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Madam Chair and members of the Committee. I am Dr. Carys Mitchelmore and I would like to take this opportunity to thank you for inviting me today to highlight some of the issues concerning the current and future use of dispersants in response to the Deepwater Horizon (DWH) Gulf of Mexico Oil Leak.

By way of background: I am faculty at the University of Maryland Center for Environmental Science, Chesapeake Biological laboratory. I have been conducting research and publishing books and articles for over 15 years concerning the impacts of pollutants, including oil and oil spill dispersants on many aquatic species. Today I am representing my views as a researcher in the field of environmental health. My career path as an aquatic toxicologist was set in place at the young age of 6, after stepping on a tar ball at a local beach. That left a lasting impression on me and I grew up fascinated with the rock pools and, unfortunately the all too often, oil sheens within. I learnt to recognize and avoid the tar balls that were an all to common a sight on the local beaches. I began investigating the impacts of oil on marine organisms following the Aegean Sea Oil spill in 1992. Since then, as opportunities have arisen, I have carried out research investigating the effects of oil and it's constituent compounds on bivalves, corals, fish and reptiles. Specifically, in the last few years my focus has been on investigating the routes of exposure to and the toxicity of the dispersant Corexit 9500 and dispersed oil on sensitive species, such as corals (REFS 1-9). I was also co-author on the recent 2005 NRC publication on "Oil Spill Dispersants: Efficacy and Effects" (REF 10).

The unfortunate recent events in the Gulf have once again brought to the forefront issues pertaining to the impacts of oil, oil spill dispersants and dispersed oil in our marine and coastal ecosystems. My testimony today will focus on issues relating to the use of dispersants, their potential impacts, the uncertainties (data gaps) regarding oil spill dispersants and dispersed oil in addition to issues pertaining to the use of alternate dispersant formulations.

The three key points I would like to raise today are the following:

1. Numerous data gaps on the effects of dispersants and dispersed oil exist hampering a full assessment of the risks of long-term surface dispersant use in the Deepwater Horizon Oil leak.

- There are significant data gaps and uncertainties relating to understanding sublethal, delayed and long-term effects of dispersant use, particularly to sensitive species (e.g. corals) and impacts to the food web.

2. Limited data exists regarding the toxicity of alternate dispersants.

- Toxicity tests for products listed on EPA's National Contingency Plan Product Schedule (NCPPS) are limited in scope and inconsistencies with respect to the reported toxicity of the reference toxicant further reduce the ability to ascertain less toxic products.

3. The subsurface use of dispersants at the site of the oil leak is unchartered territory and has not been tested prior to its use in the Deepwater Horizon Oil leak.

- The effectiveness, fate (breakdown) and toxicological effects of dispersant use in deep waters is unknown.
- There is insufficient data and baseline mapping of subsurface oil plumes and what species are present on the subfloor and at various depths in the overlying water column.

Overview and Introduction: What are dispersants and why are they used?

When oil is spilled response decisions are quickly made based upon the best available science and on numerous and often continually changing variables. Common response options used include, mechanical recovery with the use of skimmers and booms, *in situ* burning and the use of chemical dispersants. Mechanical recovery is the preferred method as it removes oil from the environment but it is not always effective given poor weather conditions (i.e. high waves etc). In the DWH incident all of these response options have been used. It was recently stated that; “no combination of response options can fully contain oil or mitigate the impacts from a spill the size and complexity of the DWH incident” (REF 11).

The decision to use chemical dispersants also depends on many factors, including, the type of oil and extent of oil weathering, where the most sensitive habitats and species are located, weather conditions (wave action is required) and the availability of dispersants and aircrafts and/or other dispersal vessels.

The use of dispersants is an environmental trade-off; the protection of one habitat at the cost of another. In the current DWH Gulf of Mexico oil leak dispersants are used to protect the shoreline (and surface) species at the expense of organisms residing in the water column and potentially those in the benthic (seabed) environment.

The Gulf of Mexico contains sensitive coastal habitats, such as wetlands, that serve as nursery grounds to numerous species, including those that migrate long distances to these breeding areas. Oil coated shorelines not only decimate intertidal food reserves for ourselves (e.g. oysters, crabs, shrimp, fish) and other organisms but will also cripple recreational activities and local economies. Oil, if allowed to come to shore, can remain in those habitats (e.g. in the sediment) for long periods of time continually exposing and impacting local resources for years or decades following the oil spill. In comparison with the shorelines and near-shore habitats, much less is known regarding the amounts and types of species present in the water column and the subfloor in both time and space.

Dispersants are chemical mixtures containing solvents, surfactants and other additives, (including proprietary chemicals) that are used to facilitate and enhance the break-up with wave energy of the surface oil slick into small oil droplets that disperse into the waters below. They **do not** remove oil from the environment, they simply change the inherent chemical and physical properties of the oil and in doing so alter the oil’s transport, fate and potential effects. The small droplets stay suspended in the water column and spread in three dimensions instead of two. The premise behind dispersant use is that this oil movement results in a plume of dispersed oil and dispersants that is quickly reduced to low levels with depth in the Ocean. In addition, this dispersal effectively increases the surface area to volume ratio of oil so that microorganisms that naturally degrade oil can be more effective in doing so. However, as stated in the NRC reports (REF 10 and 12) conflicting scientific data does exist regarding this statement and recommendations were made to reduce uncertainties with further research.

The use of dispersants is a complex and controversial subject. They are examples of known pollutants, albeit ones listed as having low-to-moderate acute toxicities, purposely added to the marine environment. Concerns regarding their use in the DWH Oil leak are related to this issue and also their potential impacts to human health particularly given the volumes involved (currently as of June 15th, over 1.3 million gallons) and the huge data gaps concerning their long-term effects to humans and wildlife.

Recently a scientific meeting (May 26-27th) of over 50 experts from government agencies, academia and industry was convened specifically to provide input for the Gulf of Mexico's regional response teams (4 & 6) on the use and effects of dispersant and dispersed oil in going forward with future incident decisions. It was the consensus of the group that "up to this point, the use of dispersants and the effects of dispersing oil into the water column has generally been less environmentally harmful than allowing the oil to migrate on the surface into the sensitive wetlands and near shore coastal habitats" (see REF 11). However, concerns were made over the unknowns especially regarding the fate and potential long-term effects (discussed in later sections herein) of dispersants and dispersed oil and their continued long-term use. The novel application of dispersants subsurface at the site of the leak was noted as uncharted territory and requires detailed monitoring and future research efforts. Therefore, some strong caveats were mentioned following the consensus statement;

(1) that increased monitoring efforts at the surface and subsurface should be carried out so that oil, dispersed oil and other parameters (e.g. dissolved oxygen) can be more accurately tracked in space and time in combination with enhanced 3D models of the subsurface oil plumes,

(2) that continued re-assessments should be made to ascertain that these trade-off decisions are still scientifically sound. I highlight and emphasize these two points.

In addition, it is quite possible that with increasing time these trade-off decisions could change given 1) the volume of dispersants used and the footprint (in space and time) of the impacted area in the water-column, 2) sensitive species movement into and out of different habitats (e.g. bluefin tuna and other species spawning in the open Ocean waters), 3) continued and increasing impact of oil onto sensitive shorelines, therefore, reducing the percentage of habitat saved by using dispersants. Of concern is that we do not (and probably never will) know the extent of the harm and loss of organisms in the water column and on the seabed. Mapping of who, what, and where species are in these habitats is limited or in the case of the seabed down at 5000ft, non-existent.

Summary of what is known about the short and long-term effects (toxicity) of dispersants and dispersed oil.

I have previously detailed in other testimonies (dated May 19th and June 10th) a summary of what is currently known (or not known) about the short and long-term effects of dispersant and dispersed oil. A summary of the main uncertainties, data gaps and questions regarding dispersant use is included below but for further details please refer to the previous testimonies (see REFS 13 and 14).

In assessing the environmental trade-off decision to use dispersants questions are first asked regarding dispersant effectiveness. Is the oil chemically dispersable and are the weather conditions conducive to achieve this? Following on from these assessments, as highlighted in the executive summary from the recent dispersant meeting; "**toxicity must be considered when a decision is made to apply chemical dispersants**" (REF 11).

Although dispersants themselves would not be released into the environment alone, toxicity tests are required (for human and environmental safety) so that they can be approved for use (i.e. listed on the EPA's National Contingency Plan Product Schedule (NCPPS) table; see REF 15) and included on the products material data safety sheets (MSDS).

1. Numerous data gaps on the effects of dispersant and dispersed oil exist.

As concluded in both of the NRC dispersant reports (REFS 10, 12) limited toxicological information exists to fully assess the risks to organisms to dispersants and dispersed oil. Although it should be noted that this lack of toxicological data is not unique to oil spill dispersants. It is mirrored by the tens of thousands of chemical contaminants (again often proprietary mixtures) that are also being released into the environment. Environmental trade-off decisions on the use of dispersants requires scientifically robust toxicity test data particularly in species that are similar to those resident species that may be impacted following an Oil Spill.

The majority of toxicity data regarding dispersants and dispersed oil are often limited in scope and address acute and short-term effects derived from laboratory toxicity tests. Acute toxicity tests are used to compare toxicity between chemicals and between organisms to identify highly toxic chemicals and sensitive organisms. Results are standardized and presented as the lethal concentration of a chemical that causes death to 50% of the test organisms following a set exposure time (i.e. LC50, 24-96 hours). The **lower** the LC50 level is (i.e. a lower number), the more toxic the chemical. There is much more limited data available detailing the potential sublethal or delayed effects of exposure, which could be much more detrimental to a population in the long term (see later section).

a) How toxic are the dispersants alone?

With respect to dispersants, toxicity depends upon the specific dispersant under study, the species being tested and also the life stage of the particular species under investigation. Some organisms are much more sensitive to (i.e. affected by) dispersants than others. For example, gulf mysids and copepods (crustaceans), diatoms (algae) and fish larvae are affected at low concentrations of Corexit 9500 (i.e. LC50, 96 hour at the low ppm level). However, other organisms are only affected by 3-10-fold higher concentrations of Corexit 9500. To date the majority of toxicity studies (those listed in the NCPPS table and in the scientific literature; see REF 10) have been focused on the Corexit formulations. Fewer toxicity studies (i.e. less species evaluated) have been carried out for Corexit 9500 compared with the earlier Corexit 9527 formulation. The Corexit formations (earlier the Corexit 9527 and then replaced by the Corexit 9500 product) have been those chosen and stockpiled for use across the USA.

In summary, some research studies have found dispersants to be less toxic compared with oil or dispersed oil in direct comparisons, although some studies report an increased dispersant toxicity compared with oil or dispersed oil (see REF 10).

b) How toxic is dispersed oil?

There is conflicting scientific evidence to date regarding the toxicity of dispersed oil in comparison to oil. The 2005 NRC report addresses this at length (REF 10). For example, some studies have stated that dispersed oil is more toxic than oil, others have shown that the toxicities of dispersed oil and oil are equivalent. The NRC 1989 report concluded that the acute lethal toxicity of chemically dispersed oil is primarily associated not with the dispersant but with the dispersed oil and it's dissolved constituents following dispersal. Some species and life stages are much more sensitive than others, for example, the LC50s for oyster and fish larvae were as low as 3mg / l (i.e. 3ppm) for dispersant alone (Corexit 9527) and 1mg / l (i.e. 1ppm) for dispersed oil (REF 16).

It is inherently difficult to compare dispersed oil with oil and discrepancies can arise simply due to the experimental design of the toxicity tests. Therefore, in the 1990's efforts were made to standardize toxicity tests (i.e. CROSERF and following publications; see discussion in REF 10). Great advances were made at that time, however, there is a dire need to expand this work further to include new additional and complicating issues that have arisen in the scientific literature since this original CROSERF working group. For example, in translucent organisms (e.g. fish larvae) the toxicity of accumulated oil can be 12-50,000 times underestimated because the traditional toxicity tests were not carried out under conditions of natural sunlight (REF 10). This phenomenon called 'photoenhanced toxicity' may be critical in determining the effects of dispersed oil in surface dwelling (e.g. translucent pelagic larvae) and shallow water translucent organisms (including corals).

c) Sublethal, delayed and long-term effects of dispersants and dispersed oil.

As summarized in the recent NRC publications oil and oil spill dispersants can cause many effects, including death and a variety of sublethal impacts including reduced growth, reproduction, cardiac dysfunction, immune system suppression, metabolic and bioenergetic effects, developmental deformities, carcinogenic, mutagenic, teratogenic effects and alterations in behavior (REFS 10, 12). These more subtle endpoints than death can none-the-less have huge consequences for populations. Additionally, delayed effects may occur which are hard to track and follow following an oil spill event unless monitoring programs span years after the spill event. Even then these monitoring programs may come too late i.e. if baseline monitoring before the spill was not carried out it is impossible to fully assess the final extent of damage.

Some aquatic species are more sensitive than others to dispersants and /or dispersed oil. Therefore, making trade-off decisions between species is difficult if toxicity data is not available for those or closely related species. Additionally, it has been shown that it is the early life stages of organisms, e.g. eggs and larvae that are more sensitive to chemicals and are at particular risk. This is especially of concern given that these life stages often inhabit surface waters, especially as is the case for the Gulf of Mexico now given that this is the spawning and reproductive period for many species. A dispersed oil plume contains high levels of dispersant, dissolved oil and oil droplets meters down into the water column where these and other essential food-web items (e.g. phytoplankton (algae) and zooplankton) reside.

Studies have also shown that dispersants may facilitate the uptake and potentially the bioaccumulation of oil constituents in organisms from ingestion routes or by oil droplets sticking to biological surfaces (e.g. fish gills) and facilitating the dissolution of oil components (dissolved polycyclic aromatic hydrocarbons (PAHs)) into tissues. However, dispersed oil has also been shown to be less ‘sticky’ and does not interact with biological surfaces or sediment (see discussions in REF 10). These issues relating to the fate (i.e. where the oil ends up) are important to know for a full risk assessment on the impact of dispersants.

Suspension (filter) feeders, such as oysters and mussels, will bioaccumulate oil droplets in addition to the dissolved oil components. Dispersed oil droplets generally range in size from <3 to 80μm. These sizes overlap with the preferred size range of food for many suspensionfeeding organisms, including zooplankton (see later). Oysters and amphipods can select these particles, as they are similar in size to the phytoplankton they feed upon.

The importance of this oil droplet (or particle bound oil PAH) exposure route was highlighted in studies flowing the New Carissa Oil spill near Coos Bay, Oregon. Mussels (suspension feeders) contained much higher levels of oil constituents (PAHs; ~500 times more) than crabs (an omnivore) collected from the same area (details contained in REF 10). Chemical (PAH) profiles also highlighted that the mussels had accumulated the PAHs both from the dissolved oil constituents in the water and from oil droplets whereas crabs had only accumulated them from the dissolved phase. These data are very important as current computer models designed to predict the effects of an oil spill do not take into account exposure routes other than the dissolved components. This research has implications for the effects of a dispersed oil plume on coastal fisheries and highlights the importance in understanding the routes of exposure of oil to species and in determining the levels of oil constituents in each of these phases for a better understanding of risk.

Understanding basic toxicity mechanisms and species sensitivity across diverse taxa in laboratory studies aid in the risk assessment of what organisms are potentially those most at risk. During a spill these data can be compared with the predicted dispersed oil concentrations (using computer modeling) or actual oil concentrations measured in the field. There is still a need to fill the serious fundamental scientific data gaps regarding the basic toxicology of dispersants and dispersed oil as highlighted in the NRC reports.

d) Specific uncertainties and data gaps.

There are still many unanswered questions that we need to know to fully assess the risks involved with dispersants and dispersed oil. These were highlighted in the 2005 NRC report (REF 10). Although the 2005 NRC study was specifically tasked to address the potential risks of dispersant use in near-shore environments many of the conclusions of the report are valid in open-ocean spills, such as the DWH leak. Many questions and data gaps needed for improved risk analyses and ultimately effective oil spill responses were highlighted. Some basic concepts and issues regarding dispersed oil fate and effects simply lacked adequate research. In addition other areas of study require increased research efforts, as conflicting data currently exists.

The many questions and issues that we have limited data for include the following;

1. What is the fate of dispersants and dispersed oil (i.e. where will they end up, in what form, how biodegradable are they and what are the break-down products? Are the break-down products more or less toxic?
2. What are the potential-long term effects of dispersant and dispersed oil, even after a brief exposure, to aquatic organisms? What are the sublethal effects? Will there be delayed effects?
3. There are limited studies on sensitive at risk organisms (e.g. corals).
4. Does dispersed oil reduce or enhance uptake/bioavailability of oil to organisms?
5. Does photoenhanced toxicity increase the 'footprint' of effects?
6. Does dispersed oil reduce or enhance microbial degradation? If enhanced will this bacterial 'bloom' result in an increased dead zone in the water (i.e. increased footprint in hypoxic zones or just a significant reduction in water oxygen levels)?
7. Is dispersed oil less 'sticky' to biological surfaces and sediment?
8. What are the routes of exposure to organisms to dispersed oil? Is it dissolved PAHs or the oil droplets, or both.
9. How will the food web be impacted? Issues relating to trophic transfer and species loss.
10. What are the new risks with subsea application? Is the oil readily biodegradable? Will it cause more damage than allowing the oil components to disperse into the air, weather and degrade by abiotic and biotic surface processes?

Unfortunately many of these questions are unanswered given the very limited opportunities available to carry out research in these areas. Some of the research recommendations made in the 1989 NRC report (REF 11) were once again highlighted in the 2005 NRC report (REF 10) as these research questions had not been undertaken during those 16 years. Since the 2005 NRC report some limited progress has been made in addressing the data gaps outlined.

2) Are there less toxic alternatives to the currently used Corexit formulations?

As detailed in the NCPPS there are fourteen products listed as approved for use as oil spill dispersants. In comparison with the available literature on the Corexit formulations even more limited and scientifically robust toxicity data exists (that is publically available) for the alternative dispersant formulations.

Recently the EPA (directive dated May 10th and addendum 2 on May 20th) requested that BP should use a less toxic dispersant (of similar reported effectiveness). Given the EPAs requested LC50 guidelines (LC50 values of ‘greater’ than or equal to 23 or 18 ppm for the fish and shrimp tests respectively) only **three** of the listed products on the EPA NCPPS would meet these toxicity criteria (see Tables 1 and 2 with suitable products highlighted in red; see footnote in tables for specific details). BP responded to EPA’s request (posted on May 22nd) and defended their use of the Corexit formulations stating limited toxicity data, potential long-term effects of some components in some of the alternative formulations coupled with limited availability in the volumes required for the DWH Gulf of Mexico oil leak. Following BP’s response the EPA announced (addendum 3 on May 26th) that in addition to requiring that BP reduces it’s use of dispersant (by around 75%) particularly at the surface they also stated that they will be carrying out toxicity tests to further evaluate these alternative products.

It is certainly a step in the right direction to consider the use of alternative dispersants that contain less inherent toxicity than the Corexit formulations, although considerations should also be made regarding;

(1) The effectiveness of the dispersant on the DWH oil (or at least oil of similar properties e.g. South Louisiana crude), especially at depth.
(2) The quantity of the alternative dispersant needed to be effective.
(3) The EXACT chemical composition (including listing of the proprietary chemicals AND their specific concentration in the mixture) of the dispersant. Many of the dispersants contain proprietary mixtures and do not list their chemical components in detail on the MSDS sheets (where available).
(4) The half-life of the dispersant and the potential breakdown products.
(5) Safety to applicators and other people who may be exposed to the aerial application of dispersants.

The toxicity data listed on the EPA NCPPS is limited in that it reports only acute toxicity to two standard test organisms, a larval fish and the mysid shrimp. However, given the perceived timing of exposure to organisms under a dispersed oil slick (i.e. acute exposures) this data is informative in assessing the relative toxicities of the different dispersants.

The data presented in the NCPPS summary table reports only the most pertinent LC50 values i.e. the data from the tests using the dispersant in a 1:10 ratio with No. 2 Fuel oil (see REF 17). These toxicity data are supplied to the EPA from the respective industries/manufacturers of the specific dispersant products. The methodology used to carry out these tests are standardized by the EPA so that all products are tested using the same test conditions (see Appendix C to 40 CFR part 300; as listed in REF 17). This details how the test solutions should be made, the concentrations to use, the specific test organisms, timing and other quality control / assurance checks, including positive and negative controls. Additional information and further toxicity tests for the products are also available on the EPA NCPPS site. In each dispersant's individual report (see REF 18 the toxicity section consists of four specific toxicity tests, all reporting LC50 values using the standard test organisms (i.e. the larval fish (after 96 hours of exposure) and the mysid shrimp (following 48 hours of exposure)):

(1) Dispersant only.
(2) No. 2 Fuel Oil.
(3) Dispersant in a 1:10 ratio with the No. 2 Fuel Oil.
(4) Reference toxicant.

In evaluating the summary data for the toxicity tests listed above (1-4) for potential alternatives in comparison to the Corexit formulations of concern is the wide variation in the LC50s reported for the No. 2 Fuel Oil and even furthermore the reference toxicity values between dispersants using the same test species (see Tables 1 and 2).

A reference toxicant is a toxic chemical that is used in performing toxicity tests to demonstrate the laboratories ability to perform the test correctly and obtain statistically robust and defensible data. Using set standard toxicity test methods and test organisms there should be good correlations between the LC50 values generated for the reference toxicant between tests in the same laboratory and between different laboratories. Common reference toxicants for marine species include, copper sulfate and potassium chloride. The reference toxicant that is required by the EPA for dispersant toxicity testing (REF 18) is the surfactant, dodecyl sodium sulfate (SDS; also called DSS). Having reference toxicants outside of the expected LC50 range could occur because of numerous factors. For example, poor quality of organisms, water, or the reference toxicant or some other factors influencing the experiments. Ultimately if you do not have a consistent LC50 for your reference toxicant then you cannot assume any of the other tests are reporting accurate data and the experiments should be repeated. Acute toxicity tests take 48-96 hours for completion.

Noteworthy is that the reference toxicant LC50s for the different dispersants listed on the NCPPS differ by orders of magnitude, up to nearly 300-fold. For example, in Table 2 reference toxicant data for the mysid shrimp tests range from an LC50 (ppm, 96-hr) from 0.98 (for Sea Brat #4) to 267.7 (for Nokomis 3-F4). One product (Nokomis 3-AA) used copper sulfate as a reference toxicant instead of the EPA required SDS reference toxicant. These issues are of concern if you are trying to compare the relative toxicity of the dispersants. Indeed, this currently, cannot be accurately assessed given the data presented on the NCPPS. These toxicity tests should be repeated. Indeed the EPA announced that they are carrying out (i.e. Addendum 3 dated May 27th) further toxicity tests, although the specific details as to the type and extent of these tests were not detailed.

a) Recommendations and future needs.

Moving forward for the DWH incident and future spills what should be carried out, in addition to scientifically robust data for the acute toxicity tests should be other longer-term (chronic) toxicity tests. These can be carried out using these and similar standard laboratory test organisms and are of 7-21 days in duration depending upon the species. These tests report data such as, growth and reproductive inhibition. Given the subsurface application of dispersants sediment toxicity tests may also be of value.

b) Proposal for an Independent test-bed for dispersants.

Unfortunately as noted earlier some of the data presented for the alternative dispersants is of limited value. In addition to effectiveness testing, accurate and reliable toxicity tests are required so that these dispersants can be considered for use. I believe it would be beneficial for the dispersant manufacturers, especially those small businesses who have much limited funds available for toxicity testing to have their products screened more cost effectively (see below) and more importantly accurately by an Independent toxicity testing center.

At the University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory (CBL) a similar testing center model is located. The Alliance for Technologies (ACT) program is a NOAA funded initiative that, for one of it's directives, acts as an Independent test-bed for aquatic sensor technologies (established in 2002). CBL is the headquarters for this program and partner institutions are spread at locations across the USA. Companies can submit their products for testing so that they can be independently compared with their competitors. It is a data and report generation exercise, fully independent and no endorsements of the products are made. To achieve this ACT carries out extensive tests using the same methodology at various sites across the USA for sensors in turn that measure the same endpoint (e.g. dissolved oxygen, DO).

Given the data currently available for dispersants, this type of program would be of use to current and future dispersant manufacturers. In brief, I propose a similar program to ACT for dispersant toxicity screening using the same basic model/framework already in place for the ACT program. Specifically, dispersants will be evaluated for acute toxicity (using the methods as detailed in EPAs Appendix C (REF 18)). Although I propose the use of a different reference toxicant that the one currently listed (SDS). In addition a re-evaluation and update of the current test protocols (last updated in 1997) are warranted. Furthermore, in the short-term, to aid in decisions for the DWH leak, toxicity tests could be carried out using a more relevant oil (either the oil currently leaking or a similar standard oil such as South Louisiana crude). To initiate this program a workshop should also be held to re-evaluate dispersant and dispersed oil standard toxicity test procedures (i.e. building on and updating the CROSERF protocols).

In summary each dispersant will be evaluated by THREE independent and EPA certified toxicity testing laboratories. These data will be collated and a final report generated. I would also propose additional screening. As stated above screening dispersants for chronic toxicity would be beneficial to understanding their potential long-term effects.

There are numerous business models that could be used for this testing facility. For example, if given agency and/or industry funding this testing facility could be run at no cost to the manufacturer. This would be particularly useful for small businesses trying to assess bringing a new potential oil spill dispersant to market. Furthermore, this test center could expand to investigate other oil spill mitigation and response strategies in addition to dispersants.

3) Subsurface application issues:

The unfortunate recent events in the Gulf of Mexico have once again raised many of the issues discussed above regarding the fate and effects of dispersants and dispersed oil in addition to adding further questions regarding the novel use of undersea dispersant application. As many have asked in the past weeks, potentially what will the environmental consequences be of the dispersant application, what will be affected, to what extent and how? This is impossible to predict for many reasons.

Open ocean spills are pre-approved (in waters >10m depth and >3 miles offshore) for dispersant application given the minimal perceived risks to the ocean and the seafloor based upon the depth and volume of water available to dilute the dispersed oil. However, this DWH oil spill is unique and a first for many reasons opening up many questions regarding the decision to use dispersants and what their potential effects may be. First, the sheer volume of dispersants applied is unprecedented; no spill in U.S. waters has used the amount of chemical dispersants that have currently been released (over 1.3 million gallons as of June 15th, 2010). Although it should be noted that the IXTOC spill (1979; see REF 19) in the Gulf of Mexico used a total of 2.5 million gallons of dispersant (not in U.S. waters), two-thirds of which were Corexit 9527. However, this was over a ten month period and not <2 months as in the DWH incident. As in the IXTOC spill dispersants are usually only applied to surface slicks. In the DWH leak dispersants are also being applied at the leak site. The question is how will this dispersed oil impact the benthic (seafloor) environment?

The surface oil slick is easily viewed via satellite but what about the sub-surface plume(s)? In toxicology it is the concentration of and the duration of exposure to a toxicant that determines its effect. Therefore, we need to know where the plume is, at what concentration, for how long and what species are present. Various agencies, oil spill responders and independent scientists are running models trying to predict the oil plumes concentration and trajectory. Additionally some measurements of oil concentrations/ particle sizes are being taken at depths in the Ocean around the spill site. Only in knowing the size of this plume in three dimensions, the concentration of the dispersed oil in the plume at these locations and the duration of exposure in one area, will predictions be able to be made of the potential effect. Indeed increased monitoring of subsurface plumes was a recommendation from the recent dispersant meeting (REF 11). Unlike with oil impacts along the coast and shoreline, it is very difficult to see the actual effects of the dispersed oil in the Ocean. Organisms that die will fall to the seafloor. Those that do not die may not show sublethal repercussions for a while. Declining populations of a water column species may occur and shoreline species may become severely limited in their food sources in addition to being faced with a contaminated food source.

With the increasing volume of oil and dispersants entering the system for extended periods of time there may be, at some time, a point reached in which the harm to the water column organisms (and now potentially benthic organisms) does not outweigh the harm to the shoreline. This may be particularly relevant if shorelines are increasingly being impacted by the oil coming onshore. Therefore, these original trade-off decisions will become less clear. These dispersants are approved for use in the open ocean, although there is no limitation as to how much and for how long they can be used. How long can the 'solution to pollution' reasoning hold? Furthermore, with the continued production of dispersed oil plumes from the surface and from the ocean floor will the dispersed oil plume reach the shallower, coastal locations that the decision to use dispersants has been based on? It is quite possible that a dispersed oil plume may reach and impact a shoreline.

In summary

Madam Chair and members of the Committee I would like to thank you again for allowing me to testify today regarding the effects of oil spill dispersants. We face huge challenges to protect our coastal and oceanic ecosystems. As in the case of oil spills this sometimes involves making difficult trade-off decisions on what ecosystem to protect at the expense of another. However, pollution cannot simply be treated as 'out of sight out of mind' or that 'the solution to pollution is dilution'. These assumptions need careful analyses on a continued basis that depend upon sound scientific data. A recommendation is to initiate a test-bed facility that would screen dispersants for toxicity using three independent laboratories. The proprietary components in dispersants should be made available to researchers and further toxicity testing of dispersants is required especially if considering alternate formulations. Although many decisions are based upon acute short-term toxicity studies we are constantly unraveling new and more subtle sublethal toxicological pathways and toxicity mechanisms. These sublethal impacts ultimately have dire consequences to a species survival, consequences of which alter the fine balance of food webs, alter ecosystem services, and the overall health of the environment. During an oil spill event it is hard to assess the effects on the organisms that you do not see and equally challenging to follow the potential long-term consequences of the spill. More respect needs to be given to efforts directed at baseline monitoring and mapping of our Oceans and seafloor ecosystems. We cannot assess impacts or follow restoration efforts unless we know what species were there beforehand. We need to monitor the subsurface plume(s) in space and time.

There are still many unanswered questions and uncertainties associated with the decisions to apply dispersants. I emphasize the recommendations for additional studies made in the recent NRC report that will help fill these critical data gaps in the knowledge and understanding of the behavior and interaction of dispersed oil on the biotic components of ecosystems (see REF 10). Whatever choices are made this unfortunate recent event in the Gulf will impact ecosystem health, local economies, food sources and recreational activities, the extent to which is currently unknown. We need better information to close these uncertainty gaps that oil spill response decisions are based upon and we need it now.
Thank you.

Table 1: Acute Toxicity data for larval fish (*Menidia beryllina*) as the lethal concentration to kill 50% of the test organisms (LC50) following 96 hours of exposure in parts per million (ppm).

Dispersant	Fish Toxicity (LC50 ppm, 96hr)			
	Dispersant & No. 2 Fuel Oil	No. 2 Fuel Oil	Dispersant Only	Reference Toxicant
NOKOMIS 3-F4	100.00	100.00	29.80	159.6 (DSS)
NEOS AB3000	57.	201.8	91.1	1.5 (DSS)
MARE CLEAN 200	42	10.72	1996	7.07 (SDS)
SEA BRAT #4	23.00	16.00	30.00	1.14 (DSS)
SAF-RON GOLD	9.25	16.76	29.43	15.94 (SLS)
ZI-400	8.35	18.05	31.76	16.13 (SLS)
Dispersit SPC 1000	7.9	11.6	3.5	6.3 (SDS)
NOKOMIS 3-AA	7.03**	22.50	34.22	-
Biodispers	5.95	12.42	13.46	11.84 (SDS)
Finasol OSR 52	5.40	5.95	11.66	8.54 (SDS)
Corexit EC9527A	4.49	10.72	14.57	7.07 (DSS)
JD-109	3.84	9.35	1.90	2.63 (DSS)
JD-2000	3.59	8.39	407.00	2.22 (SDS)
Corexit EC9500A	2.61	10.72	25.20	7.07 (SDS)

Data obtained from EPA National Contingency Plan Product Schedule Toxicity and Effectiveness Summaries: http://www.epa.gov/emergencies/content/ncp/tox_tables.htm

Detailed toxicity data obtained from: http://www.epa.gov/emergencies/content/ncp/product_schedule.htm

NOTE: Red shading denotes those dispersants that comply with the EPAs guidelines set forth in the Directive from May 10th, Addendum 2 of May 20th. http://www.epa.gov/bpspill/dispersants.html

Suitable dispersants would have an LC50 value of greater than or equal to 23.00 and 18.00 for the fish and shrimp toxicity tests respectively. **; in my original calculations (testimony on May 21st ; bipartisan briefing, House Committee on Energy and Commerce, Chairman Markey) Nokomis 3-AA was originally included in this suitable group. However, it appears the summary NCPPS table of dispersant toxicity detailing the product toxicities (1:10 product-to-No.2 Fuel Oil ratio) are actually the data for the dispersant only toxicities tests. This correction now discounts Nokomis 3-AA as a suitable less toxic alternative.

-; reference toxicant was $CuSO_4$ (5.36 96-hr and 7.83 48-hr for fish and shrimp respectively)

Table 2: Acute Toxicity data for the invertebrate mysid shrimp (*Mysidopsis bahia*) as the lethal concentration to kill 50% of the test organisms (LC50) following 48 hours of exposure in parts per million (ppm).

Dispersant	Shrimp Toxicity (LC50 ppm, 48hr)			
	Dispersant & No. 2 Fuel Oil	No. 2 Fuel Oil	Dispersant Only	Reference Toxicant
NOKOMIS 3-F4	58.40	72.70	32.20	267.7 (DSS)
NEOS AB3000	25.0	11.5	33.0	9.3 (DSS)
SEA BRAT #4	18.00	14.00	14.00	0.98 (DSS)
MARE CLEAN 200	9.84	16.12	938	9.82 (SDS)
Dispersit SPC 1000	8.2	11.7	16.6	11.7 (SDS)
Corexit EC9527A	6.60	16.12	24.14	9.82 (DSS)
NOKOMIS 3-AA	5.56**	11.07	20.16	-
JD-109	3.51	3.13	1.18	8.06 (DSS)
Corexit EC9500A	3.40	16.12	32.23	9.82 (SDS)
SAF-RON GOLD	3.04	5.93	63.00	9.83 (SLS)
Biodispers	2.66	2.82	78.90	21.81 (SDS)
Finasol OSR 52	2.37	2.37	9.37	21.81 (SDS)
JD-2000	2.19	2.58	90.50	10.50 (SDS)
ZI-400	1.77	2.66	20.96	27.80 (SLS)

Data obtained from EPA National Contingency Plan Product Schedule Toxicity and Effectiveness Summaries: http://www.epa.gov/emergencies/content/ncp/tox_tables.htm

Detailed toxicity data obtained from: http://www.epa.gov/emergencies/content/ncp/product_schedule.htm

NOTE: Red shading denotes those dispersants that comply with the EPAs guidelines set forth in the Directive from May 10th, Addendum 2 of May 20th. http://www.epa.gov/bpspill/dispersants.html

Suitable dispersants would have an LC50 value of greater than or equal to 23.00 and 18.00 for the fish and shrimp toxicity tests respectively. **; in my original calculations (testimony on May 21st ; bipartisan briefing, House Committee on Energy and Commerce, Chairman Markey) Nokomis 3-AA was originally included in this suitable group. However, it appears the summary NCPPS table of dispersant toxicity detailing the product toxicities (1:10 product-to-No.2 Fuel Oil ratio) are actually the data for the dispersant only toxicities tests. This correction now discounts Nokomis 3-AA as a suitable less toxic alternative.

-; reference toxicant was $CuSO_4$ (5.36 96-hr and 7.83 48-hr for fish and shrimp respectively)

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