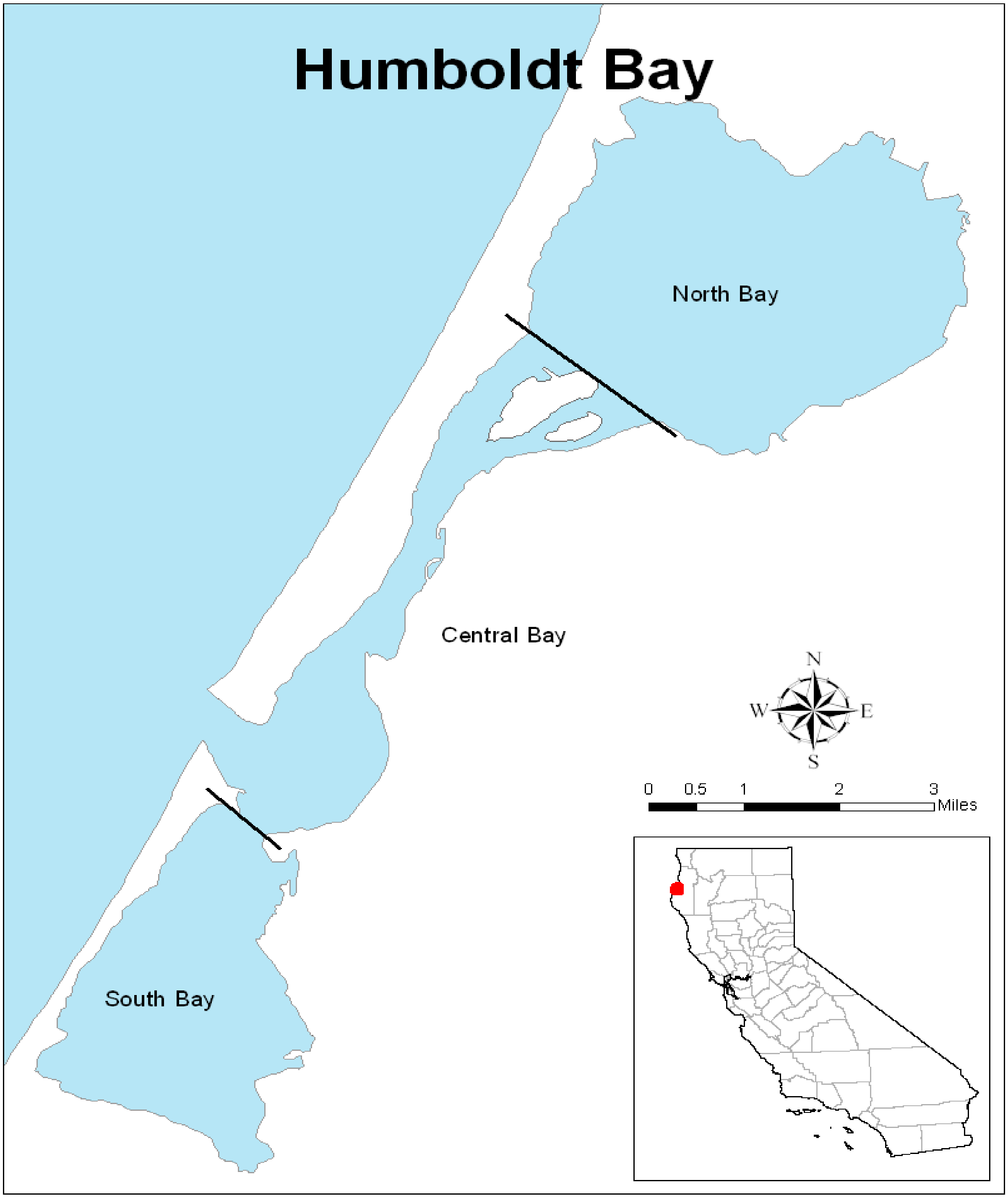

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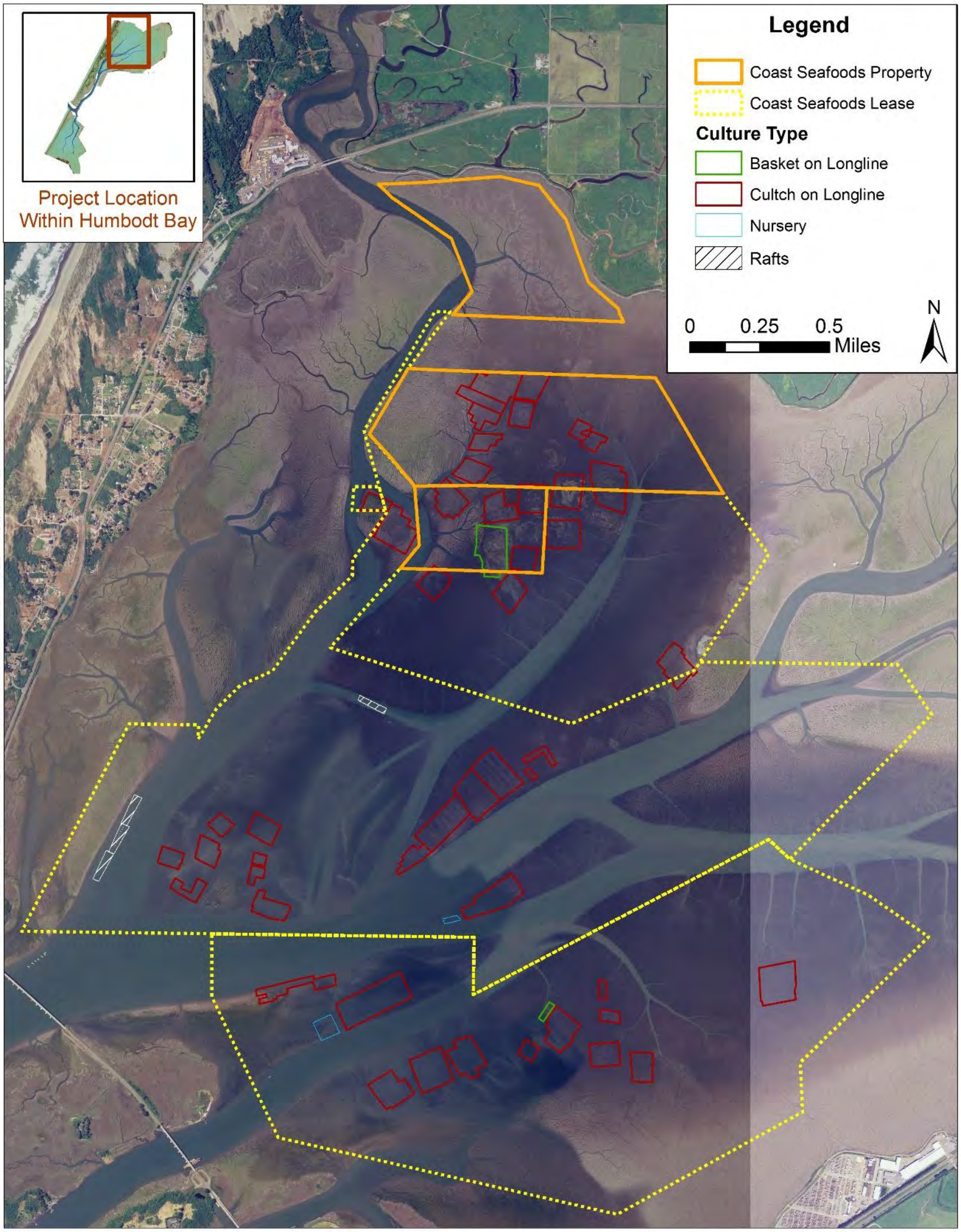

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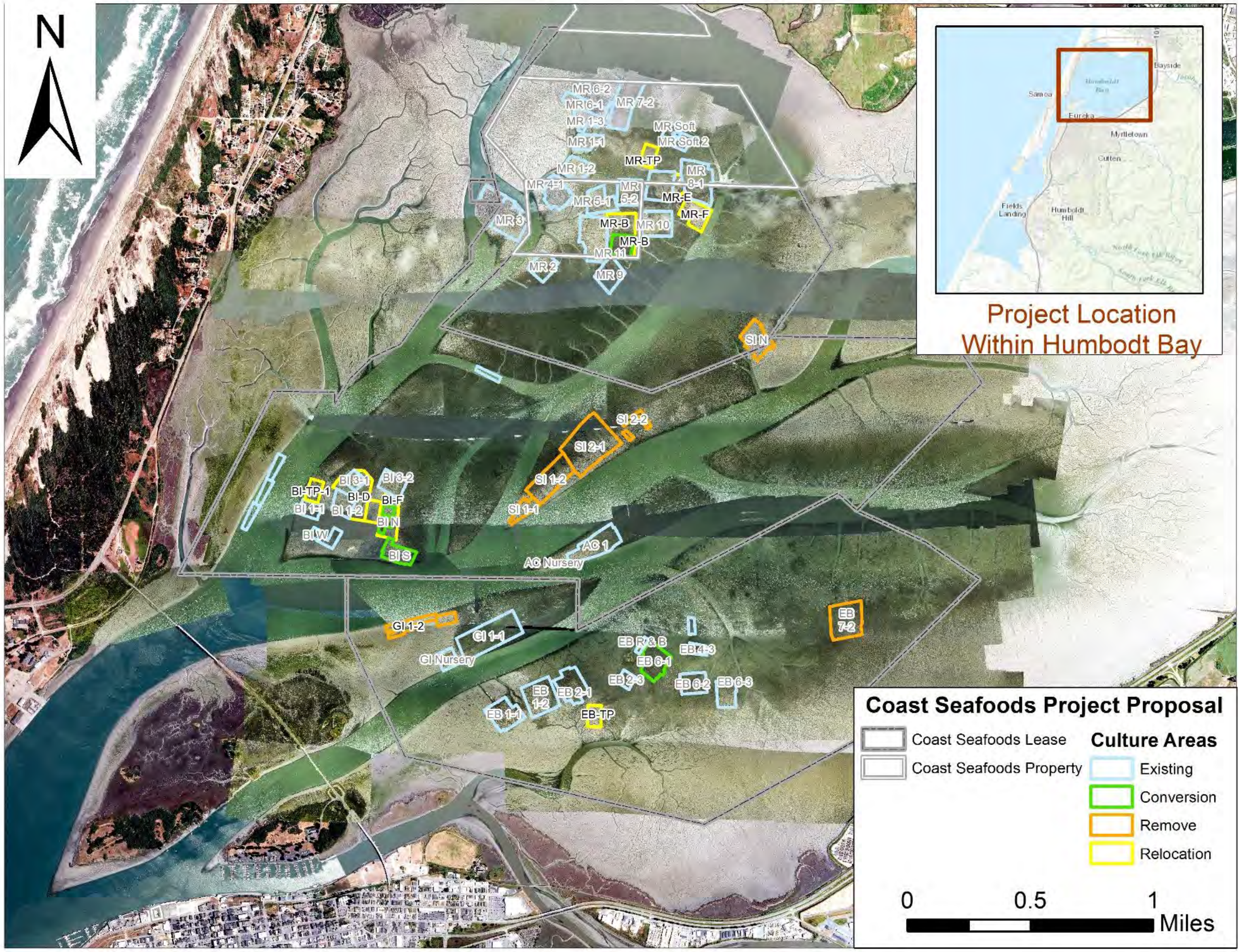

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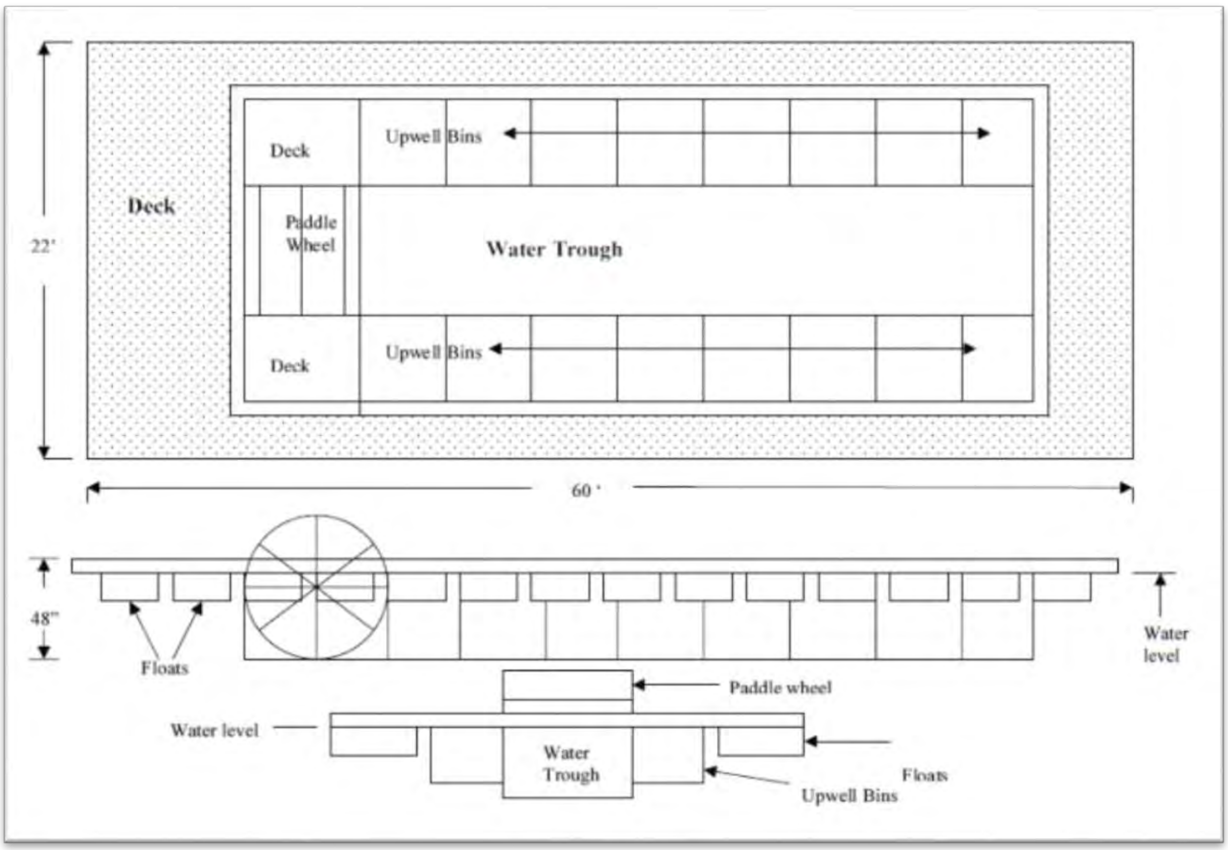
Subtidal Floating Upwelling System

Manila clams, Kumamoto and Pacific oyster seeds are matured in the FLUPSY. The FLUPSY is located on the west side of the entrance channel south of the Simpson wood chip loading dock in Fairhaven, 200 yards from the shoreline in 20 ft. of water. The FLUPSY is tied to the dock at the Eureka Boat yard. The FLUPSY is constructed of aluminum with poly-encapsulated floats with a submerged trough containing a paddle wheel (Figure 12). This trough is surrounded by 16 open wells containing upwelling bins. The paddle wheel moves the water out of the trough. For the trough to fill, the water must pass through the upwelling bins containing shellfish seed. The bins are removable for seed maintenance. The seed is about 1.4 mm long when it arrives and matured to roughly 6 mm before being placed in bags. FLUPSY activities include maintaining the seed by rinsing off bins with water, and seed grading based on size.

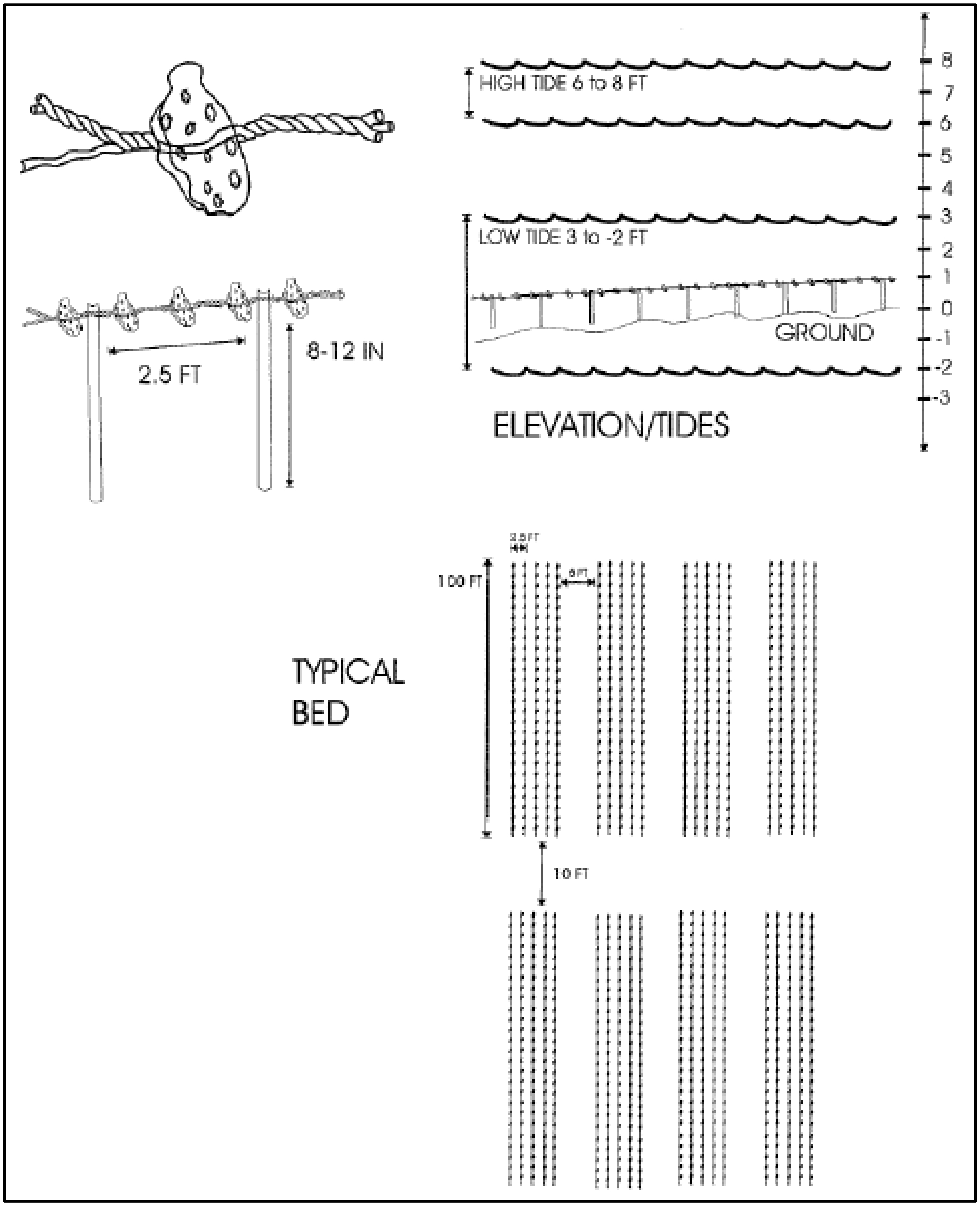


Intertidal Nurseries

Figure 6 Seed bags at a nursery.

Long-line culture utilizes cultch set with spat attached, collectively referred to as seed. Coast transports the seed by truck from Quilcene, Washington. Each year a representative sample of each type of seed is examined by a United States Department of Agriculture/Animal Plant Health Inspection Service certified veterinarian and the results of this examination are sent to the California Department of Fish and Wildlife (CDFW) with an application for import of seed. Once appropriate results are verified, CDFW issues a certification for the import of oyster seed. Upon arrival, Coast places the bags of seed in the intertidal nursery on Indian Island. Coast stacks the seed on pallets in order to prevent the bottom of the stack from becoming silted in, which suffocates the seed (Figure 6). After a period of time, which varies due to seasonal conditions (usually 2-3 months) the seed is removed from the nursery in small batches daily and is brought to the processing plant. At the plant, individual pieces of cultch are braided into the long-line rope and rebagged. Once the cultch has been braided into the rope and bagged it is put into the bay and placed on either a bed or on Coast's Arcata Channel nursery to await planting.

The seed is transported by boat to nursery areas located in Humboldt Bay on mudflats north of Indian Island and along Arcata Channel. At these nursery areas the seed is allowed to grow to a less fragile size and age. This process, called beach hardening, is needed to allow the seed to gain size and strength prior to planting. The seed is allowed to beach harden for 3 to 8 months depending on time of year, growth and condition of the seed.



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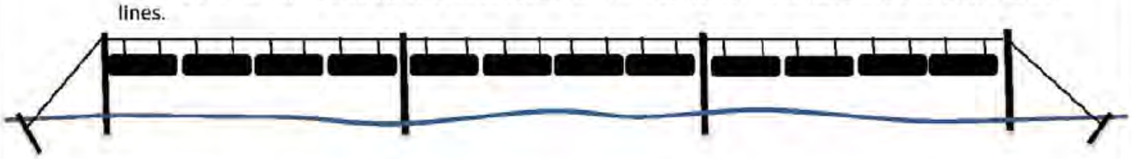
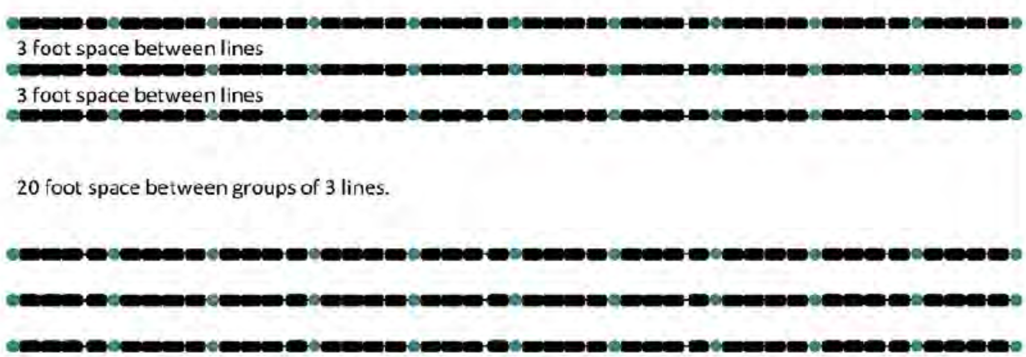
Basket-on-longline culture.

Structure (Side View): Lines are held up by 2 inch PVC pipe driven into the mud every 10 feet. Anchors made of galvanized fence posts are driven at the ends of each line. The lines are attached to the anchors and tension is created by a fence tightener. The baskets can be clipped and unclipped from the lines.



Spacing (Top View): Lines are 100 feet long and there are 40 baskets on each line. Lines are in groups of 3, with a 3 foot space between each line and a 20 foot space between each group of 3 lines. The 20 foot space is used to access the baskets with a boat.



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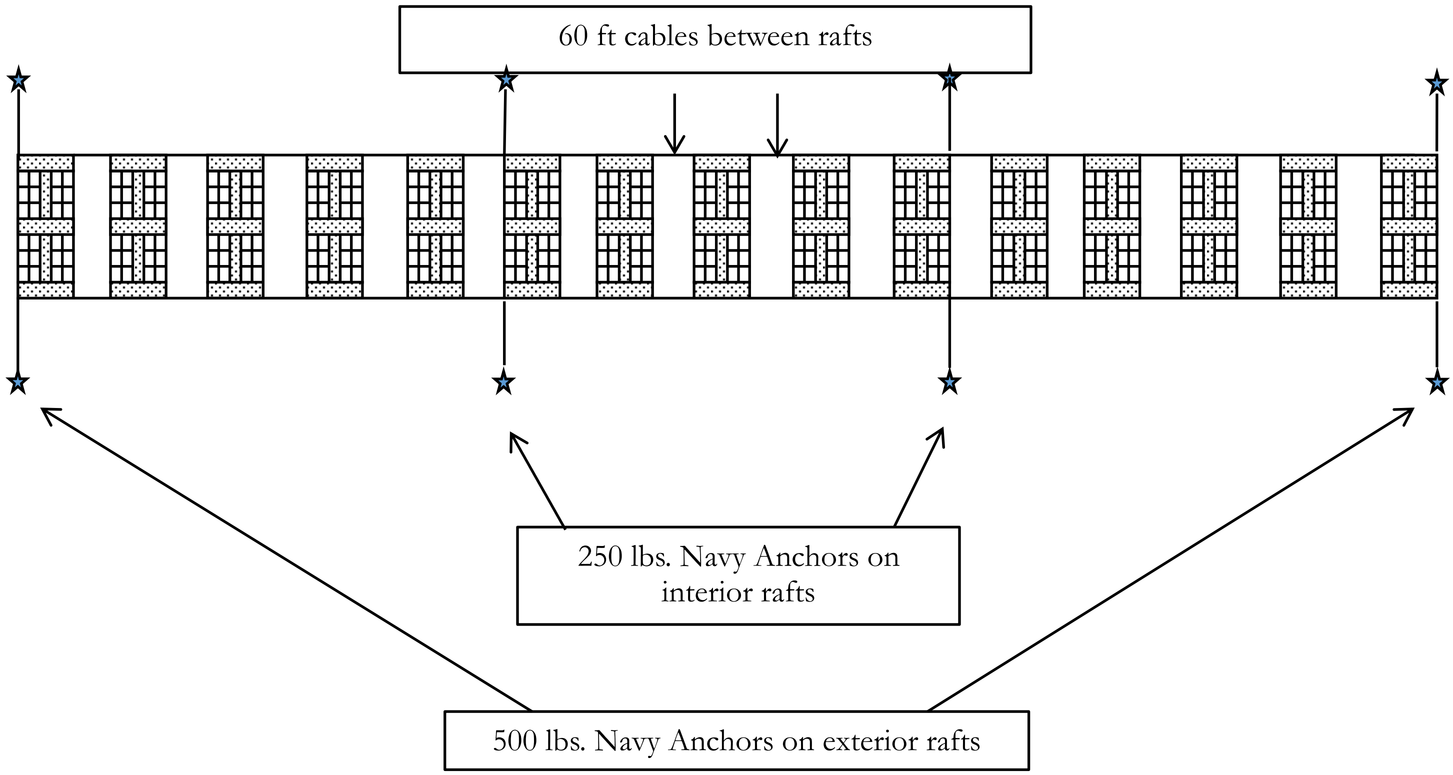
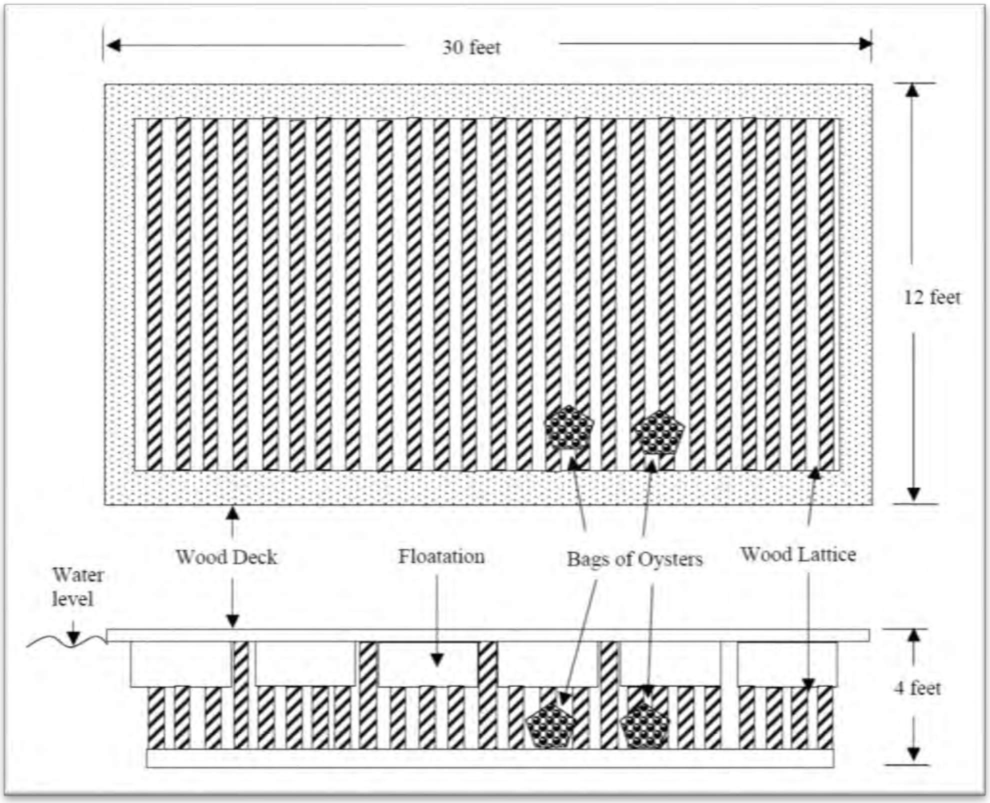


Configuration of clam rafts.

Subtidal Wet Storage Floats

The wet storage floats are located in the "cut across" channel between Bird Island and Mad River. The floats are anchored in approximately 20 ft. of water in a series of four 20-ft. by 20-ft. square wood frames, with 60 ft. between floats (Figure 14) or clam rafts in the same array or smaller may be used as wet storage floats. Bags of mature oysters recently harvested and ready for distribution to wholesalers are temporarily placed in the floats to maintain the oysters' fresh condition. Bags of oysters are placed and removed by hand and transported by boat.



Configuration of wet storage floats.

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Proposed Culture Methods and Culture Removal by Habitat Type

Area	Total Subtidal Habitat (acre)	Intertidal Habitat (acre)			Total Intertidal Habitat (acre)
		Non Eelgrass	Patchy Eelgrass	Continuous Eelgrass	
North Bay[a]	1127.2	3535.5	1928.2	1890	7353.7
Existing Culture					
Other[b]	1.0	1.1	1.6	1.2	3.9
Cultch-on-Longline	[0.1]	8.5	244.9	27.1	283.2
Basket-on-Longline	0	0	11.2	0.9	12.1
Total Culture	1	12.4	257.6	29.3	299.2
Habitat Overlap (%)	0.1%	0.4%	13.4%	1.6%	4.1%
Proposed Culture					
Other	1.0	1.1	1.6	1.2	3.9
Cultch-on-Longline	0	1.3	191.5	17.8	210.6
Basket-on-Longline	0	4.7	42.9	4.3	51.9
Test Plots (½ Basket & ½ Cultch)	0	1	8.3	2.9	12.2
Total Culture	0	8.1	244.3	26.2	278.6
Habitat Overlap (%)	0.0%	0.2%	12.6%	1.5%	3.8%
Proposed Removal					
Cultch-on-Longline	0	6.6	45.4	11.2	63.2
Habitat Overlap (%)	0%	0.2%	2.4%	0.6%	0.9%

Source: Dale, pers. comm., 2016; NOAA 2012

[a]Values for North Bay are reported as MHW, which is a similar comparison made for other estuaries along the West Coast when comparing habitat overlap.

[b]Some of the existing subtidal culture (e.g., FLUPSY, wet storage floats, clam rafts) occurs in Central Bay, although for summarization purposes it is listed in this table.

[c]Proposed culture includes both new and existing culture beds after project implementation and proposed removal.

[ ]Subtidal habitat calculations are limited to spatial overlap with floating culture in Central Bay. Although basic polygons in North Bay show an overlap with subtidal habitat, no culture would be planted in subtidal channels, including a 10-ft buffer.

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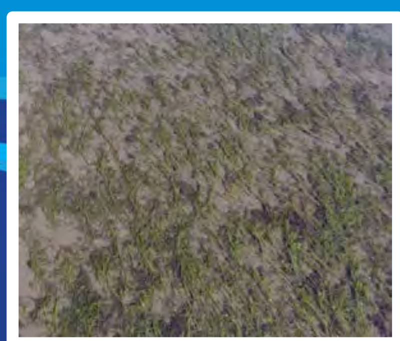
September 18 2017

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

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August 2017

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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.

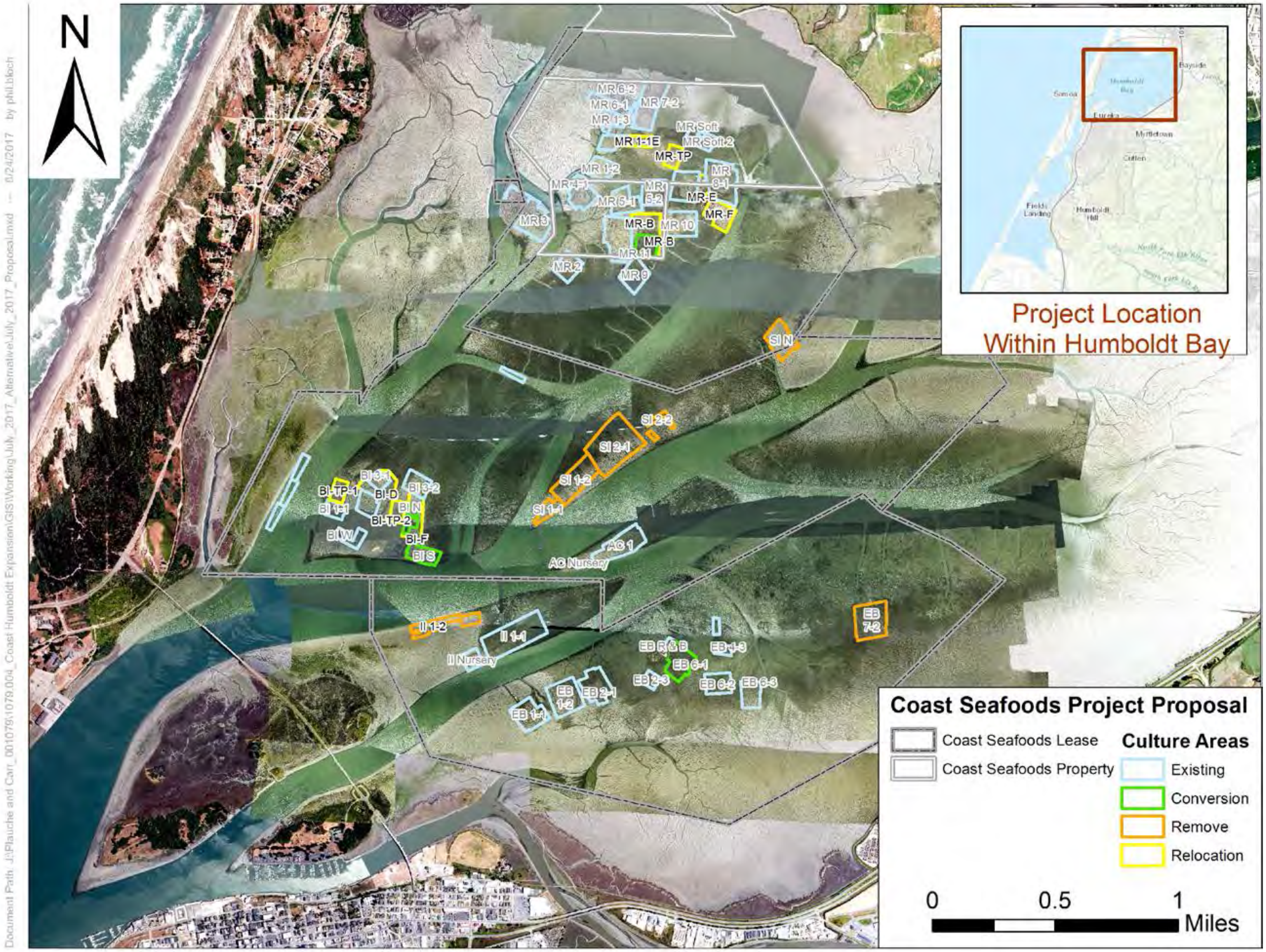

Figure 1 Coast Seafoods Project Proposal

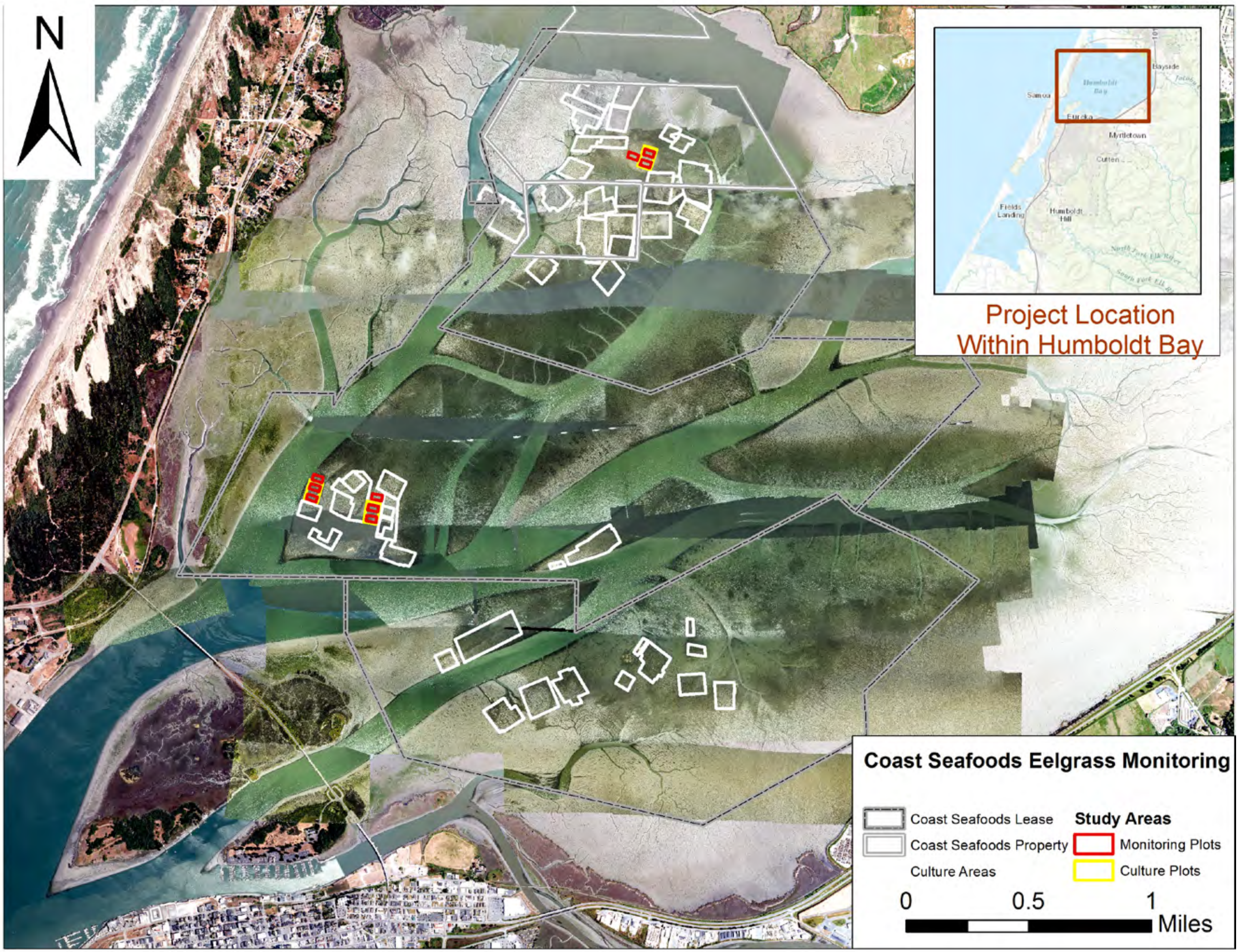

Figure 2 Proposed Culture and Study Areas

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

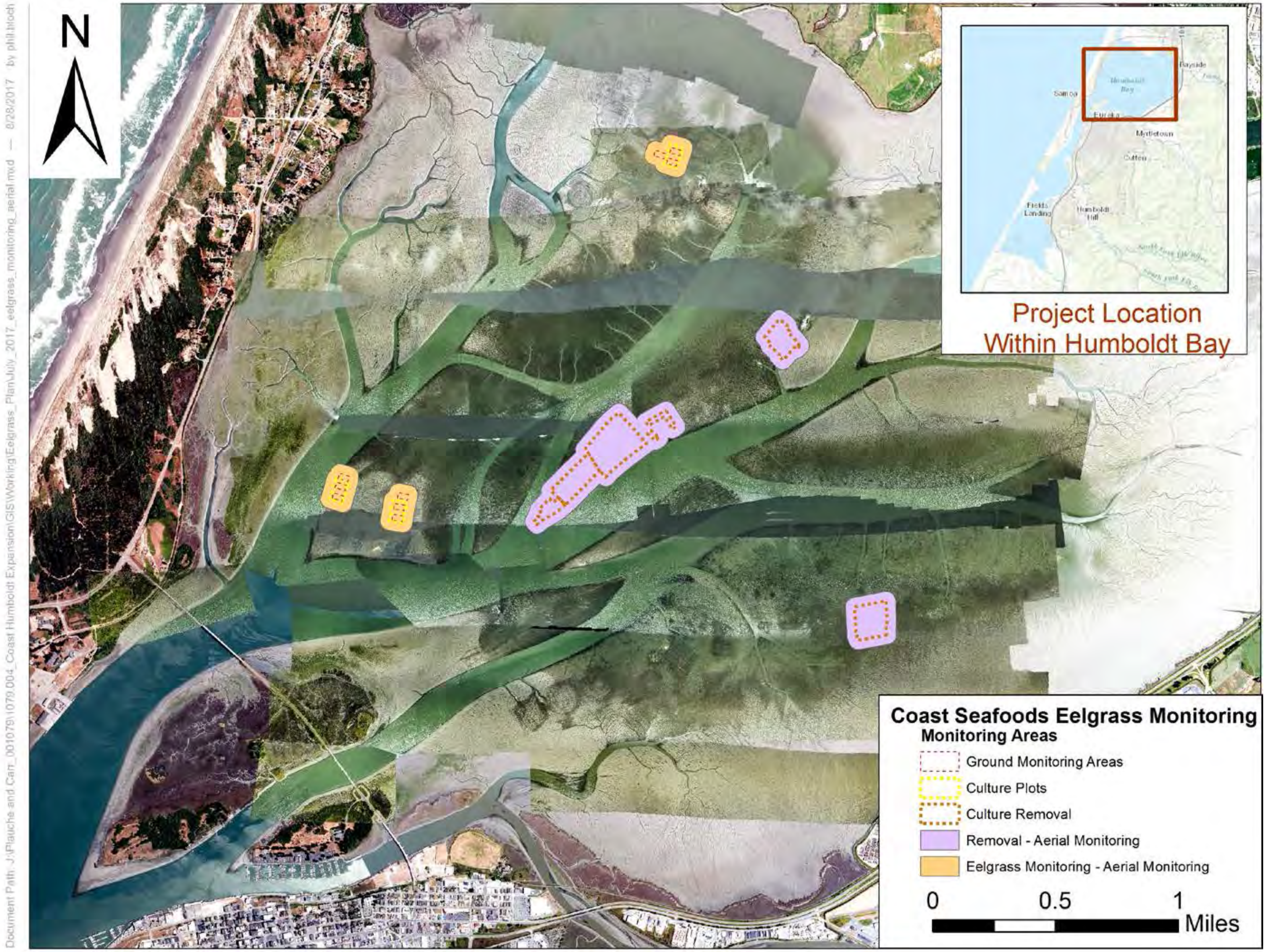

Figure 3 Overview of Low Elevation Aerial Imagery Areas.

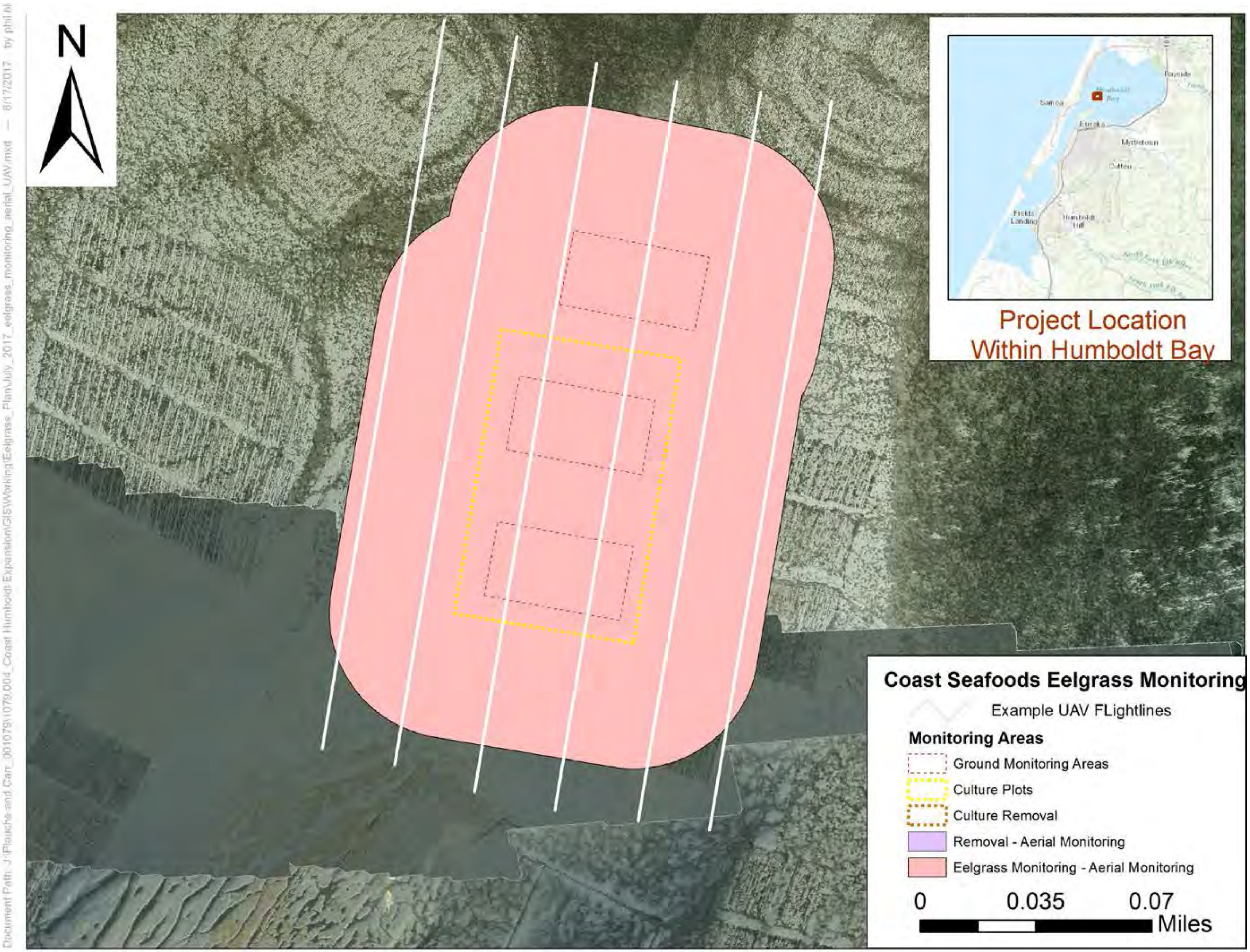

Figure 4 Example of UAV flight lines assuming 200' altitude survey elevation.

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.

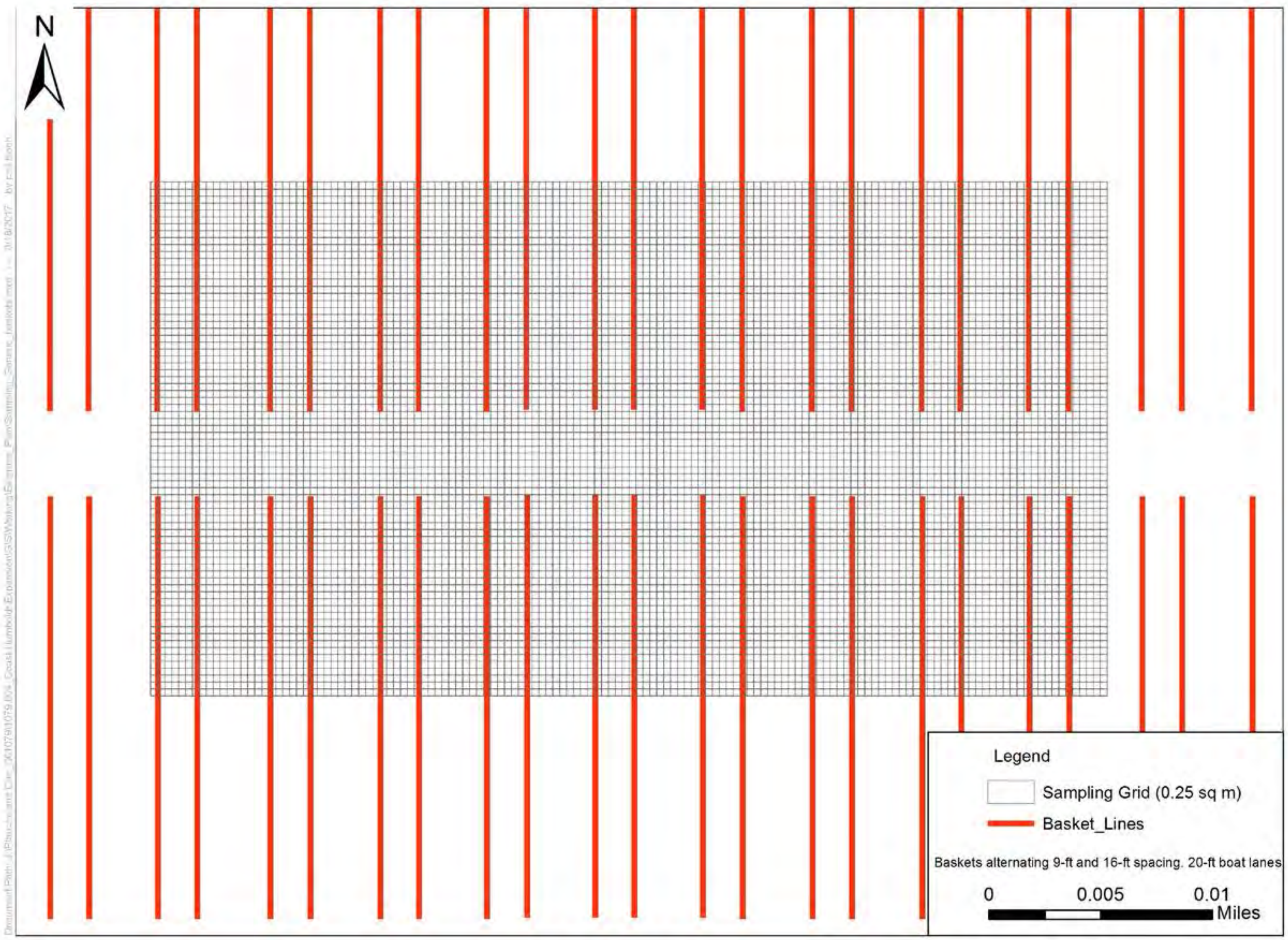

Figure 5 Diagram of Sampling Grids for Basket-on-Longline Sample Plots

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.

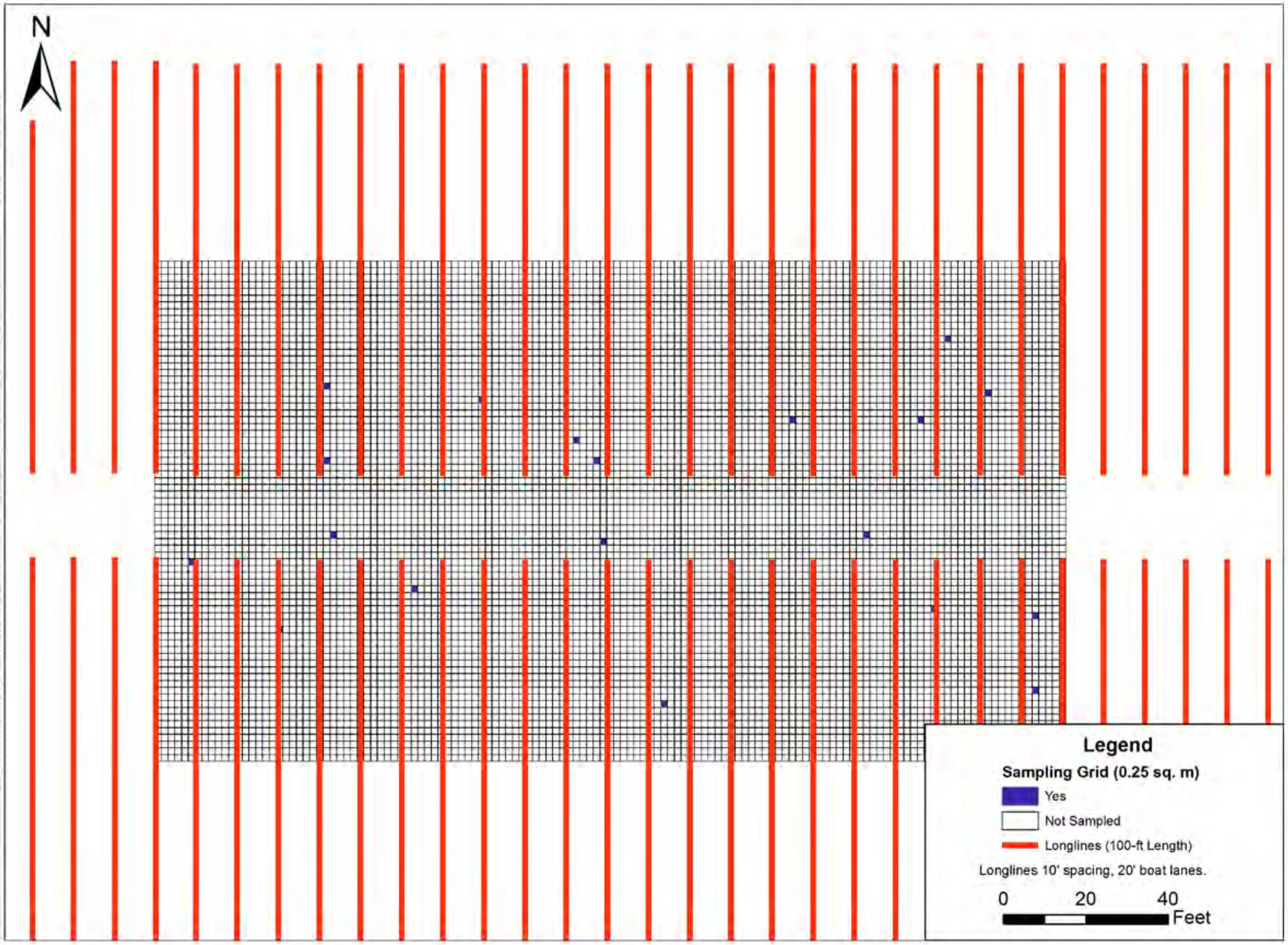

Figure 6 Diagram of Sampling Grids and Example Quadrat Locations for Cultch-on-Longline Sample Plots

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.

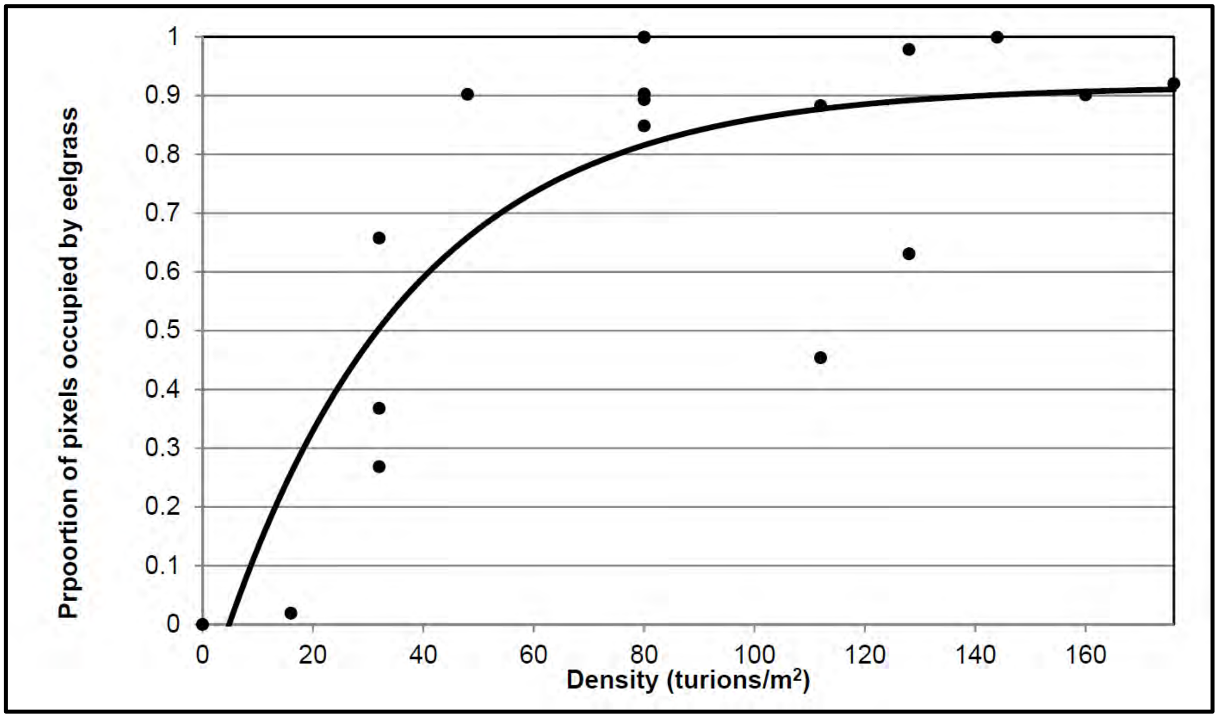

Figure 7 Relationship between Classified Eelgrass Pixel Density and Turion Density
Source: Merkel and Associates 2016

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.

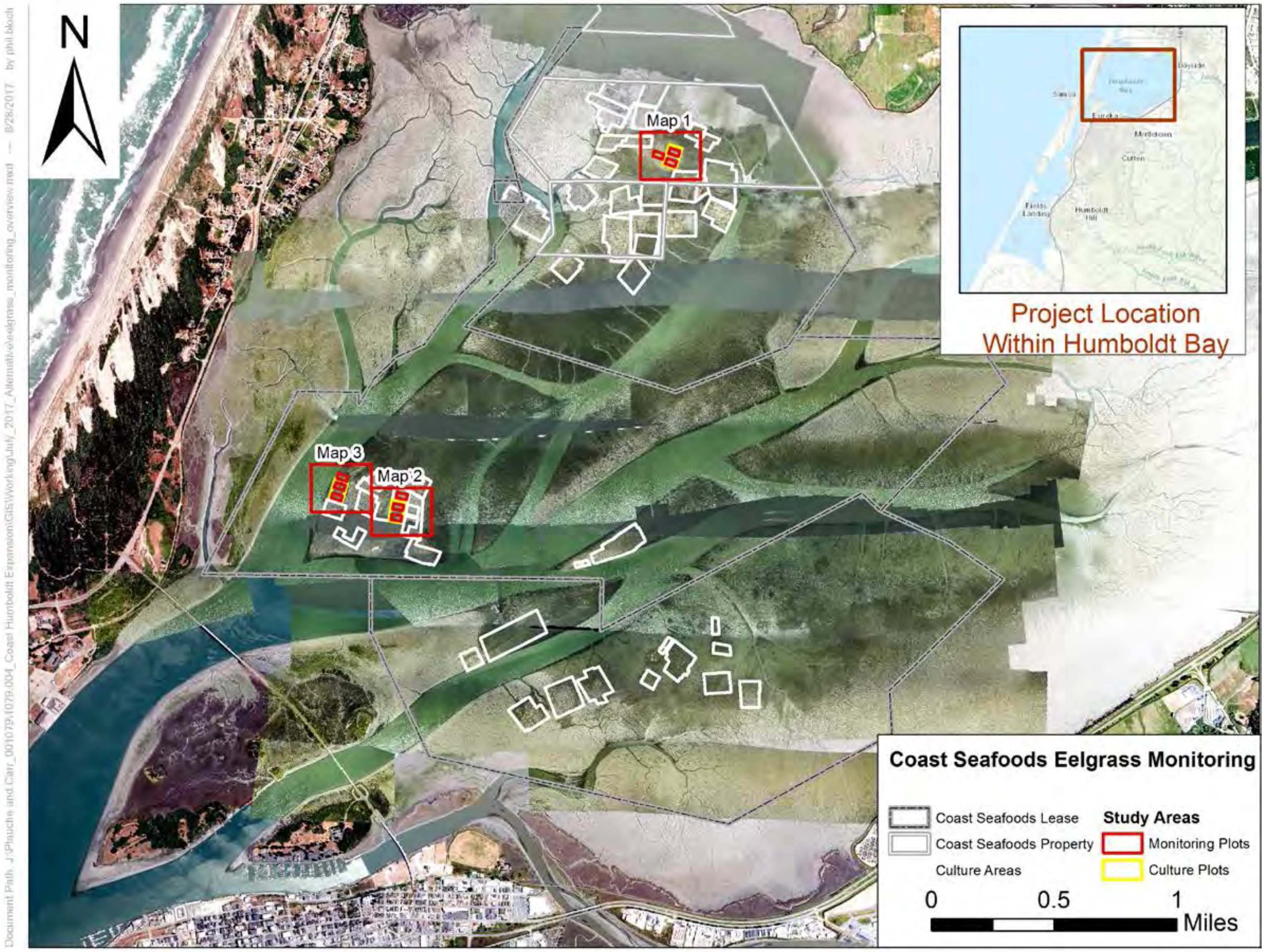
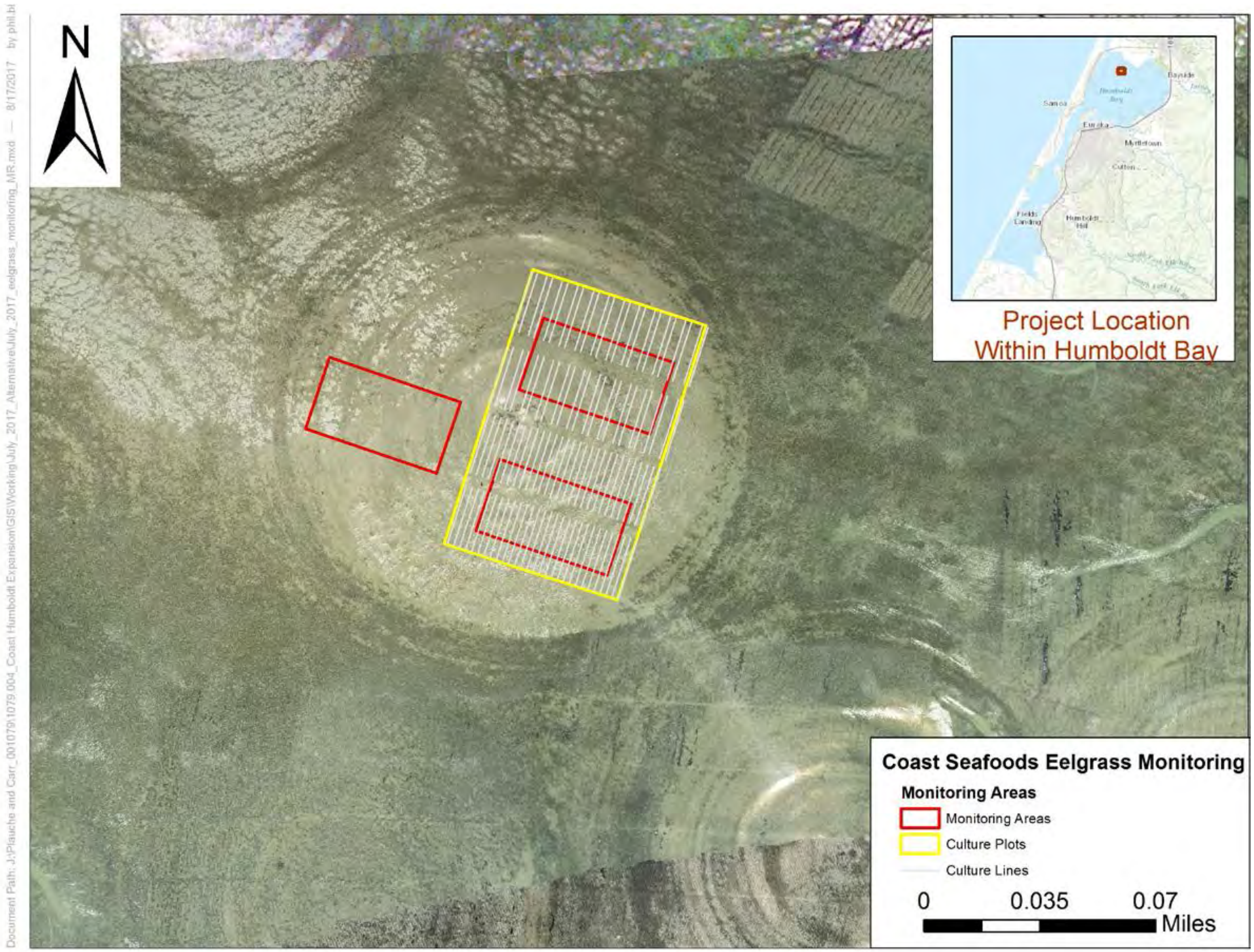
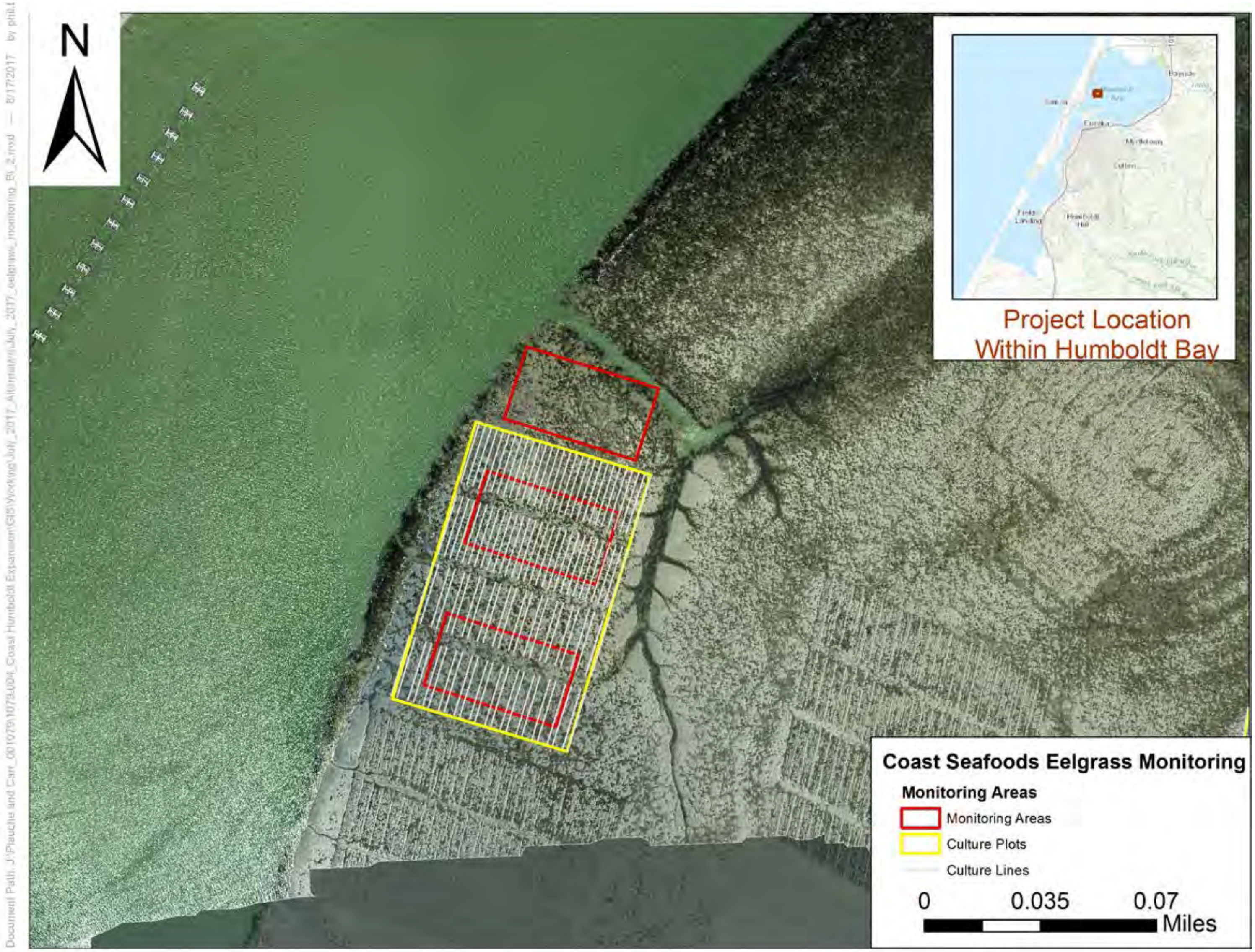


Figure A-1 Overview of Monitoring Study Areas



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 $i = 1, \ldots, n_i$ where n_i is the number of impact sites. Similarly, we computed $\bar{x}_{r,B}$ and $\bar{x}_{r,A}$ for reference sites $r = 1, \ldots, n_r$ 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 $i = 1, \ldots, n_i$ and $\bar{d}_r$ for impact sites $r = 1, \ldots, n_r$.

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 ($H_0: u_{\bar{d}_I} - u_{\bar{d}_R} < 0 \text{ or } \neq 0$).

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.

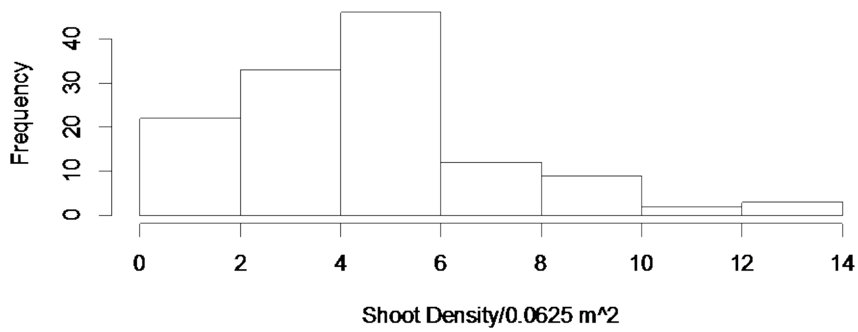
10. The sites are the sampling unit for this design. Power was estimated for four site scenarios: 10 impact with 10 reference sites, 7 impact with 7 reference sites, 10 impact with 3 reference sites, and 7 impact with 3 reference sites. Further, for each of these scenarios, power was separately estimated 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.



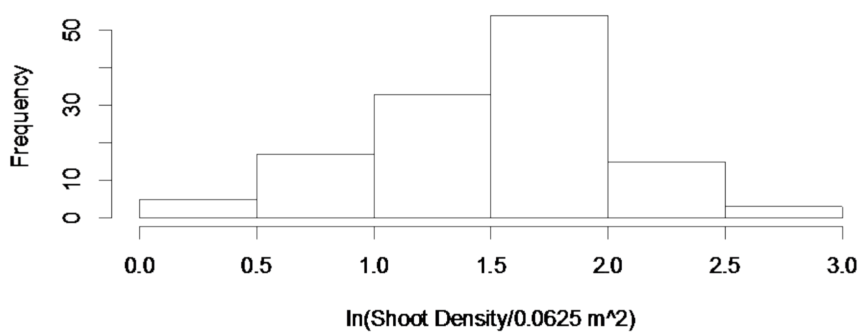


Figure 1. Histograms for the distribution of shoot density/0.0625 m^2 for all SeagrassNet quadrats in North Bay with counts > 0 (top) and the natural log-transformed distribution of the same shoot densities (bottom).

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

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