2010 Deepwater Horizon Oil Spill – Retrospective on Response to Seafood Safety Concerns

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Presentation Overview

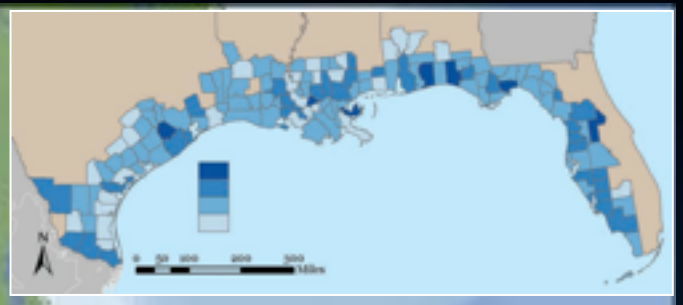
- The Gulf of Mexico at a Glance
- The Deepwater Horizon Accident
- Protective Measures for Seafood Safety
- Protocol to Re-open Fisheries
- Seafood safety Criteria and Methods
- Testing for Re-opening and Results
- Extended Surveillance Testing and Results
- Oil Dispersants and Seafood Safety
- Federal and State Interagency Coordination

The GULF OF MEXICO at a GLANCE

National Ocean Service, NOAA. 2011. The Gulf of Mexico at a Glance: A Second Glance. Washington, DC: U.S. Department of Commerce.

47,000 miles of shoreline

21 million people live in counties bordering GOM



Source: U.S. Census Bureau, 2011a; Woods and Poole Economics, Inc., 2010

580,000 square miles

584,000 cubic miles of water

5,299 feet average depth

> 15,000 marine species

Belize

Guatemala

Honduras

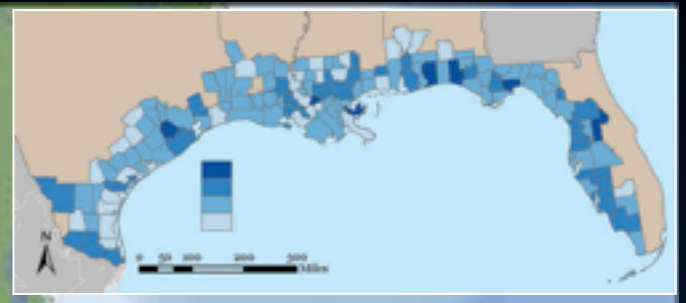
United States Census Bureau

The GULF OF MEXICO at a GLANCE

National Ocean Service, NOAA. 2011. The Gulf of Mexico at a Glance: A Second Glance. Washington, DC: U.S. Department of Commerce.

7% of the U.S. Population

184 people per square mile in coastal counties



Source: U.S. Census Bureau, 2011a; Woods and Poole Economics, Inc., 2010

20% of U.S. Gross Domestic Product

Largest Gulf Coast Industries

Oil & Gas

Shipping

Fisheries

Tourism

Belize

Guatemala

Honduras

United States Census Bureau

The GOM accounts for 16% of total U.S. domestic fishery landings
78% of domestic shrimp and 62% of domestic oysters

Average annual values from 2007 to 2009

U.S. Rank	Port	Dollars (Million)
6	Empire-Venice, LA	68
11	Brownsville-Port Isabel, TX	47
12	Dulac-Chauvin, LA	45
15	Intracoastal City, LA	37
16	Galveston, TX	36
18	Key West, FL	35
19	Bayou La Batre, AL	35
20	Port Arthur, TX	35
29	Palacios, TX	28
30	Lafitte-Barataria, LA	27

U.S. Rank	Port	Pounds (Million)
3	Empire-Venice, LA	363
5	Intracoastal City, LA	266
6	Pascagoula-Moss Pt., MS	208
7	Cameron, LA	187
26	Dulac-Chauvin, LA	34
30	Brownsville-Port Isabel, TX	24
31	Lafitte-Barataria, LA	23
33	Bayou La Batre, AL	21
36	Golden Meadow-Leeville, LA	19
38	Galveston, TX	18

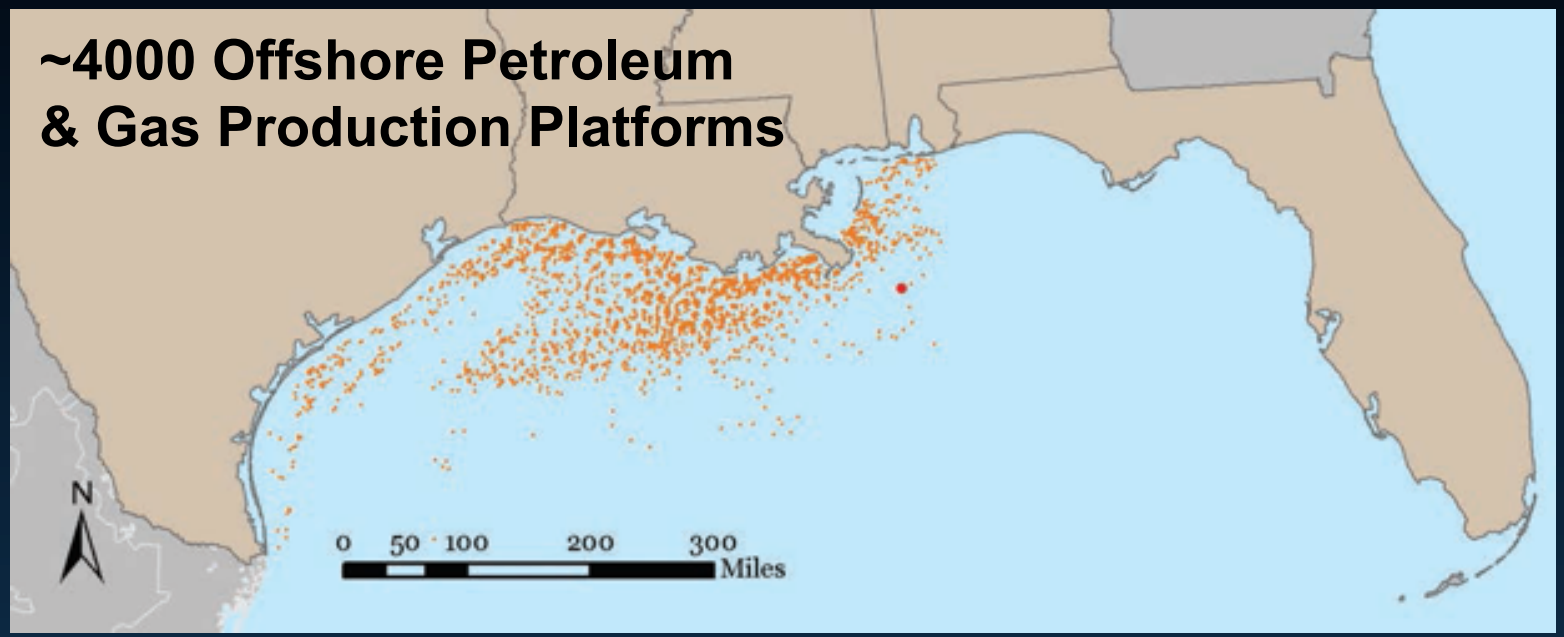
Source: National Marine Fisheries Service, Total Commercial Fishery Landings at Major U.S. Ports Summarized By Year and Ranked By Poundage and Dollars. Years queried: 2007-2009. Available from: http://www.st.nmfs.noaa.gov/st1/commercial/landings/lport_yearp.html ***2010***

Oil and Gas Structures in the Gulf of Mexico

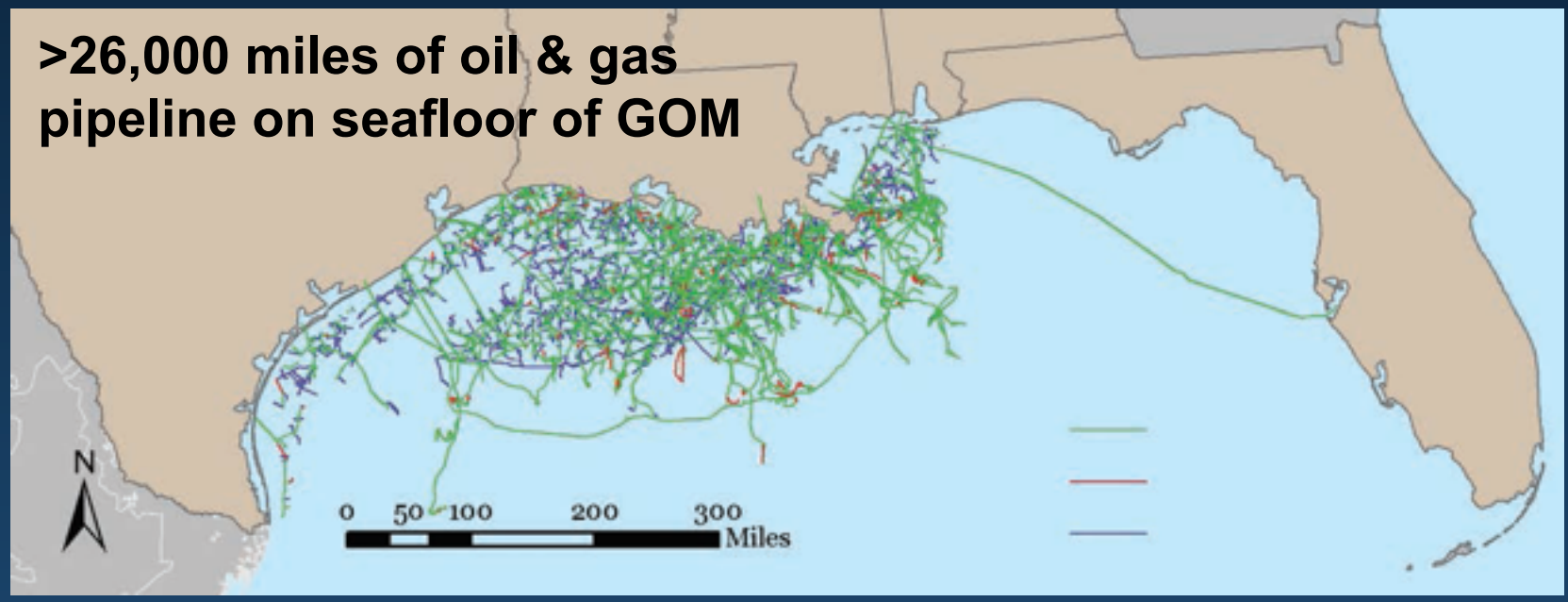
242,000 related jobs in 2010; GDP impact 26.1 Billion

29% of U.S. Domestic Crude Oil Production; 12% of Gas Production

http://www.eia.gov/special/gulf_of_mexico/map.cfm



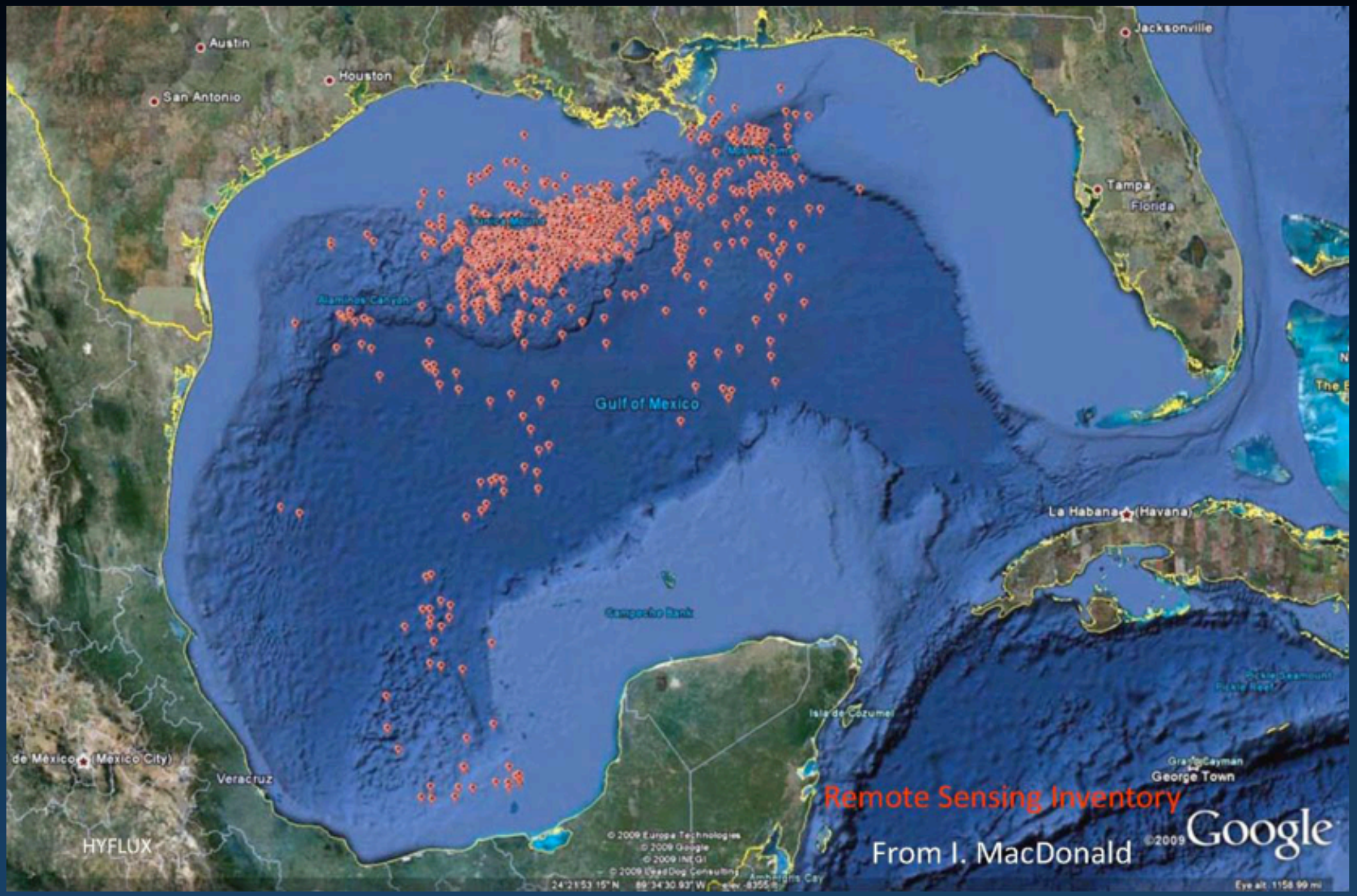
Sources: BOEMRE, 2011; USEIA, 2011



Sources: BOEMRE, 2011; USEIA, 2011

Distribution of natural seeps within the Gulf of Mexico

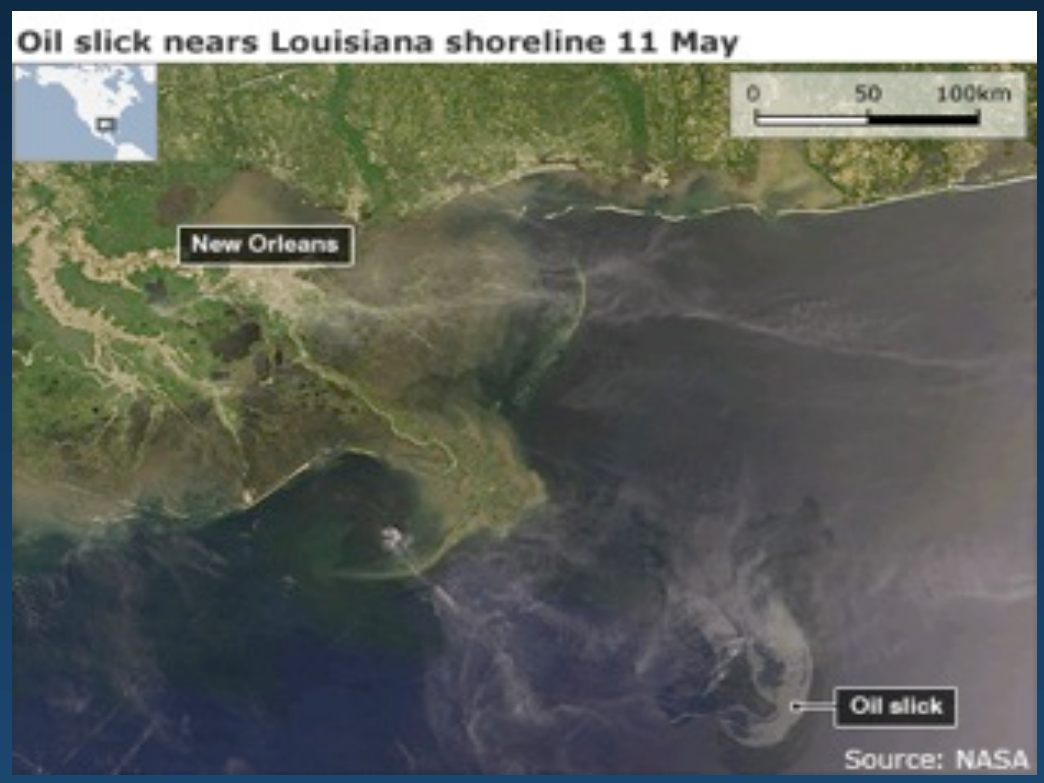
(Soley 2010, MacDonald 1998, Garcia 2009)



Deep water hydrocarbon seep (Chemosynthetic) communities (Cordes et al. 2007, 2010, Fisher et al. 2007)

April 20, 2010….

- Deepwater Horizon oil drilling platform exploded April 20, 2010
- 11 fatalities
- Rig sank on April 22
- 206 million gallons of oil escape from damaged wellhead over 87 days
- 1.9 million gallons of dispersant used to combat the spill
- Wellhead was sealed July 15, 2010



Seafood safety concerns raised by marine oil spills?

How oil can make seafood unfit for consumption:

- Potential to taint seafood with flavors and odors caused by exposure to petrochemicals
- Potential for seafood to concentrate harmful organic and inorganic petrochemicals
    - PAHs of greatest concern due to genotoxicity/ carcinogenicity

Dispersant Use

- Synthetic mixtures of chemicals introduced to oil impacted waters to disperse insoluble fractions may concentrate/ accumulate in aquatic/marine species

FDA CFSAN

Responsibilities for seafood safety in oil spill events

State Agencies

- Regulate fisheries in state territorial waters
  - MHW to 3 nautical miles seaward
  - Exception FL & TX (9 nautical miles)

NOAA

- Regulate fisheries in federal waters
  - 3 or 9 to 200 nmi (EEZ)

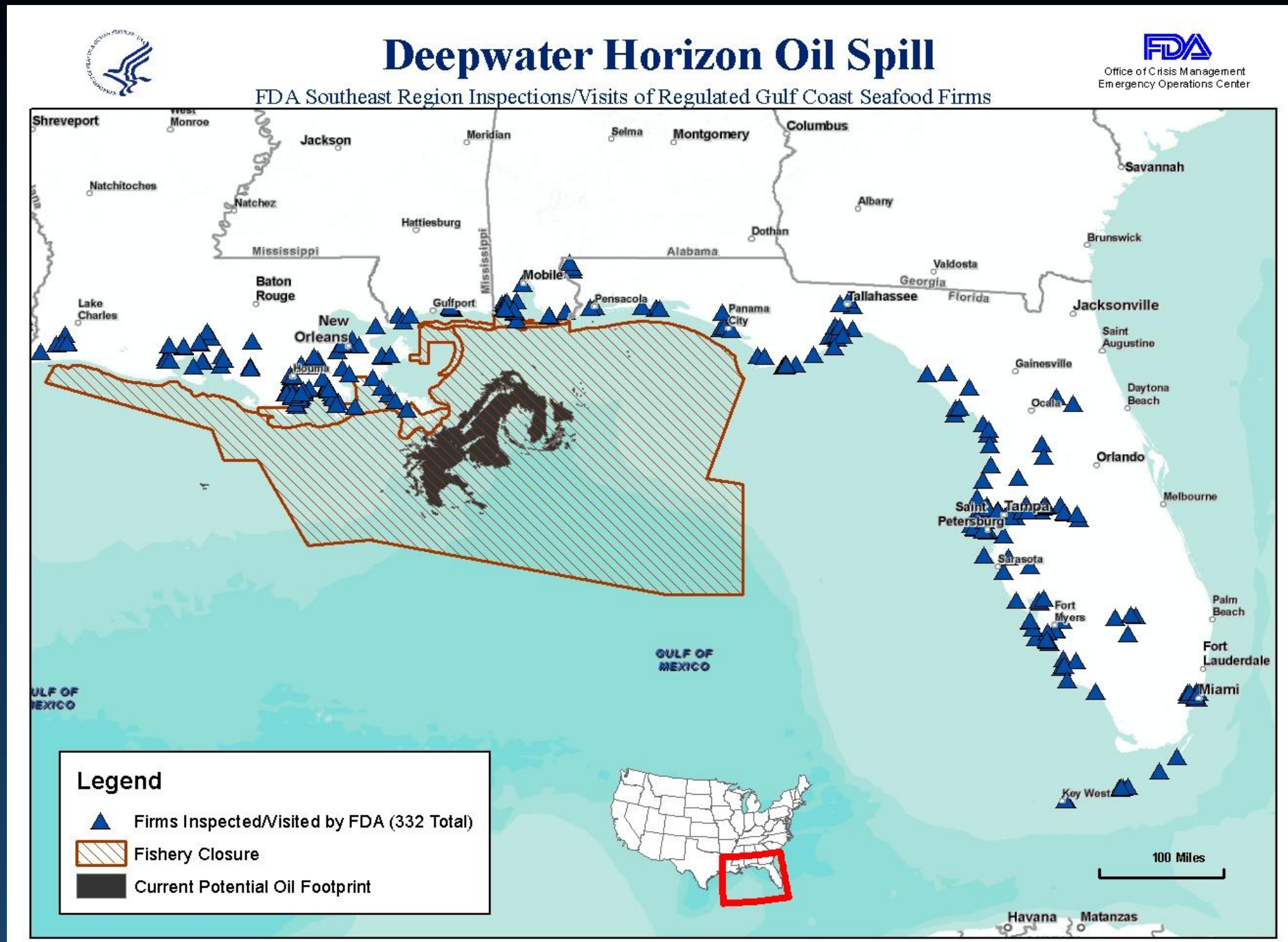
FDA

- Regulates food & seafood in interstate commerce
- Principal mission is to support States in reopening territorial waters & coordinate with NOAA to reopen federal waters
- Employs incident command structure to coordinate seafood safety response with NOAA & State health and marine resource agencies

Protective measures implemented during the spill

- Closure of oil-spill impacted waters to commercial & recreational watercraft and fishing
- Closure of areas expected to be impacted by oil to commercial or recreational watercraft and fishing
- Testing of seafood from open waters to verify that closures were protective
- Inspection of primary seafood processors & wholesalers in impacted region
- Development of protocol and criteria for re-opening fisheries

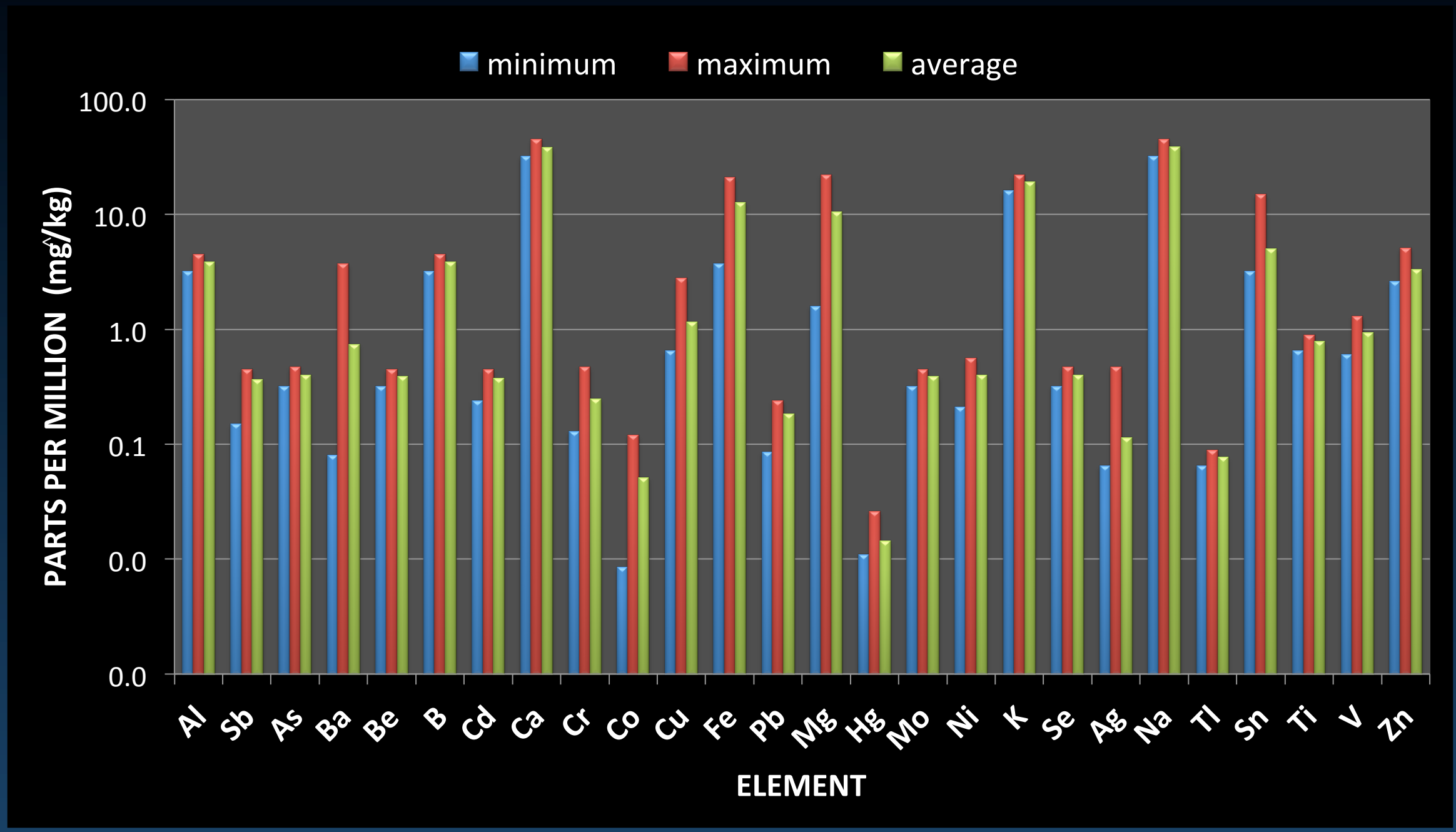
FDA visited Gulf coast seafood firms to inform and ensure seafood marketed during the spill originated from open waters



Map Contains Confidential Information | FOUO | Updated on 23 July 2010 by NBeck | Sources: FDA, NOAA

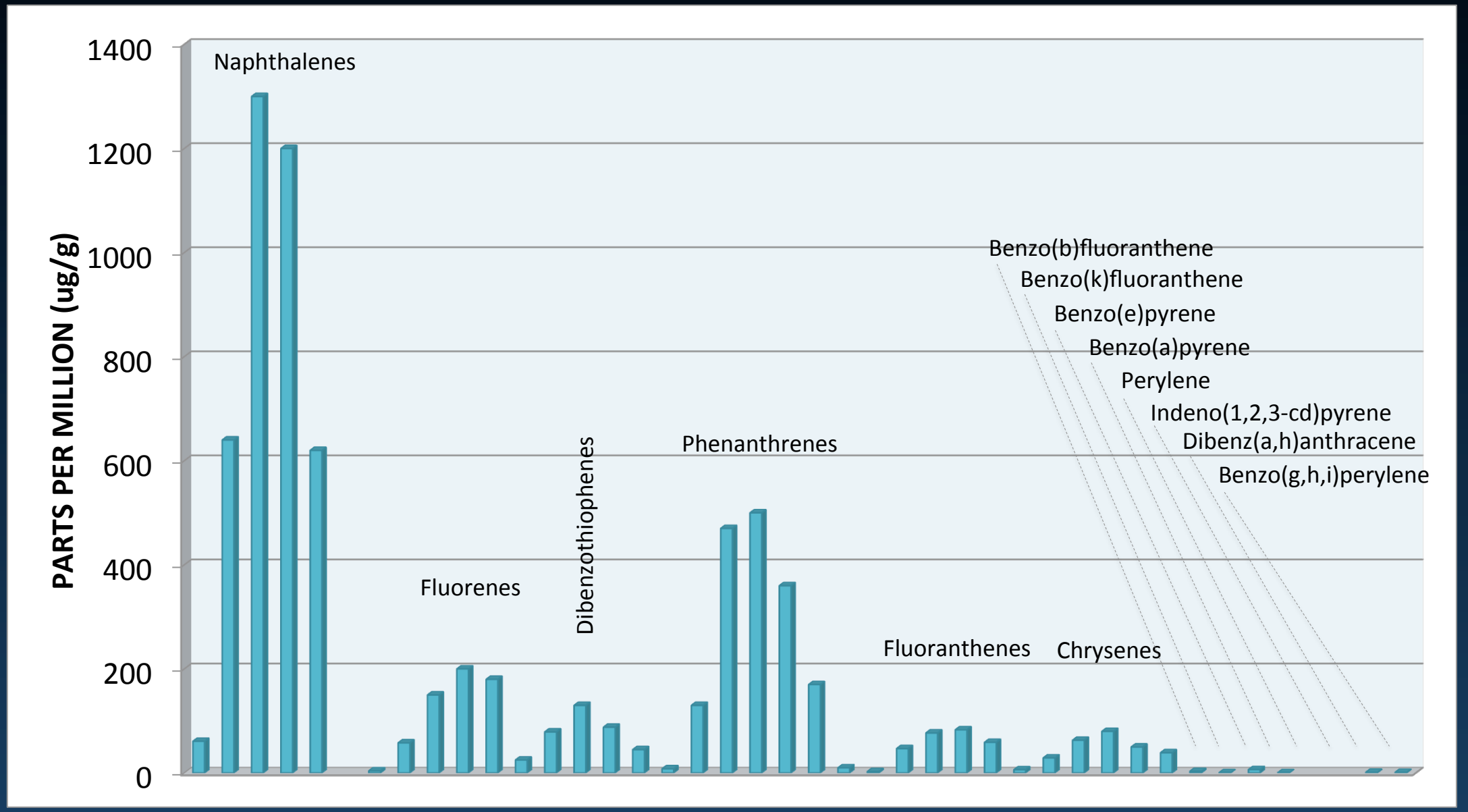
Deepwater Horizon MC252 Source Oil Metals Analysis

EPA August 26-28, 2010 (n = 10 – 20)



Deepwater Horizon MC252 Source Oil Aromatics (PAH) Analysis

ARL May 27, 2010



Fisheries re-opening protocol development

- Developed by federal and state public health agencies (LA, MS, AL, FL, TX, FDA, EPA, NOAA)
- Established criteria for assessing seafood safety and decision-making
- Established procedures for sampling and testing seafood to verify safety before fisheries would be reopened

Levels of Concern for Deepwater Horizon Oil Spill

For PAH with cancer end points estimates of contamination levels and consumption rates that, if sustained for period of 5 years, may result in excess consumer lifetime cancer risk of 1 x 10^{-5}

Chemical[1]	Levels of Concern (ppm)			Basis
	13 g/day (Shrimp & Crab)	12 g/day (Oysters)	49 g/day (Finfish)	
Naphthalene	123	133	32.7	Non-cancer EPA RfD[2]; 80kg bw
Fluorene	246	267	65.3	Non-cancer EPA RfD[2]; 80kg bw
Anthracene/Phenanthrene	1846	2000	490	Non-cancer EPA RfD[2]; 80kg bw
Pyrene	185	200	49.0	Non-cancer EPA RfD[2]; 80kg bw
Fluoranthene	246	267	65.3	Non-cancer EPA RfD[2]; 80kg bw
Chrysene	132	143	35.0	Cancer BaPE (TEF = 0.001)
Benzo(k)fluoranthene	13.2	14.3	3.5	Cancer BaPE (TEF = 0.01)
Benzo(b)fluoranthene	1.32	1.43	0.35	Cancer BaPE (TEF = 0.10)
Benz(a)anthracene	1.32	1.43	0.35	Cancer BaPE (TEF = 0.10)
Indeno(1,2,3-cd)pyrene	1.32	1.43	0.35	Cancer BaPE (TEF = 0.10)
Dibenz(a,h)anthracene	0.132	0.143	0.035	Cancer BaPE (TEF = 1.0)
Benzo(a)pyrene	0.132	0.143	0.035	10^5 Cancer Risk = 0.110 μg/person/day (78/5 yr)

[1] Includes alkylated homologues C1,C2,C3,C4 naphthalenes, C1,C2,C3 fluorenes, and combined C1,C2,C3,C4 Anthracene/phenanthrenes. Sum of ratios, measured to LOC may not exceed 1.

FDA CFSAN

Range of concentrations (ppb) of select PAHs in major food groups

Extracted examples from Table 13 of
FAO/WHO 2006 Evaluation of Certain Food Contaminants. WHO Technical Report Series 930. Geneva: WHO, International Programme on Chemical Safety. Available: http://whqlibdoc.who.int/trs/WHO_TRS_930_eng.pdf [accessed 7 October 2011].

PAH	Meat & meat products[a]	Fish & seafood[a]	Vegetables	Fruits & confections[b]	Cereals & cereal products[c]	Beverages	Oils & fats	Dairy products[d]
Naphthalene	0.9 – 55	ND – 156	0.06 – 0.5	0.18 – 4.3	2.6	-	ND – 57	0.27 – 0.9
Pyrene	1.2 – 452	ND – 217	ND – 70	ND – 12	ND – 48	ND – 9.3	MD – 330	ND – 4.8
Benzo[a]pyrene	ND – 212	ND – 173	ND – 25	ND – 1.5	ND – 5.4	ND – 0.6	ND - 164	ND – 1.3
Benzo(b)fluoranthene[f]	ND – 197	ND – 134	ND – 28.7	ND – 3.5	0.03 – 1.3	ND – 0.65	ND – 91	ND – 0.7
Benzo(k)fluoranthene	ND –172	ND – 55	ND – 17	ND – 0.2	0.02 – 1.4	ND – 0.24	ND – 99	ND – 0.1

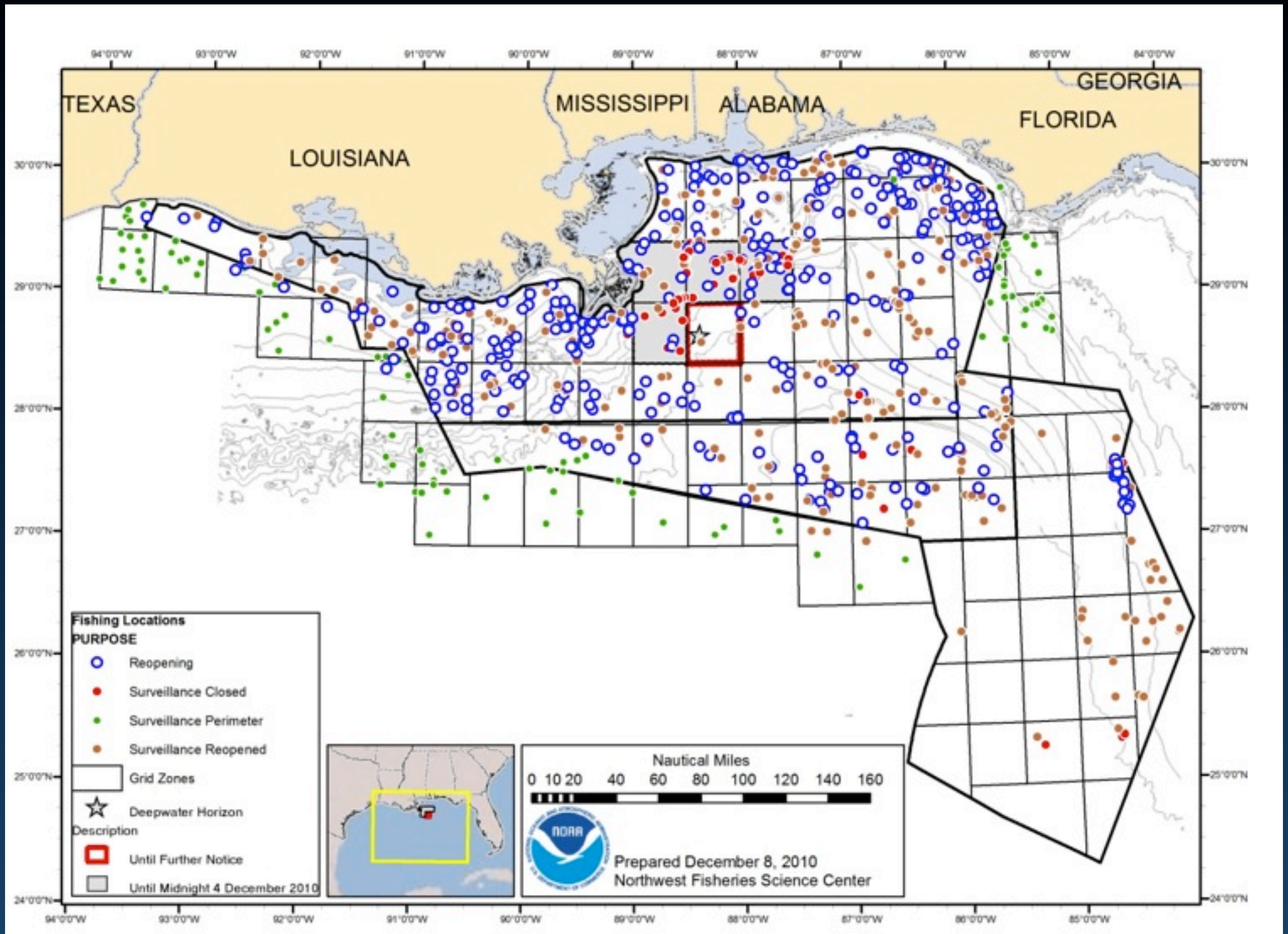
Note: compounds shown in bold were considered by the Committee to be genotoxic and carcinogenic.
ND: not detected; PAH: polycyclic aromatic hydrocarbon
a Includes grilled and smoked foods and smoke flavouring food additives
b Includes sweets and sugar
c Includes biscuits, bread, bran and breakfast cereals
d Includes butter and cheese
f Reported as sum with benzo(j + b + k)fluoranthenes in some publications

Seafood Samples Collected for Testing

Greatest to Least Risk for contamination

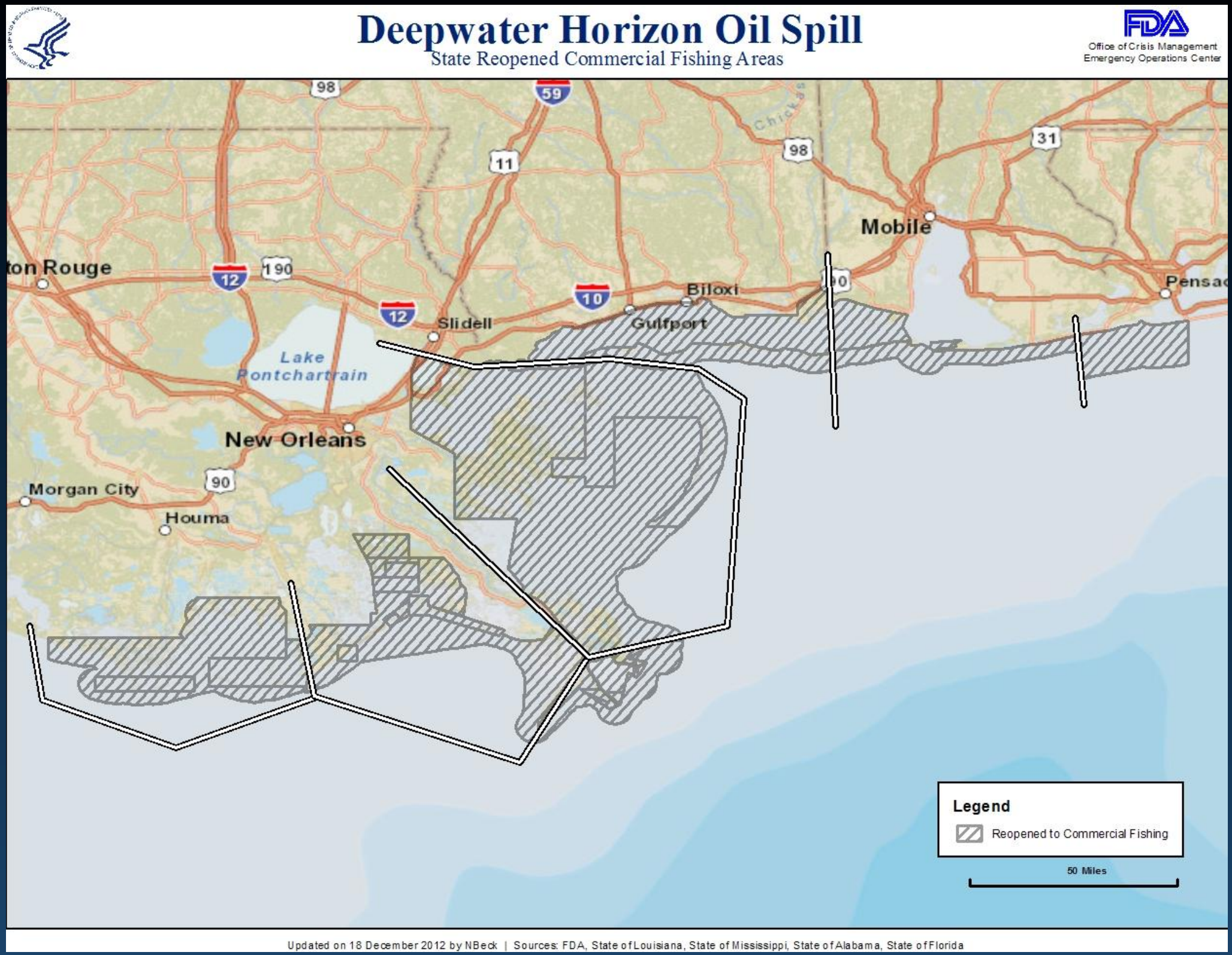
- Oysters
- Crab
- Shrimp
- Finfish

Sampling Areas in Federal Waters



Sampling coordinated through NMFS/SEFSC — Mississippi Laboratories

Sampling Areas in State Territorial Waters

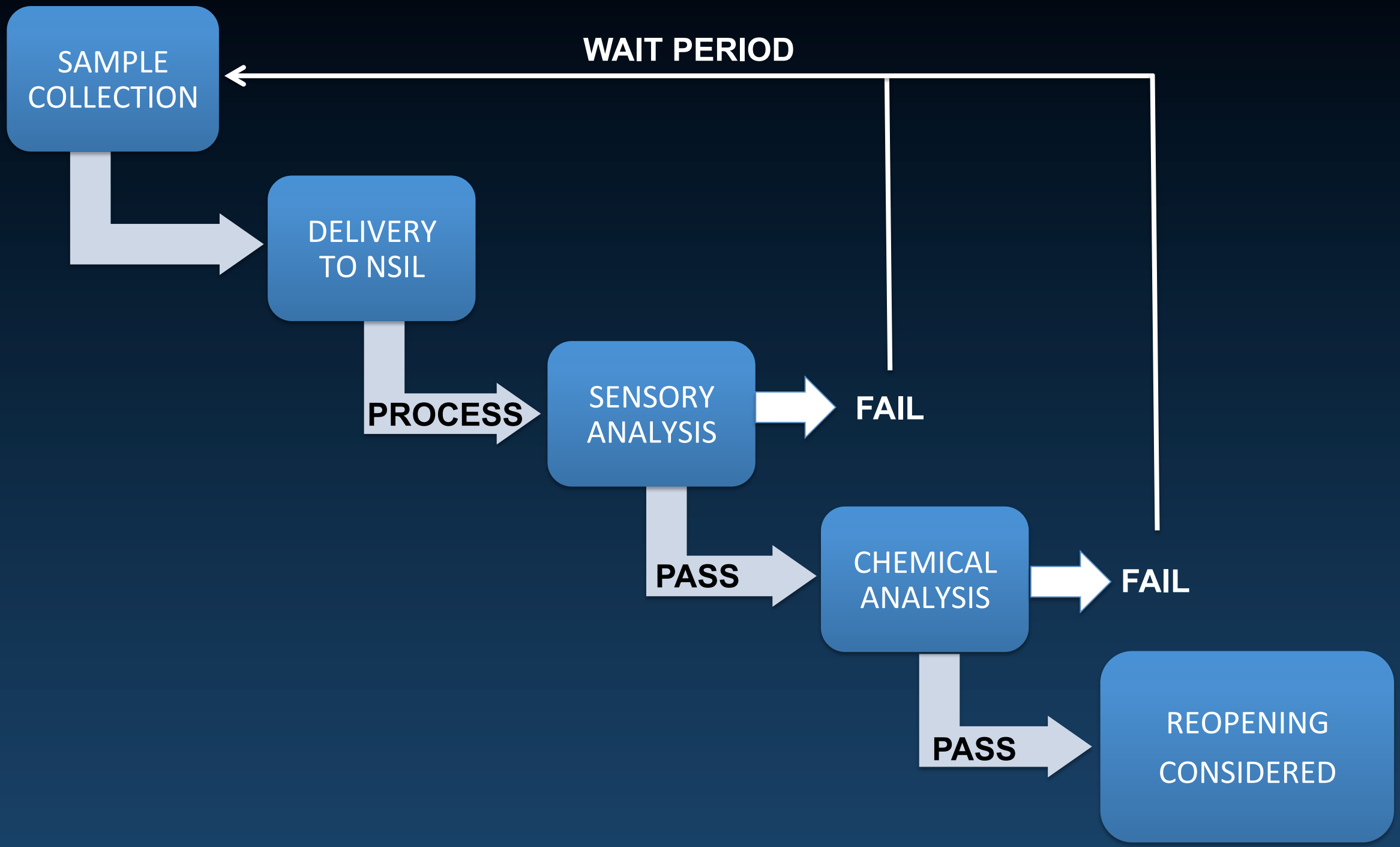


Samples Delivered to Federal and FERN Laboratories Across the Nation for Method Development & Testing

- FDA Division of Analytical Chemistry, MD
- FDA Division of Seafood Science and Technology, AL
- FDA Arkansas Regional Laboratory, AR
- FDA Southeast Regional Laboratory, GA
- Connecticut Agri. Exp. Station
- Minnesota Department of Agriculture
- FDA Kansas City District Laboratory, Kansas
- FDA Denver District Laboratory, CO
- NOAA Northwest Fisheries Science Center, WA
- California Animal Health and Food Safety
- Florida Dept. of Agriculture
- Wisconsin Dept. of Agriculture
- Arizona Department of Health Services

FDA CFSAN

SEAFOOD SAMPLE FLOW



Testing to Re-open Waters (June – November 2010)
Extended Testing After Re-opening (October 2010 – August 2011)

METHODS

SENSORY (ORGANOLEPTIC)

Reilly, TI, and York, RK (2001) Guidance on Sensory Testing and Monitoring of Seafood for Presence of Petroleum Taint following an Oil Spill. NOAA Technical Memorandum NOS OR&R 9. Seattle: Office of Response and Restoration, National Oceanic and Atmospheric Administration. 109 pp.

GAS CHROMATOGRAPHY – MASS SPECTROMETRY

Sloan CA, et al. (2005) Determining aromatic hydrocarbons and chlorinated hydro- carbons in sediments and tissues using accelerated solvent extraction and gas chromatography/mass spectrometry. Techniques in Aquatic Toxicology, ed Ostrander GK (CRC Press, Boca Raton, FL), pp 631–651.

LIQUID CHROMATOGRAPHY – FLUORESCENCE

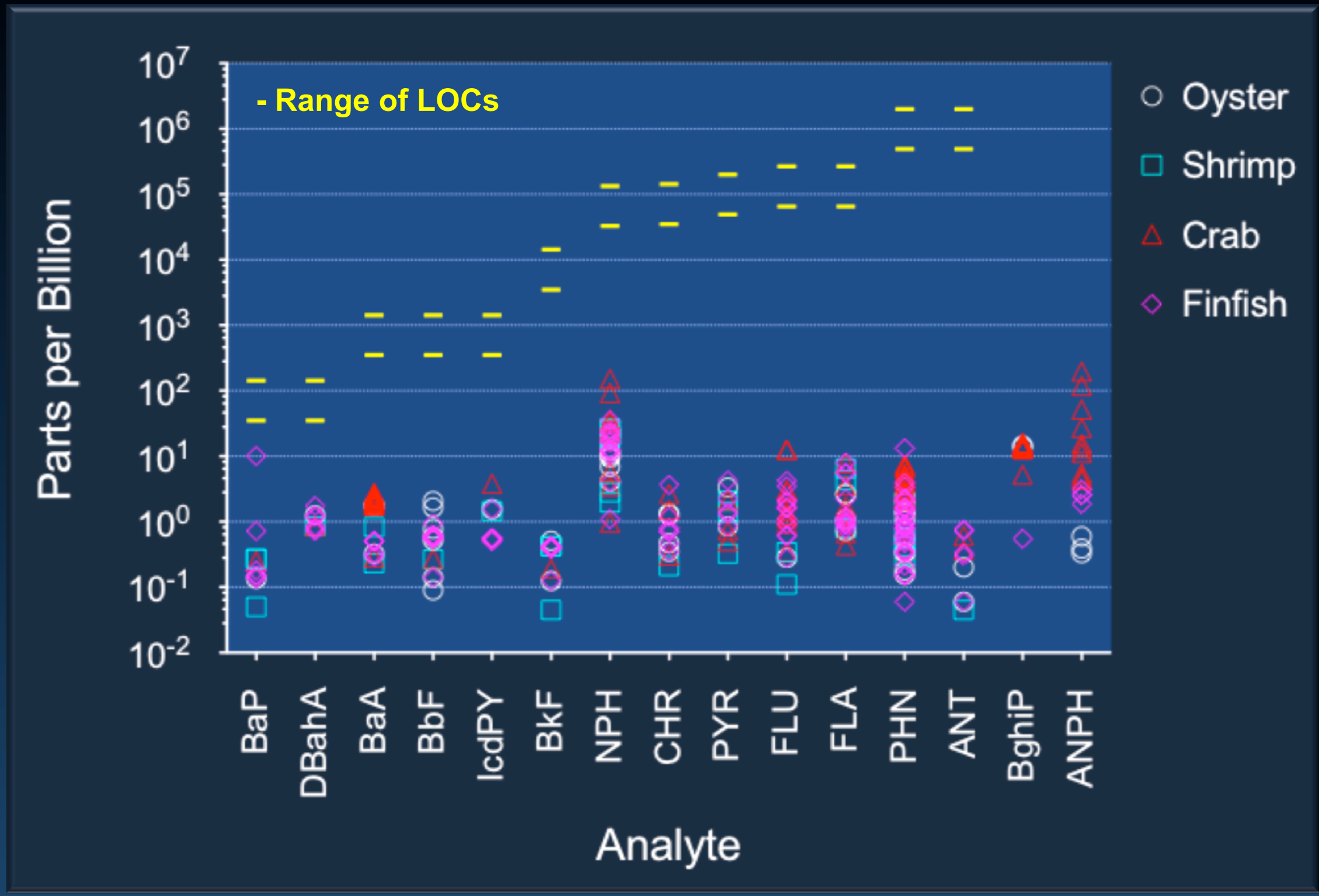
Gratz et al., 2010. Screen for the Presence of Polycyclic Aromatic Hydrocarbons in Select Seafoods Using LC-Fluorescence. U.S. FDA Laboratory Information Bulletin No. 4475, 39 pp

Available at www.fda. gov/downloads/ScienceResearch/UCM220209.pdf.

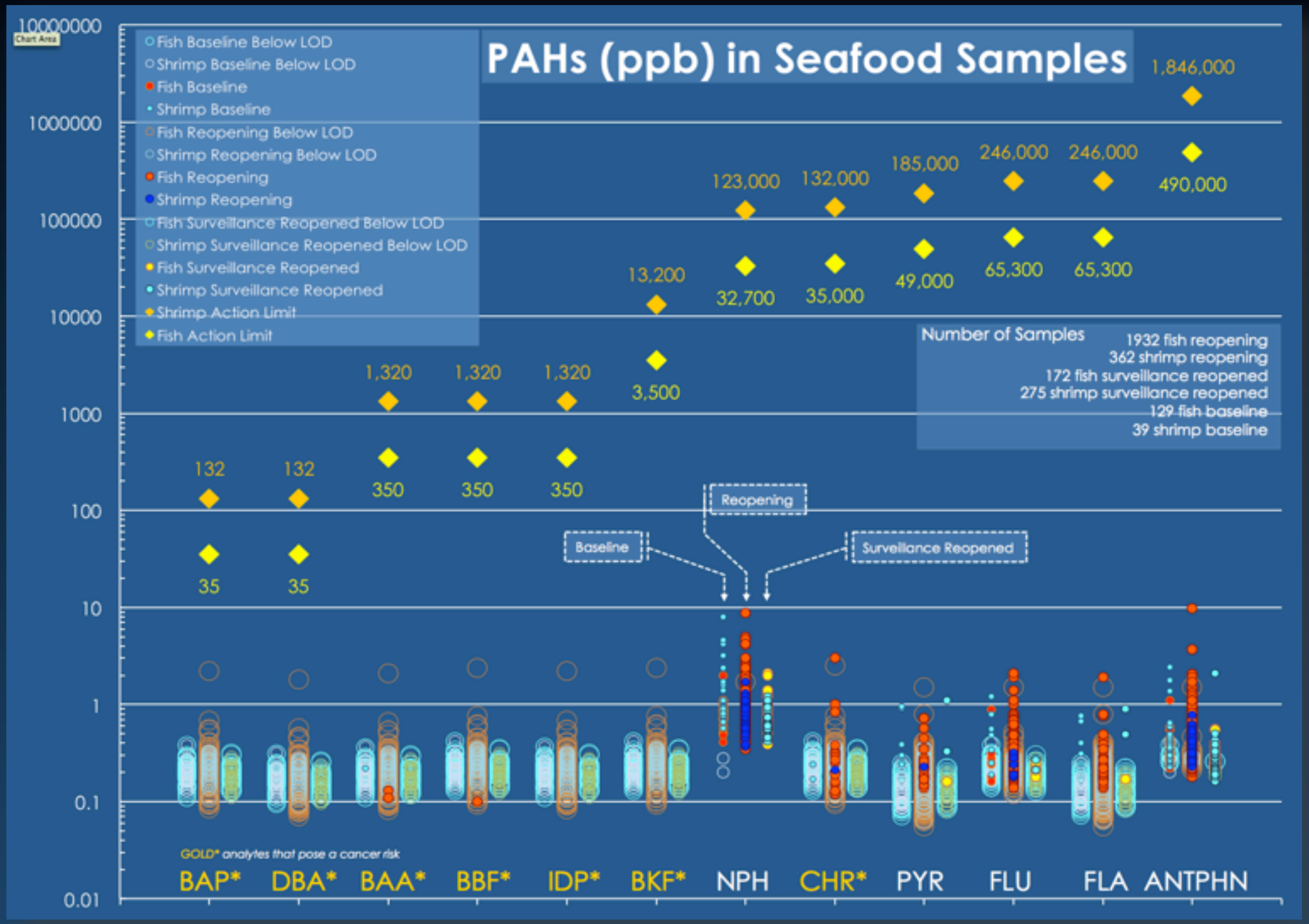
LIQUID CHROMATOGRAPHY – MASS SPECTROMETRY

Flurer RA, et al. (2010) Determination of Dioctylsulfosuccinate in Select Seafoods Using a QuEChERS Extraction with Liquid Chromatography-Triple Quadrupole Mass Spectrometry. Available at http:// www.fda.gov/downloads/ScienceResearch/FieldScience/UCM231510.pdf.

FDA Gulf State Territorial Waters
Seafood Re-Opening Sample PAH Testing Results



NOAA/NWFSC Gulf Federal Waters
Seafood Re-Opening Sample PAH Testing Results



Northwest Fisheries Science Center

Perspective on PAHs & Metals in Aquatic Species From the NOAA Mussel Watch Program National Status & Trends, Since 1986

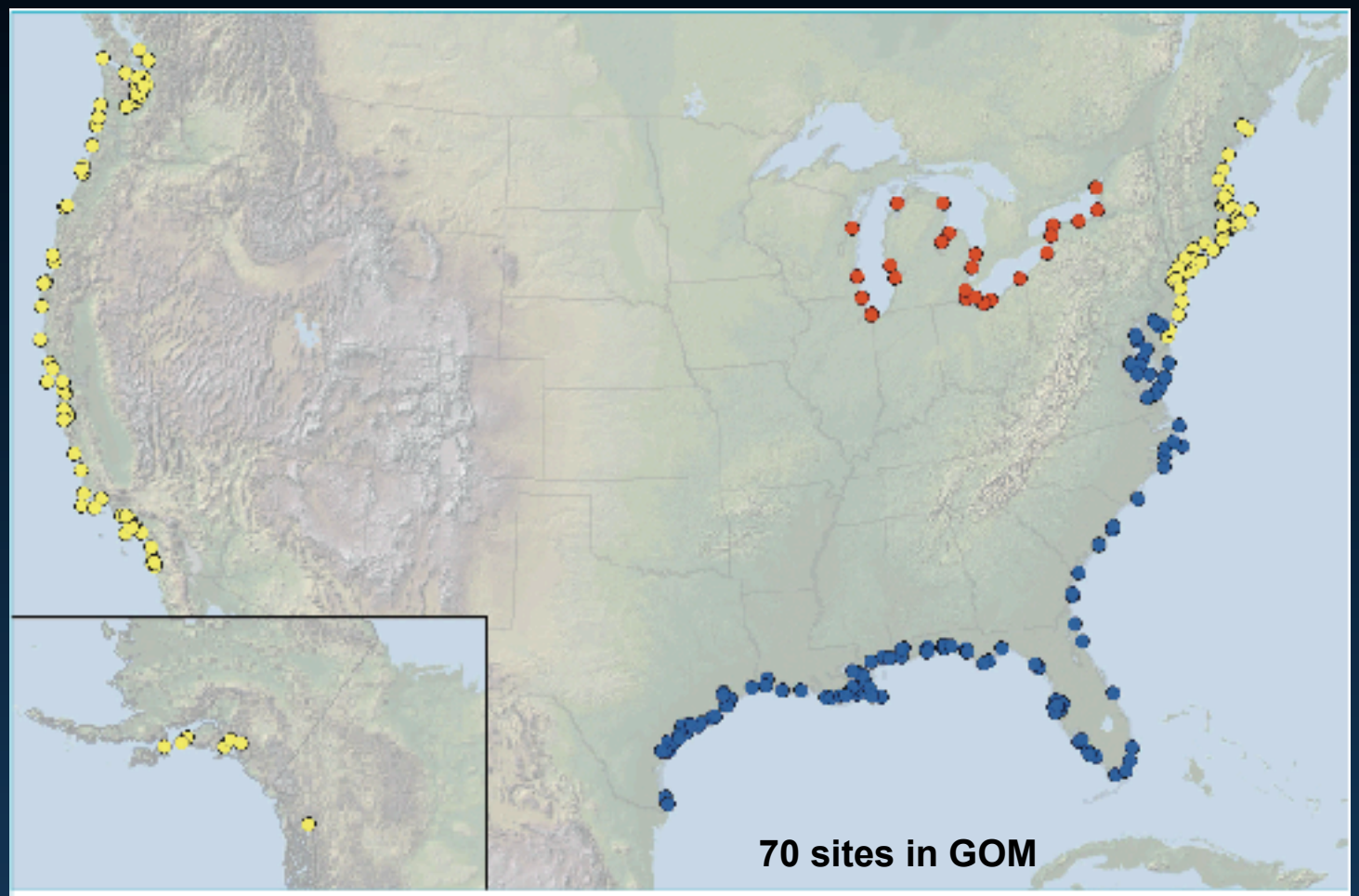


FIGURE 1. Distribution of oysters (*Crassostrea virginica*), mussels (*Mytilus species*), and zebra mussels (*Dreissena species*) collected and measured as part of the Mussel Watch Program.

MUSSELS (*MYTILUS SPECIES*)
OYSTERS (*CRASSOSTREA VIRGINICA*)
ZEBRA MUSSELS (*DREISSENA SPECIES*)

Program at a Glance

Approximately 300 monitoring sites in the Continental U.S., Alaska, Puerto Rico and Hawaii

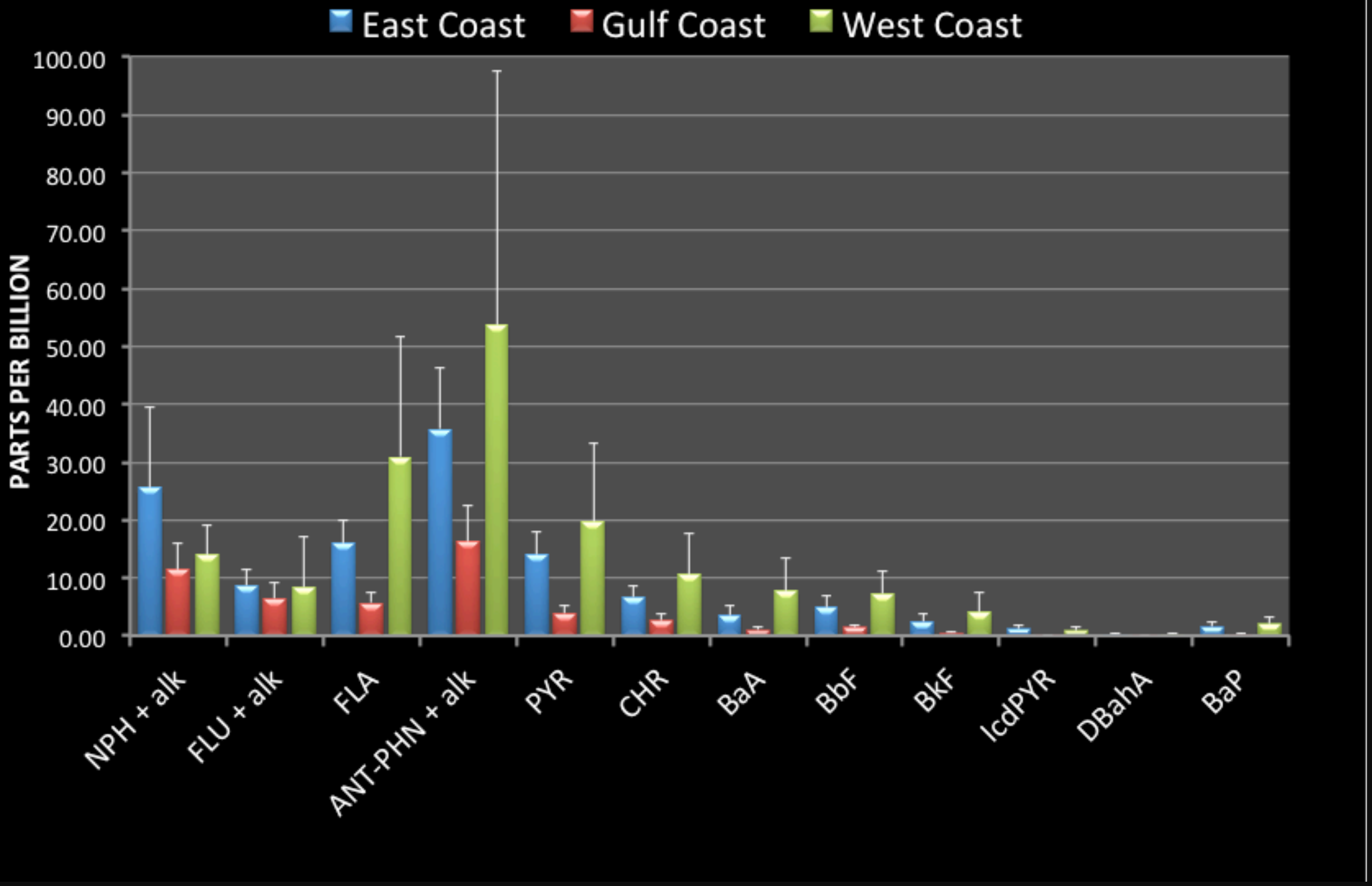
Stations 10 to 100 km apart along the entire U.S. coastline

Approximately 140 contaminants monitored in resident bivalve populations

51 PCB congeners
65 PAHs
17 Metals and Metalloids

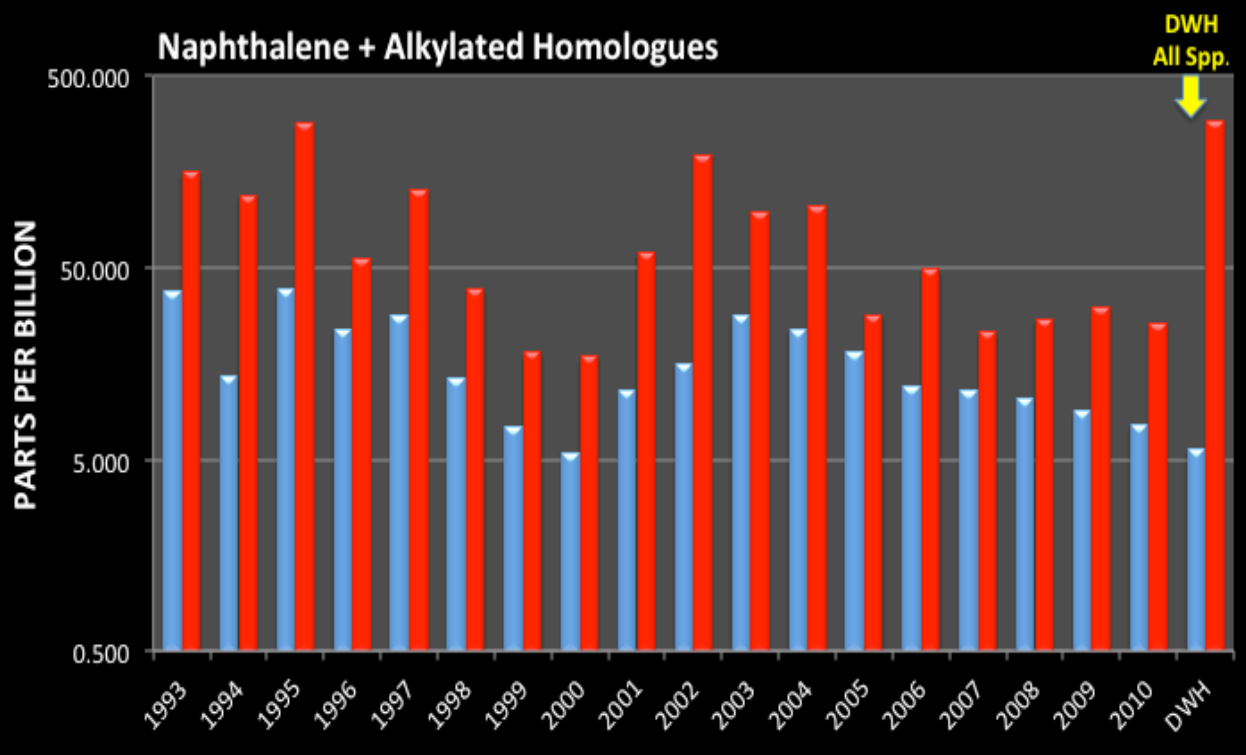
Kimbrough, K.L., Johnson, W.E., Lauenstein, G.G., Christensen, J.D., and Apeti, D.A. 2008. An Assessment of Two Decades of Contaminant Monitoring in the Nation's Coastal Zone. Silver Spring, MD. NOAA Technical Memorandum NOS NCCOS 74. 105 pp.

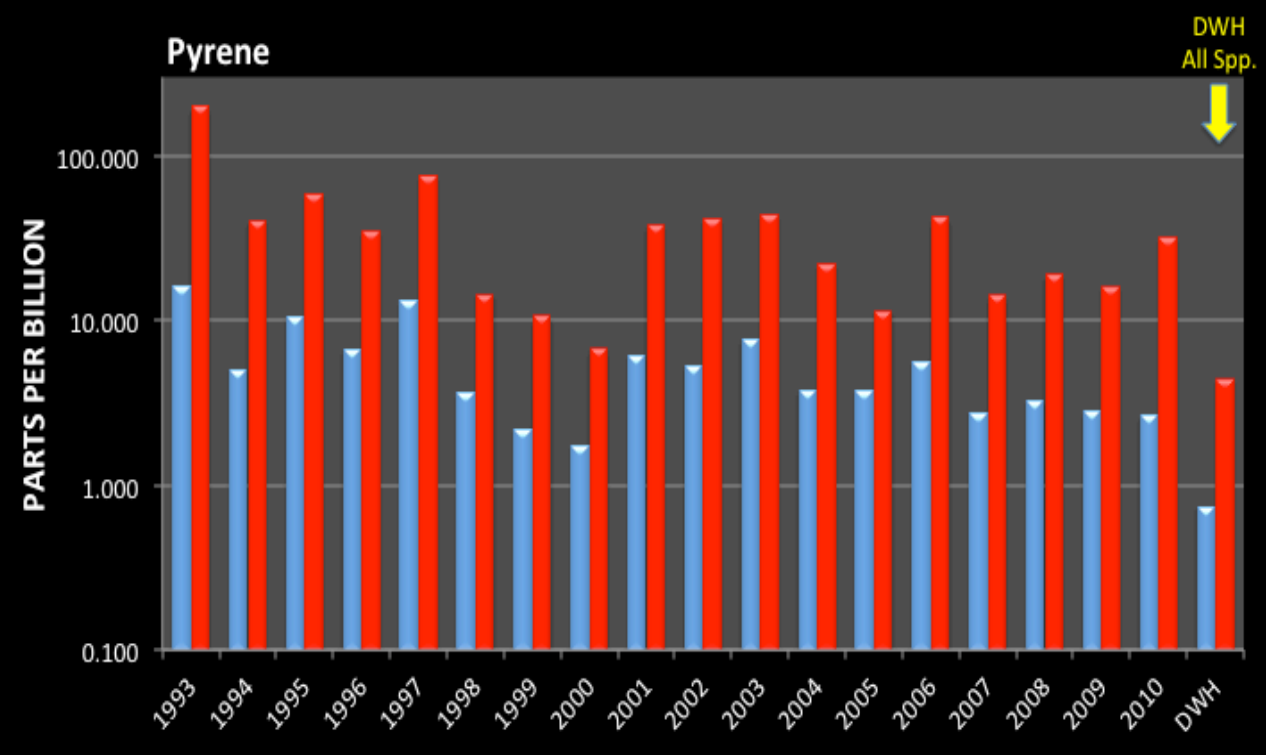
10-Year Average PAH Levels in Shellfish from U.S. East Coast, Gulf of Mexico, and West Coast 2000 - 2009

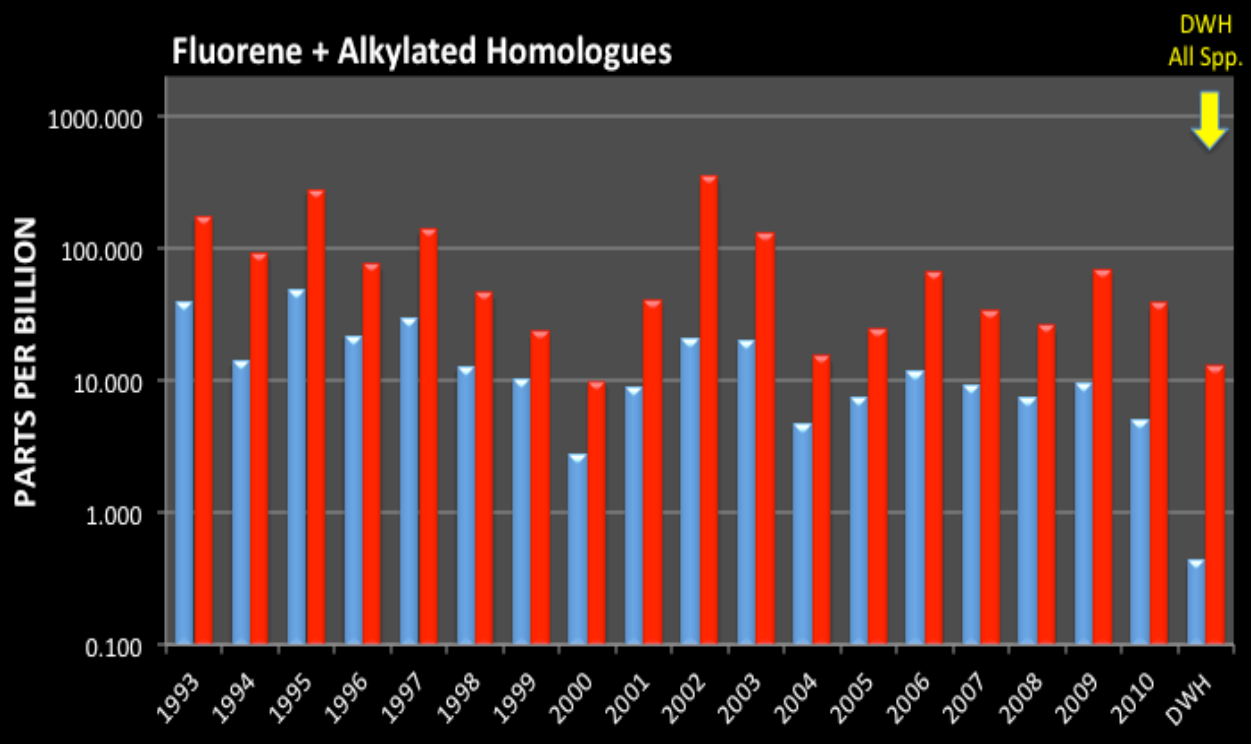


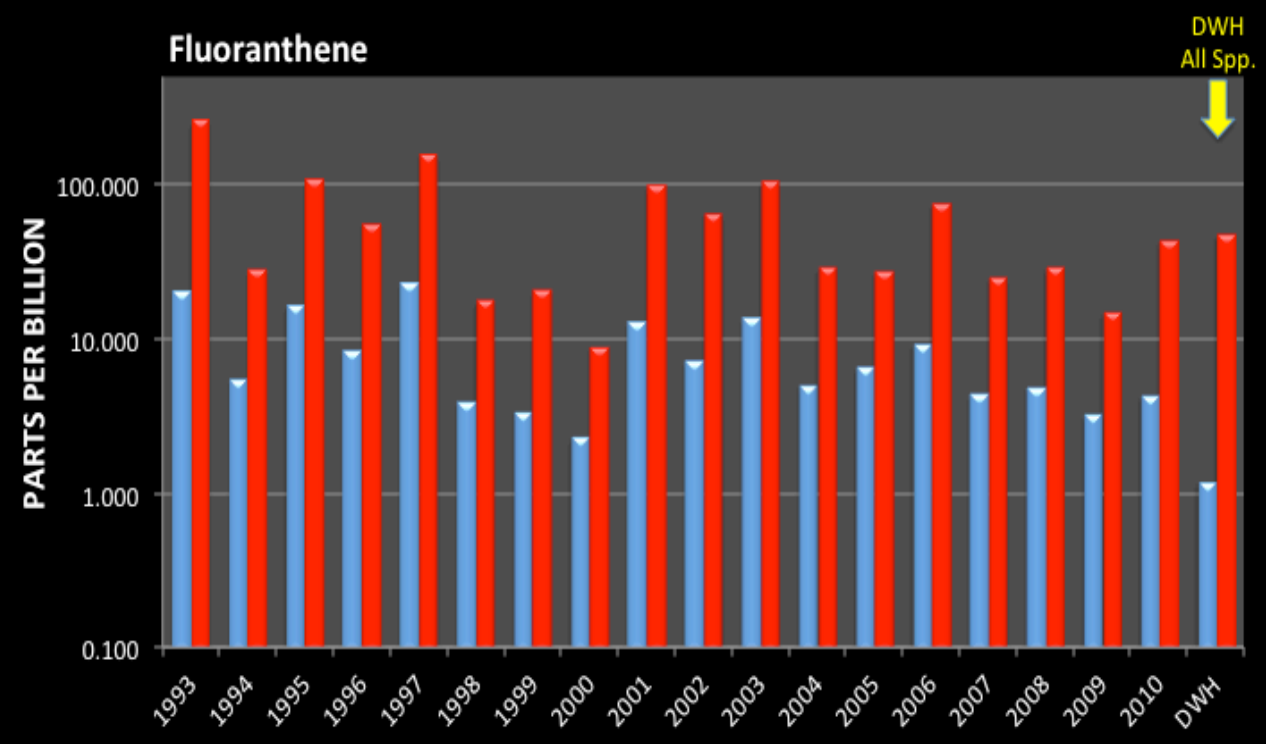
North Central Gulf of Mexico Shellfish PAH Levels

= Average = Maximum









Division of Seafood Science and Technology

NOAA National Status & Trends Mussel Watch Program

North Central Gulf of Mexico Shellfish PAH Levels

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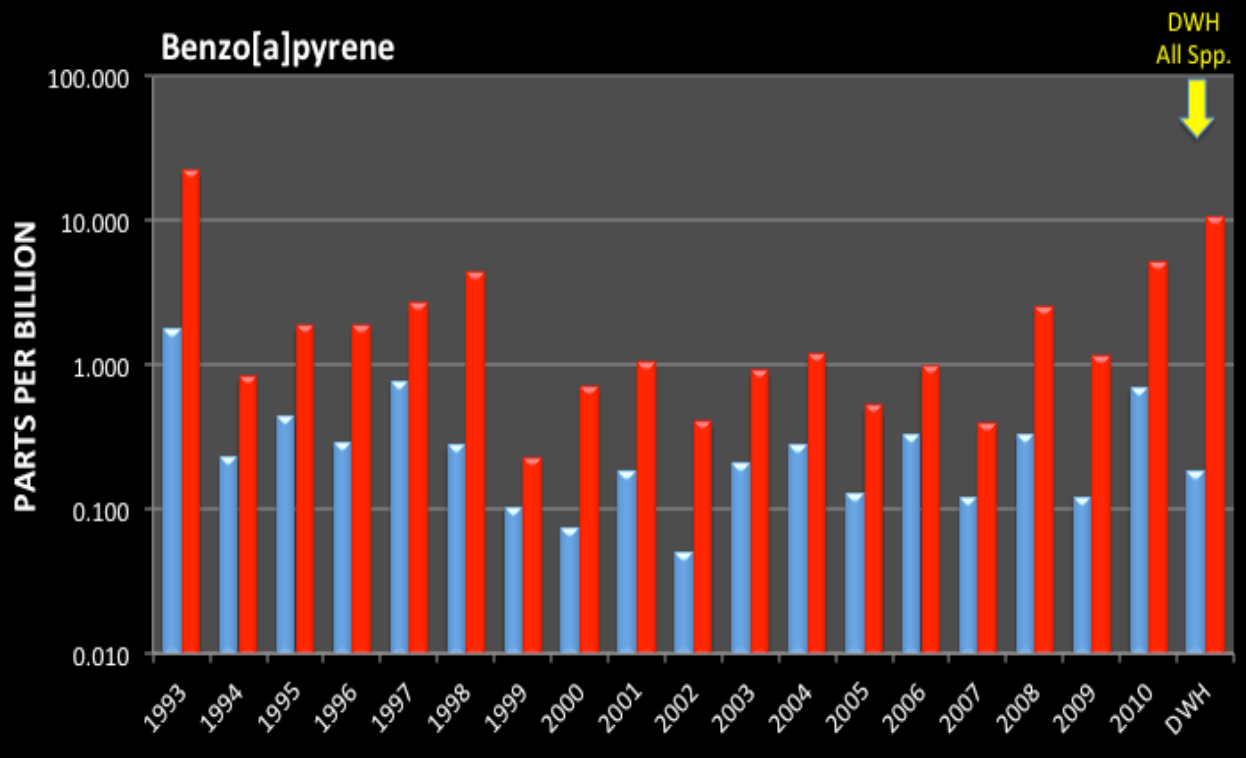

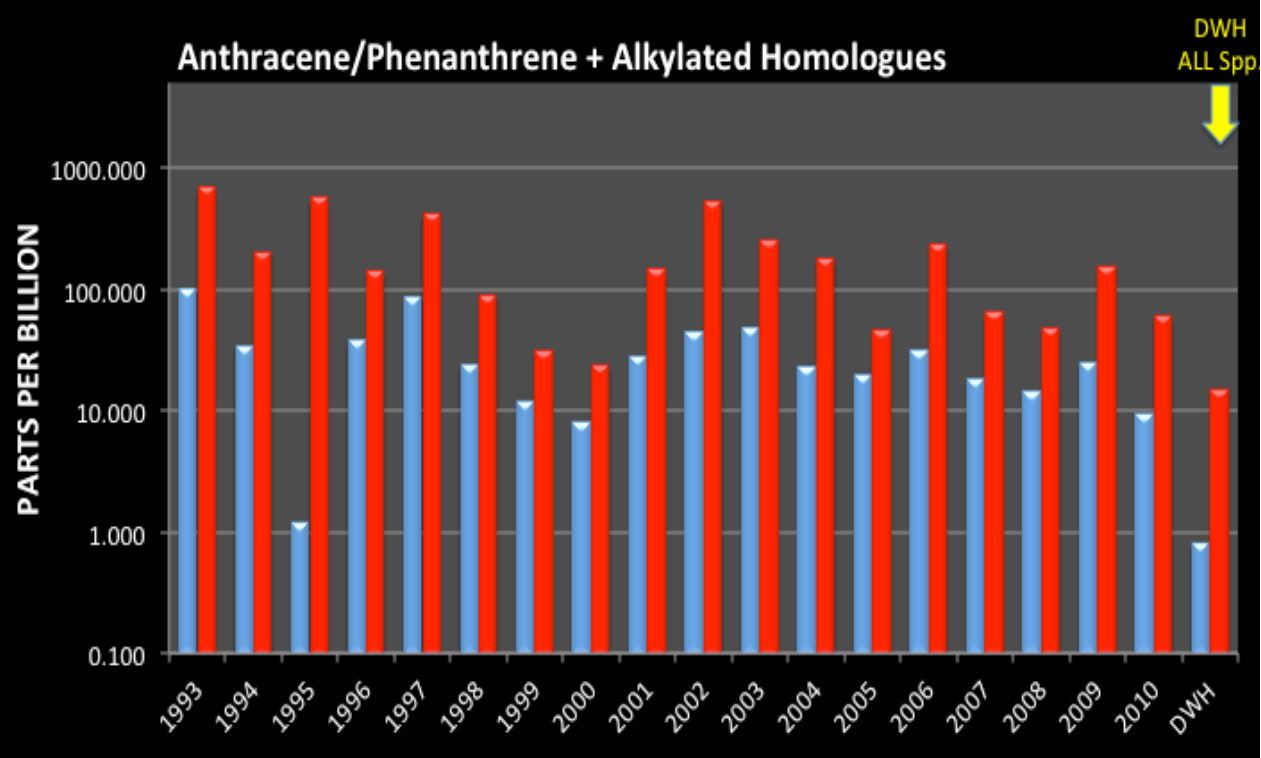

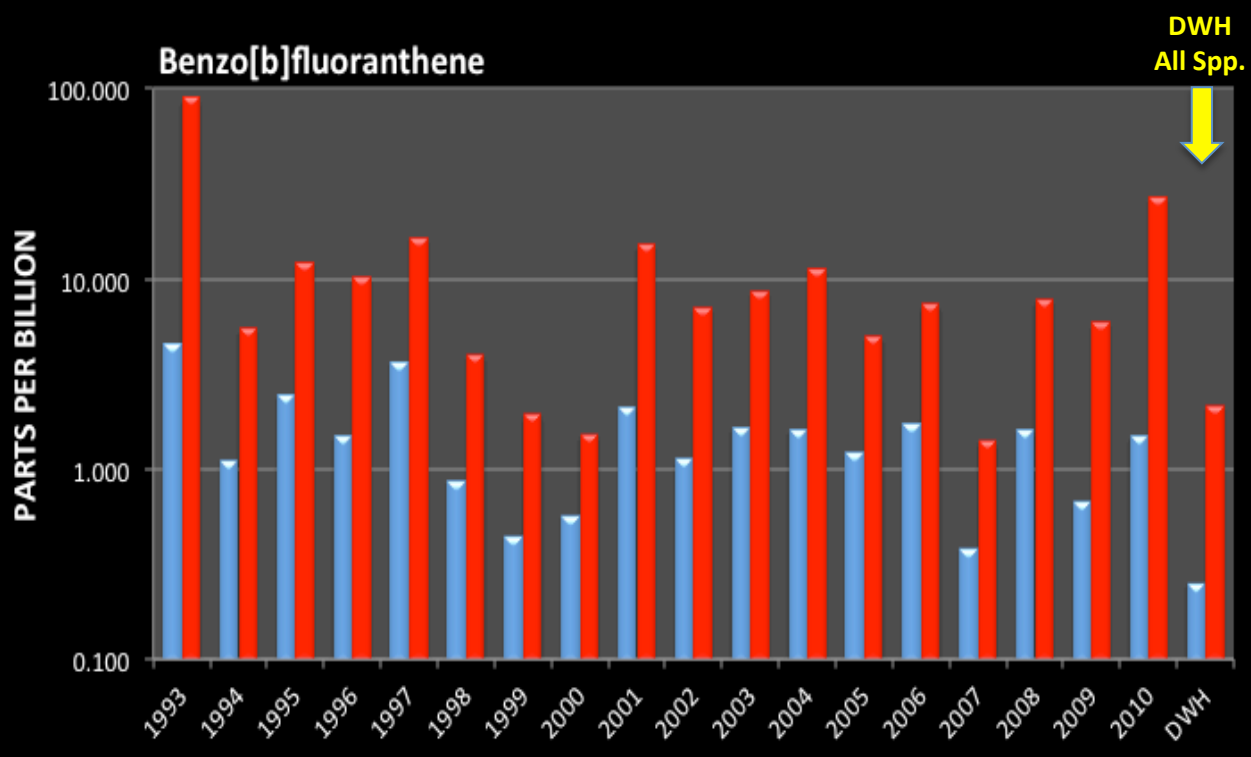

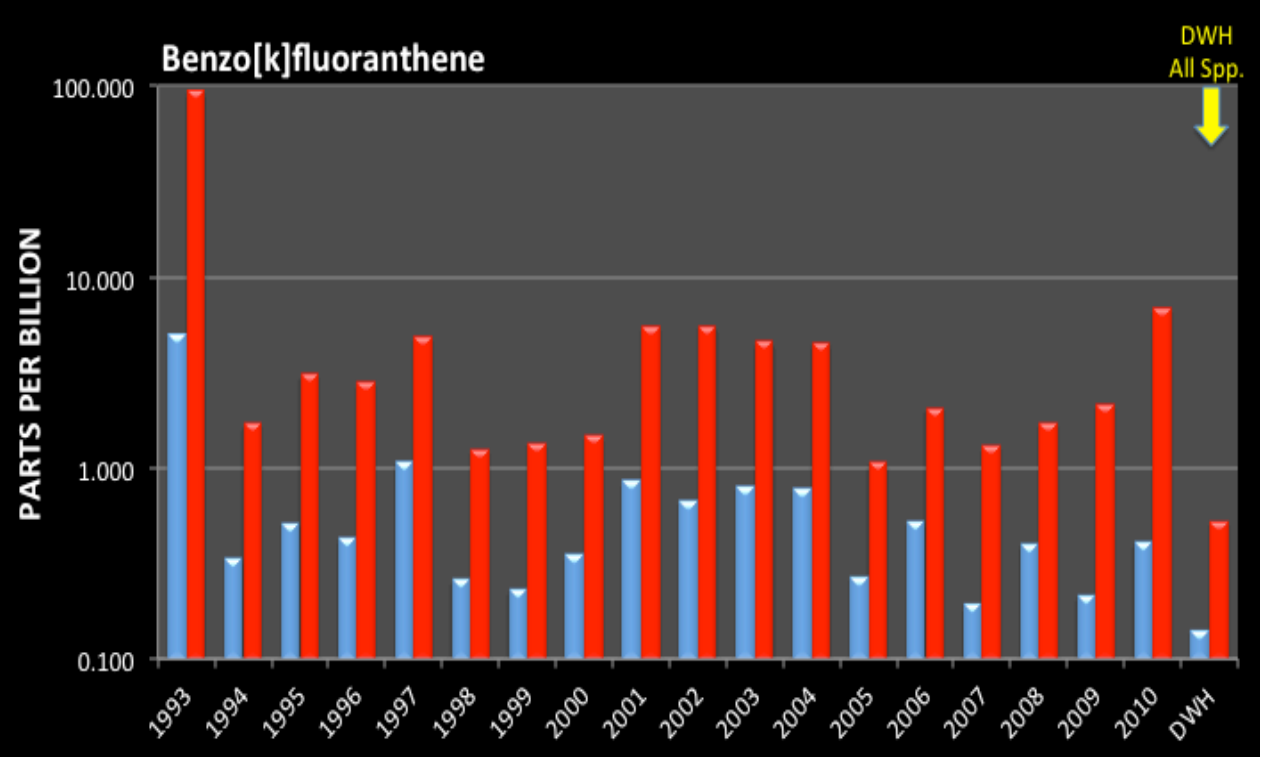

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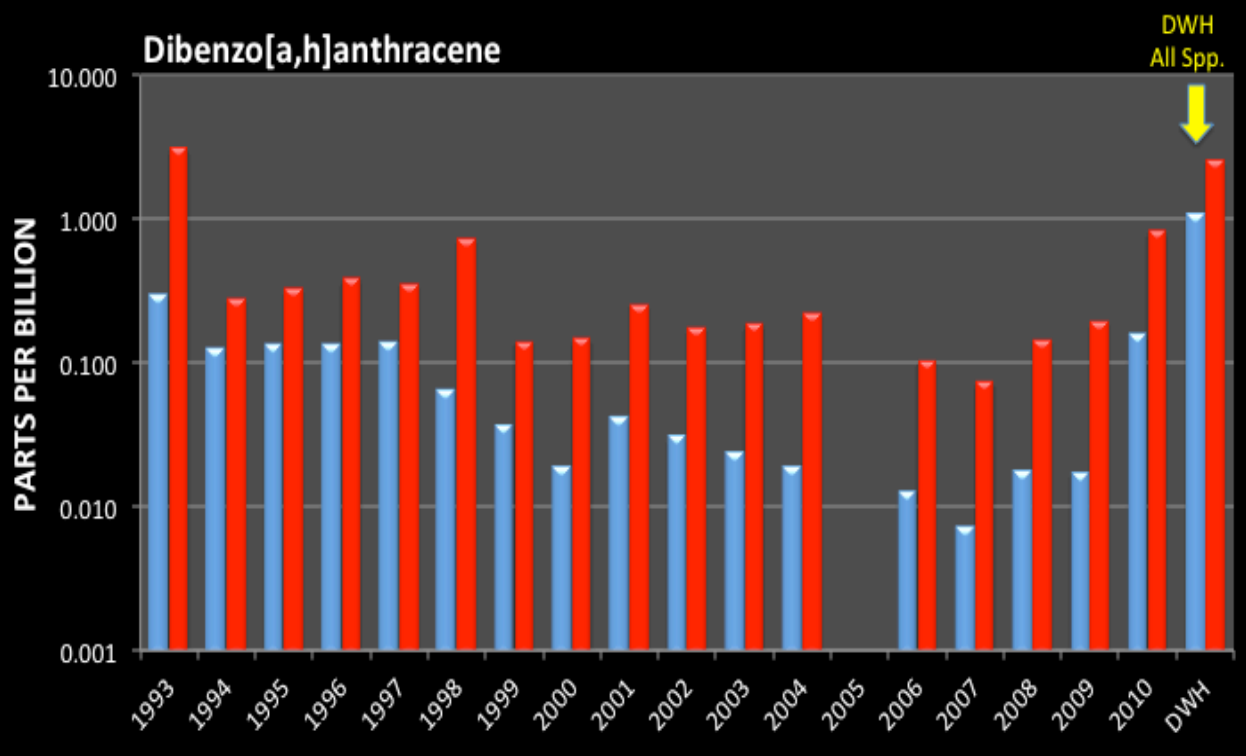
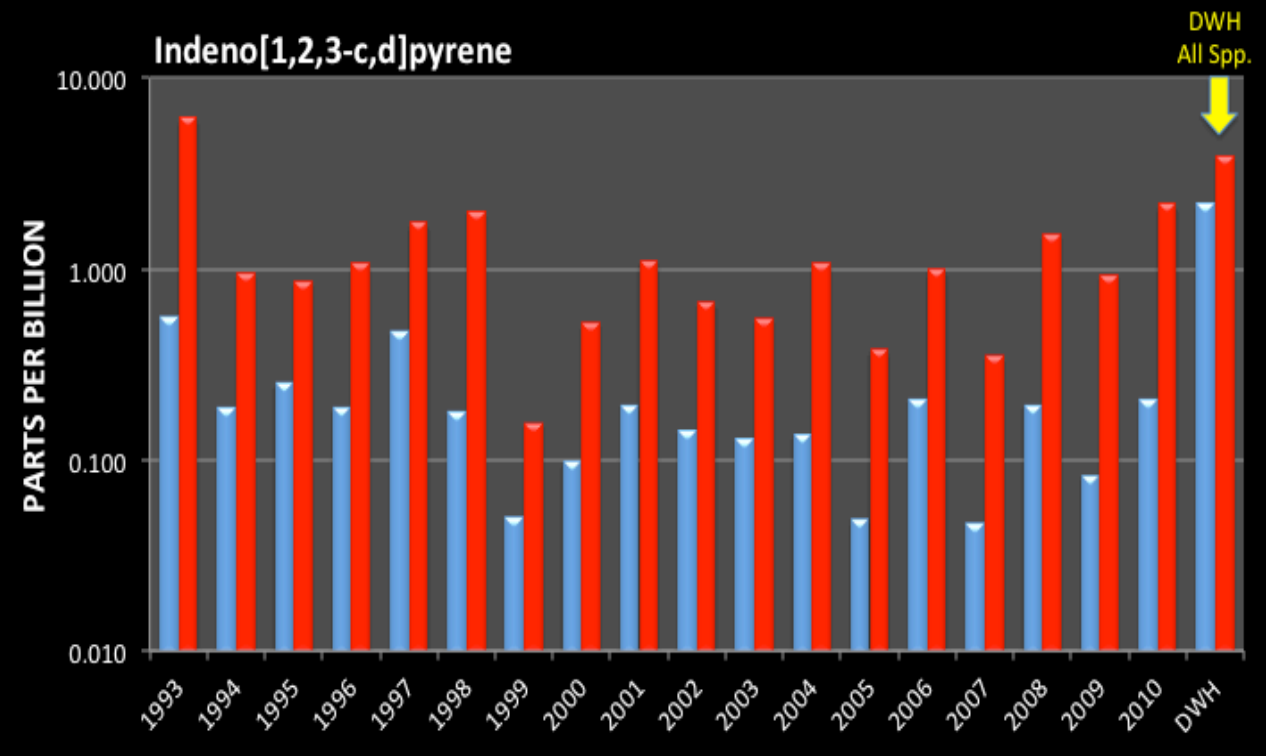
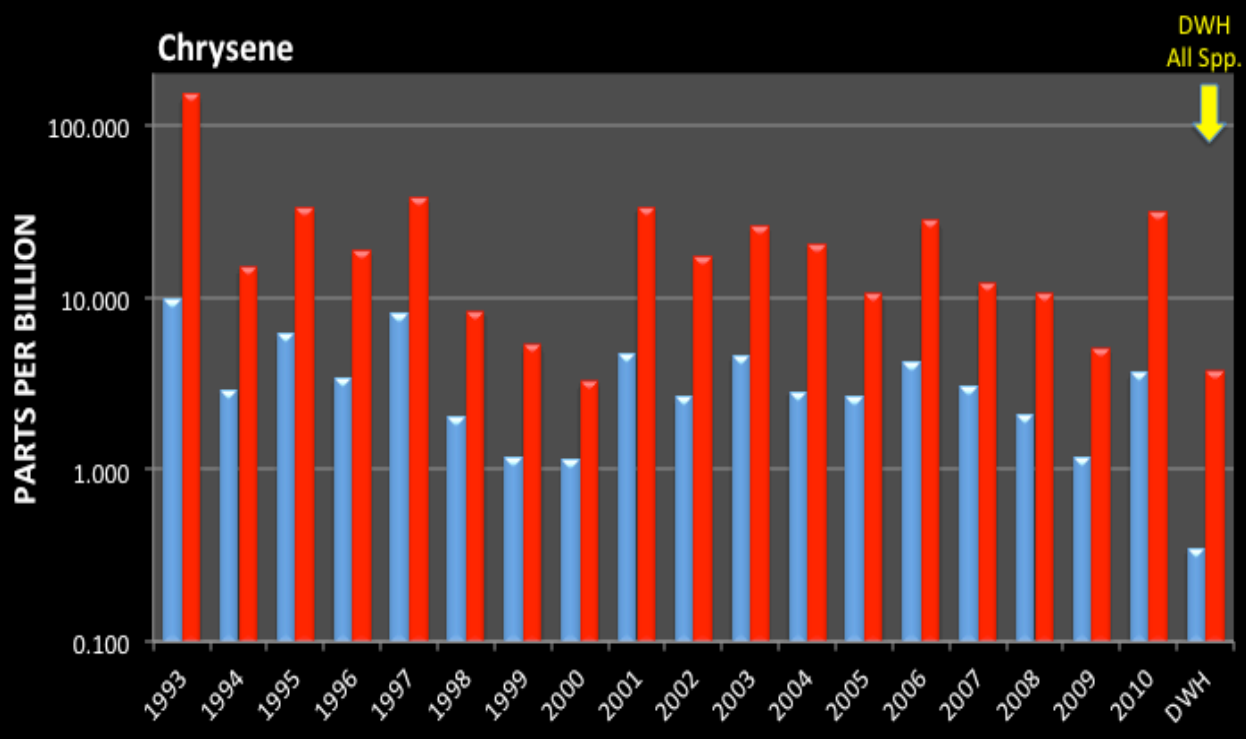
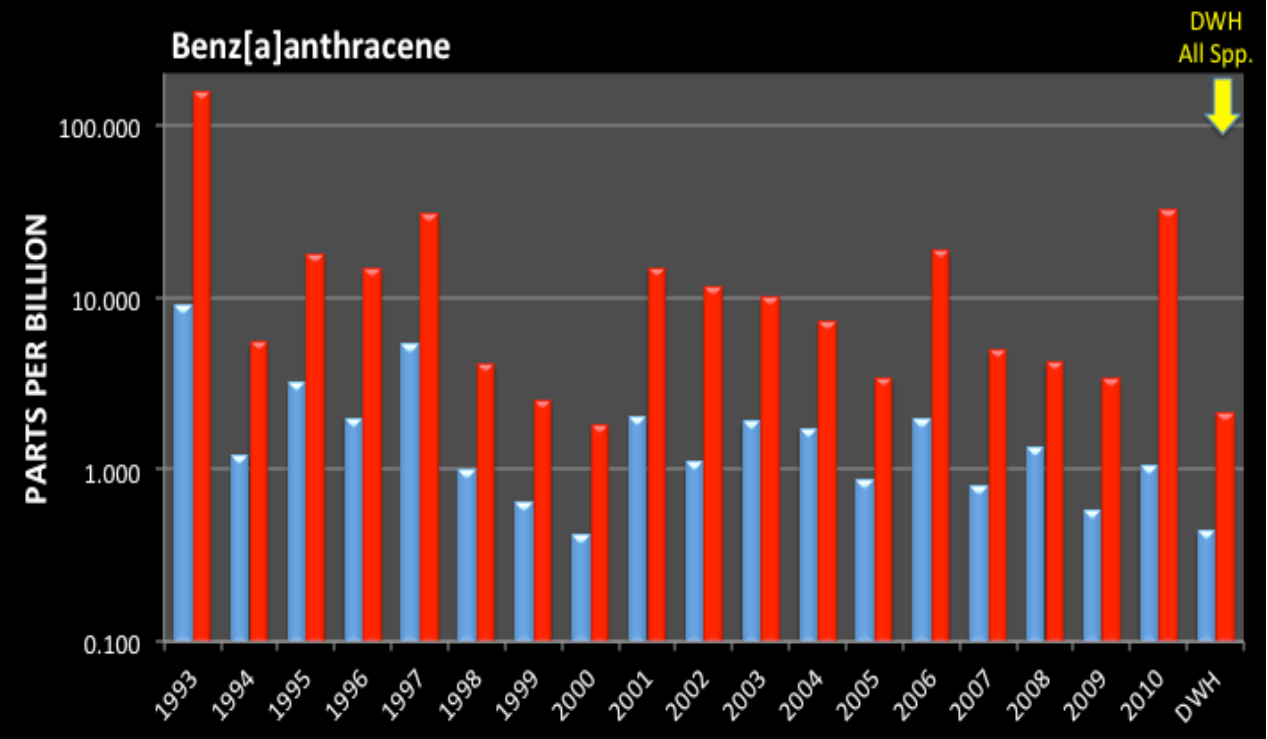




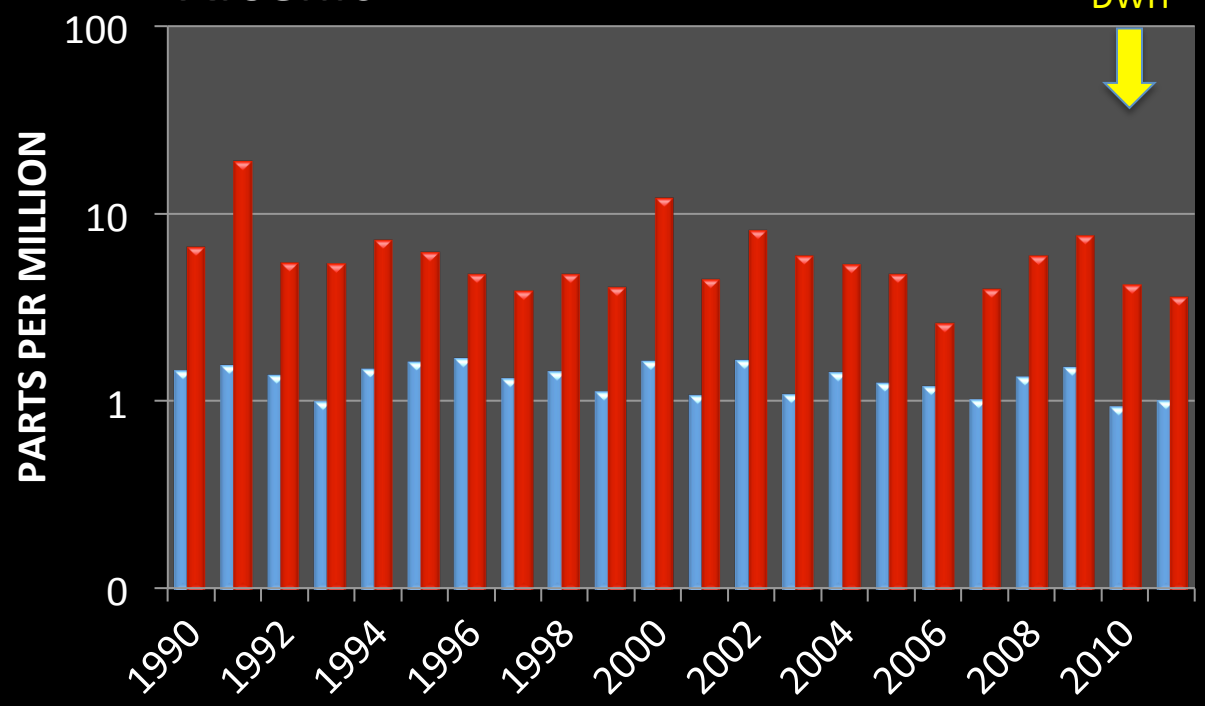




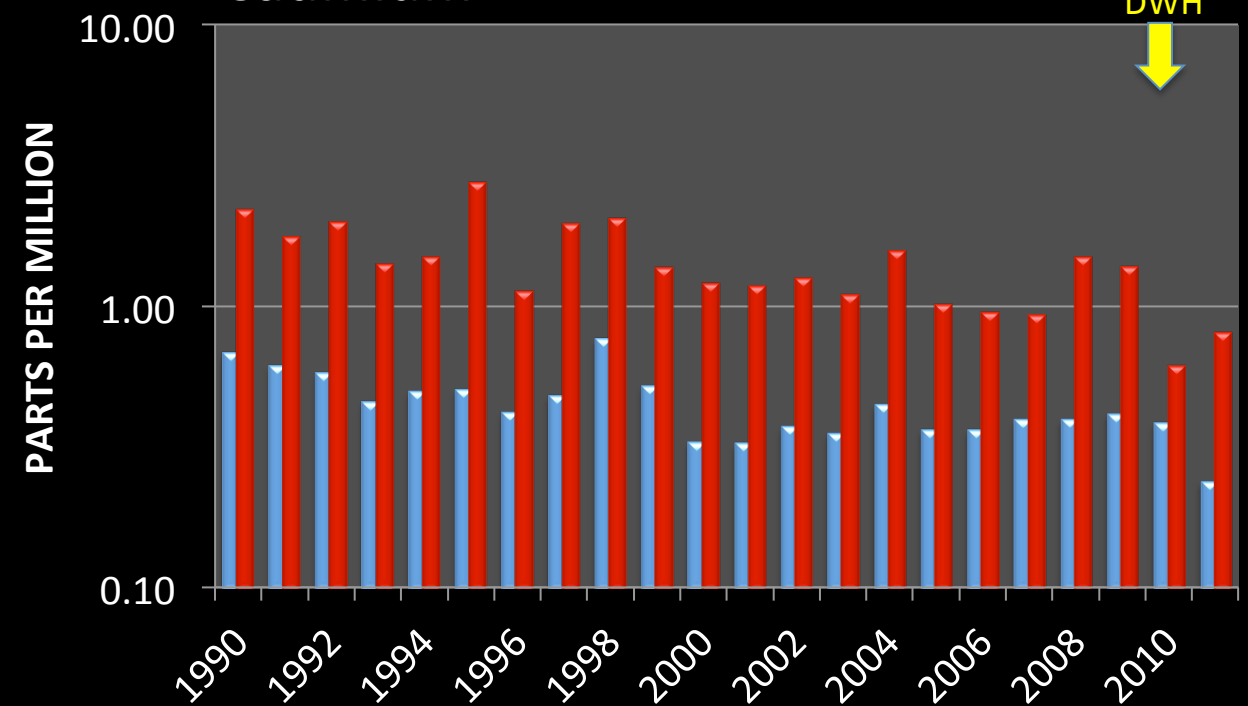
Gulf of Mexico Shellfish Metals 1990 – 2011

= Average = Maximum

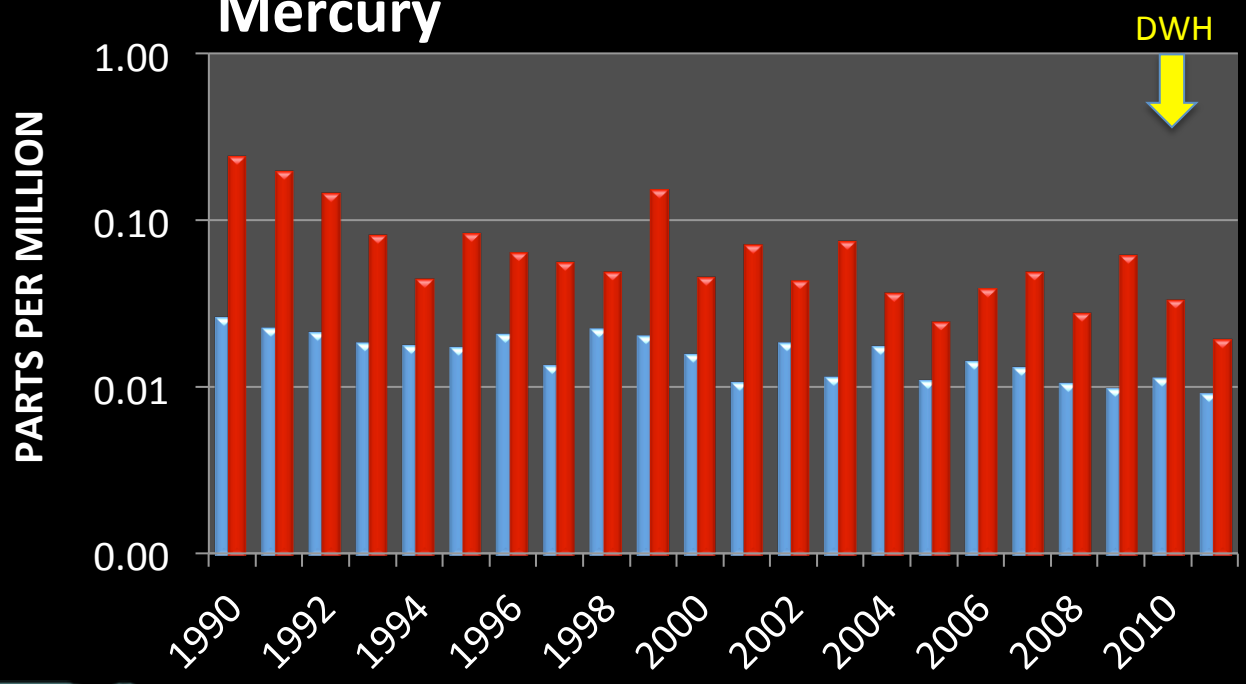
Arsenic



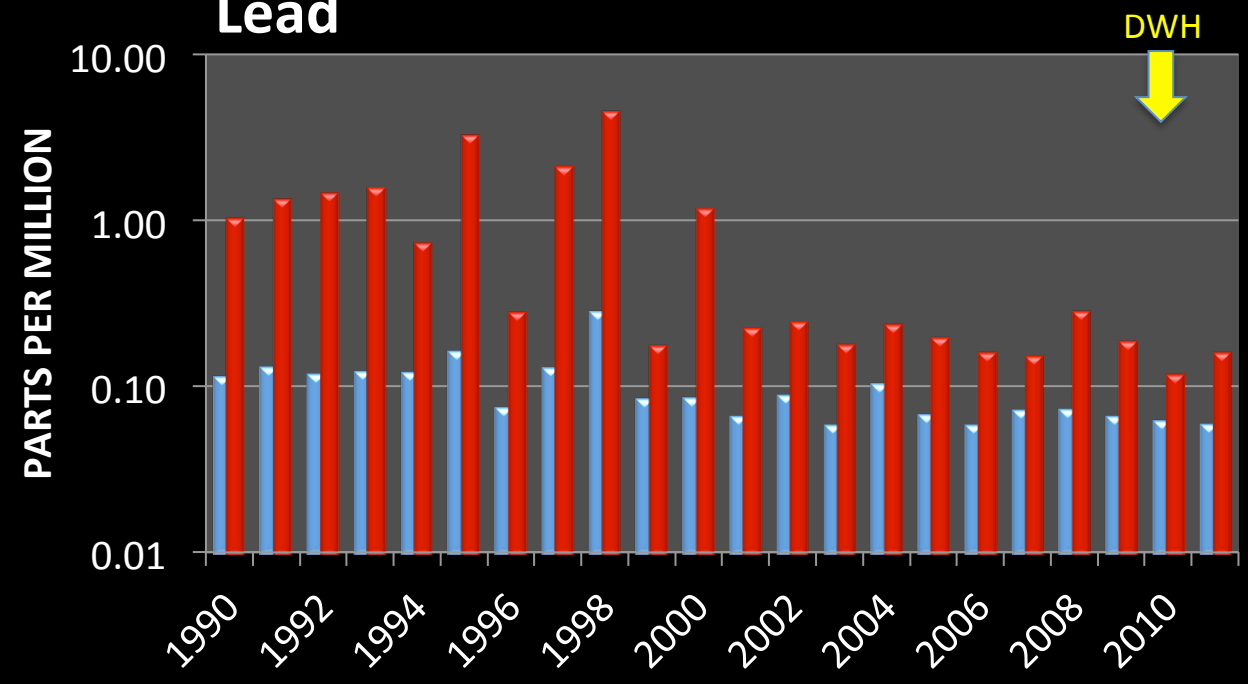
Cadmium



Mercury



Lead



FDA CFSAN

Dispersants and Seafood Safety

There was concern over the volume and toxicity of dispersants used in response to the Deepwater Horizon incident.

In considering the potential for chemical dispersants to compromise the safety of GOM seafood, initial questions concerned the potential toxicity of dispersant constituents, their concentrations and persistence in the environment, their potential for bioconcentration in seafood species, and their disposition and persistence in seafood species.

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Corexit® Ingredients

Incomplete information lead to suspicion, fear & dissemination of misinformation

Complete information lead to suspicion, fear & dissemination of misinformation

Ingredient Name	CAS No.	9527A (%)	9500A (%)
2-Butoxyethanol	111-76-2	30 - 60	undisclosed
Propylene Glycol	57-55-6	1 - 5	1 - 5
Dipropylene glycol monobutyl ether	29911-28-2	undisclosed	undisclosed
Dioctyl sodium sulfosuccinate	577-11-7	10 - 30	10 - 30
Petroleum distillates, hydrotreated light fraction	64742-47-8	undisclosed	10 - 30
Sorbitan, mono-(9Z)-octadecenoate	1338-43-8	undisclosed	undisclosed
Polyoxy-1,2-ethanediyl derivatives of sorbitan, mono-(9Z)-9-octadecenoate	9005-65-6	undisclosed	undisclosed
Polyoxy-1,2-ethanediyl derivatives of sorbitan, tri-(9Z)-9-octadecenoate	9005-70-3	undisclosed	undisclosed

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Corexit® Ingredients

Ingredient Name	CASRN	Common Uses	BCF/BAF	Rodent p.o. LD_{50}
2-Butoxyethanol	111-76-2	Soaps, cosmetics and personal care products ≤ 10% Also, lacquers and paints, agricultural chemicals Indirect & Direct Food Additive: 21 CFR 175.105(FAP 1B0233); 178.1010(FAP 4A1375); +++	2 - 3	0.2–12 g/kg
Propylene Glycol	57-55-6	Drugs, cosmetics and personal care products Food products (GRAS): 21 CFR 175.105(FAP 1B0233, 2B0650); 178.3300; 175.300; 175.320; 177.2420; +++	< 10	18-46 g/kg
Dipropylene glycol monobutyl ether	29911-28-2	Cleaners, degreasers, paints, plasticizers	< 10	3-5 g/kg
Dioctyl sodium sulfosuccinate	577-11-7	OTC Laxatives, cosmetics Indirect & Direct Food Additive: 21 CFR 73.1; 131.130; 133.124; ++++	< 10	2.6-5.7 g/kg
Petroleum distillates	64742-47-8	Paints, varnishes, lubricants (e.g. HW-40), hand-cleaners (e.g. Mojo & Goop); C-8 to C-20 Aliphatic HC; Norpar-13 (CASNR 94094-93-6) is Food-Grade	60 - 80	> 5g/kg
Span 80	1338-43-8	Cosmetics & personal care products Drugs and parenteral products Food Products: 21 CFR 73.1; 107.105; 172.515; 172.623; ++++	36 - >300	NOAEL >5 g/kg d
Tween 80	9005-65-6			
Tween 85	9005-70-3			

FDA approval means that the compound is safe for its approved uses and the human exposures associated with those uses

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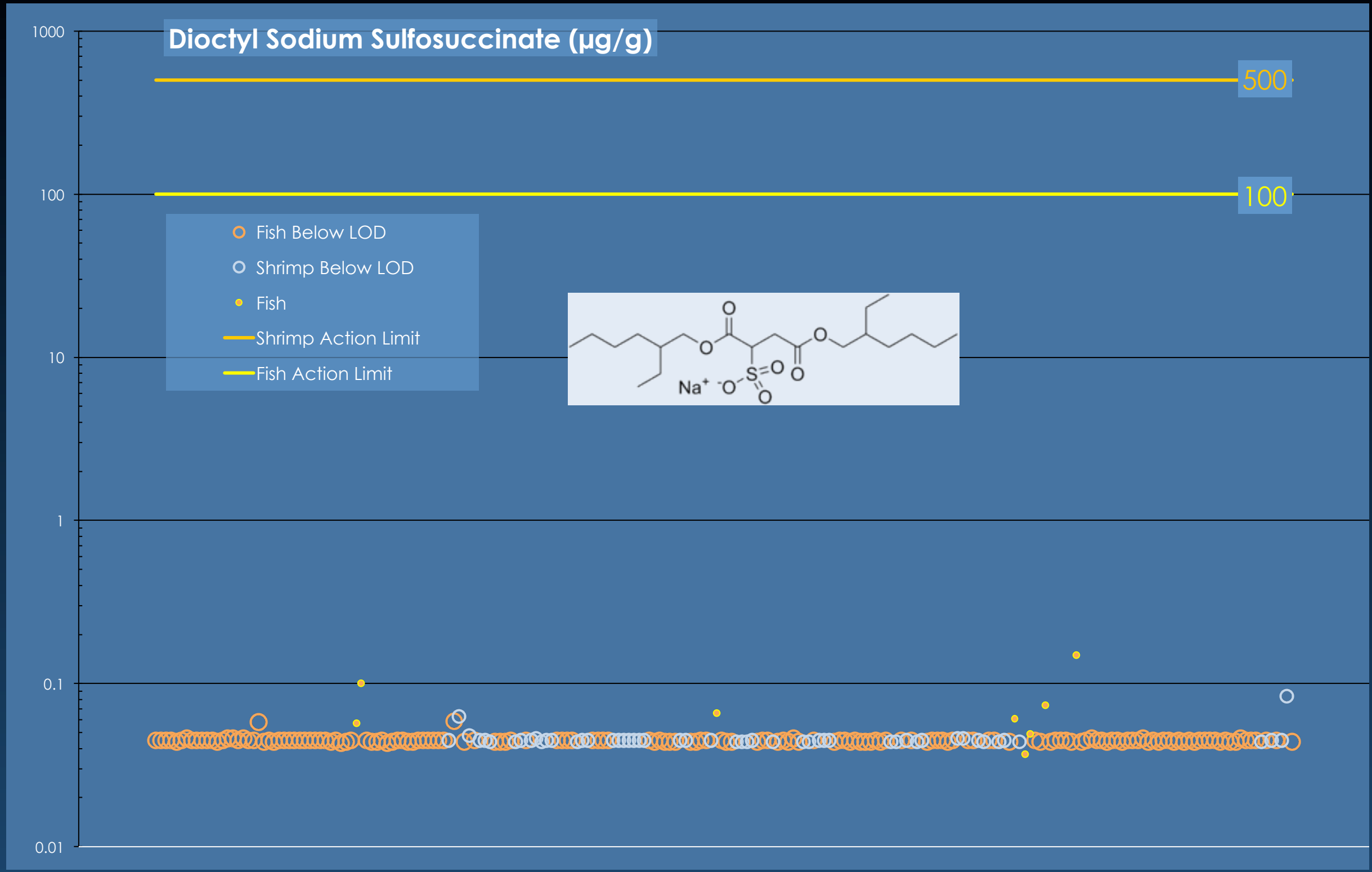
DOSS in Gulf seafood



Outcome of Seafood Safety Response and Extended Surveillance, June 2010 through August 2011

- Over 10,000 oysters, shrimp, crab and fish were collected and tested by Federal and FERN Labs
- Test methods included sensory assessment, LC-FLD LC-MS/MS and GC-MS/MS
- ~20% of samples were re-tested to verify results
- ~50% of samples were tested for dispersant (DOSS)
- LA, MS, AL and FL state laboratories continued testing through 2013
- To date, all testing results for PAHs and dispersant are below levels of concern by 100 fold to more than 1000 fold for seafood consumption

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Looking Ahead

Pemex drilling Maximinio deepwater oil well
2012-2016: At ~3000 meters Maximinio will be drilled in the Perdido Fold Belt, about 30 kilometers south of the maritime border with the United States.
(Platts)--28Feb2012/437 pm EST/2137 GMT

Thank you

Recent History of Marine Oil Spills and Seafood Safety Criteria

Spill Name & Location	Oil Type & Volume	Risk Level	Cancer Slope Factor	Body Weight (kg)	Exposure Duration (yr)	BaPE Criteria (ppb)	Consumption Rate (g/day)	Closure Period
T/V Exxon Valdes Prince William Sound, AK 1989	Prudhoe Bay Crude 11,000,000 gal	10^{-6}	1.75	60	10	120 11 3 5	**2** - mollusc **21** – crustacean **89** – salmon **52** - fish	Herring & Salmon –entire season. Advisories on bivalves in 4 subsistence areas
T/V Braer Shetland Islands 1993	Light Crude 25,000,000 gal							Wild finfish – 2 months Farmed salmon – 12 months Burrowing lobster - > 6 yr
T/B North Cape Block Island, RI 1996	Fuel Oil No. 2 828,000 gal	10^{-6}	1.75	70	5	30	**30** – all seafood	Finfish & Bivalves – 73 days Lobster – 75 – 155 days
T/V Julie N Portland, ME 1996	IFO 380 & Fuel Oil No. 2 180,000 gal	10^{-5}	7.3	70	10	14	**14** - lobster	Shellfish – 15 days
T/V Sea Empress Milford Haven, Wales 1996	Light Crude & Fuel Oil No. 6 21,274,000 gal	n/a						Finfish – 82 days Whelk & Crustaceans – 183 days Cockles – 125 days Mussels – 8 – 19 months
M/V Kure Humboldt Bay, CA 1997	IFO 180 4,537 gal	10^{-6}	9.5	70	2	34 5	**7.5** – shellfish **50** - shellfish	Oysters & Crabs – 49 days
M/V New Carissa Coos Bay, OR 1999	Bunker Oils and Marine Diesel 70,000 gal	10^{-6}	7.3	70	2	45 10	**7.5** – shellfish **32.5** - shellfish	Bivalves – 21 days
Dubai Star San Francisco Bay, CA 2009	IFO 380 400 – 800 gal	10^{-4}	11.5	70	30	44	**32.5** – all seafood	Shellfish – 25 – 37 days
Deepwater Horizon Gulf of Mexico 2010	Louisiana Light Crude 200,000,000 gal	10^{-5}	7.3	80	5	132 143 35	**13** – crustacean **12** – oyster **49** - fish	Area specific – 16 days to > 18 months