



OIL SPILL SCIENCE

SEA GRANT PROGRAMS OF THE GULF OF MEXICO

UNDERSTANDING THE HUMAN HEALTH AND SOCIOECONOMIC IMPACTS FROM THE DEEPWATER HORIZON OIL SPILL

Melissa Partyka, Danielle Bailey, Emily Maung-Douglass, Stephen Sempier, Tara Skelton, and Monica Wilson

The Deepwater Horizon oil spill was the largest marine oil spill in the history of the United States. Though the impacts to the environment have been well documented and studied extensively, widespread consequences to humans also took place. Human impacts recorded over the past 10 years include physical and mental health effects along with socioeconomic and community resilience challenges. However, in many cases clear cause-and-effect relationships between the spill and the impacts are absent.

INTRODUCTION

The Deepwater Horizon (DWH) oil spill began on April 20, 2010, approximately 50 miles off the coast of Louisiana and continued for 87 days. Oil from the spill impacted 1,313 miles of coastline, leading to

the closure of 89 beaches, while oiling of surface waters resulted in the closure of nearly 89,000 square miles of federal waters to fishing.

Large oil spills, like DWH, are defined by the National Oceanic and Atmospheric Administration (NOAA)

SYNTHESIS SERIES

The purpose of this publication is to exclusively reflect findings from synthesis activities supported by the Gulf of Mexico Research Initiative (GoMRI). GoMRI synthesis documents are the primary references for this publication. The summary may also include peer-reviewed publications and other reports cited in the GoMRI synthesis activities that help to provide foundation for the topic.



as exceeding 100,000 barrels (420,000 gallons) of oil. Large oil spills are very rare; however, they can negatively impact the health of those responding to the spill and residents of impacted areas, in addition to affecting the general welfare of coastal communities (Figure 1^a). In the case of DWH, the explosion of the oil platform that preceded the spill also led to the deaths of 11 oil industry workers. Over the following days, months, and years, the impacts of DWH were observed for some individuals, families, businesses, and communities. These impacts



A fishing boat serves as a vessel of opportunity in oil spill response by pulling an oil boom. (National Commission on the BP Deepwater Horizon oil spill)

deepened the negative effects of previous disasters in the Gulf, such as Hurricanes Katrina and Rita in 2005.^b

HEALTH IMPACTS OF THE SPILL

Human health studies following the DWH spill are the largest of their kind in history, and many are still underway. Though much remains to be understood about long-term effects, research studies conducted in the immediate aftermath of the spill provide scientists with valuable information about risks to oil response workers and coastal residents. These health impacts may be from not only from physical exposure to chemicals but also come from the social and economic disturbances caused by the spill.

Impacts to oil spill workers

Two of the largest studies on human health following DWH are ongoing. These studies examine the impacts to oil spill workers. Oil spill workers can be described as professional responders (such as U.S. Coast Guard personnel), trained lay persons (for example, fishers hired to help in response), or community volunteers who have received some or no additional training. These workers can encounter a variety of health hazards, including physical exposure to oil, fumes from burning oil, oil spill chemicals such as dispersants and cleaning agents, as well as other work stressors like high heat and humidity, long working hours, and physical and psychological strain.

The GuLF (Gulf Long-term Follow Up) STUDY, conducted by the National Institute of Environmental Health Sciences (NIEHS), is a long-term study that uses data on exposure and health outcomes drawn from surveys, home visits, and other clinical data as well as worker access to mental health services.¹ This study includes 32,608 people, 25,000 of whom actually worked on the oil spill, while the more than 7,000 remaining were non-oil spill workers (meaning people who were trained but not hired) for contrast. Another large study on oil spill workers is the U.S. Coast Guard (USCG) Deepwater Horizon Oil Spill study.² This study includes 53,519 USCG personnel, 8,696 of whom responded to the spill and 44,823

POSSIBLE EFFECTS OF LARGE MARINE OIL SPILLS ON HUMANS

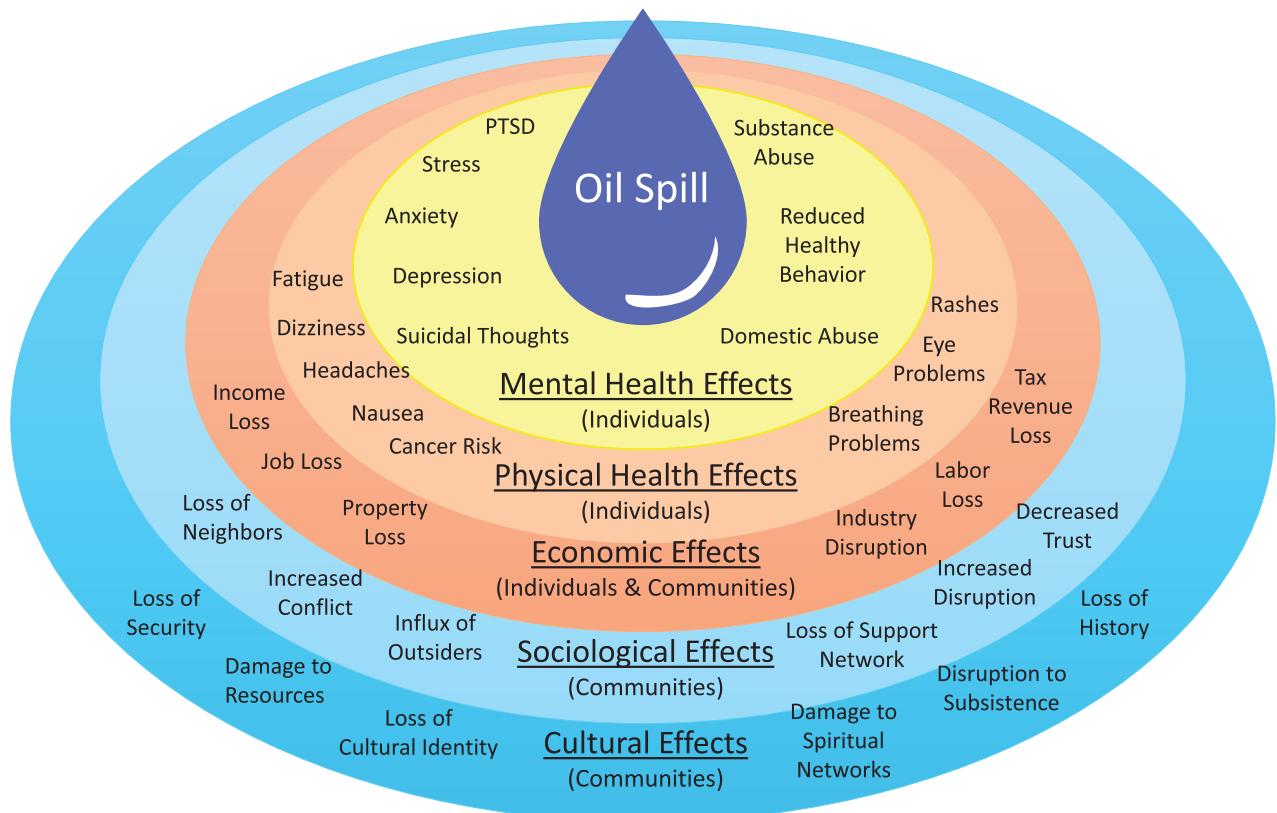


FIGURE 1. Studies of nine large oil spills showed a myriad of impacts on humans, with the following populations showing the most vulnerability: people dependent on natural resources; response and cleanup workers; people living in close proximity to the spill; children, pregnant women, and the elderly; and people with chronic health issues. (Adapted from Sandifer et al., 2020)

who did not, to provide comparison. The teams from both studies have collaborated and are attempting to determine long-term effects of exposure to oil and oil cleanup chemicals through primary pathways like inhalation and skin contact.^b

The goal of the GuLF STUDY is to quantify exposure of oil spill workers to two potentially toxic components of oil: total hydrocarbons (THC), a group of **volatile** oil-based chemicals, and another group of chemicals associated with cancer risks called BTEX-H (benzene, toluene, ethylbenzene, xylene, hexane). Scientists measured both THC and BTEX-H levels by air sampling and used the results to estimate the potential toxic effects to oil spill workers over time. Results of air sampling were mixed. Based on available data, it appears that exposure of workers to concentrations of oil-based chemicals were low compared to current **occupational exposure** standards.³ However, another study conducted from May 1, 2010 to September 30, 2010, measured coastal air quality for benzene (the B in BTEX-H) and **fine particulate matter** (also called PM_{2.5}).⁴ According to this second study, onshore concentrations were generally higher following the spill, with benzene concentrations 2 to 19 times higher and PM_{2.5} concentrations 10 to 45 times higher than pre-spill samples. Both measurements were high enough to exceed public health criteria in places near oil spill cleanup activities. Initial results of the GuLF STUDY found an increase of cases of heart disease and reduced lung function in some oil spill workers compared to non-oil spill workers. However, because air quality samples did not test for

every chemical in oil and symptoms were generally self-reported, these impacts cannot be directly linked to the oil spill or any specific chemical in the **crude oil**.^b

In contrast to the GuLF Study, the researchers of the USCG study gained access to baseline health data for its participants, since medical data are available for all active-duty USCG members from before the spill through the present.² Access to baseline data allows researchers to study changes in the health of workers after they were involved in cleanup work. Results from this study indicate that exposure to crude oil and oil spill chemicals correlated to multiple symptoms including respiratory distress, headaches, blurred vision, skin irritation, and even heart disease in some workers.^b These impacts were identified even though health protection protocols, including using personal protective equipment (PPE), were in place. This finding indicates that more work is needed to both improve PPE and its proper use to protect oil spill workers in the future.^b

Health impacts to non-oil spill workers and children

Oil spill impacts to humans are less studied than environmental impacts, and physical health effects are more researched among spill workers than in other groups of people.^b In fact, partly because large oil spills are so rare in the United States, much of what researchers know about impacts to non-oil spill workers comes from studies in other countries.^b

Some previous studies in other countries showed reproductive health effects for people exposed to chemicals in crude oil. This led to concerns about potential impacts to pregnant women in the Gulf follow-



A child chases waves on a Gulf beach years after oil from the Deepwater Horizon oil spill washed ashore. (M. Partyka)

ing DWH.⁵ However, no reported increases in cases of miscarriage or infertility in women from southeastern Louisiana, a population that lived closest to the spill, emerged after DWH.⁶ This is not to say there were no reports of negative health effects following the spill. Women physically exposed to the spill or who experienced economic impacts, such as job loss or reduced wages, reported other symptoms like wheezing or irritated eyes and noses.⁷

Children, if exposed to oil, are also more vulnerable because of their higher breathing and metabolic rates, their developing immune and hormonal systems, as well as their behavior during inquisitive play.⁸ Coastal residents and visitors were particularly concerned about young children encountering oil chemicals while playing at Gulf beaches. Children's play habits on the beach involve close contact with sand, including the potential for ingesting sand and water as they dig, bury themselves, and sit in shallow water.⁹ These behaviors had not been quantified prior to DWH. To help understand the potential health risks to children, researchers conducted a series of experiments at multiple beaches in Texas and Florida not impacted by DWH. These experiments included watching

play behavior and measuring the amount of sand stuck to children after playing for a set time. Though research is ongoing, initial results indicate that children who played at beaches that were cleaned of oil are unlikely to experience negative

health effects from any incidental exposure.^b

However, children were still impacted by DWH. Based on health status reports for children four, six, and eight years after the spill, overall health and recent physical health

problems (respiratory symptoms, eye and/or vision issues, skin problems, headaches, or unusual bleeding) were worse in children from households that experienced physical exposure to the spill or economic losses related to the spill.⁸

WHAT DOES RISK MEAN?

Thousands of chemicals can be found in crude oils, and some of them are potentially toxic to humans when inhaled, ingested, or absorbed through human skin. Following DWH many people expressed concern about the risk or likelihood of illness to themselves and their families while working outside, eating seafood, or playing at the beach. To address these concerns scientists conducted air, seafood, water, and beach sand sampling for chemicals in oil and dispersants that could be toxic to humans.⁹ But the question of risk to individuals is difficult to answer; here is why.

Individual risk can be estimated through a risk assessment. Risk assessments are developed by scientists that assign a number to risk factors and outcomes. Researchers identify hazardous chemicals and their concentrations in the environment; evaluate how someone may have been exposed by ingesting, inhaling, or touching a chemical; determine the dose that

entered the body; and gauge how the body responds to that dose.^b The result is an estimate of risk typically provided in units of probability (**Figure 2**). Risk probability is the likelihood of an individual or groups of individuals becoming ill given the concentration, exposure time, and dose of a chemical people encounter. Probabilities do not guarantee illness nor protection from illness.

It is not possible for scientists to sample everywhere, so they use models to estimate concentrations of chemicals in multiple locations. Scientists must also consider the variety of ways that different groups of people can come in contact with these chemicals. For example, oil spill workers cleaning up oil on the beach have different chemical exposure rates than recreational beach goers. The next step is to determine the dose of the chemical and whether the body's response is either likely to be **acute** or **chronic**. Acute responses, such as a cough or skin reaction, might

be noticed rapidly, but chronic responses, like some cancers, might take years to develop. These responses can vary in severity and are different for each individual depending on many factors such as overall health, access to care, and underlying conditions.

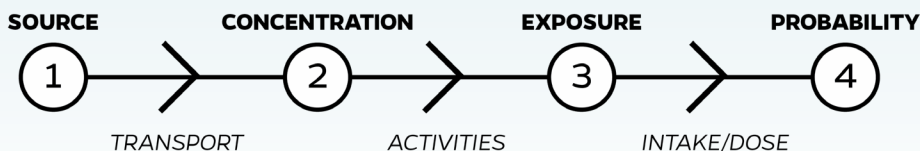
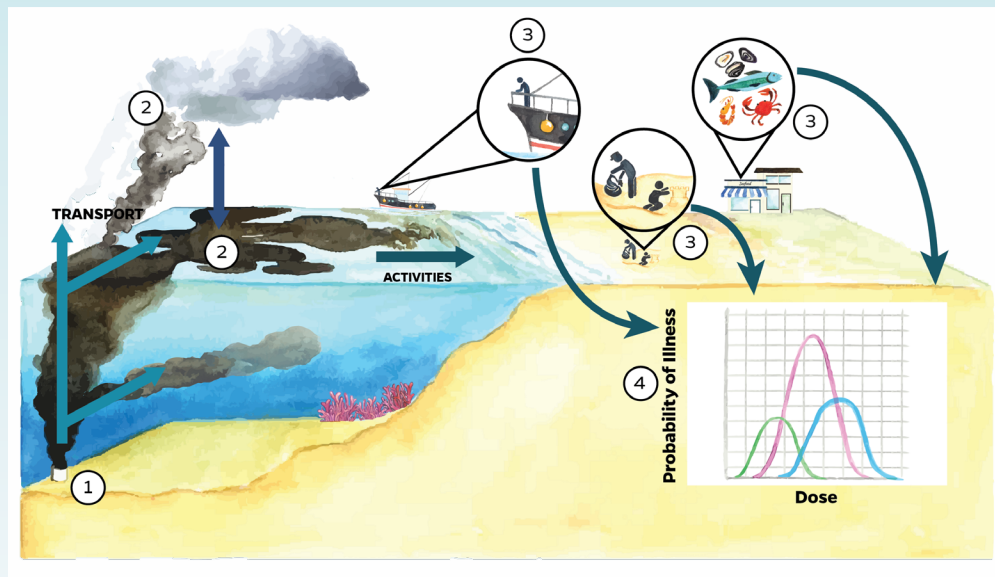


FIGURE 2. This visualization shows some of the steps involved in identifying and modeling human risk following an oil spill: 1) source of oil chemicals, 2) reduction in the concentration of chemicals during transport or movement of the chemical through the environment, 3) potential exposure to chemical during various activities, and 4) the probability of impact from chemicals based on the dose and underlying health conditions. (Anna Hinkeldey)

Impacts were more common in African American children and those from low-income households.^b

Mental health impacts

Human health impacts from an oil spill are not limited to physical illnesses. Multiple studies have found that mental and physical health are closely related during disasters, in part because environmental contamination can cause significant stress.^a However, the mental health impacts experienced by individuals following major disasters have been understudied compared to other health aspects, and the evidence of mental health distress associated with the DWH oil spill is mixed.^b The results of two large research surveys in the Gulf Coast region suggest few changes in mental or behavioral health overall followed DWH.¹⁰ However, results across a range of other, smaller studies targeting specific communities indicate increased reports from individuals of symptoms consistent with depression, anxiety, and post-traumatic stress.^b This may indicate that members of some communities are more vulnerable to negative mental health impacts following oil spills. For example, community members with ties to the fishing industry were more likely than non-fishers to report a decline in mental health. To learn more about how oil spills and other disasters can impact the mental health of communities, read [The Deepwater Horizon's impact on people's health: Increases in stress and anxiety](#).

THE SOCIOECONOMIC IMPACTS TO INDUSTRIES AND COMMUNITIES

The DWH spill resulted in numerous **socioeconomic impacts**, affecting

IF THEY CATCH IT, WILL YOU EAT IT?

After over 22,000 samples and months of testing, federal and state authorities determined that Gulf seafood was safe for human consumption.¹²⁻¹³ Though researchers have pointed out the need for improvements in the current seafood testing program, including testing for additional hydrocarbons and their potential toxic effects on consumers,¹⁴ independent studies supported the results from federal response. None of the studies found an increased risk from consuming Gulf seafood in the months and years after the oil spill.^b However, consumers continued to worry about seafood safety, even years later. While debate between researchers continues about why this was the case, most agree that risk communication about eating seafood from the Gulf was the main cause.¹³ In the future, health experts recommend that any assessment of seafood safety should be followed by plain language notices about risks to consumers. These notices should target people from many different backgrounds, cultures, ages, and ethnicities followed by regular updates.^b To learn more about the seafood testing programs put in place after the oil spill, read [The Deepwater Horizon oil spill's impact on Gulf seafood](#).

fishing, tourism, and transportation sectors, among others. Though studies have been conducted on these impacts, researchers have found that closer study of additional socioeconomic variables could help assess the value of other resources for impacted communities, including cultural identity, attitudes, and social ties.^b

Fisheries and tourism sector impacts

At the time of the spill, Gulf fisheries accounted for around 16% of all the fish caught in the U.S.,¹¹ fueling concerns of Gulf residents and non-residents about the safety of the nation's seafood supply. In anticipation of potential contamination, the federal government announced emergency fishery closures in combination with a rigorous testing program. By the height of the spill in early June, nearly 37% of federal waters in the Gulf of Mexico Exclusive Economic Zone were closed to fishing.¹² Though widespread fisheries closures following DWH reduced the

chances of contaminated seafood entering markets and restaurants, the seafood sector, and the associated tourism trade, was negatively impacted for years after the spill.^b

Scientists estimated large economic losses in the fisheries sector, which includes commercial and recreational fishing as well as marine aquaculture. Initial estimates of losses to the commercial and recreational fishing industries were \$4.9 billion and \$3.5 billion, respectively.¹⁵ The commercial shrimping impacts accounted for almost 85% of the projected impacts. One set of analyses found that consumers were likely to transition to farmed shrimp to satisfy demand, which would further harm the wild-caught shrimping industry.¹⁶ However, 10 years after the spill research is still ongoing to fully understand the true economic impacts across the diverse fishing sector.^b

Misperception of the actual damage following the spill along with confusion about potential risks to the public contributed to negative

financial impacts to multiple industries, including tourism. One report demonstrated that the public was unaware of locations and extent of damage from the oil. For example, of the non-residents surveyed, 44% believed the oil spill caused damages similar to those seen following Hurricane Katrina, and 29% of tourists canceled or postponed planned trips to Louisiana due to the spill.¹⁷ The tourism and recreation industries received about \$147 million in paid claims spanning 23 different types of businesses, such as airlines, aquaria, water sports, and more. Restaurants, lodging, and retail operations claimed a further 3.5 billion dollars in loss.^b An important finding from these reports and studies is that consumer perception matters and is an important driver of economic impact and recovery.^b

Community Resilience

Resilience can be defined many ways, but scientists that studied the human impacts of DWH typically define it to mean the ability of a community to adapt to change and learn from past experiences.^b Researchers looked at different factors that improved resilience in Gulf communities, including economic devel-

opment, social relationships, access to information, and communication with those in authority.¹⁰ These studies found that, though the spill resulted in differing economic impacts across fisheries, tourism, and oil and gas sectors, the impacts were primarily short-term. However, at the household level, and particularly in poorer households, financial impacts were still being felt years later. Further, community well-being showed signs of distress related to the spill across multiple studies. Much of the reported distress appeared to be related to economic uncertainty and mistrust in the compensation processes put in place to specifically alleviate economic distress.^b To learn more about how to help to make our communities more resilient to future disasters, read [Creating healthy communities to overcome oil spill disasters](#).

CURRENT GAPS AND FUTURE OPPORTUNITIES

A range of mental and physical health impacts have been attributed to oil spills in general and the DWH specifically, but in most cases clear cause-and-effect relationships are absent. Overall, researchers have found that mental and physical health effects and their interactions

are poorly studied for oil spill workers, their families, and others who may be exposed to or affected by them.^b Additionally, special attention should be paid to vulnerable people, including individuals with chronic illness or who suffer from healthcare and economic disparities.^b

Clear human health findings have been limited by a lack of baseline health data from before the oil spill.^a Additionally, long delays in implementing major health research activities following the spill, heavy reliance on self-reported data, limited collection of clinical health information, and a small number of long-term studies make it difficult for researchers to establish connections between symptoms experienced by some oil spill workers and coastal residents and DWH.^b In the future, researchers recommend that health studies be initiated before, during, and/or immediately following a large spill and continue long enough to identify long-term effects and potentially secondary waves of chronic illnesses.^b

Need for a community health observing system

Environmental disasters of various kinds and magnitudes occur regularly in the Gulf region, with one



Fishing boats serving as vessels of opportunity pull oil into a fire boom. (USCG)

often following another. Recurring disasters can take a toll on human health in the region, particularly in communities that already suffer significant health and economic disparities.^b Previous studies of health impacts following disasters in the Gulf demonstrated the need for baseline health information to study the effects of disasters.^a However, it became clear following DWH that these data are lacking. To ensure baseline data are in place prior to the next major disaster, scientists funded through the Gulf of Mexico Research Initiative (GoMRI) assert that ongoing health monitoring is essential to develop and maintain these types of data and to capture acute, chronic, and long-term

health impacts. They have proposed a framework for a community health observing system (CHOS) for the Gulf of Mexico region.^a

The CHOS would build upon and leverage existing, ongoing national health surveys while including new long-term studies designed to identify and describe disaster-associated health trends in the five Gulf states. The goal is to target recruitment efforts to encompass a representative sample of the Gulf region's coastal population, and specifically include people considered vulnerable or typically under-represented (for example, ethnic minorities and those who suffer health, healthcare, and eco-

nomnic disparities). The information collected through the CHOS, if implemented, will be used primarily by public health and medical professionals, emergency managers and responders, and researchers. The analysis of these data could then be used to assess disaster-related health effects; enhance disaster planning and response; improve protection for disaster responders and workers; build individual and community resilience; and promote new clinical, biomedical, and public health research and practice. Local observations and monitoring will need to continue indefinitely to ensure long-term understanding of potential impacts.^a

GLOSSARY

Acute — Occurring over a short period of time, typically less than 72 hours.

Chronic — Taking place over an extended period of time, typically weeks, months, or years.

Crude oil — Naturally occurring, unrefined oil. Crude oil is refined to produce a wide array of petroleum products (e.g., heating oils, gasoline, diesel, lubricants, asphalt, propane).

Fine particulate matter — Solid or liquid particles in

the air that are too small to see and easily inhaled.

Occupational exposure limits — The maximum concentration of a toxic substance a worker can be exposed to over a period of time without suffering harmful effects.

Socioeconomic impacts — Impacts to human populations that address both social and economic factors.

Volatile — Easily evaporated at normal temperatures.

REFERENCES

Publications resulting from the GoMRI-supported synthesis activities serve as the primary references for this work. Additional supporting literature, either cited in GoMRI synthesis papers or necessary for foundational information about the subject, is also included.

GoMRI synthesis publications

- a. Sandifer, P., Knapp, L., Lichtveld, M., Manley, R., Abramson, D., Caffey, R., . . . Singer, B. H. (2020). Framework for a community health observing system for the Gulf of Mexico region: Preparing for future disasters. *Frontiers in Public Health*, 8, 588.
- b. Sandifer, P.A., Ferguson, A., Finucane, M.L., Partyka, M.L., Solo-Gabriele, H., Hayward Walker, A., . . . Yoskowitz, D. (2021). Human health and socio-economic effects of the Deepwater Horizon oil spill in the Gulf of Mexico. *Oceanography*, 34(1), 50-67.

Supporting publications

1. Kwok, R. K., Engel, L. S., Miller, A. K., Blair, A., Curry, M. D., Jackson, W. B., . . . Sandler, D. P.; GuLF STUDY Research Team. (2017). The GuLF STUDY: a prospective study of persons involved in the Deepwater Horizon oil spill response and clean-up. *Environmental Health Perspectives*, 125(4), 570-578.
2. Rusiecki, J., Alexander, M., Schwartz, E. G., Wang, L., Weems, L., Barrett, J., . . . Engel, L. S. (2018). The Deepwater Horizon oil spill Coast Guard cohort study. *Occupational and Environmental Medicine*, 75(3), 165-175.
3. Middlebrook, A. M., Murphy, D. M., Ahmadov, R., Atlas, E. L., Bahreini, R., Blake, D. R., . . . Ravishankara, A. R. (2012). Air quality implications of the Deepwater Horizon oil spill. *Proceedings of the National Academy of Sciences*, 109(50), 20280-20285.
4. Nance, E., King, D., Wright, B., & Bullard, R. D. (2016). Ambient air concentrations exceeded health-based standards for fine particulate matter and benzene during the Deepwater Horizon oil spill. *Journal of the Air & Waste Management Association*, 66(2), 224-236.

5. Mehri, Z.O. (2010). Gulf coast oil disaster: Impact on human reproduction. *Fertility and Sterility*, 94(5), 1575-1577.
6. Harville, E. W., Shankar, A., Zilversmit, L., & Buekens, P. (2018). The Gulf oil spill, miscarriage, and infertility: the GROWH study. *International Archives of Occupational and Environmental Health*, 91(1), 47-56.
7. Peres, L. C., Trapido, E., Rung, A. L., Harrington, D. J., Oral, E., Fang, Z., . . . Peters, E. S. (2016). The Deepwater Horizon oil spill and physical health among adult women in southern Louisiana: The women and their children's health (WaTCH) study. *Environmental Health Perspectives*, 124(8), 1208-1213.
8. Slack, T., Kroeger, R. A., Stroope, S., Keating, K. S., Sury, J., Brooks, J., . . . Beedasy, J. (2020). Deepwater Horizon oil spill exposure and child health: A longitudinal analysis. *Population and Environment*, 1-24.
9. Ferguson, A., Del Donno, C., Obeng-Gyasi, E., Mena, K., Altomare, T. K., Guerrero, R., Gidley, M., Montas, L., & Solo-Gabriele, H. M. (2019). Children exposure-related behavior patterns and risk perception associated with recreational beach use. *International Journal of Environmental Research and Public Health*, 16(15), 2783.
10. Finucane, M. L., Clark-Ginsberg, A., Parker, A. M., Becerra-Ornelas, A. U., Clancy, N., Ramchand, R., . . . Black, A. B. (2020). *Building community resilience to large oil spills: Findings and recommendations from a synthesis of research on the mental health, economic, and community distress associated with the Deepwater Horizon oil spill*. RAND Corporation.
11. Shepard, A. N., Valentine, J. F., D'Elia, C. F., Yoskowitz, D. W., & Dismukes, D. E. (2013). Economic impact of Gulf of Mexico ecosystem goods and services and integration into restoration decision-making. *Gulf of Mexico Science*, 31(1), 10-27.
12. Ylitalo, G. M., Krahn, M. M., Dickhoff, W. W., Stein, J. E., Walker, C. C., Lassitter, C. L., . . . Dickey, R. W. (2012). Federal seafood safety response to the Deepwater Horizon oil spill. *Proceedings of the National Academy of Sciences*, 109(50), 20274-20279.
13. Dickey, R. & Huettel, M. (2016). Seafood and beach safety in the aftermath of the Deepwater Horizon oil spill. *Oceanography*, 29(3), 196-203.
14. Farrington, J. W. (2020). Need to update human health risk assessment protocols for polycyclic aromatic hydrocarbons in seafood after oil spills. *Marine Pollution Bulletin*, 150, 110744.
15. Sumaila, U. R., Cisneros-Montemayor, A. M., Dyck, A., Huang, L., Cheung, W., Jacquet, J., . . . Pauly, D. (2012). Impact of the Deepwater Horizon well blowout on the economics of U.S. Gulf fisheries. *Canadian Journal of Fisheries & Aquatic Sciences*, 69, 499-510.
16. Asche, F., Benneer, J. L. S., Oglend, A., & Smith, M. D. (2012). U.S. shrimp market integration. *Marine Resource Economics*, 27(2), 181-192.
17. MDRG (Market Dynamics Research Group). (2010). *Oil spill research report*. Louisiana Department of Culture and Tourism: Market Dynamics Research Group. https://www.crt.state.la.us/Assets/Tourism/research/documents/2010-2011/OilSpillReport_regional_nationwide20110407.pdf

ACKNOWLEDGMENT

Special thanks to the many external reviewers who contributed to the betterment of this oil spill science outreach publication.

SUGGESTED CITATION

Partyka, M., Bailey, D., Maung-Douglass, E., Sempier, S., Skelton, T., & Wilson, M. (2021). Understanding the human health and socioeconomic impacts from the Deepwater Horizon oil spill. GOMSG-G-21-002.

ABOUT THE GOMRI/SEA GRANT SYNTHESIS SERIES

The GoMRI Research Board established Synthesis & Legacy committees to review 10 years of oil spill science findings. Look for Sea Grant extension publications on these GoMRI synthesis topics:

- Observing and modeling oil plumes and circulation
- Combined ecosystem modeling
- Combined oil spill modeling
- How oil weathers and degrades
- Ecological/ecosystem oil spill impacts
- Human health and socioeconomic oil spill impacts
- Microbiology, genetics, and oil spills
- Dispersant-related impacts from oil spill response

SEA GRANT SCIENCE OUTREACH TEAM

Dani Bailey, Texas Sea Grant College Program,
danielle.bailey@tamu.edu

Emily Maung-Douglass, Louisiana Sea Grant College
Program, edouglass@lsu.edu

Missy Partyka, Mississippi-Alabama Sea Grant
Consortium, m.partyka@auburn.edu

Stephen Sempier, Mississippi-Alabama Sea Grant
Consortium, stephen.sempier@usm.edu

Tara Skelton, Mississippi-Alabama Sea Grant
Consortium, tara.skelton@usm.edu

LaDon Swann, Mississippi-Alabama Sea Grant
Consortium, ladon.swann@usm.edu

Monica Wilson, Florida Sea Grant, UF/IFAS Extension,
monicawilson447@ufl.edu



This work was made possible in part by a grant from The Gulf of Mexico Research Initiative, and in part by the Sea Grant programs of Texas, Louisiana, Florida and Mississippi-Alabama. The statements, findings, conclusions and recommendations do not necessarily reflect the views of these organizations.