Bioaccumulation of Oil Chemicals in Seafood

Oil spills can prompt concern about the seafood safety. This document answers common questions about bioaccumulation, a mechanism by which toxic chemicals from oil may accumulate in seafood.

Bioaccumulation is the buildup of a chemical substance in an organism to levels that are higher than in the environment where the organism lives. Bioaccumulation in seafood (fish or shellfish) can occur through one or more routes of exposure, including food items, water, sediment, or through skin and gills.

Some chemicals do not bioaccumulate at all, while others may bioaccumulate to levels many times higher than those found in water. Also, some species may bioaccumulate a given chemical more or less than other species.

What chemicals in oil can bioaccumulate in seafood?

Polycyclic aromatic hydrocarbons (PAHs) are the chemicals in petroleum-based oils most likely to bioaccumulate in seafood tissues. PAHs differ in the number of carbon and hydrogen atoms they contain, and this number determines whether we consider a given PAH to be "large" or "small." The size of a PAH affects both its tendency to bioaccumulate and its toxicity. Some of the larger PAHs are believed to cause cancer in humans. Smaller PAHs can be acutely toxic to fish and shellfish, but are not typically a health concern in seafood for people. However, smaller PAHs may cause taint (a disagreeable flavor or odor not typical of the seafood itself).

Only some PAHs bioaccumulate in seafood to levels that could pose human health risks. Scientists pay particular attention to these PAHs when seafood samples are analyzed.

What affects the bioaccumulation of PAHs in seafood?

Many factors influence the way that PAHs from a given oil bioaccumulate in a fish, shellfish, or other animal, including:

- Type of oil – each type of oil is a unique mixture of PAHs and many other chemicals, and each differs from other oils in the way that its constituent PAHs are bioaccumulated in exposed organisms.
- Behavior of the oil – some components of oil mix more readily into water than others, and this can be affected by both weather and treatment methods.
- Ability of exposed animals to metabolize and remove the chemicals from their bodies.
- Where animals live – on the shoreline, in the water, or buried in sediments.
- What animals eat – prey items may bioaccumulate PAHs and, when a predator eats those animals, its exposure to those PAHs is increased.

- Water temperature –PAHs are eliminated from the tissues of fish and shellfish faster when temperatures are warmer.
- Season – reproductive cycles and other seasonal cycles affect PAH levels in the bodies of animals.
- Fat content – fatty fish and shellfish bioaccumulate more PAHs because PAHs bind to fat and oils.

How are different seafood species affected by oil spills?

Fish are less likely to be exposed to oil than many other marine organisms. Because oil floats, fish usually don't come into contact with it. However, fish can still be at risk. Anything that increases the amount of oil in the water below the surface–such as stormy weather or use of chemical dispersants--can increase their exposure to PAHs and other chemicals in oil.

When exposed to oil, fish are relatively efficient at removing PAHs from their muscle tissue (fillets). Levels can remain higher in some organs like the liver and gall bladder. Fish bioaccumulate smaller PAHs more readily than the larger PAHs that are of greater concern because of their link to cancer.

Crustaceans (such as lobsters, crabs, and shrimp) can move away from oil but may live or feed in areas where there is a greater risk of exposure. Burrowing crustaceans can be exposed if the sediments where they live become contaminated by oil. Compared with fish, crustaceans are less able to remove PAHs from their bodies. But compared to molluscs like oysters, mussels, clams, scallops, and snails, crustaceans bioaccumulate smaller PAHs much more readily than the larger, cancer-linked PAHs.

Of the familiar kinds of seafood, **molluscs** are usually the most affected by oil spills because they are more likely to come into contact with oil and have a greater tendency to bioaccumulate PAHs. Bivalve molluscs (clams, oysters, and scallops) remove larger PAHs from their bodies more slowly than smaller PAHs. Many molluscs, like oysters and mussels, anchor themselves and can't avoid spilled oil. Others, like snails and limpets, can move, but usually not quickly enough to escape harm's way when oil washes ashore. Finally, clams living below the surface of a beach can be exposed for a long time if the silt, sand, or mud they live in is oiled.

What are the implications for seafood?

Molluscs like oysters, mussels, and clams are more likely than fish or crabs to be contaminated by PAHs and other chemicals in oil because they are more likely to be exposed to the oil for longer periods, and less able to rid their tissues of PAHs. However, if the source of oil in the environment is large, continuous, or dispersed—as is the case for Deepwater Horizon—it's possible that other seafood species may also become contaminated.

SOURCE: Office of Environmental Health Hazard Assessment, California Environmental Protection Agency