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STUDY TITLE: University Research Initiative on the Effects of Offshore Petroleum Development in the Gulf of Mexico

REPORT TITLE: Effects of Oil Spills on Coastal Wetlands and Their Recovery: Year 4 Final Report

CONTRACT NUMBER: 14-35-0001-30470

SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREA: Central Gulf of Mexico

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CUMULATIVE PROJECT COST: $172,959

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KEY WORDS: Coastal marshes; coastal restoration; oil spills; petroleum hydrocarbons; *Spartina alterniflora*; *Spartina patens*; wetlands

BACKGROUND: Oil spills can have a significant short-term impact on coastal marshes, but the long-term effects and perhaps eventual recovery are not well documented. On 23 April 1985 a break in an oil pipeline near Nairn, Louisiana, resulted in the release of approximately 300 barrels of Louisiana crude oil into a brackish marsh in southeast Louisiana. Oil spill impact studies to date have not documented potential spill impacts on a brackish marsh and have not assessed rates of recovery beyond 1 to 3 years. This project expands on a previous short-term oil spill study in this brackish Louisiana marsh. In the initial study, both photointerpretation of aerial imagery and ground based vegetation stress measurements were used to assess the near-immediate (within the first year) impact of the oil spill on the marsh vegetation. The overall goal of this investigation is to (1) document the long-term recovery rate of the oil-affected brackish marsh, (2) to separate the effect of the oil spill on marsh deterioration from ambient (background) rates of marsh degradation, and (3) to test revegetative means by which recovery can be accelerated and the damage mitigated.

OBJECTIVES: (1) Document pre-spill land loss rates using historical aerial photography and ground-truth based assessments of vegetative cover; (2) document post-spill rates of marsh recovery using recent aerial photography, field ground assessments and vegetation stress analyses; (3) determine the effect of the oil spill on the study area's rate of deterioration; and (4) determine growth rates of transplanted marsh grasses and factors controlling transplant success in impacted areas for remediation strategy considerations.

DESCRIPTION: The pipeline break occurred in a brackish marsh located ca. 0.5 km west of Nairn Louisiana (29- 25' N latitude, 87- 36' W longitude). Approximately 300 barrels of Louisiana crude oil impacted 20 ha of marsh. A total of 68 permanent plots were established in the oil impacted marsh and adjacent control marshes at the study site in 1985 to quantify the impact of the spill on the vegetation. All 68 plots were resurveyed for plant recovery in the fall of 1989 and assessed for species composition, live and dead percentage cover, and residual oil impact.

Marsh land loss rates prior to and following the spill were generated by assembling acreage data derived from six dates of imagery into a digital GIS. Land cover changes between time intervals were determined and analyzed. Wetland land loss and gain maps were generated from these data sets.

In order to assess the health of the vegetation that had appeared to recover following the spill (as indicated by an increase in vegetative cover), plant photosynthetic response was measured in 24 of the permanent plots in August 1990. Half of these selected plots were initially heavily impacted by the 1985 oil spill and the other half were not impacted and served as controls.

A field transplant experiment was established in July 1991 and harvested in December 1992 to determine if those areas within the oiled marsh that had not recovered could be restored through the use of vegetative plantings and to determine if the failure of certain areas to revegetate was due to a residual oil effect or due to increased water depth inhibiting successful vegetative re-establishment. *Spartina alterniflora* transplants were planted at two elevations (ambient elevation of the dieback sediment surface, and at an increased elevation equivalent to that of the adjoining vegetated marsh surface) in association with either oil-contaminated sediment or oil-free sediment.

SIGNIFICANT CONCLUSIONS: Rates of wetland land loss in the oiled marsh during an eight year period that bracketed the spill indicated that the rates of land loss were within the historical range measured for this site and similar to the land loss rates of adjacent reference marshes. Thus, it would appear that rates of land loss in the oiled marsh were not accelerated by the initial impact of the oil to the vegetation. Field analysis demonstrated significant vegetative recovery of the impacted marsh four years after the spill. Plant photosynthetic response showed no significant differences between control and oiled plots for either *Spartina alterniflora* or *Spartina patens*. Results from

the field transplant experiment indicated that failure of certain areas to revegetate was due to increased flooding stress and not a residual oil effect.

Above- and belowground biomass, as well as numbers of living and total stems were significantly greater in the elevated plots, whereas there were no significant differences between elevated residual oiled plots or elevated control plots for any of the variables.

STUDY RESULTS: A total of fourteen (14) compatible dates of photography were acquired and nine (9) were mapped for further spatial analysis. In addition, the 1985 study site maps (produced in the original oil spill effect study) were digitized and entered into the project data base using AUTOCAD software. Current color aerial photography of the study area was also acquired and mapped. All acreage data collected from six dates of imagery were assembled into a digital GIS and aerial data with respect to plant recovery were determined and analyzed. Wetland land loss and gain maps generated from these data sets indicated that rates of wetland land loss in the oiled marsh during an eight year period that bracketed the spill were within the historical range measured for this site and similar to the land loss rates of adjacent reference marshes.

The 1989 resurvey of the 68 permanent plots showed a significant increase in total and adjusted live vegetative cover in the oil impacted marsh compared to the 1985 survey following the spill. Single degree-of-freedom contrasts on the 1989 data comparing the oil impacted area to all non-impacted areas revealed that although the impacted area had not attained as high a percentage of total plant cover as the other areas, the proportion of live healthy vegetation was comparable to the non-impacted areas and was indicative of recovery. However, there was also a tendency for vegetative plots that were initially highly impacted to still have higher levels of total saturated hydrocarbons in the soils in 1989.

In the plant photosynthetic response study, in addition to finding no significant differences in plant photosynthetic response between control and oiled plots for either *Spartina alterniflora* or *Spartina patens*, there were also no significant differences in interstitial water salinity, sulfide, and pH, or soil Eh between control and oiled plots, further demonstrating recovery of the impacted marsh.

Data from the field transplant experiment revealed that in addition to having significantly greater biomass and stem numbers, elevated plots also had significantly higher sediment surface redox potentials, and, hence, were less reduced than the ambient elevation plots. Ambient elevation plots had significantly greater interstitial ammonium concentrations and at one site significantly greater concentrations of interstitial sulfides than the elevated plots. Importantly, there were no significant differences between the elevated control plots and the elevated oiled plots for any of the variables, indicating that there does not appear to be a residual oil effect that is preventing the successful re-establishment of vegetation in these areas.

STUDY PRODUCTS: Mendelssohn, I. A., M. W. Hester, and J. M. Hill. 1993. Effects of Oil Spills on Coastal Wetlands and Their Recovery: Year 4 Final Report. A final

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