



GULF RESEARCH PROGRAM

Project Title: Understanding Oil Spill Impacts on Fishing Communities of the Gulf of Mexico: From Deepwater Horizon to Future Spill Scenarios

Award Amount: Award Amount

Awardee: University of South Florida

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Project Key Personnel:

- James Sanchirico, Resource Economist, University of California-Davis
- Claire Paris, Biological Oceanographer, University of Miami
- Kenneth Broad, Anthropologist, University of Miami

I. PROJECT SUMMARY (from proposal)

This project will synthesize existing information to understand mechanisms underlying how oil spills such as Deepwater Horizon can affect the coupled economic, ecological and social systems of fishing-dependent communities in the Gulf of Mexico. Data synthesis phases of the project will identify specific communities differentially-dependent on fishing as part of their economy, using high-resolution fishery-independent data including mandatory commercial fishing vessel logbook records, census data and satellite tracking information. These data provide detailed fishing effort, spatial locations and economic information (landings and prices). Data at the firm level provide temporal contrasts in profitability, fishing patterns and responses to seasonal and other factors (such as oil spills). Aggregated at the community level, they provide information on the impacts of selected fisheries on the overall fish economy at the village level. Aggregating at the county, state and regional level provide other synthetic overviews. Additional data sources include economic and labor census data and ethnographic data that will be used to corroborate fishing patterns and behavior.

To simulate future spill impacts on affected fishing communities, we will use the Connectivity Modeling System configured to track the spatial and temporal dynamics of oil particles. Future scenarios will be selected to reflect recent location changes in the Gulf oil industry, and different timings of oil spills throughout the year. Models of fishing community economics, firm-level decision making regarding areas fished, and degree of dependence of individual communities on fishing will inform impact assessments for the selected oil spill scenarios.

II. PROJECT SUMMARY (from final report)

During the Deepwater Horizon blowout, the spilled oil and its accompanied response closures had negative socioeconomic effects on fishers and fisheries-dependent communities. The direct effects

include the areas, the fauna and flora that were polluted and harmed by oil, while the indirect effects include the damage associated with the fishing closures of vast areas in the Gulf of Mexico for extended time periods, forcing unplanned changes in the life patterns of fishers and fisheries-dependent communities. In the aftermath of the disaster, with a great amount of data available, we examined the effect of the oil spill and its related closures on fisher behavior and the associated socioeconomic impacts to ultimately inform improved management for future similar events. Using oil and gas development and exploration trends in the Gulf, we identify potential locations for blowout scenarios and model the oil transport over time. The oil footprint is merged with existing data sets (vessel monitoring system data, observer data, logbook data, social vulnerability data) to determine what Gulf coast communities are most at risk during a future potential spill. By looking at fisher habit types before and after a disturbance, we identify behaviors that contribute to the resiliency of certain populations of fishers. The information gained from the combination of these datasets make this project valuable to industry, resource managers, and fishing communities.

III. PROJECT RESULTS

Accomplishments

This project aimed to synthesize existing information to understand mechanisms underlying how oil spills such as Deepwater Horizon or other perturbations can affect the linked economic, ecological and social systems of fishing-dependent communities in the Gulf of Mexico. Researchers used high-resolution fishery-independent data including mandatory commercial fishing vessel logbook records, census data and satellite tracking information that provided detailed fishing effort, spatial locations and economic information (landings and prices).

Before these analyses were conducted, our researchers completed a thorough assessment of the data sources and opportunities where error can be introduced. Existing datasets provide a lot of information about fisher data, however, when the set duration is shorter (short set fisheries) than the time between locations pings from the VMS, the fishing effort is underrepresented in the data analysis. This study's intent is to manage this source of underestimation using feature engineering by manipulating data features. Improved training datasets can be assessed by window labelling instead of point labelling. This would alleviate the issue of a fishing set being missed because of the short set time relative to the time between VMS pings. While we did find that this resulted in a 2% increase of false positives, it also resulted in a substantial decrease of false negatives. A management recommendation from this is to increase the frequency of VMS location pings. In addition, observer data can also be supplemented to include other behaviors such as steaming, repositioning between sets, fish processing, etc. to improve the accuracy of the window labeling method.

To simulate future spills for projection of their impacts on affected fishing communities, we employed the Connectivity Modeling System configured to track the spatial and temporal dynamics of oil particles. Future scenarios were selected to reflect recent location changes in the Gulf oil industry, and different timings throughout the year.

In response to an oil spill, fishery grounds can be closed to mitigate the threat of contaminated seafood reaching the market. As a result, fishing communities along the Gulf coast are heavily socioeconomically

impacted. In the project, we looked at various existing data sets (vessel monitoring system data, observer data, logbook data, social vulnerability data) and merged these with various oil spill fate and transport scenarios to determine what Gulf coast communities are most at risk during a future potential spill. The information gained from the combination of these datasets makes this project valuable to industry, resource managers, and fishing communities. When future large scale oil spills occur, lessons learned from this study, including the surface and subsurface expression of the spills, impacts on communities and the effects of alternative employment and compensation schemes will be used to develop more effective and targeted fishery closures.

We found that fishers using the explore principle instead of the exploit strategy were more resilient or more adapted to fishing ground closures. These fishers had a diversified fishing portfolio on which to draw from during a disturbance, and the costs of exploring for new fishing grounds out-weighed the risks of using resources to explore an unknown gain. However, we found that this advantage may be short-lived and will decrease over time, as other vessels using the exploit strategy may observe the increased performance in others and modify their fishing locations accordingly.

By incorporating social-ecological concepts to determine fishing behavior types (FBT), we were able to gain insight into how different disturbances change human behavior leading to informed a priori management strategies. The availability of large high frequency data from fisheries-dependent data and VMS datasets provide information on behavior diversity in response to a disturbance. The different characteristics used to define these FBTs are divided into fishing strategy type and style and personality types (e.g. mobility, days at sea, use of technology, information sharing, vessel type, etc.). As a case study, we used the bottom longline fleet in the Gulf of Mexico Grouper-Tilefish fishery responding to closures from the Deepwater Horizon spill and the Endangered Species Act, the introduction of individual fishing quotas (IFQ) and a performance-related reduction of the fleet. In the analysis, three FBTs emerged with the important characteristics being exploration, mobility, days at sea, revenue, vessel type, and how “risk taking” they were. We also discovered that FBTs change may change due to the disturbance and quantify how many from each FBT exit the fishery in response to the disturbance. When providing another layer of fishing behavior in addition to the fleet, fishery and métier, management decisions are better informed and can result in tailored management strategies benefiting the fishery and the socioeconomic impact of the fisher.

Implications

Any research teams that are interested in looking into maximizing the application of existing fisher data will find our research foundational to studying both long term variability in fisher behavior and how fisher behavior changes in response to any change in the Gulf of Mexico. The Gulf is a shared resource and its management in terms of energy production, food safety and management, and ecosystem health is a main driver of the economics of the region. The interplay of these activities is critical to science and society. Further, the partnership between academia and government forged new heretofore non existent relationships that should and could be called upon in the event of future spills.

Unexpected Results

One of the major, unexpected results from the project was the reduction in exiting behavior of the fleet in the aftermath of DWH. We anticipated that business failures would have increased but in fact the

opposite occurred. We hypothesize that the combination of the Vessel of Opportunity Program and various compensation offered by the Responsible parties was sufficient to keep most businesses viable until fishing grounds were re-opened.

Project Relevance

The following audiences would be most interested in the results of this project:

- Researchers
- Educators
- Community Leaders
- Local Government Officials
- State Government Officials
- Federal Government Officials
- For-Profit Private Sector

The results from this project provide valuable tools that give insight to fishing behavior and the associated socioeconomic impact in response to naturally occurring changes, resource management decisions, and man-made disasters like the Deepwater Horizon oil spill. This knowledge can provide the energy sector and the associated monitoring agencies with a more complete picture of risk assessment. Furthermore, as spills of the future evolve, the results from this project will allow responders to anticipate the types of impacts and the effectiveness of economic mitigation measures they might consider.

Education and Training

Number of students, postdoctoral scholars, or educational components involved in the project:

- Undergraduate students: 0
- Graduate students: 2
- Postdoctoral scholars: 2
- Other educational components: 0

There were press releases on high impact research that are noted elsewhere in this report.

IV. DATA AND INFORMATION PRODUCTS

This project produced data and information products of the following types:

- Data
- Information Products
- Scholarly publications, reports or monographs, workshop summaries or conference proceedings
- Models or simulations

DATA

Data Management Report:

See attached Data Management Report.

Relationships Between Data Sets:

These dataset variables provide input to the CMS model at initiation and the output of these models is the oil mass concentrations at different conditions. The metadata for these data sets is provided at the GRIIDC website consistent with the DOIs for the publications listed below.

Additional Documentation Produced to Describe Data:

N/A

Other Activities to Make Data Discoverable:

We have clearly explained data and added supplemental material in our publications. R-code used to conduct some of the data analysis is available at GitHub.

Sensitive, Confidential, or Proprietary Data:

Yes. Some of the data were obtained under a contractual agreement with the U.S. National Marine Fisheries Service (NMFS). The agreement prevents distribution of personally identifiable information, including variables directly included in the analysis. These data are archived at NOAA's Southeast Fisheries Science Center. Researchers under a contractual agreement with NMFS can access the data provided a nondisclosure agreement is signed.

INFORMATION PRODUCTS**Information Products Report:**

See attached Information Products Report.

Citations for Project Publications, Reports and Monographs, and Workshop and Conference Proceedings:

- 1) O'Farrell, S., Sanchirico, J. N., Chollett, I., Cockrell, M., Murawski, S.A., Watson, J. T., Haynie, A., Strelcheck, A., Perruso, L. 2017. Improving detection of short-duration fishing behaviour in vessel tracks by feature engineering of training data. ICES Journal of Marine Science. (no data)
doi:10.1093/icesjms/fsw244.
- 2) O'Farrell, S., Sanchirico, J. N., Spiegel, O., Depalle, M. Haynie, A. C., Murawski, S. A., Perruso, L., Strelcheck, A. 2019. Disturbance modifies payoffs in the explore-exploit trade-off. Nature Communications, 10:3363. (data dist. Statement and GitHub)
<https://www.nature.com/articles/s41467-019-11106-y>
- 3) O'Farrell, S., Chollett, I., Sanchirico, J. N., Perruso, L. 2019. Classifying fishing behavioral diversity using high-frequency movement data. Proceedings of the National Academy of Sciences, 116:16811-16816. (no data)
<https://doi.org/10.1073/pnas.1906766116>
- 4) Cockrell, M. L., O'Farrell, S., Sanchirico, J. N., Murawski, S. A., Perruso, L., Strelcheck, A. 2019. Resilience of a commercial fishing fleet following emergency closures in the Gulf of Mexico. Fisheries Research, 218:69-82. (no data)

<https://doi.org/10.1016/j.fishres.2019.04.017>

5) Berenshtein, I., O'Farrell, S., Perlin, N., Sanchirico, J. N., Murawski, S. A., Perruso L., Paris C. B. 2019. Predicting the impact of future oil-spill closures on fishery revenues-a spatially explicit approach. ICES Journal of Marine Science. (word doc)

<https://doi.org/10.1093/icesjms/fsz138>

6) Berenshtein, I., Perlin, N., Murawski, S. A., Joye, S., Paris, C. B. 2020. Evaluating the effectiveness of fishery closures for deep oil spills using a 4-dimensional model. pp: 390-402, In: Murawski SA, Ainsworth C, Gilbert S, Hollander D, Paris CB, Schlüter M, Wetzel D (Eds.) Scenarios and Responses to Future Deep Oil Spills – Fighting the Next War. Springer 542 pp. (doi given)

7) Berenshtein, I., Paris, C. B., Perlin, N., Alloy, M. M., Joye, S. B., Murawski, S. 2019. Invisible oil beyond the Deepwater Horizon satellite footprint. Science Advances (in press), Data are submitted to GRIIDC and .csv files accompany the manuscript.

8) Chancellor E., Murawski S. A., Paris C. B, Perruso L., Perlin, N. 2020. Comparative environmental sensitivity of offshore Gulf of Mexico waters potentially impacted by ultra-deep oil well blowouts. pp: 443-466, In: Murawski SA, Ainsworth C, Gilbert S, Hollander D, Paris CB, Schlüter M, Wetzel D (Eds.) Scenarios and Responses to Future Deep Oil Spills – Fighting the Next War. Springer 542 pp.

9) Berenshtein, I., Paris, C. B., Perlin N., Alloy, M. M., Joye, S. B., Murawski, S. (20XX) Comparison of the Spatial Extent, Impacts to Shorelines, and Ecosystem and Four-Dimensional Characteristics of Simulated Oil Spills", Science Advances, in press.

10) Berenshten, I., Perlin, N., Ainsworth, C.H., Ortega-Ortiz, J.G., Vaz, A.C., and Paris, C.B. 2020. Comparisons of the spatial extent, impacts to In: Murawski SA, Ainsworth C, Gilbert S, Hollander D, Paris CB, Schlüter M, Wetzel D (Eds.) Scenarios and Responses to Future Deep Oil Spills – Fighting the Next War. Springer 542 pp. (doi given)

Websites and Data Portals:

N/A

Additional Documentation Produced to Describe Information Products:

These are described in the supplemental sections of the manuscripts.

Other Activities to Make Information Products Accessible and Discoverable:

N/A

Confidential, Proprietary, Specially Licensed Information Products:

N/A

V. PUBLIC INTEREST AND COMMUNICATIONS

Most Unique or Innovative Aspect of the Project

Integrating existing datasets from various disciplines is incredibly valuable for gaining a holistic picture of the complex system in the Gulf of Mexico. In this project, we combine physical oceanography, economics, sociology, resource management and disaster response to better prepare vulnerable communities faced with potential uncertainties in their chosen profession.

Most Exciting or Surprising Thing Learned During the Project

One of the most surprising and revealing concepts coming out of our project is the benefit of the “explore” trait vs the “exploit” trait. While exploration includes a great deal of risk and uncertainty, it can provide a buffer and contribute to resiliency.

Most Important Outcome or Benefit of Project

Getting this information out to the fisher, resource managers, and energy development communities is critical to better prepare vulnerable communities and to assess the socioeconomic risk associated with different drilling locations.

Communications, Outreach, and Dissemination Activities of Project

<http://www.tbreporter.com/environment/1-million-grant-usf-marine-science-researcher/news.usf.edu/article/templates/?a=7623&z=220>

Susan Pinker interviewed Dr. Shay O’Farrell and is profiled here in her column on the Wall Street Journal:

<https://www.wsj.com/news/types/mind-and-matter-susan-pinker>

Dr. Jim Sanchirico was interviewed by Seafood Source:

<https://www.seafoodsource.com/news/supply-trade/risk-pays-off-study-finds-fishermen-who-venture-to-new-grounds-benefit>

<https://www.sciencedaily.com/releases/2019/07/190729094536.htm>

<https://www.earth.com/news/stick-with-what-you-know/>

<https://wattsupwiththat.com/2019/08/04/it-pays-to-explore-in-times-of-uncertainty/>

<http://www.fishingbriefing.com/to-explore-or-exploit-fishing-vessel-records-show-trade-offs/>

https://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=298997

https://umresearchsymposium2019.sched.com/speaker/igal_berenshtein.74iweln

Data Report

| DataType | DigitalResourceType | Title | FileName | Creators | PointofContact | PublicationYear | RepositoryName | DOIorPersistentURL | Keywords | Publications |
|-------------------|-----------------------------------------|---------------------------------------------------------------------|-----------------|----------------------------------|-----------------------|------------------------|-----------------------|---------------------------|-----------------|---------------------|
| Interdisciplinary | Geospatial (vector, raster, or gridded) | Oil concentrations across time and space - output from oilCMS model | | Perlin, Natalie; Paris B. Claire | Claire B. Paris | | | | | |

Information Products Report

| InfoProductType | DigitalResourceType | Title | FileName | Creators | PublicationYear | Publisher | RepositoryName | DOIorPersistentURL | DatasetReference |
|-----------------------------------|---------------------|----------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|----------------|--------------------|------------------|
| Models and Simulations | Image | Fishery closure areas following the Deepwater Horizon oil spill - revisited | GoMOSES18Abstract-1 | | 2018 | GoMOSES18 Abstract | | | |
| Workshop or Conference Proceeding | Text | Fishery Closure Area | Fig1 ClosureAreaDWH | Paris, Claire; Berenshtein, Igal | 2018 | GoMOSES18 Abstract | | | |
| Models and Simulations | Image | Planned Simulations | PlannedSimulationSites | Paris, Claire; Berenshtein, Igal | 2018 | GoMOSES18 Abstract | | | |
| Models and Simulations | Image | Project Outcome Schematic | Fig3 ProjectOutcome | Paris, Claire; Berenshtein, Igal | 2018 | GoMOSES18 Abstract | | | |
| Models and Simulations | Image | The Modifiable Areal Unit Problem (MAUP) in the analysis of fishery behavior: new insights from VMS data | CIEM-ICESAbstract | Depalle, Maxime; Sanchirico, James; Thebaud, N.O.; O'Farrell, Shay; Haynie, Alan C.; Perruso, Larry | 2017 | CIEM/ICES Abstract | | | |
| Workshop or Conference Proceeding | Text | Did Exploratory Behaviour by GoM Fishers Confer Resilience to DWH Impacts? | GoMOSES18Abstract-2 | Shay O'Farrell, James N. Sanchirico, Orr Spiegel, Maxime Depalle, Andy Strelcheck, Alan Haynie, Larry Perusso and Steven Murawski | 2018 | GoMOSES18 Abstract | | | |