Bureau of Ocean Energy Management Call for Information and Nominations
Humboldt, Morro Bay and Diablo Call Areas
Characterization of benthic habitat distribution, potential impacts and mitigation

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GENERAL DESCRIPTION OF BENTHIC HABITAT

All three Call Areas are located on the outer continental shelf (OCS), as defined by federal legislation[1], which extends seaward from 3 nm limit of California's jurisdiction to the 200 nm Exclusive Economic Zone. The legislatively defined OCS is determined by the distance from the coastline, yet the habitats located within these waters are complex, with the diverse communities being shaped by a combination of the depth, geologic and oceanographic conditions present. Benthic habitat is classified primarily based on physical substrate and depth with the continental shelf being defined generally as extending out to 200 m isobath[2]. In California, the geological shelf extends offshore to the shelf break, a steep change in slope, which occurs at 130 m in northern and central California and ranges from 80 – 145 m in southern California[2]. The Call Areas are located well offshore of the continental shelf 200 m isobath on the lower continental slope ranging in depth from 500 - 1200 m. The habitats in these deeper regions of the continental slope off California are made up primarily of soft-bottom habitat with the dominant sediment type thought to be mud[3].

The Call Areas do not overlap with any state marine protected areas nor do they overlap with any currently designated federal marine protected areas. However, connections to the grid will proceed through state waters, including possibly existing state marine protected areas. Additional and comprehensive analysis of the route and impact of the grid connection will be required to ensure to minimize impacts to the nearshore. The electromagnetic fields, noise and potential increase in vessel traffic associated with constructing and operating offshore wind energy platforms would likely have a higher impact to nearshore waters. Nearshore waters are already highly impacted, and the addition of wind energy development and operation associated stressors requires a precautionary approach to energy development in these waters. There are increased densities of marine species in nearshore waters and state waters contain additional regulatory restrictions like state marine protected areas that protect critical or rare marine habitats and species.

The seemingly featureless continental slope habitat is in fact an extremely rich ecosystem that supports infaunal and microbial communities that play an important role in nutrient cycling and

[1] Federal Offshore Lands [Internet]. Bureau of Ocean Energy Management. [cited 2019 Jan 9]. Available from: https://www.boem.gov/Federal-Offshore-Lands/

[2] Allen, M.J. 2006. Continental Shelf and Upper Slope. In: All LG, Pondella DJ, Horn MH (eds). The Ecology of Marine Fishes: California and Adjacent Waters [Internet]. University of California Press. Berkley, CA; [cited 2019 Jan 9]; p. 167-202. Available from: ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/488_continental_shelf.pdf

[3] Surpless KD, Ward RB, Graham SA. 2009. Evolution and Stratigraphic Architecture of Marine Slope Gully Complexes: Monterey Formation (Miocene), Gaviota Beach, California. Marine and Petroleum Geology [Internet]. [cited 2019 Jan 9]; 26(2):269-288. Available from: doi: 10.1016/ j.marpetgeo.2007.10.005

CO_2 exchange.[4] The microbial ecology of the continental slope oxidizes methane and sequesters carbon into marine sediments helping to mitigate climate change caused by these greenhouse gases.[5,6] We are only just beginning to understand these microbial communities and their critical role in the global carbon cycle. We do not currently have a comprehensive understanding of how these communities may react to localized or wide-spread disturbances to the deep-sea benthos. Nutrient cycling is also an important component of these communities which convert critical nutrients like nitrogen and phosphorus into biological useable forms which supports the growth and reproduction of marine organisms[7]. The slope ecosystem also supports habitat forming macro-invertebrates like sponges and corals that in turn support commercially important species of groundfish. Biogenic three-dimensional structure created by living organisms like sponges, sea pens, gorgonians and other types of coral provide shelter against predators and currents, firm substratum and increased food supply. These areas also are generally associated with high densities and diversity of fishes.[8]

Photos of deep slope benthic habitat and communities from Yoklavich et al. 2016[9]

[4] Thurber AR, Sweetman AK, Narayanaswamy BE, Jones DOB, Ingels J, Hansman RL. 2014. Ecosystem function and services provided by the deep sea, Biogeosciences [Internet]. [cited 2019 Jan 9];11:941-3963. Available from: https://doi.org/10.5194/bg-11-3941-2014.

[5] Wallmann K, Piñero E, Burwicz, E, Haeckel M, Hensen C, Dale A, Ruepke L. 2012. The Global Inventory of Methane Hydrate in Marine Sediments: A Theoretical Approach. Energies [Internet]. [cited 2019 Jan 9];5. Available from: doi:10.3390/en5072449

[6] Orcutt BN, Sylvan JB, Knab NJ, Edwards KJ. Microbial ecology of the dark ocean above, at, and below the seafloor. 2011. Microbiol Mol Biol Rev [Internet]. [cited 2019 Jan 9];75(2):361-422. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3122624/

[7] Bristow LA, Mohr W, Ahmerkamp S, Kuypers MMM. 2017 Nutrients that limit growth in the ocean. Curr. Biol. [Internet]. [cited 2019 Jan 9];27:74-478. Available from: https://www.sciencedirect.com/science/article/pii/S0960982217303287

[8] Buhl-Mortensen L, Vanreusel A, Gooday AJ, Levin LA, Priede IG, Buhl-Mortensen P, Gheerardyn H, King NJ, Raes M. 2010. Biological structures as a source of habitat heterogeneity and biodiversity on the deep ocean margins. Marine Ecology [Internet]. [cited 2019 Jan 9];31:21-50. Available from: doi:10.1111/j.1439-0485.2010.00359.x

[9] Yoklavich M, Clarke ME, Laidig T, Fruh E, Krigsman L, Anderson J, Taylor J, Romsos C. 2016. A characterization of deep-sea coral and sponge communities in areas of high bycatch in bottom trawls off northern California. NOAA Technical Memorandum NMFS-SWFSC-556 (39 p.) [Internet]. [cited 2019 Jan 9]. Available from https://swfsc.noaa.gov/publications/TM/SWFSC/NOAA-TM-NMFS-SWFSC-556.pdf

Off California, groundfish is managed by the Pacific Fisheries Management Council (PFMC) and defined as 82 species including rockfish, sablefish, flatfish, and Pacific whiting that are often, but not exclusively, found on or near the ocean floor or other structures[10]. In the deeper part of the slope there are active commercial fisheries including those for dover sole, deep-living rockfishes and thornyheads[11]. The PFMC has designated Habitat Areas of Particular Concern (HAPC), which are subsets of Essential Fish Habitat, that have a particularly important ecological role in fish life cycles or are especially sensitive, rare or vulnerable. HAPCs should be considered high priority areas for conservation because they are "rare, sensitive, stressed by development, or important to ecosystem function.[12]" While the HAPC designation does not afford additional protections, the designation helps resource managers to prioritize and focus conservation efforts.[12]

Overlap with HAPC occurs in all three Call Areas with the greatest square mile overlap occurring in the Diablo Call Area (Humboldt 7.96 mi^2, Morro Bay 45.2 mi^2, Diablo 266 mi^2). In addition to overlapping with existing HAPC, the NOAA National Deep-Sea Coral and Sponge Database, 1842-Present[13] based on observations from trawl surveys, by-catch data and other scientific surveys identifies coral and sponge resources within all three Call Areas. These resources have slow growth rates and are long-lived species that provide habitat for a range of other species including important commercial species like deep-living rockfishes and thornyheads. As an example, Black coral (Order Antipatharia) are extremely slow growing and long lived and have been aged to 174 years old in California but likely live much longer, with some species of black coral in other areas having been aged to over 1000 years old[14].

Photos of Christmas tree Black Coral from Yoklavich et al. 2013[15]

[10] Habitat and Communities: Habitat [Internet]. Pacific Fisheries Management Council. [cited 2019 Jan 9]. Available from: https://www.pcouncil.org/habitat-and-communities/habitat/

[11] Laidig, T. 2001. Continental slope communities. In: Karl HA, Chin JL, Ueber E, Stauffer PH, Henley II JW(eds.), Beyond the Golden Gate: oceanography, geology, biology, and environmental issues in the Gulf of the Farallones - U.S. Geological Survey Circular 1198 [Internet]. [cited 2019 Jan 9] p. 185-191. Available from: https://pubs.usgs.gov/circ/c1198/chapters/185-191_ContinentalSlope.pdf

[12] NOAA Fisheries West Coast Region: Essential Fish Habitat. National Oceanic and Atmoshpheric Administration [Internet]. [cited 9 Jan 2019]. Accessible from : https://www.westcoast.fisheries.noaa.gov/habitat/fish_habitat/hpac.html

[13] NOAA National Deep-Sea Coral and Sponge Database 1842 – present [Internet]. National Oceanic and Atmospheric Administration [cited 2019 Jan 9]. Available from: https://catalog.data.gov/dataset/noaa-national-deep-sea-coral-and-sponge-database-1842-present

[14] Love M, Yoklavich M, Black B, Andrews A. 2007. Age of black coral (Antipathes dendrochristos) colonies, with notes on associated invertebrate species. BULLETIN OF MARINE SCIENCE [Internet]. [cited 2019 Jan 14];80:391-400. Available from: https://www.researchgate.net/publication/228350918_Age_of_black_coral_Antipathes_dendrochristos_colonies_with_notes_on_associated_invertebrate_species

[15] Yoklavich M, Laidig T, Taylor A, Watters D, Krigsman L, Love M. 2013. A characterization of the Christmas tree black coral (Antipathes dendrochristos) community on three seamounts in the Southern California Bight from a survey using a manned submersible. Report to NOAA Deep-Sea Coral Research and Technology Program [Internet]. [cited 2019 Jan 9]; Silver Spring, Maryland. 82 p. Available from: https://swfsc.noaa.gov/publications/CR/2013/2013Yoklavich2.pdf

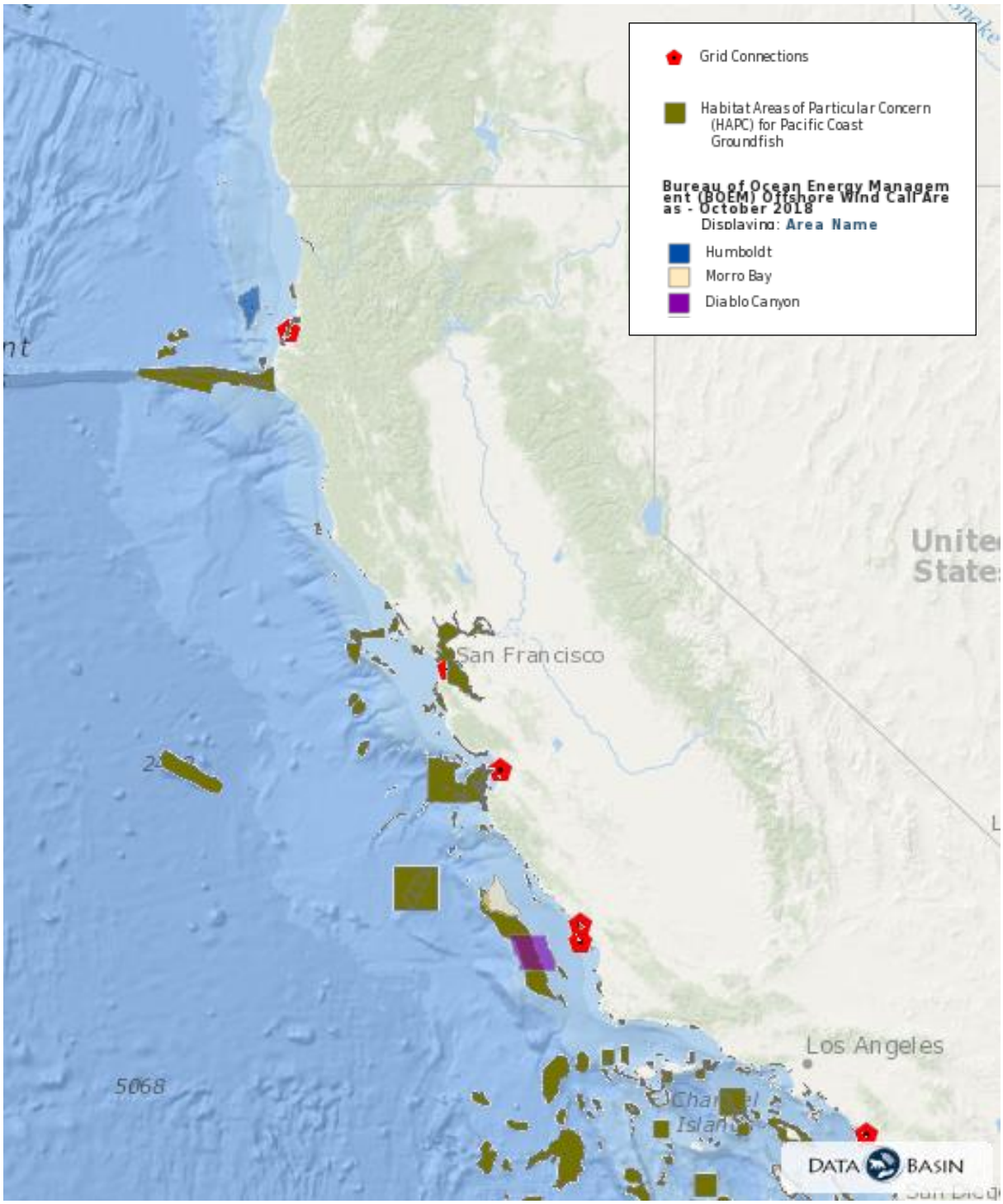

Figure 1a. Bureau of Ocean Energy Management Offshore Wind Call Areas with the Pacific Fisheries Management Council Habitat Areas of Particular Concern for Groundfish showing overlap with the Humboldt, Morro Bay and Diablo Call Areas.

Figure 1b. Detail of the Bureau of Ocean Energy Management Humboldt Call Area shown in yellow outline overlapping with the Pacific Fisheries Management Council Habitat Areas of Particular Concern (HAPC) for Groundfish shown in brown. The HAPC overlaps 7.96 mi^2 with the Humboldt Call Area.

Figure 1c. Detail of Bureau of Ocean Energy Management Morro Bay Call area shown in yellow outline overlapping with the Pacific Fisheries Management Council Habitat Areas of Particular Concern for Groundfish shown in brown. The HAPC overlaps 45.2 mi^2 with the Morro Bay Call Area.

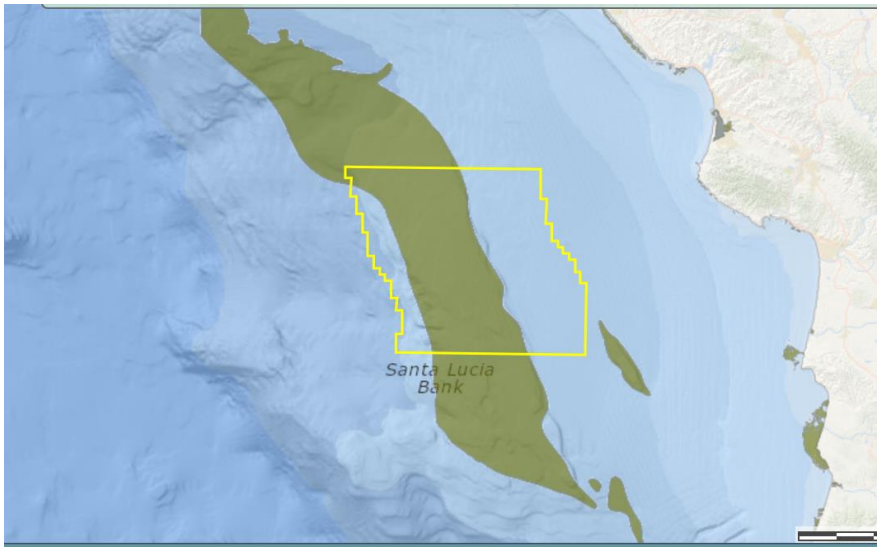

Figure 1d. Detail of Bureau of Ocean Energy Management Diablo Call Area shown in yellow outline overlapping with the Pacific Fisheries Management Council Habitat Areas of Particular Concern (HAPC) for Groundfish shown in brown. The HAPC overlaps 266 mi^2 with the Diablo Call Area.

POTENTIAL IMPACTS AND IMPACT ASSESSMENT

The benthic footprint and level of impact will depend entirely on the type of system selected and the exact location of deployment. Based on the depths of the Call Areas all types of floating offshore wind energy platforms (semi-submersible, spar-buoy, tension leg), moorings (taut-leg, catenary, semi-taut) and anchoring systems (drag-embedded, driven pile, suction pile, gravity anchor) could be used[16]. The impacts during construction and footprint vary among platforms, moorings and anchoring. A taut-leg mooring system coupled with suction pile anchors would have the smallest benthic footprint and should be assessed to determine if this combination is appropriate for the conditions in the Call Areas.

Although we have some data available describing generally the type of habitats in each of the Call Areas, detailed ground truthing of current mapping, mapping in areas where data gaps exist about the substrate and their biological communities and updated biological surveys where they have been previously done will be required to ensure the deployments sites selected minimize impact to benthic communities and avoid HAPC. New technologies such as rapid deploy landers and autonomous underwater vehicles and improvements to towed camera sleds make this work both highly feasible and affordable. It is critical that comprehensive pre-installation and ongoing-monitoring are implemented to assess not just the individual species present but also the biophysical processes. Biophysical processes encompass abiotic and biotic conditions which include the chemical, biological, physical and ecological components present. This type of monitoring will allow for assessment of impacts from installation and operation including those associated with exclusion zones for fisheries that will be established around the platforms. Traditional oceanographic sampling of the water column including instrumentation to sample

[16] Rhodri J, Costa Ros M. 2015. Floating Offshore Wind: Market and Technology Review: Prepared for the Scottish Government [Internet]. [cited 2019 Jan 9]. Available from: https://www.carbontrust.com/media/670664/floating-offshore-wind-market-technology-review.pdf

water movement and chemical components (e.g. NO^2, NO^3, CO^2, P) coupled in space and time with benthic sampling including biological sampling will be needed to accurately assess ecosystem conditions pre- and post-installation. In addition to biophysical monitoring, socioeconomic monitoring will be required to assess impacts to non-energy related commercial and recreational uses including fisheries. Currently these offshore areas are used for commercial and recreational fishing operations and any loss of fishing grounds or redirection of fishing effort due to exclusion zones being established around offshore wind energy platforms should be characterized as part of the required pre- and post-monitoring.

RECOMMENDATIONS ON CALL AREAS, DATA GAPS AND NEXT STEPS

The Humboldt Call Area has limited information available on the benthos and ranges in depth from approximately 500 m to 1100 m. The assumption based on existing maps is that the area is made up primarily of soft-sediment. Recent work by Yoklavich et al. 2016[17] with an Autonomous Underwater Vehicle (AUV) characterized 21,352 m^2 of seafloor habitat approximately 50 km to the north and south of the Call Area at a depth of 695 - 1169 m. They found soft mud sediments (85%) and some mixed rock (12%) and observed 13,758 (20 species) corals, 2549 (8 species) sponges and 5580 (18 species) fishes. This observed diversity and density of species provides strong evidence that a thorough benthic survey should occur in the Call Area to identify areas with high levels of diversity and abundance to provide siting guidance to minimize benthic impacts. The Call Area is sited between two submarine canyons, Trinidad Canyon approximately 16 km (10 mi) to the north west and Eel Canyon approximately 9 km (5.5 mi) to the south. Submarine canyons are well documented to serve as habitats, nurseries, forage areas, refugia, and carbon sequestration and storage areas[18]. It is unknown how development in proximity may affect the ecosystem functions and services provided by these canyons. We recommend a precautionary approach to development, in a phased manner starting at small pilot scale to allow for a robust assessment of impacts to both the immediate and surrounding areas.

The Morro Bay Call Area has limited information available on the benthos and ranges in depth from approximately 900 m to 1200 m. The Davidson Seamount is located approximately 30 km (49 mile) west and is part of the Monterey Bay Area National Marine Sanctuary (MBNMS) and designated as a HAPC. Directly to the east the call area abuts the MBNMS southwest and southern boundary. Directly south of the Call Area is Santa Lucia Bank which rises to 400 m from the surface and is part of a persistent upwelling cell[19,20]. This Call Area has a 45.2 mi^2 overlap with HAPC and efforts should be made to avoid anchoring in these areas. The MBNMS is home to a highly diverse array of species and habitats. It is unknown how platforms may

[17] Yoklavich, Mary, M. Elizabeth Clarke, Tom Laidig, Erica Fruh, Lisa Krigsman, Jeff Anderson, Jeremy Taylor, and Chris Romsos. 2016. A characterization of deep-sea coral and sponge communities in areas of high bycatch in bottom trawls off northern California. NOAA Technical Memorandum NMFS-SWFSC-556 (39 p.) [Internet]. [cited 2019 Jan 9]. Available from https://swfsc.noaa.gov/publications/TM/SWFSC/NOAA-TM-NMFS-SWFSC-556.pdf

[18] Fernandez-Arcaya U, Ramirez-Llodra E, Aguzzi J, Allcock AL, Davies JS, Dissanayake A, Harris P, Howell K, Huvenne VAI, Macmillan-Lawler M, Martín J, Menot L, Nizinski M, Puig P, Rowden AA, Sanchez F, Van den Beld IMJ. 2017. Ecological Role of Submarine Canyons and Need for Canyon Conservation: A Review. Frontiers in Marine Science [Internet]. [cited 2019 Jan 9];4. Available from: DOI=10.3389/fmars.2017.00005

[19] Hendy IL, Pedersen TF, Kennett JP,Tada R. 2004. Intermittent existence of a southern Californian upwelling cell during submillennial climate change of the last 60 kyr. Paleoceanography [Internet]. [cited 2019 Jan 9];19:PA3007. Available from: doi:10.1029/2003PA000965.

[20] Proposed Chumash Sanctuary: Area 2 [Internet]. Northern Chumash Tribal Council [cited 2019 Jan 9]. Available from: https://chumashsanctuary.com/area/area-2/

affect these species and habitat. A precautionary approach including phased implementation of energy development in this area is recommended.

The Diablo Call Area has limited information available on the benthos and ranges in depth from approximately 550 m to 1100 m. The western portion of the Call Area is located directly on Santa Lucia Bank and significantly overlaps (266 mi^2) with a HAPC. The NOAA National Deep-Sea Coral and Sponge Database, 1842-Present identifies significant coral and sponge observations throughout this Call Area. Generally, areas located around marine banks such as Santa Lucia Banks have complex circulation patterns and are hotspots of diversity and productivity[21]. Comprehensive baseline characterization studies will be required to document the habitats and ecological communities present. Based on current knowledge of the area the likelihood of potentially significant impacts to established benthic communities are likely higher in the Diablo Call Area when compared to Humboldt and Morro Bay Call Area. This includes the grid connection for the Diablo Call Area which would likely passing through the Point Buchon State Marine Reserve (SMR) and Conservation Area. Current state regulations do not allow development within a SMR and state policy requires state marine protected areas to be managed to promote areas of minimal human disturbance[22]. It is recommended that in addition to comprehensive surveys of Santa Lucia Bank efforts should be made to focus development outside of the HAPC. Within the Diablo Call Area there is approximately a 200 mi^2 section that does not overlap with the HAPC. Locating development in this inshore section of the Diablo Call Area outside of the HAPC may significantly reduce benthic impacts and should be explored as a priority for development in consideration of other impacts to species of concern such as marine mammals, forage fish and birds.

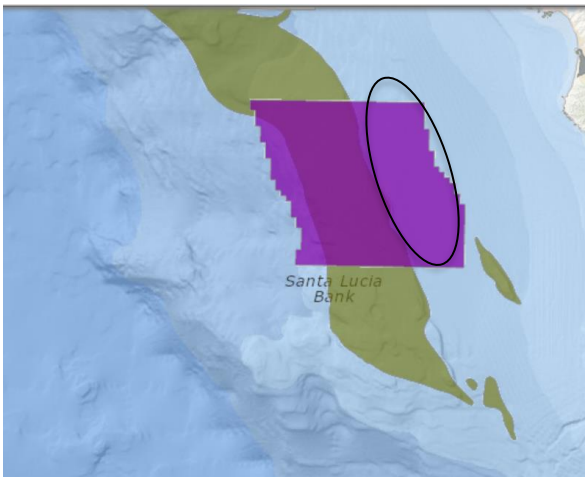

Figure 2. Bureau of Ocean Energy Management Diablo Call Area (purple) overlapping with Pacific Fisheries Management Council Habitat Areas of Particular Concern (HAPC, brown) for Groundfish. Black circle indicates approximately 200 mi2 located on the inshore area of the Call Area that should be explored as the priority location within this Call Area due to the likelihood it could reduce benthic impacts.

[21] Yoklavich M, Wakefield W. 2015. Pacific Coast Region. In: Our living oceans: habitat: Status of the habitat of U.S. living marine resources [Internet], [cited 2019 Jan 9]; p. 189-221. NOAA Technical Memorandum NMFS-F/SPO-75. Available from: https://swfsc.noaa.gov/publications/CR/2015/2015Yoklavich.pdf

[22] Marine Life Protection Act. California Department of Fish and Wildlife [Internet]. [cited 2019 Jan 9]. Available from: https://www.wildlife.ca.gov/Conservation/Marine/MPAs/MLPA

APPENDIX 1

DATA ARCHIVES SEARCHED AND DATA NEEDED TO BE ADDED TO DATABASIN
https://csumb.edu/undersea - nothing for call areas currently but library is being updated so may be a source at some point including information on nearshore benthos for cable pathway
https://data.cencoos.org/#metadata/234576d4-347b-4c69-a986-1792c3023c8e/124bf65c-56c3-43cc-b5bc-68741a571444 - ROV benthic transects nearshore off Los Osos
https://data.cencoos.org/#metadata/234576d4-347b-4c69-a986-1792c3023c8e/f8947e4a-1a57-46be-8018-4598dec1d261 - ROV benthic transects south of Eureka
IOOS Trinidad line runs right through Humboldt Call Area data needs to be added to (chemical, physical and biological summaries) data basin
https://caoffshorewind.databasin.org/
http://calcofi.org/index.php -
https://erma.noaa.gov/southwest/erma.html
https://data.cnra.ca.gov/
https://www.energy.ca.gov/renewables/offshore_energy/documents/
http://www3.mbari.org/data/mapping/NorCal_Oregon_Margin/Transit_1F.htm - this has a section of the Humboldt Call Area in high res bathymetry and should be added to databasin
https://tos.org/oceanography/article/strataform-a-program-to-study-the-creation-and-interpretation-of-sedimentar this may provide more detailed information on benthos of Humboldt call area