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OIL DISPERSANTS AND WILDLIFE

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Chemical oil dispersants are used routinely throughout the world. The most notable exception is in the United States which has discouraged their use. The improper use of large amounts of highly toxic dispersants at the wreck of the *Torrey Canyon* in 1968 (Smith 1968) was largely responsible for this cautious attitude toward oil dispersants. Field testing of chemical dispersants in the territorial waters of the United States began in September 1978, with tests off the coast of southern California sponsored by the American Petroleum Institute and the Southern California Petroleum Contingency Organization (Smith and Holliday 1979). The tests were designed to evaluate dispersant effectiveness, application procedures, and effects of chemically dispersed oil on marine organisms. The U.S. Environmental Protection Agency (EPA) has approved several dispersants for use in the United States when necessary. This approval means that oil spill response coordinators may be confronted with an increasing number of proposals to use chemicals to disperse oil.

GENERAL INFORMATION

Oil dispersants are manufactured by many chemical companies and marketed under trade names that do not describe the chemical composition or the appropriate uses (open sea, beach, method of application). The manufacturer may make specific recommendations about application methods, but information about effectiveness should be obtained from testing laboratories such as the Warren Springs Laboratory in England or regulatory agencies such as the EPA. Oil dispersants are referred to as either "conventional" or "concentrated." The conventional type consists of a surfactant, hydrocarbon solvent, and a chemical stabilizer. New conventional dispersants have less aromatic hydrocarbons in the solvent and the surfactant is more biodegradeable than the older types (Swedmark et al. 1973). Concentrated dispersants are a mixture of several surfactants and small amounts (5 to 10 percent) of additives which serve to stabilize the surfactant mixture, inhibit rust, etc. (Margaret Walsh, personal communication).

Oil dispersants can be applied from aircraft, boats, or by the use of portable sprayers. Conventional dispersants and some concentrated dispersants require mixing after the dispersant is sprayed on the oil slick. This is usually accomplished by a boat, by objects tethered behind a boat, or by high pressure water spray. Concentrated dispersants classified as "self-mixing" (e.g., Exxon Corexit 9527) require no additional mixing. Self-mixing

dispersants supposedly break oil into fairly homogeneous particles $\leq$ 1 micron in diameter which have a rise velocity of zero (Canevari 1975). Dispersants that are not self-mixing produce oil particles that are heterogeneous and vary in size from 10 microns to several millimeters. These particles will return to the water surface unless there is considerable wave action.

ADVANTAGES AND DISADVANTAGES OF DISPERSANTS

Research on dispersant effectiveness and on the biological effects of dispersed oil has been limited. Most of the information available comes from laboratory experiments which are often difficult to relate to field conditions. Although statements of advantages and disadvantages of using chemical oil dispersants are based on conclusions derived from inadequate information (Exxon Production Research Company 1978), it is appropriate to present the most commonly reported characteristics of dispersant use.

The advantages of using dispersants to control oil spills include:

1) Dispersants remove oil from the water surface by dispersing the oil into the water column. This eliminates the fire hazard, air pollution from volatilization, and the threat of serious oiling for water birds; and accomplishes the cosmetic improvement of removing the oil from sight.

2) The dispersion of oil prevents the formation of water-in-oil emulsions ("chocolate mousse") and tar balls. Water-in-oil emulsions are particularly difficult to deal with because the emulsified water causes an increase in the volume of oily material that must be removed from shorelines and the emulsions do not respond well to dispersants (Canevari 1975).

3) Dispersed oil will not adhere as well to shorelines, plants, and animals as will nondispersed oil. Dispersal, therefore, is an important consideration when oil is expected to reach intertidal areas, beaches, islands, or large concentrations of birds.

4) Dispersants increase the surface area of the spilled oil, permitting more rapid weathering and biological deterioration (Wells and Keizer 1975).

The disadvantages of using dispersants to control oil spills include:

1) Oil dispersants cause the concentration of oil in the water column to increase rapidly, with a corresponding increase in toxicity. The increase is temporary, but species not affected by the floating oil may be affected by the dispersed oil (Swedmark et al. 1973), Wells and Keizer 1975, Linden 1976, Dalla Venezia and Fossato 1977, Trudel 1978), thus increasing the short-term

biological impact in intertidal areas, shallow estuaries, and wetlands.

2) Dispersant-treated oil may penetrate deeper into sand and gravel on beaches and cause more oil to be lodged below the beach surface than would occur with untreated oil (Hayes and Gundlach 1978).

3) Dispersants may not work as well as expected. Experiments have shown that more dispersant is usually needed to satisfactorily disperse the oil than the manufacturers suggest (Swedmark et al. 1973, Linden 1975, Wells and Keizer 1975, Gill 1977, Dalla Venezia and Fossato 1977, Smith and Holliday 1979). This reduced effectiveness may be caused by bad weather, application problems, inappropriate use of the dispersant, insufficient water turbulence to keep oil particles from rising, or overly optimistic estimates of dispersant effectiveness by the manufacturer.

4) The use of chemical dispersants is basically unappealing to wildlife biologists. Dealing with environmental contamination by a toxic substance whose biological effects are only partially understood is difficult. To deal with such a contaminant by applying large amounts of another toxic substance whose effects are also only partially understood may appear to be a risky venture.

It is clear that decisions on the use of dispersants should be made carefully on a case-by-case basis.

EFFECTS OF OIL DISPERSANTS ON BIRDS

Little was known about the effects of oil dispersants or chemically dispersed oil on birds until experiments were initiated at the Patuxent Wildlife Research Center in 1978. I will briefly present the results of a recently completed study of the effects of Corexit 9527 dispersant and oil/Corexit 9527 mixtures on egg hatchability. I also will describe two other studies that are in progress. The egg hatchability study will be reported in detail elsewhere (Albers, in preparation).

In the egg hatchability study, artifically incubated eggs of the domestic mallard (*Anas platyrhynchos*) were treated on the sixth day of incubation with 1, 5, or 20 microliters (μl) of Prudhoe Bay (Alaska) crude oil, Corexit 9527, a 5:1 oil/Corexit 9527 mixture, or a 30:1 oil/Corexit 9527 mixture. All were applied to the surface of the egg with a microliter syringe. Nothing was applied to the control eggs. All four substances caused a significant ($P \leq 0.01$) reduction in egg hatchability at the 20 μl level. Corexit 9527 and the 5:1 oil/Corexit 9527 mixture also caused a significant reduction in egg hatchability at the 5 μl level. The 5:1 oil/Corexit 9527 mixture caused the death of embryos earlier than did the Corexit 9527 and the 30:1

oil/Corexit mixture. These results indicate that: (1) Corexit 9527 is at least as toxic to bird embryos as Prudhoe Bay crude oil, and (2) oil/Corexit 9527 mixtures are toxic to bird embryos but the degree of toxicity probably depends on the mixing ratio. However, it is not known whether oil/dispersant mixtures in the form of minute particles dispersed in water can be transferred to bird eggs or whether these dispersed particles pose any threat to adult birds.

One of the two ongoing dispersant studies deals with the transferability of chemically dispersed oil to bird eggs and the effects of dispersant and chemically dispersed oil on bird breeding behavior. Breeding pairs of mallard ducks are being exposed to Corexit 9527, Prudhoe Bay crude oil, a 10:1 crude oil/Corexit mixture, or no contaminant. The test substances are applied to the surface of water in water troughs located in each pen. The substances are applied during the first week of incubation, remain on the water for 2 days, and then are removed for the remainder of the incubation period. Nests from each experimental group are being monitored for nest and egg temperatures as an indirect measure of incubation behavior.

The other ongoing dispersant study concerns the effects of chronic ingestion of dispersants and crude oil/dispersant mixtures. Mallard ducklings are being fed duck starter mash containing either 1.5 percent Prudhoe Bay crude oil, 1.5 percent of a 10:1 water/Corexit 9527 mixture, 1.5 percent of a 10:1 crude oil/Corexit mixture, or no contaminant. The ducklings will be fed these diets from hatching until they are 18 weeks old. All birds then will be placed on clean feed through the end of their first breeding season. Information will be gathered to evaluate mortality, growth and development, liver and kidney damage, dehydration, hormonal profile, and egg production.

SUMMARY

Chemical oil dispersants currently are being evaluated as a method of oil spill control in the United States. Dispersants remove oil from the water surface, prevent the formation of water-in-oil emulsions, reduce the ability of oil to adhere to objects, and permit accelerated deterioration of the oil. However, chemically dispersed oil also has a greater short-term toxicity and a greater ability to penetrate sand and gravel beaches than does nondispersed oil. In addition, chemical dispersants seldom work as well as expected and, from a biologists's viewpoint, they are an undesirable method of oil spill control. Decisions on the use of dispersants should be made carefully on a case by case basis.

Corexit 9527 was found to be at least as toxic to mallard embryos as Prudhoe Bay crude oil. The toxic effects of crude oil/Corexit 9527 mixtures appear to increase as the amount of dispersant increases. Studies are underway to examine the transferability of chemically dispersed oil to bird eggs, the effects of dispersant and chemically dispersed oil on bird breeding behavior, and the effects of ingested dispersant and crude oil/dispersant mixtures on avian physiology.

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