Potential Offshore Oil Spill Impacts to Delaware

An oil spill occurring along the Mid-Atlantic could significantly impact Delaware's coastal communities and the resources upon which they depend. Oiling of Delaware's shoreline would reduce visitation to Delaware's beaches, adversely affecting beachgoers, recreational anglers and boaters, and the businesses dependent on these recreators as their primary source of revenue. An oil slick along Delaware's coast would also lead to the temporary closure of Delaware's commercial fisheries, reducing the landings revenue earned by the industry. In addition, depending on the location of a spill, oil blocking the entrance to Delaware Bay could disrupt commercial shipping activity and increase the costs incurred by vessels entering or existing the bay. A spill would also lead to increased costs for Delaware state agencies charged with aiding in spill response and cleanup.

To better understand these potential spill impacts to Delaware, the Department of Natural Resources and Environmental Control (DNREC) commissioned an oil spill risk assessment that estimates impacts to Delaware under multiple hypothetical oil spill scenarios. These scenarios vary according to spill size, season of the year, and whether mitigation measures (such as mechanical removal) are implemented to minimize spill impacts. Results for the following five spill scenarios off Delaware's coast provide key insights into the findings of the analysis:

- **Scenario 1:** 200,000-barrel spill in the summer, without mitigation measures
- **Scenario 2:** 200,000-barrel spill in the summer, with mitigation measures
- **Scenario 3:** 126-barrel spill in the summer, without mitigation measures
- **Scenario 4:** 200,000-barrel spill in the winter, without mitigation measures
- **Scenario 5:** 2,240-barrel spill in the summer, without mitigation measures

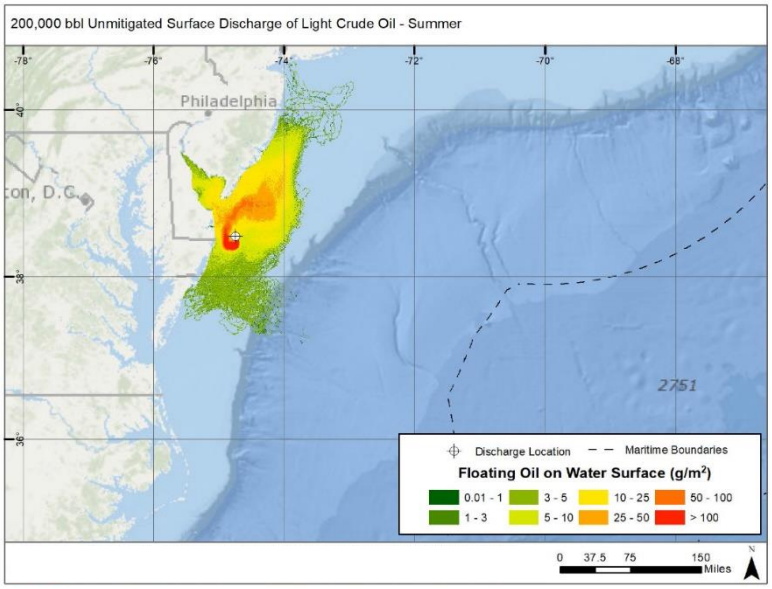
For each scenario, the fate and transport of spilled oil was modeled to assess the extent of shoreline oiling and the size and location of oiling on the surface of the water. These projections served as inputs for assessment of spill-related reductions in recreational activity and the associated welfare losses to recreators, reductions in commercial fishery landings, increased costs for maritime shipping, and spill response and cleanup costs incurred by state agencies. Complementing these estimates, the analysis also assessed the broader macroeconomic and fiscal impacts to Delaware, including changes in employment, state GDP, worker income, and revenues collected by the state.

MODELLING OIL FATE AND TRANSPORT

The SIMAP modeling system was used to simulate the fate and transport of spilled oil under each oil spill scenario. SIMAP quantifies oil trajectory, concentrations of oil hydrocarbons in the water column, areas swept by floating oil of varying mass concentrations and thicknesses, shorelines oiled to varying degrees, and the amount of oil settling to sediments. The SIMAP model has been validated with data from more than 20 large oil spills, including the *Exxon Valdez*, *North Cape,* and *Deepwater Horizon* oil spills, as well as hypothetical spills designed to verify the model.

The oil spill modeling results include two key outputs used for the analysis of socioeconomic impacts: (1) length of shoreline with oil exposure exceeding thresholds of concern; and (2) area of floating surface oil exceeding thresholds of concern. This analysis uses the former for the assessment of beach recreation and recreational fishing impacts and the latter for the assessment of impacts to commercial fishing, recreational boating, response activities, and shipping. Exhibit 1 shows projected surface oiling for the unmitigated 200,000-barrel summer spill occurring in the summer.

EXHIBIT 1. PROJECTED SURFACE OILING FOR THE UNMITIGATED 200,000-BARREL SUMMER SPILL



RECREATIONAL IMPACTS

Recreational losses were estimated for three types of coastal and marine recreation: (1) beach use, (2) recreational fishing, and (3) recreational boating. To assess the spill-related reduction in activity for each form of recreation, the projected shoreline oiling and surface slick for each scenario were overlaid on geospatial use data for each recreational activity. For areas with projected oiling above thresholds of concern, the analysis estimated activity-specific reductions in recreational user days in that area. Based on use reductions associated with past spills, the proportional reduction in user days varied according to the size of the spill, with larger spills resulting in more significant use reductions. Reductions in recreational use were valued according to estimates in the economic literature.

Estimates of lost recreational use value for each spill scenario are shown below in Exhibit 2. Losses under all scenarios are highest for beach use, followed by recreational boating, and then recreational fishing, due to differences in the estimated user day reductions across the three categories. Recreational losses are significantly higher under the larger (200,000 barrel) spill scenarios than under scenarios involving lower spill volumes. This reflects the more widespread oiling under these scenarios and the corresponding reductions in use. In addition, lost recreation use value is likely to be highest for spills occurring during the summer. This pattern is consistent with seasonal differences in coastal recreation (for example, 60 percent of beach use in Delaware occurs in the summer season). The results in Exhibit 2 also suggest that mitigation measures would not significantly reduce recreational losses under the 200,000-barrel summer scenario.

This report was prepared by IEc using Federal funds under award NA19NOS4190140 from the Delaware Coastal Management Program and the Office for Coastal Management (OCM), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the OCM, NOAA or the U.S. Department of Commerce.

EXHIBIT 2. SPILL-RELATED RECREATIONAL LOSSES (MILLIONS OF 2019$)

Spill Scenario	Beach Use	Fishing	Boating	Total Recreation
Unmitigated 200,000-barrel summer	$143.2	$1.5 to $3.5	$10.4 to $13.3	$155.1 to $160.0
Mitigated 200,000-barrel summer	$143.2	$0 to $0.2	$7.1 to $12.1	$150.3 to $155.5
Unmitigated 126-barrel summer	$31.9	$0.1 to $0.4	$0.1 to $3.6	$32.1 to $35.9
Unmitigated 200,000-barrel winter	$0	$0	$0 to $0.1	$0 to $0.1
Unmitigated 2,240-barrel summer	$66.9	$0.4 to $1.2	$4.6 to $8.2	$71.9 to $76.3

COMMERCIAL FISHING IMPACTS

To assess the commercial fisheries impacts of the spill scenarios identified above, the projected surface slick for each scenario was overlaid on gridded geospatial data depicting the distribution of commercial fishery landings. For areas where oiling was projected to occur, the analysis assumed the closure of the fishery in that area. Based on the fishery closures associated with past spills, the assumed duration of closure was expressed as a range and varied with the size of the spill, with larger spills resulting in longer closures.

Exhibit 3 presents the estimates of lost commercial fishing landings revenue by spill scenario. For each scenario, revenue losses are presented as a range, consistent with the range of closure durations specified for each scenario. Similar to recreation, fishery revenue losses are significantly higher under the larger (200,000 barrel) spill scenarios than under the scenarios involving lower spill volumes, due to a more widespread oil slick and longer fisheries closures under these scenarios. The reductions in fishery revenues are also likely to be higher for spills occurring during the summer than for spills in the winter. This reflects the timing of the open commercial fishing seasons for Delaware's more profitable fisheries. In addition, the oil spill modeling for the winter spill projected that spilled oil would be pushed southward away from Delaware fisheries by prevailing winds and currents. The results in Exhibit 3 also suggest that mitigation measures

Spill Scenario	Commercial Fishing Losses
Unmitigated 200,000-barrel summer	$3.4 to $11.3
Mitigated 200,000-barrel summer	$3.2 to $10.7
Unmitigated 126-barrel summer	$0
Unmitigated 200,000-barrel winter	$0.6 to $4.0
Unmitigated 2,240-barrel summer	$0.1 to $0.5

EXHIBIT 3. SPILL-RELATED COMMERCIAL FISHING LOSSES (MILLIONS OF 2019$)

This report was prepared by IEc using Federal funds under award NA19NOS4190140 from the Delaware Coastal Management Program and the Office for Coastal Management (OCM), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the OCM, NOAA or the U.S. Department of Commerce.

would not significantly reduce spill-related losses to Delaware fisheries under the 200,000-barrel summer spill scenario.

COMMERCIAL SHIPPING IMPACTS

The assessment of commercial shipping impacts examined the extent to which spilled oil blocking the entrance to Delaware Bay would delay vessels attempting to enter or exit the bay or divert them to an alternate route. For each spill identified above, lower and upper bound estimates of blockage duration were specified based on past spill events. For vessels diverted from their original course during the blockage, an average cost per vessel was calculated based on the difference between the original route (via Delaware Bay) and the diverted route (via C&D Canal). For vessels that remain in place rather than divert to an alternative route, the costs of delay are a function of the blockage duration.

Spill Scenario	Increased Shipping Costs
Unmitigated 200,000-barrel summer	$0.2 to $0.6
Mitigated 200,000-barrel summer	$0.1 to $0.4
Unmitigated 126-barrel summer	$0
Unmitigated 200,000-barrel winter	$0
Unmitigated 2,240-barrel summer	$0.1 to $0.3

EXHIBIT 4. SPILL-RELATED COMMERCIAL SHIPPING IMPACTS (MILLIONS OF 2019$)

Exhibit 4 presents the estimated increase in shipping costs for each spill scenario. These costs are presented as a range, bounded by the estimated closure durations specified for each scenario. Of the spill scenarios examined, the unmitigated 200,000-barrel summer spill is projected to result in the highest costs. This scenario would likely result in the blockage of the Delaware Bay for four to seven days and impact eight to 15 vessels. Mitigation efforts in response to a 200,000-barrel summer spill are projected to reduce the blockage duration by one day relative to the corresponding unmitigated spill event, blocking between seven and 13 vessels. Oil spills limited to 126 barrels are not expected to result in surface oil sheens significant enough to block the entrance to the Delaware Bay. Therefore, no costs are estimated for this scenario. Likewise, large 200,000-barrel spill events taking place in the winter are not expected to prevent passage through the Delaware Bay due to modeled oceanographic and atmospheric conditions diverting spilled oil away from the Delaware shoreline.

RESPONSE COSTS INCURRED BY DELAWARE STATE AGENCIES

To determine the potential response costs faced by the State of Delaware, a "response cost per barrel of oil spilled" value or range of values was estimated for each scenario. These estimates were derived from a response cost function obtained from the literature and, for larger spills, from response costs incurred following the *Exxon Valdez* and *Deepwater Horizon* oil spills. For each individual scenario, response costs specific to Delaware were calculated based on the fraction of surface oiling within the Delaware coastal zone relative to the surface oiling along all coastal states in the region.

This report was prepared by IEc using Federal funds under award NA19NOS4190140 from the Delaware Coastal Management Program and the Office for Coastal Management (OCM), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the OCM, NOAA or the U.S. Department of Commerce.

To isolate the portion of these costs borne by Delaware state agencies (as opposed to the party responsible for the spill or federal agencies), the analysis drew from historical data characterizing the distribution of costs between responsible parties, the federal government, and affected states.

The estimated response costs incurred by Delaware state agencies under each spill scenario are summarized in Exhibit 5. The range shown for each spill scenario reflects the range of response costs per barrel spilled. Consistent with the other impacts described above, response costs are highest under the unmitigated 200,000-barrel summer spill. At the other end of the spectrum, no response costs for oiling in the Delaware coastal zone are projected for the 126 -barrel spill scenario. In actuality, individual spills of this magnitude could result in response costs related to oiling in Delaware's coastal zone, but the oil spill modeling supporting this analysis suggests that these spills, in the specific location chosen for the spill scenarios, would likely result in little to no response for oiling along Delaware's shoreline. The estimates in Exhibit 5 also show no response cost impact for Delaware under the 200,000-barrel spill occurring during the winter. This is due to the winds and currents assumed for this scenario, which the oil spill simulations suggest would push spilled oil southward away from Delaware's coast.

EXHIBIT 5. SPILL RESPONSE COSTS BORNE BY DELAWARE STATE AGENCIES (MILLIONS OF 2019$)

Spill Scenario	Response Costs
Unmitigated 200,000-barrel summer	$63.5 to $117.2
Mitigated 200,000-barrel summer	$31.8 to $89.9
Unmitigated 126-barrel summer	$0
Unmitigated 200,000-barrel winter	$0
Unmitigated 2,240-barrel summer	$0.3

Exhibit 5 also highlights that mitigation can reduce the response costs incurred by the State. Based on the mitigation measures modeled for this analysis, mitigation reduces response costs by approximately 23 to 50% under the 200,000-barrel summer spill scenario.

OIL SPILL-RELATED ECONOMIC AND FISCAL IMPACTS

The assessment of economic and fiscal impacts focused on spill-related reductions in marine and coastal recreation and commercial fishing activity. Although spill-related changes in commercial shipping activity and spill response may have implications for the Delaware economy, the magnitude of these effects is highly uncertain, and they were therefore not estimated. To assess economic and fiscal impacts, the analysis applied the IMPLAN input-output model. In addition to capturing direct economic impacts for industries experiencing direct changes in output (e.g., hotels renting fewer rooms due to fewer vacationers visiting Delaware beach towns), input-output models capture spillover effects to other industries. The specific

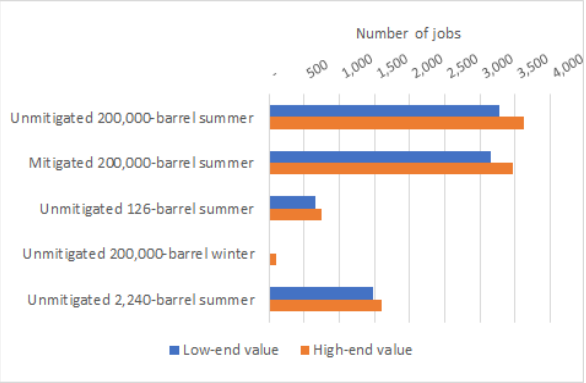
This report was prepared by IEc using Federal funds under award NA19NOS4190140 from the Delaware Coastal Management Program and the Office for Coastal Management (OCM), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the OCM, NOAA or the U.S. Department of Commerce.

economic and fiscal effects estimated with IMPLAN include changes in employment, state GDP, worker income, and state government revenue collections.

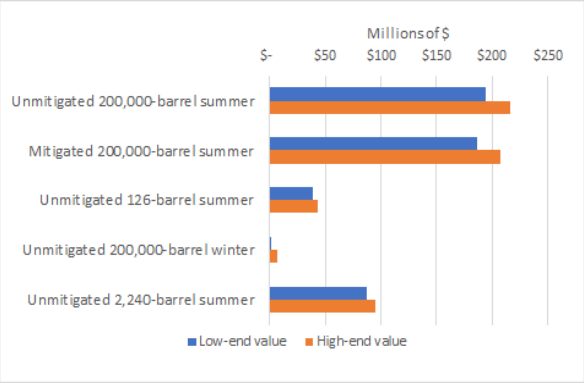
Exhibit 6 presents estimates of these impacts for each spill scenario. For each scenario, these impacts are presented as a range, consistent with the range of reduced recreational and commercial fishing activity associated with each scenario. These results highlight that the losses across all economic and fiscal metrics are significantly higher under the larger (200,000 barrel) spill scenarios than under the scenarios involving lower spill volumes. In addition, mitigation efforts are expected to reduce economic and fiscal impacts to Delaware by roughly 4% across all four metrics. The damage estimates also illustrate that economic and fiscal impacts are likely to be higher for spills occurring during the summer than for spills in the winter. This reflects the timing of the peak coastal recreational period as well as the open commercial fishing seasons for Delaware's more profitable fisheries.

EXHIBIT 6. SUMMARY OF ECONOMIC AND FISCAL IMPACTS

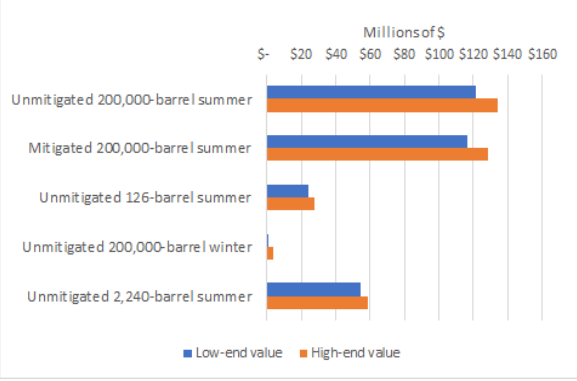
EMPLOYMENT IMPACTS



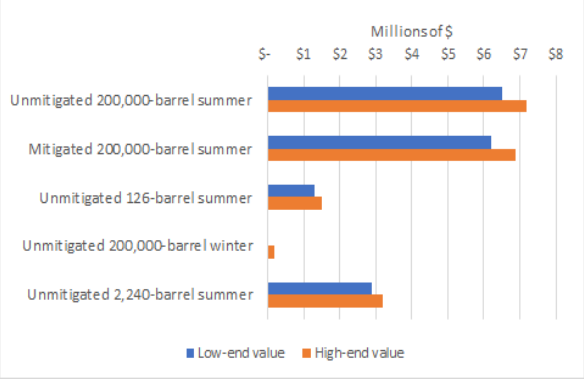
GDP IMPACTS ($M)



LABOR INCOME IMPACTS ($M)



STATE GOVERNMENT REVENUE IMPACTS ($M)



This report was prepared by IEc using Federal funds under award NA19NOS4190140 from the Delaware Coastal Management Program and the Office for Coastal Management (OCM), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the OCM, NOAA or the U.S. Department of Commerce.