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OIL SPILLS RELATED TOXICITY IN MARINE BIRDS

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Abstract

Significant attention is being given to oil spill disasters by media and public. The increasing consciousness about oil spills and the havocs it causes has led the world to actively pursue the steps to mitigate and tackle this environmental issue. Oil spills have many unfavorable impacts on marine ecosystem. Mortality of marine birds is one recurring and greatly publicized after-effect of oil spills. This review propose the need for biological monitoring of seabirds vulnerable to oil spills, in order to assess both the primary and deep-rooted effects on them. It is also crucial to lay emphasis on ways that helps in the reduction of oil spills related incidents in order to save seabirds.

Keywords
Oil Spills, Toxicity, Seabirds, Environment, Pollution

1. Introduction

Oil is one of the most important source of energy and a prime raw material for chemicals and human-made polymers across the globe. There is always a risk of oil spill during storage and transportation of petroleum, with the possibility to cause notable damage to the environment. Oil pollution has a negative impact on tourism and economy. Sea creatures are also affected by this type of pollution, as oil consist of many dangerous compounds that are not good for their health. Beauty of natural sites also gets ruined by pollution from oil spills, the strong smell of oil can be sensed faraway and the extravagant growth of green algae modify the color of water (Annunciado *et al*., 2005).

When oil is spilled in sea, it quickly spreads over the surface of water based upon its composition and density (Bucas & Saliot, 2002). The extent of oil spreading depends greatly on the type of oil spilled, temperature of water, wind speed and sea conditions. Oil having low viscosity spreads more quickly than viscous ones (Reed *et al*., 1999; Wei *et al*., 2003). It is

imperative to effectively control the spread of oil and its toxicity after an oil spill. For this purpose, use of sorbents is a good technique for cleaning up an oil spill (Wei *et al*., 2003).

Although petroleum pose a great threat to the environment during its extraction, transportation and disposal, but still it is considered as the main source of energy worldwide (Dincer, 2000). Large amount of crude oil is transported around the world by freight tankers to refinery terminals. In addition to regular discharges of refined products from ships, there are also fortuitous release of refined petroleum products from drilling rigs and tankers that originate from accidents and carelessness. In 2013, a total of 605 separate releases of petroleum from watercrafts and offshore oil and gas production facilities were proclaimed in UK waters alone (Dixon, 2009). It has been evaluated that global release of petroleum oil in to the aquatic environment range from 0.5 to 8.4 million tonnes per year, with shipping and drilling rigs contributing ~35% to this total (NRC, 2003).

2. Methodology

The literature was searched using Google Scholar. Relevant research articles were shortlisted for the detailed examination. Selected articles were analyzed for writing this article.

3. Oil Spills related Accidents

The Deepwater Horizon oil spill occurred when an offshore drilling rig exploded on April 20, 2010, releasing huge amount of oil in the Gulf of Mexico. In response to this marine oil spill, a monitoring expedition was organized in the fall of 2010 to measure the potential impact, indicating a dangerous effect on the health of seabirds and suggesting that it could take decades for affected seabirds to fully recover. (Montagna *et al*., 2013).

On July 27 (2003), the Greek tanker Tasman Spirit, carrying 67,000 tonnes of Iranian crude oil grounded at the entrance to Karachi Port. About two weeks later, on the night of August 13 and 14 (2003), the tanker shattered and threw its cargo into the sea. Strong winds and rough sea contributed to the spread of oil on about 10 kilometers of residential coastline. Two additional oil spills followed, the last on August 29 (2003), spilling over 35,000 tonnes of crude oil. Much of the shoreline affected was a recreational area with densely populated high-end residential areas and several low-income areas. Marine life was also adversely affected by this disaster (Janjua *et al*., 2013).

Exxon Valdez, an oil tanker spilled about 11.2 million gallons of oil into Prince William Sound, Alaska on March 24, 1989 (Westtermeyer, 1991; Weber & Crew, 2000). Nearly 36,115 seabirds were found dead on the beach because of this environmental disaster. Taken together, all the evidence suggests that Exxon Valdez oil killed about 250,000 seabirds (Piatt & Ford, 1996).

During the war of 1991, oil storage tanks in Kuwait were destroyed, spilling hundreds of millions of gallons of oil into the sea. Recent oil tanker accidents in the East Sea and

the Channels of Malacca have resulted in severe contamination of seawater and nearby shores, posing serious threats to the environment, including fisheries and wildlife along with huge losses of heavy oil. More than 300 oil spills related accidents have been reported in Greece annually over the past decade (Yando, 1995).

About 270,000 liters of oil was released into the sea when Nella Dan - an Australian supply ship ran aground in Buckles Bay, Macquarie Island on 3 December, 1987. It was one of the few outflows from cold oceans in the Southern Hemisphere. Many sea creatures were found dead along a two-kilometer coastline. The density of aquatic organisms greatly declined after this spill (Pople *et al*., 1990). Table 1 shows the estimated mortality rate of seabirds caused by oil spills (Burger, 1993).

4. Health Impacts of Oil Spills on Seabirds

Death of seabirds is one of the most deleterious consequence of large oil spills. Such oil can negatively impact birds in three different ways. (1) Among the most noxious impact of liquid petroleum on sea birds, contamination of their feathers has the most toxic effect on their health. Therefore, external contamination of feathers and its resultant impact on birds is among the most common forms of exposure to oil spills. The natural properties of water repellency and insulation in the feathers of birds gets impaired after exposure to oil spills. Also, flight of oiled birds is affected negatively. When oil sticks to feathers of birds, this can result in hypothermia, starvation, drowning and ultimately death of targeted birds. (2) Oil contaminates the egg shells, thereby severely affecting the embryos of the birds. The concentration of oil as little as 1–10 μL, during the first half of the incubation period of egg, is fatal for avian embryos. (3) Through preening, birds try to get the oil off their feathers, as a result, they ingest oil. Table 2 shows harmful impacts of oil spills on marine birds (Leighton, 1993).

Table 1: Death Rate of Seabirds resulting from Oil Spills

Year	Source of Oil	Site	Spill Volume (t)	Estimated Mortality of Seabirds	Reference
1937	Frank Buck	San Francisco	11,800	10,000	a
1952	Fort Mercer and Pendleton	Monomoy	22 ,400	> 3500	a
1955	Gerda Maersk	Elbe, Germany	8000	500,000	a
1966	Seestern	Medway, UK	1700	5000	b,a
1967	Torrey Canyon	English Channel	119,328	30,000	b,a,c
1976	Barge STC-101	Chesapeake Bay, V	833	20,000-50,000	d
1978	Outfall	Dounreay, UK	68	>1000	e
1978	Amoco Cadiz	Brittany, France	200,000	20,000	b,f,g
1983	Swedish Tanker	Kattegat, Denmark	500	50,000	h
1984	Unknown	Whidbey Island, Puget Sound	17	>1500	i
1984	Puerto Rican	San Francisco Bay	4900	4815	j,k
1985	Arco Anchorage	Port Angeles, WA	800	4000	l
1986	Apex Houston	S. California	87	10,577	m
1989	Exxon Valdez	Prince William Sound, Alaska	36,400	350,000-390,000	f,c,n

References: [a]Vermeer & Vermeer (1975); [b]Blackman (1986); [c]Piatt *et al*. (1990); [d]Roland *et al*. (1977); [e]Bowman (1978); [f]Piatt & Lensink (1989); [g]Jones *et al*. (1979); [h]Clausager (1983); [i]River & Island (1987); [j]Bird (1985); [k]Ford *et al*. (1987); [l]Speich (1986); [m]Page *et al*. (1990); [n]Stewart *et al*. (1991)

Research studies indicate that a relatively small amount of oil ingested by birds may have adverse impacts on the body function of sub - adult birds which eventually leads to their death. Conversely, adult birds show resistance to the harmful impacts of oil. Although oil ingestion causes physiological effects which are somewhat less than lethal, a substantial quantity of oil has been seen to become a cause of death in adult birds (Jenssen, 1994).

Table 2: Harmful Impacts of Oil Spills on Seabirds

Harmful impacts of oil on birds	Reference
1) Low fertility rate	Leighton, 1993; Eppley & Rubega, 1990; Harvey *et al*., 1982; Cavanaugh & Holmes, 1982; Gorsline & Holmes, 1982
2) Damage to red blood cells	Leighton, 1993
3) Thinning of eggshell	Harvey *et al*., 1982; Vangilder & Peterle, 1980; Holmes *et al*., 1978
4) Anemia	Troisi *et al*., 2007; Leighton *et al*., 1983; Pattee & Franson, 1982; Fry & Lowenstein, 1982
5) Changes in liver enzyme function	Jenssen *et al*., 1990; Gorsline *et al*., 1981; Gorsline & Holmes, 1981
6) Changes in adrenocortical function	Peakall *et al*., 1981, Rattner & Eastin, 1981; Gorsline & Holmes, 1981
7) External oiling of egg, blocking gas exchange through eggshell	Jenssen & Staurnes, 1989
8) Congenital malformations, embryo aneuploidy	Lewis & Malecki, 1984; Ellenton, 1982; Hoffman & Gray, 1981; Macko & King, 1980; Szaro *et al*., 1980
9) Growth rate inhibition	Peakall *et al*., 1982; Peakall *et al*., 1980
10) Abnormal osmoregulation	Peakall *et al*., 1983; Peakall *et al*., 1980
11) Changes in intestinal absorption of nutrients	Eastin & Murray, 1981
12) Disruption of endocrine system	Fowler *et al*., 1995; Peakall, 1981
13) Immune system disorders	Troisi, 2013; Rocke & Hinsdill, 1984
14) Inflammation of liver, kidney and lungs	Leighton, 1993; Khan & Ryan, 1991; Fry & Lowenstine, 1985

Oil spillage that occur by accident from drilling rigs and marine shipping in to the sea results in spills that destroys marine ecosystem services and cause serious unsustainable mortality of wildlife. Following a spill, large scale mortality within days is reported among seabirds because of external oiling. The birds who survive suffer from adverse health effects due to contact with

toxic PAHs present in the ingested oil. It was noted that despite investment of considerable resources, survival chances for rehabilitated oiled birds was rare (Troisi *et al*., 2016).

Mass death of seabirds is one of the devastating consequences of oil spills (Castege *et al*., 2007). Seabird populations are extremely exposed to oil spills because of their distribution, scavenging and breeding behavior. Followed by a spill, crude oil starts floating on the surface of water. Seabirds suffocate when they come in contact with such oil and can cause their immediate death (Camphuysen & Leopold, 2004). The water repellency in feathers of the birds is destroyed once birds' feathers come in contact with oil. This destruction in the capacity of water repellency in the feather of the birds further expose the skin of the birds to the extremes in temperature which lead to hypothermia or hyperthermia causing the eventual death of the birds. Seabirds affected by oil spills also become unable to dive or fly because of the weight of oil on their feathers. This leads to a negative impact on their foraging behavior (Jenssen, 1994; Piatt & Van Pelt, 1997). Birds are orally exposed to chemicals such as hydrocarbons which are present in crude oil. It occurs when birds ingest oil from feeding and preening. A marked fraction of lethal polycyclic aromatic hydrocarbons which, depending upon certain factors such as; the kind of oil, weathering and its extent, content of water, can make up to 30 % of the hydrocarbons present in oil (Monograph, 1989). About 170,000 metric tons of polycyclic aromatic hydrocarbons are released into the aquatic environment annually because of natural sources and oil spillage (Eisler, 1987). Plasma and tissue contamination in aquatic birds is because of these PAHs (Troisi *et al*., 2006). PAHs are further known to cause serious impacts of oiling which in the long term makes it difficult to redeem the rehabilitated cleaned aquatic birds at both individual and population level.

A research study described that Cassin's Auklets and Common Guillemot suffered from liver inflammation, haemosiderosis, and acute tubular necrosis as a result of Santa Barbara crude oil spill. Furthermore, parasite-induced lesions were found in the gastrointestinal, pulmonary, and urinary systems of both oiled and controlled birds (Fry & Lowenstine, 1985).

5. Results and Discussion

Polycyclic aromatic hydrocarbons (PAHs) are found naturally in petroleum products. Significant oiling of seabirds occur when they get exposed to harmful PAHs as a result of oil spills related incidents in marine environment. One study found that seabirds were seriously hit by oil spills because of exposure to PAHs (Troisi *et al*., 2016). Same statement was corroborated by another research work which concluded that marine birds were found to be impaired by PAHs (Adzigbli & Yuewen, 2018). Castege *et al*. (2007) found that mass mortality event of seabirds was a common aftermath of oil spills. Another research reached the same conclusion that fatality in marine organisms was

one of the dangerous impacts of oil spills (Adzigbli & Yuewen, 2018). Munella *et al*. (2011) found that The Prestige oil spill was one of the awful disaster ever appeared worldwide in terms of severe seabird mortality. Death of seabirds because of oil-spill related events in California were assessed in another research study and the possible risk of chronic oil pollution from regular shipping practices was noticed. It was concluded that thousands of birds may die as a result of small oil spills in marine ecosystem (Hampton *et al*., 2003).

The developed nations of the word have made it a priority to address oil spills related toxicity in seabirds but the situation is not the same in developing countries like Pakistan. Present review is an attempt to highlight the adverse impacts of oil spills on seabirds but no viable solution has been presented in this review so as to protect the population of seabirds from oil pollution. A comprehensive approach should be developed to address the threat, issues, and disturbance to the seabirds from oil spills.

6. Conclusion

Although there is a significant reduction in oil spills related incidents because of a variety of preventive measures that are being taken at present. But despite all these efforts, the risk of significant oil spills still loom over the well-being of marine life. There is a dire need to stop oil spills related accidents as much as possible in order to conserve the population of seabirds which are highly valued elements of biodiversity in the marine environment. This review also suggests that there is a dire need to collect information from smaller oil spills, for these might be killing as many sea birds as are being killed by the known and widely publicized large oil spills. The oil spills are a constant reminder that the catastrophe of this massive nature despite being tragic is preventable. Wherever there is a drill, there would be a spill which adversely impact not only marine life but the coastal communities and their livelihood built around fishing as well. The Persian Gulf War Oil Spill (1991), The Tasman Spirit Oil Spill (2003), BP's Deep water Horizon Oil Spill (2010) and several other incidents of the same nature are a constant reminder that the dearth of immediate attention from relevant authorities, turn the otherwise beautiful nature into a hotbed of disaster and seabird mortality.

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