



# Interagency Coordinating Committee on Oil Pollution Research: FY 2018-2019 Activities

Report to Congress  
*May 14, 2020*



*U. S. Coast Guard*

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# Message from the U.S. Coast Guard Chief, Office of Marine Environmental Response Policy

The *Oil Pollution Act of 1990* requires the Chairman of the Interagency Coordinating Committee on Oil Pollution Research to submit biennial reports on the Interagency Committee's activities. The U.S. Coast Guard chairs the Interagency Committee and first reported to Congress in 1994. This report responds to the latest Congressional requirements.

The Interagency Committee, through its activities and member agency research agendas, addresses gaps in oil pollution research by leveraging the collective skills and resources of the 15 federal member agencies as well as those of state and local governments, industry, and academia. Over the current reporting period, this approach helped reduce duplication of efforts and advanced the state of oil pollution research by capitalizing on individual agency strengths.

The Interagency Committee's member agencies continued their high level of activity over the past two years. Collectively, they conducted and sponsored 150 oil pollution related research projects and published more than 60 reports and papers. The Interagency Committee, as a coordinating body, continued to promote coordinated and collaborative research through its outreach to industry, academia, research institutions, state governments, and other nations.

Pursuant to Congressional requirements, this report is provided to the following members of Congress:

The Honorable Roger Wicker  
Chairman, Senate Committee on Commerce, Science, and Transportation

The Honorable Maria Cantwell  
Ranking Member, Senate Committee on Commerce, Science, and Transportation

The Honorable Peter A. DeFazio  
Chairman, House Committee on Transportation and Infrastructure

The Honorable Sam Graves  
Ranking Member, House Committee on Transportation and Infrastructure

I am happy to answer any further questions you may have, or your staff may contact the Coast Guard's Senate Liaison Office at (202) 224-2913 or House Liaison Office at (202) 225-4775.

Sincerely,



Ricardo M. Alonso  
Captain, U.S. Coast Guard  
Chair, Interagency Coordinating Committee  
on Oil Pollution Research

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# Interagency Coordinating Committee on Oil Pollution Research: FY 2018-2019 Activities

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# I. Executive Summary

Title VII of the *Oil Pollution Act of 1990* (OPA 90) (Pub. L. No. 101-380) established the Interagency Coordinating Committee on Oil Pollution Research (referred to as the “Interagency Committee”) to “coordinate a comprehensive program of oil pollution research, technology development, and demonstration among the federal agencies, in cooperation and coordination with industry, universities, research institutions, state governments, and other nations, as appropriate” and to “foster cost-effective research mechanisms, including the joint funding of research.” This report discusses Interagency Committee activities carried out in fiscal years (FY) 2018 and 2019, as well as activities proposed for FY 2020 and 2021.

The Interagency Committee, through its activities and member agencies’ research agendas, advanced the state of oil pollution research. The Interagency Committee identified research gaps and coordinated the collective skills and resources of the federal member agencies with those of state and local governments, industry, and academia. Over the current reporting period, this approach was effective in reducing duplication of efforts and capitalizing on individual agency strengths.

In September 2015, the Interagency Committee released its FY 2015-2021 Oil Pollution Research and Technology Plan (OPRTP), which established a research framework grouped into four broad classes: Prevention, Preparedness, Response, and Injury Assessment and Restoration. The OPRTP further classified and prioritized research within the classes into 25 standing research areas (SRAs), representing the most common research themes encountered for oil spills. The Interagency Committee established 150 research priorities across the 25 SRAs. In 2018 and 2019, the Interagency Committee focused their efforts on continuing to promote research and development in the four research classes.

In 2018-2019, member agencies continued to oversee a large number of research projects related to the prevention of, preparedness for, and response to oil spills. Overall, there were 150 active member projects during the reporting period, and member agencies generated over 60 publications from their funded research.

The Interagency Committee encouraged member agency participation in key oil spill related workshops and conferences. Several member agencies sponsored and took leadership roles in planning and conducting major conferences including the Clean Gulf and Clean Pacific Conferences, the Offshore Technology Conference, and the Gulf of Mexico (GOM) Oil Spill and Ecosystem Science Conferences. These conferences and workshops were a vital component of the Interagency Committee’s abilities to stay abreast of the latest research initiatives.

The Interagency Committee’s future initiatives include the continuation of joint interagency research initiatives, tracking and monitoring efforts under the OPRTP, developing a formalized public communication outreach strategy, and exploring best practices of transition from research to operations for spill response. These initiatives were first introduced in the 2016-2017 report and the committee’s member agencies have been actively involved with incorporating these initiatives over the past two years. It is important to note that the continuation of the initiatives are essential to the Interagency Committee’s success in the future.

## II. Legislative Requirement

This report responds to the language set forth in Section 7001(e) of the *Oil Pollution Act of 1990* (Pub. L. No. 101-380), as per the following:

### **SEC. 7001. OIL POLLUTION RESEARCH AND DEVELOPMENT PROGRAM.**

“(e) BIENNIAL REPORTS - The Chairman of the Interagency Committee shall submit to Congress every 2 years on October 30 a report on the activities carried out under this section in the preceding 2 fiscal years, and on activities proposed to be carried out under this section in the current 2 fiscal year period.”

### III. Background and Legacy Obligations

#### *Purpose of the Interagency Committee*

As prescribed by law, the purpose of the Interagency Committee is twofold: (1) to coordinate a comprehensive program of oil pollution research, technology development, and demonstration among the federal agencies; 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.

#### *Membership*

The 15 Interagency Committee members, representing independent agencies, departments, and department components, include:

Department of Commerce (DOC) represented by:

- National Oceanic and Atmospheric Administration (NOAA)
- National Institute of Standards and Technology (NIST)

Department of Energy (DOE)

Department of the Interior (DOI) represented by:

- Bureau of Safety and Environmental Enforcement (BSEE)
- Bureau of Ocean Energy Management (BOEM)
- U.S. Fish and Wildlife Service (USFWS)

Department of Transportation (DOT) represented by:

- Maritime Administration (MARAD)
- Pipeline and Hazardous Materials Safety Administration (PHMSA)

Department of Defense (DoD) represented by:

- U.S. Army Corps of Engineers (USACE)
- U.S. Navy (USN)

Environmental Protection Agency (EPA)

National Aeronautics and Space Administration (NASA)

Department of Homeland Security (DHS) represented by:

- U.S. Coast Guard (USCG)
- Federal Emergency Management Agency (FEMA)
  - U.S. Fire Administration (USFA)

U.S. Arctic Research Commission (USARC)



Guided by Section 7001(c) of OPA 90, the Interagency Committee monitors, supports, and publicizes a variety of oil pollution research and development initiatives with industry, universities, research institutions, state governments, and other entities. Several ventures were completed in the first decade of the Interagency Committee's existence, while others continue to progress through the current reporting period. Listed below are several key initiatives, identified in Section 7001(c)<sup>1</sup>:

Oil Pollution Technology Research: The cornerstone of the Interagency Committee's role and activities is the research that is funded, monitored, conducted, and coordinated by its members. Section IV of this report includes highlights of several member agencies' research initiatives. The selected initiatives illustrate a small sample of the diverse research coordinated by the Interagency Committee. Appendix B includes a listing of specific projects overseen by member agencies, with further details on the Interagency Committee's website: <http://www.dco.uscg.mil/iccopr>.

Simulated Environmental Testing: Section 7001(c)(7) directed agencies of the Interagency Committee to ensure the long-term use and operation of Ohmsett - the National Oil Spill Response Research and Renewable Energy Test Facility. BSEE continues to operate and maintain Ohmsett, which is located in Leonardo, New Jersey. Ohmsett provides independent and objective performance testing of full-scale oil spill response equipment and marine renewable energy systems (wave energy conversion devices). It is the largest outdoor saltwater wave/tow tank facility in North America and is the only facility where full-scale oil spill response equipment testing, research, and training can be conducted in a simulated marine environment using real oil under controlled environmental conditions. The Ohmsett facility is able to simulate varying wave conditions (such as breaking waves), drift ice conditions, and vessel movement up to six knots with the movable bridge. For more information on Ohmsett's capabilities and current projects, see <http://www.ohmsett.com>.

Regional Research Grant Program: Section 7001(c)(8) authorized a Regional Research Program. Funding for the program was not appropriated in FY 2018-2019<sup>2</sup>.

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<sup>1</sup> Other key requirements under this section of OPA 90 were completed, including demonstrations under Section 7001(c)(6). Technical demonstrations were held during the triennial International Oil Spill Conference in 2017 and next in 2020.

<sup>2</sup> Last appropriation for this program was in 1995.

## IV. Interagency Committee Activities

The Interagency Committee pursued several different activities during this reporting period. These activities addressed Government Accountability Office (GAO) recommendations<sup>3,4</sup> and emerging and continuing oil pollution research needs. The research activities of the member agencies, coordinated through the Interagency Committee, focused on research priorities, as identified in the OPRTP.

### *Organizational Changes*

Leadership Changes: NOAA served as the Vice Chair during the reporting period, their second successful two-year term as Vice Chair. BSEE will assume the role of Vice Chair during the FY 2020-2021 reporting period followed by EPA in FY 2022-2023 in accordance with the rotation schedule established by the 2013 revised Interagency Committee Charter. The USCG, as Interagency Committee Chair, continued to support a full-time Executive Director position to provide the Interagency Committee with robust organization, coordination, and outreach.

### *Interagency Committee Meetings*

The Interagency Committee formally met 10 times during FY 2018-2019. These gatherings included quarterly and special meetings of the membership, and engagement with the Prince William Sound Regional Citizen’s Advisory Council (PWSRCAC):

December 13, 2017	Washington, DC: Quarterly Meeting Main Themes: Canada’s Multi-partner Research Initiative, Herders for In Situ Burn Capabilities, Sub-sea and Arctic Dispersant Research
March 14, 2018	Silver Spring, MD: Quarterly Meeting Main Themes: Leveraging/Synthesizing Science into Response, Subsea Dispersant Injection
April 11, 2018	Washington, DC: Meeting with PWSRCAC
June 13, 2018	Sterling, VA: Quarterly Meeting Main Themes: Enhanced Oil Spill Detection Sensors, Superabsorbent Polymers, Arctic Testing Lab Capabilities
September 12, 2018	Arlington, VA: Quarterly Meeting Main Theme: Marine Induced Polarization
December 12, 2018	Washington, DC: Quarterly Meeting Main Theme: State of Oil Spill Models, Lab Based Studies Relevance to Real World
March 12, 2019	Arlington, VA: Quarterly Meeting Main Theme: National Academies of Sciences, Engineering, and Medicine (NASEM) Gulf Research Program, Industry Initiatives
March 28, 2019	Washington, DC: Meeting with PWSRCAC
June 12, 2019	Arlington, VA: Quarterly Meeting Main Theme: Arctic
September 11, 2019	College Park, MD: Quarterly Meeting Main Theme: In Situ Burning

<sup>3</sup> GAO, Federal Oil and Gas: Interagency Needs to Better Coordinate Research on Oil Pollution Prevention and Response. GAO-11-319, March 2011

<sup>4</sup> GAO, Oil Dispersants: Additional Research Needed, Particularly on Subsurface and Arctic Applications. GAO-12-585. May 2012

During the quarterly meetings, the Interagency Committee shared information on recent research projects; identified new research issues; hosted presenters from government agencies, industry, and academia; and developed strategies for future initiatives. At each meeting, the 15 member agencies provided their research updates. These updates prompted increased collaboration within the membership by fostering new ideas and opportunities for joint agency projects or new initiatives.

The two meetings with PWSRCAC provided opportunities for Interagency Committee members to share information with this stakeholder organization and to hear their issues and perspectives on research needs. The Interagency Committee has conducted these annual information exchange meetings with PWSRCAC since FY 2013.

### ***GAO Audit***

During FY 2018, a GAO Audit<sup>5</sup> was conducted which examined the status of federal oil spill research efforts by the Interagency Committee and how coordination has changed since the GAO last reported on it in March 2011. The GAO requested funding data and project information on oil spill research from all 15 member agencies of the Interagency Committee. Additionally, GAO interviewed representatives at each of the 15 member agencies and compared their coordination efforts to one of the federal leading practices for interagency collaboration to evaluate the Interagency Committee's efforts to coordinate oil spill research. Documents, including the 2013 Interagency Committee membership charter, Biennial Reports to Congress dating back to FY 2008, and the Interagency Committee's FY 2015 - 2021 Research and Technology Plan, were reviewed and several Interagency Committee quarterly meetings were attended by the GAO Audit team. The outcome of the GAO Audit resulted in two recommendations for the Interagency Committee, including the development of a more systematic process to identify and consult with key nonfederal stakeholders such as Natural Resource Damage Assessment (NRDA) trustee councils (specifically, large restoration funds from Exxon Valdez and Deepwater Horizon (DWH) oil spills), and to review its membership to determine whether additional agencies would provide beneficial contributions.

The Interagency Committee, upon the recommendation from the GAO is developing a systematic method for conducting membership evaluations. The Interagency Committee Executive Director under direction of the Chair, is working with member agencies to evaluate additional federal agencies that would be an asset to the Interagency Committee. Furthermore, the Executive Director will work with NRDA trustee councils to ensure that the executive action tasks from the GAO Audit are completed. It is imperative that Interagency Committee research is aligned with the NRDA trustee councils' missions. The two executive action tasks will be an ongoing effort and will continue to be addressed and evaluated as the Interagency Committee moves forward.

### ***Member Research and Technology Initiatives***

An analysis by the Interagency Committee of the member agencies more than 139 projects carried out during this reporting period<sup>6</sup> to assess the federal government's research relative to the OPRTP, and the level of focus on the identified research priorities. In many instances, research was conducted in the additional priority areas by other entities such as federal agencies

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<sup>5</sup> GAO, Offshore Oil Spills: Restoration and Federal Research Efforts Continue, but Opportunities to Improve Coordination Remain. GAO-19-31, January 2019

<sup>6</sup> Projects that have been initiated, on-going and/or completed during FY 2018-2019.

not currently represented on the Interagency Committee, or by state, local, academic, and industry researchers.

Highlights of a small sampling of the research projects that have been conducted or initiated by agencies of the Interagency Committee are presented below. These selected projects illustrate the value of the Interagency Committee's coordinated approach to conducting research, and the cross pollination of ideas, expertise, and resources. Appendix B includes a complete list of projects conducted by the Interagency Committee members in FY 2018 - 2019<sup>7</sup>.

***Prevention Research Class:***

Oil Spill Occurrence Estimators for Onshore and Offshore Crude and Refined Oil Spills on the Alaska North Slope and Cook Inlet, Alaska:

The primary objective of the BOEM funded project is to evaluate causal factors of actual onshore and offshore oil spills in Alaska's North Slope and Cook Inlet and develop a relative oil spill occurrence estimator that is suitable for use both onshore and offshore oil spills. The occurrence estimator will utilize an appropriate exposure variable to provide a model for both small and large oil spills in and adjacent to Cook Inlet and the Alaska North Slope. Researchers are addressing issues associated with petroleum hydrocarbon spill data as it relates to the number and volume of spills to compute a likelihood of occurrence, and spill-size categories to support impact analyses under the National Environmental Policy Act (NEPA) for the Beaufort and Chukchi Seas, as well as the Cook Inlet. This project was developed to address the information needs of both BOEM and BSEE, highlighting ICCOPR's mission to coordinate interagency collaboration with research and development.

Assessing Current and Future Infrastructure Hazards – Aging Infrastructure: The history of drilling is associated with a complex network of infrastructure including pipelines, platforms, subsea installations, ports, and terminals. The present-day offshore infrastructure in the Gulf of Mexico (GOM) was designed with a twenty to thirty-year life span. This DOE funded project will utilize data, big data computing, and advanced analytics to evaluate the condition of the current infrastructure and drive analyses to assess potential infrastructure hazards and optimize the development and deployment of existing and new infrastructure technologies in the offshore environment.

***Preparedness Research Class:***

Gulf of Mexico Oil Spill Response Viability Analysis: The objective of this BSEE funded project was to conduct an oil spill response viability analysis for the U.S. Outer Continental Shelf (OCS) GOM. This analysis quantified the frequency and duration that a specific oil spill response strategy was not feasible or was 'unduly' impacted such that response effectiveness was judged to be degraded due to meteorological or oceanographic (metocean) conditions. Conditions considered in the analysis included wind, sea state, salinity, and visibility using available hind cast environmental data. Response strategy options including mechanical recovery, in situ burn, and the surface applications of dispersants were included in the analysis. The project was completed in FY 2019 with the final report received February 12, 2019.

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<sup>7</sup> More detail on these projects, as well as publications, can be found through the Interagency Committee website: <http://www.dco.uscg.mil/iccopr>

Population Connectivity of Deepwater Corals in the Northern Gulf of Mexico: In partnership with Lehigh University, Harvey Mudd University, and the Georgia Institute of Technology, this NOAA funded Resources and Ecosystems Sustainability Tourist Opportunities and Revived Economies (RESTORE) project is a collaboration between an Interagency Committee agency and academic research institutions. This project will determine from where the corals in different mesophotic (15-150 meters) and deepwater (150-2400 meters) populations in the GOM originated. Vital information on the origination of the corals will aid in the conservation and restoration of these important habitats that were damaged by the DWH oil spill. This collaborative effort will enhance the understanding of GOM coral ecosystems with concrete restoration and conservation initiatives to ensure recovery of degraded deepwater coral communities. The information gained from this project will aid in decision-making regarding establishment of Marine Protected Areas by the GOM Fishery Management Council.

***Response Research Class:***

Improved In-Situ Burning (ISB) for Offshore Use: In collaboration with BSEE, this joint funded USCG project aided in determining the best practices for operational use of ISB. The aim was to facilitate better decision-making and provide operational tools for using ISB as a response option. Further objectives included the development and testing of new equipment such as igniters or fire boom, and procedures to support ISB. The collected and published results will be available for use by academia, national labs, and international stakeholders.

Detection of Oil Thickness and Emulsion Mixtures Using Remote Sensing Platforms: A multi-disciplinary team of scientists from BSEE, EPA, NOAA, USCG, Woods Hole Oceanographic Institute (WHOI), and industry partners joined together to validate remote sensing delineation and characterization of floating oil employed during the 2010 GOM DWH oil spill. Controlled tank testing at the BSEE Ohmsett facility in New Jersey and open water testing in the GOM gave researchers the opportunity to align in situ sampling of oil thickness and oil/water chemistry with aerial and shallow subsurface remote sensing. The results of this work, “*Detection of Oil Thickness and Emulsion Mixtures Using Remote Sensing Platforms*” have been published on the BSEE website. This work provided invaluable information and has created additional areas of study with the goal of developing operational tools for more efficient and effective emergency response and damage assessment. See: <https://www.bsee.gov/sites/bsee.gov/files/research-reports//1079aa1.pdf> for additional project information.

***Injury Assessment and Restoration Research Class:***

Biodegradability of Crude Oil Exposed to Surface Washing Agents (SWAs) and Chemical Herders at Two Temperatures: This EPA funded research project evaluates the biodegradation rates of oil exposed to NCP Product Schedule products that may remain in the environment after use. This information is useful during oil spill response efforts, as well as for fate and transport models.

Chemistry and Toxicity of Polar Compounds in Oil: In collaboration with Bigelow Marine Lab and UC Davis, this NOAA led project with EPA is conducting studies in relation to polar and non-polar oil compounds. These studies will quantify the relative mechanisms and potencies of polar and non-polar oil compounds utilizing weathered oil water-accommodated fractions and *Fundulus heteroclitus*, a small killifish that is found along the Atlantic Coast of the United States and Canada.

While there is a large body of research being conducted by the Interagency Committee member agencies, additional advancements in oil pollution research are being driven outside the federal government, and are helping to address research gaps. The Interagency Committee also monitors a variety of oil spill research projects funded by other non-Committee entities.

### ***Member Collaboration and Ongoing Initiatives***

In addition to the specific research projects, some member agencies prepared joint research strategies and initiatives and presented them to the Interagency Committee. These initiatives provide pathways for further research collaboration. They include:

BSEE/USCG Quality Partnership: Through this partnership, the USCG and BSEE coordinated strategic policy and oil spill preparedness and response in the offshore environment. BSEE and the USCG coordinated their research and development priorities to align their on-going and future research and development project portfolios, allowing for greater synergies.

Arctic Domain Awareness Center (ADAC): ADAC, a DHS Science and Technology (S&T) Center of Excellence, was established at the University of Alaska to provide both fundamental and applied research to support DHS's and other agencies' maritime security mission goals, including improved detection and interdiction capabilities, enhanced capacity to respond to catastrophic events, and a more secure and efficient marine transportation system. Its activities focus on interdisciplinary research, education, and technology transition in maritime security, maritime domain awareness, and extreme and remote maritime environment issues, including oil spill response, posed by the dynamic Arctic environment. Interagency Committee member agencies are integral advisors to and members and customers of the research conducted by ADAC and its network of academic researchers.

NOAA Arctic State of the Science Initiative: NOAA Arctic Dispersant State of the Science Initiative [with link to [www.crrc.unh.edu/dispersant\\_science](http://www.crrc.unh.edu/dispersant_science)]: Chemical dispersants could be a response option should a large spill occur in Arctic waters. Senior federal agency leadership identified the need for a definitive evaluation of the state-of-science of dispersants and dispersed oil (DDO), particularly as it applies to this region. To address this need, the NOAA-funded Coastal Response Research Center (CRRC) led a comprehensive effort to determine the state-of-science regarding DDO, as it applied to Arctic waters. This multi-year effort involving scientists in and outside of government concluded in FY 2019 with the publication of the scientific panel papers capturing the knowns and uncertainties for DDO efficacy and effectiveness, physical transport and chemical behavior, degradation and fate, eco-toxicity and sub-lethal impacts, and public health and food safety. During this initiative, 79 scientists across 5 panels reviewed over 3,000 papers, distributed draft panel papers to over 3,500 members of the scientific and response communities, held 232 hours of post-workshop technical calls with the scientific panels, and delivered over 100 pages of knowns and uncertainties across the five topic areas. Results were briefed to the Interagency Committee in June 2019 as part of a series of briefings on the effort domestically and internationally.

DOI Inland Oil Spill Preparedness Project Work Group: DOI's Office of Environmental Policy and Compliance and the Office of Restoration and Damage Assessment coordinated with multiple DOI bureaus<sup>8</sup> to fund projects that increase DOI's preparedness for inland oil spills. Funded projects included baseline (pre-spill) data collection for endangered fish species<sup>9</sup>, risk/vulnerability assessments for DOI lands, and modeling of oil fate/behavior in freshwater systems.

Marine Arctic Ecosystem Study (MARES): MARES is an integrated ecosystem research initiative coordinated and planned by BOEM in conjunction with its federal and private sector research partners: USARC, USCG, USGS, U.S. Integrated Ocean Observing System, Marine Mammal Commission, National Science Foundation, NOAA, Office of Naval Research, and Shell Oil Company.

BSEE/NOAA Partnership: This partnership features a multidisciplinary team of scientists from agencies such as BSEE, EPA, NOAA, USCG, NASA, CA-DFO, WHO, UNH, USF, as well as industry partners. Researchers collaborate on numerous projects in an effort to advance oil spill response, including surface oil and oil in the water column characterization. The research extends beyond the laboratory setting, including testing at BSEE's Ohmsett facility and open water testing.

BSEE/US Army Corps of Engineers Cold Regions Research and Engineering Lab (CRREL): BSEE partnered with the US Army Corps of Engineers CRREL to refurbish a portable wave tank for use in intermediate scale in situ burn research. The refurbished tank provides users of CREEL with additional capabilities to conduct some experiments under small wave conditions.

#### ***External Interagency Committee Collaborations***

Coordination and cooperation with external stakeholders is critical to advancing oil pollution research in the United States. During the reporting period, the Interagency Committee pursued collaboration with numerous external oil spill related programs through direct engagement and participation in joint meetings, forums, and workgroups.

National Academy of Science's Gulf Research Program (NAS GRP): The Interagency Committee members met with NAS GRP Advisory board members and staff several times to help shape future NAS GRP grant opportunities, in alignment with OPRTP. These interactions satisfy the requirements of the BP and Transocean Settlement Agreements for the NAS GRP to annually seek the advice of the Interagency Committee on the program direction. Interagency members also participated in several NAS workshops across the spectrum of oil spill response.

Prince William Sound Regional Citizen's Advisory Council (PWSRCAC): The Interagency Committee met two times with PWSRCAC to share current and future research initiatives, as well as results of studies of interest conducted by the members of both organizations.

Gulf of Mexico Research Initiative (GoMRI): The head of the GoMRI Sea Grant Oil Spill Outreach Team attended Interagency Committee quarterly meetings and presented updates on their research. In addition, Interagency Committee members collaborated with GoMRI researchers on specific research projects. For example, EPA and GoMRI researchers conducted

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<sup>8</sup> U.S. Geological Service, USFWS, Bureau of Reclamation, Bureau of Land Management, Bureau of Indian Affairs, and National Park Service

<sup>9</sup> Pallid sturgeon and Bull trout

research on the cutting edge technologies for spill/plume detection employed during DWH, and offered a perspective on how the response community can build from the experience to prepare for a future spill of national significance.

During this biennium, GoMRI launched its Synthesis and Legacy effort that involved several Interagency Committee member agency representatives. This effort has an objective to “document and exploit scientific achievements and advances, with the idea that synthesis will lead to new understanding and improved practices. This synthesis effort will be driven by the best available science, will include knowledge exchange with the user community, including oil spill responders, non-governmental organizations, restoration efforts, and other stakeholders, and will explore the transferability of knowledge to other geographic locations and scenarios.”

The Synthesis and Legacy effort is being conducted through workshops and scientific questions, across eight core areas, with the underlying intent to answer the following five key questions:

- What was the state of the science (“baseline”) before DWH?
- What have we learned? (Critical assessment)
- What major gaps in knowledge still exist?
- How can we best apply what we have learned? (What will be the impact – how do we make a difference?)
- Where do we go from here?

The 8 Core Areas of the GoMRI Synthesis and Legacy are:

Core Area 1 – Plume and Circulation Observations and Modeling

Core Area 2 – Fate of Oil and Weathering: Biological and Physical-Chemical Degradation

Core Area 3 – Ecological/Ecosystem Impacts

Core Area 4 – Human Health and Socioeconomic Impacts

Core Area 5 – Ecosystem Services, Human Health and Socioeconomic Impacts

Core Area 6 – Microbiology, Metagenomics and Bioinformatics

Core Area 7 – Integrated/Linked Modeling System

Core Area 8 – Knowledge Exchange with User Communities: Lessons Learned and Operational Advice

The GoMRI Synthesis and Legacy effort will provide important inputs to the Interagency Committee work on the next Research and Technology Plan.

### ***Member Agency Participation in Workshops and Conferences***

Each year a variety of workshops and conferences are held that address various facets of the petroleum industry and oil pollution research. The Interagency Committee monitors these to stay abreast of the latest topics and issues that support on-going and future research initiatives.

During the reporting period, the Interagency Committee’s member organizations participated in or directly sponsored many of these workshops and conferences, including:

International Oil Spill Conference (IOSC): The IOSC is held on a triennial basis and attracts international and domestic attendees. It is important to note that five Interagency Committee member agencies are on the permanent conference committee for IOSC: USCG, BSEE, NOAA, USEPA, and PHMSA. The IOSC was held during the last biennial report period in 2017. Currently, IOSC is in its final planning stages for the 2020 conference. Regularly scheduled meetings have been held with the IOSC Executive Committee throughout this biennial report period.



Gulf of Mexico Oil Spill and Ecosystem Science (GoMOSES): Sponsored by the GOM Research Initiative, the annual conference linked fundamental research on the GOM ecosystem with practical application. During this reporting period, the Interagency Committee members served on the planning committee for GoMOSES, participated as session and panel leaders, and presented numerous presentations on their oil spill related research during two conferences.

Clean Gulf/Clean Pacific/Clean Waterways Series: These regional conferences focused on improving oil and hazardous materials spill prevention, preparedness, and response for inland, offshore, and coastal incidents.

Offshore Technology Conference (OTC): DOE and BOEM representatives attended the OTC in Houston, TX. The OTC is the world's largest oil and gas sector trade show, where energy professionals meet to exchange ideas and opinions to advance scientific and technical knowledge for offshore resources and environmental matters. In 2019, almost 350 technical papers were presented, including three papers reflecting DOE-funded work. DOE's National Energy Technology Laboratory sponsored a booth in the Exhibition Hall and hosted a speakers' forum at the booth, highlighting DOE's R&D on oil spill prevention. BOEM's Acting Director delivered a keynote speech and participated in discussions on offshore wind.

### ***Website and Other Outreach***

The Interagency Committee continued to provide information through its website <http://www.dco.uscg.mil/iccopr>. The website provides data on research projects in accordance with the OPRTP. In addition, member agencies continued using their websites as tools to convey information on research initiatives to partners and the public. The Interagency Committee website contains links to these member sites.

Several member agencies published periodic newsletters that highlighted agency activities, including oil spill-related research. Examples include the BOEM Ocean Science quarterly newsletter, BSEE's semi-annual Ohmsett Gazette, USARC Arctic Daily Update by e-mail, the USFWS Fish & Wildlife News, and several NOAA programmatic newsletters.

## V. Future Activities

The Interagency Committee will continue to promote research and development in the four research classes: Preparedness, Prevention, Response, and Injury Assessment and Restoration. The Interagency Committee and its members plan to conduct the following future actions:

Update the Oil Pollution Research and Technology Plan: The Interagency Committee will continue to use its Oil Pollution Research Categorization Framework as a tool to track and measure research progress within the government, academia, and industry. This information will be promulgated on the Interagency Committee website. In FY 2020-2021, the Interagency Committee will evaluate what gaps remain from the FY 2015-2021 OPRTP and new gaps to establish an updated set of research priorities. This will result in the publication of the OPRTP at the conclusion of FY 2021, in line with the publication of the next Biennial Report to Congress. The Interagency Committee will continue to release revised versions of the OPRTP every six years to reflect timely conditions and needs.

Work with the National Academy of Sciences Gulf Research Program: The Interagency Committee will continue to work closely with NAS as it executes the 30-year NAS GRP that is “focused on human health and environmental protection including issues relating to offshore oil and hydrocarbon production and transportation in the GOM and on the United States’ outer continental shelf.”

Continue Outreach to Non-Federal Stakeholders: The Interagency Committee will continue to engage non-federal stakeholders to gain insights into additional research needs, share research results and ideas, and promote advancements in the state of oil pollution research and technology. The upcoming year will include an increased focus on coordination with industry research programs.

Address Emerging Issues and Challenges: The Interagency Committee will continue to monitor technological advancements for oil spill prevention and response, as well as the conditions that increase the risk of oil spills.

Evaluate the Committee Membership: The Interagency Committee will continue its standing practice of evaluating other federal agencies for membership, as recommended by the GAO Audit. The Interagency Committee extended an invitation to the U.S. Geological Survey (USGS) to attend meetings and consider membership. The Interagency Committee will also ask the membership to evaluate whether the proper elements of their agencies are represented or have visibility.

Coordinate with the Trustee Councils: The Interagency Committee will reach out to the Exxon Valdez and DWH NRDA Trustee Councils to determine if there are research areas of mutual interest and value to the parties. This may include periodic participation in meetings or other collaborative efforts.

Encourage Transition of Research to Operations: The Interagency Committee will examine the best practices of member agencies skilled at transitioning research to operations and will seek to accelerate this transition for promising Interagency Committee priority research areas.

Refurbish Ohmsett: BSEE will temporarily close the Ohmsett facility for about four months in the summer of FY 2021 to perform periodic tank repairs and refurbish the facility. This action is conducted every five years to mitigate the effects of deterioration and corrosion caused by the saline environment. The repairs and refurbishment of the Ohmsett facility will allow for improved usability of the facility for testing.

## Appendix A: List of Acronyms

ADAC	Arctic Domain Awareness Center
AUV	Autonomous Underwater Vehicle
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CRRC	Coastal Response Research Center
DDO	Dispersants and Dispersed Oil
DFO	Department of Fisheries and Oceans Canada
DHS	U.S. Department of Homeland Security
DOC	U.S. Department of Commerce
DoD	Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DOT	U.S. Department of Transportation
DWH	Deepwater Horizon
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FY	Fiscal Year
GAO	U.S. Government Accountability Office
GNOME	General NOAA Operational Modeling
GOM	Gulf of Mexico
GoMOSES	Gulf of Mexico Oil Spill and Ecosystem Science
GoMRI	Gulf of Mexico Research Initiative
HPHT	High Pressure High Temperature
IOSC	International Oil Spill Conference
ISB	In situ burning
ITAC	Industry Technical Advisory Committee
JIP	Joint Industry Project
JMTF	Joint Maritime Training Facility
MARAD	Maritime Administration
MARES	Marine Arctic Ecosystem Study
MOC	Memorandum of Cooperation
NAS	National Academy of Sciences
NAS GRP	National Academy of Sciences Gulf Research Program
NASA	National Aeronautics and Space Administration
NASEM	National Academy of Science, Engineering, and Medicine
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NIST	National Institute of Standards and Technology

NOAA	National Oceanic and Atmospheric Administration
NOPP	National Oceanographic Partnership Program
NRDA	National Resource Damage Assessment
NRT	National Response Team
OCS	Outer Continental Shelf
OPA 90	Oil Pollution Act of 1990 (Public Law 101-380)
OPRTP	Oil Pollution Research and Technology Plan
OTC	Offshore Technology Conference
PHMSA	Pipeline and Hazardous Materials Safety Administration
PINC	Potential Incident of Non-Compliance
PWSRCAC	Prince William Sound Regional Citizen's Advisory Council
R&D	Research and Development
RESTORE	Resources and Ecosystems Sustainability Tourist Opportunities and Revived Economies
S&T	Science and Technology
SETAC	Society of Environmental Toxicology and Chemistry
SRA	Standing Research Area
SWA	Surface Washing Agents
USACE	U.S. Army Corps of Engineers
USARC	U.S. Arctic Research Commission
USCG	U.S. Coast Guard
USCG RDC	U.S. Coast Guard Research and Development Center
USGS	U.S. Geological Survey
USFA	U.S. Fire Administration
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
USN	U.S. Navy
WHOI	Woods Hole Oceanographic Institute

# Appendix B: Listing of Research Projects and Papers (FY 2018 and 2019)<sup>10</sup>

## I. PREVENTION

### A. *Human Error Factors – Research Projects*

1. Oil Spill Occurrence Estimators for the Outer Continental Shelf (OCS) in the Arctic (Lead agency: BOEM): This study evaluated causal factors of actual and potential oil spills in the GOM, Pacific, and Arctic OCS, extrapolating GOM and Pacific historical oil spill rates to the Arctic.  
<https://marinecadastre.gov/espis/#/search/study/100225>
2. Oil Spill Occurrence Estimators for Onshore and Offshore Crude and Refine Oil Spills on the Alaska North Slope and Cook Inlet, Alaska (Lead agency: BOEM): This study evaluated causal factors of actual and potential onshore and offshore oil spills in Alaska's North Slope and Cook Inlet. <https://www.boem.gov/akstudies/>

### B. *Human Error Factors – Research Papers*

1. Oil Spill Occurrence Estimators: Fault Tree Analysis for One or More Potential Future Beaufort Sea OCS Lease Sales: <https://marinecadastre.gov/espis/#/search/study/100225>
2. United States OCS Oil Spill Causal Factors Report (2018):  
<https://marinecadastre.gov/espis/#/search/study/100225>
3. United States. OCS Oil Spill Statistics:  
<https://marinecadastre.gov/espis/#/search/study/100225>

### C. *Offshore Facilities and Systems – Research Projects*

1. Assessing Current and Future Infrastructure Hazards – Aging Infrastructure (Lead agency: DOE): This history of drilling is associated with a complex network of infrastructure including pipelines, platforms, subsea installations, ports, and terminals. The present-day offshore infrastructure in the GOM was designed with a 20- to 30-year life span. This task will use data, big data computing, and advanced analytics to evaluate the condition of the current infrastructure, drive analyses to assess potential infrastructure hazards, and optimize the development and deployment of existing and new infrastructure technologies in the offshore environment.
2. Infrastructure and Metocean Technology (Lead agency: DOE): The objective of this task is to develop a technology that identifies current hazardous metocean and bathymetric conditions, as well as forecast changes and potential vulnerabilities that may impact existing or future offshore infrastructure. Outputs from the technology will advance the current state of knowledge, offering insights to improve infrastructure longevity, support the identification of shallow hazards, and offshore enhanced oil recovery innovations.

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<sup>10</sup> Further detail on the projects can be found at <http://www.dco.uscg.mil/iccopr>

*D. Offshore Facilities and Systems – Research Papers*

1. Oil Spill Preparedness, Prevention, and Response on the Alaska OCS:  
<https://www.boem.gov/BOEM-2019-006/>

*E. Onshore Facilities and Systems – Research Projects: None*

*F. Onshore Facilities and Systems – Research Papers: None*

*G. Waterways Management – Research Projects*

1. Arctic Operations Support (Lead agency: USCG): This project is broad-reaching and the overall intent is to provide support to the USCG for a variety of capabilities, including testing of automatic identification system (AIS) instruments, deployment of remote sensing vehicles and aircraft, and mechanical recovery designed to work in ice conditions.
2. Ice Condition Index (ICECON) for the Great Lakes (Lead agency: USCG): This project is sponsored by the DHS S&T ADAC and is being undertaken by the University of Alaska Anchorage. This project is developing an ice condition index for the Great Lakes for mariners so they can use available data to forecast ICECON up to 120 hours into the future.
3. ICECON for the Arctic (Lead agency: USCG): This project is sponsored by the DHS ADAC and is being undertaken by the University of Alaska Anchorage. This project is developing an ice condition index for the Arctic for mariners that can use available data to forecast ICECON up to 120 hours into the future.
4. Next Generation Arctic Navigational Safety Information System (Lead agency: USCG): This project defines, develops, demonstrates, and evaluates, in an operational setting, at least one promising technology approach to the “Next Generation Arctic Navigational Safety Information System”, which provides important, time-critical information to mariners in order that they may better assess and manage their voyage risks as they transit the remote and hostile waters of the U.S. Arctic exclusive economic zone.

*H. Waterways Management – Research Papers*

1. After Action Report – Arctic Technology Evaluation 2017: This USCG paper is an after-action report that summarizes the lessons learned for use in improving the USCG RDC's Arctic operations support capabilities.
2. Alaska Automatic Identification System (AIS) Transmit Prototype Test, Evaluation, and Transition Summary Report for the Near Shore Arctic Navigational Safety Information System (ANSIS): This USCG paper is a summary report and transition guidance that captures the USCG RDC's and the Marine Exchange of Alaska's (MXAK) design, development, install, test, monitoring, and transition to operations of the near shore ANSIS prototype using AIS transmit - transition from RDC to USCG District 17 and MXAK.

3. High Frequency (HF) Digital Radio Mondiale (DRM) Broadcast Summary Report for Long Range Dissemination of Maritime Information: This USCG paper is a summary report that captures the USCG RDC's design, development, install, test, and monitoring of Digital Radio Mondiale (DRM30) over HF capability for broadcast of a wide range of navigational safety information in the Arctic at long range.  
<https://apps.dtic.mil/dtic/tr/fulltext/u2/1061702.pdf>
4. U.S. Coast Guard (USCG) Research and Development Center (RDC) Review/Status of International Maritime Organization (IMO) Maritime Safety Information (MSI) Systems: This USCG report reviews the latest developments in the IMO standards efforts to support the dissemination of MSI to the mariner, in particular, in the Arctic.  
<https://apps.dtic.mil/dtic/tr/fulltext/u2/1058184.pdf>

I. *Vessel Design – Research Projects: None*

J. *Vessel Design – Research Papers: None*

K. *Drilling – Research Projects*

1. Characterizing Offshore Subsurface Geologic Hazards – Improve Prediction of Subsurface Properties for Areas of Little or No Data to Identify Geohazards (Lead agency: DOE): The goal is to identify potential subsurface hazards and innovate new, advanced data computing methods for improving prediction of subsurface properties to inform resource, environmental, and operational needs. The work uses data and models with intelligent databases, machine learning, big data, and other advanced computing technologies to address subsurface industry challenges by applying these new technologies to help characterize and map geologic hazards, improve safety and reliability, and reduce costs.
2. Experimental Work, Calibration, and Validation of Kick Algorithms via Simulations and Laboratory Experiments – Kick Detection at the Bit (Lead agency: DOE): A kick represents the first stage of a loss of well control. If left unabated, a kick can grow in magnitude until a catastrophic loss of well control occurs, a condition known as a blowout. Thus, preventing kicks is necessary for preventing blowouts. The best opportunity to suppress a kick is when a kick is at its smallest magnitude, at its initiation. Therefore, the best opportunity to prevent a blowout is to suppress the kick as soon as possible after it initiates. To achieve this, it is essential to accurately detect a kick as soon as possible after it has initiated. This task will focus on experimental calibration and enhancement of the kick technology. Numerical analysis with select and proprietary datasets provided by industry partners will also continue.
3. Constraining Kick Signals through Advanced Multi-phase Data – Database of Kick Characteristics Resulting from a Kick Event (Lead agency: DOE): The objective of this project is to build a database of kick characteristics resulting from a kick event (e.g., acoustic velocity/resistivity as a function of kick physical properties), and use this information to help train DOE's National Energy Technology Laboratory (NETL) patented kick technology. This project is using a combination of numerical and



experimental effort to characterize and quantify properties of kick flow responses. A database of kick properties from both laboratory experiments and numerical model simulations will be produced.

4. Corrosion Resistant Aluminum Components for Improved Cost and Performance of Ultra-deepwater Oil Production (Lead agency: DOE): This project will develop the enabling technologies that will underpin the development of aluminum risers for ultra-deepwater drilling. This project will develop high strength corrosion resistant weldments between 7XXX series aluminum flanges and pipes, and develop technology to mitigate corrosion in 7XXX series alloys. This will include development of a friction stirring welding process, establishing a post-weld heat treatment schedule, and exploring cold spray to address corrosion.
5. Hexagonal Boron Nitrate Reinforced Multifunctional Well Cement for Extreme Conditions (Lead agency: DOE): This project provides a system approach for developing the next generation of well cementing with multifunctional, high performance characteristics—including mechanical, thermal, rheological, and durability properties—to prevent offshore spill and leakage at extreme high temperature, high pressure, and corrosive conditions. A proof-of-concept hexagonal boron-nitride/cement composite will be developed and tuned to offer optimum slurry formulation and rheological properties, and the best hybrid nanostructure. The actual barrier efficiency and performance of this cement formulation will be tested against gas/liquid leakage inside a simulated environment. The well cement product is cost-effective, has no toxicity, and easily integrates to existing equipment and facilities.
6. In-situ Applied Coatings for Mitigating Gas Hydrate Deposition in Deepwater Operations (Lead agency: DOE): The overall objectives of this research effort are to design, test, and validate robust pipeline coatings for commercial utilization that mitigate hydrate deposition in subsea pipelines. A novel coating developed during a previous DOE sponsored collaboration between Colorado School of Mines (CSM)-Center for Hydrate Research (CHR) and Oceanit showed promise for hydrate deposition prevention in small-scale apparatuses. The technology and methods to be used in this research will advance and scale-up this concept with second generation hydrate-phobic coatings in larger multiphase flowing systems. Particularly, the CSM-CHR deposition flow loop will be employed to assess the effectiveness of these advanced coatings during steady-state and transient (shut-in/restart) operations. Additionally, the strategy for in-situ application of the coatings to existing pipelines will be developed. The project will include the multiphase transient simulation and design.
7. Relative Permeability of Offshore Enhanced Oil Recovery (EOR) – Tool to Provide Improved Relative Permeability (kr) Curves of Water/Oil and Gas/Oil in Offshore Formations (Lead agency: DOE): The objective of this task is to develop a tool to provide improved relative permeability (kr) curves of water/oil and gas/oil in offshore formations to industry for planning of offshore EOR projects. Relative permeability (kr) descriptions in reservoir simulations dictate fluid migration yet are poorly constrained and have high levels of uncertainty.
8. Thermodynamic Modeling of Mineral Scale at High-temperature, High-pressure (HTHP) – Extend Scale Predictions to HTHP Conditions (Lead agency: DOE): The objective of this task is to extend in-pipe scale predictions to HTHP conditions.

9. Well Cement Behavior and Gas Migration During Early Hydration – Static Gel Strength (SGS) (Lead agency: DOE): Purpose of this project is to control the influx of external fluids into the cement column to ensure a competent bond between casing and the rock formation. Understanding of cement slurry performance properties to the prevention of post placement of cement is vital. The SGS of slurries cross potential flow zones in the reservoir. This research will work to eliminate gaps and unknowns allowing for improved slurry performance and testing to ensure proper cementing and eliminate gas migration and is relevant to a range of offshore settings (e.g., deepwater, Arctic, etc.).

*L. Drilling – Research Papers: None*

*M. Rail and Truck Transportation – Research Projects: None*

*N. Rail and Truck Transportation – Research Papers: None*

*O. Pipeline Systems – Research Projects*

1. A Multimodal Acoustic Tool for Pipe Inspection (Lead agency: PHMSA): The project will develop a suitable nondestructive in-the-ditch measurement method for fracture toughness; a value needed to determine the actual pressure rating of a pipeline.  
<https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=735>
2. Brain-inspired Learning Framework to Bridging Information, Uncertainty and Human-Machine Decision-making for Decoding Variance in Pipeline Computational Models (Lead agency: PHMSA): The project will develop and implement new learning framework to bridge information, uncertainty, and human-machine decision making with pipeline challenges that are becoming increasingly complex and demanding as a result of the high uncertainty and heterogeneous data.  
<https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=788>
3. Combined Cleaning and Guided Wave Inspection System for Hazardous Liquid Pipelines (Lead agency: PHMSA): The project will evaluate the feasibility of developing a low-cost and lightweight, combined inspection and cleaning tool that can be used in as many current hazardous liquid pipe cleaning applications as possible.  
<https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=737>
4. Combined Vibration, Ground Movement, and Pipe Current Detector (Lead agency: PHMSA): The project will use a suite of sensors to monitor pipelines and determine if there is unauthorized activity within the right of way. The sensors are discrete point types that can be installed in a small excavation.  
<https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=655>
5. Cost Benefit Analysis of Deploying or Retrofitting External Based Leak Detection Sensors (Lead agency: PHMSA): This project will deliver new knowledge outlining a methodology for performing cost-benefit analysis on external leak detection systems intended for use on hazardous liquid and natural gas transmission pipelines.  
<https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=741>

6. Development of a Prediction Model for Pipeline Failure Probability Based on Learnings from Past Incidents and Pipeline Specific Data using Artificial Neuron Network (Lead agency: PHMSA): This project will develop a knowledge based predictive model to assess pipeline failure through learning about causes behind pipeline failure and implementation of learning to predict failure. <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=789>
7. Improvement to Pipeline Assessment Methods and Models to Reduce Variance (Lead agency: PHMSA): This project will develop, validate, and demonstrate improved assessment methods and models to lower the variance of model outputs when assessing the impact of interactive threats. <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=727>
8. Low-variance Deep Graph Learning Framework to Bridging Information, Uncertainty, and Human-Machine Decision-making for Decoding Variance in Pipeline Computational Models (Lead agency: PHMSA): This project will provide a fundamental understanding of interacting threats and develop low-variance data-driven deep graph learning models for predictive interacting threat assessment and variance reduction. <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=783>
9. Magnet-assisted Fiber Optic Sensing for Internal and External Corrosion-induced Mass Losses of Metal Pipelines Under Operation Conditions (Lead agency: PHMSA): This project will explore and develop a high sensitivity, magnet-assisted hybrid sensor of fiber Bragg gratings and extrinsic Fabry-Perot interferometer for simultaneous measurement of temperature and pipe wall thickness as a result of the combined effect of internal and external corrosion. <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=790>
10. Modernize the Assessment of River Crossings (Lead agency: PHMSA): This project intends to supplement guidance from American Petroleum Institute, Recommended Practice 1133 “Guidance for Onshore Hydrocarbon Pipelines Affecting High Consequence Floodplains,” and to expand and improve the capabilities of existing tools available to assess and monitor pipeline riverine crossings. <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=746>
11. Non-destructive Coercimetry Fracture Toughness Assessment for Steel Pipelines (Lead agency: PHMSA): The project will demonstrate the technical and economic feasibility of a non-destructive testing solution, based on coercivity metering to assess material fracture toughness of steel pipelines while evaluating the correlation between coercivity and fracture toughness. <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=738>
12. Non-destructive Testing of Fracture Toughness for Pipeline Steels (Lead agency: PHMSA): The project will demonstrate sensitivity of a nonlinear guided wave system to show how that method can measure fracture toughness. <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=742>
13. Optimized Radar to Find Every Utility in the Street (ORFEUS) Obstacle Detection for Horizontal Directional Drilling (HDD) (Lead agency: PHMSA): This project will produce a field proven, market ready, obstacle location technology for use in HDD applications. ORFEUS is an effort aimed at developing a safe, cost effective "look-ahead" obstacle detection system for HDD equipment. <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=736>

14. Predicting Remaining Fatigue Life of a Dent with Corrosion Using Advanced Measurements and Modeling (Lead agency: PHMSA): The project will understand the evolution of material level damage in a dent (or mechanical damage), with and without corrosion. Remaining fatigue life prediction will be possible if we can measure and predict material level damage accumulation under a combination of realistic conditions. <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=784>
15. River Scour Monitoring System for Pipeline Threat Prevention (Lead agency: PHMSA): This research will develop a river scour monitoring system capable of determining the degree of scour in a river bed thereby alerting pipeline operators should the amount of cover of the pipeline become reduced. <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=739>
16. Validating Non-destructive Tools for Surface to Bulk Correlations of Yield Strength, Toughness, and Chemistry (Lead agency: PHMSA): This project will investigate non-destructive surface testing through micro-indentation and micro-machining methods for material property confirmation. <https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=729>

*P. Pipeline Systems – Research Papers: None*

## **II. PREPAREDNESS**

### *A. Pre-Spill Baseline Studies – Research Projects*

1. Assessing the Impact of Oil Spills Using Three-dimensional Oil Spill Modeling (Lead agency: BOEM): Extend NOAA's oil spill Trajectory Analysis Planner tool by integrating NOAA's new web-based General NOAA Operational Modeling Environment (GNOME) tool in 3-D and apply the result to BOEM's oil-spill risk analysis in Southern California. <https://marinecadastre.gov/espis/#/search/study/100114>
2. Compendium on Oil Spill Science (Lead agency: BOEM): This project is compiling literature on the known impacts from a range of oil spill sizes and ecosystems. The goal is to then identify what information is unknown about the oil spills and the oil spill response impacts.
3. Ecosystem Modeling Efforts in the GOM: Current Status and Future Needs to Address Management and Restoration Activities (Lead agency: NOAA): This project will conduct a comprehensive review and assessment of ecosystem modeling efforts in the GOM. <https://restoreactscienceprogram.noaa.gov/projects/assessing-ecosystem-modeling>  
[https://coastalscience.noaa.gov/data\\_reports/ecosystem-modeling-in-the-gulf-of-mexico-current-status-and-future-needs-to-address-ecosystem-based-fisheries-management-and-restoration-activities/](https://coastalscience.noaa.gov/data_reports/ecosystem-modeling-in-the-gulf-of-mexico-current-status-and-future-needs-to-address-ecosystem-based-fisheries-management-and-restoration-activities/)
4. Effects of Nitrogen Sources and Plankton Food-web Dynamics on Habitat Quality for the Larvae of Atlantic Bluefin Tuna in the GOM (Lead agency: NOAA): This project will investigate the link between nutrients, food availability, and the survival of Atlantic

Bluefin tuna larvae which can be used to improve stock assessments for this commercially and recreationally important species.

<https://restoreactscienceprogram.noaa.gov/projects/bluefin-tuna-larvae>

5. Environmental Resource Areas: Developing Products to Support Oil-spill Risk Analysis and National Environmental Policy Act (Lead agency: BOEM): This study will update the North Pacific Pelagic Seabird Database (NPPSD) by consolidating approximately 200,000 km of new survey information conducted in the Gulf of Alaska, Aleutian Islands, and the Bering, Chukchi and Beaufort Seas since the last NPPSD update in 2012.
6. Hydrocarbon Seeps in the Lower Cook Inlet, Gulf of Alaska, Chukchi Sea, and Beaufort Sea OCS Planning Areas (Lead agency: BOEM): Researchers will identify and map any available information about the locations, volumes, and chemical and weathering characteristics of hydrocarbon seeps on the Alaska OCS, as well as information regarding hydrocarbon-consuming organisms in the area.
7. Inventory of GOM Ecosystem Indicators Using an Ecological Resilience Framework (Lead agency: NOAA): This project will create a comprehensive guide for management using indicators of five common coastal habitats: salt marsh, mangrove, seagrass, oyster beds/reefs, and coral reefs.  
<https://restoreactscienceprogram.noaa.gov/projects/ecosystem-indicators>
8. Midwest Region Inland Oil Spill Preparedness Project (Risk Assessment Decision Support Tool Development) (Lead agency: USFWS): The decision support tool helps prioritize locations for spill planning in the Midwest Region using a risk assessment framework. It will result in the identification of high priority locations based upon a model that incorporates high value trust resources and relevant threats.
9. Oil Spill Impact Literature Synthesis: Crude and Refined Spills 1,000-20,000 Barrels (Lead agency: BOEM): Researchers will prepare an annotated bibliography of information regarding effects and impacts of spills of crude oil, diesel, or condensate ranging from 500–20,000 bbls in size.
10. Population Connectivity of Deepwater Corals in the Northern GOM (Lead agency: NOAA): This project will determine where the corals in different mesophotic (50-150 m) and deepwater (150-2400 m) populations in the GOM originated from, which is critical information for conserving and restoring these important habitats that were damaged by the DWH oil spill.  
<https://restoreactscienceprogram.noaa.gov/projects/deepwater-corals>
11. Sensitive Species Mapping on the Missouri River (Lead agency: USFWS): Mapping of sensitive species locations on the Missouri River, relating them back to the Sub-Area Contingency Plans. Producing Story Maps.
12. Trophic Interactions and Habitat Requirements of GOM Bryde's Whales (Lead agency: NOAA): This project will develop a comprehensive ecological understanding of GOM Bryde's whales, including the physical, oceanographic, and biological features defining critical habitat and their ecological role in GOM marine food webs.  
<https://restoreactscienceprogram.noaa.gov/projects/brydes-whales>

13. Alternative Oil Spill Occurrence Estimators for Determining Rates for the Atlantic Outer Continental Shelf (OCS) (Lead agency: BOEM): This study will examine BOEM's North, Mid-, and South Atlantic OCS planning areas to predict and validate the most applicable methodologies for determining oil spill occurrence rates.

*B. Pre-Spill Baseline Studies – Research Papers*

1. An Improved Method to Estimate the Probability of Oil Spill Contact to Environmental Resources in the GOM: <https://doi.org/10.3390/jmse7020041>
2. Crude Oil Infiltration and Movement in First-year Sea Ice: Impacts on Ice-associated Biota and Physical Constraints: <https://www.boem.gov/BOEM-2017-087/> Oil Migration in Sea-Ice: Laboratory Studies of Constraints on Oil Mobilization and Seasonal Evolution. *Cold Regions Science and Technology* 174: 102924
3. Oil Spill Preparedness, Prevention, and Response on the Alaska OCS: <https://www.boem.gov/BOEM-2019-006/>
4. Producing Distribution Maps for Informing Ecosystem-based Fisheries Management: [https://coastalscience.noaa.gov/data\\_reports/producing-distribution-maps-for-informing-ecosystem-based-fisheries-management-using-a-comprehensive-survey-database-and-spatio-temporal-models/](https://coastalscience.noaa.gov/data_reports/producing-distribution-maps-for-informing-ecosystem-based-fisheries-management-using-a-comprehensive-survey-database-and-spatio-temporal-models/)
5. Recommendations on the Use of Ecosystem Modeling for Informing Ecosystem-based Fisheries Management and Restoration Outcomes in the GOM: [https://coastalscience.noaa.gov/data\\_reports/recommendations-on-the-use-of-ecosystem-modeling-for-informing-ecosystem-based-fisheries-management-and-restoration-outcomes-in-the-gulf-of-mexico/](https://coastalscience.noaa.gov/data_reports/recommendations-on-the-use-of-ecosystem-modeling-for-informing-ecosystem-based-fisheries-management-and-restoration-outcomes-in-the-gulf-of-mexico/)

*C. Response Management Systems – Research Projects*

1. GOM Oil Spill Response Viability Analysis (Lead agency: BSEE): Conduct an oil spill response viability for the U.S. OCS GOM exclusive economic zone to quantify the frequency and duration that a specific oil spill response strategy may not be feasible or 'unduly' impacted such that response effectiveness is judged to be degraded due to metocean conditions. <https://www.bsee.gov/research-record/gulf-of-mexico-oil-spill-response-viability-analysis>
2. Market Research of Vessel of Opportunity Skimming System (VOSS) Technologies (Lead agency: USCG): The USCG RDC's objective is to research the state-of-the-market for potential technologies that can replace current VOSS equipment in USCG Districts 14 and 17. This research will aid the USCG in developing a procurement strategy for the replacement of VOSS equipment in Districts 14 and 17 to meet Oil Pollution Act of 1990 requirements.
3. Nearshore and Inland Evaluation of the Estimated Recovery System Potential (ERSP) Calculator (Lead agency: USCG): This project was initiated to assess the feasibility of, costs and benefits for, and potentially undertake the work to expand the BSEE ERSP calculator to the inland environments. The USCG RDC is currently developing a conceptual model of the inland ERSP calculator.

4. Oil Spill Response Emerging Technology Research (Lead agency: USCG): Project is aimed at standardizing a process to collect information surrounding emerging technologies that are submitted to the USCG or other government agencies for use in spill response and catalogue/store the information in a single location.
5. Trajectory Analysis Planner (TAP) (Lead agency: NOAA): Development of a web-based version of the TAP, and a TAP location for southern California.  
<https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/response-tools/trajectory-analysis-planner.html>

*D. Response Management Systems – Research Papers*

1. Feasibility of Extending the ERSP Calculator for Nearshore and Inland Waterways: A Post Workshop Report: This USCG report is a preliminary assessment that includes the outcome/results of the feasibility workshop. It captures important factors that were identified to potentially influence the inland oil response planning for the inland ERSP calculator. This report presents the highlights of the discussions during this workshop and the USCG RDC's conclusions and recommendations for the next phases of the project.
2. Oil Spill Response Technology Evaluation Report: This USCG report discusses the framework of the oil spill response technology evaluation process, describes the efficacy of the process test, and recommends changes for improvements to the process based on several subject matter experts' feedback.
3. Remote Sensing Assessment of Surface Oil Transport and Fate During Spills in the GOM  
<https://marinecadastre.gov/espis/#/search/study/100036>

*E. Other - None*

**III. RESPONSE**

*A. Structural Damage Assessment and Salvage Research Projects: None*

*B. Structural Damage Assessment and Salvage Research Papers: None*

*C. At Source Control and Containment - Research Projects: None*

*D. At Source Control and Containment - Research Papers: None*



*E. Chemical and Physical Behavior Modeling – Research Projects*

1. Automated Data Inquiry for Oil Spills (ADIOS) Oil Database Enhancements (Lead agency: NOAA): This project will utilize a workshop to develop plans for a next generation oil spill database, identify data gaps in current oil database, obtain oil samples, and partner with labs to analyze samples for inclusion in database.
2. ADIOS Oil Database Software (Lead agency: NOAA): Oil Database software, including a public Web Based interface, and private data management, updating, and sharing tools.
3. Arctic Oil Spill Modeling (Lead agency: USCG): This project is sponsored by the DHS S&T ADAC and is being undertaken by the University of Alaska at Fairbanks and Texas A&M University to support the USCG. The intent is to enhance modeling capabilities such as NOAA's GNOME to incorporate a variety of ice and Arctic- specific conditions, and incorporates both surface spills and deepwater blowout scenarios.
4. Development of an Accurate Model of the Beaufort and Chukchi Ice Drift and Dispersion for Forecasting Spill Trajectories and Providing Decision Support for Spill Response (Lead agency: BOEM): This project developed an open-source computational framework and software library for discrete element modeling of sea ice mechanics ("Siku").  
<https://marinecadastre.gov/epis/#/search/study/26899>
5. GNOME Oil Spill Transport Model Visualization (Lead agency: NOAA): Enhanced visualization in the WebGNOME oil spill fate and transport model.  
<https://gnome.orr.noaa.gov>
6. GNOME Suite Development (Lead agency: NOAA): Ongoing development of the GNOME Suite of oil spill models: WebGNOME Fate and Transport model and supporting tools.
7. Leveraging Offshore Hydrocarbon Risk Assessment Models and Datasets to Support the Evaluation and Ranking of Worst Case Discharge Scenarios (Lead agency: BSEE): This effort is to develop a suite of modeling tools to compare and rank different spill scenarios to determine which may have the greater potential for damage to the environment or have other significant detrimental impacts (such as commerce, maritime transportation, etc.).  
<https://www.bsee.gov/research-record/osrr-1046-leveraging-offshore-hydrocarbon-risk-assessment-models-and-datasets>
8. National Oceanic and Atmospheric Administration (NOAA) Web General NOAA Operational Modeling Environment (WebGNOME) Additions for Trajectories and Oil Libraries (Lead agency: BSEE): WebGNOME is an online version of NOAA Emergency Response Division's (ERD) oil spill response modeling tools. BSEE is partnering with NOAA ERD to sponsor additional enhancements to WebGNOME that will enhance the trajectory visualizations to show changes in oil concentration and other properties, such as viscosity as the oil is transported, and allow users to enter specific oil properties into a stand-alone oil library. <https://www.bsee.gov/research-record/noaa-webgnome-additions-for-trajectories-and-oil-libraries>
9. Oil Sands Products Spill Response (Lead agency: USCG): Project is researching and developing enhanced decision-making tools and recovery and mitigation tools for responding to spilled oil sands products.



10. Oil Spill Modeling for Improved Response to Arctic Maritime Spills: The Path Forward (Lead agency: USCG): This project is sponsored by the DHS S&T ADAC and is being undertaken by the University of New Hampshire to support the USCG mission. This knowledge project will identify state of the art spill models and examine how they can be integrated with current models to support Arctic spill response.

*F. Chemical and Physical Behavior Modeling – Research Papers*

1. Oil Spill Modeling in Deep Waters: Estimation of Pseudo-component Properties for Cubic Equations of State from Distillation Data:  
<https://www.sciencedirect.com/science/article/pii/S0025326X18307598?via%3Dihub>
2. Siku Sea Ice Discrete Element Method Model:  
<https://marinecadastre.gov/espis/#/search/study/26899>
3. Simulation Modeling of Ocean Circulation and Oil Spills in the Gulf Of Mexico. Volume I: Synthesis Report. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2018-039. 3 volumes.  
<https://marinecadastre.gov/espis/#/search/study/100032>

*G. Oil Spill Detection and Surveillance – Research Projects*

1. An Integrated Assessment of Oil and Gas Release into the Marine Environment at the Former Taylor Energy Mississippi Canyon 20 (MC20) Site (Lead agency: BSEE): Acoustic and optical data collections were paired with direct oil and gas and environmental sampling at the MC20 site. This data was used for oil and gas source identification, chemical characterization, and deriving estimates of flow rates from the subsurface release site.
2. Characterizing Dispersant Effectiveness of Crude Oils at High Salinities: Implications for Subsea Spill Preparedness (Lead agency: EPA): Potential oil exploration and production activities in close proximity to hypersaline water bodies (Arctic brine channels or GOM brine pool), necessitates characterization of dispersant effectiveness at high salinities. This project evaluates the performance and behavior of dispersants at high salinities.
3. Comparing Advances in Estimating and Measuring Oil Slick Thickness (Lead agency: NOAA): (1) Convene a workshop to develop plans to conduct in situ oil thickness validation and verification experiments for testing oil thickness measurements at Ohmsett; and (2) Conduct side-by-side experiments at Ohmsett; and 3) Conduct field testing at a suitable field-testing location.
4. Detection of Oil Thickness and Emulsion Mixtures Using Remote Sensing Platforms (Lead agency: BSEE): This project characterized the detection of known oil thicknesses and oil-emulsions in a controlled environment (e.g., Ohmsett). Additionally, it measured the open water oil thicknesses and oil-emulsions in the GOM at the Mississippi Canyon 20 (MC20) site. Further developed the operational methods and procedures for rapid data project generation for future operations.  
<https://www.bsee.gov/research-record/osrr-1079-deepwater-horizon-lessons-learned-methodology-and-operational-tools-to>

5. Detection and Mitigation of Oil within the Water Column (Lead agency: USCG): Project aimed at developing new spill response technologies that can accurately detect and mitigate subsurface oil within the water column to 10,000 ft.
6. Development and Implementation of Remote Sensing Techniques for Oil Spill Monitoring and Storm Damage Assessment in an Operational Context (Lead agency: NASA): Develop tools and products using all available satellite synthetic aperture radar and optical sensor to generate oil spill extent, oil spill thickness, off-shore oil production infrastructure status, and maps of large debris. Includes semi-automated algorithm development, field trials at MC20 site, and in Norway.
7. Marine Induced Polarization (Marine IP) Methods for the Detection and Mapping of Oil in an Arctic Marine Oil Spill; Including Investigation of Oil within and under Broken Ice Fields (Lead agency: USCG): This project is sponsored by the DHS S&T ADAC and is being led by Texas A&M University. This research effort will test and evaluate performance of Marine IP in the Arctic to detect and map hydrocarbons, in water and ice, and in sediment.
8. Oil Sands Products Spill Response (Lead agency: USCG): Project is researching and developing enhanced decision-making tools and recovery and mitigation tools for responding to spilled oil sands products.
9. Oil Slick and Plume Detection using LiDAR and Acoustic Technologies (Lead agency: BSEE): This project developed new approaches and algorithms to utilize LiDAR systems and acoustic sensors to detect and classify oil spills. Evaluated were the Ship LiDAR Optical Profiler and the TURBulence Ocean LiDAR systems as well as acoustic sensors.
10. Propeller Driven Long Range Autonomous Underwater Vehicle (LRAUV) (Lead agency: USCG): This project is sponsored by the DHS S&T ADAC and is being undertaken by WHOI and Monterey Bay Aquarium Research Institution to support the USCG mission. The project has designed/engineered a LRAUV with sensor packages to detect and map oil spills including under ice for long durations.
11. Three-dimensional Mapping of Dissolved Hydrocarbons and Oil Droplets Using a REMUS AUV (Lead agency: EPA): This project aims to develop an AUV with oil detection sensors and discrete sampling systems for response operations. Such response detection tools can also be used to improve our understanding of plume behavior and droplet formation. Flume tank and field test operations have begun and will continue into next FY.
12. 2018 Arctic Operations Support (Lead agency: USCG): The 2018 broad-reaching project provided support to the USCG for a variety of potential Arctic capabilities to include deployment of remote sensing vehicles/aircraft for detecting, communicating, and sampling oil spills.

#### H. *Oil Spill Detection and Surveillance – Research Papers*

1. After Action Report – Arctic Technology Evaluation 2017: This USCG paper is an after-action report that summarizes the lessons learned for use in improving the USCG RDC's Arctic operations support capabilities.
2. Estimating Oil Slick Thickness with LiDAR Remote Sensing Technology: This EPA report is a collaborative effort between the U.S. Naval Research Laboratory (NRL) and EPA. The study was funded by BSEE and was undertaken by USNRL and EPA with testing conducted at Ohmsett. <https://www.bsee.gov/sites/bsee.gov/files/research-reports//1091aa.pdf>
3. In Situ Monitoring of Dispersion in the Water Column, Final Product for the Detection and Mitigation of Oil within the Water Column Project: This USCG paper explores the results of a USCG RDC investigation into the feasibility of using state-of-the-art sensors deployed from an aircraft that can monitor the dispersion efficacy of oil in the water column after dispersant application. Different approaches to more rapidly monitor and telemetrically report dispersant efficacy from various depths/locations in the water column according to Special Monitoring of Applied Response Technologies Tier II and III criteria are also explored. <https://apps.dtic.mil/dtic/tr/fulltext/u2/1053220.pdf>
4. Remote Sensing Estimation of Surface Oil Volume during the 2010 Deepwater Horizon (DWH) Oil Blowout in the GOM: Scaling up Airborne Visible/Infrared Imaging Spectrometer Observations with Moderate Resolution Imaging Spectroradiometer Measurements: <https://www.spiedigitallibrary.org/journals/journal-of-applied-remote-sensing/volume-12/issue-02/026008/Remote-sensing-estimation-of-surface-oil-volume-during-the-2010/10.1117/1.JRS.12.026008.full?SSO=1>
5. Robotic Aircraft for Sensor Payload – Maritime Evaluations at Different Geographical Locations, Final Report: The USCG's RDC established a two-phase project to document current USCG airborne oil spill surveillance capabilities and shortfalls, and then analyze and develop recommendations to mitigate those shortfalls. Phase I of the Airborne Oil Spill Remote Sensing and Reporting project catalogued the existing organic sensor capabilities of USCG aircraft related to oil spill response. This report is Sensitive Security Information and requires approval from RDC Technical Director to access.

#### I. *In and On-Water Containment and Recovery – Research Projects*

1. Assessment of Oil Demulsification and Separation Technologies (Lead agency: BSEE): This project compiled data on current industry practices, procedures, and technologies used for oil demulsification and separation. Relevant new research and technologies were reviewed and analyzed to identify areas where technology development could enhance separation processes. <https://www.bsee.gov/research-record/assessment-of-oil-demulsification-and-separation-technologies>
2. Assessment of Innovative Sorbents (Lead agency: BSEE): This project will conduct a comprehensive assessment of sorbents for use in oil spill response. This will include identification of promising new and emerging sorbent technologies that could enhance spill response.

3. Comparative Testing of Oil Thickness Sensors (Lead agency: NOAA): This effort will support the NOAA's project to comparatively test existing oil thickness sensor technologies. BSEE will fund testing of these technologies at Ohmsett.
4. Detection and Mitigation of Oil within the Water Column (Lead agency: BSEE): Characterize the detection of known oil thicknesses and oil-emulsions in a controlled environment (e.g., Ohmsett). Measure the open water oil thicknesses and oil-emulsions in the GOM at the Mississippi Canyon 20 (MC20) site. Develop operational methods and procedures for rapid data product generation future operations. <https://www.bsee.gov/research-record/osrr-1079-deepwater-horizon-lessons-learned-methodology-and-operational-tools-to>
5. Development of an Active Ice Management System for Skimmers (Lead agency: BSEE): This project will design, build, and test an active ice management prototype to allow for improved mechanical recovery in broken ice with existing stationary skimmers. The half-scale prototype system will be tested at Ohmsett in 2020. <https://www.bsee.gov/research-record/development-of-an-active-ice-management-system-for-skimmers>
6. Development of a Field Scale Test Protocol for Type I Sorbents Recovering Oil on Water (Lead agency: BSEE): This project will develop a protocol for testing Type I sorbents to provide performance data that will predict how a sorbent may perform during typical field use.
7. Development of an Oil Thickness Sensor (Lead agency: BSEE): This project developed two sensors for measuring oil thickness on water. The first measures 3-100 mm thick oil layers while mounted to a skimmer, boom, or free-floating buoy. The second sensor measures thin sheens of oil, between 0.1 to 3 mm, and is designed as a free-floating sensor. <https://www.bsee.gov/research-record/development-of-an-oil-thickness-sensor>
8. Development of an Oil Thickness Sensor Phase II (Lead agency: BSEE): This project continues development of a capacitive sensor to measure oil thickness on water. Two prototypes will be developed. The first will be a hand-held unit that can be used from a vessel or from the side of a test tank. The second will mount on a skimmer, boom, or buoy. <https://www.bsee.gov/research-record/development-of-an-oil-thickness-sensor-phase-ii-0>
9. Evaluation of Skimmer Performance in Diminishing Oil Slick Thickness (Lead agency: BSEE): This project tested various skimming systems in varying oil slick thicknesses to better understand the relationship between oil recovery rates and recovery efficiencies, and decreasing oil slick thicknesses. <https://www.bsee.gov/research-record/evaluation-of-skimmer-performance-in-diminishing-oil-slick-thicknesses>
10. Improved In-situ Burning (ISB) for Offshore Use (Lead agency: USCG): Project encompassed several actions: refurbish the storm damaged Joint Maritime Test Facility, test upgrades to the facility, and conducting tests at facility. The aim was to facilitate better decision-making and provide some operational tools for using ISB as a response option.

11. Improved Oil Recovery Efficiency Sensor (Lead agency: BSEE): This project developed and tested an in-line, flow through oil recovery efficiency sensor to monitor in real time the percentage of oil and water in fluid recovered during oil spill response operations. This sensor was successfully tested at Ohmsett in June 2018 with multiple salinities and oil types. <https://www.bsee.gov/research-record/development-of-an-oil-recovery-efficiency-sensor>
12. Improved Oil Recovery Sensor Phase II (Lead agency: BSEE): This project will continue development of a recovery efficiency sensor. Work will improve measurement accuracy across the entire range of concentrations and allow accurate readings with a non-full pipe condition. Delivered systems will be ready for field testing and use by responders.
13. Investigation of Design Enhancements to Current Boom Technologies (Lead agency: BSEE): This project is investigating alternative boom designs that will allow boom to collect and contain oil when towed at speeds greater than the current standard 0.7 to 1 knot tow speed. Physical and Computational Fluid Dynamics modeling will be used to test promising boom designs. <https://www.bsee.gov/research-record/investigation-of-design-enhancements-to-current-boom-technologies>
14. Market Research of VOSS Technologies (Lead agency: USCG): USCG RDC's objective is to determine the availability of mechanical oil spill response technologies that can be outfitted on vessels of opportunity (VOOs) available outside of the contiguous United States (OCONUS), or in remote locations. The objective of the market research is to explore state-of-the-art, commercially available mechanical oil spill response technologies as well as emerging technologies that would aid a more effective response.
15. Methods to Enhance Mechanical Recovery in Arctic Conditions (Lead agency: BSEE): This project investigated several methods to enhance mechanical recovery in an arctic environment including using a remotely operated vehicle to recover oil under ice, developing methods to reduce icing of a vertical rope mop skimmer, and investigating the use of waste heat to improve pumping of recovered fluid. <https://www.bsee.gov/research-record/osrr-1082-methods-to-enhance-mechanical-recovery-in-arctic-conditions>
16. Mitigation of Oil in the Water Column (Lead agency: USCG): This project discusses the testing of two prototypes designed to recover suspended oil droplets in the water column at Ohmsett during calendar year 2017. USCG RDC shared data and findings from both tests and recommended future work in this area of oil spill response.
17. Response to Moving Sunken Oil (Lead agency: USCG): This project discusses the two underwater barrier systems that can mitigate the movement of sunken oil along the bottom of inland and offshore environments as well as large lakes. USCG RDC shared data and findings from both tests and recommends future work in this area of oil spill response.
18. The Effect of Dispersants on Mechanical Recovery (Lead agency: BSEE): This project will test the effect of dispersant treated oil on skimming and booming operations. The final report is currently being finalized.

19. Vessel Ice Management (Lead agency: BSEE): This project will design and test a prototype device to deflect ice in front of a vessel mounted boom arm system and allow oil to be collected with existing skimming systems in 30-70% ice fields.
20. Advancing the Icehorse Technology for Recovering Oil in Ice (Lead agency: BSEE) This project advanced a proof-of-concept for ROV-based submersible sled technology with a commercial-Off-The-Shelf (COTS) skimmer. The system is able to travel under ice and surface to recover oil. <https://www.bsee.gov/research-record/advancing-icehorse-proof-of-concept-to-make-it-more-useful-in-an-operational>

*J. In and On-water Containment Recovery – Research Papers*

1. Mitigation of Oil Moving Along the Waterway Bottom: The USCG report summarizes the results of testing of multiple prototype configurations developed to mitigate oil moving across the bottom of the waterway in inland and offshore environments. It also contains a summary of the effort and recommendations for responding to oils moving across the bottom.
2. Oil Spill Preparedness, Prevention, and Response on the Alaska OCS: <https://www.boem.gov/BOEM-2019-006/>
3. Testing of Oil Sands Products Recovery in Fresh Water: White Paper Study: This USCG report describes the results of a test conducted at Ohmsett to evaluate the recovery of weathered, diluted bitumen (dilbit) in fresh water. The collected data will help inform the effectiveness of standard skimmers in the recovery of diluted bitumen in fresh water.

*K. Shore Containment and Recovery – Research Projects*

1. Defining Protocols for Replanting as an Oil Spill Response Tactic in Coastal Marshes (Lead agency: NOAA): Conduct mesocosm experiments using coastal marsh species with various oiling and treatment regimes to evaluate recovery over a two-year period. The project will also seek to determine how re-planting influences weathering and degradation of the oil.
2. Shoreline Cleanup and Assessment Team and Cleanup Termination Enhancements (Lead agency: NOAA): Applying multiple data sources to advance understanding of remote sensing shoreline interactions, submerged and buried oil, and marsh/shoreline cleanup techniques.

*L. Shore Containment and Recovery – Research Papers: None*

*M. Dispersants – Research Projects*

1. Characterizing Dispersant Effectiveness of Crude Oils at High Salinities; Implications for Subsea Spill Preparedness (Lead agency: EPA): Potential oil exploration and production activities in close proximity to hypersaline water bodies (Arctic brine channels or GOM brine pools) necessitates characterization of dispersant effectiveness at high salinities. This project evaluates the performance and behavior of dispersants at high salinities.



2. Detection and Mitigation of Oil within the Water Column (Lead agency: USCG): This project was aimed at developing new spill response technologies that can accurately detect and mitigate subsurface oil within the water column to 10,000 feet.
3. Dispersant Effectiveness of Photo-oxidized Crude Oil (Lead agency: EPA): A collaborative project with the WHOI evaluated dispersant effectiveness of photo-weathered crude oil using the baffled flask test method.
4. Fate and Persistence of Oil Spill Response Chemicals in Arctic Seawater (Lead agency: BOEM): Quantification of the biodegradation of the chemical dispersant Corexit 9500A in Arctic seawater and determination of how the presence of crude oil alongside the dispersant affects the biodegradation of both dispersants and oil.  
<https://marinecadastre.gov/espis/#/search/study/100129>
5. Mitigating the Damage to Arctic Copepods from Surface Oil Spills: When to Apply Dispersants (Lead agency: USCG): This project is sponsored by the DHS S&T ADAC and is being undertaken by Bigelow Lab for Ocean Sciences. Project will look at the impact of an oil spill with and without the use of a dispersant on copepods that are able to move in the water column.
6. Oil Composition versus Dispersant Effectiveness (Lead agency: BSEE): This project further investigated the relationship between the oils' chemical composition (saturates, aromatics, resins, and asphaltene) and viscosity on dispersant effectiveness. A total of 14 oils were tested at two temperatures using the baffled flask method to determine dispersant effectiveness. <https://www.bsee.gov/research-record/oil-composition-vs-dispersant-effectiveness>
7. Photo-enhanced Toxicity of Dispersed and Burned Crude Oil to Arctic Mussels (Lead agency: USCG): This project is sponsored by the DHS S&T ADAC and is being led by University of Alaska Anchorage. It is studying the effects of oil, dispersants, and in-situ burning, along with photo-enhanced effects, on several physiological, biochemical, and metabolic aspects of a cold-water mussel species.
8. Screening for National Oil and Hazardous Substances Pollution Contingency Plan (NCP) Product Schedule Potential New Reference Oils (Lead agency: EPA): Currently, there is a shortage of reference oils for NCP Product Schedule testing. The EPA has been screening oils to select the new reference oils to serve research needs for the next two decades. This is a high-priority project, as reference oils are critical to maintaining the NCP Product Schedule as mandated by OPA 90.
9. Validating and Expanding the Dispersant Spray Drift (DSD) Decision Support Tool (Lead agency: BSEE): This effort is to expand on the DSD tool, previously developed by AMOG Consulting Group. The results of the effort will validate previous assumptions, add new airframes, and concentration contours to help visualize the output. <https://www.bsee.gov/research-record/validating-and-expanding-the-dispersant-spray-drift-decision-support-tool>
10. Determine the Relative Efficiency of Various Surface Dispersant Delivery Techniques/Systems. (Lead agency: BSEE) This project developed a technology selection approach to aid in the decision making process for determining the relative

effectiveness of dispersant delivery techniques/systems based on various spill characteristics and delivery system capabilities. Parameters considered include spill characteristics and properties; evaporation processes; spray platforms, weather patterns and effects; environmental restrictions; and dispersant characteristics. <https://www.bsee.gov/research-record/determine-the-relative-efficiency-of-various-surface-dispersant-delivery>

*N. Dispersants – Research Papers*

1. Fate and Persistence of Oil Spill Response Chemicals in Arctic Seawater: Technical Summary: <https://marinecadastre.gov/epis/#/search/study/100129>
2. Hydrodynamics of Oil Jets without and with Dispersant: Experimental and Numerical Characterization: This EPA research paper features a collaboration with the New Jersey Institute of Technology.
3. In Situ Monitoring of Dispersion in the Water Column, Final Product for the Detection and Mitigation of Oil within the Water Column Project: This paper explores the results of a USCG RDC investigation into the feasibility of using state-of-the-art sensors deployed from an aircraft that can monitor the dispersion efficacy of oil in the water column after dispersant application. Different approaches to more rapidly monitor and telemetrically report dispersant efficacy from various depths/locations in the water column according to SMART Tier II and III criteria are also explored. <https://apps.dtic.mil/dtic/tr/fulltext/u2/1053220.pdf>
4. Photochemical Oxidation Reduced the Efficacy of Aerial Dispersants Applied in Response to the DWH Oil Spill: This EPA research paper is a collaboration with the WHOI.

*O. In-situ Burning – Research Projects*

1. Characterization of Emissions and Residues from Simulations of Crude Oil Surface Oil Burns (Lead agency: BSEE with EPA): Inefficiency during in situ burning results in the formation of burn residues that can sink through water and be buried within sediments. This project is dedicated to characterizing emissions and residues during burning to better understand the fate of hydrocarbons during burn operations. <https://www.bsee.gov/research-record/analysis-of-emissions-and-residue-from-methods-to-improve-combustion-efficiency-of>
2. Freshwater In-situ Oil Burn Research (Lead agency: USCG): The USCG RDC aims to develop and conduct a series of ISBs that evaluate crude oil/tar sands products behavior and impacts in fresh water. Efforts will provide science-based adaptive management approach information to response planners and the Federal On-Scene Coordinator (FOSC) about ISB efficacy and applicability to most likely spill scenarios in the Great Lakes.
3. Improved ISB for Offshore Use (Lead agency: USCG): This project encompassed several actions: refurbish the storm damaged joint maritime test facility, test upgrades to the facility, and conducting tests at the facility. The aim was to facilitate better decision-making and provide some operational tools for using ISB as a response option.



4. Photo-enhanced Toxicity of Dispersed and Burned Crude Oil to Arctic Mussels (Lead agency: USCG): This project is sponsored by the DHS S&T ADAC and is being led by University of Alaska Anchorage. It is studying the effects of oil, dispersants, and in-situ burning along with photo-enhanced effects, on several physiological, biochemical, and metabolic aspects of a cold-water mussel species.
5. Development of a Low-Emission Spray Combustor for Emulsified Crude Oil (Lead agency: BSEE): BSEE is working with the Naval Research Laboratory developing technology to cleanly burn emulsions with low-pressure, atomizing technology in areas with minimal infrastructure, fast water, or inland waterways near population centers. <https://www.bsee.gov/research-record/osrr-1061-development-low-emission-spray-combustor-emulsified-crude-oil>
6. Computational Fluid Dynamics (CFD) Model for Predicting Wellhead Oil-Burning Efficiency at Bench and Intermediate Scales (Lead Agency: BSEE): An experimentally validated, computational fluid dynamics (CFD) model was developed to study burning efficiencies of intentional wellhead burns on artificial gravel islands to determine its suitability as a potential oil spill countermeasure in the event of loss of well control. <https://www.bsee.gov/research-record/osrr-1063-preliminary-technical-guidance-and-literature-review-assist-evaluation>
7. In Situ Burn Testing of California Crude Oils (Lead agency: BSEE): This BSEE project studied the ignition and burning behavior of unweathered, weathered, and emulsified variants of several California crude oils to determine the applicability of *in situ* burning as a response tool. <https://www.bsee.gov/research-record/in-situ-burn-testing-of-california-crude-oils>
8. Autonomous Underwater Vehicle Deployable Oil Spill Igniter (Lead agency: BSEE): This BSEE project advanced the proof-of-concept of a robust, underwater ignition system for use in extreme weather conditions and harsh environments to expand the window of opportunity for *in situ* burn operations. <https://www.bsee.gov/research-record/autonomous-underwater-oil-spill-igniter>
9. Innovative Fire and Fuel Configurations to Optimize In Situ Burning Volumes and Efficiencies (Lead agency: BSEE): BSEE worked with the US Army Corps of Engineers Cold Regions Research and Engineering Lab (CRREL) to test linear augmented burn techniques and technology to enhance *in situ* burn efficiencies. <https://www.bsee.gov/research-record/research-and-develop-a-linear-augmented-fire-boom-configuration-to-increase-burn>
10. Efficient Remediation of Oil Spills over Water using Fire Whirls (Lead agency: BSEE): This BSEE study characterized the structure and behavior of controlled fire whirls at the bench and intermediate scales to understand the impact on emissions, burn efficiencies, and potential advantages of fire whirls on *in situ* burning. <https://www.bsee.gov/research-record/efficient-remediation-of-oil-spills-over-water-using-fire-whirls>

11. Research and Develop Interface Insulation Systems and Vigorous Burn Inducer (Lead agency: BSEE): This BSEE research studied various insulating materials that could increase the efficiency of in situ burns and reduce the amount of burn residues. <https://www.bsee.gov/research-record/research-and-develop-interface-insulation-systems-and-vigorous-burn-inducer-to>
12. Advancement of Flame Refluxer Technology (Lead agency: BSEE): BSEE is working with academia to advance a heat feedback system developed in a previous BSEE study to enhance the efficiency and burn volumes during in situ burn operations while reducing emissions. <https://www.bsee.gov/research-record/advancing-the-maturity-of-the-flame-refluxer-technology>
13. Technology for Accelerated Clean and Complete In Situ Burning (Lead agency: BSEE): BSEE is partnering with the Naval Research Laboratory to study the use of heat pipe technology to enhance in situ burn operations. <https://www.bsee.gov/research-record/technology-for-accelerated-clean-and-complete-in-situ-burning-phase-i>

*P. In-situ Burning – Research Papers*

1. Analysis of Emissions and Residue from Methods to Improve Combustion Efficiency of In Situ Oil Burns (3-part series): This EPA report summarizes a collaborative project between BSEE and EPA.
2. An Offshore ISB Enhanced by Floating Immersed Objects: This Clean Gulf 2017 paper discusses Worcester Polytechnic Institute's (WPI) innovative solution to increase burn efficiency that was tested at the USCG RDC's Joint Maritime Test Facility.
3. Method for Measuring Burn Efficiency of Spray Flames that Simulate Scaled-Down Petroleum Wellhead Fires: This manuscript of the BSEE study conducted by the Naval Research Laboratory was accepted to the journal *Fuel*.
4. Experimental Approach for Measuring Burn Efficiency of a Reduced-Scale Wellhead Fire: This is a paper on the BSEE study to develop a burn efficiency model.
5. An Overview of Wellhead Burning: Fundamental Science to Burn Performance Prediction: This Naval Research Laboratory (NRL) paper provides an overview of the fundamental science associated with the BSEE wellhead burn efficiency model.
6. The Influence of Droplet Injection Models on Reynolds-Averaged Navier-Stokes Simulations of High-Speed Heptane/Ethane Spray Flames. This Naval Research Laboratory (NRL) paper was presented and included in the proceedings of the 11th U. S. National Combustion Meeting of the Combustion Institute in Pasadena, California, 2019.
7. High-Speed Imaging of Spray Near-Field Behavior a Turbulent Heptane/Ethane Spray Flame. The Naval Research Laboratory (NRL) presented this paper and it was included in the 11th U. S. National Combustion Meeting, Combustion Institute in Pasadena, California, 2019.

8. Dual-Pump Coherent Anti-Stokes Raman Scattering Spectroscopy Turbulent Heptane/Methane Spray Flame: The Naval Research Laboratory (NRL) presented this paper and it was included in the U. S. National Combustion Meeting, Combustion Institute in Pasadena, California, 2019
9. High-Speed Imaging of Atomization Behavior and Temperature Field Spray Flames that Simulate Oil Wellhead Fires: The Naval Research Laboratory (NRL) presented this paper and it was included in the proceedings of the 42nd AMOP Technical Seminar on Environmental Contamination and Response in Halifax, Nova Scotia, Canada
10. Dual Pump CARS Thermometry and Relative Mole Fractions Measurements a Heptane/Propane Spray Flame: The Naval Research Laboratory (NRL) presented this paper related to measurements during the experimental validation of the wellhead ignition model; the paper was included in the proceedings of the 42nd AMOP Technical Seminar on Environmental Contamination and Response in Halifax, Nova Scotia, Canada
11. Reynolds-Averaged Navier-Stokes Simulations of a Piloted Heptane/Propane Spray Flame. The Naval Research Laboratory (NRL) presented this paper related to the BSEE wellhead ignition model at the Spring Technical Meeting of the Eastern States Section of the Combustion Institute in 2018.
12. Droplet Size and Velocity Measurements a Heptane/Propane Spray Flame. Naval Research Laboratory (NRL) presented this paper related to the BSEE wellhead ignition model at the Spring Technical Meeting of the Eastern States Section of the Combustion Institute in 2018
13. Experimental Measurements and Numerical Simulations of Droplet Behavior a Heptane/Ethane Spray Flame: Naval Research Laboratory (NRL) presented this paper related to the BSEE wellhead ignition model at the 41st AMOP Technical Seminar on Environmental Contamination and Response in 2018.
14. Analysis of Emissions and Residue from Methods to Improve Combustion Efficiency of In Situ Oil Burns-Improved efficiency of burns by minimizing burn residue and/or soot: The EPA report summarizes emissions and residue findings on several BSEE projects.
15. Characterization of Emissions and Residue from Measures to Improve Efficiency of In Situ Oil Burns: This EPA report summarizes emissions and residue findings on several BSEE projects.
16. Analysis of Emissions and Residue from Methods to Improve Combustion Efficiency of In Situ Oil Burns - Innovative fire and fuel configurations to optimize in situ burning volumes and efficiencies: This report to BSEE summarizes the EPA's findings related to BSEE's linear augmented burn study.
17. The Direct Measurement of In-Situ Burn (ISB) Rate and Efficiency: This paper on a BSEE project to quantify burn rate and burn efficiency was presented at Clean Gulf 2019.

18. In Situ Ignition Testing of California Crude Oils: Naval Research Laboratory (NRL) personnel presented this paper related to the BSEE California Crude Oil Combustion study at the 41st AMOP Technical Seminar on Environmental Contamination and Response in 2018.
19. Comparing the Mass Spectra of California Crude Oils with those of their Laboratory Weathered and In Situ Burn Residuals: The Naval Research Laboratory (NRL) presented this paper related to the BSEE California Crude Oil Combustion study at the 42st AMOP Technical Seminar on Environmental Contamination and Response in 2019.
20. A Comparison of Emissions from Liquid-Fueled Pool Fires and Fire Whirls at Different Length Scales: Paper by the University of Maryland (UMD) on the emissions related to the BSEE fire whirl study for publication in the Journal *Environmental Pollution*.
21. Demonstration of Reduction in Emissions by Fire Whirls through Small Scale Experiments: Paper and presentation Paper by the University of Maryland (UMD) on the BSEE fire whirl study at the 42nd AMOP in 2019.
22. Fire Whirls and Blue Whirls: Emissions Reduction and Vortex Breakdown: Paper and presentation Paper by the University of Maryland (UMD) on the BSEE fire whirl study at the 2019 Research Symposium on Environmental and Applied Fluid Dynamics at Johns Hopkins University.
23. Comparison of emissions from liquid-fueled pool fires and fire whirls: Paper and presentation Paper by the University of Maryland (UMD) on the BSEE fire whirl study at the 11th US National Combustion Meeting in 2019

*Q. Alternative Chemical Countermeasures – Research Projects*

1. Development of a Laboratory Protocol for Effectiveness of Commercial Solidifiers in Cleaning Up Oil Spills on Water (Lead agency: EPA): This project aims to (1) develop a protocol for testing the effectiveness of solidifying an oil slick on water using commercial solidifiers; (2) evaluate the recovery of oil from solidified product; (3) determine mechanisms of solidification; and (4) quantify the effects of environmental conditions on the solidification process.
2. Development of a Laboratory Protocol for Effectiveness of Commercial Surface Washing Agents (SWA) in Cleaning Up Oil Spills on Shorelines (Lead agency: EPA): This project aims to develop a standardized and reproducible testing protocol to evaluate the shoreline cleaning efficiency of SWAs. Oil removal efficiencies for SWA are being evaluated, as well as dispersability, because an effective SWA should not disperse oil into water, as per U.S. policy.
3. Operational Limits of Herders (Lead agency: BSEE): This study measured the influence of oil characteristics and temperature on herder efficacy at the lab scale. The two commercially available herders were tested at two temperatures on 14 crude oils with varying properties. <https://www.bsee.gov/research-record/operational-limits-of-chemical-herders>

4. Quantifying the Effect of Oil Photochemical Oxidation on the Performance of Chemical Herders in Canadian Waters (Lead agency: EPA): A collaborative project with WHOI and Applied Research Associates to evaluate herder effectiveness of photo-weathered Canadian oils. This project is funded through the Canadian Multi-Partner Oil Spill Technology Research Initiative for oil research.

R. *Alternative Chemical Countermeasures – Research Papers: None*

S. *Oily Waste and Oil Disposal – Research Projects: None*

T. *Oily Waste and Oil Disposal – Research Projects: None*

U. *Bioremediation and Biodegradation – Research Projects*

1. Microbial Biodegradation of Alaska North Slope Crude Oil in Arctic Marine Sediments (Lead agency: BOEM): Perform laboratory incubation studies investigating the biodegradation of fresh and weathered crude oil in arctic sediments under aerobic and anaerobic conditions to assess biodegradation rates and to identify oil-degrading microbes, which can help to formulate predictions regarding the fate of spilled oil in sediments. <https://marinecadastre.gov/espis/#/search/study/100198>

V. *Bioremediation and Biodegradation – Research Papers: None*

W. *Other – Research Projects*

1. Oil Spill Response Emerging Technology Research (Lead agency: USCG): This project developed a standardized process to collect information surrounding emerging technologies that are submitted to the USCG or other government agencies (OGAs) for use in spill response as well as catalogue and store the information in a single location.

X. *Other – Research Papers: None*

#### **IV. INJURY ASSESSMENT AND RESTORATION**

A. *Environmental Impacts and Ecosystem Recovery – Research Projects*

1. Acute and Latent Effects of Oil Exposure on Arctic Cod (Lead agency: NOAA): Determine the latent effects of low dose embryonic exposures on growth, lipid metabolism, bioenergetic, and behavioral endpoints that are associated with first year mortality in feeding larval and juvenile stage Arctic cod.

2. Assessment of Ultraviolet (UV) Light-enhanced Toxicity of Oil to Multiple Life Stages of Marine Organisms (Lead agency: NOAA): Using embryo/larval stages of fish, crustaceans, gastropods, and echinoderms, determine effects of UV light on oil toxicity (effects on survival, growth, and reproduction). Exposures include water accommodated oil fractions and thin oil sheens.
3. Baseline Toxicity Testing of NCP Product Schedule Oil Spill Control Agents (Lead agency: EPA): Acute and chronic toxicity of commercially-available products (chemical herder and SWA) on the NCP Product Schedule using fresh and salt water species (fish and invertebrates) are being evaluated in this project.
4. Biodegradability of Crude Oil Exposed to Surface Washing Agents and Chemical Herders at Two Temperatures (Lead agency: EPA): Biodegradation rates of oil exposed to NCP Product Schedule products that may remain in the environment after use are being evaluated. Such information is useful during oil spill response efforts and for fate and transport models.
5. Chemistry and Toxicity of Polar Compounds in Oil (Lead agency: NOAA): Studies to quantify the relative mechanisms and potencies of polar and non-polar oil compounds were conducted using weathered oil water-accommodated fractions and *Fundulus heteroclitus*.
6. Compounded Vulnerability of Threatened Shallow Coral Reefs to Toxic Effects from Oil Spills (Lead agency: NOAA): (1) Conduct toxicity tests with morphologically distinct coral species (branching and boulder corals); (2) Assess multiple petroleum products and weathered oils; and (3) Compare short to longer durations of oil exposure; and (4) Incorporate measurements and effects of natural sunlight at reefs (quality and quanta of light spectra at surface and reef depths for test species).
7. Early Life Stage Fish and Invertebrate In Situ Bioassay Development for Shallow Surface Mixing Layer (Lead agency: NOAA): Develop and test an in situ bioassay tool to characterize oil toxicity in the shallow surface mixing layer to early life stages of a fish and/or invertebrate species.
8. Endangered Pallid Sturgeon Risk Assessment and Data Collection, Planning and Training (Lead agency: USFWS): The USGS developed pallid sturgeon-specific oil spill fish health assessment training. Baseline fish health sampling was conducted on pallid sturgeon and the surrogate species shovelnose sturgeon from locations in the Yellowstone River and Missouri River. Baseline health assessment index scores were calculated and samples will be maintained for comparisons for future events. A hazard analysis is complete, working with sturgeon experts, including the Bureau of Reclamation, to accurately describe potential exposure scenarios.
9. Establishing Pre-disaster Carcass Scavenging Rates (Lead agency: USFWS): Establishing baseline scavenging rates in riverine systems of the Midwest.
10. Long Term Exposure to Sunken Oil (Lead agency: NOAA): Testing the use of Marine Induced Polarization and limited pairing with passive and surface sediment grab samples to map and characterize sunken and bioavailable oil associated with the Barge DBL152 incident.

11. Metagenomic Sequencing of Oil Degrading Microbial Communities (Lead agency: EPA): The goal of this research is to better understand biodegradability of oil by differing microbial cultures in deep and surface waters, treated with various dispersants. This project uses next-generation sequence technologies to better identify the genes associated with different bacterial populations inhabiting enriched/treated mixed cultures.
12. Middle Fork Flathead River Bull Trout Risk Assessment (Lead agency: USFWS): Baseline fish health sampling was completed by USGS, National Park Service, and USFWS, in addition to Semi-permeable Membrane Device baseline Polycyclic Aromatic Hydrocarbon sampling of sediments.
13. Mussel Kill Standard Protocol (Lead agency: USFWS): Established standard operating procedures for evaluating a freshwater mussel kill.
14. Oil Spill Alternative Response Measures: Toxicity and Biodegradation of Treated Petroleum Oils (Lead agency: EPA): Canadian oils. This project is funded through the Canadian Multi-Partner Research Initiative (MPRI) for oil research.
15. Standardized Response Protocol for Listed Crayfishes (Lead agency: USFWS): Establish baseline condition for protected status species of crayfishes, in a high spill risk river system.
16. Toxicity of Diluted Bitumens in Sediment to Benthic Invertebrates (Lead agency: EPA): The sub lethal toxicity of diluted bitumens in sediment to marine and freshwater benthic invertebrates will be determined.
17. Use of Elemental Signatures to Detect and Trace Contaminant Entry to the Northern GOM Coastal Food Web: Managing Multiple Stressors (Lead agency: NOAA): This project will test whether trace elements associated with oil can be detected in oyster shells and serve as an indicator of oil exposure thus providing resource managers with a way to detect past oil exposure on oyster reefs.

*B. Environmental Impacts and Ecosystem Recovery – Research Papers*

1. Comparative Toxicity of Two Chemical Dispersants and Dispersed Oil in Estuarine Organisms: <https://link.springer.com/article/10.1007/s00244-017-0430-9>
2. Estimating the Value of Lost Recreation Days from the DWH Oil Spill: <https://www.sciencedirect.com/science/article/abs/pii/S0095069617307003>
3. Influence of Variable UV Radiation and Oil Exposure Duration on Survival of Red Drum (*Sciaenops Ocellatus*) Larvae: <https://setac.onlinelibrary.wiley.com/doi/10.1002/etc.4183>
4. Persistent Organic Pollutants in Blood and Blubber of Common Bottlenose Dolphins (*Tursiops Truncatus*) at Three Northern GOM Sites following the DWH Oil Spill: <https://www.sciencedirect.com/science/article/pii/S0048969717332679>
5. Pre-oil Spill Baseline Profiling for Contaminants in Southern Resident Killer Whale Fecal Sample Indicates Possible Exposure to Vessel Exhaust: <https://www.sciencedirect.com/science/article/pii/S0025326X18306544>



6. Spatio-temporal Models Reveal Subtle Changes to Demersal Communities following the Exxon Valdez Oil Spill: <https://academic.oup.com/icesjms/article-abstract/75/1/287/3852237?redirectedFrom=fulltext>
7. Vegetation Recovery in an Oil-impacted and Burned *Phragmites australis* Tidal Freshwater Marsh:  
<https://www.sciencedirect.com/science/article/pii/S0048969717322180>

C. *Environmental Restoration Methods and Technologies – Research Projects*

1. Linking Community and Food-web Approaches to Restoration: An Ecological Assessment of Created and Natural Marshes Influenced by River Diversions (Lead agency: NOAA): This project will investigate how river diversions influence the living communities, food web structure, and function of created versus natural marshes to inform the development of marsh restoration strategies.
2. Living Shoreline Site Suitability Model Transfer for Selected Water Bodies within the GOM: A Geographic Information System and Remote Sensing-based Approach (Lead agency: NOAA): This project will adapt an existing computer model for assessing the suitability of a site for construction of a living shoreline, apply the model to Perdido Bay/Wolf Bay/Ono Island complex in coastal Alabama; Lake Pontchartrain, Louisiana; and Galveston Bay, Texas, and develop an interactive decision support tool that allows for a rapid assessment of a site.

D. *Environmental Restoration Methods and Technologies – Research Papers: None*

E. *Human Safety and Health – Research Projects: None*

F. *Human Safety and Health – Research Papers: None*

G. *Sociological and Economic Impacts – Research Projects*

1. An Assessment of the Effects of an Oil Spill on Coastal Archaeological Sites in Louisiana (Lead agency: BOEM): Oil spills can damage and impact archaeological sites and investigations. This can be through the loss of radiocarbon-dating potential, direct impact from oil-spill cleanup equipment, looting, and/or other unanticipated effects that might diminish or destroy a site's future research potential.  
<https://marinecadastre.gov/epis/#/search/study/100052>

H. *Sociological and Economic Impacts – Research Papers*

1. Forecasting Environmental and Social Externalities Associated with OCS Oil and Gas Development, Volume 1: 2018 Revised Offshore Environmental Cost Model (OECM): This BOEM paper is the first of two volumes of a report forecasting environmental and social externalities associated with the OCS and Gas development. The OECM lays the



framework for this paper as it presents the model's cost calculation methodologies as well as descriptions of each calculation driver, including the sources of underlying data and any necessary assumptions.

2. Forecasting Environmental and Social Externalities Associated with OCS and Gas Development, Volume 2: Supplemental Information to the 2018 Revised OECM: This BOEM paper is the second of two volumes with a goal to present supplemental information on environmental and social costs that BOEM considers in conjunction with the OECM results.