OIL SPILL SCIENCE
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BIRDS OF A FEATHER — COPING WITH OIL

Emily Maung-Douglass, *Larissa Graham, Christine Hale, Stephen Sempier, Tara Skelton, LaDon Swann, and Monica Wilson*

Although birds can travel great distances, they cannot necessarily escape oil exposure from natural oil seeps or oil spills caused by humans. Scientists and natural resource managers are still trying to understand the many ways oil exposure can affect birds.

Though an entirely land-based species of bird, seaside sparrows showed signs of oil in their diet after Deepwater Horizon oil spill. (Andrea Bonisoli Alquati)

Oil can have a variety of short- and long-term effects on birds, including damage to plumage, poor health, delayed migration, and death.[1] An oiled bird may experience a cascade of effects from exposure.[2] Negative impacts to birds can include breathing problems, damage to internal organs and blood cells, as well as inability to fly and regulate their temperature. Oil exposure can cause individual birds to die, but it can also lower overall population numbers by reducing breeding, hatching, nesting habitats, and newborn survival rates, and by altering migration habits. Scientists continue to study how birds combat oil pollution, both in the timeframe immediately following a spill and in the long term.

IMPACTS

Plumage

Plumage, or the feathery covering on a bird, is critical to the health of birds. Plumage serves many roles, such as aiding in flight, attracting mates, supporting buoyancy, and insulating from cold and wet conditions. Oiling reduces the insulation provided by plumage, making it difficult for an oiled bird to maintain a stable body temperature.[3] The result is often death due to hypothermia.[3] Additionally, oiled birds might devote more time than unoiled birds to preening their feathers with their beaks in attempts to clean and straighten their plumage. Increased time spent on this behavior disrupts time spent on other behaviors like foraging, resting, and reproduction, which can negatively affect the overall health of the bird.[3] Birds may also accidentally eat oil while preening, leading to greater negative health consequences.[4]

Toxic effects and accumulation

Birds and many other animals can break down and excrete oil compounds from their bodies. While eating contaminated food may not cause oil-based compounds to build up or accumulate in birds' muscle tissue these compounds still move through the birds' bodies as the compounds are processed and may be passed to others in the food chain.[1] For example, Tundra Peregrine falcons sampled from coastal Gulf of Mexico had increased levels of oil-based compounds circulating in their blood after the Deepwater Horizon (DWH) oil spill.[5] The levels varied based on the age of the birds, likely due to age-

THE COST OF BREAKDOWN

The liver breaks down oil through a series of complex processes using enzymes. Oxygen reacts with some of the chemicals formed during these processes and the results can lead to damage in the body. The bird's liver produces **antioxidants** to reduce this damage.[4] The liver can increase the production of antioxidants in response to these damaging chemicals. Unfortunately, the damaging chemicals can also inhibit the protective actions of antioxidants, leading to damage and disease in the liver, blood, and other tissues.[7] One resulting condition is hemolytic anemia. Red blood cells carry oxygen throughout the body. The damage to red blood cells by oil causes a lack of oxygen in the tissues and damages the tissues as well.[4,7,8]

NATURAL RESOURCE DAMAGE ASSESSMENT AND THE DEEPWATER HORIZON OIL SPILL

The federal government initiated the **Natural Resource Damage Assessment (NRDA)** process during Deepwater Horizon oil spill to determine how the spill harmed natural resources, including birds.[2,9] Scientists from multiple organizations came together to study how the oil spill impacted bird reproduction, health, and long-term survival.[2,9] Impacts on the breeding populations are difficult to accurately assess, but NRDA estimates indicated between 51,600 and 84,500 birds died in the months immediately following the spill.[2] Many of the studies done as part of the assessment are cited in this publication.

Group	Estimated mortality (number of individuals)	Percent of total bird mortality	Example of this group
Gulls	23,050 - 37,266	39%	Laughing Gull
Pelicans	15,323 - 34,200	30%	Brown Pelican
Terns	7,885 - 13,162	13%	Sandwich Tern
Seabirds	3,914 - 6,020	6%	Northern Gannet
Waders	2,719 - 5,553	5%	Roseate Spoonbill
Rails	858 - 1,875	2%	Clapper Rail
Shorebirds	705 - 1,322	1%	American Oystercatcher
Loons and Grebes	781 - 1,249	1%	Common Loon
Waterfowl	410 - 639	1%	Mallard
Cormorants	476 - 1,077	1%	Double-crested Cormorant
Raptors	80 - 122	0.1%	Osprey
Landbirds	20 - 36	0.04%	Seaside Sparrow
Total losses:	**56,100 - 102,400**		

Table 1. *Scientists and natural resource managers estimated the number of birds impacted by the Deepwater Horizon oil spill in several ways during the Natural Resource Damage Assessment (NRDA). The numbers in the table represent the range and percentage of birds from each group estimated that died or were never born due to the oil spill—approximately 56,100 to 102,400 birds in total.[2] (Laughing gull figure: A. Wilson)*

FIGURE 1. *These double-crested cormorants fishing for a meal are left vulnerable to the effects of oil when exposed to it through their skin or food. (Brocken Inaglory)*

specific differences in hunting strategies and food between adults versus younger birds. For example, young falcons tend to favor preying upon other birds that are 'stragglers' in a flock. These lone birds are sometimes unable to keep up with their flock due to oiling. Scientists believe that by preying upon these oiled birds, young falcons increase oil uptake through their diets compared to adults that may not selectively prey on 'stragglers' in a flock.[5]

The skin is another route for oil to enter the body via direct exposure. Scientists found that exposing birds to oil through their skin can have health effects. Exposing the skin of double-crested cormorants to a few teaspoons of oil every few days for about two weeks is enough to cause severely labored breathing, disrupt heart function, and enlarge and soften the heart muscle (Figure 1, 2).[6]

Migration and other far-reaching effects

An oil spill has the potential to affect birds in places far outside of an oiled area (Figure 3). Migratory birds travel long distances on a predictable course at predictable times to nest, **overwinter**, and mate. Successful breeding often hinges on being in the right place at the right time for many migratory bird species. Oiled birds may have difficulties flying, causing them to be out of sync with regular migration patterns and also leading to exhaustion and further difficulty when they do arrive at the location used for mating, nesting, or feeding.[10]

Scientists studied homing pigeons to better understand the impacts of oiling on migratory bird species.[10] Homing pigeons are a good study species because they navigate long distances — like migratory birds — and can be trained to return to their human handlers. Scientists found that lightly oiled homing pigeons took longer to return home compared with unoiled birds. While many of the unoiled homing pigeons tested could complete flights without stopping, the oiled birds spent up to 50 percent of their trips not flying due to more

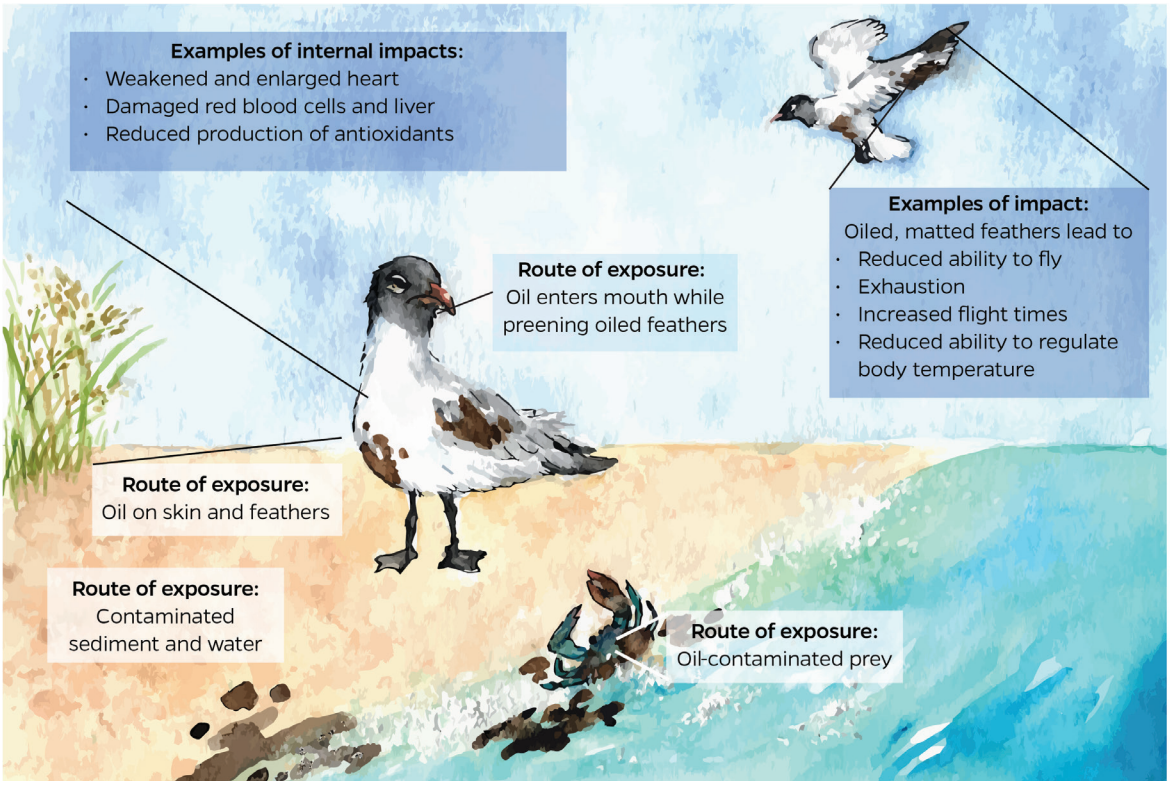

FIGURE 2. *Birds are exposed to oil via multiple routes, including through their skin, feathers, diet, and mouth. Impacts to birds are numerous and can include damage to internal organs and blood cells. (Anna Hinkeldey)*

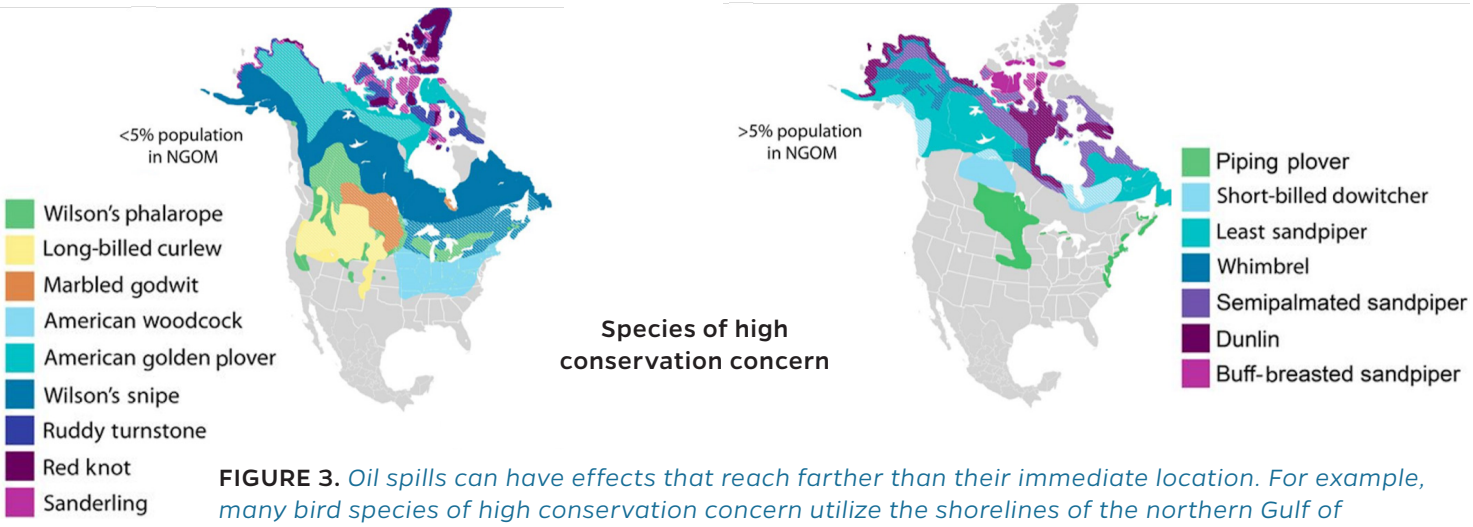

FIGURE 3. *Oil spills can have effects that reach farther than their immediate location. For example, many bird species of high conservation concern utilize the shorelines of the northern Gulf of Mexico (NGOM) as a stopover or a place to spend the winter before moving on to other locations in North America to breed (as indicated on map). Because of this connectivity, an oil spill in the Gulf of Mexico can impact distant locations like the Arctic. (Adapted from Henkel et al., 2012)*

frequent breaks or resting periods. Based on previous work done with oiled sandpipers, scientists think that the oiled pigeons needed to take long breaks during their flights because of their bodies' high energy demand to maintain flight. Feathers matted and clumped with oil are less aerodynamic and cause difficulties with flying.[10] In fact, scientists found lightly oiled sandpipers have significantly less powerful wingbeats than unoiled birds.[11] Light oiling results in slower take-offs for oiled birds and leaves them more vulnerable to attack by predators compared to unoiled birds.

Migratory birds that are able to take flight can become part of **food webs** in multiple locations and **ecosystems**.[1] This is because they may hunt and eat other animals or be eaten themselves anywhere they travel. When oiled migratory birds are eaten by other animals, it can introduce oil into food webs otherwise unaffected by an oil spill.[13] Similiarly, unoiled migratory birds may

CLEANING OILED BIRDS – LESSONS LEARNED

Many people have seen the practice of cleaning oiled birds with detergent after major oil spills. Survival of these rehabilitated and released birds can vary.[15] Scientists think that survival after oiling and rehabilitation depends on several factors, including the species affected, conditions of the spill, stress due to oiling, and cleaning techniques.[3,15] Scientists found that murres rehabilitated from various spills that occurred between 1969 to 1994 (including Exxon Valdez) had a post-cleanup life expectancy of just over one week.[16] More recent studies of birds oiled in other spills (penguins, gulls, gannets, pelicans) show post-rehabilitation survival rates similar or no different than unoiled birds.[15]

One aspect of cleaning techniques that affects post-rehabilitation survival is time allowed for plumage to dry.[3] The naturally protective and insulating oils of a bird's skin and feathers do not


(U.S. Navy photo/Mass Communication Specialist 2nd Class Justin Stumberg)

return until the plumage is dry.[17] A similar phenomenon occurs in other oiled and detergent-cleaned animals. Allowing even one week for drying and the return of naturally protective and insulating oils of the skin brought survival rates back to normal levels in sea otters when compared with the high mortality associated with otters immediately released after cleaning.[3]

FIGURE 4. *Nearly three quarters of the 30,000 birds lost during the first five months after the Exxon Valdez oil spill in Alaska were murres, like those shown above. (Dick Daniels)*

be exposed to oil when visiting oiled habitats either by ingesting contaminated prey and/or becoming oiled themselves (Figure 2).[1,14] This can have serious consequences in systems like Louisiana saltmarshes. Recent research indicates that birds there (gulls, terns, wading birds) hold uniquely important connections to many other types of marsh animals and plants.[13] Scientists identified these birds — some of which are migratory — as 'critically sensitive' to oil spills. This means that they are vulnerable to the effects of oil and are so connected to other organisms in that habitat that negative impacts to them could have a ripple effect on other plants and animals in that system.

Longer-term impacts and chronic oiling

The long-term success of a species depends in large part upon reproduction and survival of the young. Seaside sparrows live in coastal wetlands in the Gulf of Mexico and demonstrate this concept (see cover photo).[18] In the three years immediately after DWH oil spill, these birds were less successful reproducing than in previous years.[18] A possible cause could be loss of nesting habitat. Many of the plant species used by these birds as nesting habitat died due to the presence of oil in the marsh. However, this may not be the only reason these birds were less successful at reproducing. Scientists also found that seaside sparrows living in oiled areas ate oil-contaminated prey.[19] This behavior may have led to those birds producing a lower number of chicks that survived long enough to leave their nests.[18,19] In studies done on mallard ducks, chicks developing in eggs painted with **weathered oil** experienced toxic effects due to exposure. The eggs painted with oil were less likely to hatch.[20]

What can we learn from historic oil spills about the longer-term impacts on birds? More than 30,000 oiled birds died within the first five months after the 1989 Exxon Valdez oil spill in Prince William Sound, Alaska.[21] Total long-term losses to the bird population from the spill were estimated at 250,000, but it is difficult to determine exact numbers of bird losses from the Exxon Valdez spill (or any oil spill) because it was not possible to locate all carcasses.[22]

Approximately three-quarters of the birds lost to oiling during those first months after the Exxon Valdez spill were murres (Figure 4).[23] This bird is vulnerable to events like oil spills because it is slow to reproduce and spends

much of its time on the water's surface (Figure 4).[23] Some research suggests that the murre population in Prince William Sound increased in the years following the spill. The increase in numbers is likely due to individuals from other areas coming in and joining the locally impacted breeding population.[24] Baseline monitoring data are needed to accurately differentiate what impacts are due to oil spills versus shifts in other environmental factors.[23]

Meanwhile, the 2002 Prestige oil spill along the coast of Spain continues to negatively affect bird reproduction after the wrecked tanker released nearly 17 million gallons of oil.[25] The number of fully-grown European shag chicks declined by nearly half in oiled bird colonies compared to unoiled colonies 10 years later. Further, oil exposure is not restricted to the time of the spill event itself. Recent research indicates that oil can linger in the environment after a spill event and be unburied following hurricanes, tropical storms, and flooding events, re-exposing seaside sparrows and other animals to the oil.[26]

While the immediate impacts from major oil spills gain much attention, studying the impacts from chronic oil exposure is also important. Scientists spent five years studying the levels of oil-based compounds in the blood of common loons in Barataria Bay, Louisiana.[27] While there were no immediate increases of these compounds in the blood due to DWH oil spill, the results revealed that the birds in the area are chronically exposed to oil, scientists think possibly via natural oil seepages in the water.

Exposure to oil via natural seeps is not uncommon. In California, for example, there are approximately 254 reports of visibly oiled birds each year. The oil is likely from natural seeps and stirred up by large storms.[28] Constant exposure to low levels of oil can cause birds to have reduced body mass relative compared to those birds that are less exposed.[27] Such impacts lead some scientists to think that continual exposure to oil over long periods of time could lead to long-term population-level effects.

WHERE DO WE GO FROM HERE?

The Gulf of Mexico Research Initiative (GoMRI) and others continue to develop an understanding of how oil impacts birds and other wildlife. To learn more about this and the research being conducted on the Deepwater Horizon spill, visit the GoMRI website at ***www.gulfresearchinitiative.org***. Visit the Gulf Sea Grant program website at ***http://gulfseagrant.org/oilspilloutreach*** to view our other publications, about dispersants, oil, and other topics.

The 2002 Prestige oil spill continued to negatively impact the development of European shag chicks 10 years later. (Bo Eide)

Scientists think that common loons living in Barataria Bay are chronically exposed to oil, possibly via natural oil seepages in the water. (Cephas)

GLOSSARY

Antioxidants — Enzymes, like vitamins C and E, that protect the body from potentially harmful compounds generated during the breakdown of foreign chemicals (such as oil).

Ecosystem — A large community of living organisms — such as plants, animals, and microbes — in a particular area linked together through nutrient cycles and energy flows.

Food web — A system of linked food chains — a series of organisms, beginning with plants and ending with carnivores, each dependent upon the next as a source of food — within an ecological community.

Natural Resource Damage Assessment (NRDA) — The legal process used to determine the impacts of oil spills, hazardous waste sites, and ship groundings on natural resources and humans.

Overwinter — Spend the winter.

Oxidative stress — Occurs when oxygen reacts with compounds formed from the body's breakdown of foreign compounds and overwhelms the body's antioxidant protection. This can lead to damage to the body. The body produces antioxidants to protect itself from this damage.

Weathered oil — When processes such as evaporation, dissolution, bacterial decomposition, or exposure to sunlight change the chemical composition and physical appearance of oil.

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OIL SPILL SCIENCE OUTREACH TEAM

Christine Hale
Texas Sea Grant College Program
chris.hale@tamu.edu

Emily Maung-Douglass
Louisiana Sea Grant College Program
edouglass@lsu.edu

Missy Partyka
Mississippi-Alabama Sea Grant Consortium
m.partyka@auburn.edu

Stephen Sempier
Mississippi-Alabama Sea Grant Consortium
stephen.sempier@usm.edu

Tara Skelton
Mississippi-Alabama Sea Grant Consortium
tara.skelton@usm.edu

LaDon Swann
Mississippi-Alabama Sea Grant Consortium
ladon.swann@usm.edu

Monica Wilson
Florida Sea Grant, UF/IFAS Extension
monicawilson447@ufl.edu

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