OIL SPILL SCIENCE
SEA GRANT PROGRAMS OF THE GULF OF MEXICO

Oil Spill Science Discoveries: An update

Larissa Graham, Mississippi-Alabama Sea Grant
Stephen Sempier, Mississippi-Alabama Sea Grant
Emily Maung-Douglass, Louisiana Sea Grant
Christine Hale, Texas Sea Grant
Monica Wilson, Florida Sea Grant

Sea Grant
Texas • Louisiana • Florida
Mississippi-Alabama

Mobile Bay National Estuary Program
Science Advisory Committee
August 17, 2016

GULF OF MEXICO RESEARCH INITIATIVE

Gulf of Mexico Research Initiative

$500 million, 10-year investment

Goal - Improve society's ability to understand, respond to, and mitigate the effects of petroleum pollution and related stressors

Focus areas:

1. How do oil and dispersants **move around** the environment?
2. How do oil and dispersants **break down** over time?
3. How do oil and dispersants **impact the environment**?
4. How can **technology** be improved?
5. How do oil spills **impact people**?

Learn more at gulfresearchinitiative.org

Gulf of Mexico Research Initiative

To date:

- 5 competitions for funding, 1 RFP left
- $350 mil awarded (5-8% projects funded)
- 729 scientific peer-reviewed publications
- 1149 publically available data sets

Photo credits from GoMRI website: Markus Huettel, Kim Nightingale

Sea Grant Programs in our Gulf

Science-based

Non-advocacy

Embedded in and serve coastal communities throughout Gulf region

Sharing oil spill science

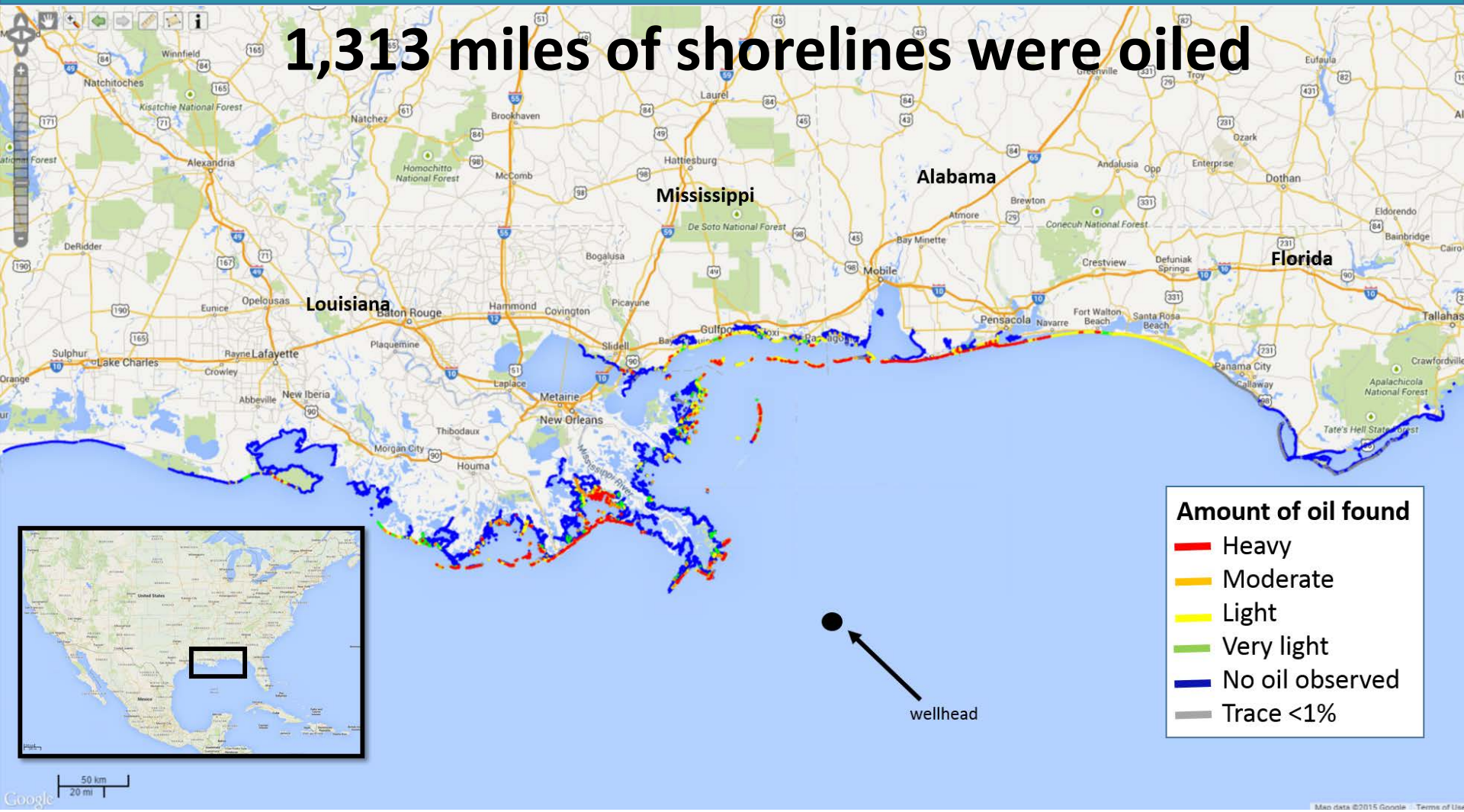
The Team

The Task

Share peer-reviewed, published science

- Science seminars & presentations
- Science outreach publications

Impact on habitats



Wetland impacts

Coastal wetlands - 52% of oiled shoreline

Oiling of marshes can lead to reduced productivity

- Chlorophyll and plant biomass showed a significant decline after the oil spill (11 and 53%)
- Recovery time could take 2 - 8 years

Oiling of marshes can lead to erosion

- Erosion rates approximately doubled in some areas for at least 3 years after the spill
- May take up to two years to see impacts

Unoiled site

Oiled site

Beach impacts

Sandy beaches - 46% of oiled shoreline

Tar balls are less mobile than sand and more mobile in high-energy environments

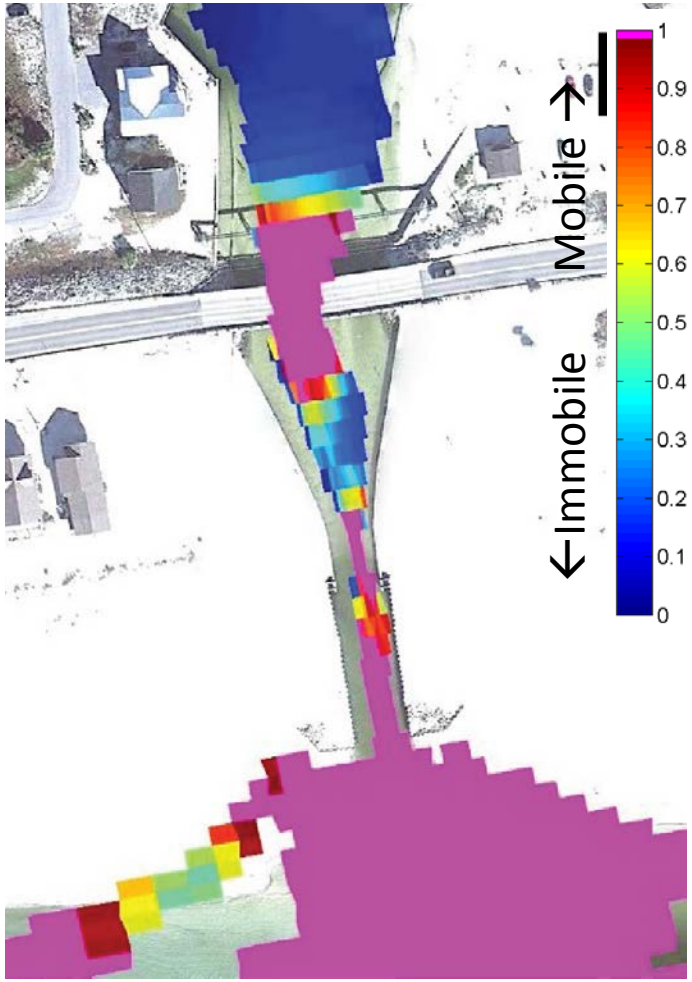
In the field:

- Wash up during relaxation phase of storms (winds 30-50mph, tides 1-5 ft)

In the lab:

- 10 cm – buried; 5 cm – mobile in surf; <1cm – hard to recover

Tar balls can become trapped in inlets



Little Lagoon, AL

Dalyander 2015

Learn more: Habitats

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THE SEA GRANT and GOMRI PARTNERSHIP

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In the immediate aftermath of the Deepwater Horizon spill, BP committed $500 million over a 10-year period to create the Gulf of Mexico Research Institute, or GoMRI. It is an independent research program that studies the effect of hydrocarbon releases on the environment and public health, as well as develops improved spill mitigation, oil detection, characterization and remediation technologies. GoMRI is led by an independent and academic 20-member research board.

The Sea Grant oil spill science outreach team identifies the best available science from projects funded by GoMRI and others, and only shares peer-reviewed research results.

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NAVIGATING SHIFTING SANDS: OIL ON OUR BEACHES

Larissa J. Graham, Christine Hale, Emily Maung-Douglass, Stephen Sempler, LaDon Swann, and Monica Wilson

During the Deepwater Horizon oil spill, emergency responders documented oil along more than 1,100 miles of shoreline. Oil washed onto and just off Gulf coast beaches. In some places, the sand buried the oil and made cleanup efforts difficult. Ongoing and completed studies are providing information that will enable responders to clean up future spills more effectively and remove the remaining oil from the Deepwater Horizon oil spill.

Oil is visible in the foreground and surf zone in this image from the Gulf Islands National Seashore, FL, that was taken on July 1, 2010. (NOAA)

The Deepwater Horizon oil spill was the worst oil spill in U.S. history with an estimated 172 million gallons of crude oil flowing into Gulf of Mexico waters.[1,2] Oil washed onto more than 1,100 miles of the Gulf coast despite intensive response efforts to stop the oil from reaching the shore.[3] More than half of the oiled shoreline was sandy beaches.[3] The amount of oil reaching the shore ranged from very light to heavy oiling. The U.S. Coast Guard ended all official cleanup

Science Seminars

- Where did the oil go?
- Impacts in the Deep Gulf of Mexico
- Impacts to Gulf Wetlands
- Oil on our beaches
- Impacts of Oil on Coastal Habitats

Outreach Publications

- Oil on our beaches
- Impact to wetlands (in draft)

Impacts to water quality

Polycyclic aromatic hydrocarbon levels, post-spill

- Significant increases (summer 2010);
  Return to pre-oiling levels (Mar 2011);
  Elevated post-storms/nearshore (summer 2011)

Corexit levels are also monitored

- Around wellhead, sampled sites for the presence of dioctyl sodium sulfosuccinate, or DOSS (May 2010); highest level was 1 ppm (100x lower than the lowest level known to harm the human liver)

- In Orange Beach, AL, found chemicals, including DOSS, in water (Sept 2010–Jan 2011); likely due to non-point source pollution not dispersant spraying

Anderson et al. (2011), Hayworth & Clement (2012); Judson et al. (2014); Gray et al. (2014)

Learn more: Water Quality

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PERSISTENCE, FATE, AND EFFECTIVENESS OF DISPERSANTS USED DURING THE DEEPWATER HORIZON OIL SPILL

Monica Wilson, Larissa Graham, Chris Hale, Emily Maung-Douglass, Stephen Sempier, and LaDon Swann

The Deepwater Horizon (DWH) oil spill was the first spill that occurred in the deep ocean, nearly one mile below the ocean's surface. The large-scale applications of dispersants used at the surface and wellhead during the Deepwater Horizon oil spill raised many questions and highlighted the importance of understanding their effects on the marine environment.

Oiled waters in Orange Beach, Alabama. (NOAA photo)

Emergency responders used a large amount of dispersants during the 2010 DWH oil spill. They applied approximately 1.8 million gallons of chemical **dispersants** (Corexit 9527A and 9500A, referred to as Corexit in this document) to surface waters that were oiled from April 22 through July 19.[1] They also injected roughly 771,000 gallons of dispersants directly into the flow of oil and gas from the Macondo wellhead (Figure 1).[1,2] Before this event, scientists did not know how effective dispersants were when used in the deep ocean.[2,3] Most studies were based on sea surface spills and predicted where the oil would go and how long it would stay in the environment. Deep waters have higher pressures and lower temperatures that can cause dispersed oil to behave differently than it does on the surface.

Science Seminars

- A look at the science and policy behind dispersants
- Understanding the toxicity of oil and dispersant mixtures and alternatives

Outreach Publications

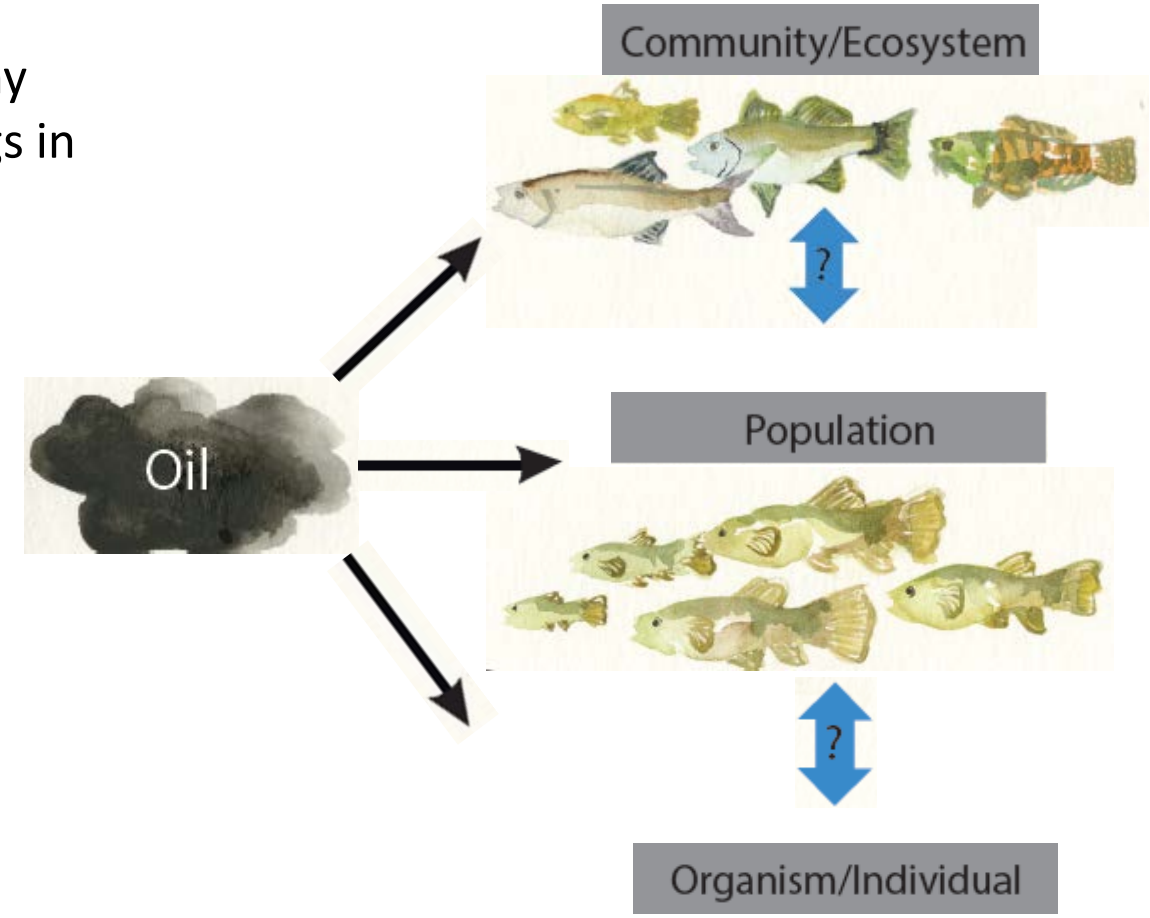
- Chemical Dispersants and Their Role in Oil Spill Response
- Fate, Transport and Effectiveness of Dispersants Used in the Deepwater Horizon Oil Spill
- Responses of Aquatic Life in the Gulf of Mexico to Oil and Dispersants

Impact on living marine resources

How do oil spills impact many different kinds of living things in an area or habitat?

How do oil spills impact a group of living things of the same species?

How do oil spills impact individual organisms?



Impacts to individuals

In the lab, oil can negatively effect animals.

CYP1A gene

Produces proteins to breakdown foreign chemicals and remove them from the body

Sub-lethal impacts of polycyclic aromatic hydrocarbons (PAHs)

- Reduced
  - Hatching success
  - Swimming ability
  - Body size
- Heart complications
- Larval development

F. Galvez

C. Green

Dubansky et al. (2013); Brweton et al. (2013); Mager et al. (2014); Crowe et al. (2014); Stieglitz et al. (2016); Esbaugh et al. (2016)

Individuals vs. populations

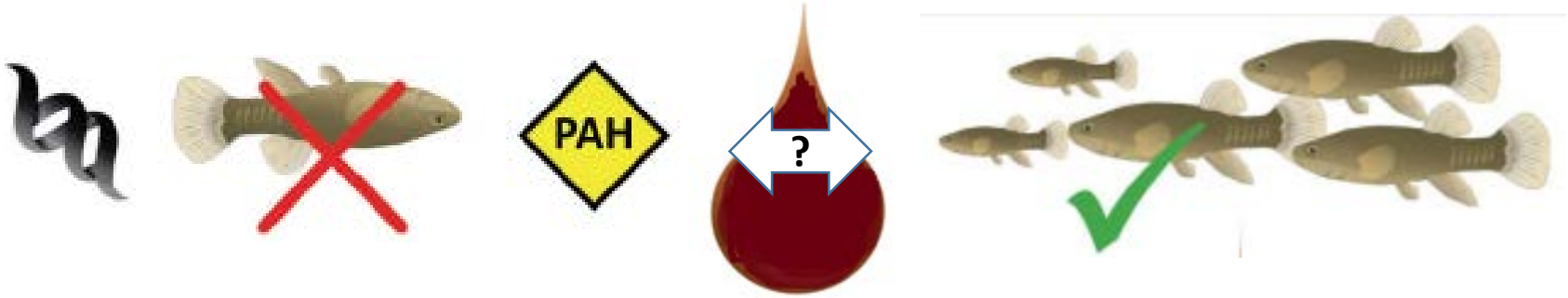
✗ ORGANISMS: 14 published studies (mostly lab); 9 species; genomic, physiological, developmental, reproductive, or survival costs in **95%** of cases

✓ POPULATIONS: 1 published study; >50 species; stable (or increasing) populations ("**100%**" of cases)

Fodrie et al. 2014

Individuals vs. populations

Long-term studies are needed.



Why?

- Concentration of oil was too low for detection in nature in the lab
- Impacts may be lagged or sublethal
- Behavioral avoidance (spatial/dietary)
- High spatial & temporal variation in populations

Challenges

- Emigration & immigration after oiling
- Fishery closures obscure population declines
- Offsetting effects cascade through food webs
- Lagged/sublethal effects
- Other environmental factors

Fodrie et al. 2014

Learn more: Living marine resources

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IMPACTS FROM THE DEEPWATER HORIZON OIL SPILL ON GULF OF MEXICO FISHERIES

Christine Hale, Larissa Graham, Emily Maung-Douglass, Stephen Sempier, LaDon Swann and Monica Wilson

Scientists are studying aquatic ecosystems in order to fully understand the 2010 Deepwater Horizon oil spill's impact. Knowing how oil and dispersants might affect fisheries can help natural resource managers maintain healthy Gulf of Mexico ecosystems and protect the livelihoods of the people who depend on them. The following publication highlights some examples of the way species were affected by the spill.

POTENTIAL OIL IMPACT

Wetlands
Nearshore Benthos
Photic Zone
Deep Benthos
Top Predators

A visualization of potential oil spill impacts to the Gulf of Mexico ecosystem, which is home to a variety of habitats and species. Adapted by Florida Sea Grant/Anna Hinkaldey.

INTRODUCTION

Oil is a mixture of many compounds. Some are known as **hydrocarbons**. These form from decomposed organic matter and occur in crude oil and natural gas. There are different types of hydrocarbons in oil. One type of hydrocarbon is a **polycyclic aromatic hydrocarbon (PAH)**. Some PAHs can be harmful to living things.[1]

Emergency response teams sometimes use chemicals such as **dispersants** to reduce the effects of oil spills. Dispersants break up spilled oil into smaller droplets. These smaller dispersed oil droplets can become more available

Science Seminars

- How did the oil spill impact Gulf fisheries?
- Healthy Gulf Seafood
- Five years later, what have we learned?

Outreach Publications

- Impacts on Gulf of Mexico Fisheries
- Responses of Aquatic Life to Oil and Dispersants
- Fisheries Landings and Disasters
- Impact on Gulf Seafood
- Impacts to dolphins (technical review)
- Impacts to turtles (in draft)

Oil spill science outreach products

Visit us on the Web or sign up for our email updates.

Sea Grant in the Gulf of Mexico

We are a regional network of the National Sea Grant College Program. Welcome!

Home | Programs of the Gulf of Mexico | Collaborative Research | Oil Spill Science | Climate Outreach Community of P

- About the Partners
- Oil Spill Science Outreach Team
- Presentations
- Publications

Oil Spill Science

What's new

Visit the following pages to learn more about our oil spill science products:

- **Publications** – Download our outreach publications to learn about the latest science that answers questions about the oil spill. Click here to learn more.
- **Presentations** – Join us at one of our upcoming science seminars where experts present on various oil spill topics. Click here to learn more about upcoming and past seminars.

About the partners

Oil Spill Science Outreach Team

Presentations

Publications

Sea Grant

gulfseagrant.org/oilspilloutreach

GULF OF MEXICO RESEARCH INITIATIVE

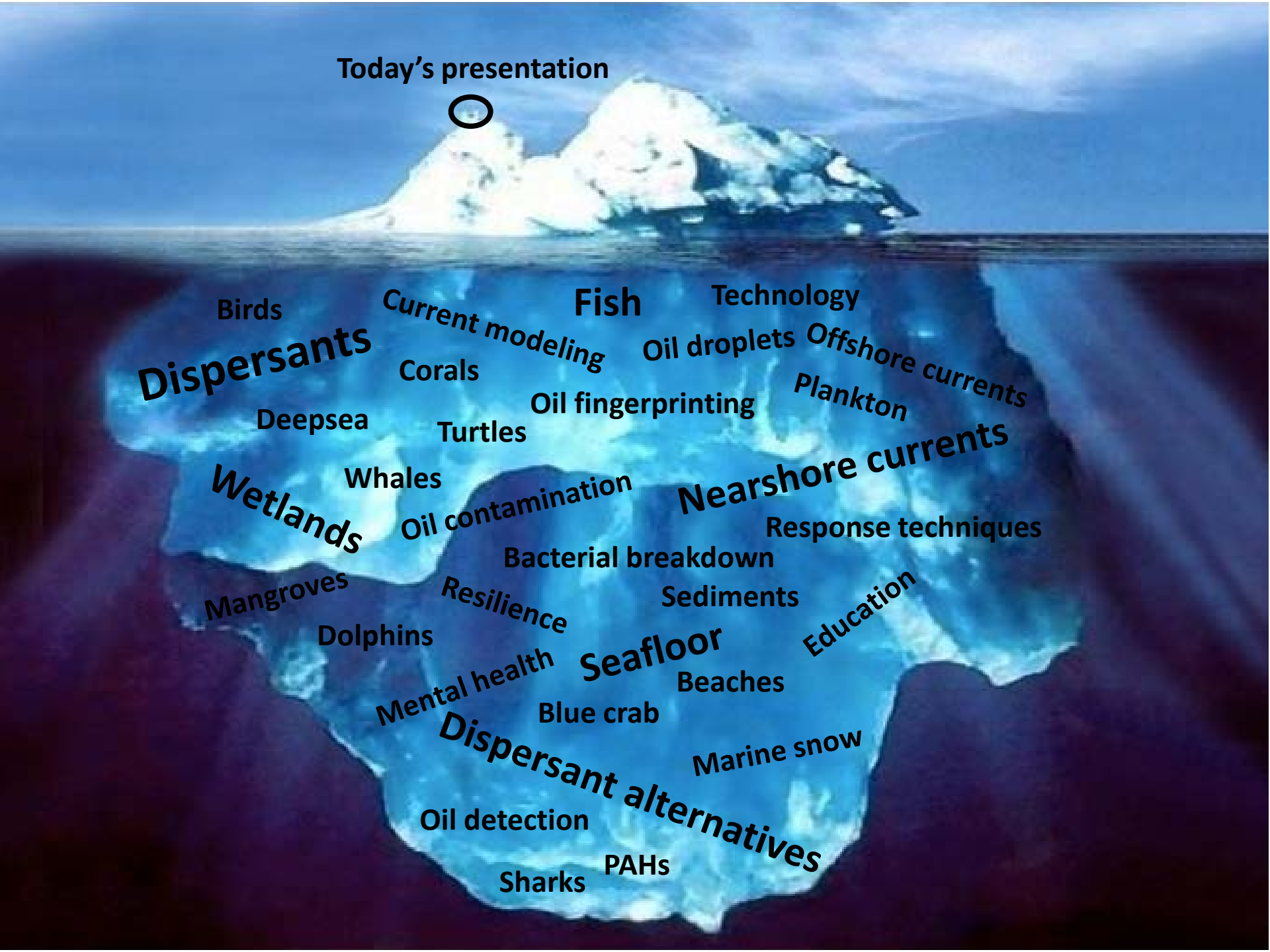
GoMRI publications

research.gulfresearchinitiative.org

GRIIDC data

Gulf Research Initiative Info & Data Cooperative

data.gulfresearchinitiative.org


Today's presentation
Birds
Current modeling
Fish
Technology
Dispersants
Oil droplets
Offshore currents
Corals
Plankton
Oil fingerprinting
Deepsea
Turtles
Nearshore currents
Whales
Wetlands
Oil contamination
Response techniques
Bacterial breakdown
Mangroves
Resilience
Sediments
Education
Dolphins
Seafloor
Mental health
Beaches
Blue crab
Dispersant alternatives
Marine snow
Oil detection
PAHs
Sharks

Thank you for listening!

Feel free to contact me at:

Larissa Graham

Larissa.Graham@auburn.edu

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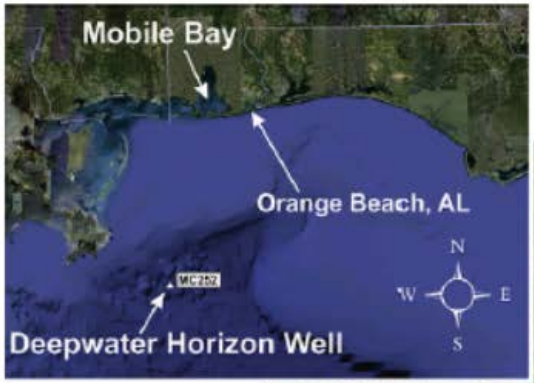
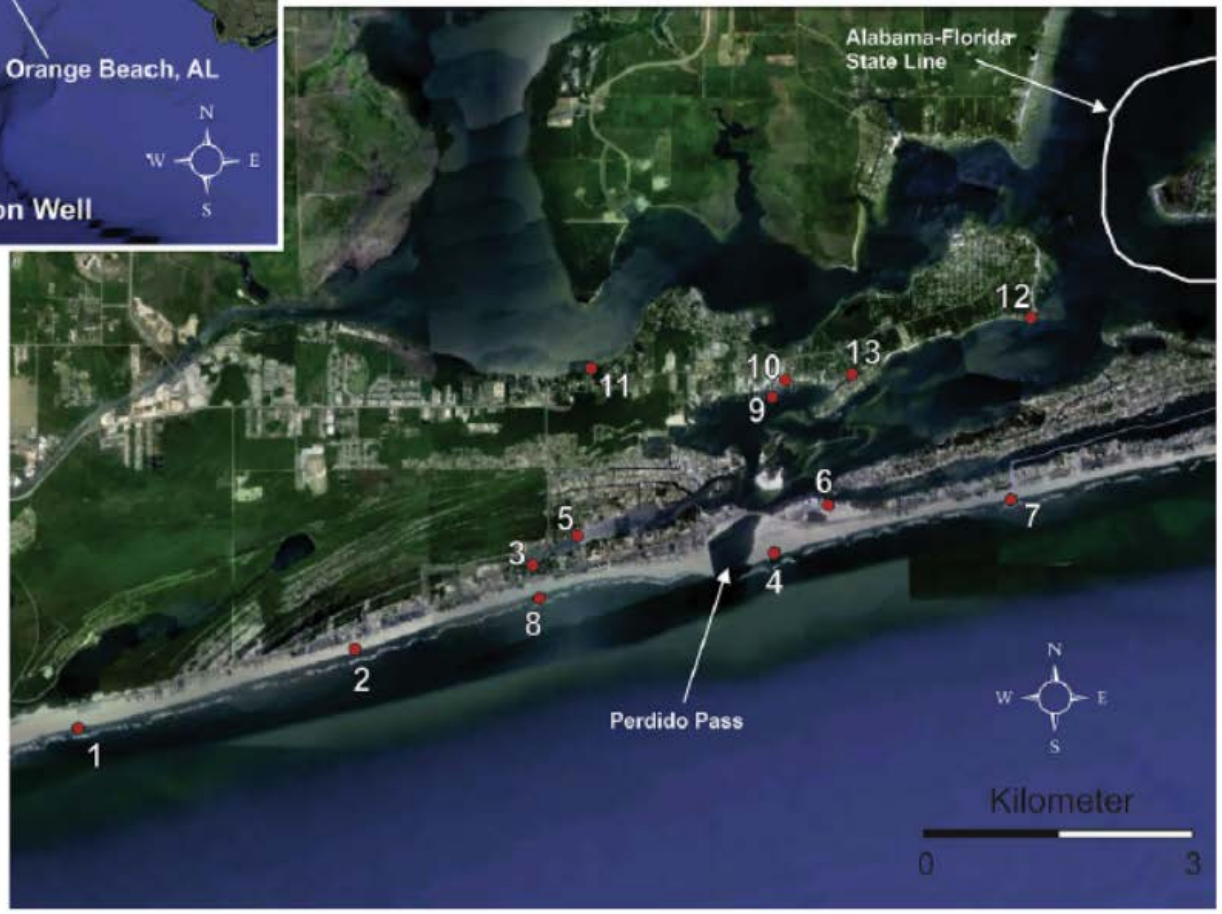
Extra slides

Dispersants



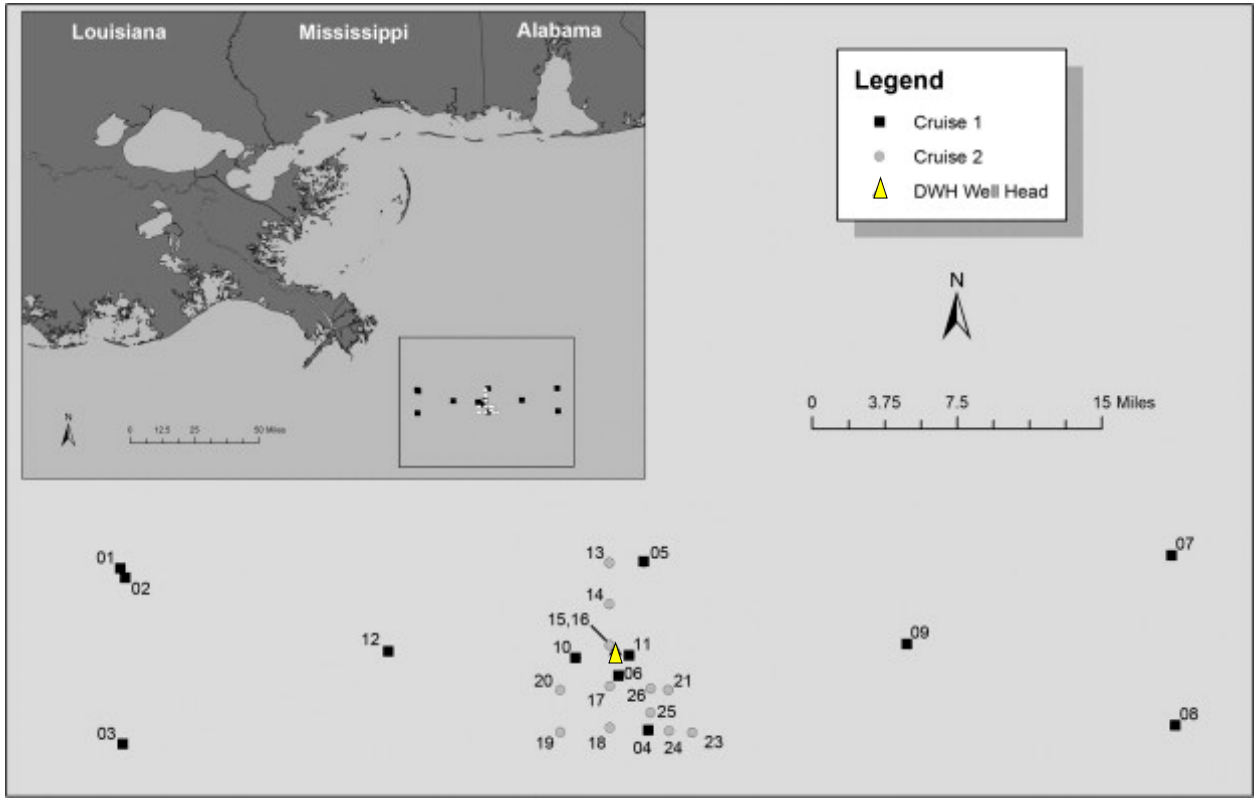
Hayworth et. al 2012



Orange Beach, AL
Sept 2010 – Jan 2011

- Found chemicals also in dispersant
  - Likely due to point and non-point sources, not Corexit.

DOSS and Human Health



DOSS

- Primary agent in Corexit
- Highest level outside of area immediately surrounding well-head (3 km): 1 ppm
- 100x lower than lowest level known to harm to human liver

Human liver: Judson et al. (2014) *Environ Sci Technol* 44: 5979-5985.
DOSS data: Gray et al. (2014) *Chemosphere* 95: 124–130.

Impacts to populations

Population numbers of some fish and shrimp increased after the spill.

Brown shrimp

Sheepshead

Spotted sea trout

White shrimp

Mangrove snapper

Pigfish

Fodrie & Heck 2011;
van Der Hamm & de Mutsert 2014