Effect of hydrocarbon contamination on oyster reef commensal assemblage colonization rates

Mitchell G. Bogran, Jenessa L. Kay, and Kenneth M. Brown
Department of Biological Sciences, Louisiana State University

Abstract:

Oyster reefs in Barataria Bay, Louisiana provide essential habit for juvenile fish and intertidal invertebrates; after the *Deepwater Horizon* oil spill in April 2010, the effect to these communities was unknown. Preliminary data revealed the long-term effects of hydrocarbon contamination on the diversity and abundance of these commensal communities were neither large nor consistent, however, without being able to sample immediately after the spill, the short-term effects of the oil spill on the oyster reef community went unidentified. To study the immediate effects of oil pollution on commensal organisms, eighteen mesh bags filled with oyster cultch were placed in Barataria Bay in June 2013. Half of the bags were filled with shell soaked in oil to provide a hydrocarbon-contaminated oyster reef surface. Three bags of each treatment were collected after one, two and four weeks post deployment. The organisms collected from the bags were identified and the colonization rate of commensal recruitment was analyzed. The results indicated that there was a reduction in the species richness and abundance in the oil-treated commensal assemblages compared to the control commensal assemblages. Results from this study provide further understanding of the impact of hydrocarbon contamination on organisms that take refuge in oyster reefs.

Introduction:

In 2010, the *Deepwater Horizon* oil spill affected the Gulf of Mexico, releasing 4.9 million barrels of crude oil in to the water. It eventually spread along the coastline of Louisiana, washing into the marshes, including Barataria Bay. Located in the southern wetlands of Louisiana, this estuary is economically important for the entire state of

Louisiana. Barataria Bay provides the necessary environment for oyster reefs to flourish. Oyster reefs (*Crassostrea virginica*) not only provide millions of dollars in economic benefits (LDWF, 2004) but also provide vital habitat and refugia for commercially important juvenile fish and intertidal invertebrates. The reef also acts as a boundary to avert storm surges from overtaking the wetlands, and filters the water, preventing zones of hypoxia from harming the wildlife.

The economically important fish and invertebrate species that are harvested from oyster reef areas include blue crabs, shrimp, groupers, and drum (Kaplan, 1988). Previous studies have shown that hydrocarbon contamination can reduce diversity and abundance of these organisms dependent upon oyster reefs for habitat (Banks and Brown, 2002; Hulathduwa et al., 2006). The oysters themselves are also affected by oil spill contamination as they are unable to break down the polycyclic aromatic hydrocarbons (PAH's) found in oil, causing slowed growth, decrease in size, and altered recruitment patterns (Smith and Hackney, 1989; Banks and Brown, 2002). To further examine how hydrocarbon contamination affects species richness and abundance of oyster commensal organisms, a study of oyster reef colonization in response to acute hydrocarbon contamination was conducted over a period of 4 weeks. The null hypotheses state that there is no difference in assemblage species richness or abundance between the oiled and control communities over throughout the colonization period.

Methods:

Referencing Shoreline Cleanup Assessment Technique (SCAT) data following the *Deepwater Horizon* oil spill, Grand Isle was selected as the study site based on its high salinity and low levels of oil exposure. To recruit commensal organisms, eighteen 0.3 m x 0.3 m bags constructed from 2 cm Vexar mesh were filled with oyster cultch and attached to PVC poles at the site. Half of the bags of cultch were coated in crude oil to simulate exposure to hydrocarbons following an oil spill event. The oiled commensal bags were placed approximately 150 m from the unoiled control bags to prevent cross-contamination. Bags were deployed at the beginning of June 2013. Three bags were collected from each treatment site at intervals of one, two, and four weeks. Upon bag retrieval, the contents of each bag were sieved through 1 mm mesh and organisms were identified to the lowest taxonomic level possible. A SAS Two-way ANOVA determined analysis of abundance and species richness.

Results:

By four weeks there was a significant difference in species richness between oiled and control cultch (Table 1; Figure 1) with diversity lower on oiled cultch. Also by four weeks, there was a significant difference in total commensal abundance between oiled and control cultch (Table 1; Figure 2) with abundance lower on oiled cultch.

Source	**Richness**	**Abundance**
Week	6.3**	37.4**
Treatment	6.9*	22.5**
Week x Treatment	1.9	6.9*

Table 1: F statistics for SAS Two-way ANOVA for species richness and abundance. One asterisk indicates $p < 0.05$, two $p < 0.01$.

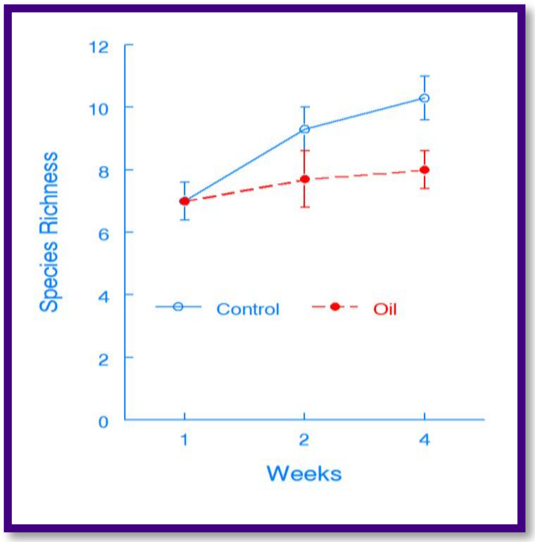

Figure 1: Average species richness (± SE) over 4 weeks in control and oil-exposed cultch.

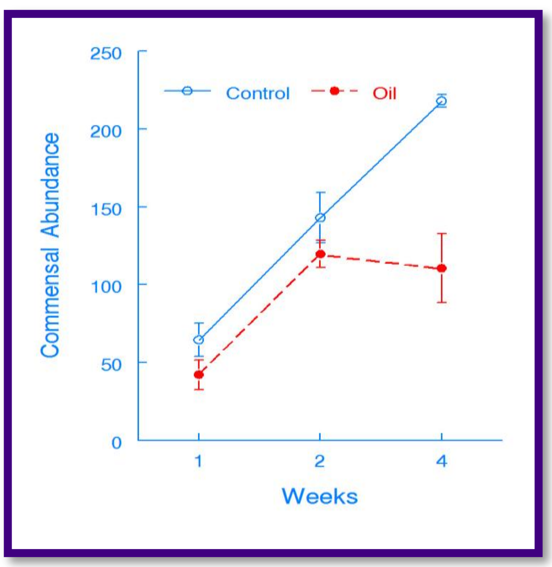

Figure 2: Average commensal abundance (± SE) over 4 weeks in control and oil-exposed cultch.

Discussion:

Since there was a significant difference in species richness and abundance, both of the null hypotheses are rejected; oil exposure does appear to have an effect on commensal assemblage. Previous studies in our lab looking at the long-term effect of hydrocarbons found little difference between oiled and non-oiled sites, but by simulating oil exposure we found there was a distinct short-term difference.

To further examine the recruitment response of oyster commensal organisms to acute hydrocarbon contamination, this study was extended to eight weeks as part of the Master's project for my UROP mentor. We also repeated the experiment in the fall in order to observe any variation based on seasonal changes. The results for the eight-week commensals show the same trend as the previous four weeks: a greater increase in abundance and species richness for the control sites over the contaminated sites. The results from the second replicate of our experiment are still being analyzed. During my UROP experience I also assisted my graduate mentor on an experiment testing the effects of different artificial reef construction materials on the commensal communities around Barataria Bay. These two projects will help us better understand how to manage artificial reefs in regard to the commensal organisms they support, particularly in the aftermath of environmental disasters similar to *the Deepwater Horizon* oil spill.

After performing this research experiment I have gained a vast array of knowledge and skills which will prepare me for my future endeavors in graduate school. The process of developing and executing an experiment, as well as analyzing the results and reflecting on our accomplishments, will better prepare me for a future in research. Finally, working on my first research project this past summer has allowed me to have a much greater appreciation of the concepts involved with working on graduate-level research. In the past, I did not understand the importance of statistical analysis or how to convert the results into a cohesive discussion.

Working with my mentor and having another year of education in this field has allowed me to understand what is expected in a research project. I was able to gain field experience by putting out and collecting commensal bags in Barataria Bay. In the lab, I went through the entire process of gathering and analyzing data in order to obtain reliable information to publish. I will use what I learned from this research project in my future both at graduate school and in a professional career. I am interested in continuing to work in marine biology, especially in the marine mammal field, and I plan to apply to graduate school with a specific program in cetacean studies. The most important information I can take away from this project is how to ask a question that needs to be researched. In schools today, it seems that students only want to find the answers to questions but don't understand or appreciate how those answers were found in the first place. The journey to finding these answers is the culmination of countless hours of research, and I am glad to have started on the path of adding to this wealth of knowledge.

References:

Banks, P.D. and K.M. Brown. 2002. Hydrocarbon effects on fouling assemblages: the importance of taxonomic differences, seasonal, and tidal variation. *Marine Environmental Research.* 53: 311-326

Hulathduwa,Y. and K. M. Brown. 2006. Relative importance of hydrocarbon pollutants, salinity and tidal height in colonization of oyster reefs. *Marine Environmental Research.* 62:301-314.

Kaplan, Eugene H. *Southeastern and Caribbean Seashores*. Boston: Houghton Mifflin, n.d. Print. 1988.

Louisiana Department of Wildlife and Fisheries. 2004-2005 *Annual Report*. Retrieved from http://www.wlf.louisiana.gov/sites/default/files/pdf/publication/33559-2004-05-annual-report/ldwfannualreport0405r.pdf

Smith, Craig M., and Courtney T. Hackney. The effects of hydrocarbons on the setting of the American oyster, Crassostrea virginica, in intertidal habitats in southeastern North Carolina. *Estuaries* 12.1 (1989): 42-48.