WRITTEN TESTIMONY OF

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FOR

'SOUTHERN CALIFORNIA OIL LEAK: INVESTIGATING THE IMMEDIATE EFFECTS ON COMMUNITIES, BUSINESSES, AND THE ENVIRONMENT"

OCTOBER 18, 2021

Chair Porter, Chair Lowenthal, and Members of the Committees:

Thank you for the invitation to participate in the hearing "*Southern California Oil Leak: Investigating the Immediate Effects on Communities, Businesses, and the Environment.*" It is my honor share my experience and knowledge about the impacts of marine oil spills and to recommend actionable steps toward fewer and less harmful marine spills in the United States. This statement reflects my personal professional views and does not necessarily represent those of my institution, the University of California at Santa Barbara.

I am a Professor of Earth Science and Biology at the University of California Santa Barbara and hold the Norris Presidential Endowed Chair. I also lead the Marine Science graduate and undergraduate programs and participate in a variety of other marine research and educational activities. I specialize in the interaction of chemicals and microorganisms in the marine environment and have authored over 130 scientific publications. In particular, I have devoted over two decades investigating the fate and impacts of hydrocarbons in the marine environment, initially focusing on natural oil and gas seeps and then later turning my interest to major spills including the 2010 Deepwater Horizon blowout in the Gulf of Mexico and 2015 Refugio Beach Oil Spill along the Gaviota coastline. I was directly involved with these oil spills through independent scientific investigation of environmental processes, engagement with the Unified Command, and direct involvement with the trustees of the Natural Resource Damage assessment. I have extensive personal experience investigating the behavior of oil, gas and petrochemical products in the environment that includes spill response activity, hundreds of hours of bottom time with scuba as well as crewed, remote and autonomous submersibles, dozens of oceanographic expeditions, and numerous coastal sampling campaigns. I have also studied and written about other spill events and recently uncovered evidence for sloppy dumping of the chlorinated pesticide, DDT (and other petrochemical wastes), in the deep ocean offshore from the site of the Pipeline P00547 rupture[1,2]. I have also served on two relevant panels of the National Academy of Sciences: The Use of Dispersants in Marine Oil Spill

[1] Kivenson V, KL Lemkau, O Pizarro, DR Yoerger, C Kaiser, RK. Nelson, C Carmichael, BG Paul, CM Reddy, DL Valentine (2019) Ocean dumping of containerized DDT waste was a sloppy process Environmental Science and Technology 53(6) 2971-2980. https://pubs.acs.org/doi/full/10.1021/acs.est.8b05859

[2] Xia, R. A Toxic Secret Luks in the Deep Sea https://www.latimes.com/projects/la-coast-ddt-dumping-ground/

Response[3] and Spills of Diluted Bitumen from Pipelines: A Comparative Study of Environmental Fate, Effects, and Response[4]. Lastly, I am a former resident of both Santa Ana and Irvine, CA, and I hold a PhD in Earth System Science from the University of California at Irvine.

For the past two weeks I have closely watched the Pipeline P00547 Incident unfold and offered my expertise to inform the public about this unfortunate event. I have provided ten or more interviews to local and national media to communicate scientific insight to the public. I have engaged with multiple independent groups of area scientists toward informing scientific response activities and have engaged in discussions with my worldwide network of expert scientists. I have conducted background research on the spilled oil, production in the Beta Field, and the local oceanographic conditions. I also spent a full day visiting the Orange County Coastline from Seal Beach to Laguna Beach, to hone my insight and provide me with first-hand knowledge. In addition to my academic and communication work, I am also providing expert support to the state of California.

Oil Spills Overview.

Oil spills have far reaching impacts. They cause environmental damage, psychological distress, economic disruption, and other social challenges. Each spill is also unique, and while it is instructive to learn from past spills, it is also prudent to avoid absolute comparisons between events. I will limit my written testimony today to consider the causes and consequences of environmental impacts from spilled oil, with a focus on the Pipeline P00547 Incident.

In considering potential impacts from an oil spill event, numerous factors come into play including the quantity, location and properties of the discharge, the circumstances of the release, transport pathways to the coastline, weather and ocean conditions, locations of sensitive habitats, and actions to mitigate damages. The outcome of these events is also dictated by availability of infrastructure, resources, and personnel. To contextualize my discussion of environmental impacts, I will begin by contextualizing key activities that are undertaken in response to an oil spill.

Anatomy of an oil spill response.

To understand the environmental impacts of an oil spill, it is useful to understand the contextual factors that currently exist to mitigate those impacts. The occurrence of a major oil spill triggers a series of interdependent responses that are rooted in both state and federal legal and regulatory frameworks (see Figure 1 for an overview).

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[3] National Academies of Science, Engineering and Medicine's Committee on the Evaluation of the Use of Chemical Dispersant in Oil Spill Response (2019) The Use of Dispersant in Marine Oil Spill Response. National Academies Press. 342 pages. https://www.nap.edu/catalog/25161/the-use-of-dispersants-in-marine-oil-spill-response

[4] National Academies of Science, Engineering and Medicine's Committee on the Effects of Diluted Bitumen on the Environment (2015) Spills of Diluted Bitumen from Pipelines: A Comparative Study of Environmental Fate, Effects, and Response. The National Academies Press, ISBN 978-0-309-38010-2. 180 pages. https://www.nap.edu/catalog/21834/spills-of-diluted-bitumen-from-pipelines-a-comparative-study-of

A core component to combatting an oil spill is the formation of an incident command structure to guide response activities and deployment of resources. While the responsibility for immediate mitigation of discharge and impacts falls to the responsible party, these activities are typically guided by a lead on-scene coordinator – an officer of the US Coast Guard for major marine spills such as the Pipeline P00547 Incident. A host of state, federal and local agencies contribute to these response efforts toward the common goal of "preventing a bad situation from getting worse". A reasonable way to explain this component of the response is that it ends when there are no longer actionable items – very much like a firefighter returning to the station after combatting a fire.

I can offer a view on the response process as it relates to spill impacts, based on participation in two previous spills, engagement with the response community in the context of preparedness, and service to the National Academy of Science on two related study panels.

The mitigation of spill impacts benefits from a regulatory framework that considers the relationship between spill potential and location and sets the requirement for deployable assets by worst case release and proximity to sensitive habitats (see Figure 2 and associated source document for an example from the Beta oil field). Spill impact mitigation also benefits from the extensive planning process that goes on behind the scenes in the spill response community. Here in EPA's Region 9 there are quarterly meetings in which federal, state and local agencies along with other relevant entities meet and discuss the response trade. These groups also hold training exercises to test their readiness and consider possible spill scenarios, and conduct after-action reports to assimilate lessons from past events. While this system is imperfect and can be frustrating to outsiders, it is a highly functional approach and remains the envy of those in many other nations.

I offer this background because a major goal of the response efforts is to minimize the impacts of a spill, on humans and the environment. In the case of the Pipeline P00547 Incident we have seen extensive cleanup efforts on the water, along the beaches and in select wetlands over the past two weeks, which are relevant when considering the overall impacts.

In addition to the incident command structure, there are other response activities that may occur simultaneously. One key activity is the Natural Resource Damage Assessment process. Under ideal circumstances, this is a cooperative process conducted jointly by trustee agencies (representing federal, state and tribal entities) and the responsible party. The goal of this process is to determine the damages that occurred to natural resources, compensate the public for the loss of those resources, and return the injured resources to their original condition. Importantly, damages identified in this process are ultimately rooted in their economic value and there is an important distinction between damages (which carry an economic toll) and environmental impacts (which may not carry a demonstrable economic toll). The Natural Resource Damage Assessment process typically begins with preassessment at the onset of a major spill, but can progress well beyond the lifetime of the incident command, as scientific studies are performed to assess long term damages.

In parallel with the formal incident response and damage assessment processes, other response activities may also occur including various investigations related to regulatory compliance, violations of e.g., the clean water act, or criminal actions. For example, the response to the Refugio Beach Oil Spill included a failure investigation by the Pipeline and Hazardous Material Safety Administration. There was also a criminal investigation of the responsible party by the State of California, which ultimately lead to a felony conviction – a case in which I testified as an expert for the prosecution.

Oil Spill Impacts

The environmental impacts of marine oil spills occur within the unique context of the affected environment, but also within the context of response activities, chemical and physical processes, and the longevity of oil in the environment. There is a saying in the oil spill community that "no two spills are the same", which also pertains to the impacts of spills.

As a preface to discussion on impacts, it is important for me to note that I do not study the ecology of animal and plant communities or toxicology, but that my expertise borders these areas insomuch as I investigate the composition of oil, the microbial processes associated with oil, and other aspects of oil's behavior in the marine environment. Here I will frame my discussion of impacts from the perspective of my expertise. Also note that I do not discuss economic or psychological impacts that result from major spills.

In considering potential impacts for an offshore spill I subdivide potential oil exposure pathways in both time and space. I do this because it is useful to superimpose the chemical and physical changes to the oil with the environments that oil might encounter. Here I outline some primary areas that I consider, and provide a first order commentary on the relative importance of each phase or process for the Pipeline P00547 Incident.

The first phase I consider for subsurface release is from the point of oil discharge to the sea surface. Key processes to consider at this stage are the spontaneous formation of microdroplets at the point of pressurized discharge and the dissolution of low-molecular weight hydrocarbons during the buoyant rise of the oil from the sea floor to sea surface. Both mechanisms lead to trapping of hydrocarbons within the ocean's water column. For the Pipeline P00547 Incident, the discharge depth was reportedly around 95 feet and the pipeline pressure was reportedly 21-28 atmospheres (ambient pressure at this ocean depth is ~4 atmospheres). Based on these and other factors, it is possible that microdroplet formation occurred and likely that some dissolution occurred, but for these circumstances I would predict that only a very small fraction of the oil's mass was affected.

The second phase I consider is for oil at the sea surface, from the time it surfaces until the time it encounters a shoreline environment. During this phase oil typically forms a slick at the sea surface where it can impact animals that inhabit this interface. Slicks can occur at different thicknesses and can spread or contract depending on the ambient conditions – notably winds and sea state. Slicks are also subject to natural weathering processes with evaporation and photochemical transformation leading to changes in chemical composition and physical properties of the spilled oil. Slicks can also incorporate other floating material such as kelp and seagrass, forming floating aggregates. These processes can each impact the exposure potential from oil at the sea surface. For the Pipeline P00547 Incident, nearly all the released oil would have formed slicks, and substantial quantities of oil rapidly reached the shoreline of Orange County. However, a key unknown factor is the quantity of oil that was transported away from the coastline and further into the open ocean – which would effectively drive a prolonged surface exposure commensurate with extended weathering of the oil.

The third phase I consider is typically the most apparent in the course of a spill – inundation of the coastline. The coastline of Orange County includes a combination of sandy beaches, wetlands and rocky shoreline, and oil from this spill encountered each of these environments. A complete accounting of potential impacts to each of these settings is beyond the scope of this testimony, but I would point to wetlands in particular as an exemplary area of concern. Oil can enter these sensitive habitats driven by tidal flow and then become trapped, leading to prolonged exposure. What's more, cleanup activities themselves in wetlands can cause substantial damage, requiring a detailed decision process to balance between the lesser of two ills – accept the damages from prolonged oiling or cause damage in the act of remediation. The oil inundation at Talbert Marsh and the subsequent cleanup efforts represent a case study of this issue.

The fourth phase I consider is the fate of oil after encountering the shoreline environment. For rocky coastline and wetland environments, oil may become trapped by any of several mechanisms. In the case of rocky coastline, oil may stick to rocks and weather in place, gradually forming a solid coating on the rock, or may become otherwise trapped in this highly textured setting. In the case of wetlands, oil may adhere to vegetation or become incorporated into sediments in quiescent areas. In both settings oil may also be drawn back out to sea. Impacts from exposure are possible for these and other scenarios.

The sandy beach environments along Orange County's coastline require additional consideration because this is an environment in which submerged oil can form with potential impacts to seafloor and water column biota. I base this claim on prior experience including observations from the 2015 Refugio Beach Oil Spill – which also occurred from a pipeline rupture of crude oil and inundated sandy beaches (see Figures 3 and 4 for examples of submerged oil from the 2015 Refugio Beach Oil Spill). The combination of high energy waves, abundant sand and highly adhesive crude oil leads to the formation of oil-mineral aggregates in this setting – as wave action mixes oil with sand. The incorporation of minerals (i.e., beach sand) into a highly adhesive oil matrix increases the bulk density of the oil aggregates (see Figure 5 for an example of an oil-mineral aggregate associated with this incident). This is important because the density of such aggregates can readily match or exceed that of seawater, meaning that the resulting aggregates will no longer float at the surface if and when they are drawn into the surf zone by waves and tides, but can become suspended in the water column or be transported at or near the sea floor. I refer to such oil here as submerged oil. The potential relevance to the Pipeline P00547 Incident is that initial beach oiling events can drive formation of submerged oil particles in the early stages of a spill within the first tidal cycle following beach oiling. Once submerged, neither the transport of this oily material, its biological effects, or its propensity to be regurgitated back onto the shoreline are well understood, pointing to a clear scientific need to better understand these processes.

While such aggregates of submerged oil can be colloquially categorized as 'tar balls' or 'tar mats', it is important to note that at the point of formation these aggregates incorporate the same chemical components as were present in the crude oil from which they formed, including toxic components such as polycyclic aromatic hydrocarbons. The composition of such aggregates can change over time, through gradual leaching, chemical modification, microbial metabolisms, or combined effects, potentially driving exposure to nearby biota.

The formation of submerged oil is not unique to California, but seems to be pervasive here. The reasons for this are because our geography is conducive to sandy beaches (particularly in the southern part of the state), our beaches experience high wave energy due to exposure to the open Pacific, and much of our offshore oil production comes from geologic reservoirs that are prone to heavy, viscous oils by nature of their depositional, tectonic and thermal histories.

Further Considerations

The scientific knowledge that underpins our understanding of oil spill processes has been greatly improved through recent technological advances in areas that include ocean observation, computational modelling, analytical chemistry and molecular microbiology. Nonetheless, our understanding is insufficient to accurately account for the fate of discharge for many marine spills, meaning that for many incidents we don't even know where all the oil goes in the environment. The support for research on oil spill science is highly episodic and generally tied to the previous big disaster. In my opinion there is a need for stable research support in the oil spill area that incorporates baseline environmental studies as well as both applied and basic research questions. Having trained numerous graduate students and postdoctoral scholars, I would also point out that research in this area provides an excellent opportunity to train a diverse and technically savvy workforce in STEM disciplines.

Oil production and transport along the CA coast has been an environmental threat even preceding the first drilling of offshore wells here 125 years ago. The Pipeline P00547 Incident serves as yet another reminder of the consequences for offshore oil production. However, this is not the only pollution threat faced by the California coast, and I argue that our understanding and preparedness for marine pollution events needs to account for more than just oil spills. There are three events I would point to as being potential harbingers of future trends. First is the 2020 grounding of the *M/V Wakashio* in Mauritius. The oil that spilled in this incident was a very low sulfur fuel oil, a new formulation that punctuates the changes to the marine transportation industry and may exhibit different environmental behaviors compared to traditional fuel oil. Second is the combined nurdle-oil-nitric acid spill that occurred off Sri Lanka in 2021 following the fire aboard the *M/V X-Press Pearl*. Nurdles are a very small pellets of plastic (~5mm in this instance) which serve as raw material in the manufacture of plastic products, and this spill saw a combination of burnt and unburnt nurdles inundate the coastline of Sri Lanka. Third, I would point to the 2019 beach oiling in Brazil. This incident saw over 1000 miles of oiled coastline, yet the source of the oil has yet to be identified. Events of these types could readily occur off the coast of California and elsewhere in the US, and point to the need for broader preparedness and additional scientific inquiry. Notably, seemingly atypical events such as the multi-component spill of the *M/V X-Press Pearl* may be more likely to occur with the buildup of vessels outside ports related to delays in loading and offloading of cargo. From my vantage, marine spill events are often triggered by atypical circumstances.

The distinction between cleanup and recovery is an important consideration for the environmental impacts of oil spills. The past two weeks have seen an impressive cleanup operation as teams of workers have scoured the waters and coastline to recover actionable oil. However, cleanup does not equal recovery, and actionable oil does not equal all oil. Recovery of nature from an oil spill includes a complicated network of ecological and environmental processes that may respond differently to initial oiling versus long term exposure. As a result, recovery can be slow to occur and difficult to predict, particularly when baseline pre-spill conditions are not established. While complete recovery from a spill necessarily takes as long as the slowest component, it can be useful to separately consider different components of the environment. While I do not have specific answers for the timing of recovery for the Pipeline P00547 Incident, I would suggest to frame the discussion of this topic around the specific settings such as wetlands, tide pools, rocky shoreline, sandy beaches, harbors, intertidal zone, subtidal zone etc…

Finally, I will close by highlighting some knowledge gaps I view as 'soft spots' in our understanding of impacts relevant to the Pipeline P00547 Incident. The first pertains to the fate and impacts of submerged oil, including oil on the seafloor, buried within the sand and sediment, and suspended in the water column. Simply put, we don't know enough about the underlying processes to predict the long term impacts from this oil. The second pertains to the chemical transformation that occurs for oil exposed to sunlight, particularly the potential for production and release of toxic photoproducts from otherwise non-toxic components of the oil. The third pertains to the ecosystem wide effects of multiple stressors. Much of the Orange County coast, particularly around the wetland areas of Newport Beach and Huntington Beach, is heavily populated. Such population and associated industry creates a host of stressors on the natural ecosystem. The addition of oil pollution to this setting adds additional stress to the ecosystem, with impacts that can be difficult to predict.

I appreciate the opportunity to testify before you today and am prepared to respond to any questions from members of the Committee.

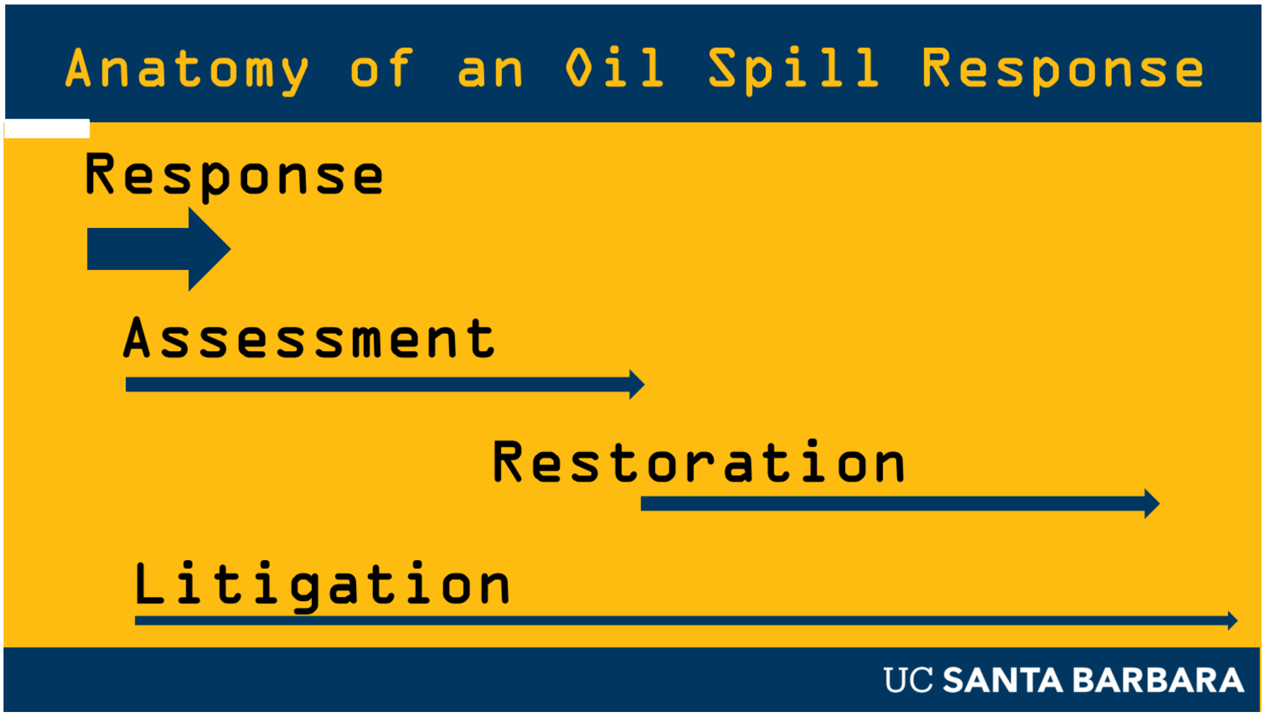

Figure 1. Anatomy of an oil spill response.

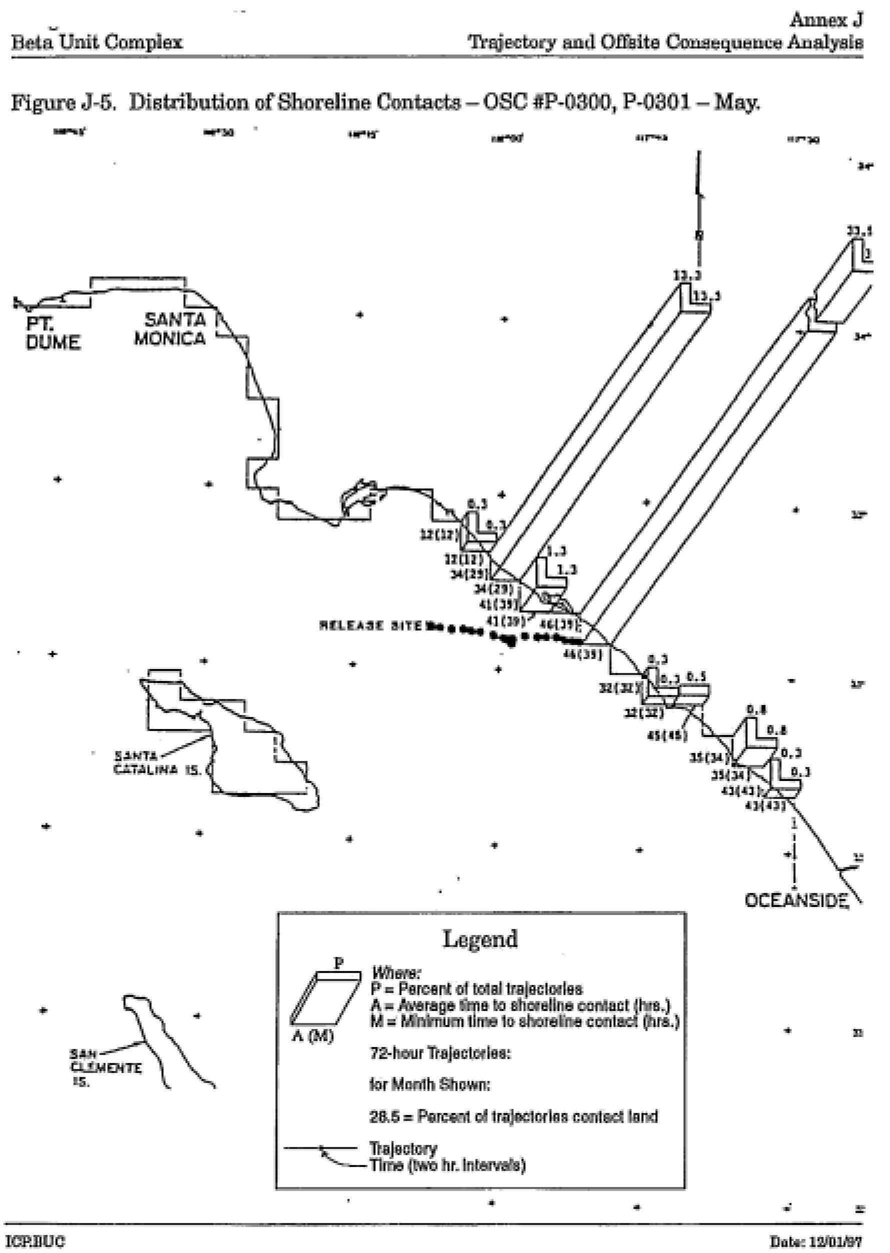

Figure 2. This map demonstrates one model projection for shoreline oiling for a discharge from the Beta oil field. This document was published in 2012 as part of the Oil Spill Prevention and Response Plan for the Beta oil field that includes the oil transport from Platform Elly to shore. Available from: https://www.bsee.gov/sites/bsee.gov/files/oil-spill-response-plan-osrp/inspection-and-enforcement/beta-operating-company-osrp-april-2012.pdf

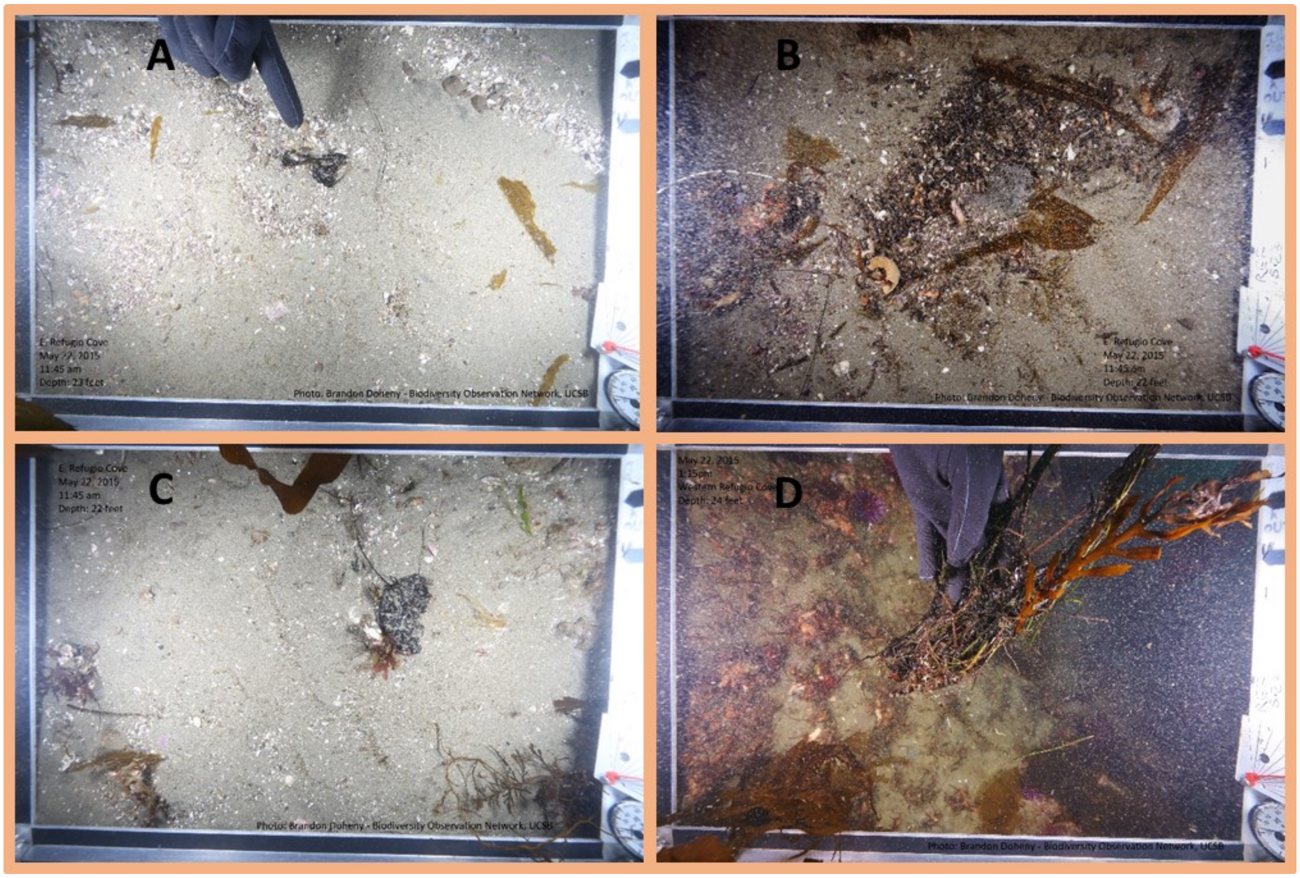

Figure 3. Images collected by scuba divers in the subtidal zone during the Refugio Beach Oil Spill in 2015. Each image displays an occurrence of submerged oil at the sea floor. For additional details see DL Valentine, Benthic Oiling from the 19 May 2015 Line 901 Rupture at Refugio: A Compilation of Evidence, in the Administrative Record of the Refugio Beach Oil Spill (URL: https://pub-data.diver.orr.noaa.gov/admin-record/6104/VSCS_Final_Report_Submerged_Oil_r052819.pdf).

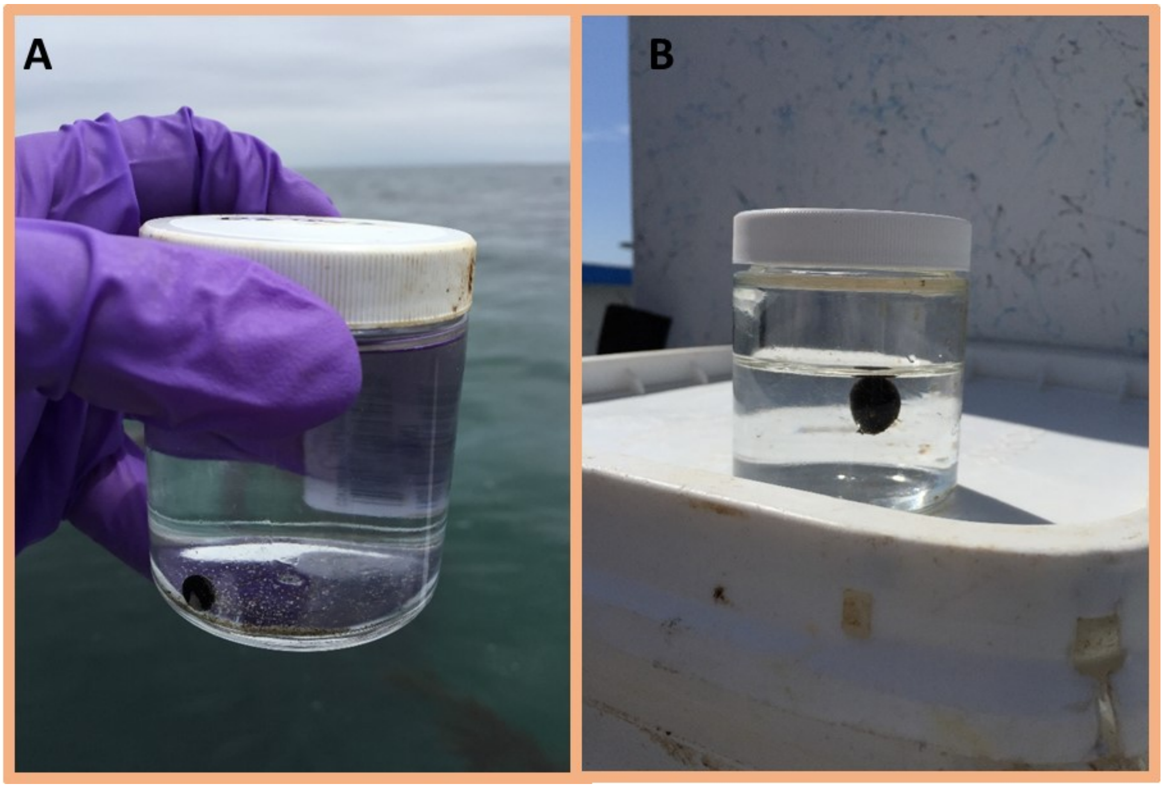

Figure 4. Images of submerged oil samples from the Refugio Beach Oil Spill. A) This negatively buoyant sample was collected by a scuba diver near the sea floor and sank when placed in a container with seawater. B) An oil aggregate/droplet with slight positive (but near neutral) buoyancy, collected immediately beneath the sea surface. For additional details see: DL Valentine, Benthic Oiling from the 19 May 2015 Line 901 Rupture at Refugio: A Compilation of Evidence, in the Administrative Record of the Refugio Beach Oil Spill (URL: https://pub-data.diver.orr.noaa.gov/admin-record/6104/VSCS_Final_Report_Submerged_Oil_r052819.pdf).

Figure 5. Image of the interior of an oil aggregate highlighting the incorporation of sand grains and sea grass. This sample was collected from Newport Beach, CA on October 9, 2021.