Written Testimony of Dr. Jeffrey Short
United States House of Representatives
Committee on Science and Technology
Subcommittee on Energy and Environment
"Deluge of Oil Highlights Research and Technology Needs for Oil Recovery and Effective Cleanup of Oil Spills"

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Good morning. I am the Pacific Science Director for Oceana, an international marine conservation organization dedicated to using science, law, and policy to protect the world's oceans. Oceana's headquarters are in Washington, DC, we have offices in five states as well as Belize, Belgium, Spain, and Chile. Oceana has 300,000 members and supporters from all 50 states and from countries around the globe.

Prior to joining Oceana, I worked at the National Oceanic and Atmospheric Administration (NOAA) as an oil pollution research chemist for 31 years, including nearly 20 years studying the fate and effects of oil from the 1989 *Exxon Valdez* spill. Having experienced this major spill as a scientist, as a citizen and as a 41-year resident of Alaska, I have a keen appreciation for the devastation such events can cause. I want to express my deep appreciation to Chairman Baird and the members of the Committee for your invitation to share my perspectives on the long-term consequences of major oil discharges on the environment and on the communities and livelihoods that are invariably scarred by them. In particular, I speak here today to honor the memory of the eleven men whose lives were lost at the onset of the Deepwater Horizon tragedy, in the hope that my words may play some part, however small, in preventing additional loss of life in our quest for energy.

My invitation to comment here requested that I provide an historical perspective on oil spills and oil spill cleanup capacity, the short- and long-term ecological and social effects of spills and spill cleanup techniques, and the scientific research and monitoring that is needed to move forward effectively. I will address these three general issues in turn, and conclude with comments on gaps in the federal oil spill response capacity and what is needed to support a coordinated federal response going forward.

I. Historical Perspectives on Oil Spills and Oil Spill Cleanup Capacity

Recent Large Oil Spills in Waters of the United States

Although unusual, large marine oil spills cannot be considered as rare occurrences in waters of the United States. We are well aware of the 1969 Santa Barbara blowout, and since the 1989 *Exxon Valdez* spill which discharged at least 258,000 barrels of oil into Prince William Sound, Alaska, there have been another ten large (> 5,500 barrels) oil spills in the U.S, about once every two years on average. Of these, four exceeded 45,000 barrels, and the Deepwater Horizon is on track to become one of the top ten largest accidental marine discharges in history. The Deepwater Horizon has already released more than 500,000 barrels of oil, and if not stopped may reach 1,200,000 barrels or more by August when relief wells will hopefully plug the leak. In comparison, the 1979 Ixtoc I blowout, the largest accidental marine oil discharge in history, released an estimated 3,200,000 barrels into Mexican waters also in the Gulf of Mexico.

In every case, large oil spills are the result of unique and unforeseen causes. The *Exxon Valdez* spill was famously the result of criminal negligence by the tanker captain. The 1990 *Mega Borg* spill (115,000 barrels) resulted from an explosion in the vessel's pump room during lightering. A combination of heavy rains and lax maintenance led to the 2006 Citgo Refinery spill (67,000 barrels). The 2008 New Orleans spill (60,000 barrels) followed the collision of a tanker with a barge on the Mississippi River. Most of these and other large spills in the U.S. are the result of a combination of human error and unfortunate circumstances.

Oil Spill Cleanup Capacity

Once a marine spill occurs, there are three basic initial response options: skimming, *in situ* burning and chemical dispersants (most of this section is a summary of Fingas 2000). While frequently very effective when applied to small spills, each of these approaches has substantial limitations. Their efficacy varies greatly not only with the type of oil involved, but also with the properties of the oil as it changes following release. Once released, the composition of oil changes (i.e. "weathers") as a result of evaporation, dissolution of the more water-soluble components, microbial degradation, photo-oxidation, and the absorption of water. Water absorption may be especially troublesome, because it can increase the oil viscosity dramatically, which may have profound effects on the effectiveness of response methods.

There are a number of designs for mechanical oil skimming devices, which vary considerably in capacity and efficiency. Once oil is herded off the surface by focusing booms usually towed by one or more vessels toward a mechanical skimming device, the skimming device then may accomplish oil removal by any of a variety of mechanical means, including adherence to adsorptive materials or conveyance to oil-water separators by drums, belts, brushes, oleophilic rope, suction or a combination of these. Oil-water separation may be accomplished by means of separation weirs, holding tanks or centrifugation. Depending on the type and weathering state of the oil involved and environmental conditions such as sea state and temperature, these methods range in effectiveness from nearly nil to 95%.

In situ burning may oxidize as much as 90% of the oil ignited. However, burning requires corralling the slick to thicknesses of at least 2 mm and preferably more, and the boom must be fireproof and is not available for corralling while burning is underway. Also, the oil must not have lost much of its complement of volatile components, or it will not ignite, so the window of opportunity for *in situ* burning is usually limited to the first couple of days after oil reaches the surface. In general, burning is simply not capable of removing more than a small proportion of the oil released from large-scale discharges, except in cases where oil is ignited at the onset by the accident producing the spill, in which case the benefits of relatively efficient oil removal may come at a cost of human injury and death, as occurred during the 1990 *Mega Borg* spill. During the 1989 Exxon Valdez spill, crew safety was a major concern that precluded intentional ignition of the slick while the oil was near the vessel.

Skimming and *in situ* burning require corralling oil within booms, and hence only work in mild weather conditions. For the Deepwater Horizon, the leakage estimates imply a rate of slick creation on the order of about 2 football fields per minute, appearing erratically within a circle nearly two miles across. The largest skimmers in the Gulf of Mexico can sweep about 10% of the area within this circle per hour, and most skimmers are considerably smaller. The slick created by the *Exxon Valdez* expanded at a rate of about a half a football field per *second*, for two and a half days. These expansion rates exceed the available skimming capacity considerably, especially when the need for boom maintenance between deployments is considered. Consequently skimming retrieved an estimated 8% of the oil spilled from the *Exxon Valdez* (Wolfe et al. 1994), and is intercepting only a small fraction of the Deepwater Horizon oil that reaches the sea surface.

Dispersants act by lowering the surface tension between the oil-water interface, decreasing the mixing energy needed to disperse the oil into tiny microdroplets. To work effectively, the dispersant must be applied under conditions of moderate mixing energy, and the oil must not have weathered much. When effective, the microdroplets become entrained into the water column where they are much more susceptible to microbial degradation.

Dispersants are typically ineffective when applied to mousse or in calm conditions, and if the sea state is greater than a few feet it can be difficult to hit the slick when released from aircraft. Another limitation of dispersants is that when they do work, the large surface area of the microdroplets promotes back-extraction of the dispersant out of the oil, which may lead to re-aggregation of the oil and re-surfacing of a slick far from the point of dispersion.

Other methods that have been proposed to deal with oil released at sea include application of agents to sink the oil or to cause it to aggregate into a more easily collectible mass. By transporting oil from the surface to the seafloor, sinking agents merely change the site of toxic effects and are therefore not generally used. Gelling agents have also been proposed, but they have the disadvantage of requiring application of large amounts of the agent, and the resulting gelled mass may interfere with other response options such as skimming or *in situ* burning. The mass requirement alone precludes their large-scale application to big oil releases. Similarly, oil absorbent materials such as hair, hay, or polypropylene pads or strips may work well for small-scale applications, but become increasingly impractical to deploy and retrieve in larger-scale situations.

Even when used in combination effectively, response options at sea usually cannot be applied to more than a small fraction of the oil discharged during a large-scale release. The reason has more to do with the difficulty of bringing the necessary resources for applying these mitigation methods at the scale required than with limitations inherent to the methods themselves. All three at-sea response options require mild weather conditions and daylight, which all but guarantees they will not be able to be applied to much of the oil. New response technologies that are brought forward generally face the same challenges of delivering them on the scale, duration and at the rate needed to make a material difference during a large-scale release, and are therefore less effective than it might seem. Hence, most of the oil from large scale releases either drifts out to the open ocean where it slowly weathers to form tarballs that eventually sink to the deep ocean seafloor, or else impacts shorelines, where additional measures may be brought to bear to mitigate impacts.

The cleanup technologies most effective for shoreline remediation depend on the state of the oil when it contacts the shoreline and the nature of the shoreline contacted. Oil that forms tarballs that wash onto sand beaches may be simply picked up and disposed of, as was the case during the 2007 Hebei Spirit oil spill in the Republic of Korea. Despite very heavy fouling of beaches within a national park, nearly one million Koreans volunteered to help pick up the heavy oil residues from the impacted shorelines, and succeeding in removing nearly all the oil that came ashore. However, if the oil is not dealt with immediately, there is the risk that it will be mixed beneath sandy beaches by wave action where it can re-surface months or years later, or be transported to the immediately adjacent subtidal where it may persist for years and perhaps decades, both of which occurred following the 2002 *Prestige* heavy fuel oil spill that fouled the beaches and shorelines of northwest Spain.

Oiled shorelines may also be treated by wiping with oil absorbent materials, sometimes augmented by application of surface-washing agents and pressure washing equipment, or by application of bioremediation agents consisting of oil-consuming microbes mixed with the nutrients they need to grow. Beach scrubbing is labor intensive and usually fails to remove more than a small proportion of the oil present, even when augmented by surface-washing agents (Mearns 1996). Also, these agents, along with more aggressive washing methods such as high-pressure, hot- or cold-water washing may do more damage to the biological communities inhabiting the beach than the oil would (Mearns 1996). Less intrusive methods such as bioremediation can be very effective, but only provided the needed nutrients can be efficiently supplied for the time required for the oil to be completely consumed.

While a number of other approaches have been tried for removing oil from shorelines, all are costly, and none work very well. Only about 10% of the oil that impacted shorelines following the 1989 Exxon Valdez oil spill was removed, despite the efforts of over 10,000 cleanup workers laboring over two successive years and trying a wide array of approaches (Wolfe et al. 1994).

II. Ecological and Social Effects of Spills and Spill Cleanup Techniques

Ecological Effects of Spills and Cleanup Techniques

A. Impacts of Spills

Some of the most damaging effects of oil spills occur through the contact hazard they pose to wildlife transiting the sea-air interface or while foraging on oiled shorelines (Spies et al. 1996), especially oiled marshes. Even small amounts of oil adhering to the skin, hair or feathers of sea turtles, marine mammals and seabirds can seriously inhibit motion and reduce their ability to thermoregulate, both of which often kill the animals. Inhalation of volatile hydrocarbons near oil slicks can cause lung damage and induce narcosis leading to drowning.

Natural and chemically-enhanced dispersion of oil presents an ingestion hazard to wildlife, fish and other marine organisms that mistake oil for food (e.g. Carls et al. 1996). Large aggregations of surface oil such as mousse patties or tarballs may be ingested by sea turtles, marine mammals, and seabird and may kill animals directly or cause illness that increases vulnerability to predation. Oil microdroplets are efficiently accumulated by suspension feeders such as clams, barnacles, some kinds of zooplankton, and deepwater corals. Zooplankton may ingest oil droplets which become mixed with inorganic material from other prey and ejected as oily fecal pellets that sink to the seafloor (Conover 1971), where they may be scavenged by deepwater corals and other animals inhabiting the seafloor.

Most oils contain monocyclic and polycyclic aromatic compounds (MAC and PAC, respectively), which along with closely related compounds may be toxic to marine life in several ways. The MACs are among the most water soluble components of oils, and at sufficiently high concentrations (typically around 1 part per million, or ppm) can induce narcosis-like effects in fish leading to death (French-McKay 2002). PACs, which include polycyclic aromatic hydrocarbons and closely related compounds in which one or more of the aromatic carbon atoms is replaced by nitrogen, oxygen or sulfur, can be much more toxic and operate through different toxicity mechanisms.

In addition to being notoriously carcinogenic, PACs can cause developmental abnormalities in fish embryos and larvae at concentrations below one part per billion (ppb; Carls et al. 1999, Heintz et al. 1999). Some PACs can also cause toxicity through a phenomenon called photoenhanced toxicity (reviewed by Diamond 2003). This occurs when certain PACs are absorbed by skin cells or are accumulated into tissues of translucent organisms in the presence of ultraviolet radiation from sunlight, where they may catalyze the conversion of oxygen molecules inside cells into a much more reactive state that causes oxidative damage. Because the oxidative damage usually does not affect the PACs catalyzing the conversion, a single PAC molecule may convert tens of thousands of oxygen molecules, which may either kill affected cells outright or make them cancerous.[1] As with induction of developmental abnormalities, photoenhanced toxicity may be lethal to translucent organisms at PAC exposure concentrations of one ppb or less (Duesterloh et al. 2002).

Embryotoxic and photoenhanced toxicity effects are most likely in habitats where oil accumulates adjacent to limited volumes of seawater, restricted water circulation and high biological productivity, such as coastal salt-marshes. A relatively high ratio of oil to water along with restricted circulation increases the likelihood of toxic effects, and high biological productivity in those areas attracts animals.

Not all of the toxic components of oil have been identified. Evidence for toxicity to shellfish associated with unidentified components has been clearly demonstrated (Rowland et al. 2001), but because oil is such a complex mixture of compounds, identifying the components responsible poses a challenging research task. In addition, it is becoming increasingly clear that both identified and un-identified toxic agents in oils act through multiple toxicity mechanisms, many and perhaps most of which are poorly understood.

Being lipophilic (or "fat-loving"), hydrocarbons tend to bioaccumulate in lipid stores of organisms. This process can lead to concentrations in lipids that are one-thousand to one-million times greater than respective concentrations in ambient water (DiToro et al. 2000), increasing with the molecular mass of the hydrocarbon involved. Fortunately, vertebrates possess elaborate biochemical pathways for eliminating the aromatic compounds they absorb (Livingstone 1998), so these compounds do not tend to biomagnify up the food chain. Another result of this ability is that hydrocarbons tend to be difficult to detect in vertebrates, even following substantial exposure to them. Hence, monitoring fish for hydrocarbons is often uninformative, because most of the hydrocarbons accumulated have been transformed into metabolic products that are not detected by ordinary hydrocarbon analysis. Analysis should be directed toward the metabolites themselves in these cases.

B. Impacts of Cleanup Techniques

Of all the cleanup techniques available, application of dispersants poses the most serious threats to marine life. In themselves, dispersants are mildly toxic to sea life (see www.epa.gov/med/Prods_Pubs/ecotox.htm), comparable to the toxicities of household detergents. Their ingredients are readily biodegradable, which reduces their environmental lifetime considerably. The ingredients of some dispersants may pose inhalation, contact and other hazards to cleanup workers exposed to them during application, as well as to marine mammals that may be coated during aerial application. As with *in situ* burning, worker safety is the paramount concern with application of dispersants.

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[1] For this reason cleanup workers and others should therefore scrupulously avoid skin contact with crude oil, especially while in strong sunlight.

When used successfully, dispersants dramatically accelerate dissolution of the more toxic components of the oil they disperse (Fingas 2000), which may expose sea life to higher risk of toxic effects. Accumulation of oil microdroplets by suspension feeders is especially worrisome when dispersants are applied near the coast. Biological productivity in general increases dramatically as the coast is approached, and many suspension feeders, such as oysters, are important commercially. Risks to wildlife must be weighed against impacts that arise from no response, and are especially acute when sensitive and vulnerable habitats such as coastal marshes are threatened. Oil cannot be removed from these habitats without serious collateral damage, and if left in place it may continue to kill fish and wildlife for years and possibly decades. From this perspective, dispersants have a distinct advantage because they provide a measure of control over where and toxicity occurs.

A further concern regarding dispersant application has arisen in the context of the Deepwater Horizon blowout. Application at the leak source appears to have accelerated creation of deep-water oil plumes. While this reduces the amount of oil reaching the surface, microbial degradation of the oil carries a poorly understood risk of depleting the oxygen content of the water within such plumes. It is conceivable that this process may deplete oxygen to levels that are dangerous for sea life, and might lead to a submerged "dead zone". While this risk is presently thought to be unlikely, such oil dispersion plumes should be monitored carefully to evaluate such risks.

If oil reaches shorelines in a less-weathered, more fluid state, it can penetrate into substrates more deeply which can make it more problematic to remove. In some cases, natural degradation of oil may be enhanced by mechanical disturbance of shoreline substrates to increase the availability of oxygen (Mearns 1996). Oil percolated into the coarse sediments of some beaches in Prince William Sound following the 1989 *Exxon Valdez* oil spill, where some of it became trapped in an anoxic layer and persisted for decades (Short et al. 2007). Mechanical disturbance was impractical there and would likely have caused as much or more damage to the resident biota as the oil. Both fresh and weathered oil that gets into coastal vegetation, especially into salt marshes can be nearly impossible to remove without resorting to extreme measures, such as cutting the vegetation to just above the root mass to expose and collect oil on the seabed and disposing of the oiled vegetation. This reduces the contact hazard posed by the oil to wildlife, but at the cost of eliminating nesting and rearing habitat for at least a season and perhaps permanently if the vegetation fails to grow back.

The benefits of shoreline cleanup and remediation techniques must be carefully weighed against their risks. Aggressive methods such as high-pressure, hot- or cold-water washing may sterilize biologically productive shorelines and remove fine particulate material that is an essential habitat characteristic for some organisms (Mearns 1996), leading to habitat alteration that may take decades to recover from. Such methods may also endanger cleanup workers if oil is converted into an aerosol that might be inhaled. Use of beach cleaning agents may be helpful in some circumstances, although these chemicals may be mildly toxic to biota. Application of bioremediation methods, usually consisting of oil-degrading microbes combined with nutrients to support their growth can be very effective at removing oil from shorelines provided adequate oxygen is available and nutrients can be efficiently re-supplied (Mearns 1996). Bioremediation materials are usually sprayed onto beaches, and exposure to the solvents used may be a concern for cleanup workers.

C. Ecosystem Effects

The animals and plants killed by the direct effects of oil spills, or by response, mitigation and remediation efforts may lead to changes in the structure and functioning of marine ecosystems (Peterson et al. 2003). Such changes are often difficult to detect, especially when species and habitats at risk are inadequately characterized during the planning phases of offshore oil and gas exploration and development. Nonetheless, irreversible changes to marine ecosystems are among the most long lasting impacts that accidental oil discharges can have. Species extinctions are one kind of irreversible ecosystem change, but others are possible as well.

Predators near or at the top of marine food webs often exert strong structuring effects by controlling the populations of their prey. These structuring effects may form a “trophic cascade”, wherein populations of prey species that support relatively large populations of top predators are themselves limited, and their low numbers allow their own prey species to flourish, and so forth down the food chain. If an oil spill and consequent cleanup activities reduce large numbers of top predators such as marine mammals or seabirds, these relationships may shift, causing sometimes dramatic changes in the abundances of various species, perhaps including commercially important species. Such shifts may require decades for recovery, and in extreme cases an ecosystem may shift to a new metastable equilibrium state irreversibly.

Social Effects of Spills and Cleanup Techniques

Large scale oil spills can have devastating economic and other social impacts. Fishery closures far in excess of what is needed to keep oil-tainted seafood out of the marketplace may be ordered because of the need to be cautious in the face of uncertainty regarding the extent and duration of oil pollution, with commensurate economic losses for the industry. In extreme cases, such closures may lead to permanent loss of market share, if products are displaced by competitors that gain better market acceptance, such as happened the once-lucrative pink salmon fishery in Prince William Sound, Alaska following the 1989 *Exxon Valdez* spill.

Exaggerated fears of oil-contaminated shorelines and seas may cause profound economic losses to tourism industries. Most of the public will avoid exposure to any perceived risk posed by an uncertain or poorly-understood threat such as is typically associated with oil pollution, and these reactions are exacerbated by the typical selection bias imposed by news media covering such events. The most extreme examples of contamination get the most coverage, creating the impression of much more extensive contamination than is actually the case.

Fisheries and aquaculture involving suspension feeding organisms such as oysters and clams are especially vulnerable to oil contamination, particularly if dispersants are used nearby. These organisms may easily become tainted by oil because they are so efficient at accumulating oil microdroplets.

Oil spill cleanup efforts may provide a temporary boon to local economies by providing a source of additional income, which may be especially welcome by those livelihoods are jeopardized by fishery closures, product contamination or oil-related declines in tourism. However, these benefits are typically short-lived, and may create additional adverse social impacts. Selective participation in cleanup efforts may create winners and losers within the same communities, engendering resentments that can seriously damage the character and social fabric of these communities. Protracted lawsuits typically add to individual and community stress. In extreme cases, where some members of a community are financially ruined while others are enriched, the result may be considerably increased incidences of domestic violence, substance abuse, violent crime and suicide, as was documented in communities affected by the 1989 *Exxon Valdez* spill (Russell et al. 1996).

III. Scientific Research and Monitoring Needs

Scientific research and monitoring needs fall into four categories: elucidation of toxic agents and mechanisms; monitoring the short- and long-term effects of spills; identification of vulnerable habitats, species and life-stages; and development of better cleanup and response technologies.

The funding made available to the oil pollution research community in the aftermath of the 1989 *Exxon Valdez* oil spill led to fundamental advances in our understanding of the toxic components and mechanisms of oil pollution. As a result of this work, it is now more realistically appreciated that oil pollution can affect fish and wildlife populations, and probably humans as well, in subtle but serious ways, and that much more remains to be discovered. Because this line of research has little potential for direct commercial benefit but is likely to bolster the case for greater regulation of petroleum products and the petroleum industry, there are almost no sources of funding available apart from governments. Yet even relatively modest investments in such research may yield substantial dividends. By elucidating what biological resources are at risk, policy makers will be able to avoid impacts that are presently unsuspected to biological resources, while also avoiding overly strict regulation and resource closures that invariably lead to economic losses.

Better monitoring of short- and long-term oil spill effects interacts synergistically with research on toxic agents and mechanisms by providing opportunities to verify the relevance of the toxicity research, and by providing evidence for impacts that have not been considered heretofore. Again, the 1989 *Exxon Valdez* spill provides an example of this positive dynamic linking these efforts. The embryotoxicity research conducted in the aftermath of this spill (and supported by the funding made available by it) was inspired by field observations of relatively poorer survivals of pink salmon embryos rearing in streams on oiled beaches compared with those on un-oiled beaches. As a result of the embryotoxicity research, we now have a better idea of where, when, how and what to look for to determine whether a particular spill causes more subtle damage to exposed populations. We now realize, for example, that oil need not kill exposed biota directly; merely weakening biota even slightly very often results in their eventual premature mortality from increased vulnerability to predation or disease.

Once a spill begins, there is an immediate need to quickly determine the biological resources most at risk. In addition to identifying the most vulnerable species and life-stages, the most vulnerable, productive and otherwise important habitats should be afforded priority for allocation of spill response resources to mitigate impacts. Currently such habitats are identified using an environmental sensitivity index that is based on shoreline geomorphology. This index does not account for variation in biological productivity, reproductive habitat, ecosystem complexity, biodiversity, or habitat that supports rare, threatened or endangered species. Coastal zone maps that identify such important ecological areas in advance would be an invaluable asset to spill response officials to reduce the impacts of spills on the affected ecosystems.

Finally, research on better methods for collecting and remediating the effects of spilled oil are urgently needed. Recent research, again funded in the aftermath of the 1989 *Exxon Valdez* spill, has led to promising methods for delivering nutrients to oil buried within beaches, and it is likely that better designs for the oil collection devices used with surface skimmers would lead to significant increases in their effectiveness. Improved dispersant formulations that are less toxic to humans and to wildlife, along with better methods for delivering would be welcome additions to the limited array of tools available for mitigating spills. Along these lines, the Environmental Protection Agency (EPA) could helpfully waive prohibitions against oil discharges at sea and on shorelines to allow for experimental spills wherein new dispersant and other oil mitigation measures could be realistically tested. However, a requirement for such waivers should be adherence to rigorous standards of scientific practice. All too often field tests that fail to meet basic criteria for scientific experiments, such as positive and negative control treatments, replication, quantitative evaluation of test results, etc. are promoted as “scientific” when in fact they barely meet reasonable criteria for pre-experiment feasibility studies. At minimum, the EPA, NOAA, the Minerals Management Services and the U.S. Coast Guard should insist that rigorous scientific standards be met before relying on results claimed for new approaches to oil spill response and mitigation.

IV. Concluding Remarks.

The science of oil spills is an especially complex branch of environmental science. As is hopefully clear from the above sections, oil affects species and ecosystems in ways that are often subtle and in any case are far from well understood. Once spilled, oil affects the environment in myriad ways, including many that are currently unknown, and response and cleanup actions add to the complexity. Every spill of any size presents unique impacts and response challenges.

When a spill is very large, factors related to scale seriously constrain our ability to contain them. For every spill situation there is some size threshold beyond which the efficacy of response, mitigation and restoration are primarily limited not by the available techniques or stockpiles of materiél, but by the ability to apply them effectively to where the oil is. By definition, very large spills expand quickly to impact large areas, and as slicks fragment and respond to the vagaries of winds and currents, keeping track of the oil becomes nearly impossible, especially with loss of visual contact at night (which may be prolonged in the Arctic), or when storms preclude surveillance flights while moving the oil rapidly. The fundamental problem becomes one of keeping track of all the oil parcels moving ever farther away from each other in a big ocean, and having the resources to identify and deliver the right combination of response options in a timely manner before loosing track of the oil again. At some point this challenge becomes hopeless beyond some size threshold. It is for these and related reasons that a scientific panel recently convened to review dispersant use for the Deepwater Horizon blowout concluded that "No combination of response actions can fully contain oil or mitigate impacts from a spill the size and complexity of the DWH incident" (Coastal Response Research Center 2010).

Fixing our ability to track and apply appropriate response measures to spills the size of the Exxon Valdez or the Deepwater Horizon blowout would require orders of magnitude greater investments in obtaining and maintaining the delivery infrastructure required. In the case of the Deepwater Horizon blowout, concerns regarding whether the current Administration acted quickly enough or made the right decisions, or whether they should have "taken over" the spill are largely beside the point. Neither the United States government nor the oil industry have the resources to fully contain a discharge the size of the Deepwater Horizon, and only the oil industry has the resources to be able to eventually stop the flow.

Recognizing the truth of the panel's conclusion has important implications for oil spill response policy and for how we go forward with regulating offshore oil and gas development. Regulatory policy has heretofore subscribed to the fiction that adequate spill response plans are a reasonable requirement for offshore oil and gas exploration and development. Spill scenarios that could not be contained by the resources and approaches described in these plans were conveniently dismissed as too improbable to warrant consideration, despite their recurrences over the last two decades. Given that continued oil production from U.S. territorial waters will increasingly require drilling in ever more challenging environments such as deeper ocean waters or in the Arctic, where we have little engineering experience in either, we must face a stark choice: Either we must accept that risks of uncontrollable releases will continue to escalate, leading to more frequent accidents akin to the Deepwater Horizon, or we must tighten our regulation of offshore oil and gas exploration and production considerably.

More generally, the United States government has a responsibility to manage the nation's natural resources wisely. The desire for smaller government implies a commensurately constrained ability to meet this responsibility. The effect of this is to cede these responsibilities to the industries that profit most from natural resource exploitation, and operate under a fiduciary responsibility that requires them to place their narrow economic interests above the wider interests of the public. To the extent that this effort succeeds, we should expect more and even bigger environmental disasters like the Deepwater Horizon blowout. Simply put, the Congress is faced with the question, "does America hold the long term health and biodiversity of our ocean resources in commensurate value as the short term demand for oil?" And if so, is the Congress willing to pay for their protection?

The United States is fortunate to have a substantial number of talented, dedicated environmental scientists in the employ of our resource agencies, whose primary motivation is to ensure that development of natural resources is done in a manner that does not inflict unacceptable damage on the capacity of our natural environment to sustain us. Recent years have seen increasing marginalization of their contributions, yet their understanding of and appreciation for the complexity of environmental interactions is unparalleled. Their advice should not be casually dismissed in favor of short-term economic arguments, and the steady erosion of their base budgets that has occurred over the last two decades should be reversed.

To cite one especially relevant example here, NOAA's Office of Response and Restoration, which is responsible for providing scientific advice to guide oil spill response efforts and to evaluate the environmental damages caused by oil spills, has lost about 30% of its staff over the last 8 years, seriously straining their capacity to do their job when faced with a event on the scale of the Deepwater Horizon blowout. Other natural resource agencies in the federal government have faced similar budget reductions. Just as it costs money to maintain a fire department, it costs money if the federal government is going to recover its ability to independently assess the environmental risks of oil and other economic development, and to respond effectively to accidents when they occur.

As oil exploration pushes into these more challenging environments, the oil industry is positioned to reap most of the benefits while the public is saddled with nearly all of the risk. As I noted initially, this risk extends to loss of livelihoods and of life itself. It is for these reasons that my organization, Oceana, recommends a ban on new offshore drilling and a reinstatement of the moratoria previously in effect before 2008.

With these sober facts in mind, I recommend the Congress take the following actions:

1. I commend Chairman Baird and Representative Woolsey for introducing HR 2693 to amend the research provisions of the Oil Pollution Act of 1990, and I urge the Congress to pass it.

2. Immediately, include the expertise of scientists (including people with local and traditional knowledge) in a comprehensive review of the health and biodiversity

of the ecosystems within the range of offshore drilling. (I would be privileged to participate in further discussion of the framework of such a review).

3. Stop offshore drilling until the President's Commission on the Deepwater Horizon blowout has completed their report and you can determine from the comprehensive science review in point number 2 above if we should go forward, how, when and where. It is Oceana's belief that the only appropriate conclusion for the panel is that new offshore drilling is not worth the risks and should not be allowed.

4. Conduct a thorough review of the Outer Continental Shelf Lands Act and other related federal laws to ensure inclusion of the necessary oversight and protections of America's living marine resources.

5. Provide NOAA, EPA and the United States Coast Guard with the authority and the resources necessary for understanding, regulating and protecting America's oceans.

6. Initiate a process that will lead to a National energy plan that includes adequate protection for our oceans.

V. References

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