Spatial Effects of Hypoxia on Fish and Fisheries

KM Purcell & JK Craig
NOAA Southeast Fishery Science Center
http://kevin-purcell.com
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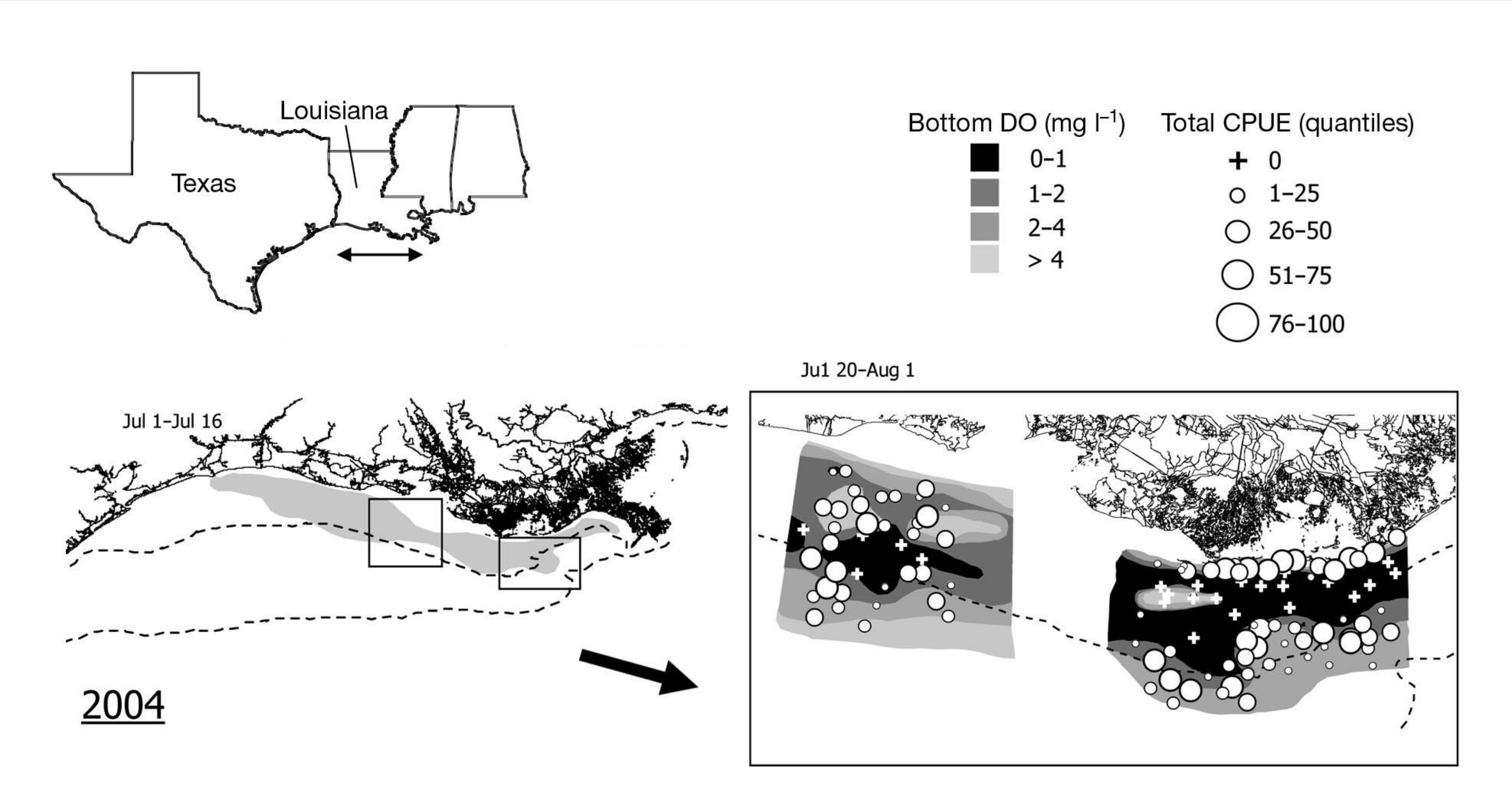
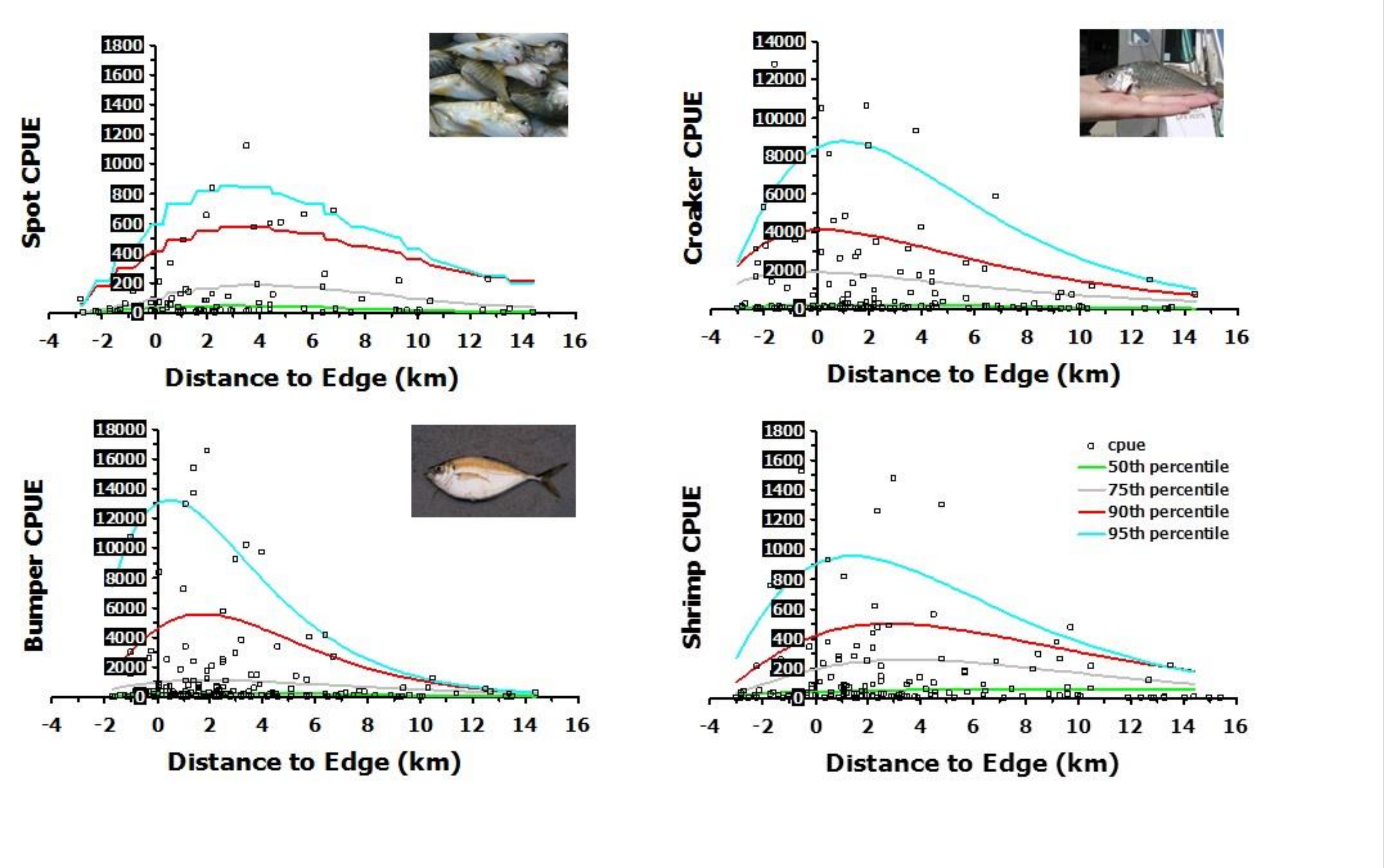
Distribution Shifts

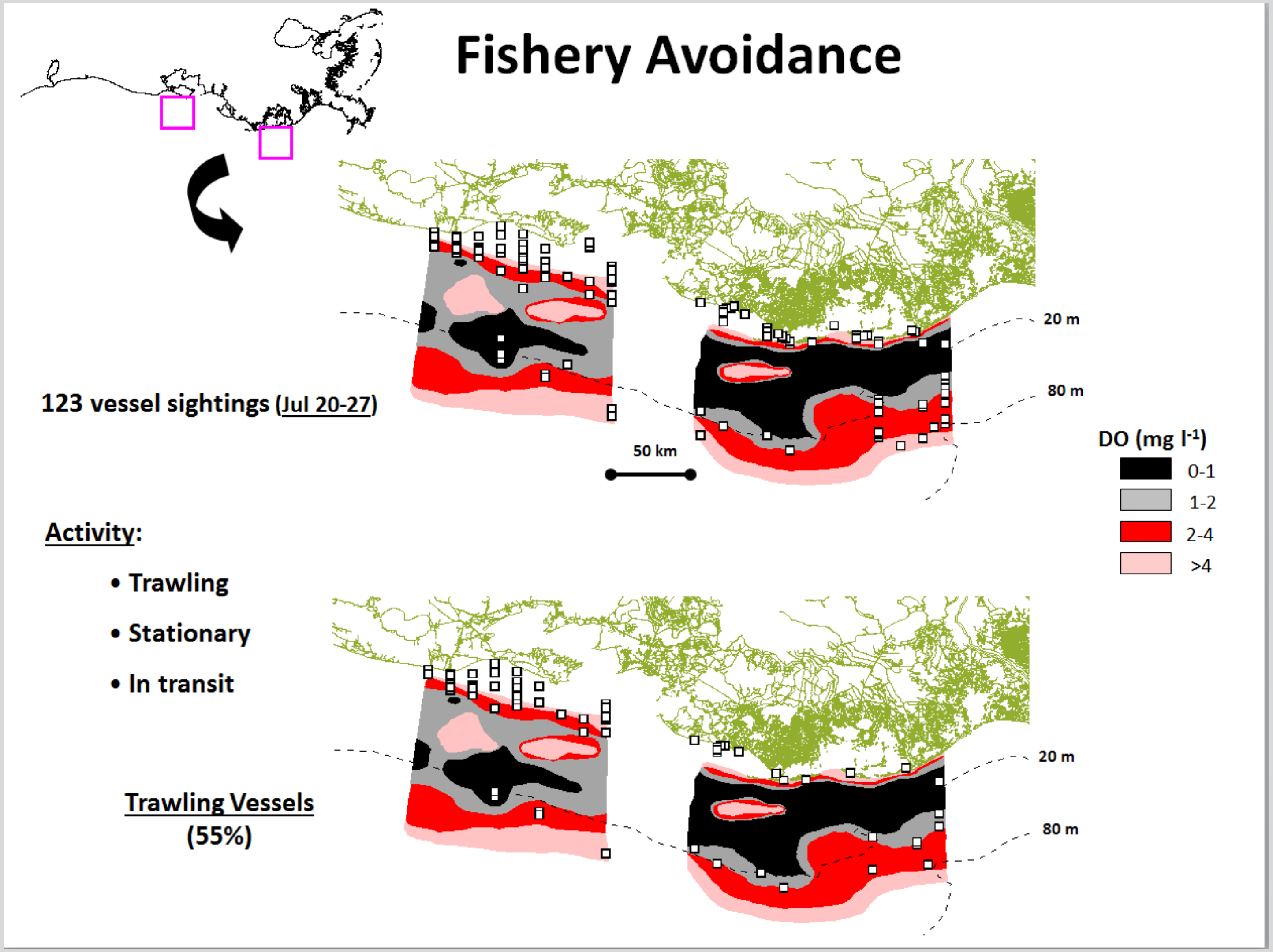


Craig 2012 *MEPS* doi: 10.3354/meps09437

Aggregation on the hypoxic edge



Shifts in Fishery Distribution



Questions

- Given the documented distribution shifts of populations
- What are the consequences of hypoxia for population and fishery dynamics?
- What indirect effects could arise from changes in the behavior of both fishery resources and targets?
- What predictive abilities do we have to identify spatially resolved effects of hypoxia?

Approaches

- Retrospective Analysis
  - Examine spatial & temporal patterns in fishery dependent and independent datasets for hypoxia effects
- Aerial Surveys
  - Aerial surveys for hypoxia effects on fleet dynamics
- Economic Analysis (Smith & Bennear)
  - Effects of hypoxia on harvest, rents or profits

Retrospective Model

- We constructed a regression model to examine the relationship between shrimping fishery effort and environmental parameters

$$X_{d,y,(\rho,\varphi)} = \alpha_1\,(y) + \alpha_2\,(pGAL) + \alpha_3\,(totEFF) + g_1\,(D) + g_2\,(pPND) + g_3\,(JD) + g_4\,(\rho,\varphi) + g_5\,(\rho,\varphi)\,DO + e_{d,y,(\rho,\varphi)}$$

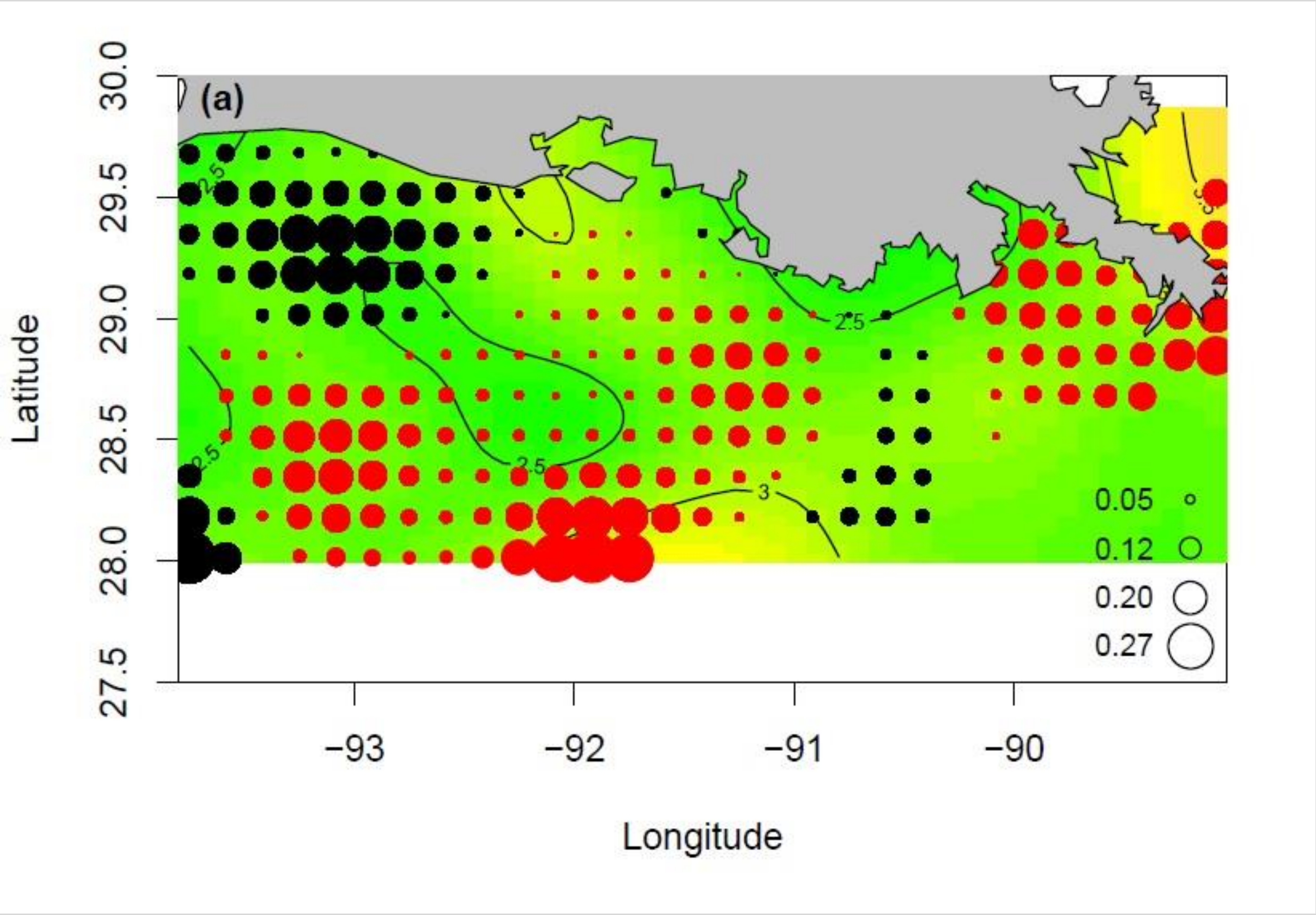
- Response : Total Effort

(Avg. Tow Duration, Avg. Tow Count)

- Covariates and parameters

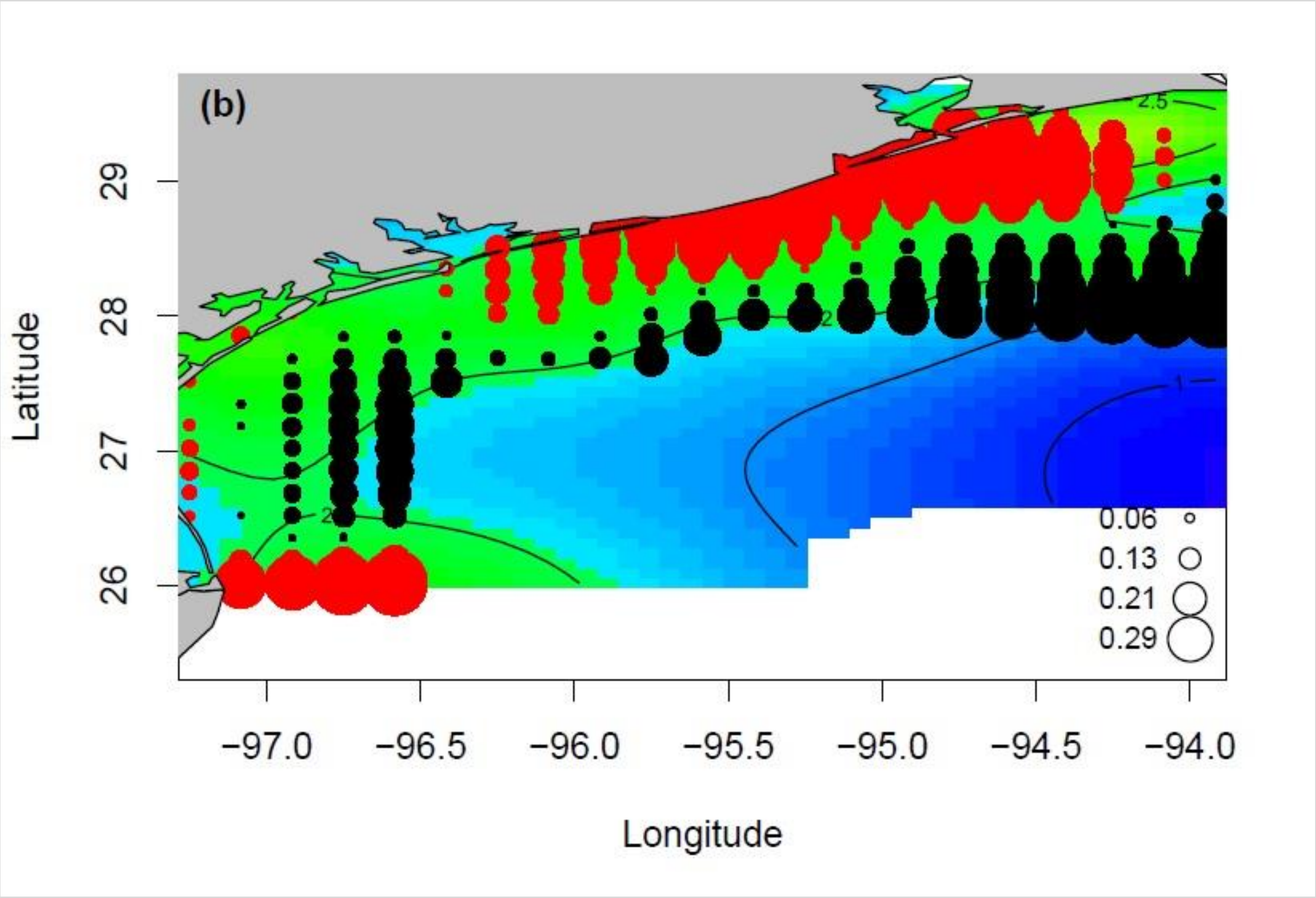
1. Year
2. Fuel price
3. Total effort
4. DO
5. Depth
6. Dockside price
7. Day of year
8. Spatial location.

Louisiana



(a)
30.0
29.5
29.0
28.5
28.0
27.5
Latitude
-93
-92
-91
-90
Longitude
0.05
0.12
0.20
0.27
2.5
3

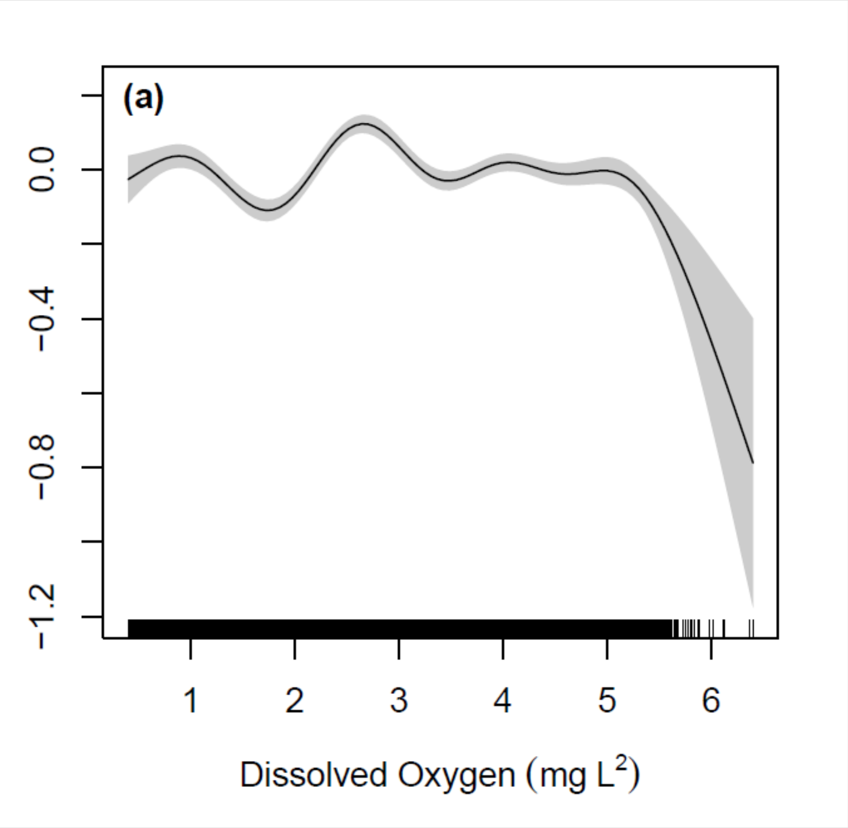
Texas



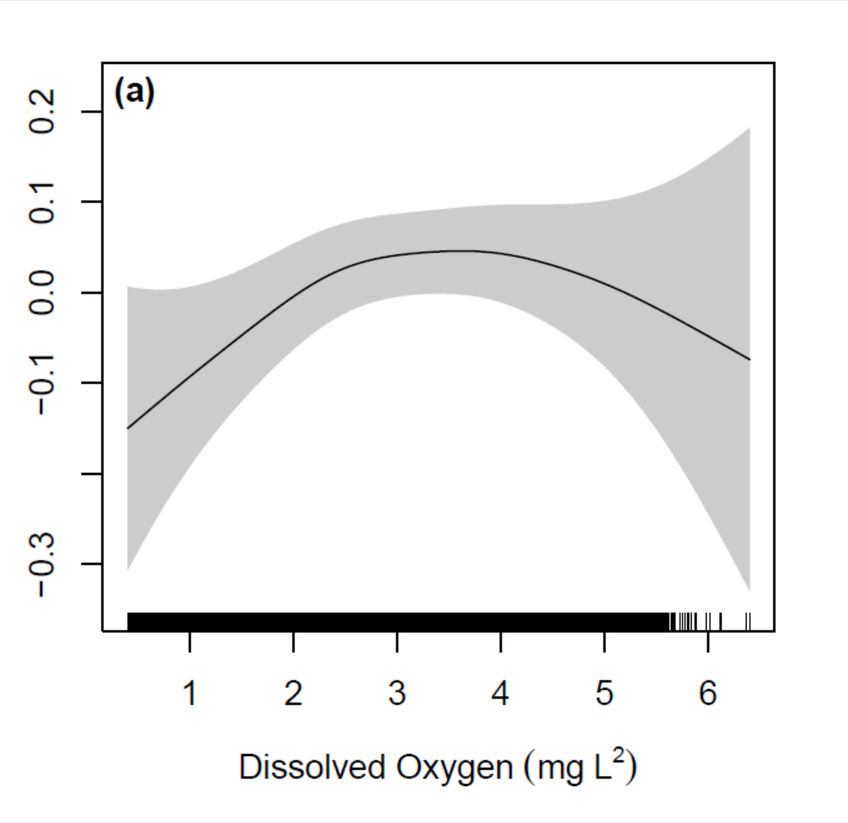
(b)
2.5
2
1
29
28
27
26
Latitude
0.06
0.13
0.21
0.29
−97.0
−96.5
−96.0
−95.5
−95.0
−94.5
−94.0
Longitude

Fisherman Behavior

Tow Count



Average Tow Duration



Menhaden Fishery

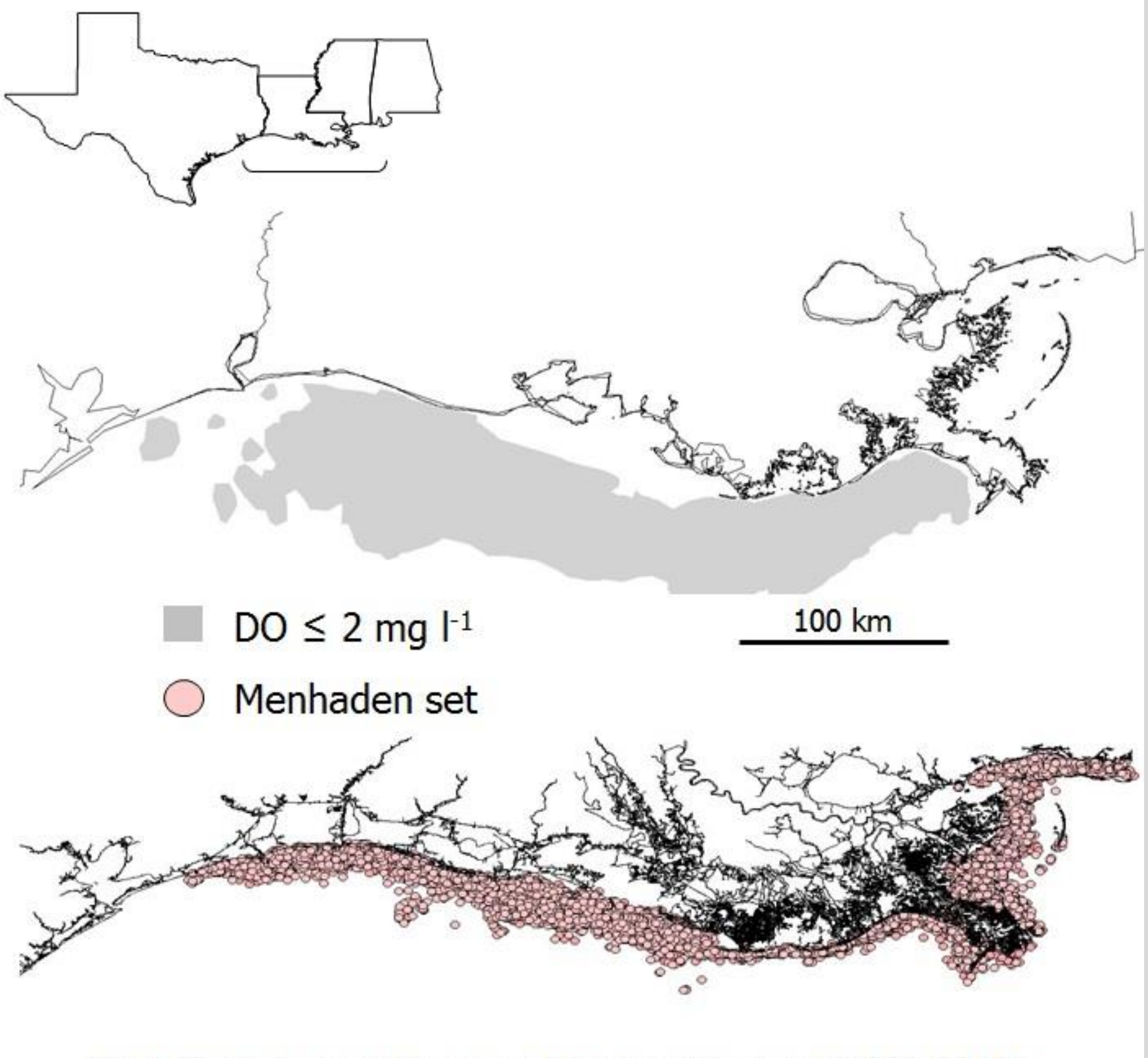
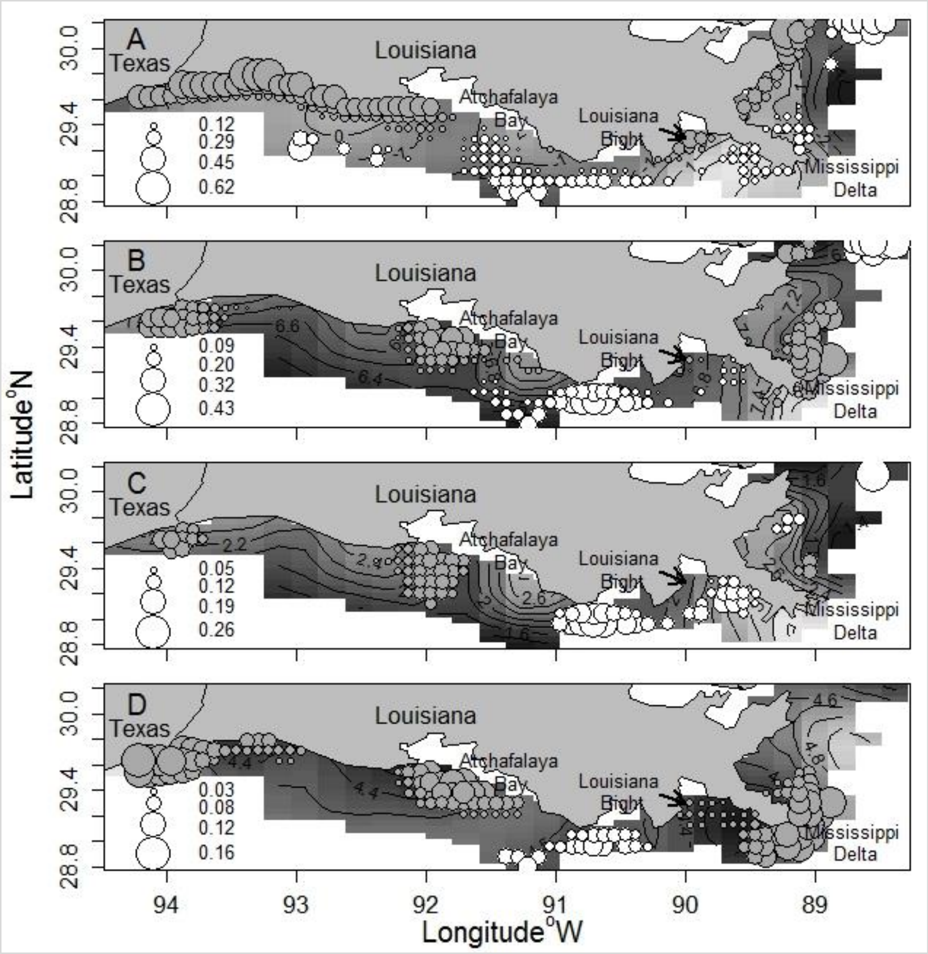


Fig.1 (Top) Composite map of the hypoxic zone (1983-2010). (Bottom) Menhaden set locations (2006-2007).

Menhaden Effects



Probability

Total Catch

# of Sets

CPUE

In Retrospect…

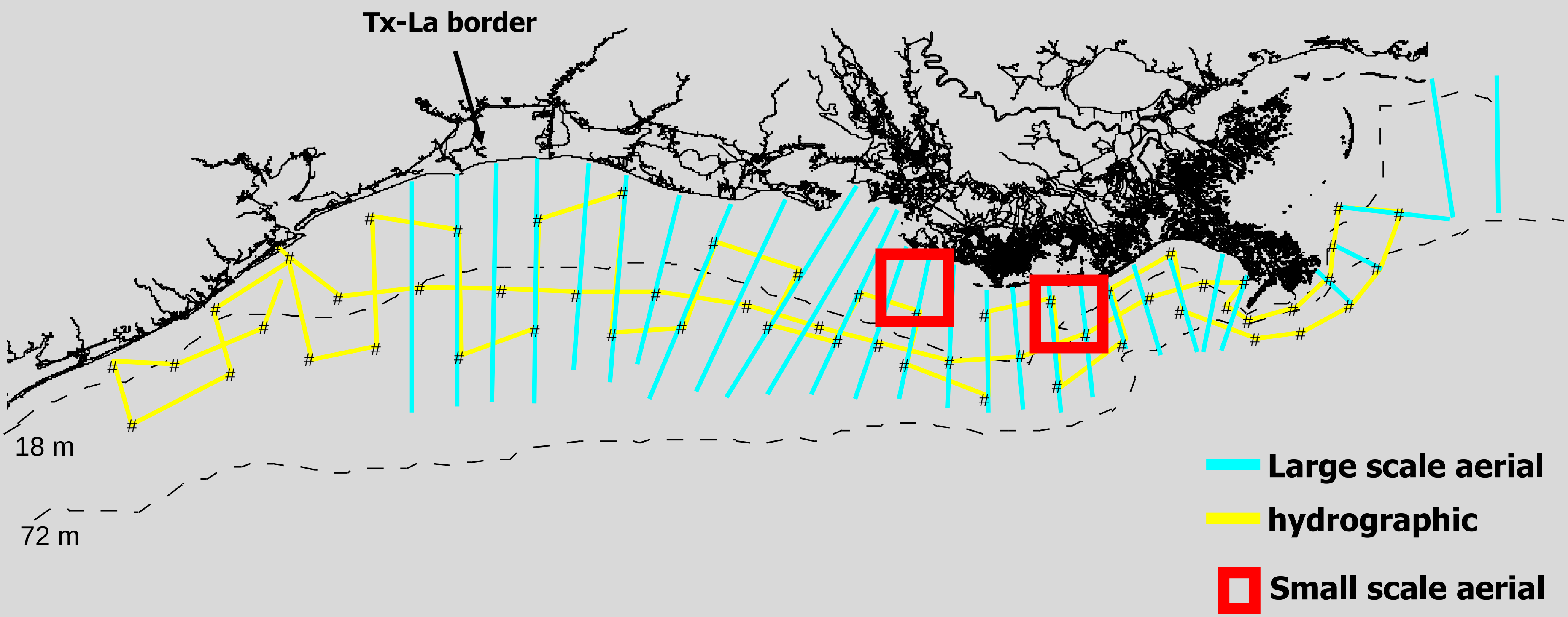
- Hypoxia effects spatial distribution and spatial allocation of fishery resources
- Hypoxia effects the fishing behavior

Aerial Survey

- Are the effects seen on smaller spatial scales similar over a shelf-wide scales?
- Are similar spatial distribution and behavioral effects evident in other data streams?

Shelf-wide Spatial Scale

June 24 – July 1 2011

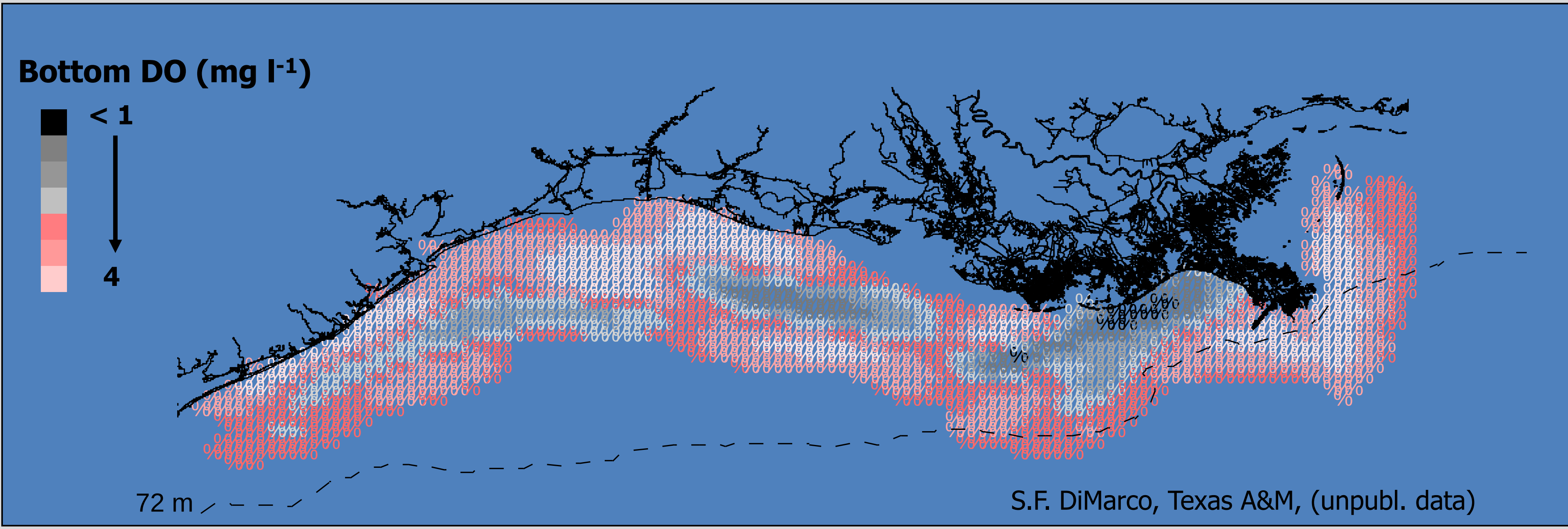


Aerial Transects

- synoptic with hydrographic survey (6/24 – 7/1)
- 29 transects; avg 13 km apart, perpendicular to depth contours
- Reference site east of delta
- Vessel location, activity, approximate heading

Shelf-wide Spatial Scale

June 24 – July 1 2011

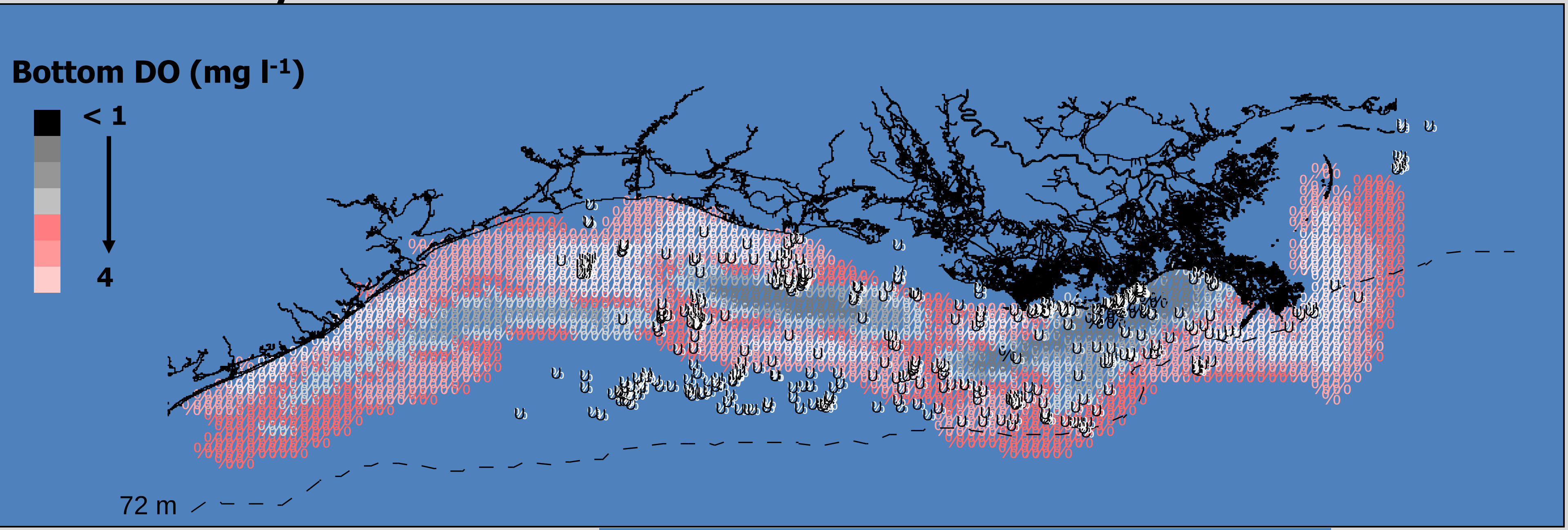


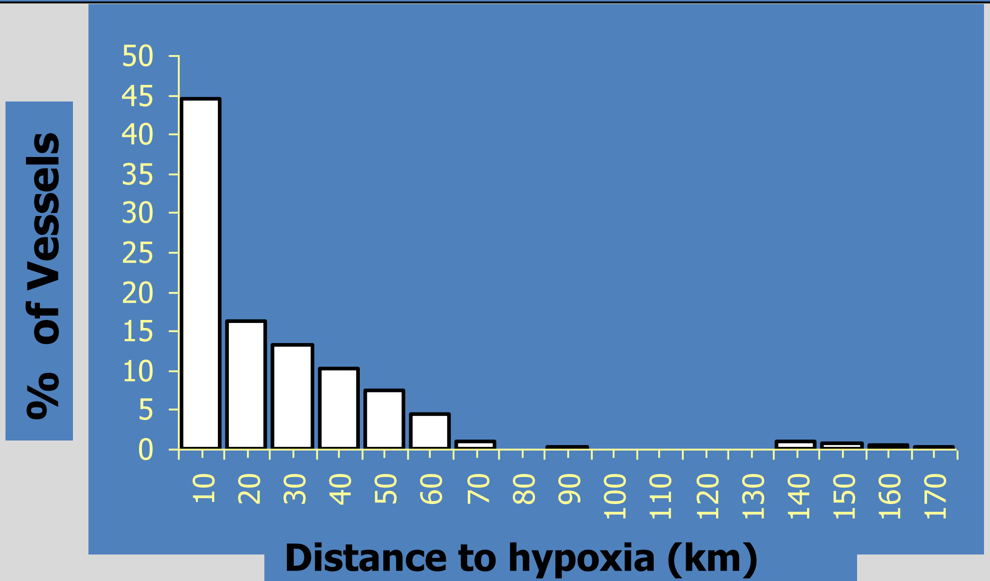
<u>Bottom DO (2011)</u>

- **5,400 km² (17,520 km² by late July)**
- **Stretched over ~ 700 miles of coastline (onto Texas shelf)**
- **Mostly hypoxic (<1-2 mg l⁻¹), little anoxia (<1 mg l⁻¹)**
- **Three distinct patches**

Shelf-wide Spatial Scale

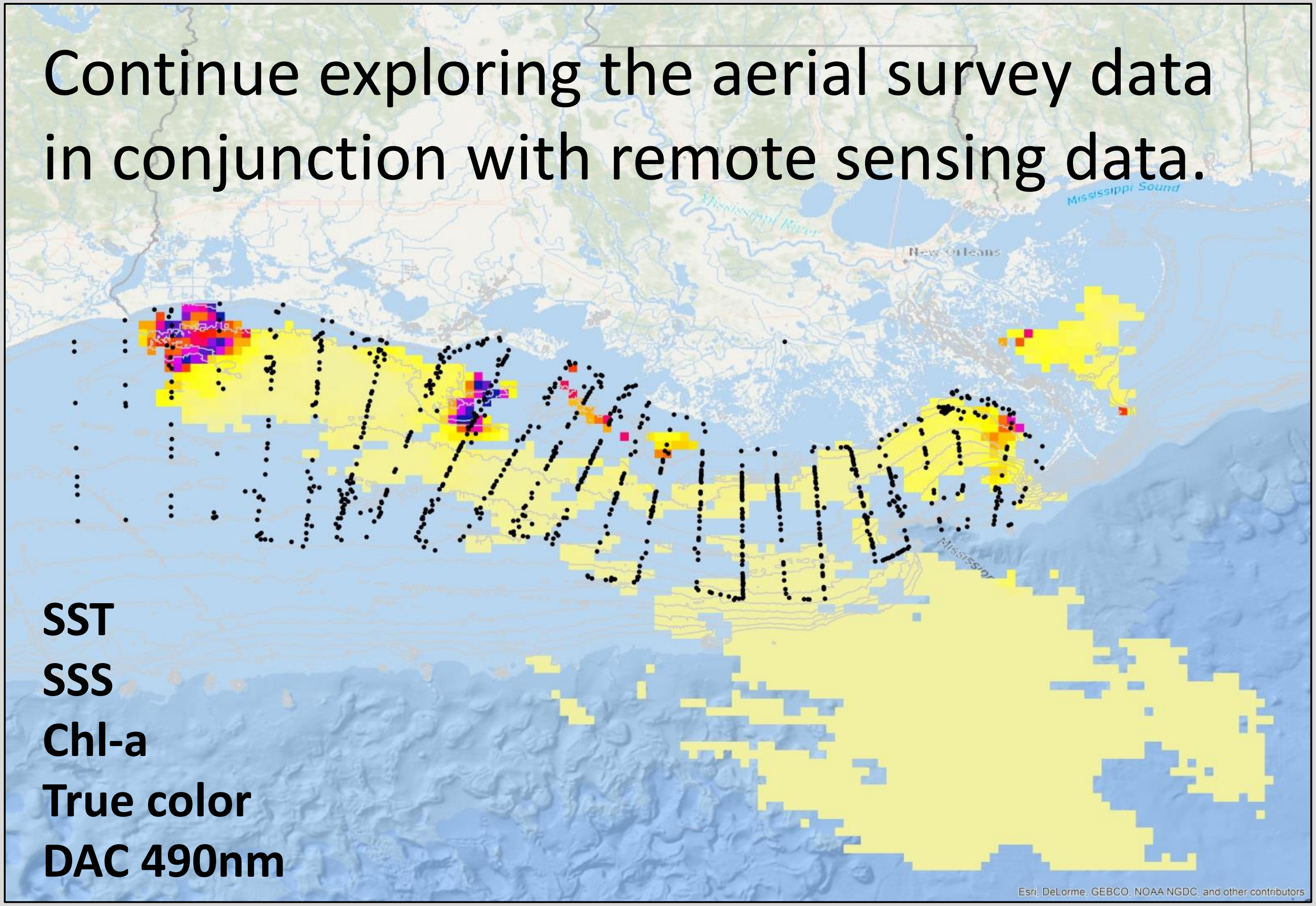
June 24 – July 1 2011





Future Directions …

Continue exploring the aerial survey data in conjunction with remote sensing data.



SST
SSS
Chl-a
True color
DAC 490nm

Acknowledgments

- NMFS Pascagoula and Galveston Labs, and the Gulf State Marine Fisheries Commission (*data access*)
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