UNIVERSITY OF WEST FLORIDA: ACUTE EFFECTS OF OIL ON NORTHERN GULF OF MEXICO REEFS AND REEF COMMUNITIES

Dr. William F. Patterson III, University of West Florida
Dr. Charles H. Jagoe, Florida Agricultural and Mechanical University

SCIENCE ACTIVITIES

1) General Summary

The overall goal of this study was to examine acute effects of the Deepwater Horizon Oil Spill (DHOS) on reef fishes at a series of natural reefs (n = 16) on the northern Gulf of Mexico (Gulf) continental shelf. Specific objectives included sampling reef fish communities with a micro remotely operated vehicle (ROV) to test for differences in fish community structure between pre- versus post-spill time periods; examining reef fish bile and liver samples for the presence of metabolites or enzyme activity indicative of exposure to polycyclic aromatic hydrocarbons (PAHs); examining age and growth via analysis of otolith microstructure to determine if the DHOS had a significant effect on fish size at age; and, examining stomach contents and muscle stable isotope ratios ($\delta^{13}C$, $\delta^{15}N$, and $\delta^{34}S$) to test if the DHOS affected reef fish trophic ecology.

Project personnel, along with numerous volunteers, participated in 34 sampling cruises between fall 2010 and spring 2012 to meet project objectives. Ninety-nine video samples were collected at study reefs, with 37,925 fish observed among 86 taxa (95.3% to species) in those samples. Fish tissue samples also were collected from 721 individuals among 53 fish species, with 575 liver samples analyzed for enzyme activity and 331 muscle tissue samples analyzed for C, N, and S stable isotopes.

Liver enzyme data indicated a higher prevalence of PAH exposure among fish sampled south of Alabama versus farther to the east in fall 2010 and winter 2011; however, high enzyme activities dissipated after winter 2011. There were significant difference in reef fish community and trophic structure (PERMANOVA, $p < 0.001$) after versus before the DHOS. Groups showing the greatest percent declines (many by 100%) included small demersal planktivores, such as damselfishes and cardinalfishes. However, abundances of larger reef fishes, such as red snapper, vermilion snapper, gray triggerfish, and groupers, also were lower after the spill. Stable isotope data indicate trophic shifts occurred within species following the DHOS. For example, red snapper and tomtate relied more on benthic versus pelagic production (lower $\delta^{34}S$ values) but fed at higher trophic levels (higher $\delta^{15}N$) following the spill.

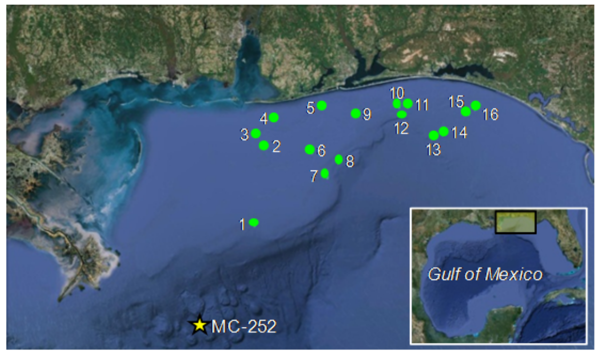
Overall, project results indicate the DHOS had a significant impact on reef fishes in the northern Gulf. Ongoing research is being conducted to examine the chronic versus acute nature of this event with respect to reef fish community and trophic structure. Results of this study confirm the utility of multi-disciplinary approaches to examine oil spill effects on fish communities, and they are as critical to examining potential long-term impacts of the spill as are the pre-spill data we collected on reef fish communities prior to the DHOS. Another lesson learned is that cooperative research can be effectively employed to examine oil spill effects. Many researchers competed for shiptime in the months following the spill, but we were able to bypass that given we conducted all sampling onboard chartered fishing vessels. This reduced costs and made our sampling team more nimble, while at the same time alleviating potential strain on research vessel resources in the Gulf.

2) Results and scientific highlights

Natural reef sites (n = 16; Table 1 and Figure 1) were sampled quarterly from fall 2010 through spring 2012 to examine differences in reef fish community and trophic structure before versus after the DHOS. Orthogonal transects were sampled with a micro ROV for a total area sampled of ~1,000 m^2 at each site. Fish were then sampled with hook and line to obtain tissue samples for a variety of purposes. Stomach samples were extracted to examine fish diet. Muscle tissue samples were extracted and analyzed with stable isotope ratio-mass spectrometry for $\delta^{13}C$, $\delta^{15}N$, and $\delta^{34}S$ stable isotopes. Otoliths were removed for age and growth analysis. Lastly, liver and bile were sampled to test for enzyme activity or bile metabolites indicative of exposure to polycyclic aromatic hydrocarbons (PAHs).

Table 1 and Figure 1. Natural reef sites sampled during 2010-2012 to examine reef fish community and trophic structure, as well as exposure to PAHs.

Number	Site	Lat	Long	Depth m
1	**Mobile Edge**	**29 24N**	**87 57W**	**81**
2	Natural Bottom West	29 55N	87 53W	32
3	**SE Banks**	**30 00N**	**87 57W**	**24**
4	Tree Bottom	30 06N	87 48W	18
5	**Green's Hole**	**30 08N**	**87 10W**	**34**
6	Trysler Grounds	29 53N	87 31W	40
7	**Yellow Gravel**	**29 43N**	**87 24W**	**59**
8	The Edge	29 49N	87 19W	65
9	**Dutch Banks**	**30 11N**	**87 26W**	**22**
10	AJ Rock	30 11N	86 51W	33
11	**Nikki Grounds**	**30 11N**	**86 47W**	**31**
12	Destin Edge 2	30 07N	86 52W	55
13	**Destin Edge 1**	**30 07N**	**86 49W**	**57**
14	Mingo Ridge	29 59N	86 34W	61
15	**Natural Bottom East**	**30 08N**	**86 19W**	**36**
16	Good Rock	30 10N	86 16W	32



Project personnel included 5 M.S. and 1 Ph.D. student, in addition to the PIs (see Table in section 9), who participated in 34 sampling cruises (see Table in section 3) between fall 2010 and spring 2012 to meet project objectives. Most sampling was conducted onboard chartered fishing vessels; however, project personnel also participated on two research cruises conducted onboard Florida Institute of Oceanography ships to expand the diversity of species sampled. In total, 99 video samples were conducted at study reefs, with 37,925 fish observed among 86 taxa (95.3% of taxa to species). Tissue samples also were collected from 721 individuals among 53 fish species, with 575 liver samples analyzed for enzyme activity and 331 muscle tissue samples analyzed for C, N, and S stable isotopes.

There were significant difference in reef fish community and trophic structure (PERMANOVA, $p < 0.001$) after versus before (Patterson et al. 2011) the DHOS. Groups showing the greatest percent declines (many by 100%) included small demersal planktivores, such as damselfishes and cardinalfishes. However, abundances of larger reef fishes, such as red snapper, vermilion snapper, gray triggerfish, and groupers, also were lower after the spill. Stable isotope data indicate trophic shifts occurred within species following the DHOS. For example, red snapper and tomtate relied more on benthic versus pelagic production (lower $\delta^{34}S$ values) but fed at higher trophic levels (higher $\delta^{15}N$) following the spill.

Bile and liver samples were analyzed for bile fluorescence and enzymatic biomarkers indicative of oil exposure. We assayed three enzymes induced by exposure to petroleum hydrocarbons: ethoxyresorufin-o-dethylase (EROD, a marker for cytochrome p450-1A activity), glutathione-S-transferase (GST), and superoxide dismutase (SOD). EROD is a marker for cytochrome p450-1A activity. EROD and GST are key enzymes in the phase 1 and phase 2 metabolic pathways responsible for the processing and excretion of toxic organic compounds including PAHs and other hydrocarbons. SOD is instrumental in detoxifying reactive oxygen species that are generated by exposure to PAHs and other petroleum components. A number of previous studies have shown that these enzymes are up-regulated in response to exposure to oil and PAHs. Metabolized PAHs can be excreted in bile, so measurement of these metabolites by GC-MS or fluorescence methods also provides evidence of oil exposure.

Liver and bile samples were frozen on dry ice, and stored at -80C until analysis. Bile samples were diluted 500-2000 fold in 48% methanol and fluorescence measured at 290 nm excitation/335nm emission for the determination of naphthalene metabolites (Aas et al. 2000). For enzyme analyses, 50-100mg of sample (wet weight) was homogenized in cold Tris-DTT-glycerol buffer, centrifuged at 10000g, and the supernatant (S9 fraction) used for enzyme analyses. EROD was assayed by following the formation of resorufin from ethoxyresorufin by fluorometry, using minor modifications of published methods (Eggens and Galgani 1992; Vehniainen et al. 2012). GST was measured using the conjugation of 1-chloro-2,4,dinitrobenzene (CDNB) to glutathione, which produces a colored product that can be detected by spectroscopy (Habig et al. 1974). SOD was determined by measuring the inhibition of the reaction of a tetarazolium dye (WST-1) with superoxide anions produced by the xanthine/xanthene oxidase reaction using kits purchased from Sigma-Aldrich. All assays were performed in triplicate in 96-well plates in multimode plate readers. Enzyme activities were normalized to protein concentrations in the s9 fractions; protein concentrations were measured by spectroscopy (Bradford 1976).

Liver samples (n=575) were analyzed from 40 fish species. Six species were represented by 20 or more individuals, allowing assessment of spatial and temporal trends. EROD activity was detectable in approximately 80% of the individuals, and SOD and GST were detectable in 99%. EROD, GST and SOD appeared to vary among species, although this assessment is difficult because not all species were collected at each sampling event or location. However, activities of all three enzymes were generally highest in gray triggerfish, and lowest in red and vermillion snappers.

Distribution of EROD and bile fluorescence suggested that high values for these biomarkers were more common immediately following the oil spill in summer and fall 2010. Median values for EROD activity, expressed as pmols of resorufin produced per minute per mg protein, also were highest in summer and fall 2010 (64 and 80 pmol min^{-1} mg $protein^{-1}$, respectively) compared to winter, spring and summer 2011 (19, 7 and 13 pmol min^{-1} mg $protein^{-1}$, respectively), with all species and locations pooled. GST and SOD activities did not show a similar pattern. Median GST activity was highest in summer 2011 at the end of our sampling period (195 nmols of CNDB conjugated per minute per mg protein), compared to a median activity of 92 nmols min^{-1} mg $protein^{-1}$ during and immediately after the spill in the summer of 2010. Median SOD activity declined from 8.6 units mg $protein^{-1}$ in the summer of 2010 to 2.1 units mg $protein^{-1}$ in the winter of 2010-2011, then increased again in the summer of 2011 (median 17.4 units mg $protein^{-1}$), possibly reflecting a seasonal or temperature effect. GST and SOD activities were weakly correlated (Spearman's correlation coefficient = 0.37, with all locations and species pooled), but EROD and bile fluorescence were not correlated with SOD or GST. The EROD and bile fluorescence values support the idea that some reef fish in the area were exposed to PAHs and/or other oil hydrocarbons in the months following the oil spill. Additional analyses of bile and liver PAH concentrations are underway to better understand and document these exposures.

References:

Aas, E., Beyer, J. and A. Goksoyr. 2000. Fixed wavelength fluorescence (FF) of bile as a monitoring tool for polyaromatic hydrocarbon exposure in fish: and evaluation of compound specificity, inner filter effect and signal interpretation. Biomarkers 5:9-23.

Bradford, M.M. 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein using the principle of protein dye binding. Anal. Biochem. 72:248-254.

Eggens, M.L. and Galgani, F. 1992. Ethoxyresorufin-O-deethylase activity in flatfish: fast determination with a fluorescence plate reader. Mar. Environ. Res. 33:213-221.

Habig, W.H. M.J. Pabst, and W.B. Jacoby. 1974. Glutathione S transferases, the first enzymatic step in mercapturic acid formation. J. Biol. Chem. 249:7130-7139.

Patterson, W.F., III, J.H. Tarnecki, and J.T. Neese. 2010. Fisheries ecology of artificial versus natural reefs on the northwest Florida shelf. Final Report for Florida Fish and Wildlife Research Institute. 39 pp.

Vehniainen, E.R., Schulz, E., Lehtivuori, H., Ihalainen, J.A., and A.O.J. Oikari. 2012. More accuracy to the EROD measurements – the resorufin fluorescence differs between species and individuals. Aquat. Toxicol. 116-117:102-108.

3) Cruises & field expeditions

Ship or Platform Name	Chief Scientist	Objectives	Dates
F/V Intimidator	Will Patterson	1) sample site 1, plus other shelf edge/upper slope deep reefs; 2) obtain biological samples from reef fishes (n = 40 among 10 species)	9/18-9/19/10
F/V Backdown 2	Will Patterson	1) sample sites 11, 12, and 13 with ROV; 2) obtain biological samples from reef fishes (n = 26 among species)	10/31/10
F/V Rip Tide	Will Patterson	1) sample sites 7 and 8 with ROV; 2) obtain biological samples from reef fishes (n = 24 among 8 species)	11/9/10
F/V Total Package	Joe Tarnecki	1) sample sites 5, 6, and 9 with ROV; 2) obtain biological samples from reef fishes (n = 15 among 5 species)	11/10/10
F/V Total Package	Joe Tarnecki	1) sample sites 5, 9, 10 and 13 with ROV; 2) obtain biological samples from reef fishes (n = 25 among 6 species)	12/3/10
F/V Rip Tide	Joe Tarnecki	1) sample sites 3 and 4 with ROV; 2) obtain biological samples from reef fishes (n = 15 between 2 species)	12/4/10
F/V Intimidator	Joe Tarnecki	1) sample sites 6, 7, and 8 with ROV; 2) obtain biological samples from reef fishes (n = 27 among 7 species)	12/10/10
F/V Total Package	Joe Tarnecki	1) sample sites 13 and 15 with ROV; 2) obtain biological samples from reef fishes (n = 9 among 6 species)	2/13/11
F/V Total Package	Joe Tarnecki	1) sample sites 10, 11, and 15 with ROV; 2) obtain biological samples from reef fishes (n = 20 among 6 species)	2/15/11
F/V Backdown 2	Joe Tarnecki	1) sample sites 12, 14, 15, and 16 with ROV; 2) obtain biological samples from reef fishes (n = 20 among 5 species)	2/22/11
F/V Intimidator	Joe Tarnecki	1) sample sites 2, 3, and 4 with ROV; 2) obtain biological samples from reef fishes (n = 15 among 5 species)	3/23/11
F/V Rip Tide	Joe Tarnecki	1) sample sites 6, 7, and 8 with ROV; 2) obtain biological samples from reef fishes (n = 15 among 6 species)	4/10/11
F/V Backdown 2	Joe Tarnecki	1) sample sites 13, 14, 15, and 16 with ROV; 2) obtain biological samples from reef fishes (n = 20 among 8 species)	4/13/11
F/V Total Package	Joe Tarnecki	1) sample sites 5, 10, 11, and 12 with ROV; 2) obtain biological samples from reef fishes (n = 20 among 9 species)	4/14/11
F/V Total Package	Joe Tarnecki	1) sample sites 5 and 9 with ROV; 2) obtain biological samples from reef fishes (n = 38 among 5 species)	4/17/11
F/V Rip Tide	Joe Tarnecki	1) sample sites 1, 2, and 3 with ROV; 2) obtain biological samples from reef fishes (n = 15 among 4 species)	5/6/11
F/V Rip Tide	Joe Tarnecki	1) sample sites 4, 6, and 9 with ROV; 2) obtain biological samples from reef fishes (n = 18 among 5 species)	5/11/11
F/V Total Package	Joe Tarnecki	1) sample sites 5, 7, and 8 with ROV; 2) obtain biological samples from reef fishes (n = 20 among 6	5/13/11

		species)	
R/V Weatherbird	Joe Tarnecki	1) sample sites 5, 10, 12, and 13 with ROV; 2) conduct trawl sampling on the shelf; 3) obtain biological samples from fishes (n = 56 among 16 species)	5/16-5/19/10
F/V Backdown 2	Joe Tarnecki	1) sample sites 10, 11, 12, 13 and 14 with ROV; 2) obtain biological samples from reef fishes (n = 36 among 7 species)	5/26/11
F/V Backdown 2	Joe Tarnecki	1) sample sites 15 and 16 with ROV; 2) obtain biological samples from reef fishes (n = 22 among 5 species)	5/27/11
R/V Bellows	Dick Snyder	1) sample site 5 with ROV; 2) conduct trawl sampling on the shelf; 3) obtain biological samples from fishes (n = 19 among 13 species)	6/25-6/27/11
F/V Rip Tide	Joe Tarnecki	1) sample sites 1, 2, 3, and 4 with ROV; 2) obtain biological samples from reef fishes (n = 20 among 6 species)	7/24/11
F/V Rip Tide	Joe Tarnecki	1) sample sites 6, 7, and 8 with ROV; 2) obtain biological samples from reef fishes (n = 15 among 6 species)	7/25/11
F/V Backdown 2	Joe Tarnecki	1) sample sites 13, 14, 15, and 16 with ROV; 2) obtain biological samples from reef fishes (n = 20 among 4 species)	7/27/11
F/V Backdown 2	Joe Tarnecki	1) sample sites 10, 11, and 12 with ROV; 2) obtain biological samples from reef fishes (n = 15 among 4 species)	8/1/11
F/V Total Package	Joe Tarnecki	1) sample sites 5 and 9 with ROV; 2) obtain biological samples from reef fishes (n = individuals from species)	8/4/11
F/V Total Package	Joe Tarnecki	1) sample site 5 with ROV; 2) obtain biological samples from reef fishes (n = 5 among 4 species)	3/13/12
F/V Intimidator	Joe Tarnecki	1) sample sites 1, 7 and 8 with ROV; 2) obtain biological samples from reef fishes (n = 15 among 5 species)	3/15/12
F/V Backdown 2	Joe Tarnecki	1) sample sites 10, 11, and 12 with ROV; 2) obtain biological samples from reef fishes (n = 12 among 5 species)	3/26/12
F/V Backdown 2	Joe Tarnecki	1) sample sites 13, 14, and 15 with ROV; 2) obtain biological samples from reef fishes (n = 12 among 4 species)	3/27/12
F/V Total Package	Joe Tarnecki	1) sample sites 2, 3, 4, and 6 with ROV; 2) obtain biological samples from reef fishes (n = 12 among 3 species)	3/30/12
F/V Total Package	Joe Tarnecki	1) sample site 9 with ROV; 2) obtain biological samples from reef fishes (n = 4 fish between 2 species)	4/9/12
R/V Weatherbird II	Jeff Chanton	1) sample sites 5, 8, 10, and 13 with ROV; 2) conduct trawl sampling on the shelf; 3) obtain biological samples from fishes (n = 36 fish among 23 species)	5/19-5/21/12

4) Peer-reviewed publications, if planned:

a. Published, peer-reviewed bibliography (Copies of the papers are requested)

None

b. Manuscripts submitted or in preparation (Please note target journal, and anticipated date of publication or submission)

Patterson, W.F. III, C.H. Jagoe, D.J. Hollander, I.C. Romero, A.S. Kane, and M.O. James. In Prep. Acute and chronic effects of the Deepwater Horizon Oil Spill on northern Gulf of Mexico Reef Fish Communities . To be submitted to Science in winter 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
Acute and chronic effects of the Deepwater Horizon Oil Spill on northern Gulf of Mexico reef fishes	Patterson, W.F. III	Patterson, W.F. III, J. Tarnecki, C. Jagoe, I. Romero, D. Hollander, A. Kane, and M. James.	SEDAR Episodic Mortality Workshop	Y	13-15 November 2012
Acute and chronic effects of the Deepwater Horizon Oil Spill on northern Gulf of Mexico reef fishes	Patterson, W.F. III	Patterson, W.F. III, J. Tarnecki, C. Jagoe, I. Romero, D. Hollander, A. Kane, and M. James.	Gulf Estuarine Research Society Biannual Meeting	Y	8-9 November 2012
Acute and chronic effects of oil on northern Gulf of Mexico reef fish communities	Patterson, W.F. III	Patterson, W.F. III	Dauphin Island Sea Lab	N	18 January 2012
Acute and chronic effects of oil on northern Gulf of Mexico reef fish communities	Patterson, W.F. III	Patterson, W.F. III, C. Jagoe, and J.H. Tarnecki	University of South Florida	N	5 January 2012

6) Other products or deliverables

None

7) Data

Accompanying spreadsheet contains project metadata records.

PARTICIPANTS AND COLLABORATORS

8) Project participants

First Name	Last Name	Role in Project	Institution	Email
Will	Patterson	Principal Investigator	UWF/USA	wpatterson@disl.org
Chuck	Jagoe	Co- Principal Investigator	FAMU	chjagoe@gmail.com
Joe	Tarnecki	Technician	USA/DISL	jtarnecki@disl.org

Institutions: UWF = University of West Florida, USA = University of South Alabama, FAMU = Florida Agricultural and Mechanical University, DISL = Dauphin Island Sea Lab.

MENTORING AND TRAINING

9) Student and post-doctoral participants

First Name	Last Name	Post-doc / PhD / MS / BS	Thesis or research topic	Institution	Supervisor	Expected Completion year
Joe	Tarnecki	MS	Red snapper feeding ecology	UWF	Patterson	2013
Joshua	Neese	MS	Red snapper age and growth	UWF	Patterson	2013
Michael	Norberg	MS	Tomtate population ecology	USA	Patterson	2013
LaTrishia	Allen	PhD	Oil biomarkers in fish and inverts	FAMU	Jagoe	2015
Diana	Johnson	MS	PAH exposure in fish	FAMU	Jagoe	2012
Kali	Farris	MS	PAHs in fish bile and Hg in fish liver	FAMU	Jagoe	2012

10) Student and post-doctoral publications, if planned

a. Published, peer-reviewed bibliography

None

b. Manuscripts submitted or in preparation

Allen, L., Johnson, D., Farris, K. W. Patterson, J. Tarnecki, and C. Jagoe. In Prep. Biomarkers of oil exposure and effects in reef fish from the northern Gulf of Mexico after the Deepwater Horizon oil spill. To be submitted to Environmental Toxicology and Chemistry in winter 2013.

Farris, K. and C. Jagoe. In Prep. Relationships between PAH and mercury concentrations in tissues and trophic position of reef fish from the northern Gulf of Mexico after the Deepwater Horizon oil spill. To be submitted to Environmental Pollution in winter 2013.

Neese, J.T., W.F. Patterson, III, and M.A. Norberg. In Prep. Decline in size at age in northern Gulf of Mexico red snapper following the Deepwater Horizon Oil Spill. To be submitted to Environmental Biology of Fishes in spring 2013.

Tarnecki, J.H., W.F. Patterson, III, and C.H. Jagoe. In Prep. Effect of the Deepwater Horizon Oil Spill on the trophic ecology of red snapper in the northern Gulf of Mexico. To be submitted to Transactions of the American Fisheries Society in spring 2013.

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
PAH metabolites in bile and enzymatic biomarkers in livers of reef fish from the northern Gulf of Mexico after the Deepwater Horizon Oil Spill	Allen, L.	Allen, L., D. Johnson, C. Jagoe, W.F. Patterson III, and J.H. Tarnecki	Society of Environmental Toxicology and Chemistry North America 33rd Annual Meeting	Y	11-15 November 2012

Diet and trophic ecology of Red Snapper, *Lutjanus campechanus*, at natural and artificial reefs in the northern Gulf of Mexico	Tarnecki, J.H.	J.H. Tarnecki and W.F. Patterson III	Gulf Estuarine Research Society Biannual Meeting	Y	8-9 November 2012
Tomtate, *Haemulon aurolineatum*, population demographics and diet in the northern Gulf of Mexico	Norberg, M.J.	Norberg, M.J., W.F. Patterson III, and J.H. Tarnecki	Gulf Estuarine Research Society Biannual Meeting	Y	8-9 November 2012
Organic geochemical evidence for oil spill impacts on fish in the Gulf of Mexico: comparative and quantitative analyses of polycyclic aromatic hydrocarbons	Romero, I.C.	Romero, I.C., D.J. Hollander, W.F. Patterson III, and 9 co-authors	Gordon Research Conference on Organic Geochemistry	Y	29 July-3 August 2012
Relationship between polynuclear aromatic hydrocarbons in fish bile and mercury content in liver from the Gulf of Mexico after the Deepwater Horizon Oil Spill	Farris, K.	Farris, K, D. Johnson, L. Allen, W. Patterson, J. Tarnecki and C. Jagoe	NOAA Educational Partnership Program Research Forum	Y	26-28 March 2012
Detection of polynuclear aromatic hydrocarbons in fish bile using fluorescence from the Gulf of Mexican Deepwater Horizon Oil Spill	Johnson, D.	Johnson, D., L. Allen, K. Farris, W. Patterson, J. Tarnecki, and C. Jagoe	NOAA Educational Partnership Program Research Forum	Y	26-28 March 2012
Identification of the relationship between polycyclic aromatic hydrocarbons in fish livers from the Gulf of Mexico after the Deepwater Horizon Oil Spill	Allen, L.	Allen, L., D. Johnson, K. Farris, W. Patterson, J. Tarnecki, and C. Jagoe	NOAA Educational Partnership Program Research Forum	Y	26-28 March 2012
Organic geochemical evidence for oil spill impacts on fish in the Gulf of Mexico: Comparative and quantitative analyses of polycyclic aromatic hydrocarbons	Romero, I.C.	Romero, I.C., D.J. Hollander, W.F. Patterson III, and 9 co-authors	2012 Ocean Sciences Meeting	Y	20-24 February 2012
Detection of fish bile metabolites by fluorescence from the northern Gulf of Mexico-Deepwater Horizon Oil Spill	Johnson, D.	Johnson, D., L. Allen, K. Farris, W. Patterson, J. Tarnecki, and C. Jagoe	2012 Ocean Sciences Meeting	Y	20-24 February 2012

12) Images

None

13) Continuing Research

This line of research is being continued with funding from Florida's Department of Environmental Protection (DEP), as well as from GoMRI via the C-IMAGE research consortium. With DEP funding (citation below), PI Patterson and colleagues have been examining changes in reef fish community structure at artificial reefs across the shelf south of Dauphin Island, AL to south of Destin, FL. Biological tissues also are sampled to test for differences in fish diet, age and growth, and trophic position following the spill. With GoMRI funding through C-IMAGE, PI Patterson and colleagues have continued examining effects of the DHOS on reef fish community structure and ecology at the 16 natural reefs that were examined with original GoMRI (FIO-BP) funding.

Current Funding:

Effect of Deepwater Horizon Oil Spill On fish communities associated with artificial reefs off northwest Florida, with David Hollander as PI, and Andrew Kane, Margret James, and William Patterson as co-PIs. 2012-13. Florida Department of Environmental Protection. $352,053; USA budget $152,544.

Center for Integrated Modeling and Analysis of the Gulf Ecosystem (C-IMAGE), with Steve Murawski as PI and multiple co-PIs, including Will Patterson. 2012-2015. Gulf of Mexico Research Initiative. $11,000,000; USA budget $471,966.