

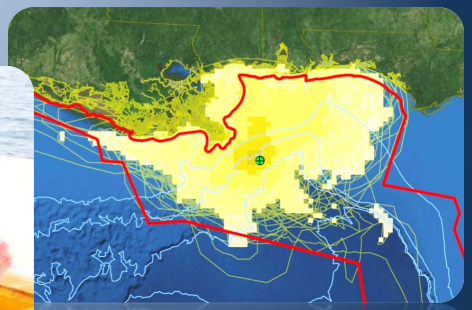

# Understanding the Ecological Effects of large Oil Spills: *Deepwater Horizon* and *IXTOC-I*

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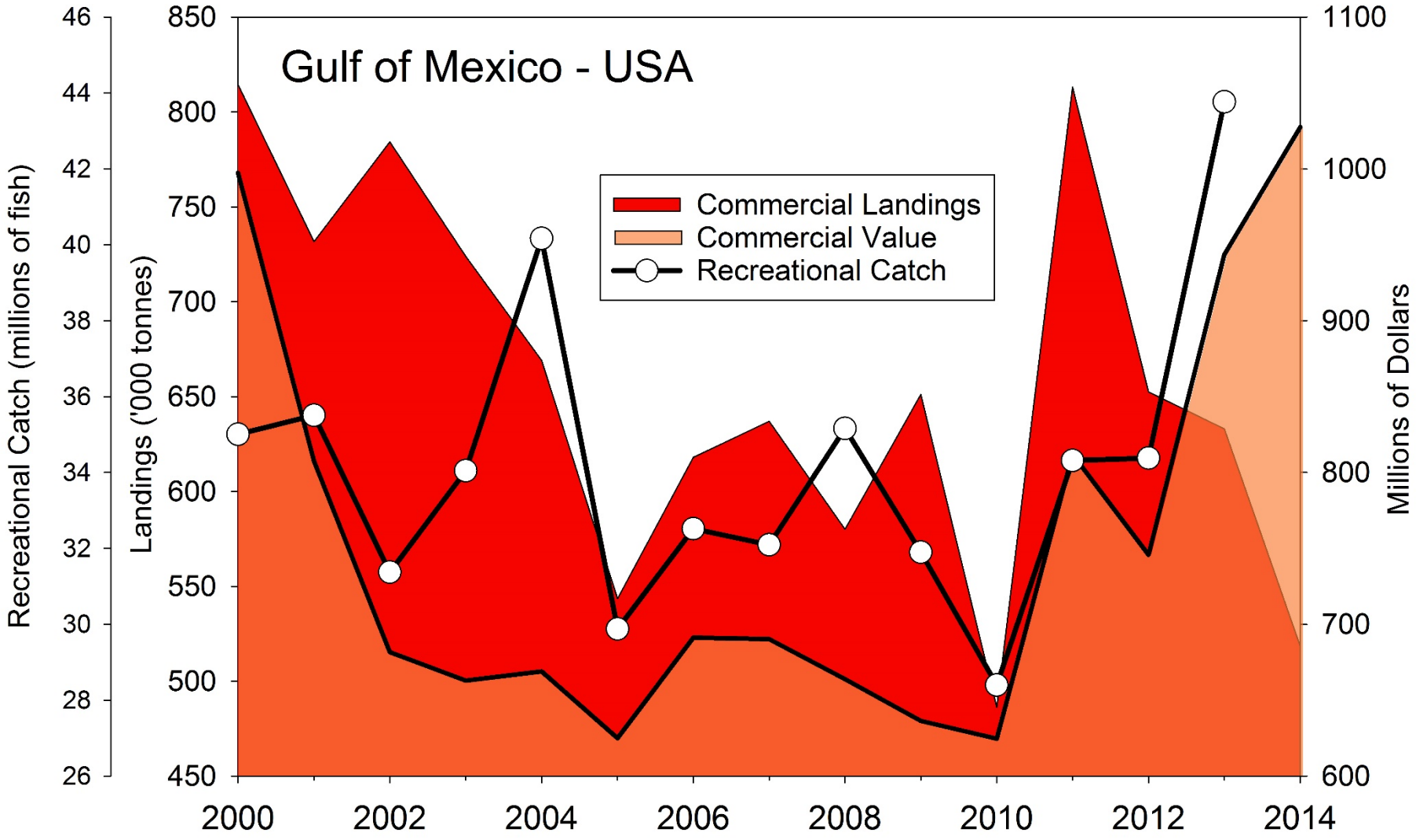
UNAM Symposium
4 May,, 2016
Mexico City

# Some Ecological Priorities

- Impacts of oil spills on Seafood Safety
- Impacts on Fish & Wildlife
- Comparing Northern & Southern Gulf Fish Populations, are they equally resilient?
- Connectivity between Northern and Southern Gulf
- Potential Impacts of Future Spills

# Impact of DWH on Northern Gulf of Mexico Fisheries?



# Were Seafood Supplies Protected?

**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

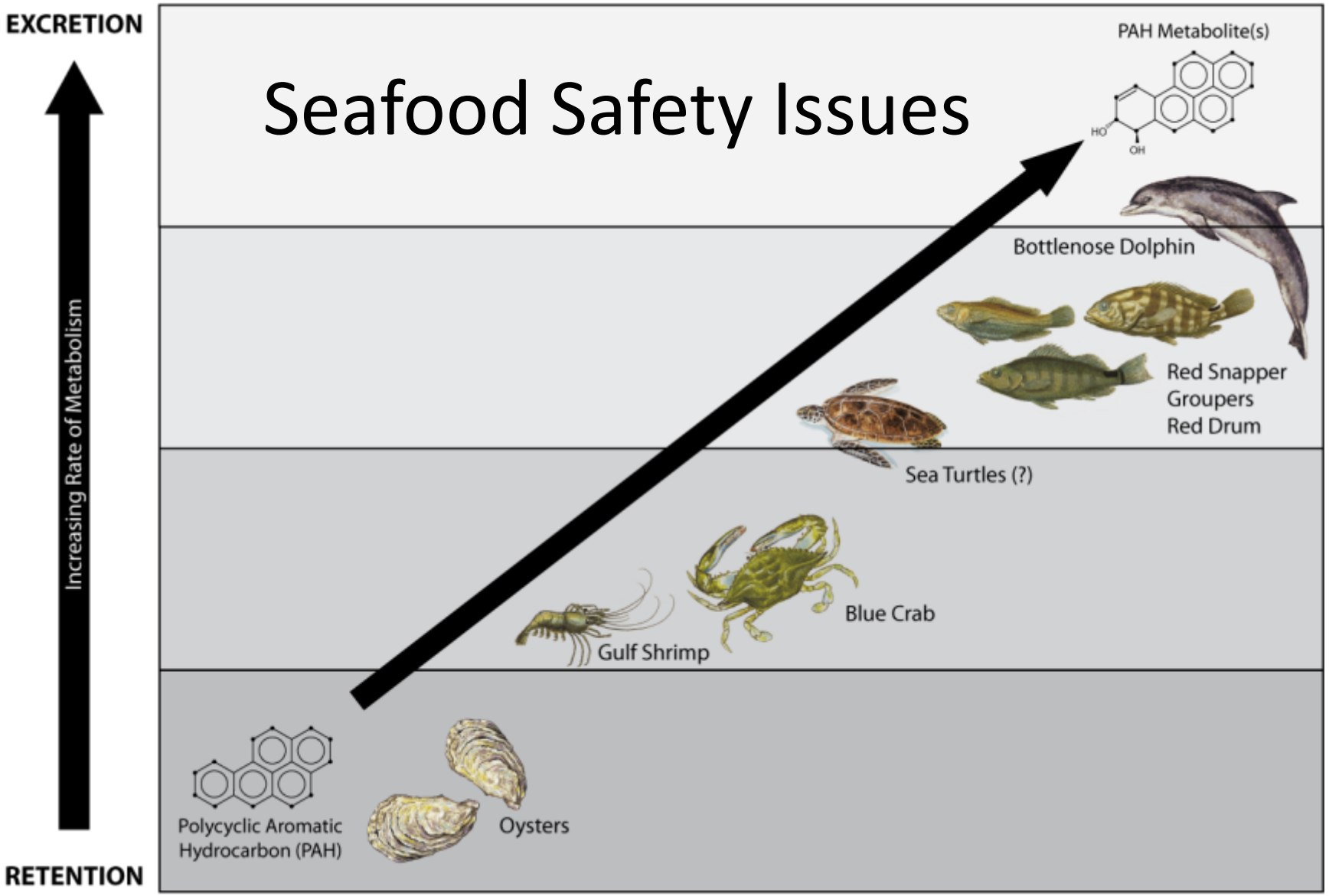
**Sum of May, June, July Oil Concentration**

- 1-22
- 22-73
- 73-211
- 211-524

0 60 120
Miles

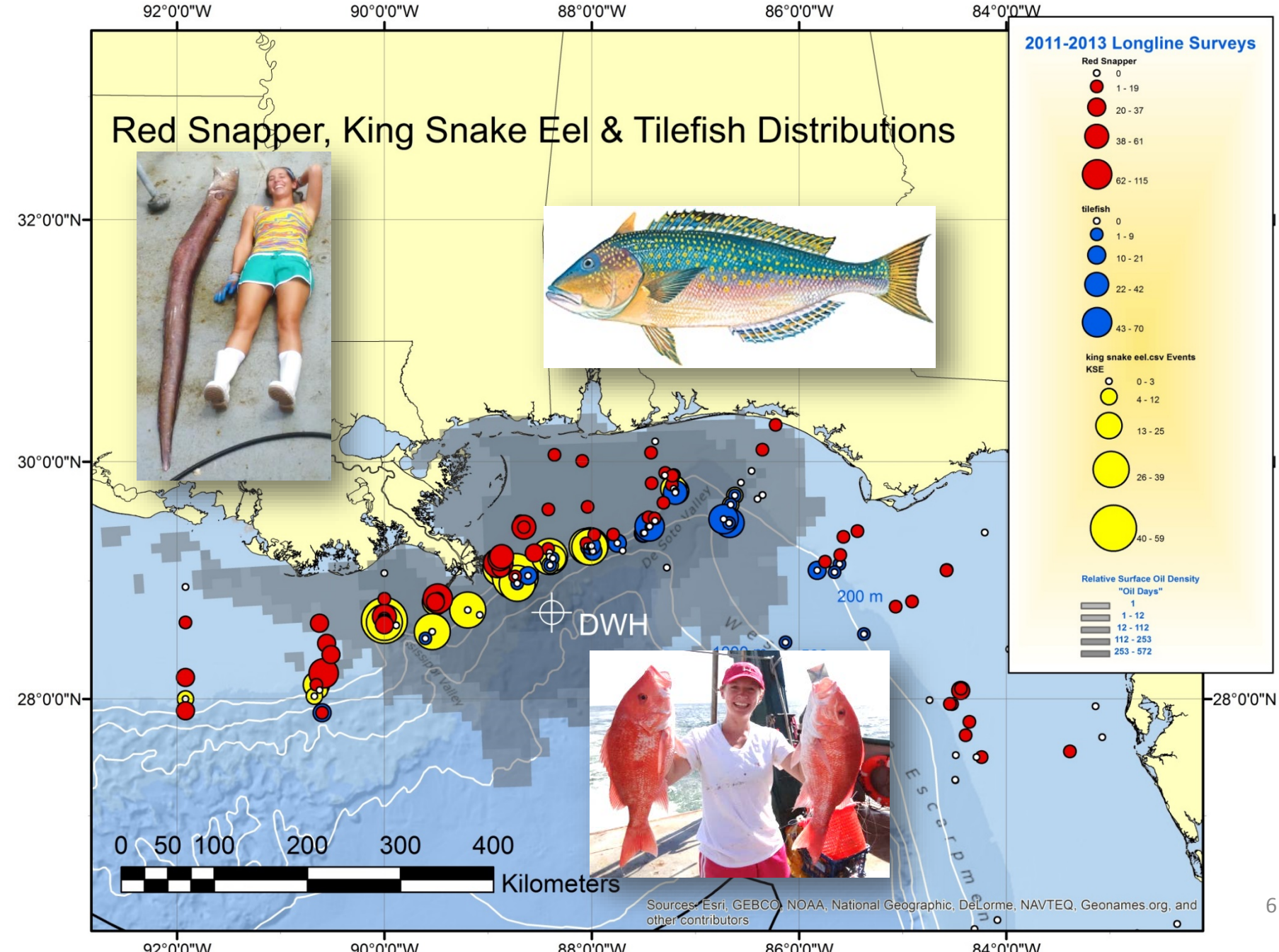
**No Samples of Seafood Exceeded FDA Action Limits for Hydrocarbons**

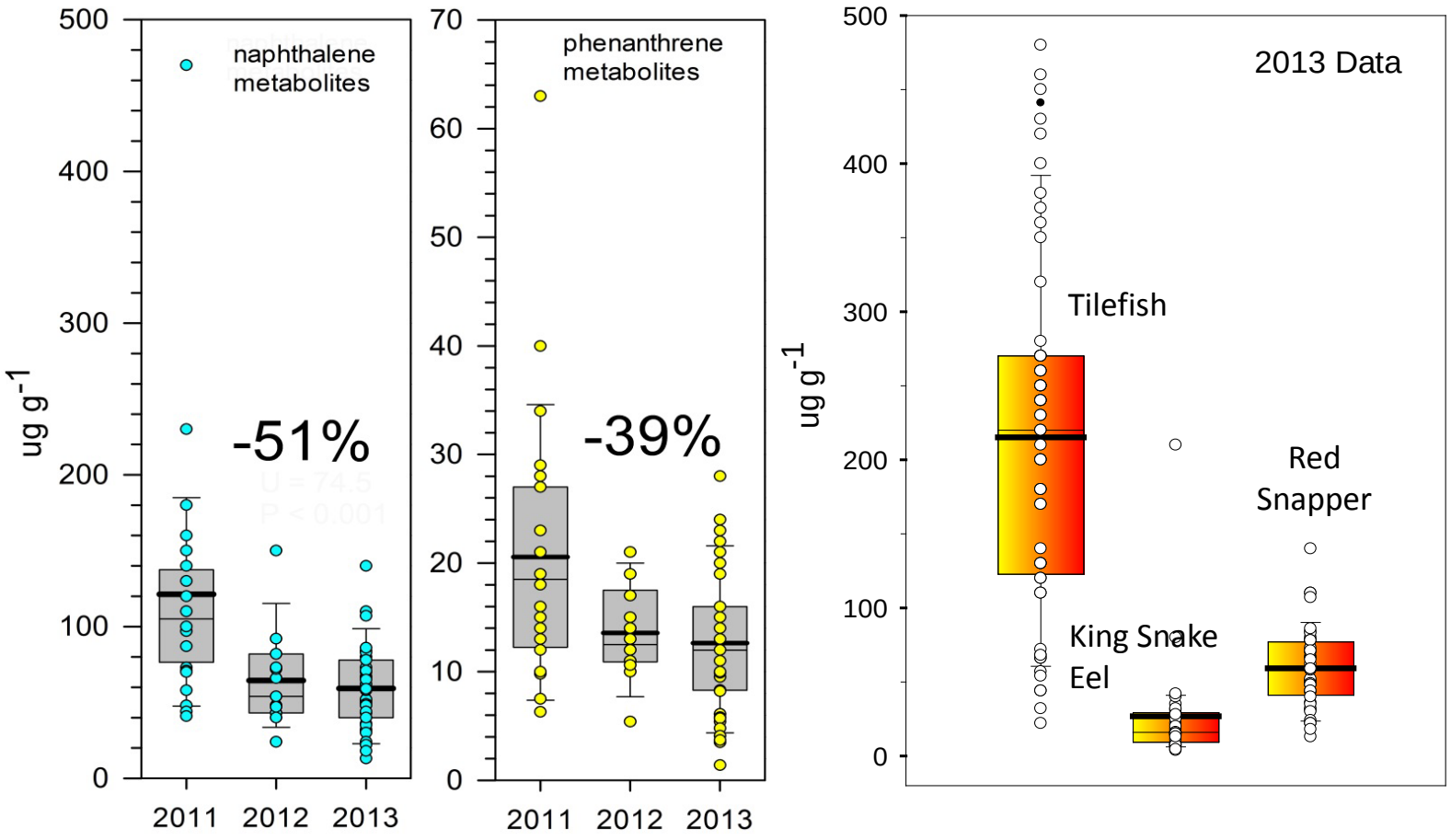
# Extent of Metabolism of PAHs




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

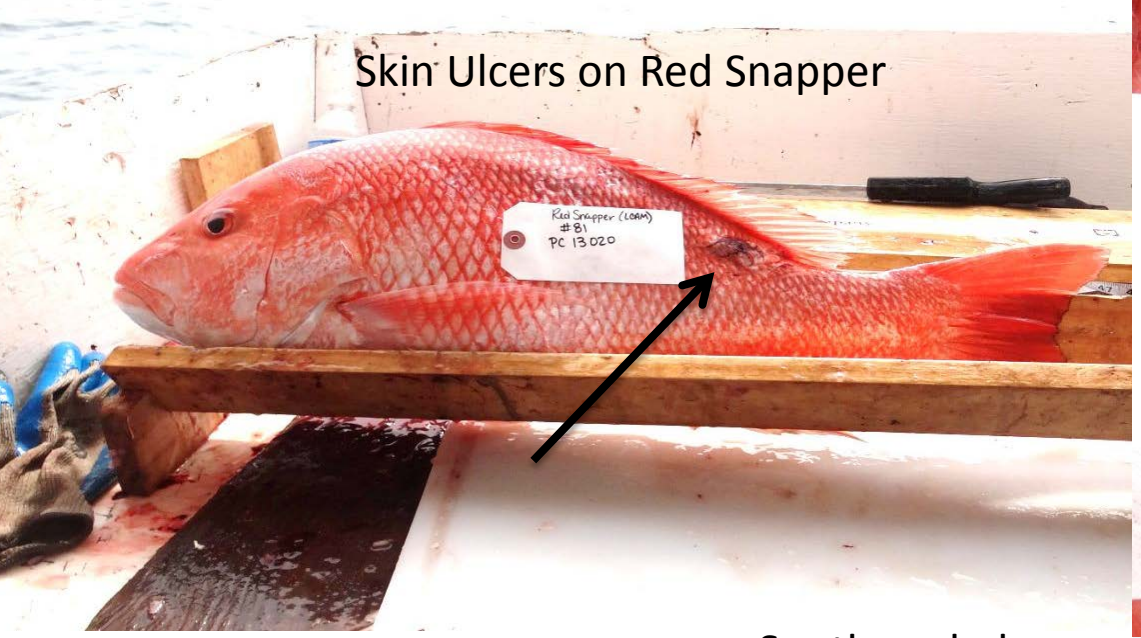
Different species can exhibit different contamination levels, even if taken from the same place

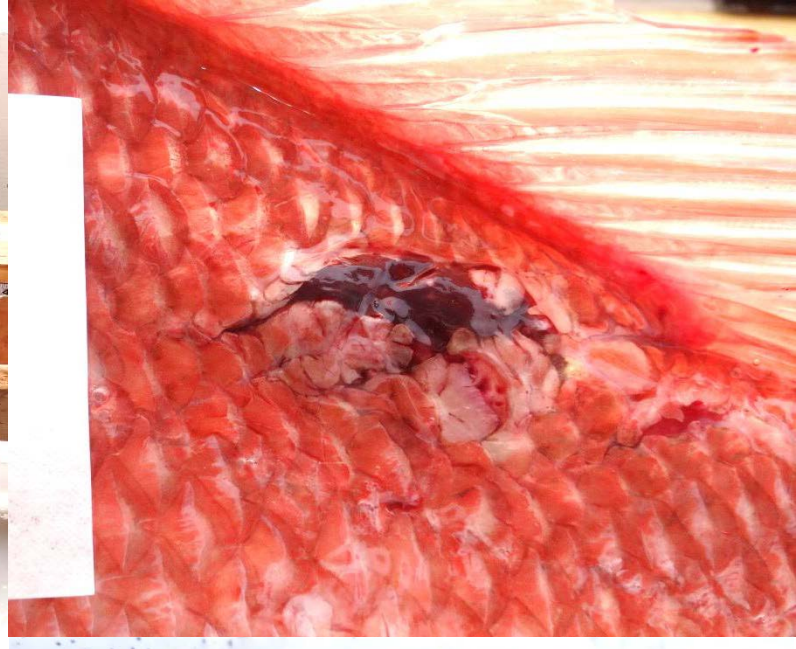




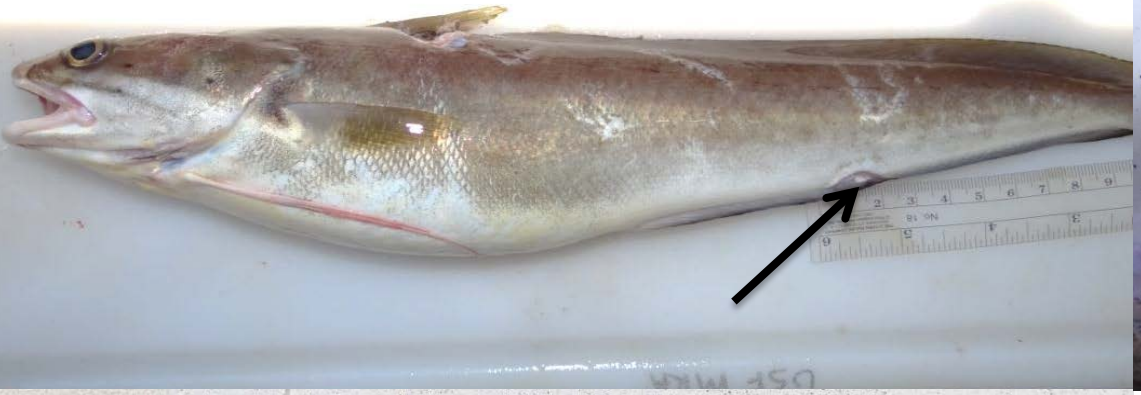

Changes in bile contamination of napthalene and phenanthrene metabolites in red snapper (left) sampled in the Northern Gulf of Mexico, 2011-2013

Skin Ulcers on Red Snapper



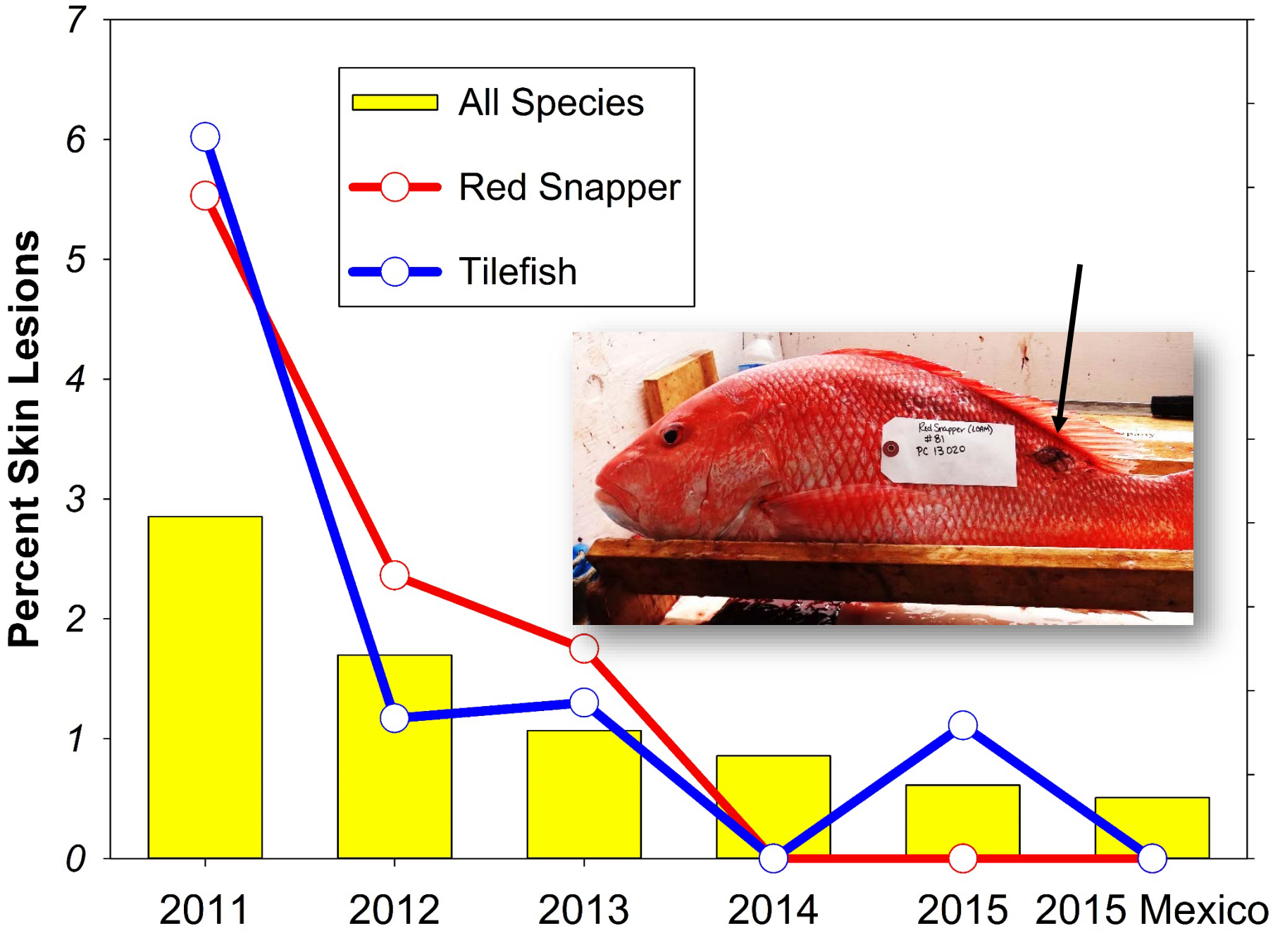



Southern hake



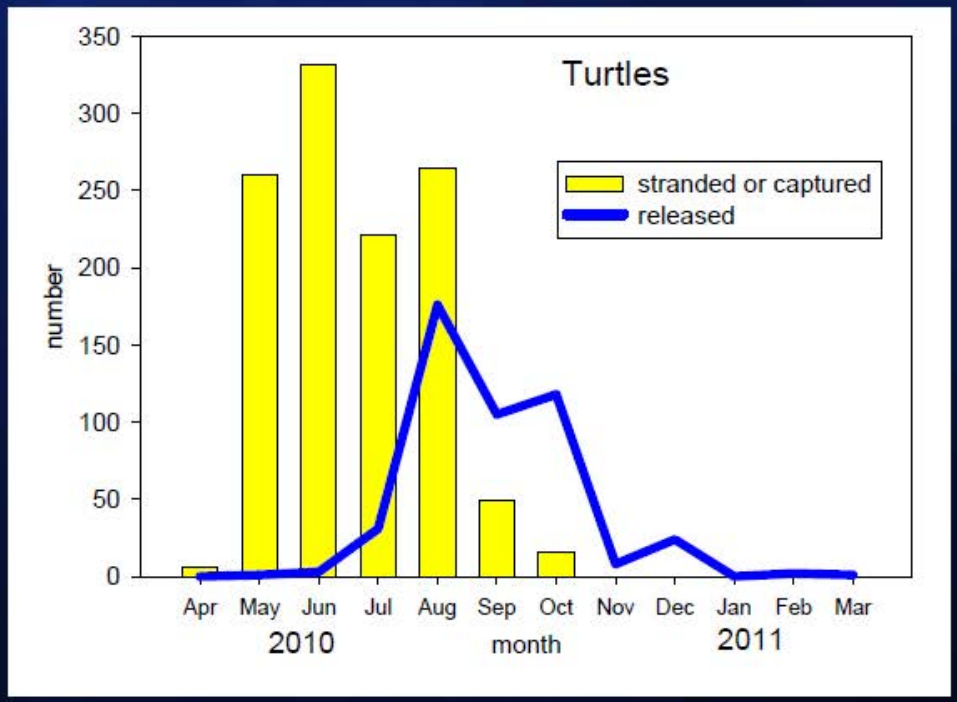
tilefish

Conger eel


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


1,149 total turtles
469 released alive after rehabilitation

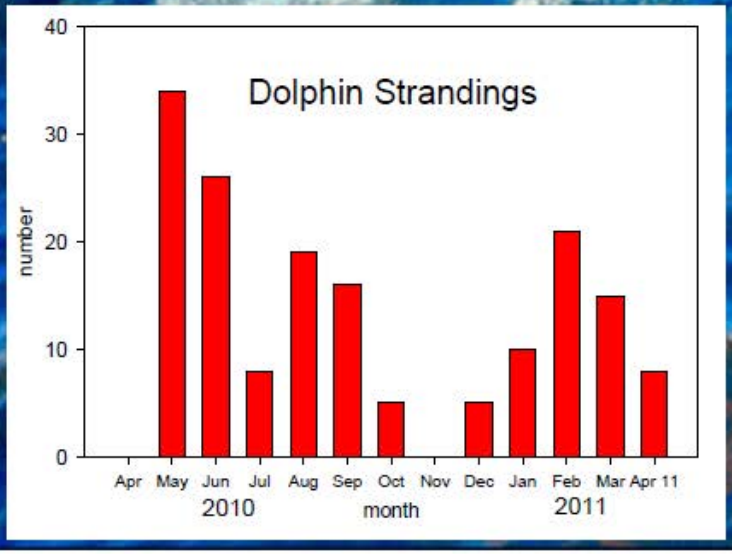
Most juvenile Kemps Ridley



# Dolphin Strandings

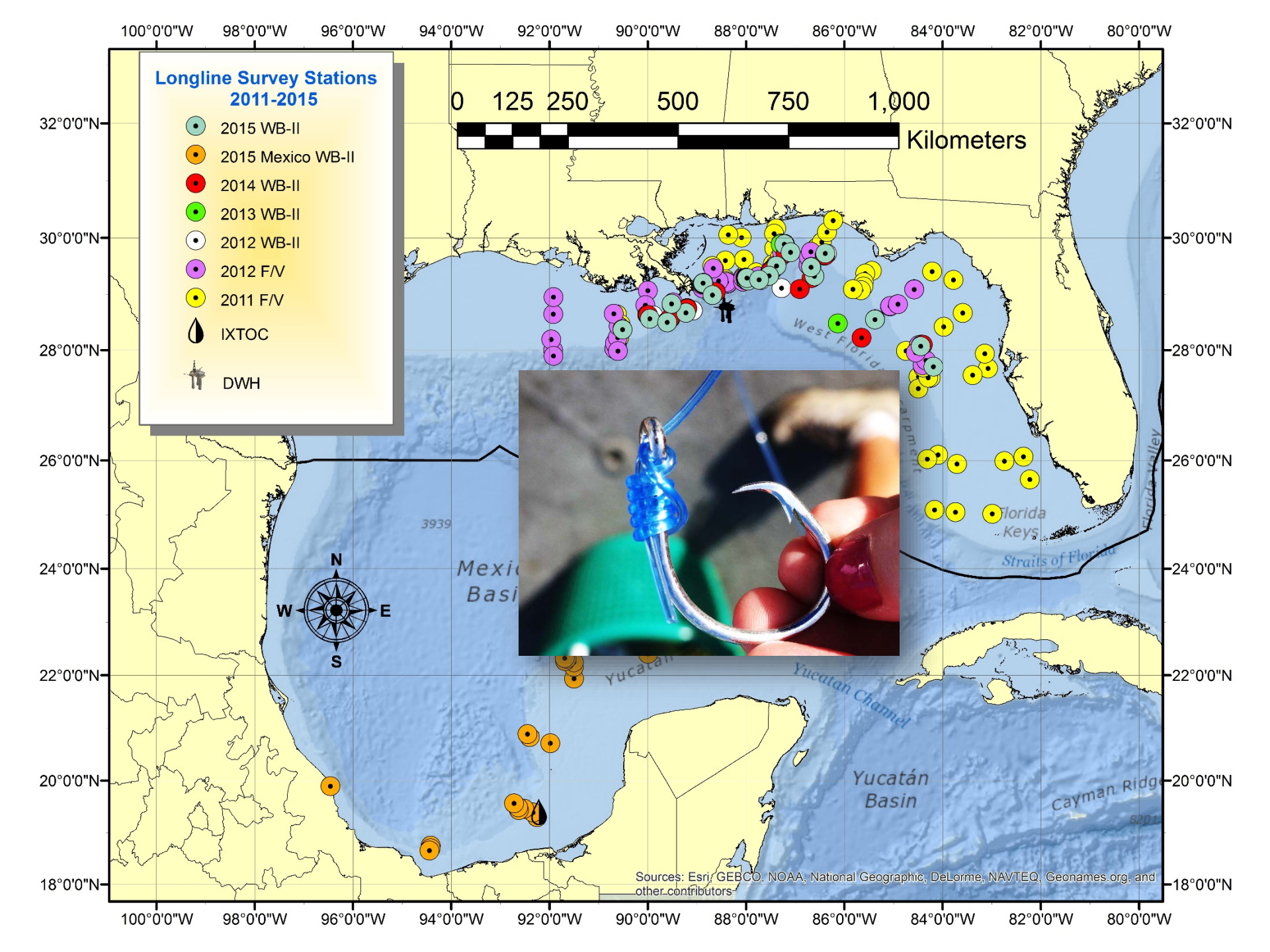
## Health Study in Barataria Bay

167 dolphins
5 released

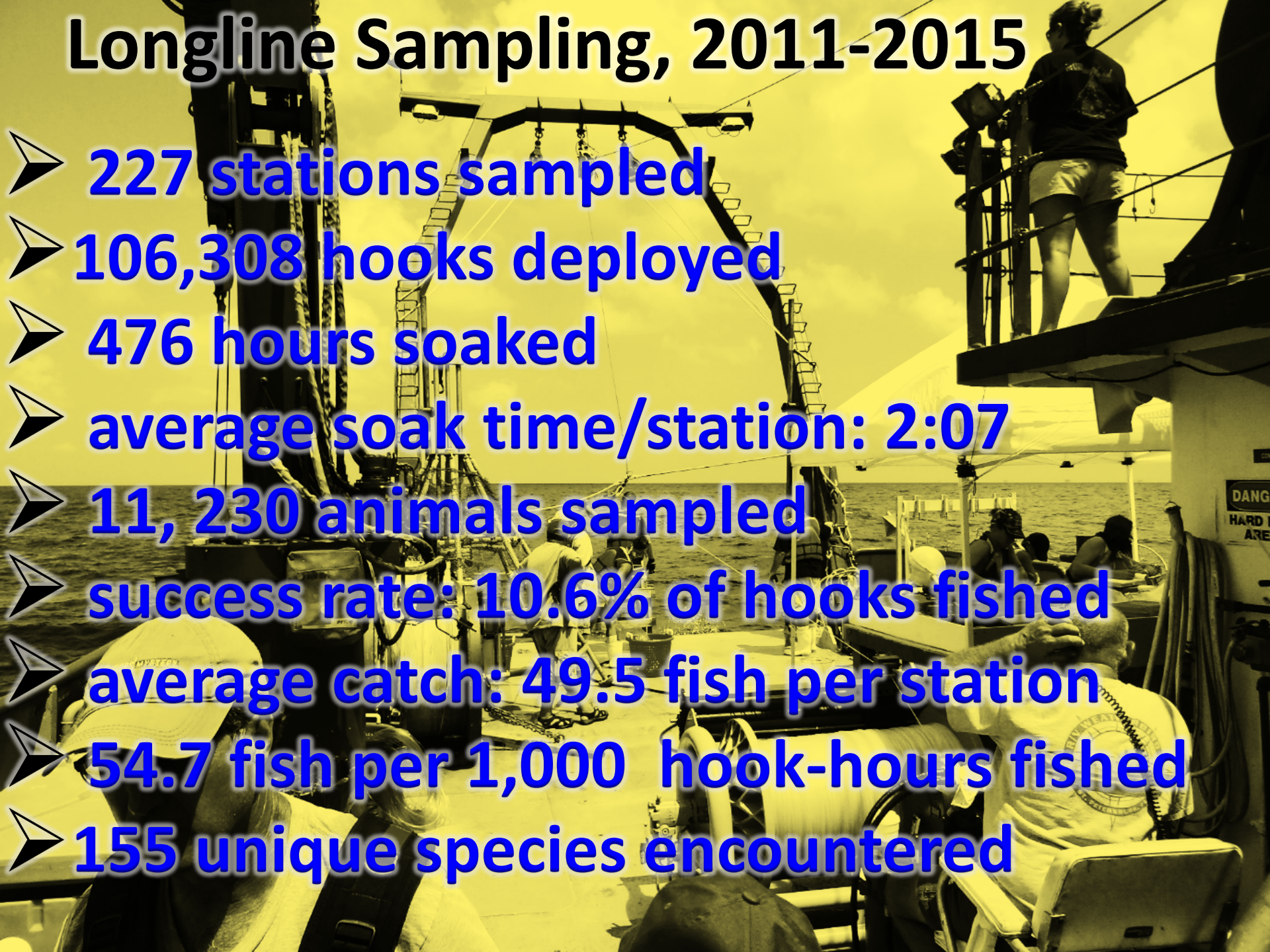


# Comparing NGoM & SGoM Fish

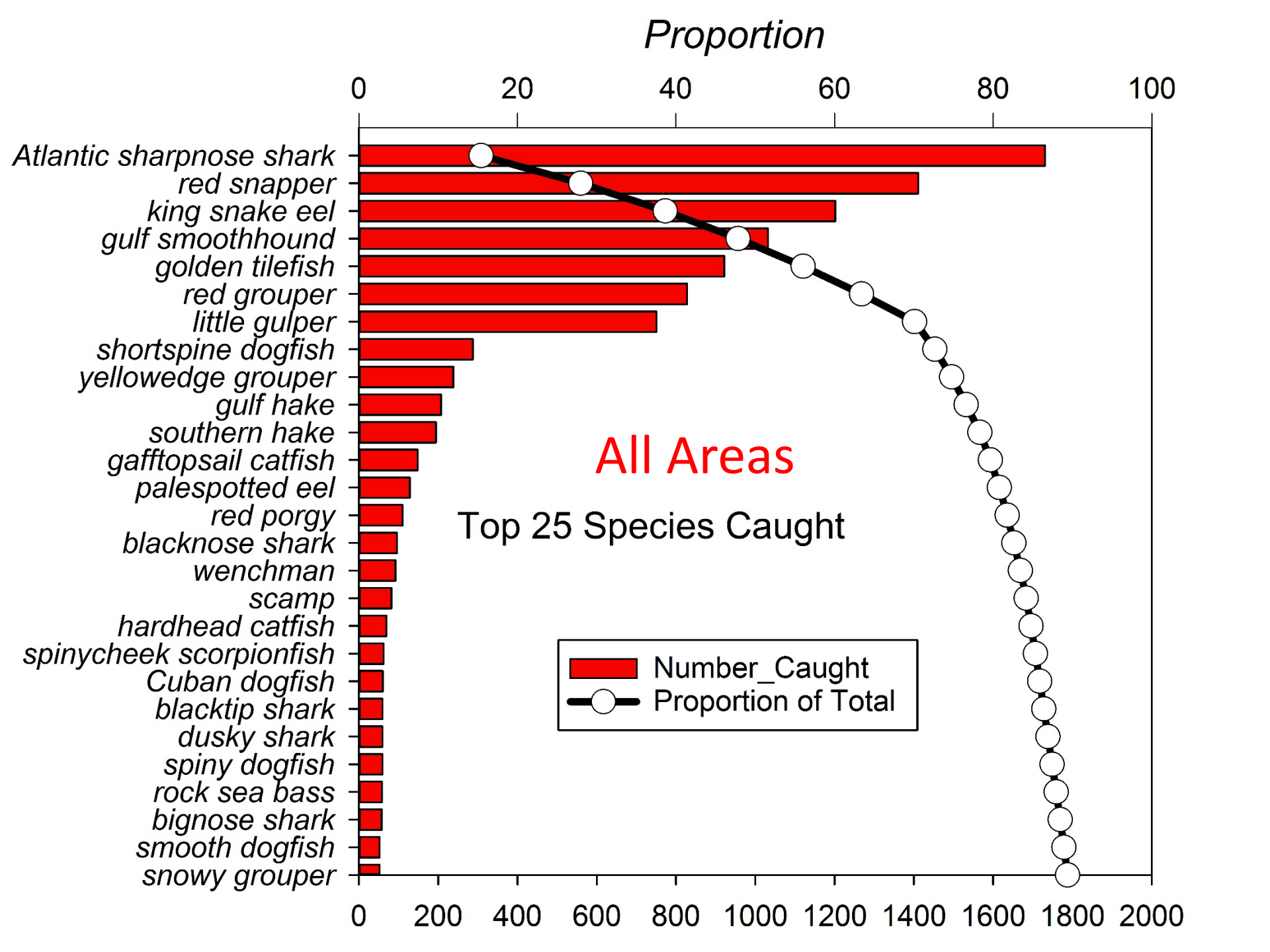
- Provide synoptic fish collections supporting oil spill-related studies
- Understand factors influencing the biogeography and productivity of demersal fish populations on the continental shelves of the Gulf of Mexico
- Develop a comprehensive baseline of demersal fish contamination throughout the Gulf of Mexico
- Monitor temporal and spatial changes in fish contamination, and understand the impacts of oil development/production activities, & accidents
- Better understand the susceptibility of Gulf fish populations to mega-oil spills

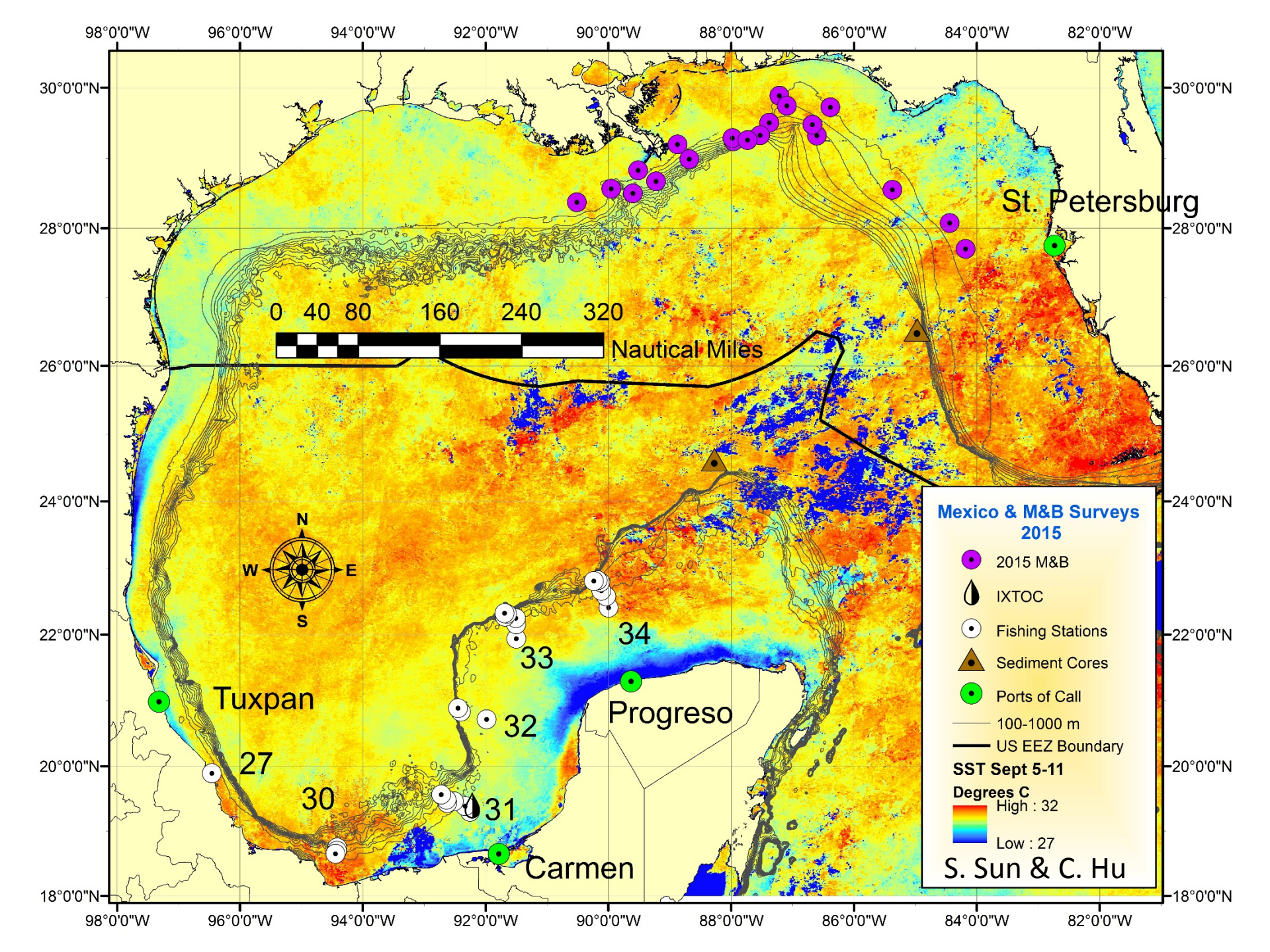

Longline Survey Stations
2011-2015
2015 WB-II
2015 Mexico WB-II
2014 WB-II
2013 WB-II
2012 WB-II
2012 F/V
2011 F/V
IXTOC
DWH
0 125 250 500 750 1,000
Kilometers
N
W
E
S
Florida Keys
Straits of Florida
Yucatan Channel
Yucatán Basin
Cayman Ridge
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors
100°0'0"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
80°0'0"W
32°0'0"N
30°0'0"N
28°0'0"N
26°0'0"N
24°0'0"N
22°0'0"N
20°0'0"N
18°0'0"N

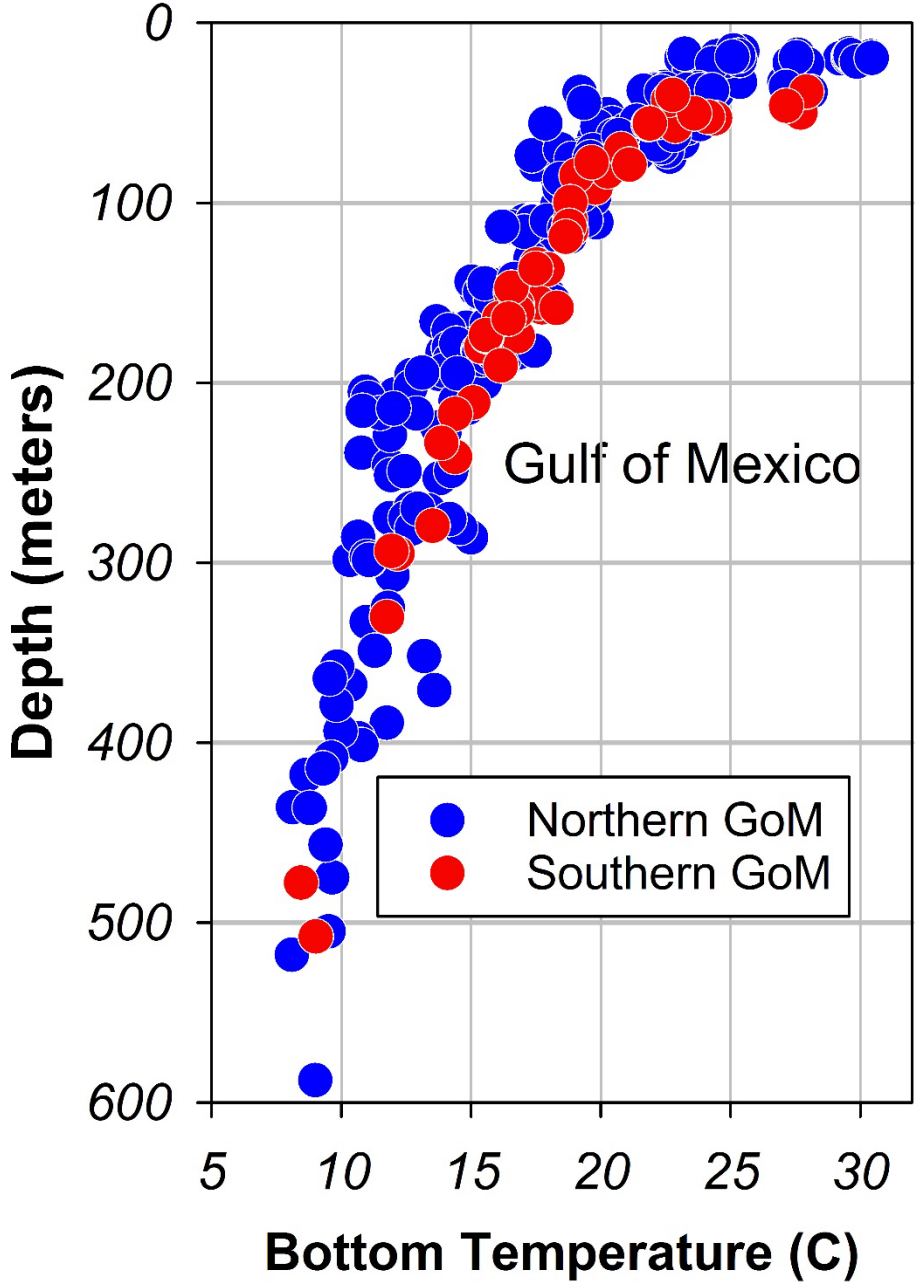
# Longline Sampling, 2011-2015

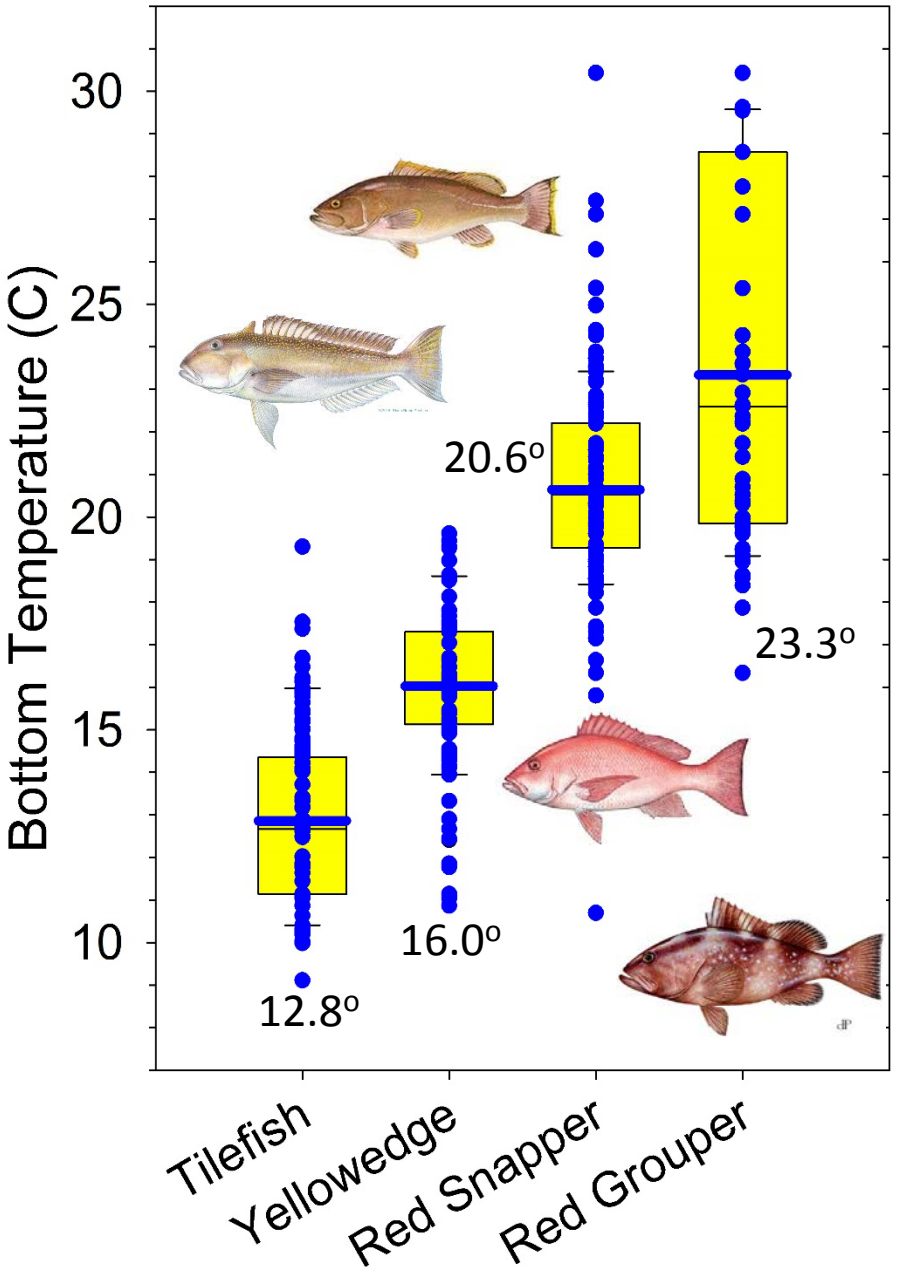


- 227 stations sampled
- 106,308 hooks deployed
- 476 hours soaked
- average soak time/station: 2:07
- 11, 230 animals sampled
- success rate: 10.6% of hooks fished
- average catch: 49.5 fish per station
- 54.7 fish per 1,000 hook-hours fished
- 155 unique species encountered


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


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
18°0'0"N
St. Petersburg
0 40 80 160 240 320
Nautical Miles
N
W
E
S
Tuxpan
27
30
31
Carmen
32
33
34
Progreso
Mexico & M&B Surveys 2015
2015 M&B
IXTOC
Fishing Stations
Sediment Cores
Ports of Call
100-1000 m
US EEZ Boundary
SST Sept 5-11
Degrees C
High : 32
Low : 27
S. Sun & C. Hu


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
20.6°
23.3°
16.0°
12.8°
Tilefish
Yellowedge
Red Snapper
Red Grouper

# Bray-Curtis Similarity (SIMPROF Groups)

**Top 30 - Species Associations**

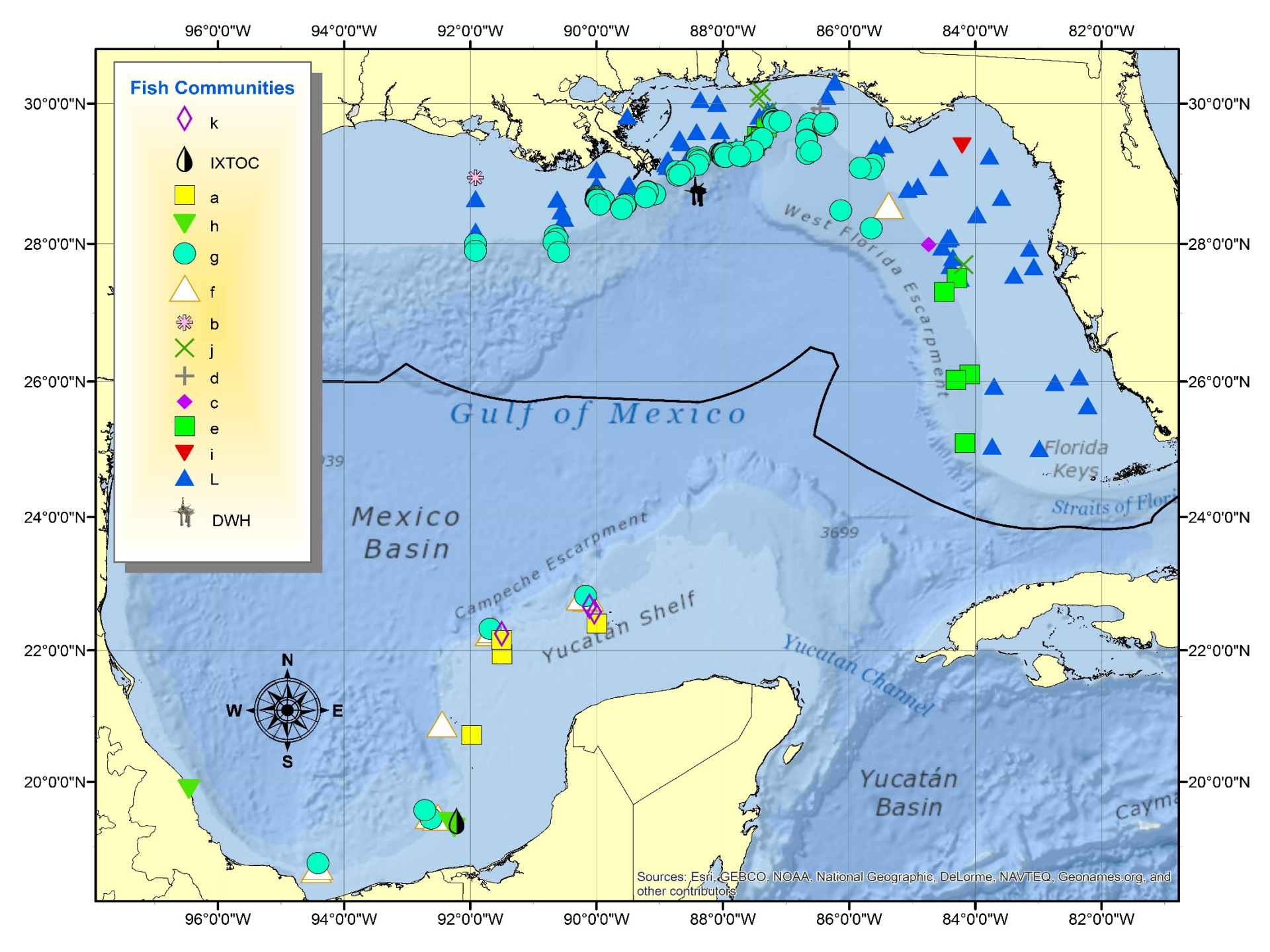
*Groupings of Stations*

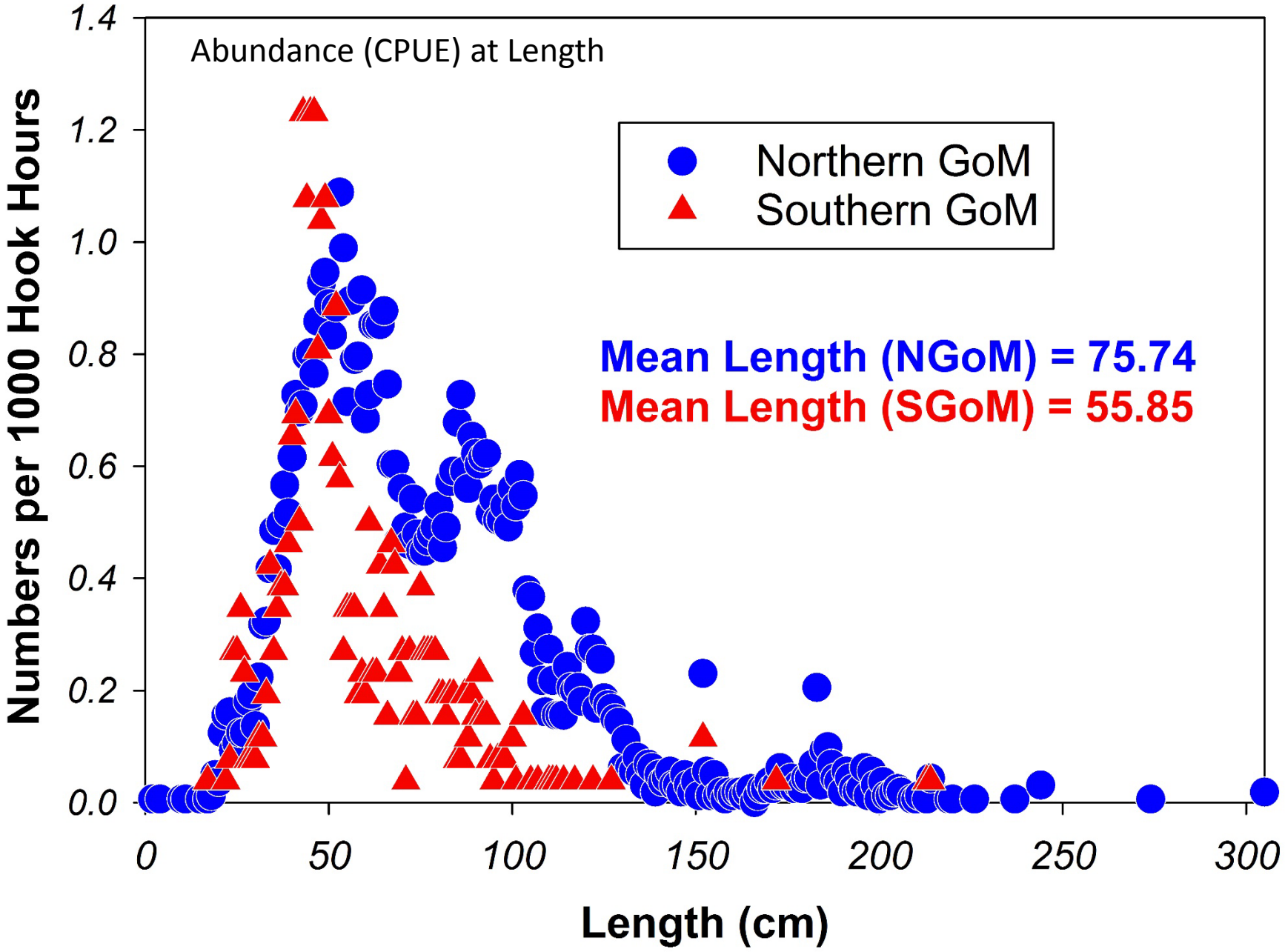
dogfish sp
smooth puffer
Cuban dogfish
little gulper
gulf hake
king snake eel
gulf smoothhound
spinycheek scorpionfish
shortspine dogfish
golden tilefish
southern hake
wenchman
yellowedge grouper
blueline tilefish
red porgy
palespotted eel
mustelus sp
blacktip shark
red snapper
Atlantic sharpnose shark
Florida smoothhound
dusky shark
blacknose shark
blackfin tuna
bignose shark
red grouper
smooth dogfish
honeycomb moray
hardhead catfish
gafftopsail catfish

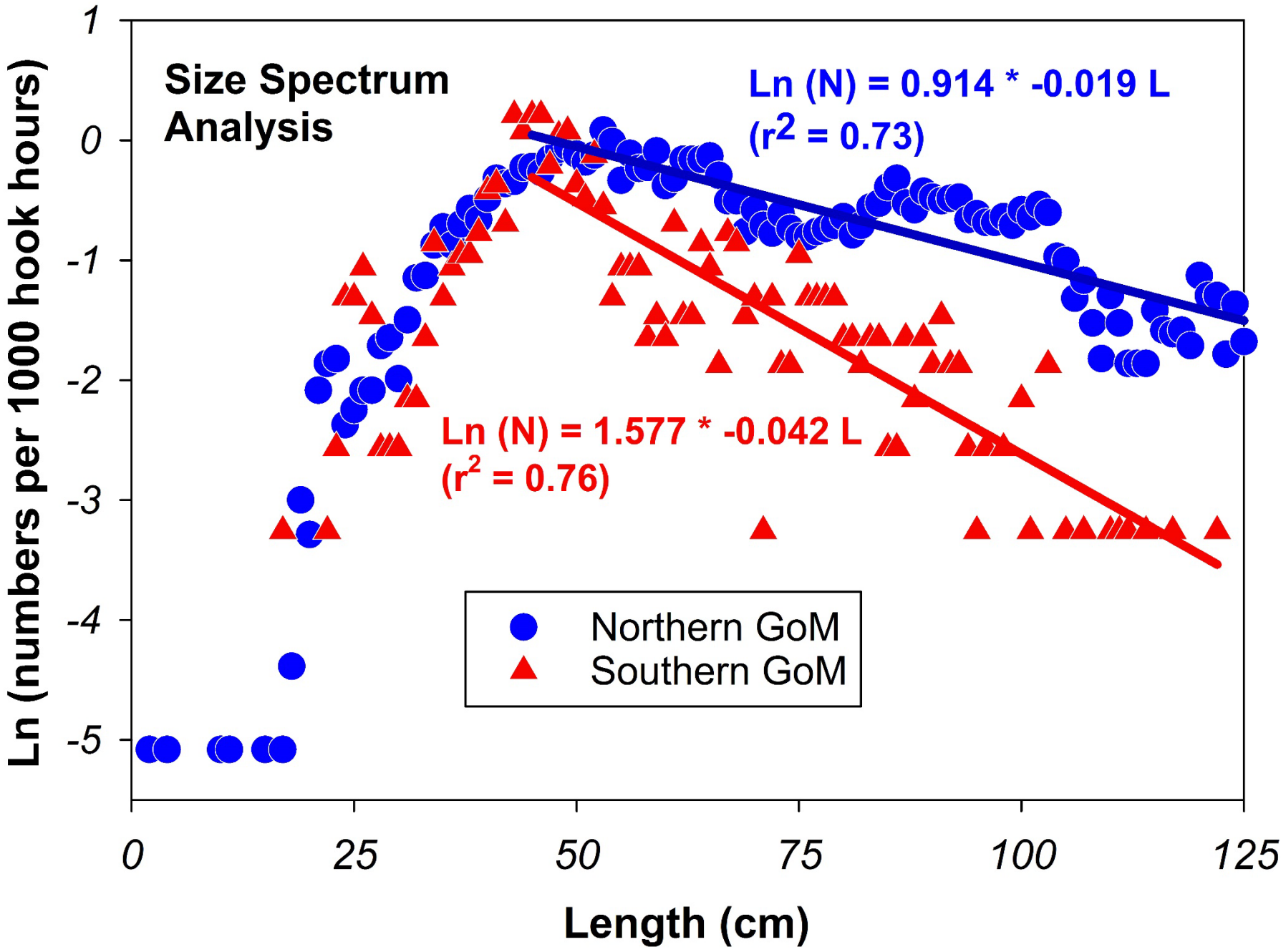
b a d i j k L h e g f c

4th Root of Abundance

20 10 0

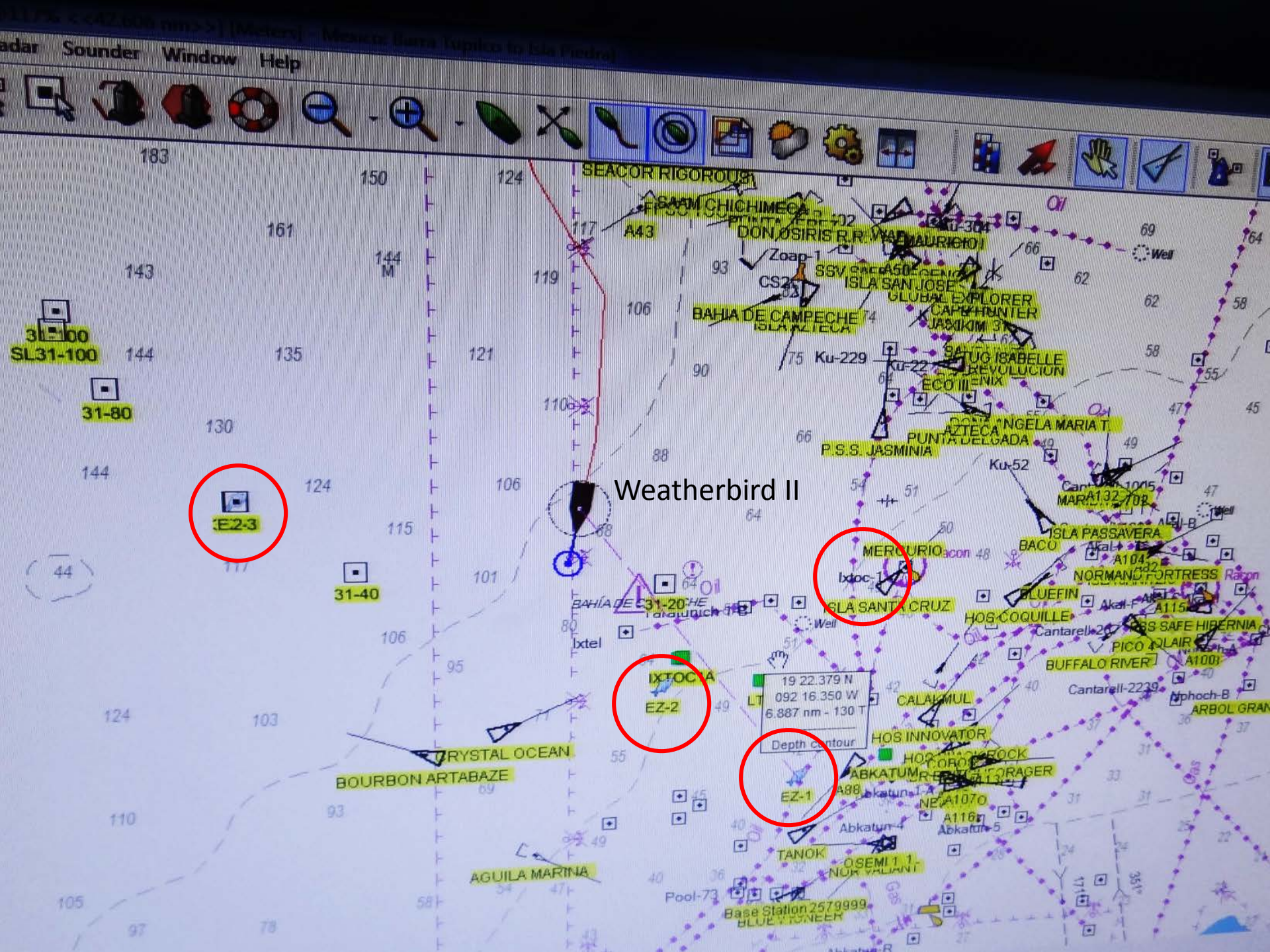

Fish Communities
k
IXTOC
a
h
g
f
b
j
d
c
e
i
L
DWH
96°0'0"W
94°0'0"W
92°0'0"W
90°0'0"W
88°0'0"W
86°0'0"W
84°0'0"W
82°0'0"W
30°0'0"N
28°0'0"N
26°0'0"N
24°0'0"N
22°0'0"N
20°0'0"N
Gulf of Mexico
West Florida Escarpment
Florida Keys
Straits of Flori
Mexico Basin
Campeche Escarpment
Yucatan Shelf
Yucatan Channel
Yucatán Basin
3699
N
W
E
S
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors


Abundance (CPUE) at Length
Northern GoM
Southern GoM
Mean Length (NGoM) = 75.74
Mean Length (SGoM) = 55.85
Numbers per 1000 Hook Hours
Length (cm)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
50
100
150
200
250
300


Size Spectrum Analysis
Ln (N) = 0.914 * -0.019 L
(r2 = 0.73)
Ln (N) = 1.577 * -0.042 L
(r2 = 0.76)
Northern GoM
Southern GoM
Ln (numbers per 1000 hook hours)
Length (cm)
1
0
-1
-2
-3
-4
-5
0
25
50
75
100
125

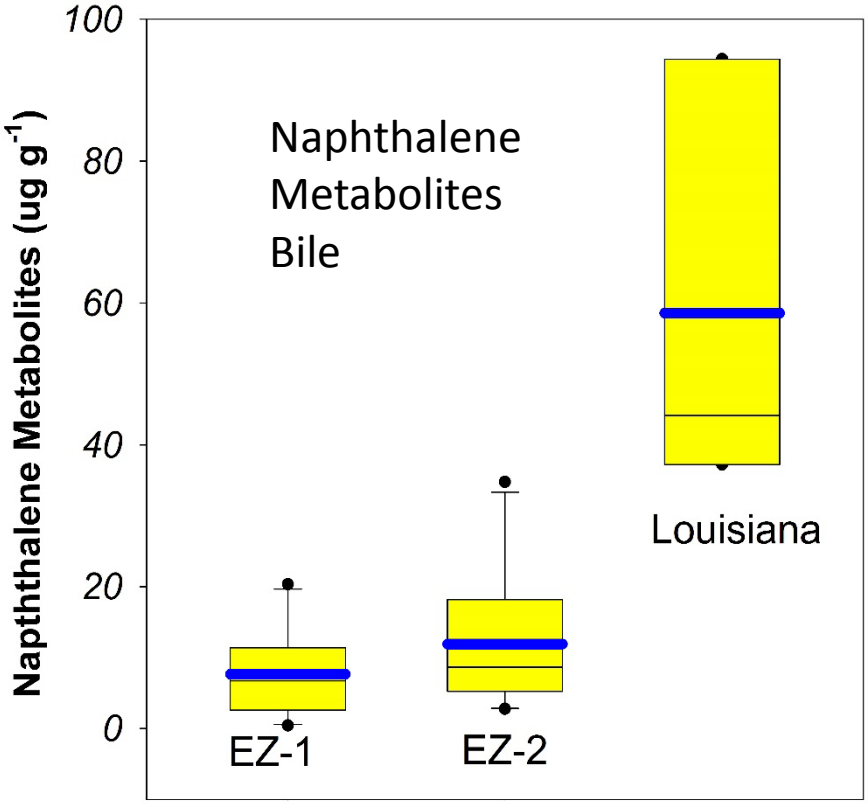
# Comparative Contaminant & Fish Health Studies

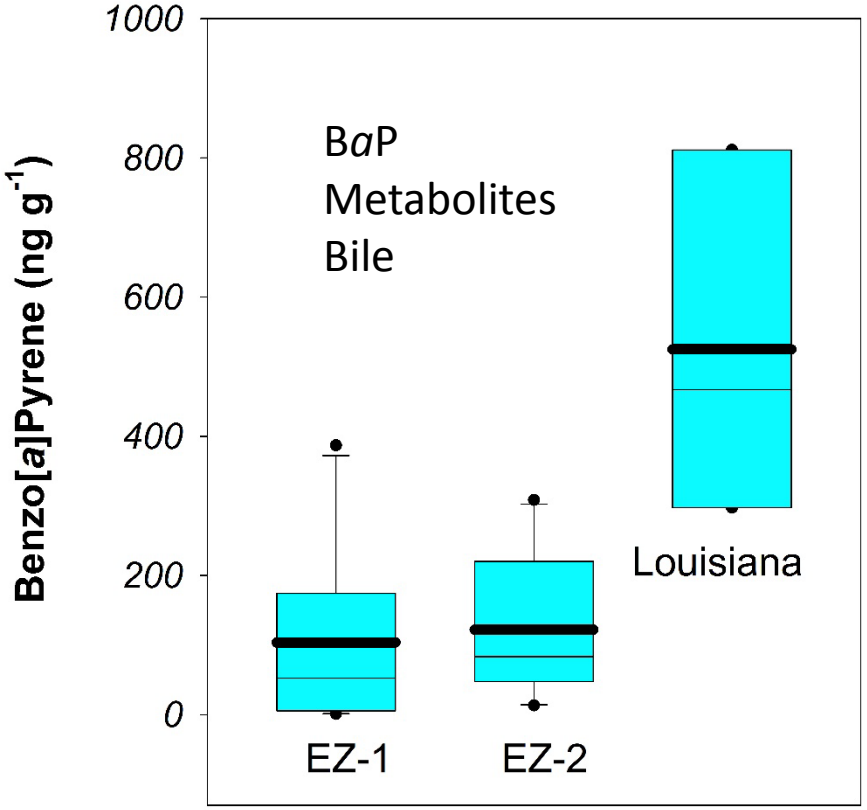
Sampling the “Exclusion Zone” Near IXTOC I


adar Sounder Window Help
Weatherbird II
SEACOR RICOROSO
A43
DON OSIRIS R.R.
Zoap-1
CS2
ISLA SAN JOSE
GLOBAL EXPLORER
CAPE HUNTER
BAHIA DE CAMPECHE
ISLA AZTECA
Ku-229
TUG ISABELLE
ECO III
AZTECA
ANGELA MARIA T.
PUNTA DELGADA
P.S.S. JASMINIA
Ku-52
SL31-100
31-80
E2-3
31-40
31-20
MERCURIO
ISLA SANTA CRUZ
ISLA PASSAVERA
BACO
NORMAND FORTRESS
BLUEFIN
HOS COQUILLE
BUFFALO RIVER
PICO
Cantarell-2239
IXTOCOA
EZ-2
19 22.379 N
092 16.350 W
6.887 nm - 130 T
Depth contour
CALAMUL
HOS INNOVATOR
CRYSTAL OCEAN
BOURBON ARTABAZE
ABKATUN
EZ-1
TANOK
AGUILA MARINA
Base Station 2579999

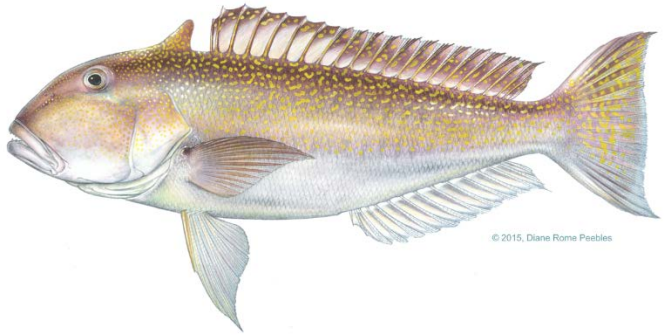
# Gafftopsail Catfish

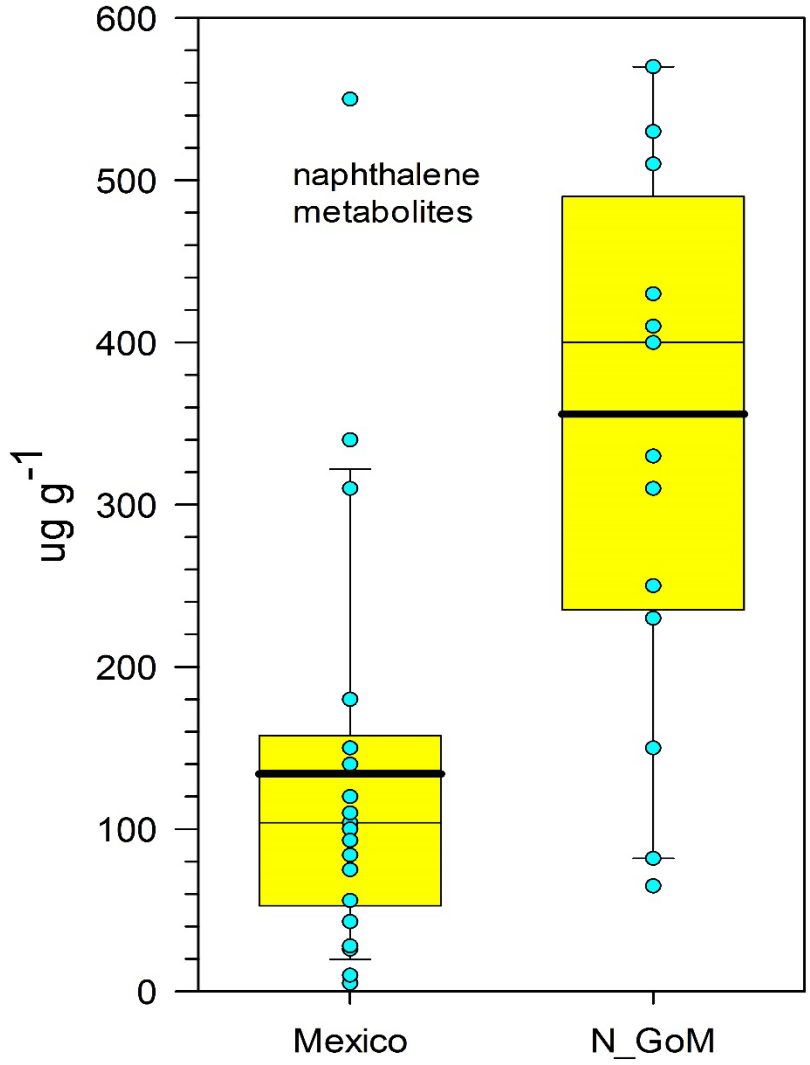
(*Bagre marinus*)

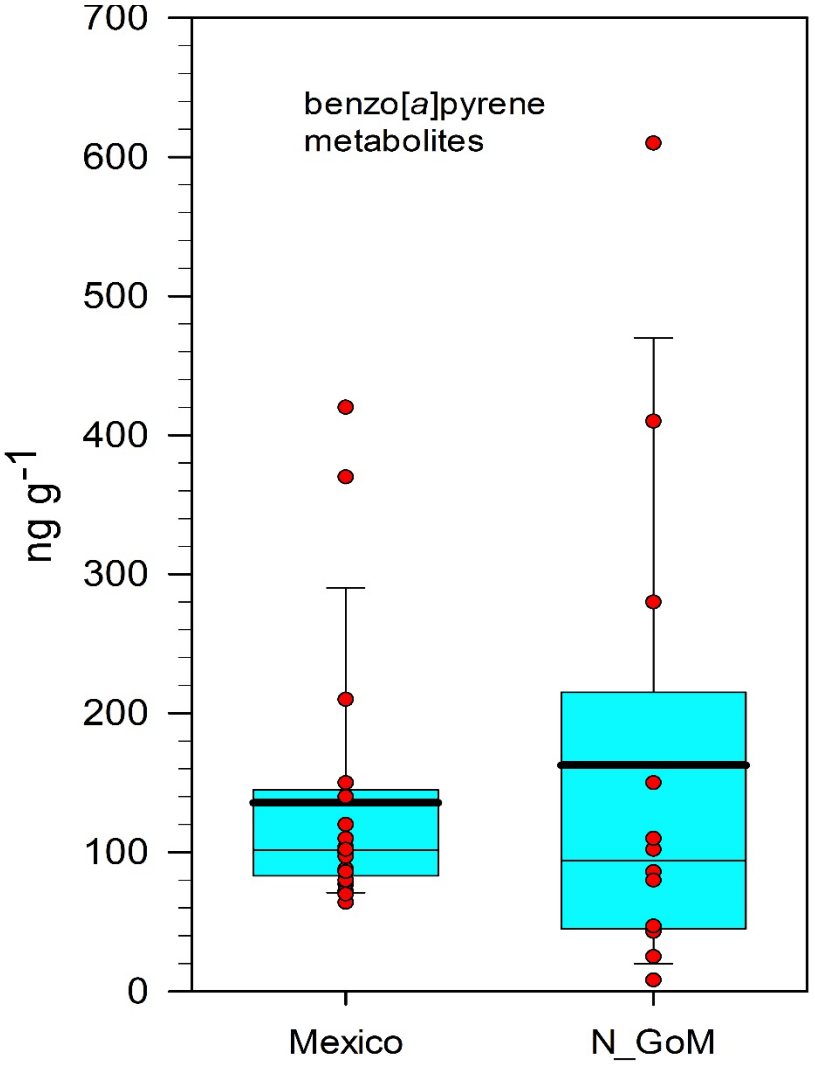


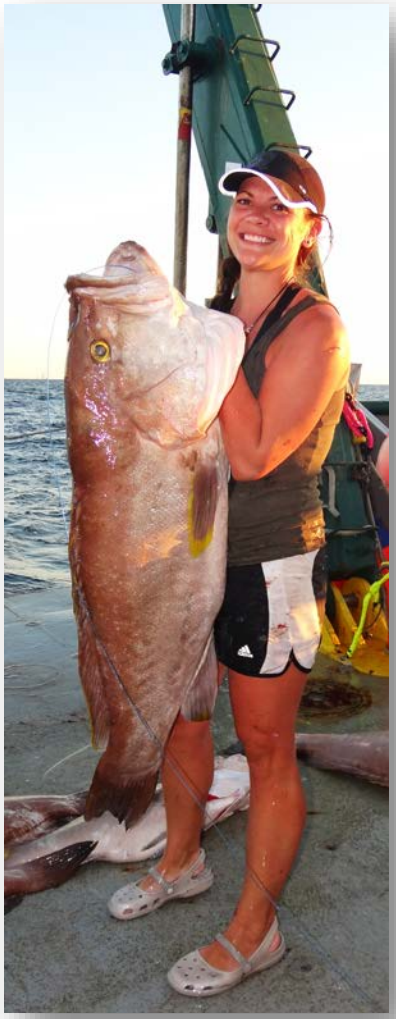
# *Golden Tilefish*

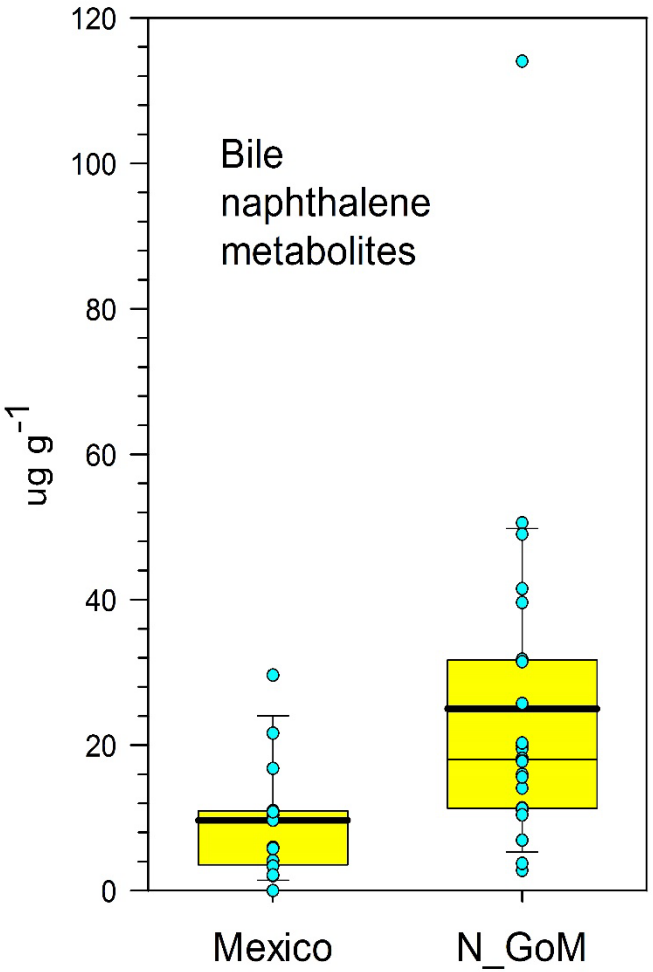


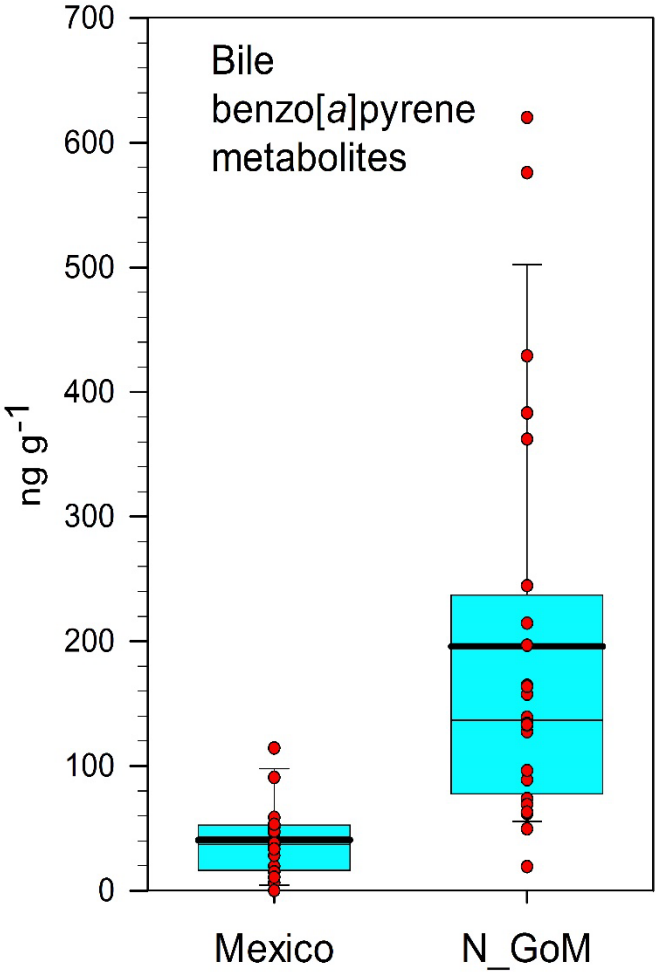



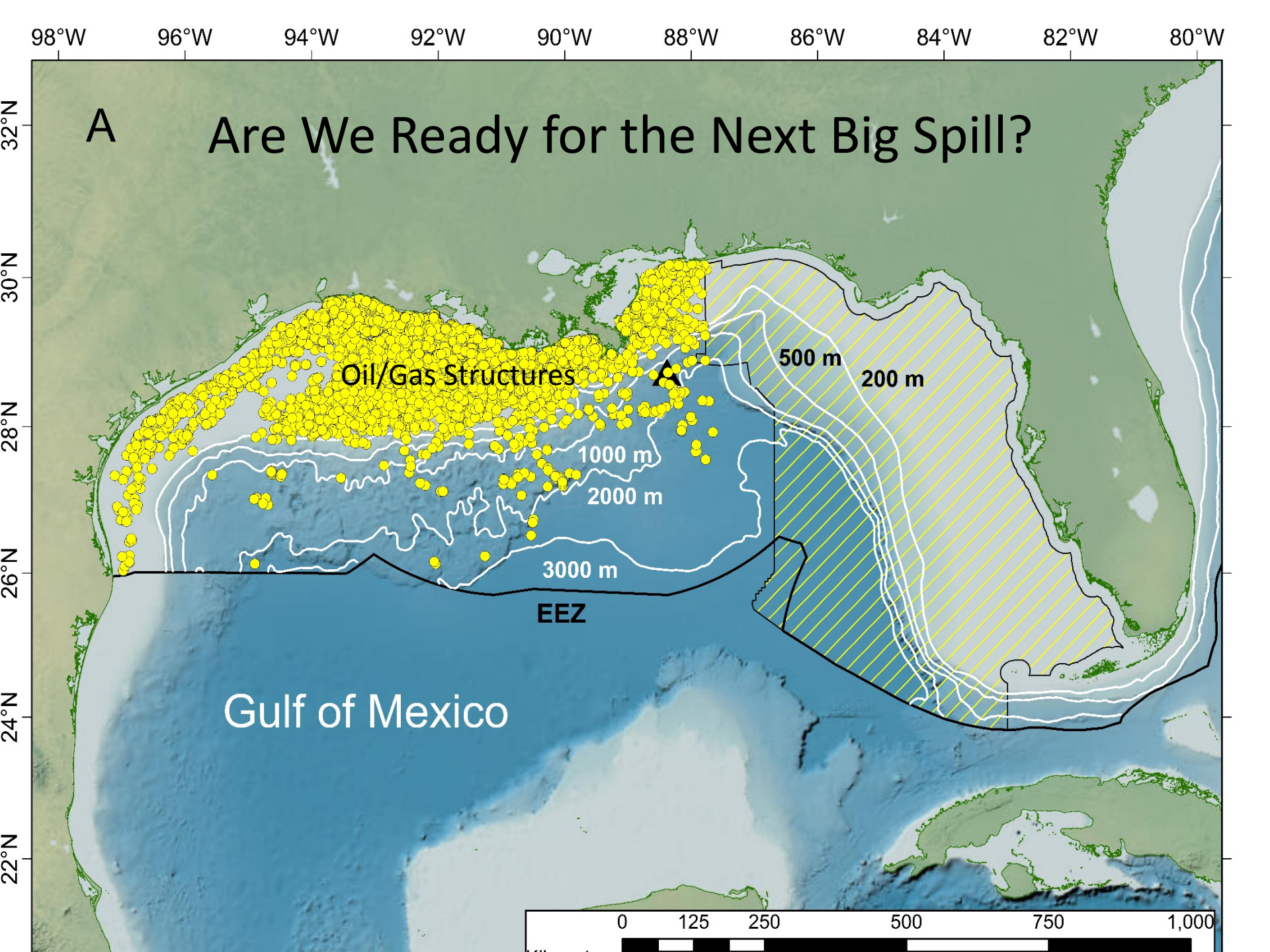



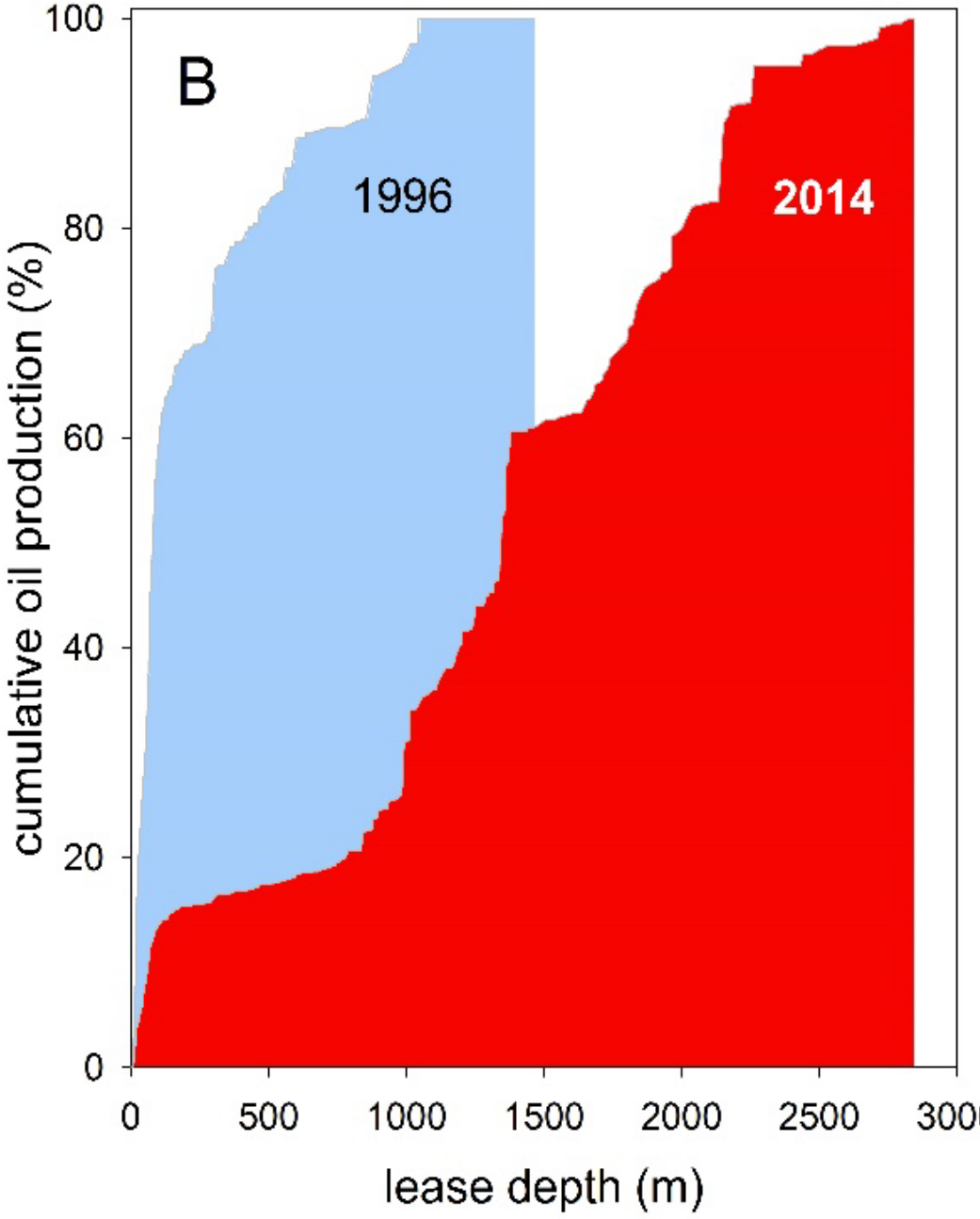
# *Yellowedge Grouper*

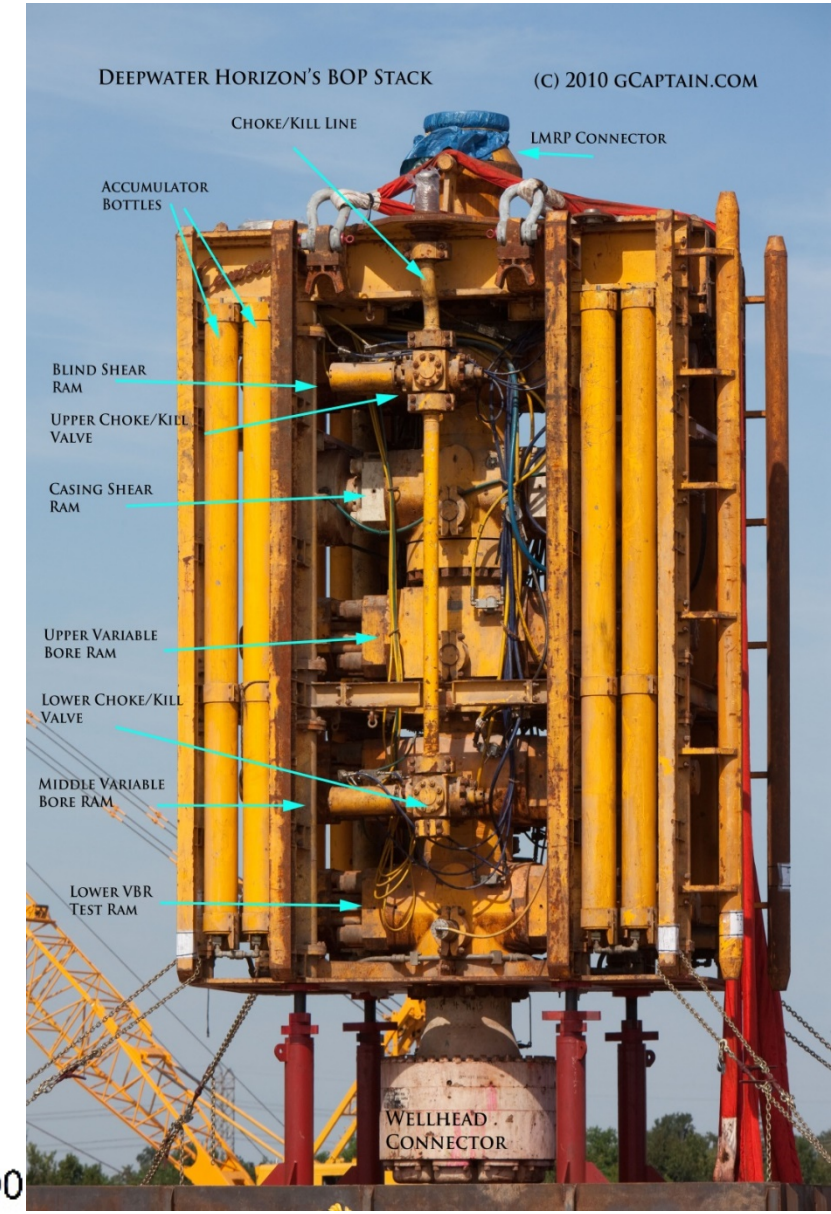




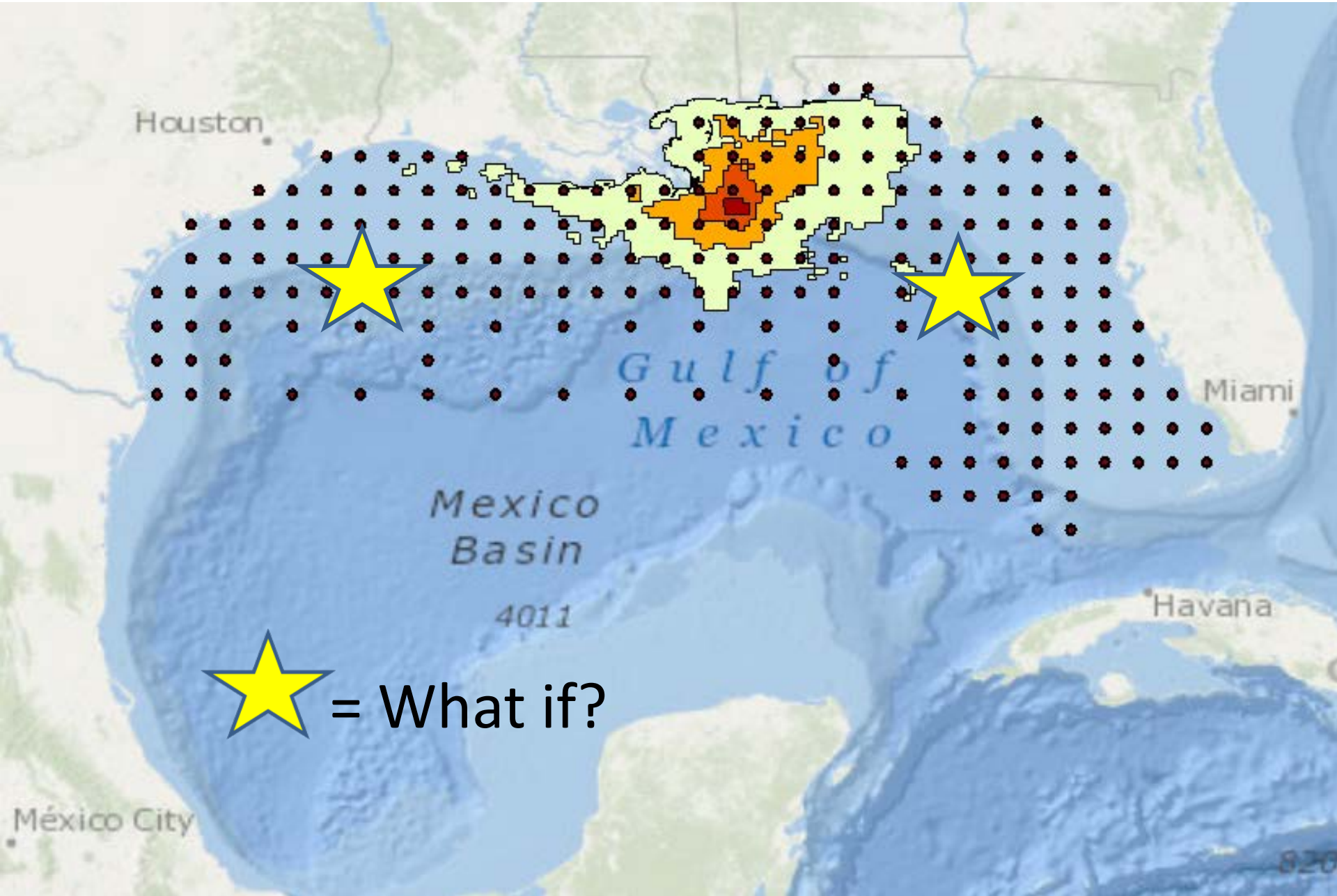




A
Are We Ready for the Next Big Spill?
98°W
96°W
94°W
92°W
90°W
88°W
86°W
84°W
82°W
80°W
32°N
30°N
28°N
26°N
24°N
22°N
Oil/Gas Structures
500 m
200 m
1000 m
2000 m
3000 m
EEZ
Gulf of Mexico
0
125
250
500
750
1,000

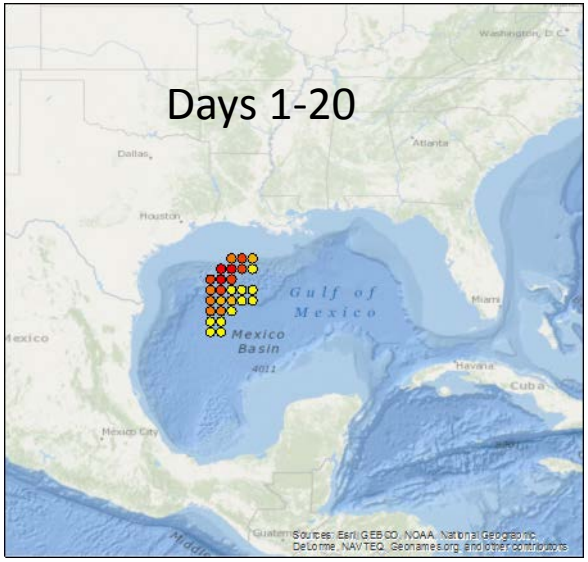

B
1996
2014
cumulative oil production (%)
0
20
40
60
80
100
0
500
1000
1500
2000
2500
3000
lease depth (m)

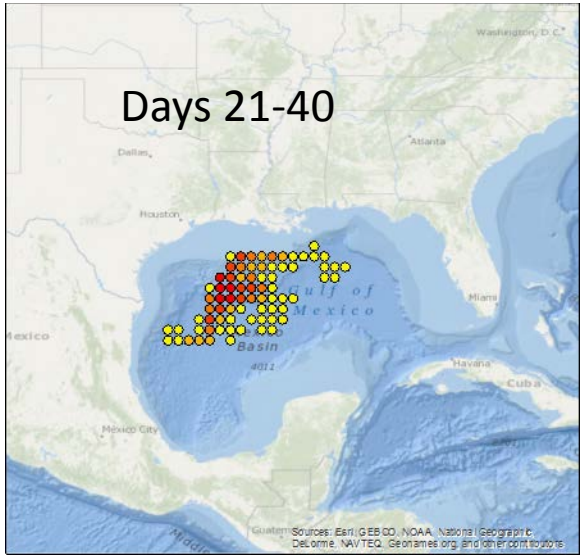

DEEPWATER HORIZON'S BOP STACK
(C) 2010 GCAPTAIN.COM
CHOKE/KILL LINE
LMRP CONNECTOR
ACCUMULATOR BOTTLES
BLIND SHEAR RAM
UPPER CHOKE/KILL VALVE
CASING SHEAR RAM
UPPER VARIABLE BORE RAM
LOWER CHOKE/KILL VALVE
MIDDLE VARIABLE BORE RAM
LOWER VBR TEST RAM
WELLHEAD CONNECTOR

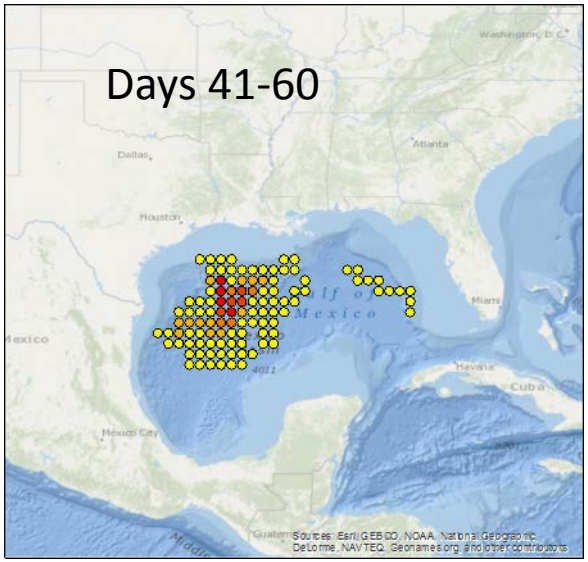
# Fish Larvae Data, 1982-Present vs. Oil Spill Distribution

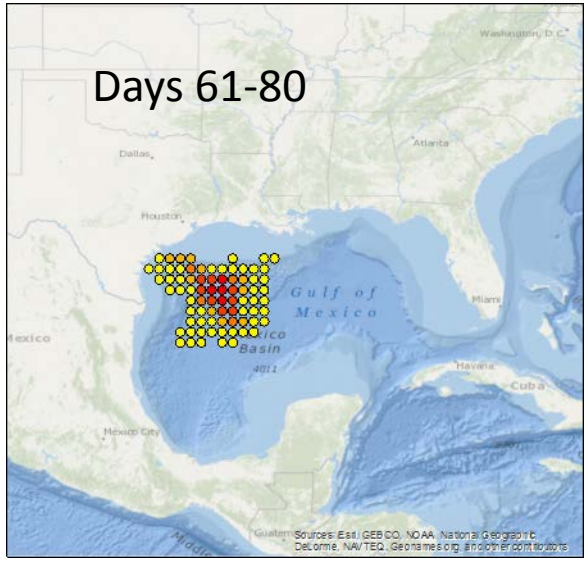


# Scenario 2 - 27N and 93.5W



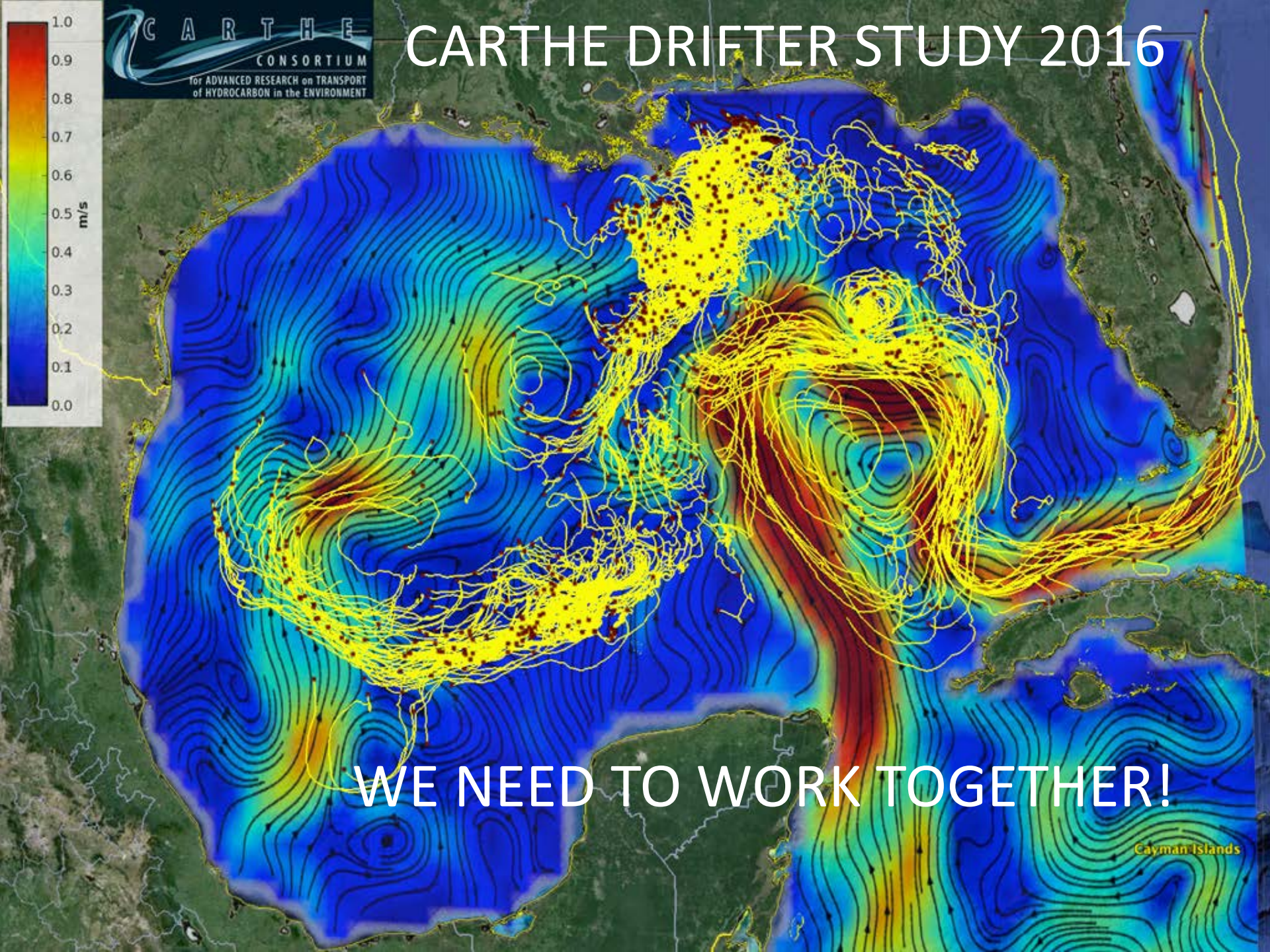



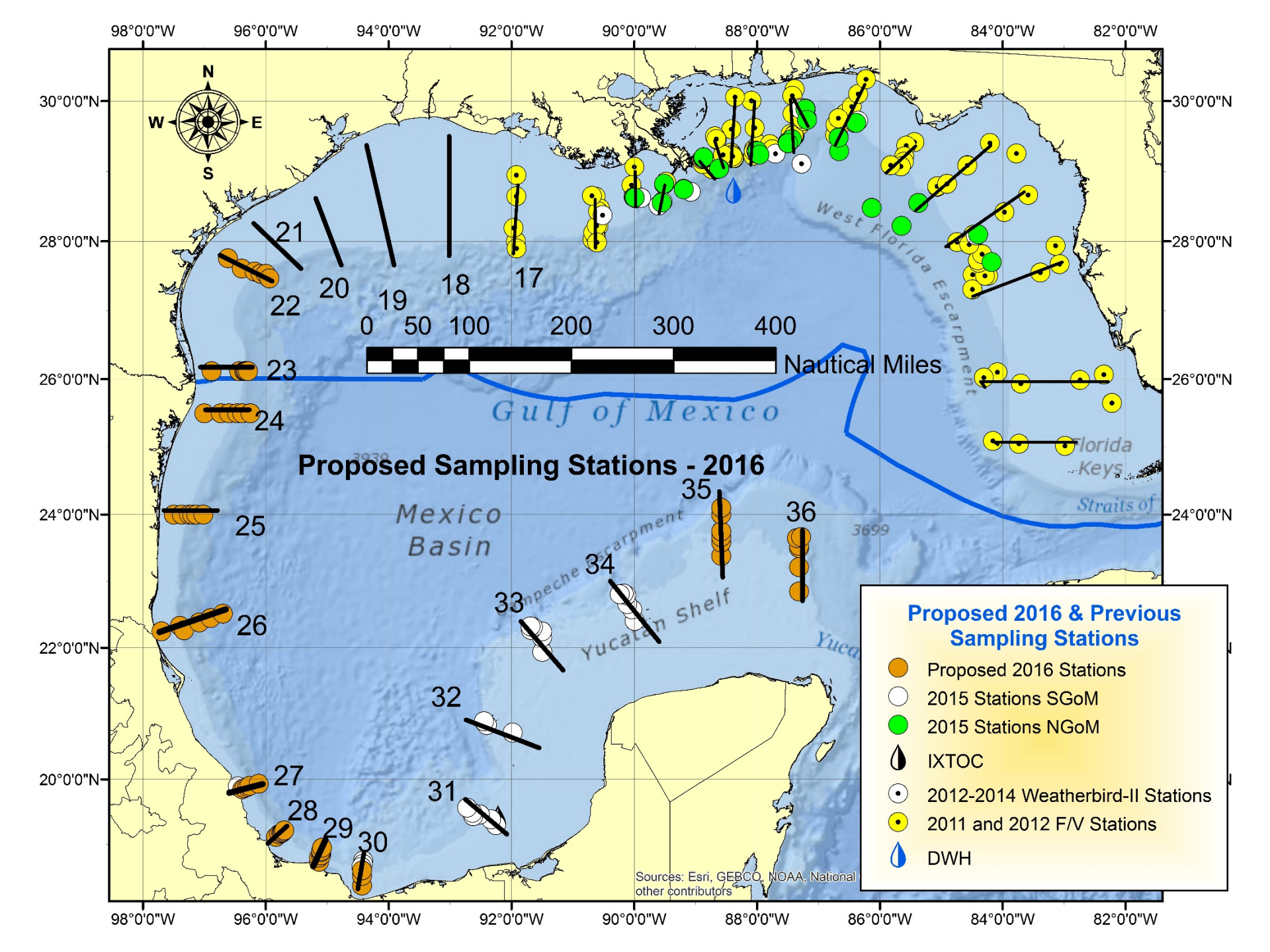

**Legend**

**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


CARTHE
CONSORTIUM
for ADVANCED RESEARCH on TRANSPORT of HYDROCARBON in the ENVIRONMENT
CARTHE DRIFTER STUDY 2016
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
m/s
WE NEED TO WORK TOGETHER!
Cayman Islands

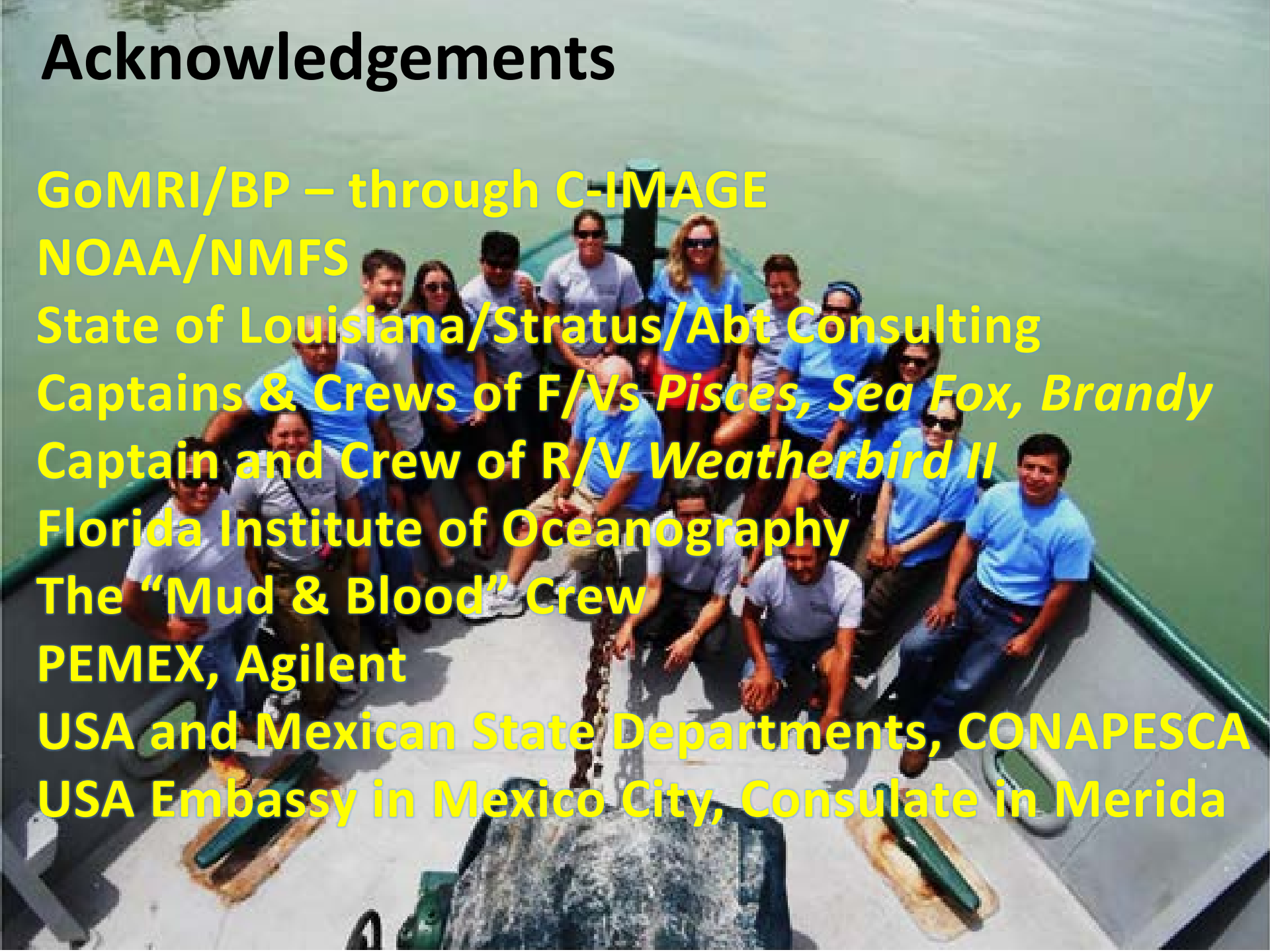

Proposed Sampling Stations - 2016
Gulf of Mexico
Mexico Basin
West Florida Escarpment
Florida Keys
Straits of
Campeche Escarpment
Yucatan Shelf
0 50 100 200 300 400
Nautical Miles
N
S
E
W
98°0'0"W
96°0'0"W
94°0'0"W
92°0'0"W
90°0'0"W
88°0'0"W
86°0'0"W
84°0'0"W
82°0'0"W
30°0'0"N
28°0'0"N
26°0'0"N
24°0'0"N
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

# Summary

- ✓ Highly structured fish communities in the northern and southern GoM, with greater commonality at depth
- ✓ Size and diversity spectra provide important tools for understanding comparative population & community dynamics among shelf demersal fish communities
- ✓ Some indication of lower contamination levels for the same species off Mexico than in the northern Gulf but differences between current ingestion and body burden? (Adolfo's Talk Susan's Poster)
- ✓ Have completed about 1/3 of the planned "Gulf-wide" survey of continental shelves (40-300 meters deep)
- ✓ Year 2 (August, 2016) will finish Mexican sampling & work up the Texas Coast; Year 3 (2017) completion, resulting in the first *comprehensive* baseline of the Gulf

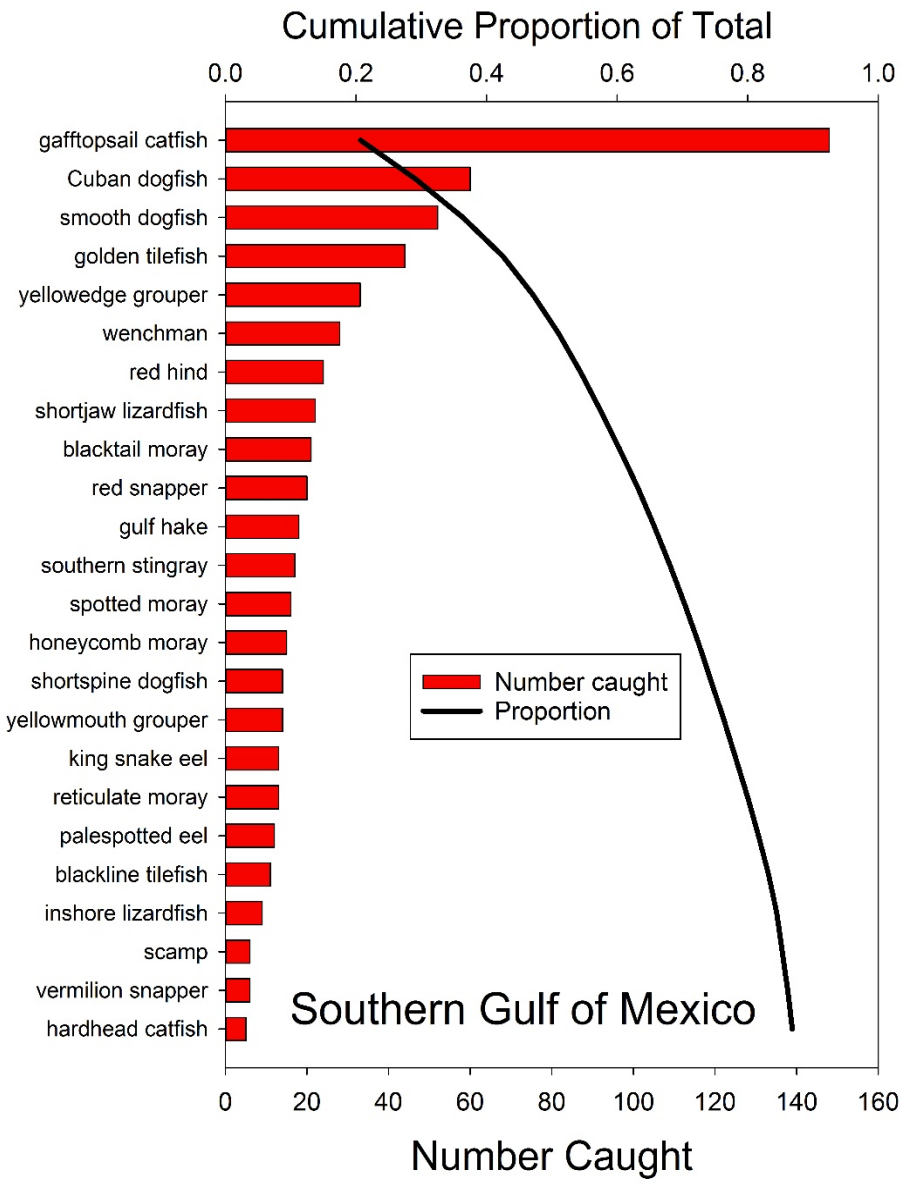
# Acknowledgements

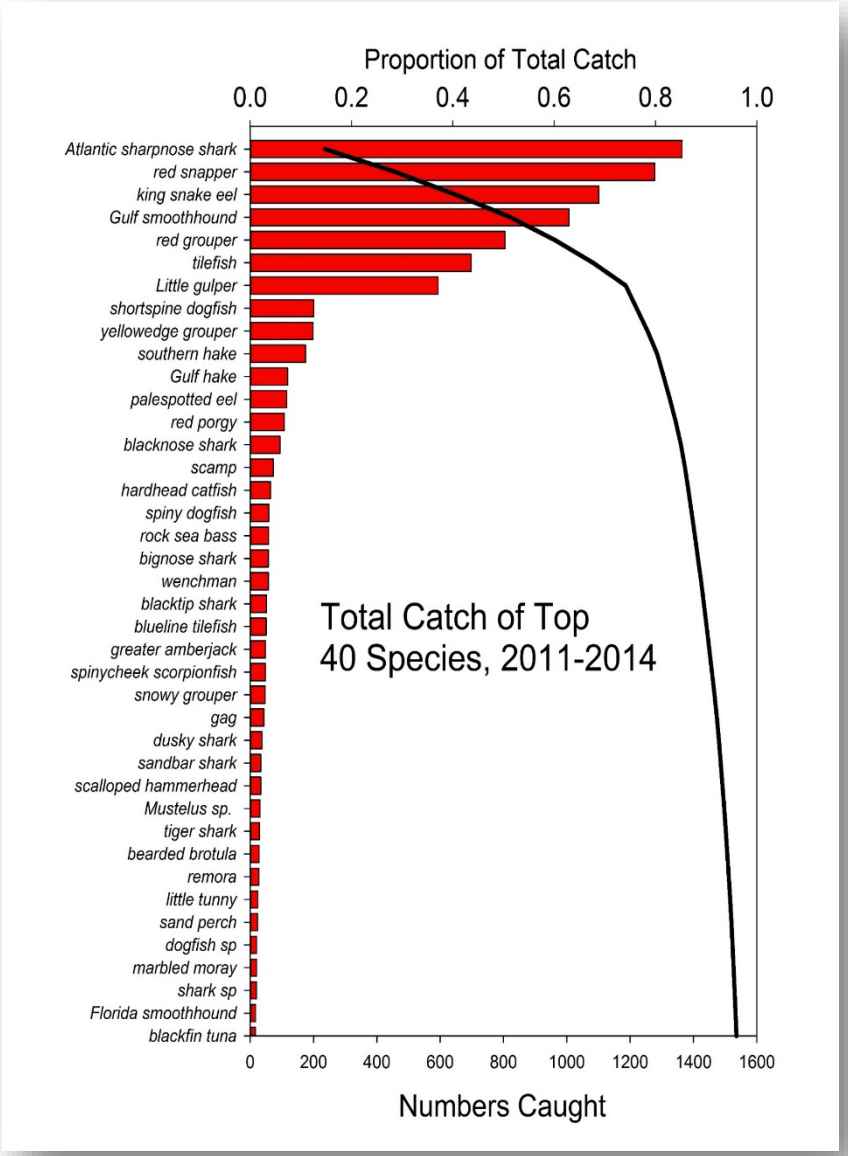
GoMRI/BP – through C-IMAGE
NOAA/NMFS
State of Louisiana/Stratus/Abt Consulting
Captains & Crews of F/Vs *Pisces, Sea Fox, Brandy*
Captain and Crew of R/V *Weatherbird II*
Florida Institute of Oceanography
The "Mud & Blood" Crew
PEMEX, Agilent
USA and Mexican State Departments, CONAPESCA
USA Embassy in Mexico City, Consulate in Merida

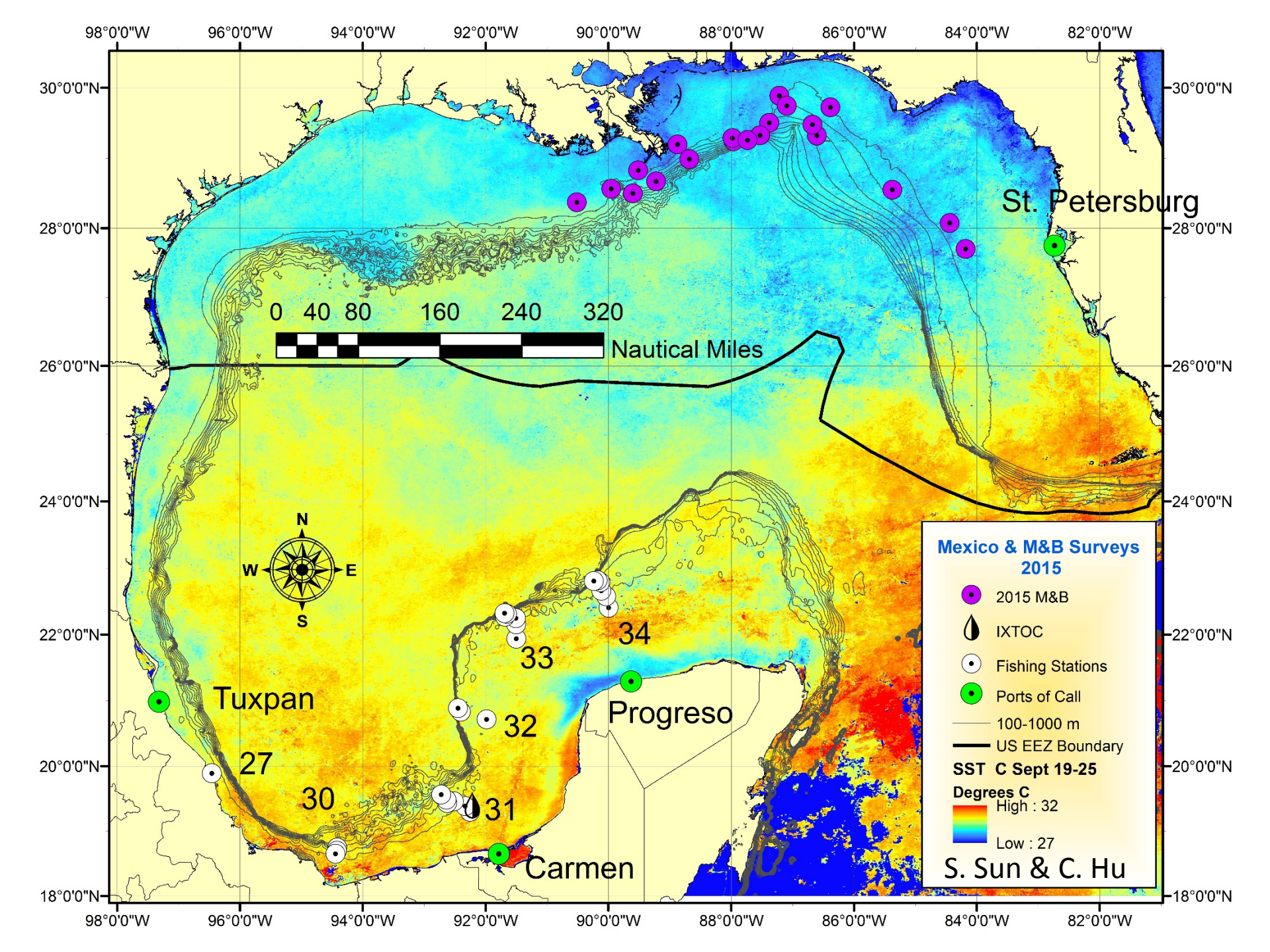


# Backup Slides

- 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?


Cumulative Proportion of Total
0.0
0.2
0.4
0.6
0.8
1.0
gafftopsail catfish
Cuban dogfish
smooth dogfish
golden tilefish
yellowedge grouper
wenchman
red hind
shortjaw lizardfish
blacktail moray
red snapper
gulf hake
southern stingray
spotted moray
honeycomb moray
shortspine dogfish
yellowmouth grouper
king snake eel
reticulate moray
palespotted eel
blackline tilefish
inshore lizardfish
scamp
vermilion snapper
hardhead catfish
Number caught
Proportion
Southern Gulf of Mexico
0
20
40
60
80
100
120
140
160
Number Caught


Proportion of Total Catch
0.0
0.2
0.4
0.6
0.8
1.0
Atlantic sharpnose shark
red snapper
king snake eel
Gulf smoothhound
red grouper
tilefish
Little gulper
shortspine dogfish
yellowedge grouper
southern hake
Gulf hake
palespotted eel
red porgy
blacknose shark
scamp
hardhead catfish
spiny dogfish
rock sea bass
bignose shark
wenchman
blacktip shark
blueline tilefish
greater amberjack
spinycheek scorpionfish
snowy grouper
gag
dusky shark
sandbar shark
scalloped hammerhead
Mustelus sp.
tiger shark
bearded brotula
remora
little tunny
sand perch
dogfish sp
marbled moray
shark sp
Florida smoothhound
blackfin tuna
Total Catch of Top
40 Species, 2011-2014
0
200
400
600
800
1000
1200
1400
1600
Numbers Caught


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
18°0'0"N
St. Petersburg
0 40 80 160 240 320
Nautical Miles
N
W
E
S
Tuxpan
27
30
31
32
33
34
Progreso
Carmen
Mexico & M&B Surveys 2015
2015 M&B
IXTOC
Fishing Stations
Ports of Call
100-1000 m
US EEZ Boundary
SST C Sept 19-25
Degrees C
High : 32
Low : 27
S. Sun & C. Hu