THE ENVIRONMENTAL EFFECTS OF THE DEEPWATER HORIZON OIL SPILL

by Garrett Nagle

The Deepwater Horizon oil spill occurred on 20 April 2010 in the Gulf of Mexico (Figure 1). It resulted from an explosion on a BP oil rig and caused the death of 13 people, 11 of whom were on the oil rig at the time, and two additional oil-related deaths. Seventeen others were injured. Oil continued to gush out of the well for three months. In total, about 4.9 million barrels of crude oil leaked during the disaster. Environmental impacts of the spill persist, even though the well has been capped.

A number of factors affect the impact of an oil spill, including the amount of oil that is leaked, the type of oil, the climate into which it escapes (bacterial activity is faster in warmer environments) and the nature of wave activity (high wave energy can help to break up oil slicks).

On 19 September the relief well process was successfully completed and the government declared the well 'effectively dead'. However, the oil spill continued to cause extensive damage to marine and terrestrial habitats and to the Gulf of Mexico's tourism and fishing industries. In November 2010, three months after the well was declared 'dead', 11,000 km^2 of the Gulf were closed again after tar balls were found in shrimp-catchers' nets. The total amount of Louisiana shoreline affected by oil grew to over 510 km in late November. In January 2011 tar balls continued to be washed up, wetlands marsh grass remained fouled and dying, and crude oil lay offshore in deep water and in fine silts and sands onshore. The scale of the Deepwater oil spill is outlined in Figure 2.

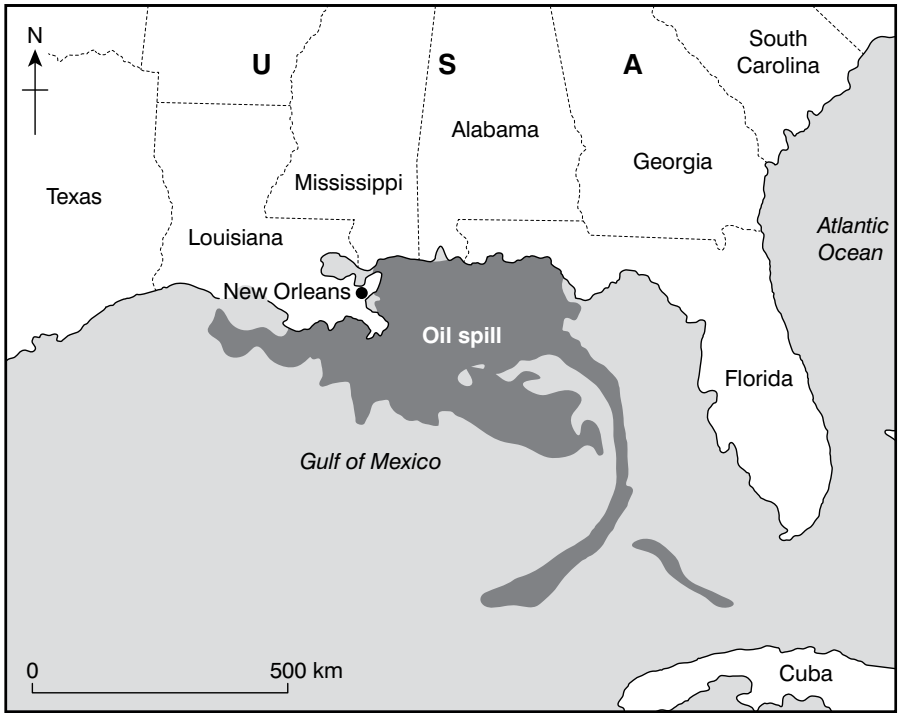

Figure 1: **Extent of the Deepwater Horizon oil spill**

1 barrel of oil is approx. 86 litres = 2 tanks of petrol (average-sized car)	
Total spill:	Best case 450,000 barrels
	Worst case 1.8 mb
Wildlife recovery:	20–30 years
Areal extent:	10,700 km^2
Oil spills in context:	Deepwater 450,000 to 1.8 mb
	Amoco Cadiz 1.6 mb
	Exxon Valdez 271,000 barrels
World oil consumption:	3.5 mb per hour
	86 mb per day
	31,000 mb per year
Proven reserves:	1,255,100 mb (29 years' worth)
mb = million barrels	

Figure 2: **The oil spill in numbers**

Source: www.sustainabilitymedia.com

Environmental impacts

Several ecosystems have been identified as being particularly at risk from the oil spill: beaches and barrier islands, the continental shelf and shallow water, and the open ocean (Figure 3).

Beaches and barrier islands

Dry sand, rocks and grassland provide an important habitat for breeding and nesting. Many species require the

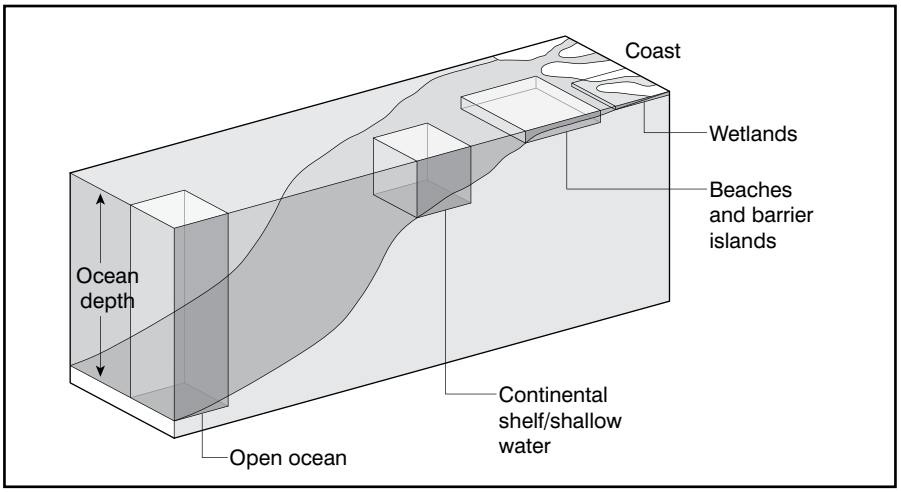

Figure 3: **Ecosystems at risk from the Deepwater Horizon oil spill**

Figure 4: **A sea bird severely contaminated by oil**
Source: Wikimedia Commons

isolated breeding areas that the islands provide. Beach-nesting shorebirds include plovers and egrets, which feed on small invertebrates along the beach and nest on the ground. The Gulf of Mexico is the only location in the world where Wilson's plover is found. About 50,000 brown pelicans live in the Gulf of Mexico. They mate during April, so the oil spill put a whole generation at risk. These birds travel up to 18 km between their nesting ground and their feeding area, so booms are ineffective at reducing the risk of oiling. Beach-nesting terns and gulls roost on the sand and plunge into the water to feed, so they are doubly at risk of oiling. Migrating birds, such as sandpipers, use the beaches for rest stops, and they too are at risk of contamination by oil (Figure 4).

Five of the world's seven species of sea turtle live, migrate and breed in the Gulf of Mexico. Because oil floats, sea turtles are at risk from oil. During nesting, not only can turtles be oiled on the beach, but their eggs may suffer chemical exposure which can result in decreased survival of hatchlings.

Continental shelf and shallow waters

This region includes coral reefs, sea-grass beds and sandy bottoms that are home to invertebrates which are valuable both commercially and in terms of ecosystem function. Owing to sunlight penetration and nutrient availability, these waters are normally very productive.

In smaller oil spills, oil stays on the surface and it has little impact at depth apart from reducing the amount of light received. However, depending on their size and composition, underwater plumes could have a disastrous effect on the submarine ecosystem.

Different species of turtle forage in this zone for a mixture of crabs, crustaceans, sea grass and algae. According to the US National Oceanic and Atmospheric Administration (NOAA), every dead turtle that was examined had heavy oil in its mouth and guts. Sharks spawn in the summer and use the grasslands as nurseries, so their eggs and young are particularly at risk at this time. Species especially at risk include the sand tiger shark and the black tip shark.

Louisiana produced over 18 million kilograms of blue crab in 2008. Oil can coat their gills and cause respiratory problems. The Gulf of Mexico normally produces 67% of the USA's clams and oysters. Bivalves such as clams and oysters filter contaminants through the water, although at a slow rate. Oysters may close their shells for short periods but are vulnerable if oil is present when they re-open.

The Gulf accounts for about 75% of the USA's shrimps. The key season for brown shrimps is June–October. They are especially vulnerable due to their thin shells, exposed legs and eyes, and because they live in the sediment that becomes contaminated with oil. Even low doses of oil affect reproduction, growth, feeding, movement and behaviour.

Nine species of dolphin live in the Gulf and spend most of their lives there. They are at risk of chemical inhalation when they breathe.

The open ocean

The open ocean is divided into three zones. The upper euphotic – or sunlit – zone where photosynthesis occurs, contains most life. The twilight zone lacks light and has less oxygen. Species such as squid live in this zone. In the deep, dark benthic or abyssal zone, many organisms feed on decomposing matter which has drifted down to the ocean floor.

Crude oil can clog fish gills. Extended exposure to crude

oil can cause a build-up of contaminants in mammals' bodies. Oil can kill larvae and eggs. Toxic chemicals may kill many marine organisms. For example, jellyfish drift in the currents in the twilight zone. They have no means of avoiding the oil. If they are covered in oil, species that feed on them, such as turtles and sperm whales, will ingest oil.

Bluefin tuna have declined to less than 20% of their 1970 population. Drifting fish larvae are extremely sensitive to oil and chemicals. Whale sharks feed on plankton near the surface. They could be affected by a reduction in their food supply.

Sea turtle hatchlings are also at extreme risk of the oil. They seek floating seaweed mats where they can evade predators. However, winds and currents may drive the oil and the drifting mats into the same area. The hatchlings cannot dive very deep so are at risk from surface oil. In addition, young turtles may confuse floating oil for seaweed mats.

The Deepwater spill

The Deepwater spill was by far the largest in US history, almost 20 times greater than the *Exxon Valdez* oil spill in Alaska in 1987. However, the damage to the environment and the wildlife might be less in the Gulf due to various factors such as warmer water (hence increased bacterial activity) and the fact that the oil leaked deep under water (rather than directly onshore). Eight US National Parks were put at risk. Over 400 animal species that inhabit the Gulf of Mexico were threatened by the oil spill, including the green turtle, the loggerhead turtle and the leatherback turtle. Birds at risk included herons, terns, egrets and spoonbills. The area affected by the spill includes more than 1,200 fish species, 200 birds, 1,400 molluscs, 1,500 crustaceans, 4 sea turtles, and nearly 30 marine mammal species.

By November 2010, over 6,800 dead animals had been reported, including 6,100 birds, 600 sea turtles, 100 dolphins and other mammals. Harry Roberts, Professor of Coastal Studies at Louisiana State University, claimed that 4 million barrels of oil would be enough to 'wipe out marine life deep at sea near the leak and elsewhere in the Gulf' as well as 'along hundreds of miles of coastline'. Such a volume of oil could alter the chemistry of the sea, with unforeseeable results. The oil can harm fish directly, and microbes used to consume the oil result in reduced oxygen levels. The marine ecosystem could require years or even decades to recover. The crude oil that escaped from the well contained approximately 40% methane by weight, compared with about 5% found in a typical oil deposit. Methane can create dead zones where oxygen is depleted.

Scientists also found evidence of an oil-and-dispersant mix under the shells of tiny blue crab larvae in the Gulf. This suggests that the dispersants had broken up the oil into tiny droplets, small enough to enter the food chain. This occurred on a section of coastline stretching from Grand Isle, Louisiana to Pensacola, Florida.

Fisheries

On 29 April 2010 Louisiana declared a state of emergency after weather forecasts predicted the oil slick would reach the Louisiana coast. An emergency shrimping season was opened on 29 April so that a catch could be brought in before the oil advanced too far, but by 30 April oil began washing up on wildlife refuges and seafood grounds on the Louisiana Gulf Coast. Nevertheless, 60–70% of oyster and blue crab harvesting areas and 70–80% of fin-fisheries remained open. However, in May a further ten oyster beds south of Lafayette (Louisiana) were closed due to oil pollution.

According to the European Space Agency, 20% of the juvenile bluefin tuna were killed by oil in the Gulf's most important spawning area. The loss of juvenile tuna was significant due to the 82% decline of the tuna's spawning stock in the western Atlantic during the 30 years prior to the oil spill.

Petroleum by-products found in Gulf seafood

Levels of anthracene, a toxic hydrocarbon and a by-product of petroleum, were found to be twice the acceptable level. In November 2010 a shrimp boat trawling waters north of the Deepwater Horizon well site hauled in a load of tar balls along with thousands of dollars' worth of shrimp, ruining the catch. The waters had been reopened to fishing on 15 November and were re-closed on 24 November. Over 11,000 km^2 of Gulf waters were closed to shrimping operations.

Conclusion

The Deepwater Horizon oil spill was the worst ever in US waters. Thirteen people were killed as a result of the explosion and almost 5 million barrels of oil were spilled into the Gulf of Mexico. It took more than three months to cap the oil well. The environmental damage was severe – although it could have been worse. The combination of high temperatures and high wave energy during the tropical cyclone season helped to break up the oil spill. Nevertheless, the impact on local wildlife and the local fisheries industry was large-scale.

Activities

1 Study Figure 1.
(a) Identify three main ecosystems affected by the oil spills.
(b) In what ways is the Deepwater spill different from spills involving oil tankers?

2 Study Figure 2, which provides information on the Deepwater Horizon event.
(a) Approximately how much oil was leaked in the Deepwater Horizon event?
(b) How does this compare in size with the *Exxon Valdez* disaster?
(c) How long may it take for wildlife to recover?
(d) Approximately how long are proven oil reserves predicted to last?

3 Study Figure 5. Comment on the location and relative size of each spill.

4 Why could the oil spill in the Gulf of Mexico be cleaned up faster than a spill in Alaska?

5 Read the extract in Figure 6 and then answer the questions below.
(a) What are carcinogens?
(b) What is the source of PAHs?
(c) What are the potential impacts of PAHs on humans and mammals?

6 Visit this website:
www.nytimes.com/interactive/2010/05/27/us/201005_oil-spill-photo-gallery.html
Choose some of the images on the website and make a Powerpoint presentation about the Deepwater Horizon disaster.

Other scientists claimed that the oil spill waters contain carcinogens (cancer-forming substances). High levels of chemicals were found in the sea off the coast of Louisiana. Also off the coast of Grand Isle, Louisiana, scientists discovered polycyclic aromatic hydrocarbons or PAHs, which are often linked to oil spills and include carcinogens and chemicals that pose various risks to human health (such as high levels of asthma, cancer, and birth defects). These were 40 times higher than before the oil spill. The chemicals (PAHs), they said, can kill animals right away in high enough concentrations and can cause cancer over time. These compounds may enter the food chain through organisms like plankton or fish. The PAH chemicals were most concentrated in the area near the Louisiana Coast, but levels have also jumped two- to three-fold off Alabama, Mississippi and Florida.

Figure 6: **The effects of PAHs on the health of humans and other mammals**

Oil spill	Location	Date	Tonnes of crude oil
Kuwait oil fires	Kuwait	January 1991 – November 1991	136,000,000–205,000,000
Kuwait oil lakes	Kuwait	January 1991 – November 1991	3,409,000–6,818,000
Lakeview Gusher	Kern County, California, USA	May 1910 – September 1911	1,200,000
Gulf War oil spill	Iraq, Kuwait and Persian Gulf	January 1991 – 28 January 1991	818,000–1,091,000
Deepwater Horizon	Gulf of Mexico, USA	April 2010 – July 2010	560,000–585,000
Ixtoc I	Gulf of Mexico, Mexico	June 1979 – March 1980	454,000–480,000

Figure 5: **The world's largest oil spills**