NOVA SOUTHEASTERN UNIVERSITY OCEANOGRAPHIC CENTER AND UNIVERSITY OF NORTH FLORIDA: Trophic Dynamics and Ecosystem Changes within the SE Florida Coastal Pelagic Fish Community

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SCIENCE ACTIVITIES

1) General Summary

Narrative (1 pages maximum): Please provide a brief overview of the project and goals supported during the conduct of this project. Be sure to highlight any 'lessons learned' that could be applied to other/future oil spill related projects (e.g., management, data support, logistics, etc.). Listing accomplishments against project activities, objectives and milestones in bulleted form is acceptable.

The coastal pelagic complex is the name given to the group of fishes spatially located in the waters over the continental shelf extending to the shelf edge. These fishes include members of the Scombridae and Coryphaenidae families. The coastal pelagic area is simply described as the ecotone between the mixed coastal waters of the continental shelf and the oligotrophic pelagic waters associated with the shelf edge and offshore. The Southeast Florida waters are unique in that the continental shelf is extremely close to the coastline, allowing a multitude of species to inhabit and interact within the coastal pelagic ecosystem. Understanding the interconnectedness of inshore and offshore fishes within the southeast Florida shelf is vital for assessing and predicting the effects of the British Petroleum Deepwater Horizon (DwHOS) event effluent. The narrow continental shelf allows for rapid transport of offshore contaminants into inshore environments from the likely transport mechanism of DwHOS oil and dispersant (OD) contaminants from the northeastern Gulf of Mexico through the Loop and Florida Currents.

We conducted fisheries dependent and independent sampling at approximately three-week intervals or less across the width of the southeast Florida shelf to establish a baseline understanding of the coastal pelagic ecosystem in order to detect ecosystem shifts, which can then be used in turn to assess changes in community structure from anthropogenic sources. Stomach content analysis was used to determine predator-prey interactions, with additional analyses of nitrogen stable isotope ratios to determine trophic level and carbon stable isotope ratios to trace carbon sources in the diet of these coastal pelagic fishes. The samples were also used to trace exposure and effects of exposure to polycyclic aromatic hydrocarbons (PAHs). The potential toxicological effects of the DwHOS event on coastal pelagic fishes in the Florida Straits were assessed by conducting laboratory-based assays for the cytochrome P4501A1, biliary fluorescent aromatic compounds, and PAH-DNA adduct biomarkers. These combined trophic and ecotoxicity results provide important information for assessing policy options for the coastal pelagic fisheries resources of the Florida Straits.

2) Results and scientific highlights

Narrative (2 pages maximum): This should be a summary of significant results (positive and negative) and conclusions during the conduct of this project. Listing science results and highlights in bulleted form is acceptable. In each case, please explain the impact of the result.

Completed trophic dynamics work: The trophic dynamics component of this project examined the diets and trophic positioning (via stable isotope ratios) of a suite of coastal pelagic fishes, including dolphinfish *Coryphaena hippurus* (n=99), little tunny *Euthunnus alleteratus* (n=212), skipjack *Katsuwomus pelamis* (n=38), blackfin tuna *Thunnus atlanticus* (n=173), albacore *Thunnus alalunga* (n=7), Atlantic bonito *Sarda sarda* (n=8), wahoo *Acanthocybium solandri* (n=25), Spanish mackerel *Scomberomorus maculatus* (n=8), cero mackerel *Scomberomorus regalis* (n=2), king mackerel *Scomberomorus cavalla* (n=203), and greater amberjack *Seriola dumerili* (n=9).

Samples for this project were collected via fishing tournaments and individual angler donations from Southeast Florida from 2010 through 2012. Upon collection of the individual fish, the following samples were taken and archived: muscle, liver, stomach, gonad, and otoliths. Where possible, blood and bone samples were also taken and archived.

Stomachs were tagged, archived, and fixed in 10% formalin for ≥ 7 days, then transferred to a 70% ethanol. Any identifiable material (scales, fins, etc.) was recorded, measured, and weighed. The identifiable material present in each stomach is used to identify prey items to the lowest possible taxonomic level. Identifiable bait items and empty stomachs are not included in the results. Quantitative Indices of analysis used both Frequency of Occurrence (%O) and Percent Composition by Number (%N). For stable isotope analyses, The muscle tissue samples are collected from the dorsal musculature of each fish, placed on ice, then frozen at -80 °C. A clean portion of the muscle tissue is cut up into small 3-5mm2 pieces and placed on a drying tin. The tins are placed in a 60°C oven for 48hr to 1 week, to dry the samples. The dried muscle tissue is pulverized to homogenize the sample into a powder-like consistency. The δ13C values are used to determine dietary assimilation of the prey items and indicate spatial variation and geographic range based on prey assimilation, while the δ15N values are used to determine the trophic position of the predator species.

Carangidae (scads), Clupeidae (herrings), and Exocoetidae (flying fish) were the most frequently occurring prey item found in the stomachs of all the species except wahoo. Ommastrephidae (squids) were the most common prey item in wahoo stomachs. The blackfin tuna exhibited the most diversity with prey items ranging from small teleosts to invertebrates and other marine flora (e.g., *Sargassum* sp.). The different groupings of δ13C and δ15N values supports the diverse diet and indicates that blackfin may function in multiple trophic levels. King mackerel exhibited a diet with the highest percentage (62%) of teleost materials present in the stomachs. The grouping and higher δ15N values (comparatively) suggest a higher trophic position compared to the rest of the coastal pelagic complex. Wahoo showed a diet with only squid present in the stomachs and no teleost. However, these those findings are potentially a result of sample size; evaluations of statistical power are ongoing. Wahoo δ15N values suggest a lower trophic position compared to the rest of this coastal pelagic complex. **No changes in trophic positions or diet compositions were seen between years for any of these species.**

Completed biomarker work: This biomarker component of this project examined exposure of pelagic teleosts from Florida's south Atlantic coast to polycyclic aromatic hydrocarbons (PAHs), the most toxic constituents of petroleum, in order to assess the potential impacts of the Deepwater Horizon oil spill on these commercially and recreationally important species. Since initial concerns regarding the potential

transport of DwHOS oil to the Atlantic coast appear largely unrealized, the data obtained in this project provide researchers with a reconnaissance of pollutant exposure and effects in fish from the southeastern U.S. coast. These values may also be useful for comparison with data from pelagic fish sampled from areas on the Gulf coast that were impacted by the DwHOS.

UNF personnel examined activity of cytochrome P4501A1 (Cyp1A1), a key enzyme that is involved in the metabolism of PAHs and is generally induced when fish are exposed to elevated concentrations of these compounds, in liver samples from pelagic teleosts that were captured in recreational fishing tournaments and necropsied by NSU researchers. Initial plans to perform three additional PAH biomarker tests (i.e., measurements of biliary PAH metabolites, levels of covalent associations between potentially carcinogenic PAH metabolites and DNA, and occurrence of micronuclei in fish erythrocytes) were put on hold due to the lack of appropriate samples for conducting these assays (i.e., bile, blood smears). However, samples for conducting additional biomarker assays in sampled individuals have been archived for future analysis.

To date, UNF personnel have examined hepatic Cyp1A1 activity in a total of 128 teleosts from Florida's south Atlantic coast. This includes the following: 47 king mackerel, 24 blackfin tuna, 21 little tunny, 11 swordfish, 9 wahoo, 9 skipjack tuna, and 7 dolphinfish. Samples from additional fish have recently been provided to UNF and will be analyzed in the near future. Samples were homogenized at a 1:5 ratio in homogenization buffer (10 mM Tris, 250 mM sucrose, 1 mM EDTA, 0.2 mM dithiotreitol, 0.1 mM PMSF, pH 7.4) using a bead homogenizer. Homogenates were clarified by centrifugation twice (8,000g for 10 min, followed by 12,000g for 20 min, both at 4°C), producing a S9 fraction. S9 fractions were analyzed for protein concentration via the Bradford assay and Cyp1a1 via the microplate EROD assay described in Sepulveda et al. (2004). All samples were measured in triplicate, and positive Cyp1a1 readings were confirmed by follow-up analysis.

In general, teleosts examined in this study exhibited low, but measurable levels of Cyp1a1 activity, i.e., mean levels of EROD activity ranged from ~0.1 to 2 pmol resorufin/min/mg protein in all species that were examined. Furthermore, although there were species-specific differences in Cyp1a1 activity (e.g., levels in king mackerel and blackfin tuna were notably greater than those observed in most other species), **none** of the 128 samples tested exhibited levels that were greater than those observed in fish from non-impacted sites that have been measured in previous studies using the same procedure; e.g., a previous study on largemouth bass from Florida reported mean EROD activity values ranging from ~2-8 pmol resorufin/min/mg protein in fish from reference locations (Sepulveda et al., 2004). Therefore, data on Cyp1a1 activity suggest that pelagic teleosts examined in the present study have experienced minimal exposure to Cyp1a1-inducing compounds, such as PAHs, polychlorinated dibenzodioxins, and coplanar polychlorinated biphenyls.

Species	EROD Mean	Range	Sample size
Thunnus atlanticus	2.06	0.00 - 4.86	24
Katsuwonus pelamis	1.64	0.00 - 2.88	9
Euthynnus alletteratus	0.35	0.00 - 3.04	21
Scomberomorus cavalla	1.46	0.00 - 6.09	47
Coryphaena hippurus	0.41	0.00 - 1.42	7
Acanthocybium solandri	0.8	0.00 - 0.33	9
Xiphias gladius	0.44	0.00 - 1.45	11

3) Cruises & field expeditions

Ship or Platform Name	**Class** (if applicable)	**Chief Scientist**	**Objectives**	**Dates**
[none conducted specifically for this project]				

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

Gelsleichter J, Leary A, Long MC, Piercy AN, Hueter RE, and Kerstetter DW. Multibiomarker assessment of PAH exposure and effects in epipelagic fishes from the northern Gulf of Mexico. To be submitted to a toxicology-themed journal such as *Aquatic Toxicology*, *Marine Environmental Research*, *Chemosphere*, or *Science of the Total Environment* before May 2013.

Moore T, A Hirons, J Gelsleichter, and DW Kerstetter. Trophic dynamics of the Southeast Florida, USA coastal pelagic fish complex. To be submitted to a fisheries/ecology-themed journal such as *Fisheries Management and Ecology*, *Fish and Fisheries*, or *Marine and Freshwater Research*, or to a higher-tier journal such as *Marine Biology* before August 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**
[none listed – all presentations were done with students]					

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

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.

Lists of samples have been provided previously per FIO requests, although updated lists can be provided at any time. All of the tissue samples from the specimens noted above in the narrative are archived in -80 ˚C conditions at the NSU Oceanographic Center, with the

exception of the gonads, which are stored in NB 10% formalin at the NSU Oceanographic Center Fisheries Laboratory.

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
James	Gelsleichter	Co-Principal Investigator	University of North Florida	jim.gelsleichter@unf.edu
David	Kerstetter	Co-Principal Investigator	Nova Southeastern University	kerstett@nova.edu

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
Travis	Moore	MS	Coastal pelagic fish trophic ecology	NSU	D. Kerstetter	August 2013
Andrew	Piercy	Post-doc	PAH effects in Atlantic fishes	UNF	J. Gelsleichter	August 2012
Arianne	Leary	BS	Laboratory analysis	UNF	J. Gelsleichter	May 2012
Matthew	Long	BS	Laboratory analysis	UNF	J. Gelsleichter	May 2013

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)

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
Trophic dynamics of the Southeast Florida, USA coastal pelagic fish complex (poster)	T. Moore	T. Moore and D.W. Kerstetter	Gulf of Mexico Oil Spill and Ecosystem Science Conference	N	January 2013
Effects of the Deepwater Horizon oil spill on epipelagic fish populations in the northeast Gulf of Mexico (poster)	C. Long	C. Long, A. Leary, R.E. Hueter, D. Kerstetter and J. Gelsleichter	Gulf of Mexico Oil Spill and Ecosystem Science Conference	N	January 2013
Trophic dynamics of the Southeast Florida, USA coastal pelagic fish complex (poster)	T. Moore	T. Moore and D.W. Kerstetter	63rd Annual Tuna and Billfish Conference	N	May 2012
Trophic dynamics and ecosystem changes within the SE Florida coastal pelagic fish complex (oral)	T. Moore	T. Moore and D.W. Kerstetter	32nd Annual Meeting of the Florida Chapter of the American Fisheries Society	N	February 2012
Trophic dynamics and ecosystem changes within the SE Florida coastal pelagic fish community (poster)	T. Moore	T. Moore and D.W. Kerstetter	62nd Annual Tuna and Billfish Conference	N	May 2011
Assessment of Exposure to Cytochrome P4501a1-inducing Pollutants in Pelagic Fishes from the Western North Atlantic and Gulf of Mexico through Analysis of Liver EROD Activity (oral).	A.N. Piercy	A. Piercy, J. Gelsleichter, M. McCallister, D. Kerstetter, and R.E. Hueter	2012 meeting of the Southern Division of the American Fisheries Society, Biloxi, MS.	N	January 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.

Photo of NSU Oceanographic Center masters student Travis Moore (yellow shirt) collecting tissue samples from albacore at the Yamaha Contender Miami Billfish Tournament in Miami Beach, FL (April 2011).

Photo of NSU Oceanographic Center co-Principal Investigator David Kerstetter collecting tissue samples from dolphinfish at the NSU Oceanographic Center Scholarship Fishing Tournament on Duck Key, FL (November 2011).

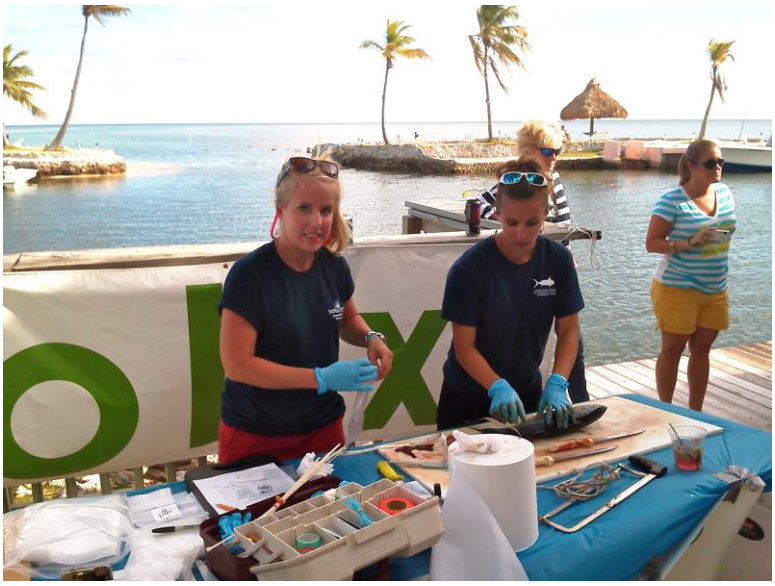

Photo of NSU Oceanographic Center masters students Lacie Carter (left) and Jessy Adams (right) collecting tissue samples from a little tunny at the Mad Dog Mandich Fishing Tournament in Islamorada, FL (October 2012).

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).

NSU is not continuing this work under other funding, although biological samples (muscle, liver, gonad, otoliths) are continuing to be collected opportunistically from all of the coastal pelagic species in this study. All samples in this continuing collection will be archived using the same methodologies listed above.

UNF is currently 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. This work is supported by grant from Gulf of Mexico Research Initiative to Florida State University (DEEP-C: Deep-sea to Coast Connectivity in the Eastern Gulf of Mexico). Data from the current study will be compared to results from this future work.