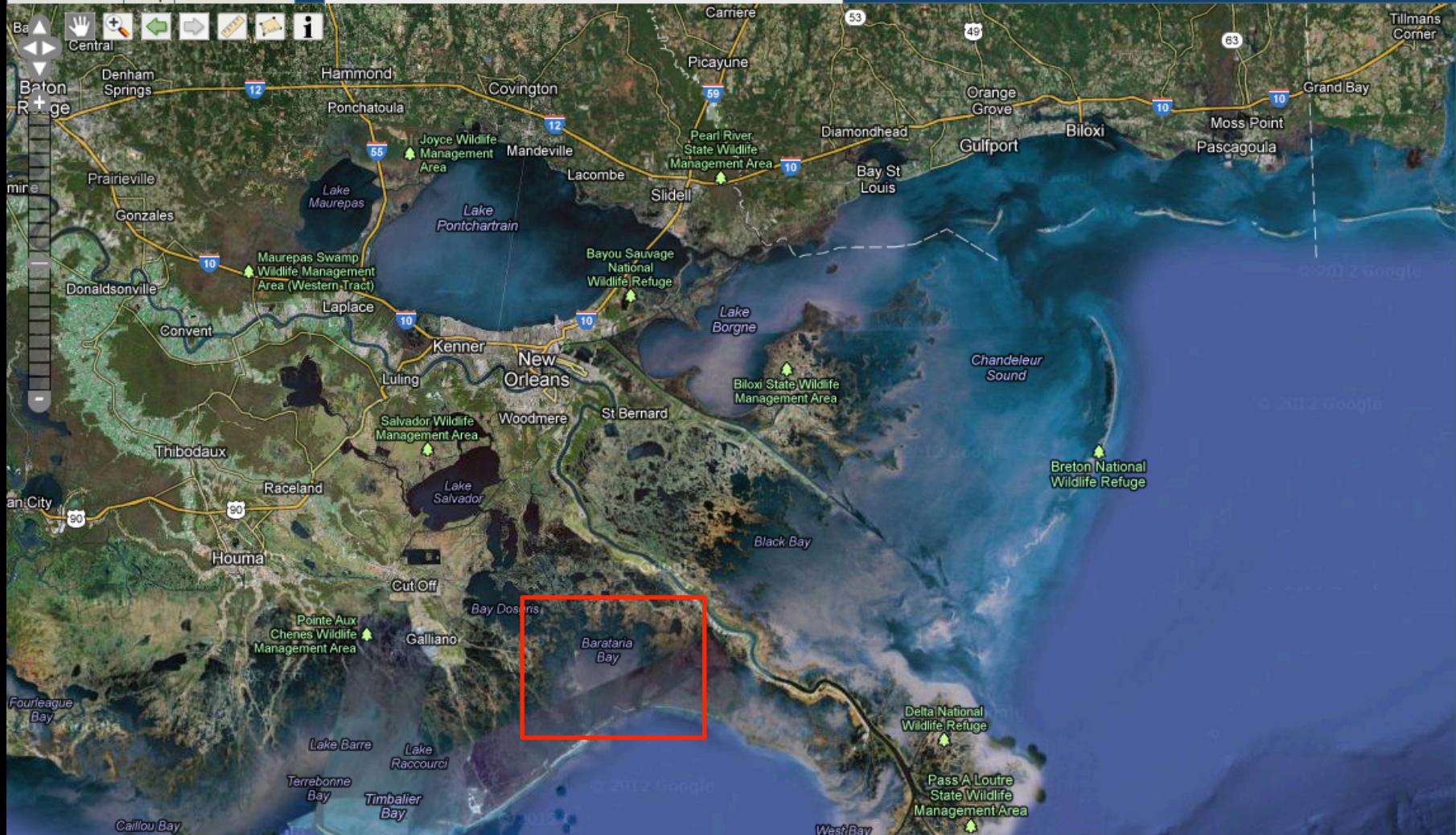


# ERMA GULF RESPONSE

Information Help Recent Data

Find



20 km

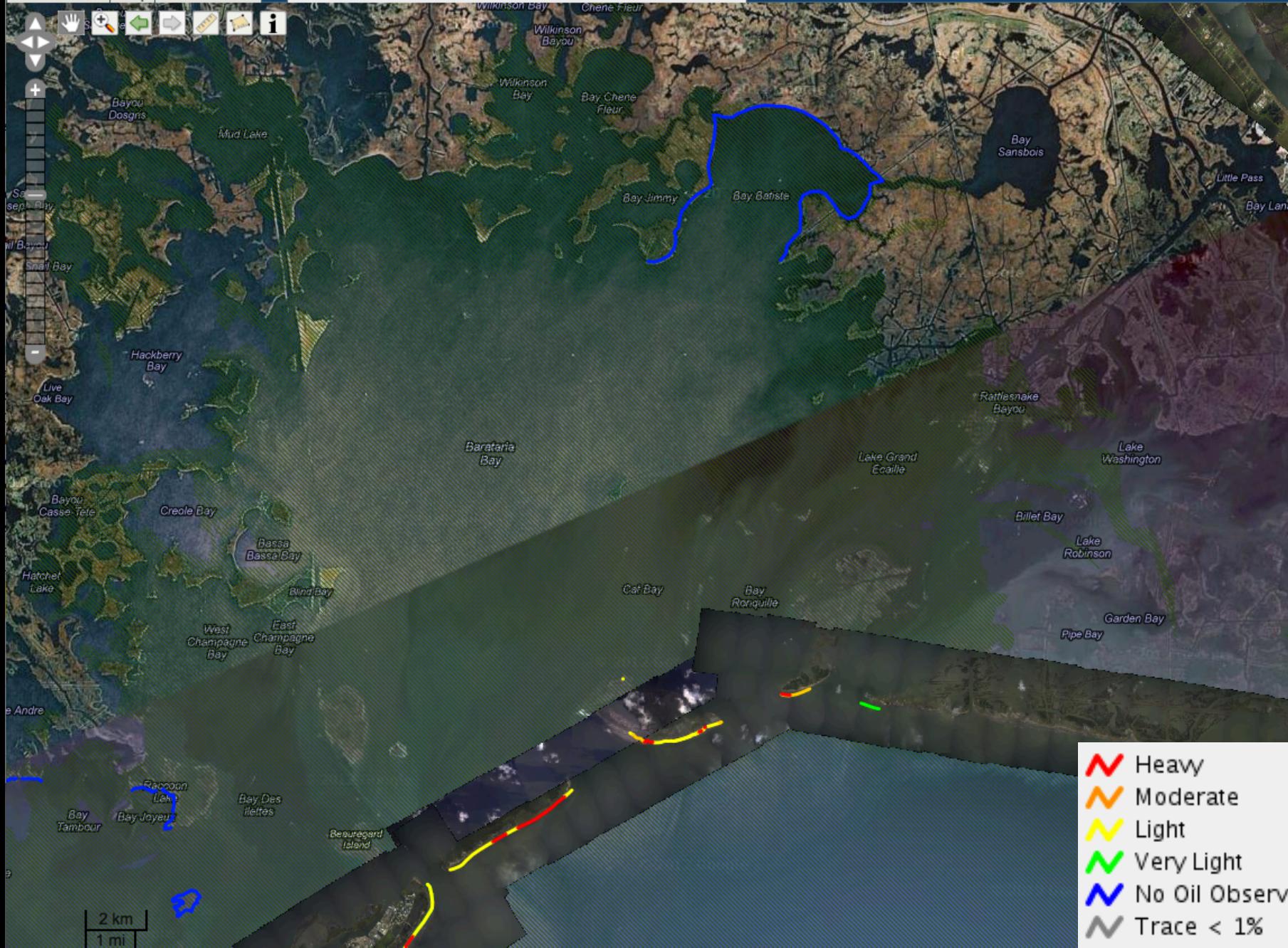
10 mi



# ERMA GULF RESPONSE

May 29, 2010

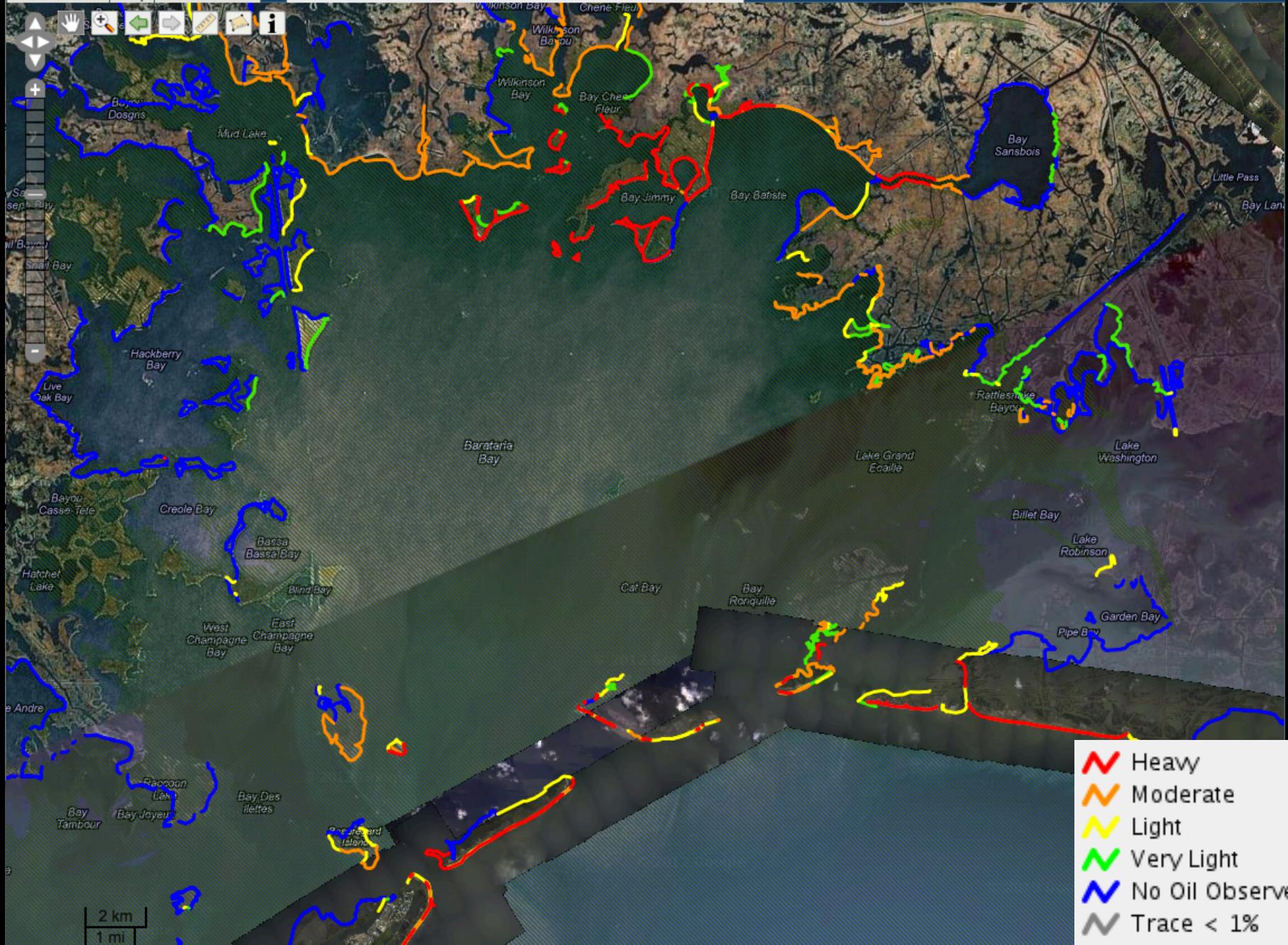
Information Help Recent Data Find



# ERMA GULF RESPONSE

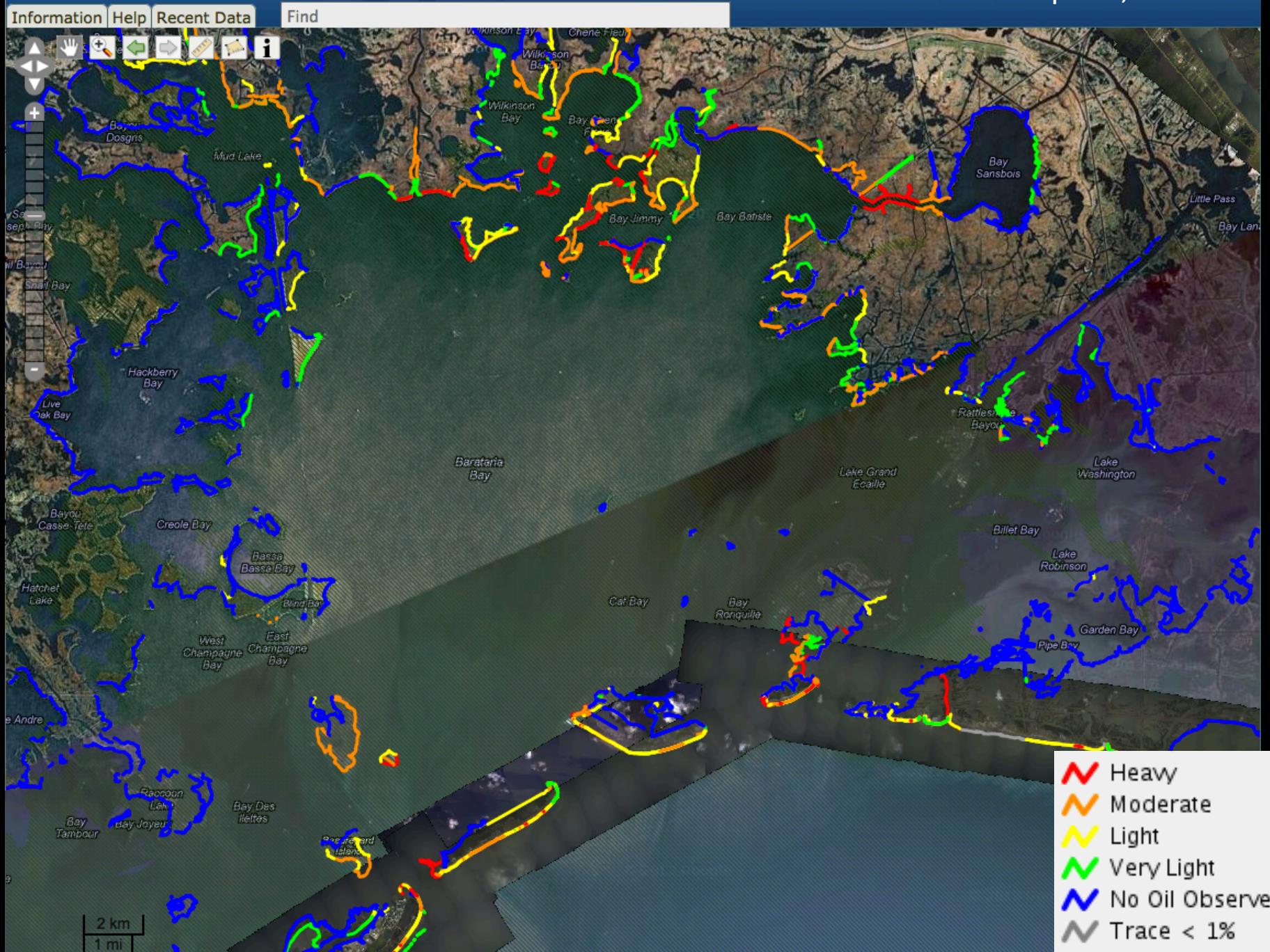
June 25, 2010

Information Help Recent Data Find



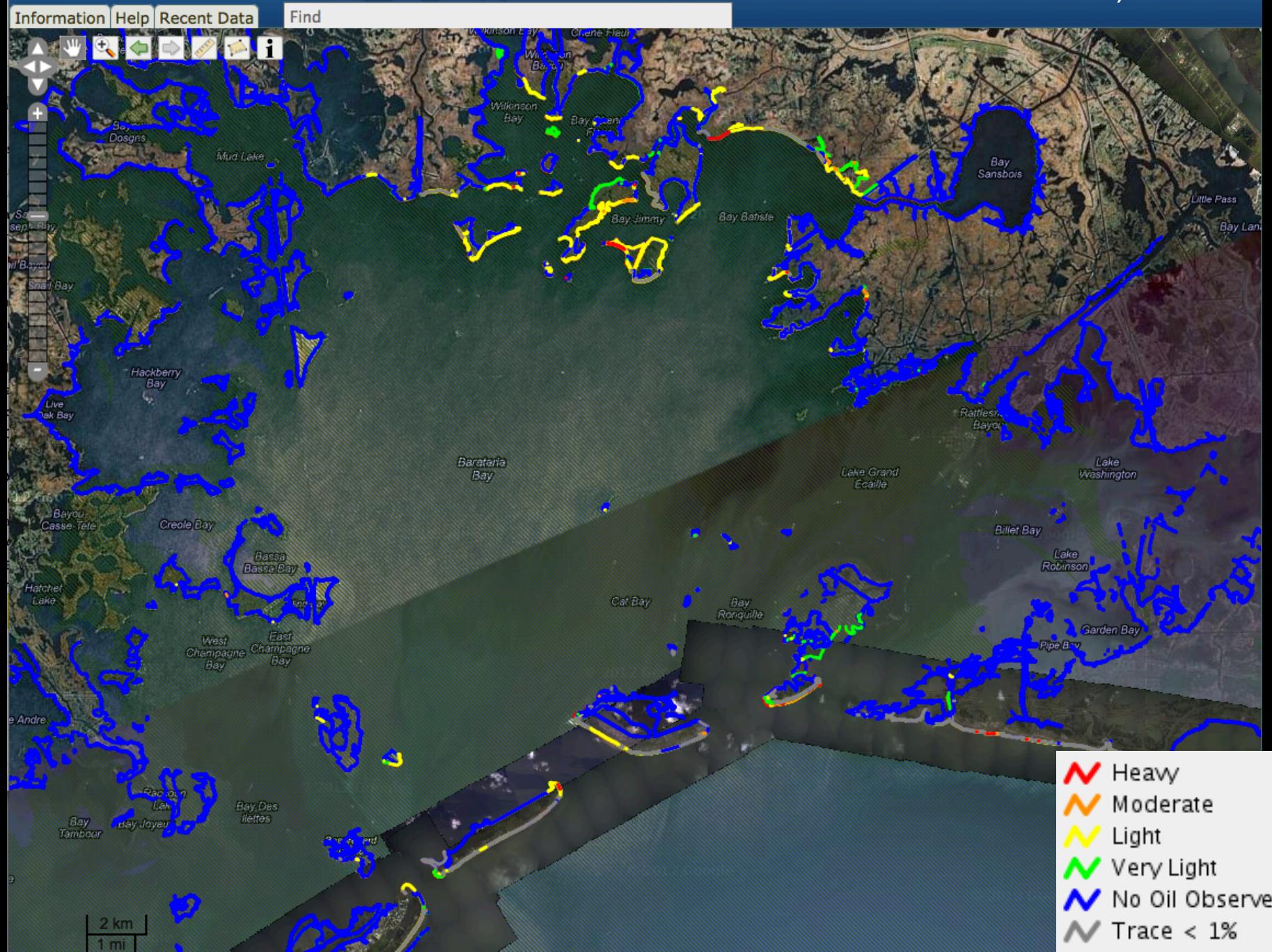
# ERMA GULF RESPONSE

Sept 17, 2010



# ERMA GULF RESPONSE

Nov 28, 2012



# PUBLIC HEALTH PRECAUTIONS

This beach has been impacted by the oil spill in the Gulf of Mexico.

Oil may come and go at any time and it may not be visible.

If you see oil in the water, you are cautioned not to enter.

- Do not handle tar balls.
- Avoid contact with the oil.
- If you get oil or tar balls on your skin, wash with soap and water.
- If you get oil on your clothing, launder as usual.
- Do not use harsh detergents, solvents or other chemicals to wash oil from skin or clothing; they may promote absorption of the oil through the skin.
- If the odor causes nausea, vomiting, headache or breathing problems, leave the affected area.

## FOR MORE INFORMATION CONTACT:

Alabama Department of Public Health	1.866.264.4073
Report oiled wildlife	1.866.557.1401
Report odor	1.800.424.8802

ADVISORIES WILL BE POSTED AS NECESSARY.

ADPH.ORG

Complaints of respiratory problems and headaches, and depressive illness, has skyrocketed.

**Figure 6.3: Recent Changes in Emotional Well Being Along the Gulf Coast**

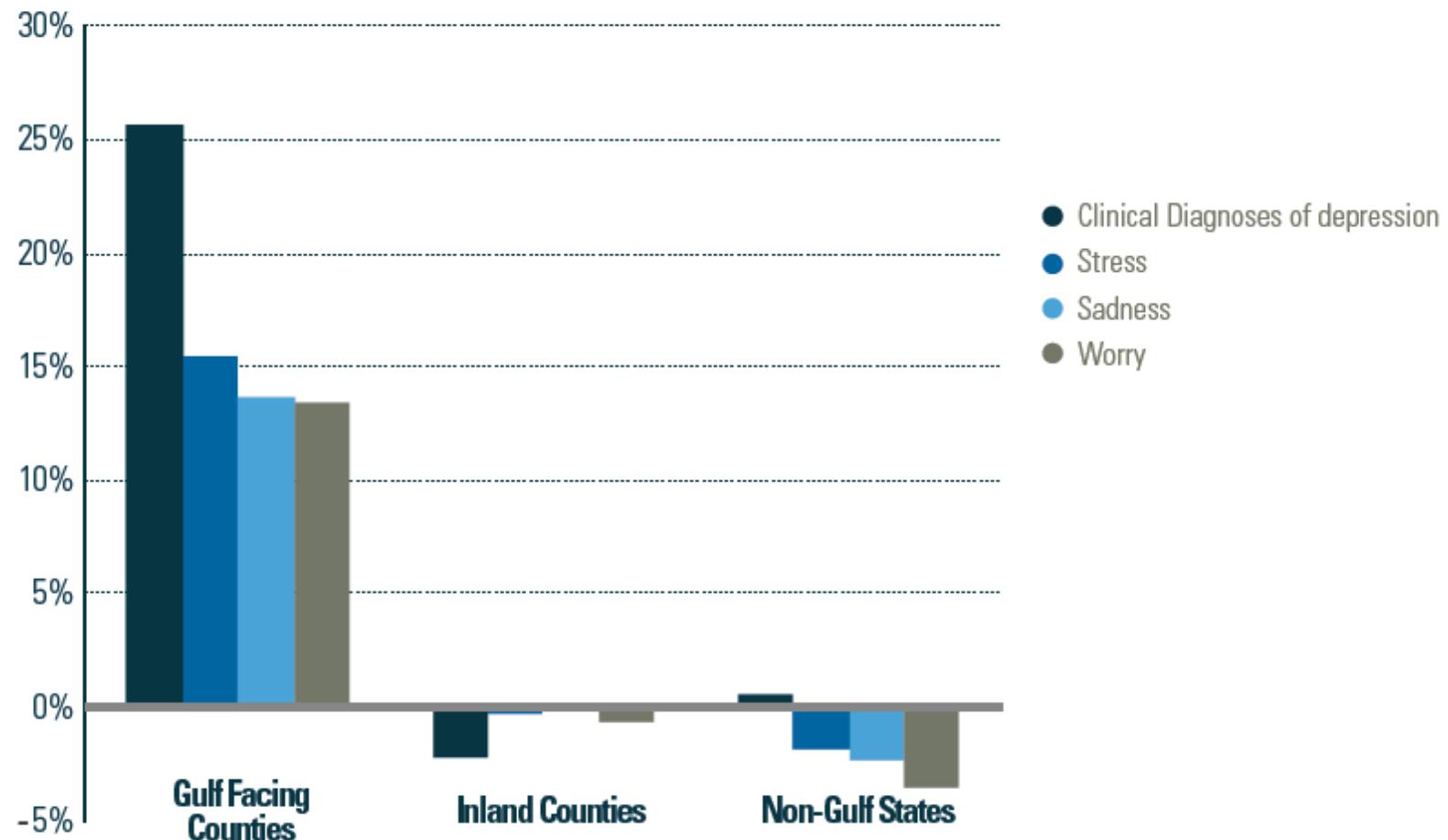
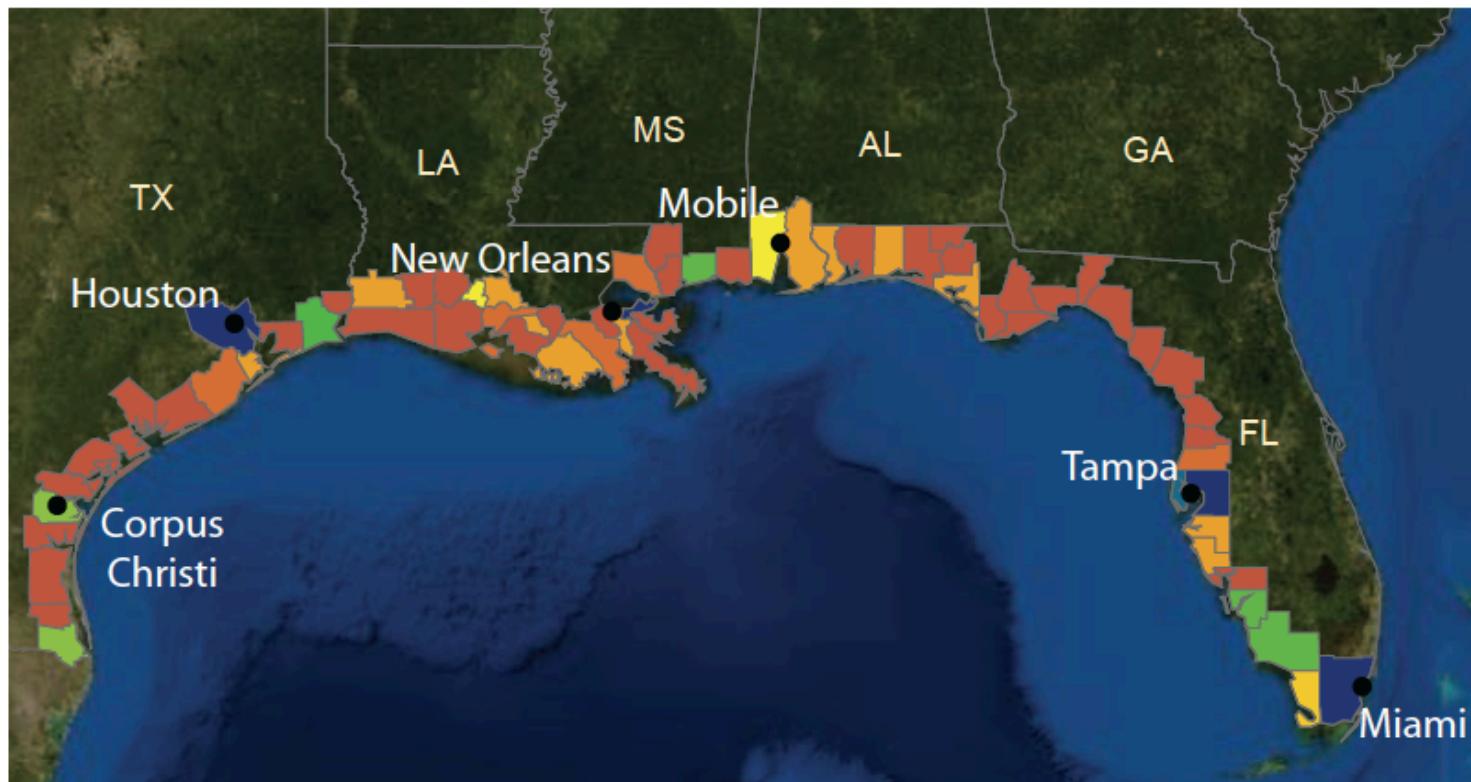


Figure 6.2: Annual Tourism & Fishing Revenue: Economic Activity by County



- \$0-\$200,000
- \$200,000-\$400,000
- \$400,000-\$600,000
- \$600,000-\$800,000
- \$800,000-\$1,000,000
- \$1,000,000-\$1,200,000
- \$1,200,000-\$1,400,000
- \$1,400,000-\$1,600,000
- \$1,600,000-\$1,800,000
- \$1,800,000-\$2,000,000
- \$2,000,000+

Source: 2007 U.S. Economic Census

Note: Tourism includes: sporting goods stores, scenic/sightseeing transport (water), fishing clubs/guides, hunting/fishing reserves, camps, boat rentals, hotels, casinos, and nature parks. Fishing includes: finfish, shellfish, other seafood, canning, frozen seafood, seafood markets and wholesalers.

# Public Perception

Vendor sign at taste of Chicago

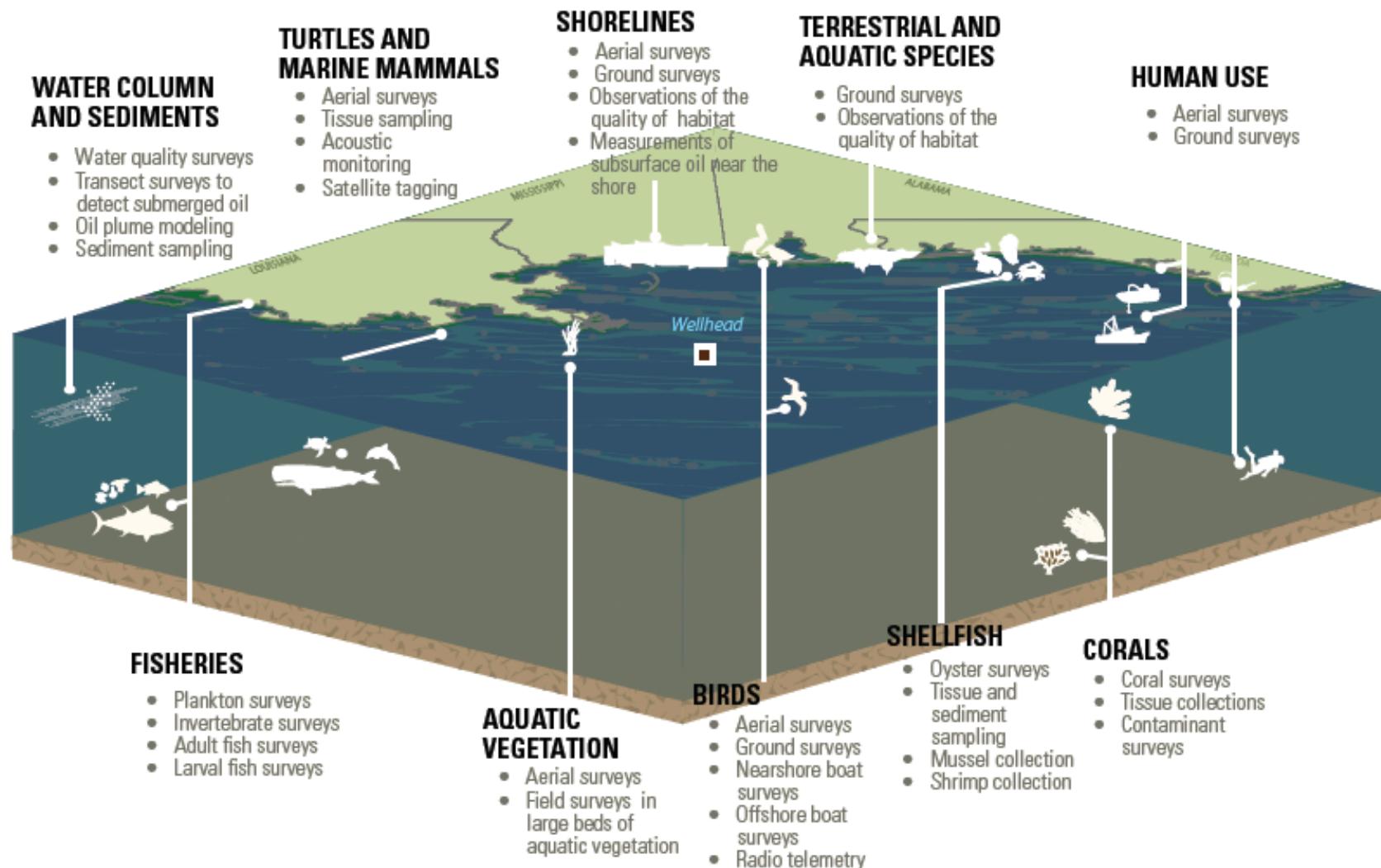


Perception is reality for the Gulf seafood industry. The economic calamity that descended when commercial fisheries were closed as a health-safety precaution should have been alleviated when they reopened, but the public still wasn't buying. Fact: After a rigorous testing campaign, most commercial species appear untainted.

*Albert Ettinger*

**“We were called liars when we said we didn’t have oil on the beaches”** - Patricia Denny (worked for a real estate company in Destin, FL, when real estate business came to an abrupt halt following the spill)

**Figure 6.1: Assessment Categories for Natural Resource Damage Assessment**



This figure represents the various natural resource categories being assessed as part of the Deepwater Horizon Natural Resource Damage Assessment. Such an assessment, which always follows an oil spill, is used to make the public whole for ecological damages caused by a spill. This graphic illustrates the three-dimensional challenges that an assessment of a deep sea blowout presents.

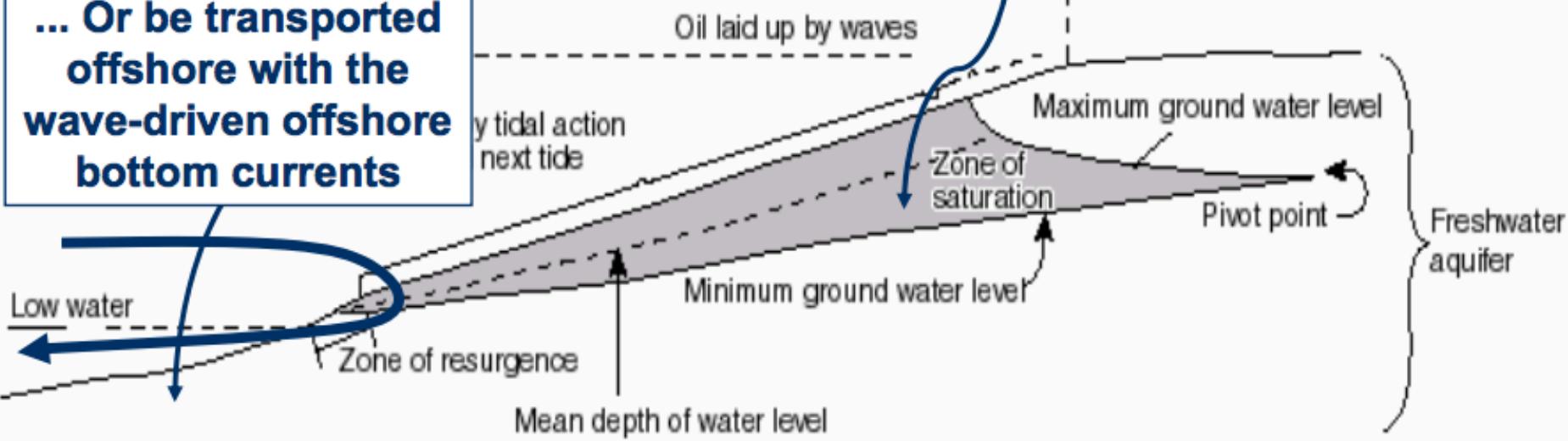
# Oil fate and transport

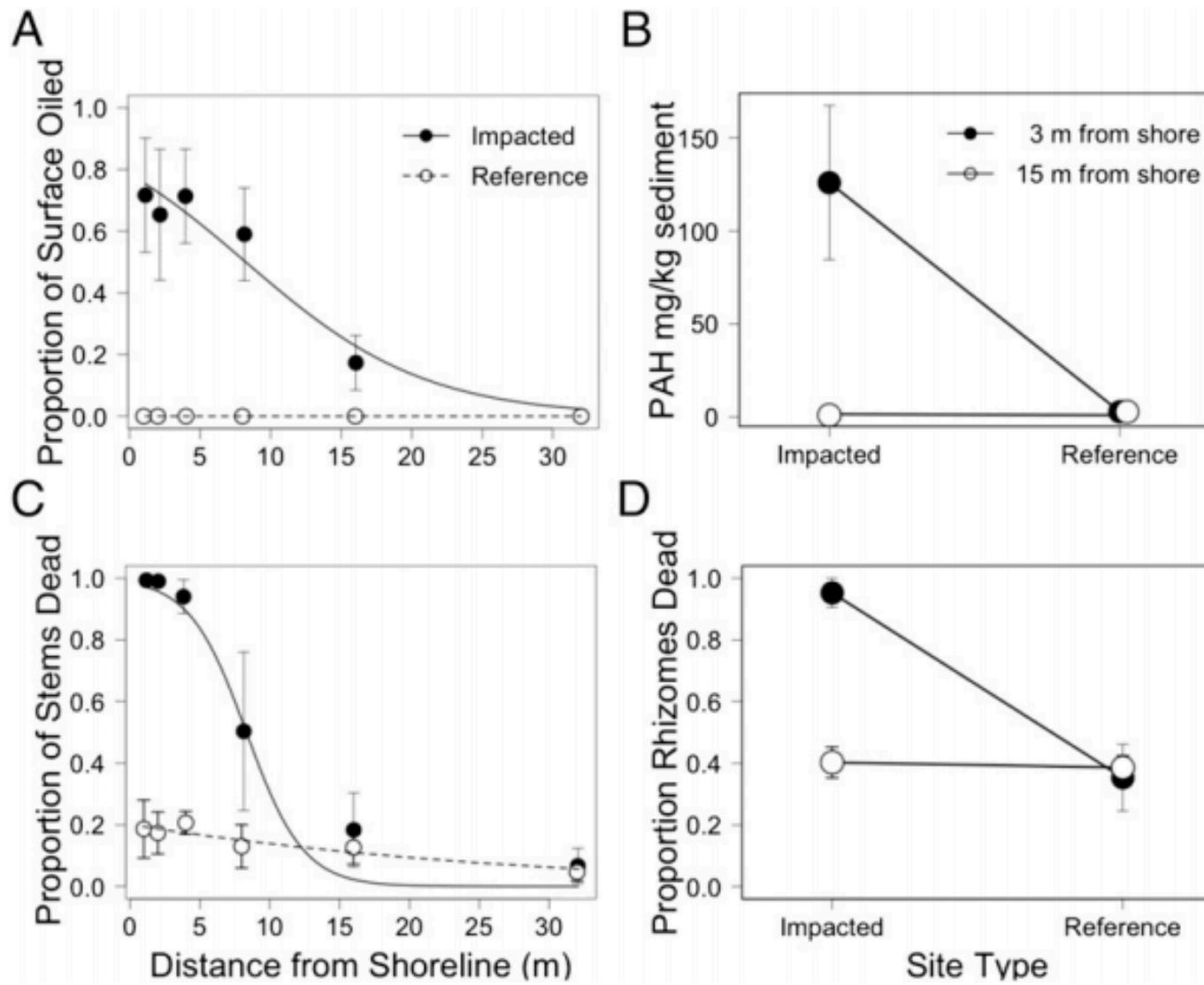
## Beaching...

**Oil on the foreshore can incorporate sediment and remain in the nearshore**

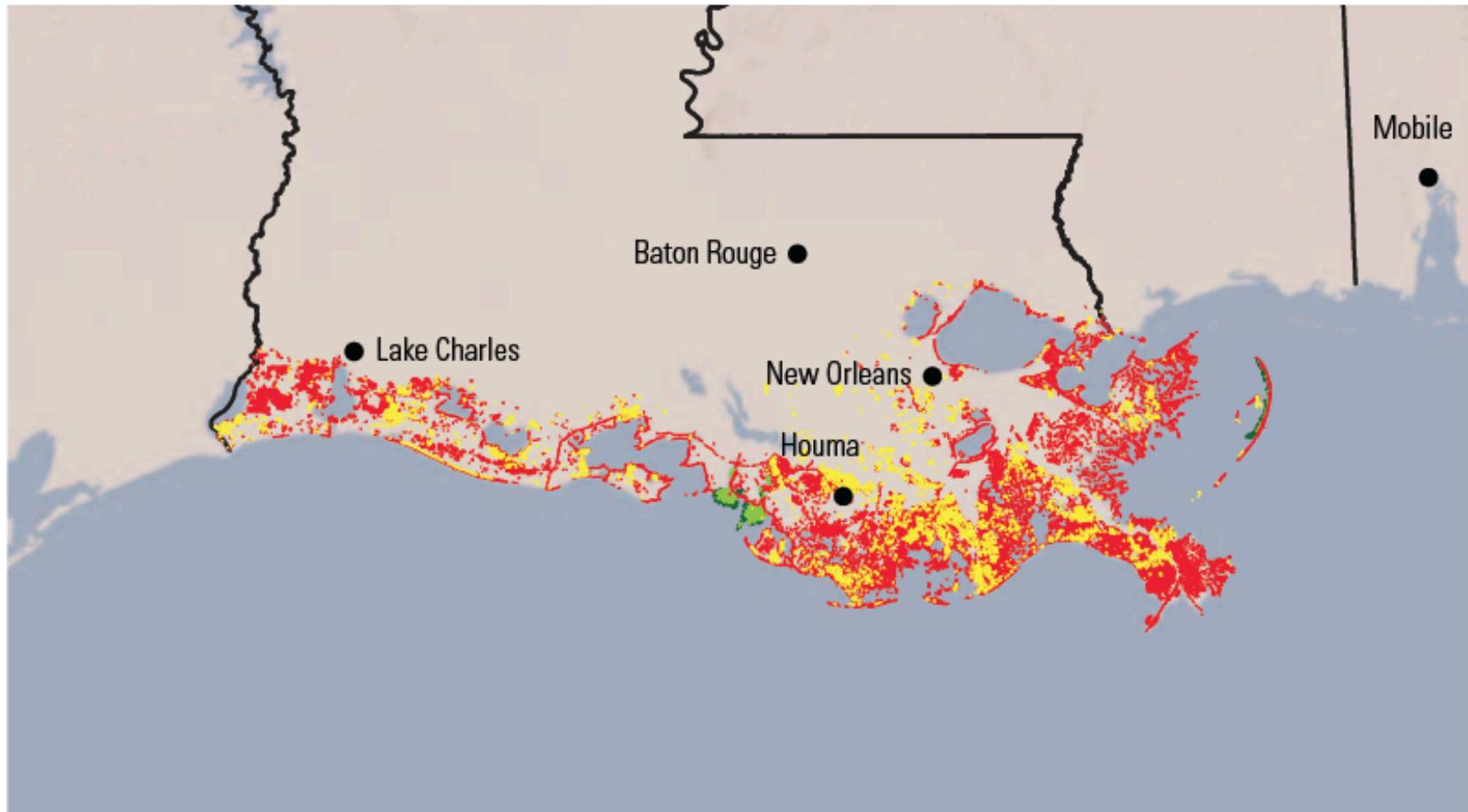
**... Or be transported offshore with the wave-driven offshore bottom currents**

**Oil on the foreshore or backshore can penetrate into sediments and form a reservoir that leaks out over time**





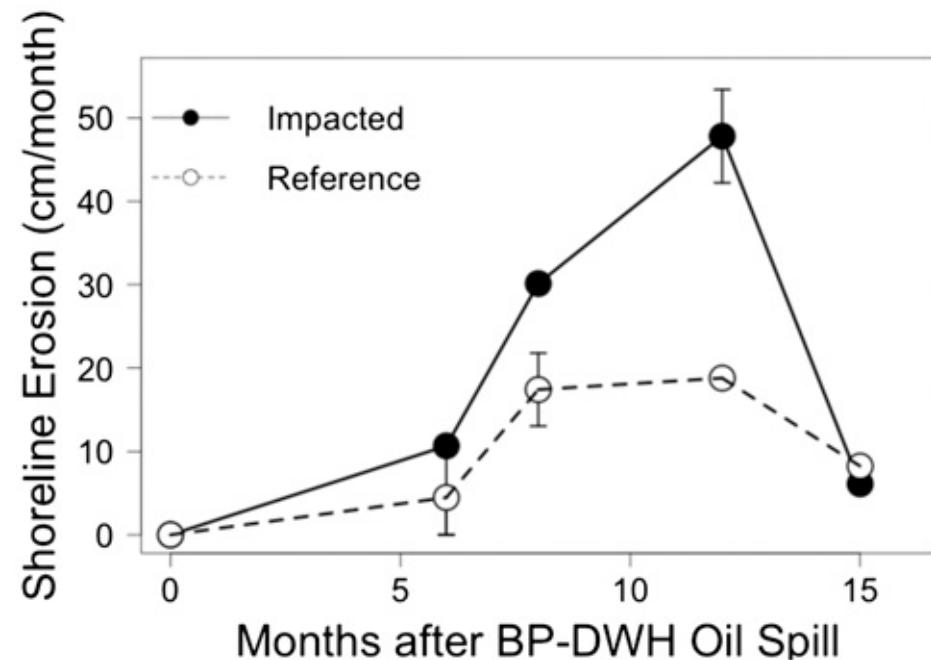
# Louisiana Coastal Erosion



- Land Loss 1932–2000
- Land Gain 1932–2000
- Projected Land Loss 2000–2050
- Projected Land Gain 2000–2050

“heavy oil coverage on the shorelines of Louisiana marshes, already experiencing elevated retreat because of intense human activities, induced a ... feedback that amplified this erosion and thereby set limits to the recovery of otherwise resilient vegetation”

- Silliman et al., 2012 *PNAS*



“a clear example of how multiple human-induced stressors can interact to hasten ecosystem decline”

# Given beaching: Some key questions...

- How long will a coastal area be impacted with no intervention?
- What will be the natural removal rate?
- What happens to oil washed off the beach?
- What happens if we disperse the oil just before it comes ashore?
- ... or apply other mechanical or chemical treatments on shore?
- Is this better or worse than dispersion offshore?

# Long-Term Ecosystem Response to the Exxon Valdez Oil Spill

Charles H. Peterson,<sup>1\*</sup> Stanley D. Rice,<sup>2</sup> Jeffrey W. Short,<sup>2</sup> Daniel Esler,<sup>3</sup>  
James L. Bodkin,<sup>4</sup> Brenda E. Ballachey,<sup>4</sup> David B. Irons<sup>5</sup>

19 DECEMBER 2003 VOL 302 SCIENCE

- Unexpected persistence of oil
- Long-term exposures to sub-lethal levels of oil-associated toxins
- Sub-lethal exposures can threaten long-term resilience of species
- Recovery can be delayed because of indirect cascading effects

# Persistence of oil

**Biological effects are a function of exposure.**

- duration of exposure
- concentration of exposure
- chemical nature of exposure

**Sediments provide refuge from degradation**

- sediment-associated organisms persistently exposed
- trapping under mussel beds = enduring route of entry into food chains in Alaska
- oiled sediments = persistent source of mortality for fish embryos in Alaska

# Long-term Population-level impacts

## Chronic exposures from sediments

- Low levels of contaminants can be toxic to sensitive life stages
  - elevated mortality in fish embryos in oiled sediments > 4 years after Valdez spill
- Marine mammals and birds may be continuously exposed through the food chain
  - many of the toxic chemicals in oil can be sequestered in tissues (e.g., exposures to animals that eat bivalves)
  - recovery of Alaskan sea otters and Harlequin ducks much slower than anticipated

# Long-term Population-level impacts

## **Sub-lethal exposures → indirect effects on survival**

- decline from compromised health, growth, reproduction
  - salmon exposed during development: as adults, *their* embryos showed reduced survival (controlled lab studies)
    - Endocrine disruption, developmental defects
  - shorebirds: reduced breeding, smaller eggs, enhanced chick mortality

# Long-term Population-level impacts

**Acute mortality is not necessarily predictive of long-term population-level effects**

→ But acute mortality is easier to associate with a cause



# Long-term Population-level impacts

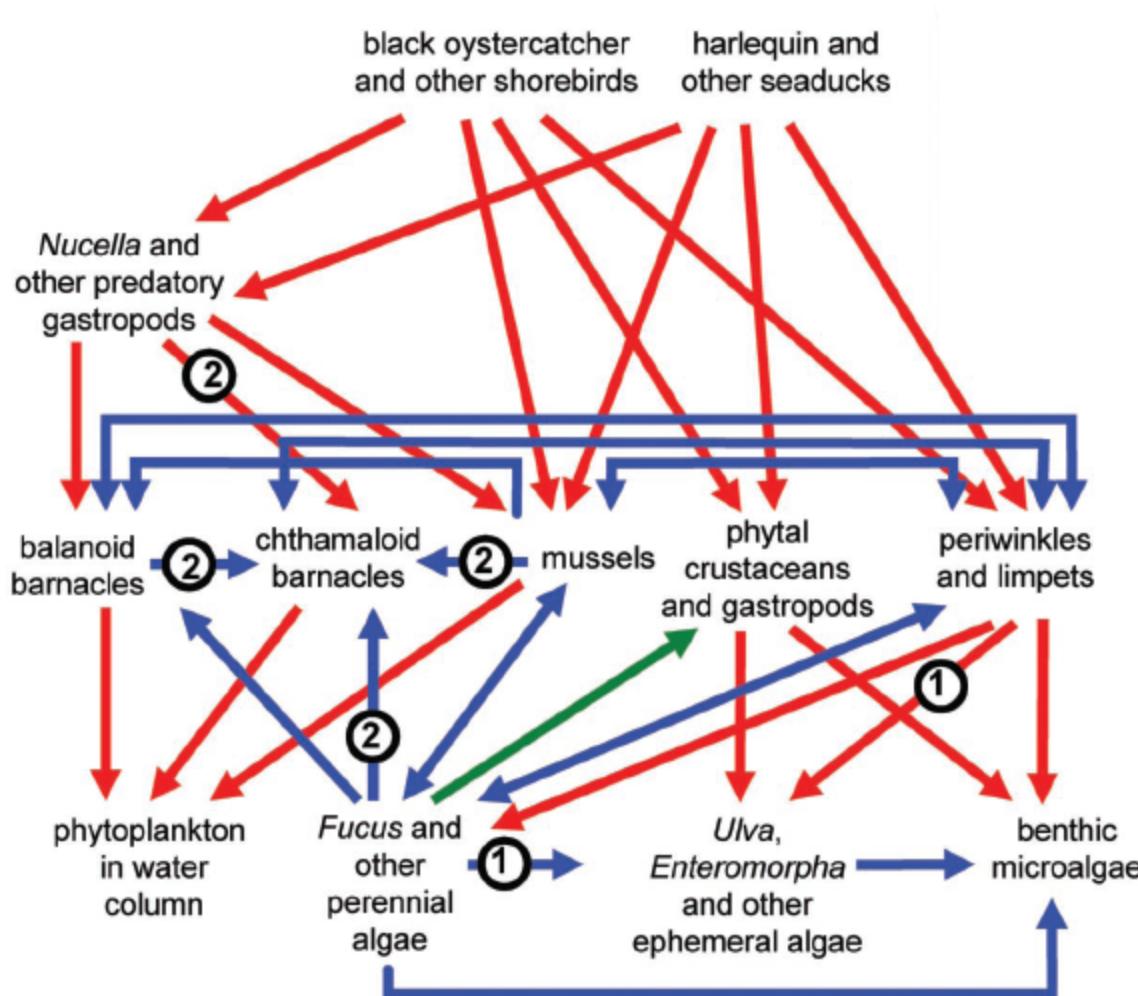
**Acute mortality is not necessarily predictive of long-term population-level effects**

→ But acute mortality is easier to associate with a cause

**Some important impacts, such as population-level impacts, take time to emerge**

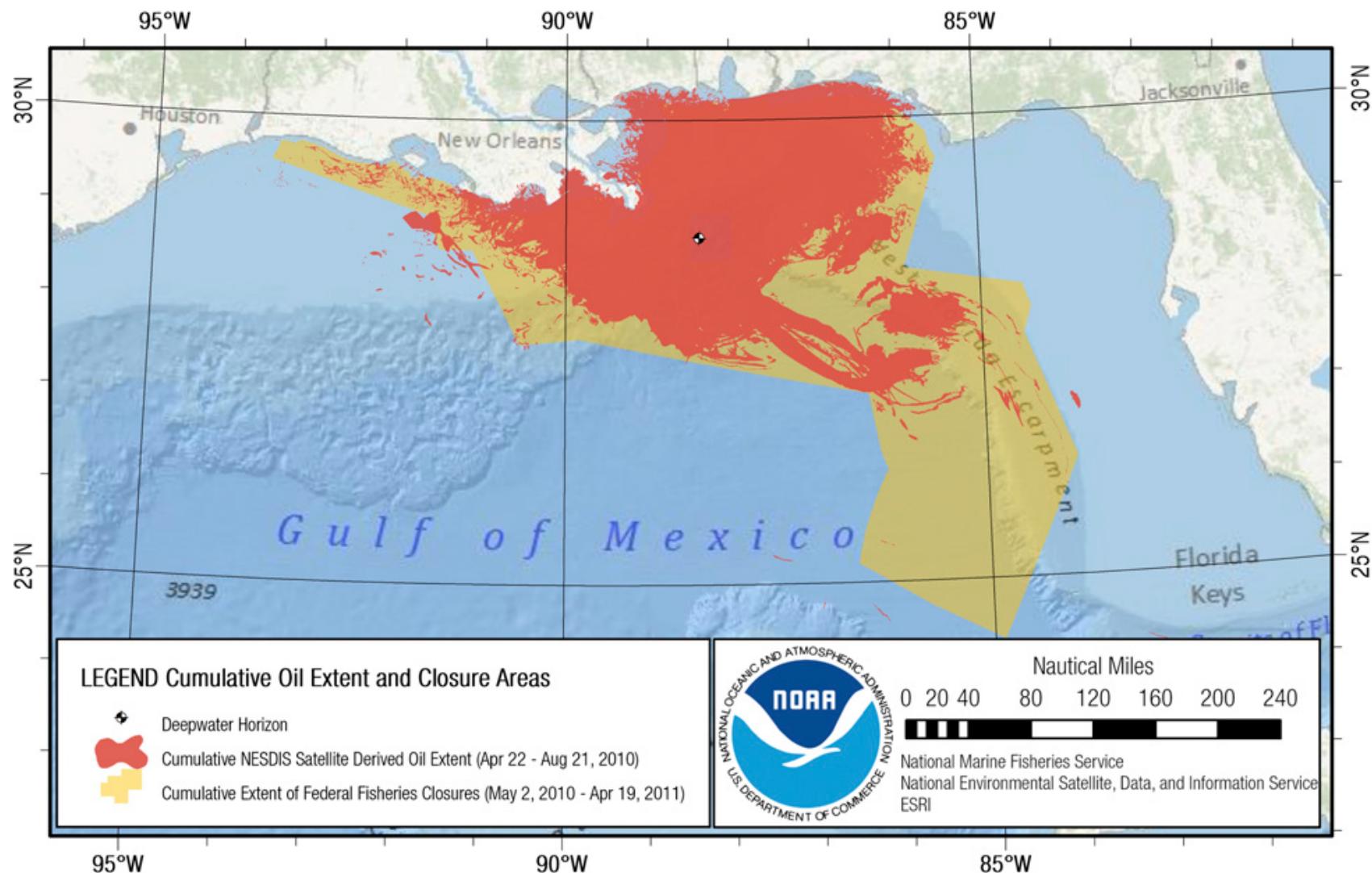
→ The more distant an effect from an initiating event, the more difficult to associate with a cause  
(e.g., smoking -----> cancer)

# Long-term Population-level impacts

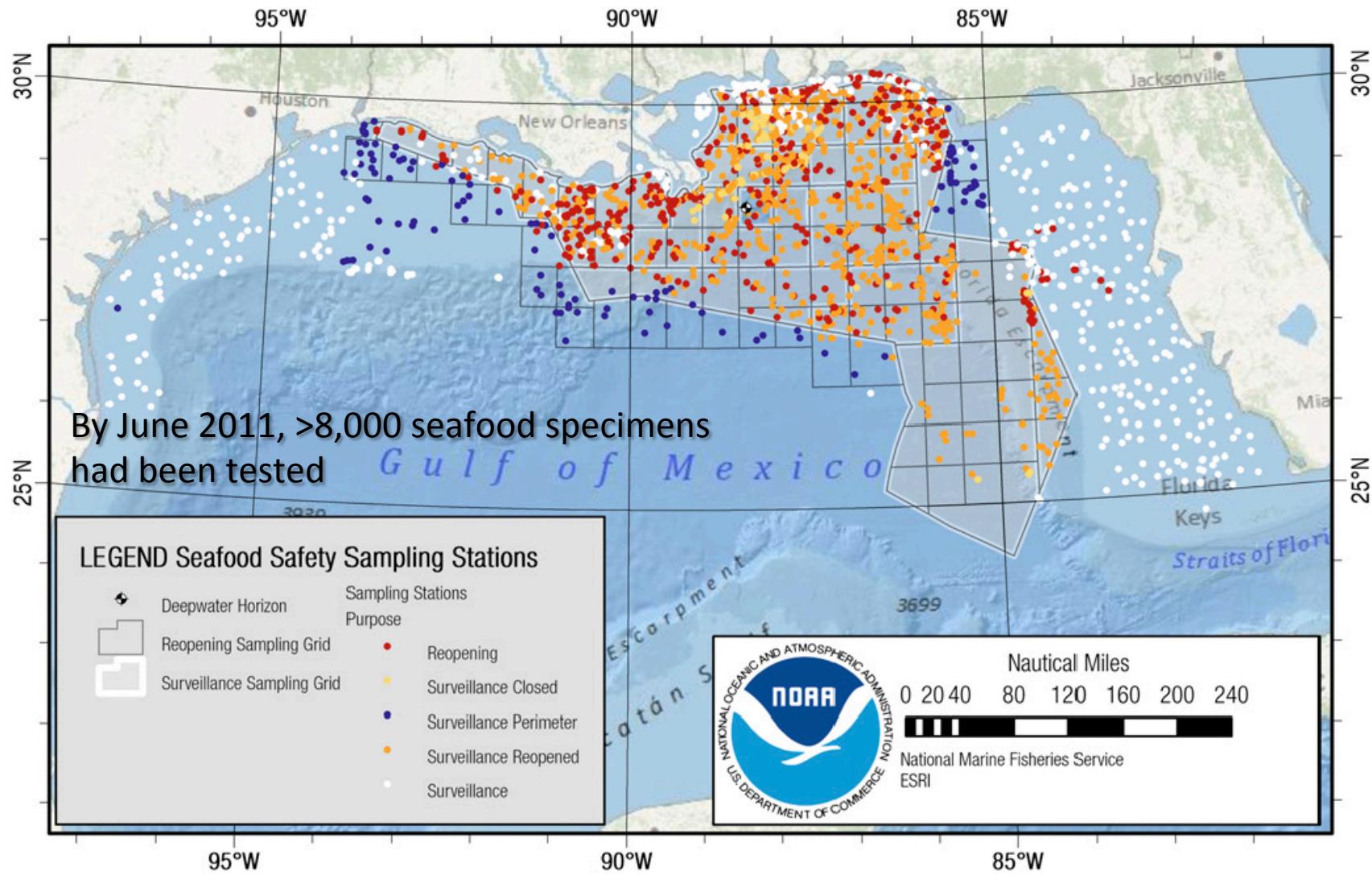


**Everything is connected**

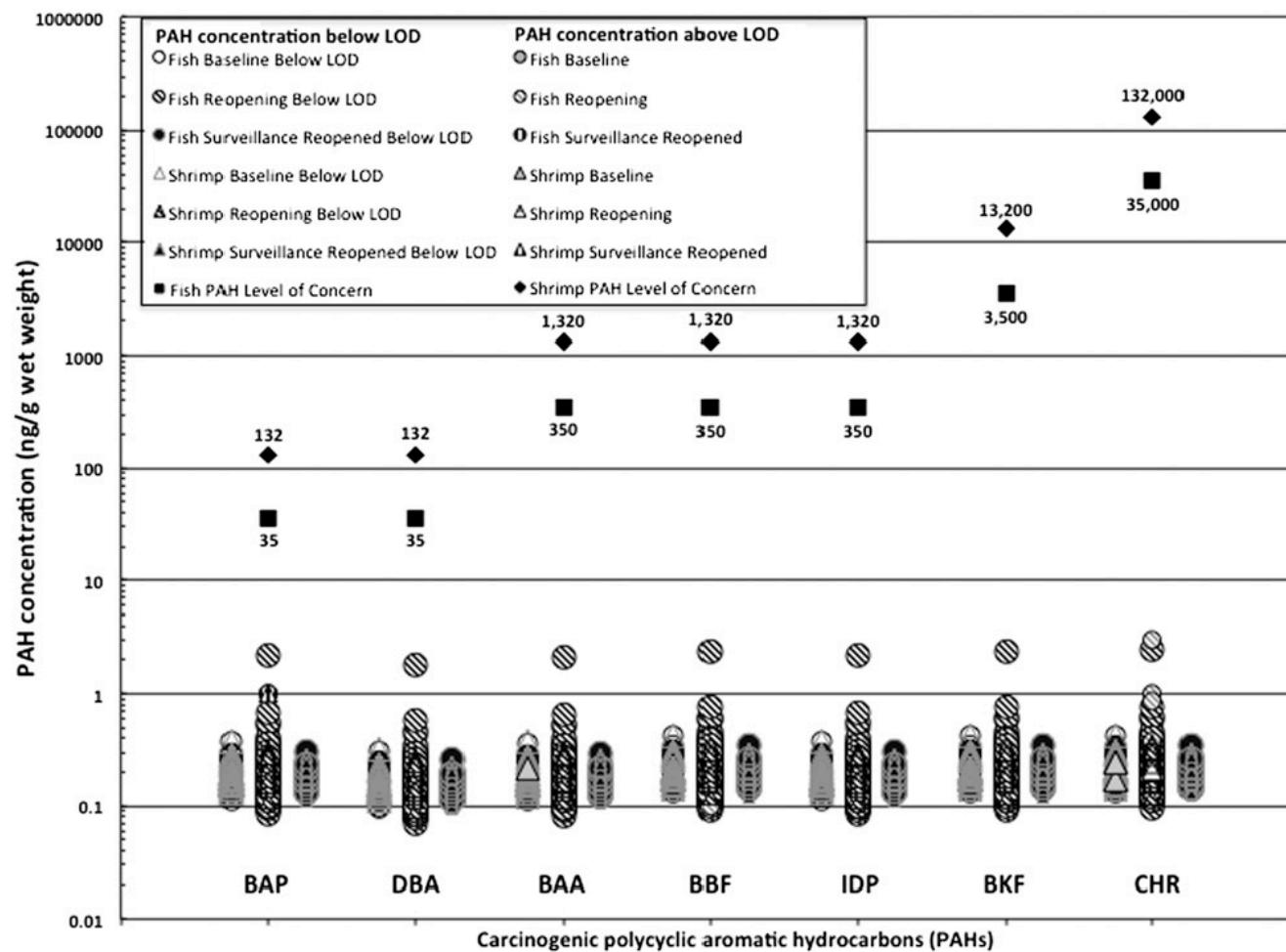
# Seafood safety...



# Seafood safety...

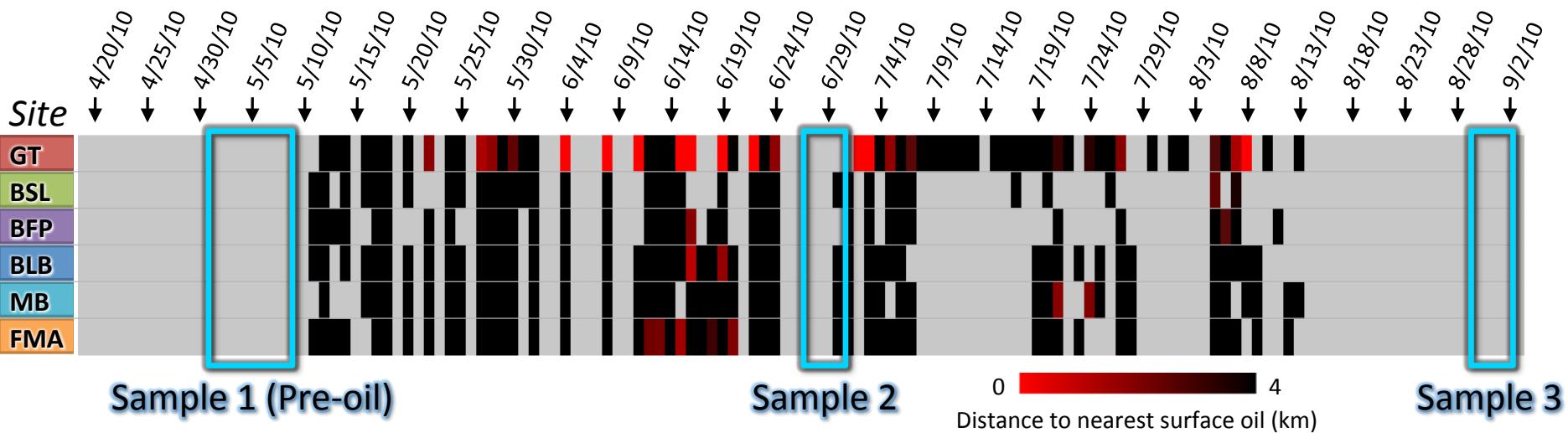
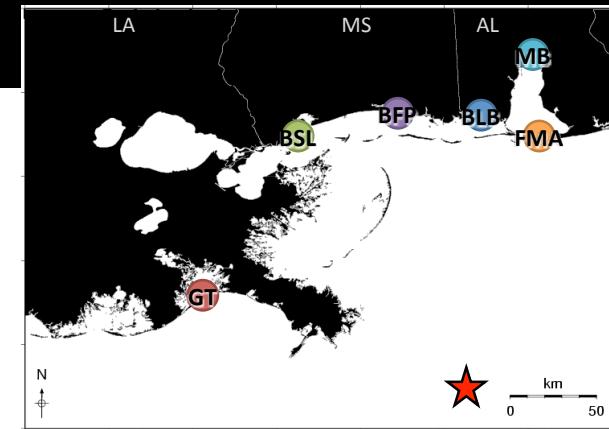
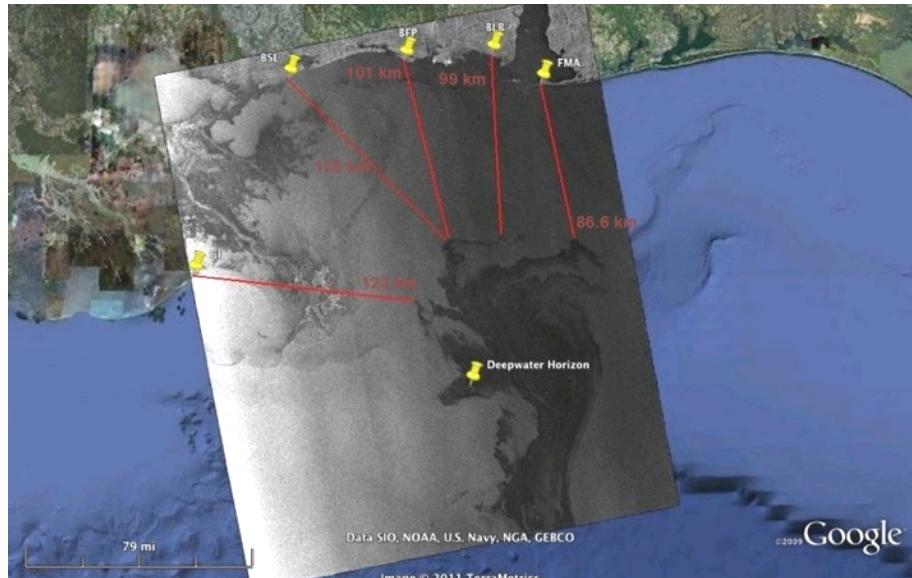


# Seafood safety...



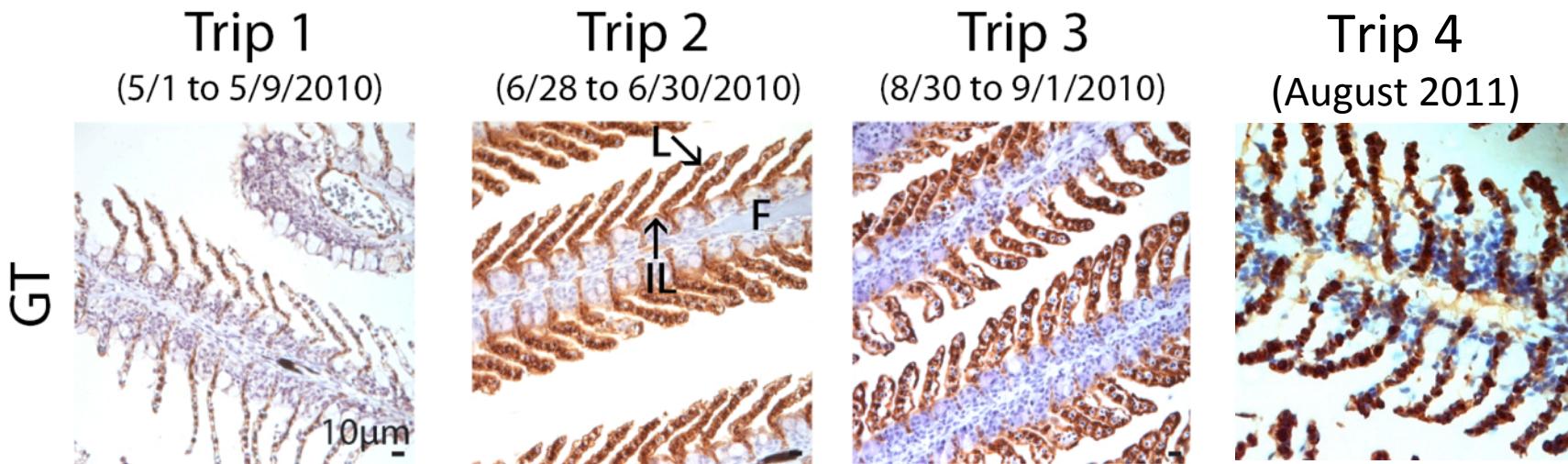
**BUT...** is a fish that is officially safe for human consumption necessarily a healthy fish?

# DHW contamination effects on Gulf of Mexico species



# DHW contamination effects on Gulf of Mexico species

## Gulf Killifish - Gill structure



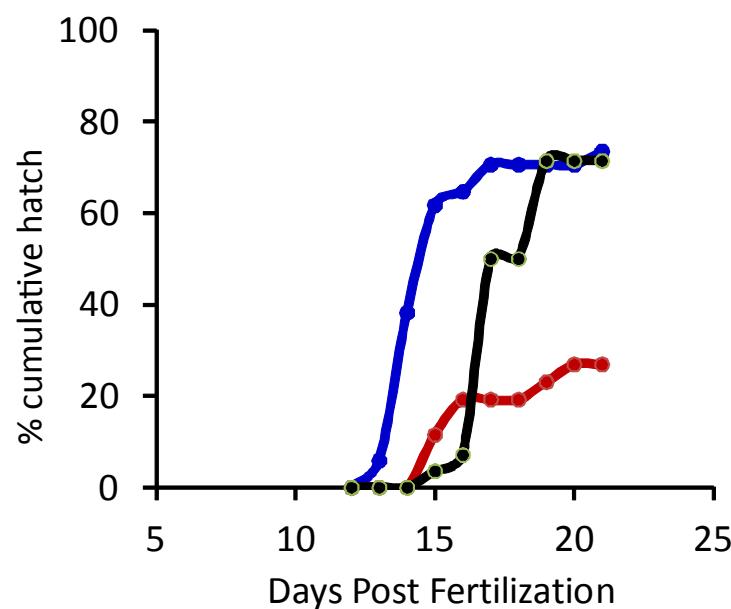
Dark red stain = CYP1A protein in gills from fish collected *in situ*  
Blue stain = hematoxylin (nuclei)

- Epithelial lifting
- Lamellar clubbing
- Hyperplasia
- Aneurism

# DHW contamination effects on Gulf of Mexico species

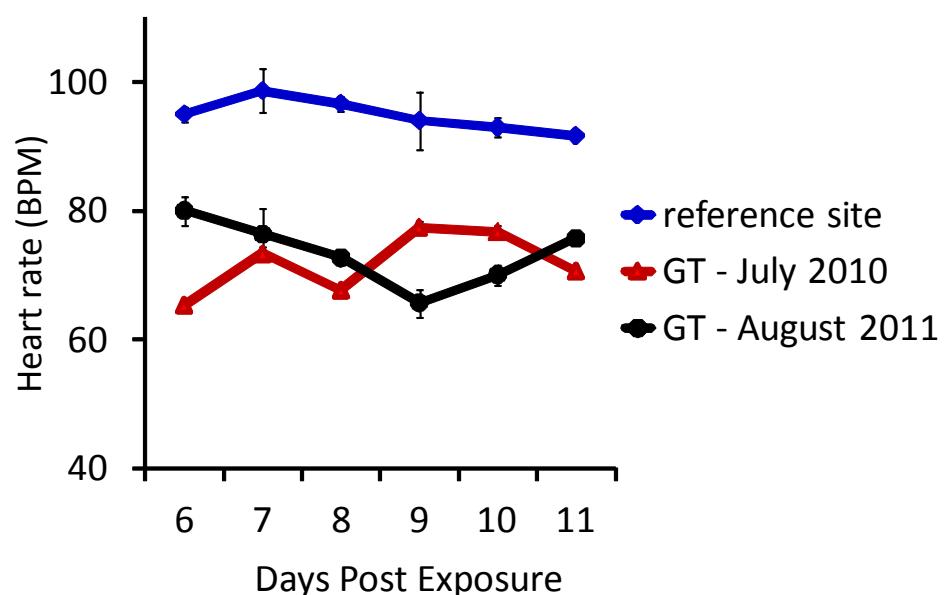
## Gulf Killifish - Development

Hatching success



→ decreased success,  
delay, at oiled sites

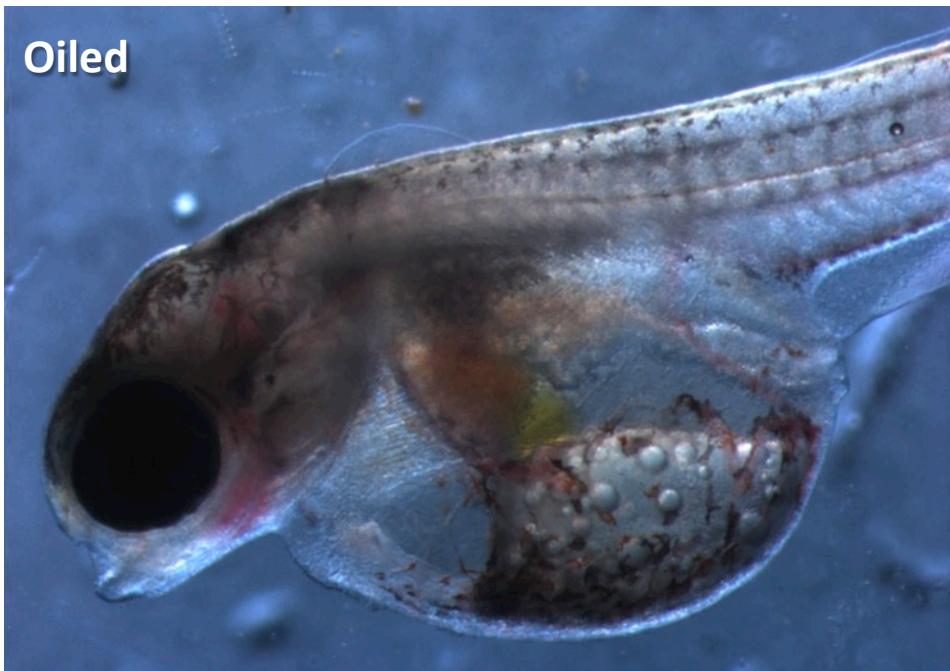
Heart rate



→ diminished at oiled sites

# DHW contamination effects on Gulf of Mexico species

## Gulf Killifish - Development



## Developmental phenotypes

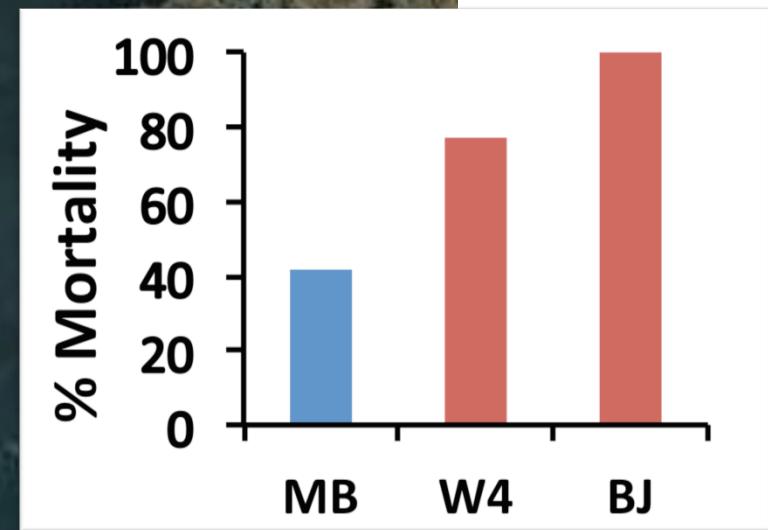
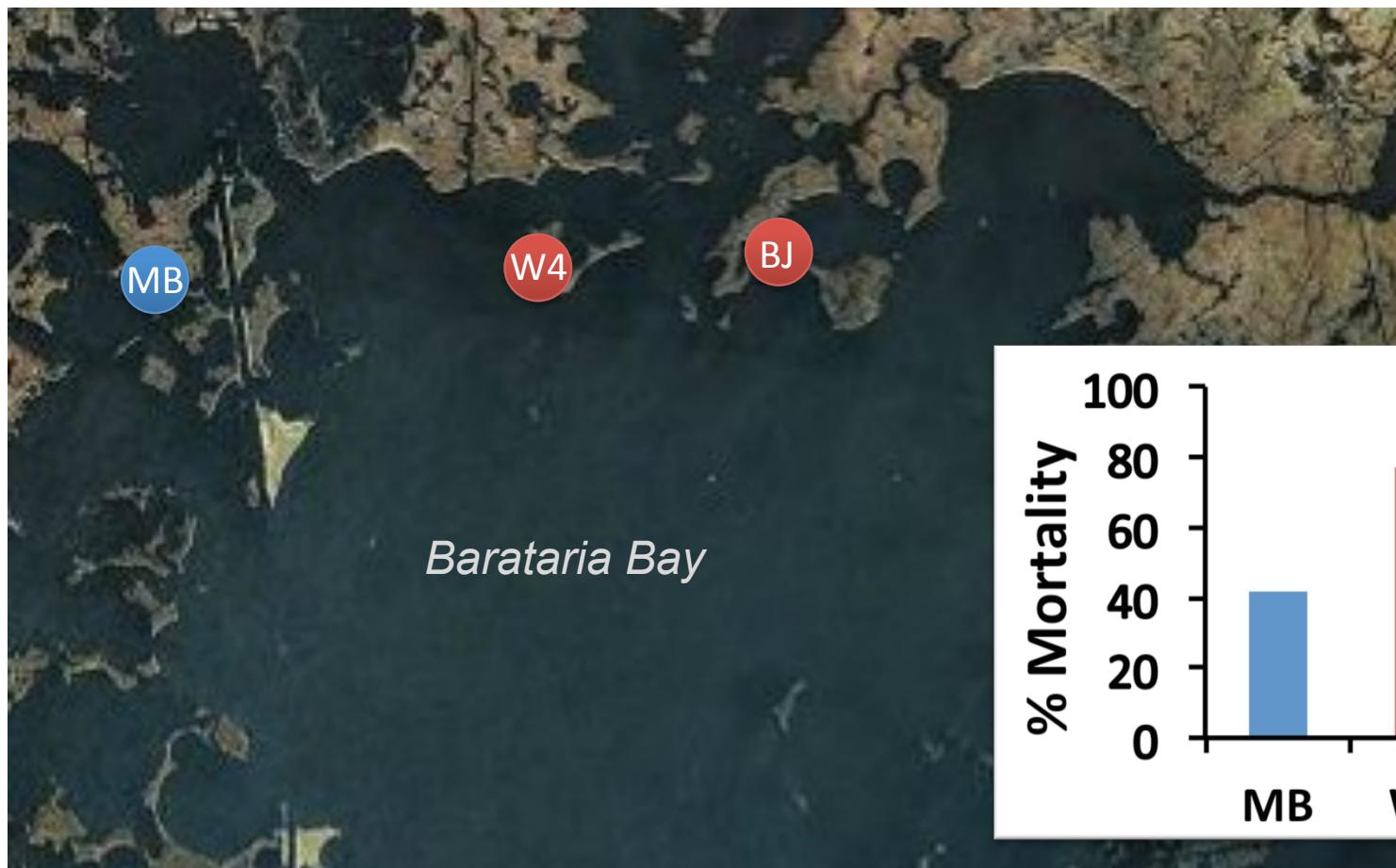
- Pericardial edema
- Enlarged pericardial space
- Tube heart
- Decreased size at hatch
- Enlarged guts
- Listless at hatch



# DHW contamination effects on Gulf of Mexico species

## Gulf Killifish - Development

Field-deployed developing embryos → low hatching success



Data: F. Galvez, B. Dubansky

# DHW contamination effects on Gulf of Mexico species

*Redfish - Immune dysfunction?*



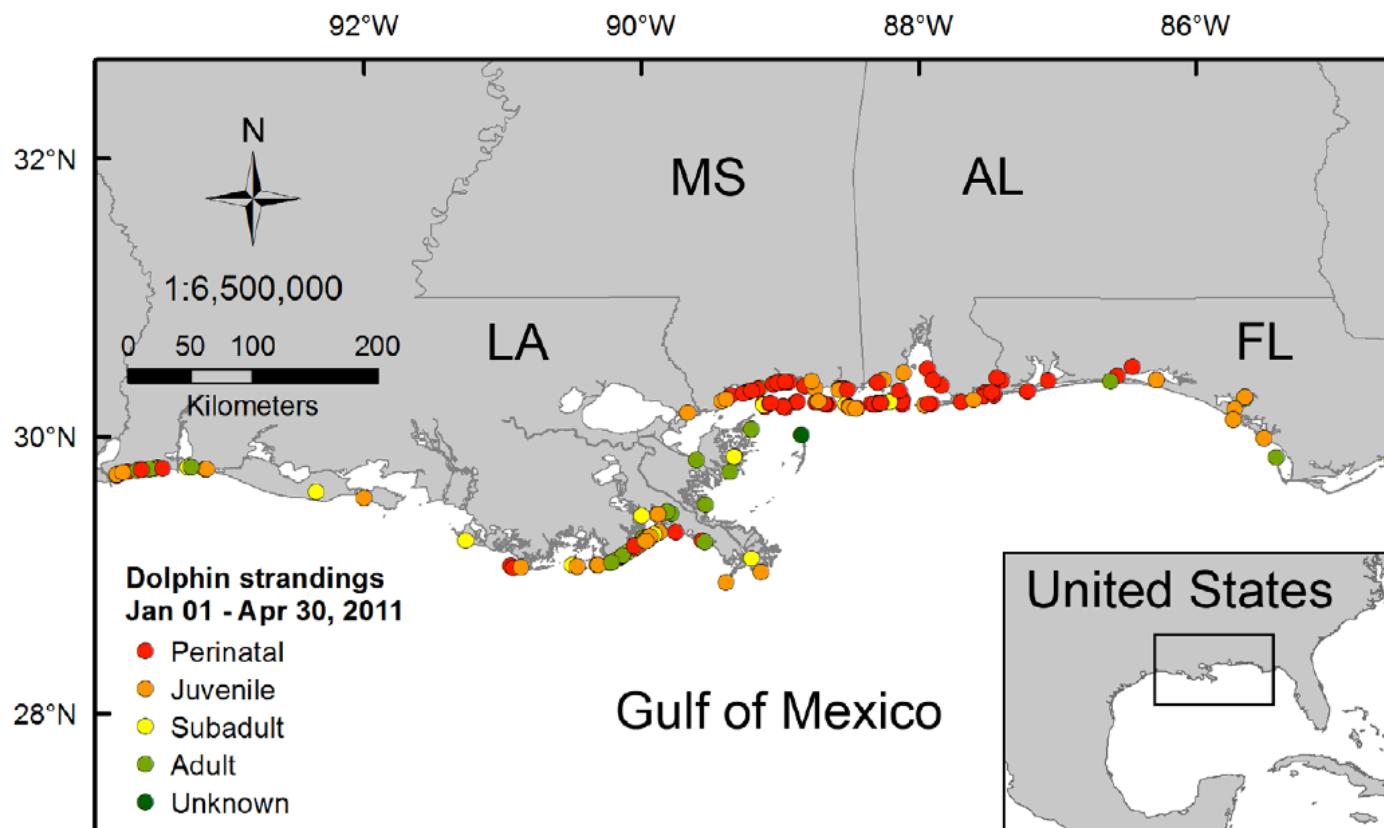
Donald Waters



James Cowen

# DHW contamination effects on Gulf of Mexico species

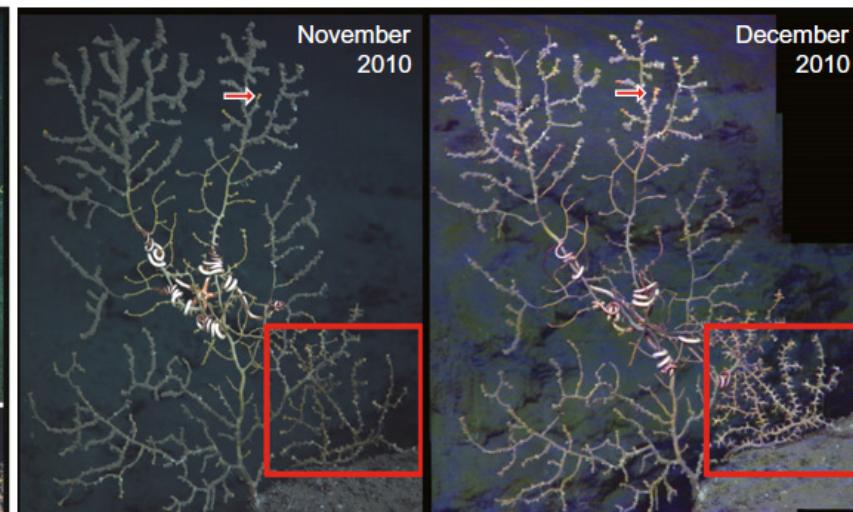
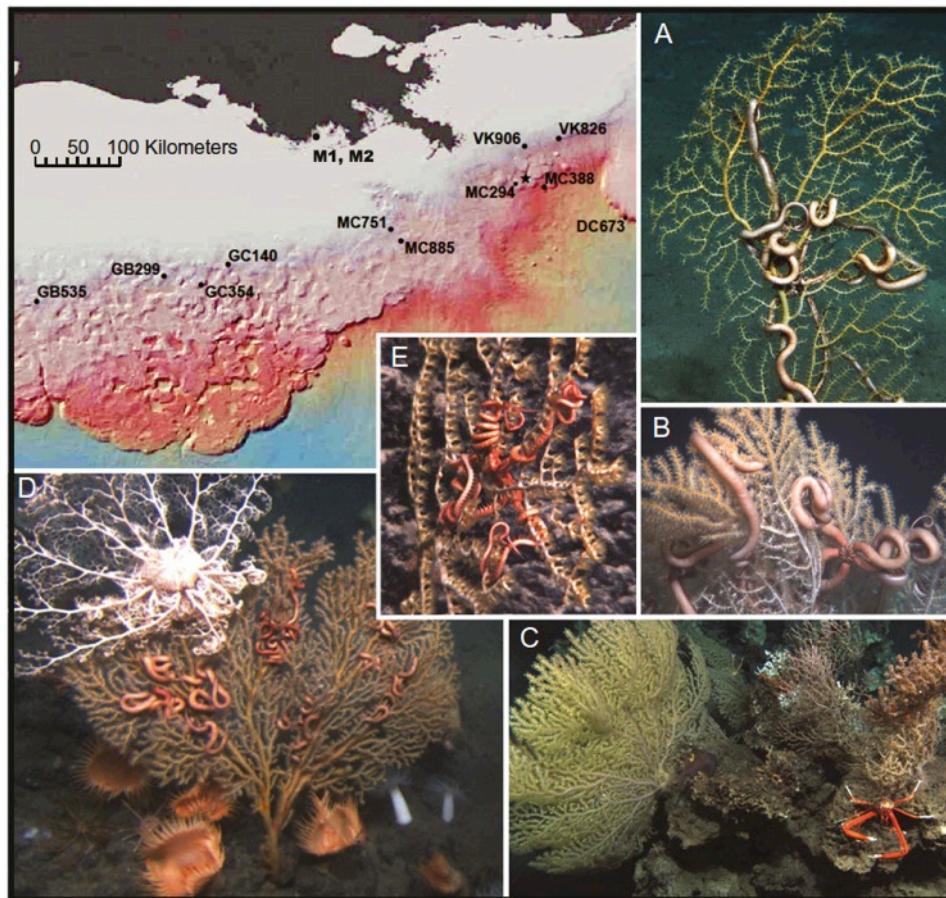
## Dolphins - Increased strandings



**Figure 1. Location of dolphin strandings in the northern Gulf of Mexico, January through April 2011.** Dolphin strandings are shown separated by age class (defined in Table 1) for Louisiana (LA), Mississippi (MS), Alabama (AL), and western Florida (FL) [12]. Unknown = data not reported.  
doi:10.1371/journal.pone.0041155.g001

# DHW contamination effects on Gulf of Mexico species

## Deep Sea - Corals



Impacted corals at MC 294 → brown floc and tissue loss.  
Brown floc fingerprints as Macondo Well oil.

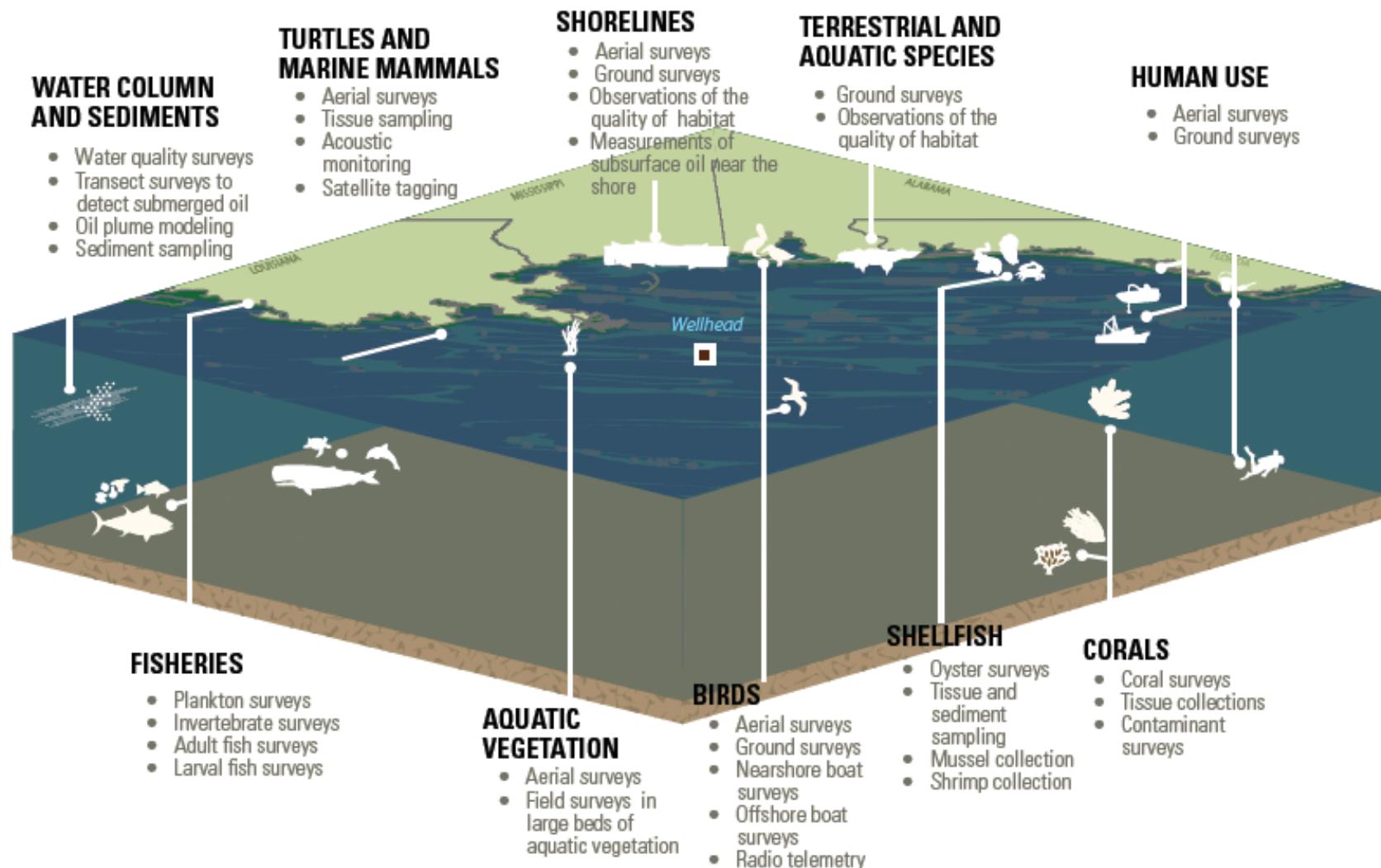
Healthy deep-water coral communities observed in November 2010 from various sites >20 km from the Macondo well

White et al., 2012

# Interaction with other stressors...

- Impaired osmoregulation – compromised gill structure
- Impaired hypoxia tolerance
- Immune dysfunction
- Decreased metabolic scope → impairs swimming performance

**Figure 6.1: Assessment Categories for Natural Resource Damage Assessment**



This figure represents the various natural resource categories being assessed as part of the Deepwater Horizon Natural Resource Damage Assessment. Such an assessment, which always follows an oil spill, is used to make the public whole for ecological damages caused by a spill. This graphic illustrates the three-dimensional challenges that an assessment of a deep sea blowout presents.

# Estuaries are stressful places

TEMPERATURE

HYPOXIA

SALINITY

PATHOGENS

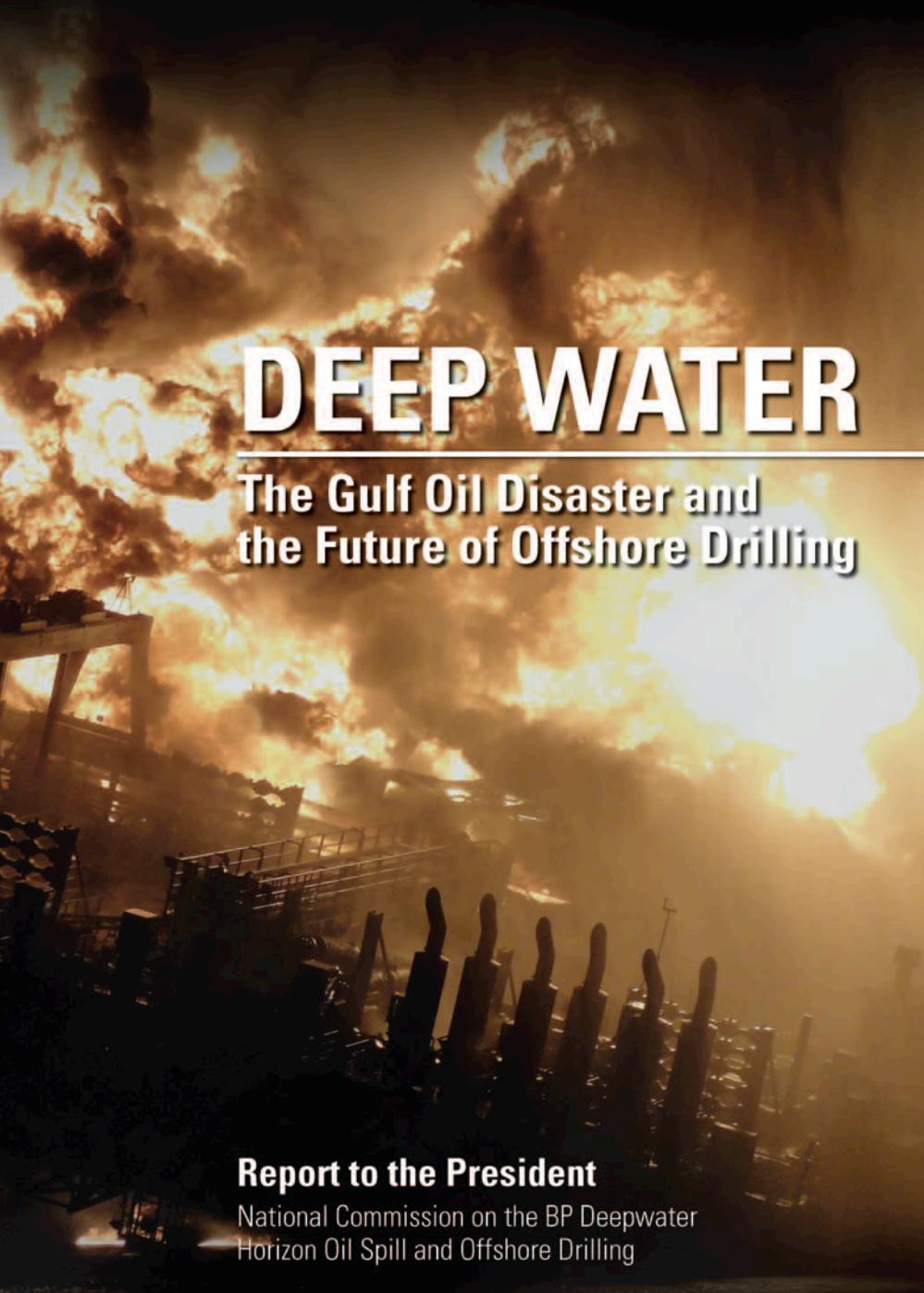
COMPETITION/PREDATION

HABITAT LOSS

HARVEST

CONTAMINANTS





# DEEP WATER

---

The Gulf Oil Disaster and  
the Future of Offshore Drilling

**Report to the President**

National Commission on the BP Deepwater  
Horizon Oil Spill and Offshore Drilling

# Report to the President - Conclusions

- Could have been prevented
- Caused by series of mistakes by BP, Haliburton, Transocean → poor culture of safety
- Deepwater drilling involves risks → industry + government are not adequately prepared
- Regulatory oversight requires reforms
- Oil/gas industry need to take their own steps to dramatically increase safety
- The technology, law/regulations, practices for containing/responding/cleaning up lag behind the risks of remote deepwater drilling → government must close that gap, industry must support and not resist that effort
- Scientific understanding of sensitive environments is inadequate – as is understanding of human and natural impacts of oil spills

# Sources:

## Report:

Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling.

Report to the President

National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, Jan. 2011

<http://www.oilspillcommission.gov/>

## Book:

Fire on the Horizon: The untold story of the gulf oil disaster

John Konrad & Tom Shroder, 2011

## Lecture:

Roland Horne, professor; Stanford University, November 16, 2010

## Primary literature

## Personal experience

# Genomic and physiological footprint of the Deepwater Horizon oil spill on resident m...

Andrew Whitehead<sup>a,1</sup>, Benjamin Dubansky<sup>a</sup>, Charlotte Bodinier<sup>a</sup>, Tz...  
Vandana Raghunathan<sup>e</sup>, Jennifer L. Roach<sup>a</sup>, Nan Walker<sup>e</sup>, Ronald B...

Departments of <sup>a</sup>Biological Sciences, <sup>c</sup>Environmental Sciences, and <sup>d</sup>Oceanography and  
University, Baton Rouge, LA 70803; <sup>b</sup>Department of Chemistry and Biochemistry, Texas S...

Edited by Paul G. Falkowski, Rutgers, The State University of New Jersey, New Brunswick,  
June 13, 2011

The biological consequences of the Deepwater Horizon oil spill are unknown, especially for resident organisms. Here, we report results from a field study tracking the effects of contaminating oil across space and time in resident killifish during the first 4 mo of the spill event. Remote sensing and analytical chemistry identified exposures, which were linked to effects in fish characterized by genome expression and associated gill immunohistochemistry, despite very low concentrations of hydrocarbons remaining in water and tissues. Divergence in genome expression coincides with contaminating oil and is consistent with genome responses that are predictive of exposure to hydrocarbon-like chemicals and indicative of physiological and reproductive impairment. Oil-contaminated waters are also associated with changes in...



LETTER

## CYP1A expression fails to demonstrate exposure–response relationship

**Kenneth D. Jenkins<sup>1</sup>, Margaret A. Branton, and Steven Huntley**  
Cardno ENTRIX, Concord, CA 94520

Conflict of interest statement: Funding was provided by BP.



## Multitissue Molecular, Genomic, and Developmental Effects of the Deepwater Horizon Oil Spill on Resident *Fundulus grandis*)

Benjamin Dubansky,<sup>\*,†</sup> Andrew Whitehead,<sup>‡</sup> Jeffrey T. M...

<sup>†</sup>Louisiana State University, Department of Biological Sciences, 208 Life  
Sciences

<sup>‡</sup>University of California, Davis, Department of Environmental Toxicology

<sup>\*</sup>Clemson University, Department of Biological Sciences, 132 Long Hall

Supporting Information

**ABSTRACT:** The Deepwater Horizon oil rig disaster resulted in crude oil contamination along the Gulf coast in sensitive estuaries. Toxicity from exposure to crude oil can affect populations of fish that live or breed in oiled habitats as seen following the Exxon Valdez oil spill. In an ongoing study of the effects of Deepwater Horizon crude oil on fish, Gulf killifish (*Fundulus grandis*) were collected from an oiled site (Grande Terre, LA) and two reference locations (coastal MS and AL) and monitored for measures of exposure to crude oil. Killifish collected from Grande Terre had divergent gene expression in the liver and gill tissue coincident with the arrival of contaminating oil and up-regulation of cytochrome P4501A (CYP1A) protein in gill, liver, intestine, and head kidney for over one year following peak landfall of oil (August 2011)

compared to fish collected from reference sites. Furthermore, laboratory exposures of Gulf killifish embryos to field-collected sediments from Grande Terre and Barataria Bay, LA, also resulted in increased CYP1A and developmental abnormalities when exposed to sediments collected from oiled sites compared to exposure to sediments collected from a reference site. These data are predictive of population-level impacts in fish exposed to sediments from oiled locations along the Gulf of Mexico coast.



## Comment on “Multitissue Molecular, Genomic, and Developmental Effects of the Deepwater Horizon Oil Spill on Resident Gulf Killifish (*Fundulus grandis*)”

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#### Corresponding Author

\*Phone: (616) 610-4614; e-mail: walter.pearson@stantec.com.

#### Notes

The authors declare the following competing financial interest(s): This research was supported by BP Exploration & Production, Inc.

Correspondence/Rebuttal

pubs.acs.org/est