Recent Scientific Developments in Natural Resource Injury Assessment and Quantification

Prepared for: Conference of Western Attorneys General

San Francisco, CA

July 31, 2017

Connie Travers, MS

Abt Associates
1881 Ninth St.
Suite 201
Boulder, CO 80302

Connie_Travers@abtassoc.com

Role of Science in NRDA

- Who is responsible for the release? (liability)
- What was released (e.g., hazardous substances, oil)?
- Where did the contamination go? (pathway)
- When did the release(s) occur? (timing)
- What was exposed? (confirmation of exposure)
- What injuries occurred? What natural resource services were lost and what is the value of those losses? (injury and damage assessment)
- How can the injuries and service losses be restored? (restoration planning)

Role of Science in NRDA

Recent Scientific Developments in Natural Resource Injury Assessment and Quantification

- Emerging Contaminants
- Emerging Effects
- Evolving Methods

Emerging Contaminants

Example: Perfluorochemicals (PFCs) (aka PFASs)

- Human-made persistent organic compounds
- Used to make products that resist heat, stains, oil, and water (i.e., “non-stick”, “stain-resistant” and “waterproof”)
- Used in textiles and leather products, metal plating, the photographic industry, semi-conductors, paper and packaging, coating additives, cleaning products, and pesticides (U.S. EPA 2014)
- Fire-fighting foam (for petroleum-based fuels) used at oil refineries, airfields

PFCs

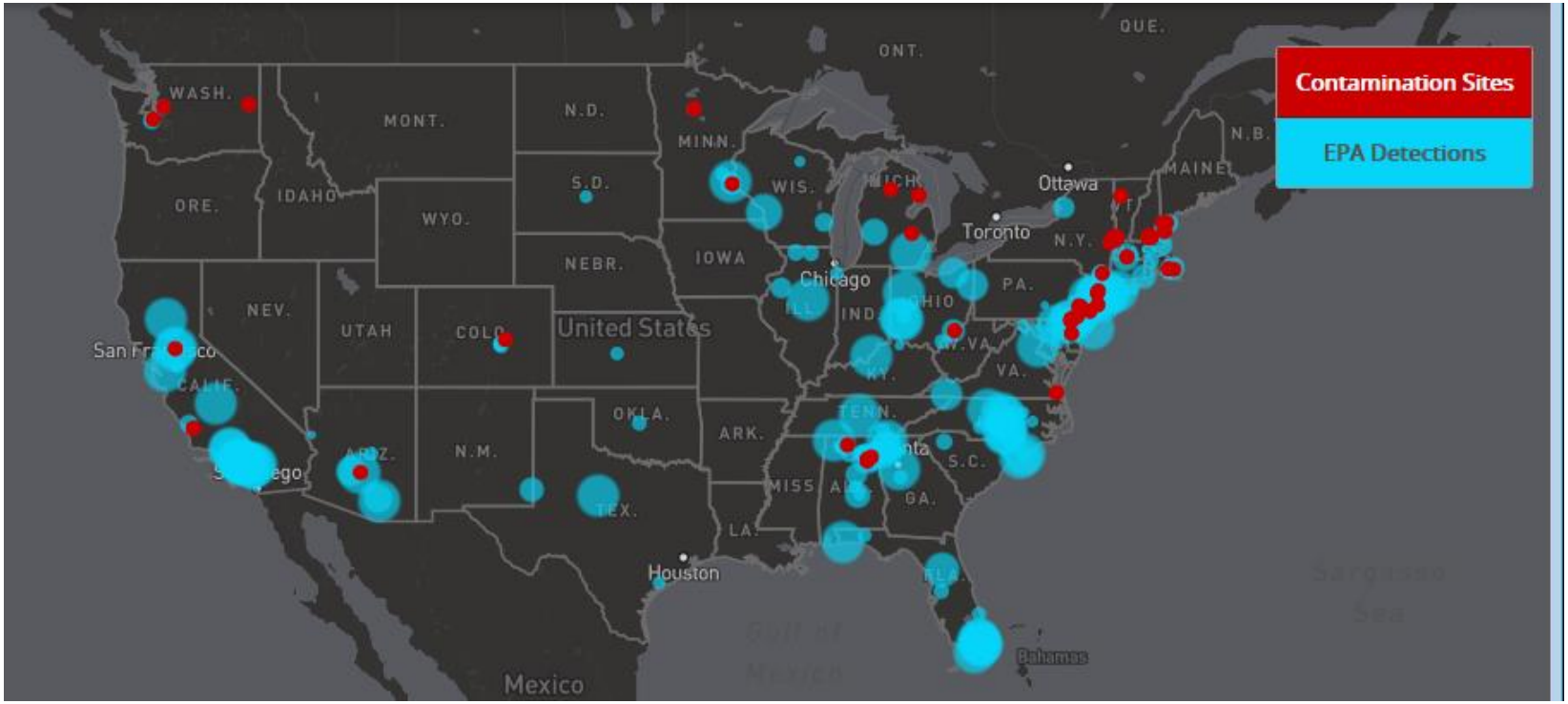
- PFCs present in blood of people and animals world-wide.
- Increasing awareness of PFC persistence and mobility
- Increasing data from toxicity studies, particularly for widely-produced PFOA (Perfluorooctanoic acid) and PFOS (Perfluorooctyl sulfonate)
- Less known about toxicity of other PFCs.

PFCs

- Lack of scientific agreement on health effects. Information from studies of laboratory animals and epidemiological studies of humans exposed.
- Studies finding potential links to bladder and kidney cancer, immunotoxicity in children, risks to developing fetuses and infants
- Manufacturers (e.g., 3M) argue PFCs have never been proven to cause harm to humans at environmental concentrations.
- Some researchers concerned by risks to sensitive populations at very low concentrations (parts per trillion levels, less than a drop of food dye in a 1000 Olympic size swimming pools)
- Increasing litigation over human health effects and natural resource damages from PFC releases

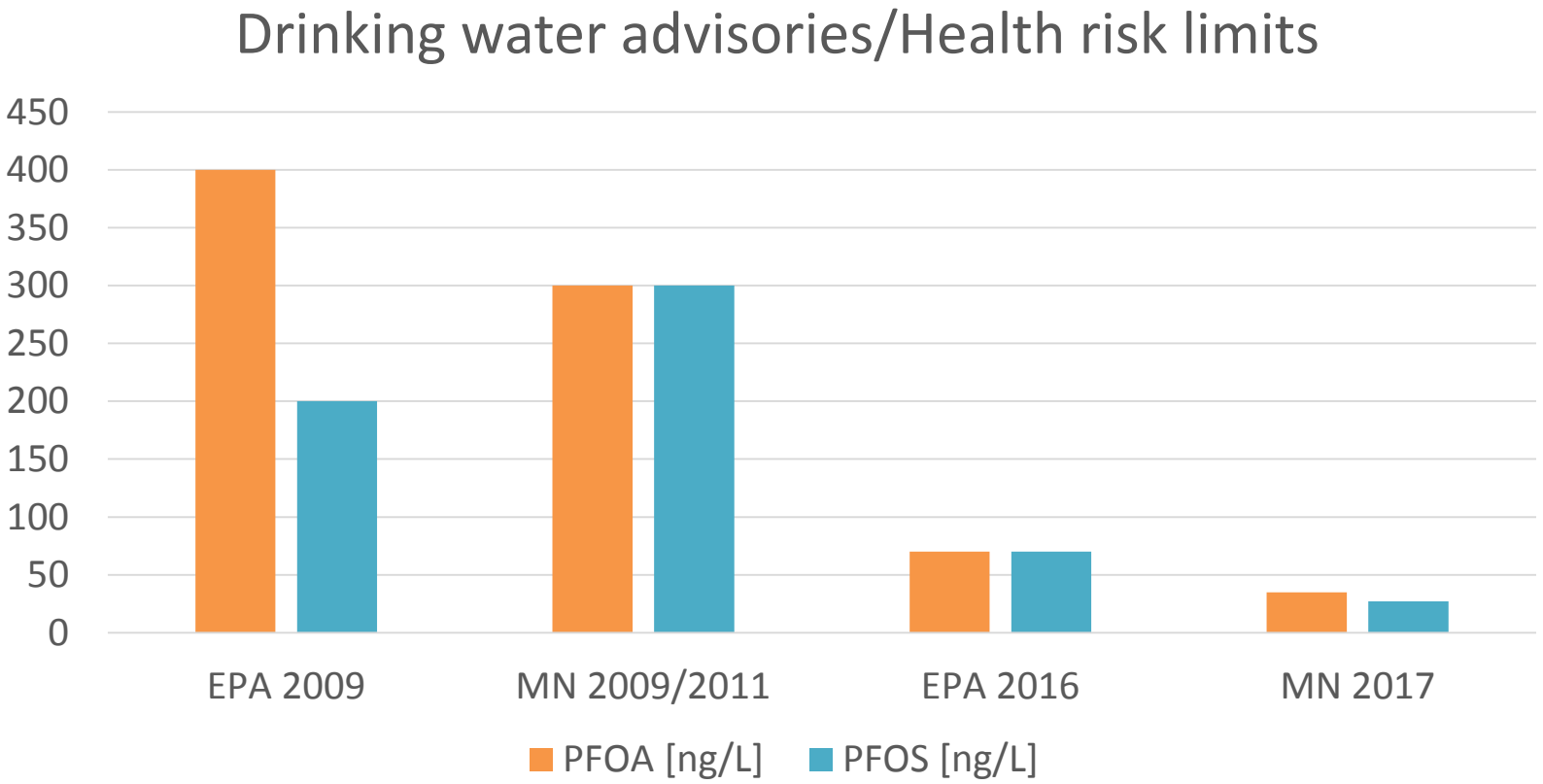
PFCs

PFC water contamination sites and
public water supplies with PFC detections.



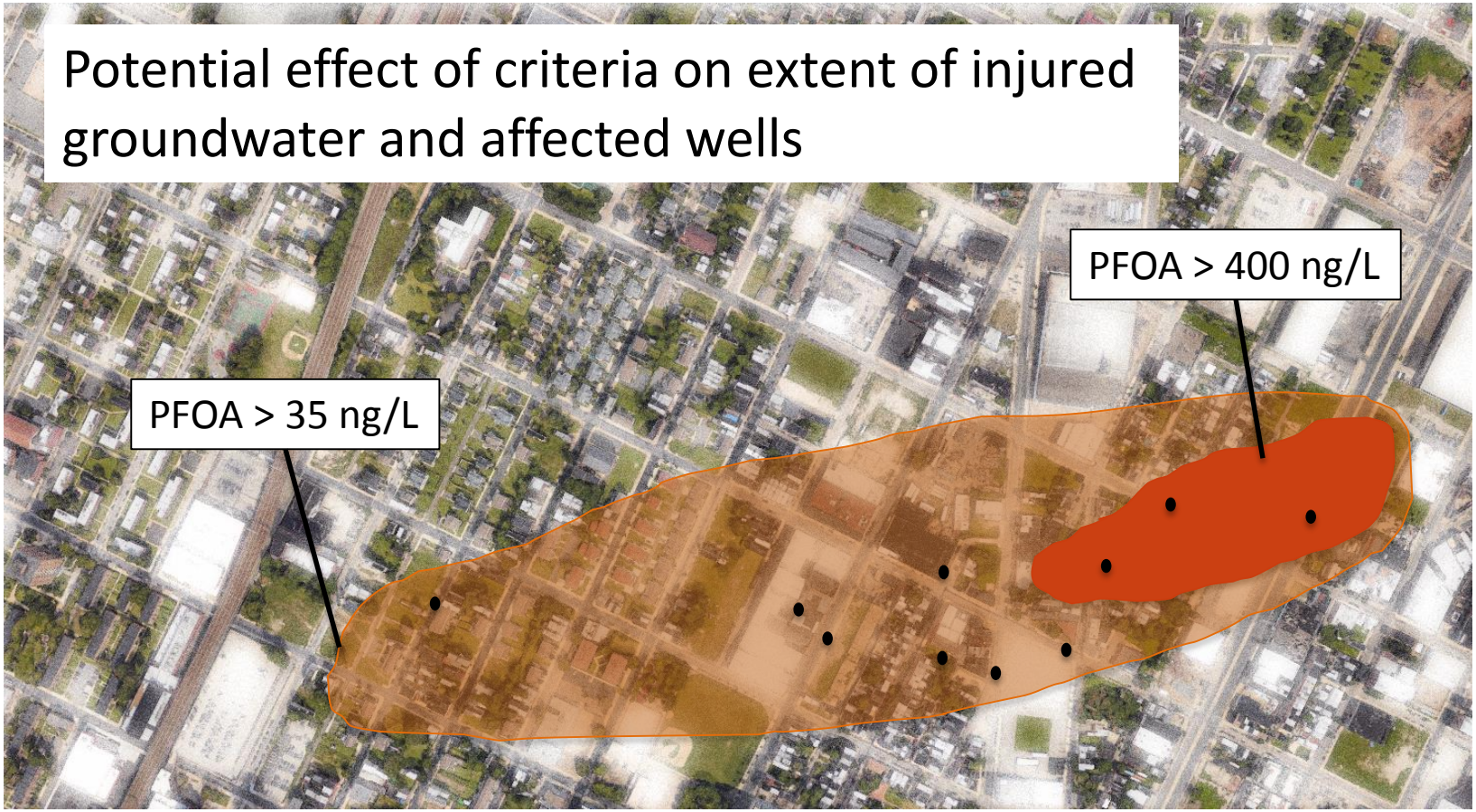
Source: Northeastern University Social Science Environmental Health Research Institute data, map by EWG
http://www.ewg.org/interactive-maps/2017_pfa/index.php#.WX6i8U27rIV

PFCs



Proposed MCL NJ= 14 ng/L for PFOA;
DW advisories VT = 20 ng/L for PFOA and PFOS

PFCs


Potential effect of criteria on extent of injured groundwater and affected wells
PFOA > 400 ng/L
PFOA > 35 ng/L

PFCs

Fish Consumption Advisories for PFOS

- Accumulates in fish
- Biological resource injury definition [43 CFR 11.62(f)(1)(ii) and (iii)]

Meal advice categories based on levels of PFOS in fish

Level of PFOS in fish [ng/g, or parts per billion (ppb)]	Meal frequency
≤ 40	Unrestricted
> 40 to 200	1 meal/week
> 200 to 800	1 meal/month
> 800	Do not eat

Source: Minnesota Department of Health, 2008.

PFCs

NRDA issues

- Baseline (i.e., “absent the release”) issues:
  - Background concentration in environment (water, biota)?
  - Multiple sources?
- PFCs not on CERCLA Hazardous Substances List (state law may allow definition as hazardous substance/waste)
- EPA has not set enforceable drinking water MCLs under SDWA
- Scientific research ongoing to understand effects on human health and environment.

PFCs

- Potential injury assessment consequences of states/feds lowering guidelines for PFOA and PFOS
  - New or additional concerns about specific drinking water sources
  - Increased spatial/temporal extent of exposed/injured resources
  - Increased concerns about pathways to other resources
  - Impact on FCAs

PFCs

The future for injury assessment for PFC contamination?

- Minnesota's NRDA litigation against 3M at Cottage Grove for injuries to groundwater, surface water, sediment and aquatic life.
- Identification of new locations with PFC concentrations creating public, state, and federal concerns
- Increasing class action and NRDA litigation

Emerging Effects

Deepwater Horizon NRDA Toxicity Testing

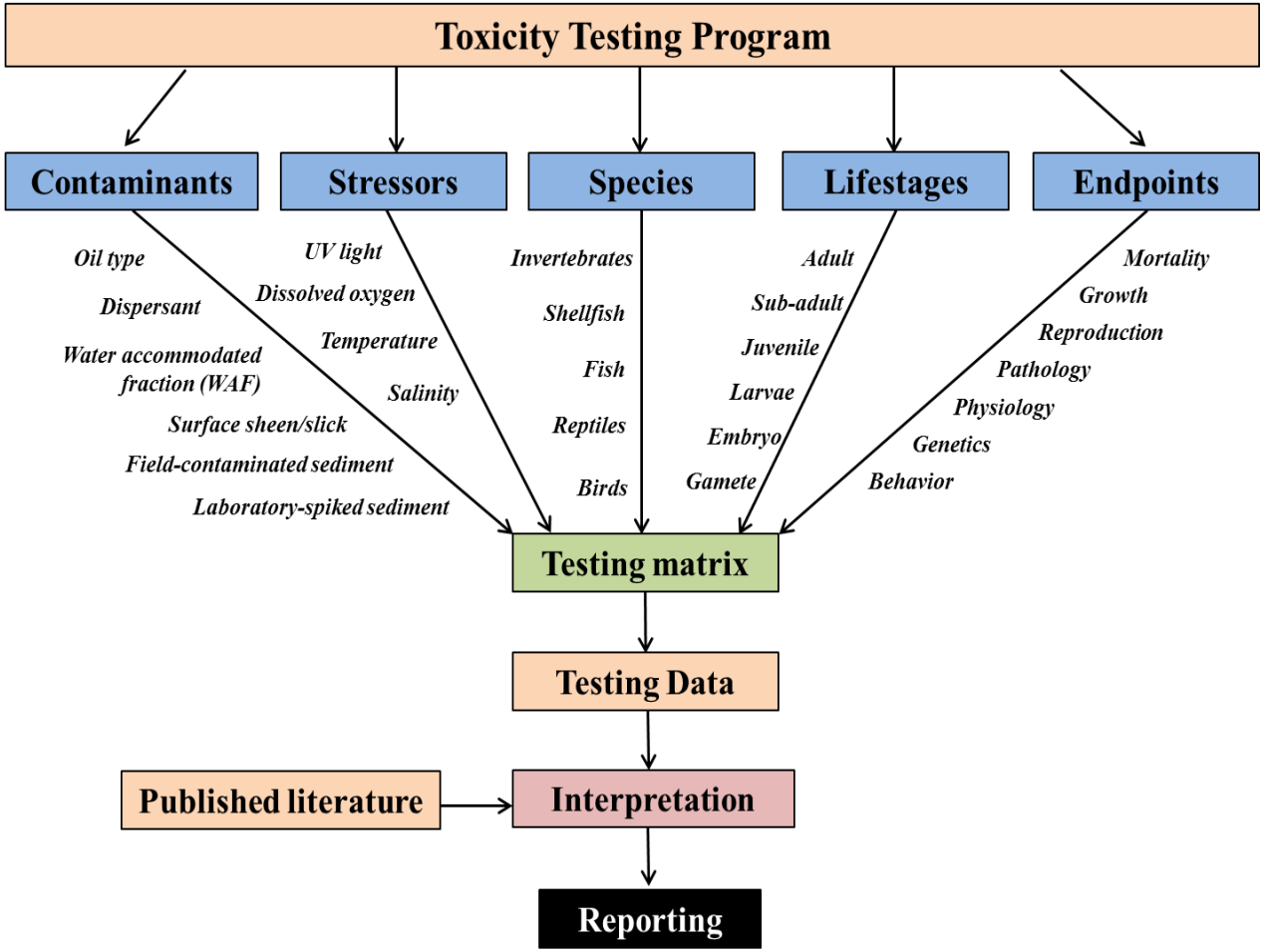
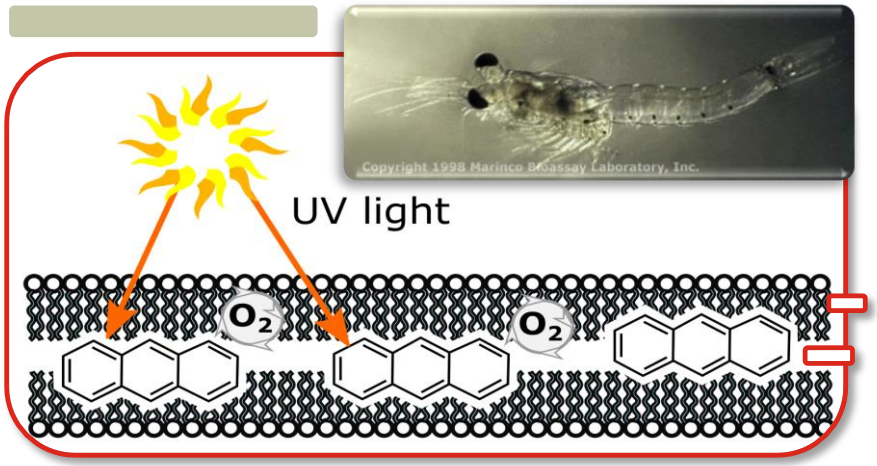


Photo-Induced Toxicity of Oil to Aquatic Organisms



Abt Associates
University of North Texas
CSIRO (Australia)

Photo-Active PAHs in Oil

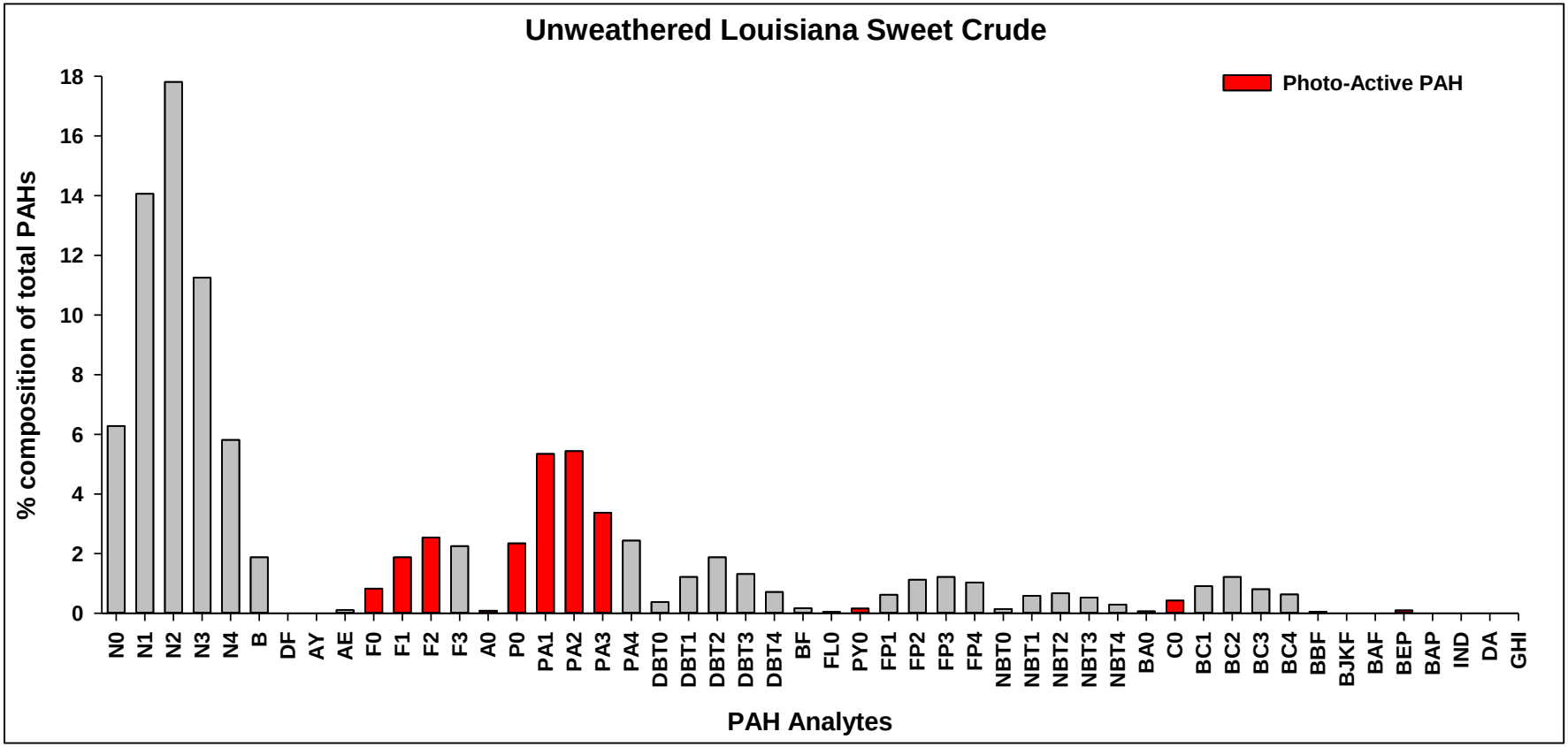
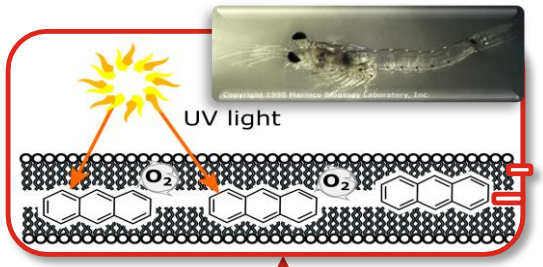
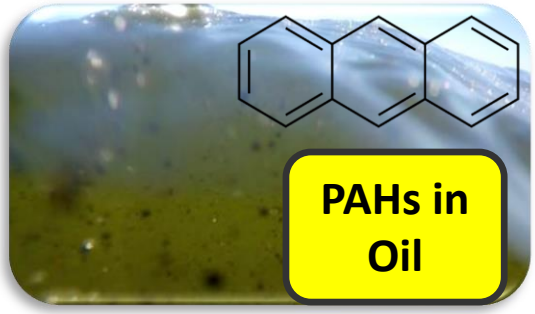


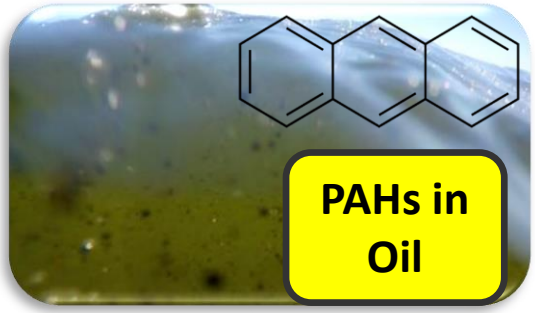
Photo-Induced Toxicity

Photo-Sensitization

Photo-Modification







Toxic Photoproducts

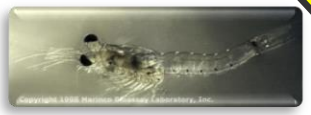
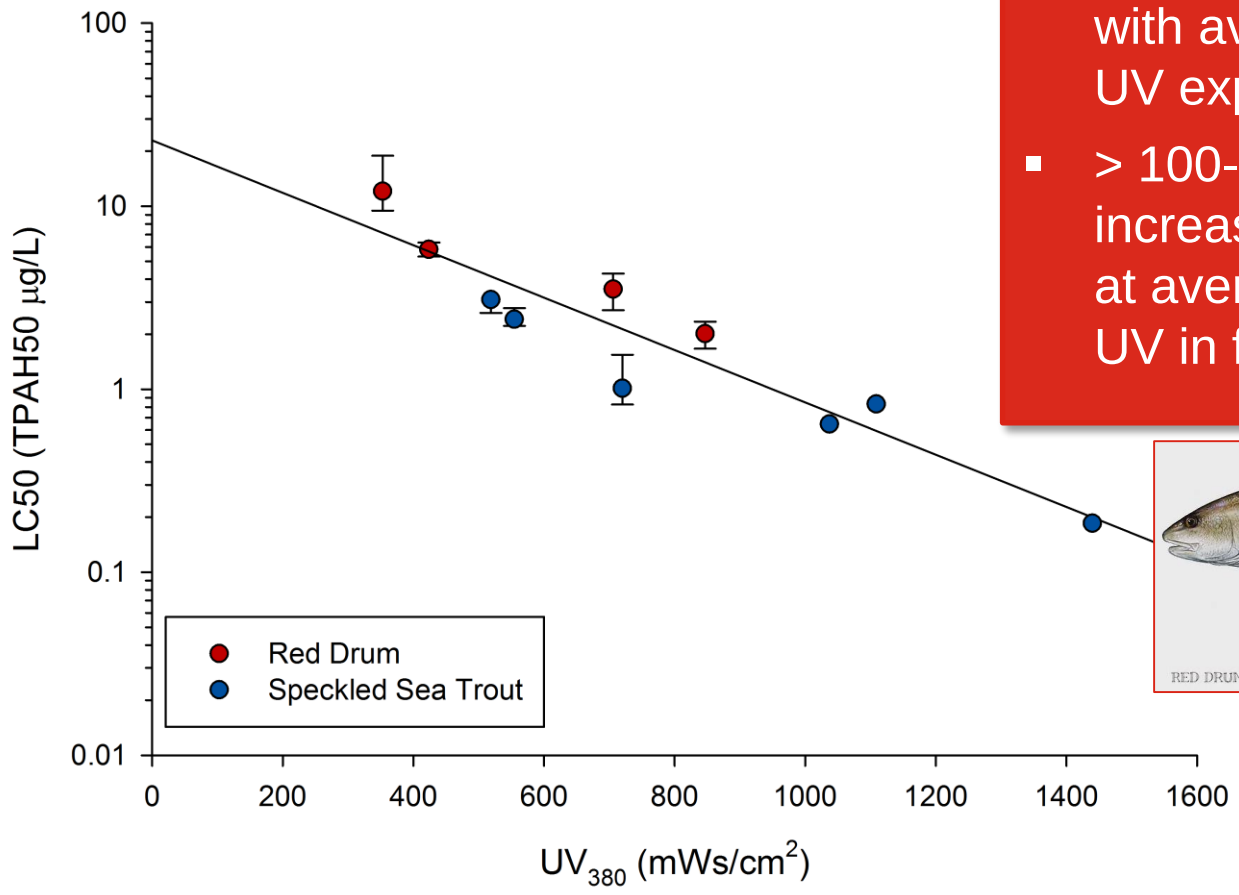
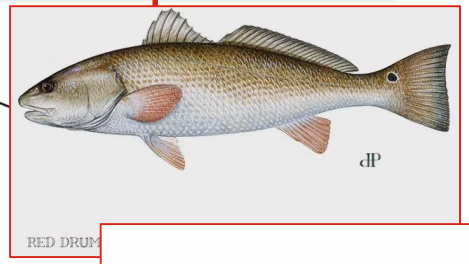


Photo-Sensitization



- Toxicity increases with average daily UV exposure
- > 100-fold increase in toxicity at average daily UV in field



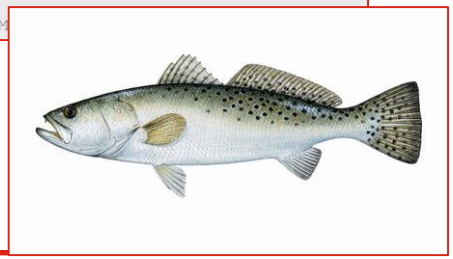
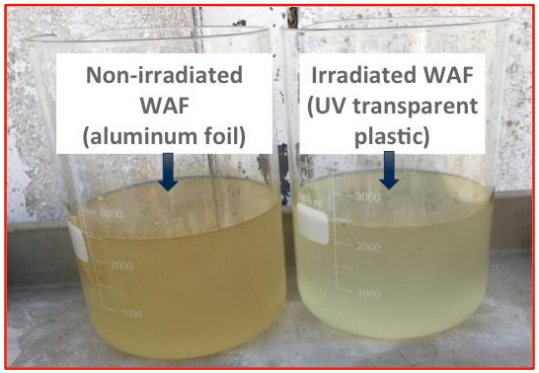


Photo-Modification: Chemistry



Measured production of oxy-phenanthrene

Apparent increase in anthraquinones

Photo-Modification: Black Bream

- Concentrated WAF exposed to UV for 4 hours (no organisms)
- Bream embryos exposed to diluted, irradiated WAF for 24 hours (no UV)

LC50 Values

Non-irradiated WAF = 72 µg/L TPAH50 (nominal)

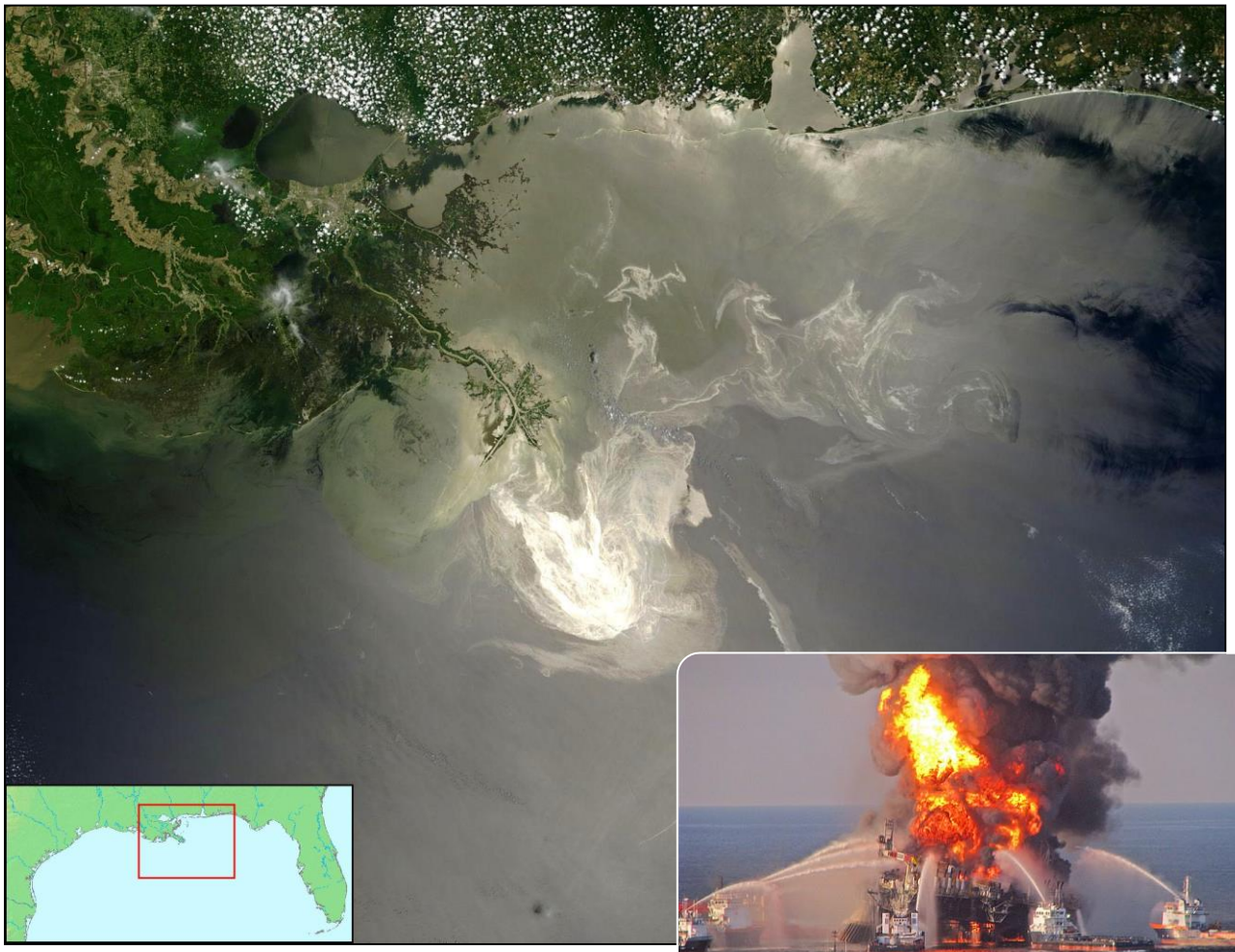
Irradiated WAF = 11 µg/L TPAH50 (nominal)

Toxicity of the exposure solution increases by ~6.5 fold after only 4 hours of UV exposure

Deepwater Horizon Oil Spill

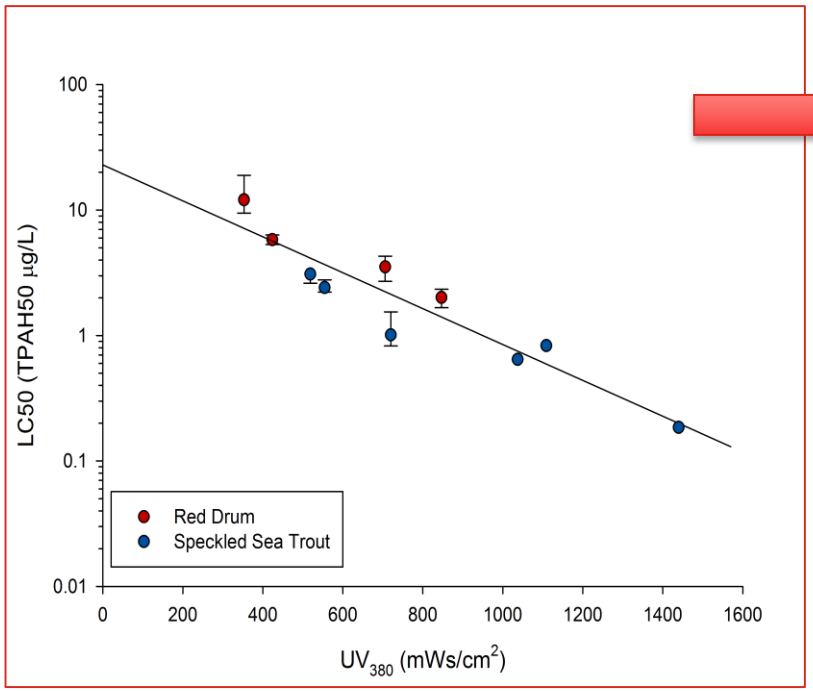
Surface oiling ~100,000 km^2

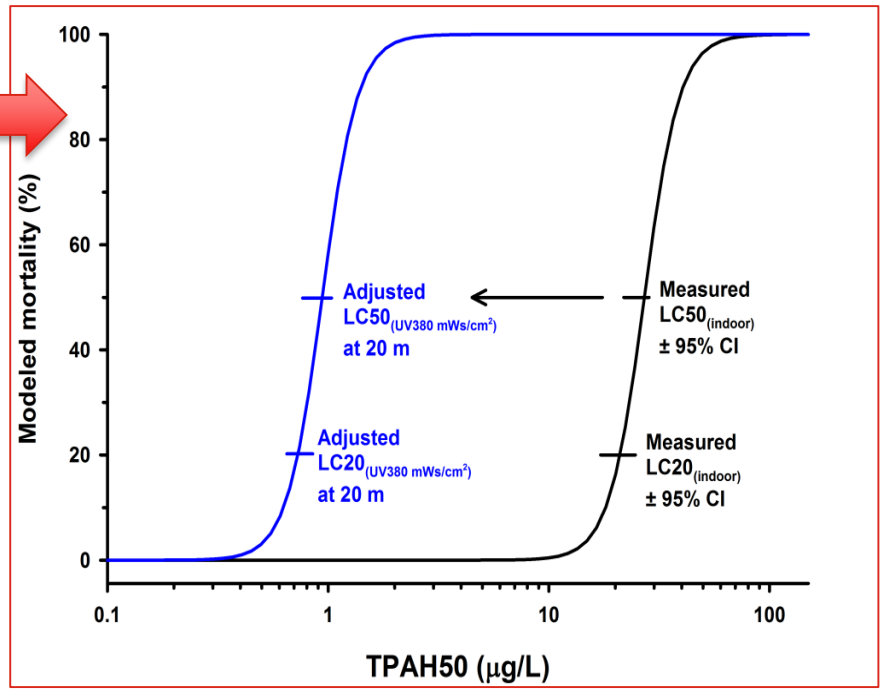
Potential influence of UV enhanced toxicity on organisms near surface and in shallow water.



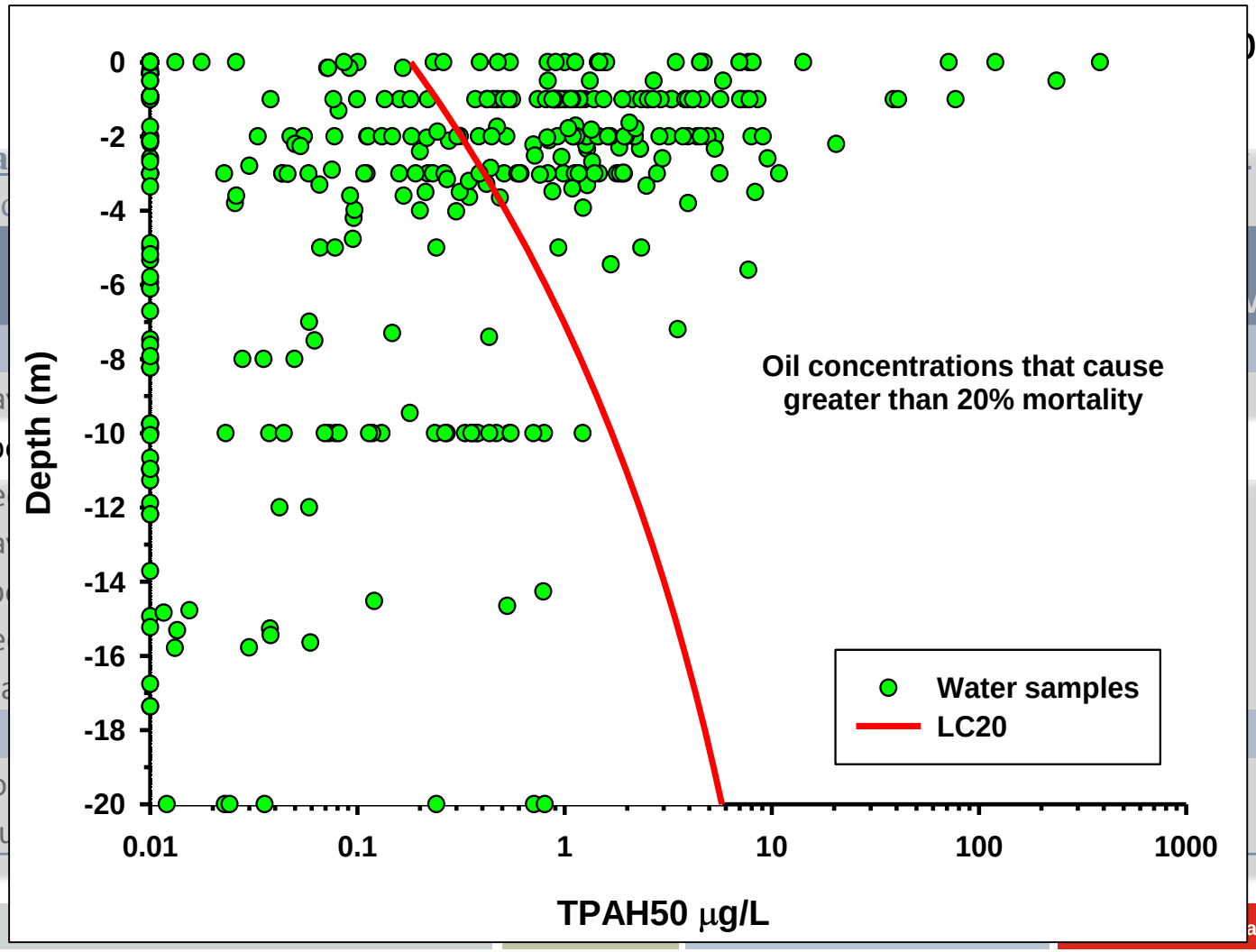
Modeling Toxicity

- Find LCx at environmental UV using slope of line
- Adjust equation of dose-response curve using adjusted LC50





Estimating Injuries



www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan/

Photo-induced Toxicity Conclusions

- We observed direct photo-sensitization of oil in all invertebrate and vertebrate species tested
- We observed increased oil toxicity in UV-irradiated oil-water mixtures suggesting photo-modification
- UV-enhanced oil toxicity has important implications when evaluating environmental exposures and quantifying injuries to PAHs

Evolving Methods

NRDA ephemeral data collection

- Ephemeral data – time-sensitive data collected to study the environmental impacts of a spill/release

NRDA ephemeral data collection considerations

- Data collection opportunities and needed evidence may be lost if response slow or unprepared
- Response teams don't have same goals as teams collecting NRDA data

Yellowstone River Oil Spill; Source: NY Times, 7/2/2011

NRDA ephemeral data collection- State Needs

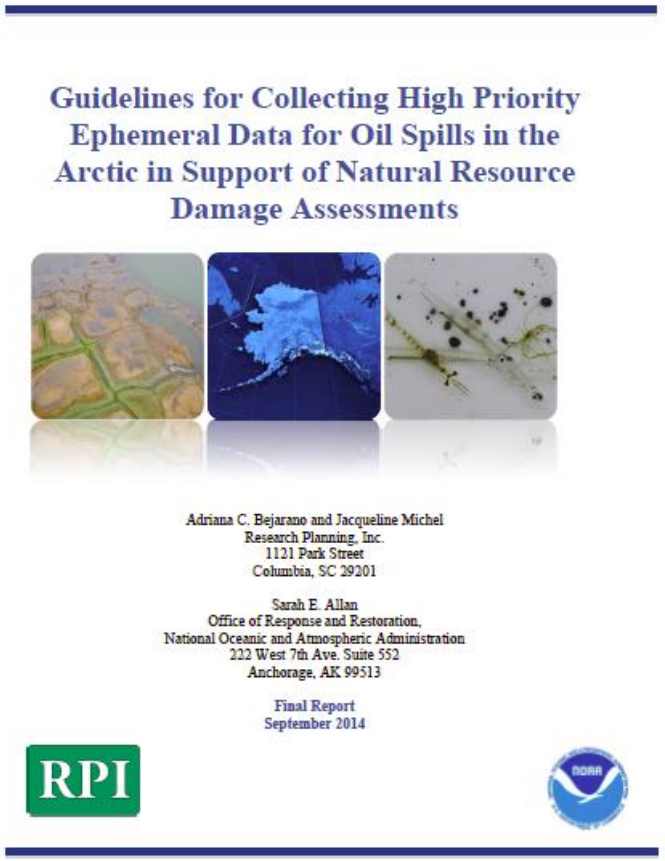
- Collect “high-priority” litigation-quality data to assess exposure, quantify injury for state resources. Don’t rely entirely on federal agencies
- Previously-prepared guidance documents and SOPs for collection of litigation-quality ephemeral data in state-relevant habitats and natural resources
- Methods to allow field staff to target exposed areas
- Sufficient trained staff (state and/or contractor) who can respond quickly and competently

NRDA ephemeral data collection

- Remote Sensing Tools
  - Satellite images, aerial overflights, drones
  - Better target sampling of areas exposed to oil/contaminant releases
  - Collect images/data that can be used to qualitatively or quantitatively support injury assessment

NRDA ephemeral data collection

- NRDA Lessons Learned/Post-Audit
  - Evaluate data quality and use to improve collection in future spills/releases
  - Improve training and guidance documents



Guidelines for Collecting High Priority Ephemeral Data for Oil Spills in the Arctic in Support of Natural Resource Damage Assessments

Adriana C. Bejarano and Jacqueline Michel
Research Planning, Inc.
1121 Park Street
Columbia, SC 29201

Sarah E. Allan
Office of Response and Restoration,
National Oceanic and Atmospheric Administration
222 West 7th Ave. Suite 552
Anchorage, AK 99513

Final Report
September 2014

RPI

Summary

Future NRDA injury assessments may want to

- consider emerging contaminants,
- include new information on toxic effects, and
- work to improve ephemeral data collection methods

Questions?

BOLD
THINKERS
DRIVING
REAL-WORLD
IMPACT

DWH NRDA

- The findings and conclusions in this presentation are those of the authors and do not necessarily represent the view of the National Oceanic and Atmospheric Administration (NOAA) or any other natural resource Trustee for the BP/*Deepwater Horizon* (DWH) Natural Resource Damage Assessment (NRDA). Some of the information being presented was used in the development of the DWH Oil Spill Draft Programmatic Damage Assessment and Restoration Plan/Draft Programmatic Environmental Impact Statement.
- More information on the DWH NRDA, including data, results, and lists of our collaborators, can be found at: www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan.
- All toxicity testing data now available online: https://www.diver.orr.noaa.gov/web/guest/dwh-toxicity-studies