

BURNING OF OILED LOUISIANA COASTAL MARSH: FIELD EVALUATION

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ABSTRACT: Burning was evaluated as a method of remediating oiled Louisiana *Spartina alterniflora* salt marsh. A short-term reduction in plant biomass was observed; however, 1 year after burning, plant biomass was the same as in control plots. A comparison of the normal alkane profile in the soil residue following oiling to preburn oil showed a loss of more volatile hydrocarbons. Similar patterns were observed for aromatic hydrocarbons. More than half the aromatic hydrocarbons detected in the plume were derived from unburned hydrocarbons. Carbonyl sulfide and carbon disulfide were the main sulfur gases found in the smoke plume.

The susceptibility of coastal marsh habitats to an oil spill, recommended cleanup methods, and habitat recovery has been a topic of interest to various agencies. The potential impact of burning as a method of oil removal from marsh environments includes disturbance and death of biota from the direct effects of burning as well as the potential effects of residual hydrocarbons. Burning may also emit pollutants into the atmosphere. Previous studies have primarily addressed burning oil on water. There are limited studies assessing burning oiled marsh environments. The effect of burning on wetland plants, atmosphere contamination, and residue accumulation has not been adequately addressed for oiled Louisiana coastal wetlands.

Study site and treatment

A *Spartina alterniflora* salt marsh in Terrebonne Basin, Louisiana (Pointe au Chien, Wildlife Management Area), was oiled with South Louisiana crude in August 1995. The experimental design was a randomized block field design with a factorial treatment arrangement of four replications of the following treatments: (1) oiled and burned, (2) control, and (3) oiled. Each plot consisted of 2.5 m × 2.5 m enclosures made of aluminum-lined plywood retainers installed to a depth of 15 cm into the sediment to minimize oil leaks to the adjacent areas. Oil was applied at 2 L m⁻² slowly to the surface of each plot and was burned the day following oil application.

Vegetative recovery

Plant density and plant biomass were monitored for 1 year following burning of the oiled marsh. Burned plots contained less plant biomass than control or oiled plots at the end of the growing season following oiling (November 1995). However, 1 year after oiling (August 1996), there was no statistical difference in the plant biomass among the plots (Figure 1). The results showed that burning of oiled marsh results in only a short-term reduction in the production of *Spartina*

alterniflora.

Characterization of postburn residue

Comparison of the normal alkane chromatographic profile (m/e 85 for the pre- and postburn oil samples) taken from marsh soil shows a loss of the more volatile hydrocarbons. Compounds between nC-9 and nC-16 exhibited varying degrees of depletion, with the loss directly related to the individual compound's vapor pressure (volatility). A similar pattern was observed for the aromatic hydrocarbon (AH) profile (Figure 2). Overall, the effects of distillation were less than those reported for burning oil on water.

Characterization of the particulate/vapor sample

The AH (aromatic hydrocarbon) detected in the particulate and semi-volatile organic vapor samples taken from the smoke plume was found to be composed of a mixture of both petroleum- and combustion-derived AH. An AH profile comparison of the initial oil, the postburn residue, and the particulate/vapor sample is shown in Figure 2.

A modified fossil fuel pollution index (FFPI) was used to assess the relative contribution of petroleum-derived AH to combustion-derived AH. Pure petroleum-based oils generally have an FFPI approaching 1.00 (values between 0.90 and 0.98 are common). A dominance of pyrogenic or combustion-derived AH has values near 0.00. The initial oil and the postburn residue sample had a modified FFPI of 0.92 and 0.91, respectively. The particulate/vapor sample had a modified FFPI of 0.67, indicating that more than half of the AH detected was derived from unburned hydrocarbons transported within the plume.

Measurement of sulfur and other gases

Solid adsorbent preconcentration was used to collect sulfur dioxide, hydrogen sulfide, carbonyl sulfide, methanethiol, dimethyl sulfide, and carbonyl sulfide in the smoke plume. In the laboratory, solid adsorbent tubes were thermally desorbed and analyzed by a gas chromatographic method. A gas chromatograph method was also used to analyze methane, carbon dioxide, carbon monoxide, and nitrous oxide collected in glass gas sampling bulbs and Vacutainers.

Carbonyl sulfide and carbon disulfide were the main components in the smoke plume (Figure 3). Concentrations of sulfur dioxide were almost negligible. It was also established that concentrations of all measured volatile sulfur compounds were considerably higher in the smoke plume as compared to background. Carbon dioxide concentrations were in the range of 7,240 to 31,990 ppm. In contrast, carbon monoxide concentrations were below 100 ppm.

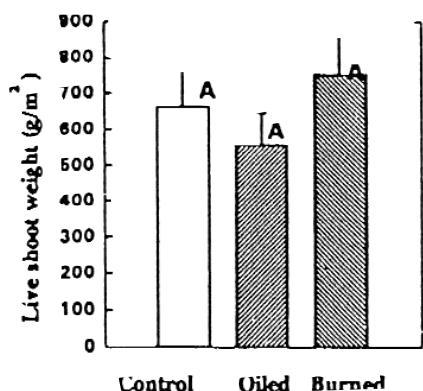


Figure 1. Live and dead shoot weights of *Spartina alterniflora*

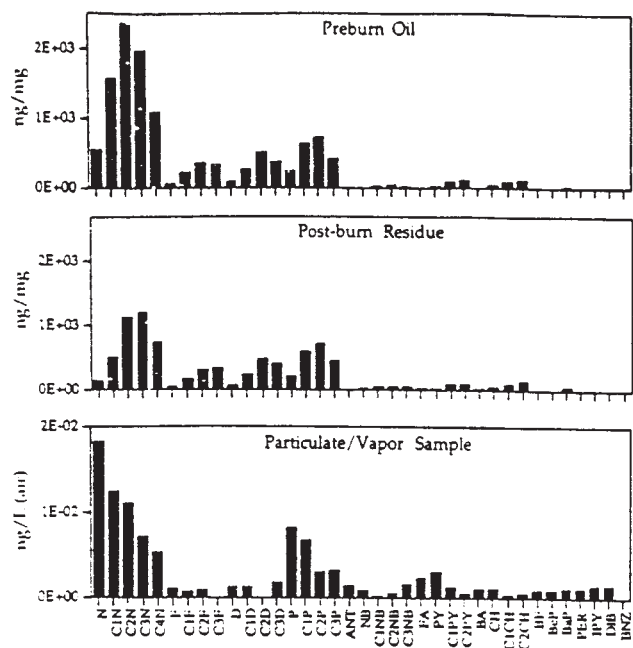


Figure 2. AH profile comparison of the preburn crude oil (top), postburn residue (middle), and the plume particulate/vapor sample (bottom). The preburn and postburn histogram plots are plotted on the same scale to highlight evaporative changes. The particulate sample is normalized to the most abundant AH target compound, naphthalene (N). (Key: N—naphthalene, CxN—alkylated homologues containing X number of alkylated carbon groups, F—fluorine, D—dibenzothiophene, P—phenanthrene, ANT—anthracene, NB—naphthobenzothiophene, FA—flouranthene, PY—pyrene, BA—benzo[a]anthracene, CH—chrysene, BF—benzo[b]fluoranthene and benzo[k]fluoranthene combined, BeP—benzo[e]pyrene, BaP—benzo[a]pyrene, PER—perylene, IPY—indeno[1,2,3-cd]pyrene, DIB—dibenz[a,h]anthracene, and BNZ—benzo[ghi]perylene.)

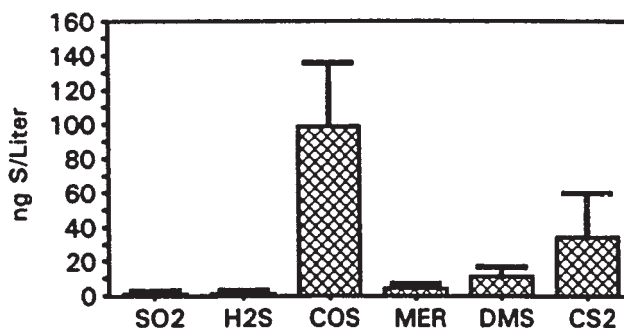


Figure 3. Concentration of different sulfur compounds in the smoke plume of in-situ burning of oiled salt marsh

Conclusions

Based on the variables studied, burning of oiled marsh appears to be a suitable remediation for removing oil. *Spartina alterniflora* recovered rapidly following burning. The smoke plume results from this experimental in-situ marsh burn are similar to results obtained from oil fires in Kuwait and plumes generated from burning diesel fuel.

Biography

R. D. DeLaune is a professor at Louisiana State University, Wetland Biogeochemistry Institute, who specializes in wetland environmental issues. He has conducted research on oil impacts in wetland ecosystems.