10.0 EELGRASS

10.1 Background and Setting

10.1.1 The General Role of Eelgrass in Humboldt Bay

Eelgrass (*Zostera marina*) is a perennial aquatic grass that occurs in estuarine contexts along the western coast of North America from the Sea of Cortes and Baja California to Alaska (the species also occurs along the coasts of other continents).[1] Section 4.4.1 of Draft Plan includes the following summary statement regarding eelgrass in Humboldt Bay:

> Eelgrass … grows in muddy to fine-sand substrates within Humboldt Bay, generally near the elevation of "Mean Lower Low Water," and extending to both higher and lower elevations. Eelgrass occurs in extensive stands throughout much of Arcata Bay, and in virtually all of the parts of South Bay that occur at suitable elevations. The eelgrass meadows in Arcata Bay are typically less dense than those in South Bay. Historical studies in Humboldt Bay have demonstrated that both the area covered by eelgrass and the density of eelgrass stems within occupied areas varies through time. Computations reported in Barnhart and others (1992) indicated that almost half of the primary production in Humboldt Bay may result from eelgrass (see EIR Chapter 8), but the seasonal and annual variability in eelgrass productivity is not well understood, and it is not certain how eelgrass in Humboldt Bay varies through time, nor even how closely the stands in Arcata Bay compare with those in South Bay.
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> Eelgrass has long been recognized as an important habitat for some fish and wildlife species (… see Phillips 1984 for a general discussion of eelgrass meadow ecology in the Pacific Northwest). Currently eelgrass meadows are generally thought to provide foraging habitat or cover for a variety of fish and invertebrate species, including species that have commercial value and species that are listed under the federal or state Endangered Species Act, based on study results from other locations along the Pacific coast. The use of eelgrass meadows by several of the sensitive species is not firmly established for Humboldt Bay or other similar open embayments, however, and the uncertainty regarding the ecological role (or roles) of eelgrass is a source of management contention (…).

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1 The eelgrass genus, *Zostera*, is cosmopolitan. In addition to *Z. marina*, the genus includes about 60 other species, which occur in similar habitat conditions in other parts of the world. One Asian species, "dwarf eelgrass," (*Z. japonica*), is an invasive nonindigenous species on the West Coast [see URL: http://www.issg.org/database/species/ecology.asp?si=859&fr=1&sts= (viewed April 2006)]. Dwarf eelgrass grows in similar habitat condition as *Z. marina*, and the presence of the species is associated with stabilized sediment surfaces that lead to changes in vegetative, invertebrate, and vertebrate species in West Coast estuaries. Since the 1950s dwarf eelgrass has become abundant in many estuaries in Washington state. A colony of dwarf eelgrass was discovered in Humboldt Bay (subsequent to the publication of the study by Boyd and others 2002), located at the outer margin of the salt marsh on the northern side of Woodley Island. In 2003 staff from the District, the U.S. Fish and Wildlife Service, other interested agencies, and a number of volunteers physically removed the plants in this colony. At the present time the bay appears to be free of this invader, but the District continues to monitor the Woodley Island site, as well as the bay as a whole. Dwarf eelgrass is not considered to be a desirable element in Humboldt Bay's ecology.

> Agencies of the federal government have adopted a "no net loss" policy for eelgrass in southern California estuaries; the Department of Fish and Game has expressed a similar position for all state waters. Conversely, eelgrass in several estuaries in Washington State has been removed, historically, to facilitate commercial shellfish aquaculture. The regulatory status of eelgrass in Humboldt Bay is not clearly established at the present time. Personnel from several federal and state agencies and academic institutions are involved in research on various elements of eelgrass ecology, although typically little of this work occurs in Humboldt Bay. District staff members frequently confer with research and regulatory agency personnel about eelgrass studies, and the District participates in several monitoring efforts that track eelgrass coverage in Humboldt Bay.

A map of the approximate distribution of eelgrass in Humboldt Bay is shown in EIR Figure 10-1a (Arcata Bay) and 10-1b (South Bay). As has been documented by many authors in recent years, the distribution of eelgrass in Humboldt Bay is not uniform through time or space; rather, the extent or occurrence of eelgrass coverage in the bay varies from year to year. The causes of the variability are not well understood, but appear to be related to physical factors such as sedimentation or the physical removal of eelgrass by wind or wave erosion.

Aside from any specific roles that eelgrass meadows or smaller eelgrass patches may play for individual fish and wildlife species or for commercially important fish species (see below), eelgrass may be justifiably regarded as an important element in the bay's ecosystem simply because of its ecological significance. As an aquatic plant species that is present in Humboldt Bay on a year-round basis, eelgrass would likely be considered an important source of organic production even without reference to trophic-dynamic interpretations. The attribution to eelgrass of more than 40 percent of the primary production within the Humboldt Bay ecosystem (see Chapter 8.0) indicates that eelgrass is one of the most important production sources in the bay, and quite likely is the most important primary producer in the bay's waters.[2]

As summarized in NMFS (2005), eelgrass production is actually a composite of the net photosynthetic production of eelgrass itself in combination with the production of a variety of other organisms that grow on eelgrass blades as epiphytes (the invertebrates that live on or in eelgrass blades are not primary producers and are not part of the net primary production within the estuary). Eelgrass primary production may be consumed directly by a variety of invertebrates; many of these invertebrates are themselves consumed by other invertebrates or by vertebrate predators (mostly fishes).

Quite apart from its role in the estuarine ecosystem generally, however, eelgrass has been implicated as a specific and important habitat element for organisms that have been identified as a management concern for Humboldt Bay, including fish species and some non-fish wildlife species. Eelgrass has also been identified as an element that is important in the application of several regulatory and non-regulatory programs that operate in reference frameworks that are larger than Humboldt Bay or the Draft Humboldt Bay Management Plan.

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2 As noted in Chapter 8.0, the magnitudes of "production" for the elements in the Humboldt Bay ecosystem have not been described quantitatively.

Figure 10-1a. Eelgrass in Arcata Bay, 2000. (Note: North is to left.)

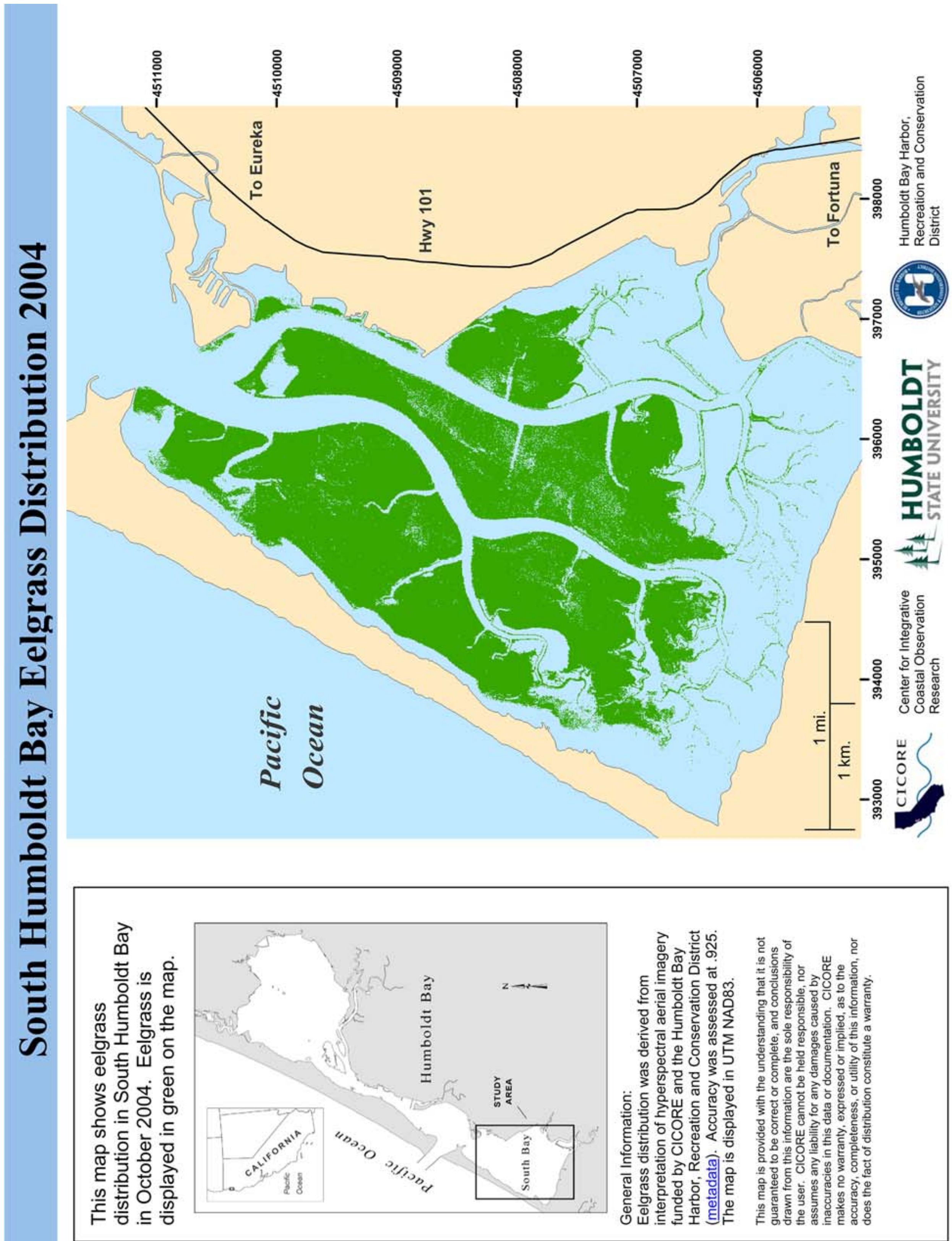

Figure 10-1b. Eelgrass in South Bay, 2004. (Note: North is to left.)

10.1.2 The Role of Eelgrass as a Significant Habitat Element for Fish

As a matter of general consensus, effective fisheries management in the first decade of the 21st Century should utilize an ecosystem-based approach (e.g., Pikitch and others 2004; many others), and eelgrass is quite evidently an element that must be considered in a management approach based on the Humboldt Bay ecosystem. For fishery management purposes eelgrass meadows have, in addition to their role in sustaining the ecological dynamics of the estuary, also been identified as a significant habitat element for fish. Eelgrass occurs in two contexts that are significant from a regulatory perspective, and thus from a CEQA perspective: (1) the role of eelgrass in sustaining fish or other species listed pursuant to the federal or state Endangered Species Act, and (2) the role of eelgrass as an element in Essential Fish Habitat pursuant to the Magnuson-Stevens Fishery Conservation and Management Act.

10.1.2.1 Eelgrass and Fish Species Listed Pursuant to Endangered Species Acts

Among the species covered by the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA) are several fish species (see Chapter 11.0). Three of these species are salmonids, each with a listing under both the ESA and the CESA. In addition, all three species have received Critical Habitat designations pursuant to the ESA. The Critical Habitat designation for each of these species has implicated Humboldt Bay's waters (see Chapter 11.0).

In evaluating the potential relationships among a proposed action[3] and the importance of various habitat elements in Humboldt Bay, the National Marine Fisheries Service (NMFS) prepared a summary of existing scientific literature that addressed of the role of eelgrass (NMFS 2005). The following text, which addresses the role of eelgrass in the habitat requirements for the three listed species, is excerpted from that summary:

> ***"Predation Refuge***. Eelgrass provides structural shelter for a variety of marine organisms (Orth and Heck 1984, Main 1987). This may lower predation pressure, allowing more time to forage to meet the organisms' energetic needs. The protection value may vary with the structure of the eelgrass bed and is generally limited to smaller species, juveniles, or cryptic species (Jackson *et al.* 2001). Some species may also utilize bare areas as long as the seagrass refuge is available nearby (Summerson and Peterson 9184).
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> "Orth *et al.* (1984) suggested that shoot density, patchiness, leaf area, leaf morphology, and the thickness, structure and proximity of the rhizome layer to the sediment surface are the primary characteristics that affect predation rates. This structural complexity, along with the associated epiphyte complex, is also often related to fish abundance and species richness (Phillips 1984). Wyda *et al.* (2002) demonstrated a significantly higher abundance, biomass, and species richness of fish assemblages within sites that have high levels of eelgrass habitat complexity … compared

3 The subject action was an application by Coast Seafoods for U. S. Army Corps of Engineers approval for mariculture activities in Humboldt Bay. The specific application is not a subject for this EIR, and will be evaluated in a separate CEQA document. The quotations from the Biological Opinion and Essential Fish Habitat consultation quoted in this chapter are presented solely because they reflect a recent literature review of the roles of eelgrass in the habitat valuations of the listed species and in the habitats values of a number of species covered by Fishery Management Plans pursuant to the Magnuson-Stevens Fishery Conservation and Management Act.

to sites without any eelgrass. Based on these results, Wyda *et al.* (2002) suggested that alterations in eelgrass habitat structure may have significant effects on the fish assemblage. Fish diversity and eelgrass biomass were also significantly correlated in surveys conducted in Craig, Alaska (Murphy *et al.* 2000).

"Eelgrass is also thought to provide shelter for migrating salmonid smolts (Phillips 1984). When exposed to predators, juvenile Chinook salmon preferentially chose eelgrass habitat over oyster clusters in field experiments in an enclosure, as well as in mesocosm experiments involving exposure to a mock predator (Dumbauld *et al.* 2004). This behavior suggests eelgrass may provide a more effective refuge from predation. ...

"Eelgrass as Habitat for Listed Salmonids. Adequate prey species and forage base, as well as adequate cover and marine vegetation have been identified as important elements in estuarine and nearshore habitats for Pacific salmon (Roni *et al.* 1999). The value of eelgrass to salmonids lies within its context within an individual estuary. If the distance between vegetated patches increases predation risk or physical stress, adult and juveniles of large, mobile organisms may avoid the unstructured mudflats (Micheli and Peterson 1999). Phillips (1984) suggested Chinook salmon were "transient" users of eelgrass for feeding and cover. Murphy *et al.* (2000), however, did not observe a significant association of juvenile salmon with eelgrass. In Alaska, Murphy *et al.* (2000) reported that salmonid fry and smolts were generally smaller in eelgrass sites than in non-eelgrass habitats, but suggest that the presence of salmon fry in eelgrass areas may be related to physical factors such as low exposure to currents, rather than the presence of eelgrass per se. In a study conducted in southeastern Alaska comparing fish utilization of kelp and eelgrass, the majority of juvenile coho salmon (90-135 mm) were collected in eelgrass beds (Johnson *et al.* 2003). Eelgrass drift habitat may also be a critical resource for Chinook salmon and coho salmon (Nightingale and Simenstad 2001). Within Humboldt Bay, coho salmon smolts have been captured under clumps of floating eelgrass …"

The information upon which the excerpted text is based is considered unlikely to reflect fully the importance of eelgrass to these salmonid species, simply because it is unlikely that adequate research has been conducted yet to accomplish that task. As noted elsewhere in this EIR, it is yet unlikely that all of the factors that are important as habitat for these species have been characterized; nonetheless, the importance of eelgrass as a habitat element for these listed species emerges from the evaluation.

10.1.2.2 Eelgrass and Essential Fish Habitat

Essential Fish Habitat (EFH) is a regulatory construct that applies for fish species covered by one or more of the Fishery Management Plans (FMPs) developed by the "Fishery Management Councils" in the United States. As summarized on a webpage of the National Marine Fisheries Service:

"On October 11, 1996, Congress passed the Sustainable Fisheries Act (Public Law 104-297) which amended the habitat provisions of the Magnuson Act. The re-named Magnuson-Stevens Act (Act) calls for direct action to stop or reverse the continued loss of fish habitats. Toward this end, Congress mandated the identification of habitats essential to managed species and measures to conserve and enhance this habitat. The Act requires cooperation among the National Marine Fisheries Service (NMFS), the Fishery Management Councils, and Federal agencies to protect, conserve, and enhance 'essential fish habitat.' Congress defined essential fish habitat for federally managed fish species as ‘those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.’ ”[4]

As described in Chapter 11.0, there are at least 35 fish species that are known or believed likely to be associated with Humboldt Bay that are listed on one of the three FMPs (the “Groundfish” Plan, the “Pacific Salmon” Plan, and the “Coastal Pelagics” Plan) for the region covered by the Pacific Fishery Management Council (PFMC). These species include at least two species that are also covered by the federal and state ESAs discussed above,[5] but the focus of the FMPs is fish species that are commercially important.

The EFH management construct erected by the Magnuson-Stevens Act resulted in the opportunity for the PFMC and NMFS to focus more closely than had generally been the prior case on habitat factors important for the species covered by the FMPs. Eelgrass has long been identified as an important habitat element in the estuarine parts of the life cycles of some of the species covered by FMPs that are under the jurisdiction of the PFMC. By hypothesis, eelgrass would then likely be an element in the EFH for at least some of the species covered by the three FMPs.

Because the EFH requirements are relatively new, the identification of EFH elements has been somewhat slow to develop. However, the Arcata NMFS office recently provided recommendations regarding EFH in Humboldt Bay (NMFS 2005), providing an initial perception of EFH from the federal regulatory agency most directly involved with the EFH requirements. The EFH consultation presented the following description of the importance of eelgrass as an element in the EFH for species covered by the three plans:[6]

“<u>Eelgrass as Essential Fish Habitat for Managed Species</u>

“*Groundfish*

“Within the Pacific Groundfish FMP, eelgrass is specifically mentioned in the EFH descriptions for lingcod and black rockfish. Eelgrass is also specifically mentioned in the life history descriptions of cabezon, black rockfish, bocaccio, brown rockfish, grass rockfish, quillback rockfish, splitnose rockfish, and English sole. In addition, vegetated areas in estuaries and the nearshore are listed in a number of other groundfish EFH descriptions. Seagrasses are identified by the PFMC as a preliminary preferred alternative for designation as a Habitat of Particular

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4 See URL: http://www.psmfc.org/efh/efh.html (viewed December 2005) or URL: http://www.pcouncil.org/habitat/habback.html#efh (viewed December 2005) for additional information. These webpages have links to other pages that briefly describe EFH for each of the three FMPs identified in this chapter.

5 These two salmonid species formerly were commercially and recreationally important species for the Humboldt Bay region.

6 The excerpt from the EFH consultation is presented here for information purposes only. It is unknown whether the EFH identification summarized in this excerpt may be altered as additional information becomes available and additional deliberations by the PFMC take place. Future consultations, carried out for future project applications, may or may not result in similar findings, and applicants for future approvals should not presume that this excerpt will necessarily reflect future findings by NMFS or other parties.

Concern. The information and descriptions in the Pacific Groundfish FMP should not necessarily be considered as entirely comprehensive. It was noted in the Pacific Groundfish FMP that there are substantial gaps in the knowledge of many Pacific groundfish species. Moreover, the Pacific Groundfish FMP states that information and life histories of species managed by the FMP will undoubtedly change over time as new information becomes available.

"In addition to the information provided in the FMPs, there is literature documenting the importance of eelgrass to some species of groundfish (*e.g*., Nightingale and Simenstad 2001). English sole, copper rockfish, and rockfish larvae/juveniles are considered "resident" users of eelgrass beds, and black rockfish, kelp greenling, lingcod, cabezon, butter sole, Dover sole, sand sole, starry flounder, and spiny dogfish are considered "transient" users, as described in Phillips' (1984) description of eelgrass meadows in the Pacific Northwest.

"Many rockfish juveniles settle into shallow, vegetated (e.g., kelp and eelgrass) habitats to meet critical juvenile rearing needs. These habitats provide both predation refuge and increased access to prey resources. Availability of juvenile habitat may play an important role in predicting recruitment success. Juvenile rockfish may also be closely associated with drift seagrass for both feeding and refugia while they move between pelagic and nearshore habitat (Nightingale and Simenstad 2001).

"Several rockfish species (*e.g., S. inermis, melanops, oblongus, caurinus, schlegi*) recruit to seagrass beds in shallow, soft bottom embayments (Love *et al*. 1991). Johnson *et al.* (2003) demonstrated that juveniles of many commercially important species utilize eelgrass habitat in Southeastern Alaska. Furthermore, they opined that discrete eelgrass patches may be "essential" for rearing or spawning, particularly to some species of rockfish. Murphy *et al*. (2000) also observed a close association between rockfish and submerged vegetation, both eelgrass and kelp. Their results indicated that juvenile rockfish move into vegetated inshore areas in April and May, and age-0 rockfish move into eelgrass in August and September. In fact, 97 percent of the age-0 rockfish caught in September were caught in eelgrass. Matthews' (1990) observations also confirmed that juvenile rockfish use shallow vegetated areas mainly in summer and use rocky reefs in fall and winter. Similarly, West et al. (1994) indicated that rockfish need a combination of vegetated shallows and rocky reefs to provide both summer and winter habitat. Beak Consultants demonstrated that rockfish, cabezon, and greenlings, as well as other fish species, utilized eelgrass in Puget Sound during their juvenile stages for shelter and food for a portion of their life cycle (Phillips 1984). Adult quillback rockfish have also been observed to retreat to eelgrass habitat at night (CDFG 2001).

"Haldorson and Richards (1987) examined the utilization of various habitats by young-of-the-year (YOY) copper rockfish. Specifically, they sampled the densities of YOY copper rockfish in kelp, eelgrass, agarum slopes, and sand habitat during August, September, and October 1985. They found that densities of YOY copper rockfish were highest in eelgrass during the September and October sampling periods. In August, densities of YOY copper rockfish were highest in kelp with eelgrass exhibiting the second highest densities. They suggested that kelp forests and perennial macrophytes, such as eelgrass, may be especially valuable as nursery areas and could potentially contribute disproportionately large numbers of individuals to older age classes.

"Love et al. (2002) identified eelgrass beds, in addition to kelp beds and rock outcrops, as essential habitat for young rockfishes (*Sebastes* spp.) by providing an important nursery function. In addition, Moore *et al*. (2000) determined that eelgrass supported high biodiversity and provided important habitat for juvenile rockfish and other fish species. As noted in Love *et al.* (2002), "Loss or alteration of these nursery habitats, which are already limited in abundance, could have long-lasting detrimental consequences to the survival of rockfishes and the replenishment of their populations." Other groundfish species could also be similarly affected, especially for overfished species such as bocaccio and lingcod, which both utilize eelgrass habitat.

"Young rockfishes achieve their highest growth rates in the warmer water of shallow habitats (Love *et al.* 1991). Foraging efficiency is determined by the rate of food harvested relative to energy expended. Reduced refuge availability may increase the need for predator avoidance and thus reduce the time spent foraging. Thus, changes in habitat characteristics that alter prey availability and/or refuge availability may reduce the growth and survival of young rockfish. The indirect effects of predators and shelter availability has (sic) been observed in coral reef fish systems (e.g., Schmidt and Holbrook 1985), but has not been examined for rockfishes (Love *et al.* 1991). Although it has not been substantially studied, shelter availability is presumed to be very important for early life stages of rockfish (Love *et al.* 1991). "During years of high abundance of potential recruits, resources critical to early post-settlement survival may limit the density of recruits" (Love *et al.* 1991). Thus, the shelter provided by eelgrass habitat within Humboldt Bay may enhance post-settlement survival.

"The majority of species utilizing seagrass beds in temperate regions are (sic) ocean-spawned species that have been transported inshore by currents. Unfortunately, little is known abut (sic) the importance of eelgrass during these early critical stages. In order to ensure survival of new recruits, they must find suitable habitat. Size and quality of the chosen habitat may be important for determining the carrying capacity of an area (Jackson *et al.* 2001). In Japan, larvae and small juveniles of black rockfish (*Sebastes inermis*) are known to initially recruit to Zostera beds (Pasten *et al.* 2003). They tend to settle in eelgrass during early spring, synchronized with a semi-lunar cycle at new and full moon phases. Doty *et al.* (1995) also suggested that shallow vegetated habitats, such as macroalgae and eelgrass, are temporally important for settlement and initial rearing of copper, quillback and brown rockfish within Puget Sound.

"Kelp greenling are reportedly common in Humboldt Bay and may occur in eelgrass habitat, as well as other habitat types in close proximity to eelgrass, such as shallow tidal channels and mudflats (Barnhardt (sic) *et al.* 1992; Johnson *et al.* 2003). Very young juveniles of English sole were observed to utilize seagrass beds as nursery habitat in Puget Sound (Phillips 1984). Although adult English sole are also found in bare areas, they may also exhibit a proximal association will eelgrass, as evidence (sic) by the fact that many fishermen in Puget Sound collect English sole in or near eelgrass beds (Thayer and Phillips 1977).

"Pacific Salmon [7]

"Adequate cover and marine vegetation in estuarine and nearshore habitats have been identified as important elements in Pacific salmon marine EFH in estuarine and nearshore habitats (PFMC 1999). Similarly, the Pacific Salmon FMP suggests alterations to eelgrass beds may result in loss of cover from predators, loss of primary productivity, and loss of prey. Loss of eelgrass beds is specifically identified as a habitat concern. Given their importance, the aerial (sic) extent of submerged aquatic vegetation is used as a habitat indicator for Pacific Salmon EFH. NMFS also

7 It will be recalled that some salmonid species are covered by the Pacific Salmon Management Plan of the PFMC, in addition to being listed under the ESA and the CESA. This discussion applies solely to the EFH elements of species covered by the requirements of the Magnuson-Stevens Act.

believes reductions in quantity and quality of eelgrass within a given areal extent are important considerations.

"In Drayton Harbor, Washington, Thom et al. (1989) found no significant difference in the mean values of total epibenthos density, salmon prey density, and salmon density between mudflat and eelgrass. Thom et al. (1989) concluded that mudflats are important for a short period in early spring for feeding outmigrating salmon, and the eelgrass meadow is important for an extended period in the summer. Thom et al. (1989) found that changes in salmonid distribution were related to shifting abundant preferred prey (*Harpactius* (sic) *uniremis* and gammarid amphipods). However, protected mudflat in a marina contained more microalgae and higher densities of salmonid prey than the mudflat exposed to wind driven waves. Based on stable carbon isotope studies, the harpacticoid copepods and gammarid amphipods consumed by salmon in estuaries assimilate carbon directly or indirectly from microphytobenthos (Simenstad and Wissmar 1985). High intertidal mudflats receive more light and heating earlier in the season with a shift from winter neap tides to daylight times (Admiraal and Peletier 1980). However, early spring winds can disturb the development of microphytobenthos in early spring which can result in annual variability in primary and secondary production (Amspoker and McIntire 1986).

"The value of eelgrass habitat to salmonids lies within its context within an individual estuary. If the distance between vegetated patches increases predation risk or physical stress, adult and juveniles of large, mobile organisms may avoid the unstructured mudflats (Micheli and Peterson 1999). Phillips (1984) suggested Chinook salmon and coho salmon were "transient" users of eelgrass for feeding and cover. Murphy et al. (2000), however, did not observe a significant association of juvenile salmon with eelgrass. In Alaska, Murphy et al. (2000) reported catch of coho smolts and forage fish (Pacific herring and Pacific sand lance) was similar at eelgrass and non-eelgrass habitats. However, salmonid fry and smolts were generally smaller in eelgrass sites than in non-eelgrass habitats. Murphy et al. (2000) suggests (sic) that the presence of salmon fry in eelgrass areas may be related to physical factors such as low exposure to currents, rather than the presence of eelgrass per se. However, the functional attributes of the eelgrass that lead to reduced current and wave baffling associated with the eelgrass structure are not discussed. In a study conducted in southeastern Alaska comparing fish utilization of kelp and eelgrass, the majority of juvenile coho salmon (90-135 mm) were collected in eelgrass beds (Johnson et al. 2003). Eelgrass drift habitat may also be a critical resource for Chinook salmon and coho salmon (Nightingale and Simenstad 2001). …

"Coastal Pelagics

"Northern anchovy were described to be transient users of eelgrass by Phillips (1984). Eelgrass undoubtedly provides indirect benefits via its ecological contribution to the nearshore. Drift eelgrass may also serve as cover for some coastal pelagics, such as northern anchovy (Nightingale and Simenstad 2001)."

In essence, the fishery science underlying EFH considerations in the Humboldt Bay region clearly implicates eelgrass to some degree in the habitat needs of fish species covered by each of the three FMPs. These general conclusions, which are based primarily on general ecological information and research conducted in other parts of the Northwest, are consistent with the known results of applied research from the Humboldt Bay region. As part of ongoing University of California research on rockfishes in this region, Schlosser (pers. comm.) has identified eelgrass within the bay as an important habitat for juvenile rockfishes, which enter the bay in the spring as relatively small fish (ca. 50 mm in length).[8] These juvenile fish were regularly detected in eelgrass through the summer, before abandoning eelgrass habitats in the fall (ca. October) for unknown habitats, at lengths of about 90 mm (indicating the importance of the eelgrass habitats for supporting growth). In the spring Schlosser and her colleagues also detected 1-year-old rockfish in eelgrass, at lengths of 180-200 mm, which had wintered elsewhere and then returned to eelgrass in the bay. Schlosser and her colleagues have not detected 2-year-old fish, and concluded that by their second spring the rockfish have moved offshore. As noted in Chapter 11.0, these rockfish have historically formed an important element in the commercial fishery in northwestern California, implicating eelgrass beds in the bay in maintaining this commercially important fishery.

Eelgrass in Humboldt Bay should, hypothetically, also be important for non-commercial fish species in the bay. This hypothesis has not been investigated extensively. However, recent research by personnel from the Arcata office of the USFWS has looked at the use of eelgrass in Arcata Bay (Pinnix and others 2005). The sampling carried out in this study included eelgrass areas and some of the longline oyster beds in Arcata Bay, with a specific objective of seeking correlations (positive or negative) between oyster culture, eelgrass, and fish use. The authors captured more than 20,000 individuals of a variety of species, and summarized the general results of the study as:

> "Of the 49 fish species captured during this study, shiner surfperch, English sole, northern anchovy, speckled sanddab, and Pacific herring were captured in largest numbers. Other species captured in significant numbers included topsmelt, Pacific sardine, bay pipefish, walleye surfperch, bay goby, surf smelt and staghorn sculpin. Fish species captured during this study were similar to those captured by Cole (reference omitted). … Seasonal influences, based on month sampled, were significant on all metrics that were used to describe the fish community composition (species richness, Simpson's Diversity Index, and Shannon-Weiner Diversity Index) and fish abundance (CPUE). The variation in shrimp trawl catches during this study showed a strong seasonal trend with more fish in the North Bay during late spring and summer months compared to late fall and winter months. … Species richness was generally highest during the spring and summer and lowest in the winter. …
>
> "The various habitats that exist do so because of the amount of time that each habitat is inundated; mudflats occur in the shallowest areas of the bay that are dewatered the greatest amount of time during the tidal cycle, thus one would expect lower fish numbers in these habitats. Additionally, fish are attracted to structure and oyster culture and eelgrass habitats in North Humboldt Bay provide structure. The highest catches and diversity of species captured during the course of the study generally occurred in or adjacent to oyster culture and eelgrass habitats in North Humboldt Bay."

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8 Pilings and other structures were also identified as important for some species evaluated in these studies. Eelgrass, pilings, rocks, and such structural elements in the bay are "habitat" for species of mobile fish and invertebrates. A full description of the bay's ecosystem would identify these habitat elements and characterize their use by various species. That is, the habitat preferences of mobile species make up an element in the accommodation of the species to one another. The presence of the physical habitat elements is necessary to maintain all of the species; the absence of eelgrass or pilings would mean the absence of the species that require or significantly prefer those habitat elements.

As a general statement of fish use of Humboldt Bay, this excerpt confirms the importance of eelgrass beds for a variety of common fish species.[9] The occurrence of various fish species was not uniform throughout the bay, nor was the distribution of species uniform through time.

As a general summary, this EIR concludes that eelgrass is a significant habitat element for many of the fish species that compose the ichthyofauna of the bay. The generalized conclusions reached by NMFS (2005), based largely upon research results from other locations, regarding the "essentiality" of eelgrass beds for species covered by the FMPs of the PFMC appear to be fully valid for the Humboldt Bay ecosystem, based upon an independent consideration of the arguments and citations presented in the NMFS report. In addition, evidence from other local studies indicates that eelgrass is among the structural elements that are important in determining habitat values for other fish species in the bay.

10.1.3 Eelgrass as a Key Habitat Element for Wildlife

While there are many (non-fish and non-invertebrate) wildlife species associated with Humboldt Bay's waters and wetlands, one wildlife species has been universally identified as "dependent" on eelgrass. Pacific (formerly known as "black") brant (*Branta bernicla nigricans*) are small geese that are associated with marine habitats along the western coast of North America (other brant subspecies are found in the Atlantic basin and in Eurasia, and have similar associations with seagrasses). The Pacific brant is considered a "sensitive" wildlife species in this EIR because it is included (together with the eastern subspecies) in the "Audubon Watch List" (see Chapter 11.0), although Pacific brant are also given special management consideration by a variety of state agencies along the West Coast.

Pacific brant nest in the high arctic, and migrate southward to wintering zones along the Pacific Coast [see Derksen and Ward (1993) and Pacific Flyway Council (2002) for an overall summary of this species' biology]. The total number of individuals in the species exceeds 100,000 birds, now generally recognized as divided genetically into two stocks.[10] The "grey-bellied" form apparently nests in the Canadian high arctic and largely winters along the coast in Washington. The more abundant "black-bellied" form nests farther west in Canada, Alaska, and Siberia, and migrates along the Pacific coast. About 80 percent of these birds winter in Mexico; the remainder winter in smaller coastal lagoons along the coast between Alaska and California.

The brant that occur along the West Coast appear to include birds with varying migratory tendencies. Humboldt Bay once hosted a substantial wintering population of brant, identified by Monroe (1973) at about 5000 birds, but by Springer (1982) at about 10,000 birds. For reasons that are not completely understood, the behavior of the birds changed in the 1950s and 1960s, and the wintering population began bypassing Humboldt Bay or remaining only for a short time; some investigators have

9 The excerpt also indicates that the "structure" provided by the oyster mariculture operations is also an important habitat element for fish in Humboldt Bay, a result that is useful in the District's consideration of the environmental impacts of mariculture activities.

10 See URL: http://www.sfu.ca/biology/wildberg/species/spbrant.html (viewed December 2005).

concluded that the birds were responding to hunting by humans (e.g., see Kramer and others 1979). As identified by the Pacific Flyway Council (2002:10), Humboldt Bay hosts larger instantaneous brant abundances during migrations: "Peak counts of spring staging brant at Humboldt Bay were 20,000-40,000 from 1950-77, declined to 10,000-15,000 in the 1980s, but have increased to 20-25,000 in the late 1990s."

The identification of a functionally dependent relationship between brant and eelgrass is long-established. Eelgrass (primarily *Z. marina*, but also *Z. japonica* where this species occurs) have universally been identified as the primary food source for brant. Various reports have identified macroalgae, particularly *Ulva*, as a secondary food that may be consumed by wintering and migrating brant if eelgrass is not available, and there are reports that brant may occasionally consume grass. Breeding brant apparently rely to a substantial degree on native grasses and sedges in coastal saltmarshes, but eelgrass appears to be the key food source for migrant and wintering birds (Ward and others 2005). In fact, specific research results (e.g., Wilson and Atkinson 1995) and summaries (Ward and others 2005) have identified a direct correspondence between the availability and abundance of eelgrass and the abundance of brant in Pacific Coast estuaries, and most biologists have concluded that declines in eelgrass abundance lead directly to declines in brant abundance and potentially to ecological and geographical changes in the areas used by brant.

10.1.4 Summary Statement About the Importance of Eelgrass in Humboldt Bay's Ecology

Humboldt Bay provides a variety of habitat elements for fish and wildlife species that occur in the bay. These elements include the waters of the bay, the mudflats, the saltmarshes, the prey populations, and a variety of other factors that determine the suitability of the bay for natural populations. However, there is little doubt that eelgrass, as a specific habitat element for a variety of species and for some species that have been designated as being of special management concern, warrants the focus that it has begun receiving in California and elsewhere.

The District acknowledges the importance of eelgrass in the bay's ecology, and recognizes an obligation to focus specific management efforts on eelgrass. The District has already been engaged with eelgrass management in Humboldt Bay. The District has participated in eelgrass mapping and research projects in Humboldt Bay for nearly a decade. In addition, the District's management of mariculture activities subject to the District's authority has led directly to many of the results reported above. In carrying out the policies in the Draft Management Plan, the District intends to include eelgrass as a specific management focus and an indicator of the Plan's environmental benefits.

10.2 Issues to be Addressed and Thresholds of Significance

The Environmental Checklist in Appendix A includes several items for which eelgrass is possibly or definitely an environmental concern, including item IV.a addressing potential effects for species that are listed under the ESA or the CESA or their habitats; IV.b addressing sensitive community types; IV.c addressing impacts on wetlands; and item IV.d addressing fish and wildlife movements. All of these items were identified in the Initial Study as potential environmental concerns arising from the adoption of the Humboldt Bay Management Plan.

Comments received in response to the Notice of Preparation indicated that at least two commenters felt that this EIR should address biological resources that could be affected by the Draft Plan's implementation, including the habitat elements that affect sensitive species. The analytical elements in these comments indicated that the commenters were aware of the relationships among habitat elements, including eelgrass, and the species that were covered by state and federal laws protecting sensitive species.

Thresholds of significance for environment concerns in a programmatic environmental document for a management plan are not easily drawn. As noted many times in this EIR, a "threshold of significance" convention is used throughout the EIR that recognizes that the potential environmental effect of the plan would be significant if the proposed policies in the plan increase the potential for occurrence of a possible impact beyond what would be expected if the policies recommended in the plan were not carried out. This assessment requires a judgement regarding the likelihood that the plan will create or exacerbate adverse conditions that would not occur without the plan. If a reasonable argument is possible that the Plan's policies would exacerbate a possible adverse condition, or create a new adverse condition that does not occur at the present time, then the effect of the Plan is judged to be environmentally significant.

10.3 Environmental Effects of Plan Alternatives

10.3.1 "No Project" (Existing Master Plan)

The existing Humboldt Bay Master Plan does not have any specific policy recommendations regarding eelgrass. However, the Master Plan does identify the ecological significance of eelgrass, and the Master Plan states that the Arcata Bay and South Bay areas that are dominated by eelgrass "must be conserved." Ordinance No. 7, the District's current policy with respect to use of the bay's waters, does not specifically address eelgrass, although the ordinance does follow the recommendations of the Master Plan with respect to designating much of Arcata Bay and South Bay as "Conservation – Water."

Should the District elect not to adopt the Humboldt Bay Management Plan, a continued reliance on the 1975 Master Plan would leave the District without specific policy direction with respect to eelgrass other than the general edict quoted above.

10.3.2 Proposed Management Plan

Implementing the Draft Humboldt Bay Management Plan could lead to potential actions that could affect eelgrass in Humboldt Bay. District experiences with current activity and use pattern in Humboldt Bay have indicated that eelgrass may be affected by some harbor-related activities, as well as that many recreational activities also cause the loss of eelgrass. Based on the District's experience, the following policies in the Draft Plan are among those that appear to have a potential for producing adverse effects on eelgrass.

Harbor Policies:

- HLU-3: Assist in removing potential constraints for marine-dependent or coastal-dependent land uses along the Samoa Peninsula, Fields Landing Channel, Eureka shorelines, and other harbor-related areas
- HLU-4: Assist in removing potential constraints for marine-dependent or coastal-dependent land uses on harbor-related parcels in the South Bay
- HLU-6: Develop "specific plans" for District-owned parcels
- HWM-2: Dredging may be authorized to meet Plan purposes
- HWM-3: Re-deposition of dredged materials within Humboldt Bay may be authorized to meet Plan purposes
- HWM-4: Placement of fill within Humboldt Bay may be authorized to meet Plan purposes
- HFA-5: Designate a Preferred Aquaculture Use Area in Arcata Bay, and require Best Management Practices to meet environmental constraints

Recreation Policies:

- ROP-3: Identification of designated recreational use areas
- RFA-3: Water-oriented recreation facilities; access for fishing and shellfish harvesting
- RFA-5: Environmentally sensitive areas
- RSA-5: Support opportunities for recreational fishing
- RSA-9: Support for a water trails program for Humboldt Bay

The Draft Management Plan is intended to provide a "self-mitigating" programmatic management program for Humboldt Bay. In general, the goal in such an approach is to assure that policies that could result in adverse effects are accompanied by other policies that moderate or prevent possible adverse effects. For example, while several of the policies identified above might adversely affect eelgrass, policies HFA-6 and HFA-7, CAE-4, and CAS-2 and CAS-3 are beneficial for eelgrass protection, and were included in the HBMP explicitly to assure that no adverse long-term impacts remain as a consequence of Plan implementation. However, as noted throughout this EIR, the Plan's success in avoiding impacts depends entirely on the full implementation of all of the Plan's policies.

10.3.2.1 Habitat for Listed Fish Species

The Biological Opinion (BO) prepared by the National Marine Fisheries Service (NMFS 2005) for a proposed mariculture project concluded that the proposed activity would reduce cover density and productivity in up to 250 acres of eelgrass in Humboldt Bay. The BO also included a finding that the proposed activities were unlikely to adversely affect the three listed salmonids that were the subject of the consultation (see Chapter 11.0). This conclusion included a finding that the activities would not adversely affect the migratory corridors of the listed species through the waters of Humboldt Bay, and this finding applies to the eelgrass beds.

It may be fairly argued that the proposed mariculture project will in the future will be subject to the policies of the Management Plan, and that this EIR could consider whether the reduction in density and productivity in 250 acres of eelgrass would be considered to be an environmentally significant impact to these listed species and their habitat if reviewed pursuant to the Management Plan. Because the National Marine Fisheries Service, the federal regulatory and trustee agency charged with protecting the listed salmonids, has found that the mariculture activities do not significantly affect these species, then the District is entitled to rely on the NMFS judgement of significance, and to reach concordance with the NMFS (2005) finding. That is, were the effects of the mariculture activities, *per se*, on the listed salmonids a subject for review in this EIR, the EIR would find that the effects on these species, or on their habitats within the bay, including eelgrass, would not be environmentally significant.

In a larger sense, the EIR may address the question regarding whether the Plan's policies are related to significant effects on the salmonids. This concern is addressed in Chapter 11.0. The EIR concludes, generally, that insufficient knowledge currently exists for the EIR to definitively determine whether the Plan's policies are associated with impacts on these species (see subsection 11.3.2.1 for the rationale supporting this conclusion).

10.3.2.2 Essential Fish Habitat

The BO prepared by the National Marine Fisheries Service for the sensitive fish, cited above, concluded that the proposed mariculture activities would adversely affect eelgrass density and cover in approximately 250 acres of Humboldt Bay. In reviewing the potential significance of this impact to Essential Fish Habitat pursuant to the Magnusson-Stevens Act, NMFS found:

> "Various federally managed species directly utilize eelgrass habitat and indirectly benefit from the ecosystem functions eelgrass provides. Therefore, the diminished eelgrass functionality … would result in both direct and indirect adverse effects to EFH."

The District is entitled to rely on the opinions of this federal regulatory and trustee agency with respect to EFH. The District's own concerns about the maintenance and improvement of fish stocks in Humboldt Bay argue, moreover, for a similar conclusion: a loss of eelgrass area or productivity is an adverse effect, based upon considerations that were not specifically identified in the NMFS opinion. In other words, owing to the well-documented importance of eelgrass for a number of the fish species covered by FMPs, this EIR finds that it is a reasonable conclusion that the reduction of cover and productivity in 250 acres of eelgrass habitat in Humboldt Bay would be a significant impact to the potential habitat for these 35 fish species pursuant to the requirements of CEQA.

The context of the finding in this EIR is less precise, however. The EIR finds that a loss of eelgrass area within the bay constitutes a significant adverse effect, but that the threshold of significance for the effect is not known with certainty. In a larger sense, the implementation of the Draft Plan is expected to lead to the implementation of several harbor-related and recreation-related policies that could be associated with an adverse effect to eelgrass (see above). In such a context, the loss of eelgrass is explicitly a "cumulative" effect under CEQA, and thus the indirect effects on EFH is also a "cumulative" effect of human use of the bay, which clearly occurs because of a variety of causes. The minimum magnitude of adverse effects to eelgrass that constitutes a "significant impact" to fish habitat is not clear. At the present time, this EIR presumes that there is no "threshold" impact; that is, any degree of eelgrass loss or impairment will have some degree of adverse effect on the species that require eelgrass. Therefore this EIR finds that the implementation of the Plan will be associated with potential effects to eelgrass, and to the fish species that find EFH in the bay, and those effects are identified in this EIR as environmentally significant.

It should be noted that, pursuant to CEQA, the District may approve the proposed Management Plan, notwithstanding potential impacts to eelgrass, subject to the adoption of feasible mitigation measures. This EIR finds that the incorporation of feasible mitigation measures, as specified below, will reduce potential Plan-related impacts to eelgrass to levels that are acceptable, in the sense required by CEQA.

10.3.2.3 Habitat for Wildlife

The importance of eelgrass for Pacific brant, an environmentally sensitive wildlife species according to the requirements of CEQA, is well established in the scientific literature. As noted previously, both historical (e.g., Wilson and Atkinson 1995) and recent (e.g., Ward and others 2005) scientific works have concluded that brant abundance is directly related to eelgrass abundance and productivity, and that eelgrass losses cause reductions in the ability of Pacific coast estuaries to support brant.

In the context of the CEQA document for the Management Plan, the operative question is whether the Plan's policies that could affect eelgrass distribution, density, and productivity constitute an environmentally significant effect that will produce an indirect significant effect on brant. Owing to the well-documented relationship between brant and eelgrass, this EIR finds that the implementation of some of the harbor-related and recreation-related policies in the Draft Plan would be associated with environmentally significant effects on eelgrass. As in the previous subsection, the EIR finds that this is an incremental effect and that there is no level at which the loss of eelgrass is inconsequential.

As noted above, the District may approve the CEQA document for the Plan, and the Plan itself, subject to the adoption of feasible mitigation measures. This EIR finds that the incorporation of the feasible mitigation measures, identified below, reduces potential impacts to eelgrass, and to brant, to levels that are acceptable pursuant to CEQA.

10.4 POLICY CONSIDERATIONS FOR MITIGATING POTENTIALLY SIGNIFICANT EFFECTS

The policies recommended in the Draft HBMP largely address the potential environmental consequences of the Plan. However, this EIR finds that a modification in policies that direct the District to maintain habitat for biologically important species, and for commercially important fish species covered by the FMPs of the PFMC, is necessary in order to reduce the potential incremental and cumulative impacts to eelgrass that could result from the Plan's implementation to levels that are less-than-significant.

10.4.1 Eelgrass Maintenance as Important Wildlife Habitat

This EIR recommends that Policy CAS-1 be amended to read as follows (deleted text in ~~strikethrough~~; added text underlined):

CAS-1: Maintain biological diversity and important habitats throughout Humboldt Bay

Policy: The District shall, to the extent possible, maintain viable populations of native species in Humboldt Bay, distributed in appropriate habitats within the Bay, in a state that will maintain the ecological functions of the Humboldt Bay ecosystem. The District shall develop a plan, in consultation with local, state, and federal agencies, non-profit conservation organizations, and other interested parties, which is focused on maintaining the native biological diversity and important habitats that are present in Humboldt Bay and its watershed. The plan shall expressly address eelgrass and other habitats that are closely linked to environmentally sensitive species. The plan shall identify strategies for District adoption that will assist the District in managing or protecting native biological diversity while carrying out District operations. The District ~~may~~ shall also incorporate considerations that could result from actions proposed to the District by applicants for District approvals. The District shall adopt findings with respect to the requirements of this plan when approving District operational programs or when approving any applications for approvals submitted to the District.

10.4.2 Eelgrass Maintenance as Essential Fish Habitat

This EIR recommends that Policy CAS-2 be amended to read as follows (added text underlined):

CAS-2: Maintain and enhance conditions required by commercially important fish, invertebrate, and plant species

Policy: The District shall, to the extent possible, maintain viable populations of commercially important fish species and invertebrate species, and the habitats for these species. The District shall develop a plan, in consultation with local, state, and federal agencies, non-profit conservation organizations, and other interested parties, which is focused on maintaining the diversity of native and desired non-native fish and invertebrate species present in Humboldt Bay and its watershed. The plan shall identify strategies for District adoption that will assist the District in managing or protecting native and desirable non-native fish, invertebrate, and plant species while carrying out District operations. The District ~~may~~ shall also incorporate considerations that could result from actions proposed to the District by applicants for District approvals. The plan shall identify District responsibilities with respect to managing the population levels and habitat for commercially important native fish species and their habitats, including eelgrass, and the plan shall identify the District's responsibilities for implementing the Essential Fish Habitat recommendations of NOAA Fisheries. The plan shall also address District responsibilities with respect to managing population levels and habitat for commercially important invertebrate or plant species. The District shall adopt findings with respect to the requirements of this plan when approving District operational programs or when approving any applications for approvals submitted to the District.