Deep-pelagic research in the Gulf of Mexico: Understanding ecosystem variability and trends

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DEEP PELAGIC NEKTON DYNAMICS OF THE GULF OF MEXICO

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Collaborations before, during and after the Deepwater Horizon Spill

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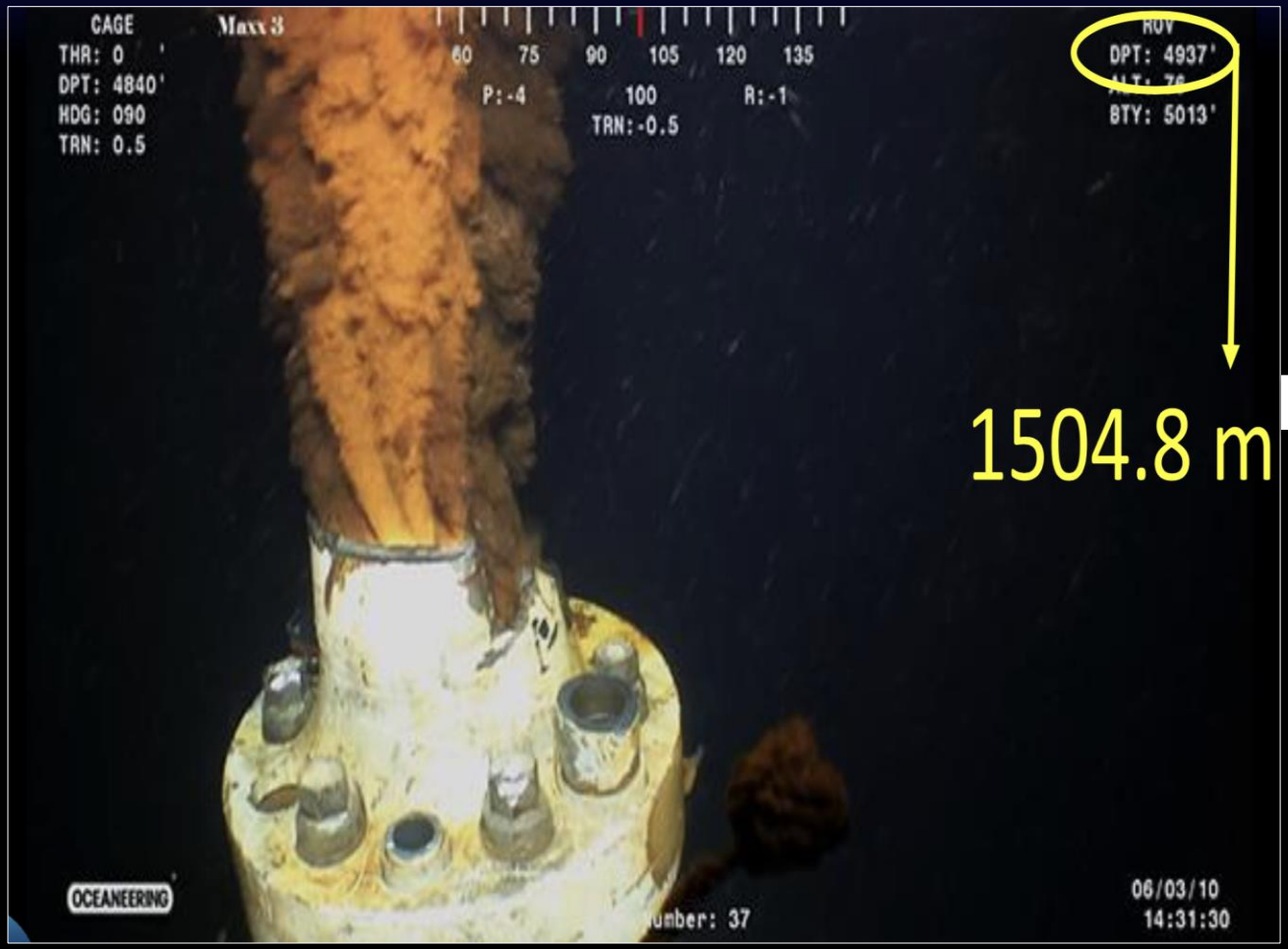
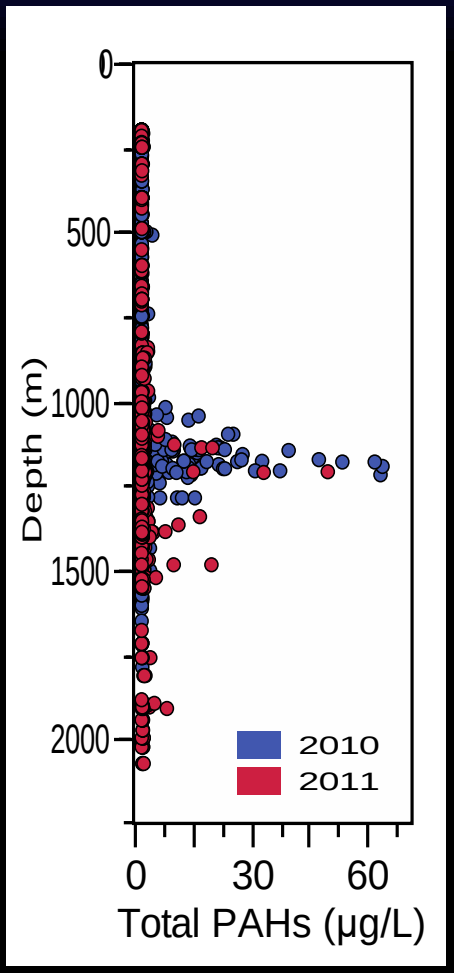
The DWH oil spill began as a deep-pelagic phenomenon





Romero et al. (2018) Env. Sci. & Tech.

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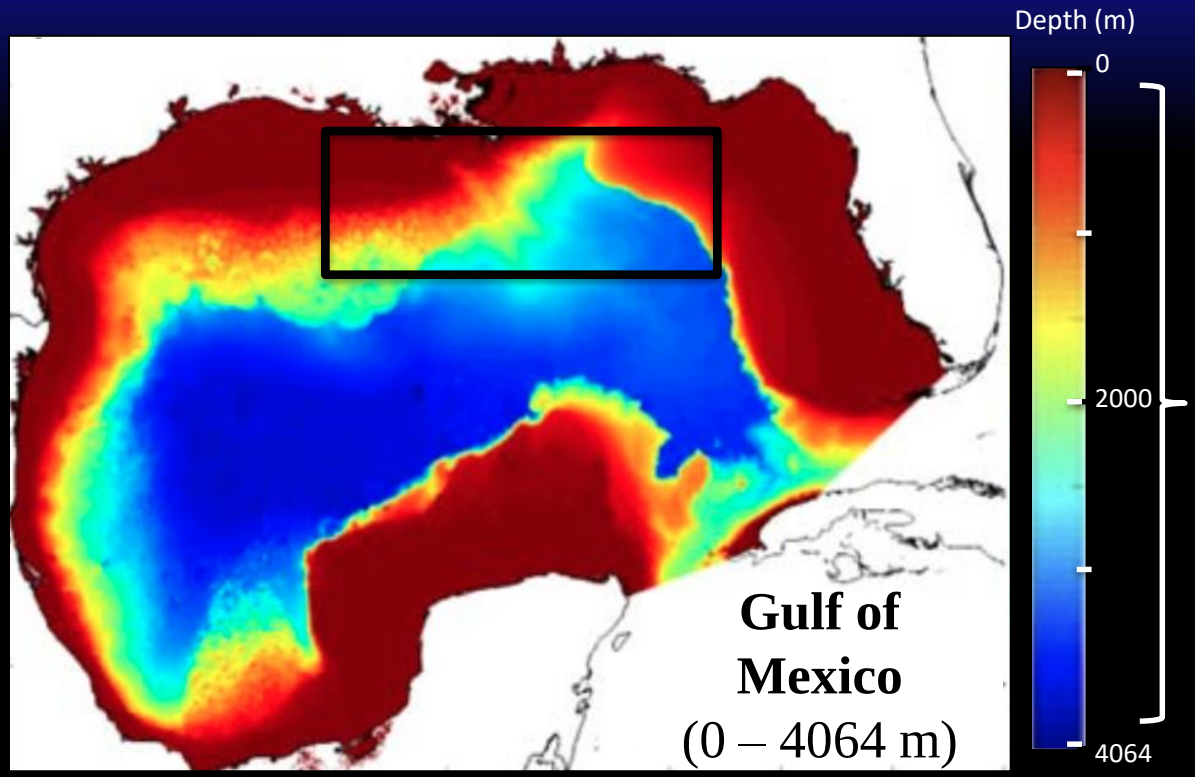

GoM Deep-pelagic Ecosystem (>200m)

- 90.4% of the Gulf of Mexico's volume
- Largest existing data gap in the GoM, no baseline data before the DWH spill
- Long-term sampling is required to address variability

Ramifications of impacts to the deep-sea

- Largest global biomass of mesopelagic fishes (~ 1×10^9 t), higher than global fish landings (~ 1×10^8 tonnes)
- Efficiently links lower and higher trophic levels through movement and consumption
- Deep-pelagic GoM ecosystem services:
  carbon sequestration,
  fisheries production,
  byproducts accumulation

Diplospinus multistriatus

(Gjosæter and Kawaguchi, 1980; Wilson et al. 2009; Rowe et al. 2013; Young et al. 2015)

Collaborations before, during and after the DWH spill
- Timeline -

Collaborations before, during and after the DWH spill
- Timeline -

2007 → 2010 → 2011 → 2015 → 2016 → 2017 → 2018 → 2019 → 2020

Steve W. Ross (UNC at Wilmington)

ELSEVIER

Deep Sea Research Part II: Topical Studies in Oceanography

Volume 57, Issues 21–23, November 2010, Pages 1926–1956

Gulf of Mexico Cold Seeps

Species composition and distributions of mesopelagic fishes over the slope of the north-central Gulf of Mexico

Steve W. Ross[a], Andrea M. Quattrini[b], Adela Y. Roa-Varón[a], Jennifer P. McClain[a]

[a] University of North Carolina at Wilmington, Center for Marine Science, 5600 Marvin Moss Lane, Wilmington, NC 28409, USA

[b] Temple University, Biology Department, 1900 N. 12th Street, Philadelphia, PA 19122, USA

Seep areas >1000 m depth (AC601, GC852, AT340)

R/V *Cape Hatteras* (Duke-UNC Oceanographic Consortium)

USGS

UNCW

Collaborations before, during and after the DWH spill
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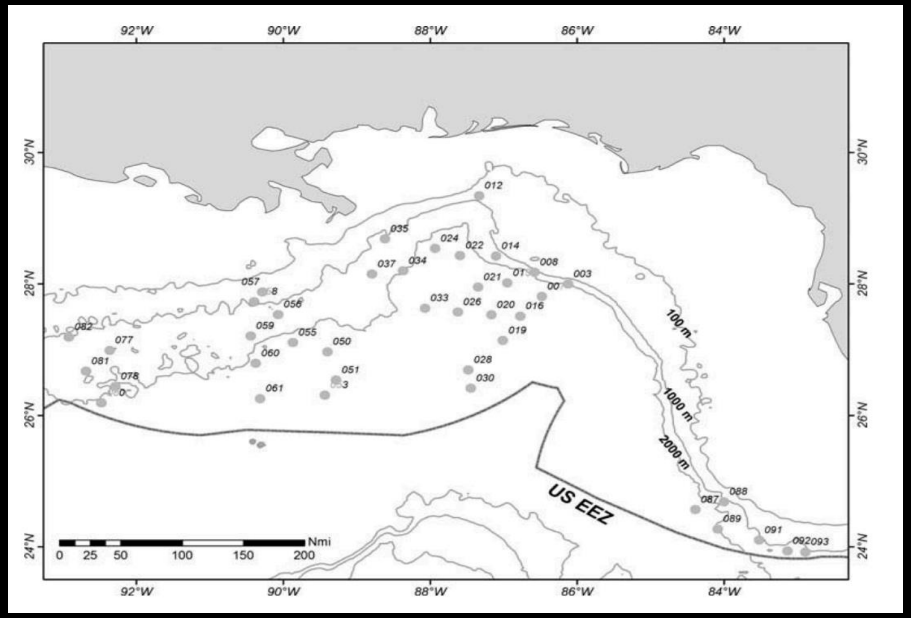
Pre-spill

NOAA National Marine Fisheries Service (NMFS):

Sperm Whale Acoustics Prey Survey (SWAPS)

Line transects (collection) and acoustic survey, visual surveys

Lance Garrison, Chief Scientist



January-March 2010

R/V *Pisces* (NOAA)

Collaborators:
Mike Vecchione, Heather Judkins, Mark Grace

Judkins et al. (2015)

Collaborations before, during and after the DWH spill
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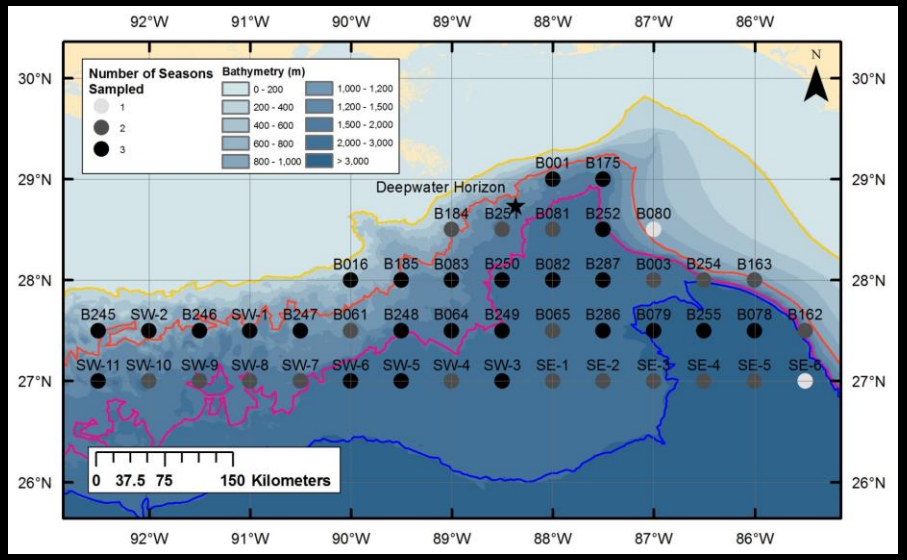
NOAA Natural Resource Damage Assessment:

Offshore Nekton Sampling and Analysis Program (ONSAP)

Total (2010-2011): 235 sea-days, 1580 samples

Tracey Sutton, Nova Souteastern University



Large-scale sampling

NOAA FSV *Pisces*

M/V *Meg Skansi*

Collaborations before, during and after the DWH spill
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Joseph Torres (USF)

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

$\delta^{13}C$ and $\delta^{15}N$ in deep-living fishes and shrimps after the Deepwater Horizon oil spill, Gulf of Mexico

Ester Quintana-Rizzo [a,*], Joseph J. Torres [a], Steve W. Ross [b], Isabel Romero [a], Kathleen Watson [a], Ethan Goddard [a], David Hollander [a]

Three areas in the NGoM

R/V *Weatherbird II* (Florida Institute of Oceanography, FIO)

NSF

STATE OF FLORIDA INSTITUTE OF OCEANOGRAPHY FIO

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C-IMAGE-II

Collaborations before, during and after the DWH spill

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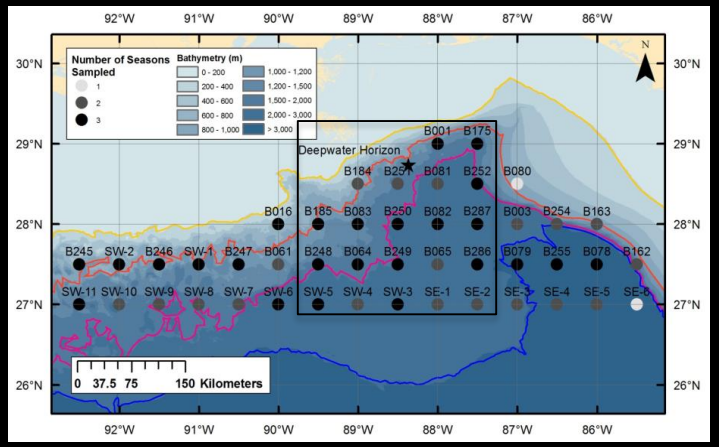
Tracey Sutton (DEEPEND director)



- Characterize the oceanic ecosystem of the NGoM to infer baseline conditions in the water column.
- Establish a time-series with which natural and anthropogenic changes can be detected.

FIU Florida International University · San Antonio Zoo · University of Washington · Harriet L. Wilkes Honors College, Florida Atlantic University · USF · NSU Nova Southeastern University · Texas A&M University Galveston · Naval Research Laboratory Stennis Space Center

Collaborations before, during and after the DWH spill

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Additional funds to improve baseline and timeseries datasets

Pre-spill samples from:

Mark Grace – NOAA Federal

NOAA- Offshore Nekton Sampling and Analysis Program

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DWHOS and the Deepwater Gulf

Effect on the biota

Communities (biodiversity) | Populations | Individuals

Assessment needs:

- Faunal inventory
- Quantitative abundance/distribution data
- Habitat characterization

Effect on ecosystem

- Production
- Food web structure
- Trophic transfer
- Ecosystem resilience and recovery

Overall DEEPEND Goals

- Characterize drivers of 'natural' variability
- Determine if observed variability falls outside 'natural' conditions

DEEPEND - accomplishments

- 11 successful cruises
- About 2000 trawl samples
- 27 peer-reviewed papers to date, a similar number in review, 64 publically available datasets
- Largest database of its kind

Image: DEEPEND/Danté Fenolio

DEEPEND - Results

By goals:

- Characterize the pelagic fauna
- Characterize pelagic diversity in space and time
- Characterize trophic ecology
- Characterize diel vertical migration (behavior)
- Delineate potential longer-term consequences of DWHOS on the pelagic fauna

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DEEP PELAGIC NEKTON DYNAMICS OF THE GULF OF MEXICO

Goal: characterize the pelagic fauna

Microbial assemblages

111,195 unique microbial taxa belonging to 1,552 genera, 812 families, 474 orders, 222 classes, and 67 phyla (Lopez et al. *in prep*)

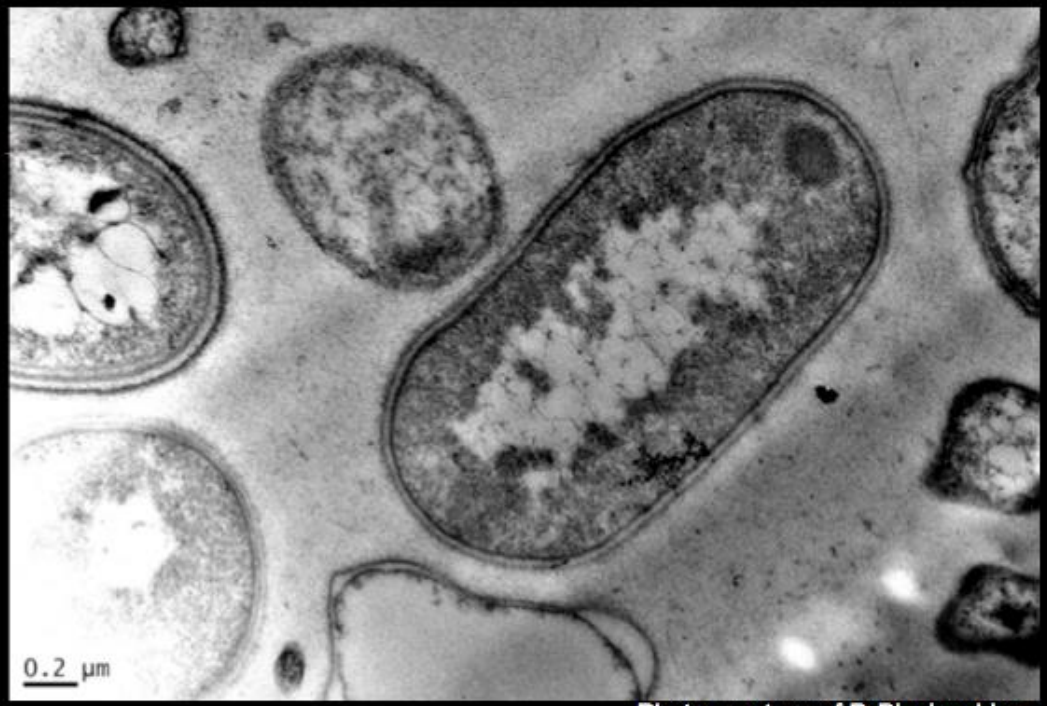


Photo courtesy of P. Blackwelder

Goal: characterize the pelagic fauna

Gelatinous zooplankton assemblages

141 species identified to date

- 1 in 4 are new to Gulf of Mexico

(Youngbluth et al., in prep.)

Image: DEEPEND/Danté Fenolio

Goal: characterize the pelagic fauna

Fish diversity:

897 species identified to date

- 186 are new to Gulf of Mexico

- ~20 are new to science

(Sutton et al., in prep.)

Astronesthes sp. nov.

Image: DEEPEND/Danté Fenolio

Goal: characterize the pelagic fauna

Deep-sea shrimp diversity:

132 species identified to date

- 5 are new to Gulf of Mexico

(Frank et al., in prep)

Goal: characterize the pelagic fauna

Deep-pelagic cephalopod diversity:

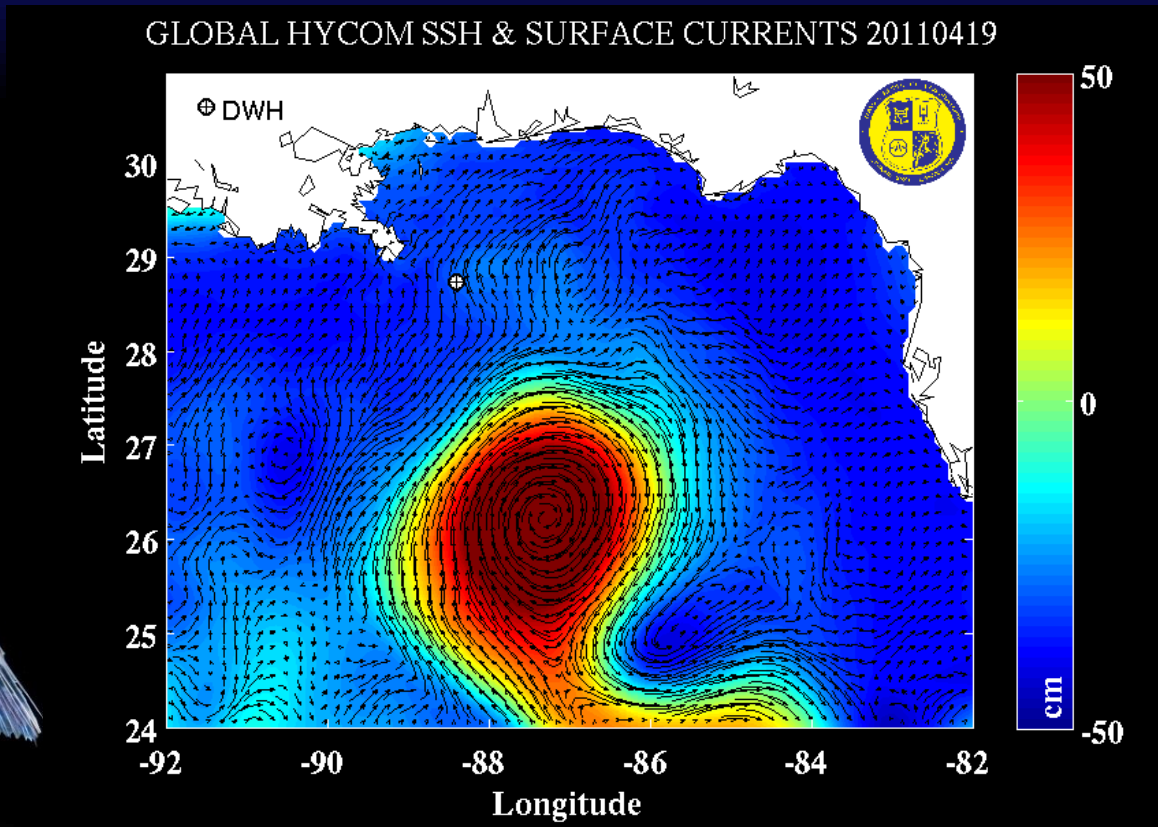
68 species identified to date

- 5 are new to science

(Judkins et al., in prep. and in review)

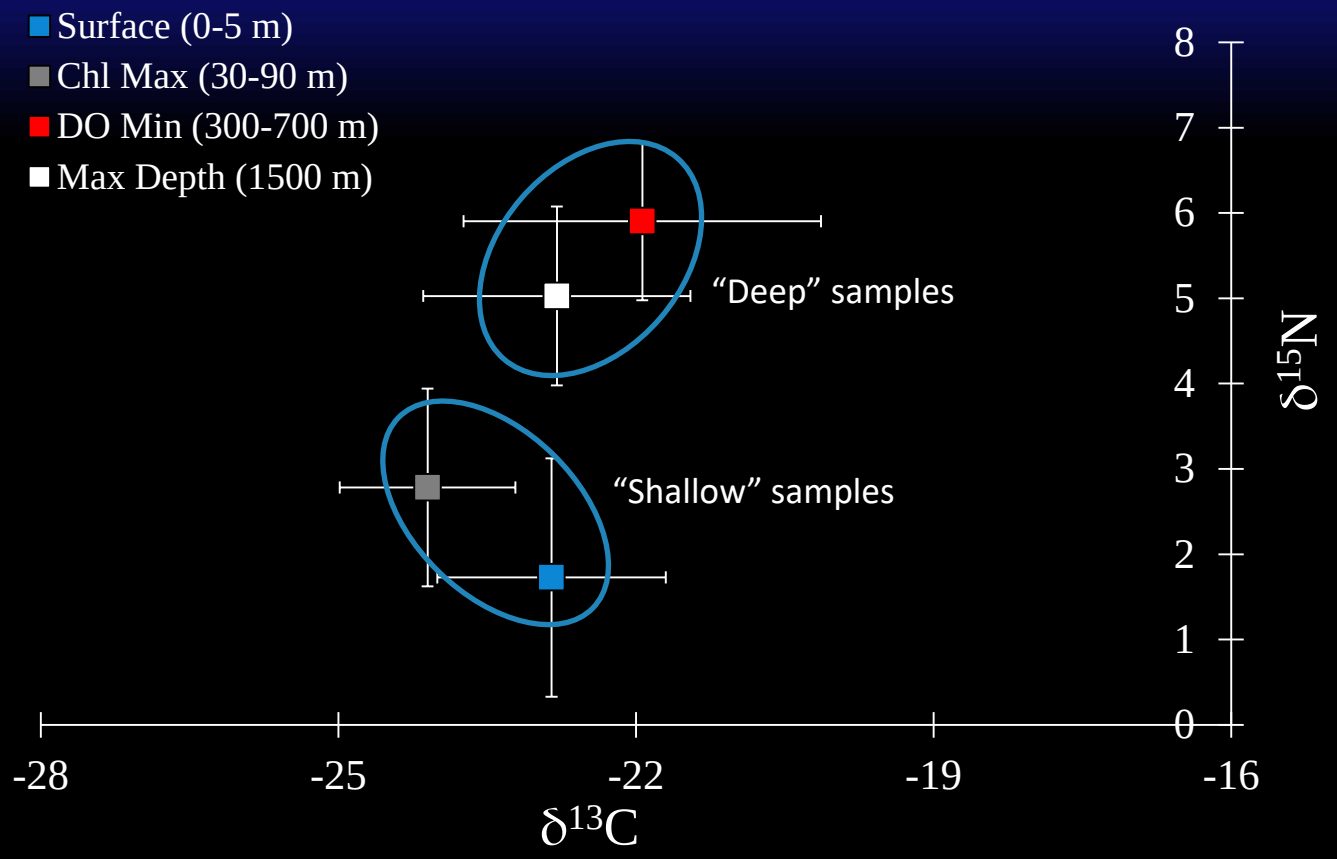
Goal: characterize pelagic diversity in space and time

Photos: Fenolio, Frank, Shale, Youngbluth, and Zankl



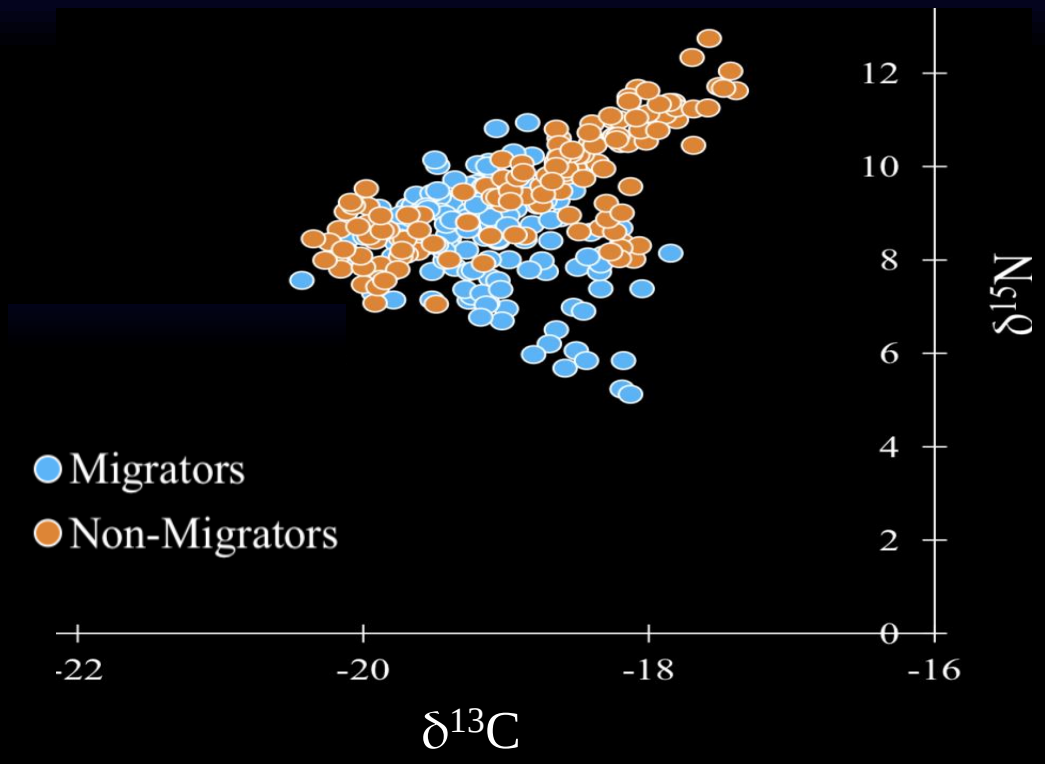
Johnston et al., (in press) An Empirically Validated Method for Characterizing Pelagic Habitats in the Gulf of Mexico Using Ocean Model Data. *L&O Methods.*

Goal: characterize trophic ecology



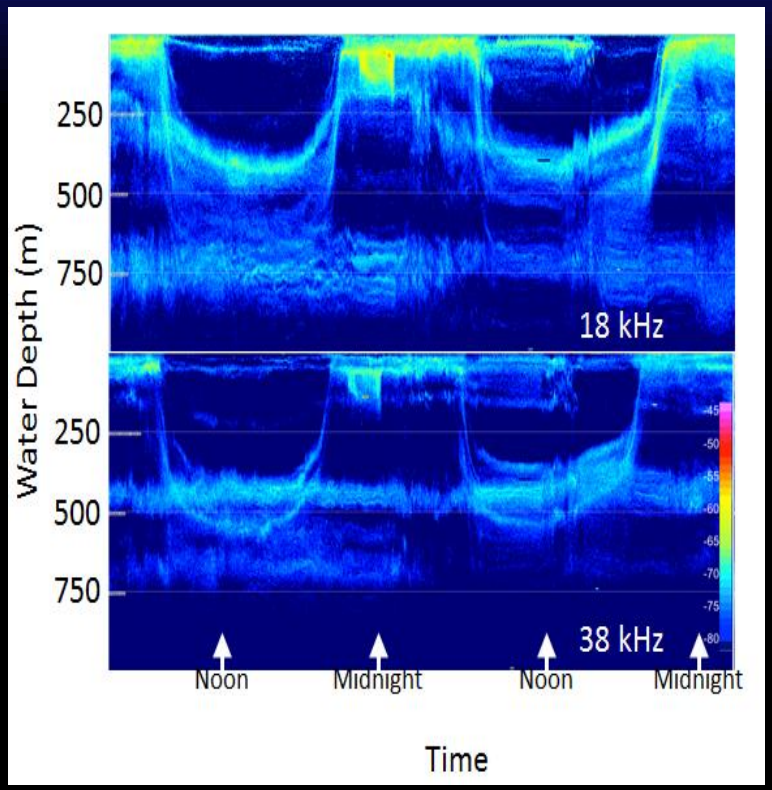
Richards et al., (2018) Trophic ecology of meso- and bathypelagic predatory fishes in the Gulf of Mexico. *ICES Journal of Marine Science.*

Goal: characterize trophic ecology

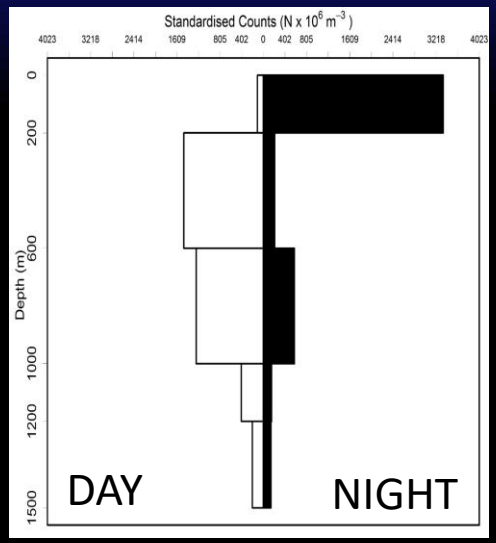


Richards et al., (2018) Trophic ecology of meso- and bathypelagic predatory fishes in the Gulf of Mexico. *ICES Journal of Marine Science.*

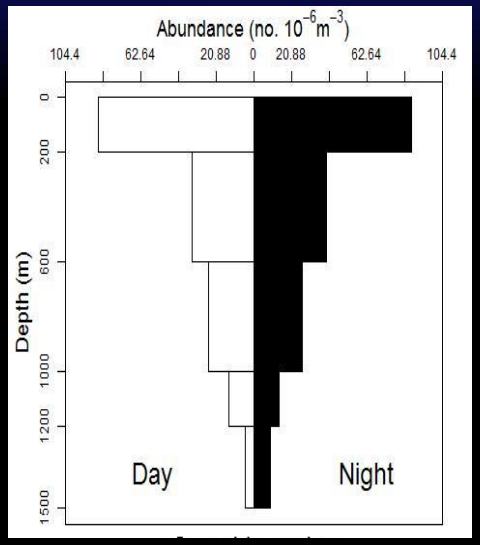
Goal: characterize diel vertical migration (behavior)



Multifrequency acoustic data (Kevin Boswell, FIU)



Fish: Myctophids
(e.g., Lampanyctus alatus, Ceratoscopelus warmingii)



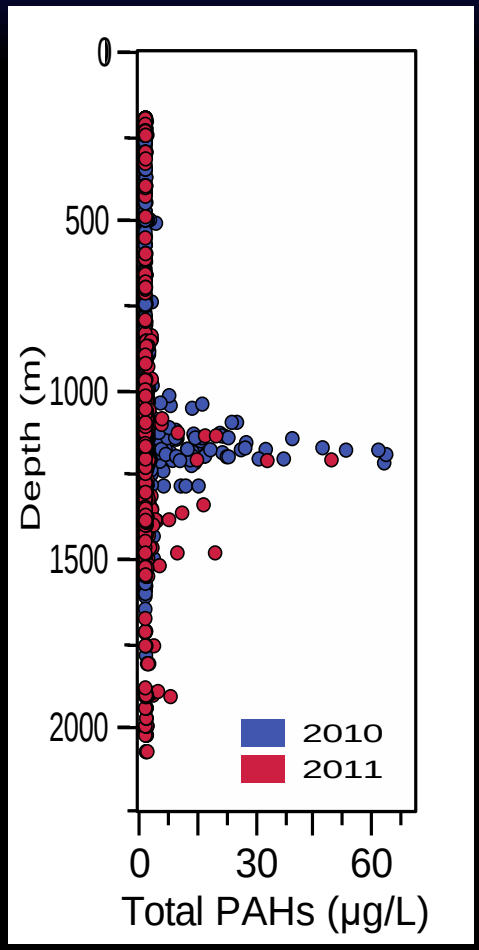
Cranchia scabra
Glass squid

(Sutton et al. *in prep*)

Goal: were there longer-term consequences of DWHOS on the pelagic fauna?

Ramifications of bathypelagic migration and the *Deepwater Horizon* oil spill:

Flux of animals through the submerged plumes (Sutton et al., in prep.)



Romero et al. (2018) Env. Sci. & Tech.

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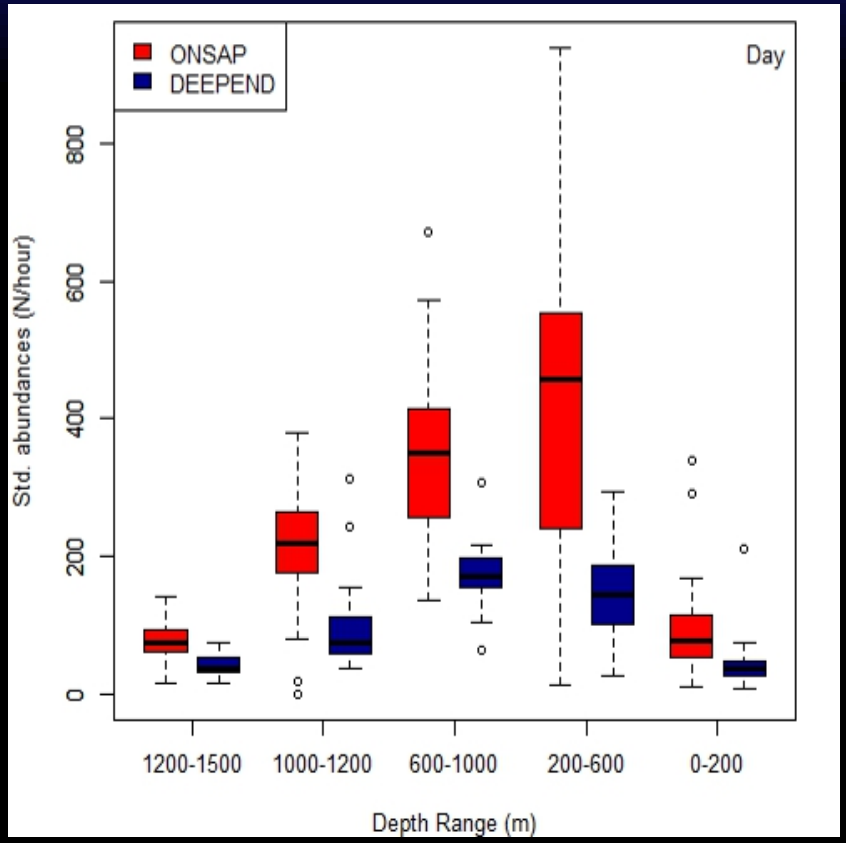
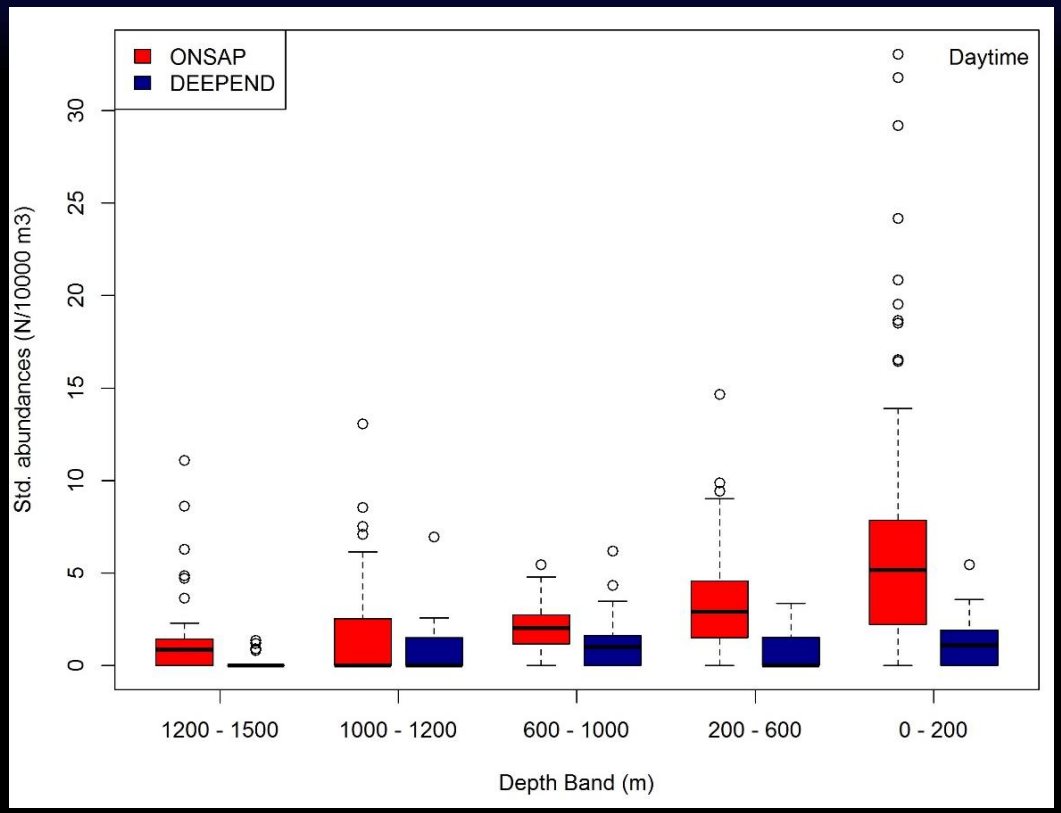


(Sutton et al., *in prep*.)

The decline in pelagic fish numbers from 2011 to 2016

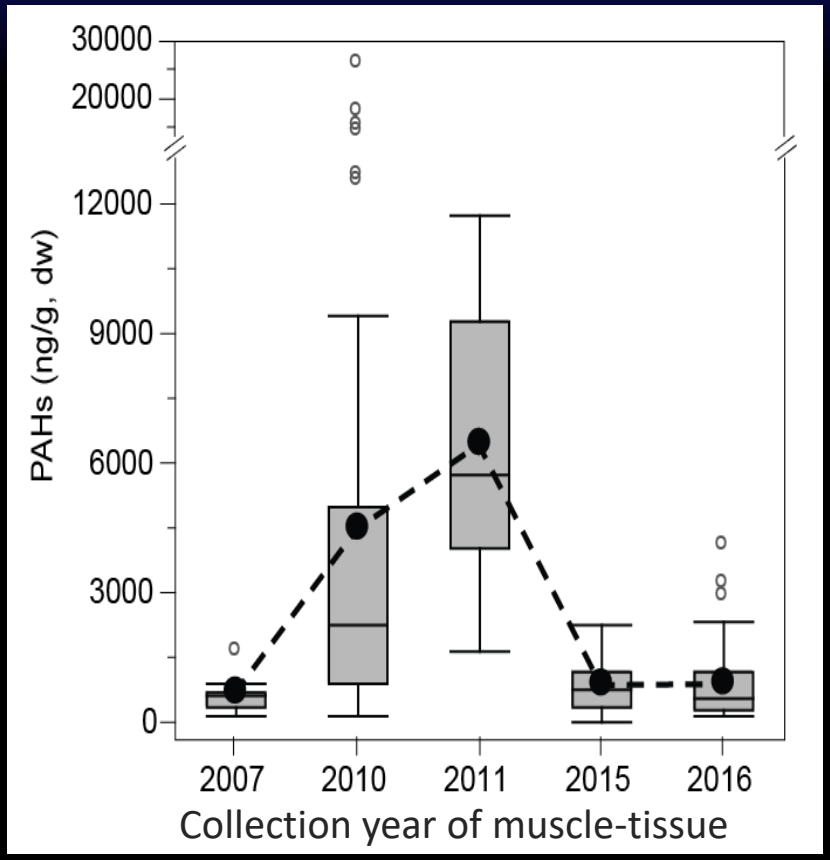
Goal: were there longer-term consequences of DWHOS on the pelagic fauna?



(Sutton et al., *in prep*.)

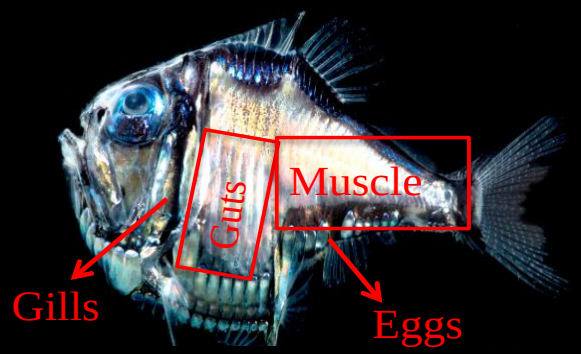
The decline in cephalopods numbers from 2011 to 2016

Goal: were there longer-term consequences of DWHOS on the pelagic fauna?



Romero et al. (2018) Env. Sci. & Tech.

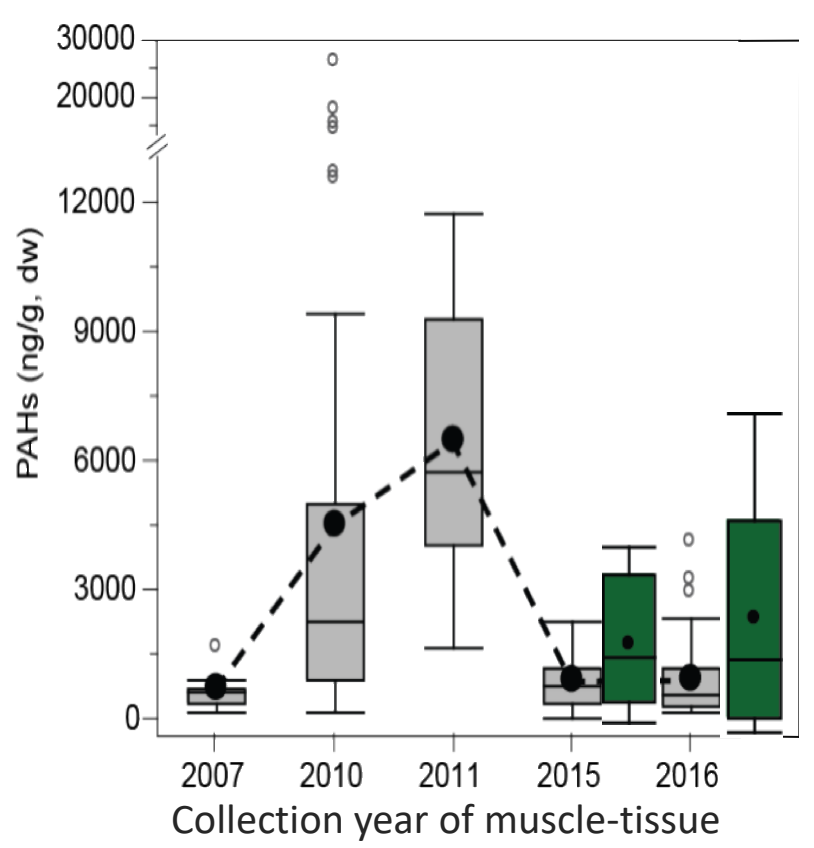
- Results observed regardless of differences in diet, site and feeding ecology among species
- Post-spill (2010-11) with a 7-10 fold increase in PAH level
- Lower levels in 2015-16: Fish community recovered???



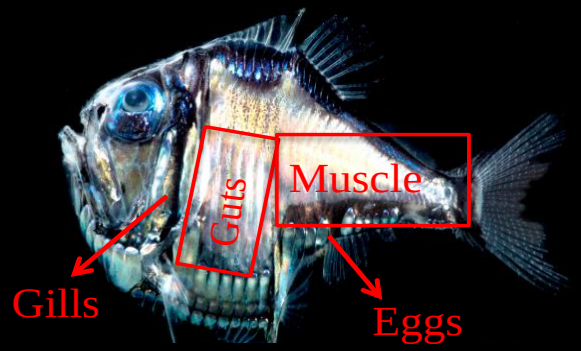
Argyropelecus aculeatus

Is there still an oil signal in the pelagic fauna?

Goal: were there longer-term consequences of DWHOS on the pelagic fauna?



- 2015-16 indicated decline of PAH levels close to pre-spill but only in muscle-tissue. Unhatched eggs contain ~50% more PAHs.
- Based on other species, PAH content in unhatched eggs above levels with known sublethal effects in embryos: potential year-class losses.



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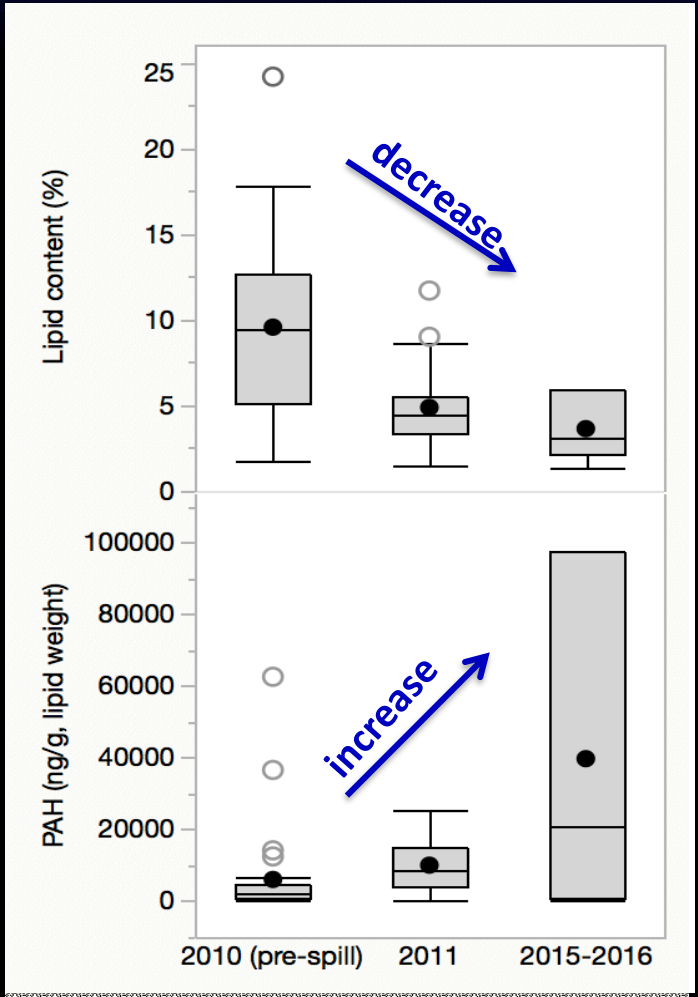
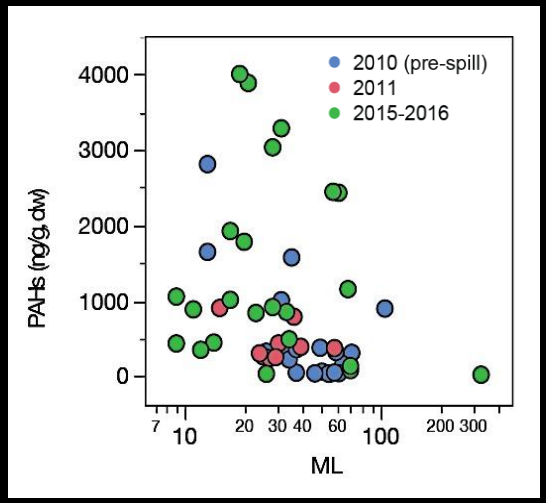
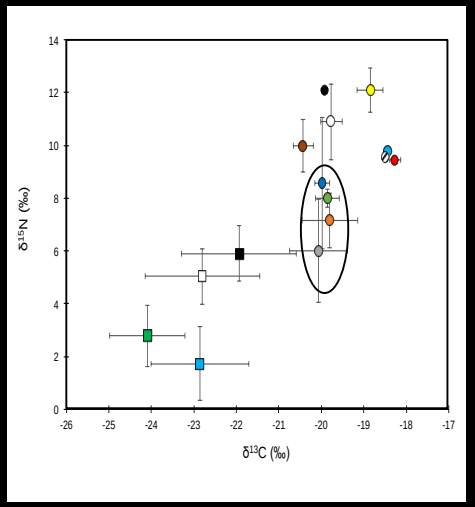


Romero et al. (in prep)

No trends





Cephalopods

2015-16 indicated a 7-fold increase of PAH levels in contrast to a 3-fold decrease of lipid content in mantle tissue. This results indicate a low nutritional intake that can potentially affect reproduction and survivorship.

Japetella diaphana
(DEEPEND/Dante Fenolio)

Ongoing work: filling the gaps

- Impact on population genetics
- Long-term persistence of contaminants in the water column: DOC/POM characterization
- Lipid content dynamics: composition of fatty acids for diet nutritional characterization
- Time-series assessment of PAHs in unhatched eggs
- Modeling population dynamics and contaminants: age-class analysis
- Longer time-series

Thank you!

Tracey Sutton, Kevin Boswell, Heather Bracken-Grissom, April Cook, Sergio deRada, David English, Ron Eytan, Danté Fenolio, Tamara Frank, Chuanmin Hu, Heather Judkins, Chad Lembke, Joseph Lopez, Jon Moore, Martha Nizinski, Brad Penta, Jay Rooker, Mahmood Shivji, Michael Vecchione, David Wells, Marsh Youngbluth

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