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Committee on Science and Technology
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By Dr. Nancy E. Kinner[1]
Co-Director, Coastal Response Research Center
236 Gregg Hall
University of New Hampshire
Durham, NH 03824
603.862.1422

Hearing: *Deluge of Oil Highlights Research and Technology Needs for Effective Oil Spill Recovery and Clean Up*

Chairman Baird, Ranking Member Inglis, and distinguished members of the Committee on Science and Technology's Subcommittee on Energy and Environment, thank you for the opportunity to appear before you today on behalf of the University of New Hampshire and the Coastal Response Research Center. My perspective on the question of oil spill research and technology needs is highly influenced by my work with the Coastal Response Research Center (CRRC) since its inception in 2002. In order to make that perspective clear, I will give you an overview of the Center's history, mission and activities and its approach to oil spill research & development (R&D).

I. Overview of Coastal Response Research Center

NOAA's Office of Response and Restoration (ORR) became increasingly aware of the lack of oil spill R&D in its areas of primary responsibility: fate and behavior of spills and their impacts on natural resources and human activities. ORR recognized the role that a research university could play in addressing the R&D needs as well as the approach it would use to do so. Hence, in 2002 ORR started working within the University of New Hampshire to address this problem. The CRRC (http://www.crrc.unh.edu), a partnership between NOAA ORR and the University of New Hampshire, was created to address the need for improved spill response and restoration. The Center oversees and conducts independent research, hosts workshops, and leads working groups that address gaps in oil spill research in order to improve response, speed environmental recovery, and reduce the societal consequences of spills. In 2004, the partnership was codified by a memorandum of agreement between the University of New Hampshire and NOAA. CRRC acts as an independent, non-partisan entity to bring together members of the oil spill community, as well as those in relevant fields outside the spill community, including local stakeholders, and state, federal and international agencies to address the many technical, economic, social, and environmental issues associated with oil spills in marine environments. Funding for the Center has been largely by Congressional appropriation (Table 1) with some allocations from ORR's base budget.

[1] -Appendix A contains information on Dr. Kinner's research on bioremediation of contaminated subsurface environments.

Table 1
CRRC Funding History

Fiscal Year	**Appropriation**	**Grant to UNH**	*[Other funding; specify]*
2002	$750,000	$701,997	
2003	$750,000	$714,580	
2004	$2,000,000	$1,978,955	
2005	$2,000,000	$1,694,312	
2006	$3,000,000	$2,481,900	$75,000 (Marine Debris/NOAA, ORR)[1]
2007	$1,800,000	$1,435,249	
2008	0	0	$49,000 (eSCAT/NOAA, ORR)[1] $60,000 (ERMA®/NOAA, ORR)[1] $36,000 (In-situ/API)[2] **$145,000 (2008 Subtotal)**
2009	0	0	$25,000 (Workshop/ExxonMobil)[2] $63,000 (Workshop/NOAA OCRM)[3] $162,000 (ERMA®/NOAA, ORR)[1] **$250,000 (2009 Subtotal)**
2010	0	$200,000	$220,000 (ERMA®/ for Gulf/NOAA)[1] $30,000 (eSCAT for Gulf/NOAA)[1] $65,000 (NOAA, OCRM)[3] $139,000 (NOAA, ORR)
TOTAL 02-10	**$10,300,000**	**$9,206,993**	**$924,000** **($139,000 for CRRC's Direct Oil Spill R&D Use)**

[1]eSCAT and ERMA® funding is primarily for the UNH Research Computing Center to work on computer programming. Marine Debris funding was for an Environmental Research Group project.
[2] $61k to the Center for Spills in the Environment from API ($36k for In Situ Burning) and $25k from Exxon Mobil for partial support of the 2009 R&D Workshop)
[3] Funding for workshop on Ocean Thermal Energy Conversion (OTEC) - not oil spill related.

The Center is served by a multi-agency Advisory Board, comprised of members from U.S. EPA, NOAA, USCG, state-based R&D programs and industry that provide guidance on program direction. The board, in conjunction with the UNH and NOAA co-directors, developed five objectives for CRRC: (1) funding and oversight of relevant, peer-reviewed research that is able to be developed into practical improvements in oil spill response; (2) hosting topical workshops and working groups that include representatives of all spill community stakeholders to focus research efforts, and ensure that crucial real-world experience from oil spill practitioners is considered; (3) educating the next generation of spill responders through outreach and support of undergraduate and graduate student projects; (4) involving members of the international oil spill community to tap into expertise from around the world; and (5) developing response tools to aid responders.

Funding of relevant, peer-reviewed research is accomplished through a periodic request for proposal (RFP) process. Proposals are reviewed by three to four experts in the area of the proposed research. They are ranked by their scientific validity and how well they address key research needs related to the fate, behavior and effects of oil in the environment, and are likely to lead to practical improvements in oil spill response and restoration. A panel of leading scientists and practitioners then review the peer-reviewed and ranked proposals and recommend which should be funded. Each funded research project is assigned a NOAA liaison to ensure the research can be transformed into practice, and in addition, the CRRC's Science Advisory Panel meets annually to review progress of the research and provide feedback to improve the quality and efficacy of the research.

II. Oil Spill Response R&D Prior to the Deepwater Horizon Incident

The 1989 *Exxon Valdez* spill in Alaska directly resulted in the landmark Oil Pollution Act of 1990 (OPA 90), part of which addressed the need for R&D to improve prevention, preparedness, response and restoration. Specifically, an Interagency Coordination Committee on Oil Pollution Research (ICCOPR) was formed, headed by the U.S. Coast Guard (USCG), and included the Mineral Management Service (MMS), Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), National Institute of Standards, Department of Energy, Department of Defense, NASA, FEMA, US Fire Administration, and U.S. Fish & Wildlife Service. ICCOPR's role, as set forth in OPA 90, is to: (1) to prepare a comprehensive, coordinated Federal oil pollution research and development (R&D) plan; and (2) to promote cooperation with industry, universities, research institutions, State governments, and other nations through information sharing, coordinated planning, and joint funding of projects. Funding for R&D for states and universities was authorized, but after an initial infusion of money in the immediate aftermath of the *Exxon Valdez*, was never appropriated. In fact, the Federal and private sector money spent on oil spill R&D has decreased significantly since 1990 (Appendix B). OPA 90 also authorized some R&D funding for USCG, MMS and EPA for oil spill response. NOAA was not given any R&D funding as part of OPA 90. [N.B., I do not know why this happened, but find it ironic as NOAA is one of the Federal agencies most closely aligned with research, particularly in the marine environment.] The decrease in funding was related to the belief that through a focus on prevention and preparedness, we would not face a major spill event again of the scope and magnitude of the *Exxon Valdez.* Unfortunately, the Deepwater Horizon Gulf oil spill has proved that assumption to be horribly wrong. It is important to note that the amount of oil spilled from maritime shipping accidents, particularly from tankers, has fallen dramatically with the advent of better navigational aids, inspections and, in the case of tankers, the double hulled requirements. Likewise, there has been a specific response structure established with USCG in charge of a well defined incident command system (ICS), a network of Regional Response Teams (RRTs), and Area Committees. This command and control hierarchy is tested frequently in mandated drills and exercises at the local, regional, national and international level (e.g., Canada).

III. Problems with the Current R&D Model

The question is: how do we improve oil spill R&D going forward, based on what we have learned from the past, including the Deepwater Horizon incident?

One problem facing oil spill R&D was the lack of robust peer review requirements for any research performed. This resulted in skepticism regarding findings from industry or NGO financed projects and even some projects funded by Federal agencies. Many of the reports generated from these R&D projects were never published in scientific or engineering peer-reviewed journals. This does not mean the results are invalid, but it does mean that they are often questioned by key stakeholders in the "opposing camp". There are also cases where the experimental design/methods underlying the research were flawed and the data could not be used. For example, the CRRC, in conjunction with NOAA ORR and U.S. EPA, reviewed over 700 data points on acute toxicity of individual polycyclic aromatic hydrocarbons (PAHs) to aquatic organisms for an oil spill response field guide. The Center used a set of criteria (Table 2) to review each data point, including whether the PAH concentration to which the organism was exposed was actually measured, or just inferred from the initial mass added to the test chamber. After this standard quality assurance and quality control (QA/QC) process was completed, over 200 data points had to be eliminated because they did not meet QA/QC criteria.

Table 2: Screening Criteria for PAH Data Used to Create the Acute Toxicity Field Guide

Data for Naphthalene, Acenaphthalene, Anthracene, Fluoranthrene, Phenanthrene and/or Pyrene
LC50 measured at 24, 48, 72, 96 or 128 hours
LC50 method used
Concentration of contaminant measured at least once
>3 datapoints available

A second problem is the lack of coordination between federal, state, and international governmental agencies; and other stakeholders (e.g., NGOs and industry) regarding oil spill R&D. ICCOPR only consists of federal agencies and was therefore, not able to be a hub for the entire oil spill R&D community. Any proposal to move forward with oil spill R&D must include all stakeholders because the results must be "accepted" by all parties to minimize duplication and avoid overlap of the limited amount of funding that will ever be allotted to this topic due to the realities of budget constraints.

Since its inception in 2004, CRRC has hosted over 20 workshops on a wide variety of topics across the spectrum of oil spill R&D needs, and leads working groups on: oil dispersants; modeling of oil in the environment; submerged oil; toxicity of oil; and ephemeral data needs. The workshops (Table 3) have identified deficiencies in response and restoration, while the working groups (Table 4) help coordinate which agency funds specific R&D projects to avoid duplication of effort.

Table 3: CRRC-led R&D Needs Workshops.

U.S. Coast Guard Arctic Response - April 23, 2010
NRDA in Arctic Waters: The Dialogue Begins - April 20-22, 2010
Sea Grant & NOAA ORR Collaboration - January 25, 2010
Ocean Uses Atlas - January 12-14, 2010
Response to Liquid Asphalt Releases in Aquatic Environments - October 21, 2009

2009 Research & Development Needs - March 17-19, 2009
Oil Spill Modeling Working Group Meeting - September 16-17, 2008
Opening the Arctic Seas: Envisioning Disaster & Framing Solutions - March 18-20, 2008
HEA Metrics Workshop - December 4-6, 2007
Environmental Response Data Collection Standards - September 25-27, 2007
Modelers' Summit - June 26, 2007
Submerged Oil Workshop - December 12-13, 2006
Innovative Coastal Modeling for Decision Support: Integrating Physical, Biological, and Toxicological Models - September 26-28, 2006
Toxicology Working Group Summit - August 15 & 16, 2006
Workshop on Research Needs: Human Dimensions of Oil Spill Response - June 13-15, 2006
Research & Development Needs for Making Decisions Regarding Dispersing Oil - September 20-21, 2005

Table 4: CRRC-led Working Groups

Dispersants Working Group
Modeling Working Group
Submerged Oil Working Group
Toxicity Working Group
Ephemeral Data Working Group

A third problem is the need of translation of the results of oil spill R&D into practice. While some of the needed oil spill R&D involves fundamental work, much of it must be very focused on how the knowledge gained can actually be used in the field by responders and those charged with compensatory restoration of natural resources and their associated human activities. Hence, models for R&D, such as the National Science Foundation (NSF) prototype, are not completely satisfactory because of the lack of emphasis on transferring research into practice.

In keeping with its mission to ensure that research is transformed into practice, CRRC has created several spill response tools that are currently being used in the response to the Deepwater Horizon incident in the Gulf of Mexico, including the Environmental Response Management Application (ERMA®), the Oil Spill Toxicity Field Guide, and the link between the Clarkson Deepwater Oil and Gas Blowout Model (CDOG) and NOAA's GNOME surface slick model. These response tools were created to address deficiencies identified at CRRC workshops.

Another issue that is beginning to plague the oil spill community is the wave of retirements of experienced practitioners and researchers. One of the Centers missions is to educate the next generation of scientists and engineers who will pursue careers in oil spill response and restoration. CRRC has provided funding for four masters students and two Ph.D. students who have conducted research topics as diverse as movement of submerged oil, human dimensions of oil spills, and biodegradation potential of oil in Arctic environments. CRRC has also helped to educate numerous undergraduate students who participated in workshops as recorders and assisted with graduate student research projects.

Since its inception, CRRC has funded 27 research projects through its peer review process for a total of $4.3M. The research foci, as mandated by the Center's Advisory Board, are oil-in-ice, dispersed oil and submerged oil. Within these foci, the topics funded center around: injury and recovery of natural resources, socio-economic issues, and transport and weathering of oil. All of these are areas that specifically address NOAA ORR's role as a natural resource trustee and as the principal scientific advisor to the Federal On-Scene Coordinator during an oil spill. The research projects have resulted in 51 publications in peer reviewed journals.

Relevant to the Deepwater Horizon spill, the Center leads a Dispersants Working Group (DWG) consisting of 26 stakeholders, agencies and organizations that fund dispersant-related research. The goal of the DWG is to pursue an integrated approach to dispersants research by participating in a coordinated research plan where requests for proposals (RFPs) or the equivalent are shared among the members and duplication of effort is avoided. Each member funds research in its own area of responsibility. For example, USCG, MMS and NOAA fund research on: the SMART dispersant monitoring protocols, the efficacy and effects of dispersants respectively. The CRRC coordinates the group's activities by including: (1) holding annual DWG meetings (typically at oil spill conferences such as Clean Gulf every November); (2) postings of reports, RFPs and other elements of interest on its website; (3) hosting public forums where the latest research is discussed; and (4) updating/revising the dispersants use R&D needs as DWG member funded projects are completed and when/if new R&D questions are identified. Appendix C contains a list of all the $8.2.M of dispersants research that DWG members have funded since 2005 as well as the topics remaining to be funded. CRRC has funded $2.4M of the dispersants research. Other funders include: MMS, USEPA, USCG, Non-US government agencies/organizations (e.g., CEDRE, SINTEF, JIP, Environment Canada, Canada's Fisheries and Ocean and industry. The total R&D needs in the area of dispersants research was estimated at <$30M without any questions associated with the Deepwater Horizon Incident. Unfortunately, the reason that more of the R&D needs, identified by the NRC 2005 dispersants report and the needs identified by the CRRC hosted dispersant/dispersed oil meeting sessions (2005, 2007, 2009) have not been funded is simply a lack of funding by federal agencies, states and the lack of commitment to R&D by the oil industry. State R&D programs in Louisiana and California have undergone major budget cuts recently. Texas continues to have a strong financial commitment to R&D. API and the major oil companies have reduced R&D spending markedly and decreased the personnel they have committed to oil spill response research.

In all of these cases, the common element is the widely held belief prior to April 20, 2010 that we no longer have major oil spills, as witnessed by the 20+ years that have elapsed since the *Exxon Valdez* incident. Deepwater Horizon has reminded us that this belief is inaccurate; that as we have continued to drill for oil and gas in more extreme coastal and offshore environments, we have assumed greater risks

(e.g., drilling in very deep water; in potentially harsh environments as in the Arctic) without preparing for the consequences should a spill occur.

IV. Future Oil Spill R&D

If the Deepwater Horizon incident results in more funding appropriated for oil spill R&D, the question becomes how to best design the vehicles to: (1) determine the research needed, (2) coordinate financial support among the possible funding entities, (3) solicit proposals, (4) select the ones to fund, (5) insure the results are useful to the oil spill response and restoration community, (6) transformed into practices, and (7) determine when the R&D is sufficient or if new funded projects are needed to resolve the problem.

A. Determining the R&D Needs

In 2003 and again in 2009, the CRRC convened workshops of ~30-50 representatives of the oil spill community, to develop a host of research priorities for oil spill response and restoration. The topics for which R&D needs were developed included: spill response during disasters; spill response technologies; acquisition, synthesis and management of information for spills; human dimensions of spills; ecological monitoring and recovery following spills; biofuels; ecological effects of spills; and environmental forensics. [N.B., The organizing committee for the 2009 workshop decided not to include breakout groups on dispersed and submerged oil, liquid asphalt, spill modeling, or oil-in-ice because recent workshops hosted by CRRC which delineated those R&D needs.]

The goal of the 2009 workshop, and all CRRC workshops, is to bring stakeholders from federal and state spill-related agencies, industry, NGOs and researchers from academia and other research organization together to discuss knowledge gaps and their associated R&D needs and potential RFP (request for proposal) topics. For each proposed project the workshop participants provide objectives, guidelines, potential issue/problems that could be encountered, and an explanation of the application to the decision-making process. These become the basis for RFPs that each member writes in its area of responsibility or focus. Hence, when they create their agency's/group's oil spill RFPs, they will likely use some part of the R&D workshop needs. [N.B., the agencies/groups may also have RFPs on other topics, related to their specific mission.] Though the working groups coordinate who covers which R&D needs, they do not dictate the RFP topics funded by each member. This has been a reality since the concept of working groups in 2005. It is also a reality that any future coordinating effort would face (e.g., ICCOPR) because members want to maintain autonomy to control who and what proposals get funded. Even if this could be overcome by forcing U.S. Federal agencies to fund projects by a common mechanism, it would be difficult to get cooperation from states, NGOs, other countries, and industry. Therefore, the working group model may be the best option to insure R&D is coordinated among the stakeholders. Further, it is key to have participation in the R&D needs workshops by representatives of all stakeholders (e.g., federal and state agencies, industry, NGOs, national and international) and a mix of researchers (e.g., academics) and practitioners (e.g., responders). Researchers can offer an infusion of ideas based on fundamental principles and cutting-edge science and engineering, while practitioners can insure that the realities of response are injected into the discussion.

B. Solicitation and Selection of Proposals

Almost all funding entities have some form of public solicitation, though the extent is limited in some cases. The biggest differences are in selection of the proposals/researchers to fund. As noted earlier, RFP processes that require proposals to undergo rigorous peer review (i.e., similar to that used by the U.S. National Science Foundation) are usually viewed as having the most credibility. However, the type and extent of peer review varies widely among oil spill funding entities. Some RFPs are funded primarily on a research team's qualifications with little review on the experimental design proposed to address the R&D need. This oftentimes results in research whose results may not be accepted by all (e.g., industry funded research selected by this process may not be accepted by NGOs or governmental agencies).

Even when peer review is used to review the entire proposal, the extent of review can be varied. Some agencies conduct primarily an internal review using their own scientists/engineers, whereas others use a combination of external scientists /engineers and practitioners. This is a fundamental difference in the use of peer review to produce research that addresses a funding entity's needs.

C. Utility of Results in Response and Restoration

When the research is conducted to produce a detection or response device, it is usually not a problem to generate practical results. These are typically engineering types of projects, often conducted by consultants. For example, one problem faced when oil sinks (i.e., becomes submerged) to the bottom and collects on a muddy sediment in nearshore coastal waters, is that it becomes very difficult to detect. This R&D needs was identified in a CRRC and USCG hosted workshop in December 2006. Subsequently, the USCG R&D Center (New London, CT) issued a Broad Agency Announcement (BAA) to solicit proposals on this topic. In the first funding allocation, USCG funded several groups with promising technologies to perform preliminary demonstrations of their capabilities. Subsequent funding was focused on the technologies able to detect the submerged oil at the large-scale MMS-operated OHMSETT test tank in New Jersey. Results are pending, but should establish which technology to pursue for further funding to meet the overall goal of submerged oil detection.

This type of research contrasts with the more fundamental R&D that must be conducted to answer questions of the fate, behavior and effects of oil. These are often the questions that must be addressed by NOAA and USEPA. For these questions, a broader scientific community must be involved (e.g., academicians). When that happens, there is often the possibility that the results may be less directly used by the responders. There are two primary reasons for this. (1) The researchers often have little experience with oil spills or the constraints imposed by working in field where there is often only a short window in which to respond. (2) Researchers who study fate, behavior and effects issues are not usually as focused on producing a product as those who are working on technology development. CRRC has developed two solutions to address this problem. Each RFP topic is assigned a NOAA practitioner to serve as a Point of Contact (POC) during the proposal development stage. Researchers interested in submitting a proposal on the RFP topic are strongly encouraged to talk with the POC not only about the topic, but also about the operational, logistical, and field conditions that constrain application of the project results. [N.B., The POC has no role in the peer review process.] Since CRRC instituted this approach the majority of the proposals received have been much more focused on addressing the R&D specific needs, indicating the researchers have a much better grasp of the constraints of a spill response.

Once a project is funded, a NOAA liaison is assigned to the team. The liaison is a NOAA employee who will use the research to address R&D issues s/he will face during a spill response (e.g., a NOAA spill modeler was the NOAA liaison on a research project aimed at applying a probability model to predict where submerged oil might move in shallow nearshore waters). Again, since using this approach, CRRC has found that the research results are more easily transferred to practitioners.

D. Updating R&D Needs

The working group members meet annually, if at all possible (though sometimes participation is limited by budget constraints of some of the partners) to review progress towards meeting the R&D needs identified during the workshops. Public forums are held when the members determine sufficient progress has been made towards addressing needs. In addition, they allow for discussion of whether an R&D need has been fully addressed so it can be removed from the "list". They also foster discussion of new R&D needs in the interim between workshops.

E. Oil Spill Research and Technology Needs

The topics of workshops hosted by the CRRC with representatives of the members of oil spill community have focused on the areas of greatest need in the field: dispersed oil, submerged oil, integrated 3D spill modeling, Arctic oil spill needs, including Natural Resources Damage Assessment, toxicity, fate and behavior of liquid asphalt, along with topics identified on the 2009 Research & Development Priorities: Oil Spill Workshop.

The Deepwater Horizon response has faced several of these issues (e.g., dispersed oil fate and behavior, acute and chronic toxicity, submerged oil detection, 3D modeling), but has also brought to light some new issues associated with understanding the fate and behavior of oil released from wells at great depth (e.g., fate and behavior, propensity for natural dispersion in the water column, emulsification, containment).

There has also been an issue with the use of new technologies for response (e.g., products designed to absorb floating oil without uptake of water, a variety of dispersants) and for stopping the uncontrolled flow of the oil from the riser. There must be a method to test these new technologies before they are applied in an actual event. The risks of doing that are very high and not likely to be taken by the Unified Command or the Federal On-Scene Coordinator. Perhaps a model for this kind of testing can be adopted from the water treatment industry. USEPA funds the National Sanitation Foundation to run a technology testing program where manufacturers pay to have independent research laboratories evaluate their devices by using pre-established protocols and standard analytical methods. This subjects all technologies designed to treat a certain contaminant to the same standards and testing. It is important to note that the cost of the evaluation is borne by the manufacturer, but that USEPA provides base funding to the National Sanitation Foundation to administer the program and establishes the protocols and standards.

V. A Model for a Coordinated Federal Research Program

The question of how to coordinate a Federal research program on oil spill response and restoration is one that is complex and must be carefully considered. The ICCOPR model of OPA 90 is not satisfactory, in part because much of the funding authorized was not appropriated. At least three other factors contribute: (1) the expectation that all of the Federal agencies on ICCOPR would actively participate when they were only tangentially associated with oil spill response, (2) the expectation that the Federal agencies would have the capacity to oversee a multi-faceted R&D program when little of their normal agency focus was on R&D, and (3) the assumption that Federal oversight would bring about the integration, coordination, and acceptance of the results of the R&D. The concept of Federal oversight is not fundamentally flawed, because the government should insure that the needed R&D is conducted, especially on the issues associated with drilling operations and transport in extreme and unexplored environments (e.g., deep ocean drilling, Arctic environment).

I recommend that Congress consider the following model going forward: an interagency committee co-chaired by NOAA and USCG that is comprised of those agencies actually funding oil spill response and restoration R&D (e.g., MMS, USEPA, USFWS) as well as the various states that have active oil spill R&D programs (e.g., TX, CA, and LA) and well established oil spill R&D programs (e.g., OSRI, CRRC, PWSRCAC, CIRCAC). However, such a Federal and state focused committee, even with the inclusion of federally funded programs that have R&D, is missing two major players in oil spill R&D: industry R&D programs and international oil spill R&D entities (e.g., those of Canada, France, Norway). Researchers from these two groups need to be included in the discussions.

The committee needs an outside Executive Agent – respected by all the Federal agencies and states -- to serve as de-facto staff, to foster coordination among members, and to manage an external research program addressing priority national needs as defined by the committee, but not being addressed by specific existing Federal or state efforts.

Selection of the Executive Agent, via a competitive process, should be merit based, with continuation based on periodic performance reviews. The Executive Agent should have well-recognized and respected capabilities that warrant its selection for such a role including the demonstrated ability to:

- Work with the spill community to prioritize important issues needing attention,
- Administer a nationally competitive research,
- Facilitate coordination of Federal, State, private sector, and as possible, international spill response research,
- Produce independent, third-party peer reviews of its work, and
- Serve as a neutral party in fostering cooperation among national and international members of the oil spill community.

Finally, I suggest we also consider a new paradigm for conducting some controversial R&D projects (e.g., ones to establish toxicity thresholds of key species). Scientists representing all stakeholders

should be brought to the table by the Executive Agent to identify the R&D need (e.g., objectives, guidelines, potential issues, application to decision-making) and then to develop the experimental design and materials and methods as well as the data analysis techniques to be used. By agreeing to these essential components of the project in advance, the results obtained will be much more likely to be accepted, so that progress towards better spill response and restoration can be made more rapidly.

VI. Conclusions

- The CRRC, a partnership between NOAA ORR and the University of New Hampshire, was created to address the need for improved spill response and restoration. The Center oversees and conducts independent research, hosts workshops, and leads working groups that address gaps in oil spill research in order to improve response, speed environmental recovery, and reduce the societal consequences of spills. CRRC acts as an independent, non-partisan entity to bring together members of the oil spill community, as well as those in relevant fields outside the spill community, including local stakeholders, and state, federal and international agencies to address the many technical, economic, social, and environmental issues associated with oil spills in marine environments. Funding for the Center has been largely by Congressional appropriation with some allocations from ORR's base budget.

- There are four major impediments to oil spill R&D:
    - the inadequate funding available for R&D on a sustained basis (See Appendix B).
    - the lack of robust peer review requirements for research performed has resulted in skepticism regarding findings.
    - the lack of coordination between Federal, state and international government agencies; and other stakeholders (e.g., NGOs and industry) regarding oil spill R&D. ICCOPR only consists of federal agencies and is therefore, not able to serve as a hub for the entire oil spill R&D community.
    - the need to translate results of oil spill R&D into practice. While some of the needed oil spill R&D involves fundamental work, much of it must be very focused on how the knowledge gained can actually be used in the field by responders and those charged with compensatory restoration of natural resources and their associated human activities.

- Future R&D needs should be identified using a working group model to insure R&D is coordinated among all stakeholders. Further, it is key that participation in the workshops that focus on identifying R&D needs include representatives of all stakeholders (e.g., Federal and state agencies, industry, NGOs, national and international) and a mix of researchers (e.g., academics) and practitioners (e.g., responders).

- Solicitation and selection of R&D proposals should be based on a rigorous external peer review process including scientists, engineers and practitioners.

- Efforts, such as assigning responders as points of contact during the RFP process and practitioners to serve as liaisons for funded R&D projects, are essential to producing research

results that are readily transferred to use during response and restoration.

- It is important to update oil spill R&D needs regularly (e.g., at least every 5 years or after a major incident) as questions are resolved and new problems arise that need to be addressed.

- Oil spill response and restoration areas that have significant R&D needs include: dispersants and dispersed oil; submerged oil; integrated 3D spill modeling; Arctic oil spill needs, including Natural Resources Damage Assessment; toxicity, fate and behavior of liquid asphalt; spill response during disasters; spill response technologies; acquisition, synthesis and management of information for spills; human dimensions of spills; ecological monitoring and recovery following spills; biofuels; ecological effects of spills; and environmental forensics; as well as issues brought to light by the Deepwater Horizon incident: the fate and behavior of oil released from wells at great depth (e.g., propensity for natural dispersion in the water column, emulsification, containment).

- The ICCOPR model of OPA 90 is not satisfactory, not only because much of the funding authorized was not appropriated, but because of: (1) the expectation that all of the Federal agencies on ICCOPR would actively participate when they were only tangentially associated with oil spill response; (2) the expectation that the Federal agencies would have the capacity to oversee a multi-faceted R&D program when little of their normal agency focus was on R&D; and (3) the assumption that Federal oversight would bring about the integration, coordination, and acceptance of R&D needed for oil spill response. The concept of Federal oversight is not fundamentally flawed, because the government has responsibility to insure that the needed R&D is done, especially on the issues associated with drilling operations and transport in extreme and unexplored environments (e.g., deep ocean drilling, Arctic environment).

- Congress should consider the following model going forward: an interagency committee co-chaired by NOAA and USCG that is comprised of these agencies actually funding oil spill response and restoration R&D (e.g., MMS, USEPA,USFWS) as well as the various states that have active oil spill R&D programs (e.g., TX, CA, and LA) and well established oil spill R&D programs (e.g., OSRI, CRRC, PWSRCAC, CIRCAC). Oil spill researchers from industry and international R&D programs should be included in the discussions. The committee needs an outside Executive Agent – respected by, all the Federal agencies and states on the committee -- to serve as de-facto staff, to foster coordination among members, and to manage an external research program addressing priority national needs as defined by the committee, but not being addressed by specific existing Federal or state efforts.

Appendix A

Information on Dr. Kinner's research of bioremediation and contaminated subsurface environments

Prior to the formation of the CRRC, Dr. Kinner worked in the field of bioremediation. In the late 1980's, she lead an examination of the potential for *in situ* enhanced biodegradation of gasoline in New Hampshire groundwater through the introduction of nutrients and electron donors and found that complete *in situ* bioremediation is possible under optimal conditions. In the early 1990's, it became apparent that ecological interactions within the groundwater microbial community may be playing a role in bioremediation, she had NSF funding for research at the Massachusetts Military Reservation (MMR) in Sandwich, MA with partners at the United States Geological Survey (USGS) to investigate the role protistan predation on bioremediation of a subsurface wastewater plume. This research formed a cornerstone for future predation-linked bioremediation studies, and determined that groundwater protists can have a potentially rapid and major impact on bacteria associated with groundwater bioremediation. In the late 1990's, a spill of #2 fuel oil in a salt marsh in Portland, ME spurred CICEET-funded research on enhanced biodegradation of petroleum in salt marshes through the addition of nutrients and terminal electron acceptors such as oxygen and nitrate. This research found that bioremediation of petroleum contaminated salt marshes is possible through the addition of nutrients, oxygen and nitrate, with significantly less disturbance than typical mechanical remediation methods. Shortly thereafter, the Bedrock Bioremediation Center was formed with a grant from USEPA and examined bioremediation of chlorinated solvents in a fractured bedrock aquifer, a poorly understood environment with respect to bioremediation. The work focused on bioremediation of trichloroethene (TCE), one of the most common groundwater contaminants, and led to a better understanding of the important role nanoflagellates have in biodegradation of TCE, and confirmed the presence of nanoflagellates in anaerobic fractured-bedrock aquifers, something previously thought impossible. More recently, CRRC has partnered with SINTEF, the University of Rhode Island, and the University of Alaska in a Joint Industry Project (JIP) to examine the role of predation on biodegradation of crude oil in Arctic sea ice. This research is ongoing.

APPENDIX B

Oil Pollution
Research and Development Funding
Prepared for NOAA ORR by CRRC

R&D Needs

Title VII of the Oil Pollution Act of 1990 (OPA-90) addresses research. It mandated that an interagency committee, chaired by U.S. Coast Guard, develop a multi-disciplinary plan to identify "significant oil pollution research gaps" and "establish research priorities and goals for technology development related to prevention, response, mitigation and environmental effects". The first plan was released in 1993 and reviewed by the National Academy of Sciences. That plan was last revised in 1997, after which the Interagency Committee was less active. The broadly representative Advisory Committee to the Coastal Response Research Center (a partnership between NOAA and the University of New Hampshire managing a national peer-reviewed competitive program) urged the Center to focus on this as one of its early activities. In 2003 and 2009, the Center hosted workshops which included participants from a broad spectrum of the oil spill community that resulted in reports on research needs for five year horizons. Each plan built upon the preceding ones and incorporated knowledge gained from research conducted over the intervening years.

R&D Funding

At the Federal level, OPA-90 authorized $30M from 1991-1995 to fund a regional research competitive grants program to universities and research institutions. This program only funded 20 R&D projects totaling $5.2M in 1994 -1995. EPA (~$0.9M/yr), MMS (~$0.9M/yr) and USCG (~$0.7 – $2M/yr) have used a fairly constant portion of the monies they receive from the Oil Spill Liability Trust Fund (OSLTF) to support specific R&D projects. A Congressional earmark, from 2002 to 2007, provided $0.5 to $3M/yr to NOAA to support its R&D partnership with the Coastal Response Research Center.

At the State level, there has been modest, but consistent funding for oil pollution R&D: Texas ($1.2M/yr since 1991), California ($0.3M – $0.6M/yr since 1993), and Louisiana ($0.5M to $0.8M/yr since 1993). Each State's program funds research projects primarily through competitive intrastate grants. OPA-90 provided ~$0.8 M/yr for the Prince William Sound Oil Spill Recovery Institute (OSRI) in Alaska (generated from interest from a ~$22M trust within the OSLTF). While focused on regional research needs, these programs have provided important information to improve overall oil spill response.

Industry support for R&D, primarily through the American Petroleum Institute (API), the Marine Spill Response Corporation (MSRC) and a few joint industry/government programs, peaked from the mid 1970's to mid 1990's (~ $50M expended by API over the years 1975-1996; MSRC conducted a $30M research effort that was terminated in the mid-1990's). Since then, the private sector has drastically decreased its oil pollution R&D funding (API spent ~$40K/yr for research since the year 2000).

APPENDIX C

Dispersant Research

Dispersed Oil Research Data

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
Table 1. EFFICACY TOPIC 1: Chemical Parameters that Influence Overall Effectiveness.							
1A. Research Topic	***Literature synthesis on physical and chemical properties of oils that determine the overall effectiveness of dispersant application***	"Dispersants: An Electronic Bibliography on Effectiveness, Technological Advances, and Toxicological Effects." Conover (LUMCON Library, LSU)		Complete		http://www.lumcon.edu/library/dispersants/	Louisiana OSRADP
		"Stability and the Resurfacing of Dispersed Oil." Fingas (Environment Canada)	Partial	Complete		http://www.pwsrcac.org/docs/d0026200.pdf	PWS RCAC
		"A Review of the Emulsification Tendencies and Long Term Petroleum Trends of Alaska North Slope Oils and the White Paper on Emulsification of ANS Crude Oil Spilled in Valdez." Fingas (Environment Canada)	Partial	Complete		http://www.pwsrcac.org/docs/d0024800.pdf	PWS RCAC
		"Technology Assessment of the Use of Dispersants on Spills from MMS-Regulated OCS Facilities" SL Ross Envrionmental Research Ltd.	Partial	Complete		http://www.mms.gov/tarprojects/349.htm	MMS
		"Assessment of the Use of Dispersants on Marine Oil Spills in California" SL Ross Envrionmental Research Ltd.	Partial	Complete		http://www.mms.gov/tarprojects/413.htm	MMS
		"Chemical Characteristics of an Oil and the Relationship to Dispersant Effectiveness" Emergencies Science Division, Environment Canada	Partial	Complete		http://www.mms.gov/tarprojects/436.htm	MMS
		"Identification of Window of Opportunity for Chemical Dispersants on Gulf of Mexico Crude Oils" SL Ross Environmental Research Ltd.	Partial	Complete		http://ww.mms.gov/tarprojects/595.htm	MMS
1B. Research Topic	***Refining existing datasets to correlate physical and chemical properties of different types of oils with***	"Effectiveness by use of dispersant on various oils at relevant weathering degree and ice concentrations." Task leader - SINTEF (Norway)	Partial	June, 2008		TBA	Shell

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
		"Wave Tank Studies on Dispersant Effectiveness as a Function of Energy Dissipation Rate and Particle Size Distribution." Lee, Venosa (Bedford Institute of Oceanography, Canada)	Partial	2009	$199,999	www.crrc.unh.edu/center_projects.htm/center_projects.htm	CRRC
		"Effects of Dispersants on Oil-SPM Aggregation and Fate in US Coastal Waters." Khelifa, Fingas (Environment Canada)	Partial	2008	$126,378	www.crrc.unh.edu/center_projects.htm	CRRC
		"Development of a Numerical Algorithm to Compute the Effects of Breaking Waves on Surface Oil Spilled at Sea: Dispersion and Submergence/Over-Washing as Extremes of a Theoretical Continuum." Reed, Daling, Johansen (SINTEF Materials and Chemistry, Norway)	Partial	Complete	$278,750	www.crrc.unh.edu/center_projects.htm	CRRC
		"Measurements and Modeling of Size Distributions, Settling and Dispersions (turbulent diffusion) Rates of Oil Droplets in Turbulent Flows." Katz, Gopalan (The Johns Hopkins University, Department of Mechanical Engineering)	Partial	January, 2009	$240,158	www.crrc.unh.edu/center_projects.htm	CRRC
		EMSA - Project: "Decision Support Tool for Dispersant Use." (SINTEF, CEDRE, Alun Lewis Ltd)	Partial	Completed 2006	$100,000	EMSA-Report + Model tool available: Contact: Lito.Xirotyri@emsa.eu.int	SINTEF/ EMSA/ CEDRE/ Lewis
		"Correlating Results of Dispersants Effectiveness at Ohmsett with Identical At-Sea trial: Effects of Oil Viscosity and Dispersant to Oil Ratios" SL Ross Envrionmental Research Ltd.	Partial	Complete		http://www.mms.gov/tarprojects/477.htm	MMS
		(above)				http://www.mms.gov/tarprojects/526.htm	
		"Analysis of IFO-180 and IFO-380 Oil Properties for Dispersant Windo of Opportunity" SL Ross Envrionmental Research Ltd.	Partial	Complete		http://www.mms.gov/tarprojects/506.htm	MMS

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
		"Correlating Reults of Ohmsett Dispersant Test with At-Sea Trials: Workshop to Coordinate Publications and Prioritize Follow-up Research" SL Ross Envrionmental Research Ltd.	Partial	Complete		http://www.mms.gov/tarprojects/507.htm	MMS
		Mitigating Oil Spills from Offshore and Gas Activities by Enhancement of Oil-Mineral Aggregate Formation (DFO Canada - Center for Offshore Oil & Gass Environmetnal Research)				http://www.mms.gov/tarprojects/585.htm	MMS
1C. Research Topic	***Protocols for creating weathered oil/emulsions***	"Harmonization of SINTEF / CEDRE Methodologies."		complete		SINTEF- reports: Contact: per.daling@sintef.no / Francois.Merlin@cedre.fr	SINTEF/ CEDRE
		"Development of a Method to Produce Large Quantities of Realistic Water-In-Oil Emulsions for Use in Evaluating Oil Spill Response Equipment and Methods." Belore (SL Ross Environmental Research Ltd.)		Complete		http://www.mms.gov/tarprojects/516.htm	MMS
1D. Research Topic	***Development of standard oils with known dispersibility over a range of variables, for use in comparison with***	"Wave Tank Studies on Dispersant Effectiveness as a Function of Energy Dissipation Rate and Particle Size Distribution." Lee, Venosa (Bedford Institute of Oceanography, Canada)	Partial	see previous		www.crrc.unh.edu/center_projects.htm	CRRC
		"Development of a Numerical Algorithm to Compute the Effects of Breaking Waves on Surface Oil Spilled at Sea: Dispersion and Submergence/Over-Washing as Extremes of a Theoretical Continuum." Reed, Daling, Johansen (SINTEF Materials and Chemistry, Norway)	Partial	see previous		www.crrc.unh.edu/center_projects.htm	CRRC
		"Measurements and Modeling of Size Distributions, Settling and Dispersions (turbulent diffusion) Rates of Oil Droplets in Turbulent Flows." Katz, Gopalan (The Johns Hopkins University, Department of Mechanical Engineering)	Partial	see previous		www.crrc.unh.edu/center_projects.htm	CRRC
		"Harmonization of SINTEF / CEDRE Methodologies"		see previous			SINTEF/ CEDRE

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
1E. Research Topic	***Development and intercomparison studies of methods for measuring droplet size distributions and energy dissipation rate in different***	"Wave Tank Studies on Dispersant Effectiveness as a Function of Energy Dissipation Rate and Particle Size Distribution." Lee, Venosa (Bedford Institute of Oceanography, Canada)	Complete	see previous		www.crrc.unh.edu/center_projects.htm	CRRC
		"Development of a Numerical Algorithm to Compute the Effects of Breaking Waves on Surface Oil Spilled at Sea: Dispersion and Submergence/Over-Washing as Extremes of a Theoretical Continuum." Reed, Daling, Johansen (SINTEF Materials and Chemistry, Norway)	Complete	see previous		www.crrc.unh.edu/center_projects.htm	CRRC
		"Measurements and Modeling of Size Distributions, Settling and Dispersions (turbulent diffusion) Rates of Oil Droplets in Turbulent Flows." Katz, Gopalan (The Johns Hopkins University, Department of Mechanical Engineering)	Complete	see previous		www.crrc.unh.edu/center_projects.htm	CRRC
		"JIP-Coastal Spill Contingency-Lifetime of Weathered Oils Using Flume Basin."		2008	$300,000	Contact: merete.moldestad@sintef.no	SINTEF/ JIP
		"Laboratory Testing to Determine Dispersion Predictability of the Baffled Flask Test (BFT) and Swirling Flask Test (SWT)" US EPA and University of Cincinnati	Partial	Complete		http://www.mms.gov/tarprojects/513.htm	MMS
		"Chemical Dispersant Research at Ohmsett: Phase 2 - Validation of Small-Scale Laboratory Test Dispersant Effectiveness Ranking " (Mr. Randy Belore/Dr. Ken Trudel, S.L. Ross Environmental Research, Ltd)				http://www.mms.gov/tarprojects/638.htm	MMS
		"Analysis of Dispersant Effectiveness of Heavy Fuel Oils and Weathered Crude Oils at Two Different Temperatures Using the Baffled Flask Test" US EPA and University of Cincinnati	Partial	Complete		http://www.mms.gov/tarprojects/529.htm	MMS
1F. Research Topic	***Design and implement a research program to fill identified***	"2005 Research & Development Needs For Making Decisions Regarding Dispersing Oil"	Partial	Complete		www.crrc.unh.edu/dwg/dispersant_workshop_report_complete.pdf	CRRC

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
		"JIP: Oil in Ice-Project4: Dispersant Effectiveness in Ice"		2009	$350,000	Draft report . 2009 Contact: per.daling@sintef.no	Norwegian reseach Counsil/ JIP
		"Using Dispersants to Test and Evaluate the Effectiveness of Dispersants in Cold Water and Broken Ice." Belore (SL Ross Environmental Research Ltd)		Complete		http://www.mms.gov/tarprojects/450.htm	MMS
		"Ohmsett 2003 Cold Water Dispersant Effectiveness Experiments." Belore (SL Ross Environmental Research Ltd.)		Complete		http://www.mms.gov/tarprojects/476.htm	MMS
		"Dispersant Effectiveness Testing on Heavy OCS Crude Oils at Ohmsett." Belore (SL Ross Environmental Research Ltd.)		Complete		http://www.mms.gov/tarprojects/514.htm	MMS
		"The Effect of Warming Viscous Oils Prior to Discharge on Dispersant Performance." Belore (SL Ross Environmental Research Ltd.)		Complete		http://www.mms.gov/tarprojects/527.htm	MMS
		"Dispersant Effectiveness Testing on Realistic Emulsions at Ohmsett." Belore (SL Ross Environmental Research Ltd.)		Complete		http://www.mms.gov/tarprojects/542.htm	MMS
		"Calm Sea Application of Dispersants." Trudel, Belore (SL Ross Environmental Research Ltd.)		Complete		http://www.mms.gov/tarprojects/545.htm	MMS
		"Chemical Dispersibility of OCS Crude Oils in Non-Breaking Waves; Part 1 Determining the Limiting Oil Viscosity for Dispersion in Non-Breaking Waves." Trudel, Belore (SL Ross Environmental Research Ltd) Lewis (Alun Lewis Oil Spill Consultancy)		Complete		http://www.mms.gov/tarprojects/546.htm	MMS
		"Research at Ohmsett on the Effectiveness of Chemical Dispersants on Alaskan Oils in Cold Water." Trudel, Belore (SL Ross Environmental Research Ltd.)		Complete		http://www.mms.gov/tarprojects/568.htm	MMS

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
		"Laboratory Study to Compare the Effectiveness of Chemical Dispersants When Applied Dilute versus Neat" SL Ross Environmental Research Ltd	Partial	Complete		http://www.mms.gov/tarprojects/350.htm	MMS
		"Changes with Dispersant Effectiveness with Extended Exposure in Calm Seas" S.L. Ross Environmental Research Ltd and Alun Lewis Oil Spill Consultancy	Partial	Complete		http://www.mms.gov/tarprojects/590.htm	MMS
		"Development of a Training Package on the Use of Chemical Dispersants for Ohmsett - The National Oil Spill Response Test Facility" S.L. Ross Environmental Research Ltd.	Partial	Complete		http://www.mms.gov/tarprojects/613.htm	MMS
		"Chemical Dispersant Research at Ohmsett" S.L. Ross Environmental Research Ltd.	Partial	Complete		http://www.mms.gov/tarprojects/615.htm	MMS
		"Chemical Dispersant Research at Ohmsett" S.L. Ross Environmental Research Ltd.Literature Review on Chemical Treating Agents in Fresh and Brackish Water" (Randy Belore, S.L. Ross Environmental Research, Ltd.)				http://www.mms.gov/tarprojects/635.htm	MMS
		"Chemical Dispersant Research at Ohmsett: Phase 2 - Evaluation of Dispersant Effectiveness in Low-Dose, Repeat Applications" (Mr. Randy Belore/Dr. Ken Trudel, S.L. Ross Environmental Research, Ltd)				http://www.mms.gov/tarprojects/638.htm	MMS
		"Chemical Dispersant Research at Ohmsett: Phase 2 - Validation of Small-Scale Laboratory Test Dispersant Effectiveness Ranking " (Mr. Randy Belore/Dr. Ken Trudel, S.L. Ross Environmental Research, Ltd)				http://www.mms.gov/tarprojects/638.htm	MMS
		"Review of Ohmsett Cold Water Testing." Fingas, DeCola (Environment Canada)		February 2006		http://www.pwsrcac.org/docs/d0030200.pdf	PWS RCAC

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
Table 2. EFFICACY TOPIC 2: Operational and Hydrodynamic Parameters that Influence Overall Effectiveness.							
2A. Research Topics	***Determination of the factors that represent realistic operational conditions for wave tank test systems***	"JIP-Coastal Spill Contingency-Lifetime of Weathered Oils." And the CRRC-project (see below)		2008	$150,000 + $120,000	Both projects just initiated. Contact: Merete.moldestad@sintef.no or oistein.johansen@sintef.no	SINTEF
2B. Research Topics	***Improving models of dispersed oil transport in the upper mixed layer***	CRRC-project: "Development of Numerical Algorithms to Compute the Effects of Breaking Waves."		see previous		www.crrc.unh.edu/center_projects.htm	CRRC/ SINTEF
		"Field Verification of Oil Spill Fate & Transport Modeling and Linking CODAR Observation System Data with SIMAP Predictions" Payne, French-McCay, Terrill, Nordhaussen (Payne Environmental Consultants, Inc.)	Complete	2007	$196,041	www.crrc.unh.edu/center_projects.htm	CRRC
2C. Research Topics	***Update SMART monitoring protocols***	"Field Verification of Oil Spill Fate & Transport Modeling and Linking CODAR Observation System Data with SIMAP Predictions." Payne, French-McCay, Terrill, Nordhaussen (Payne Environmental Consultants, Inc.)	Partial	see previous		www.crrc.unh.edu/center_projects.htm	CRRC
		"The NEBAJEX (MUMM /SINTEF /CEDRE)"	Complete	2003	EU-funded project	Reports available: MUMM (Belgium) Contact: R.Schallier@mumm.ac.be	SINTEF/ MUMM/ CEDRE
		"Upgrade of SMART Dispersant Effectiveness Monitoring Protocol" S.L. Ross Environmental Research Ltd.	Partial	Complete		http://www.mms.gov/tarprojects/598.htm	MMS/USCG

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
2D. Research Topics	***Assessment of the effects of dispersant application on subsequent mechanical recovery of***	"Mechanical Recovery of Oil Treated with Dispersant."		2002	$50,000	SINTEF Report available (in Norwegian)	SINTEF/ Norwegian Authorities
		"Investigation of the Ability to Effectively Recover Oil Following Dispersant Application" S.L. Ross Environmental Research Ltd.		Complete		http://www.mms.gov/tarprojects/589.htm	MMS
2E. Research Topics	***Optimizing the operational effectiveness of dispersant***	"Improve and Adapt Existing Dispersant Application Technology for Oil in Ice and Low Temperatures." Task leader Sintef	Partial	August 2009		TBA	Shell
		"Development of New Application System for Large Response Vessels."	Complete	2006	$60,000	Report in Norwegian - Norsk Hydro Contact: Fredrik.Schlanbusch@hydro.com or per.daling@sintef.no	SINTEF
		"JIP-Oil in Ice: Development of Boat Application Systems Use in Ice-Covered Areas."	Partial	2009	$550,000	Just initiated, project plans exists. Contact: per.daling@sintef.no	SINTEF/ JIP
		"Chemical Dispersant Research at Ohmsett: Phase 2 - Evaluation of Dispersant Effectiveness in Low-Dose, Repeat Applications" (Mr. Randy Belore/Dr. Ken Trudel, S.L. Ross Environmental Research, Ltd)				http://www.mms.gov/tarprojects/638.htm	MMS
2F. Research Topics	***Evaluation of new technologies for monitoring dispersant effectiveness in the***	"Upgrading of Instrumentation at SINTEF and Testing During Field Trials."		2006	$150,000	Report to NOFO: from 2006 field trial (in Norwegian) Contact: per.daling@sintef.no	SINTEF/ Statoil/ NOFO

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
Table 3. TOPIC 3: Modeling Integration of Chemical, Operational and Hydrodynamic Parameters.							
3A. Research Topics	***Workshop on requirements for integrating oil toxicity and***	"Innovative Coastal Modeling for Decision Support: Integrating Physical, Biological, and Toxicological Models"	Complete	Sept, 2006		http://www.crrc.unh.edu/fall_institute/	CRRC
		"EIF Acute Project." (Statoil, Hydro, SINTEF, DnV)		2007	$150,000	Contact: Hanne Greiff Johnsen (HANJO@statoil.com) or oistein.johansen@sintef.no	SINTEF/ Statoil/ Hydro
3B. Research Topics	***Improved models to predict dispersant effectiveness and oil fate***	"Development of a Numerical Algorithm to Compute the Effects of Breaking Waves on Surface Oil Spilled at Sea: Dispersion and Submergence/Over-Washing as Extremes of a Theoretical Continuum." Reed, Daling, Johansen (SINTEF Materials and Chemistry, Norway)	Partial	see previous		www.crrc.unh.edu/center_projects.htm	CRRC
		"AMOS (JIP): Development of OSCAR-3DPlume."		1999-2004	$500,000	Contact: Mark.reed@sintef.no	SINTEF/ JIP
		"Validation of the Two Models Developed to Predict the Window of Opportunity for Dispersant Use in the Gulf of Mexico" (Khelifa, Environment Canada)				http://www.mms.gov/tarprojects/637.htm	MMS
		"Development of OSCAR-3D Plume: For Use of Dispersant in Shallow Water."		1999-2004	$500,000	Contact: Mark.reed@sintef.no or jim.r.clark@exxonmobil.com	SINTEF/ ExxonMobil

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
Table 4. EFFECTS TOPIC 1: Fate of Oil and Dispersed Oil in the Water Column and Other Habitats.							
1A. Research Topics	***Understanding the interactions of chemically dispersed oil droplets with suspended***	"Effects of Dispersants on Oil-SPM Aggregation and Fate in US Coastal Waters." Khelifa, Fingas (Environment Canada)	Partial	see previous		www.crrc.unh.edu/center_projects.htm	CRRC
		"Fate and Effects of Dispersed Oil in Shallow Water."	Plan to initiate in 2010	2009	$250,000	Contact: Alf.g.melbye@sintef.no	SINTEF/ JIP
1B. Research Topics	***Assessment of the degree, rate, and consequences of surfactant leaching from surface slicks and chemically dispersed oil droplets***	"Petroleum Environmental Research Forum (PERF) Project--Dispersant Effectiveness after Extended Contact." Resby (SINTEF), Nedwed (ExxonMobil)	Focus is assessment of degree, rate, and consequences of surfactant leaching from surface slicks--no study of dispersed oil droplets	May, 2007	$350,000	http://www.mms.gov/tarprojects/563.htm	ExxonMobil, Total, Statoil, US MMS, OSRL, Alaska Clean Seas, Sakhalin Energy Investment Company (Shell operated), Dept of Fisheries and Oceans Canada, TX General Land Office
		"SERF-JIP: Effectiveness of Dispersants after Extended Contact Time with Oil." (SINTEF /CEDRE cooperation)		2007	$300,000	Contact: tim.j.nedwed@exxonmobil.com or janne.resby@sintef.no	SINTEF/ CEDRE
1C. Research Topics	***Reconciliation of the differences between the empirical evaporation approach and traditional pseudo-***	"Field Validations of Model Predictions."		1996-2000		Contact: Mark.reed@sintef.no	SINTEF

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
1D. Research Topics	***Quantification of the biodegradation kinetics of dispersed oil***	"Several Recent Research Projects at SINTEF." within biodegradation of WAF and dispersed oil	Partial	2000-2006	$400,000	Contact: Odd.G.Brakstad@sintef.no	SINTEF/ JIP/ Norwegian Research Council
		"Biodegradation of Chemically Dispersed Oil: an Ecosystem Approach" (AEA Technology)	Partial	Complete		http://www.mms.gov/tarprojects/338.htm	MMS
		"Effects of Chemically Dispersed and Biodegraded Oils" (Plymouth Laboratories, Inc)	Partial	Complete		http://www.mms.gov/tarprojects/449.htm	MMS
1E. Research Topics	***Improve, verify, and validate oil spill trajectory and fate models***	"Field Verification of Oil Spill Fate & Transport Modeling and Linking CODAR Observation System Data with SIMAP Predictions." Payne, French-McCay, Terrill, Nordhaussen (Payne Environmental Consultants, Inc.)	Partial	July, 2007	Complete	www.crrc.unh.edu/center_projects.htm	CRRC
		"Delivery and Quality Assurance of Short-Term Trajectory Forecasts from HF Radar Observations." Garfield (San Francisco State University), Paduan (U.S. Naval Postgraduate School), Ohlmann (UC Santa Barbara)	Partial	Dec, 2008	$229,904	www.crrc.unh.edu/center_projects.htm	CRRC
		"A Continuous Ongoing Process."			$100,000/ year	Contact: Mark.reed@sintef.no	SINTEF

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
Table 5. EFFECTS TOPIC 2: Realistic Exposure Regimes/Toxicity Testing.							
2A. Research Topics	***Develop methods for collection and analysis of samples of dissolved phase and particulate/oil-droplet phase PAH in environmental***	"Acute and Chronic Effects of Oil, Dispersant and Dispersed Oil to Sensitive Symbiotic Cnidarian Species, Including Corals." Mitchelmore, Baker, Hatch (University of Maryland Chesapeake Biological Laboratory)	Partial	July, 2008	$199,247	www.crrc.unh.edu/center_projects.htm	CRRC
		"Studies Using Aquatic Turtles (the Diamondback Terrapin and Snapping Turtle) to Assess the Potential Long-Term Effects of Oiling of Nests During Early Embryonic Development." Rowe (University of Maryland Chesapeake Biological Laboratory)	Partial	2008	$205,421	www.crrc.unh.edu/center_projects.htm	CRRC
		"Long-term Effects - Exposure Methodology Development."	partial	2007	$100,000	Contact: Trond.Nordtug@sintef.no	SINTEF/ Norwegian Research Council
2B. Research Topics	***Monitoring dispersed oil concentrations at spills of opportunity***	SINTEF is responsible for all monitoring of dispersed oil during field testing by NOFO of dispersant on experimental oil spills	Partial		$150,000/ year	NOFO-reports (in Norwegian); Contact: per.daling@sintef.no	SINTEF
		Effects of Dispersed Oil on Arctic Marine Environments				Contact: victoria.broje@shell.com	JIP/Shell
2C. Research Topics	***Literature synthesis of dispersed oil toxicity studies***	"Effect of Dispersed Oil."	partial	2007	$100,000	Report pending. Contact: Tone Frost, Statoil (TKF@statoil.no) or Trond.Nordtug@sintef.no	SINTEF/ Statoil

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
2D. Research Topics	***Standard methods for toxicity testing of dispersed oil appropriate for***	"Method Development for Testing Effects of Dispersed Oil Droplets on Fish Larvae and Calanus."	Partial	2007	$100,000	Contact: Trond.Nordtug@sintef.no	SINTEF/ Norwegian Research Council
		"Chemical Response to Oil Spill: Ecological Effects Research Forum (CROSERF)" (Ecosystem Management and Associates, Inc)	Partial	Complete		http://www.mms.gov/tarprojects/296.htm	API, Exxon, Chevron, Marine Spill Response Corporation, state government agencies (AK, CA, FL, LA, TX, WA), federal government agencies (MMS, NOAA, EPA) and Environment Canada

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Table 6. EFFECTS TOPIC 3: Integration to Make Short and Long Term Prediction of Effects.							
3A. Research Topics	***Synthesis of existing dispersed oil toxicity data to support risk-based decision making for use of dispersants at spills***	"Environmental Impact Factor (EIF Acute)." SINTEF /Veritas	Partial		$100,000	Reports: Contact: Hanne Greiff Johnsen (HANJO@statoil.com) or oistein.johansen@sintef.no	SINTEF/ Hydro/ Statoil
3B. Research Topics	***Effects of dispersed oil on wildlife***						
3C. Research Topics	***Effects of short-term exposure to dispersed oil***	"Acute and Chronic Effects of Oil, Dispersant and Dispersed Oil to Sensitive Symbiotic Cnidarian Species, Including Corals." Mitchelmore, Baker, Hatch (University of Maryland Chesapeake Biological Laboratory)	Complete	see previous		www.crrc.unh.edu/center_projects.htm	CRRC
		"Acute and Chronic Effects of Crude and Dispersed Oil on Chinook Salmon Smolts (*Oncorrhynchus tshawytscha*)." Tjeerdema (University of California, Davis)	Complete	2006	$150,000	www.crrc.unh.edu/center_projects.htm	CRRC
		"Influence of Dispersants on Oil Toxicity in Fish Embryos." Incardona, Scholz, Collier, Blanchard (NOAA Fisheries, Northwest Fisheries Science Center)	Complete	Ongoing			NOAA/ NWFSC
		"The Relationship Between Acute and Population Level Effects of Exposure to Dispersed Oil, and the Influence of Exposure Conditions Using Multiple Life History Stages of an Estuarine Copepod, *Eurytemora affinis* , as a Model Planktonic Organism." Aurand, Coelho (Ecosystem Management & Assoc)	Complete	July, 2008	$232,062	www.crrc.unh.edu/center_projects.htm	CRRC

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		"Effects of Dispersed Oil on Cod-Larvae."	Partial	2007-2009	$600,000	Contact: Trond.Nordtug@sintef.no	SINTEF/ JIP
		"Understanding fitness-related effects of dispersed oil on Calanus finmarchicus"	Partial	2010-2012	$1,406,432	Contact: Bjørn Henrik Hansen (BjornHenrik.Hansen@sintef.no)	SINTEF/RCN
3C. Research Topics	***Effects of short-term exposure to dispersed oil***	"Acute and Chronic Effects of Crude and Dispersed Oil on Chinook Salmon Smolts (*Oncorrhynchus tshawytscha*)." Tjeerdema (University of California, Davis)	Effects of short term-exposure to dispersed oil	2006			CA OSPR
3D. Research Topics	***Long-term effects of short-term exposures to dispersed oil***		Long-term effects of short-term exposure to dispersed oil	Initiate Summer 2007; Complete Summer 2008	$451,110	Report of short-term studies provided to CRRC 9/1/06. Publications in draft.	CA OSPR
		"Acute and Chronic Effects of Crude and Dispersed Oil on Chinook Salmon Smolts (*Oncorrhynchus tshawytscha*)." Tjeerdema (University of California, Davis)	Effects of short term-exposure to dispersed oil	Initiate Spring 2007; Completion Summer 2007			CA OSPR
			Long-term effects of short term exposure to dispersed oil	Initiate Summer 2007; Complete Fall 2008	$174,098	Winter 2008	CA OSPR
		"Effect of Oil and Dispersant and Dispersed Oil on Feathers"					CA OSPR
		"Physical Fate and Biological Effects of Dispersed Oil in Shallow Water." Preproject	Complete	2008		State of the art reports (restricted). Contact: Alf.g.melbye@sintef.no	JIP: Statoil, Eni

Topics from CRRC Workshop Report on "Research & Development Needs For Making Decisions Regarding Dispersing Oil"		Project/PI	Project's Coverage of Research Topic	Expected Completion Date	Funding $	Report/Abstract Available? If so, when & where	Funding Agency
		"Dispersants as Oil Spill Countermeasures for the Remediation and Restoration of Sensitive Coastal Habitats" Lin (Louisiana State University)	Complete		$188,472	www.crrc.unh.edu/center_projects.htm	CRRC
3E. Research Topics	***Integration of fate and toxicity models with population models to predict short- and long-***	"Innovative Coastal Modeling for Decision Support: Integrating Physical, Biological, and Toxicological Models."	Complete	2006		http://www.crrc.unh.edu/fall_institute/	CRRC
		"NRDAM for the 1991 Gulf War, Arabian Gulf"		2003	$300,000	Report restricted: Contact: Mark.reed@sintef.no	SINTEF
		Coastal and shoreline oil spill response: Fate of oil spill in coastal waters	Covers processes involved in the fate of dispersed oil, with emphasis on the effect of presence of dispersant on these processes	Initiate Primo 2010. Complete primo 2012	$150,000	Contact: Alf.g.melbye@sintef.no	JIP: Statoil / Shell / Eni