
***Deepwater Horizon* Natural Resource
Damage Assessment Technical Report:
Evaluation of Potential Exposures and Injuries
to Colonial Birds in Coastal Louisiana Caused
by the 2010 *Deepwater Horizon* Oil Spill**
Technical Report
Draft

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1. Introduction and Summary

This technical report describes our characterization of injury to colonial nesting birds from *Deepwater Horizon* (DWH) oil in coastal Louisiana. The exposure to oil and response activities resulted in injuries to colonial breeding birds in Louisiana coastal habitats. Quantifying these impacts is difficult given the sources of uncertainty to measure avian mortalities (IEc, 2015). By providing estimates of the number of colonial breeding birds potentially exposed to oil, we provide some bounds on the potential for this type of avian injury.

To investigate the potential effects of DWH oil on colonial birds in Louisiana, we reviewed various datasets (e.g., colonial breeding bird abundance, shoreline oiling) to evaluate potential exposures and injuries of colony birds among Louisiana coastal basins between May and July 2010. We focused on specific colonies where available data allowed more detailed analyses to illustrate the convergence of oil on island colonies, and likely exposures and injuries. Our analysis indicated decreases in abundance at Louisiana colonies from May to June that had nesting population estimates prior to and after the arrival of oil at the colony and surrounding marsh.

Our synthesis of available data illustrated a likely contribution of DWH oil exposure and response disturbances to observed declines in abundance during 2010 at some bird colonies in Louisiana; however, we did not quantify the degree and extent of injury. The actual proportion of the colonial birds present that came into contact with DWH oil, and the extent of oil exposure, is uncertain because they were not comprehensively measured for all colonies throughout the spill period in 2010 due to difficulties in sampling around colonies (IEc, 2015). Consequently, complete quantification of the ultimate fate of oiled colony birds was not undertaken, but some proportions of the birds present in oiled colonies were injured due to the DWH oil and that injury was not quantified.

Although the specific injury to colonial nesting birds is largely unquantified, bird colony restoration in complex coastal marsh habitats such as those that were oiled would result in restoration to these island colony habitats that support regionally and globally significant abundance of breeding birds (Remsen et al., 2015).

2. Description of the Resource and Context for the Analysis

Coastal Louisiana is critically important for colonial nesting waterbirds in North America. Nearly all of coastal Louisiana is classified by the National Audubon Society as Important Bird Areas at state, continental, or global levels (Audubon, 2015; Figure 1). Louisiana's coastal zone contains the largest river delta system on the continent, the largest contiguous marsh complex in the conterminous United States, and has several remote islands. These isolated islands located



Figure 1. All coastal basins in Louisiana are recognized as Globally Important Bird Areas by the Audubon Society of America.

Source: Audubon, 2015.

adjacent to highly productive wetlands and nearshore marine habitat make coastal Louisiana attractive to millions of nesting birds each spring and summer (Gosselink, 1984). The remoteness of many islands from larger land masses offers bird nesting habitat that is free of most predators (Greer et al., 1988). The remoteness also reduces anthropogenic disturbances from many sources including vehicles, industry, fire, foot traffic, and general visitation.

Wetlands and waterways in coastal Louisiana support a high biomass of various fish and invertebrate prey species that provide abundant food resources adjacent to nesting areas which support energy demands for foraging nesting birds. The presence of ideal nesting habitat adjacent to productive wetlands enhances the nesting and chick rearing attractiveness of coastal Louisiana. The resulting use of Louisiana's coastal habitats by colonial nesting waterbirds makes large densities of these species vulnerable to any impacts to coastal habitats including marine oil spills.

The timing of the DWH oil spill coincided with the colonial nesting bird season when hundreds of thousands of nesting birds were heavily packed onto many small remote islands on the edge of the Gulf of Mexico and exterior bays. During the DWH oil spill in 2010, Louisiana coastal habitats, including marsh areas that contain high numbers of island colonies, were extensively oiled (Wobus et al., 2015). Wildlife responders collected over 2,000 bird carcasses and live but impaired birds from colonies (and nearby areas associated with colonies) in Louisiana coastal basins in 2010 and 2011 (Figure 2). However, the number of carcasses and live birds collected during such searches represents a small fraction of the overall number of dead and impaired birds due to various factors, including carcasses sinking, being scavenged, or being missed by searchers, among other factors (IEc, 2015). Therefore, given the extensive overlap of oil and the large abundance of colonial nesting birds, the full extent of exposures and associated injuries to colony birds represents a largely unquantified yet likely significant portion of total avian injuries caused by the DWH oil spill.



Figure 2. Photograph shows 42 oiled Laughing Gulls and 1 oiled Tricolored Heron collected from Dry Bread Colony (east of the Mississippi River) on July 22, 2015.

Photo source: Louisiana Department of Wildlife and Fisheries.

The remainder of this report is structured as follows: We present data on the abundance of bird colonies reported in May and June 2010 and shoreline oiling data for May–July 2010 to establish the spatio-temporal overlap between oil and bird colonies in Section 3. We present case studies of individual colonies that illustrate the potential effects of oil exposure on bird abundance in Section 4. We present a summary of disturbances to bird colonies associated with DWH response activities in Section 5. Finally, we present a summary of our observations in Section 6.

3. Overlap between Colonial Breeding Birds and DWH Oil in Coastal Louisiana

In this section, we review data collected by the U.S. Fish and Wildlife Service (USFWS) on the abundance of Louisiana bird colonies during May–June 2010 in relation to data on the arrival and extent of surface and shoreline oiling to explore the possible extent to which colonial nesting birds were exposed to oil throughout coastal Louisiana.

3.1 Colonial Bird Abundance in 2010

In May and June 2010, USFWS conducted aerial surveys to collect data on bird abundance at many colonies in coastal Louisiana (Colibri and Ford, 2015). Estimates were made based on point counts of individual birds and nests by evaluation of photographs taken of individual colonies (Colibri and Ford, 2015). The results revealed a total estimated number of approximately 130,000 nesting pairs at surveyed colonies (Colibri and Ford, 2015). The majority of total colonial bird abundance in the northern Gulf of Mexico was observed in Louisiana (Colibri and Ford, 2015; Table 1). This number is likely an underestimate of total colony abundance in 2010 because surveys were flown in early May through mid-June, prior to peak abundance and nesting activity that typically occurs in mid- to late June (e.g., Shields, 2014; Burger, 2015).

Table 1. Total abundance (number of nesting pairs) for four exemplar species in 2010. These species were among the most injured (in terms of numbers of individuals) by the DWH oil spill (Colibri and Ford, 2015). No data for Mississippi or Texas were reported. ND: No data.

State	Brown Pelican	Laughing Gull	Royal Tern	White Ibis
Louisiana	21,836	42,072	38,446	5,687
Alabama	6,713	433	791	4,106
Florida	1,143	430	1,406	ND
Total	29,692	42,935	40,643	9,793
Louisiana % of Gulf of Mexico	74%	98%	95%	58%

Nearly half of the northern Gulf of Mexico shoreline that was oiled occurred in marsh habitats that included bird island colonies, and approximately 95% of the oiled marsh was in Louisiana (Michel et al., 2013; Figures 3 and 4). Furthermore, these habitats were exposed repeatedly to oil as it washed ashore over the 87 days that oil flowed from the wellhead (U.S. District Court, 2014).



Figure 3. Map of bird colonies in Louisiana surveyed by USFWS in 2010. Notice most are exposed to Gulf of Mexico and open bays. Note locations in reference to the oiling map (Figure 4) below.

During the DWH response effort, Shoreline Cleanup Assessment Technique (SCAT) teams did not assess oiling rates on many bird colonies. These areas were purposely omitted from assessment due to the presence and sensitivity of nesting birds and the desire not to cause additional disturbance and detriment to the birds. An example of this is Cat Island (also known as Mangrove Island) in Barataria Bay. The SCAT designation of oiling rate on this island is “NA,” which means the shoreline on this colony was not surveyed. In fact, this colony was heavily oiled (Figure 5) and demonstrates that SCAT oiling rates for Louisiana colonies are underreported.

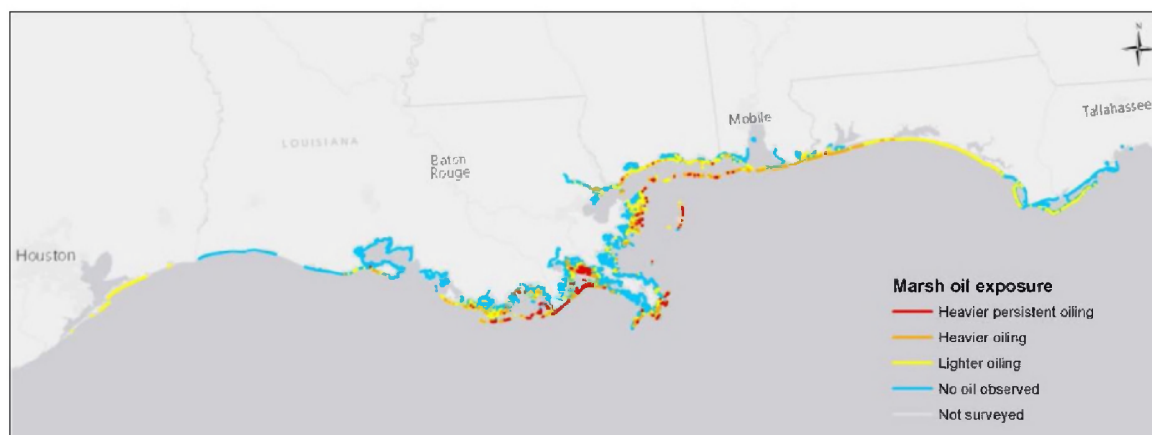


Figure 4. Shoreline oiling rates of Northern Gulf of Mexico from DWH oil spill. Higher oiling rates occurred in coastal areas in Louisiana that also have high concentrations of bird colonies (Figure 3). Note that “No oil observed” and “Not surveyed” refer to SCAT survey designations. The Trustees determined through the natural resource damage assessment sampling that a number of these segments were exposed to DWH oil.

Therefore, oil was present throughout coastal Louisiana colonies and in shoreline areas around bird colonies in May–July 2010 during the nesting season. The presence and extent of oil in these areas exposed some proportion of colonial nesting birds to oil.

3.2 Potential Pathways and Effects of Oil Exposure on Birds

DWH oil contaminated the water surface, marsh sediment, wrack, and shorelines that contain colonial bird colonies. Essentially every habitat niche that these birds require to survive was oiled, including marsh habitats for feeding, resting, breeding, and nesting. The oil remained in many of these locations for weeks and months, and became a persistent source of exposure for waterbirds in southeast Louisiana.



Figure 5. Cat (or Mangrove) Island was heavily oiled, but not surveyed by SCAT teams. (A) Heavily oiled sorbent boom and oil trapped between boom (foreground) and colony (background) were documented around the colony, thereby posing a persistent risk of oil exposure to colonial birds. (B) Oiled shoreline, oiled wrack, and oil in nesting material on the colony. Note young oiled pelican in nest.

Photo source: Louisiana Department of Wildlife and Fisheries.

Because heavily oiled areas had extensive oiling on the water surface, the soil, and vegetation, birds that were present in these habitats were likely exposed via multiple pathways. For example, birds came into direct contact with surface oil while swimming, resting, and feeding in the water. Oiled vegetation provided another direct route of exposure to birds walking, perching, foraging, breeding, nesting, tending to eggs or chicks, or hiding from predators. A third pathway of exposure would have been ingestion of oil when preening oiled feathers, and unintentionally ingesting contaminated soil or sediment while feeding. Many birds on the colonies stage at the colony's marsh edge prior to or just after attending their nest (Gosselink, 1984). Therefore, any oil on the edge of the colony that pooled and settled on vegetation would have provided direct exposure to adult birds and secondary exposure to chicks and eggs in the nest. Bird behavior during the nesting season in oiled environments provided additional exposure to young birds in 2010. The contamination of breeding adult birds during foraging activities, resting, or staging led to the transport of oil from feathers of adults to chicks and eggs in the nest. This transport and subsequent secondary impacts to chicks and eggs were observed during the summer of 2010 (Figure 6). As young birds began to leave the nest, the persistence of oil on and adjacent to colonies was particularly detrimental to fledglings. As they learn to fly, fledglings venture several times from the nest to the water's edge (Burger, 1996). This behavior likely exposed them repeatedly to oil, particularly if oil was present on land (i.e., in the soil, on the vegetation) and on the water's surface. Young birds are considerably less skilled at flying and walking and often stumble and fall down in and around the marsh edge as they attempt to scramble back onto land. The marsh edge was generally the location where most of the oil pooled and persisted for extended periods of time, particularly on vegetation. Consequently, fledgling behavior combined with the presence of oil throughout shoreline habitats exposed these young, vulnerable birds via multiple pathways (Figure 7).

Both internal and external exposure of birds to DWH oil caused a suite of adverse effects. These effects include feather damage and loss of function which leads to loss of buoyancy and loss of or labored flight capability. The results of these impacts, can lead to increased energy expenditure and mortality.

4. Case Studies of Potential Effects of Oil Exposure at Louisiana Bird Colonies

In this section, we focus on specific colonies that have sufficient abundance and oiling data to allow analysis of how the DWH oil spill might have affected bird colonies. These case studies are intended to illustrate the potential sequence and consequences of colonial bird exposure to DWH oil during the summer of 2010.



Figure 6. Breeding adults as well as their chicks were exposed to DWH oil. Chicks became oiled when in contact with oiled parent birds, as shown in the photograph above of oiled Brown Pelican chicks at Cat Island colony. Brown Pelican chicks should be covered in white down feathers at this stage of development.

Photo source: Louisiana Department of Wildlife and Fisheries.

4.1 Case Study of Colonies in Barataria Bay and East of the Mississippi River

Upon review of the data that was used to compile the Analysis of 2010 – 2013 Photographic Census Data From Waterbird Breeding Colonies in the Vicinity of the Deepwater Horizon Oil Spill report, we learned that the vast majority of colonies were surveyed only once during the May and June 2010 study period. However, five colonies were surveyed twice – once in May and a second time in June (Colibri and Ford, 2015). Of these five colonies that were surveyed twice, two were west of the Mississippi River in Barataria Bay (Queen Bess and Cat islands), and three were east of the river (Drum Island, Martin Island, and Breton Island). The repeated abundance estimates for these five colonies provided an opportunity to explore potential changes in abundance in relation to the timing of oil arrival at or near colonies.



Figure 7. Heavily oiled Laughing Gull chicks adjacent to an unoiled adult on a gull colony east of the Mississippi River. Chicks became oiled while learning how to fly. The repeated running back and forth from the shoreline to the central colony put them at repeated contact with oiled vegetation. This behavior exposes them more to oiling than adult birds that have the ability to fly into the colony and potentially avoid the heavily oiled perimeter.

Photo source: Louisiana Department of Wildlife and Fisheries.

As mentioned above, USFWS colony abundance estimates are likely underestimates of total colony abundance in 2010 because peak colony abundance in Louisiana typically occurs in mid-to late June. Consequently, abundance estimates for the five colonies that were surveyed twice should have increased between the May and June surveys as more breeding birds arrived at the colonies.

We calculated percent changes in abundance observed between the May and June surveys for Brown Pelican, Laughing Gull, terns (e.g., Royal Tern, Sandwich Tern, unidentified terns), and waders (e.g., Great Egret, Snowy Egret, Reddish Egret, Tricolored Heron, Roseate Spoonbill, White Ibis) at the five colonies mentioned above. We then compared the calculated changes in abundance of colonies located in Barataria Bay to those of colonies located east of the Mississippi River. Finally, we used SCAT and satellite measurements of surface oil data measured by synthetic aperture radar (SAR; Garcia-Pineda et al., 2009) in the respective basins to examine whether the arrival of oil coincided with changes observed in abundance on the five colonies with duplicative abundance surveys.

4.2 Changes in Colonial Bird Abundance

Combined abundance of Brown Pelican, Laughing Gull, terns, and waders observed at Queen Bess and Cat islands in Barataria Bay declined between 38% and 63% on average among species or bird groups, and by approximately 48% overall (Figures 8A and 8B). In contrast, combined abundance of the same species observed at Breton Island, Martin Island, and Drum Island east of the Mississippi River (Chandeleur/Breton Sounds) increased by approximately 68% overall (Figure 8C–8E). This increase in nesting pairs east of the Mississippi River included gains in Brown Pelicans at each colony.

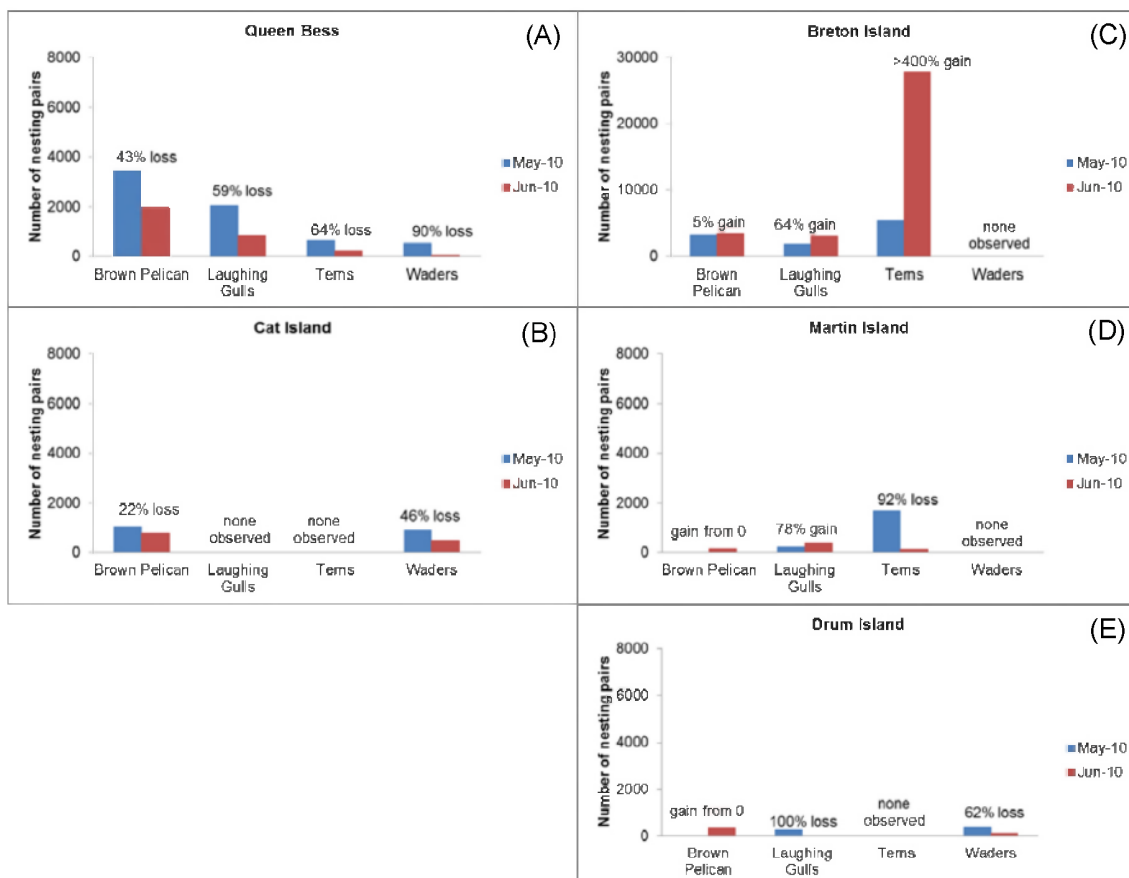


Figure 8. Comparisons of bird abundance estimates (number of nesting pairs) from May (blue bars) and June (red bars) from colonies located west of the Mississippi River (left column; A and B) and from colonies east of the River (right column; C–E).

4.3 Timing of Surface and Shoreline Oiling in Basins Relative to Changes in Colony Abundance

The differences in observed abundance between colonies in Barataria Bay and east of the Mississippi River align with differences in the timing of oiling in the two areas. Based on satellite-derived estimates of surface oil from SAR (Garcia-Pineda et al., 2009) and SCAT oiling data [obtained from the ERMA (2015)], oil first arrived at Louisiana nearshore areas in early May 2010 (Figure 9). However, significant oiling occurred earlier in open water areas within marsh habitats and along shorelines in Barataria Bay (i.e., west of the Mississippi River) (Figure 9A) compared to those east of the Mississippi River (i.e., Chandeleur/Breton Sound, Figure 9B).

Significant oiling of marsh areas, including island colonies, in Barataria Bay began in mid-May 2010 and continued throughout the summer. Thus, oil arrived between the May 7 and June 14 aerial surveys of Queen Bess and Cat islands (Figure 9A). This timing coincides with the observed decline in abundance at these colonies. In contrast, significant oiling of marsh habitats and island colonies, including Drum Island, Martin Island, and Breton Island, did not begin until late June through mid-July 2010, which was after the second abundance survey for these colonies (June 14; Figure 9B).

5. Disturbance

As oil threatened the Louisiana coastline, several response operations took place to prevent and clean oil from shorelines that likely affected colonial nesting birds on the colonies. Colonial birds use these small remote islands for nesting to avoid predators and disturbance (Greer et al., 1988). However, these same colonies received heightened attention (i.e., disturbance) during the DWH oil spill from boom deployment crews, clean-up crews, media, SCAT teams, and others. On many colonies, booms moved into the colonies, likely impacting nests, nesting habitat, and the chicks themselves (Figure 10).

Response activities and lack of timely, effective clean-up not only resulted in physical impacts to the colonies, but also likely enhanced oil exposure to the colonies and colonial birds. As noted above and shown in Figure 5, in many locations throughout southeast Louisiana, oiled booms were found retaining oil on the water against colonies for several days at a time (Figure 11). The daily persistence of oil, in combination with tidal fluctuations, likely enhanced oil exposure on shorelines, vegetation, and sediment at colonies. Additionally, lost nesting habitat destroyed by response activities, such as boom removal, would likely impact nesting success in future years.

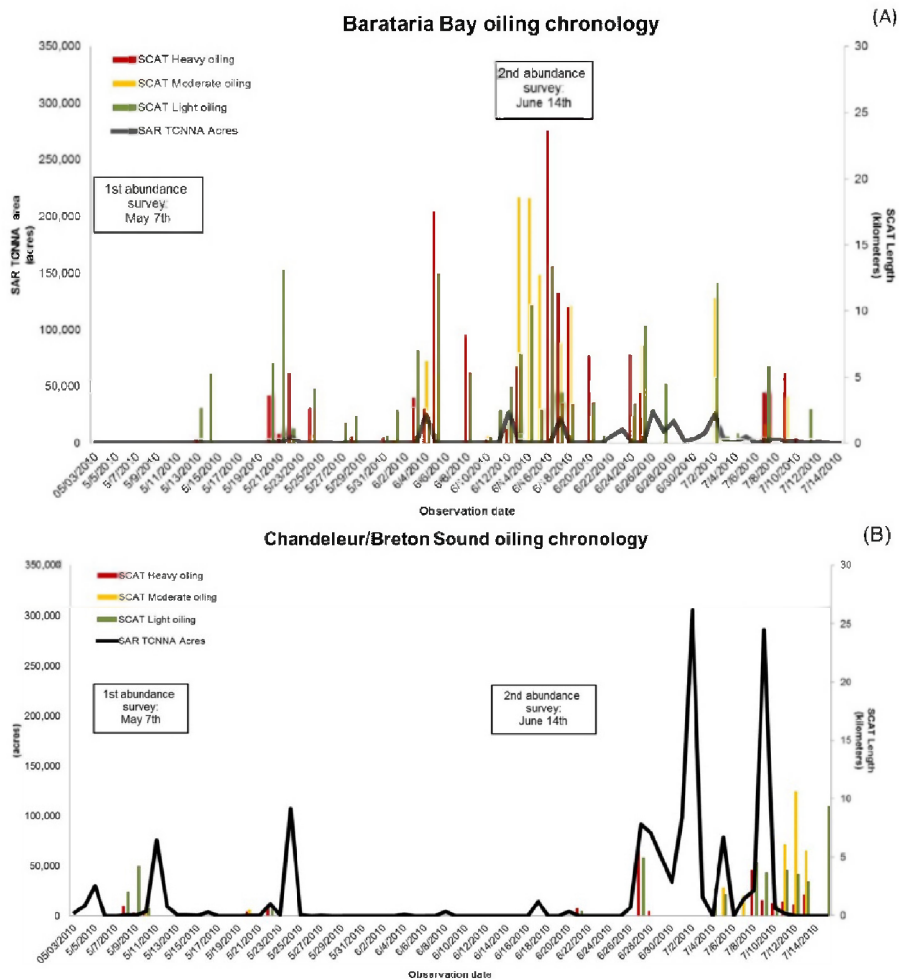


Figure 9. Area (black lines, left vertical axes) and shoreline lengths (colored lines, right vertical axes) detected by SAR and SCAT, respectively, for Barataria Bay (A) and Chandeleur/Breton Sound (B). Two abundance surveys were conducted on the same dates at two colonies in Barataria Bay and three colonies east of the Mississippi River (Chandeleur/Breton Sound), but the timing of extensive (in acreage of surface water and shoreline length) and heavy oiling (in shoreline length) occurred earlier and between the two surveys in Barataria Bay. Bird abundance of Brown Pelicans, Laughing Gulls, terns, and waders on colonies in Barataria Bay declined by approximately 48% overall, while abundance of the same species on colonies east of the Mississippi River increased by approximately 68% overall during the same time period (Figure 8). The difference in these two trends is at least partially due to oil exposure and resulting injury of colonial breeding birds at Barataria Bay colonies compared to the biologically expected seasonal increases in colony abundance where oil had not yet arrived at colonies east of the river.



Figure 10. Containment and sorbent boom washed ashore in Brown Pelican colony on the east side of Mississippi River. The boom is wrapped around pelican nests and fledglings on nests in the colony, which likely resulted in injuries to nesting birds, their nests, and their fledglings.

Photo source: Louisiana Department of Wildlife and Fisheries.



Figure 11. Oil trapped by a boom against Cat (or Mangrove) Island colony in Barataria Bay.

Photo source: Louisiana Department of Wildlife and Fisheries.

The impacts of these activities were not quantified due to the sensitive nature of the habitat and nesting birds and the inherent difficulties performing surveys in colonies. Consequently, response injuries would represent additional unquantified injuries to colonial birds.

6. Discussion

6.1 Summary of Findings

Our analysis of changes in colonial breeding bird abundance in coastal Louisiana that occurred coincident to the arrival and degree of oil at colonies illustrates some key findings:

1. The abundance of Brown Pelicans, Laughing Gulls, terns, and wading birds declined by approximately 48% overall at two colonies in Barataria Bay from May to June 2010. The

abundance of the same species at three colonies east of the Mississippi River did not show similar declines, and increased 68% overall during the same time period.

2. In normal conditions, colony abundance is expected to increase from May through late June when peak abundance is reached. Abundance data between May and June for colonies east of the Mississippi River were consistent with this expectation.
3. In contrast, abundance declines observed between May and June 2010 at colonies in Barataria Bay were inconsistent with expected biological trends. Significant oiling of open water and shoreline marsh habitats – including at and around colonies – occurred between the two survey dates in Barataria Bay, and likely was the primary driver in the observed decline.
4. Therefore, the arrival and degree of open water, colony, and shoreline oiling that occurred in May and June 2010 likely contributed to abundance declines observed among colonies in Barataria Bay. Neither significant oiling nor comparable declines in bird abundance occurred during the same period among colonies east of the Mississippi River (e.g., Chandeleur/Breton Sounds).
5. The trend of bird injury on colonies in response to heavily oiling and associated disturbance was likely experienced on other colonies with heavy oiling in southeast Louisiana. Due to the varying severity of oil impacts and disturbance, the actual severity and quantification of injury are uncertain but likely significant. Other colonies with lesser degrees of oiling likely also experienced some level of impacts as well.

6.2 Sources of Uncertainty

Our approach included sources of uncertainty that limited our analysis and results to being illustrative and not quantitative, including:

- ▶ Abundance data were not collected multiple times for most colonies in Louisiana, which limited our ability to directly compare May to June 2010 abundance estimates in relation to potential oil exposures to only five total colonies.
- ▶ SCAT data were only available for 25 out of 94 (27%) of colonies in coastal Louisiana surveyed by USFWS. Among colonies with SCAT data, 14 (56%) were heavily oiled during the summer of 2010. Oil reached and penetrated into marsh habitats in many areas that were not surveyed or where oil was not detected by SCAT teams (e.g., Cat Island; Figure 5). We did not quantify the extent and degree of oiling at all colonies and throughout the spill period.

- ▶ Although more than 2,000 carcasses and live birds were collected from colonies in Louisiana, the consistent monitoring of bird colonies during the DWH spill was significantly hindered by restrictions on response workers that were designed to prevent disturbance of breeding and nesting birds.
- ▶ In addition to potential effects of oil exposure, DWH response activities also affected colonies. Many colonies were encircled by various types of boom, some of which stranded onto colonies and injured nesting habitat. In some cases, oil overtopped smaller booms and was trapped between the shoreline of colonies and the boom. The actual magnitude of these response injuries was not quantified, but likely represents another significant portion of injuries to colonial birds.
- ▶ As with the colonial adult bird injury, we did not quantify fledgling injury. The direct loss of fledglings caused by oil exposures and the indirect loss of fledglings following the death of their parent birds are additional largely unquantified colonial bird injuries.

6.3 Conclusions

Our approach demonstrated spatio-temporal overlap between colonial breeding birds and extent degree of oiling around colonies, and suggested that oil exposure and associated disturbances at colonies in Barataria Bay from May to June 2010 contributed to the observed bird abundance decline. It is likely that this pattern occurred elsewhere and during other time periods, as bird abundance would have likely peaked in mid- to late June, and oil exposures in other Louisiana colonies occurred throughout 2010. This trend is especially true for other SCAT documented heavily oiled colonies such as Raccoon Island, the largest colony of nesting birds in the northern Gulf of Mexico, and others in Terrebonne Bay.

The actual proportion of hundreds of thousands of colonial breeding birds that USFWS reported to be present in May–June 2010 that came into contact with oil is uncertain because of difficulties in sampling colonies (IEc, 2015). Similarly, the degree to which birds were oiled is uncertain, and complete quantification of the ultimate fate of colony birds was not undertaken. However, some proportion of colonial birds was exposed to oil and disturbance from DWH-related activities. Further, some proportion of those birds would have been injured. Other sources of information support the conclusion that an unquantified number of colony birds were injured by the oil spill.

Although the specific injury to colonial breeding birds is largely unquantified, colony restoration in complex coastal marsh habitats such as those that were oiled would result in restoration to these island-dependent species.

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