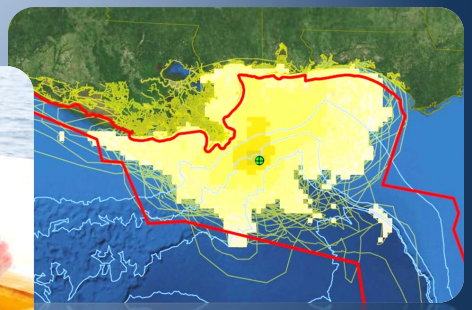


Impacts and Science in the Aftermath of *Deepwater Horizon*

Steven A. Murawski
University of South Florida
smurawski@usf.edu

Gulf Consortium Meeting
21 April, 2016
Tampa

Outline

- What have we learned?
- What do we need to know?
- How can we be better prepared for future disasters?
- Ongoing monitoring and research funded by various entities

Some Current Research and Monitoring Programs Funded in the Gulf

- Gulf of Mexico Research Initiative (GoMRI) $500 m, basic research and monitoring of contaminant effects
- National Academy of Science (NAS Gulf Program) $500 m over 30 years, engineering, worker safety and monitoring the environment
- Florida Restore Act Centers of Excellence Program (FLRACEP) `$40 m over 15 years
- National Fish and Wildlife Foundation (NFWF Gulf Environmental Benefits Fund) ~$340 m in Florida, $2b total
- Natural Resources Damage Assessment (NRDA), projects ending as settlement has occurred, transition to monitoring restoration

What do People Care About?

- Where is (or was) the Oil?

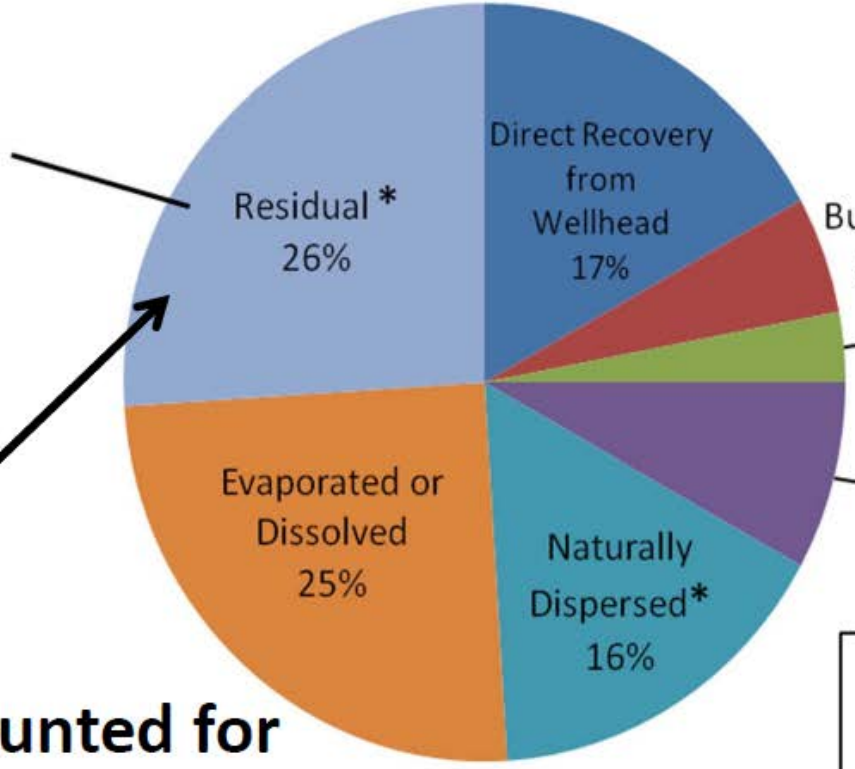
  How Toxic is it?

  How Fast is it Going Away?
- What About Dispersants?
- Is the Seafood Safe to Eat?
- Impacts on Wildlife & People?
- Are We Better Prepared for the Next Time?

Where is (was) the Oil?

Deepwater Horizon Oil Budget

Based on estimated release of 4.9m barrels of oil

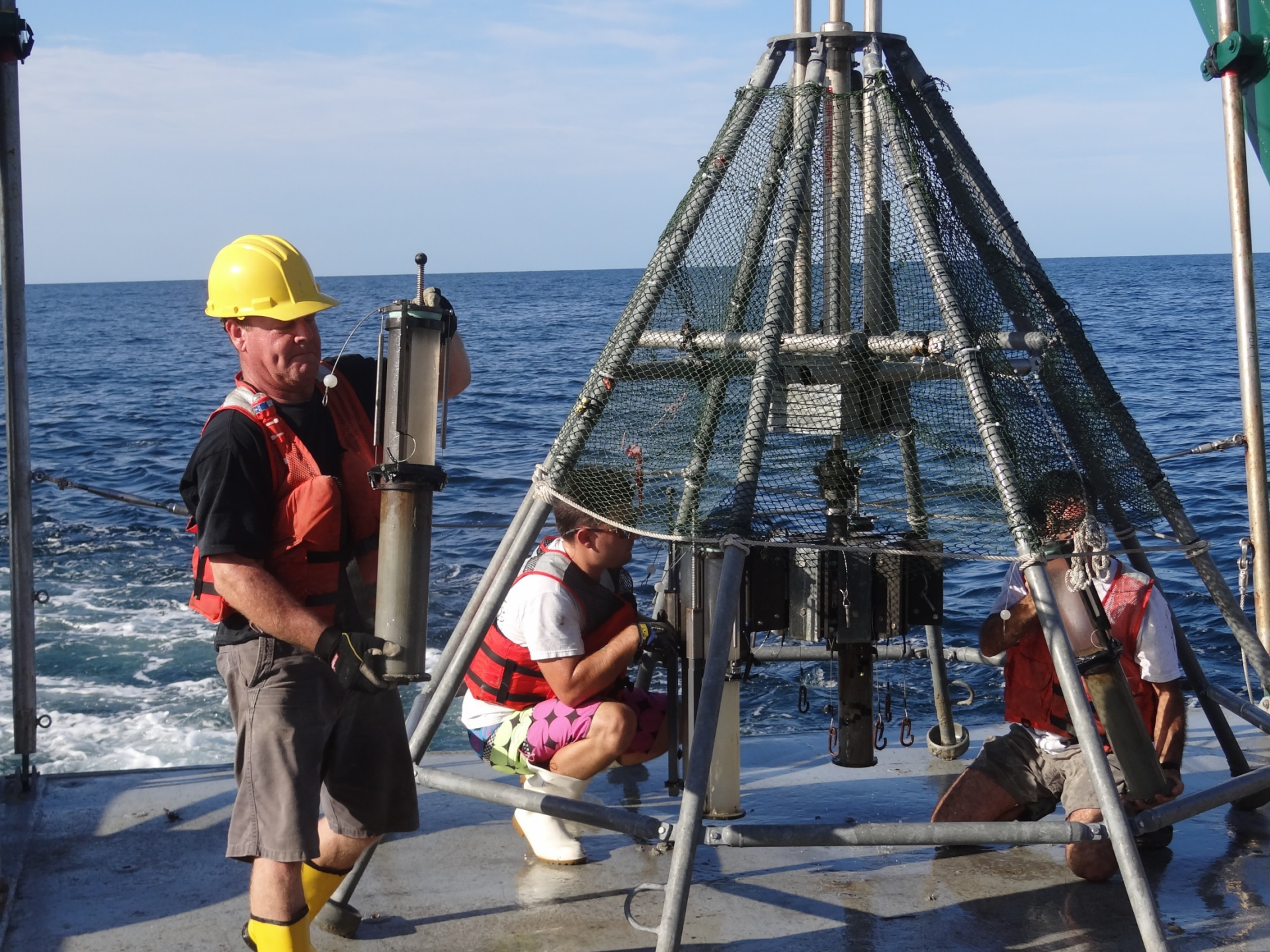


Residual includes oil that is on or just below the surface as light sheen and weathered tar balls, has washed ashore or been collected from the shore, or is buried in sand and sediments.

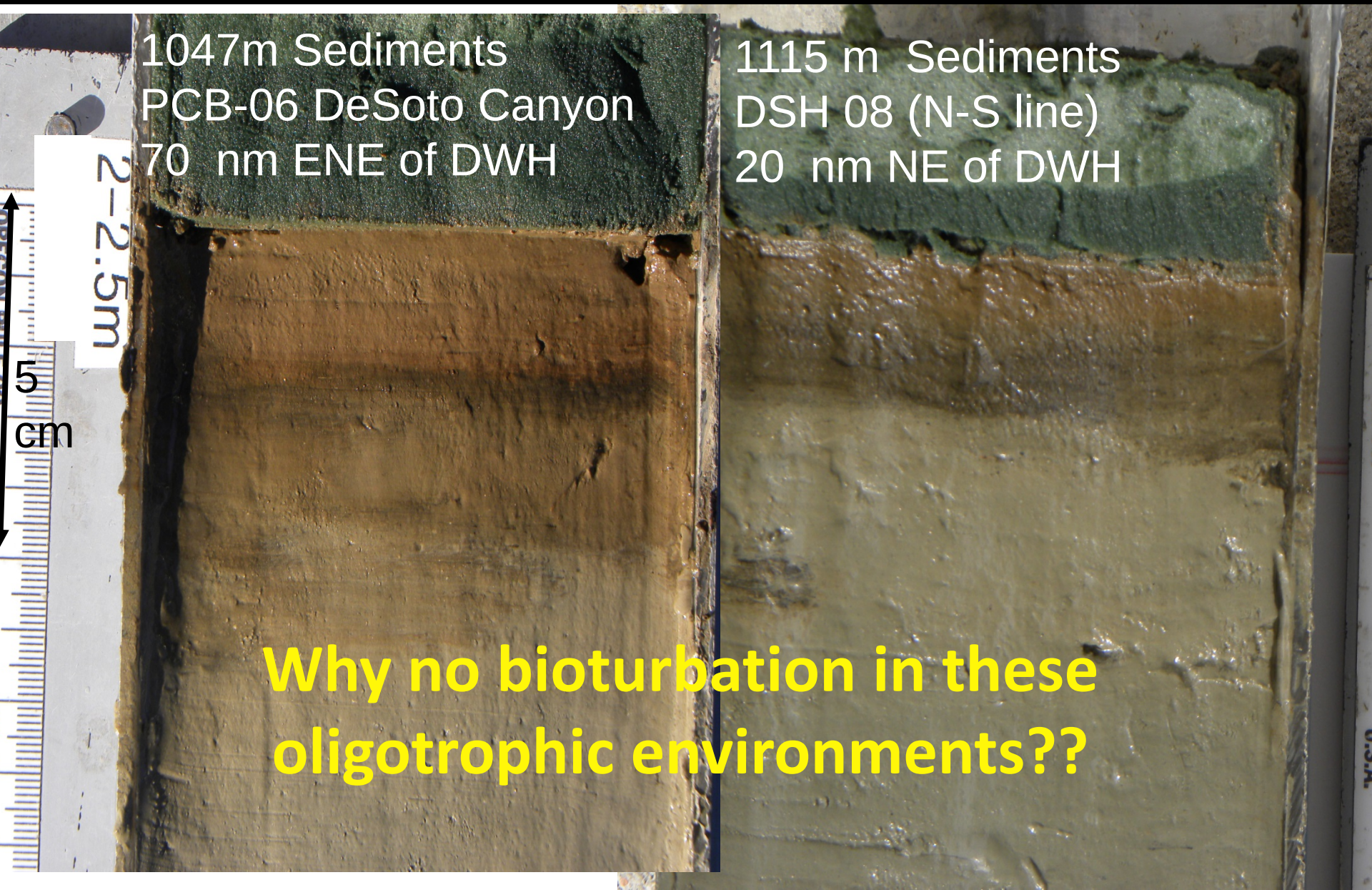
Unified Command Response Operations

~25% Unaccounted for

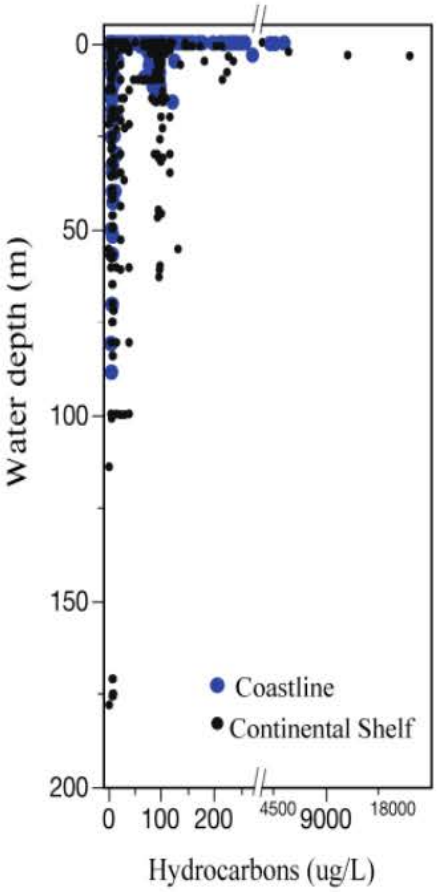
*Oil in these 3 categories is currently being degraded naturally.



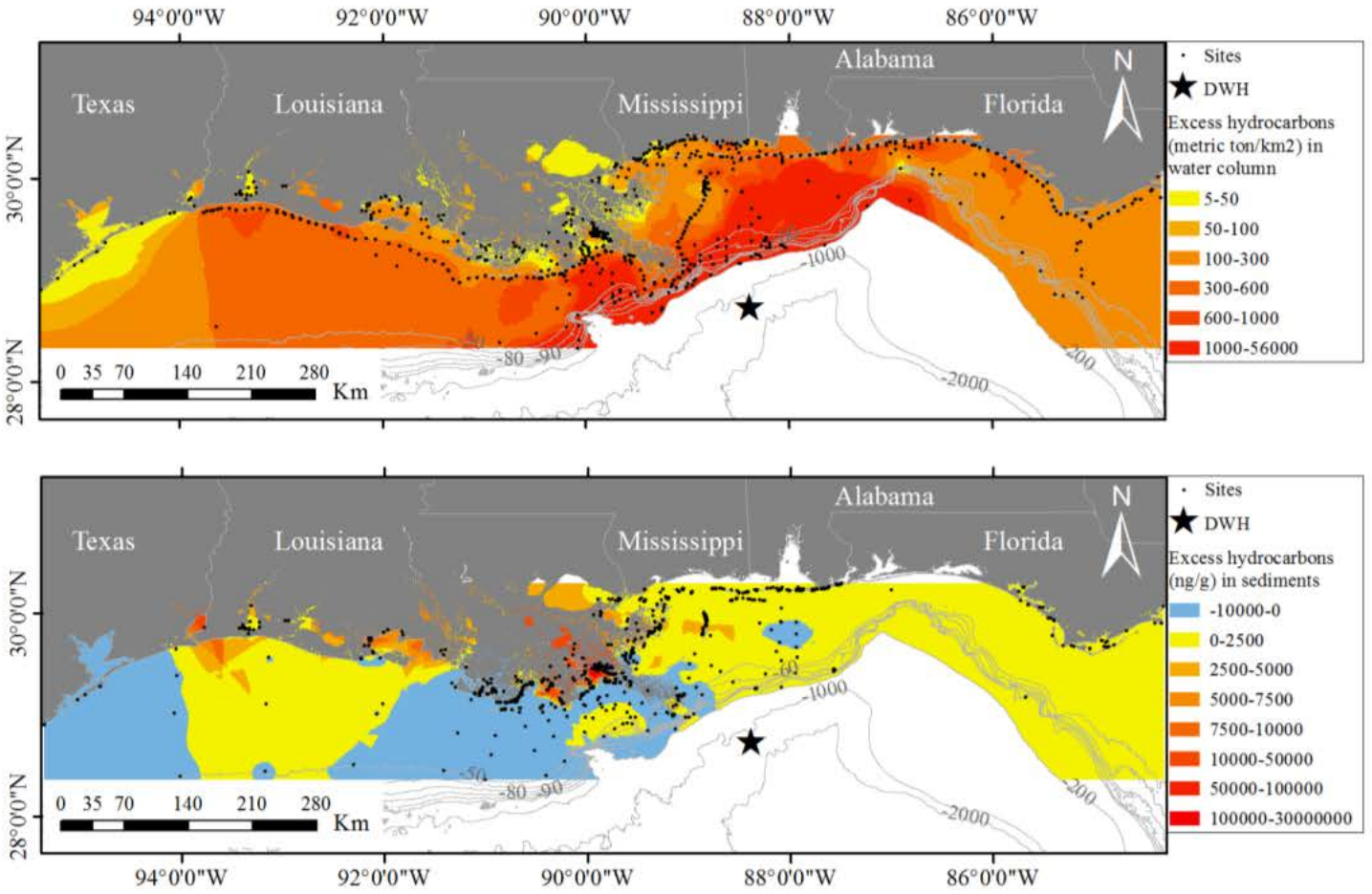
Abrupt changes in the sedimentary depositional system at 1000-1200m during the DwH blowout



Depth Profile in Water

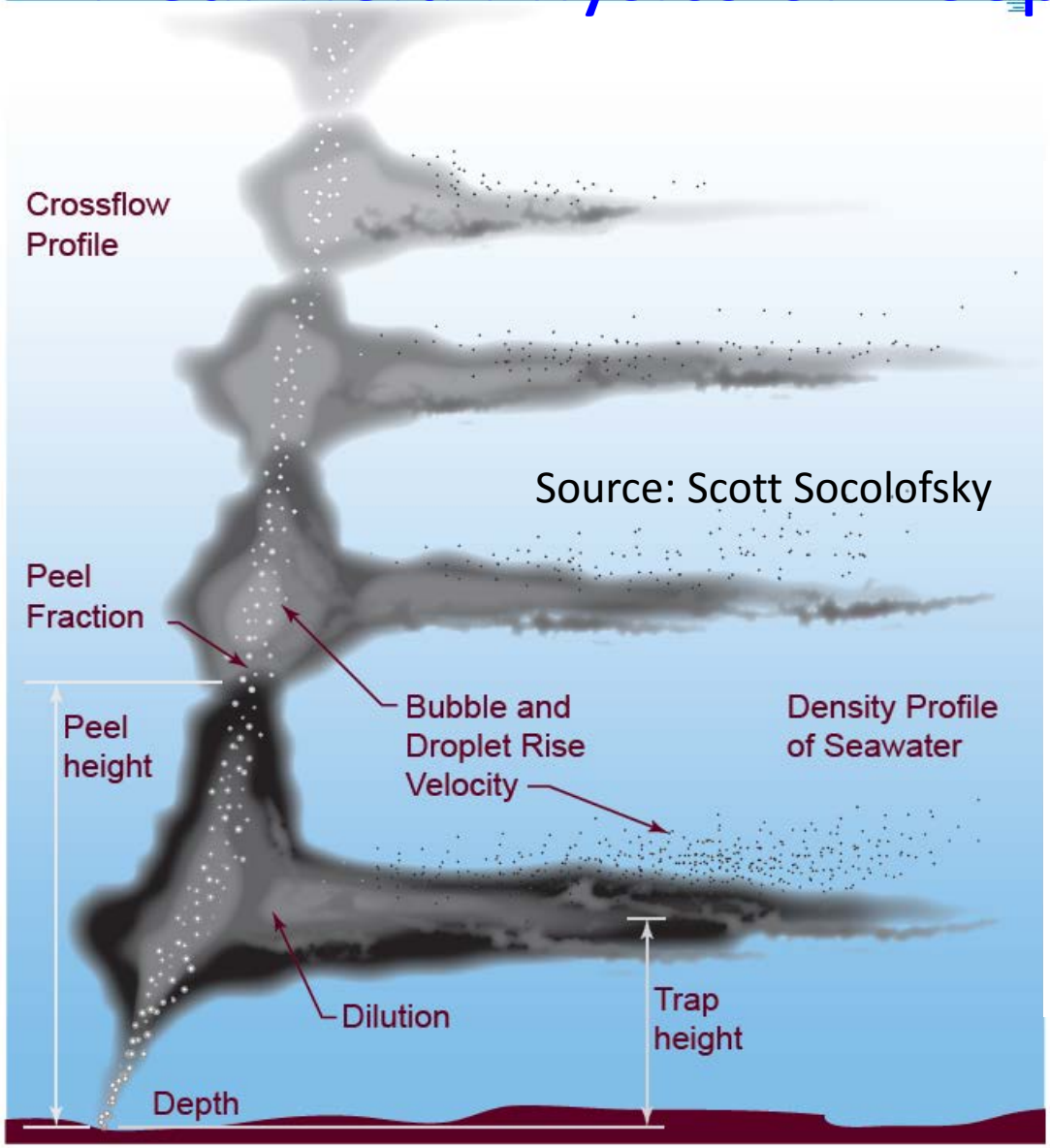


Oil in the Water Column

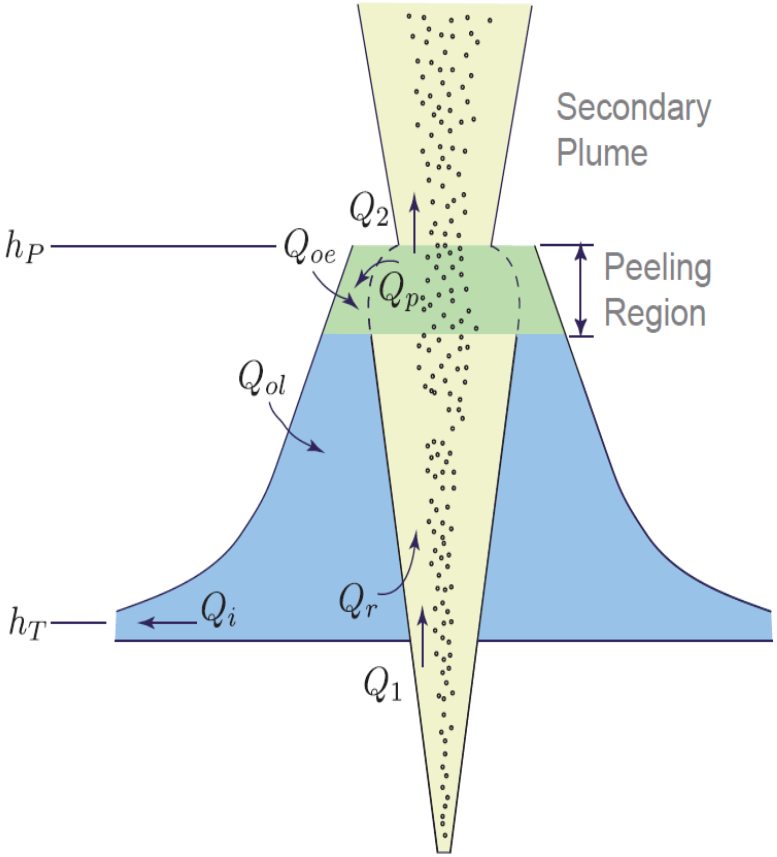


Oil on the Bottom

Uniqueness of DWH:
Near field Physics of Deep Blowouts



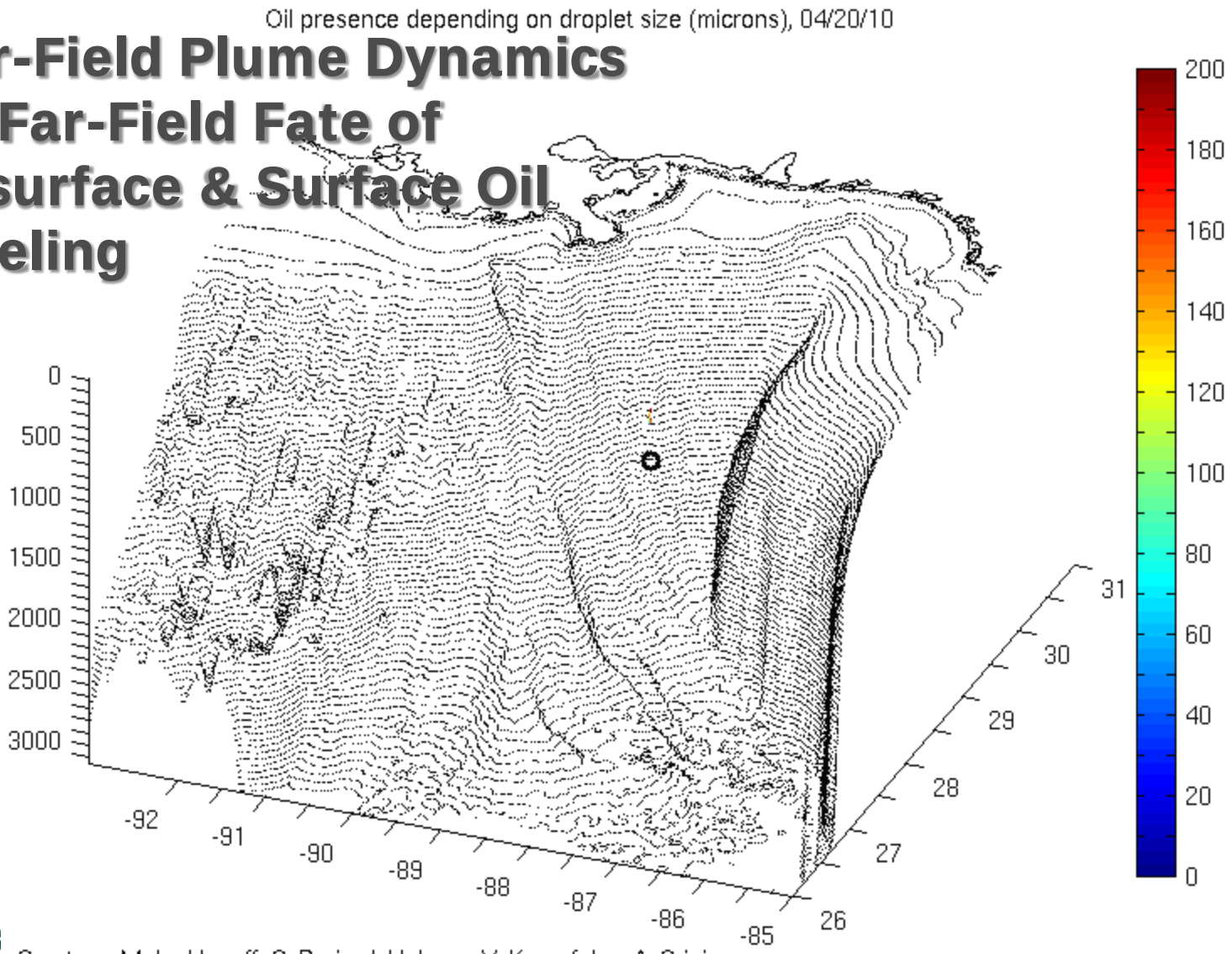
Model of flows in a stratified multiphase plume



Dynamically coupled to GoM circulation models

SUBSEA: 3D animation of the Macondo well blowout from Apr. 20 to Sep. 6, 2010

Near-Field Plume Dynamics and Far-Field Fate of Subsurface & Surface Oil Modeling

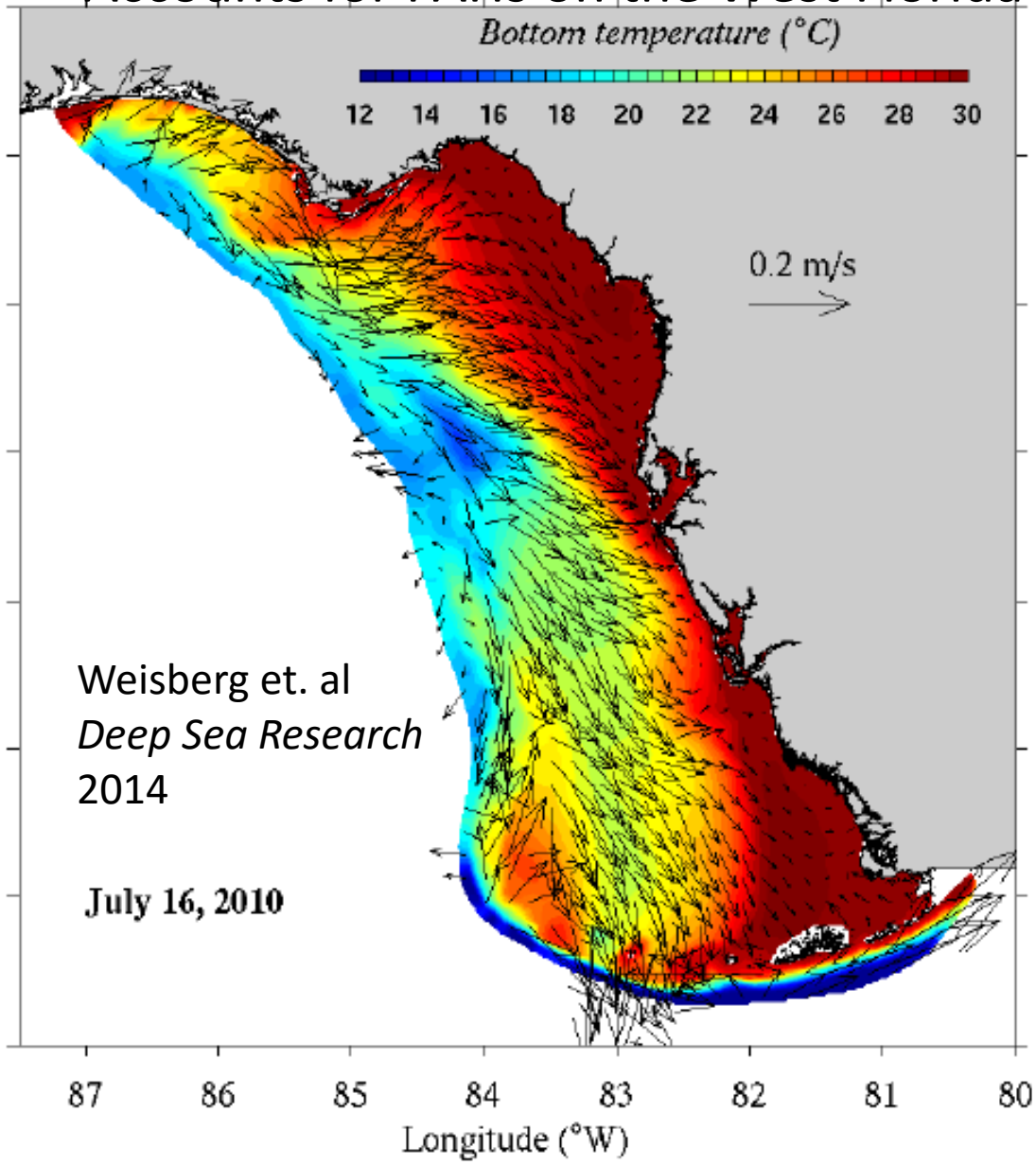


UNIVERS OF MIAM. Courtesy: M. Le Henaff, C. Paris, J. Helgers, V. Kourafalou, A. Srinivasan

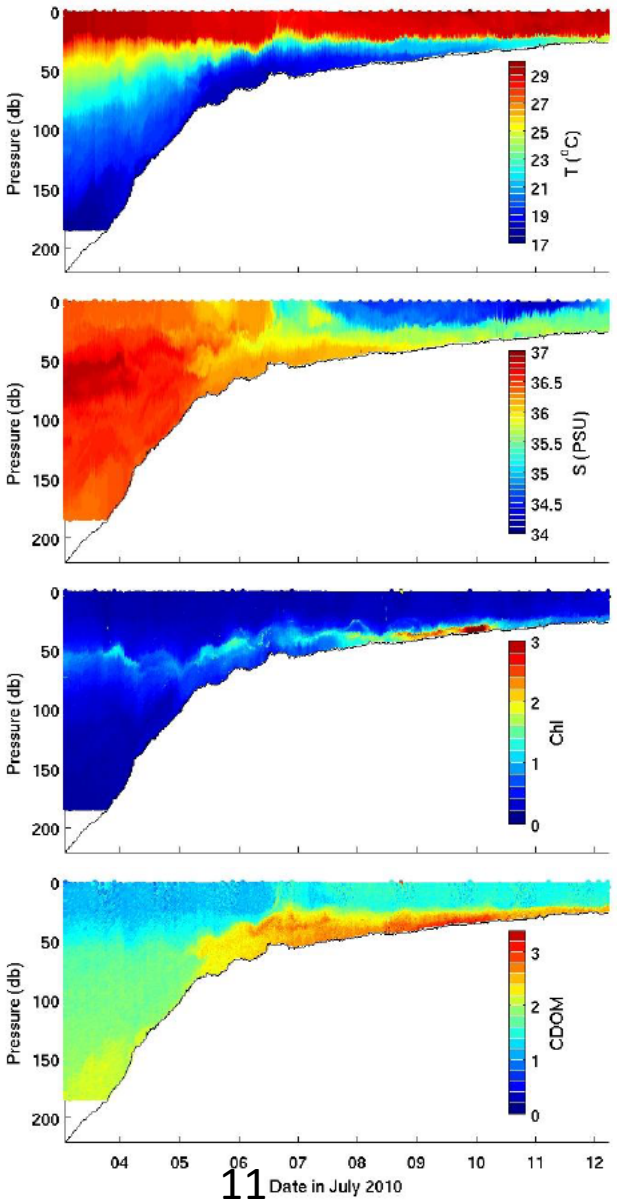
neter (μm)

(Paris et al. 2011, submit. EST)

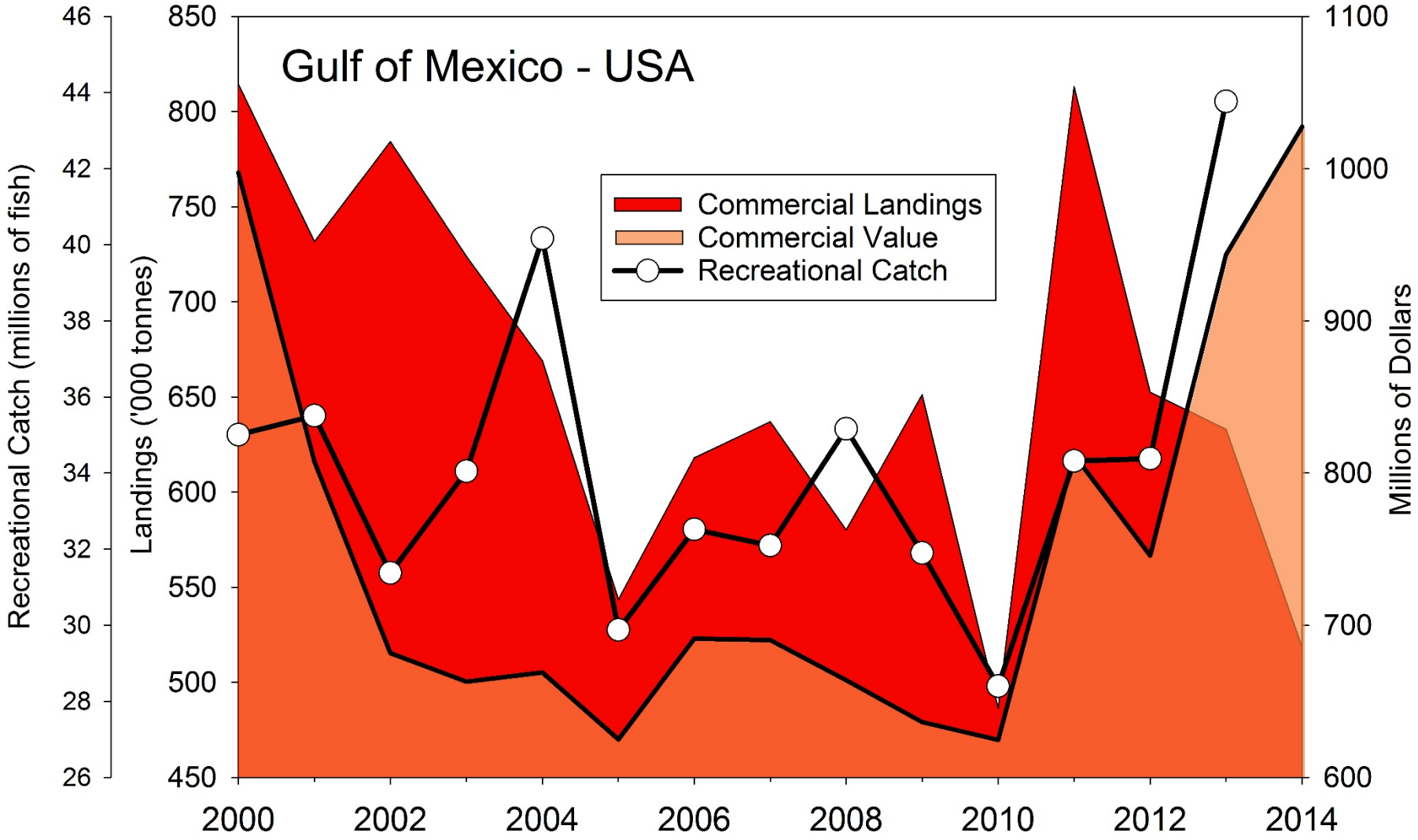
Possible Sub-Surface Transport of Dissolved Hydrocarbons to WFS Accounts for PAHs on the West Florida Shelf?



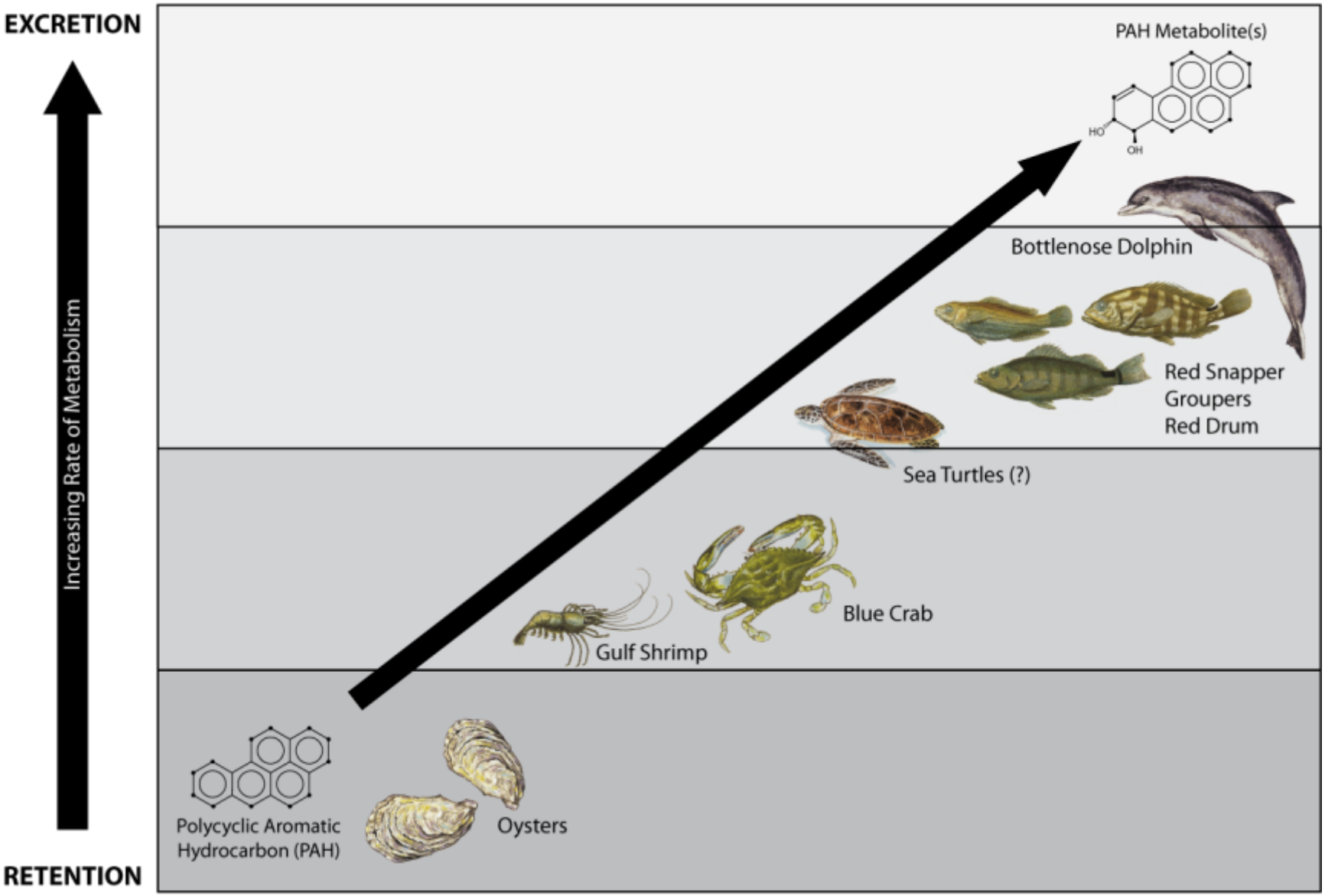
Weisberg et. al
Deep Sea Research
2014



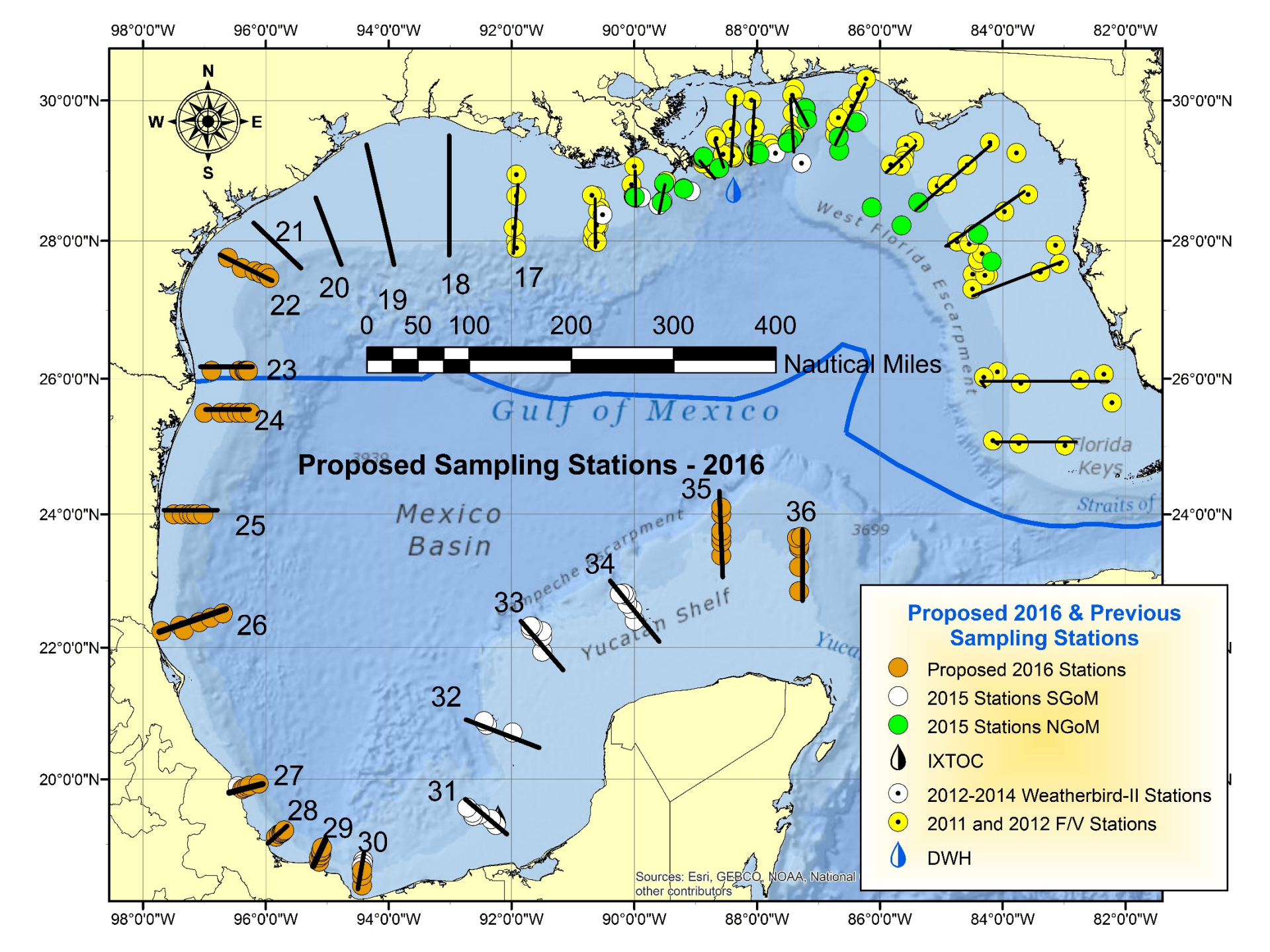
What About Gulf of Mexico Fisheries?



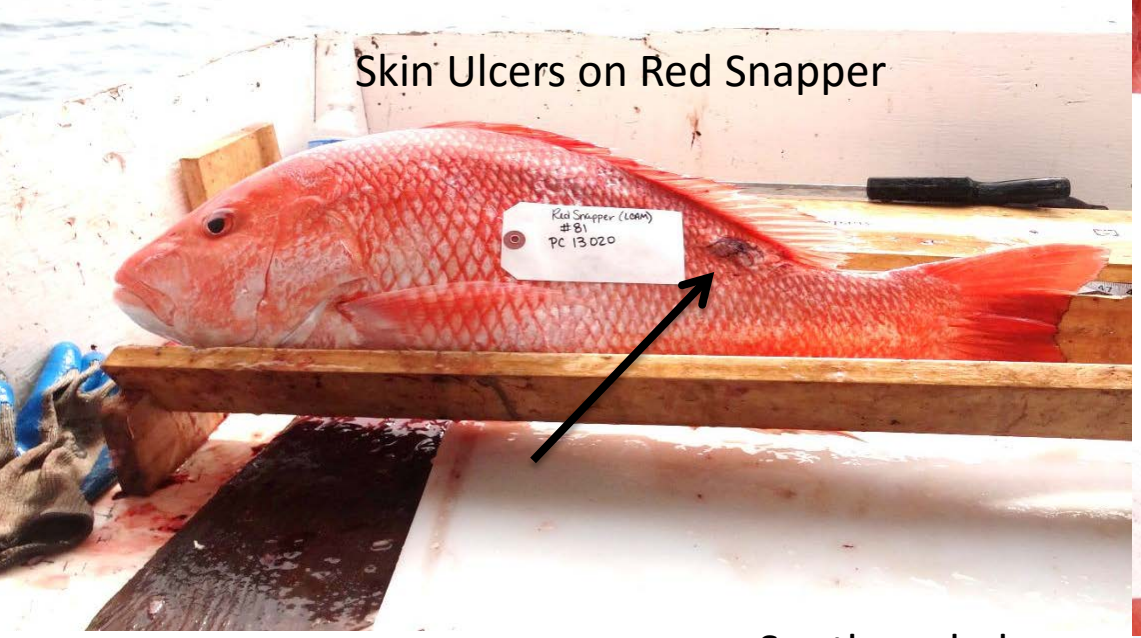
Extent of Metabolism of PAHs

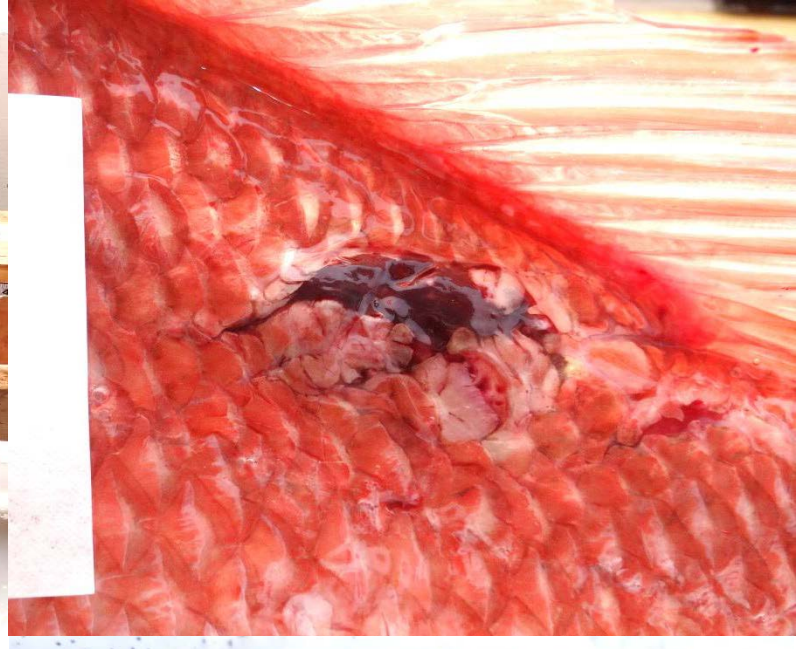


Depiction by Su Kim based on "Metabolism of PAHs in the Aquatic Environment, ISBN# 0-8493-6844-8 Editor U.Varanasi

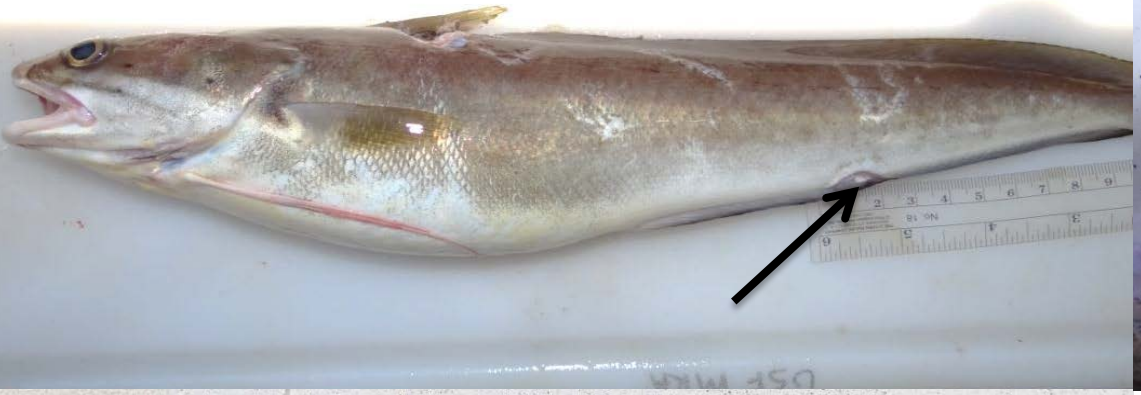

Proposed Sampling Stations - 2016
Gulf of Mexico
Mexico Basin
West Florida Escarpment
Florida Keys
Straits of
Campeche Escarpment
Yucatan Shelf
0 50 100 200 300 400
Nautical Miles
N
S
E
W
98°0'0"W
96°0'0"W
94°0'0"W
92°0'0"W
90°0'0"W
88°0'0"W
86°0'0"W
84°0'0"W
82°0'0"W
30°0'0"N
28°0'0"N
26°0'0"N
24°0'0"N
22°0'0"N
20°0'0"N
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
Proposed 2016 & Previous Sampling Stations
Proposed 2016 Stations
2015 Stations SGoM
2015 Stations NGoM
IXTOC
2012-2014 Weatherbird-II Stations
2011 and 2012 F/V Stations
DWH
Sources: Esri, GEBCO, NOAA, National
other contributors

Skin Ulcers on Red Snapper





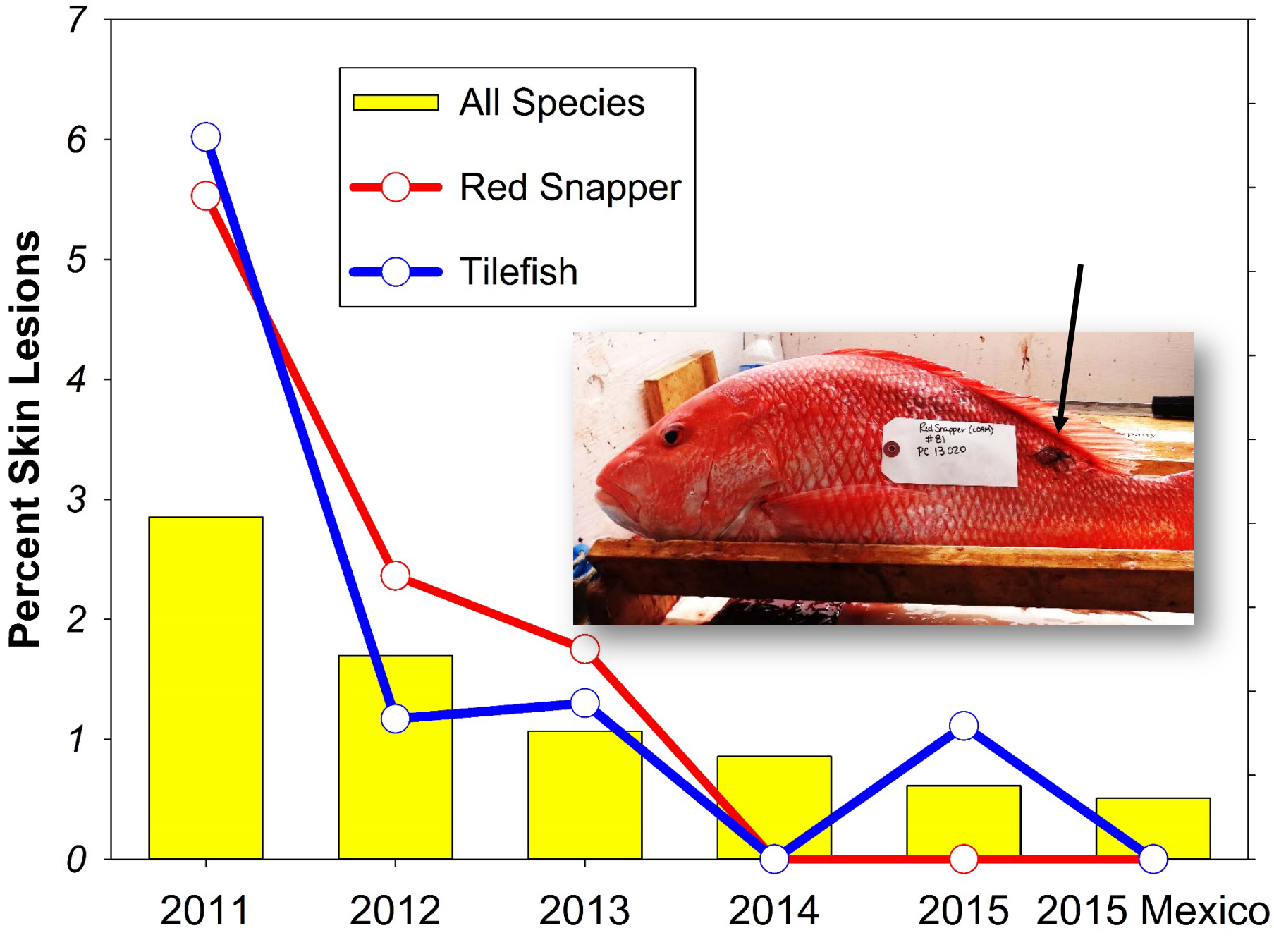
Southern hake

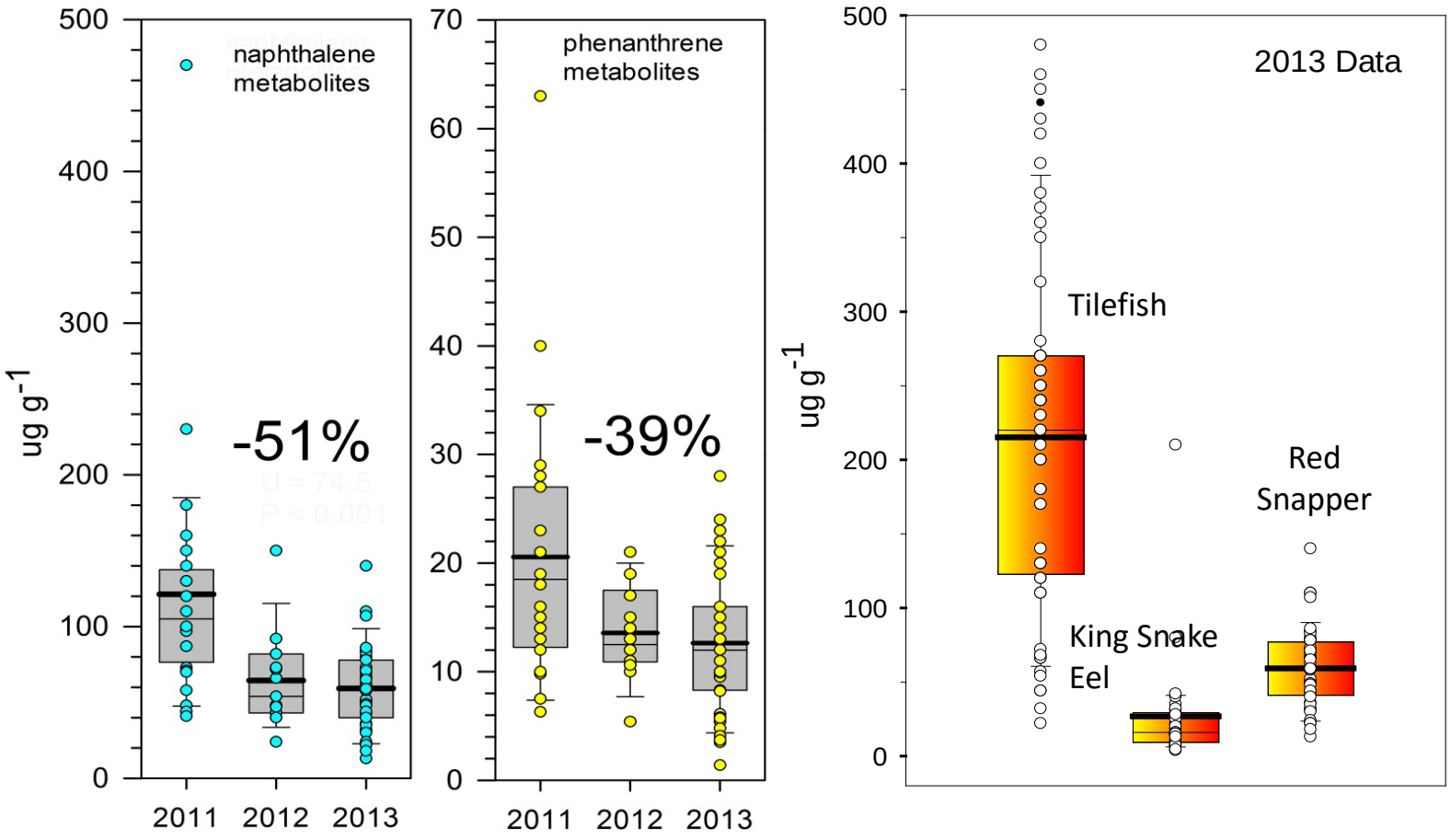


tilefish

Conger eel

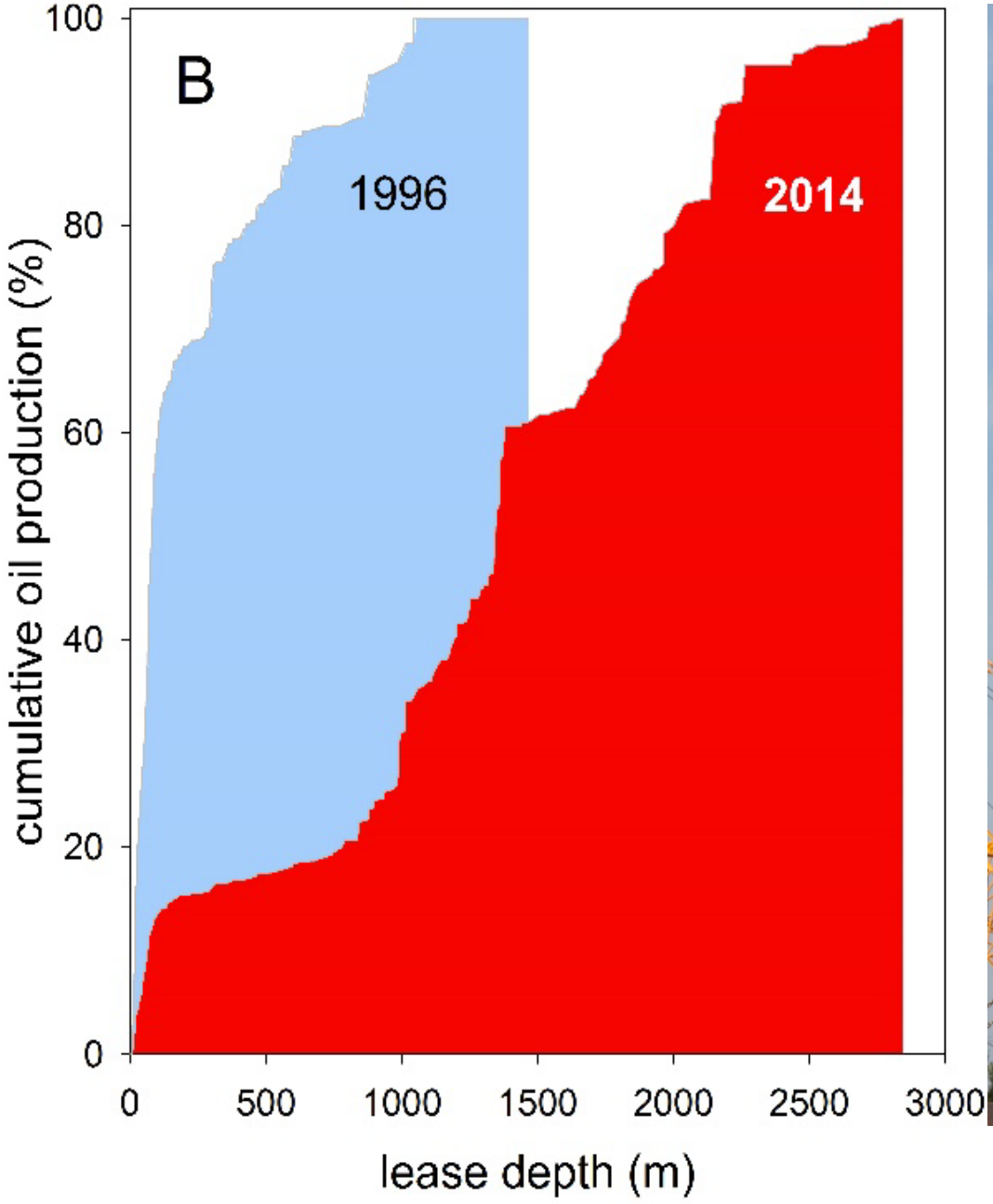
© Gainesville.com

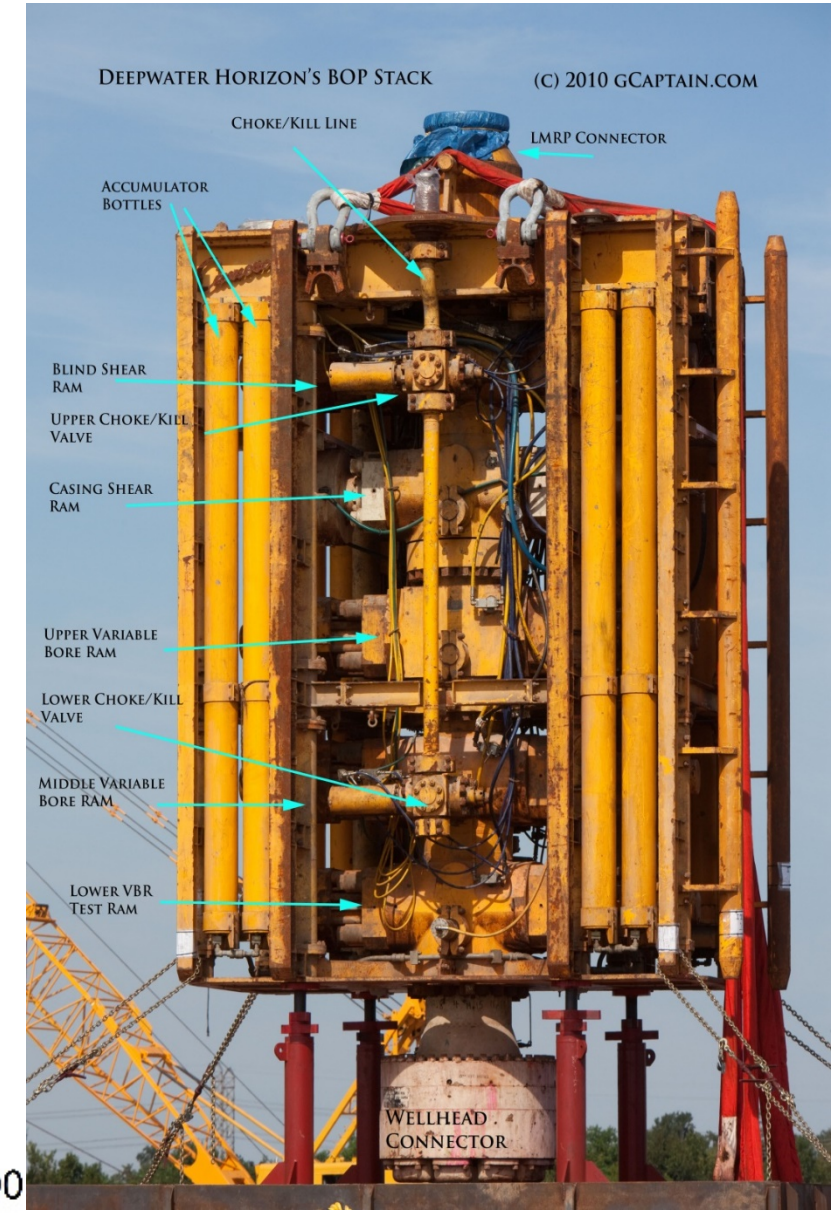

Percent Skin Lesions
0
1
2
3
4
5
6
7
All Species
Red Snapper
Tilefish
Red Snapper (LOAM)
#81
PC 13020
2011
2012
2013
2014
2015
2015 Mexico



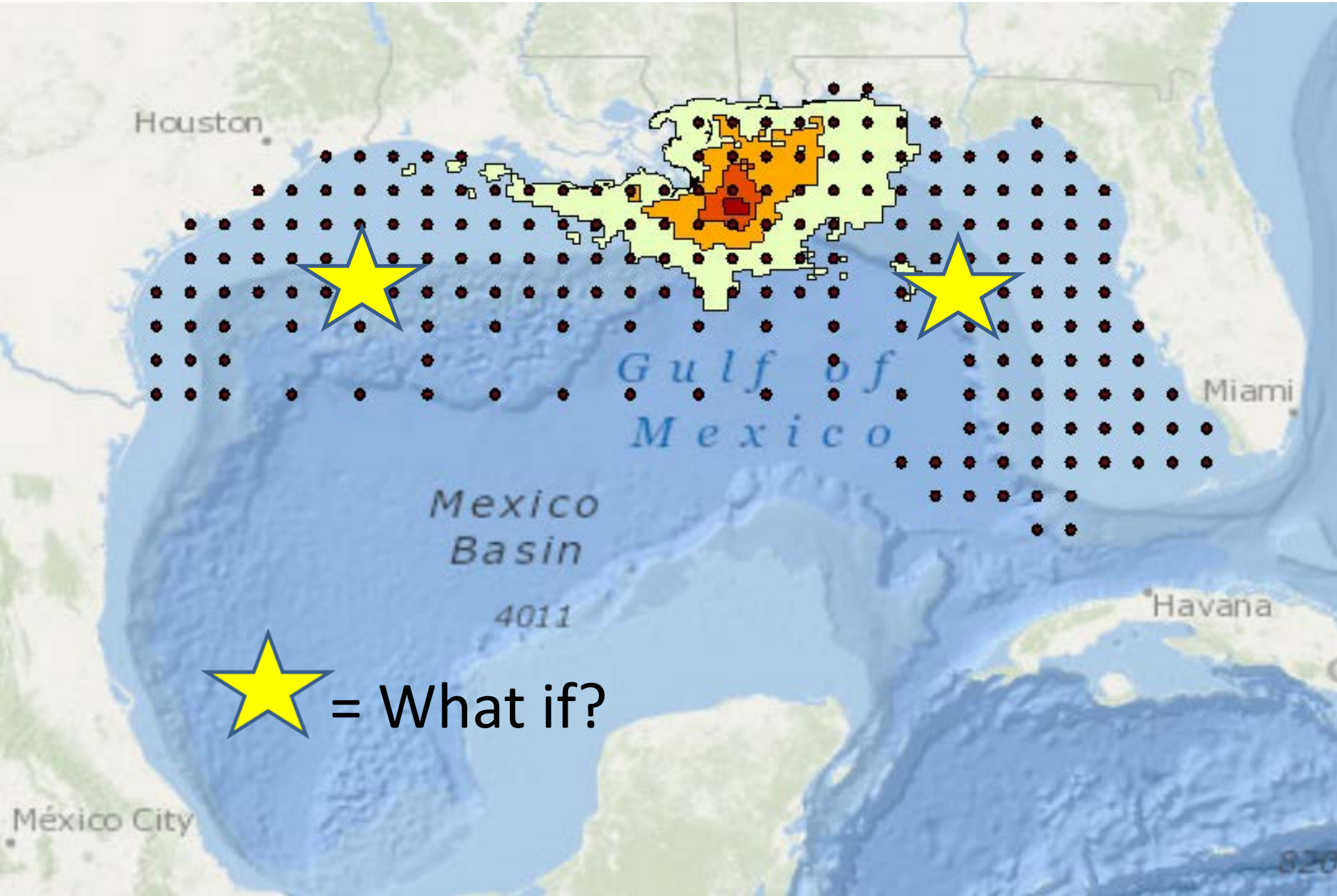
Changes in bile contamination of napthalene and phenanthrene metabolites in red snapper (left) sampled in the Northern Gulf of Mexico, 2011-2013

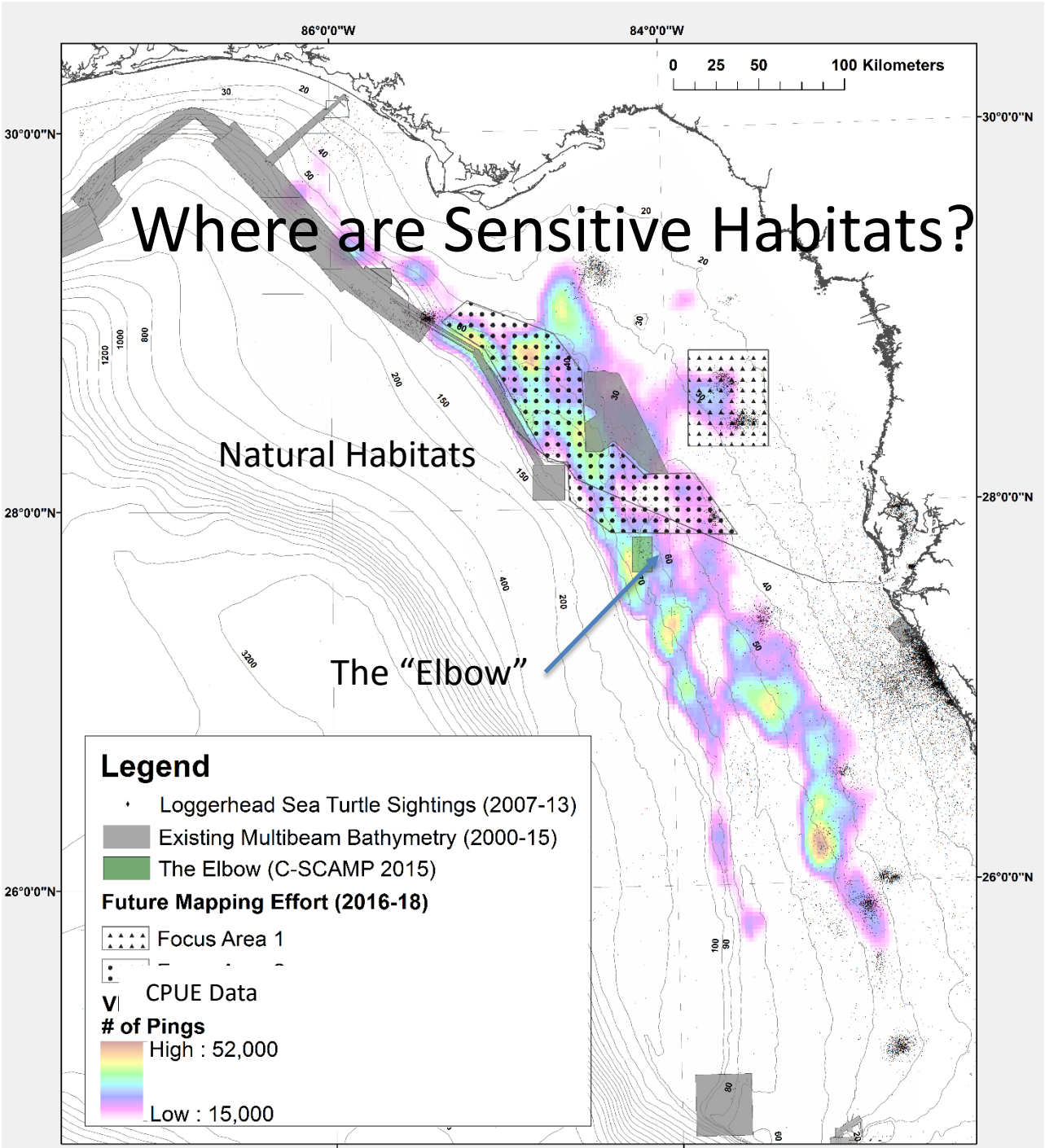
A
Are We Ready for the Next Big Spill?
98°W
96°W
94°W
92°W
90°W
88°W
86°W
84°W
82°W
80°W
32°N
30°N
28°N
26°N
24°N
22°N
Oil/Gas Structures
500 m
200 m
1000 m
2000 m
3000 m
EEZ
Gulf of Mexico
0
125
250
500
750
1,000


B
1996
2014
cumulative oil production (%)
0
20
40
60
80
100
0
500
1000
1500
2000
2500
3000
lease depth (m)

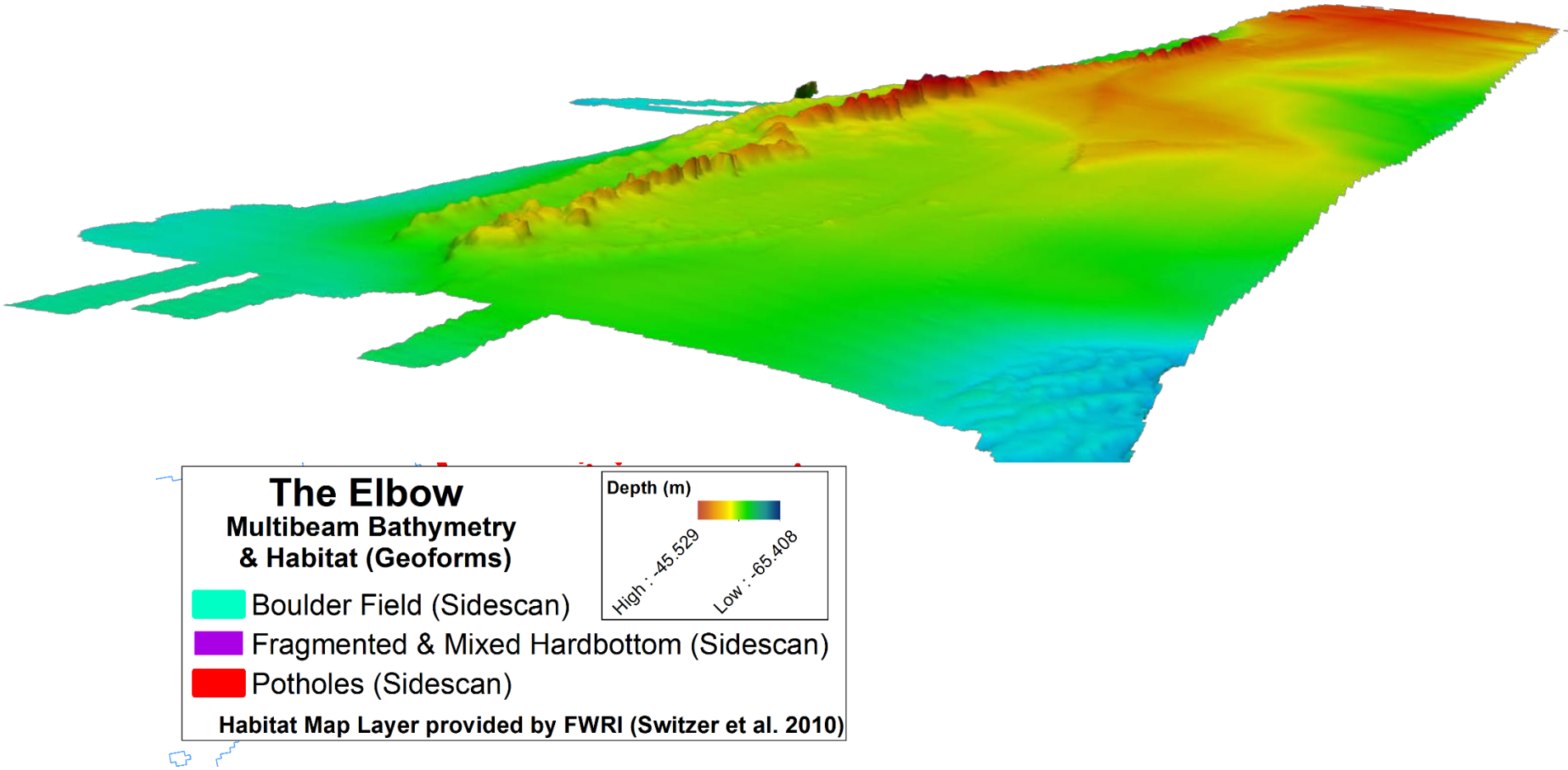

DEEPWATER HORIZON'S BOP STACK
(C) 2010 GCAPTAIN.COM
CHOKE/KILL LINE
LMRP CONNECTOR
ACCUMULATOR BOTTLES
BLIND SHEAR RAM
UPPER CHOKE/KILL VALVE
CASING SHEAR RAM
UPPER VARIABLE BORE RAM
LOWER CHOKE/KILL VALVE
MIDDLE VARIABLE BORE RAM
LOWER VBR TEST RAM
WELLHEAD CONNECTOR

Fish Larvae Data, 1982-Present vs. Oil Spill Distribution

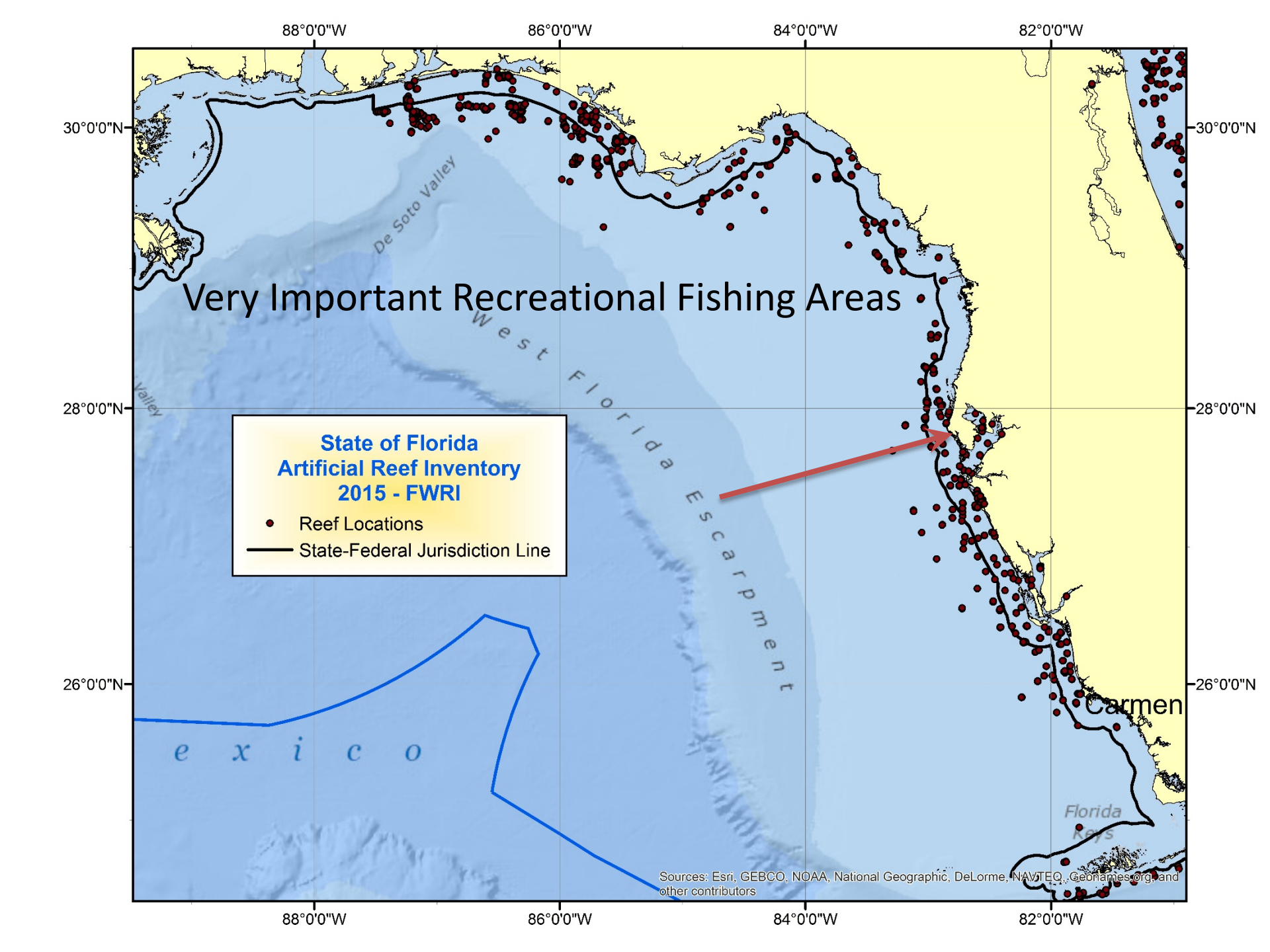


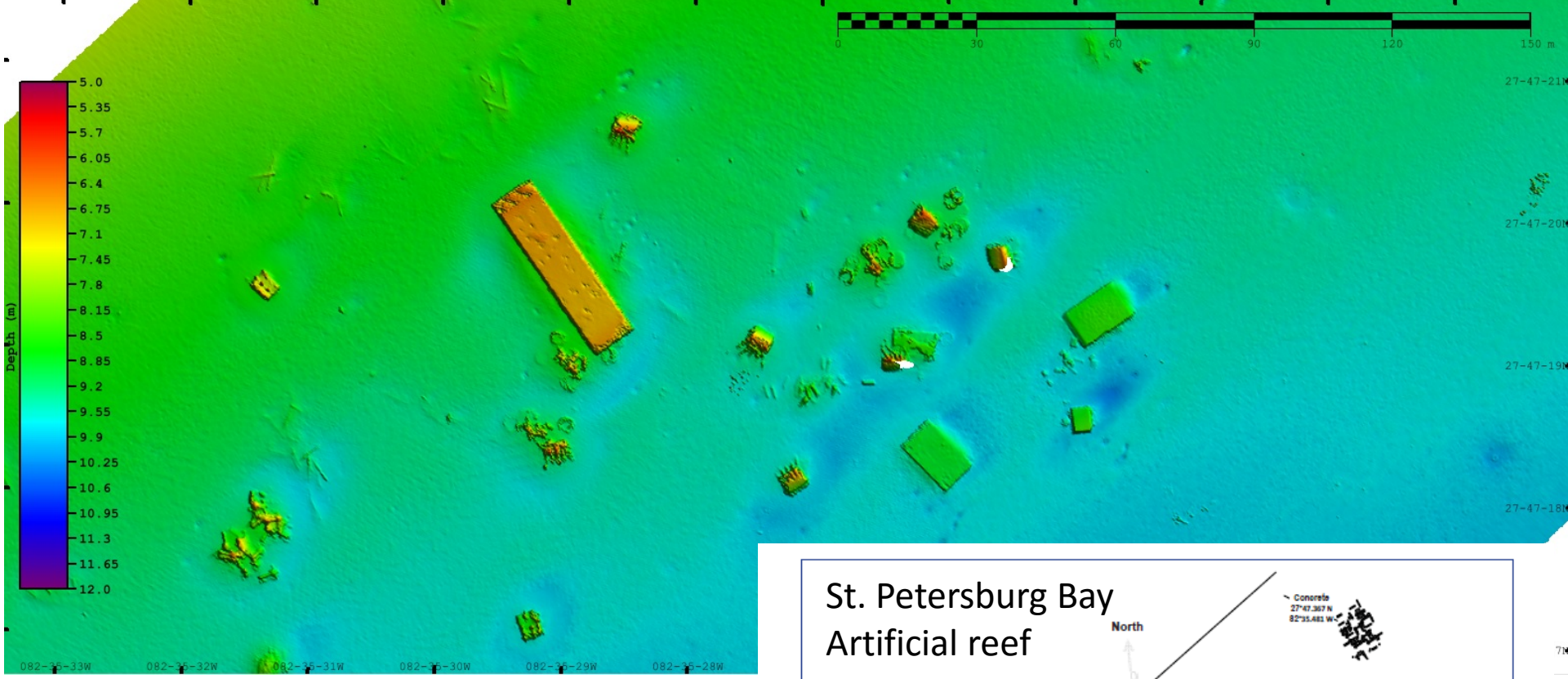

86°0'0"W
84°0'0"W
0 25 50 100 Kilometers
30°0'0"N
28°0'0"N
26°0'0"N
Where are Sensitive Habitats?
Natural Habitats
The "Elbow"
Legend
Loggerhead Sea Turtle Sightings (2007-13)
Existing Multibeam Bathymetry (2000-15)
The Elbow (C-SCAMP 2015)
Future Mapping Effort (2016-18)
Focus Area 1
CPUE Data
# of Pings
High : 52,000
Low : 15,000

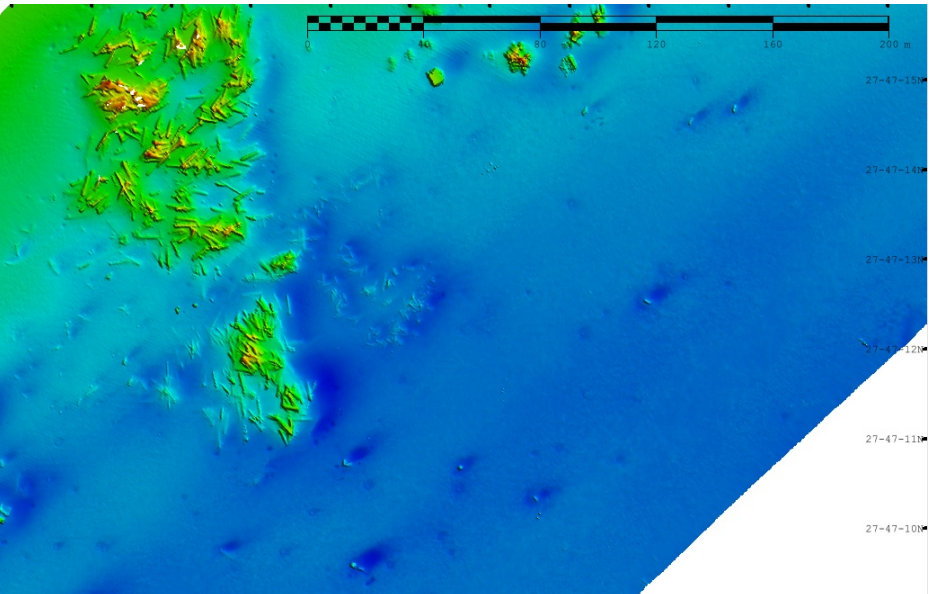
High-Resolution Habitat Mapping

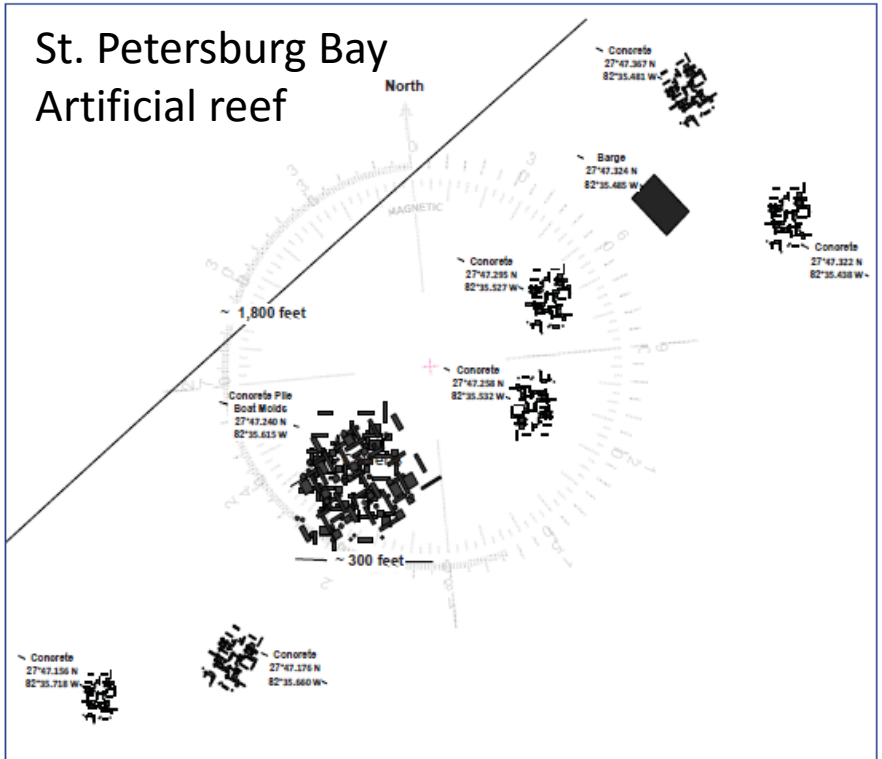


Elbow, Hard Bottom Ridge


Very Important Recreational Fishing Areas
State of Florida
Artificial Reef Inventory
2015 - FWRI
Reef Locations
State-Federal Jurisdiction Line
88°0'0"W
86°0'0"W
84°0'0"W
82°0'0"W
30°0'0"N
28°0'0"N
26°0'0"N
De Soto Valley
West Florida Escarpment
Carmen
Florida Keys
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors


Depth (m)
5.0
5.35
5.7
6.05
6.4
6.75
7.1
7.45
7.8
8.15
8.5
8.85
9.2
9.55
9.9
10.25
10.6
10.95
11.3
11.65
12.0
0
30
60
90
120
150 m
27-47-21N
27-47-20N
27-47-19N
27-47-18N
082-35-33W
082-35-32W
082-35-31W
082-35-30W
082-35-29W
082-35-28W


0
40
80
120
160
200 m
27-47-15N
27-47-14N
27-47-13N
27-47-12N
27-47-11N
27-47-10N


St. Petersburg Bay
Artificial reef
North
MAGNETIC
Concrete
27°47.367 N
82°35.481 W
Barge
27°47.324 N
82°35.485 W
Concrete
27°47.322 N
82°35.438 W
Concrete
27°47.295 N
82°35.527 W
~ 1,800 feet
Concrete
27°47.258 N
82°35.532 W
Concrete Pile
Boat Molds
27°47.240 N
82°35.615 W
~ 300 feet
Concrete
27°47.156 N
82°35.718 W
Concrete
27°47.176 N
82°35.660 W

What Else do we Need to Know?

- What are the Baselines of contamination in sediments, water and biota associated with the ~4,000 oil and gas facilities in the Gulf (and pipeline fields as well)
- How do the depth of the water and specific oil composition affect the efficacy of response measures?
- What resources are at risk from a potential oil spill at any location in the Gulf?
- How would surface and sub-surface oil spills move, at what rates, and in response to what factors?
- What are the environmental consequences of oil spill response measures (burning, dispersants, sand berms, water releases)?
- Can ultra-deep drilling and production be accomplished with greatly reduced risks of environmental damage?

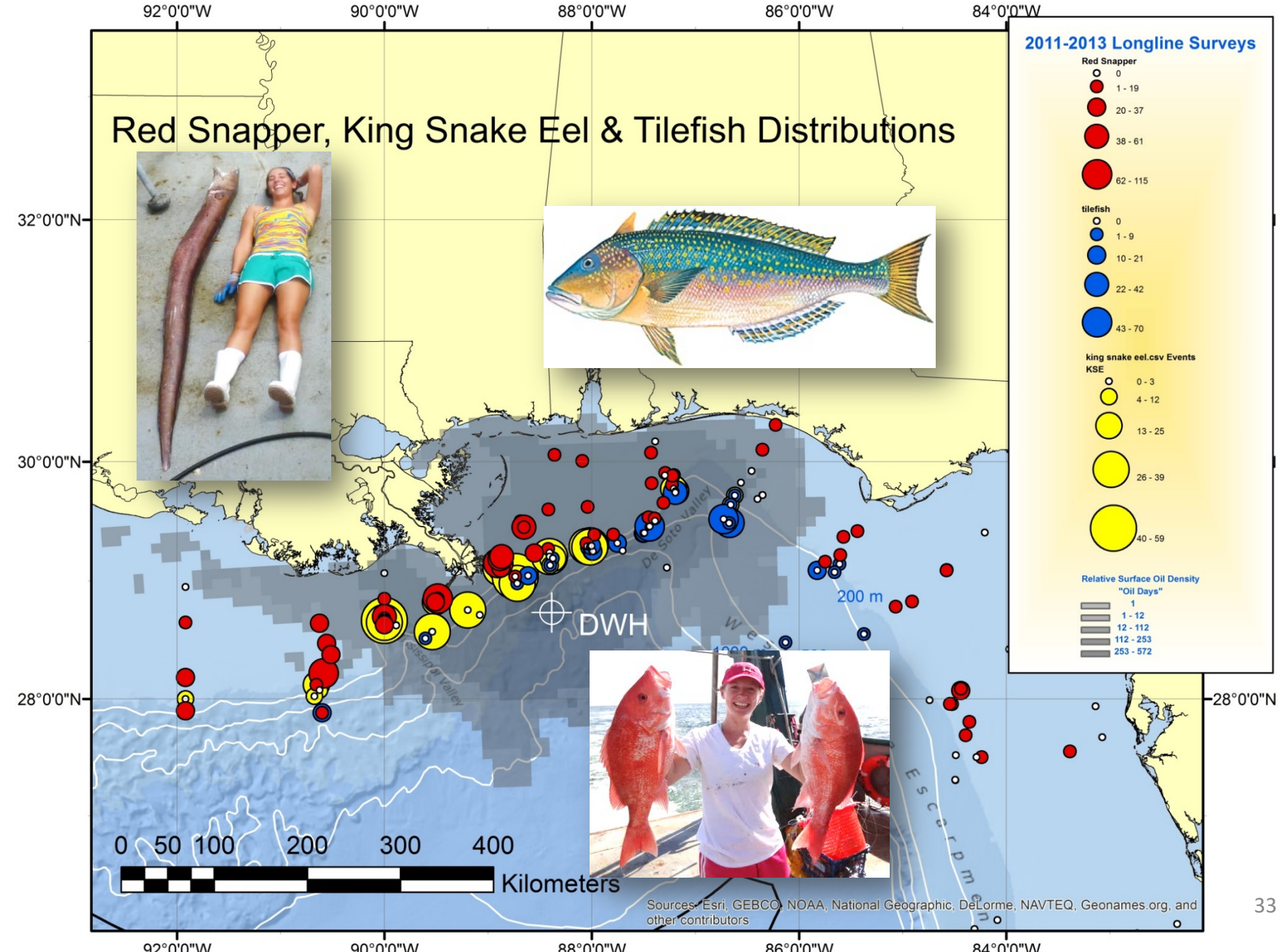
Summary

- Considerable progress in understanding the impacts of DWH, some of which will be with us for decades
- Science investments by various sources are helping to understand what the best response strategies are
- The next spill will not be like DWH – probably deeper and in a different location
- We are better prepared but are we adequately prepared?

Questions?

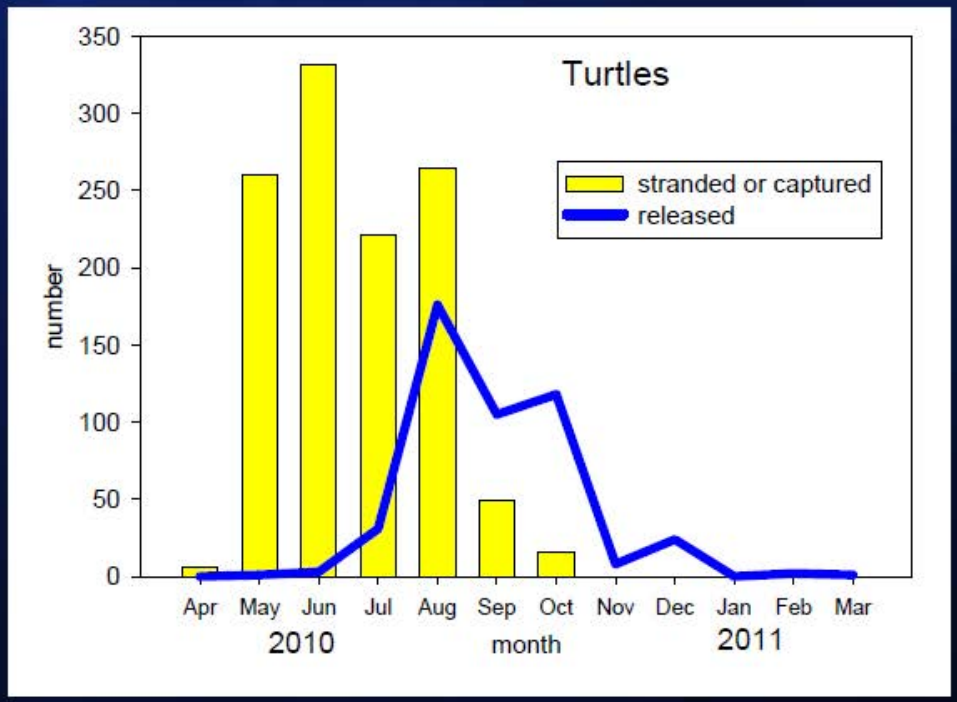
Backup Slides

Different species can exhibit different contamination levels, even if taken from the same place



1,149 total turtles
469 released alive after rehabilitation

Most juvenile Kemps Ridley



Population-Level Exposure?

Using SEAMAP larval samples, Estimated 6% of Red Snapper Larvae coincident with DWH Oil (time and space overlap) >> just considering eastern sub-stock

Emily Chancellor (2014)

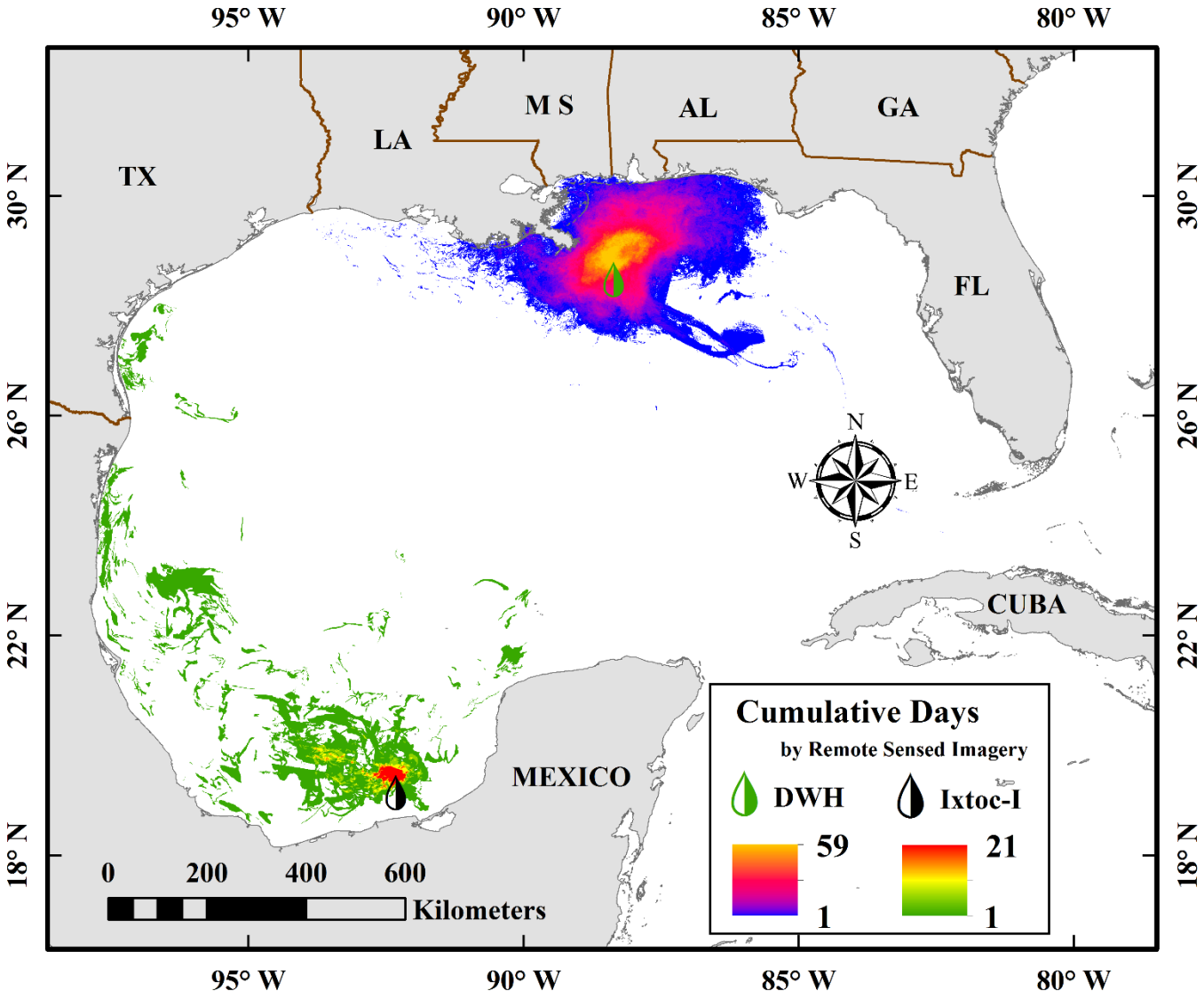
Oil Density Map Estimation - Gulf Coast

Map Date :20 July 2010
Produced at AFSC - Jan Benson
Data Source: NOAA, The Response Group, ESRI
Sum of all 5 min cells where light = 1, medium = 5, and heavy = 10

Deepwater Horizon Incident Site
FisheryClosure 07 13 2010
All Trajectory Files

Sum of May, June, July Oil Concentration
1-22
22-73
73-211
211-524

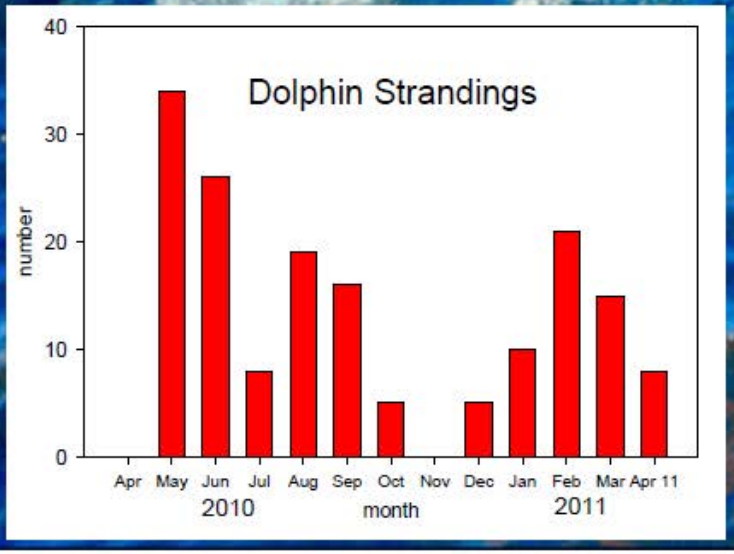
94°W 92°W 90°W 88°W 86°W 84°W
30°N 28°N 26°N 24°N

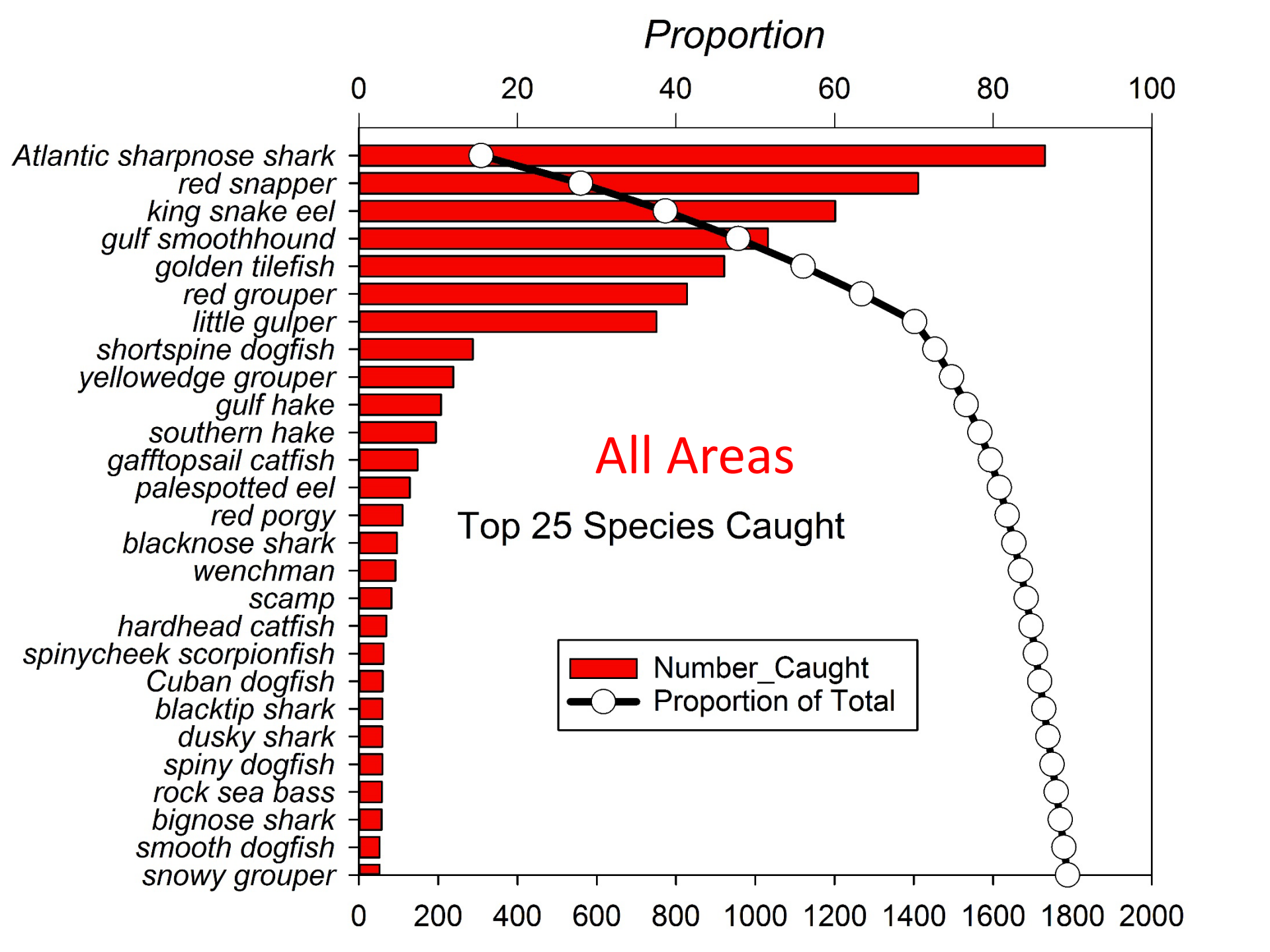

95° W
90° W
85° W
80° W
30° N
26° N
22° N
18° N
TX
LA
M S
AL
GA
FL
CUBA
MEXICO
N
W
E
S
0
200
400
600
Kilometers
Cumulative Days
by Remote Sensed Imagery
DWH
59
1
Ixtoc-I
21
1

Dolphin Strandings

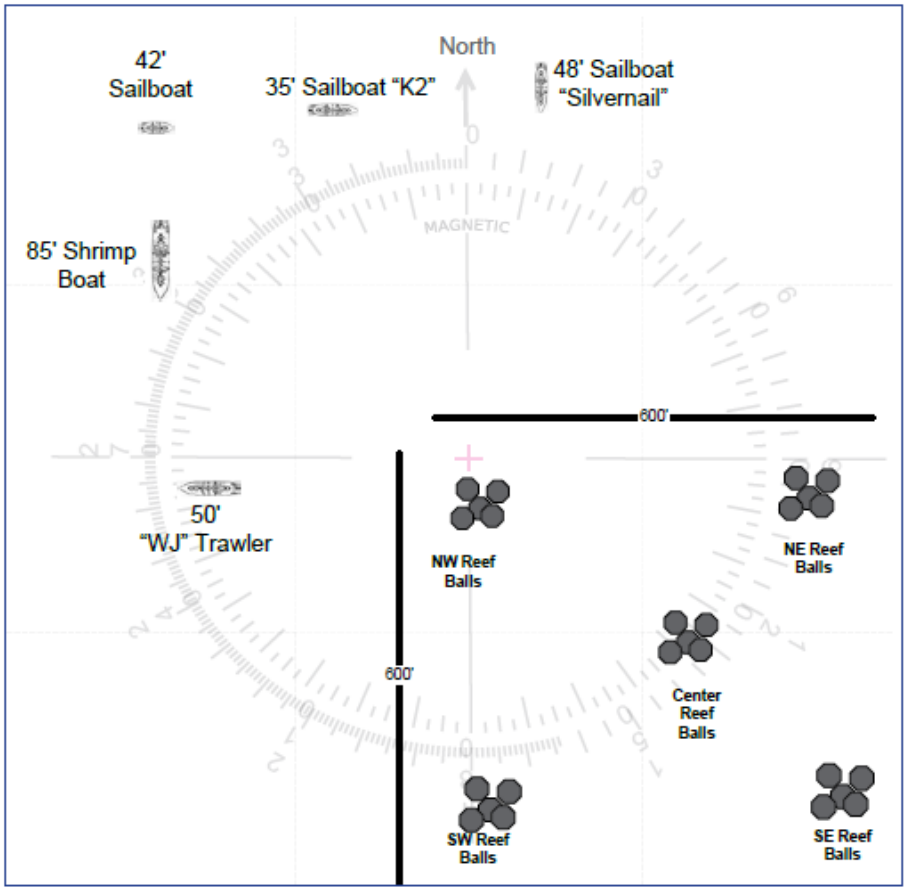
Health Study in Barataria Bay

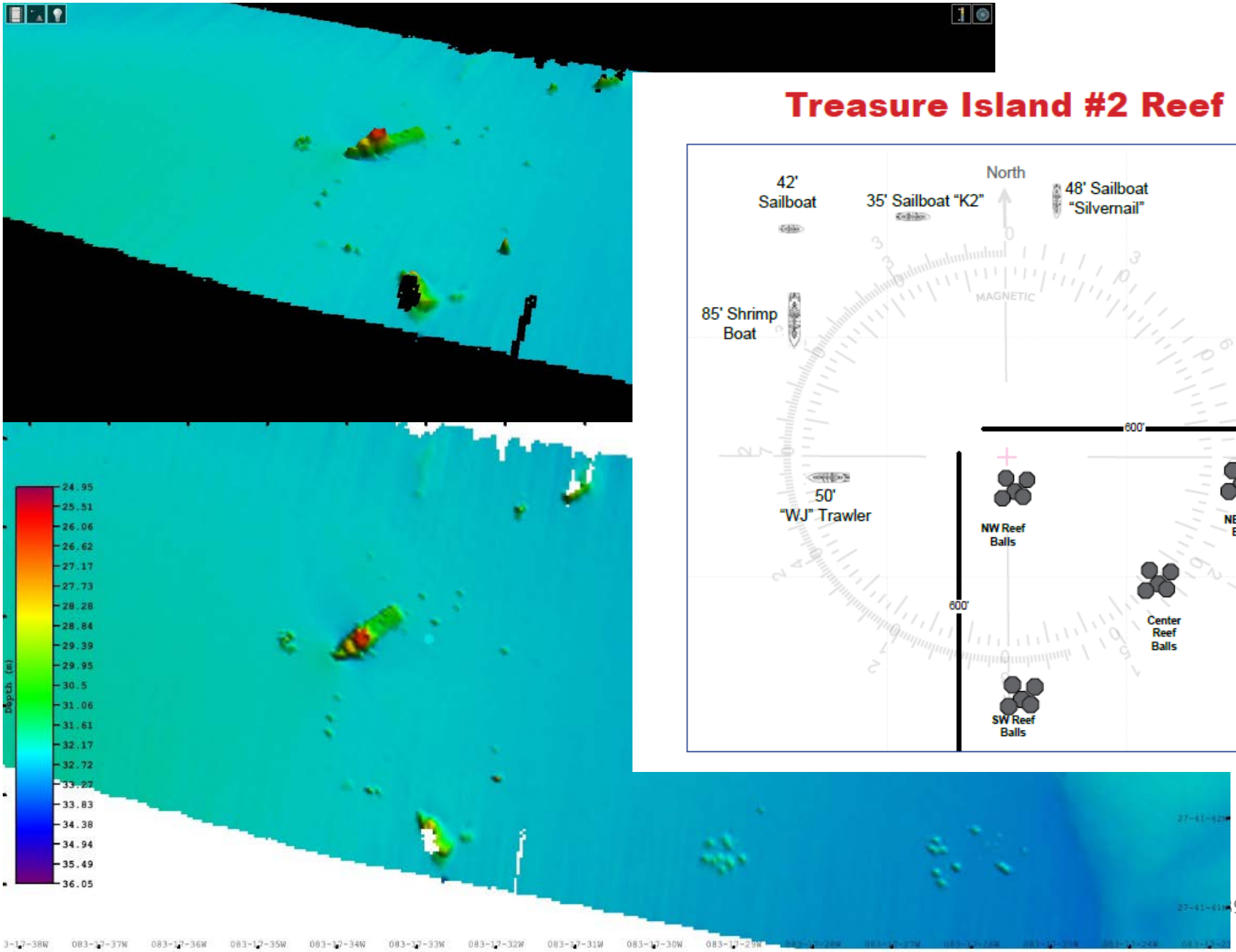
167 dolphins
5 released




Proportion
0
20
40
60
80
100
Atlantic sharpnose shark
red snapper
king snake eel
gulf smoothhound
golden tilefish
red grouper
little gulper
shortspine dogfish
yellowedge grouper
gulf hake
southern hake
gafftopsail catfish
palespotted eel
red porgy
blacknose shark
wenchman
scamp
hardhead catfish
spinycheek scorpionfish
Cuban dogfish
blacktip shark
dusky shark
spiny dogfish
rock sea bass
bignose shark
smooth dogfish
snowy grouper
All Areas
Top 25 Species Caught
Number_Caught
Proportion of Total
0
200
400
600
800
1000
1200
1400
1600
1800
2000

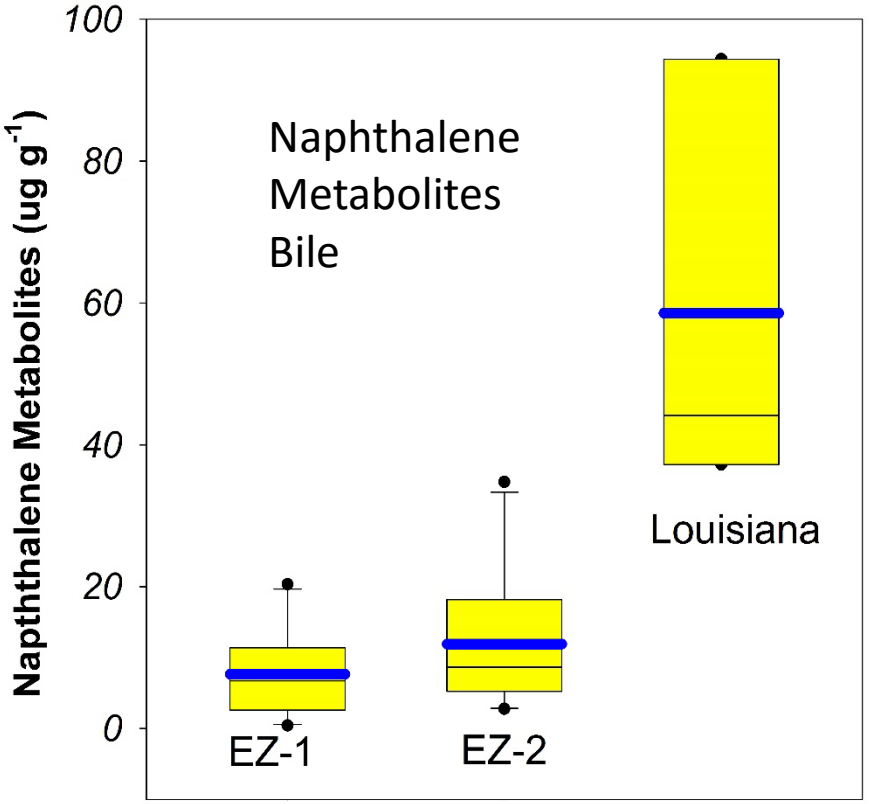
Treasure Island #2 Reef

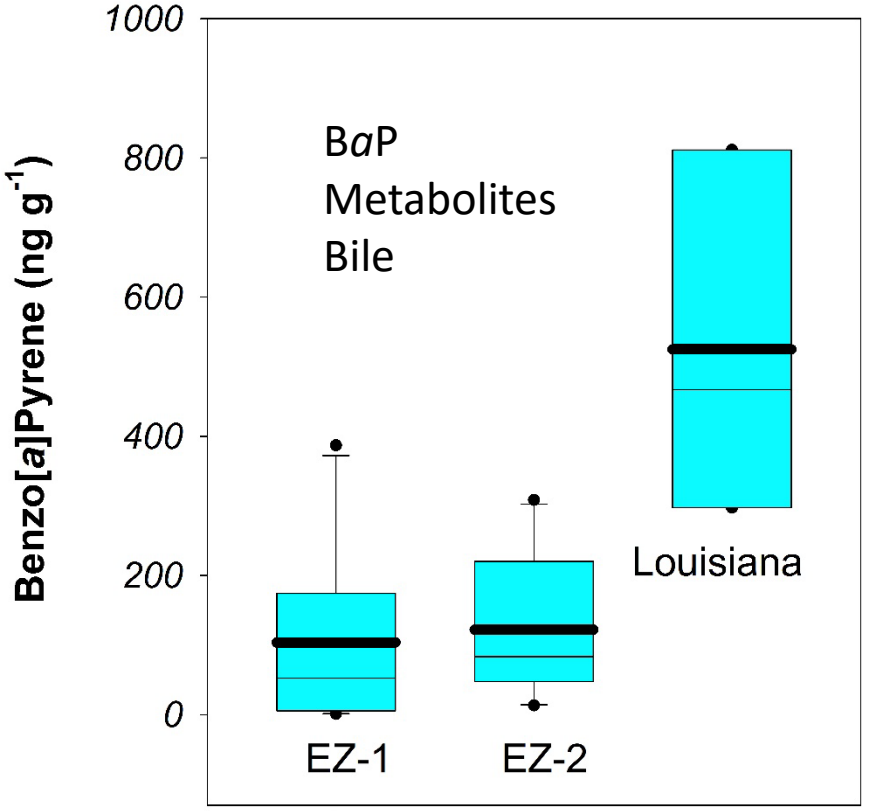




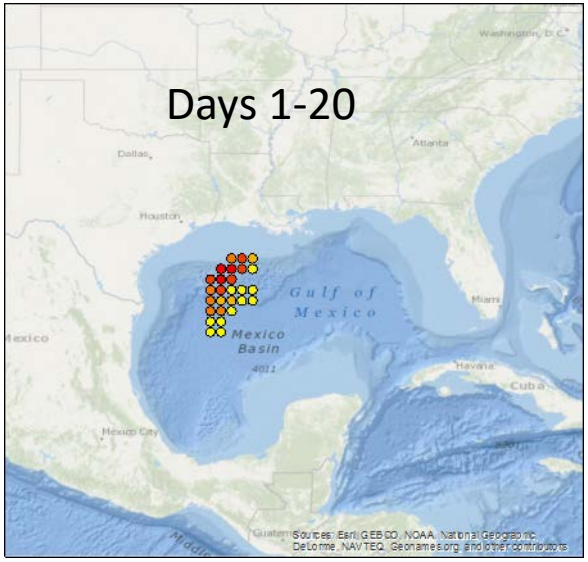
Gafftopsail Catfish

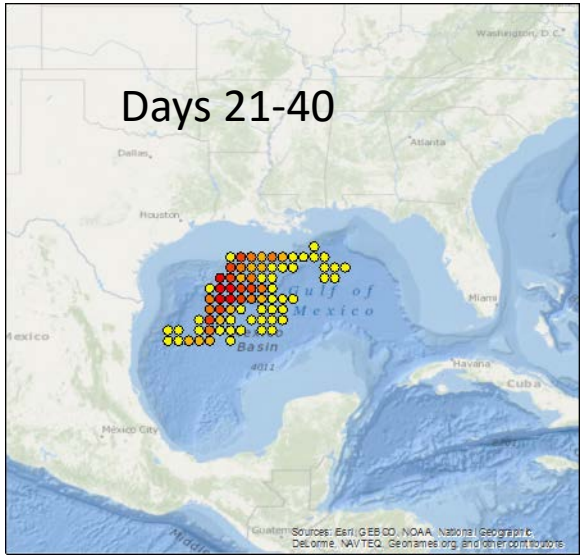
(*Bagre marinus*)

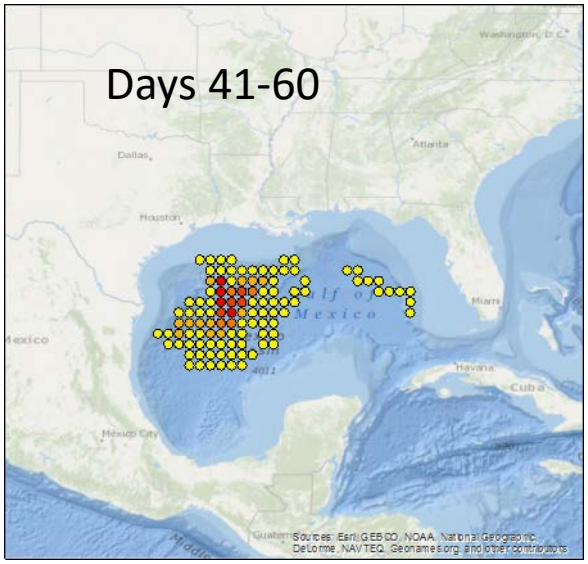


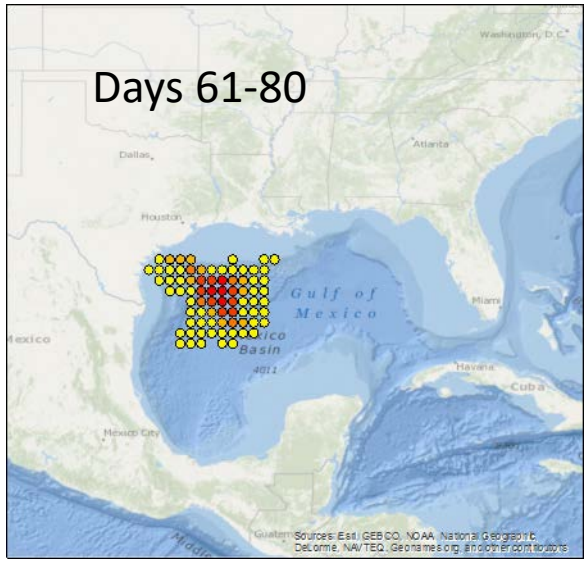


Scenario 2 - 27N and 93.5W









Legend

oil mass

- 0.099 - 138.020
- 138.020 - 452.789
- 452.789 - 1378.455
- 1378.455 - 6322.816
- 6322.816 - 35814.694

CMS Simulations
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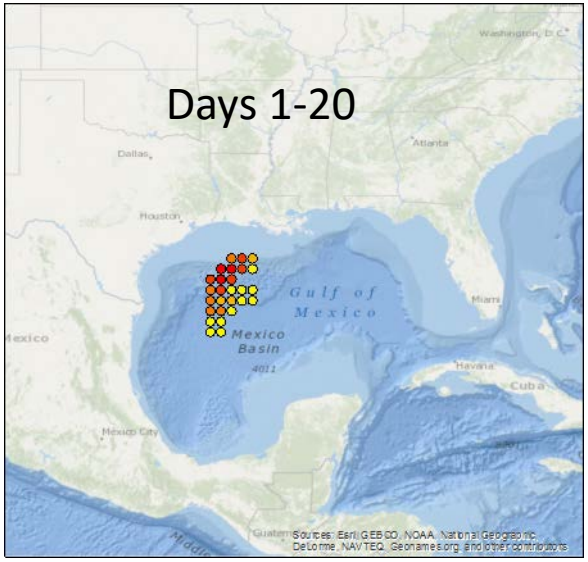
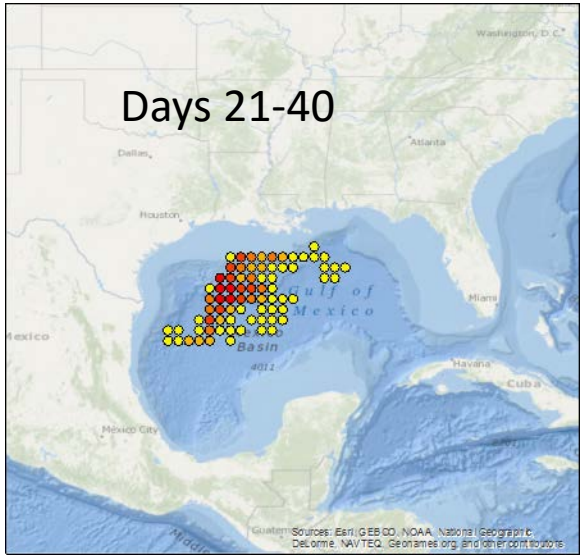
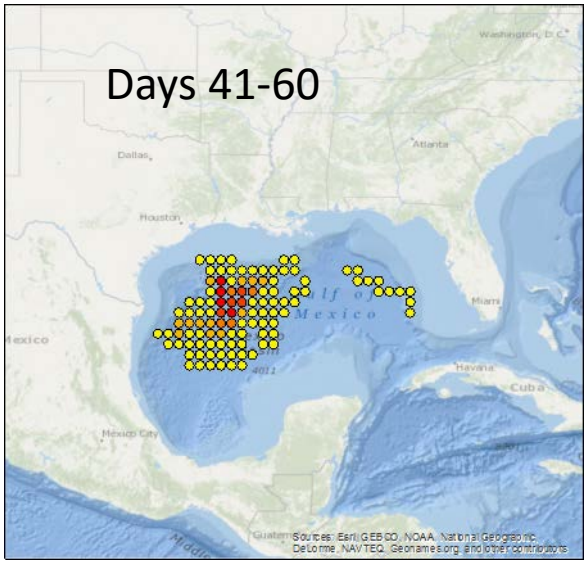
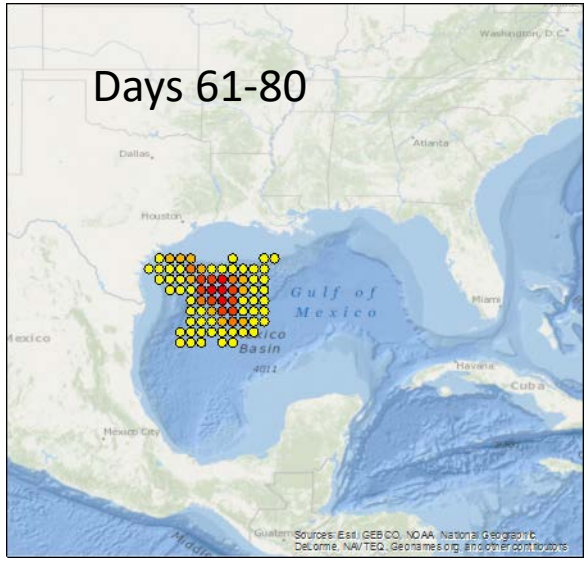
Scenario 2 - 27N and 93.5W









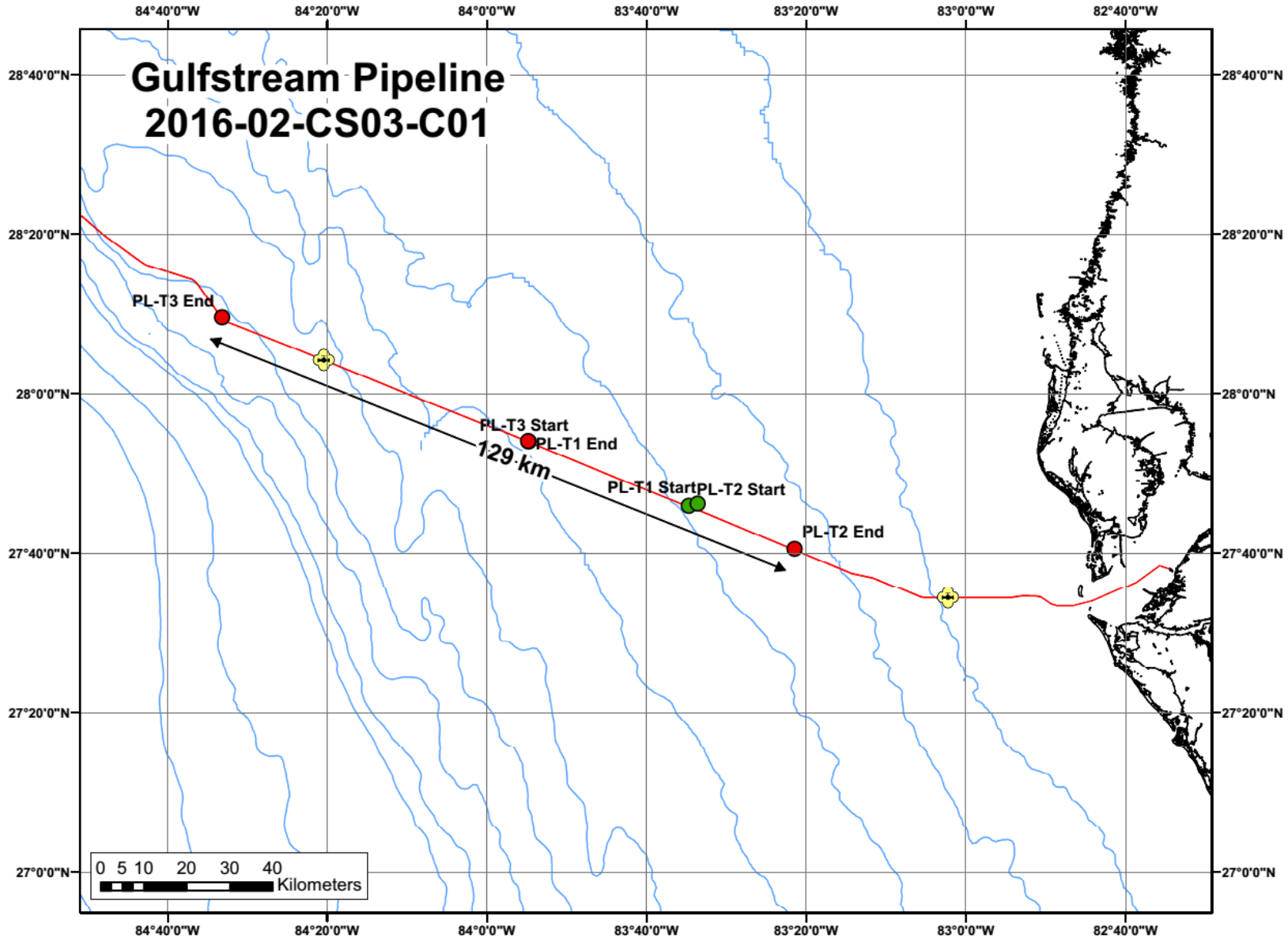
Legend

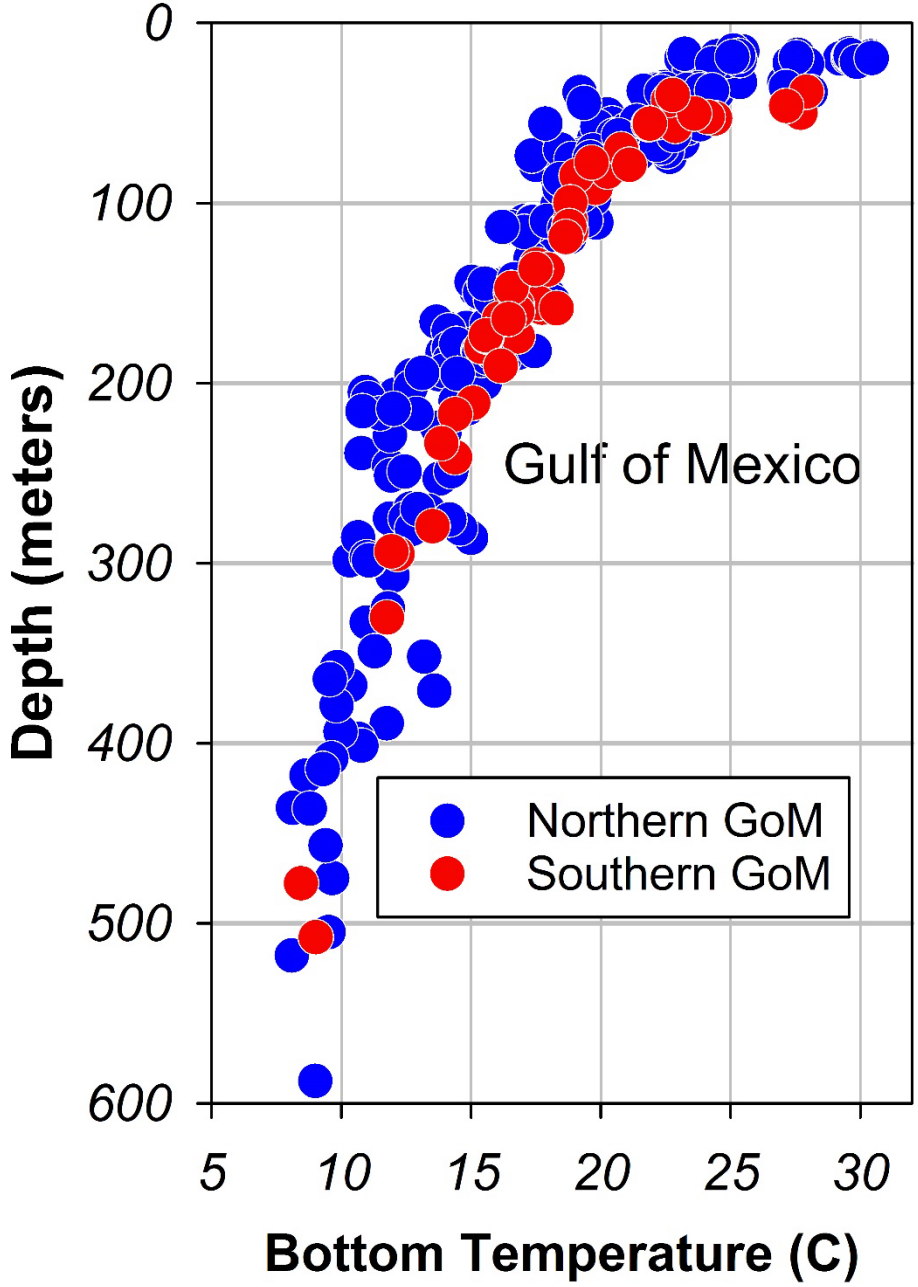
oil mass

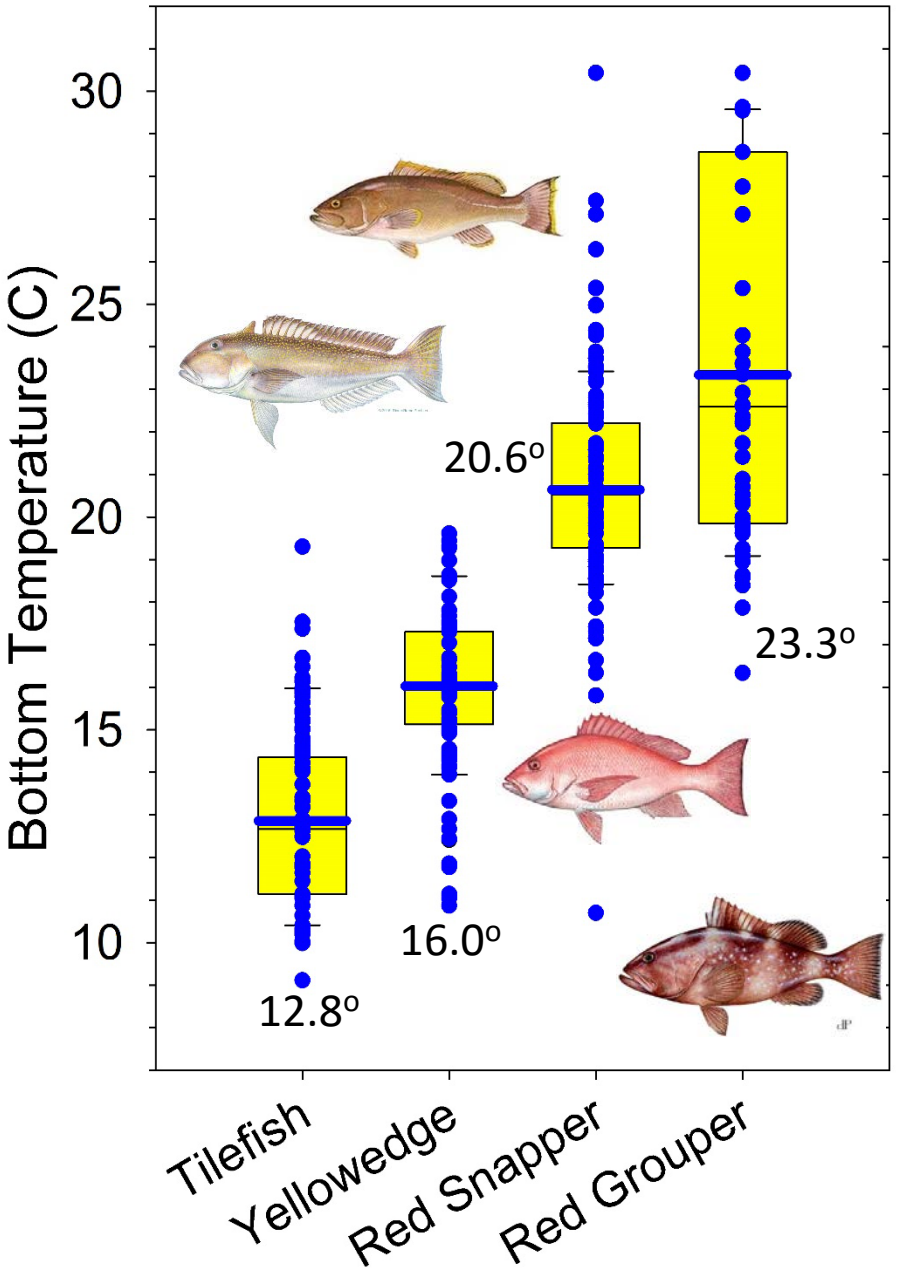
- 0.099 - 138.020
- 138.020 - 452.789
- 452.789 - 1378.455
- 1378.455 - 6322.816
- 6322.816 - 35814.694

CMS Simulations
D. Lindo &
C. Paris

Gulfstream Pipeline




Depth (meters)
0
100
200
300
400
500
600
5
10
15
20
25
30
Bottom Temperature (C)
Gulf of Mexico
Northern GoM
Southern GoM


Bottom Temperature (C)
30
25
20
15
10
12.8°
16.0°
20.6°
23.3°
Tilefish
Yellowedge
Red Snapper
Red Grouper