MASTER

EFFECTS OF OIL ON A TUNDRA POND

Final Report

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SUMMARY OF ACTIVITIES AND EVALUATION OF PROGRESS

There is a general interest in effects of oil on organisms and communities in nature, rather than in the laboratory. This is particularly important in the arctic due to overland transport of crude oil. A group of scientists have studied shallow tundra ponds and the effects of oil at Barrow, Alaska, for three field seasons.

It has been shown, (Miller et al. 1978) on tundra ponds, within 45 days after a uncontrolled oil spill on a whole pond, that 75% of the oil (by weight) was lost due to weathering. Class composition analysis of the Prudhoe Bay crude oil revealed that after an initial decrease in the aromatic fraction on day 1, that all fractions (i.e., saturate, aromatic, and asphaltics) lost weight at the same rate in 13 days.

Toxic effects of crude oil (Federle et al. 1978) revealed that the zooplankton Daphnia middendorffiana and Brachinecta paludosa were killed within 5 days in contained oil spills. This correlated with observations made on whole pond oil spills. In contained oil spill experiments, crude oil decreased the primary production of the water column by 90-100% within 5 days. Production recovered to 40-50% of the control levels by day 15. However, the composition of the phytoplankton was altered with the complete elimination of the Cryptophyte Rhodomonas minuta. The oil also caused a shift in phytoplankton from a predominance of Cryptophytes to Chrysophytes.

It was also shown, (Bergstein and Vestal 1978) that in contained oil spills, the biodegradation of oil could be enhanced with the addition of an oleophilic phosphate detergent. This was revealed by an increase by two logs in the number of oil degrading bacteria in the presence of the detergent. ^{14}C -labeled hydrocarbon degradation by the indigenous microflora of the water column and sediment revealed that the saturate fraction of oil was degraded before the polyaromatic fraction of oil. Apparently, the addition of an oleophilic phosphate detergent may be an important tool to use to increase the biodegradation of crude oil as well as to disperse the oil on arctic waters.

A three year study of two spills in tundra ponds at Barrow showed that oil has a highly specific impact on the benthos (Mozley and Butler 1978). Instead of a toxic effect on the entire community, as occurred with the crustacean zooplankton, certain insect species inhabiting the vegetated margins of the ponds were eliminated. Physical entrapment by the floating oil slick or the film coating stems of emergent sedges and grasses appeared to cause this mortality, and species specific behaviors may be responsible for the observed selectivity. Recovery of affected populations may take years due to the long life cycles of arctic insects (Mozley and Butler, in press), and the poor dispersal capabilities of many arctic species. Large scale spills covering many contiguous lakes and ponds could have especially long lasting impacts.

List of Publications

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