FLORIDA STATE UNIVERSITY COASTAL AND MARINE LAB AND UNIVERSITY OF NORTH FLORIDA:

ASSESSMENT OF DEEPWATER FISH ASSEMBLAGES ASSOCIATED WITH DESOTO CANYON AND CONTINENTAL SLOPE WATERS IN THE EASTERN GULF OF MEXICO

R. Dean Grubbs
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SCIENCE ACTIVITIES

1) General Summary

The goals of our project were to complete one 10-day cruise aboard the R/V Weatherbird II to document the faunal assemblages of fishes associated with the west Florida slope and DeSoto Canyon and to collect samples for assessing exposure of fishes to pollutants associated with the Deep Water Horizon (DwH) oil spill. By collaborating with investigators funded by FIO to complete a compatible project (P.I. M. Heithaus- FIU), this project was expanded to include three research cruises over two years. Our objectives and outcomes are summarized below.

The primary objectives of this work were to:

A. Describe and examine differences in species assemblages and relative abundances of demersal fishes associated with DeSoto Canyon and the adjacent continental slope (200-2000 m).

Results: We completed three cruises (42 sea days), setting 128 demersal longline/trap sets at depths ranging from 199 to 2,645 meters and capturing 1,196 deep-sea fishes from 45 species. Catch rates and species richness varied with depth and region but were not affected by proximity to DwH. Species richness was highest at depths of 400-600 m for elasmobranchs and <400 m for teleosts. Elasmobranch catch rates were highest <600 m deep near DeSoto Canyon and 400-900 m deep on the West Florida Slope. Teleost catch rates were highest <400 m deep regardless of region, but were much higher near DeSoto Canyon than on the West Florida Slope. Regional community structure varied as functions of depth and temperature with assemblages associated with 200-400 m, 500-900 m, and 900-1700 m isobaths. Species assemblages also varied regionally, likely as functions of habitat and edaphic factors.

B. Collect liver and bile samples from dominant species to examine spatial and depth-mediated differences in exposure to polycyclic aromatic hydrocarbons (PAHs).

Results: PAH biomarker assays have been performed and data analyzed on 476 deepwater fishes including 63 hagfishes, 217 elasmobranchs, and 195 teleosts. Additional samples are currently being analyzed. The results indicate that deepwater fishes from the northeast Gulf of Mexico are exhibiting physiological signs of heightened exposure to PAHs. This is based on comparisons of Cyp1a1 activity and biliary FAC concentrations in fishes from reference sites versus oiled sites. Temporal declines in some biomarkers in fishes from oiled sites suggest they reflect recent elevated exposure to petrogenic PAHs, such as from DwH, rather than persistent sources of petroleum contamination. It is unclear whether elevated PAH exposure is sufficient to cause cell- or organ-level affects.

Secondary objectives of this project were to:

C. Use hepatosomatic indices as proxies for testing spatial differences in fish condition.

Liver and body weights were collected from seven dominant taxa to calculate HIS values. These data are currently being analyzed.

D. Collect muscle tissue from all species for stable isotope analyses including using radiocarbon ratios to examine attenuation of long-term exposure to hydrocarbons.

Samples for stable isotope analyses were collected from 931deepsea fishes. Multiple stable isotope projects have been initiated or completed. See report from M. Heithaus and colleagues for details.

E. Collect specimens and samples (including curation of new species) to aid in resolving phylogenetic uncertainties and understanding life history traits in collected taxa.

Fishes collected during this project are contributing to a multitude of studies of taxonomy and life histories. Five manuscripts have been submitted and many others are planned.

2) Results and scientific highlights

Survey results: We completed three research cruises in the northeastern Gulf of Mexico (NEGOM) aboard the R/V Weatherbird II. During the first cruise (05-20 April 2011) we made 44 demersal longline sets at depths ranging from 199 to 2,014 meters. During the second cruise (24 August to 01 September 2011) we completed 29 demersal sets ranging from 201 to 1,357 meters deep. Finally, we completed a third cruise (30 March – 16 April 2012) completing 55 demersal sets between 200 and 2,645 meters deep. All cruises included sets on the "West Florida Slope" off St. Petersburg, the "North Florida Slope" south of the Florida Panhandle and throughout DeSoto Canyon east of the DwH. During the second and third cruises, we also included sets west of the DwH to the Louisiana shelf edge. We collected 1,196 deepsea fishes during these cruises including 335 elasmobranchs (sharks and relatives) from 20 species, 561 teleosts (bony fishes) from 25 species, and 300 hagfishes from 3 species. *Paraliparis* cf. *calidus* was the smallest teleost caught (~8 cm) and *Ophichthus rex* was the largest (~200 cm). *Etmopterus virens* was the smallest shark captured (16 cm) and *Hexanchus griseus* was the largest (500 cm) These specimens yielded more than 10,000 samples that have been or are being used in life history and population genetics studies, analyses of exposure to hydrocarbons, and studies of trophic structure using stable isotope and traditional diet methods. In addition, many voucher specimens from rare or unresolved taxa were retained and many have already contributed to taxonomic revisions.

Relative abundance of demersal fishes: We divided the NEGOM into three regions for analyzing catch rates and community structure: A) the west Florida slope (WFS) offshore of St. Petersburg, an area likely unaffected by DwH, B) the north Florida slope and eastern DeSoto Canyon (NFS), an area minimally affected by DwH, and C) western DeSoto Canyon and the Louisiana slope, an area heavily affected by DwH. Catch rates (animals per set) were negatively correlated with depth and positively correlated with temperature. The large majority (85%) of fishes were captured shallower than 600 meters. Teleost species richness and relative abundance was highest at the shallowest sights (<400 m) and lowest between 500 and 900 m, with a secondary peak below 1,200 m. Elasmobranch species richness and relative abundance were highest between 300 and 600 meters deep. Overall elasmobranch catch rates were similar between regions; however, catch rates were highest less than 400 m deep in the northern regions (NFS and LAS) but highest at 400-900 meters deep off the WFS. Teleost catch rates were highest at depths less than 400 m in all regions, however, overall teleost catch rates were much higher in the northern areas (NFS and LAS) than off the WFS. Catch rates for elasmobranchs and teleosts were similar between the regions minimally affected (NFS) and presumably heavily affected (LAS) by DwH. This is a positive indication the DwH may not have had population level effects on these communities. However, given the slow growth rates, long maturity schedules, and low reproductive rates of many of these taxa, it is also possible that DwH-mediated affects have yet to manifest.

Community structure: Cluster analyses and analyses of similarity revealed distinct faunal assemblages among the large demersal fishes mediated by depth, region and other factors. As has been reported for other taxa, distinct upper slope (200-400 m), mid-slope (400-900 m) and deep slope (>900 m) assemblages are apparent. Multiple clusters occupy similar depths, however, and are likely driven by meso-scale differences in habitat type and edaphic factors. Unexpectedly, species composition also varied considerably between the three regions. Some species common in one region are rare in another. For example, the gulper shark *Centrophorus* cf. *granulosus* is abundant in the LAS but uncommon on the NFS and rare on the WFS, *Squalus* cf. *mitsukurii* was abundant on the WFS and the NFS but rare on the LAS, and the shallower congener *Squalus cubensis* was common on the LAS and the NFS but absent from the WFS. The regional differences in relative abundance and community structure are likely related to differences in habitats resulting from very different geological processes and terrestrial influence between these regions.

PAH Biomarkers: We examined exposure of deepwater fishes in the NEGOM to polycyclic aromatic hydrocarbons (PAHs), the most toxic constituents of petroleum, in order to assess the ecological effects of DwH oil. Samples were collected from deepwater fishes in areas minimally and heavily exposed to oil for DwH. Laboratory analyses of three biomarkers of PAH exposure were conducted at UNF: 1) activity of cytochrome P4501A1 (Cyp1A1), a key enzyme involved in the metabolism of PAHs; 2) presence of biliary fluorescent aromatic compounds (FACs), PAH metabolites commonly used as indicators of increased metabolism of oil constituents; and 3) occurrence of micronuclei, erratic "extra" nuclei that occur in greater numbers in erythrocytes of fishes that have been exposed to genotoxic chemicals such as PAHs. The occurrence of hepatic PAH-DNA adducts, covalent bonds between PAHs and DNA that can cause DNA damage in organisms exposed to these compounds was examined in a subset of shark samples and will continue in the future. PAH biomarker assays have been performed on 476 deepwater fishes collected during this study, including 63 hagfishes, 217 elasmobranchs, and 195 bony fish, and more samples are being analyzed. Only results for sharks and bony fishes are discussed here.

Most bony fish exhibited low, but measurable levels of Cyp1A1 activity, though a few individuals exhibited very high EROD activity, suggesting heightened exposure to PAHs or other Cyp1A1-inducing compounds. Although overall Cyp1A1 levels were "low" (i.e., comparable with those measured in coastal bony fishes from unaffected sites using the same assay), there were significant differences between the range of levels observed in conspecifics from reference and oil-affected locations. This suggests that bony fishes residing in oil-affected sites are exhibiting signs of greater exposure to Cyp1A1-inducing compounds, but exposure may not be severe enough to cause higher-levels effects on cell and organ function. Alternatively, it may indicate that deepwater teleosts normally exhibit much lower levels of Cyp1A1 activity than their shallow water counterparts and that the differences observed between sites is of greater concern. Cyp1A1 activity levels in elasmobranchs were generally lower than those observed in bony fishes. Like the bony fishes, there were significant differences between Cyp1A1 activity in sharks from reference sites and oil-affected locations, suggesting greater exposure to Cyp1A1-inducing compounds in the latter (particularly for *Squalus* cf. *mitsukurii*). However, even in oil-affected locations, the overall levels of Cyp1A1 activity were low in sharks, comparable with those reported in sharks from typical "industrialized" sites. Therefore, it is unclear whether the higher Cyp1A1 activity is due to exposure to oil from the DwH or other sources of petroleum.

Biliary FAC concentrations in bony fishes and sharks from oil-affected sites were similar to published values observed in bony fishes (there are no published values for sharks) from locations contaminated with PAHs via natural or non-catastrophic sources (i.e., shipping, natural seeps, nearby petroleum terminals). Therefore it is unclear if they reflect exposure to PAHs originating from these sources or from DwH. However, there were exceptionally high levels of biliary FACs in some bony fishes, particularly tilefish, from areas adjacent to the DwH site. While levels in some species did not differ significantly between oil-affected and reference locations, there were subtle differences that allude to greater levels of PAH exposure in oiled areas. A temporal decline over the course of this study in the levels of biliary naphthalene-level metabolites in sharks from oil-affected locations suggest recovery from heightened exposure to petrogenic PAHs. Thus, these data support the hypothesis that fishes from oil-affected locations are exhibiting physiological signs of elevated PAH exposure but whether these levels are capable of causing higher levels effects remains unclear. We have examined the presence of micronuclei in blood smears of all elasmobranchs and no micronuclei were detected in any samples. Therefore, there is no evidence for chromosomal damage in these sharks.

3) Cruises & field expeditions

Ship or Platform Name	**Class** (if applicable)	**Chief Scientist**	**Objectives**	**Dates**
R/V Weatherbird II	IV	R. Dean Grubbs	Sampling deep demersal fishes	5-20 Apr 2011
R/V Weatherbird II	IV	R. Dean Grubbs	Sampling deep demersal fishes	24 Aug – 01 Sep 2011
R/V Weatherbird II	IV	R. Dean Grubbs	Sampling deep demersal fishes	30 Mar – 16 Apr 2012

4) Peer-reviewed publications, if planned (Note: a special section will focus on student and post-doctoral publications)

A special symposium on the Biology of Deepwater Chondrichthyans was held at the 2012 annual meeting of the American Elasmobranch Society. Manuscripts associated with this symposium are being submitted to the journal Deepsea Research II for peer-review. Four presentations from this symposium were associated with this FIO project and manuscripts are in preparation or in review. These include:

Grubbs RD, J Gelsleichter, M Heithaus, K Gastrich, C Cotton. In prep. Demersal elasmobranch assemblages associated with DeSoto Canyon and the continental slope of the eastern Gulf of Mexico relative to the Deepwater Horizon oil spill. Target Journal: Deep Sea Research II, to be submitted January 2013

Gelsleichter J, AE Leary, RD Grubbs, ME Heithaus. Impacts of the Deepwater Horizon Oil Spill on deepwater shark populations in the northeast Gulf of Mexico. Target Journal: Deep Sea Research II, to be submitted January 2013

Cotton, C F, R D Grubbs, J A Musick. Submitted. Reproduction and embryonic development in two species of North Atlantic squaliform sharks, *Centrophorus* cf. *niaukang* and *Etmopterus princeps*: evidence of matrotrophy? Submitted to Deepsea Research II

Churchill, D, MR Heithaus, JJ Vaudo, RD Grubbs, and JI Castro. In review. Trophic interactions of common elasmobranchs in deep-sea communities of the Gulf of Mexico revealed through stable isotope and stomach contents analysis. Submitted to Deep Sea Research II

Other manuscripts:

White, W T, D A Ebert, G J P Naylor, H Ho, P Clerkin, A Verissimo, C Cotton. In review. Revision of the genus *Centrophorus* (Squaliformes: Centrophoridae): Part 1 – Redescription of *Centrophorus granulosus* (Bloch & Schneider), a senior synonym of *C. acus* Garman and *C. niaukang* Teng

Moura, T, E Jones, C F Cotton, S B Irvine, R K. Daley, M W Clarke, P Lorance, K Jakobsdottir, L J López-Abellán, P Crozier, G Diez, I Fossen, J E Dyb, R B Severino, P Pascual-Alayón, H Dobby, I Figueiredo. In prep. Large- scale distribution of three deep-water Squaliforms integrating data on sex, maturity and environment.

Veríssimo A, Cotton C, Burgess G, Buch R, Guallart J, Gailbraith J. In prep. A revision of the gulper sharks (genus *Centrophorus*) in North Atlantic waters

Grubbs RD, J Gelsleichter, M Heithaus, K Gastrich, C Cotton. In. prep. Community structure of deep demersal fishes in the northeastern Gulf of Mexico. To be submitted summer 2013

Gelsleichter J, AE Leary, RD Grubbs, ME Heithaus. Multibiomarker assessment of PAH exposure and effects in deepwater fish populations impacted by the Deepwater Horizon Oil Spill. To be submitted summer 2013

5) Presentations and posters, if planned (Please provide copies of each) (Note: a special section will focus on student presentations)

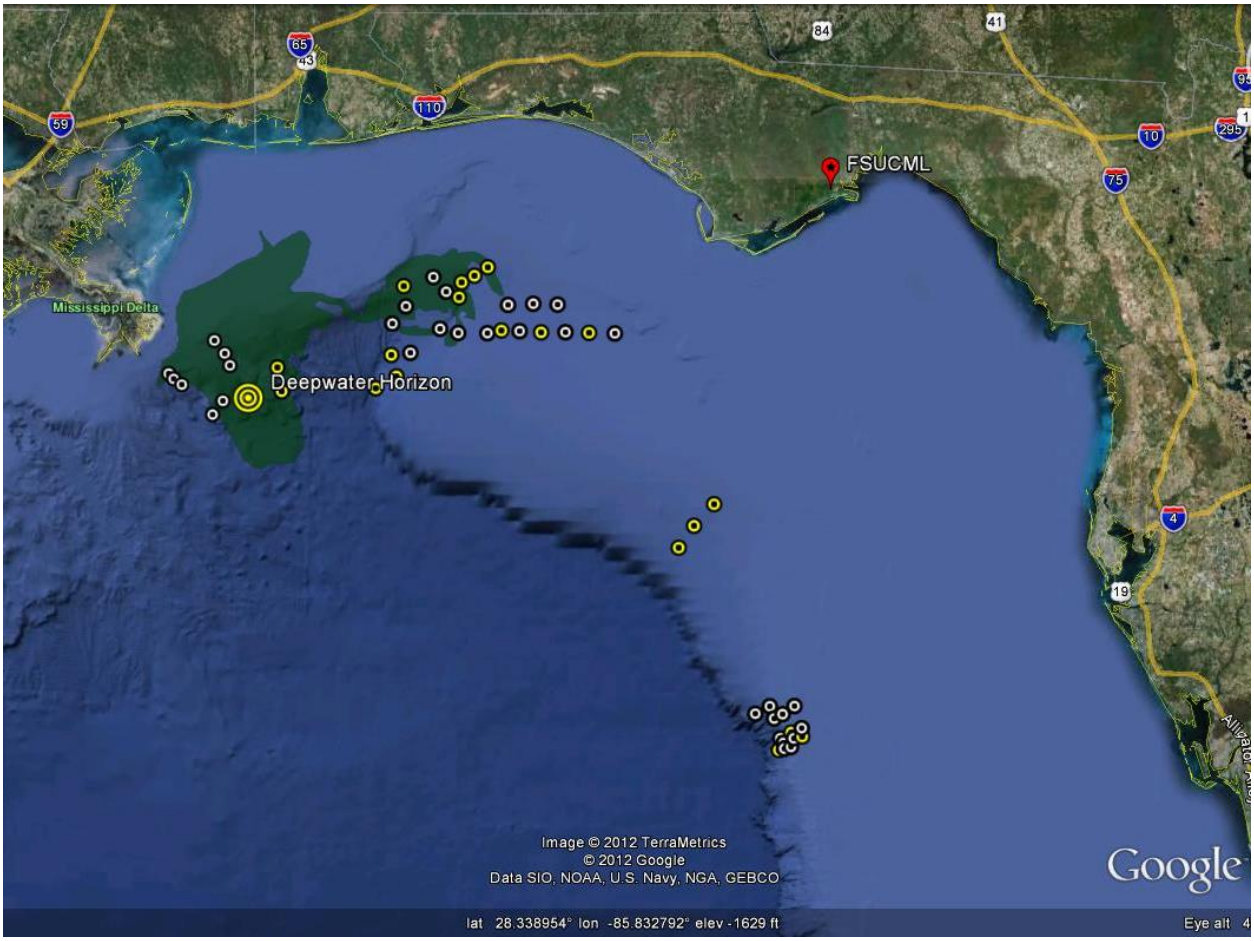
Title	**Presenter**	**Authors**	**Meeting or Audience**	**Abstract published (Y/N)**	**Date**
Community Structure of Deep Demersal Fishes from Desoto Canyon and Adjacent Habitats of the Eastern Gulf Of Mexico After Deepwater Horizon	Grubbs, RD	Grubbs, RD, F Coleman, C Koenig, J Gelsleichter, M Heithaus, C Cotton	Gulf of Mexico Oil Spill and Ecosystem Science Conference	N	20-22 January 2013
Effects of the Deepwater Horizon Oil Spill on Deepwater Fish Populations from the Northeast Gulf of Mexico.	J. Gelsleichter	Gelsleichter, J, AE Leary, M Heithaus, RD Grubbs	Gulf of Mexico Oil Spill and Ecosystem Science Conference	N	20-22 January 2013
Invited presentation: Movements and trophic ecology of deepwater sharks associated with DeSoto Canyon and the adjacent continental slope	Grubbs, RD	Grubbs, RD, M Heithaus, D Churchill, J Gelsleichter, F Coleman, C Koenig	Gulf Fisheries Symposium, St. Petersburg, FL	N	14-15 September 2012
Demersal fish assemblages associated with DeSoto Canyon and the adjacent continental slope.	Grubbs, RD	Grubbs, RD, J Gelsleichter, M Heithaus, F Coleman, C Koenig	Deep-C Consortium “All Hands” Meeting., Tallahassee, FL	N	21-22 August 2012
Effects of the Deepwater Horizon Oil Spill on deepwater shark populations from the northeast Gulf of Mexico.	Gelsleichter, J	Gelsleichter, J, D Grubbs, M Heithaus, A Leary, A Piercy	Deep-C Consortium “All Hands” Meeting., Tallahassee, FL	N	21-22 August 2012
Effects of the Deepwater Horizon Spill on the trophic interactions of deep-sea sharks and associated species of the Gulf of Mexico.	Churchill D	Churchill, D, M Heithaus, D Grubbs, J Vaudo	Annual Meeting of the American Elasmobranch Society, Vancouver, BC	Y	8-13 August 2012
Effects of the Deepwater Horizon Oil Spill on	Gelsleichter, J	Gelsleichter, J, D Grubbs, M	Annual Meeting of the American	Y	8-13 August 2012

deepwater shark populations from the northeast Gulf of Mexico.		Heithaus, A Leary, A Piercy	Elasmobranch Society, Vancouver, BC		
Demersal Elasmobranch Assemblages associated with Desoto Canyon and the Continental Slope of the Eastern Gulf of Mexico relative to the Deepwater Horizon Oil Spill	Grubbs, RD	Grubbs RD, J Gelsleichter, M Heithaus, K Gastrich, C Cotton.	Annual Meeting of the American Elasmobranch Society, Vancouver, BC	Y	8-13 August 2012
Reproduction and embryonic development in two species of North Atlantic squaliform sharks, *Centrophorus* cf. *niaukang* and *Etmopterus princeps*: evidence of matrotrophy?	Cotton, C	Cotton, C, D Grubbs, J Musick	Annual Meeting of the American Elasmobranch Society, Vancouver, BC	Y	8-13 August 2012
Vertical movements, residency and post-release survival of Bluntnose Sixgill Sharks (*Hexanchus griseus*) in the central Pacific and western north Atlantic.	Grubbs, RD	Grubbs, RD	Cowshark Conservation Workshop V., Seattle, WA.	N	29 April 2012
Demersal fish assemblages associated with Desoto Canyon and the continental slope of the eastern Gulf of Mexico relative to the Deepwater Horizon oil spill	Grubbs, RD	Grubbs, RD, J Gelsleichter, M Heithaus, K Gastrich, C Cotton	Annual Ocean Sciences Meeting, Salt Lake City, UT	Y	20-24 February 2012
Effects of the Deepwater Horizon Oil Spill on Deepwater Fish Populations from the Northeast Gulf of Mexico	Gelsleichter, J	Gelsleichter, J, A Leary, H Drakos, M Davis, M Gonzalez de Acevedo, M McCallister, R Ford, M Heithaus, RD Grubbs	Southern Division of the American Fisheries Society, Biloxi, MS	y	26-29 January 2012

6) Other products or deliverables

Please list (for example: maps, models, tools) and indicate where they can be located/obtained.

FIO_Grubbs_Heithaus_Fishes_List_with_Images.pdf



Primary sampling sites

7) Data

Please provide a spreadsheet indicating the metadata and ancillary information on the location and status of the archived samples. Also, indicate if there are any issues with respect to data archiving schedule and plan. If you have a lot of metadata, representative samples will suffice. This will all be incorporated into the GoMRI database at some point in the future.

Metadata for data collected and an example data sheet are provided in the file:
FSUCML_DeepC_DataSheet

These data are being provided to the GoMRI database as related to the Deep-C Consortium.

PARTICIPANTS AND COLLABORATORS

8) Project participants

Please list the participants of your project, their role(s) and contact information. No personal information will be released.* ***Note: Student/educational information will be collected elsewhere in this report****.*

** We understand one person may fulfill more than one role; please list all applicable roles using the following standardized titles: Principal Investigator, Co-Principal Investigator, Scientific Participant, Technician, Lab Assistant, Administrative Support.*

First Name	Last Name	Role in Project	Institution	Email	Gender	Race	Citizenship
Dean	Grubbs	Principal Investigator	FSU	dgrubbs@bio.fsu.edu	M	W	US
James	Gelelsichter	Co-Principal Investigator	UNF	jgelsleichter@unf.edu	M	Other	US
Mike	Heithaus	Principal Investigator	FIU	Heithaus@fiu.edu	M	W	US
Charles	Cotton	Scientific Participant	VIMS	chip@vims.edu	M	W	US
Kirk	Gastrich	Scientific Participant	FIU	kgastrich@fiu.edu	M	W	US
Emily	Warchol	Scientific Participant	U of Florida	ewarchol@flmnh.ufl.edu	F	W	US
Willy	Bemis	Scientific Participant	Shoals Marine Lab	wbemis@bio.umass.edu	M	W	US
Ale	Mickle	Technician	FSU	Am05k@fsu.edu	F	Hispanic	US/Peru
Annabelle	Brooks	Scientific Participant	Cape Eleuthera Institute	annabellebrooks@ceibahamas.org	F	Italian	UK

MENTORING AND TRAINING

9) Student and post-doctoral participants

Please list the student participants of your project, their educational role, and other information. No personal information will be released.

First Name	Last Name	Post-doc / PhD / MS / BS	Thesis or research topic	Institution	Supervisor	Expected Completion year	Gender	Race	Citizenship
Jeremy	Vaudo	Post-doc		FIU	Heithaus		M	W	US
Diana	Churchill	MS		FIU	Heithaus		F	W	US
Matthew	Kolmann	MS		FSU	Grubbs	August 2012	M	W	US
Mike	McCallister	MS		UNF	Gelsleichter	August 2012	M	W	US
Kristine	Parsons	PHD		VIMS	Latour		F	W	US
Rachel	Decker	MS		FIU	Heithaus		F	W	US
Kier	Smith	MS		FAU	Kajiura		M	W	US
Derek	Burkholder	PHD		FIU	Heithaus		M	W	US
Lisa	Hollensead	MS		FSU	Grubbs	July 2012	F	W	US
Travis	Richards	MS		FSU	Grubbs		M	W	US
Shomen	Mukherjee	Post-doc		FIU	Heithaus		M	Other	
Robin	Sarabia	MS		FIU	Heithaus		F	W	US
Ryan	Ford	MS		UNF	Gelsleichter	August 2012	M	W	US
Cheston	Peterson	MS		FSU	Grubbs	August 2013	M	W	US
Johanna	Imhoff	PHD		FSU	Grubbs	May 2017	F	W	US
Allison	Strong	MS		FSU	Grubbs	May 2015	F	W	US
Brenda	Anderson	MS		UNF	Gelsleichter	May 2013	F	W	US
Arianne	Leary	BS		UNF	Gelsleichter	May 2012	F	W	US
Monica	Collazos	BS		UNF	Gelsleichter	May 2013	F		

Melissa	Gonzalez De Acevedo	BS		UNF	Gelsleichter	May 2012			
Hilary	Drakos	BS		UNF	Gelsleichter	May 2012			

10) Student and post-doctoral publications, if planned
   a. Published, peer-reviewed bibliography (Copies of the papers are requested)
   b. Manuscripts submitted or in preparation (Please note target journal, and anticipated date of submission or publication)

In Review

Churchill, D., M. R. Heithaus, Jeremy J. Vaudo, D. R. Grubbs, and J. I. Castro. In review. Trophic interactions of common elasmobranchs in deep-sea communities of the Gulf of Mexico revealed through stable isotope and stomach contents analysis. Deep Sea Research II

Giresi, M M, R D Grubbs, D S Portnoy, J R Gold. Submitted. A Morphological Key to Distinguish Among Smoothhound Sharks (Genus *Mustelus*) in the Gulf of Mexico. Proceedings of the Gulf and Caribbean Fisheries Institute.

In preparation

Churchill, D., M. R. Heithaus, Kirk Gastrich, and D. R. Grubbs. Spatial and temporal variation in trophic interactions in deep water communities in the Gulf of Mexico. Target Journal: Marine Ecology Progress Series

Churchill, D., M. R. Heithaus, Kirk Gastrich, and D. R. Grubbs. Variation in trophic position of common large-bodied scavengers in deep sea habitats of the Gulf of Mexico.

11) Student and post-doctoral presentations and posters, if planned (Please provide copies of each)

Title	**Presenter**	**Authors**	**Meeting or Audience**	**Abstract published (Y/N)**	**Date**
Effects of the Deepwater Horizon Spill on the trophic interactions of deep-sea sharks and associated species of the Gulf of Mexico.	Churchill D	Churchill, D, M Heithaus, RD Grubbs	American Elasmobranch Society	Y	July 2012

12) Images

Please attach high-resolution images and provide details including a description of the image, location, credit, date, etc. Of note: Image may be used in FIO or GoMRI promotions, so please make sure you have rights to use the image.

This project generated thousands of images at sea. Dr. Mike Heithaus provided high resolution images from this work in his report. I provided some additional images in two pdf files (listed below). High-resolution versions of these and many others are available upon request.

Images of most captured species are provided in the file:
FIO_Grubbs_Heithaus_Fishes_List_with_Images.pdf

Images from on-deck are contained in the file At_sea_images_for_FIO.pdf

13) Continuing Research

If you are continuing this research under another grant, please include granting authority and title of award and a very brief synopsis (2-3 sentences).

Florida State University is the lead institution on the DEEP-C Consortium (Deepsea to Coast Connectivity in the Eastern Gulf of Mexico) supported by grant from Gulf of Mexico Research Initiative. Our work continues as a primary component of Deep-C. As part of Deep-C, UNF is also subcontracted to conduct biomarker assays on fishes collected throughout the northeast Gulf as part of a 3-year follow-up study on the impacts of the Deepwater Horizon Oil Spill. Data from the current study will be compared to results from this future work. Work conducted with Deep-C will also fuel continuation of some components of the FIO-supported study led by FIU. Heithaus (FIU) and Grubbs (FSU) intend to seek funds to support continuation of components that are not supported by Deep-C.