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Oil Spills: A Look into the Ecological Effects and the Cleaning Techniques

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On February 21, 2021, a Iranian tanker off the coast of Israel experienced an oil spill. Israeli officers were quick to to label the incident an act of "eco-terrorism". Such allegations are not uncommon in the area of oil, which is tied inextricably to the world of politics. However, while the politics the oil is still a source of debate, one thing is certain: oil spills have major ecological implications on the ocean and the marine life that resides within it.

Oils spills are certainly not a novel phenomena, and the recent incident in coast of Israel cannot be looked at in isolation. In 1989, *Exxon Valdez*, a tanker located in Valdez, Alaska, swerved into a rocky outcrop and spilled close to 11.6 million gallons of oil. The aftermath resulted in close to $3 billion in damages [1]. Still, the *Exxon Valdez* incident is eclipsed by the oil spills in Kuwait (1991) and the Gulf of Mexico (1979). Less conspicuous are the thousands of smaller spills that pollute the ocean.

"The 1989 *Exxon Valdez* oil spill" from *Essentials of Oceanography* by Trujillo and Thurman

A common misconception about oil is that it is not biodegradable. However, oil is composed of hydrocarbons, which are organic and can be broken down. In fact, many oil spill cleaning techniques rely on this property of oil. Interestingly, oil is often considered by scientists to be the least dangerous pollutant in the ocean due to its chemical structure. Due to its biodegradable nature, oil does not seem to have lasting consequences for the ecology of the ocean system. Studies done in the aftermath of the *Exxon Valdez* oil spill found that species such as bald eagles, pacific herring, and cormorant experienced a temporary decline in population that rebounded within 10 years [1].

"A bird covered by oil from the *Exxon Valdez* oil spill" from *Essentials of Oceanography* by Trujillo and Thurman

This is not to say that oil spills are innocuous. If oil spill is concentrated in an area, it could have devastating consequences for the ecology of the area. For instance, in 2001, an oil spill in the Galapagos Islands reduced the population of 62% of the marine iguanas on the island [1]. More generally, even small traces of oil contamination in the ocean can be chemically toxic to marine life when absorbed into the organs and tissues. Due to the precarious balance of marine life, even small changes can have cascading consequences for an ecological system. For instance, since the oil spill from the *Deep Water Horizon* rig (2010), fish in the Gulf of Mexico have continually shown contamination with polycyclic aromatic hydrocarbons [2].

To mitigate the effects of oil spills on the environment - especially in low energy environments where water does not disperse the spill - there are generally three steps. The first step is to contain the oil spill - though the efficacy of this technique has been a source of debate in the scientific community. The oil is captured by booms and skimmers (normally boats), which skim the top of the water to extract the oil.

Oil boom in action from *"How Do Oil Booms Work?"*, www.tech-faq.com

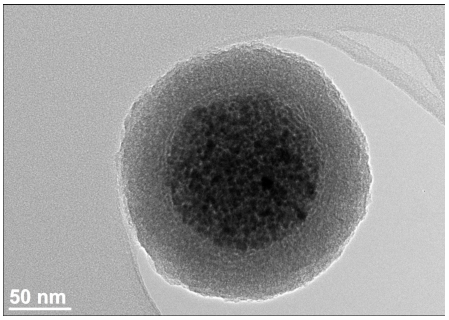
The second step in cleaning oil is to add an emulsifying agent to disperse the oil and allow micro-organisms to more quickly digest the spill. In the *Deep Water Horizon* oil spill, 1.8 million gallons of dispersants was added to the Gulf of Mexico [2]. Dispersants allow bacteria and photooxidation to more easily break down the compounds. However, this practice is not without its controversies. Critics argue that dispersants add other harmful chemicals to the ocean that could have adverse effects on an ecosystem. In recent years, these dispersants have encountered greater regulatory pressures and obligations by international organizations.

The final step of the cleaning process is known as bioremediation, which relies on bacteria and fungi to metabolize the

spilled oil. This step is one with large scientific consensus because it is minimally invasive to the ecology and highly effective.

Some other interesting techniques for cleaning include burning the fuel that lies on top of the water. This was used with great efficacy in the *Deep Water Horizon* explosion to release extraneous oil slicks floating in the Gulf of Mexico [2]. The disadvantage of this method, however, it the release of carbon that is contributing to global warming.

In spite of all these cleaning techniques for handling oil spills, scientists have yet to find a method that is 99% effective. Oil droplets remain in the system even after exhausting all the aforementioned techniques. Though bacteria and fungi will eventually degrade the droplets, it may not be soon enough to effectively mitigate damage to the ecology of the ocean.



Zoomed-in image of magnetic nanoparticle from *"Magnetic nanoparticles"*, en.wikipedia.org

In recent years, scientists have made significant progress in the field of magnetic nanoparticles that could help to solve this problem. In 2017, scientists at UT Austin developed magnetic nanoparticles that could attract oil droplets from water. A positively-charged, polymer coating was applied to the nanoparticles [3]. This allowed them to attract the negatively charged oil particles. Through the research was only a proof of concept, it has promising implications for the future cleaning of oil spills. Once the technology is adopted on large industrial scale, it will be possible to address oil spills with greater efficacy.

While scientists have a limited ability to control the demand of oil and and the politics that surrounds its, they are developing techniques and methodologies that can prepare us to deal with oil spills with greater efficacy. The field is ripe for innovation and disruption.

Citations

[1] Trujillo, Alan P., and Harold V. Thurman. Essentials of Oceanography. 3rd ed., Pearson, 2020.

[2] Pallardy, Richard. "Deepwater Horizon Oil Spill." Encyclopædia Britannica, Encyclopædia Britannica, Inc., www.britannica.com/event/Deepwater-Horizon-oil-spill.

[3] "Magnetic Nanoparticles Will Help Clean Oil Spills." VICE, www.vice.com/en/article/xw8aj4/magnetic-nanoparticles-oil-spill-lead-drinking-water.

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