Appendix F:

Avian Resources Technical Report

AVIAN SPECIES IMPACT ASSESSMENT

COAST SEAFOODS COMPANY
HUMBOLDT BAY SHELLFISH CULTURE: PERMIT RENEWAL & EXPANSION PROJECT

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Table of Contents

Tables

Figures

Section 1.0 Introduction

The following report includes an impact assessment for avian species associated with the Humboldt Bay Shellfish Culture: Permit Renewal and Expansion Project (Project) which is proposed by Coast Seafoods Company (Coast). The purpose of the impact assessment is to assist Coast with preparation of a Draft Environmental Impact Statement (DEIR) for compliance with the California Environmental Quality Act. The below impact assessment is based on the project description provided by Coast and is included in the Project's DEIR.

Section 2.0 Avian Species Impact Assessment

2.1 Impacts to Special-Status Bird Species

2.1.1 Marbled Murrelet

The marbled murrelet (*Brachyramphus marmoratus*) occurs along the Pacific coast from Alaska to California, foraging nearshore in marine subtidal and pelagic habitats for small fish and invertebrates (U.S. Fish and Wildlife Service [USFWS] 1992). Nesting occurs in mature, coastal coniferous forest with nest cups built on large branches in tall trees. In California, nesting occurs primarily in Del Norte and Humboldt counties, but occurs south to Santa Cruz County. The loss of old-growth forest is a primary reason for this species' decline (USFWS 1992). In California, marbled murrelets nest in redwoods greater than 200 years old (Nelson 1997). They are also vulnerable to oil spills along the coast. Marbled murrelets are known to occur in small numbers in Humboldt Bay as foragers, particularly in the late summer and fall; they are observed primarily in the subtidal entrance portion of the bay between King Salmon and the Elk River mouth (Strong pers. comm. 2015). They are unlikely to occur in the project area, as their foraging habitat (i.e., subtidal channels and open bay habitats) does not overlap with the areas proposed for shellfish culture, which are primarily located in in North Bay, and thus the project is not expected to impede their ability to forage. While boat traffic in North Bay is expected to increase by 18 additional boat trips per week, the Project would not result in any additional trips to Central or South Bay. If any murrelets forage in subtidal channels in the vicinity of the project, they would be accustomed to occasional boat traffic and the small increase in boat traffic is not likely to result in a substantial increase in disturbances as compared to existing conditions. Impacts on foraging marbled murrelets are therefore considered less than significant under CEQA.

2.1.2 Western Snowy Plover

The western snowy plover (*Charadrius nivosus nivosus*) nests along the Pacific Coast from Damon Point, Washington to Bahia Magdalena, Baja California, Mexico (USFWS 2007). Degradation and use of habitat for human activities has been largely responsible for the decline in snowy plover breeding population; other important threats to the snowy plover are mammalian and avian predators, and human disturbance (Page et al. 1995). In the Humboldt Bay region, western snowy plovers primarily breed and winter in ocean-fronting beaches (Brindock and Colwell 2011) although small numbers of plovers have been documented nesting on gravel bars of the Eel River (Colwell et al. 2011). Nonbreeding western snowy plovers infrequently occur on the interior of Humboldt Bay (Colwell 1994), but mostly in the South Bay on sandier substrates rather than on softer substrates associated with mudflats in North Bay. As noted above, the Project would not result in any additional boat trips to South Bay. Because they are not expected to occur within the subtidal or low intertidal areas proposed for shellfish culture, impacts on western snowy plovers are considered less than significant under CEQA.

2.1.3 California Brown Pelican

The California brown pelican (*Pelecanus occidentalis californicus*), a subspecies of the brown pelican (*P. occidentalis*), ranges widely along the U.S. West Coast. The brown pelican (entire species) was federally listed as endangered, and the California subspecies was listed as endangered by the State of California, due to widespread reproductive failures linked to environmental contaminants such as DDT. It was state and federally delisted in 2009; however, the subspecies remains fully protected by the State of California. The California brown pelican nests in the Channel Islands in southern California and Mexico, but occurs widely along the U.S. West Coast as far north as British Columbia, Canada (Jaques et al. 2008). They feed in estuaries and nearshore ocean waters, plunge-diving to capture small schooling fishes near the water's surface. Communal roosting occurs year-round as pelicans move up and down the coast, and this roosting appears to have several important functions such as predator detection and avoidance, assistance with finding prey, and socialization (Jaques et al. 2008). Pelicans roost on sandbars, pilings, jetties, breakwaters, and offshore rocks, sometimes in large communal roosts that can number in the thousands. In Humboldt Bay, roosting has been reported on Sand Island (high count of 350 pelicans in summer), oyster racks (high counts of just over a hundred pelicans in summer and fall), jetties, mudflats, and manmade structures (Jaques et al. 2008). They are most abundant in Humboldt Bay from summer through mid-fall (Nelson 1989). Potential impacts on roosting California brown pelicans are described in *Impacts to Roosting Birds*, below.

2.1.4 Black Brant

The black brant (*Branta bernicla nigricans*) is a sea goose that relies on Pacific coastal habitats. Brant nest in the arctic, including areas in Alaska, Canada, and Russia (Pacific Flyway Council [PFC] 2002). Due to their broad range, the Pacific Flyway brant population is a shared resource amongst Mexico, the United States, Canada, Russia and Japan (PFC 2002). The population of black brant is monitored by the Pacific Flyway Council (PFC) pursuant to the 2002 Pacific Flyway Management Plan for the Pacific Population of Brant (Brant Management Plan) (PFC 2002). The PFC produces recommended management procedures intended to guide cooperative management between state and federal wildlife management agencies. Brant are managed for sustained yield, with a population objective of 150,000 birds. The Brant Management Plan recommends protecting critical brant habitat in the species' range, including pursuing mitigation for loss or degradation of eelgrass beds, grit and loafing sites (PFC 2002). Black brant are considered a species of special concern while wintering/staging in California.

2.2 Impacts to Black Brant

2.2.1 Brant Use of Humboldt Bay

Humboldt Bay is an important wintering area and spring staging site for brant in the Pacific flyway. Based on peak use, Humboldt Bay is the most important spring staging site in California and the fourth most important site in the Pacific flyway (Moore et al. 2004). Annual estimates of total use-days ranged between 1 to 6 million before 1954, but since have usually been less than 1 million, reaching a low of 285,000 in 1985 (Moore and Black 2006a). The total Pacific Flyway black brant population estimates based on midwinter surveys in January averaged 133,300 from 1991 to 2000 (PFC 2002). During a two-year study, Humboldt Bay was estimated to support 28 percent of the flyway population (37,600 birds) in 2000 and 58 percent (77,800 birds) in 2001 (Lee et al. 2007), indicating that a substantial proportion of the population relies on Humboldt Bay. Although "wintering" brant are generally considered winter residents of the Bay, the resident brant population in January and early February is not completely stable, with 3 to 8 percent turnover per week until 15 February (Lee et al. 2007). The mean stopover duration for all birds in winter and spring (January – April) was estimated to be 26 days (Lee et al. 2007). Therefore, in a given year, Humboldt Bay supports a substantial proportion of the black brant population during migration.

Black brant feed almost exclusively on eelgrass (Ward et al. 1997, 2005; Moore et al. 2004), making them vulnerable to degradation of existing eelgrass habitat (Pacific Flyway Council [PFC] 2002, Ward et al. 2005).[1] A large proportion of Pacific Flyway brant uses Humboldt Bay, likely due to its high eelgrass abundance and relative isolation from other suitable spring staging sites (Moore et al. 2004). Eelgrass varies in quantity and quality, and is unavailable to brant during two high tides per day, making the achievement of energy demands challenging for brant (Clausen 2000, Moore and Black 2006b). Brant have been documented repeatedly returning to eelgrass beds that are relatively high in quality (density, biomass, and nutrient content), and have been seen waiting over eelgrass beds until tides recede (Moore and Black 2006b), suggesting brant are making foraging decisions based on prior experience and performance. This observation also suggests that eelgrass quality in Humboldt Bay is important to the ability of brant to meet energetic demands for migration, and thus a reduction in quality and quantity could result in impacts to the flyway population.

There is anecdotal evidence that brant have experienced eelgrass shortages on occasion in Humboldt Bay, and although their non-breeding diet is restricted almost exclusively to eelgrass, brant have been observed in salt marshes and pastures in those years (Moore et al. 2004). Eelgrass shortages have occurred in the winter/spring of the years 1937/38, 1940/41, 1951/52, 1952/53, 1957/58, and 1997/98 (various sources as cited in Moore et al. 2004). The most recent circumstance (1997/98) where eelgrass was unavailable was hypothesized to be due to a long storm duration coupled with a tide cycle that did not allow for eelgrass exposure at low tide, as opposed to any reduction in eelgrass quantity or quality (Dale pers. comm. 2014). There were no notable declines in brant use of Humboldt Bay in those years (despite a decline in their main food source), possibly because of energetic constraints to brant migration and the relative isolation of the bay from others along the Pacific Flyway (Moore et al. 2004). Moore et al. (2004) suggest Humboldt Bay may be a bottleneck for migrating brant, and that some individuals may be unable to move to another site along the flyway without first obtaining adequate energy reserves (i.e., from surrounding habitats, if necessary). However, in most years, there is no evidence that overall eelgrass abundance has been insufficient to support wintering and staging brant in Humboldt Bay, and brant appear to meet their energetic requirement foraging on a relatively stable and

[1] A 1995 study of black brant correlated oyster aquaculture in Willapa Bay, Washington with a reduction in eelgrass abundance and corresponding decrease in brant use-days (Wilson and Atkinson 1995); however, the study is not as germane to the Project as other studies, such as those mentioned below, as the study area occurred in oyster ground culture as opposed to off-bottom longline culture.

abundant source of eelgrass, except in rare circumstances where heavy rains and tide conditions can constrain foraging efforts.

Surveys conducted in Humboldt Bay each February between 1976 and 2000 found a mean number of 5,049 brant in South Bay and 1,322 brant in North Bay. Otherwise stated, approximately 80 percent of the birds were observed in South Bay during that period (Moore et al. 2004). Based on comparisons with historical data (1931-1941), the relative proportions of brant using South Bay and North Bay have been similarly distributed (Moore et al. 2004). However, the most recent 2015 winter/spring annual surveys conducted by the Humboldt Bay National Wildlife Refuge detected a recent shift in brant population from South Bay to North Bay, estimating a total of 192,400 bird days for North Bay and 147,930 bird days for South Bay (Refuge, unpublished data). For example, an April survey estimated 3,650 birds occupying North Bay and 2,860 birds in South Bay.

To better inform the impact assessment process, H. T. Harvey & Associates conducted surveys for black brant in North Bay in April 2015, representing the approximate period of peak abundance for the species during the 2015 spring migration period (H. T. Harvey & Associates 2015). Surveys were conducted throughout the entire North Bay area (as weather allowed) during high and low tides to record the abundance of brant using North Bay (Figure 1). Surveys were also conducted in North Bay to document the number of brant occurring within Coast's existing aquaculture beds and areas that are proposed for aquaculture expansion. It was not feasible to survey within all existing aquaculture beds or proposed expansion areas; only sites within the "study area" as depicted in Figure 1 were surveyed. While the survey included both cultch-on-longline and basket-on-longline sites, the majority of the existing aquaculture beds surveyed consisted of cultch-on-longline. Time-lapse camera monitoring was conducted to augment survey efforts with behavioral observations in aquaculture structure. The information provided below regarding time-lapse recordings was collected from locations depicted in Figure 1.

The mean count during low tide in North Bay was 4,164 birds (range 3,120—5,559) and the mean count during high tide was 3,170 birds (range 2,234—4,340). The observed differences in low and high tide counts reflect observations that brant would congregate in areas away from inundated mudflats during high tides, concentrating in areas including Eureka Slough, areas south of Samoa Bridge (i.e., along Indian Island), or on the lee side of marsh habitats. This occurred presumably because foraging opportunities were more limited during high tides in North Bay when eelgrass was inundated and brant were likely avoiding the windy conditions in the open bay that were more prevalent during afternoon spring high tide surveys.

The results of the 2015 North Bay brant surveys indicate that tide height influences brant use of aquaculture plots and undeveloped expansion areas. During high tides, brant were observed in similar densities in expansion plots (mean density=1.0 birds/acre) and existing plots (mean density=1.3 birds/acre). However, during low tides, black brant were consistently observed in higher densities in undeveloped expansion plots (mean density=2.6 birds/acre) compared to existing aquaculture plots (mean density=0.1 birds/acre). Supplemental time-lapse recordings taken during the April survey period provide further anecdotal evidence that brant forage and traverse both existing and proposed aquaculture sites when water is sufficiently high to swim, but do not

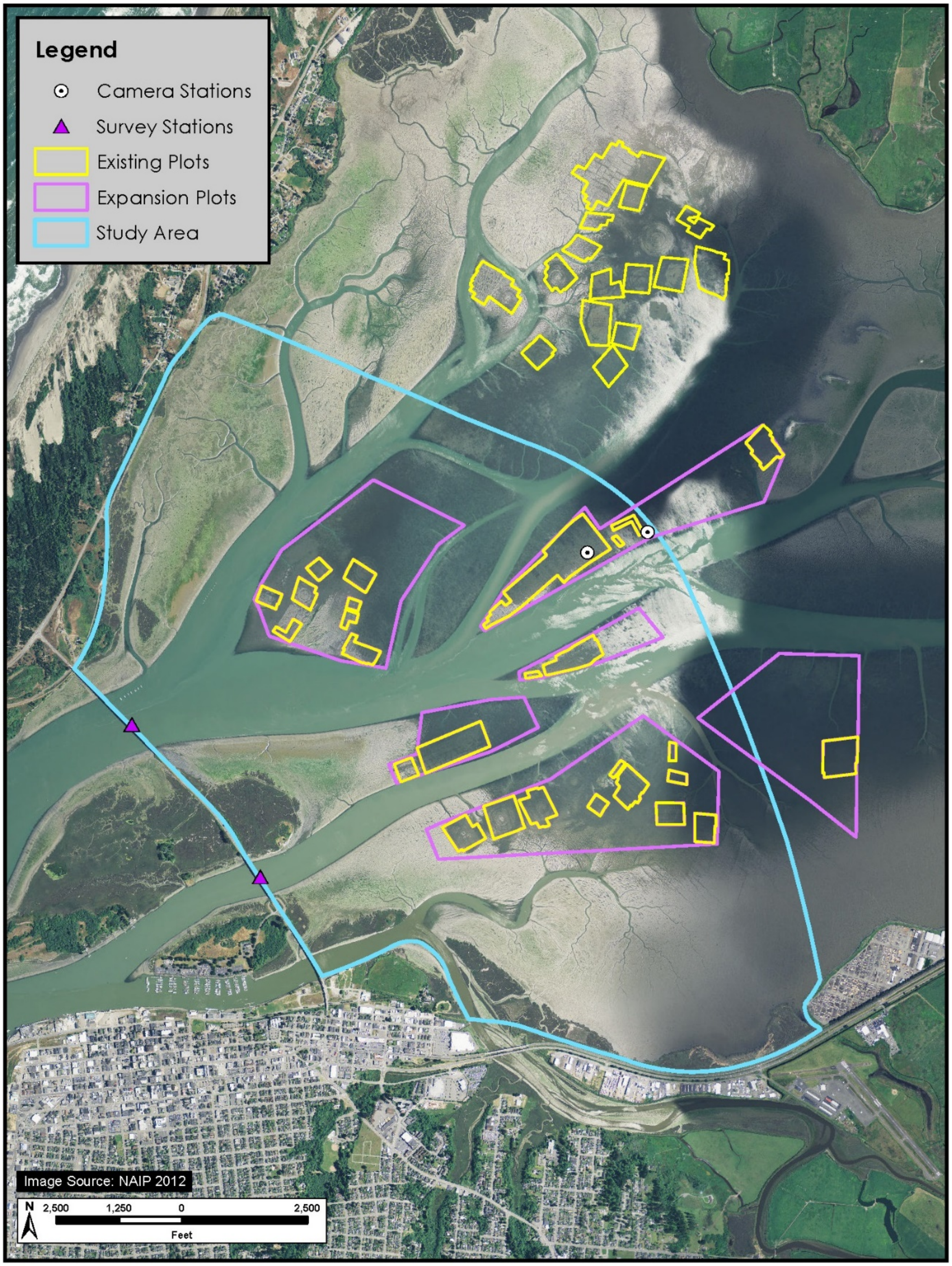

Figure 1. Map of North Bay Depicting Black Brant Survey Areas[2]

[2] Portions of the expansion footprint have been altered since the brant surveys were conducted (HTH 2015); however the majority of the altered expansion footprint occurs outside the study area for the surveys.

occur in sites with longlines at lower tides when the infrastructure is exposed, impeding their swimming ability, even in wider rows within longlines (i.e., 10-foot "boat rows"). The time-lapse video also indicated that brant did not avoid the edges of the existing aquaculture sites at any tidal level. Collectively, this evidence suggests that brant utilize their preferred method of foraging in shallow water when tide height provides sufficient access to rooted eelgrass. The presence of structure apparently precludes them from foraging in this manner when the structure impedes their ability to easily swim through aquaculture sites. Although brant are occasionally observed walking across dry beds and foraging at very low tides, they apparently employ that behavior infrequently, likely due to higher energetic costs associated with foraging in that manner. It should be noted that during these surveys and other observations, eelgrass did not appear to be a limiting resource for brant in North Bay; eelgrass appeared to be abundant bay-wide and brant did not appear to be restricted in their ability to forage.

The effects of brant avoidance of aquaculture structures and the Project's impact on brant food sources were further evaluated using a modeling approach based on a concept developed by Stillman et al. (2015). Stillman et al. (2015) developed a modeling approach to analyze the effects of reduction in eelgrass biomass and disturbance on brant in Humboldt Bay. The model estimates the amount of biomass loss and disturbance caused by the Project and its potential to increase stopover duration, reduce daily mass gain, and reduce emigration from Humboldt Bay. An increase in stopover duration could reduce reproduction success; thus this more conservative metric is used as a threshold of significance under CEQA for impacts associated with loss of foraging resources and human disturbance discussed below.

2.2.2 Impacts to Brant Foraging Resources

2.2.2.1 Summary of an Existing Model

Stillman et al. (2015) present an individual-based model that predicts changes in daily mass gain, stopover duration, and survival of black brant in Humboldt Bay in response to sea level rise, changes in eelgrass abundance, and increases in anthropogenic disturbance (e.g., boat traffic). The model takes advantage of the best available data on eelgrass density, distribution, and biomass in Humboldt Bay based on surveys conducted in December and January 2001/02 and 2002/03 as part of a California Sea Grant study (as described in Stillman et al. 2015). Population parameters of black brant, including population abundance, energetics, and thresholds for behavioral shifts, are derived from Humboldt Bay-specific data whenever possible (e.g., population abundance, arrival date of first brant, and maximum feeding depth), and from data that most closely approximates the Humboldt Bay population otherwise (e.g., brant mass on arrival, brant target mass on departure, and energy expenditure while foraging or resting). The model follows a population of brant over a 183-day spring season in which brant arrive, forage and move throughout the Bay to optimize individual mass gain, and emigrate once a target mass threshold of 1,580 grams is reached. Model predictions were within 35% of observed values in Humboldt Bay for 11 properties of the modeled brant population; however, model predictions were sensitive to 10% changes in some model parameters, notably eelgrass energy content and metabolizability.

The model predicts that the total biomass of eelgrass in Humboldt Bay could support up to five times the number of brant than have been observed to use the Bay in recent years; however, the authors are careful to point out that this result is somewhat misleading because brant are limited in their ability to fully capitalize on the resource. Eelgrass is only available during a limited window of tidal height, which imposes a temporal limitation on the amount of total eelgrass that is available for foraging. When this temporal limitation is accounted for, the model predicts that as little as a 10% decrease in eelgrass biomass or increase in human disturbance could result in a significant decrease in daily mass gain, which in turn results in a significant increase in stopover duration (i.e., delayed migration toward the breeding grounds). A decrease in the number of birds emigrating from Humboldt Bay was not predicted until eelgrass biomass was reduced or human disturbance was increased by at least 30%.

Delayed migration can result in reduced fitness for black brant and may delay egg laying and hatching at the breeding grounds in some years. Earlier hatch dates for black brant have been associated with greater growth potential relative to other goslings in the same cohort (Sedinger and Flint 1991), and first year survival of goslings increases with size at the end of the first summer (Sedinger and Chelgren 2007). Growth in the first year has also been positively associated with lifetime growth potential (Sedinger and Flint 1991), and in general, larger birds have a higher likelihood of survivorship and reproductive success. If the Stillman et al. (2015) model's assumed body mass threshold for emigration is incorrect, and geese instead leave the bay at a lower mass, migration delay may be less or none. This was not evaluated explicitly in the model, but the reduction in mass accumulation rates in response to reduced eelgrass, as predicted by the model, implies that geese would be leaving at a smaller size. This is expected to affect reproductive success. If the assumed body mass threshold is correct or underestimated, then migration may be delayed, and gosling growth potential would be negatively affected, to the degree it could result in a significant impact to brant.

While the Stillman et al. (2015) model is based on the best available data, it should be noted that the model approach uses a conservative estimate of the total eelgrass biomass available in Humboldt Bay. Eelgrass biomass at the beginning of the model simulation is calculated only for the three youngest shoots of the turion occurring within "dense eelgrass beds" (based on NOAA Coastal Services mapping 2009), and thus does not include biomass for older shoots or eelgrass occurring throughout the Bay in "patchy" eelgrass patches (defined as >10% to <85% cover). Brant preferentially feed on the three youngest shoots because they are the most energetically dense (Moore 2002), and tend to choose areas of higher biomass and nutritional quality (Moore and Black 2006b); however, they also forage in areas of lower biomass and nutritional quality due to tide-height restrictions to high-quality foraging areas (Moore and Black 2006b) and brant consume some (although a smaller proportion) of the older leaves (Moore 2002). Underestimating total biomass in this way, and calculating the amount of floating eelgrass as a percentage of the total biomass, underestimates the available floating eelgrass biomass as well. Although feeding on older eelgrass shoots and in patchy eelgrass beds would provide fewer calories per energy expended compared to feeding on young shoots in dense beds, there is caloric value associated with the biomass that is not accounted for in the model.

It should also be noted that model predictions are based on model simulations in which many parameters are held constant. If model parameters are close to the true values for Humboldt Bay eelgrass and brant populations, predictions should be accurate, but ignoring uncertainty in model parameters makes the standard deviations of those predictions smaller than they should be (i.e., overestimating precision). However, given the size of the projected effect and conservative assumptions discussed above, this issue is not expected to affect the conclusions of the analysis.

2.2.2.2 Project Specific Modeling

To assess whether the project could reduce eelgrass biomass availability to the extent that stopover duration for brant would be significantly increased, the biomass of eelgrass within the project footprint was estimated using the same modeling approach as used in Stillman et al. (2015). Eelgrass biometric parameters consisting of above ground biomass and average shoot length, derived from Sea Grant December/January biometric data collected in 2001/2002 and 2002/2003 (S. Schlosser, unpublished data as cited in Stillman et al. 2015), were modeled as a function of depth relative to mean lower low water (MLLW) (as described in Stillman et al. 2015). To model total winter eelgrass biomass associated with continuous eelgrass habitat in Humboldt Bay, biometric model parameters were incorporated with eelgrass depth range data (0.3 to -1.3 m MLLW in North Bay and 0.4 to -2.1 m MLLW in South Bay; Shaughnessy et al. 2012) in conjunction with the Humboldt Bay DEM (Gilkerson 2008) using ArcGIS 10.1 (ESRI, Redlands, CA). Model grids were developed at 25 m^2 spatial resolution for both North and South Bays and attributed with cell center coordinates (WGS84 UTM zone 10 North in meters), eelgrass biomass (grams dry weight per square meter), eelgrass shoot length (meters), and cell depth (meters relative to MLLW). Model grids were then incorporated with tidal inundation data to project the proportion of that biomass that would potentially be available to foraging brant. Shapefiles depicting existing aquaculture and proposed aquaculture expansion areas within modeled continuous eelgrass habitat were then used to assess total eelgrass biomass that may be affected by the Project, as well as the proportion of that habitat that could be rendered unavailable to foraging brant due to their propensity to avoid oyster longlines during periods of low tide exposure. This portion of the modeling process differed from that presented in Stillman et al. (2015) in that the existing aquaculture was not excluded (either partially or wholly) from brant availability in their model. Thus, the resulting biomass estimates presented below likely reflect a more conservative estimate of eelgrass that is available to brant. However, this change in the modeling approach precludes direct comparisons to the results of the Stillman model.

Map algebra expressions were generated from functions described in Stillman et al. (2015) (Table 1) to relate eelgrass above-ground biomass (grams dry mass m^{-2}) and shoot length (m) to a depth relative to MLLW. This was done within the depth range capable of supporting continuous eelgrass habitat in North and South Bays using the Humboldt Bay DEM. Taking into consideration the spatial resolution of the DEM (25 m^2 grid cells), depth-specific biomass and shoot length projections were generated at 25 m^2 resolution for all areas deemed capable of supporting continuous eelgrass habitat in North and South Bays. To determine the proportion of rooted eelgrass habitat potentially available to foraging brant, winter tidal water level observations[3] and day length predictions (civil twilight)[4] were incorporated with depth-specific eelgrass biomass and shoot length projections in conjunction with the maximum depth brant reach below the water surface (0.4 m; Clausen 2000). All modeled continuous eelgrass habitat determined to be within the reaching depth of foraging brant at the lowest tidal height during winter daylight hours was considered to be available to brant. In doing so, we eliminate all eelgrass (in all areas, Bay-wide) that occurs below a depth that brant would never be able to access during winter daylight hours. It should be noted that because eelgrass biomass and associated shoot lengths were modeled from the late winter/early spring when they are at a minimum, the biomass estimates are conservative (because they likely increase throughout the season of brant occurrence in the Bay).

Table 1. Expressions Describing Eelgrass Biomass and Shoot Length as a Function of Depth for Arcata Bay and South Bay (Stillman et al. 2015)

Basin	Biomass Function	Shoot Length Function
North Bay	$y = -33.83x^2 - 21.28x + 31.30$	$y = -0.423x + 0.590$
South Bay	$y = -31.13x^2 - 41.92x + 47.61$	$y = -0.095x + 0.349$

To estimate potential impacts to eelgrass biomass and the proportion of that biomass that is potentially available to brant considering existing and proposed oyster longline aquaculture operations, the following metrics were incorporated into the analysis. First, information describing reduction in eelgrass density associated with long-line oyster aquaculture, in particular a 4.8% reduction in eelgrass density due to shading associated with longlines, was used as a surrogate for biomass and applied to all areas associated with both existing aquaculture operations and proposed aquaculture expansion areas.[5] It should be noted that an estimate of reduced density to infer reduced biomass without additional information may result in an underestimate of biomass reduction because density is a function of surface area, whereas biomass is a function of volume.

To estimate the proportion of eelgrass biomass that would be rendered unavailable to brant as a result of longline infrastructure, behavioral observations from survey efforts and time-lapse videos of brant utilizing existing lease sites were also used to determine the relative water elevation at which brant became excluded from the areas. For Coast's existing operations, brant were observed to depart when longlines became exposed at the water surface, based on the time-lapse video. For project expansion areas, longlines are proposed to be established at a height of 1' (0.3 m) for cultch-on-longlines and 40" (1.02 m) for basket-on-longlines. This depth of exclusion was then incorporated with depth-specific shoot length estimates to determine the proportion of the eelgrass canopy remaining above the longlines, and therefore available to brant. Eelgrass biomass, which was assumed to be evenly distributed vertically from the substrate surface to the tip of the longest leaf, was then multiplied by the proportion of the canopy remaining above the height of the longlines to estimate the

[3] Information derived from: http://tidesandcurrents.noaa.gov/inventory.html?id=9418767.
[4] Information derived from: see http://aa.usno.navy.mil/data/docs/RS_OneYear.php.
[5] Based on further analysis after the model was run, the projected loss in eelgrass density was revised to project a 5.0% reduction in density. See Section 6.5, Biological Resources. This small increase in the projected eelgrass density reduction did not impact the overall estimates or conclusions of this analysis.

reduction in rooted eelgrass biomass potentially available to foraging brant across both existing and proposed aquaculture lease areas. Because survey results indicate brant do not avoid the edges of existing aquaculture sites, no additional buffer areas of exclusion (i.e., around the project footprint) were included in this analysis.

The eelgrass modeling results indicate that eelgrass biomass was more evenly distributed throughout Humboldt Bay in 2001/2002 and 2002/2003 than has been previously estimated; the model estimated approximately 51.5% of the eelgrass biomass occurred in South Bay and 48.5% occurred in North Bay. While eelgrass biomass per unit area is significantly greater in South Bay than North Bay, eelgrass shoot lengths are significantly longer on average in North Bay than South Bay, resulting in greater vertical distribution in North Bay. Taking into account the differences in the upper limits of continuous eelgrass distribution (0.3 vs. 0.4 m MLLW) and shoot lengths between the two basins, the greater vertical distribution of eelgrass biomass in North Bay likely provides a longer window for foraging on rooted eelgrass during low tides as eelgrass becomes accessible earlier during the falling tide and remains available longer during the rising tide.

Without accounting for the effects of aquaculture on eelgrass availability to brant, eelgrass biomass within the project expansion area was estimated to be approximately 9% of the total biomass in Humboldt Bay (or 18% of the eelgrass biomass in North Bay), and biomass in Coast's existing aquaculture areas was estimated to be approximately 3% of the total Bay-wide biomass. Thus biomass within both existing and proposed areas was estimated to be approximately 12% of the total biomass in Humboldt Bay. The Bay-wide eelgrass biomass reduction (i.e., the impact to brant foraging) as a result of Project activities was estimated to be approximately 3%. This relies on the following assumptions: 1) aquaculture reduces overall eelgrass biomass by 4.8% within the Project footprint; 2) brant will forage on shoots taller than the longlines and other structures (when tide height allows); and 3) there is no buffer around project footprints (i.e., where brant are excluded).

A direct comparison to the results of the Stillman et al. (2015) model is not possible because they did not account for biomass reduction or temporal loss of availability associated with brant avoidance of exposed longline infrastructure within existing aquaculture areas, whereas this analysis includes these effects at Coast's existing and proposed aquaculture sites. However, we do not expect the differences between biomass estimates used in Stillman et al. (2015) and those presented here to be substantially different other than the reduction in biomass associated with existing aquaculture areas.

The 3% estimated loss of functionally available eelgrass is considered to be less than significant under CEQA. A Bay-wide reduction of this magnitude is unlikely to result in additional energetic constraints such that daily mass gain is reduced or stopover duration is increased according to the Stillman et al. (2015) model, provided that aquaculture height is maintained at elevations at or below those evaluated. Because higher elevation aquaculture infrastructure than evaluated would result in a further reduction in foraging opportunity for brant, the Project incorporates mitigation measure BIO-3, requiring Coast to maintain a maximum longline height of 1-ft above the surface or lower for cultch-on-longline and 40-inches above the surface or lower for basket-on-longline culture.

2.2.3 Impacts Associated with Human Disturbance

Disturbance near brant foraging, gritting, or roosting habitat, including loud noise or the presence and movement of people, may alter brant behavior. Such disturbance could result in temporary or permanent habitat loss attributable to avoidance of areas that have suitable habitat but intolerable levels of disturbance, a reduction in foraging efficiency if high-quality foraging areas are affected, and increased movement (e.g., flight response) or altered activity patterns. Reduced foraging time and increased flight time can deplete energy reserves of brant (Ward et al. 1994), thus reducing the potential for brant to migrate and breed. Disturbance that interrupts other behaviors such as resting or gritting can result in similar energetic constraints. The behavior budget (i.e., percent of daylight observations) for brant was estimated by Schmidt (1999) as follows: 45% locomotion, 36% foraging, 11% preening, 5% resting, and <2% alert, and <2% flying. Forging typically occurred during low tides when eelgrass was available whereas resting and loafing (swimming) occurred more during high tides (Schmidt 1999).

Henry (1980) found that areas subject to human disturbance in Humboldt Bay were used at lower densities by brant than other areas. In addition to hunting activities (which are now only allowed in the fall), clamming on mudflats and aircraft resulted in the highest levels of disturbance. Schmidt (1999) estimated that brant experienced some type of disturbance during 3.3% of the daylight hours (or 119 seconds per hour of daylight) they were observed (Schmidt 1999). When brant were disturbed, a flight response was recorded approximately 56% of the time. The majority of brant disturbances in Humboldt Bay resulted from small boats (those under 23 feet; 27%), the presence of people (22%), and large boats (those over 23 feet; 21%); natural disturbances (caused mainly by birds) resulted in disturbance approximately 10% of the time. It is unknown if conditions related to human disturbance have changed significantly since the Schmidt (1999) study was conducted, but it is unlikely that a substantial increase in boating or other disturbances has increased since then. Because the tidal cycle constrains their ability to obtain eelgrass (Moore and Black 2006), brant have limited ability to compensate for foraging time lost to disturbance. Schmidt (1999) noted that larger, slower moving vessels were less likely to elicit a response from brant, compared to smaller and faster moving vessels. The author also noted that brant were observed in the mornings near the "main channels" feeding on adjacent eelgrass beds but after the first boast passed, brant often would not return to those areas until late evening, suggesting foraging areas near channels may be used less frequently due to the frequency of boat use.

The modelling approach presented in Stillman et al. (2015) was also used to assess the sensitivity of brant to disturbance in Humboldt Bay and offers a framework for assessing the project's impact on brant. The amount of time that brant were disturbed was varied within the model by increments of 10% to reflect a range of conditions that brant may experience. Results suggest that disturbance levels exceeding 30% (i.e., a loss in 30% of foraging time) reduce the number of brant emigrating from Humboldt Bay (Stillman et al. 2015), although reductions in mass gain and increases in stopover duration were apparent at a 10% level of disturbance (as interpreted from Figure 7 in Stillman et al. 2015).

To accommodate the additional expansion area, the Project will result in additional boat trips and the presence of personnel in North Bay. At most, two additional boats and an additional 18 boat trips will be needed throughout the Bay on a weekly basis, with individual trip length remaining at 4 hours for scows and skiffs and at 4 to 6 hours for harvesters (see Table 4.4 in Project Description). The additional boat trips will result in an increase in approximately 74 boat hours per week. While some boats will carry up to two additional crew members, crew numbers on other boats will remain the same. Further, while the additional boat trips will service additional areas of Coast's proposed farm, it will not increase the frequency of disturbances on any particular plot or area. As with existing culture areas, oysters will be harvested and planted every 1.5 to 3 years, depending on culture method, conditions, species of oyster and other factors. Between harvests, culturists visit cultch-on-longline plots (proposed on 522 acres) approximately once a month to perform maintenance. Visits to basket-on-longline plots (proposed on 96 acres) are more frequent, with some work performed on different areas of each plot on an almost daily basis (the whole plot is not visited daily). Rack-and-bag culture, which represents a maximum of 4 acres of the expansion area, requires the most frequent maintenance, with crews working throughout the bed on an almost daily basis (see Tables 4.2 and 4.3 in Project Description).

Although aquaculture expansion will result in an increase in human disturbance in North Bay, the increase is not expected to be significant beyond existing conditions. It is unlikely that the increased disturbance levels attributable to the project will result in the total disturbance time of brant within the bay to be greater than 10%, considering that under pre-project conditions, disturbance levels for all human activities bay-wide have been estimated at 3.3%. The increase in disturbance associated with boat traffic will most likely affect brant foraging along channel edges (nearest boat traffic) as well as within eelgrass beds when culturists visit aquaculture sites. However, culturists will frequently be present in aquaculture sites during low tide, when culturists can walk on exposed beds but when brant are unable to forage due to low water levels and the presence of longlines and other structure (as discussed above). As such, brant are less likely to be disturbed during many of those activities, as they are unlikely to occur in those areas during the lowest tide cycles. In some cases, birds may habituate to human disturbance, but it is possible that increased disturbance, coupled with a loss of foraging opportunity at lower tides (due to the presence of aquaculture structure), may result in some areas being unused by brant. Nonetheless, although there will be additional energetic costs to brant associated with increased human disturbance because of the increased activity, this increase is not expected to approach CEQA significance thresholds and the impacts are considered less than significant.

2.2.4 Impacts Associated with Loss of Grit Sites

Migrating brant feed almost exclusively on eelgrass and thus their ability to forage is restricted by the tidal cycle, but gritting sites are also very important areas that brant need to access to acquire sandy grit (Lee et al. 2004, Moore and Black 2006, Bjerre 2007, Spragens et al. 2013). Gizzard grit is ingested by brant as an aid to mechanically breakdown eelgrass and provides an important source of calcium (Lee et al. 2004, Bjerre 2007). Brant tend to visit grit sites when they become available during retreating tides; grit sites occur relatively high in the intertidal zone and thus are available earlier than eelgrass beds (Lee et al. 2004, Moore and Black 2006). Brant then move from grit sites to eelgrass beds when tidal elevations are low enough for brant to access them (Moore and Black 2006). Although grit sites appear to be abundant in Humboldt Bay, brant have been observed preferentially selecting particular grit sites that provide supplemental calcium and include larger than average particle sizes (Lee et al. 2004, Bjerre 2007). In some cases, brant have been observed staging over the best gritting sites awaiting tides to recede, and brant continue to use gritting sites even when eelgrass (which occurs at lower elevations) was available for foraging (Bjerre 2007). Based on available literature, the primary grit sites in Humboldt Bay occur along the northern portion South Spit of South Bay (Lee et al. 2004, Bjerre 2007). The South Spit is a large sandbar between the South Bay and Pacific Ocean where higher-elevation sandy substrate is available to brant on receding tides before eelgrass at lower elevations is available for foraging.

Approximately 6 gritting locations have been documented in South Bay (Figure 2) (Lee et al. 2004, Spragens et al. 2013). Because most of the literature regarding brant use of Humboldt Bay focuses on South Bay, there is little information about important grit sites in North Bay. However, there is indication that brant use multiple areas for gritting in North Bay. Two areas in particular have been noted as potentially important gritting sites: Sand Island and the northern shore of Indian Island, east of the Samoa Bridge (Figure 2) (Spragens pers. comm. 2015). Sand Island is located approximately 300 ft northeast of the northernmost portion of the project footprint, and the northern portion of Indian Island occurs at least 2,000 ft south/southeast of the project footprint. Other potential gritting sites include the shores of Woodley Island and the intertidal area of Jacoby Creek (Gabriel pers. comm. 2015), also outside the project footprint.

Although specific gritting sites within the project footprint have not been identified, it is feasible that there are some potential grit sites in the project area and that brant may be precluded from using those sites after the installation of aquaculture infrastructure. The loss of gritting sites may result in brant using other sites, possibly resulting in higher energetic costs associated with additional movements to access other areas. However, the majority of the intertidal footprint of the project occurs in lower intertidal areas (that are occupied by eelgrass) and are unlikely to contain suitable grit. Grit sites tend to be in higher, sandy areas that are exposed early on outgoing tides before lower-elevation eelgrass beds are exposed enough for foraging (Lee et al. 2004). Thus any available grit within the Project footprint would be unavailable to brant except at very low tides and thus they are likely less important than other gritting sites that are higher in elevation, such as Sand Island. Also based on sediments mapping (mapping available through http://humboldtbay.org/data-downloads), most of the project substrate is associated with finer particles than used for grit. Because brant tend to use gritting sites on receding tides, it is unlikely that brant will be constrained in their movements to access them. Rather, their ability to forage is more likely to be restricted by the project through placement of aquaculture infrastructure in eelgrass (see *Impacts to Foraging Resources*). Because the project is not expected to impact any known gritting sites of importance to brant, and because the Project expansion will occur at lower tidal elevations than are associated with known important gritting sites for brant in Humboldt Bay, the impact is considered less than significant under CEQA.

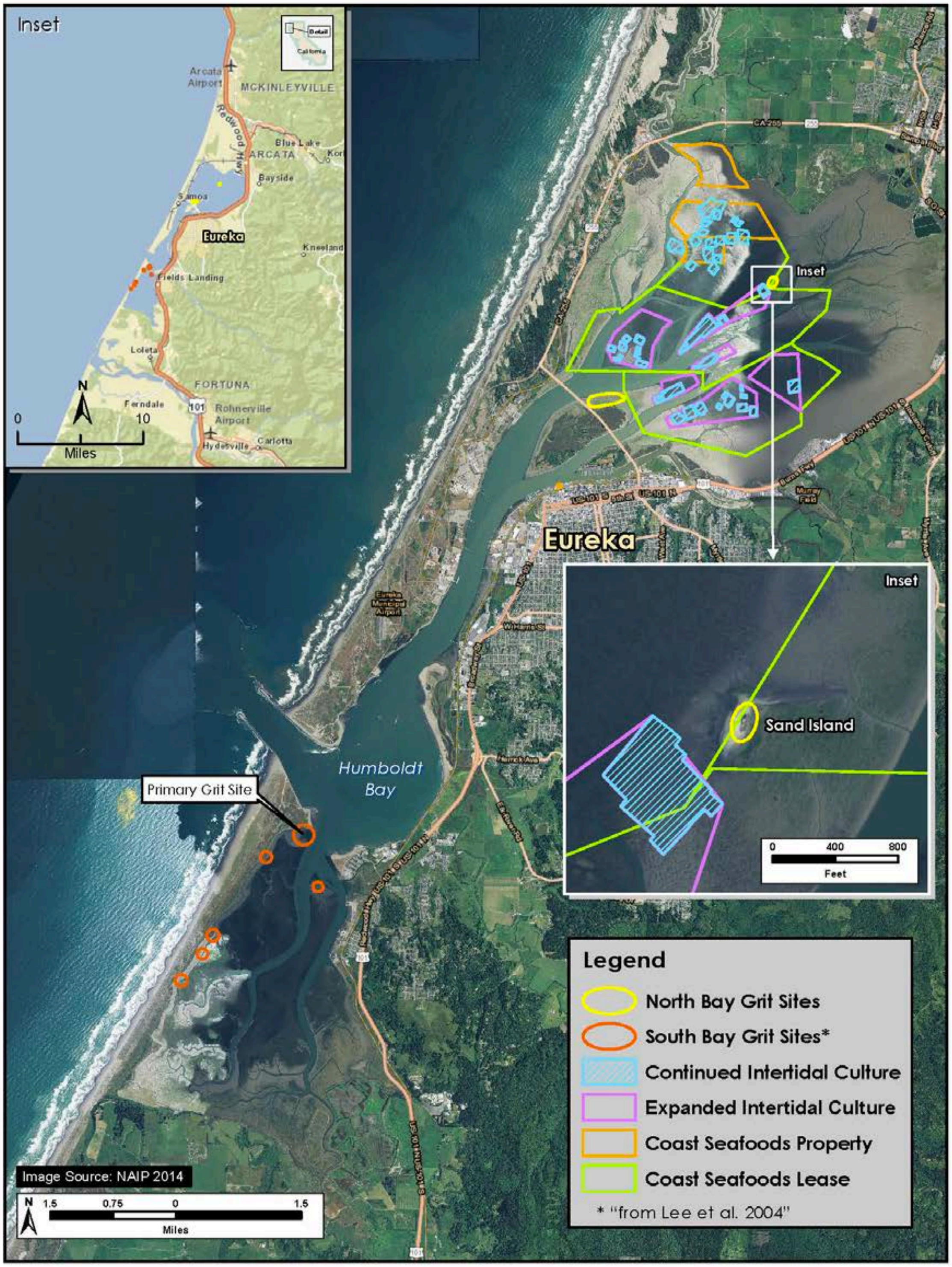

Figure 2. Map of Humboldt Bay Depicting Potential Black Brant Grit Sites in South Bay and North Bay

2.2.5 Alternative 1: 10-Foot Spacing Alternative

As discussed in detail under the Preferred Alternative, the Project could impact black brant by reducing foraging opportunities through the placement of aquaculture structure in eelgrass. The placement of aquaculture structure has the potential to shade eelgrass, thus reducing the amount of biomass under the culture that is available to brant. The Alternative 1 scenario includes the use of 10-foot longline spacing, which would reduce the shading effects attributed to the tighter longline spacing under the Preferred Alternative scenario. Although this would result in a lower level of eelgrass biomass reduction, the larger project footprint (955 acres) would result in a reduction in foraging opportunity. This is because the presence of structure apparently precludes brant from foraging when structure impedes their ability to easily swim through aquaculture sites. Therefore, Alternative 1 would result in a higher degree of functional eelgrass loss to brant, as they will have a reduced foraging window in the larger expansion areas compared to the Preferred Alternative. Although 10-foot row spacing may allow brant to forage more easily through the wider gaps, compared to the narrower spacing in the Preferred Alternative, there is no evidence that brant will use the wider rows in low tide (thus they are presumed not to). Although there will be an additional reduction in foraging opportunity under Alternative 1, with the implementation of the mitigation measures to maintain maximum longline height, overall bay-wide eelgrass biomass will, however, not be reduced (either by shading or through exclusion) to levels that would restrict the ability for brant to acquire mass during migration, emigrate, and successfully breed.

In addition to restricting their foraging ability, the expanded footprint in Alternative 1 would result in higher levels of human disturbance to brant. With a larger footprint, equipment and personnel will traverse a larger extent of North Bay, resulting in increased levels of human disturbance in areas where no culture is proposed under the Preferred Alternative. Additional boat trips will need to occur to plant, maintain, and harvest the larger intertidal aquaculture footprint, resulting in 33 additional boat trips/week (as compared to existing conditions), totaling 134 additional hours/week of boat travel (compared to 74 additional hours in the Preferred Alternative). The additional boat traffic would be primarily located in larger channels, which would increase the likelihood that brant avoid foraging areas along channels. However, the increase in boat traffic is not likely to result in a significant increase in disturbance as compared to existing conditions, and would likely be under the thresholds of significance identified in the Stillman et al. (2015) model. Therefore, this impact under Alternative 1 is considered less than significant.

2.2.6 Alternative 2: Reduced Footprint

Potential impacts to black brant under the Alternative 2 scenario are similar to those described above under the Preferred Alternative and Alternative 1, except the potential impacts would be lower in magnitude. Alternative 2 includes a smaller expansion footprint and a lower number of boat trips per week (17 additional trips/week as compared to existing conditions) and fewer boating hours (68 additional hours/week) than the Preferred Alternative or Alternative 1. Under the Alternative 2 scenario, black brant are expected to experience a reduction in foraging habitat and an increase in human disturbance compared to existing conditions. However, as with the Preferred Alternative, potential impacts are considered less than significant under CEQA in the reduced footprint scenario.

2.2.7 Alternative 3: Existing Footprint Alternative

Alternative 3 represents no change in Coast's aquaculture operations compared to existing conditions. As such, no additional impacts to black brant foraging habitat or additional levels of human disturbance associated with movement of equipment or personnel will occur. Under Alternative 3, black brant currently using culture sites are expected to be habituated to current levels of human disturbance. Therefore, under Alternative 3, impacts to black brant are considered less than significant under CEQA.

2.2.8 Alternative 4: No-Project Alternative

Under Alternative 4, Coast will cease its operations and remove all infrastructure associated with its existing Harbor District permit. Although decommissioning activities may result in impacts to eelgrass from increased presence of personnel (i.e., during equipment removal), any habitat impacts would be temporary and eelgrass would be expected to regenerate in disturbed areas. The decommissioning of existing operations would also result in increases in localized human disturbance during infrastructure removal, and thus brant may experience a higher degree of localized (but temporary) disturbance under Alternative 4. However, the increase in activity would be of short duration and in most cases would not exceed the current levels of human disturbance (i.e., associated with planting and harvest). Thus the effects to black brant under Alternative 4 are considered less than significant under CEQA.

2.3 Impacts to Roosting Birds

Bird species such as double-crested cormorants (*Phalacrocorax auritus*), California brown pelicans, Caspian terns (*Hydroprogne caspia*), Forster's terns (*Sterna forsteri*), elegant terns (*Thalasseus elegans*), and gulls (*Larus* spp.) can be found roosting on structures within Humboldt Bay. Abundance of some species within the bay varies seasonally: Forster's terns are most abundant in winter and spring, elegant terns occur in fall, and pelicans peak in late summer/fall. While double-crested cormorants and gulls are generally abundant year-round, they show a significant increase in species diversity and numerical abundance in winter (eBird 2015). These birds may roost on rafts or other structures associated with aquaculture, and pelicans have been reported roosting on Sand Island located in close proximity to existing shellfish culture areas, as well as on oyster racks in North Bay (Jaques et al. 2008).

Noise and boat traffic has the potential to disturb roosting birds and cause them to flush from the area. As further described in Section 6.12, Noise in the Project's DEIR, the Project has the potential to result in small increases in noise associated with harvest activities and increased boat traffic. The frequency and degree of this disturbance will vary by culture activity. Intertidal oyster culture areas will experience a higher degree of culture-associated disturbance during the planting and harvesting cycle, which occurs only every 1.5-3 years. Between harvests, bed maintenance is minimal, occurring only once per month for cultch-on-longline (up to 522 acres of the expansion area). Basket-on-longline plots (up to 96 acres of the expansion area) receive more frequent visits with crews working through some parts of most beds on an almost daily basis. Visits to rack-and-bag sites will be most frequent, occurring on an almost daily basis (see Tables 4.2 & 4.3 in Project Description). As described above, the Project would require a maximum of 18 additional boat trips/week. The noise generated during boat trips and maintenance activities will be similar to what occurs from other existing uses on the bay including recreational users (e.g., hunters, fishermen, and paddle and motor boaters) and commercial users (e.g., shippers and commercial fishermen), and represents a moderate increase in boat activity over existing conditions. Activity at the FLUPSY is more frequent, with daily crew visits by boat to maintain the seed; however, activity on the existing FLUPSY is not expected to increase as a result of placing additional bins.

Further, the increase in activity to maintain and operate Coast's intertidal beds will generally not be located near roosting sites. As shown in Figures 4.4 and 4.5 in the Project Description in the DEIR, Coast's intertidal sites are located in different parts of North Bay than their subtidal raft locations; generally most culture activity will take place at a distance that would not disturb birds roosting on Coast's existing rafts or other structures where birds roost. Although culturists will traverse the main channels via boat to access intertidal sites, birds are unlikely to flush from roosts when boats move through the channels, as any roosting birds would be acclimated to regular occurrences of boats passing by. Culture activity would also take place at a significant distance from nearshore or onshore roosting activities, at a distance where noise or human presence associated with the Project would not likely disrupt roosting birds. As noted in the Project's DEIR, noise generated by Project operations is generally within existing ambient background noise conditions, although passing skiffs and longline harvesters may result in short and localized noise increases above ambient conditions, particularly at roosting sites that are located in areas of North Bay significantly removed from roads, bridges, or the shoreline.

While Coast's increased activity on the bay will be limited, some birds may react to disturbance caused by culture activities by flushing to nearby sites and possibly returning after the activity is complete, whereas others may flush at greater distances and abandon the immediate area if they are more wary of humans or noise. These disturbances have energetic costs associated with flight while birds search for alternative roost sites. However, it is expected that roosting birds in the bay are generally habituated to human disturbance, given that birds often roost on sites that are near human activity (e.g., docks, piers, etc.). It is also expected that individuals that are not habituated to regular human disturbance will roost in more remote areas of the bay. Because roosting birds are regularly observed on subtidal aquaculture gear, it is likely that those individuals have habituated to disturbance and are not significantly disturbed by aquaculture activities. Roost sites in the bay, which include docks, posts, and other structures, are not a limited resource, as there are numerous unoccupied roost sites in the bay year-round. As described above, the increase in boat traffic and worker activity (relative to existing conditions) would be minimal and infrequent. Therefore, the effects of human disturbance on roosting birds is considered less than significant under CEQA.

2.3.1 Alternative 1: 10-Foot Spacing

Potential impacts to roosting birds under Alternative 1 are similar to those described above under the Preferred Alternative scenario. Under Alternative 1, there is more potential for disturbance to roosting birds because there would be a larger culture footprint. With a larger footprint, equipment and personnel will traverse a larger extent of North Bay, resulting in increased levels of human disturbance in areas where no culture is proposed under the Preferred Alternative. In addition, as described above, to the increased spatial extent of human disturbance, additional boat trips will need to occur to plant, maintain, and harvest the larger intertidal aquaculture footprint. Although the larger footprint and increased boat traffic could result in more frequent human disturbance to roosting birds, it is expected that roosting birds, particularly those using artificial structures, are generally habituated to human disturbance. Individuals that are not habituated to regular human disturbance will likely roost in more remote areas of the bay. Also, roost sites in the bay would not a limited resource under Alternative 1 or any of the project scenarios. Therefore, the effect of human disturbance on roosting birds under Alternative 1 is considered less than significant under CEQA.

2.3.2 Alternative 2: Reduced Footprint Alternative

Potential impacts to roosting birds under Alternative 2 are similar to those described above under the Preferred Alternative scenario and Alternative 1 except there is a lower potential for impacts to roosting birds. Alternative 2 includes a smaller expansion footprint and a lower number of boat trips per week than the Preferred Alternative. As discussed above, human disturbance (associated with movement of equipment and personnel) can disturb and flush birds, resulting in increased energetic costs. Because roost sites are not limited in the bay and most birds roosting are generally habituated to human disturbance, the effect of human disturbance on roosting birds under Alternative 2 is considered less than significant under CEQA.

2.3.3 Alternative 3: Existing Footprint Alternative

Alternative 3 represents no change in Coast's aquaculture operations compared to existing conditions. As such, no additional boat trips will occur and the level of human disturbance to roosting birds will remain the same as current conditions. Under this scenario, birds in the project area are expected to be habituated to current levels of human disturbance and impacts to roosting birds under Alternative 3 are considered less than significant under CEQA.

2.3.4 Alternative 4: No-Project Alternative

Under the Alternative 4 scenario, Coast will cease its operations and remove all infrastructure. The decommissioning of existing operations would likely result in temporary increases in localized human disturbance associated with infrastructure removal. However, the increase in activity would be of short duration and in most cases would not exceed the current levels of human disturbance (i.e., associated with planting and harvest). Thus the effects of human disturbance on roosting birds under Alternative 4 are considered less than significant under CEQA.

2.4 Impacts to Nesting Birds

As described above, culture areas will be visited for planting, harvest, inspection, and maintenance activities. One of the existing shellfish culture areas (cultch-on-longline) is located approximately 320 feet from the southwestern edge of Sand Island, which supports a nesting colony of Caspian terns and double-crested cormorants. The proposed expansion area will not occur closer to Sand Island than existing operations. In 2001-03, 809 double-crested cormorant nests (representing 13% of the statewide total and the largest colony in northern California), and 262 individual Caspian terns, were counted on Sand Island (Capitolo et al. 2004). In 2008, only 103 cormorant nests were counted (Caspian terns were not counted), reflecting a reduction in nests from previous counts; it is possible some birds may have moved to Teal Island in the South Bay where their numbers increased (365 nests in 2003 to 485 nests in 2008) (Adkins and Roby 2010). In 2014, more than 400 cormorant nests were counted and over 300 Caspian tern nests were estimated on Sand Island; the colony was also active in 2015, although numbers are not yet available (P. Capitolo, University of California Santa Cruz, unpublished data). The colony is presumed to be still active.

Human disturbance associated with Project operations in the vicinity of Sand Island has the potential to flush nesting Caspian terns and double-crested cormorants. Such disturbances could result in the loss of eggs and/or chicks, and even cause permanent nest or colony abandonment (Ellison and Cleary 1977, Shuford and Craig 2002). However, to avoid impacts to nesting birds on Sand Island, the Harbor District imposed a condition as part of Coast's existing permit to locate its shellfish beds at least 100 meters from the MHHW line of Sand Island. This condition would be continued and applied to the current Project as well (Mitigation Measure BIO-2). Areas proposed for expanded intertidal culture would not be located any closer to Sand Island than existing culture areas and the frequency of boat trips to the area is not expected to increase. Impacts to nesting Caspian terns and double-crested cormorants on Sand Island as a result of shellfish culture operations are therefore considered less than significant under CEQA.

2.4.1 Alternative 1: 10-Foot Spacing

As described above, Caspian terns and double-crested cormorants nest on Sand Island in North Bay. Similar to the Preferred Alternative, Alternative 1 would not include new culture areas closer to Sand Island than existing operations., Further, Mitigation Measure BIO-2 requires that aquaculture activities and equipment will remain at least 100 meters away from the MHHW line of Sand Island; therefore impacts to nesting birds on Sand Island are considered less than significant under CEQA under Alternative 1.

2.4.2 Alternative 2: Reduced Footprint

Because Alternative 2 would not include new culture areas closer to Sand Island, the potential impacts to nesting Caspian terns and double-crested cormorants nesting on Sand Island under Alternative 2 are the same as those described for the Preferred Alternative and Alternative 1. In all scenarios Mitigation Measure BIO-2 requires that aquaculture activities and equipment will remain at least 100 meters away from the MHHW line of Sand Island. With implementation of this mitigation measure, impacts to nesting birds on Sand Island are considered less than significant under CEQA under Alternative 2.

2.4.3 Alternative 3: Existing Footprint Alternative

Alternative 3 represents no change in Coast's aquaculture operations compared to existing conditions. As such, no additional boat trips will occur and the potential for impacts to nesting birds will remain the same as current conditions. Nonetheless, Coast would be required to implement Mitigation Measure BIO-2, which requires that aquaculture activities and equipment remain at least 100 meters away from the MHHW line of Sand Island.

With implementation of this measure, impacts to nesting birds on Sand Island are considered less than significant under CEQA under Alternative 3.

2.4.4 Alternative 4: No-Project Alternative

Under the Alternative 4 scenario, Coast will cease its operations and remove all infrastructure. The decommissioning of existing operations would likely result in temporary increases in human disturbance associated with infrastructure removal in areas of current aquaculture operations. Nevertheless, impacts to nesting birds on Sand Island are considered less than significant under CEQA under Alternative 4.

2.5 Impacts to Birds from Artificial Lighting

Artificial lighting has been attributed to adverse effects on terrestrial, aquatic, and marine birds, fish, and mammals (Rich and Longcore 2006). Potential effects on marine and migratory birds include attraction to lights, disorientation, and injury or death due to collision with structures (Rich and Longcore 2006). When birds fly into lighted areas at night, they may become disorientated and circle artificial lights (Herbert 1970). Floodlights are known to attract and kill migratory birds, particularly on cloudy or misty nights during fall and spring (Rich and Longcore 2006). However, no additional permanent lighting will be installed as a result of the Project. Additional lighting will be limited to lighting that will be infrequently used by culturists and by workboats accessing shellfish culture areas at night. For this reason, this potential impact is considered less than significant under CEQA.

2.5.1 Alternative 1: 10-Foot Spacing

Artificial lighting has the potential to adversely affect migratory birds and other wildlife. As described above for the Preferred Alternative, no additional permanent lighting will be installed as a result of the Project and any additional lighting will be limited to culturists infrequently using personal lighting and workboats as they access shellfish culture at night. Alternative 1 will result in a larger footprint (955 acres) and the occasional use of lighting will occur over a larger spatial extent of North Bay than under the Preferred Alternative. However, because the use of lighting will occur infrequently for night work and no permanent lighting will be installed, the potential impact is considered less than significant under CEQA.

2.5.2 Alternative 2: Reduced Footprint

Under Alternative 2, there will be a smaller expansion area footprint (300 acres), as well as fewer boat trips and boating hours in North Bay compared to Alternative 1 or the Preferred Alternative. As with other alternatives, any additional lighting will be limited to lighting that is infrequently used by culturists on workboats accessing culture areas at night. This potential impact is considered less than significant under CEQA.

2.5.3 Alternative 3: Existing Footprint Alternative

Alternative 3 represents no change in Coast's aquaculture operations and no additional lighting will occur beyond current conditions. The only lighting will be associated with the infrequent lighting used by culturists when they access culture areas from workboats at night. As discussed above under the Preferred Alternative, the potential impact associated with lighting is considered less than significant under CEQA.

2.5.4 Alternative 4: No-Project Alternative

Under Alternative 4, Coast will cease its operations and remove all infrastructure. In this scenario, no additional lighting is expected to occur compared to existing conditions, as nighttime access to culture areas will no longer be needed. It is possible some nighttime lighting will be used during decommissioning, but any such lighting will be temporary and localized, and most decommissioning work would likely occur during the day. This potential impact is considered less than significant under CEQA.

2.6 Impacts to American Wigeon and Other Waterfowl

Humboldt Bay is the main waterbird migration stopover and wintering area between San Francisco Bay and the mouth of the Columbia River in Oregon. Common waterfowl species in Humboldt Bay during winter include dabbling ducks: American wigeon (*Anas americana*), green-winged teal (*A. crecca*), northern pintail (*A. acuta*), and mallard (*A. platyrhynchos*); diving ducks: greater and lesser scaup (*Aythya marila* and *A. affinis*), bufflehead (*Bucephala albeola*), and surf scoter (*Melanitta perspicillata*); and other waterbirds such as the American coot (*Fulica americana*) (Denson and Bentley 1962, Nelson 1989). Wigeon are one of the first species to arrive in fall, and by far the most abundant waterfowl species in North Bay, followed by pintail and diving ducks (Denson and Bentley 1962, Nelson 1989). Diving ducks generally occur in the deeper channel areas of Humboldt Bay (Nelson 1989), although some diving species, such as scaup, are known to feed on eelgrass (Nienhuis and Groenendijk 1986, Austin et al. 1998, Savard et al. 1998, Kessel et al. 2002) and thus may forage in shallower areas of the bay where shellfish culture sites are located. Surf scoters could also occur at the shellfish culture sites, because they are strongly attracted to and feed on biofouling mussels that accumulate on the shellfish aquaculture structures (Kirk et al. 2007, Žydelis et al. 2008).

Based on winter surveys conducted in 1987-88, waterfowl numbers were higher in the South Bay than North Bay (approximately 8,400 versus 8,000 birds), although American wigeon were more abundant in North Bay than in South Bay (approximately 3,900 versus 2,900 birds) (Nelson 1989). Statewide breeding duck population estimates declined by 30%, from 448,750 ± 69,360 (mean ± SE) in 2014 to 315,450 ± 42,000 birds in 2015, attributed to decreased habitat availability as a result of drought conditions in the California Central Valley (Skalos and Weaver 2015). Current statewide estimates for breeding waterfowl are as follows: American wigeon – 1,893; green-winged teal – 2,143; northern pintail – 772; mallard – 173,865; lesser scaup – 1,295; bufflehead – 2,166 (Skalos and Weaver 2015). In addition to waterfowl, American coots numbered 470,654 in the same study.

American wigeon is the waterfowl species (other than black brant, see *Impacts to Black Brant* below) most likely to be affected by shellfish culture, based on their habitat use, food preferences, and relative abundance in winter in North Bay. Wigeon utilize a variety of habitat types in and around the bay, occurring in permanent freshwater ponds in fall, shifting to tidal habitats in mid-winter, then moving to flooded pastures in spring, presumably to maximize foraging performance (Brendan 2015). When in tidal habitats of the bay, they are often found in the vicinity of the large eelgrass beds (Denson and Bentley 1962), where they are known to feed on both emergent and free-floating eelgrass (invasive *Zostera japonica* and endemic *Z. marina*), and generally occur in low densities (maximum of 1.4 birds/acre from winter 2014 surveys) (Brendan 2015). Other dabbling ducks that occur in the bay, including pintails, mallard, scaup, and teal, are also known to feed on eelgrass, although it makes up a smaller proportion of their diets than it does for wigeon (Nienhuis and Groenendijk 1986, Baldwin and Lovvorn 1994). Feeding on emergent eelgrass generally occurs during low tides when the birds have direct access to eelgrass beds (Baldwin and Lovvorn 1994, Brendan 2015).

Potential impacts to waterfowl as a result of the Project, including human disturbance and loss of foraging habitat, are described below.

2.6.1 Impacts from Human Disturbance

As described in *Impacts to Roosting Birds*, leased areas will be visited with varied frequency for routine maintenance and inspection and, in intertidal culture areas, every 1.5-3 years for harvest and planting. Related to these activities, noise will be generated from small boats, movement and maintenance of equipment, generators and mechanical harvesters, and communication among aquaculture workers. The frequency of boat trips to each shellfish bed will not increase with the expanded intertidal culture; however, additional boats, crew and boat trips will likely be necessary to maintain and operate the expanded culture area (see Tables 4.2 & 4.3 in Project Description). Boat traffic and the presence of personnel associated with visits to shellfish culture sites could disturb waterfowl and cause birds to flush from foraging areas and reduce temporal and/or spatial access to food.

As described above in *Impacts to Brant*, a recently-developed model used to assess the sensitivity of black brant to disturbance in Humboldt Bay predicted a reduction in the potential for brant emigration at disturbance levels of greater than 30% (i.e., a loss in 30% of foraging time), and a reduction in mass gain and increase in stopover time was predicted at a 10% level of disturbance (as interpreted from Figure 7 in Stillman et al. 2015). Although energetic requirements and ability to gain mass are likely different for other waterfowl, including wigeon, that have different (and more varied) diets, the Stillman et al. (2015) energetics model represents a valid framework for assessing effects of disturbance.[6] The Stillman model provides that brant are likely to experience energetic constraints when disturbance levels exceed 10%. Using the same threshold of significance for species like wigeon is appropriate given that wigeon are likely to experience similar energetic constraints at those disturbance levels, although the threshold is likely conservative for two reasons: first wigeon have a more varied diet and second wigeon body mass is approximately half that of brant (DeVault et al. 2003) and thus their basil metabolic rates and energetic costs associated with flight are lower.

[6] It is unlikely that brant and wigeon will compete for available eelgrass resources, given that brant typically arrive in Humboldt Bay in late winter and spring, and wigeon consume eelgrass in tidal habitats primarily in mid-winter.

Although aquaculture expansion will result in some increase in human disturbance, given the limited increase in boat trips and activity as compared to existing conditions, the project is not anticipated to result in a greater than 10% increase in disturbance time above existing conditions (see *Impacts to Brant* above for further interpretation of the Stillman et al. [2015] model). As explained above, there will be a maximum of 18 additional boat trips per week throughout North Bay (totaling an additional 74 hours per week), however the number of hours each boat is active in the bay will remain the same. Waterfowl in the bay are already somewhat habituated to the current level of human disturbance from boat traffic and other activities. For example, the highest densities of American wigeon in Humboldt Bay (relative to other known habitat types around the bay) coincide with winter waterfowl hunting that also occurs on the bay, suggesting their winter habitat use of the bay is not particularly influenced by disturbance (Brendan 2015). Therefore, any additional energetic costs to waterfowl associated with increased human disturbance generated by the Project are considered less than significant.

2.6.2 Impacts to Waterfowl Foraging

The project could reduce the amount of available eelgrass foraging habitat for waterfowl by precluding them from entering all or portions of shellfish culture sites. The project includes 492 acres of shellfish cultivation in dense (≥85% cover) eelgrass and 108 acres in patchy eelgrass (>10% to <85% cover) (see Table 6.5.5, DEIR). There is evidence that waterfowl avoid moving amongst shellfish culture structures during low tides, which coincide with the period when eelgrass beds are most available for foraging. In an Irish estuary, wigeon fed on green algae attached to oyster culture structures, which indicates a willingness to enter and utilize the structures, but only when the tide was high enough to allow them to swim amongst the structures (Higerloh et al. 2001). This behavior was also observed by black brant in North Bay (H. T. Harvey & Associates 2015) and wigeon likely exhibit a similar behavior (i.e., swimming through and foraging on rooted or floating eelgrass in aquaculture areas when water levels are sufficiently high). Thus, wigeon are not likely to be constrained from foraging in shellfish beds except when tide levels are too low to allow access to shellfish beds by water.

Wigeon occur in much lower numbers and forage in lower densities then brant, indicating that there are unlikely to be food shortages associated with eelgrass depletion when they utilize that resource. In addition, unlike brant (see *Impacts to Brant* above) wigeon and other waterfowl are much more plastic in their ability to forage on a wide variety of vegetation, and they forage on intertidal areas for a much shorter duration of their annual cycle (i.e., in mid-winter). There is no indication that other foraging resources are limited for waterfowl in the Humboldt Bay region and thus there are alternative foraging opportunities. A reduction in eelgrass foraging potential during low tides is not expected to restrict foraging to the extent that waterfowl ability to emigrate and breed is impacted. Therefore, the potential loss of waterfowl foraging habitat as a result of temporal or spatial exclusion at shellfish culture structures is considered less than significant.

2.6.3 Alternative 1: 10-Foot Spacing

As discussed above for the Preferred Alternative, the Project could impact waterfowl species by reducing available foraging habitat through habitat modification or by precluding them from foraging in previously accessible areas. Among the waterfowl that occur in Humboldt Bay, American wigeon is the species (other than black brant) most likely to be affected by shellfish culture. Wigeon forage on eelgrass in Humboldt Bay during mid-winter. Aquaculture structure has the potential to shade eelgrass, thus reducing the amount of biomass under the culture that is available to wigeon and other species. The use of 10-foot longline spacing in Alternative 1 would reduce the shading effects attributed to the tighter longline spacing under the Preferred Alternative scenario. Although this would result in a lower level of eelgrass biomass reduction, the larger project footprint (955 acres) would result in an overall reduction in foraging opportunity relative to the Preferred Alternative. This is because the presence of structure likely precludes wigeon from foraging when structure impedes their ability to easily swim through aquaculture sites (similar to effects described for brant). Although, Alternative 1 would result in less eelgrass available to wigeon, the reduction in temporal availability of eelgrass is unlikely to result in food shortages for wigeon or other waterfowl. Wigeon occur in relatively low numbers (compared to brant), forage on a wide variety of vegetation, and forage in intertidal areas for a short duration of their annual cycle (i.e., in mid-winter), and thus a reduction in the temporal loss of eelgrass foraging opportunity is unlikely to constrain their ability to emigrate and breed.

In addition to restricting their foraging ability, the expanded footprint in Alternative 1 would result in higher levels of human disturbance to wigeon or other waterfowl. With a larger footprint, equipment and personnel will traverse a larger extent of North Bay, resulting in increased levels of human disturbance in areas where no culture is proposed under the Preferred Alternative. As described above additional boat trips will be needed to plant, maintain, and harvest the larger intertidal aquaculture footprint. The additional boat traffic would primarily be focused along the larger channels. However, waterfowl using the bay are accustomed to existing levels of disturbance (particularly in channels) and although some individuals may not use areas of high boat traffic, additional energetic costs to wigeon or waterfowl associated with increased human disturbance is not likely to constrain individuals' ability to emigrate and breed successfully. Although Alternative 1 will result in reduced foraging opportunities and higher levels of disturbance, the effects on waterfowl are less than significant under CEQA.

2.6.4 Alternative 2: Reduced Footprint

Potential impacts to waterfowl under the Alternative 2 scenario are similar to those described above under the Preferred Alternative and Alternative 1 except the potential impacts would be lower in magnitude. Alternative 2 includes a smaller expansion footprint and a lower number of boat trips per week. Under the Alternative 2 scenario, waterfowl are expected to experience a loss of foraging habitat and an increase in human disturbance compared to existing conditions. However, as with the Preferred Alternative, potential impacts are considered less than significant under CEQA in the reduced footprint scenario.

2.6.5 Alternative 3: Existing Footprint Alternative

Alternative 3 represents no change in Coast's aquaculture operations compared to existing conditions. As such, no additional impacts to waterfowl foraging habitat or additional levels of human disturbance associated with movement of equipment or personnel will occur. Under Alternative 3, waterfowl currently using culture sites are expected to be habituated to current levels of human disturbance. Under Alternative 3, impacts to waterfowl are considered less than significant under CEQA.

2.6.6 Alternative 4: No-Project Alternative

Under Alternative 4, Coast will cease its operations and remove all infrastructure from the North Bay. Although decommissioning activities may result in impacts to eelgrass from increased presence of personnel (i.e., during equipment removal), any habitat impacts would be temporary and eelgrass would regenerate in disturbed areas. The decommissioning of existing operations would also result in increases in localized human disturbance during infrastructure removal, and thus wigeon and other waterfowl may experience a higher degree of localized (but temporary) habitat loss under Alternative 4. However, the increase in activity would be of short duration and in most cases would not exceed the current levels of human disturbance (i.e., associated with planting and harvest). Thus the effects to waterfowl under Alternative 4 are considered less than significant under CEQA.

2.7 Impacts to Migratory Shorebirds

Humboldt Bay has been designated as a Site of International Importance in the Western Hemisphere Shorebird Reserve Network because it is considered an important estuary for migrating and wintering shorebirds in the Pacific flyway. Numerous species, sometimes numbering in the thousands, use Humboldt Bay during migration. As many as 32 shorebird species and over 80,000 individuals have been recorded during a spring migration (as observed during surveys conducted in April 1991); however, shorebird counts conducted during the 1990's reflect a decline relative to historic estimates (Colwell 1994). Various non-breeding shorebird species use intertidal mudflat areas of Humboldt Bay for foraging, although specific habitat use may be differential based on species morphology, as well as habitat conditions such as water depth (related to tidal cycles) and substrate type.

Shorebirds are very flexible in their diets and consume prey opportunistically, with considerable dietary overlap among species and foraging guilds (Skagen and Oman 1996). They often take prey in accordance with availability, concentrating where prey is most dense (Goss-Custard 1970, 1977, 1979), therefore observed distribution of foraging shorebirds likely reflects an abundance of available prey in those locations. Shorebirds typically concentrate at the edge of a receding tideline, where worms, crustaceans, and bivalves occur close to the surface and are available for consumption. Thus, hydrologic regimes and ecosystem processes that maintain abundant invertebrate populations are more important than the presence of specific invertebrate taxa for shorebirds. Near the waterline, shorebird microhabitat use usually depends on each species' leg length, as well as the size and shape of their bills. For example, short-billed semipalmated plovers (*Charadrius semipalmatus*) and black-bellied plovers (*Pluvialis squatarola*) often feed on recently exposed mud, using visual foraging methods. Small sandpipers, such as western sandpiper (*Calidris mauri*) and least sandpipers (*Calidris minutilla*), forage on recently uncovered mud and shallow water. Mid-sized birds such as dunlin (*Calidris alpina*), long-billed dowitchers (*Limnodromus scolopaceus*), and short-billed dowitchers (*Limnodromus griseus*) can forage in slightly deeper water (by probing with their bills), and larger shorebirds such as willets (*Tringa semipalmatus*), long-billed curlews (*Numenius americanus*), and marbled godwits (*Limosa fedoa*) are able to probe in deeper water (although these species will forge in exposed areas as well). In addition to bill shape and leg length, sediment type can dictate where shorebird species forage and sediment particle size influences shorebird distribution in Humboldt Bay. For instance, sanderlings (*Calidris alba*) tend to select areas with coarser sediments and American avocets (*Recurvirostra americana*) tend to occur in areas with finer sediments (Danufsky and Colwell 2003).

In addition to intertidal habitats, shorebirds in Humboldt Bay also exploit non-tidal habitats, particularly agricultural fields when intertidal mudflats are inundated (Colwell and Dodd 1997, Long and Ralph 2001). Shorebird use of pastures is correlated with (and dependent on) rainfall, as shorebirds likely exploit increased prey availability when pastures are wet, or possibly their use of pastures is related to a decrease in prey availability on mudflats during rainfall (Colwell and Dodd 1997). Shorebird use of non-tidal habitats has been observed in other estuaries, including in San Francisco Bay where shorebirds regularly use salt ponds, salt pans, marsh ponds, and other habitats (H. T. Harvey & Associates 2005).

2.7.1 Shorebird Foraging in the Project Area

While some shorebirds may be attracted to intertidal aquaculture areas due to an increase in foraging resources (Caldow et al. 2007, Forrest et al. 2009) or favorable changes in substrate heterogeneity (Trianni 1996, Quintino et al. 2012)[7], much of the Project is at suboptimal tidal depths for shorebird foraging. The vast majority of the Project is proposed to occur in low-elevation areas that are frequently inundated such that they are unavailable for foraging shorebirds during a large proportion of the tidal cycle, relative to the higher, unvegetated mudflats. In particular, shorebirds are unlikely to forage in the 492 acres of the Project proposed in dense eelgrass beds; those areas experience frequent inundation and are of lower value to shorebirds compared to unvegetated mudflats, where shorebirds typically forage. Some areas, such as those classified as “patchy eelgrass” (108 acres) may support shorebird foraging to some extent, as they include some unvegetated mudflats that shorebirds may forage in, but, in general, the elevation of the proposed Project footprint is low in the tidal frame.

2.7.2 Impacts to Shorebird Foraging

The placement of additional shellfish culture in intertidal areas has the potential to impact shorebirds by reducing the amount of available foraging habitat through habitat modification or by precluding shorebirds from foraging in previously accessible areas. Due to variation in foraging technique, sensitivity to structures in intertidal habitats, and social structure (i.e., flocking vs. territorial behavior), some shorebird species may be differentially affected by the project. The relative importance of Humboldt Bay for migration or for extended non-breeding periods (i.e., wintering) differs between shorebird species due to variation in migration strategies. For instance, small sandpipers (*Calidris* spp.) arrive in Humboldt Bay in large flocks and can be observed numbering in the thousands (Colwell 1994), although their residency time in the estuary is short. A study on radio-marked western sandpipers found that the mean length of stay in Humboldt Bay was 3.3 days (Warnock and Bishop 1998), indicating this species uses multiple short flights and stopovers during migration. In contrast, long-billed curlews spend long “wintering” periods (i.e., June through March) in Humboldt Bay and establish non-breeding low-tide territories and use agricultural fields, particularly during winter rain periods (Colwell and

[7] The Project’s potential impacts on the benthic environment are discussed in Section 6.5.X of the Project’s DEIR.

Dodd 1997, Colwell and Mathis 2001). Territorial birds that reside in the bay longer, like long-billed curlews, are more likely to be adversely affected by the project than birds with little fidelity to specific foraging sites.

The most relevant study in assessing whether shorebirds forage in aquaculture longline plots was conducted by Connolly and Colwell (2005) in North Bay. The study compared low-tide shorebird use of aquaculture plots (cultch-on-longline) to adjacent intertidal flats without the presence of aquaculture (as control sites). Connolly and Colwell's (2005) results indicate greater bird 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.[8] Where differences occurred, five species (willet, whimbrel [*Numenius phaeopu*s], dowitchers, small sandpipers, and black turnstone [*Arenaria melanocephala*]) were more abundant on longline plots than control plots during the study (Connolly and Colwell 2005). The authors suggest that increased abundance of these shorebirds on longline plots may be related to an increase in foraging opportunity or an increase of prey density or diversity. One species (black-bellied plover) was more abundant only on control plots. The authors suggest that greater use of control plots by black-bellied plovers may be a result of greater abundance of their principle prey items occurring on control plots, or factors related to reduced foraging efficiency related to their visual foraging methods. Although little is known about invertebrate prey in Humboldt Bay, prey may be less available to black-bellied plovers under long-lines because there is a higher concentration of shorebirds that are attracted to food resources under the lines (compared to non-aquaculture sites), or prey may be less detectable due to visual obstructions in long-line plots.

While a 1996 study by Kelly et al. conducted in Tomales Bay provided evidence of avoidance of aquaculture activities by some species of shorebirds, the study has limited applicability to the Project.[9] The oyster culture methods studied by Kelly et al. (1996) included bottom culture in mesh bags as well as bag culture elevated on racks—longline aquaculture was not studied. The Kelly et al. (1996) results are thus not as directly applicable to the Project as the Connolly and Colwell (2005) study of off-bottom longline aquaculture in North Bay. Moreover, the National Research Council (NRC) reviewed the Kelly et al. (1996) study in relation to oyster culture in Drakes Estero (NRC 2009), California and found it supported the conclusion that shorebirds would be minimally impacted by continuation of on-bottom culture methods in the Estero.

> The presence and activity of mariculture workers on plots did not affect the distribution of shorebirds analyzed for many species and no movements in or out of culture plots were associated with culturist activity. … Consequently, only the obligate probers are likely to be negatively affected by mariculutre

[8] Note that the Connolly and Colwell (2005) results may be less applicable to long-billed curlews, as many individuals of this species will occupy non-breeding territories in Humboldt Bay (Colwell and Mathis 2001) and the study plots were established irrespective of curlew territories (Colwell pers. comm. 2014). Thus, although long-billed curlews may have shown no preference for longline or control plots in the study, use or avoidance of aquaculture areas is difficult to assess because few territories likely overlapped with study plots (Connolly and Colwell 2005).

[9] The 2003 Southern Pacific Shorebird Conservation Plan, published by Point Blue Conservation Science, recommends prohibiting further alteration of tidal flats for oyster culture as a priority conservation action for Humboldt Bay. The Conservation Plan does not differentiate between different oyster culture methods but does cite Kelly et al. (1996) to support its recommendation, based on sedimentation effects associated with bottom-culture.

on intertidal flats in Drakes Estero, while most species remain unaffected and some that forage visually on surface prey may benefit from invertebrates associated with culture bags and epibiotic growth on the bags and oysters.

Results of recent monitoring efforts in North Bay also suggest that shorebirds readily forage under aquaculture longlines. Wildlife-monitoring cameras were deployed in North Bay to observe bird behavior in existing aquaculture plots (as well as in non-developed areas for comparison) in relation to tide height and aquaculture infrastructure (H. T. Harvey & Associates 2015). Cameras were deployed in April 2015 such that time-lapse photography could be recorded for approximately 3 days. One camera was set up to record activity in an area occupied by eelgrass that is proposed for aquaculture expansion. This camera did not capture shorebird activity, because the bed was too low in tidal elevation and water levels were not sufficiently low enough for shorebirds to access the site. In imagery taken by the other camera on a longline plot, shorebirds were observed in large numbers foraging in and adjacent to the aquaculture plots when water levels were low enough for shorebirds to access the site. Although no quantitative assessment of the camera imagery was conducted, shorebird use within and outside of the aquaculture plots (i.e., within view of the camera) appeared to be similar. No behavioral differences in shorebird use within the plot were observed (e.g., shorebirds readily foraged under the lines). Shorebirds were observed first accessing the area when water levels were low enough for shorebirds to stand and forage and they continued to forage until water levels rose to levels that forced them to cease foraging and leave the site. During the recordings, larger marbled godwits would arrive before small species (i.e., small sandpipers [*Calidris spp.*]), as the smaller birds can only access the sites when fully exposed or in very shallow water. Although the camera imagery represents a small sample size, the recordings confirm the previous findings of Connolly and Colwell (2005) and suggest that shorebird foraging occurred irrespective of the presence of longlines. Shorebird presence in or out of aquaculture areas was primarily dependent on water levels and access to food resources in shallow water or exposed mudflat.

Although some species of shorebirds may avoid culture areas and some culture techniques may have a greater exclusive effect, avoidance of aquaculture areas is unlikely to result in adverse effects such as increased competition for food and reduced body condition for most species. Many shorebird species (e.g., western sandpipers) demonstrate plasticity in selecting stopover sites, thus allowing them to opportunistically exploit food resources when available and to avoid predators. This is evidenced by large flocks of small sandpipers that are routinely observed foraging on mudflats throughout Humboldt Bay for brief durations during migration. Because sandpipers demonstrate low site fidelity and rely on a very small proportion of the Bay during migration, the Project (particularly given its generally low elevation) is unlikely to restrict foraging opportunities.

If exclusion from forage sites occurs, it may have a greater impact on larger species such as long-billed curlews: large, territorial birds that rely on intertidal foraging areas for extended periods during the non-breeding season. Curlews maintain wintering foraging territories in North Bay, particularly along channel edges, and it is possible that some curlews may be displaced from newly developed aquaculture areas. Curlews use pastures as alternative habitats during wet periods, and thus some of their energetic needs may be satisfied from foraging in other habitats; however, their territoriality on mudflats during low tides suggest those areas represent important foraging areas for meeting their energetic needs for migration and reproduction. Loss of available habitat could also result in increased competition and reduced foraging efficiency in alternative foraging areas, such as pastures, or altered activity patterns that reduce energy reserves and increase predation risk. Further, if curlews do maintain territories in aquaculture areas, they will be periodically displaced by the presence of humans (see DEIR Table 6.5.6). Larger shorebirds, such as curlews, experience higher energetic costs when forced to fly than smaller species, thus they are likely to be impacted more by human disturbance than smaller species.

The wintering population of curlews in Humboldt Bay has been estimated to be approximately 200-300 individuals (Leeman and Colwell 2005) and the long-billed curlew range-wide population has been estimated to be over 161,000 individuals (Jones et al. 2008). Black-bellied plovers are relatively common in Humboldt Bay: observations (based on high counts conducted November 1998-January 1999) totaled 1,752 birds (Danufsky and Colwell 2003). The population of black-belled plovers (*P. s. squatarola*; those breeding in Alaska) has been estimated 262,733 individuals (considered a conservative estimate) and is considered a stable population, although the Atlantic population (*P. s. cynosurae*), estimated at 100,000 individuals, is thought to be declining (Andres et al. 2012). Both species demonstrate territoriality in wintering habitats that can make them more susceptible to human disturbance and habitat exclusion than non-territorial shorebirds.

Curlews have been observed in intertidal habitats in densities ranging from 0.05 to 0.09 birds per hectare (or 0.02 to 0.04 birds per acre; Mathis et al. 2006). Density was estimated at 0.36 birds per hectare (0.15 birds per acre) in the Elk River estuary, where density of curlews was highest. Within the Project footprint, areas located on the southwest side of Bird Island and south of Sand Island include areas of high density curlew use (>20 birds in an approximately 61 acre-area) along with other areas of lower curlew densities; however, it should be noted that longlines already occur (and occurred during the study period) within those high-density grid-cells mapped by Mathis et al. (as well as other areas with curlew use). While the coexistence of high-density curlew sites and Coast's existing aquaculture gear provides some evidence that curlews may not be adversely affected by the gear and culture activities, the resolution of the Mathis et al. study does not lend itself to any definitive conclusions regarding whether curlews are affected by longline gear. However, it should be noted that Mathis et al. also found that curlews were generally absent from low intertidal habitats in the center of Humboldt Bay that are exposed for shorter intervals than higher elevations, suggesting that curlews are less likely to rely on dense eelgrass beds for foraging. Therefore, curlews may not regularly forage in the majority of the Project area, given that it is mostly characterized by dense eelgrass at low intertidal elevations that is unlikely to be used frequently (if much at all) due to regular tidal inundation and low potential as foraging habitat. While curlews have been identified in a variety of habitats in Humboldt Bay, there is a general preference to forage near the edges of tidal channels. Conservation Measure BIO-10 will further reduce impacts to curlew habitat near tidal channels through requiring that Coast maintain a 10-foot buffer from tidal channels for shellfish plots within the expansion area.

While use of the Project area by curlews may be limited, it is likely that the Project area will overlap with some sites currently used by curlews for foraging. Curlews may be flushed during some activities (particularly planting and harvesting); however direct access to most culture sites will occur infrequently (see Table 6.5.6, DEIR) and boat traffic in subtidal channels results in little disturbance to shorebirds using nearby intertidal areas at low tide. Therefore, impacts to curlews are expected to be less than significant.

Black-bellied plovers are also susceptible to human disturbance. As noted above, black-bellied plovers were found under longlines less than in control sites (i.e., undeveloped plots), the only species documented to demonstrate a potential avoidance of longline sites by Connolly and Colwell (2005). This species also demonstrates territoriality in wintering areas (Danufsky and Colwell 2003) and their distribution in intertidal areas may be spaced to reflect winter territories. However, it should be noted that black-bellied plovers were observed foraging within Coast's existing longline areas during a reconnaissance site visit performed by H. T. Harvey & Associates in April 2015, suggesting there is some acclimation by this species to longlines. Similar to curlews, they are unlikely to use much of the Project area because most of the expansion area occurs in low-elevation dense eelgrass beds that provide limited foraging access for shorebirds during most portions of the tide cycle. Further, they are unlikely to experience substantial human disturbance given the infrequent access to individual beds within the proposed expansion area, and boat traffic in subtidal channels results in little disturbance to shorebirds. Although some territories of curlews and black-bellied plovers may be impacted, the small potential for impact is not expected to result in population-level impacts that are sufficient to meet the CEQA criteria for significance. Further, most species of shorebirds have been shown to readily forage in aquaculture plots and may benefit from resources associated with the culture. Thus the Project is expected to result in less-than-significant impacts to shorebirds under CEQA standards.

2.7.3 Alternative 1: 10-Foot Spacing

As discussed above for the Preferred Alternative, the Project could impact migratory shorebirds by reducing available foraging habitat through habitat modification or by precluding shorebirds from foraging in previously accessible areas. Shorebirds are unlikely to forage regularly in dense eelgrass beds, due to frequent inundation in those low areas (i.e., compared to higher, unvegetated mudflats). Although the majority of the Project footprint includes low-elevation areas, the larger footprint (955 acres) associated with Alternative 1 includes higher intertidal areas that include patchy eelgrass and unvegetated mudflats. As such, the potential to impact shorebirds in Alternative 1 is greater than under the Preferred Alternative due to a higher likelihood that they currently forage in portions of the increased project footprint.

As discussed above, shorebirds have been observed foraging under longlines and there is evidence that shorebirds readily adapt to foraging in off-bottom culture areas. However, some species (i.e., long-billed curlews and black-bellied plovers) could avoid culture sites more than others and there is greater potential for habitat loss under Alternative 1 for those species. Shorebirds are more likely to experience increased exposure to human disturbance under Alternative 1 than the Preferred Alternative. The larger project footprint represents a larger area in which shorebirds can be disturbed when equipment and personnel move through North Bay, resulting in increased levels of human disturbance in areas where no culture is proposed under the Preferred Alternative. In addition to the increased spatial extent of human disturbance, additional boat trips will need to occur to plant, maintain, and harvest the larger intertidal aquaculture footprint, resulting in 90 boat trips/week, totaling 352 hours/week of boat travel (compared to 292 hours in the Preferred Alternative).. Although Alternative 1 has a higher potential to impact shorebirds, particularly associated with higher levels of human disturbance, the impacts are not expected to result in population-level impacts that are sufficient to meet the CEQA criteria for a significance. Thus, the Project is expected to result in less-than-significant impacts to shorebirds under CEQA standards.

2.7.4 Alternative 2: Reduced Footprint

Potential impacts to migratory shorebirds under the Alternative 2 scenario are similar to those described above under the Preferred Alternative and Alternative 1, except there is a lower potential for impacts to occur. Alternative 2 includes a smaller expansion footprint and a lower number of boat trips per week (74 trips/week) and fewer boating hours (286 hours/week) than the Preferred Alternative or Alternative 1. Under Alternative 2, some shorebird species may experience a loss of foraging habitat and there will be an increase in human disturbance compared to existing conditions. However, as with the Preferred Alternative, potential impacts are considered less than significant under CEQA.

2.7.5 Alternative 3: Existing Footprint Alternative

Alternative 3 represents no change in Coast's aquaculture operations compared to existing conditions. As such, no additional impacts to shorebird foraging habitat or additional levels of human disturbance associated with movement of equipment or personnel will occur. Under Alternative 3, shorebirds currently using culture sites are expected to be habituated to current levels of human disturbance and impacts to shorebirds are considered less than significant under CEQA.

2.7.6 Alternative 4: No-Project Alternative

Under Alternative 4, Coast will cease its operations and remove all infrastructure from the North Bay. The decommissioning of existing operations would likely result in temporary increases in localized human disturbance associated with infrastructure removal, and thus shorebirds may experience a higher degree of localized habitat loss under this scenario. However, the increase in activity would be of short duration and in most cases would not exceed the current levels of human disturbance (i.e., associated with planting and harvest). Thus the effects to shorebirds under Alternative 4 are considered less than significant under CEQA.

Section 3.0 Cumulative Impacts

Cumulative impacts assessed under CEQA relate to impacts associated with "reasonably foreseeable" future projects that may incrementally or compound environmental impacts. Other projects occurring within Humboldt Bay have potential to contribute to cumulative impacts on with avian species. The Humboldt Bay Harbor, Recreation and Conservation District (District) has proposed another aquaculture project: the Humboldt Bay Mariculture Pre-Permitting Project. The project would include 3.1 acres of subtidal aquaculture rafts and approximately 266.2 acres of off-bottom intertidal shellfish production. Further, Hog Island Oyster Company (Hog Island) and Taylor Mariculture LLC (Taylor) have obtained regulatory approvals to add 21 culture rafts in subtidal areas (15 FLUPSY rafts and 6 nursery rafts), and Humboldt Bay Oyster Company, North Bay Shellfish, and Aqua Rodeo Farm farm a total of approximately 15 acres of intertidal shellfish culture, none of which is located in dense eelgrass.

3.1 Cumulative Impacts to Black Brant

The Project's potential impacts on black brant associated with reduction in foraging opportunity, increased human disturbance, and loss of grit sites is assessed in detail in Section 2.2. The District's mariculture project also has the potential to result in similar impacts to black brant and thus there is potential for cumulative impacts associated with the District Project and the Project. The Taylor and Hog Island projects may increase the level of human disturbance in the Bay but are not expected to contribute to brant impacts associated with the reduction in foraging opportunities or grit sites.

The intertidal portion of the Project will occur primarily within areas of dense eelgrass (492 acres) with much smaller proportions of the Project footprint occurring in patchy eelgrass and other habitats. As discussed more fully above, the Bay-wide eelgrass biomass reduction (i.e., the impact to brant foraging) as a result of the Project was estimated to be approximately 3%. This functional loss of eelgrass to brant is not expected to result in significant energetic constraints to brant. The intertidal portion of the District Project will almost completely avoid dense eelgrass beds, with most of the footprint of that project occurring in patchy eelgrass (approximately 56%) and a very small proportion (approximately 2.7%, or 7.3 acres) occurring in dense eelgrass. As noted above, only dense eelgrass beds were used to estimate Bay-wide eelgrass biomass (and thus the estimate is conservative). As such, the patchy eelgrass beds in the District's aquaculture footprint are not considered in the biomass estimates even though a portion of the eelgrass will be available for foraging. While the temporal loss of dense eelgrass beds within the District's aquaculture footprint could result in additional loss of foraging totaling a fraction of a percent of the Bay-wide eelgrass availability, the reduction is not expected to result in delayed emigration or other energetic effects. Moreover, the District has proposed a buffer around eelgrass plants within its lease areas, such that a reduction in eelgrass availability is unlikely to occur as a result of the District Project. The Taylor and Hog Island projects are sited in deeper subtidal areas outside of brant foraging areas. The cumulative effects associated with a reduction in foraging opportunity for brant are thus considered less than significant.

Impacts on black brant associated with human disturbance as a result in increased boat traffic and human presence was also assessed in Section 2.2 above. As assessed using the Stillman et al. (2015) framework, the Project is not expected to result in disturbances approaching thresholds likely to energetically constrain brant (i.e., 10% level of disturbance time). Because the District Project will primarily avoid eelgrass, there is less potential for brant to be disturbed by culturists working on District sites in the (higher-elevation) intertidal areas. However, all four proposed projects will result in an increase in boat traffic in the main channels of Humboldt Bay that could result in cumulative effects on brant. The District's project includes approximately 266 acres of intertidal culture and 3.1 acres of subtidal aquaculture rafts. It is likely that the same culture methods used in either the Project or the District Project will require a similar number and frequency of site visits for operation, maintenance, planting, and harvesting, although the District Project allows culturalists flexibility in determining what culture method to pursue, making accurate predictions of boat traffic difficult. Although unknown in number, it is also likely that the 21 subtidal rafts that have been authorized in the Taylor and Hog Island projects will require some increase in boat traffic in the main channels.

Although it is not possible to quantify an interaction between repeated boat disturbance and reduction in foraging ability (i.e., at lower tides), conservatively it can be assumed that brant may abandon foraging areas along main boating channels and other areas of repeated disturbance. This is most likely to occur along the largest channels, particularly the main channel north of Indian Island. The northern shore of Indian Island (east of the Samoa Bridge) has been identified as a potential gritting site. Although the Project will avoid this area, the District Project includes a site that occurs in that vicinity (Intertidal 3), thus some gritting areas may be exposed to disturbance as well. As a result, brant may shift some of their distribution within North Bay to avoid repeated disturbance and some portion of individuals may respond by shifting to South Bay, where the majority of the brant distribution formerly occurred.

The ability for brant and other waterbirds to acclimate to some level of disturbance should not be discounted. Currently, brant (as noted above in Section 2.2) are distributed roughly equally between the two basins (and eelgrass biomass is also similar in the two basins) despite the current level of aquaculture occurring in North Bay. This suggests that brant have adjusted their behavior (i.e., become acclimated to some levels of disturbance) to some extent to exploit areas of eelgrass abundance, and it is unlikely that brant would completely abandon most foraging sites, particularly those that receive little disturbance, such as longline areas (as opposed to rack-and-bag areas). A shift in brant distribution could result in higher levels of grazing in less disturbed areas. However, the results of eelgrass biomass modelling efforts indicate the reduction in available biomass under proposed Project conditions does not approach significance thresholds (i.e., approximately 3% reduction in foraging potential). Thus it is unlikely that brant will experience a significant reduction in foraging opportunity Bay-wide such that their ability to emigrate and breed is threatened. As such the cumulative effects on brant are considered less than significant under CEQA.

3.2 Cumulative Impacts to Roosting Birds

Many birds roost on structures within Humboldt Bay, including double-crested cormorants, California brown pelicans, Caspian terns, Forster's terns, elegant terns, and several gull species. These birds roost on rafts or other structures, as well as on Sand Island. Noise and other sources of human disturbance can cause them to flush from the area. These disturbances have energetic costs associated with flight while birds search for alternative roost sites. As discussed in Section 2.3 above, a maximum of 18 additional boat trips/week are expected throughout the bay in order to maintain the Project, increasing the number of boat hours necessary to maintain the beds and conduct harvest and planting activities by 74 hours per week. The District project allows culturist flexibility in the types of intertidal culture they use, thus it is infeasible to predict the number of boat trips that will occur weekly. However, it is estimated that the most labor-intensive technique, involving rack-and-bag, would result in approximately 138 trips per year or 2-3 visits per week on average; the actual number of trips per week to each site will likely be much less because some sites will include longlines, which require much less maintenance. Finally, the 21 culture rafts approved for installation by Hog Island and Taylor will also likely require additional boat movement throughout the Bay.

The movement of boats and culturist associated with the four projects may result in cumulative effects to roosting birds. However, culturists will use the main channels to access intertidal sites. Birds are unlikely to flush from roosts when boats move through the channels, as roosting birds would be acclimated to regular boat traffic in those areas. It is expected that roosting birds in the bay are generally habituated to human disturbance, given that birds often roost on sites that are near human activity (e.g., docks, piers, etc.), and that individuals that are not habituated to regular human disturbance will roost in more remote areas of the bay. Roost sites in the bay are not a limited resource, as there are numerous unoccupied roost sites in the bay year-round. Therefore, although there is increased potential for cumulative effects associated with disturbance to roosting birds, the impact is considered less than significant under CEQA.

3.3 Cumulative Impacts to Nesting Birds

Sand Island occurs in the north-central portion of North Bay (see Figure 2 above). Double-crested cormorants and Caspian terns nest on Sand Island and human disturbance associated with Project operations in the vicinity of the island has the potential to flush nesting Caspian terns and double-crested cormorants. Disturbances could result in the loss of eggs and/or chicks, and potentially nest or colony abandonment. Human disturbance associated with the District's project also has the potential to impact the Sand Island colony; however the lease sites associated with the District Project do not occur near Sand Island and boats associated with the District Project are not expected to traverse the north-central part of North Bay, as access to the higher elevation intertidal sites occur via the main channels. Mitigation Measure Bio-2 also requires Coast to maintain a 100-meter buffer around the MHHW line of Sand Island, avoiding the potential for the Project to impact nesting birds. Therefore, cumulative impacts to nesting birds are not expected to occur and are considered less than significant under CEQA.

3.4 Cumulative Impacts to Birds from Artificial Lighting

Artificial lighting is known to have adverse effects on wildlife, including birds. However, the Project will not result in additional permanent lighting and new lighting will be used infrequently by culturists working at culture areas at night. The District's project will also involve new lighting but will be limited to boats and culturists, and potentially new floating rafts. New lighting on District Project rafts will include shielded light fixtures to avoid light spillage into adjacent areas and utilize yellow-spectrum lights to minimize glare. Thus cumulative impacts associated with artificial lighting are considered less than significant under CEQA.

3.5 Cumulative Impacts to Wigeon and other Waterfowl

As discussed in Section 2.6 above, boat traffic and the presence of personnel associated with the Project could disturb waterfowl, causing birds to flush from foraging areas and reducing temporal and/or spatial access to food. Human disturbance associated with the Project can result in increased energetic costs as well as a reduction in foraging opportunity. The waterfowl species most likely affected by the Project is American wigeon, which occur in low densities on the Bay in winter when they feed on both emergent and floating eelgrass. As discussed in detail in Section 2.6 for wigeon and other waterfowl, and in more detail in Section 2.2 for black brant (potential impacts to that species are greater than for other waterfowl), the Project is not expected to result in significant impacts to waterfowl foraging opportunities or in human disturbance such that waterfowl are energetically constrained in regards to emigration or breeding. The District Project is also not expected to significantly affect waterfowl foraging primarily because that project largely avoids dense eelgrass areas and mainly occurs in higher-elevation unvegetated mudflats.[10] While there is potential for both projects to result in cumulative effects on waterfowl through increased disturbance, this impact is not expected to be significant given that waterfowl in the bay are already somewhat habituated to the current level of human disturbance from boat traffic and other activities. Moreover, the highest densities of wigeon in the Bay coincide with winter waterfowl hunting, indicating that winter habitat use is not strongly influenced by disturbance. As such, cumulative foraging and disturbance-related impacts to American wigeon and other waterfowl are considered less than significant under CEQA.

3.6 Cumulative Impacts to Migratory Shorebirds

The Project's potential impacts on shorebirds associated with reduction in foraging opportunity and increased human disturbance is assessed in detail in Section 2.7. The District Project also has the potential to result in impacts to shorebirds and thus there is potential for cumulative impacts associated with both projects. The Taylor and Hog Island projects are not expected to impact migratory shorebirds as they will not add structure to intertidal areas.

[10] Because the Taylor and Hog Island raft projects will be installed in subtidal areas, they are not expected to contribute to potential cumulative impacts to waterfowl foraging.

As discussed above, Humboldt Bay is an important estuary for migrating and wintering shorebirds in the Pacific Flyway. Although Project-related impacts to shorebird foraging may occur, the effects are expected to be less than significant under CEQA based on existing evidence of shorebird use of aquaculture sites; specifically, the low tidal elevation of the project site generally does not support substantial shorebird use. The District Project has greater potential to affect shorebirds, as it occurs in higher-elevation mudflats that represent more typical foraging habitat for shorebirds (i.e., they are inundated less frequently). However, as more fully described in the Pre-Permitting Project Draft EIR, foraging-related impacts to shorebirds as a result of the District Project are expected to be less than significant. Further, given that the two projects differ in elevation type and habitat type, they are unlikely to affect foraging resources to the same extent and thus cumulative impacts to shorebird foraging from both projects are expected to be less than significant.

As described in the Section 2.2 above, increased human disturbance from both the Project and District Project may result in a reduction in foraging opportunity and increased energetic costs for shorebirds. The proposed Project will result in a maximum of 74 additional boat hours per week (for a maximum of 292 hours/week). The District Project will likely result in a similar number of boat hours, given the District Project's similarity in footprint size as compared to the Project. However, shorebirds are unlikely to be flushed by boats moving through channels to or from aquaculture sites, as shorebirds occur on exposed flats and boats move through subtidal areas. For instance, during a reconnaissance site visit associated with brant surveys, shorebirds were observed foraging under longlines in close proximity to the passing boat and they did not typically flush or alter behavior as the boat passed by. As such, the greatest impact to shorebirds related to human disturbance likely occurs when culturists directly access aquaculture sites, which may be at low tides when shorebirds can be present. In some cases, there will be higher levels of disturbance, such as rack-and-bag culture sites that experience almost daily activities, while sites with cultch-on-longlines will experience infrequent levels of disturbance (i.e., once/month for inspections, other than harvest and planting). Therefore, shorebirds may avoid areas that receive frequent disturbance, but they are unlikely to be regularly disturbed in areas with cultch-on-longline, which represents the majority of the proposed culture. Thus, even though there will be effects associated with both aquaculture projects, cumulative impacts to shorebirds are expected to be less than significant under CEQA.

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