, Indian Island, and portions along Arcata Channel. Therefore, the impacts to transportation/traffic were considered less than significant.

As described above for impacts to recreation, the Revised Project would result in a reduced potential conflict with watercraft on Arcata Bay. The reduction in overall acreage of the existing operations and consolidation of operations would improve potential navigation by boats. Although the potential amount of time that culture gear is exposed would increase under the Revised Project (weighted average of 19% of the year; see Table 4), the areas where culture would be consolidated is considered of less utilized for recreational purposes. Therefore, the Revised Project would not result in any new significant impacts associated with transportation/traffic, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

5.0 CUMULATIVE IMPACTS

Section 15130 of the CEQA Guidelines states that cumulative impacts shall be discussed where they are significant. As discussed in the Certified EIR, there are other aquaculture companies that farm in Humboldt Bay. The total of other existing shellfish aquaculture activity is approximately 15 acres of intertidal habitat and 56 rafts in subtidal habitat. In addition, there are two proposed projects that are significant in size: (1) a proposal by Mr. Jerry Yeung, and (2) the Pre-Permitting Project by the Harbor District. Note that the Certified EIR combined these two projects, but since January 2017 Mr. Yeung separated the proposal from the Pre-Permitting

Project. The proposed projects have a combined total of approximately 329 acres of intertidal shellfish aquaculture in Arcata Bay. The cumulative amount of shellfish aquaculture activities analyzed in the Certified EIR included 1,202 acres of intertidal culture, 91 rafts, and 3.1 acres of subtidal culture.

The Certified EIR determined that the Approved Project would not result in any cumulative impacts because the location of culture activities provided enough spatial separation. In addition, the frequency of culture activities is distributed throughout the year so that effects would not accumulate in any one area. These effects were compared to locations where cumulative impacts have been observed, which includes locations in France that have culture densities that are magnitudes higher (e.g., Leguerrier et al. 2004, Bouchet and Sauriau 2008) compared to that proposed in Humboldt Bay.

The cumulative impacts associated with the Revised Project would be further reduced from the levels analyzed in the certified EIR. As opposed to the Approved Project, would expand Coast's proposed footprint, the Revised Project would reduce Coast's footprint as compared to its existing operation.

The carrying capacity analysis provided in the Certified EIR analyzed up to 1,516 acres of shellfish aquaculture activity in Arcata Bay (Harbor District and SHN 2015). The carrying capacity analysis concluded that shellfish aquaculture operations accounted for a clearing efficiency of up to 0.46, which is well below the 1.0 value that indicates cultured shellfish are filtering the bay's waters more quickly than they can be flushed and replaced. Further, this value is a conservative estimate, and a shorter amount of replacement time is likely more accurate. In addition, shellfish provide nutrients to the system that can trigger phytoplankton growth. Overall, the cumulative acreage of shellfish aquaculture proposed in Arcata Bay does not appear to be close to a concern for carrying capacity, and the smaller amount of proposed acreage under the Revised Project makes this conclusion even stronger.

In terms of species effects from the proposed 623 acres of shellfish aquaculture in Humboldt Bay, many of the same concerns addressed above would be relevant. The proposals from Mr. Yeung and the Harbor District are in higher elevations compared to the Revised Project, which will avoid some potential for cumulative impacts to the same species (e.g., eelgrass, salmonids, Pacific herring, sturgeon, black brant). Figures 6 and 7 illustrate the relationship between existing and proposed culture activities and mapped observations of green sturgeon and coho salmon, respectively. Further, the amount of acreage and types of activities are significantly lower than that analyzed in the Certified EIR. Therefore, the Revised Project would not result in any new significant impacts associated with cumulative impacts, and it would not substantially increase the severity of any significant impacts previously identified in the Certified EIR.

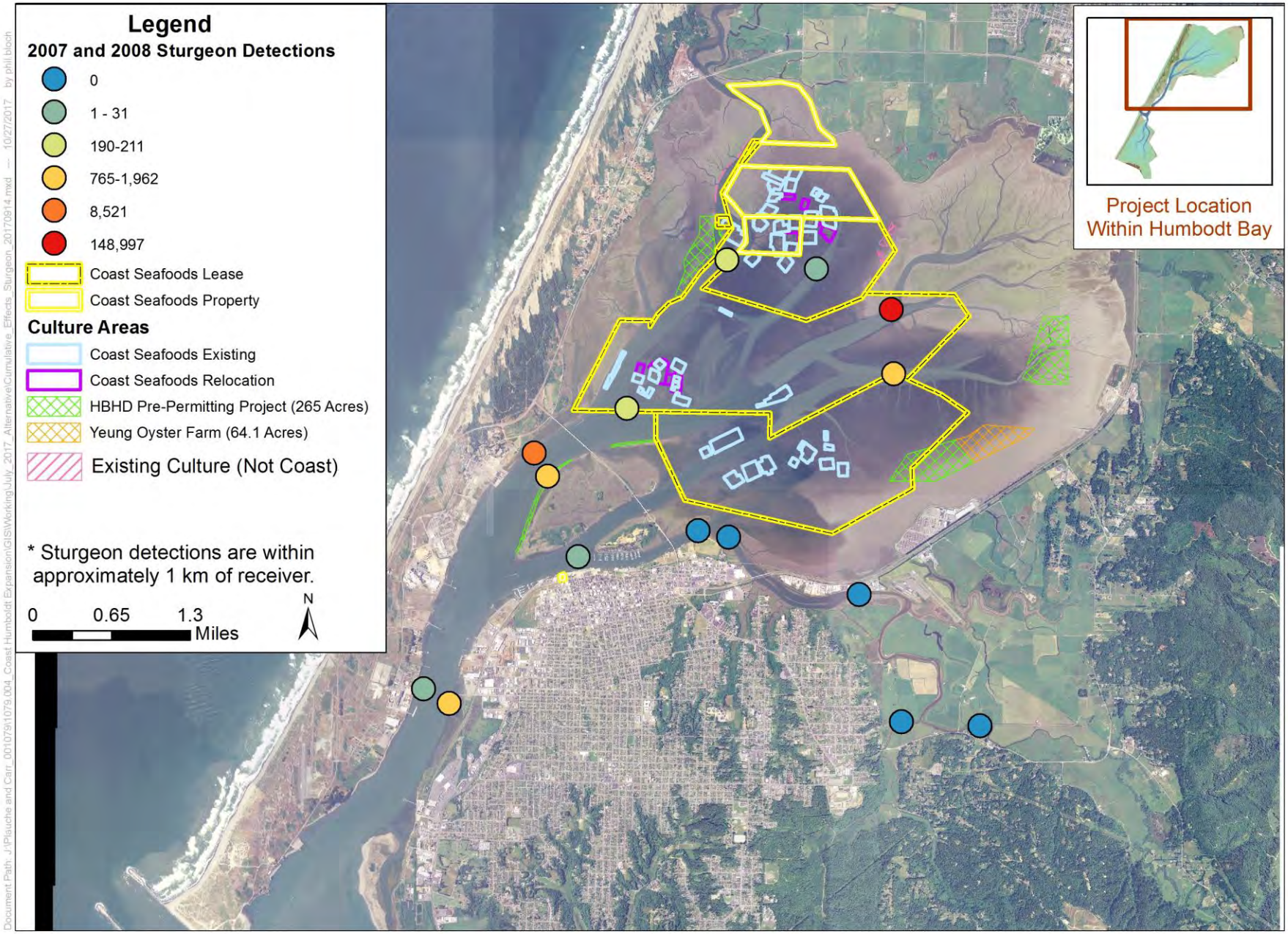

Figure 6 Cumulative Impacts of Existing and Proposed Culture Activity to Green Sturgeon

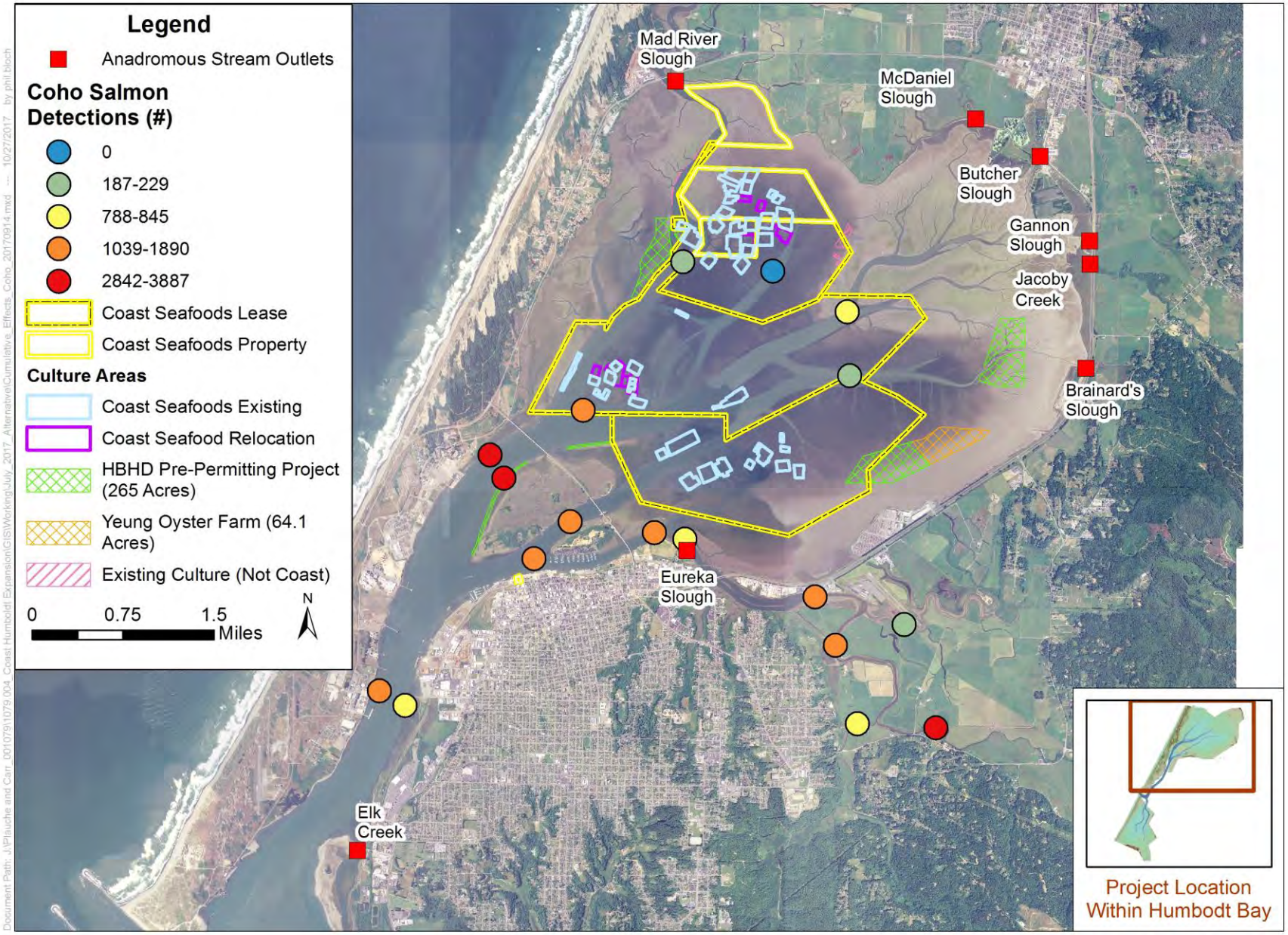

Figure 7 Cumulative Impacts of Existing and Proposed Culture Activity to Coho Salmon

6.0 CONCLUSIONS

The Revised Project reduces the overall acreage of the existing culture operations, eliminates the expansion of culture into fallow areas of Arcata Bay used for shellfish aquaculture over the last 60 years, consolidates 2/3 of the culture operations into the western portion of Arcata Bay, prioritizes areas of historical impacts for consolidation of culture operations, and moves culture activities into areas of Arcata Bay that are considered less sensitive for fish and wildlife resources. Overall, while the Certified EIR identified no significant and unavoidable adverse impacts associated with the Approved Project, the Revised Project would result in further reductions to most environmental impacts as compared to those analyzed in the Certified EIR.

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Appendix A

Conservation Measures, Mitigation Measures, and Commission Special Conditions

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APPENDIX A: CONSERVATION MEASURES, MITIGATION MEASURES, AND COMMISSION SPECIAL CONDITIONS

Certified EIR Potential Impact Number	Certified EIR Topic	Conservation Measures	Mitigation Measures	California Coastal Commission Special Conditions**
IMPACT CR-1	Placement of equipment	None proposed.	MITIGATION CR-1: Coast will designate an authorized point of contact (Cultural Resources POC) in the event of inadvertent discovery of any cultural or archaeological resource or human remains or Native American grave goods during Project implementation; Coast will ensure that the Harbor District has the name and current contact information for its Cultural Resources POC. MITIGATION CR-2: Best practices associated with inadvertent discovery of an archaeological resource during ground-disturbing activities, as detailed in the R-DEIR. MITIGATION CR-3: Best practices associated with inadvertent discovery of human remains or Native American grave goods during ground-disturbing activities, as detailed in the R-DEIR.	Special Condition 19: Greg Dale is the authorized POC. Special Condition 20: List of protocols to be followed if an archaeological resource is discovered during ground-disturbing activities. Special Condition 21: List of protocols to be followed if human remains or Native American grave goods are discovered during ground-disturbing activities. The mitigation measures are consistent with Special Condition 19, 20, and 21, with additional details provided in the Commission (2017) staff report.
IMPACT CR-2	Impacts to eelgrass as a tribal cultural landscape	CONSERVATION BIO-1 through BIO-8 would apply (see below).	MITIGATION BIO-1 applied in the R-DEIR, but was revised into Special Condition 2, 3, and 13 (see below).	Special Condition 2, 3, 13, and 15 would apply (see below).
IMPACT CR-3	Impacts to other species with cultural significance	CONSERVATION BIO-9 through BIO-12 would apply (see below).	MITIGATION BIO-2 through BIO-4 would apply (see below).	Special Condition 4, 5, 7, 10 and 16 would apply (see below).
IMPACT BIO-1	Impacts associated with overwater structures	None proposed.	None proposed.	Special Condition 6: All intake systems used by Coast to supply water from Arcata Bay for maintenance cleaning and clam tray washing shall be designed with a screened intake and velocity as specified in the Commission (2017).
IMPACT BIO-2	Amount of gear to be installed and changes to unstructured habitat from the addition of shellfish aquaculture gear	CONSERVATION BIO-1: Coast will not cause the intentional deposition of shells or any other material on the seafloor. CONSERVATION BIO-3: Monthly and post-storm inspection of aquaculture beds will occur to ensure that gear is properly maintained.	None proposed.	Special Condition 2: Coast shall complete the removal of equipment from an equal or greater area of cultivation beds prior to the installation of relocation beds; Coasts footprint shall be limited to 279 acres by December 31, 2019.
IMPACT BIO-3	Eelgrass density reduction analysis	CONSERVATION BIO-2: Longline spacing for new shellfish culture beds would occur at 10-ft intervals for cultch-on-longline and alternating 9-ft and 16-ft intervals for basket-on-longline. CONSERVATION BIO-4: Rack-and-bag culture beds would not be planted within 25 ft of an existing eelgrass bed. Note: rack-and-bag culture methods are no longer proposed for the Revised Project. CONSERVATION BIO-5: No anchoring of the longline harvester would be done that would shade the same area of eelgrass for a period exceeding 12 hours. CONSERVATION BIO-6: Larger work boats would be anchored in the channel outside of eelgrass beds and smaller skiffs would be used to access longlines where eelgrass is present when the area is inundated. CONSERVATION BIO-7: Boats will be operated in such a way as to minimize the degree of sediment mobilization and avoid propeller scarring in areas of eelgrass. CONSERVATION BIO-8: No dredging, hydraulic harvesting, “bed cleaning,” or any other activities with a hydraulic harvester would occur.	MITIGATION BIO-1: Removal of at least 1 acre of existing culture area in Sand Island, Indian Island, and Arcata Channel for each 4 acres of expansion. Total removal is estimated as 64.7 acres for 256 acres of expansion. Note: this was modified by the Commission (2017) to be a total of 21 acres of removal from Sand Island, Indian Island, and East Bay without an expansion (as noted in Special Condition 2, 3, and 13).	Special Condition 3: Coast shall submit a revised Eelgrass Monitoring Plan that quantifies any loss of eelgrass density or percent vegetated cover within the three relocated cultivation beds; eelgrass performance shall be assessed on an annual basis over a 5-year monitoring term; see Commission (2017) for more details. See Appendix A for the details of the eelgrass monitoring plan. Special Condition 13: Removal of cultivation beds from EB 7-2, SI 1-1, SI 2-1, SI 2-2, SI-N, and GI 1-2/II 1-2. Special Condition 15: Include a 5-ft space between groups of 5 2.5-ft spaced lines for the following cultivation beds: BI Wk, EB 2-3, MR 10, MR 2, MR 5-1 k, MR 5-2, MR 8-2, and MR 9.
IMPACT BIO-4	Potential trampling of eelgrass related to access and activities during shellfish aquaculture operations	CONSERVATION BIO-2 through BIO-8 would apply (see above).	MITIGATION BIO-1 applied in the R-DEIR, but was revised into Special Condition 2, 3, and 13 (see above).	Special Condition 2, 3, 13, and 15 would apply (see above).

Certified EIR Potential Impact Number	Certified EIR Topic	Conservation Measures	Mitigation Measures	California Coastal Commission Special Conditions**
IMPACT BIO-5	Potential to contribute to habitat fragmentation by placing oyster longline aquaculture within patchy and continuous eelgrass beds and boat use	CONSERVATION BIO-2 through BIO-8 would apply (see above).	MITIGATION BIO-1 applied in the R-DEIR, but was revised into Special Condition 2, 3, and 13 (see above).	Special Condition 2, 3, 13, and 15 would apply (see above).
IMPACT BIO-6	The potential to affect the development of floating eelgrass rafts and wrack within intertidal habitat of North Bay	CONSERVATION BIO-2 through BIO-8 would apply (see above).	MITIGATION BIO-1 applied in the R-DEIR, but was revised into Special Condition 2, 3, and 13 (see above).	Special Condition 2, 3, 13, and 15 would apply (see above).
IMPACT BIO-7	The potential to change sediment distribution and tidal circulation	CONSERVATION BIO-7 and BIO-8 would apply (see above).	None proposed.	None proposed.
IMPACT BIO-8	The potential to change water column nutrients and turbidity conditions within intertidal habitat of North Bay	None proposed.	None proposed.	None proposed.
IMPACT BIO-9	The potential to exceed carrying capacity in Humboldt Bay	None proposed.	None proposed.	None proposed.
IMPACT BIO-10	The potential to change the presence and persistence of contaminants within North Bay	CONSERVATION HAZ-1, HAZ-2, and HAZ-3 would apply (see below).	None proposed.	None proposed.
IMPACT BIO-11	The potential to change sediment quality underneath shellfish aquaculture gear due to biodeposits from filter-feeding organism	CONSERVATION BIO-1 would apply (see above).	None proposed.	None proposed.
IMPACT BIO-12	The potential to change benthic invertebrate species composition through the addition of nutrients to the sediment or adding structure	None proposed.	None proposed.	None proposed.
IMPACT BIO-13	The potential to change benthic species composition through trampling during site access for shellfish aquaculture activities (e.g., planting, harvesting, and maintenance)	None proposed.	None proposed.	None proposed.
IMPACT BIO-14	The potential to introduce non-indigenous species (NIS) to Humboldt Bay from commercial shellfish aquaculture operations	None proposed.	None proposed.	None proposed.
IMPACT BIO-15	The potential to naturalize cultured oysters (that are NIS) into Humboldt Bay	None proposed.	None proposed.	Special Condition 17: Coast shall implement management practices during grading and handling of non-native clams to prevent spillage, including by using screens during Washington activities; all cultivated clams shall be removed from the rafts and bay prior to reaching 12 mm shell size.
IMPACT BIO-16	Potential impacts to Dungeness crab from the expansion of oyster aquaculture in Humboldt Bay	CONSERVATION BIO-2 and BIO-3 would apply (see above). CONSERVATION BIO-9: New shellfish culture beds will not be planted within 10 ft of a subtidal channel.	None proposed.	None proposed.
IMPACT BIO-17	Potential impacts to Pacific lamprey from the expansion of oyster aquaculture in Humboldt Bay	CONSERVATION BIO-2 and BIO-9 would apply (see above).	None proposed.	None proposed.
IMPACT BIO-18	Potential impacts to sturgeon from the expansion of oyster aquaculture in Humboldt Bay	CONSERVATION BIO-2 and BIO-9 would apply (see above).	None proposed.	Special Condition 9, 13, and 15 would apply (see above).
IMPACT BIO-19	Potential impacts to salmonids from the expansion of oyster aquaculture in Humboldt Bay	CONSERVATION BIO-2 and BIO-9 would apply (see above).	None proposed.	Special Condition 9, 13, and 15 would apply (see above).
IMPACT BIO-20	Potential impacts to longfin smelt from the expansion of oyster aquaculture in Humboldt Bay	CONSERVATION BIO-2 and BIO-9 would apply (see above).	None proposed.	None proposed.
IMPACT BIO-21	Potential impacts to Pacific herring from the expansion of oyster aquaculture in Humboldt Bay	CONSERVATION BIO-2 and BIO-9 would apply (see above).	MITIGATION BIO-2: Herring egg monitoring and consultation with the California Department of Fish and Wildlife (CDFW). Coast will ensure that all employees who supervise work on the tidelands are trained by a qualified biologist to conduct pre-work herring spawn surveys. See Appendix B for the details of the Pacific herring egg monitoring plan.	Special Condition 7: Coast shall visually inspect beds prior to planting and/or harvesting, to determine if Pacific herring has spawned on eelgrass, culture materials, or substrate; see Commission (2017) for more details. The mitigation measure is consistent with Special Condition 7.

Certified EIR Potential Impact Number	Certified EIR Topic	Conservation Measures	Mitigation Measures	California Coastal Commission Special Conditions**
IMPACT BIO-22	Potential impacts to groundfish from the expansion of oyster aquaculture in Humboldt Bay	CONSERVATION BIO-2 and BIO-9 would apply (see above).	None proposed.	None proposed.
IMPACT BIO-23	Potential impacts to marine mammals from the expansion of oyster aquaculture in Humboldt Bay	CONSERVATION BIO-9 would apply (see above). CONSERVATION BIO-10: Coast will not conduct any activity when a marine mammal is observed hauled out in or near a culture area ready for planting, scheduled maintenance, or harvesting until the mammal has left on its own and without provocation from Coast. CONSERVATION BIO-11: Coast will not intentionally approach or harass marine mammals during vessel transits.	MITIGATION BIO-3: Culture would be removed from Sand Island (see MITIGATION BIO-1 above) to avoid the harbor seal haul-out location and nesting birds on Sand Island.	Special Condition 16: During vessel transit, harvest, maintenance, inspection, and planting operations, Coast shall avoid approaching, chasing, flushing, or directly disturbing shorebirds, waterfowl, seabirds, or marine mammals. The conservation measure is consistent with Special Condition 16.
IMPACT BIO-24	Potential impacts to special-status bird species from the expansion of oyster aquaculture in Humboldt Bay	None proposed.	None proposed.	Special Condition 16 would apply (see above).
IMPACT BIO-25	Potential impacts to black brant foraging from the expansion of oyster aquaculture in Humboldt Bay	CONSERVATION BIO-12: Coast will not intentionally approach or harass migratory birds that are actively feeding or resting within the project area.	MITIGATION BIO-1 applied in the R-DEIR, but was revised into Special Condition 2, 3, and 13 (see above). MITIGATION BIO-4: Impact on eelgrass availability to black brant. If monitoring data demonstrate that eelgrass impacts are above the Project's adaptive management thresholds and additional mitigation is implemented, the mitigation provided eelgrass must be available to black brant.	Special Condition 2, 13, and 15 would apply (see above). Special Condition 4: Coast shall submit a revised Brant Monitoring Plan capable of detecting and visually documenting and recording brant foraging activity on eelgrass beds within existing, relocated, and converted cultivation beds; see Commission (2017) for more details. See Appendix C for the details of the black brant monitoring plan.
IMPACT BIO-26	Potential impacts to black brant associated with human disturbance from the expansion of oyster aquaculture in Humboldt Bay	CONSERVATION BIO-12 would apply (see above).	None proposed.	Special Condition 5: Coast shall submit a Vessel Management Plan that includes: (1) a map showing the travel routes and landing or cultivation bed access sites, and (2) procedures to limit herding or flushing of black brant or shorebirds. Special Condition 16 would apply (see above).
IMPACT BIO-27	Potential impacts to black brant associated with loss of grit sites from the expansion of oyster aquaculture in Humboldt Bay	None proposed.	None proposed.	Special Condition 14: Between the months of November and June, no vessel transit or cultivation activities shall be carried out within 384 meters of the black brant grit site at Sand Island (see Appendix D for a map of the black brant grit sites); marine debris collection efforts and water quality sampling required by the California Department of Public Health shall be exempt from this requirement.
IMPACT BIO-28	Potential impacts to roosting birds from the expansion of oyster aquaculture in Humboldt Bay	CONSERVATION BIO-12 would apply (see above).	None proposed.	Special Condition 5 and 16 would apply (see above).
IMPACT BIO-29	Potential impacts to nesting birds from the expansion of oyster aquaculture in Humboldt Bay	None proposed.	MITIGATION BIO-3 would apply (see above).	Special Condition 5 and 16 would apply (see above).
IMPACT BIO-30	Potential impacts to birds from artificial lighting	None proposed.	None proposed.	None proposed.
IMPACT BIO-31	Potential impacts to birds from human disturbance	CONSERVATION BIO-12 would apply (see above).	None proposed.	Special Condition 5 and 16 would apply (see above).
IMPACT BIO-32	Potential impacts to waterfowl foraging from the expansion of oyster aquaculture in Humboldt Bay	CONSERVATION BIO-12 would apply (see above).	None proposed.	Special Condition 2, 13, and 15 would apply (see above).
IMPACT BIO-33	Potential impacts to shorebird foraging from the expansion of oyster aquaculture in Humboldt Bay	CONSERVATION BIO-9 and BIO-12 would apply (see above).	None proposed.	Special Condition 2, 13, and 15 would apply (see above).
IMPACT AV-1	Effect on scenic vistas and visual character from worker and vessel presence	None proposed.	None proposed.	None proposed.
IMPACT AV-2	Effect on scenic vistas and visual character from shellfish culture equipment presence	CONSERVATION AV-1: Reflective materials such as shiny metals will not be used.	None proposed.	None proposed.
IMPACT AV-3	Effects of glare and artificial lighting	CONSERVATION AV-1 would apply (see above).	None proposed.	None proposed.

Certified EIR Potential Impact Number	Certified EIR Topic	Conservation Measures	Mitigation Measures	California Coastal Commission Special Conditions**
IMPACT AQ-1	Contribution to PM_{10} levels	None proposed.	MITIGATION AQ-1: Coast shall comply with the requirements of all adopted air quality plans, including plans covering particulate emissions, and shall implement all actions required by the AQMD for Coast's shellfish aquaculture operations.	None proposed.
IMPACT GHG-1	Generation of GHGs	None proposed.	None proposed.	None proposed.
IMPACT GHG-2	Conflict with an applicable plan, policy, or regulation adopted for reducing the emissions of GHGs	None proposed.	None proposed.	None proposed.
IMPACT WQ-1	Water Quality	None proposed.	None proposed.	None proposed.
IMPACT WQ-2	Sedimentation	None proposed.	None proposed.	None proposed.
IMPACT HAZ-1	Hazard to people or the environment through the routine transport, use, emission, or release of hazardous materials	CONSERVATION HAZ-1: Coast will not discharge any feed, pesticides, or chemicals (including antibiotics and hormones) into Humboldt Bay waters. CONSERVATION HAZ-2: Coast will implement an equipment maintenance program for all vessels used in mariculture activities to limit the likelihood of release of fuels, lubricants, paints, solvents, or other potentially toxic materials associated with vessels as a result of accident, upset, or other unplanned events. CONSERVATION HAZ-3: Coast will continue to fuel boats at commercial fuel dock facilities, carry oil spill absorption pads and seal wash decks or isolate fuel areas prior to fueling so as to prevent contaminants from entering the water.	None proposed.	None proposed.
IMPACT HAZ-2	Hazard from the abandonment or loss of marine debris	None proposed.	MITIGATION HAZ-1: Following storm or adverse weather events, Coast will patrol culture areas for escaped or damaged culture equipment, promptly retrieve any equipment encountered and, if it cannot be repaired and placed back into service, properly dispose of the escaped equipment on land. In addition, Coast will retrieve or repair any escaped or damaged culture equipment that it encounters while conducting routine daily and/or monthly maintenance activities associated with shellfish culture (e.g. bed inspections, shellfish grading and sorting). If the escaped gear cannot be repaired and replaced on the shellfish bed, it will be properly disposed of on land. MITIGATION HAZ-2: Within 30 days of harvest on any area that is being discontinued or taken out of production for one year or more, Coast will remove all shellfish culture apparatus from the area, including but not limited to, stakes, racks, baskets, and pallets. Note: modified by Special Condition 9. MITIGATION HAZ-3: Coast will implement annual employee training regarding marine debris issues and how to identify loose culture gear and proper gear repair and removal methods. MITIGATION HAZ-4: Coast will conduct quarterly bay cleanups in coordination with other interested parties or organizations, which will include walking portions of the bay and shorelines to pick up escaped shellfish gear and other trash (regardless of whether it is generated by the Project). The volume of shellfish gear collected shall be recorded. MITIGATION HAZ-5: Coast will not leave tools, loose gear, or construction materials on its owned and leased tidelands or surrounding areas for longer than one tide cycle. All gear installed in the Project area will be kept neat and secure.	Special Condition 8: By December 31 of each year, Coast shall submit an annual report describing the status of each bed within the operation footprint and updates on cleanups and the effectiveness of debris management. Special Condition 9: Within 30 days of harvest on any cultivation bed that is being discontinued, abandoned, removed, or taken out of production for 6 months or more, Coast shall notify the Executive Director and propose a schedule to remove all piles of oysters and oyster shells, and all culture apparatus from that bed; see Commission (2017) for more details. Special Condition 10: Coast shall carry out operations consistent with the Marine Debris Reduction and Management practices detailed in the Commission (2017) staff report. The mitigation measures are consistent with Special Condition 10, with additional details on management provided in the staff report.

Certified EIR Potential Impact Number	Certified EIR Topic	Conservation Measures	Mitigation Measures	California Coastal Commission Special Conditions**
IMPACT HAZ-3	Health hazard from bioaccumulation of dioxins in shellfish meat	None proposed.	None proposed.	None proposed.
IMPACT REC-1	Effects on recreational facilities	None proposed.	None proposed.	None proposed.
IMPACT REC-2	Effects on recreational users of the bay	CONSERVATION REC-1: Coast shall avoid operations in the mapped area of the EBMA from midnight until sunset on days designated by CDFW as brant hunting days, including season opening and closing days (typically brant hunting is limited to Wednesdays, Saturdays, and Sundays between November 15 and December 15). This conservation measure shall not apply in the case of emergency conditions or other operations, such as marine debris removal, required by Coast to comply with other conditions of approval or mitigation measures, or ensure the safety of its operations. CONSERVATION REC-2: By December 1 of each year, Coast will submit a current bed map to the Harbor District for posting on the Harbor District's website; Coast will also post the current bed map on its website. The map will describe the locations of all of Coast's subtidal and intertidal culture in North Bay. Coast will provide electronic copies of the bed map upon request.	None proposed.	Special Condition 11: Coast shall submit an updated version of the Cultivation Bed Mapping and Marking Plan (Cultivation Area Plan); see the Commission (2017) for additional details. See Appendix E for the details of the cultivation bed mapping and marking plan. Special Condition 12: Except for emergency situations, Coast shall avoid on-water operations within its leased and owned areas depicted in Appendix F from one hour before sunrise until sunset on days that are designated by CDFW as brant hunting days. The conservation measures are consistent with Special Condition 11 and 12, with additional details provided in the staff report.
IMPACT NOISE-1	Generation of noise levels in excess of established standards	None proposed.	None proposed.	None proposed.
IMPACT TRANS-1	Effects of intertidal culture operations and equipment on watercraft (e.g. boats, kayaks) navigation	CONSERVATION REC-1 and REC-2 would apply (see above).	None proposed.	Special Condition 11 and 12 would apply (see above).

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Appendix B
Eelgrass Monitoring Plan

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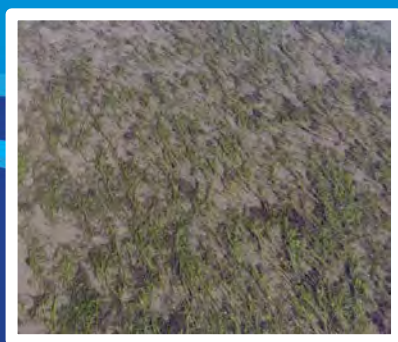
CONFLUENCE
ENVIRONMENTAL COMPANY

Shellfish Aquaculture Humboldt Bay Permit Renewal and Modification Project
EELGRASS MONITORING PLAN

Prepared for:

Coast Seafoods Company
August 2017



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Shellfish Aquaculture Humboldt Bay Permit Renewal and Modification Project
EELGRASS MONITORING PLAN

Prepared for:

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TerraStat Consulting Group

August 2017

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APPENDICES

1.0 INTRODUCTION

Coast Seafoods/Pacific Seafoods Company (Coast) has developed a proposal for shellfish aquaculture activities in Humboldt Bay for the Shellfish Aquaculture Humboldt Bay Permit Renewal and Modification Project (Project). A prior version of the Project, which proposed a substantial expansion of Coast's cultivated footprint, and its potential impacts to eelgrass, are described in the Recirculated Draft Environmental Impact Report (R-DEIR) and Final EIR (FEIR). Following the California Coastal Commission Meeting on June 7, 2017, a revised plan was developed that focuses on reconfiguring the existing farm to limit impacts to eelgrass and other natural resources. Coast will relocate culture activity by removing culture activity from Sand Island and an isolated growing area in East Bay (EB 7-2) and relocating additional culture activity to portions of Mad River and Bird Island adjacent to ongoing culture activity (Figure 1). As part of this reconfiguration, Coast proposes to monitor oyster culture areas in Bird Island and Mad River (Figure 2) to understand the potential interactions between proposed longline and basket culture spacing and eelgrass.

This eelgrass plan has two components with related objectives and performance measures.

- Measurement of eelgrass performance in Test Plots
    - Document changes in eelgrass density or areal cover characteristics in test plots comparing observed levels to pre-project and reference conditions.
    - Compare observed changes to predicted levels of eelgrass suppression reported in the recirculated Draft Environmental Impact Report for the project.
- Measurement of eelgrass performance in Removal Areas
    - Document changes in areal cover within removal areas. Eelgrass cover within removal areas will be compared to adjacent areas to evaluate recovery of eelgrass.

This document describes the context for the Project's eelgrass monitoring program, and the planned monitoring methods that will be used. In addition to describing methods for monitoring eelgrass within culture areas, this plan also describes methods that will be used to evaluate eelgrass where removal of aquaculture will occur. The methods are consistent with the guidance and recommendations of the California Eelgrass Mitigation Policy and Implementing Guidelines (CEMP) (NMFS 2014), with modifications and interpretations to account for the character of the Project site and potential impacts.

2.0 PROJECT BACKGROUND

Coast owns or leases approximately 4,300 acres of intertidal and subtidal habitat in Arcata Bay, also called North Bay, of the Humboldt Bay estuary. Most of the intertidal habitat in these areas was historically used by Coast, and predecessor companies, to support shellfish aquaculture since at least the 1950s. In 2006, Coast reduced its aquaculture footprint from approximately 500 acres to 300 acres, and converted its operations from on-bottom to off-bottom aquaculture. The mitigation provided for impacts associated with the 2006 permit action has components of comprehensive management planning, in-kind mitigation, and out-of-kind mitigation. As described in Section 2.1 below, eelgrass impacts from the current Project are expected to be less than those authorized by the 2006 permit action. Therefore, potential eelgrass impacts from ongoing aquaculture operations have been previously mitigated and the Project includes several additional minimization measures to further reduce ongoing effects to eelgrass where oyster culture and eelgrass co-occur.

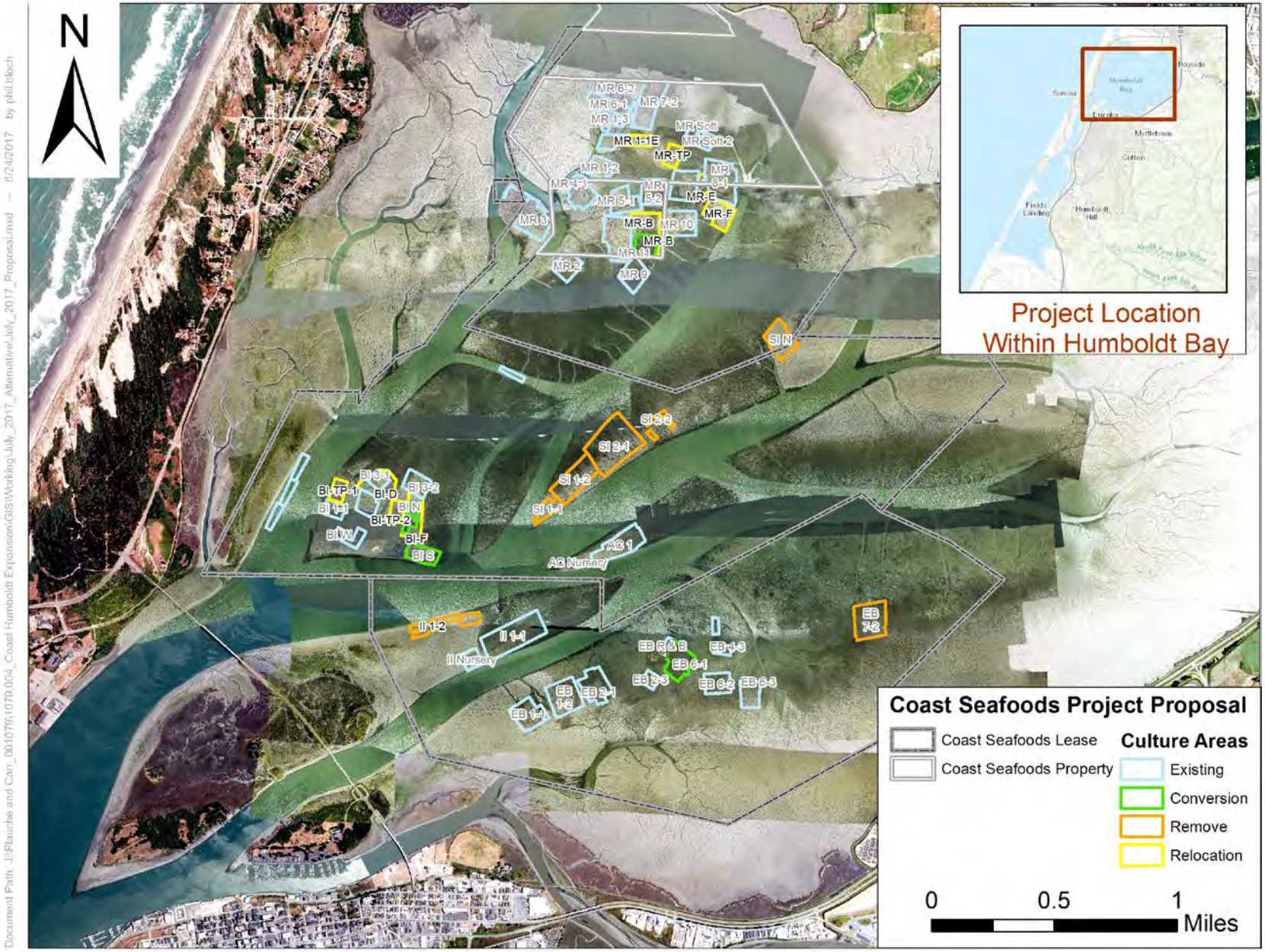

Figure 1 Coast Seafoods Project Proposal

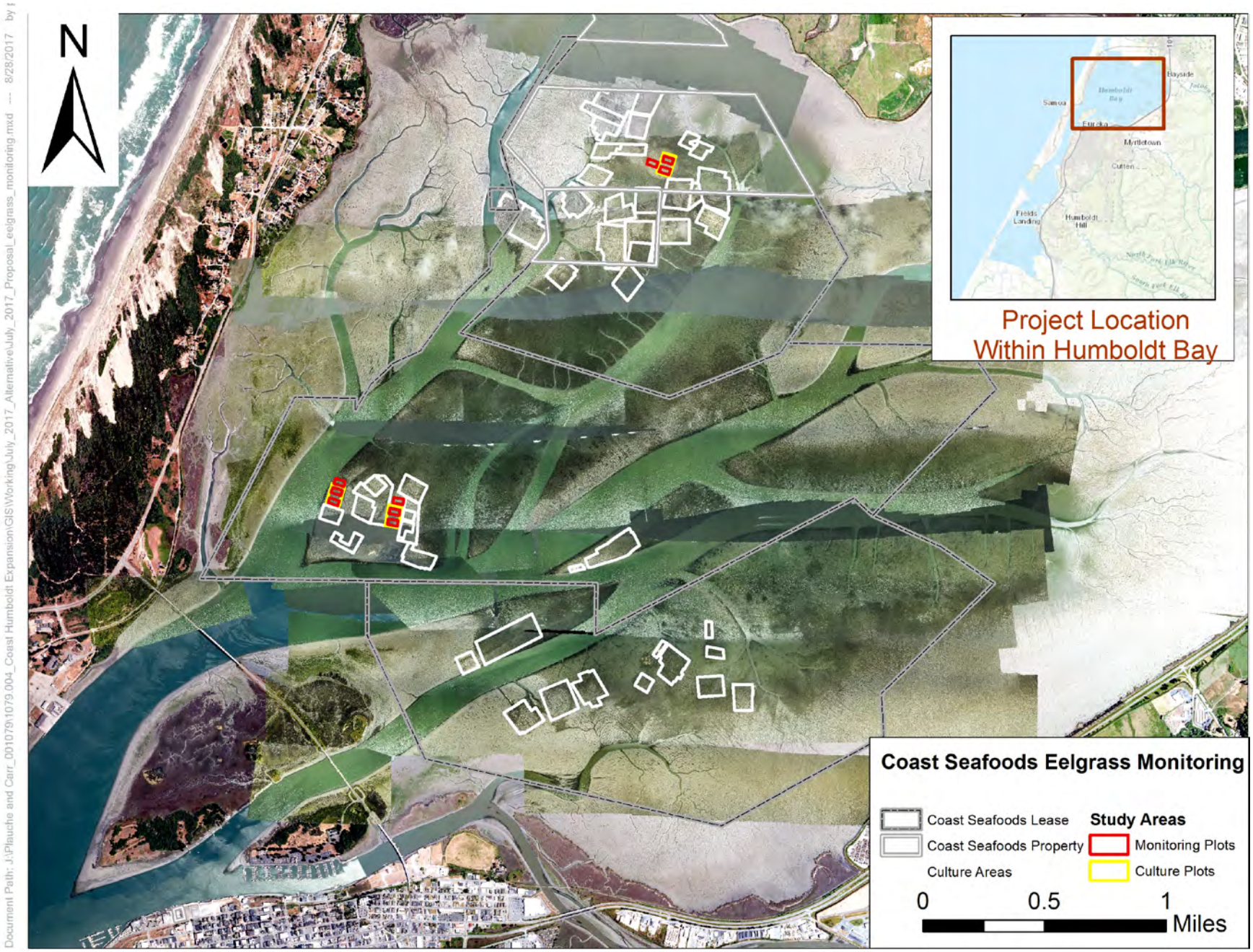

Figure 2 Proposed Culture and Study Areas

2.1 Minimization Measures

Minimization measures associated with the reconfiguration of Coast's oyster growing areas include the removal of activity from targeted areas and increased line spacing in relocated oyster culture beds or existing beds that are converted from cultch-on-longline to basket-on-longline.

The removal of culture from Sand Island and a portion of East Bay (bed EB 7-2) is expected to result in improved eelgrass conditions within these areas due to the removal of eelgrass suppression associated with culture equipment or activity. Beds scheduled for removal have 2.5-ft line spacing between cultch-on-longline lines. After removal of aquaculture gear, eelgrass within these culture beds is expected to recover to eelgrass densities, cover characteristics, and ecological functions that are similar to adjacent areas that have not had recent aquaculture impacts. This recovery has been documented in other areas in Humboldt Bay where Coast has previously ceased aquaculture operations.

Relocated culture beds are currently fallow or unused areas where off-bottom culture activity will be established. These areas were selected after reviewing existing culture areas and eelgrass conditions in Humboldt Bay to consolidate Coast's cultivation activity and to minimize potential conflicts between culture activity and eelgrass habitats. These areas are primarily located adjacent to existing growing areas and in areas where eelgrass is currently at low abundance based on recent (2016) aerial photos.

In addition, culture activity in relocated culture beds will use wider line spacing than existing culture activity. Line spacing will be 10-ft between lines for cultch-on-longline activity and alternating 9-ft and 16-ft line spacing for basket-on-longline. These line spacings are substantially greater than the 2.5-ft spacing in the beds scheduled for removal. Increased line spacing is expected to result in less eelgrass suppression and, therefore, higher overall eelgrass abundance within culture beds. The role of line spacing was evaluated in research in Humboldt Bay (Rumrill and Poulton 2004), and has been supported by observations in several other bays (summarized in Confluence 2016).

2.2 Study Areas

Coast Seafoods proposes establishing four growing areas to monitor the interactions between culture activity and eelgrass. These growing areas are a portion of the relocation areas located on Bird Island and Mad River (Figure 2). Each of these growing areas is approximately 3.06 acres in area, with half of each area used for cultch-on-longline grown at 10-ft spacing with double-hung lines and the other half used for basket-on-longline at alternating 9-ft and 16-ft spacing. These growing areas will be intensively monitored using both ground-based and aerial-based monitoring to evaluate the response of eelgrass density and cover to aquaculture activity. Each study area has an adjacent reference area where no culture activity is proposed

that will also be monitored. These study areas are intended to characterize the response of eelgrass to commercial scale off-bottom aquaculture activity in Humboldt Bay.

3.0 REMOVAL, RELOCATION AND CONVERSION SCHEDULE

Coast has developed a proposed schedule for reconfiguring the existing farm operations (Table 1). Removal of gear will follow the projected harvest dates identified in Table 1 and would generally occur during spring and fall months over a 2-year period. Relocation and conversion areas would occur during the same 2-year period. At no point will the amount of relocation plots exceed the rate of removal.

Table 1 Proposed Schedule for Removal, Relocation and Conversion

Culture Type	Bed Label	Proposed Year	Bed Size (Acres)
Removal			
Longline	I-I 1-2	2017	6.56
Longline	S-I 2-1	2017	20.86
Longline	S-I 2-2	2017	2.37
Longline	S-I 1-2 A	2017	1
Longline	S-I NORTH	2017	7.42
Longline	S-I 1-1	2018	3.7
Longline	S-I 1-2	2018	2
Longline	S-I 1-2 B	2019	5.38
Longline	S-I 1-2 C	2019	3.02
Longline	EB 7-2	2019	11.21
Total Removal			63.52
Relocation			
Longline/Basket	MR TP	2017	3.06
Longline/Basket	BI TP 1	2017	3.06
Longline/Basket	BI TP 2	2017	3.06
Longline/Basket	EB TP	2017	3.06
Basket	MR F	2018	6.3
Basket	BI F	2018	4.6
Longline/Basket	MR B	2018	8.1
Longline/Basket	BI D	2018	8.6
Longline/Basket	MR E	2018	2.4
Total Relocation			42.24
Conversion			
Basket on line	BI S	2017	1.33
Basket on line	BI N	2017	2.86
Basket on line	MR 11	2018	4.65
Basket on line	BI S	2019	4
Basket on line	EB 6-1	2019	7.77
Total Conversion			20.61

Oyster farming responds to market conditions and, therefore, some planned dates and actions identified in Table 1 may not occur or may be delayed. Basket-on-line methods grow single oysters for the half-shell market and cultch-on-longline methods grow cultch oysters for the shuck market. Similarly, beds scheduled for conversion may be retained as longline beds at existing spacing or converted to basket-on-longline. If a bed is converted to basket-on-longline at alternating 9-ft and 16-ft spacing, it will not be reverted to longlines at 2.5-ft spacing. Beds scheduled for removal will be removed according to the identified schedule.

4.0 MONITORING METHODS

The following text describes the monitoring methods for eelgrass areal coverage and eelgrass density. The study areas are described above in Section 2.2. High-resolution images of each of the four areas are shown in Appendix A, which also illustrates the relationship between the planned line layouts and monitoring areas. Within each study area, there are two 0.6-acre monitoring plots, with one monitoring plot for each culture method. Monitoring plots are centered in the study plots so that culture activity surrounds them. These monitoring plots are expected to be representative of eelgrass responses to culture activities at the commercial bed scale.

4.1 Eelgrass Areal Coverage Measurements

All monitoring and removal areas will be monitored for eelgrass areal coverage by taking a complete census of eelgrass within these areas using high resolution (approximately 4 cm pixel or smaller) aerial imagery. The goal of the areal coverage measurements is to assess whether culture activities cause a change in eelgrass bed areal extent, using the bed definition provided in the CEMP of "any eelgrass within 1 m^2 quadrat and within 1 meter [m] of another shoot" (NMFS 2014), and comparing the measurements in the relocation areas to natural eelgrass bed variation within Arcata Bay. Eelgrass areal coverage will be mapped within the study area culture beds and adjacent reference areas (within 200-feet of bed boundaries including all identified reference areas, Figure 3) using aerial imagery collected during low tides during the eelgrass growing season (May through August).

Aerial imagery will be collected using unmanned aerial vehicles (UAVs) that are flown in a pre-planned grid pattern with a minimum of 50% overlap (side-lap and end-lap) between images. Based on the cameras on DJI Phantom 4, images collected during flights at 200-feet above ground surface will be recorded along flight lines 52 m or less apart with images captured every 39 m or less (see Figure 4). This will result in several hundred images in the study area, which will be combined into a single mosaic for each flight, and ultimately individual flights will be

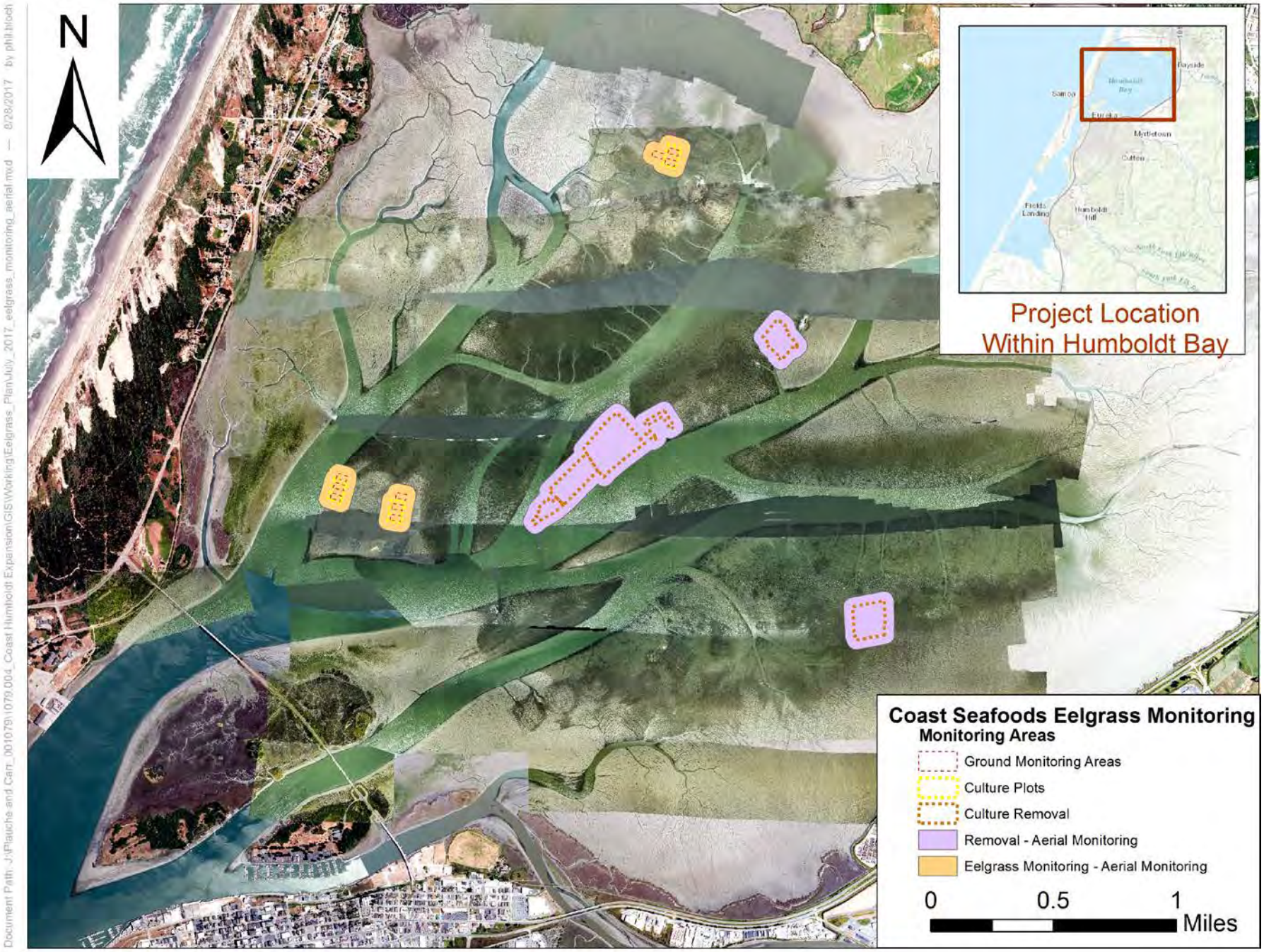

Figure 3 Overview of Low Elevation Aerial Imagery Areas.

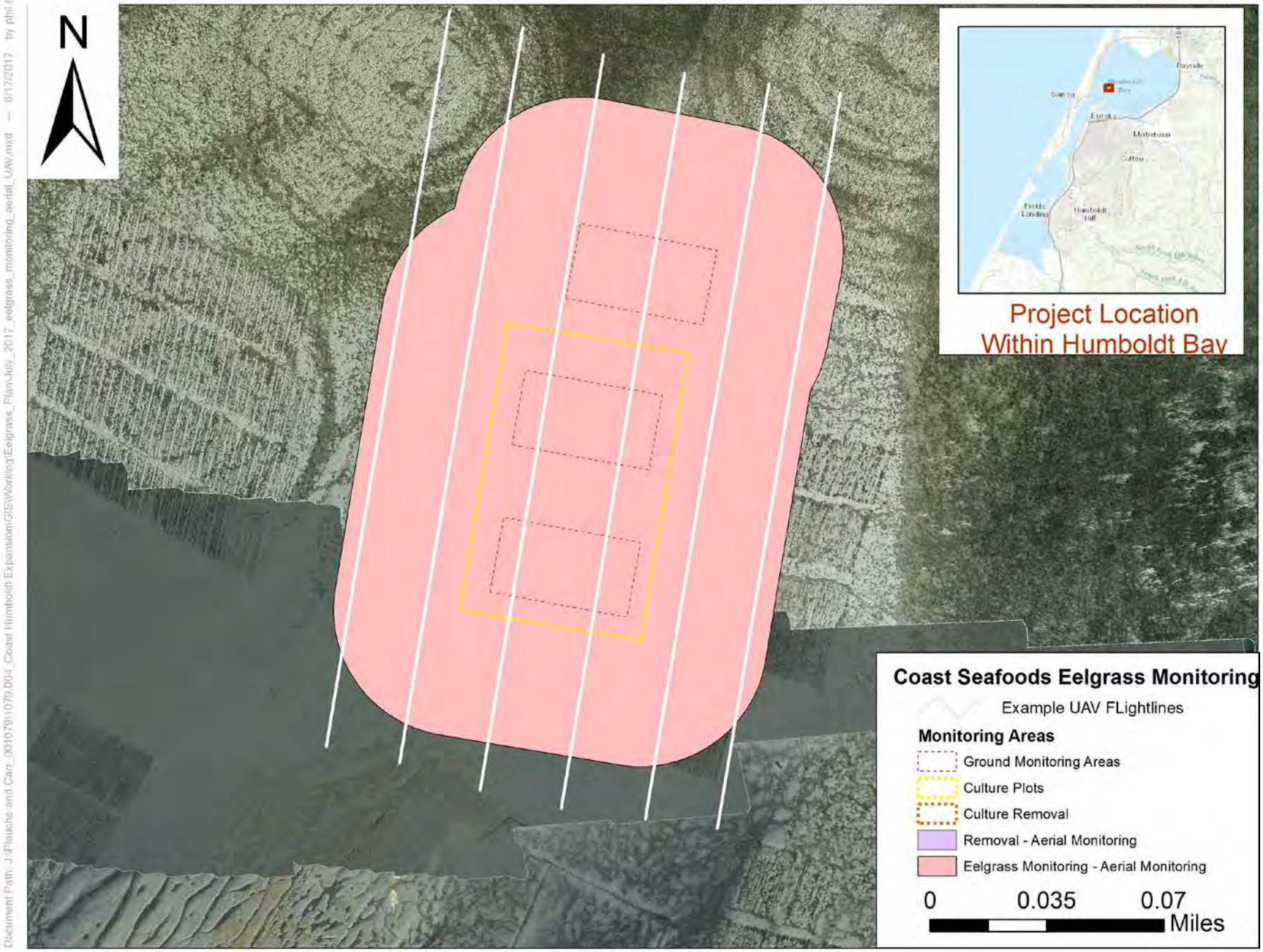

Figure 4 Example of UAV flight lines assuming 200' altitude survey elevation.

combined. The UAV flights will occur during tides lower than 0 feet (ft) mean lower low water (MLLW).

UAV flights are planned to occur at altitudes above ground of 150 ft to 200 ft, although lower flights may be necessary based on weather conditions (e.g., fog, wind). Positional information derived from UAV GPS/GLONASS receivers and embedded in aerial image metadata will be integrated with ground control point coordinates established by handheld, sub-meter GPS receivers to georeference each aerial orthomosaic. Ground control point locations will be identified with high contrast aerial targets readily visible in the aerial to georeference the imagery. The lowest available daytime tides, within the eelgrass growing season, will be prioritized for this effort.

4.1.1 Aerial Image Classification

The imagery collected by UAV will be processed to create high resolution orthophoto of the areas of interest. Imagery will then be classified into habitat classes using an iterative approach. Both unsupervised and supervised classification methods will be used. Unsupervised classification uses computer algorithms to classify pixels based on their similarity into a pre-determined number of classes. Supervised classification bases the pixel classes on areas of known habitat classes (e.g., eelgrass, water, and mud), and uses algorithms to identify other areas that are similar to areas of known habitat. A minimum of 100 ground observation points will be used to characterize habitat for each year of areal cover measurements. A portion of the ground observation points will be used to help improve the image classification process (as described above), and a portion of the ground observations will be used to evaluate the accuracy of the image classification. Aerial imagery will be retained by Coast on durable storage media in a raw (mosaic, but not interpreted) and interpreted forms for future analysis.

4.1.2 Image Classification Error

Image classification error will be assessed by generating a misclassification table, or error matrix. Ground observations that were not used to train imagery classification will be used to characterize the misclassification rate for the image interpretation. This is where predicted classes will be compared with ground observations to determine the accuracy of the classification. Prior to developing the error matrix, all non-eelgrass feature categories will be collapsed to support a binary error assessment aimed at distinguishing eelgrass from non-eelgrass features. The error matrix will assess user's accuracy (frequency at which classified features on the map are present on the ground), producer's accuracy (frequency at which real features on the ground are correctly portrayed on the classified map) and overall accuracy of the eelgrass classification. The Project will target achieving a user's accuracy for eelgrass habitat of no less than 85%. User accuracy may be calculated using resampled data and/or based on eelgrass bed area rather than individual orthomosaic pixels. Ground truth observations may be comprised of a combination of actual ground observations, including observations from density

quadrats, and synthetic ground observations taken from high resolution orthorectified photographs collected from extremely low altitude UAV flights (e.g., observations from 20 m (66 ft) or less above ground elevation). An evaluation of synthetic vs. actual ground observations will occur to confirm the suitability of using synthetic ground observations.

4.1.3 Habitat Mapping

Ground observation points will be evenly distributed between two classes of habitat: eelgrass and not eelgrass. This level of ground truthing follows guidance by Congalton (1991) for establishing 50 samples in each class of habitat being classified using aerial imagery. Once imagery is classified, pixels within the image will be categorized into one of four categories: eelgrass, mudflat, culture gear, water, or other (e.g., people, boats, etc.).

Eelgrass habitat will be further mapped based on "eelgrass observations." This means that, on a pixel basis, eelgrass is present. Eelgrass will also be mapped based on "eelgrass vegetated habitat," based on the CEMP definition. This means that a 0.5-meter buffer around pixels identified as eelgrass observations will be classified as vegetated eelgrass habitat, while a 5-meter buffer around these pixels will be classified as being components of the eelgrass spatial distribution per the CEMP.

4.2 Density Measurements

All monitoring plots, both inside culture areas and adjacent reference areas, will be monitored for eelgrass density using a sampling design developed to assess eelgrass conditions for the population of study areas while also allowing for assessment of geographic blocks or strata. Thus, the study design is intended to characterize the response of eelgrass to each culture type (baskets and longlines) at the scale of Humboldt Bay. However, individual study areas can also be evaluated by comparing results within the study areas to adjacent reference areas.

Limited eelgrass density will also be collected in removal areas, but the methods vary from the methods for density measurements described below.

The monitoring program design will assess two types of culture beds (or treatments) independently: (1) basket-on-longline beds (n = 4 monitoring plots), and (2) cultch-on-longline beds (n = 4 sample plots) (Figure 2). Monitoring plots will be established within each proposed study bed, and monitoring of these plots will be used to represent the eelgrass conditions, and response of eelgrass to culture activity, for each treatment. Treatments will use a common set of reference areas (n = 4) that are paired with each study area. Monitoring plots will be established during Year 0 (baseline monitoring) and will be tracked for at least 5 years. However, field effort may be reduced after Year 3, based on monitoring results and upon approval of applicable resource agencies.

Eelgrass density will be compared to baseline conditions to evaluate effects of longline culture using a Before-After Control Impact (BACI) design, with adjustments based on the regional changes as observed in the reference areas. The group of reference sites will be used as controls unless effects are noted that appear to affect just one geographic sub-region. In those instances, only the reference areas within the geographic sub-region will be used. The sampling design presented here is intended to assess change by doing an Analysis of Variance (ANOVA) test using each sample plot as a unit to test significance and assessing the difference in the mean of sample plot and mean for reference and control areas over time. Representative monitoring plots will be monitored during low tides targeting the period in, or within 2 weeks of, June each year for one season prior to planting in the relocation areas and up to 5 years after oyster planting (see Table 1 for planting schedule).

Statistical power will be lower for evaluating change in individual culture beds; however, changes in individual culture bed eelgrass density can be assessed by evaluating the mean density and confidence interval around that mean. In addition, a post-hoc analysis by geographic sub-area (e.g., Mad River or Bird Island) and type of treatment (e.g., basket or longline) can be conducted, as described below, to provide an understanding of eelgrass density response. The monitoring plan is designed to assess the Project overall and for performance criteria to be applied at the Project scale, however the monitoring approach will facilitate analysis by culture bed, geographic sub-area, or treatment type that can be used in adaptive management planning.

4.2.1 Culture Beds (Treatments)

Conceptual layouts for culture beds were identified using the proposed spacing for longlines and baskets, and providing 20-foot gaps between groups of longlines and baskets for boat access (Appendix A). Final placement of lines will occur based on field conditions; however, these conceptual layouts are representative of the planned orientation and line spacing for the culture beds. Where possible, the planned orientation is with the lines in a north-south direction, which is predicted to have the least shading impacts.

Culture lines, the prescribed gaps between them, and the boat lanes separating these set of lines from adjacent culture, comprise the area to be monitored within each sample plot. The total area to be monitored within each sample plot is 220 ft by 120 ft (or 0.6 acres). The sampling unit is the sample plot, and 0.25 m^2 or 0.0625 m^2 quadrats will be used to sample eelgrass density within the sampling unit. A set of 20 quadrats will be used to measure densities within the sample plot and will comprise the estimate of the density within the sample plot and the bed. The entire sample plot will be divided into 0.5 m by 0.5 m grids, which represent all potential locations for 0.25 m^2 quadrats, for a total of approximately 9,900 potential quadrat locations within each sample plot. Figure 5 provides an example of the grid for a basket-on-longline sample plot.

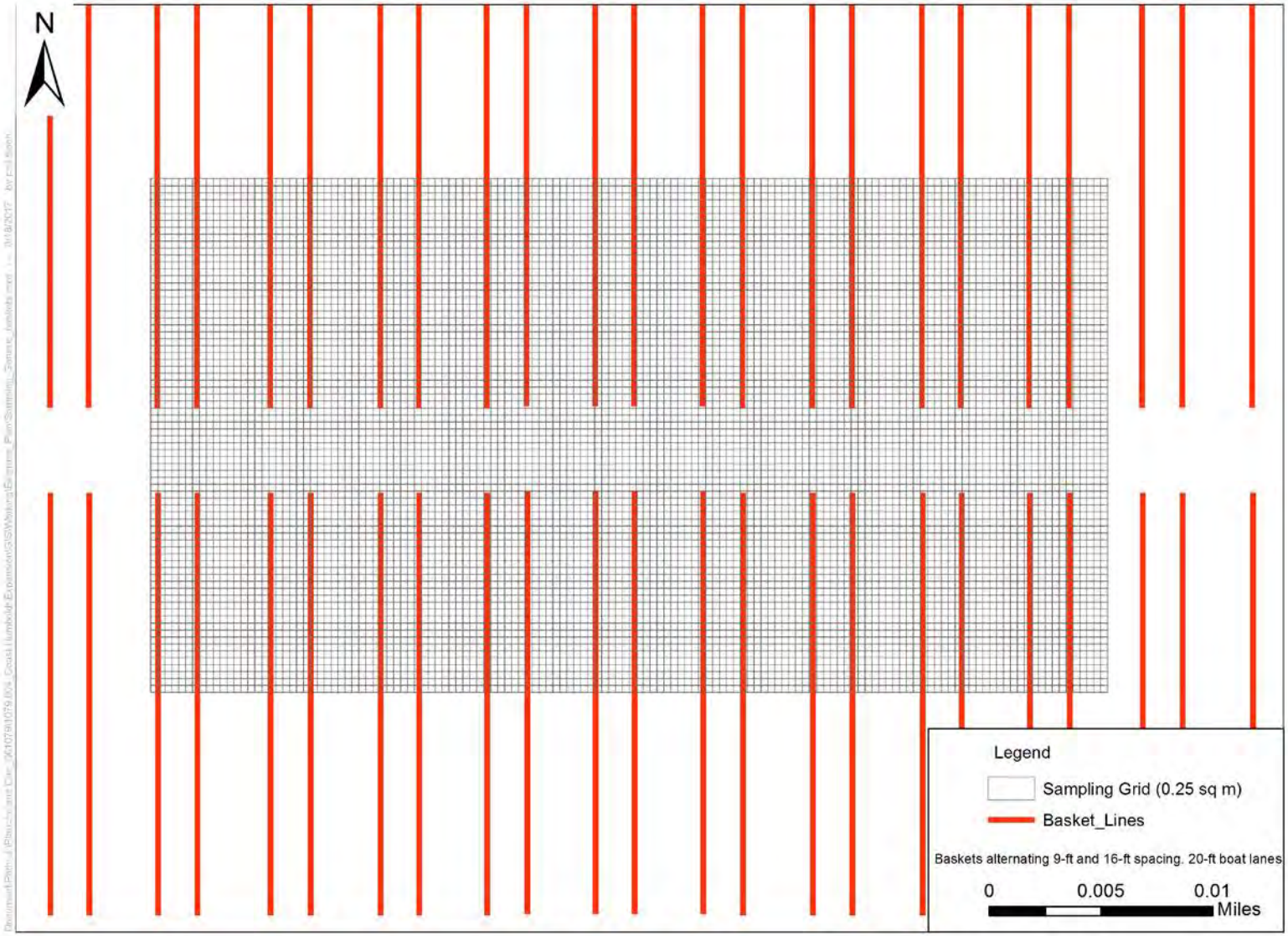

Figure 5 Diagram of Sampling Grids for Basket-on-Longline Sample Plots

A random number generator will be used to select the 20 quadrat locations, without replacement, for each sampling season. Figure 6 provides an example of quadrat locations within a cultch-on-longline sample plot. A total of 20 quadrats will be used to generate the estimate for mean eelgrass density within the sample plot. This number of quadrats is predicted to reduce the variance around the estimate of the mean density (see Appendix B). Ultimately, the statistical analyses will be based on comparisons at the sample plot level. The number of monitoring and control plots, given the quadrat sampling within those plots, is predicted to provide sufficient power to test the hypothesis that eelgrass density will decrease by 25% or less with alpha = 0.2 and beta = 0.2 for one-sided t-test (see the "statistical assessment" section below and Appendix B).

The alpha and beta values used here are larger than those described in the CEMP (NMFS 2014). These values were increased to account for special conditions due to the heterogeneity associated with Arcata Bay and the Project, extending across elevation and other environmental gradients in an approximately 4,300-acre study area. The number of sampling units may be increased between years if variance exceeds predictions and more sampling will economically increase statistical power.

During a sampling season, quadrat locations may have no eelgrass present. Density measurements characterize the density of eelgrass when eelgrass is present. Therefore, quadrat locations with no eelgrass present will be excluded from sampling. To avoid both locations without eelgrass and potential bias, field staff will either use a prepared sequence of additional sample locations or move the quadrat to the nearest adjacent habitat area that contains eelgrass to ensure that 20 valid quadrat samples are collected in each sample plot. For example, field staff will lay out approximately 30 quadrat locations with quadrats 21 through 30 identified in a numbered sequence. Only the first 20 quadrats where eelgrass is present will be used in subsequent analyses.

Sample plot locations will be recorded using a differential global positioning system (dGPS), with sub-meter accuracy, and quadrat locations will be navigated to using measurements from the centerline. Eelgrass turions will be counted in each quadrat and other conditions will be recorded, including elevation, ponding, exposure, substrate, site history, and other context-dependent factors. These additional conditions will be characterized using a combination of geographic information system (GIS) data and field notes.

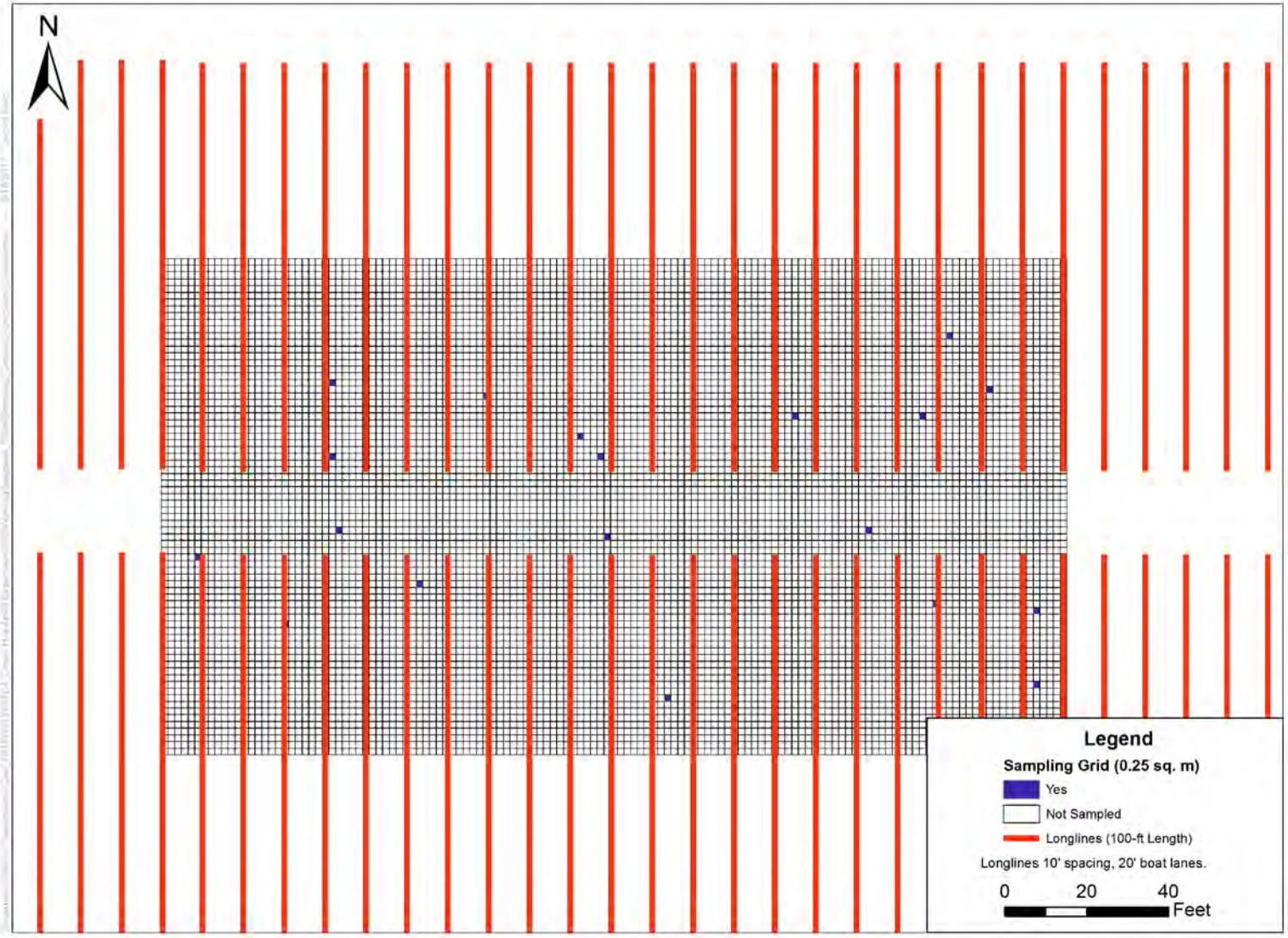

Figure 6 Diagram of Sampling Grids and Example Quadrat Locations for Cultch-on-Longline Sample Plots

4.2.2 Reference Areas

Reference areas were selected from locations that occur more than 10 ft and less than 200 ft from the edge of proposed relocated culture beds. Monitoring plots will be the same size as treatment plots, which are a total of 220 ft by 120 ft (or 0.6 acres), that are within eelgrass with no culture activity present. Reference areas are limited to locations where 2009 habitat characterizations indicate that eelgrass is present (NOAA 2012). Selection of quadrat locations for reference areas will follow the same methods as for the treatment plots.

A total of 4 reference areas were identified, one per study area, that are representative of the conditions within the study areas.

4.2.3 Statistical Assessment

An analysis of sample variance in eelgrass population sampling in Humboldt Bay was conducted and a power analysis developed. Details of this analysis are provided in Appendix B. Although this analysis was initially performed for an earlier version of this project, the overall sampling approach and statistical analysis plan remains the same. A range of potential scenarios were evaluated to help ensure the monitoring approach would be robust. These scenarios include varying the number of quadrat samples within each bed between 5 and 20, varying the number of reference areas between 3 and 10, varying the alpha between 0.1 and 0.2, varying the analysis methods between one-tailed (detecting change in one direction) and two-tailed (detecting change in either direction), and varying the baywide eelgrass density to evaluate the ability to detect change within a bed when eelgrass density decreases by 10% in the bay overall.

This analysis demonstrates that the monitoring plan is robust for these scenarios. Statistical power is sufficient at a beta of 0.2 for a baywide analysis with 4 samples and 4 reference areas when 20 quadrats per site are sampled. Natural variability could make achieving an alpha and beta of 0.1 difficult. The primary intent of this monitoring plan is to detect potential decreases in eelgrass density (one-tailed analysis). However, this sampling intensity will in many cases be sufficient to detect change in either direction. To account for potential differences in quadrat size, a statistical power for 0.0625 m^2 and 0.25 m^2 quadrats was evaluated for one scenario. This evaluation demonstrated that power would be similar for either quadrat size. However, a 0.25 m^2 quadrat size was selected for this monitoring effort.

4.3 Removal Areas

Removal areas will be evaluated to characterize recovery of eelgrass within existing culture areas identified for removal of culture gear and cessation of culture activities. Following harvest, all gear associated with aquaculture operations will be removed, consistent with permit conditions. It is anticipated that gear will be removed within no more than 90 days of the final

harvest activity. These sites will focus on natural recovery of eelgrass within culture areas where longlines are removed.

Removal areas will be monitored for both areal extent and eelgrass density within the areas where culture is removed and adjacent reference areas. Monitoring will use only UAV technology to track both areal extent and eelgrass density. Areal extent will be tracked as described above using aerial imagery and ground-truthing.

Eelgrass density assessments will occur in five 0.7-acre (30 m X 100 m) "zones" established using GIS within the restoration and adjacent reference areas. To assess eelgrass density, the pixels of the aerial imagery will be binned into up to five categories: (1) no eelgrass, (2) very low density (1 to 10 turions per m^2), (3) low density (10 to 30 turions per m^2), (4) medium density (30 to 50 turions/m^2), and (5) high density (>50 turions/m^2). These density categories will be re-evaluated after collecting data from one field season to assess the ability to identify these density categories, and may be adjusted based on that evaluation. Improvements to the monitoring plan would be presented to applicable resource agencies for approval.

Ground samples in eelgrass within the removal areas will also be used to measure eelgrass density using either 0.0625 m^2 or 0.25 m^2 quadrat methods, as described in Section 4.1.2, and may be combined with or replaced by high resolution orthorectified photographs taken from extremely low elevation UAV flights (e.g., observations from 20 m (66 ft) or less above ground elevation) to verify or reject classification assignments based on spatial interpretation of the higher altitude UAV mosaic. These eelgrass density values will be used to verify the accuracy of eelgrass density categories derived from the aerial imagery.

In addition, a presentation by Merkel and Associates (2016) noted that above approximately 80 turions per m^2 it is difficult to accurately characterize differences in eelgrass density (Figure 7) due to layering of turions. The goal of eelgrass mitigation in these areas is for eelgrass conditions within fallowed culture areas to become similar to adjacent reference areas. High density eelgrass (>50 turions/m^2) likely provides similar ecological functions (see discussion below), therefore the eelgrass density categories are consistent with eelgrass functional groups.

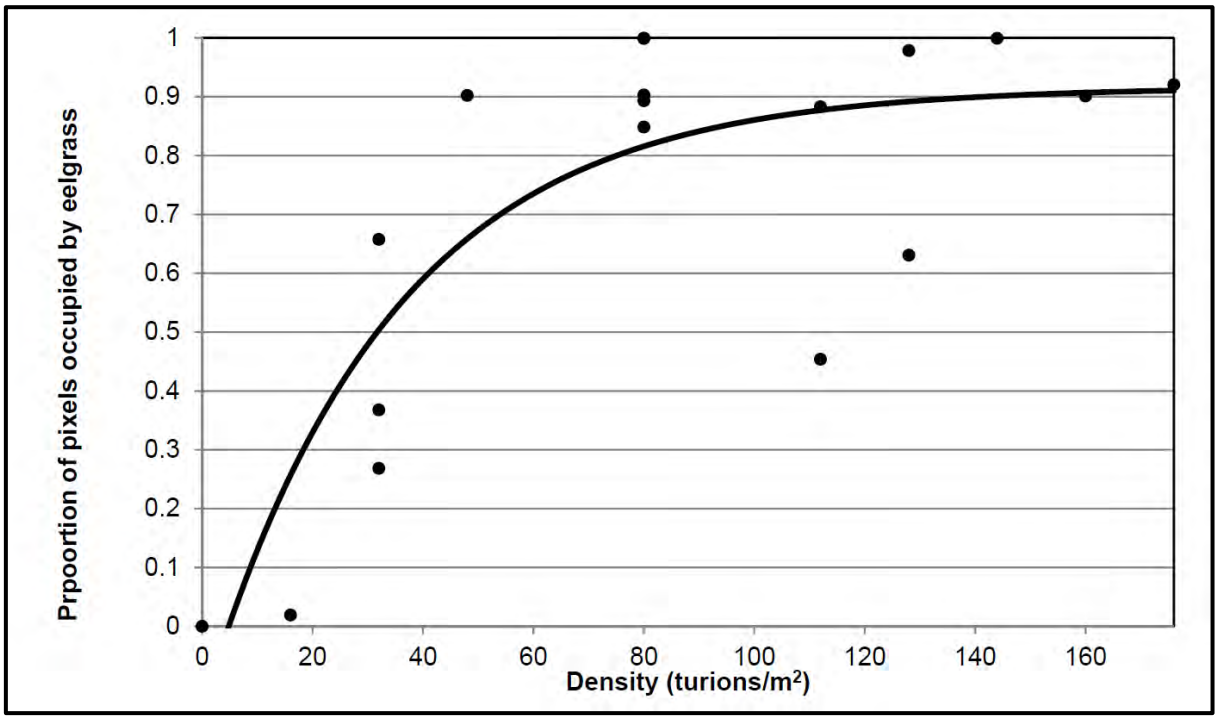

Figure 7 Relationship between Classified Eelgrass Pixel Density and Turion Density
Source: Merkel and Associates 2016

Research has been done on species that use different eelgrass densities (Holt et al. 1983, Orth et al. 1984, Murphey and Fonseca 1995, Fonseca et al. 1996a, b, Irlandi 1997, Fonseca et al. 1998, Hovel and Lipcius 2001, Boström et al. 2006, Hosack et al. 2006). This research does not appear to be conclusive that a higher density of eelgrass supports a higher number of organisms. Rather, a matrix of habitat that includes bare mudflats, low density eelgrass, and high density eelgrass is thought to be the most supportive for a wide variety of marine species. By providing this habitat matrix, increasing eelgrass density and areal extent, and removing human activities in the removal areas, Coast will be providing in-kind mitigation for any potential reduction of eelgrass ecological functions within the proposed relocation areas.

5.0 REPORTING

Reports of monitoring activities will occur annually and include a description of the surveys undertaken, the confidence in the classification of aerial data, interpretation and statistics associated with the data collected, and any other notable observations since the last report. These reports, and the aerial imagery, will be distributed to regulatory agencies and the Humboldt Bay Harbor, Recreation and Conservation District. Reports will evaluate changes in both eelgrass density and areal extent.

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Appendix A

Conceptual Layout of Culture Beds and Monitoring Plots

COAST SEAFOODS EELGRASS MONITORING PLAN
APPENDIX A – CONCEPTUAL LAYOUT OF CULTURE BEDS AND SAMPLE PLOTS

Coast Seafoods/Pacific Seafoods Company (Coast) has developed a proposal for shellfish aquaculture activities in Humboldt Bay for the Shellfish Aquaculture Humboldt Bay Permit Renewal and Expansion Project (Project).

The eelgrass monitoring plan includes density measurements within the representative study areas to characterize response of eelgrass to culture activity in Humboldt Bay. The sampling design for the density measurements will assess two types of culture beds (or treatments) independently: (1) basket-on-longline beds and (2) cultch-on-longline beds.

Conceptual layouts for culture beds were identified using the proposed sample spacing for longlines and providing 20-foot gaps between groups of longlines for boat access. Map 1 through Map 3 show the conceptual layouts for the proposed Study Areas. Final placement of longlines will occur based on field conditions, however, these conceptual layouts are representative of the planned orientation for the culture beds.

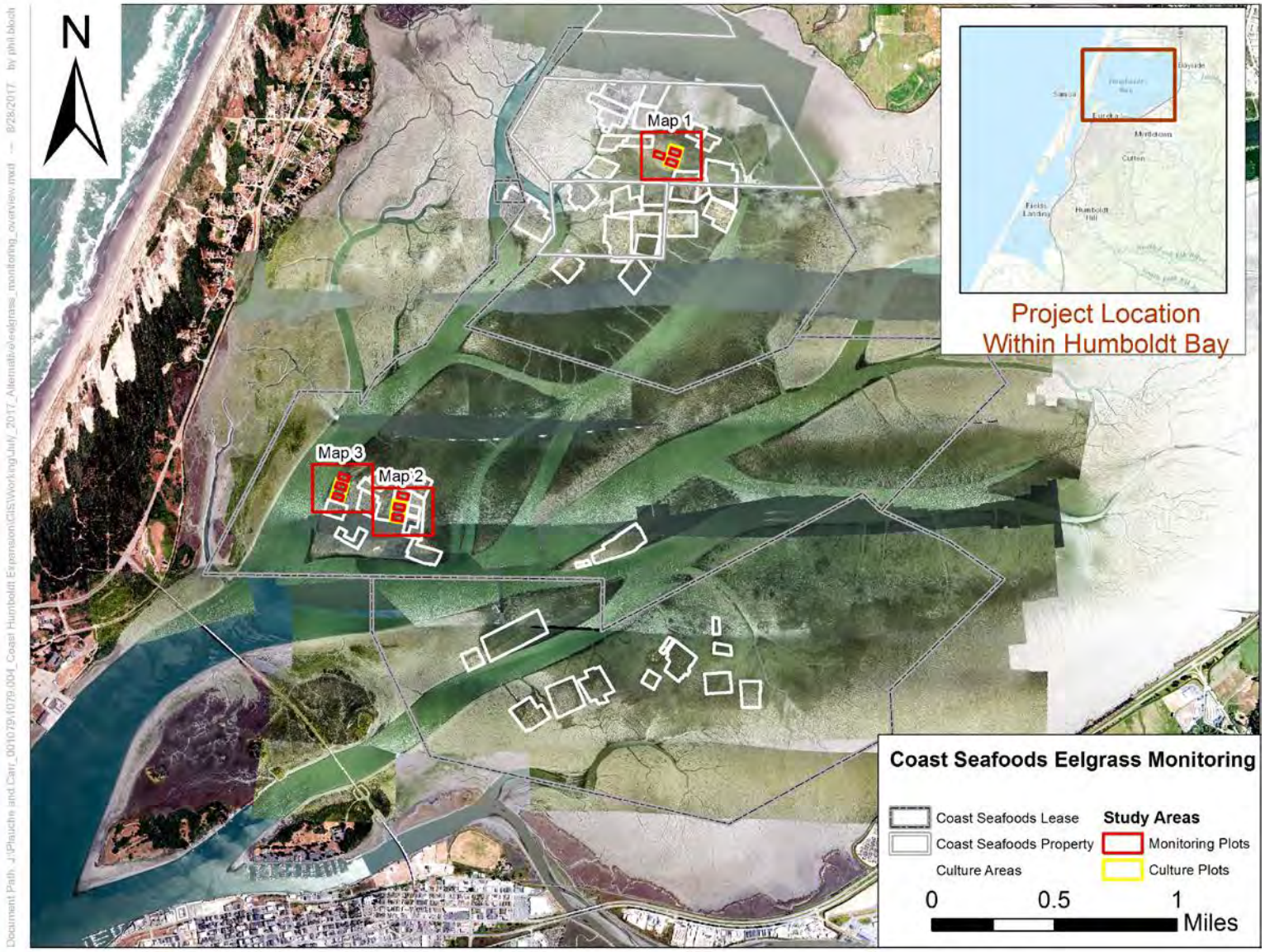
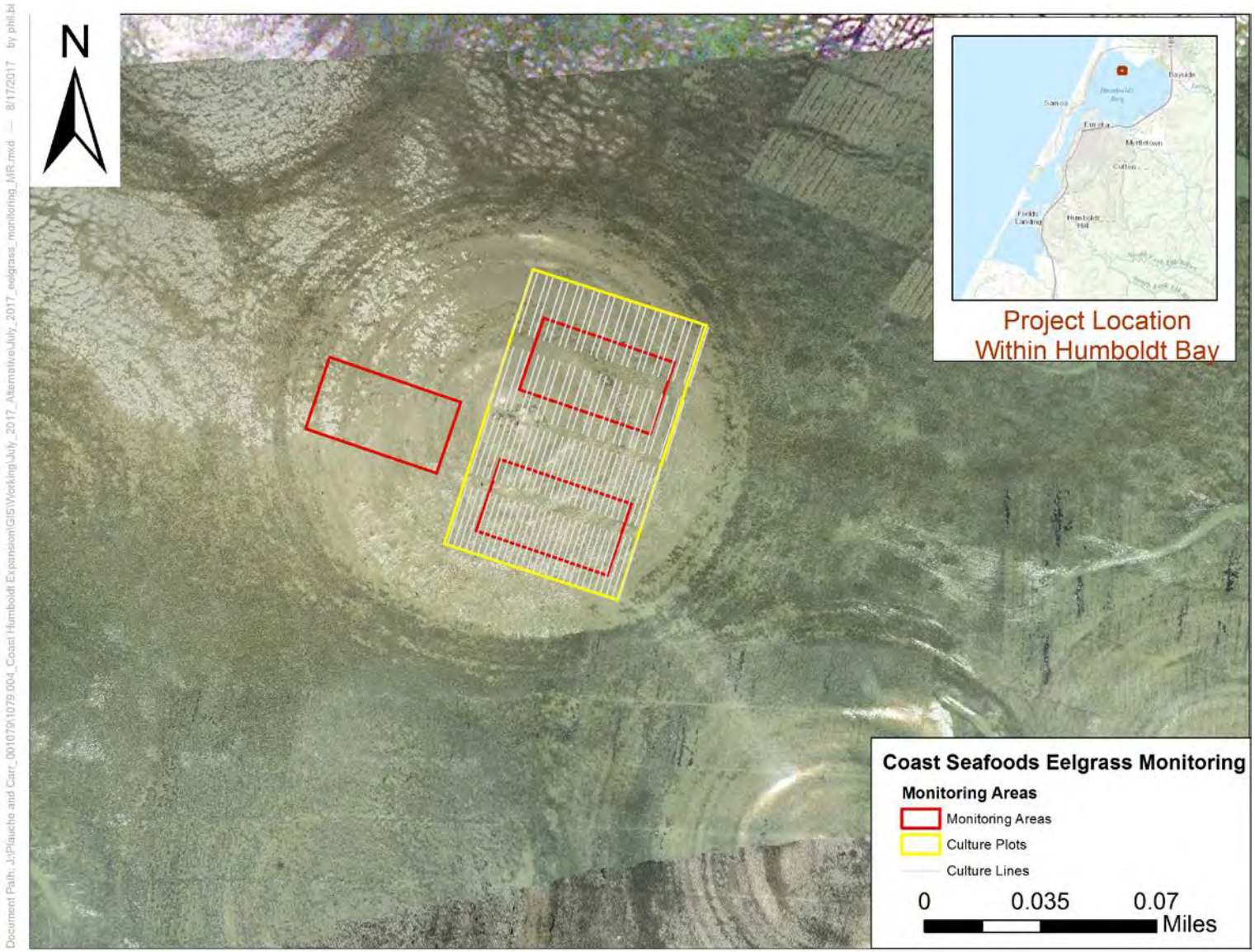
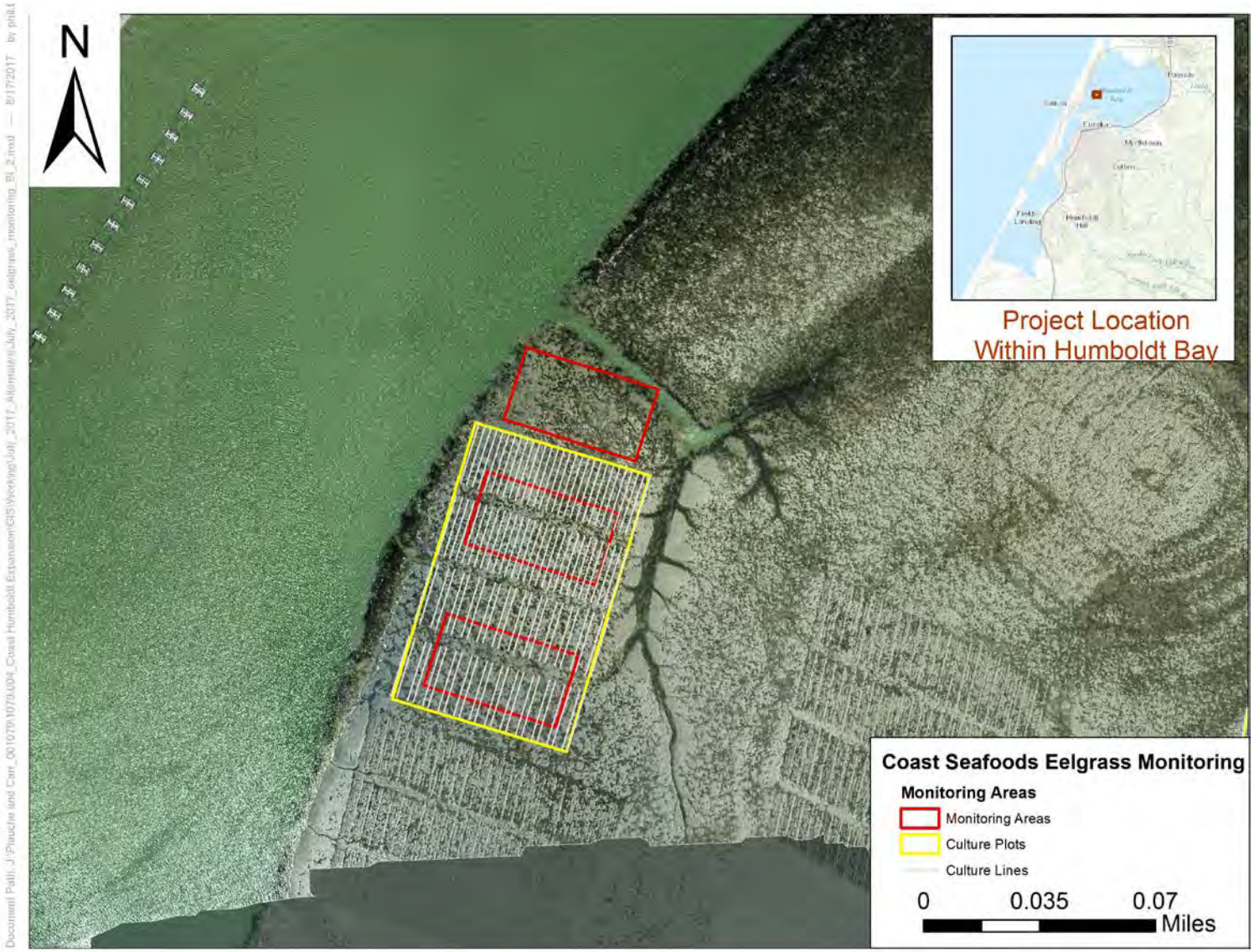


Figure A-1 Overview of Monitoring Study Areas



Map 1 Conceptual Layout of Mad River Study Area

Map 2 Conceptual Layout of Bird Island (East) Study Area.



Map 3 Conceptual Layout of Bird Island (West) Study Area

CONFLUENCE
ENVIRONMENTAL COMPANY

Appendix B

Power Analysis for Coast Seafood's Eelgrass Monitoring

Memorandum

To: Phil Bloch

From: Tamre Cardoso, Ph.D., TerraStat Consulting Group

Date: 30 March 2017

Re: Power Analysis for Coast Seafood's Eelgrass Monitoring

This memo summarizes results for an analysis to estimate statistical power for 0.0625 m^2 quadrat sampling of eelgrass shoot density per m^2 using measurements from impact and reference sites.

Power Analysis Methods/Assumptions/Caveats

1. The number of impact sites are fixed based on planned locations for Phase I expansion. There are 10 proposed longline sites and seven proposed basket sites.
2. Reference areas are buffered areas around the expansion sites. Depending on how the reference areas are partitioned, they could be considered as a minimum of three sites based on general location, or divided into 10 sites of approximately the same areal size of the expansion plots by extending the boundaries of the expansion plots through the reference areas.
3. The estimated power assumes that the data will be analyzed as a BACI experiment with multiple sites and one year before/after. The analysis used a two-sample t-test on natural log-transformed shoot densities with pooled variances, comparing "Impact – Reference" on differences between "After – Before".
4. Simulated data were generated for the power analysis using parameter estimates based on the 2007 – 2010 SeagrassNet data from North Bay. All "Before" data and "Reference After" data were randomly drawn from a lognormal distribution with a mean and variance based on the SeagrassNet data. All "Impact After" data were drawn from a lognormal distribution with a reduced mean to achieve an approximate 25% decrease in shoot densities, on average. See the SeagrassNet Data section below for more details on parameter estimates.
5. The analysis assumed that 0 densities would not be observed in any quadrats.
6. Simulated data were based on counts from 0.0625 m^2, but counts were then scaled to shoots/m^2 for power estimation.
7. The basic hypothesis test scenario is based on the calculation of differences. Specifically, a hypothesis test for a single simulation was calculated as follows:

a. Transformed the simulated shoot density data using a natural log transformation to obtain unimodal, approximately symmetric shoot density distributions with no apparent outliers.

b. For each site (impact or reference), calculated mean shoot density for all "Before" observations and all "After" observations. This resulted in $\bar{x}_{i,B}$ and $\bar{x}_{i,A}$ for impact sites $i = 1, \dots, n_i$ where n_i is the number of impact sites. Similarly, we computed $\bar{x}_{r,B}$ and $\bar{x}_{r,A}$ for reference sites $r = 1, \dots, n_r$ where n_r is the number of reference sites.

c. For each site, calculated the difference between the mean densities for "After – Before", resulting in $\bar{d}_i$ for impact sites $i = 1, \dots, n_i$ and $\bar{d}_r$ for impact sites $r = 1, \dots, n_r$.

d. Performed a two-sample *t*-test assuming equal variances using natural log transformed with null hypothesis, the mean of the mean differences for impact sites is equal to the mean of the mean differences for the reference sites (H_0: $u_{\bar{d}_I} - u_{\bar{d}_R} = 0$) vs. the alternative hypothesis that the mean of the mean differences for impact sites is less than (or not equal to) the mean of the mean differences for the reference sites (H_0: $u_{\bar{d}_I} - u_{\bar{d}_R} < 0$ or $\neq 0$).

8. Power was estimated using both two-tailed and one-tailed alternative hypotheses. Estimated power was calculated as the percentage of tests with a *p*-value less than the significance level based on 1000 simulations. Significance levels were either $\alpha = 0.1$ or $\alpha = 0.2$.

9. A second set of power analyses were run using simulated data with overall average 10% lower initial shoot densities than those observed in the SeagrassNet data set.

10. The sites are the sampling unit for this design. Power was estimated for four site scenarios: 10 impact with 10 reference sites, 7 impact with 7 reference sites, 10 impact with 3 reference sites, and 7 impact with 3 reference sites. Further, for each of these scenarios, power was separately estimated for three levels of effort: 5, 10 or 20 quadrats/site.

11. The reported power values are estimates. Actual power may vary, as the estimates were produced assuming a specific mean and variance for shoot densities. Variations in the variance associated with the distribution of shoot densities in Humboldt Bay may lead to different power for a given test.

12. This power analysis does not address stratification. Estimates of strata variances are needed to estimate overall power combined across multiple strata.

SeagrassNet Data

Figure 1 shows the distribution of the SeagrassNet data for all 0.0625 m^2 with shoot densities greater than 0 for all surveyed quadrats in North Bay. The distribution of shoot densities is right skewed. Under a natural log transformation, the data appear unimodal, and approximately symmetric. As such, simulated data for the power analysis were generated by drawing random quadrat densities from a lognormal distribution using parameters values estimated from the SeagrassNet data; namely, meanlog = 1.478 and sdlog = 0.566. The meanlog value of 1.478 was used to represent "before" conditions for impact sites, and "before" and "after" conditions for reference sites. Data for the "after" condition for impact sites were drawn using a lower meanlog value in order to generate a set of data with an average decrease of 25% over all "after" impact quadrats.

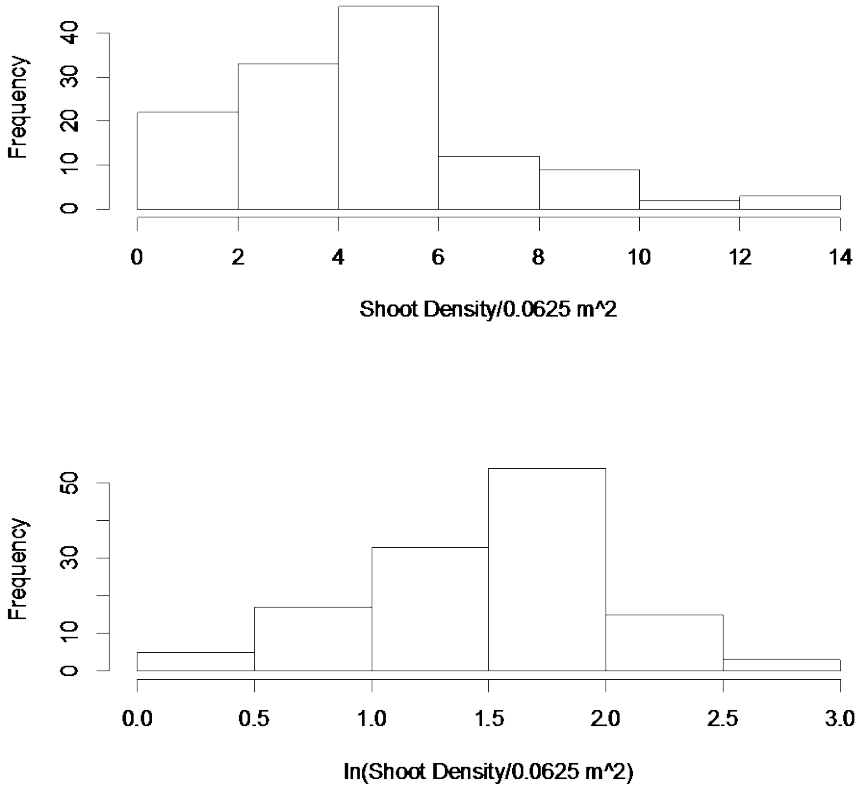


Figure 1. Histograms for the distribution of shoot density/0.0625 m^2 for all SeagrassNet quadrats in North Bay with counts > 0 (top) and the natural log-transformed distribution of the same shoot densities (bottom).

Results

Summary statistics for the initial shoot densities scaled to 1 m^2 are shown in Table 1. Set 1 is for the initial power analysis using the mean and variance from the SeagrassNet data set. Set 2 bases initial shoot densities assuming an overall 10% decrease in the initial values in Set 1.

The estimated power for the Set 1 conditions are summarized in Tables 2 – 5. The summary statistics for the "After – Before" impacts are shown in Table 6. Similar output for Set 2 simulations are summarized in Tables 7 – 11.

Table 1. Summary statistics for the initial shoot densities/m^2 for each set of power analyses.

Power Analysis	**Min**	**Q1**	**Median**	**Mean**	**Q3**	**Max**
Set 1: using mean and variance from SeagrassNet	5.825	47.990	70.240	82.470	102.900	1165.000
Set 2: Overall 10% decrease in baseline densities from Set 1	4.134	41.230	60.490	71.080	88.760	918.700

Table 2. Estimated percent power for sampling at 10 sites (both impact and reference) with variable numbers of 0.0625 m^2 quadrats per site. Estimates are provided for significance levels of 10 and 20 percent, as well as for two-tailed and one-tailed tests. Estimates are based on 1000 simulations with an average impact in year two of approximately a 25% decrease in shoot density at expansion sites.

	$\alpha = 0.2$		$\alpha = 0.1$	
Number of Quadrats Per Site	Two-tailed	One-tailed	Two-tailed	One-tailed
5	65.4	82.4	50.9	65.4
10	88.1	96.2	78.2	88.1
20	98.8	99.5	96.8	98.8

Table 3. Estimated percent power for sampling at seven sites (both impact and reference) with variable numbers of 0.0625 m^2 quadrats per site. Estimates are provided for significance levels of 10 and 20 percent, as well as for two-tailed and one-tailed tests. Estimates are based on 1000 simulations with an average impact in year two of approximately a 25% decrease in shoot density at expansion sites.

	$\alpha = 0.2$		$\alpha = 0.1$	
Number of Quadrats Per Site	Two-tailed	One-tailed	Two-tailed	One-tailed
5	55.5	72.4	39.7	55.5
10	78.6	90.2	64.1	78.6
20	94.7	98.4	88.6	94.7

Table 4. Estimated percent power for sampling at 10 impact sites and three reference sites with variable numbers of 0.0625 m^2 quadrats per site. Estimates are provided for significance levels of 10 and 20 percent, as well as for two-tailed and one-tailed tests. Estimates are based on 1000 simulations with an average impact in year two of approximately a 25% decrease in shoot density at expansion sites.

	$\alpha = 0.2$		$\alpha = 0.1$	
Number of Quadrats Per Site	Two-tailed	One-tailed	Two-tailed	One-tailed
5	43.5	64.8	28.5	43.5
10	63.6	81.1	47.0	63.6
20	86.0	93.7	75.8	86.0

Table 5. Estimated percent power for sampling at seven impact sites and three reference sites with variable numbers of 0.0625 m^2 quadrats per site. Estimates are provided for significance levels of 10 and 20 percent, as well as for two-tailed and one-tailed tests. Estimates are based on 1000 simulations with an average impact in year two of approximately a 25% decrease in shoot density at expansion sites.

	$\alpha = 0.2$		$\alpha = 0.1$	
Number of Quadrats Per Site	Two-tailed	One-tailed	Two-tailed	One-tailed
5	41.3	63.2	26.8	41.3
10	60.8	77.9	43.5	60.8
20	83.8	91.6	70.7	83.8

Table 6. Summary statistics Set 1 scenarios for the percent decreases associated with "After – Before" for Impact sites.

Sites	# Quad	Min	Q1	Median	Mean	Q3	Max
10 I/10 R[a]	5	-51.6	-30.1	-24.8	-24.1	-18.0	13.7
	10	-44.4	-28.9	-24.5	-24.6	-20.4	-1.3
	20	-37.5	-27.8	-24.8	-24.6	-21.6	-4.4
7 I/7 R	5	-57.2	-31.9	-25.0	-24.0	-16.8	20.8
	10	-47.7	-30.1	-24.9	-24.8	-19.1	0.8
	20	-41.2	-28.4	-24.7	-24.6	-21.1	-6.1
10 I/3 R	5	-51.6	-30.8	-24.8	-24.1	-18.0	13.7
	10	-44.4	-28.9	-24.5	-24.6	-20.4	-1.3
	20	-37.5	-27.8	-24.8	-24.6	-21.6	-4.4
7 I/3 R	5	-57.2	-31.9	-25.0	-24.0	-16.8	20.8
	10	-47.7	-30.1	-24.9	-24.7	-19.1	0.8
	20	-41.2	-28.4	-24.7	-24.6	-21.1	-6.1

[a] I = impact site; R = reference site

Table 7. Estimated percent power for sampling at 10 sites (both impact and reference) with variable numbers of 0.0625 m^2 quadrats per site. Mean shoot density assumed an overall 10% decrease from SeaGrassNET estimates. Estimates are provided for significance levels of 10 and 20 percent, as well as for two-tailed and one-tailed tests. Estimates are based on 1000 simulations with an average impact in year two of approximately a 25% decrease in shoot density at expansion sites.

	$\alpha = 0.2$		$\alpha = 0.1$	
Number of Quadrats Per Site	Two-tailed	One-tailed	Two-tailed	One-tailed
5	69.8	84.6	55.1	69.8
10	91.4	96.3	82.1	91.4
20	98.8	99.7	96.9	98.8

Table 8. Estimated percent power for sampling at seven sites (both impact and reference) with variable numbers of 0.0625 m^2 quadrats per site. Mean shoot density assumed an overall 10% decrease from SeaGrassNET estimates. Estimates are provided for significance levels of 10 and 20 percent, as well as for two-tailed and one-tailed tests. Estimates are based on 1000 simulations with an average impact in year two of approximately a 25% decrease in shoot density at expansion sites.

	$\alpha = 0.2$		$\alpha = 0.1$	
Number of Quadrats Per Site	Two-tailed	One-tailed	Two-tailed	One-tailed
5	58.0	72.7	41.8	58.0
10	76.2	88.6	61.8	76.2
20	94.2	98.4	87.2	94.2

Table 9. Estimated percent power for sampling at 10 impact sites and three reference sites with variable numbers of 0.0625 m^2 quadrats per site. Mean shoot density assumed an overall 10% decrease from SeaGrassNET estimates. Estimates are provided for significance levels of 10 and 20 percent, as well as for two-tailed and one-tailed tests. Estimates are based on 1000 simulations with an average impact in year two of approximately a 25% decrease in shoot density at expansion sites.

	$\alpha = 0.2$		$\alpha = 0.1$	
Number of Quadrats Per Site	Two-tailed	One-tailed	Two-tailed	One-tailed
5	47.6	65.6	33.0	47.6
10	63.5	81.2	48.0	63.5
20	85.0	94.6	73.2	85.0

Table 10. Estimated percent power for sampling at seven impact sites and three reference sites with variable numbers of 0.0625 m^2 quadrats per site. Mean shoot density assumed an overall 10% decrease from SeaGrassNET estimates. Estimates are provided for significance levels of 10 and 20 percent, as well as for two-tailed and one-tailed tests. Estimates are based on 1000 simulations with an average impact in year two of approximately a 25% decrease in shoot density at expansion sites.

	$\alpha = 0.2$		$\alpha = 0.1$	
Number of Quadrats Per Site	Two-tailed	One-tailed	Two-tailed	One-tailed
5	82.1	92.6	67.6	82.1
10	59.4	77.2	43.8	59.4
20	81.0	93.7	68.3	81.0

Table 11. Summary statistics Set 2 scenarios for the percent decreases associated with "After – Before" for Impact sites.

Sites	# Quad	Min	Q1	Median	Mean	Q3	Max
10 I/10 R[a]	5	-55.7	-31.1	-24.7	-24.2	-17.8	17.5
	10	-44.5	-29.0	-24.7	-24.5	-20.4	2.2
	20	-39.8	-27.3	-24.4	-24.3	-21.4	-10.6
7 I/7 R	5	-59.7	-31.9	-24.9	-24.0	-17.0	30.5
	10	-47.4	-29.6	-24.9	-24.4	-19.4	17.9
	20	-41.6	-27.9	-24.5	-24.2	-20.8	-2.7
10 I/3 R	5	-55.7	-31.1	-24.7	-24.5	-20.4	17.5
	10	-44.5	-29.0	-24.5	-24.6	-20.4	2.2
	20	-39.8	-27.3	-24.4	-24.3	-21.4	-10.6
7 I/3 R	5	-59.7	-31.9	-24.9	-24.0	-17.0	30.5
	10	-47.4	-29.6	-24.9	-24.4	-19.4	17.9
	20	-41.6	-27.9	-24.5	-24.2	-20.8	-2.7

[a] I = impact site; R = reference site

Memorandum

To: Phil Boch

From: Tamre Cardoso, Ph.D., TerraStat Consulting Group

Date: 21 May 2017

Re: Power Analysis for Coast Seafood's Eelgrass Monitoring: Updates for Strata

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This memo summarizes results for an analysis to estimate statistical power for 0.0625 m^2 quadrat sampling of eelgrass shoot density per m^2 using measurements from impact and reference sites. Specifically, this memo provides tables with estimated power to detect an approximate 25% decrease in turion density within impact sites based on combinations of impact and reference sites that are confined within strata. The four strata are EBMA basket beds, Bird Island longline beds, Bird Island basket beds, and Mad River longline beds.

Power was estimated under three scenarios, all with 20 quadrats per site: 1) using the original variance that was used in the initial set of power analyses; 2) using a 10% decrease in variance; and, 3) using a 20% decrease in variance. Under stratification, it is reasonable to assume that the variances within a given strata will be more homogeneous and possibly lower than the variance used for all sites combined.

Results

Estimated power is shown in Tables 1 – 3. The numbers from Tables 1 – 3 are also combined into a single table (Table 4) for easier comparisons within a stratum. In general, power increased as the variance decreased. The one exception was for the Bird Island basket beds with two impact sites and three reference sites. For this case, power did not increase when variance was decreased approximately 10%. Estimated power is similar to that calculated using the original variance estimate. This lack of decrease in power may be due to the low degrees of freedom for the Bird Island basket bed (*df* = 3), relative to the general variability in the simulated data.

If a post-hoc analysis by strata or bed is conducted, it is possible that there may not be enough power to detect a 25% decrease in turion density. This will of course depend on the actual variances that are seen during field sampling. I recommend that confidence intervals be produced for any post-hoc analyses in order to help evaluate changes before and after impact.

Table 1. Estimated percent power for sampling within four strata using the original standard deviations estimated from the SeagrassNet data and 20 0.0625 m^2 quadrats per site. Estimates are provided for significance levels of 10 and 20 percent, as well as for two-tailed and one-tailed tests. Estimates are based on 1000 simulations with an average impact in year two of approximately a 25% decrease in shoot density at expansion sites.

	$\alpha = 0.2$		$\alpha = 0.1$	
Stratum	Two-tailed	One-tailed	Two-tailed	One-tailed
EBMA (5 Impact, 2 Reference)	70.9	86.2	54.2	70.9
Bird Island Longline (6 Impact, 3 Reference)	81.5	90.9	68.0	81.5
Bird Island Basket (2 Impact, 3 Reference)	53.6	76.1	30.8	53.6
Mad River (4 Impact, 3 Reference)	75.5	88.3	58.6	75.5

Table 2. Estimated percent power for sampling within four strata using an approximately 10% decrease in variances estimated from the SeagrassNet data and 20 0.0625 m^2 quadrats per site. Estimates are provided for significance levels of 10 and 20 percent, as well as for two-tailed and one-tailed tests. Estimates are based on 1000 simulations with an average impact in year two of approximately a 25% decrease in shoot density at expansion sites.

	$\alpha = 0.2$		$\alpha = 0.1$	
Stratum	Two-tailed	One-tailed	Two-tailed	One-tailed
EBMA (5 Impact, 2 Reference)	71.1	86.4	63.6	71.1
Bird Island Longline (6 Impact, 3 Reference)	83.8	94.0	71.3	83.8
Bird Island Basket (2 Impact, 3 Reference)	50.3	75.8	30.4	50.3
Mad River (4 Impact, 3 Reference)	77.3	91.4	61.8	77.3

Table 3. Estimated percent power for sampling within four strata using an approximately 20% decrease in variances estimated from the SeagrassNet data and 20 0.0625 m^2 quadrats per site. Estimates are provided for significance levels of 10 and 20 percent, as well as for two-tailed and one-tailed tests. Estimates are based on 1000 simulations with an average impact in year two of approximately a 25% decrease in shoot density at expansion sites.

	$\alpha = 0.2$		$\alpha = 0.1$	
Stratum	Two-tailed	One-tailed	Two-tailed	One-tailed
EBMA (5 Impact, 2 Reference)	76.6	90.5	59.7	76.6
Bird Island Longline (6 Impact, 3 Reference)	87.9	95.5	73.9	87.9
Bird Island Basket (2 Impact, 3 Reference)	58.3	80.4	33.5	58.3
Mad River (4 Impact, 3 Reference)	81.8	93.2	65.3	81.8

Table 4. All the power estimates from Tables 1 – 3 in a single table.

		$\boldsymbol{\alpha = 0.2}$		$\boldsymbol{\alpha = 0.1}$	
Stratum	**Variance**	**Two-tailed**	**One-tailed**	**Two-tailed**	**One-tailed**
EBMA (5/2)	Original	70.9	86.2	54.2	70.9
	10% Decrease	71.1	86.4	63.6	71.1
	20% Decrease	76.6	90.5	59.7	76.6
Bird Island Longline (6/3)	Original	81.5	90.9	68.0	81.5
	10% Decrease	83.8	94.0	71.3	83.8
	20% Decrease	87.9	95.5	73.9	87.9
Bird Island Basket (2/3)	Original	53.6	76.1	30.8	53.6
	10% Decrease	50.3	75.8	30.4	50.3
	20% Decrease	58.3	80.4	33.5	58.3
Mad River (4/3)	Original	75.5	88.3	58.6	75.5
	10% Decrease	77.3	91.4	61.8	77.3
	20% Decrease	81.8	93.2	65.3	81.8

Appendix C
Pacific Herring Egg Monitoring Plan

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APPENDIX C: PACIFIC HERRING EGG MONITORING PLAN

Coast Seafoods engages in aquaculture activities in Humboldt Bay throughout the year. This includes activities during potential herring spawning periods that will be subject to pre-activity observations based on the approach taken for Pacific Herring Work Window Waivers for San Francisco Bay. The approach for Pacific Herring Work Window Waivers in San Francisco Bay was last updated prior to the 2014 Pacific herring spawning period in response to concerns about in-water activities due to drought conditions.

PERIOD OF MONITORING

Annual observation periods would be between December 15 and February 28. Pacific herring spawning activity occurs annually in Humboldt Bay, however several factors affect the timing of spawning events which typically occur between December 15 and February 28. Spawning could occur one or more months prior to or after the typical spawning period. California Department of Fish and Wildlife (CDFW) may request that spawning monitoring activities start early or extend longer in years when spawning activity is occurring beyond the December 15 to February 28 period.

PRE-ACTIVITY MONITORING AND REPORTING

Pre-activity monitoring is comprised of visual observations of the areas within active aquaculture beds where activity is planned to occur up to 24-hours prior to activities. This may include ground access and egress routes, and any staging areas in addition to aquaculture gear. Visual observations will be reported using a Herring Daily Observation Form which identifies the observation location, observer, date, time, activities, whether herring or spawn were observed, and approximate numbers and species observed on-site. A copy of this form is attached at Attachment 1. Observer forms will be collected and reported to CDFW once per week. Observations that include herring spawn will result in: (1) cessation of activities on the bed, (2) notification of CDFW, and (3) avoid planned activities on the bed for a period of 21 days after initial observation.

AREA OF MONITORING

Pacific herring in Humboldt Bay typically use North Bay for spawning, and within North Bay, an area known as the East Bay Management Area (EBMA) has received heightened interest due to the frequency that herring spawning activity occurs within this area. Herring spawning has been detected in other portions of North Bay and may occur in Entrance or South Bay at times.

Coast Seafoods has active and planned oyster aquaculture beds in North Bay (Figure C1). For beds in the EBMA a pre-activity observation will occur prior to harvest, or planting activities. Pre-activity observations will be performed by trained observer. Limited maintenance and observation activities will not require pre-activity monitoring.

For culture beds outside of the EBMA, pre-activity surveys will not be required. However, if CDFW identifies active spawning near beds outside of EBMA and notifies Coast or if signs of potential spawning activities are present (e.g., presence of adult herring moving in and out of the bed, presence of milt in the water, elevated bird or marine mammal feeding activity), then pre-activity monitoring activities will occur.

For all beds and activities, potential spawn will be noted and reported to trained Coast herring observers for confirmation and if confirmed transmitted to CDFW.

During the spawning season, observers will report observations and activities within EBMA to CDFW weekly using the daily reporting form.

OBSERVER QUALIFICATIONS

Prior to the spawning season, Coast field staff will be briefed on the importance of detecting herring spawn. Lead staff will be trained by CDFW in spawn detection and reporting. Observers are staff with 3 or more years of experience working in intertidal environments. Coast is responsible for maintaining a list of qualified staff and for ensuring enough trained observers are available to support aquaculture activities. Coast shall transmit its proposed list of qualified observers to CDFW by November 20th each year.

OBSERVER DUTIES

Observers are responsible for observing with aquaculture beds, areas of access or egress, and any staging areas, up to 24 hours prior to activities within that area. Observers shall look at aquaculture gear, vegetation and hard substrates that might be used for spawning. Observers shall have sufficient time in advance of planned oyster culture activities to assess the areas where activities are planned. Observers shall also have sufficient authority to end all field activities in areas where spawn or active spawning activity is observed. The observer is responsible for completing the daily observation forms and submitting those to Coast. Coast is responsible for transmitting daily observation forms to CDFW contacts on the Friday of each week for aquaculture activity from December 15 through February 28th.

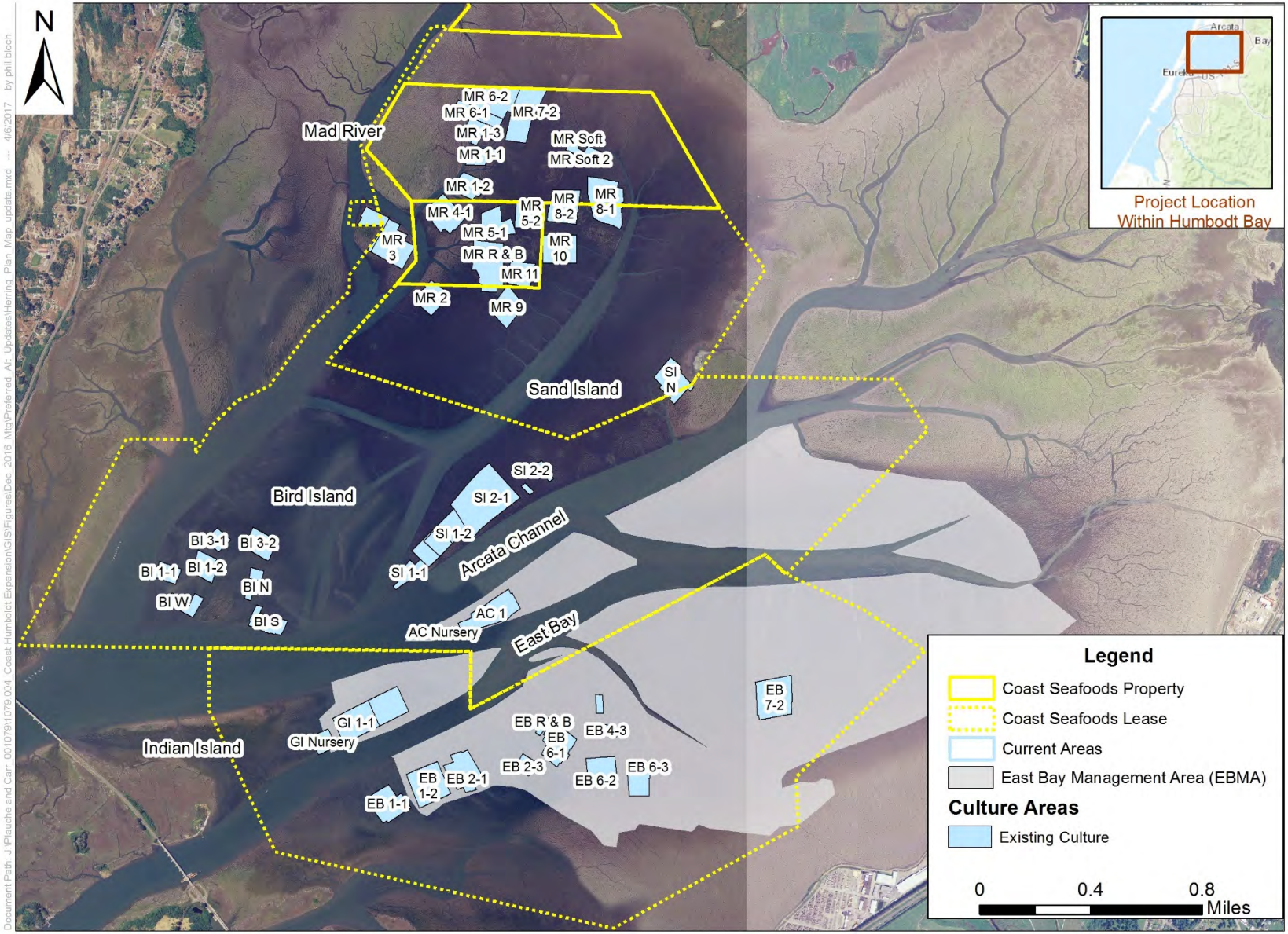

Figure C1 Existing Oyster Culture Beds for Coast Seafoods in Humboldt Bay

Attachment 1: Pacific Herring Eggs Daily Observation Form

If at any time Pacific herring eggs are detected within the aquaculture bed, all activities shall stop immediately and Department staff (see contact information below) shall be notified.

California Department of Fish and Wildlife Contact Information

James Ray, Marine Environmental Scientist
Office phone: 707-441-5755
Email: James.Ray@wildlife.ca.gov

Coast Seafoods Bed Name/Location: _____

Observer Name: _____

Date: _____

Start Time: _____

Stop Time: _____

Environmental Conditions (tide stage, wind, cloud cover, etc.):

Project activities during observation period (Circle one):

Harvest Planting Maintenance

Other: _____

Describe Pacific herring activity and location(s), if observed:

Identify any species aggregations within 500 meters (1/4 mile):

- California Least Tern #_____
- Brown Pelican # _____
- Cormorant # _____
- Gulls # _____
- Harbor Seal # _____
- California Sea Lion # _____
- Other: _____# _____

Additional notes and observations:

Appendix D
Vessel Management Plan

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APPENDIX D: VESSEL MANAGEMENT PLAN

The purpose of this Vessel Management Plan is to describe anticipated vessel operations necessary for Coast Seafoods' oyster and clam aquaculture activities in Humboldt Bay. This plan 1) shows the travel routes and landing or cultivation or bed access sites and 2) describes procedures to limit herding or flushing of black brant or shorebirds within Arcata Bay.

This Vessel Management Plan is based on the best professional judgement regarding the access and egress to planned oyster aquaculture beds in Arcata Bay by Coast Seafoods staff. This plan also includes information regarding vessel operations, including types of vessels and vessel frequency.

TRAVEL ROUTES AND BED ACCESS

Figure D1 shows a map of the travel routes and landing or cultivation bed access sites that Coast Seafood's vessels shall use to access the cultivation areas. In general, Coast will use major deepwater channels to travel between their plant located at (25 Waterfront Dr, Eureka, CA 95501) and nursery or cultivation sites. When reaching the vicinity of cultivation sites vessels will either directly approach cultivation sites or travel in smaller deep-water channels into the mudflats to access sites.

During low tide landing sites for vessels will be adjacent to these channels such that the bow, and at times the entire vessel will be allowed to ground on exposed mudflats. However, the typical landing process will keep the stern and engines in deepwater channels.

During high tide vessels may operate within or adjacent to cultivation beds (Table 1).

Table 1. Cultivation Bed Access through Major Channels

Channels	Acres of Existing and Proposed Culture	Notes
North Bay Channel	45.9 acres	Travel route to Mad River, Arcata or Pantherotti Channels
East Bay Channel	70.4 acres	Travel route to Arcata Channel
Arcata Channel	10.9 acres	
Pantherotti	151.1 acres	Mad River culture areas accessed by a combination of Pantherotti and Mad River Channels.
Mad River Channel		

Note that marine activities are subject to factors such as weather, tides and other issues that are beyond the control of Coast Seafoods and may necessitate changes from planned vessel movements. Furthermore, Coast Seafood vessels and staff may access other areas and travel routes for emergency response, environmental monitoring, or debris collection/removal.

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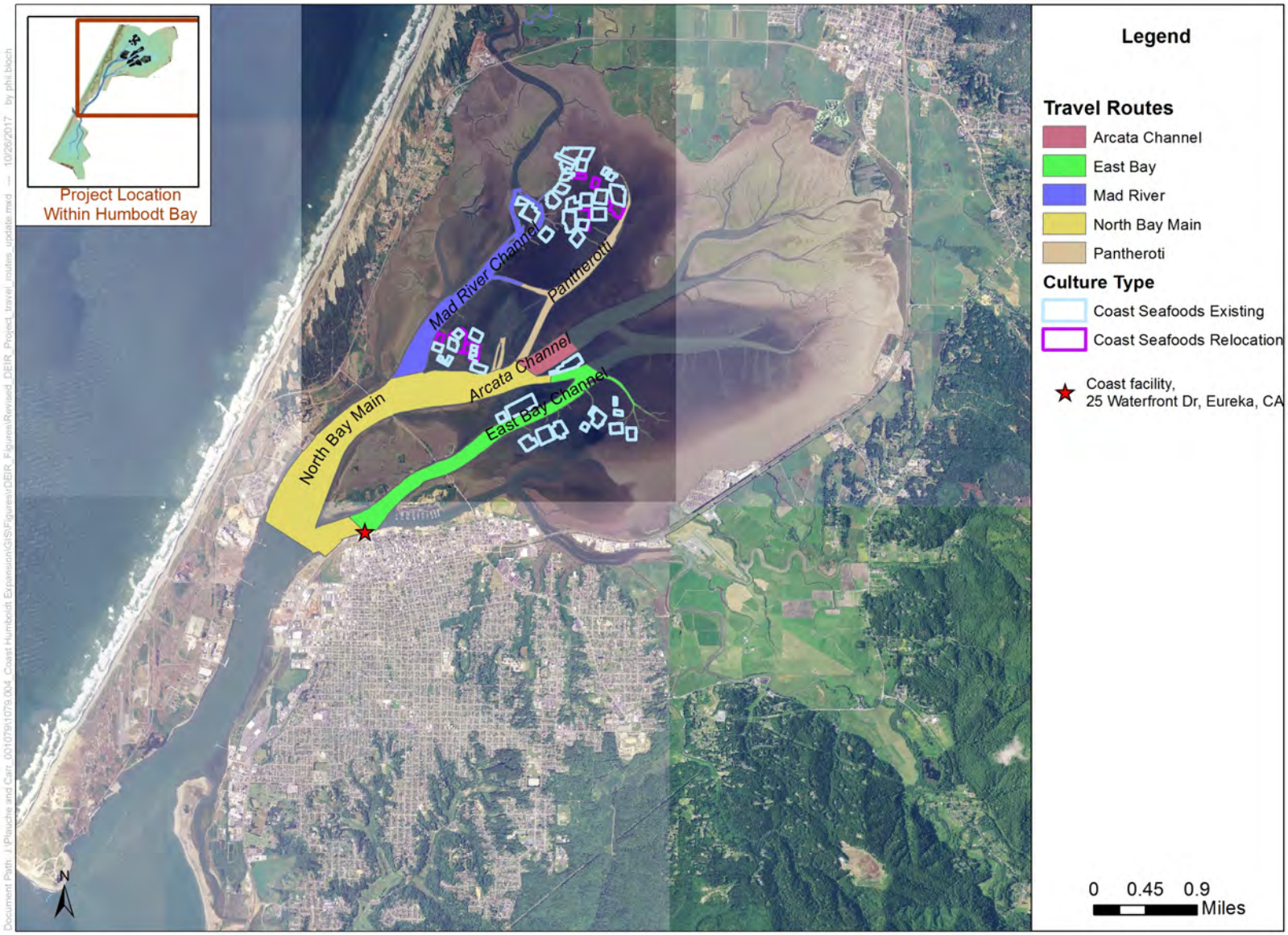

Figure D1 Travel routes and channel buffer areas.

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PROCEDURES TO LIMIT HERDING OF FLUSHING BIRDS

Humboldt Bay is an important bird area used by a diverse mix of resident and migratory birds. Large influxes of birds occur during the fall and spring months due to southerly and northerly migrations. Portions of Humboldt Bay accessed by Coast Seafoods staff for oyster and clam aquaculture are used for foraging and loafing by waterbirds (including shorebirds and waterfowl).

Although few studies have examined the relationship between boat traffic and bird fitness, it is generally assumed that direct flushing responses may affect bird fitness by altering site use. Flushing is defined as birds swimming, walking, running, or flying away from approaching watercraft. Although alert behavior by birds may be a component of flushing behavior, alert responses alone are not considered to be flushing.

Studies have evaluated flushing responses to waterbirds (Rodgers Jr and Schwikert 2002, Peters and Otis 2006), wading birds (Bratton 1990) and some individual seabirds such as marbled murrelets (Bellefluer et al. 2007). Species distributions in Humboldt Bay are likely driven by calendar date, tidal stage and water body width (Peters and Otis 2006). Studies indicate that responses to boat traffic varies based on boat speed, species and habitat context. Faster boats create flushing response at greater distances (Bellefleur 2007 and Rodgers and Schwikert 2002). Birds in trees or on docks are considerably less likely to flush compared to birds in the water or along banks (Bratton 1990). The average flushing distance for waterbirds from outboard-powered boats is between 23 and 53 meters with birds flushing between 9 and 140 meters from vessels (Rodgers and Schwikert). Bratton (1990) found that in an open bay like Humboldt Bay, approximately 80% of birds did not flush in response to boats passing 25 or more meters away.

Therefore,

- Except when approaching landing sites or access channels, Coast Seafood will maintain a buffer from channel/mudflat edge of 25 meters while transiting at speed along major channels to limit the potential to flush birds.
- Between mid-February and mid-April of each year, Coast will avoid known Brant gritting sites (Figure D2).
- When flocks of birds (50 or more) are encountered within travel routes, Coast Seafoods will reduce speed to avoid flushing and use alternate routes when possible.

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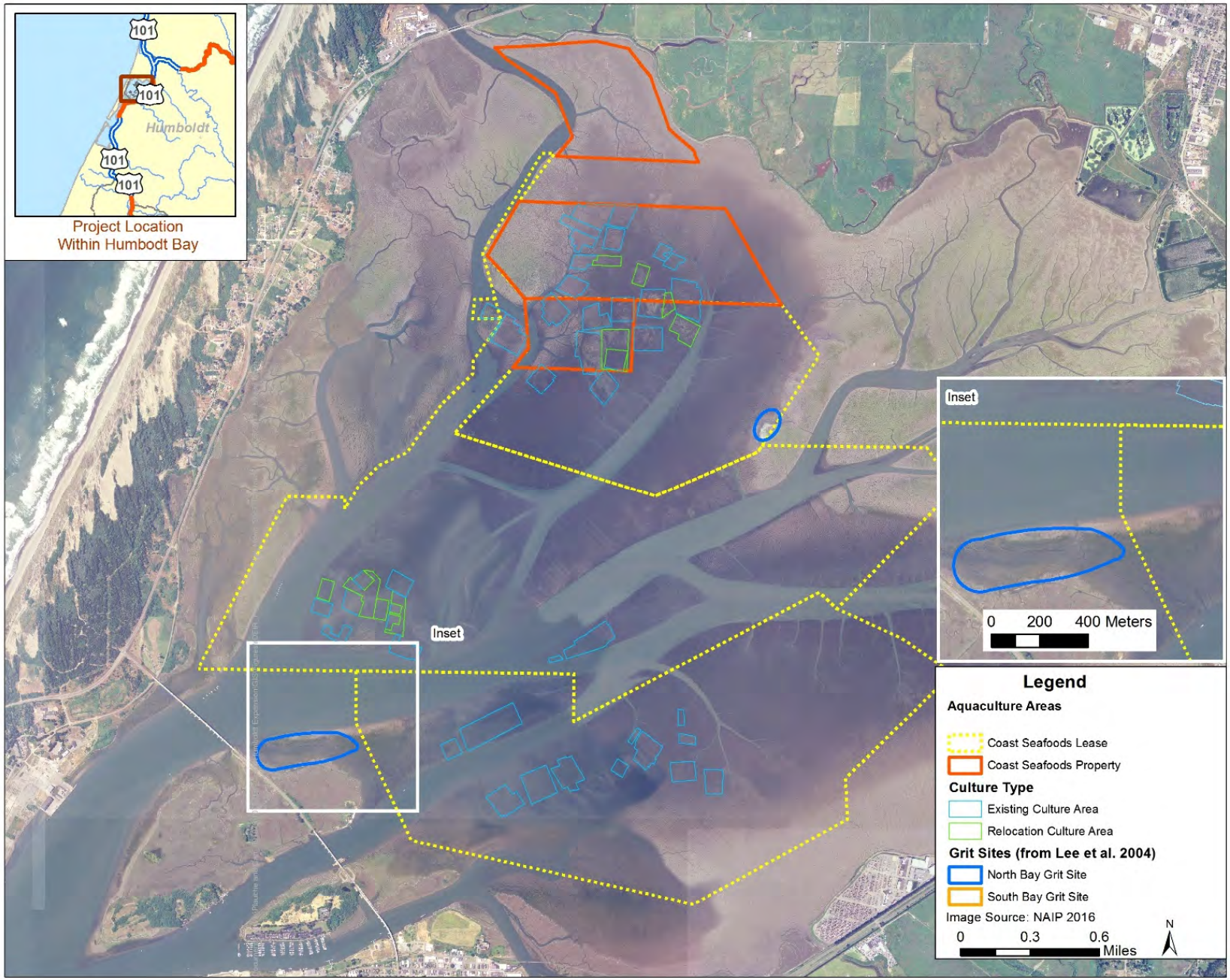

Figure D2 Brant Grit Sites in North Bay.

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Appendix E

Draft Black Brant Monitoring Plan

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H. T. HARVEY & ASSOCIATES

Ecological Consultants

Coast Seafoods Company
Humboldt Bay Shellfish Aquaculture Operations
Humboldt County, California: Renewal 2017—
Black Brant Monitoring Plan

Project 3225-11

Prepared for:

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Prepared by:

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Draft: October 2, 2017

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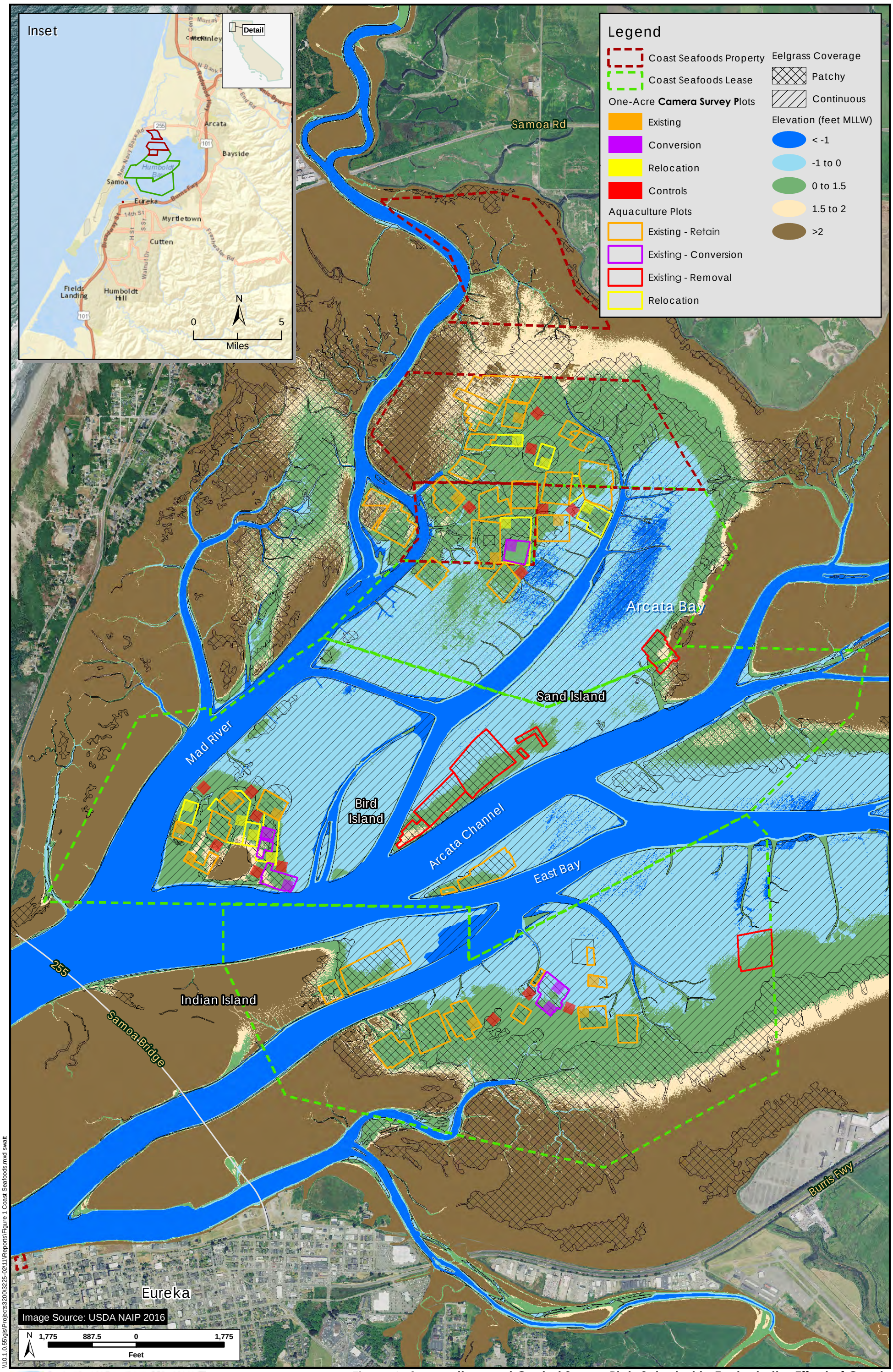
Section 1. Introduction

In February 2017, the Humboldt Bay Harbor, Recreation and Conservation District (Harbor District) certified the Final Environmental Impact Report for the Coast Seafoods Company Humboldt Bay Shellfish Aquaculture Permit Renewal and Expansion Project (Harbor District 2016a). In June 2017, the California Coastal Commission denied that expansion permit; however, Coast Seafoods subsequently proposed a modified continuation of their aquaculture program, and the Coastal Commission approved that revised project on September 14, 2017. The revised project (hereafter "Project") entails modifications to the existing aquaculture layout that will be made over the course of approximately 2.5 years (California Coastal Commission 2017). Those modifications will remove some existing culture beds but add other new beds, with an eye on consolidating the aquaculture operations outside of specific sensitive habitat areas, and ultimately will reduce the total acreage of oyster cultivation beds by approximately 21 acres (17%) and the overall operational footprint (the area including and surrounding the cultivation beds that is used for cultivation activities and vessel transit) by nearly one-third (Figure 1). At the same time, Coast Seafoods will modify the cultivation techniques they use in certain areas to bolster per-acre productivity.

In approving Coast Seafoods' revised operations plan, the Coastal Commission stipulated certain conditions of approval (COAs) designed to ensure adequate protections for eelgrass (*Zostera marina*), the predominant species of aquatic plant in Humboldt Bay, and several sensitive fish and wildlife species, including black brant (*Branta bernicla nigricans*; hereafter "brant") (California Coastal Commission 2017). The black brant is a species of special concern in California, for which Humboldt Bay serves as a primary late-winter/spring migration staging area (Moore 2002, Moore et al. 2004, Lee et al. 2007). The bay provides these arctic-nesting geese with large expanses of eelgrass, which is their primary food outside of the breeding season (Ward et al. 1997, 2005; Moore et al. 2004; Elkinton et al. 2013). Aquaculture operations have the potential to affect the availability of eelgrass to foraging brant through both potential changes in eelgrass distribution or availability and increased disturbance caused by the aquaculture operations (H. T. Harvey & Associates 2015, Demers et al. 2015, Stillman et al. 2015).

The COAs for reducing impacts to brant include managing vessel traffic to avoid brant focal use areas and prevent herding and flushing of brant, protecting key grit acquisition sites, and avoiding intentional disturbance of brant during on-water operations. In addition, the COAs stipulated that a brant monitoring plan be developed and implemented "prior to installation of cultivation equipment within relocation cultivation beds." Further, the brant monitoring plan must satisfy the following conditions:

1. The plan is reviewed and approved by the Executive Director of the Coastal Commission, whose review is informed by an independent peer review of the plan.



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H. T. HARVEY & ASSOCIATES
Ecological Consultants

Figure 1. **Aquaculture and Control Survey Plots Selected to Evaluate the Effect of Coast Seafoods Renewed Aquaculture Operations Plan on Black Brant in Arcata Bay**

Coast Seafoods Aquaculture Revised Brant Monitoring Plan (3225-11)

September 2017

2. The monitoring program is capable of:
    a. Detecting and visually documenting and recording brant foraging activity on eelgrass beds within existing, relocated, and converted cultivation beds (i.e. specifically feeding on eelgrass growing within beds rather than drift feeding).
    b. Determining how that level of foraging activity compares with foraging occurring on eelgrass growing outside cultivation beds.
3. The survey techniques primarily rely on the use of remote cameras, but may be augmented with other techniques, including field surveys and acoustic detection.
4. The monitoring program includes surveys carried out during the appropriate seasons during baseline conditions and Year 1, 2, and 5 after installation of relocated cultivation beds or conversion of existing cultivation beds to configurations with wider spacing.
5. The monitoring plan will be implemented by a qualified, independent, third party that is approved by and reports to the Executive Director of the Coastal Commission.

1.1 Monitoring Objectives

This monitoring plan is designed to achieve the following specific objectives:

1) Evaluate brant use of Arcata Bay in the vicinity of Coast Seafoods longline aquaculture operations from mid-November through mid-April, when brant occur and forage on eelgrass in Humboldt Bay.
2) Use automated trail cameras and time-lapse videography/photography to document brant activity in treatment and control plots based on a standardized sampling schedule that collects high temporal-resolution data during daytime hours for several multi-day periods each month.
3) Develop understanding about the specific effects of longline infrastructure and spacing on the probability of brant feeding in aquaculture plots, noting that this monitoring effort is not designed to differentiate the specific effects of human disturbance (e.g., boat traffic) on brant activity.
4) Implement a statistically viable sampling design that involves:
    a. Baseline monitoring of brant activity in longline aquaculture plots that will be newly planted or converted to wider spacing after the winter 2017/spring 2018 brant occupancy season
    b. Temporally consistent monitoring and evaluation of brant use of, and feeding in, existing longline aquaculture plots with narrow (2.5-foot) line spacing, newly planted and converted longline plots with wide (9-foot) spacing, and nearby control plots that do not contain aquaculture infrastructure
    c. Control plots that effectively represent the range of eelgrass densities (i.e., patchy versus continuous) and tidal-exposure conditions present in relevant aquaculture plots
    d. Monitoring of brant activity in aquaculture and control plots across a broad range of tidal conditions and attendant variation in the surface exposure of relevant longline aquaculture gear

Section 2. Monitoring and Data Collection Methods

2.1 Study Plots

Monitoring will focus on documenting brant activity in clusters of proximate aquaculture and control plots located on Bird Island (BI), in the Manila Reach (MR) culture section in the northwestern portion of Arcata Bay, and in the vicinity of plot EB 6-1 in East Bay (EB) (Figure 1). Within each subarea, 1-acre (see Section 2.3) treatment monitoring plots were selected to represent (a) existing narrow-spaced aquaculture plots, (b) wider-spaced relocation (newly planted) aquaculture plots, and (c) wider-spaced conversion aquaculture plots (Figure 1). Control plots were then selected (also arranged as individual 1-acre plots) to provide reasonable matching in space and time (and for statistical purposes) of the various types of treatment plots. Limited availability of proximate spaces with no aquaculture and similar eelgrass and bathymetry characteristics restricted the number of control plots that could be placed in suitable locations.

In aggregate, the selected control plots mimic the eelgrass coverage (patchy or continuous) and bathymetry characteristics of the relevant aquaculture plots in each subarea to the degree possible given variation caused by placement limitations (Tables 1 and 2). The control plots are placed near the relevant treatment plots to ensure that both experience similar levels of general human disturbance, apart from the treatment plots being subject to focused aquaculture maintenance activity. Helping to control for the potential influence of general human activity (including general Coast Seafoods operational activity in the subarea, as well as other recreational boating activity) on brant activity patterns in this manner is important to help focus the investigation on discerning whether the aquaculture infrastructure itself inhibits brant foraging. That said, further manipulations of specific control plot locations may be required in consultation with Coast Seafoods to minimize conflicts with maintenance-related boat traffic and operations.

The COAs for the Project require that all active aquaculture plots are marked with posts that are highly visible at all water levels and are placed every 200 feet along the outer sides and at each corner of every individual plot. These posts will be used to support the monitoring cameras (see Section 2.3). Additional marker posts that are similarly visible at all water levels will be placed within relevant aquaculture study plots to further demarcate the boundaries of 1-acre subsections, which will be the standardized surveillance areas for individual monitoring cameras (see Section 2.3). Other marker posts will be installed to support the relevant cameras and demarcate the comparable 1-acre control plots.

Table 1. Aggregate Percentage Representation of Eelgrass Coverage in Brant Sampling Plots by Plot Type and Subarea

Plot Type / Subarea	Number of 1-acre Plots[1]	Continuous Eelgrass	Patchy Eelgrass	Other
Existing Narrow-Spaced Aquaculture				
Bird Island	4	0	100	0
East Bay	3	0	100	0
Manila Reach	4	8	92	0
Total	11	3	97	0
Conversion to Wider-Spaced Aquaculture				
Bird Island	2	0	100	0
East Bay	1	0	100	0
Manila Reach	1	0	0	100
Total	4	0	75	25
Relocation Wider-Spaced Aquaculture				
Bird Island	4	44	53	3
Manila Reach	4	19	81	0
Total	8	32	67	1
Control Plots				
Bird Island	6	36	64	0
East Bay	3	43	55	2
Manila Reach	6	46	54	0
Total	15	41	58	0

[1] The distribution of plots is illustrated in Figure 1.

2.2 Timing and Extent of Monitoring

The Project COAs specify that the monitoring program encompass baseline conditions and Years 1, 2, and 5 after cultivation beds are relocated or converted to longline configurations with wider spacing. Coast Seafoods' schedule for accomplishing the approved bed removals, relocations (new plantings), and conversions spans more than 2 years, from summer/fall 2017 through fall 2019; however, all of the relevant plot relocations and conversions are scheduled to occur by winter 2018/2019. The commencement of plot manipulations in fall 2017, inconsistent representations of relocation and conversion plots among the three subareas in different annual periods, and the extended overall manipulation schedule preclude establishing a consistent sampling regime that effectively encompasses all plots within an integrated multi-year statistical modeling framework. Baseline monitoring will occur only in treatment plots that are scheduled for relocation and conversion after spring 2018. Baseline monitoring will commence in fall 2017 in relocation and conversions plots where that is feasible. At the same time, monitoring of selected control plots will commence, as will post-manipulation monitoring of selected existing narrow-spaced aquaculture plots, and relocation and conversion plots that are completed before mid-November 2017. In a few cases, monitoring

of additional control plots will begin during fall/winter 2018 commensurate with monitoring of other relocation and conversion plots that are completed by then.

Table 2. Aggregate Percentage Representation of Bathymetry Classes in Brant Sampling Plots by Plot Type and Subarea

Plot Type / Subarea	Number of 1-acre Plots[1]	Substrate Elevation (Feet) Relative to Mean Lower Low Water				
		< -1	-1 to 0	0 to 1.5	1.5 to 2	>2
Existing Narrow-Spaced Aquaculture						
Bird Island	4	0	1	97	2	<1
East Bay	3	0	41	59	0	0
Manila Reach	4	0	22	78	0	0
Total	11	0	20	80	1	<1
Conversion to Wider-Spaced Aquaculture						
Bird Island	2	0	3	97	<1	0
East Bay	1	0	52	48	0	0
Manila Reach	1	0	0	100	0	0
Total	4	0	22	78	<1	0
Relocation Wider-Spaced Aquaculture						
Bird Island	4	0	0	100	0	0
Manila Reach	4	0	9	91	0	0
Total	8	0	4	96	0	0
Control Plots						
Bird Island	6	0	1	92	6	<1
East Bay	3	0	26	74	0	0
Manila Reach	6	1	19	80	0	0
Total	15	<1	13	84	2	<1

[1] The distribution of plots is illustrated in Figure 1.

Two of five plot conversions and four of nine plot relocations are scheduled to occur in fall 2017, with these manipulations involving plots in the BI (relocation and conversion plots) and MR (only relocation plots) subareas. No baseline monitoring will be possible for these plots; hence, the relevant assessment will be limited to a post-manipulation control-impact assessment comparing brant activity in treatment and control plots, with an unbalanced design due to the lack of plot conversions in the MR subarea during the relevant initiation period. If the conversions and new plantings are completed before mid-November, then a full Year 1 season of post-manipulation monitoring will occur during the 2017/2018 brant occurrence period. Otherwise, the relevant treatment and control monitoring would commence whenever the new plantings and plot conversions are completed and extend through mid-April 2018. The truncated monitoring period would limit the value of the resulting Year 1 data from these specific plots. Nevertheless, the matched control-

impact assessment would represent a meaningful contribution when integrated with full-season data additional years in a multi-year statistical model.

Two other plots are scheduled for relocation in winter 2017/2018, one each in the BI and MR subareas. With the monitoring period commencing in mid-November, baseline monitoring of these plots potentially could be done for a few weeks before the plots are planted. However, the data generated from such limited-duration baseline monitoring would not effectively support a before-after-control-impact (BACI) statistical assessment and, therefore, will not be pursued. Instead, as above, Year 1 monitoring will commence once the plots are planted and extend through mid-April 2018, and the resulting data will be integrated with data from the fall 2017 plots (collectively composing the Set 1 plots) in a multi-year control-impact statistical model.

The three remaining plot conversions are scheduled to occur in fall/winter 2018/2019 (one each in the BI, MR, and EB subareas), and the three remaining plot relocations are scheduled to occur between spring 2018 and winter 2018/2019 (one in the BI subarea and two in the MR subarea). For these aquaculture plots and relevant control plots (collectively composing the Set 2 plots), a full annual season of baseline data will be collected during the 2017/2018 brant occurrence period. Year 1 post-manipulation monitoring will then commence in mid-November 2018, or as soon as the relevant plot conversions and new relocation plantings are completed, and will occur concurrent with Year 2 post-manipulation monitoring of the Set 1 plots. Year 2 post-manipulation monitoring of the Set 2 plots will then occur during the 2019/2020 brant occurrence period, concurrent with Year 3 post-manipulation monitoring of the Set 1 plots. Finally, Year 5 post-manipulation monitoring of the Set 2 plots will occur during the 2022/2023 brant occurrence period, concurrent with Year 6 post-manipulation monitoring of the Set 1 plots.

2.3 Camera Monitoring

H. T. Harvey & Associates (2015) previously used time-lapse photo monitoring during different tidal conditions to provide insight about how brant respond to aquaculture infrastructure as it is progressively exposed during low tides. This study revealed that brant generally vacated aquaculture areas once a receding tide exposed the longline gear at the surface, but the study was restricted to culture plots with spacing of 2.5 feet between adjacent longlines. In comparison, the relocated and converted plots approved as part of this Project will have variable but generally wider 9–10-foot spacing between the longline rigs. The widening of the spacing intervals was driven in part by a motivation to increase the potential for brant to forage between the lines when the longline gear is exposed at low tides. Therefore, this monitoring program will include additional time-lapse photo monitoring to further confirm whether brant respond differently to existing aquaculture plots with 2.5-foot longline spacing and newly relocated or converted plots with wider spacing.

Time-lapse photography will be accomplished using high-definition (HD) trail cameras programmed to record photographs once per minute during daylight hours. Cameras will be placed to provide effective surveillance of all relevant study plots and yield confident (a) enumeration of brant within standardized and well-marked plot spaces, and (b) evaluation of brant behavior by quantifying proportions of brant engaged in feeding and nonfeeding behavior. Cameras will be placed to monitor selected study plots, with each camera positioned to

effectively surveil a clearly marked 1-acre space. Cameras focused on aquaculture plots will be positioned to surveil both edge and interior portions of plots.

During each winter/spring season when monitoring occurs (see below), photographs will be collected continuously during daylight hours for two 5-day periods each month from mid-November through mid-April (noting, however, that adjustments to the twice-a-month 5-day sampling regime ultimately may be warranted after initial monitoring is completed, depending on brant activity patterns and the volume of photographs that require careful screening). The 5-day sampling periods will be selected to provide representative coverage of tidal ranges that are relevant to evaluating the influence of longline aquaculture gear on brant activity. Oysters can be grown at substrate elevations ranging from -2.0 to +3.0 feet Mean Lower Low Water (MLLW), but optimal conditions range from -1.0 to +1.5 feet MLLW, and this is the range over which Coast Seafoods' aquaculture operations typically occur (Harbor District 2016b). At low tides ranging from -2.0 to +0.5 feet MLLW, longline gear is generally highly exposed above the water surface, whereas mid tides ranging from +0.5 to +2.0 feet MLLW typically represent a transitional range across which longline gear is variably exposed, and longline gear is generally well below the water surface at high tides above +2.0 to +4.0 feet MLLW, depending on the type of gear involved. Cultch-on-longline gear typically extends only 12–16" above the substrate, whereas basket-on-longline gear typically extends 26–40" above the substrate. In Arcata Bay, eelgrass occurs at mean substrate elevations ranging from -3.1 to +1.4 feet MLLW (Gilkerson 2008). Brant are able to forage on eelgrass that is up to approximately 16" below the water surface (Clausen 2000). Therefore, to effectively represent a broad range of foraging potential relative to differential exposure of longline gear, the brant sampling regime will be designed to span both incoming and outgoing tides across the range from -2.0 to +4.0 feet MLLW.

2.4 Photo Review and Data Collection

Photos will be taken throughout daylight hours whenever the cameras are operating, because programming the cameras to further constrain the photo taking to specific daylight hours will not be possible without investing in unnecessarily costly camera systems. For purposes of collecting data on brant numbers and behavior, however, only photos taken during the aforementioned tide range (-2.0 to +4.0 feet MLLW) will be reviewed. For each photo, the following data will be recorded:

- Plot number
- Camera number
- Date and time
- For aquaculture plots: longline gear (a) not exposed, (b) at or near surface, or (c) well exposed above water surface
- Numbers of brant (a) tipped up and feeding, (b) engaged in other feeding behavior (e.g., skimming on loose eelgrass fronds, upright and consuming eelgrass, or feeding off of exposed longline gear); (c) on the water not obviously involved in feeding behavior, and (d) landing on or flying off the plot
- Number of other waterbirds present

Section 3. Analysis Methods

3.1 Comparing Brant Abundance in Aquaculture and Control Plots

Although not entirely equivalent, the result of the multi-year sampling scenario outlined in Section 2.2 will be four annual seasons of monitoring for both the Set 1 and Set 2 study plots, conforming as closely as possible to the general expectations of the Project COAs. The lack of baseline data for the Set 1 plots will preclude integrating those data with the Set 2 data in a BACI analysis, which is a more powerful statistical design than a simple control-impact design. Therefore, the analyses will explore insight generated from two modeling approaches: (1) a post-manipulation control-impact analysis that integrates equivalent, non-baseline data from both sets of plots, and (2) a BACI analysis limited to data from the Set 2 plots. In both cases, a series of generalized linear mixed-effects models (GLMMs) incorporating repeated measures will be constructed and evaluated to determine how brant abundance and behavior vary in relation to predictors of interest. Of primary interest will be models developed with a response variable that reflects the numbers or proportions of brant engaged in the four different feeding and nonfeeding behaviors identified in Section 2.4 (fifth bullet). Accommodating a multi-part response variable such as this will require building multi-response GLMMs (classically known as a form of multiple analysis of variance or MANOVA) (e.g., see Hadfield 2010). Less-complex models that incorporate simple-average brant counts per 30-minute sampling period as a response variable also may be informative.

To account for inherent variation in the characteristics of different subareas of Arcata Bay in which distinct clusters of aquaculture and control plots are located, and the attendant effects on brant activity, all models will include **SubareaID** (i.e., BI, MR, and EB) as a random variable. **PlotID** also will be modeled as a random effect.

Following are the fixed-effects predictors that will be evaluated in the GLMMs:

Year: Blocking factor to represent annual monitoring seasons

Culture Type: Classification of individual plots as (a) existing narrow-spaced cultch-on-longline, (b) new wide-spaced cultch-on-longline, (c) new wide-spaced basket-on-longline, or (d) control

Tide Level: Average height above or below MLLW during each 30-minute photo sampling period

Tide Stage: Incoming or outgoing

Gear Exposure Level: (a) not exposed, (b) at or near surface, or (c) exposed well-above water surface

Eelgrass Density: Coarsely classified as patchy or continuous based on a 2009 classification of benthic habitats throughout Humboldt Bay (Gilkerson 2008, NOAA 2015), combined with insight gleaned from more recent Google Earth aerial imagery.

Other Waterbirds: Plot-specific counts of other waterbirds to account for possible displacement or resource-competition effects on brant

Hierarchical series of candidate models will be constructed and evaluated based on Akaike's Information Criterion (AIC) scores and parameter significance tests to assess the relative importance of different predictor variables and identify top models (Burnham and Anderson 2002). The series of candidate models will include selected interactions focused on elucidating how the culture type, tidal conditions, and eelgrass density interact to influence brant activity. Once the top models are identified, those models will be used to evaluate the degree to which, and conditions under which, brant abundance and feeding behavior are influenced by the presence of narrow- and wide-layout longline aquaculture gear.

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Appendix F
Hunting Avoidance Area

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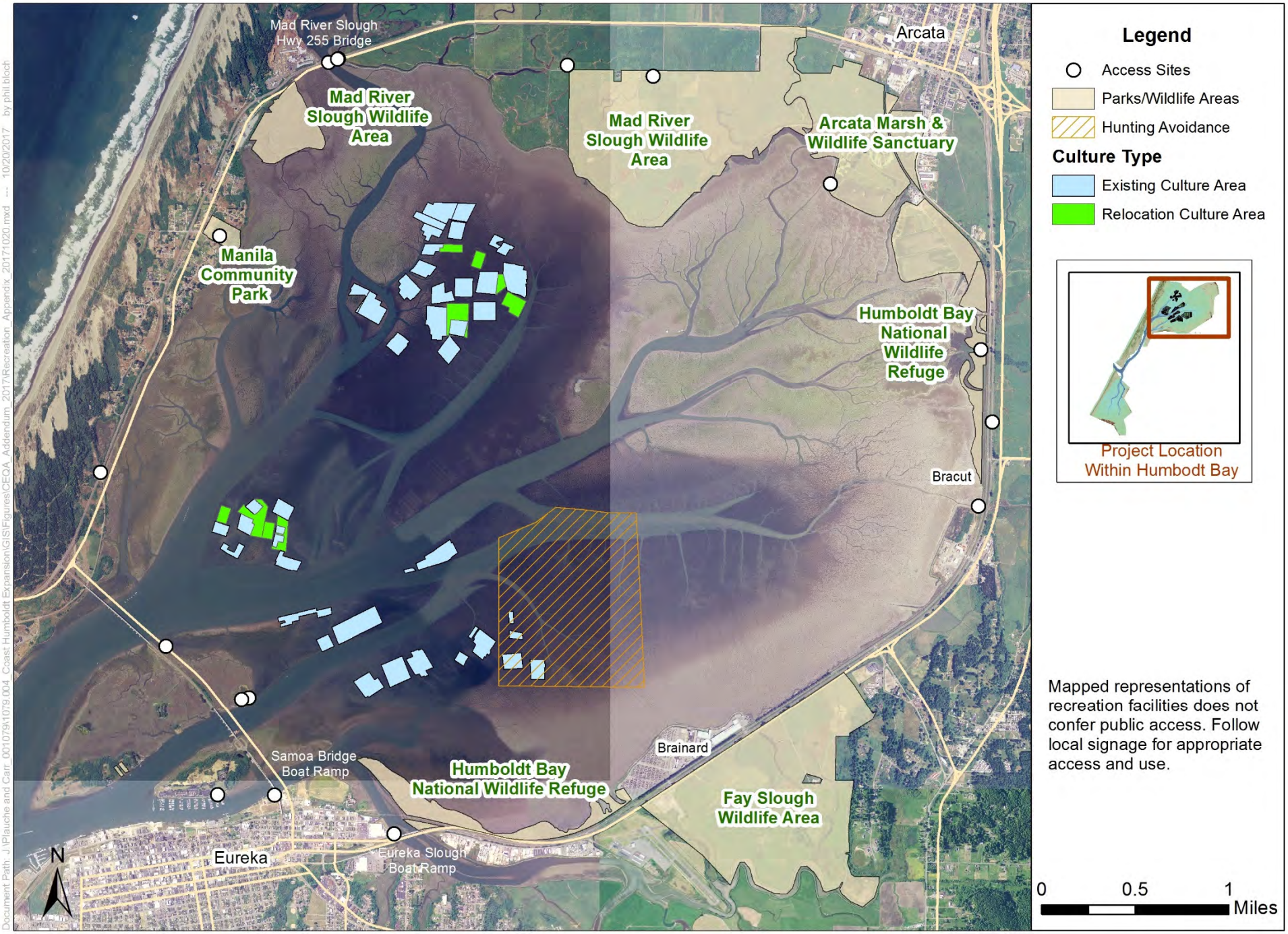

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Appendix G

Cultivation Bed Mapping and Marking Plan

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APPENDIX G: COAST SEAFOODS CULTIVATION BED MAPPING AND MARKING PLAN

Coast Seafoods ("Coast") submits this Updated Cultivation Bed Mapping and Marking Plan in compliance with Conservation Measure REC-3 described in the Coast Seafoods Company Humboldt Bay Shellfish Aquaculture Permit Renewal and Expansion Project Environmental Impact Report and Coastal Commission Coastal Development Permit No. E-06-003-A5 ("CDP") Condition 11. This updated map and plan is pursuant to CDP 9-17-0646.

CULTIVATION MAP

Coast will delineate the location of each bed on a map with labels containing the designated area (i.e. Bird Island = BI) and bed name (usually a number but can be a word). Accompanying the map will be a list of the latitude and longitude for the corners of each bed. The map of Coast's existing beds is included as Attachment 1. This map and list of coordinates will be updated annually by December 1.

Coast will provide a digital and hard copy of the cultivation map to the Harbor District and California Coastal Commission. The Harbor District will make the map available on its website. Coast will also post the current bed map on its website. Further, Coast will provide a digital copy of the map and any updates to anyone that submits a written request to Coast for a copy of the map. Laminated maps will also be posted at highly visible locations at the Woodley Island Marina, the Wharfinger Building, Arcata Marsh and Wildlife Sanctuary, and Humboldt State University Aquatic Center.

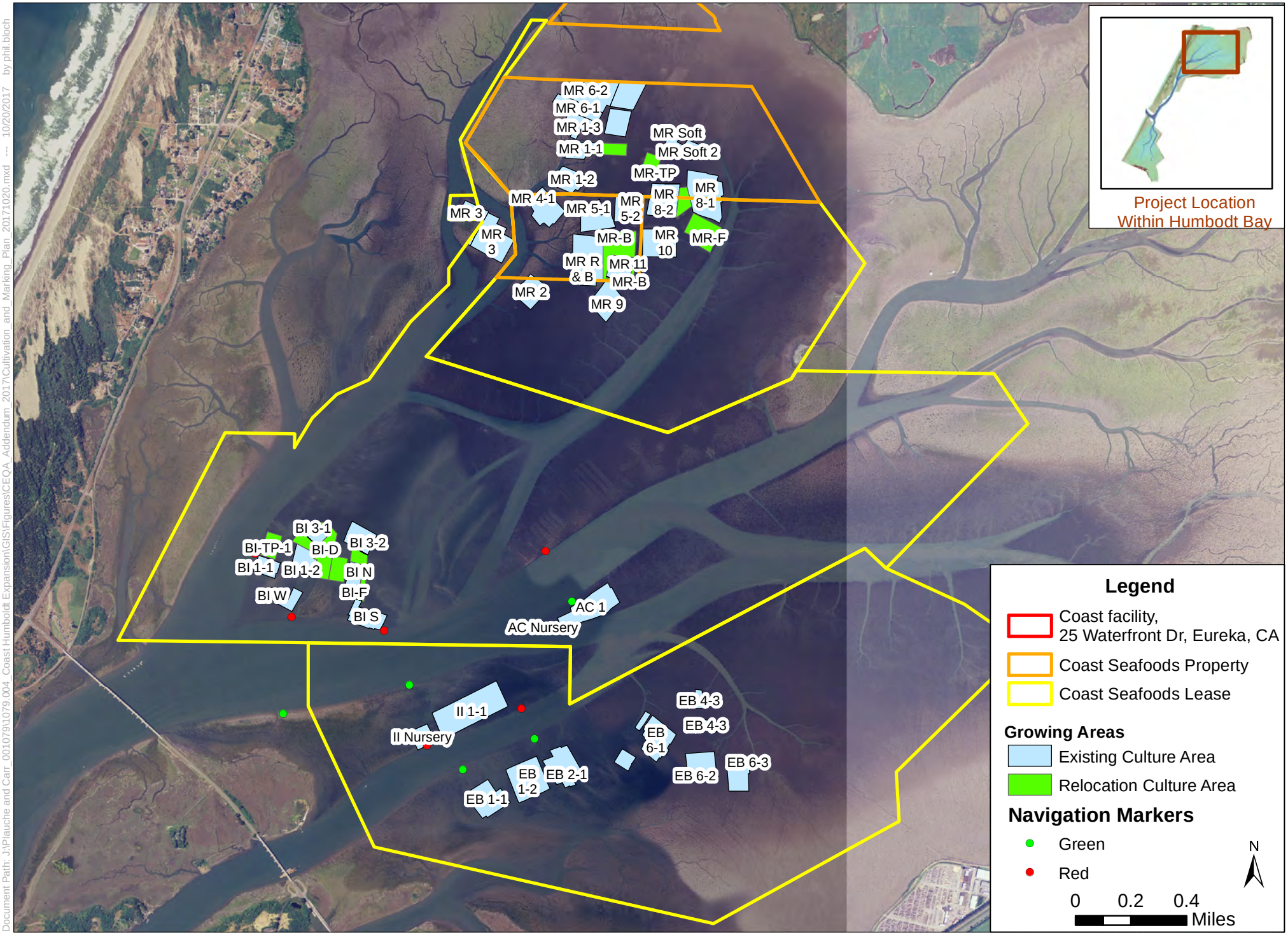
BED MARKING

Each bed will be marked by 10-foot-tall 2-inch PVC pipe planted approximately 2 feet into the substrate. This will allow the marking stake to be seen during all but the most extreme high tides. The marking stakes will be placed at each corner of a delineated bed and every 200 feet along each side of the bed. Marking stakes will be removed within 30 days of harvest on any plot that is being discontinued, abandoned, fallowed, or taken out of production for six months or more.

Each stake will have white reflective tape and will have the bed location and name clearly marked on the top of the stake. Also below this name will be the side of the bed that the stake is on. For example, a stake on the southwest corner of a bed will have "SW Corner" on it. Coast also uses stakes and posts in its operations within beds to mark places where it has placed

harvesting tubs, bags for planting, or marking lanes or seed classes. These stakes are temporary and will move within a bed as a bed goes through the different stages of cultivation. These operational stakes and posts within a cultivation bed will be marked with blue reflective tape. Areas between beds that are frequented by vessels and recreational users will have the same stakes but will be marked with red tape on the right side (starboard) of the channel or vessel passage area when entering the harbor and green tape on the left side (port) of the channel or between beds. The stakes will have "Vessel Lane" marked on them. Coast will do the marking and maintain the stakes but does not accept responsibility or liability for mariner's activities or reliance on the markers for navigation. As part of its Marine Debris Reduction and Management Plan (CDP Condition 10), Coast shall remove any unused stakes, posts and sticks, and any bed markers from beds that are fallowed pursuant to CDP Condition 9.

Coast Seafoods Cultivation Map and Navigation Marking Plan



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Coast Seafoods Cultivation Map and Marking Plan - Bed Corner Coordinates

Bed Corner	Site Label	Longitude	Lattitude	Approximate Bed Size (acres)
1	AC 1	-124.140	40.826	10.2
2	AC 1	-124.140	40.826	10.2
3	AC 1	-124.137	40.828	10.2
4	AC 1	-124.136	40.827	10.2
5	AC Nursery	-124.140	40.826	0.7
6	AC Nursery	-124.141	40.826	0.7
7	AC Nursery	-124.142	40.826	0.7
8	AC Nursery	-124.141	40.826	0.7
9	BI 1-1	-124.161	40.829	3.1
10	BI 1-1	-124.161	40.829	3.1
11	BI 1-1	-124.159	40.829	3.1
12	BI 1-1	-124.160	40.828	3.1
13	BI 1-2	-124.157	40.830	4.4
14	BI 1-2	-124.157	40.828	4.4
15	BI 1-2	-124.159	40.829	4.4
16	BI 1-2	-124.158	40.830	4.4
17	BI 3-1	-124.156	40.831	2.6
18	BI 3-1	-124.157	40.830	2.6
19	BI 3-1	-124.158	40.831	2.6
20	BI 3-1	-124.157	40.831	2.6
21	BI 3-2	-124.154	40.831	5.1
22	BI 3-2	-124.153	40.831	5.1
23	BI 3-2	-124.153	40.830	5.1
24	BI 3-2	-124.155	40.830	5.1
25	BI 3-2	-124.155	40.830	5.1
26	BI 3-2	-124.154	40.831	5.1
27	BI N	-124.154	40.829	1.2
28	BI N	-124.155	40.829	1.2
29	BI N	-124.155	40.828	1.7
30	BI N	-124.155	40.828	1.7
31	BI S	-124.152	40.826	5.3
32	BI S	-124.152	40.826	5.3
33	BI S	-124.155	40.826	5.3
34	BI S	-124.154	40.827	5.3
35	BI W	-124.158	40.828	2.3
36	BI W	-124.158	40.828	2.3
37	BI W	-124.158	40.827	2.3
38	BI W	-124.160	40.827	2.3
39	BI W	-124.160	40.827	2.3
40	BI W	-124.159	40.827	2.3
41	EB 1-1	-124.143	40.817	7.9
42	EB 1-1	-124.145	40.816	7.9
43	EB 1-1	-124.147	40.817	7.9
44	EB 1-1	-124.147	40.817	7.9
45	EB 1-1	-124.145	40.818	7.9

Coast Seafoods Cultivation Map and Marking Plan - Bed Corner Coordinates

Bed Corner	Site Label	Longitude	Lattitude	Approximate Bed Size (acres)
46	EB 1-2	-124.141	40.818	10.0
47	EB 1-2	-124.143	40.817	10.0
48	EB 1-2	-124.144	40.819	10.0
49	EB 1-2	-124.142	40.819	10.0
50	EB 1-2	-124.142	40.819	10.0
51	EB 2-1	-124.140	40.818	8.1
52	EB 2-1	-124.141	40.819	8.1
53	EB 2-1	-124.140	40.820	8.1
54	EB 2-1	-124.138	40.818	8.1
55	EB 2-3	-124.135	40.819	2.1
56	EB 2-3	-124.136	40.819	2.1
57	EB 2-3	-124.136	40.820	2.1
58	EB 2-3	-124.135	40.819	2.1
59	EB 4-3	-124.129	40.821	1.8
60	EB 4-3	-124.131	40.821	1.8
61	EB 4-3	-124.131	40.823	1.1
62	EB 4-3	-124.130	40.823	1.1
63	EB 6-1	-124.134	40.821	7.8
64	EB 6-1	-124.132	40.820	7.8
65	EB 6-1	-124.133	40.819	7.8
66	EB 6-1	-124.134	40.820	7.8
67	EB 6-2	-124.131	40.818	5.5
68	EB 6-2	-124.131	40.819	5.5
69	EB 6-2	-124.129	40.820	5.5
70	EB 6-2	-124.129	40.818	5.5
71	EB 6-3	-124.127	40.819	5.2
72	EB 6-3	-124.127	40.818	5.2
73	EB 6-3	-124.128	40.818	5.2
74	EB 6-3	-124.129	40.819	5.2
75	EB 7-2	-124.117	40.822	11.2
76	EB 7-2	-124.120	40.822	11.2
77	EB 7-2	-124.120	40.824	11.2
78	EB 7-2	-124.117	40.824	11.2
79	EB R & B	-124.134	40.822	0.9
80	EB R & B	-124.134	40.821	0.9
81	EB R & B	-124.135	40.821	0.9
82	EB R & B	-124.135	40.821	0.9
83	GI 1-1	-124.148	40.820	16.8
84	GI 1-1	-124.149	40.821	16.8
85	GI 1-1	-124.144	40.823	16.8
86	GI 1-1	-124.144	40.822	16.8
87	GI 1-2	-124.154	40.821	6.6
88	GI 1-2	-124.154	40.822	6.6
89	GI 1-2	-124.149	40.823	6.6
90	GI 1-2	-124.149	40.822	6.6

Coast Seafoods Cultivation Map and Marking Plan - Bed Corner Coordinates

Bed Corner	Site Label	Longitude	Lattitude	Approximate Bed Size (acres)
91	GI Nursery	-124.149	40.821	3.3
92	GI Nursery	-124.148	40.820	3.3
93	GI Nursery	-124.150	40.819	3.3
94	GI Nursery	-124.150	40.820	3.3
95	MR 10	-124.135	40.847	7.8
96	MR 10	-124.132	40.847	7.8
97	MR 10	-124.132	40.845	7.8
98	MR 10	-124.135	40.845	7.8
99	MR 11	-124.136	40.844	4.7
100	MR 11	-124.137	40.844	4.7
101	MR 11	-124.137	40.845	4.7
102	MR 11	-124.135	40.845	4.7
103	MR 1-1	-124.138	40.851	3.4
104	MR 1-1	-124.139	40.850	3.4
105	MR 1-1	-124.140	40.850	3.4
106	MR 1-1	-124.140	40.851	3.4
107	MR 1-2	-124.139	40.849	5.0
108	MR 1-2	-124.140	40.849	5.0
109	MR 1-2	-124.141	40.849	5.0
110	MR 1-2	-124.140	40.850	5.0
111	MR 1-3	-124.138	40.852	4.0
112	MR 1-3	-124.139	40.851	4.0
113	MR 1-3	-124.140	40.851	4.0
114	MR 1-3	-124.140	40.853	4.0
115	MR 2	-124.141	40.844	5.4
116	MR 2	-124.142	40.842	5.4
117	MR 2	-124.144	40.843	5.4
118	MR 2	-124.142	40.844	5.4
119	MR 3	-124.148	40.847	3.6
120	MR 3	-124.147	40.848	3.6
121	MR 3	-124.144	40.846	9.6
122	MR 3	-124.144	40.845	9.6
123	MR 4-1	-124.142	40.847	6.7
124	MR 4-1	-124.142	40.848	6.7
125	MR 4-1	-124.142	40.849	6.7
126	MR 4-1	-124.140	40.848	6.7
127	MR 5-1	-124.137	40.847	6.2
128	MR 5-1	-124.137	40.847	6.2
129	MR 5-1	-124.139	40.847	6.2
130	MR 5-1	-124.139	40.848	6.2
131	MR 5-1	-124.138	40.848	6.2
132	MR 5-1	-124.138	40.848	6.2
133	MR 5-2	-124.135	40.847	6.4
134	MR 5-2	-124.137	40.847	6.4
135	MR 5-2	-124.137	40.849	6.4

Coast Seafoods Cultivation Map and Marking Plan - Bed Corner Coordinates

Bed Corner	Site Label	Longitude	Lattitude	Approximate Bed Size (acres)
136	MR 5-2	-124.137	40.849	6.4
137	MR 5-2	-124.137	40.849	6.4
138	MR 5-2	-124.135	40.849	6.4
139	MR 6-1	-124.140	40.854	4.5
140	MR 6-1	-124.138	40.853	4.5
141	MR 6-1	-124.141	40.853	4.5
142	MR 6-1	-124.141	40.854	4.5
143	MR 6-2	-124.136	40.854	9.2
144	MR 6-2	-124.137	40.853	9.2
145	MR 6-2	-124.138	40.853	9.2
146	MR 6-2	-124.140	40.854	9.2
147	MR 6-2	-124.140	40.854	9.2
148	MR 8-1	-124.130	40.850	11.8
149	MR 8-1	-124.130	40.850	11.8
150	MR 8-1	-124.130	40.847	11.8
151	MR 8-1	-124.131	40.848	11.8
152	MR 8-1	-124.132	40.850	11.8
153	MR 8-2	-124.132	40.849	7.9
154	MR 8-2	-124.133	40.847	7.9
155	MR 8-2	-124.135	40.847	7.9
156	MR 8-2	-124.134	40.849	7.9
157	MR 9	-124.136	40.843	6.3
158	MR 9	-124.136	40.843	6.3
159	MR 9	-124.137	40.842	6.3
160	MR 9	-124.138	40.843	6.3
161	MR 9	-124.138	40.843	6.3
162	MR 9	-124.137	40.844	6.3
163	MR R & B	-124.137	40.844	10.2
164	MR R & B	-124.139	40.844	10.2
165	MR R & B	-124.140	40.846	10.2
166	MR R & B	-124.137	40.846	10.2
167	MR Soft	-124.133	40.851	2.1
168	MR Soft	-124.133	40.852	2.1
169	MR Soft	-124.132	40.852	2.1
170	MR Soft 2	-124.132	40.851	2.4
171	MR Soft 2	-124.132	40.851	2.4
172	MR Soft 2	-124.131	40.851	2.4
173	MR Soft 2	-124.132	40.850	2.4
174	MR Soft 2	-124.133	40.851	2.4
175	BI TP 1	-124.161	40.829	3.1
176	BI TP 1	-124.160	40.831	3.1
177	BI TP 1	-124.159	40.830	3.1
178	BI TP 1	-124.160	40.829	3.1
179	BI-D	-124.156	40.829	8.6
180	BI-D	-124.555	40.831	8.6

Coast Seafoods Cultivation Map and Marking Plan - Bed Corner Coordinates

Bed Corner	Site Label	Longitude	Lattitude	Approximate Bed Size (acres)
181	BI-D	-124.157	40.831	8.6
182	BI-D	-124.159	40.830	8.6
183	BI-D	-124.157	40.828	8.6
184	BI TP 2	124.156	40.829	3.1
185	BI TP 2	-124.156	40.830	3.1
186	BI TP 2	-124.155	40.829	3.1
187	BI TP 2	-124.155	40.828	3.1
188	BI-F	-124.155	40.827	4.6
189	BI-F	-124.154	40.827	4.6
190	BI-F	-124.153	40.830	4.6
191	BI-F	-124.154	40.830	4.6
192	MR-B	-124.137	40.844	8.1
193	MR-B	-124.138	40.847	8.1
194	MR-B	-124.135	80.847	8.1
195	MR-B	-124.135	40.844	8.1
196	MR-F	-124.132	40.847	6.4
197	MR-F	-124.131	40.849	6.4
198	MR-F	-124.130	40.846	6.4
199	MR-F	-124.129	40.847	6.4
200	MR-E	-124.132	40.849	2.4
201	MR-E	-124.130	40.847	2.4
202	MR-E	-124.131	40.848	2.4
203	MR-E	-124.132	40.849	2.4
204	MR-TP	-124.135	40.850	3.1
205	MR-TP	-124.134	40.849	3.1
206	MR-TP	-124.135	40.851	3.1
207	MR-TP	-124.134	40.850	3.1
208	MR-1-1E	-124.138	40.851	3.0
209	MR-1-1E	-124.138	40.851	3.0
210	MR-1-1E	-124.136	40.851	3.0
211	MR-1-1E	-124.136	40.851	3.0

Notes:

1: Latitude and Longitude are in World Geodetic System (WGS) 1984 geographic coordinates, decimal degrees.

2: Corners that are shared between beds may only be listed for one bed

3: Some beds may have irregular shapes. Please refer to Coast Seafoods Cultivation Map and Marking Plan (October 2017) for beds outlines.

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ENVIRONMENTAL COMPANY