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THE 50-MILE BALLAST-OIL DUMPING PROHIBITED ZONE OFF ALASKA, RECONSIDERED IN THE LIGHT OF AVAILABLE DATA GLEANED FROM SIGNIFICANT INCIDENTS

CLEAN WATER

FEDERAL WATER QUALITY ADMINISTRATION
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CORVALLIS, OREGON

THE 50-MILE BALLAST-OIL DUMPING PROHIBITED ZONE OFF ALASKA RECONSIDERED IN THE LIGHT OF AVAILABLE DATA GLEANED FROM SIGNIFICANT INCIDENTS

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DEPARTMENT OF THE INTERIOR

In its assigned function as the Nation's principal natural resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.

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INTRODUCTION

This paper on the 50-mile ballast dumping prohibited zone consists of four sections: (1) Simplified statements of biological and chemical knowledge and understanding of petroleum pollution in the Alaskan environment based on what may be considered as having been learned, or at least inferred, from observation and experience in spill areas combined with such scientific data as was available; (2) abbreviated statements of information deficiencies for analysis of the Alaskan situation; (3) discussion of the 50-mile prohibited zone; and (4) references utilized.

INCIDENTS AND INFORMATION GLEANED

Santa Barbara (Southern California)

In the well publicized Santa Barbara oil pollution incident commencing January 1969, a detailed and well documented biological and ecological survey was conducted by various groups and the results compiled (Battelle, 1969).

One noteworthy observation from the point of view of analysis of an oil dumping prohibited zone was recorded:

"A weather bureau meteorologist estimated that downwind oil slick drift ranged from 10-20% of surface wind velocity, and stated, ...'instances of skin layer shear were noted with surface oil moving rapidly past nearly stationary free floating debris suspended less than half an inch below the water surface.' The above is in contrast with the experience in the Torrey Canyon incident during which the oil movement averaged 3.3-3.4% of the wind velocity."

The complication here is obvious that kind of petroleum, prevailing temperature, and density, and other current, offshore versus channel and high seas movement, have not been identified for purposes of their comparison. However, it is well to consider what the situation would be should significant differences in average wind induced movement occur.

It was fortunate that the area in question had been the subject of extensive marine flora and fauna studies so that when studies of the four basic areas of petroleum release consequences:

(1) Sea birds

(2) Intertidal and nearshore communities

(3) Offshore and benthic communities

(4) Marine mammals

were carried out, before and after comparisons were possible, even though their specific applicability to Alaskan waters may be moot.

Sea birds

Considerable data were amassed on the sea bird consequences; the important observation was the extrapolation (p. 12.8) from the bird handling requirements noted at Santa Barbara (1000 birds treated) to Torrey Canyon (5800 birds treated) to the facilities for handling and treating birds that would be required should a major release occur in Cook Inlet in May or September. The estimate made was 100,000!

Intertidal and nearshore communities

Based on periodic, before and after observations it was concluded that no significant acute effects on intertidal organisms were observed at any of the ten stations surveyed.

After some months some possible effects may have begun to manifest themselves (apparent degradation of fauna; increase in flora) which were interpreted as possible long-term effects of the oil's toxicity. This seems a rather short period over which to encounter long term effects. No fates or mechanisms were considered.

One observer who had previously observed the Torrey Canyon and the Ocean Eagle effects of crude petroleum spills was quoted to the effect that lack of intertidal effects was attributable to the use of only limited amounts of dispersant chemicals and because crude oil itself was not highly toxic to the macrofauna and flora observed.

Later observations of intertidal organisms indicated that except in a few still badly polluted areas the species examined were reproducing normally.

Offshore and benthic communities.

Studies were made of pelagic fish eggs and larvae, phytoplankton and zooplankton, spawning, and hydrographic conditions: Nutrient concentrations, dissolved oxygen, light transmittance.

No changes were observed in the presence or absence of anchovy larvae and eggs and of some other fish species, and phytoplankton and zooplankton did not seem adversely affected.

There were no observed detrimental effects on fauna, benthic organisms, and pelagic fishes, though mysid shrimp may have suffered transient decrease.

Marine mammals

While much was written, early on, about the doomed mammals, of which many had oil coatings, no significant damage was observed in these species (seals, whales). They cleansed themselves, apparently with no damage, but hair seals in Alaska were reported by seal hunters to have suffered from oil in their coats following the Kodiak incident. This is documented below.

Torrey Canyon Aftermath (England and France)

Detergents utilized by the British with some prior screening* for their chemical, physical, biological behavior were held to have been extremely damaging biologically, and also, not very useful in dispersing the oil.

Birds were the most vulnerable of surface species; seals and other marine mammals do not appear to have been directly

* The French local officials required eager salesmen to obtain clearances from local university workers based on biological screening for their proposed dispersants and beach cleaning materials. This example of prudent French bourgeois character is better understood, perhaps in terms of the advantage of a few more days of make ready time over their English cognates.

damaged either here or in the Santa Barbara case. Moreover, no apparent plankton damage occurred. No data were obtained on shellfish on the French coast as these areas were not invaded by oil (Smith, 1967).

However, observations, approximately 19 months later, of rocky shores (Biglane, 1968) showed limpets grazing on rock faces, cleansing the oil stains. Where the rocks had been cleansed by use of detergent, algae were prevalent but rock mollusca species had disappeared and not yet repopulated.

A particular marine worm, *Nereis*, useful as bait, was much more plentiful than before; it might be speculated that this change in species dominance was indicative of a pollutional stress effect, but it is based on the recollections of "the oldest inhabitants."

It was estimated by workers at the Marine Biologique à Roscoff that the Torrey Canyon effect on Brittany flora and fauna was destruction of the order of 10 percent of the biomass, but was now, 19 months later, about up to count, except for some decapod species about wiped out.

Cook Inlet (Alaska)

Cook Inlet, like Santa Barbara channel, is subject to long-term seep and short-term acute accidental input of petroleum from production facilities. A detailed analysis of the local situation within Cook Inlet from the point of view of input and biological and physical removal (Kinney, 1970) shows that while the accidental input of Alaskan petroleum is quite substantial (between equal to and twice the long term average seepage input of 10,000 gallons per year), degradation through the naturally occurring inoculum plus the very turbulent tidal situation is adequate to take care of the total annual input.

Rates of ultimate removal give estimated removal times of the order of a few months (2-10 months) and are principally biological, though tidal removal is significant. No estimate was made of the steady state inventory and compartmentalization. No ultimate pelagic damage was noted, though this is an important fishery with many species.

San Juan (Puerto Rico, semi-tropical)

The Eagle was the source of 30,000 tons of Venezuelan crude deposited off San Juan. It was reported in the Wall Street Journal that "an official of the Interior Department's FWPCA says that ideally, action should be taken within the first 10-12 hours, before volatile parts of the crude evaporate, leaving a tar-like residue." This is probably a misquote or at least an oversimplification of the remarks. The Torrey Canyon aftermath indicated that only rapid evaporation of the more volatile, more poisonous fractions (presumably mostly aromatic and presumably also more soluble) prevented an even greater biological catastrophe. It would seem at least equally justifiable to allow volatile fraction evaporation to proceed prior to addition of large amounts of additional chemical reagents in attempts to disperse the entire crude. Furthermore, our experience with successful handling of major spills is severely limited and there is no backup of basic research information available so that no specification of the ideal method and timing of various proposed procedures to handle the oil may be considered reliable at this time (May 1970).

Buzzards Bay (Massachusetts)

A barge carrying 14,000 barrels #2 diesel fuel went aground off Chappaquoint Point (Oil & Hazardous Material, 1970). Number 2 fuel oil is a fairly light fraction of petroleum and for a first approximation we may take it as resembling the early volatile fractions of crude (no specific original crude was specified) which are, generally speaking, more volatile, more soluble, and contain more toxic components. Estimates were that 4,000 barrels were lost with onshore winds keeping it concentrated in the harbor and estuary. We cannot conclude the results observed were entirely due to the chemical nature of the oil because the longer term concentration in closed areas by onshore winds complicates the situation.

The initial (first day) biological results were catastrophic, but what is worse is that oil has been detected in sediments at depth and preliminary indications are that the oil is causing the death of bottom organisms.

The natural oil content of surface layers in the ocean has been evaluated at a number of locations (Garrett, 1967). Large fractions of the oils which are ubiquitous on the surface and to 30 m. depth are of probable petroleum origin; it may be concluded that long term low level concentrations of petroleum products are prevalent in surface ocean and nearshore waters.

The basic chemical, temperature, wind and wave, and current data are available for the Northeast Pacific (Dodimead, 1968), and see also Figure 1, but detailed rates and mechanisms and fates have not been established for processes involving petroleum in the world ocean.

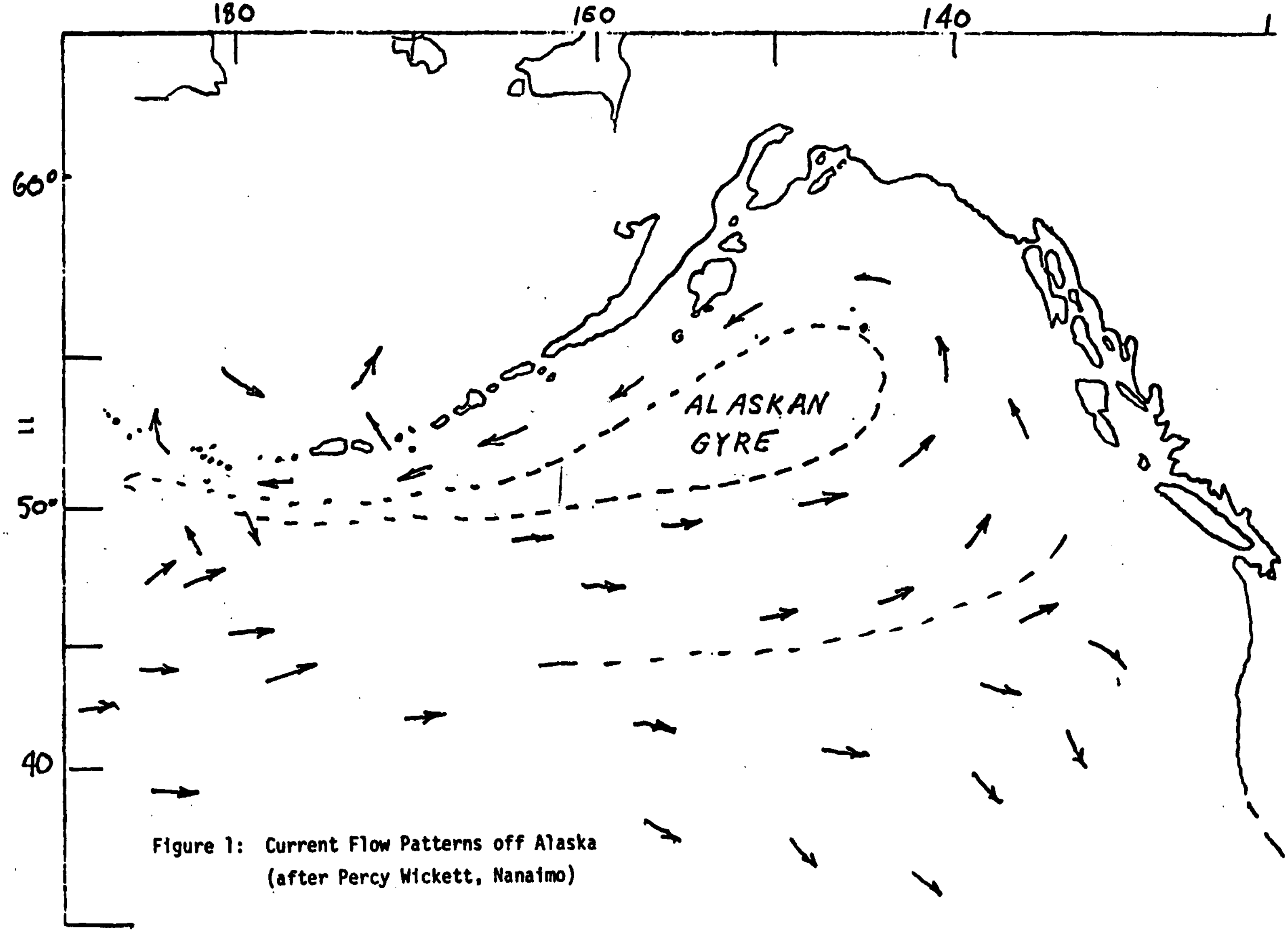

Figure 1: Current Flow Patterns off Alaska
(after Percy Wickett, Nanaimo)

INFORMATION DEFICIENCIES

The treatment of oils and other hazardous materials in the marine environment is not a well developed branch of knowledge. Most references to "oil" pollution indicate to this author that the "oily" character of the petroleum material is its overriding characterization quality; that is most superficial in terms of chemical behavior, and in fact is an extension of the original meaning of the word oil.* Be that as it may, it is essential that we recognize in any pollution incident involving petroleum, significant chemical, physical, and biological differences are to be anticipated.

The water quality standards to be maintained are not based on detailed knowledge of fates and mechanisms. (Water Quality Criteria, 1968).

Furthermore, the procedures available are, at best, emergency use only (Oil & Hazardous Materials, 1968) and do not purport to solve the ecological problems of oil in the marine environment.

"It is apparent that our knowledge of the physiological effects of various components of crude petroleum and of the factors that determine plant and animal growth and affect tolerances of marine species is deficient." (Galtsoff, 1968).

*Such extension leads to the embarrassment that we use the word oil for a tar or pitch substance that is obviously no oleum!

Since there are great differences in chemical composition of petroleums, it is essential to know, if intelligent action is desired, the petroleum composition, the physical and chemical environmental conditions prevailing, the biota in the area, and their probable response to the petroleum, and to the clean-up methods chosen from a list of methods available. All of this information is not only lacking in any organized manner, but due to the extreme emergency conditions prevailing during large spills, no previously reasoned experimental program has been mounted.* For example, it is possible that when DO (dis-solved oxygen) and available nitrogen nutrient are high, oil degradation rates will be high (given the requisite inoculum). But such detailed nutrient mechanisms are not well established and the coastal waters data seem non-existent.

A research proposal (Andresen, 1966) to identify and quantify all sources of petroleum pollution in Alaska takes on a new urgency at this time. It would have been useful to have had this material on hand prior to establishment of a prohibited zone distance.

*The usual descriptive biological observation - the number of tarred birds was estimated at 86,000 and some seals were alleged by seal hunters to have had their pelts ruined - would not seem very useful for long-term solution of marine petroleum pollution. Reference to - within the memory of the oldest inhabitants - may be quantitative with regard to their age group but not necessarily to their observations.

A more recent research proposal (Wagner, 1970), detailed in its approach to some specific chemical and biological oceanographic background and basic data essential to understanding responses to petroleum pollution, is now worth review and selection of some items for investigation, not only in Cook Inlet, but especially for all Alaskan coastal areas subject to petroleum pollution, viz: North Slope Coast, Valdez, Archipelago, Kodiak Island, Bristol Bay.

It would seem useful to coordinate the above two research projects. The probable areas of importance and the baseline evaluation should then ultimately be followed up for estimation of long-term response, fate and mechanisms, as a minimum recommendation.

Furthermore, it should be noted that a number of southeastern Alaskan bays, harbors, and coves were evaluated for prevailing conditions prior to July 1966. (Oceanographic, 1966; Silver Bay, 1957). At this time, a review of these areas for long term petroleum fates and mechanisms seems desirable.

A minor amount of information is available on needs for research and correctional work related to petroleum pollution control in southwestern Alaska (Alaska Water Laboratory, 1967).

DISCUSSION

Temperate, Tropical, and Arctic Zone Ecological Stress

One obviously important aspect of the combined biological and chemical effects of petroleum pollution considered as an ecological stress in Alaska is the great temperature difference as compared to temperate zones. Most of the available information seems addressed to temperate zones.

It has been recognized that the homeostatic resources of the tropical biota are less than those of temperate zone biota and that pollutional stress on these biota results in greater effects in the tropics. The question naturally arises, then, are ecological stresses of petroleum pollution expected to be more or less damaging in cold water areas than in temperate zone waters?

I believe, based on greater specialization of species, less favorable living conditions (as indicated by fewer species) that cold water species are, like tropical species, living further out on the limb of possible existence. If so, I would conclude more damaging situations as a result of pollution. This analysis is speculative at best.

Dispersants and Alaskan Ambient

The kinds of crude concerned and their possible differences in biological effects have been mentioned above. It is probable that similar questions will arise in the chemical sense. For example, Kuwait crude left some very recalcitrant chunks of tar and was easily distinguishable from Alaskan crudes. But, the toxicity, efficiency, and general physical chemistry of dispersants will be related to not only their own chemical identity, but also to that of the crude on which they are operant and on the marine environment prevailing there. Dispersants are frequently surfactants. The properties of surfactants in a marine environment, the micelle structure and windrow formation, interaction of hydrophobic and hydrophyllic substances with sometimes both in one molecule, the surface monolayers of oil materials and gas transmission dynamics, and the effects of all these on productivity and the resident biota are not immediate questions related to a prohibited zone evaluation. But they are important long term questions which must not only be investigated if solutions are sought to marine environment pollution problems, but which must also be kept in mind by the executive formulating agreements on prohibited zone lines.

Furthermore, it is easily conceivable that a dispersant, nontoxic and efficient in temperate zones will be far less useful in Alaskan waters.

So, in the face of many questions as yet unanswered, we conclude that the empirical approach to petroleum discharges in Alaskan waters seems indicated. There is certainly "oil" washed up on shore although we are assured no ballast slops or other discharges are made within the 50-mile zone.

The prevailing currents and the Alaskan gyre system are well documented (Figure 1). The fact that these materials do float in and that many birds die seems incontrovertible. But if the lighter fractions or the aromatic fractions have been previously dispersed by evaporation and solution - that is if the prohibited zone is far enough out to ensure enough time under any conditions of wind and current, the worst part of the problem may still be in existence at sea.

Because of variable time and temperature relations and heat transfer and solution rates, it is not practical to compute a theoretical time-line. Any ballast slops mixture can easily be handled at the dock. It is probable that on-board centrifugal separators are technically feasible. It is difficult, therefore, to justify a line closer than one which would certainly prevent concentration into the Alaskan shore system. Pending research and development which allows for contingencies and problems and ecological protection no rational case can be made for a rule other than that empirical observation of a line beyond which concentration into the Alaskan system does not occur.

The analogy to the Mediterranean petrol dumping problem is marked. The 1954 convention considered a 50-mile and a 100-mile discharge zone. But this is not meaningful in a land locked sea. The competitive mechanisms and fates of the oil

1. to shore
2. sink to benthic degradation by solution and dispersion
3. evaporation

ensure that a reasonable fraction will certainly pollute the near coastal waters and the beaches! (Girotti, 1968)

Most Alaskan commerce will near the end of its transport run close to Alaska and we must conclude that all of their dump will, as in the Mediterranean, go into the same three competitive mechanisms:

1. to shore via windrow and slick movement
2. sinking, solution, and dispersion - 50%*
3. evaporation - 20%*

Unfortunately, as we have noted above, no meaningful rate measurements on these mechanisms are available, no evidence is at hand of long-term cold water ecological disturbances attributable to fates and mechanisms of petroleum in various environments (this information is not available for temperate waters, either, it may be noted). (Blumer, M.) (Feldman, M. H., 1970).

An early study of seepage sources (California, 1959) concluded that the deposition of oil substances on a given beach may be expected to vary greatly from point to point on any given day and to vary greatly from day to day. Since these observations were of a nearby beach system subject to a fairly uniform seepage, it may be concluded that for oily substances commuting in from repetitious, but random, dumping at sea, at greater distances and in a more complex tide, and current, and archipelago system, these depositions will be even more random from day to day and from place to place. This prediction is in excellent agreement with observed "bird counts" on Kodiak beaches where observations ranging from 1 to 175 birds per mile of beach were made.

*Hypothetical computations based on Torrey Canyon experience.

The estimates of damage based on dead birds counted on short stretches of long archipelago coast lines must be considered approximate only (Morris, 1970).

The important observation here is that petroleum products apparently dumped at distances greater than 50 miles are still washing up into nearby shore waters and beaches in quantities sufficient to do considerable damage in a variety of economic and aesthetic and environmental considerations (Hickel, 1970).

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