Chapter 13
Oil Spills

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This chapter focuses on oil spills and international efforts to mitigate the impact on the oceans, communities, and wildlife.

What Is Oil?

Oil is formed from the prehistoric remains of animals and plants that have died and been compressed and heated. This is crude oil, and it has to be extracted from the ground whether on land or in the ocean. It is refined to form fuels, lubricants, plastics, rubber, industrial chemicals, and a wide range of other products. The refinery process divides crude oil into lighter components such as natural gases, kerosene, and light diesel oils; medium grade oils; and residual or heavy oils, which are left at the end of the refining process.

What Is an Oil Spill?

Oil that enters the environment through human causes can be considered a spill, including through accidents and intentional releases. In the ocean, oil spills can occur through shipping accidents; leaks from pipelines, boats, and coastal or offshore development; washings or discharges from ships' tanks and lubricating oils; run-off

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from land via rivers and jettisoned aircraft fuel. Spills also result from deliberate sabotage of oil wells and pipelines. Large spills generally result from a terrible accident, and people are often also killed in such incidents. The impact of a spill depends on the type of oil spilled, the environment into which it is spilt, and the weather conditions.

Scene of the oil spill in the waters around Mauritius after Japanese bulk carrier, MV Wakashio, ran aground on 25 July 2020. *Credit* Jean Garrett/Greenpeace

Impacts of Oil Spills on Marine Life

Oil has a toxic impact on wildlife. The lighter, more toxic components of oils evaporate and impact air-breathing animals like seabirds, turtles, marine mammals, and even people responding to the spill. Oil smothers and damages habitats and sticks to animal's feathers, fur, or skin, especially seabirds, seals, and marine otters. While attempting to remove the oil from their bodies, the animals swallow it, and the toxins interfere with the animal's ability to feed, breathe, breed, and survive.

In the water, some oil spreads out and breaks down relatively quickly, in particular where clean-up chemicals are used. However, the dispersed and broken down oil is often consumed by marine wildlife, particularly fishes. The oil can then accumulate in the food chain, as the fish are in turn eaten by seabirds and marine mammals. Sometimes, oil mixed with sand and sediments may reappear many months or years after the spill and can still stick to the feathers, fur, or skin of animals that come into contact with it.

What Causes Oil Spills in the Ocean?

Shipping Accidents

Ships carrying or fuelled by oil can cause a spill if involved in an accident. Accidents might be collisions between ships or between a ship and a structure such as breakwaters, piers, rocks, or icebergs. Ships might also spill oil when they run aground on a shallow reef or suffer a malfunction.

Chronic Discharges

Every year over 300,000 tonnes of oil are released into the ocean through the routine operation of ships. This oil comes from leakage from the stern tubes which link the ship's engine and the propeller; lubricating oils used on deck and underwater; and washing out of cargo holds that deliver oil. These sources of oil are allowed by law, but illegal discharges often occur at the same time. In the late 1990s, 300,000 birds were dying every year off the Newfoundland coast because of chronic oil discharges. Lubricants which biodegrade are less toxic than lubricating oils but are not widely used.

Contaminated Water

Offshore oil and gas installations release oil through "produced water" and "displacement water", which is water that is contaminated with oil, and by digging up and discarding muds and rocks that contain oil, known as "cuttings". Between 2009 and 2017, in the Northeast Atlantic, over 40,000 tonnes of oil were discharged by offshore oil and gas installations, including nearly 2000 tonnes of accidentally spilled oil. In recent years, oil discharged in drilling fluid and cuttings has increased, according to annual reports.

Oil Additives

Chemicals are often added to oil products, such as lubricant chemicals added to fuel oils to help improve engine performance. These additives are also a threat to wildlife. In 2013, in two different incidents, more than 4000 birds including guillemots, puffins, razorbills, and gannets washed up on beaches on the south coast of England covered in a sticky substance. The substance was an additive sometimes added to oils in ships' engines, which was being flushed into the sea during the

cleaning of ships tanks. At that time, the discharge was allowed by law, but subsequent action by the International Maritime Organization (IMO), the United Nations body responsible for regulating international shipping, banned the discharge at sea and required any residues to be disposed of while ships are in port.

How Else Does Oil End Up in the Ocean?

Natural seeps, where oil leaks from the underlying seafloor sediments, are the largest source of oil in the ocean. Directly at the seep, the oil is toxic to marine wildlife particularly animals living on the seabed. Ecosystems close to oil seeps are adapted to the slow release of oil over long time periods, and some bacteria can even use parts of the oil as an energy source. The oil from a seep can however spread and affect wildlife, particularly seabirds, from further afield. A Californian study found natural seeps off the coast oil around 1000 seabirds each year.

Impacts of Oil Spills

In general, the bigger the oil spill, the larger the environmental and social impact is. However, even small spills can have a major impact. For example, in 2000 the *MV Treasure* spilled 400 tonnes of fuel oil following structural damage during bad weather off the coast of South Africa. The spill resulted in the temporary closure of South Africa's ports and had a major impact on the penguin colonies because it happened during their breeding season. The biggest marine oil spill occurred in 2010—the Deepwater Horizon oil spill—where the offshore drilling rig suffered a malfunction, explosion, and fire, resulting in the death of eleven people. The well gushed crude oil into the Gulf of Mexico for 87 days before it was capped and stopped. Much of the oil was released at depth and damaged deep-water marine habitats. Around 572 miles of coastline were affected, along with thousands of seabirds and marine wildlife including dolphins, turtles, and fishes. Four years after the spill, a study on the very young life stages of fishes, such as tuna, indicated biological defects after exposure to the oil (see Box 1).

Oil spills also affect local communities dependent on coastal and marine resources. Following an oil spill, it is usual for fisheries in the area to close until authorities can be confident that there is no risk to the public from the consumption of fish and shellfish. Closures might last a few weeks, but in some cases fisheries have been closed for many months following a spill. Other industries such as tourism and marine sports can also be restricted or reduced following spills, with impacts on local economies and loss of revenue lasting for months or even years.

See Table 13.1 for examples of oil spills from oil installations, oil fields and ships, and a range of environmental and social impacts. For inspiration from those taking action to reduce the impacts from oil spills, see Chap. 32 on Inspiring Voices, and the incredible achievements of Marilyn Slett and the Heiltsuk community.

Table 13.1 Impacts of a selection of oil spills from oil fields, offshore installations, and ships (n.b. these examples are illustrative of impacts and not intended to be comprehensive)

Name and installation or vessel type	Year	Location	Size of spill	Social, environmental, and economic impacts
Oil wells and pipelines	1991	Gulf of Kuwait	Estimated between 270,000 and 820,000 tonnes crude oil	• Sabotage of wells and pipelines • Oiled area covered more than 4000 km^2
Deepwater horizon oil rig explosion and blowout	2010	Gulf of Mexico, USA	Estimated between 492,000 and 627,000 tonnes crude oil	• Loss of 11 human lives • Spill over 87 days • 572 miles of shoreline oiled • Thousands of seabirds and marine wildlife including dolphins, turtles, and fish affected
Ixtoc 1 oil well explosion	1979	Bay of Campeche, Mexico	Estimated 454,000–480,000 tonnes crude oil	• Spill over ten months • Spill covered 1100 square miles • Severe damage to marine life
Nowruz oil field spill	1983	Persian Gulf	260,000 tonnes crude oil	• Collision between an oil tanker and the Nowruz Field platform • Spill continued for 7 months
SS Atlantic Empress, supertanker, collision	1979	Off the coast of Tobago, Caribbean	287,000 tonnes light crude oil	• Twenty-seven human lives lost • Ship towed out to sea • Much of cargo burnt

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Table 13.1 (continued)

Name and installation or vessel type	Year	Location	Size of spill	Social, environmental, and economic impacts
Amoco Cadiz supertanker, ran aground	1978	Brittany, France	223,000 tonnes of light crude oil and heavy fuel oil	• Affected 320 km of coastline • Nearly, 20,000 dead seabirds were recovered • Millions of dead invertebrates such as sea urchins and shellfish were washed ashore following the spill • Clean-up operations had a negative impact on the coastal habitats with salt marshes taking many years to recover
M/T Haven tanker, explosion	1991	Genoa, Italy	144,000 tonnes crude oil	• Six human lives lost • Leaked oil for 12 years • Affected Italy and France
SS Torrey Canyon oil tanker grounding	1967	Isles of Scilly, UK	119,000 tonnes crude oil	• Largest vessel to be wrecked at the time • Over 40 years after the spill a bio-remediation project was initiated to speed up the breakdown of the recovered oil
Sanchi oil tanker collision, fire	2018	Off Shanghai, China	136,000 tonnes of ultra-light crude oil (condensate)/2000 tonnes bunker oil	• Thirty-two crew members died • Ship burnt and drifted for a week before sinking

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Table 13.1 (continued)

Name and installation or vessel type	Year	Location	Size of spill	Social, environmental, and economic impacts
MV Prestige	2002	Off the Atlantic coast of Spain	63,000 tonnes of heavy fuel oil	• Fisheries bans lifted nearly a year later • Four years after, the health of the mussels and environment in Galicia and on the Basque coast had not returned to pre-spill conditions • Total losses for the northern Spanish and Basque coasts fishing industry were estimated at over €296 million
Exxon Valdez struck a reef	1989	Prince Willian Sound, Alaska	37,000 tonnes crude oil	• Affected 2100 km of coastline • More than 1000 sea otters and 35,000 birds known to have died • Twenty-five years later, some species including salmon and sea otters had recovered, but others remained in recovery, with some, including a pod of killer whales, pigeon guillemots, and herring, not recovering

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Table 13.1 (continued)

Name and installation or vessel type	Year	Location	Size of spill	Social, environmental, and economic impacts
MV Erika	1999	Off the Atlantic coast of France	15,000 tonnes	• Estimates of losses for the tourism industry between 2002 and 2006 set at nearly €719 million • Figures do not include the shoreline cleaning, environmental damage, or public administration costs
MV Selendang Ayu suffered engine failure, drifted for 2–3 days, ran aground	2004	Off the Aleutian Islands, Alaska	1200 tonnes of oil fuel	• Six crew members died during the rescue operation • Around 138 km of Unalaska Island coastline was affected by the spilled oil • Three years later, sea ducks still had elevated body burdens of oil derivatives • After 4 years, oil still recorded at 21 of 24 beaches
MV Treasure structural damage to the ship following bad weather	2000	Off the coast of South Africa	Estimated 400 tonnes of fuel oil	• Temporary closure of South Africa's ports • Threatened species, included penguins and seals • Greatest impact was on declining penguin colonies as the spill happened during the breeding season • Over 20,000 oiled penguins were recovered and treated

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Table 13.1 (continued)

Name and installation or vessel type	Year	Location	Size of spill	Social, environmental, and economic impacts
MV Solomon Trader grounded on the coral reefs	2019	In the Solomon Islands	Estimated 100 tonnes of heavy fuel oil	• Polluted three miles of reefs and coastline • Local communities had to stop fishing • Children could not play in the water • Local freshwater springs were reported as contaminated • Clean-up costs estimated in the region of tens of millions of dollars

Responding to an Oil Spill

In the ocean, oil can be transported over large distances, dependent on the local currents and wind conditions. Oil type, accessibility of the spill, weather conditions at the time of the spill, presence of local communities, important habitats, and wildlife populations will all influence the response effort. As soon as oil is spilled, it starts "weathering". Some oil will evaporate, and some will disperse and dissolve into the seawater where it becomes available to the marine wildlife swimming in the water column. Oil will also be mixed with water forming an emulsion, and some could sink into seabed sediments where it can persist for months or even years. Oxidation will also take place at the sea's surface, and biodegradation will occur as oil sinks into the water column. The type of oil, weather conditions, and thickness of oil slick will determine which of these weathering processes is dominant. Lighter oils evaporate and disperse more quickly than heavy oils. Strong winds will spread a slick further, affecting a larger area, but will also help with dispersing the lighter oil components. Wave action will help with dispersion but also drive emulsification of heavier oils leading to the creation of emulsified oil which is much harder to break down and disperse and creates much larger volumes of oily mixtures. Even once the oil has disappeared from the sea surface, it continues to pose a threat to marine wildlife and habitats.

Controlled burn of oil on the surface of the Gulf of Mexico near BP's Deepwater Horizon spill source. *Credit* Daniel Beltrá

Responding to an oil spill is important, but it is impossible to recover all the oil spilled, and sometimes only a small percentage, as little as 10%, can be recovered. Booms can be used to contain the oil and to protect economic interests, habitats, and wildlife populations. Skimmers can be used to recover the oil from the sea surface, while chemicals can disperse the oil and speed up natural degradation. Sometimes it is possible to burn the oil while it floats on the sea surface. All methods however have their limitations—skimmers can get clogged by heavy oils, dispersants are toxic to other marine life, and collection of oil and oil mixed with sand, pebbles, and beach debris can be damaging to the shoreline wildlife and habitats. It is also necessary to consider how recovered oil and oiled material will be stored and treated. In many remote locations such as the Arctic, there will be limited options for containing the material recovered and for further treatment or disposal.

Following an oil spill and clean-up operation, long-term monitoring of the spill impact and recovery is very important, particularly in low energy environments such as salt marshes, mud flats, seagrass beds, and mangroves where oil can be trapped and persist for many years. Even with comprehensive recording of the impact of a spill, the full cost in terms of wildlife and habitats will often not be fully evaluated. In most cases, many oiled seabirds will never be recovered, they will die at sea and disappear. The impact on marine mammals caught up in spills, inhaling fumes, or feeding on contaminated fish and invertebrates, may not be evident for months or even years. Often it is not possible to evaluate the impact on plankton, the loss or reduction in numbers of shoreline or benthic invertebrates, or changes in algal cover on miles of coastline. Studies can provide estimates and should out of necessity continue for years—the full recovery of all wildlife populations following the *Exxon Valdez* spill in Alaska had not been achieved 25 years after the spill, and long-term impact following the Deepwater Horizon oil spill on dolphin populations in the Gulf of Mexico will take years to fully evaluate.

Box 1: Findings of the US Federal Government's Programmatic Damage Assessment and Restoration Plan for the Deepwater Horizon Spill

- Nearly, all 21 species of dolphins and whales in the Northern Gulf have injuries, and the population of spinner dolphins could take approximately one hundred years to fully recover.
- As many as 167,000 turtles were killed during the disaster, nearly a quarter of the Sargassum habitat important for juvenile turtles was heavily oiled.
- Between two and five million larval fish were directly killed, while a number of species of adult fish have been documented with oil spill injuries including skin lesions, rotting fins, and oil in the livers.
- Oil and oil spill response efforts killed up to 8.3 billion oysters.
- At least 93 species of bird were exposed to the oil, with estimates that between 10,000 and 19,000 brown pelicans died. The resulting loss of birds would likely impact food webs of the Northern Gulf of Mexico.

- The impact to seabed habitats in the Gulf could take decades to hundreds of years to fully recover.
- Ten years after the accident, the final impacts of the spill were still being evaluated.

International Efforts to Reduce the Risk of Oil Spills and Intentional Discharges

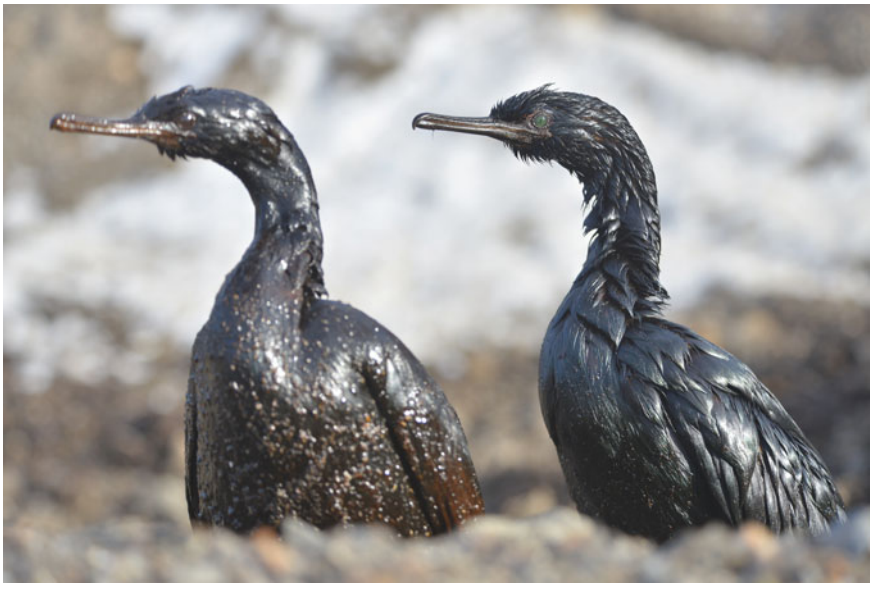
Between the 1960s and 1990s, large accidental oil spills were one of the most visible pressures on the ocean. Major oil tanker spills and sabotage of oil wells and pipelines resulted in news headlines showing wildlife and beaches smothered in oil and devastated communities trying to clean-up. Efforts to improve the safety and management of shipping oil cargoes reduced the number of large oil spills. However, spills and discharges continue to damage marine life and ecosystems, particularly on a local scale. Preventing oil spills is by far the best option.

Oil spills and oily discharges from shipping are regulated by the International Maritime Organization (IMO). Governments that sign up as members of the IMO accept rules for their countries on the safety and security of shipping and preventing marine and atmospheric pollution. Governments then regulate oil spills or discharges at a national level. Where there is the potential for spills to affect the waters and wildlife of more than one country, countries cooperate with one another to set regional regulations. In the North Sea (one of the busiest oil production regions), for example, a regional group regulates discharges of the water produced during the extraction of oil which is contaminated with oils and chemicals. The IMO also designates Particularly Sensitive Sea Areas (PSSAs)—areas of special ecological, socio-economic, or scientific importance which are vulnerable to shipping activities, particularly pollution. In these areas, protection measures are applied which reduce the likelihood of an oil spill. For example, in the Torres Strait, an area of ocean between Australia and Papua New Guinea, a two-way shipping route has been introduced to reduce the risks of collisions and groundings. Other shipping management measures include identification of areas for ships to avoid and deep-water routes.

The most important agreement aimed at preventing oil pollution from shipping is the International Convention for the Prevention of Pollution from ships or MARPOL Convention. It was accepted by IMO members in the 1970s and includes regulations to address accidental oil spills and operational discharges. To minimise the risk of oil spills, the MARPOL Convention requires oil tankers to have structural barriers like double hulls and additional protection for fuel tanks. In addition, ships are required to monitor and control the discharge of oily wastes, to have an oil pollution emergency plan, and ports are required to provide reception facilities so that ships can discharge oily wastes on return to port. The Convention also bans the use and carriage of heavy fuel oils in the Antarctic, and similar protection is being called for to protect

the wildlife and Indigenous communities in the Arctic. The Convention identifies Special Areas where the amount of oil that can be legally discharged from ships is severely restricted. Special Areas include the Mediterranean, Baltic, Black and Red Seas, the Middle East Gulfs, Gulf of Aden, and waters of Northwest Europe and Antarctica. Similar restrictions have also been introduced in the Arctic.

Another international agreement, the Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC), sets out a global framework to address oil spills and responsibilities in the event of an oil cargo or bunker (the fuels used aboard vessels) spill. The OPRC sets out priorities following an oil spill: once risks to human lives and safety have been addressed, the priority is limiting further spillage and then recovering oil and cleaning-up the oil. Operators of all ships and offshore oil installations must prepare detailed plans for responding to incidents, so that there is no delay in responding to a spill; have stockpiles of oil spill response equipment; and run training exercises.



Seabirds covered in oil. *Credit* Mikhail Pyzhov/Greenpeace

What Can I Do?

Most of us feel helpless when a large oil spill happens. Groups fully trained in clean-up techniques or wildlife rescue will respond to a spill. Some of these groups are charities or work on a voluntary basis and so rely on public support, for example

through donations. Some wildlife rescue centres and environmental groups, such as International Bird Rescue, have oil spill clean-up facilities and will train volunteers. If you can volunteer your time and labour, it will be necessary to explore what opportunities exist where you live, as it differs from country to country and region to region.

Perhaps most important is to recognise that demand for goods and commodities, in a world that uses fossil fuels to deliver them, drives the risk of oil spills. The volume of goods shipped around the world each year is enormous. In 2018, trade by sea reached an all-time high of 11 billion tonnes, representing over 80% of global trade—see Chap. 12 on Shipping and the Ocean. In addition to oil spills, international shipping is a major source of greenhouse gas emissions. Writing to political representatives or to local media can help to inform others of the issues. It can also provide public support for political decisions and commitments, such as moving away from consumerist policies in countries where it is relevant. Purchasing locally produced goods can help to reduce the level of demand for commodities to be shipped around the world, both reducing the risk of oil spills and reducing emissions from shipping. A lot of people would need to make the shift to have an impact, so supporting public campaigning and political leadership can be a big help.

It is also important to remember that many oil spills and oil discharges do not make headline news, and long after the images have disappeared from screens and social media, there will be impacts. The causes and the consequences of an oil spill need to be well understood, so that lessons can be learnt to prevent a repetition of events. In many countries, anyone can help to inform others of issues and push for answers by writing letters or emails to political representatives to make sure that the answers and the follow-up process are made public, and that those responsible for delivering future protections do a good job.

Recommendations for Further Reading

www.ncbi.nlm.nih.gov/books/NBK220703/
www.imo.org/en/OurWork/Environment/PollutionPrevention/OilPollution/Pages/Default.aspx
Oil spills|National Oceanic and Atmospheric Administration (noaa.gov)
www.hfofreearctic.org
www.bird-rescue.org/get-involved/volunteering-internships.aspx
www.cleanerseas.com/10-worst-oil-spills-in-world-history/

Dr. Sian Prior I studied marine biology and chemical oceanography at Bangor, University of Wales, and completed a Ph.D. at Queen Mary and Westfield College, University of London. I started my career in marine policy working for a trade association representing the interests of the UK ports industry. Later, I moved to working on the development and advocacy of marine policy for WWF and more recently for coalitions of environmental groups. I am incredibly lucky to still be able to combine my training in marine sciences with the development of marine policy. I now appreciate how valuable it was to start my working life focused on port and shipping policy—after all most activities at sea take place from ships or boats. For me, linking science with policy and with law has always been fundamental if the use of coastal and marine resources and management of maritime industries is to be compatible with the protection of marine ecosystems, communities, and wildlife.