Environmental Impact in Geographically Remote Areas

An Assessment of Response and Possible Solutions

AUTHORS

Sean Allen Stickney, Marine Science Technician Third Class (MST3), United States Coast Guard Sector Key West, 1073A Farragut Rd. Key West, FL 33040

Brian Patrick O'Neil, Marine Science Technician First Class (MST1), United States Coast Guard Sector Key West, 1166A Gilmore Dr. Key West, FL 33040

ABSTRACT

INTRODUCTION

Renowned naturalist and marine biologist Rachel Carson perhaps best describes the Florida Keys in her nationally acclaimed book *The Edge of the Sea* by stating "I doubt that anyone can travel the length of the Florida Keys without having communicated to his mind a sense of the uniqueness of this land of sky and water and scattered mangrove-covered islands. The atmosphere of the Keys is strongly and peculiarly their own. This world of the Keys has no counterpart elsewhere in the United States, and indeed few coasts of the Earth are like it." (Carson, R., 1955). The Florida Keys are an archipelago consisting of about 1,700 islands located in the farthest southeast portion of the United States (NOAA Florida Keys National Marine Sanctuary, n.d.). The Keys begin approximately 15 miles south of Miami and extend south-southwest into the ocean, acting as the easternmost border of the Gulf of Mexico on the western shores, and the westernmost border of the Atlantic Ocean on the eastern shores. Located in the sub-tropics between 24 and 25 degrees latitude north, the Keys share significantly more meteorological characteristics with the Caribbean islands than the rest of Florida (NOAA Florida Keys National Marine Sanctuary, n.d.). As such, they experience two main seasons with a hot,

wet, and humid season running from June through October, and a cooler drier period running from November through May. This sub-tropical climate and the unique geographical characteristics of the area have laid the foundation for the Florida Keys as one of the most biologically and ecologically diverse ecosystems in the United States, with some species such as the endangered Key Deer being found nowhere else in the world. All in all over 2,900 square nautical miles of waters are protected as part of the Florida Keys National Marine Sanctuary (NOAA Florida Keys National Marine Sanctuary, n.d.).

Using case studies and analytical data compiled from other significant oil spill incidents, we will conduct a cohort study to assess the potential impact of a worst-case discharge, outlined and defined in the Florida Keys Area Contingency Plan (ACP), on the Florida Keys and what response actions could potentially be taken to mitigate the effects of this spill.

METHODS

To properly analyze and assess the potential impact of a worst-case discharge on the Florida Keys, it was necessary to utilize a variety of government generated and private scientific resources. Response considerations were developed by utilizing a cost/benefit analysis based off of pre-existing recommendations in the Florida Keys ACP.

Scenario

The scenario being utilized for our projections and analysis is a worst-case discharge specifically developed for the Florida Keys Area Contingency Plan by the Area Committee; a group of federal, state, and local agencies which includes but is not limited to the United States Environmental Protection Agency (USEPA), United States Coast Guard (USCG), National Oceanic and Atmospheric Administration (NOAA), and the Florida Department of Environmental Protection (DEP). The parameters of the scenario, as exercised in triennial

Preparedness for Response Exercise Program (PREP), reads as following, “As a result of the increased threat from international offshore drilling, the Worst Case Discharge (WCD) Scenario for an offshore drilling site is 75,000 barrels (bbls) per day for 30 days.” (Nguyen, J. D., 2012). These figures were developed in the aftermath of the Deepwater Horizon spill as estimations based off of exploratory off-shore drilling which commenced in 2012 off of Cuba and the Bahamas (Nguyen, J. D., 2012). A map of these exploratory drilling operations and their proximity to the Florida Keys is included below in Figure 1.

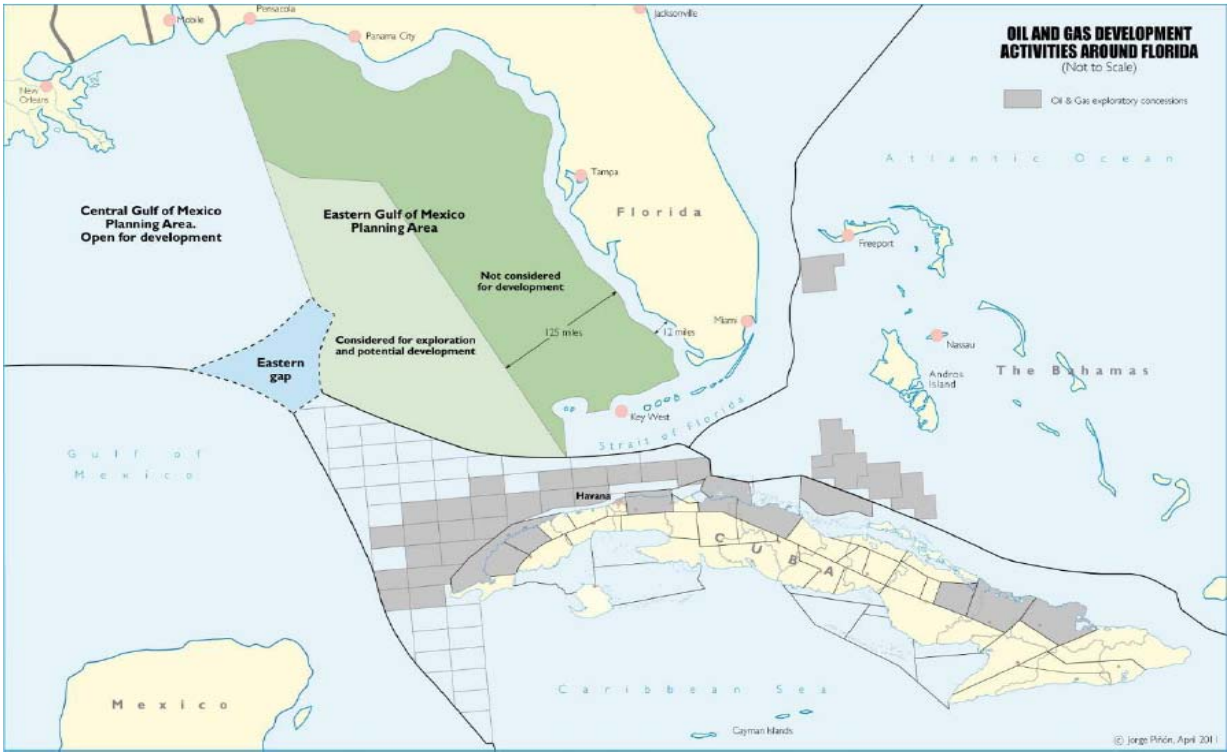

FIGURE 1: EASTERN GULF OF MEXICO AND CARIBBEAN OIL DRILLING SITES (Nguyen, J. D., 2012)

Based off of these estimations, a total discharge of approximately 2,250,000 barrels (bbls) of oil could be reasonably expected to impact the Florida Keys, to varying degrees, in a catastrophic incident.

Population Impact Projections

To determine potential impacts of the worst-case discharge scenario on animal and plant populations located in the Florida Keys, we will utilize a bevy of mortality rates and scientific data collected in the aftermath of the Deepwater Horizon oil spill. In the case of Deepwater Horizon, the most impacted animal populations were tetrapod vertebrates; specifically endothermic vertebrates (birds) and Cetaceans (marine mammals) (Westerholm, D. G., & Rauch, S. D. III, 2016). In light of this, tetrapod vertebrate' will be the focus of our animal impact projections, for which we will utilize mortality rates and population impact numbers collected and disseminated by NOAA and the Department of the Interior (DOI) as part of the National Resource Damage Assessment (NRDA) which was conducted in the aftermath of the Deepwater Horizon spill. For the purposes of this study, we will limit the projected impact, based on similar numbers in Deepwater Horizon, to those which would be experienced in the first year of the spill. It is acknowledged that these numbers often do not reflect long term impact on these populations as a result of lost or compromised habitat, chronic health effects associated with oil exposure, or lost reproductive capabilities due to a myriad of factors (Westerholm, D. G., & Rauch, S. D. III, 2016). Numbers from the aforementioned NRDA will also be utilized for projected impacts on the near-shore environment, to include beaches, wetlands, and other exposure categories. Due to the relative synchronicity of plant and animal life in the previously affected areas as compared to the Florida Keys, these projections will prove successful in providing a general estimation of total environmental impact in the given scenario.

Response Considerations

To properly assess appropriate response actions a cost-benefit analysis will be utilized. The Florida Keys represent a unique environment in that the entire near-shore environment is classified as a national marine sanctuary. In light of this, a three tiered "diamond" classification

system is utilized to classify environmentally, economically, and operationally significant resources (Nguyen, J. D., 2012). The aforementioned Florida Keys Area Contingency Plan fully acknowledges the lack of resources pre-positioned within the Florida Keys to protect these resources, and also provides estimations of required assets in the event of a worst-case discharge. Overall estimations of projected monetary losses in the recreational and tourism industries will be considered in conjunction with environmental impact to properly assess the benefit of implementing the recommended actions.

RESULTS

Population Impact

The effects of the Deepwater Horizon oil spill on the Gulf Coast and the marine environment were unprecedented. One of the most severely impacted populations was endothermic vertebrates. Conservative estimates produced as part of the NRDA put the death count for the 93 affected species somewhere between 51,600 and 84,500 birds (Westerholm, D. G., & Rauch, S. D. III, 2016). The highest respective percentages of that death count occurred in brown pelicans, laughing gulls, terns, skimmers, and northern gannets (Westerholm, D. G., & Rauch, S. D. III, 2016). Additionally, between 4,600 and 17,900 chicks died before they could fledge as a result of their parents not returning to the nest (Westerholm, D. G., & Rauch, S. D. III, 2016). Perhaps even more disturbing is the effects Deepwater Horizon had on island waterbird colonies. Since many islands and similarly inaccessible geographic areas were not able to be reached or properly quantified in large-scale data, the NRDA trustees identified several specific islands in Barataria Bay off the coast of Louisiana to serve as a baseline for expected impact. This is particularly important when it is considered within the scope of our study, as the Florida Keys are predominately comprised of isolated and exposed islands which could

experience similar impacts in the given scenario. Highlighted species in the Barataria Bay study, conducted on Queen Bess and Cat Island respectively, included the brown pelican, laughing gull, terns, and waders (Westerholm, D. G., & Rauch, S. D. III, 2016). The recorded impact of Deepwater Horizon on the number of nesting pairs of each species is included in Table 2 below.

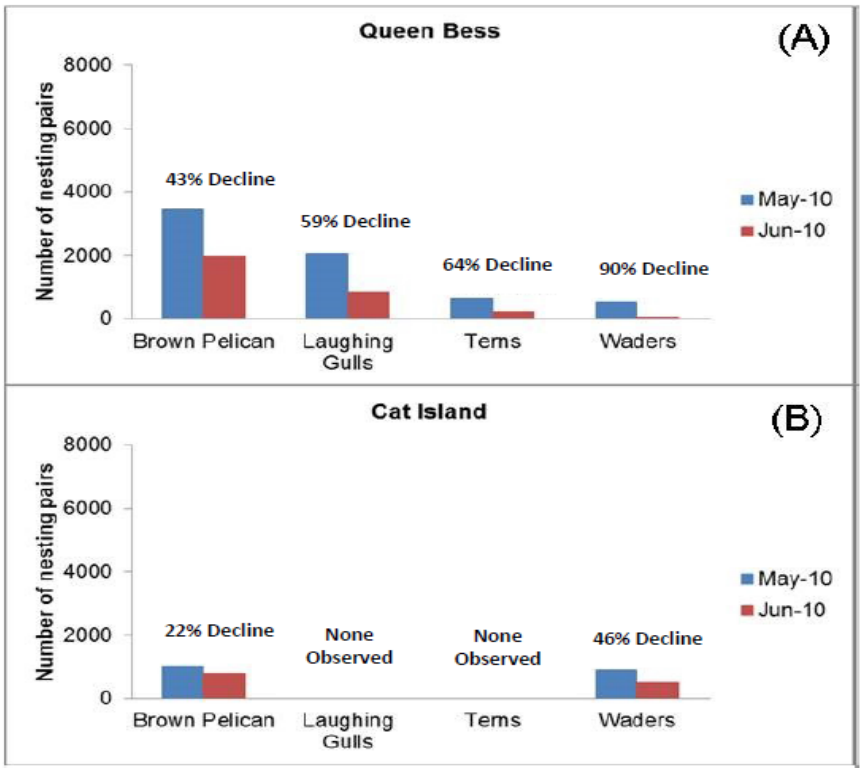

TABLE 2: CHANGE IN SPECIES ABUNDANCE AT TWO OIL AFFECTED COLONIES IN BARATARIA BAY IN 2010 (Westerholm, D. G., Rausch, S. D. III, 2016).

Un-coincidentally, these happen to be a few of the most prevalent bird species in the Florida Keys as well. Brown Pelicans have year-round colonies in every area of the Keys, with particularly substantial colonies on Pavilion Key, the Dry Tortugas, Lower Biscayne Bay, and all major landmasses from Marathon to Key Largo (Nguyen, J. D., 2012). Populations of terns, waders, and laughing gulls are equally as established throughout the Keys.

Another substantially impacted group included cetaceans.

Cetacean Stock	Pre-spill Abundance Estimate	95% CI	Population Exposed to Oil (%)	95% CI
Bottlenose dolphin Barataria Bay	2,306	1,973-2,639	NA	NA
Bottlenose dolphin Mississippi River Delta	820	657-984	NA	NA
Bottlenose dolphin Mississippi Sound	4,188	3,617-4,760	NA	NA
Bottlenose dolphin Mobile Bay	1,393	1,252-1,535	NA	NA
Bottlenose dolphin western coastal	20,161	14,482-28,066	23	16-32
Bottlenose dolphin northern coastal	7,185	4,800-10,754	82	55-100
Continental shelf dolphins[a]	63,361	42,898-87,417	13	9-19
Bottlenose dolphin oceanic	8,467	4,285-16,731	10	5-20
Sperm whale	1,635	1,132-2,359	16	11-23
Bryde's whale	26	12-56	48	23-100
Beaked whales[b]	1,167	643-2,117	12	7-22
Clymene dolphin	3,228	1,558-6,691	7	3-15
False killer whale	316	121-827	18	7-48
Melon-headed whale	1,696	709-4,060	15	6-36
Pantropical spotted dolphin	33,382	25,489-43,719	20	15-26
Short-finned pilot whale	1,641	710-3,790	6	4-9
Pygmy killer whale	281	131-601	15	7-33
Pygmy/dwarf sperm whales[c]	6,690	3,482-12,857	15	8-29
Risso's dolphin	1,848	1,123-3,041	8	5-13
Rough-toothed dolphin	2,414	964-6,040	41	16-100
Spinner dolphin	6,621	3,386-12,947	47	24-91
Striped dolphin	2,605	1,537-4,415	13	8-22

[a] Continental shelf dolphins is a combination of shelf bottlenose dolphins and Atlantic spotted dolphins.

[b] Beaked whales is a combination of Blainville's beaked whales, Cuvier's beaked whales, and Gervais' beaked whales.

[c] Pygmy/dwarf sperm whales is a combination of pygmy sperm whales and dwarf sperm whales.

FIGURE 3: PRE-SPILL ABUNDANCE AND PERCENTAGE OF POPULATION OILED FOR CETACEANS IN THE NORTHERN GULF OF MEXICO (WESTERHOLM, D. G., RAUCH, S. D. III, 2016)

Cetacean Stock	Population Killed (%)	95% CI
Continental shelf dolphins[a]	4	2-6
Bottlenose dolphin oceanic	3	1-5
Sperm whale	6	2-8
Bryde's whale	17	7-24
Beaked whales[b]	4	2-6
Clymene dolphin	2	1-4
False killer whale	6	3-9
Melon-headed whale	5	2-7
Pantropical spotted dolphin	7	3-10
Short-finned pilot whale	2	1-3
Pygmy killer whale	5	2-8
Pygmy/dwarf sperm whales[c]	5	2-7
Risso's dolphin	3	1-4
Rough-toothed dolphin	14	6-20
Spinner dolphin	16	7-23
Striped dolphin	5	2-7

[a] Continental shelf dolphins is a combination of shelf bottlenose dolphins and Atlantic spotted dolphins.

[b] Beaked whales is a combination of Blainville's beaked whales, Cuvier's beaked whales, and Gervais' beaked whales.

[c] Pygmy/dwarf sperm whales is a combination of pygmy sperm whales and dwarf sperm whales.

FIGURE 4: PERCENTAGE OF CETACEAN POPULATION DEATHS

(WESTERHOLM, D. G., RAUCH, S. D. III, 2016)

Response Considerations

DISCUSSION

Trajectory Forecasting

CONCLUSION

REFERENCES

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