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Effects of oil pollution on birds

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Abstract. As a non-renewable energy source, oil has an unshakable position in the development of human beings. Still, no one has noticed that the oil buried deep in the ground is also inextricably linked to the birds flying in the air. This article focuses on how oil, except diet, has been linked to bird deaths. The first research direction is to study the feather structure and function of birds. It is concluded that oil will damage the functionality of feathers and make the feathers of birds unable to function. The second research direction is about the inversely proportional relationship between the flight speed of birds and oil and the directly proportional relationship between energy consumption and oil. It is concluded that oil will affect the speed and energy consumption of birds and make birds more vulnerable to predation by natural enemies. The third research direction is the analysis of the damage degree of oil to birds' eggs and young. Based on these studies, it is possible to find out feasible methods that can effectively reduce the harm of oil extraction operations to birds without affecting normal human activities. Let birds have a way to reproduce healthily and safely without hindering human development.

Keywords: birds, oil pollution, bird protection.

1. Introduction

Birds are a fundamental part of the ecosystem, occupying the aerial domain and supporting hundreds of habits. Petroleum, a non-renewable resource, is vital to the development of human society and is essential for most forms of transportation. However, oil is also harmful when accidentally in contact with the surroundings. The oil spill is a devastating environmental disaster that can have long-lasting effects on the ecosystem, economy, and communities. The oil spill causes by accidents involving tankers, barges, pipelines, refineries, drilling rigs, and storage facilities, while also occurring from recreational boats and marinas. In recent years, an increasing number of offshore oil spills have prompted mankind to gradually draw attention to the problem of oil spills. But most of the victims of these oil spills are marine life in the sea and human beings, and few people notice that birds are also sufferers of these oil spills. Most people think there is no relation between birds and oil hidden in the ground or bottom of the sea. Due to human beings discovering and extracting oil, oil has had an unintended relationship with birds. If an oil field built on oceans and lakes leaks, the species that depend on these lakes and seas will be the first to hurt. Most of the suffering species are aquatic animals, followed by birds. As people all know, most birds consume fish and need lakes and streams to rehydrate, so birds are further linked to oil spills because of the way they feed and drink.

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There are several different results from various experiments from studies in different countries. One study from Canada's Pacific coastline includes twelve bird species and describes the situation between the oil industry and birds. The high-density oil interactions of all 12 bird species almost coincide with the high bird density [1]. The higher bird density means the birds are more likely to rest, breed, or nest in these places, but it also increases the interaction between the birds' group and the oil field. Similar to the first study in Colorado, Niobrara Shale, a main oil-producing area, also has abundant bird populations [2]. What's more serious is that because it is inland, birds can only inhabit this high mountain because of the lack of a large area of the living environment. The mountains birds depend on are where the shale and oil fields are located, making the birds' habitats heavily damaged by oil drilling operations. Another article from New Zealand in the southern hemisphere expresses how all 55 types of birds living nearby the New Zealand shoreline and archipelago respond to oil contamination and the species' vulnerability. Based on the research, 17 species are accompanying high or moderate vulnerability and low response options, which is the most concerning group due to oil contamination. Luckily, twelve of these seventeen species live on New Zealand's offshore sub-Antarctic islands, a region far from the highest-risk oil spill area [3]. Three pieces of research above discuss the relationship between birds and oil contamination, but how did oil harm the birds? Petroleum is known to be toxic to almost all living organisms. A group of researchers from Canada studied the harm of oil pollution to seabirds by detecting the polycyclic aromatic compounds (PACs) and trace elements in the liver of two seabird species: murres and guillemots. The researchers found that the murres represented a relative increase in oxidative stress, another type of poisoning signal for the birds, and changing purine metabolism [4]. If the levels of PAC and trace elements in the bird's body exceed the limit they can bear, the bird will die. Oil pollution kills millions of birds on the planet each year. The above examples are just a small part of the world. However, that is a critical argument. Many people only know that oil will constantly hurt the birds when birds directly get the oil or indirectly get it from its poisoned meal, such as fish, crabs, and shrimp, and ultimately kill them. However, they do miscalculate what additional directions oil can harm birds. The main goal of this paper is to tell the reason for the previous question with different directions to explore the tragedy that happened to the birds.

2. Oil effect on seabird feather

One oil-based trouble that birds suffer from is their feathers. Bird feathers protect body organs from direct contact with the outside world just like human skin. Feathers, whose primary functions are waterproofing, insulation, and warmth, play an enduring role in the survival of seabirds as an essential component of all birds. The dexterity and water repellency of seabird feathers derive from their complex hydrophobic microstructure, which includes shafts and branches with hooked twigs on the outside and smooth twigs on the inside. The feather's hydrophobicity and lipophilicity construction cause it easier to bring oil from the water. For example, a <3 μm film of oil on the water surface can clog branch hooks and cause adjacent branches to unite. Added oil continuously interrupted this layered matrix, leaving the barbs disheveled but still muscular [5]. The efficiency of seabird feathers is poor because the oils joined to the feather can damage the form and function of the feather. If the feather absorbs the oil, it will not anymore allow to resist water and voltage or withstand the temperatures of its body in the water. Because the feather does not maintain heat, seabirds are more likely to get sick or freeze to die after coming into the water. Because the feather loses insulation, seabirds are more likely to receive electrocution when they hit utility poles or rest on wires. In addition, as the feathers lose waterproofing, the raised moisture in seabirds' feathers makes them weightier. Increasing feather pressure reduces the seabirds' flexibility, making them more sluggish to hunt or escape, spending more energy along the seasonal journey, and catching electrocuted drowning. It is a law of nature that predators are more likely to pursue success in slow-moving or better-catching seabirds than in ordinary seabirds.

Birds do not have a clear territory and movement track like other land creatures, they are freer. They usually search for food on the shore, but sometimes fly to the ocean. Since the orbits of seabirds are changeable, it is complicated for people to prevent the question of oil on the feather which also means that birds' feathers are often contaminated with oil by inadvertent behavior. There are two possible

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directions to ease the obstacle provided for humans. The first direction is to identify secret emergencies as early as attainable and remove them or preserve as many seabirds as possible from an oil leak or decrease mortality. This plan is the most accepted plan human beings use for saving animals. Once people find individual species vulnerable, humans use this plan to help the species. However, this plan is inappropriate for seabirds because the range of activities of seabirds is far huge for humans to manage. Even if humans wanted to protect seabirds, they could only protect them from harm while they were hatching young because seabirds stay on shore for long periods only when they are hatching eggs. When they are at sea, because they are far away from land, humans cannot follow them anytime and anywhere. The second one is to build an oil field lacking the action range of seabirds. Most of the seabirds lived nearby the shore region. They feed, nest, breed, and sleep on the shore. Most seabirds have the habit of returning to their nests, so it is probable to forecast the furthest range distance of their actions. The outer range is the place where no seabirds catch fish. Out of the zone will be a safe place for seabirds while implementing oil operations. This is an effective method, but it needs to be communicated and negotiated with the oil company to reach an agreement before it can be implemented.

3. Oil effect on migratory ability and energy expenditure

Another effect of oil pollution is the reduced migrating ability and increased energy expenditure of migratory birds to fly long distances. Migrating birds are a group of bird species that will transport from one place to another to find food resources based on the season. The reason why these migratory birds need a long-distance trip is to find enough food for the winter, and this trip has brought many hidden dangers to these migratory birds, such as not being able to find food in time and encountering the natural enemy. One experiment with homing pigeons found that 59% of the oiled birds require more time than the unoiled birds on the same days and in the same environmental conditions. While the more distances the oiled homing pigeons flew, the more time they needed than the unoiled group [6]. The oiled birds based on the data showed they need more time for homing. Based on the data, it can be confirmed that when migrating birds are oiled, they are slower than before and the oiled birds take longer to return to their nests. Migratory birds generally act in groups. Combined with the hidden dangers mentioned above, the group of migratory birds that are oiled will be more likely to be attacked by natural enemies and will reach their destination more slowly, or they will find food more slowly.

The oiled migratory birds are not only dangerous because of their speed but also threatened because of their more energy expenditures or frequent stopovers. More stopovers give more chances for the enemies to catch the birds in their journey to find new food resources. Another experiment for migrating birds proves that. Within the 1000 km distance, the oiled migrating birds cost an additional 60 to 120 KJ for each leg and 1.5 to 7.5 days at each stopover. This result cannot exclude the effect of oil-ingesting birds, which may lead to another reason for increasing energy costs and migrating duration [7]. This data represents the energy costs and stopover frequency of oiled birds for a long journey. Such a large energy consumption makes these birds have to find more food to replenish energy during the journey, which means they need more stopover time. The natural enemies of these migratory birds will use the extra rest time of these migratory birds to catch them, which makes the living environment of these migratory birds even worse. Similar experiment from the same group in 2017, Maggini's group researched two groups of sandpipers. They found that the oiled group flew a shorter distance per unit of time and tend to have a larger takeoff angle in their baseline flight than the control group [8]. This data support that the oiled birds required more energy expenditure than the control group because oiled birds need more energy and time to reach the same distance as the control group. Also, the takeoff angle is another piece of evidence that the birds have a greater weight and need more energy to take off. During their second takeoff, the oiled birds' takeoff angle dropped significantly because the energy cost is much higher than the control group. They are tired of flying away or traveling to other places.

The problem with natural enemies is that humans have no right to interfere with the laws of nature, but the damage caused by oil pollution to birds is caused by humans, so people have the right and obligation to solve the damage caused by oil pollution to nature. Tackling oil pollution is more difficult for these migratory birds than for those with permanent homes because they have a wider range of action.

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There is very little protection humans can do for migratory birds. One possible approach is to create protected areas at their important rest stops and terminus. Everglades National Park is a great example for proving this idea. Within a 1.5 million acres area, the national park becomes a terminus or home to over 350 bird species. In this wild place, no industry, and rare human makes birds have no interaction with the oil pollution and this environment is safe for birds to live in normally.

4. Oil effect on reproduction

Petroleum not only hurts the birds with feathers and flying ability but also reduced the growth rate of bird pups with its harmful compound. As mentioned in the first case, birds' feathers will also absorb and bring the oil leaks in the ocean to their nest when they return from the water. When the seabirds hatch their eggs, the oil will leave on the eggs. The petroleum saturates eggshells and poisons embryos. In one study about crude oil with eggs, the researchers detected five groups of eggs within 2.5, 5, 10, 20 μL, and a control group. Within 12 days, control eggs and eggs exposed to 2.5 μL had >75% survival, while eggs exposed to 5 μL or more of crude oil resulted in 25% and 0% embryo survival. The oil also caused developmental delays or retarded embryonic growth for the surviving group. The more crude oil-affected group presented fewer heart rates and metabolic rates [9]. In other words, the more crude oil-affected group is more likely to be death or illness. This data is undoubtedly a major blow to the living environment of birds. The bird's parents will never know or notice their inattentive behavior can cost their babies dead eggs or premature death. Dead eggs or premature death are especially difficult for some rare, endangered, or single egg-laying bird species to survive. These species' populations will drop increasingly and eventually break the ecological balance and become a disaster in the ecosystem. Most people may think that a bird's eggshell protects the young from harm unless the eggshell breaks, but from the above data it appears that the eggshell is a dispensable shield against oil pollution. According to the exposure content, there are different degrees of damage to the eggs, but it is certain that the more exposure, the greater the damage. In one of the research from 2014, a group of researchers found that with the same number of seaside sparrows in the oiled group and control group. The oiled group birds are dramatically lower in percentage than the control group, with only 5% surviving to fledge in an oiled group compared to around 45-50% surviving to fledge in the control group in 2013 [10]. The contrast between these two sets of data is very strong. It can be seen that the living environment of the seaside sparrow is already very harsh, but the arrival of oil pollution has made their survival rate shrink again or even less than one-tenth of the previous survival rate. This is undoubtedly a major hazard to their population reproduction. Even if the birds are not dead and sick, they will respond much more slowly than normal birds, which leads them more easily to be caught or killed by predators when they grow up. Oil pollution has serious consequences for the reproduction of animals of the least concern, so it may be meaning extinction for threatened animals. For saving the eggs from oil pollution, the method is very similar to saving the migratory birds, which is building the natural park. The migratory birds' terminus of the journey is usually the place for laying their eggs, so building national parks saves the migratory species as well as all birds' eggs. The national park is illegal to have any industry. In the park, the only possible place for contact with oil is the ocean or streams, but since there is a national park the government can't allow any industry near or interact with the national park. Therefore, it is safe for birds to stay and lay healthy eggs.

5. Conclusion

It is difficult for humans to detect and prevent the impact of oil pollution on birds. Only after repeated analysis and comparison can people conclude. Many people only know oil will be stuck on the feather of birds, but they do not know oil can also damage feathers. The oil destroys the structure and function of the bird's feathers, making them unable to maintain a constant temperature and conduct electricity after being submerged in water. When the oils attach to their feathers, the birds gain so much weight that they can no longer fly long distances efficiently or evade predation. Even eggs and young birds can be seriously injured by oil. Some died before breaking their shells, and some died before they matured, which greatly reduced the survival rate and maturity rate of young birds. The above lists a series of

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targeted and feasible bird rescue programs. In reality, human beings have long ago chosen nature reserves as their main rescue solution. Nature reserves may not have received widespread attention and understanding from the public at the beginning because nature reserves do not affect ecological restoration in the short term. But after years of comparative research, it has been found that nature reserves do play a key role in bird protection. One is because the protected areas are far away from industrial areas or oil mining areas, which indirectly reduces the connection between birds and industrial development. The second is that humans will not harm birds in the protected area, because all dangerous behaviors are illegal. The third is that nature reserves generally provide the largest range of protection space for animals and plants to ensure that they can live normally and be connected with human life. Although it may not be possible to establish large-scale protected areas, as long as there are protected areas, people and birds can coexist peacefully on this planet without interfering with each other. There is no doubt that the effects of oil pollution are enormous, affecting and harming humans, plants, and animals. Fortunately, human beings have realized the harm of oil pollution and have made their contributions to the protection of animals and plants. The area of oil pollution is decreasing year by year, and the reports of harm to animals and plants are also decreasing accordingly. There are reasons to believe that with the efforts of all human beings on the earth, the environment of the earth will become better and better.

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