What follows is an updated version of a letter originally submitted to the PFMC on September 2, 2015 with the addition of 36 signatories, making a total of 137 as of September 14, 2015.

September 14, 2015

Dorothy Lowman, Chair
Pacific Fishery Management Council
1100 NE Ambassador Place, #101
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RE: Scientists statement on habitat protection for waters beyond 3,500 meters (public comment for agenda item H.8)

Dear Chair Lowman and Council Members,

We the undersigned 137 marine scientists write to request that you include an alternative for closing federally managed waters deeper than 3,500 meters to bottom trawl fishing gear in your upcoming habitat amendment to the Groundfish Fishery Management Plan (FMP). We appreciate the previous steps taken by the Pacific Fishery Management Council (Council) to protect unfished deepwater areas, including the existing bottom trawl closure of seabed between 1,280 meters and 3,500 meters water depth.[1] We also appreciate your past attempt to include waters deeper than 3,500 meters in this protective closure. [2] While that previous attempt was ultimately unsuccessful, new information on the area, a bolstered legal authority for habitat protection, and the current FMP amendment now provide another opportunity to protect this area.

Our scientific understanding of the area in question is still quite limited and yet we know that it has the paired attributes of value and vulnerability that justify protection. The deep sea is of critical importance to the global ecosystem and human society, providing a variety of services that support, provision and regulate everything from shallower-water productivity to the global climate.[3] An ecosystem-based approach to fisheries management (EBFM), which this Council has increasingly used in its decision-making, calls for recognizing the intrinsic value and vulnerability of these pristine deep-sea habitats and protecting them until the potential impacts of any human activity that might be authorized in the future are fully understood and addressed.

Deep-sea areas and their characteristics:

The deep sea, including the abyssal plain areas now under consideration for protection by the Council, is crucial to our lives and to the health of global oceans. The deep sea provides a host of important ecosystem functions and services. It helps reduce the impacts of anthropogenic carbon release by transporting, oxidizing and storing greenhouse gasses like carbon dioxide and methane.[4] It provides important natural resources to humans, from fish stocks to potential new medicine, mineral or energy resources.[5] Off the U.S. west coast, the upwelling that makes the California Current one of the most vibrant and productive marine ecosystems in the world is an example of deep-sea nutrient regeneration, where the bounty of the deep sea is brought back to the surface to fuel primary production and thus harvestable fish stocks.[6] Finally, the living marine habitat of the deep sea, including the corals found beyond 3,500 meters off California, are a crucial foundation of this important ecosystem. In fact, scientists refer to cold-water corals found on deep shelf, slope,

and abyssal plain habitats as "ecosystem engineers" because of their role in creating habitats used by invertebrates and fish.[7]

The deep-sea floor can generally be divided into two broad zones: continental margins (~ 200 meters to 4,000 meters depth) and abyssal plains (generally dominated by soft sediments and found from ~ 4,000 meters to 6,000 meters depth).[8] Within these broad zones there are important regional habitats that inject additional structural and biological diversity, such as seamounts, canyons, hydrothermal vents and methane seeps. Combined, deep-sea ecosystems are the largest environment on Earth, with over 63% of the surface area of the globe found deeper than 200 meters. Marine life is similarly concentrated here: 50% of total marine benthic biomass is found below 3,000 meters.[9]

Unprotected seafloor deeper than 3,500 meters makes up ~ 40% of federally managed ocean waters in the Exclusive Economic Zone (EEZ) of the U.S. West Coast. This area is found off California south of the undersea feature known as the Mendocino Ridge. The diversity of habitats found in this region has long been recognized, for example the National Oceanic and Atmospheric Administration's Fisheries Service (NOAA Fisheries) describes this area as follows: "*features that occur beyond 3500m include hydrothermal vents, soft-bottom sediments, and hard bottom areas with biogenic habitats such as deep sea corals.*"[10] While the presence of these features is recognized their location and abundance is still largely uncharted. For example, it is estimated that globally over 100,000 seamounts over one kilometer in height remain uncharted.[11]

Despite its vast size and importance as an ecosystem, the deep sea remains among the least known and understood environments on Earth. According to a National Research Council report, some estimates suggest that as much as 95 percent of the world ocean and 99 percent of the ocean floor are still unexplored.[12] This limited exploration presents fundamental and recognized challenges to sustainable management of extractive industries in the deep sea. For example NOAA's Deep-Sea Coral Research and Technology Program states that "*Currently, it is impossible to ascertain the overall extent of deep coral communities, much less their condition or conservation status in U.S. waters, because so many of the deeper areas these communities inhabit have been explored incompletely or have not been explored at all.*"[13] The deep sea off the U.S. West Coast is no exception. NOAA Fisheries recently described the state of deep-sea habitat surveys in this area: "*seabed habitat mapping has been conducted only over continental shelf and slope and inland seas, and coverage of those areas is very patchy across the West Coast. The abyssal plain and continental rise remain largely un-described for seabed type and extent.*"[14]

Despite the limits of our knowledge, we have learned enough to say that the deep-sea floor is a vibrant ecosystem whose biodiversity rivals that of coral reefs.[15] The deep-sea floor features extensive areas of living marine (biogenic) habitat, three dimensional structures created by organisms including corals and sponges. Deep-sea corals are fragile, bottom-dwelling animals that grow at depths greater than 50 meters with certain species capable of living for more than 4,000 years if undisturbed.[16] Throughout their extensive lives, deep-sea corals are thought to form essential fish habitat.[17] While we do not know the precise distribution of deep-sea corals off California, we do know they occur in the federally-managed waters deeper than 3,500 meters.[18]

While corals are obvious epicenters of biodiversity, much of the total deep-sea diversity is found living in or on mud. These are areas fueled by a steady but slow diet of falling "marine snow" (comprised of mucus, fecal matter, and body parts) with periodic and dramatic "feasts" of organic matter delivered quickly due to a bloom of marine creatures miles above on the surface.[19]

Occasionally larger food deposits occur, such as "whale falls" that bring an unexpected bounty of food to the deep sea and result in a unique community that can persist for a century.[20] Each of these deposits to the deep sea bring with them carbon from the atmosphere, helping to mitigate global climate variability. Concurrently, the activity of animals on the seafloor release the nutrients trapped in this deposited food so they may later fuel the phytoplankton that shallower water fisheries need to thrive.[21]

In addition to the supporting and regulating services that the deep-sea delivers, the mystery of the deep sea provides important cultural and historical services to society. Each new scientific expedition to the deep ocean floor yields new discoveries ranging from novel species, such as a carnivorous sponge found off California,[22] to entirely new habitats, such as new methane seeps found right offshore of San Diego in 2012.[23] In December 2014, deep-sea life made headlines all over the world when an expedition to the Mariana Trench set a new world record for the deepest observation of a living fish, an unidentified and possibly new species of snailfish filmed at 8,143 meters (26,872 feet).[24] Just this year off California, researchers from NOAA led a team that located and surveyed the wreck of the World War Two aircraft carrier USS *Independence* in water half a mile deep within the Gulf of the Farallones National Marine Sanctuary.[25]

These areas and the services they provide are not impervious to human impacts.[26] Climate change is expected to pervasively impact the functions of the deep sea in several ways as a result of ocean acidification, declining oxygen and productivity, and increasing temperature.[27] In addition to these global stressors, the deep sea and its ecosystem services are under increasing demand and pressure on multiple fronts, including fishing, hydrocarbon extraction, and mining.[28] NOAA Fisheries, discussing the seafloor beyond 3,500 meters off California, stated that "*all or most of the deep sea environments are likely to be highly sensitive to impact, including very low levels of fishing effort (e.g. a single trawl), and have extended recovery times (over 7 years). Thus, they can be very sensitive to bottom trawling and would take a long time to recover from this impact*."[29]

The aforementioned extensive lifespan of deep-sea corals is clearly irreconcilable with requirements in U.S. fisheries law to minimize adverse effects to essential fish habitat that are more than minimal and not temporary, as any fishing impacts cannot be considered temporary on human time scales.[30] The impacts of trawling on these communities has also been shown: deep-sea coral communities that have experienced trawling have a three-fold decrease in the diversity and density of fauna present.[31]Further, impacts such as this that result in biodiversity loss have been found to result in an exponential decline in the functions that occur in the deep sea.[32] There is little question that deep-sea habitats will be exposed to multiple human impacts in the coming decades with unknown ramifications to the ecosystem services they provide. However physical disturbance from extractive fishing practices, if it occurs, would likely exacerbate or overshadow these other stressors by modifying the structure and biodiversity of the deep.

Protecting pristine deep-sea floor is consistent with an ecosystem-based approach:

Almost twenty years ago, in its report to Congress, the Ecosystem Principles Advisory Panel (EPAP) articulated basic policies for implementing EBFM that included two key recommendations consistent with a precautionary bottom trawling closure beyond 3,500 meters: (1) proactively evaluate the effects of potential new fisheries in advance and (2) apply the precautionary approach.[33] Additionally, the EPAP further articulates the importance of habitat protection in its report for both target and non-target species.[34] More recently, over 200 scientists and policy experts

developed a consensus statement on EBFM that highlighted scientific understanding of marine ecosystems and articulated the vision of the scientific community when it recommends ecosystem-based management for the ocean. This 2005 statement includes recommendations that bolster the case for protecting the abyssal plain areas off California now. In particular, the signatories to this statement include the following as one of nine key elements of marine ecosystem based management: "*Require evidence that an action will not cause undue harm to ecosystem functioning before allowing that action to proceed*."[35] They also articulate what it means to apply a precautionary approach, stating that "*levels of precaution should be proportional to the amount of information available such that the less that is known about a system, the more precautionary management decisions should be."*[36]

Conclusions

In light of the current lack of information on the remote seafloor beyond 3,500 meters, including the fact that corals and other biogenic habitat are known to exist there but are largely unmapped, it is clear that a precautionary closure is appropriate. The impacts of fishing there cannot be adequately estimated or analyzed at this time given current information, except to say that there would almost certainly be detrimental impacts.

Therefore it is the consensus of the undersigned scientists that protection of this valuable and vulnerable area is a sensible and scientifically defensible action. It is consistent with the best scientific information available and with an ecosystem based approach to management. We recognize and appreciate the past efforts of the Council to implement an ecosystem based approach and to protect important habitats, and we now encourage you to include alternatives to close waters beyond 3,500 meters to bottom trawling.

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International Signatories: Many of the ecosystem services provided by the deep sea extend far beyond the jurisdictions of one country. While the stakeholders for the extractable resources in this area are U.S.-based, the stakeholders for the regulating services provided by the deep sea are the global population. As the alternative proposed here has ramifications far outside of the U.S. EEZ, we have included signatories from outside of the U.S. to show support for this letter.

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Notes:

[1] PFMC, Amendment 19 Final EIS, December 2005, page ix
[2] Ibid.; see also NOAA Fisheries, Amendment 19 Record of Decision, March 2006, pp. 24-25
[3] Thurber, A.R., Sweetman, A.K., Narayanaswamy, B.E., Jones, D.O.B., Ingels, J., Hansman, R.L. 2013. Ecosystem function and services provided by the deep sea. Biogeosciences 11(14), 3941-3963.
[4] Ibid.
[5] Ibid.
[6] Ibid.
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