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Project Summary

Sources, Fates and Effects of Aromatic Hydrocarbons in the Alaskan Marine Environment with Recommendations for Monitoring Strategies

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Information about polycyclic aromatic hydrocarbons in the Alaskan marine environment is relatively sparse. About 300 references were reviewed to create an assessment of the current state of knowledge on sources, fates and effects of oil-derived polycyclic aromatic hydrocarbons in cold marine waters.

This Project Summary was developed by EPA's Environmental Research Laboratory, Corvallis, OR, to announce key findings of a literature review that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The objective of the full report is to critically review what is known about the sources, fates and effects of polycyclic aromatic hydrocarbons (PAH) in the Alaskan marine environment. Based on this review, several information needs are identified and recommendations made for the design of research and monitoring strategies to fill these needs.

The specific areas reviewed are 1) the natural and anthropogenic sources of aromatic hydrocarbons in the Alaskan marine environment, 2) the physical, chemical and biochemical fates of these compounds in marine ecosystems, and 3) the bioaccumulation and biological effects of aromatic hydrocarbons in marine organisms.

Findings

The major point sources of polycyclic aromatic hydrocarbons (PAH) in the Alaskan marine environment are discharges of treated produced water, crude oil tanker ballast water and domestic/industrial sewage. These, as well as new point sources of PAH, can be expected to increase in number and volume as offshore reserves of oil and gas are developed and industrial activity in Alaska increases. Currently, these point sources contribute only a small portion of the total PAH entering the Alaskan coastal waters from all sources. Major non-point sources of PAH in Alaskan coastal waters and sediments are aerial deposition of particle-bound PAH derived from remote industrial and other combustion sources. Burning of wood for home heating and in controlled or wild forest fires may be major sources of airborne particulate PAH in some parts of Alaska. Additional important sources of PAH include erosion of peat and coal deposits and submarine oil seeps.

The composition of hydrocarbon assemblages in marine sediments of developed and remote areas of Alaska reveal a predominantly biogenic (natural) and pyrogenic (combustion) origin. Oil spilled in the ocean under arctic and subarctic conditions similar to those in Alaska tends to be quite persistent. In coastal areas characterized by high suspended sediment loads, such as Cook Inlet, the Beaufort Sea and Norton Sound off the Yukon River, PAH from spilled oil will adsorb rapidly to suspended sediment and be transported to the bottom, where they are quite persistent. Evaporation of low molecular weight aromatic hydrocarbons is slow at low water temperatures and is nearly completely impeded by ice cover.

The main mechanisms of removal of PAH and related hydrocarbons from Alaskan marine waters are evaporation, photochemical and chemical degradation, and metabolism by marine bacteria, fungi, phytoplankton, and animals. In Alaskan waters, these processes tend to proceed more slowly than at lower latitudes because of low ambient temperatures and low net incident solar radiation during much of the year. Thus, PAH introduced into Alaskan waters by natural mechanisms, intentional discharges, or accidental spills will tend to persist and may accumulate over time to high concentrations in Alaskan marine sediments.

Alaskan marine animals readily accumulate PAH and related hydrocarbons during exposure to these compounds in the water, food, or sediment. Bioaccumulation is most rapid and efficient from the water. However, since PAH reach high concentrations and are more persistent in sediments than in water, the major source of PAH for benthic and demersal marine animals is from contaminated sediments.

Bioconcentration factors (concentration in tissues/concentration in medium) for PAH increase with increasing PAH molecular weight and tend to be higher in marine molluscs than in polychaetes, crustaceans, and fish. This is directly related to the relative capability of these taxa to metabolize and excrete PAH. Because PAH are metabolized by members of higher trophic levels, there is no evidence of biomagnification of PAH in marine food webs.

Low temperatures, characteristic of Alaskan waters, have only a slight effect on rate of accumulation of PAH in marine animals but do seem to slow metabolic degradation and excretion of accumulated PAH. The slower rate of depuration plus the greater persistence of PAH in low temperature marine environments may mean that the potential for chronic impacts of PAH pollution of the Alaskan marine environment is greater than for more temperate and tropical climates.

Alaskan marine animals do not appear to be significantly more sensitive to aromatic hydrocarbons than similar species from more temperate and tropical climates. However, because of the greater persistence of light aromatics and PAH in cold Alaskan waters, biological impacts of an Alaskan oil spill may be more severe and subsequent recovery slower than for a similar spill in a warmer climate. However, many marine communities in Alaskan coastal environments are already naturally stressed by the severe climatic conditions. Such communities recover rapidly following a disturbance such as an oil spill or cessation of a chronic pollutant discharge. The Alaskan marine populations most likely to be severely damaged by oil spills and chronic discharges are the large, long-lived species such as king crabs, salmon, and marine mammals.

Conclusions

Based on this literature review,it is concluded that the following additional information is needed to more accurately assess the impact of aromatic hydrocarbons: a quantitative inventory of PAH sources in the Alaskan marine environment; composition over time of produced water and ballast water discharges and their long-term fate after discharge to Alaskan coastal waters; sensitivity to and PAH metabolism by populations and communities of marine animals from the high arctic (Chukchi and Beaufort Seas); and field validation of arctic oil spill models. To address these needs, the design of long-term monitoring studies is presented to assess the environmental impacts of produced water discharges to Cook Inlet and of offshore oil and gas development in the Beaufort Sea.

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The complete report, entitled "Sources, Fates and Effects of Aromatic Hydrocarbons in the Alaskan Marine Environment with Recommendations for Monitoring Strategies," (Order No. PB 86-168 291/AS; Cost: $22.95, subject to change) will be available only from:

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