Earth Gauge
A National Environmental Education Foundation Program

Gulf Oil Spill Series: Effects on Invertebrates

Earth Gauge's Gulf Oil Spill series focuses on unique topics related to the Gulf of Mexico and the effects of the 2010 oil spill. All fact sheets, images and videos are freely available for use on-air and are available online at **http://www.earthgauge.net/2010/gulf-oil-spill-resources**.

FROM SPILLS TO SPECIES

Crude oil, such as that which has been leaking into the Gulf of Mexico, can have a range of effects on marine organisms. Invertebrates – animals without backbones, such as fish larvae, plankton, jellyfish, starfish, crabs, shrimp and bivalves – are crucial to the marine food web, yet are more difficult to monitor than larger animals such as mammals, birds and sea turtles. Invertebrate species in the Gulf number in the thousands. In addition, they are often small or microscopic, and some live in the benthic (bottom) zone or throughout the water column, where they may be more difficult to track.

Oil slick. NRL& USGS.

A variety of factors affect the impact of oil on invertebrate populations, including the type of oil, how long the oil has been in the water, concentration, type of habitat, microbial communities present, weather conditions and water quality. Latitude can also be a factor. Hydrocarbons – organic compounds made up of carbon and hydrogen that are the building blocks of oil – linger longer in high latitude marine environments. In addition, high latitude ecosystems have simple food webs and lower biodiversity; if a keystone species' population is reduced after an oil spill, there are few to no species that can take its place in the food web.

Because oil spills input a large amount of oil into the marine environment in a short amount of time, marine bacteria that typically digest oil from natural sources cannot break it down fast enough to prevent impacts on other marine life. In addition, if there is more sediment in the water, it mixes with oil, causing the oil to sink or travel farther outside of the spill area.

Once it enters the ocean, crude oil breaks down into three main components, which each affect invertebrates in a different way. Volatile compounds evaporate at the surface or dissolve in the water column, impacting animals such as plankton that live close to the surface and take in a large amount of water relative to their body size. Another component of oil forms a thick "mousse," which coats mammals and birds, in addition to washing onshore and impacting tidal communities. The third is a sinking component that impacts invertebrates, fish and mammals below the surface.

OIL'S TOXINS

Oil contains numerous toxic compounds that are released into the water as it breaks down. The most toxic to marine species are *polycyclic aromatic hydrocarbons* (PAHs) – chemicals such as benzene and toluene that are known carcinogens and neurotoxins to humans and animals, and in addition, cause other health problems. Some of these evaporate from the surface or dissolve in the water column. Others persist in water, where they can wash onto shorelines, settle in sediment and become chronic pollutants. Some fish and mammals can metabolize PAHs, but many invertebrates cannot. Thus, PAHs that persist in water or sediment may accumulate in the tissues of certain invertebrate species and affect the food web.

Sample of Gulf crude oil. USGS.

Some PAHs are *phototoxic*: they become toxic when exposed to sunlight. These are particularly dangerous to transparent zooplankton – tiny animals that float on ocean currents (some near the surface, where they are exposed to sunlight) and act as a main food source for larger organisms, including baleen whales.

Chemical dispersants, such as Corexit, used during the Gulf oil spill may also be toxic to invertebrates. Corexit is biodegradable; but due to the complex nature of the chemical and the depth at which it was released, scientists are uncertain about the exact effects and extent of harm it has caused to marine animals. Various scientific studies are taking place that will monitor invertebrate species, as well as water and sediment, for toxins in the aftermath of the spill (see CURRENT STUDIES below).

IMPACTS ON INVERTEBRATES

Adult, juvenile and larval forms of marine invertebrates, as well as the larvae of some vertebrates like fish, are at risk from oil and its contaminants. Individuals, populations, communities and the Gulf ecosystem may be affected by both direct and chronic exposure from the recent spill.

Individuals

Oil affects individual invertebrates in myriad ways. The most obvious effect of direct exposure to concentrated oil is mortality. However, dispersed, less concentrated oil is more readily taken in by invertebrates, especially filter feeders such as oysters and corals, potentially leading to long-term effects on respiration, mobility, digestion, growth and reproduction. If mobility is reduced, they can become more vulnerable to predators or get carried to new locations to which they are not adapted.

Profile: Sea Stars (Starfish)

Starfish, like other *echinoderms*, have bodies that are open to sea water. Rather than blood that circulates through arteries and veins, they have water vascular systems that process water into and out of their bodies through special organs. The outside and inside surface of an adult starfish is covered with tiny hair-like structures called *cilia*, which help this process. When the cilia and internal organs get coated with oil, the organism's body begins to malfunction, resulting in death or degraded functions (reproduction, digestion, transport, etc.). Starfish larvae also have cilia that help them move through the water, so they are vulnerable to direct exposure to oil as well. Starfish and sea urchin populations took several years to recover after being eliminated from an area off the coast of Baja California affected by an oil tanker leak in 1957.

Orange sea star. NURC/UNCW and NOAA/FGBNMS.

Profile: Oysters

Oysters, clams and other *bivalve mollusks* (having two shells connected by a hinge) are filter feeders: they siphon seawater into their bodies and eat plankton and other suspended organisms within it. Therefore, they also take in contaminants that are in the surrounding water. PAHs and other chemicals can accumulate in their tissues, making them unsafe for humans and animals to eat. When contaminated oysters are eaten, the predators in turn may accumulate the contaminants in their fatty tissues if the chemical concentrations are too high for them to metabolize quickly. Exposure to low concentrations of PAHs causes oysters to work harder to feed, leaving less energy for other functions such as growth. Oil also impairs the ability of bivalves and snails to attach to a substrate, making them more likely to get carried away by currents or consumed by predators.

Populations

Populations of marine invertebrates undergo changes in size, age, reproductive rate, feeding, movement and disease after oil spills.

Profile: Polychaetes

Polychaetes are a class of worms that are well-adapted to many different marine environments, from hydrothermal deep-sea vents to the ocean surface. They are tolerant to pollution, and some populations actually thrive and grow after oil spills. Because of this, they can serve as an indicator species, helping scientists to locate areas of heavy pollution.

Blue crab larva. Maryland Department of Natural Resources.

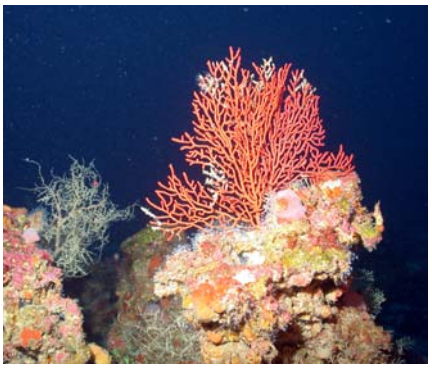
Profile: Shrimp and Crabs

The Gulf's three main species of shrimp (white, pink and brown) and crabs (blue, Gulf stone, stone and fiddler) live in coastal areas. Both adults and young shrimp and crabs live in near-shore waters or coastal wetlands. Oil that reaches the coast impacts the entire life cycle of both shrimp and crabs. Small oil-and-dispersant droplets have been found within the shells of tiny blue crab larvae near the Gulf oil spill; Louisiana waters yield more than 25 percent of the United States blue crab catch each year. The Gulf's shrimp fisheries closed on May 15, 2010, though fisheries in Mississippi waters reopened in early August, 2010. Shrimp fisheries will likely be impacted in 2011 as well.

Communities and Ecosystems
Invertebrate communities (populations of many species living in the same ecosystem) are known to have a range of impacts from oil spills that affect the entire ecosystem. Competition between different species changes, as do predator and prey interactions. Biodiversity is reduced when many populations significantly decrease after a spill. The ecosystem dynamic changes overall as species that are more tolerant to oil pollution and those that can swim rebound more quickly than species that are more sensitive and less mobile. Bioaccumulation may also occur if contaminants from oil and dispersants accumulate in the fatty tissues of animals and spread throughout the marine food web. In addition, many important habitats in the Gulf, such as coral reefs, mangroves and sandy beaches, are damaged with exposure to oil and its contaminants.

Profile: Pyrosomes
In June, 2010 thousands of dead *pyrosomes* – sea cucumber-like organisms that live on the sea floor – were found floating on the water's surface less than 10 miles from the spill. These are an important food source for sea turtles and other marine organisms, and thus, their die-off may already be altering the food web in that region.

Profile: Coral Reefs
The Gulf is home to deep-sea coral reefs, as well as shallow-water reefs off the Florida and Texas coasts. Coral reefs are some of the most diverse and productive ecosystems on Earth. Oil may impact reefs in different ways, depending on the conditions of the spill. Direct impact can lead to anoxic (no oxygen) conditions, essentially suffocating corals. Reefs can also be exposed to oil-related chemicals and dispersants if mixing occurs in the water column. If the water contains a lot of sediment, the chemicals mix with sediment and sink, possibly smothering deeper reefs. The damage to coral communities impacts the reef ecosystem overall, and recovery can take several years or decades. After the Bahia Las Minas oil spill in Panama in 1986, some coral reefs died and others were permanently damaged. On the contrary, after the Arabian Gulf Spill of 1991 – the largest oil spill on Earth – coral reefs were expected to suffer dramatic impacts. However, they received only minor damage from the oil, considering the amount of oil to which they were exposed.


Deep sea corals at Flower Garden Banks National Marine Santuary, off the coast of Louisiana and Texas. NOAA.

CURRENT STUDIES
There are many unknowns about the effects of dispersed oil and chemical dispersants on invertebrates that were exposed during the Gulf oil spill. Below are some current studies investigating the impacts of the spill on invertebrates.

Mollusks as Indicators: Marine biologists from the California Academy of Sciences, Louisiana State University and Denison University are using mollusks to track oil-related contaminants in sediments.
Learn more: **http://www.sciencedaily.com/releases/2010/05/100524143425.htm**

Gulf Invertebrates, Before and After: The Smithsonian National Museum of Natural History has the largest and most comprehensive collection of marine invertebrates from the Gulf. Scientists will compare post-oil spill invertebrate samples to baseline samples in the Smithsonian archive to help determine the damage to each species. Learn more:

- **http://collections.nmnh.si.edu/emuwebizweb/pages/nmnh/iz/Query.php**
- **http://ocean.si.edu/ocean-photos/google-map-invertebrates-oil-spill-region**
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Sediments and Shellfish: Scientists with the National Centers for Coastal Ocean Science are tracking short and long-term contamination in invertebrates by testing sediments, shellfish and seawater near the Gulf Coast before and after oil reaches the shore.
Learn more: **http://oceanservice.noaa.gov/news/features/may10/nccos-deepwater.html.**

Fiddler Crabs: Texas Tech University is examining the bioaccumulation of hydrocarbons from crude oil and dispersants in fiddler crabs that were exposed during the spill.
Learn more about Texas Tech oil spill research: **http://www.tiehh.ttu.edu/**

Coastal Monitoring: The National Oceanic and Atmospheric Administration's COAST (Coastal Ocean Assessments, Status, and Trends) program monitors coastal ecosystems throughout the United States, including the Gulf Coast, for contaminants. The Mussel Watch and Bioeffects Assessments Programs are testing bivalve species and sampling sediment before and after the spill to determine how toxic compounds have affected these species.
Learn more: **http://ccma.nos.noaa.gov/about/coast/welcome.html**

Special thanks *to Dr. Chris Mah of the Department of Invertebrate Zoology at Smithsonian's National Museum of Natural History; Dr. Jonathan Maul of the Department of Environmental Toxicology at The Institute of Environmental and Human Health, Texas Tech University; and Dr. Gunnar Lauenstein of the NOAA National Centers for Coastal Ocean Science for their contributions to this paper.*

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