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BACKGROUND: This technical report on oil in mangrove ecosystems contains papers written by participants of a Workshop held August 1995 at McNeese State University and sponsored by the U.S. Minerals Management Service. It is the second in a series of three workshops which were supported under a cooperative agreement between MMS and McNeese State University. In the mangrove technical report experts with a variety of professional backgrounds address subjects including the effects of oil and modeling these effects, restoration of oiled habitat, solutions for remediating oil impacts.

OBJECTIVES: The technical report: (1) reviews the states-of-knowledge on oil spill impacts and discusses a possible model; (2) evaluates management practices of remediation and habitat restoration; and (3) identifies areas where future research is critically needed.

DESCRIPTION: The magnitude and spatial location of emergent coastal vegetation (including salt and brackish marshes and mangrove forests) in the Gulf of Mexico exceeds 6 million acres. Of this, 64% occurs in Louisiana and 19% in Texas. Well-developed mangrove forests dominate the low-wave-energy intertidal shoreline from

about mid peninsular Florida south through the Florida Keys. Numerous mangrove forests have been subjected to perturbation by oil spills in various parts of the world and this workshop was undertaken to address problems in terms of what is truly "known" (versus what is "asserted" from casual observations) of the effects of petroleum and remediation of these effects.

SIGNIFICANT CONCLUSIONS: Oil causes mortality and reduced growth of the dominant plant species in both marsh and mangrove habitats. However, there is wide variation in the degrees of "effects" that depends on: (1) the type and degree of "weathering" of oil spilled, (2) the plant species affected, (3) the frequency of spills, (4) the possible synergistic influences of other stressors such as high salinity or freezes, (5) local conditions (e.g., point in the tidal cycle, levels of rainfall and co-occurrence of storms and oil spills) and (6) effects of other biota (e.g., fiddler crab burrows can facilitate penetration of oil into the sediment).

Oil produces mutations in mangroves and probably (but this has not yet been studied) in marsh plant species. The rate of mutations in the genes that produce chloroplasts was directly, linearly, proportional to the soil concentration of polynuclear aromatic hydrocarbons (PAHs) derived from petroleum. These findings suggest to important possibilities.

Oil causes extensive mortality in invertebrate populations, probably affects fish that forage in the systems at high tide, and almost certainly disrupts many important ecological processes that they mediate in mangrove systems. These links have received little attention and an assessment of the effects of oil on ecological processes needs to be a research priority.

Oil soaks into mangrove sediments and probably affects soil microbial assemblages that are fundamental to detrital decay and re-mineralization of nutrients. These poorly-studied communities also fuel major food webs of the marsh and mangrove systems and the adjacent open water portions of the estuaries. Understanding the effects of oil contamination on marsh and mangrove sediment microflora is critical to truly understanding the long-term consequences of oil in these systems.

Oil may affect the outcomes of ecological succession through differential effects on marsh and mangrove species. Differential mortality or reductions in growth rates and reproductive fitness may have long-term consequences on community structure by changing competitive dominance and succession patterns. Few studies have addressed this problem and thus this is an area of needed research.

STUDY RESULTS: Bioremediation has been a topic of considerable management and research interest for some time. There are two fundamental ways that bioremediation (using microbes to degrade oil) is carried out. First, nutrients can be used in aerobic environments to stimulate growth of naturally-occurring microbial species that consume petroleum hydrocarbons. Second, laboratory cultures of bacteria and/or bacteria+nutrient amendments can be applied to sites that have been oiled.

Positive results (oil degradation) that may occur in lab experiments with such cultures rarely, if ever, are particularly effective in the field. However, this is an area for further research.

Remediation burning of oil is another mechanism that has been applied in a few instances in marshes. Burning has not been attempted as a oil spill management technique in mangrove forests and workshop participants believed that its use would probably be inappropriate in this system.

Oil dispersants and vegetation cleaners have received use in both real spill and experimental settings and a number of problems with use of these chemicals has been noted. Most notably, the toxicity of dispersed oil to most species is unclear.

Flushing oil using water under pressure and vacuuming oil holds promise for removing ponded oil from marsh and mangrove systems and should be evaluated further. Low pressure flushing with un-heated water may be an effective way to remove pooled oil without disrupting the sediment of the marsh or mangrove system.

Sorbents (materials that absorb oil) occur in a variety of types and have been used to blot oil from marsh or vegetation surfaces. Many of the most promising are "natural" materials such as matted, dried vegetation that may absorb and hold oil (therefore keeping it out of marsh or mangrove sediments) and maintain it in an aerated environment to increase microbial degradation of the oil.

Habitat restoration will be important after many oil spills. In some instances natural recovery of a remediated and "prepared" site may be all that is necessary. However, in many instances planting mangroves will greatly enhance the rate of initial mangrove cover and eventual forest development and succession.

STUDY PRODUCTS: Louisiana Environmental Research Center McNeese State University 1997. Managing Oil Spills in Mangrove Ecosystems: Effects, Remediation, Restoration, and Modeling. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. NTIS No. PB98-142268. Contract No. 14-35-0001-30690. MMS 97-0003. 81 pp.

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Service Gulf of Mexico OCS Region, Metairie, LA. NTIS No. PB96-185764. Contract No. 14-35-0001-30690. MMS 95-0063. 249 pp.