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Non-anthropogenic Diet-based Oiling of Predatory Birds

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Oiling of wildlife can have important consequences to individual animals and populations (Kingston 2002). Individual birds that are heavily oiled lose their ability to fly and may become ill or die from hypothermia, starvation, exhaustion, or drowning (Clark 1984, Rocke 1999). For example, large-scale oiling from the Exxon Valdez spill caused local declines in populations of many avian taxa (Irons et al. 2000). Although most oiling reports involve marine wildlife exposed to oil leaked from vessels or oil rigs, oiling also can occur in terrestrial environments, for example, via birds drinking water in puddles on asphalt roadways (Clark and Gorney 1987) or landing in oil field wastewater disposal facilities (Trail 2006, Ramírez 2010).

The vast majority of wildlife oiling reported in the literature is anthropogenic in nature, usually caused when hydrocarbons are aggregated by humans and then spilled into wildlife habitats. However, there are non-anthropogenic routes by which hydrocarbons or their components are available (Howard 1962, Dean et al. 1998, Morandin and O'Hara 2014), and it follows that there are non-anthropogenic risks to wildlife from oiling. Likewise,

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hydrocarbons do not come exclusively from fossil remains and there are other sources of hydrocarbons in natural systems that wildlife encounter routinely. For example, most species of marine mammals and terrestrial mammals that hibernate contain extensive subcutaneous fat (Vaughn et al. 2010), and many are predated or scavenged by a wide range of predatory birds. Similarly, fish oils can disrupt form and function of seabird feathers (Morandin and O'Hara 2014), and some fish-eating birds regurgitate fish oils when threatened (Hagelin and Jones 2007).

We observed four separate instances of natural oiling of nestling Golden Eagles (*Aquila chrysaetos*) in California. Here we report those observations and describe the likely mechanisms by which the oiling occurred. We also describe our actions to aid these individuals, so that other permitted biologists have a set of known-success actions they may choose to take if they encounter similarly oiled animals. This is, to our knowledge, the first published report of non-anthropogenic oiling of raptors caused by overprovisioning of terrestrial prey.

Observations

The four nests where we observed oiled eagles were found in the course of research activity into eagle movements and demography. In each case, eagle nests were in or near oak–pine (*Quercus–Pinus*) savannah habitat bordering California's Central Valley, and in each case the oil on the birds appeared to be from dead California ground squirrels (*Otospermophilus beecheyi*) that adult eagles brought to the nest as food in greater quantities than the nestlings consumed. In some cases, the birds were so heavily oiled that their ability to glide from the nest was compromised and it is unlikely that they would have been able to survive to independence without prophylactic attention.

Nest 1 and Nest 2. Over 6 yr of monitoring Golden Eagle nests in the region of the Altamont Pass Wind Resource Area (APWRA) in the Diablo Range of Central California (Hunt 2002), two of us (DD and REJ) visited 93 eagle nests with 144 young. Of these, three nestlings in two nests were oiled.

On 27 May and 03 June 1994, we visited two Golden Eagle nests in which nestlings approximately 7.5-wk old were oiled. Both nests were built in valley oak (*Quercus lobata*) trees located within Contra Costa County. One nest contained a single nestling and 53 ground squirrel carcasses. The other nest contained two nestlings and 46 ground squirrel carcasses.

At each site, a climber secured the nestling(s), and lowered the nestling(s) to the ground, where a ground crew used dry towels to remove as much oil as possible. In each case, the climber removed all ground squirrel carcasses, nest lining, and oiled sticks from the nest. The ground crew banded the nestlings and provided fresh sticks and leaves to create a clean nest substrate, and the climber returned the birds to their nests.

We climbed the two nests again on 4 and 15 June 1994, when the nestlings were 8.5 and 9.0 wk old. We removed eight more California ground squirrel carcasses from the nest with one young, and 29 additional squirrel carcasses and one Barn Owl (*Tyto alba*) carcass from the nest with two young. Although the young eagles appeared less oiled on the second visit, we again cleaned the young with dry towels. Finally, we fitted each nestling with a 65-g VHF transmitter manufactured by BioTrack (Wareham, U.K.), and returned them to their nests.

We tracked the survival of all three radio-tagged Golden Eagles within their nest areas, and through weekly aerial surveys. All three oiled nestlings fledged successfully. Two were eventually killed by collision with wind-turbine blades in their third (13 May 1997) and fourth (7 April 1998) years of life. The third eagle survived at least through its fourth year (26 June 1998), when its transmitter fell off as designed (Hunt et al. 1999).

Nest 3. On 16 May 2013, at approximately 0900 H PDT, several of us (TEK, PHB, JAD, JMD, ST, JLC, TGG) visited a Golden Eagle nest in Tulare County, California. The nest was built in a blue oak (*Q. douglasii*) situated on a hillside used for grazing cattle and above citrus and row crops in the valley bottom below. This territory had fledged young in each of two previous years (P. Bloom unpubl. data). Shortly before our visit in 2013, a helicopter survey by PHB revealed the presence of three nestlings near fledging age (approximately 8 wk old).

Nestlings at near-fledging age that are disturbed by climbers will sometimes jump from the nest and glide, often for hundreds of meters, from their nest. Two climbers went to the nest tree and, as they began their ascent, the three nestlings jumped from the nest. However, unlike typical eagle nestlings of this age, these birds did not glide from their nest. Instead they dropped rapidly to the ground, alighting heavily, approximately 3 m from the nest tree.

Upon inspection, we observed that, although well fed, each of these birds was heavily coated in a light-weight oil. As a consequence of this oiling, all the birds' feathers were matted and wet, with compressed plumes (Fig. 1A). Oiling of the anterior and posterior body feathers appeared to have reduced their insulative value. The wings (Fig. 1B) and tail (Fig. 1C) of each bird were so wet that individual feathers were matted, resulting in numerous gaps between feathers. These reduced the wing surface area and appeared to undermine the aerodynamic competency of the wings. Oiling of the bodies extended from the head (Fig. 1A) to the vent (Fig. 1C).

Inspection of the nest bowl revealed that the nestlings had been lying in a congealed layer of putrid carcasses of partially or wholly uneaten California ground squirrels (Fig. 2A). The remains of the squirrels decomposed in the hot California sun, percolating fat throughout the nest and

Figure 1. Oiled Golden Eagle nestlings photographed 16 May 2013 in Tulare County, CA (Nest 3 in the text). Images show oiling of (A) body feathers; (B) an outstretched wing; and (C) tail. The matted feathers and gaps between flight feathers illustrate heavy degree of oiling that appeared to have consequences for the aerodynamic competency of the flight feathers.

onto everything in it, including the young eagles lying belly-down in the nest bowl.

Because we had observed evidence that the oiling of these eaglets impeded their ability to fly, we believed that the young were unlikely to successfully fledge in their oiled state. As such, we consulted with biologists from the U.S. Fish and Wildlife Service and a veterinarian, as to a course of action. Based on these conversations, we elected to move the birds to a facility where we washed them in warm water with a gentle non-toxic dish detergent (Dawn®, Proctor and Gamble Co., Cincinnati, OH U.S.A.). We used a handheld electric blow-dryer to dry the birds and we banded them with U.S.G.S. aluminum bands. Although their feathers were still oiled, they were visibly less matted and more closely resembled an un-oiled state (Fig. 2B).

Upon return to the nest site, we removed many of the dead ground squirrels from the nest bowl and poured aspen shavings onto the nest surface. The bedding

Figure 2. Before and after pictures of a Golden Eagle nest in Tulare County, CA, on 16 May 2013 (Nest 3 in the text). The images show (A) the nest before cleaning, filled with ground squirrel carcasses flattened and decomposed into a putrid greasy layer that produced the oil that coated the eagle nestlings (Fig. 1); and (B) the three eagle nestlings post-cleaning, with full crops and perched on aspen pet bedding that we used to cover the nest surface and the ground squirrel carcasses we were unable to remove from the nest.

provided a layer of protection and an absorbent material between the nestlings and the remaining ground squirrel residues that we were unable to remove. At approximately 1600 H PST, we fed each eagle approximately 800 g of stew beef and we returned them to their nest (Fig. 2B). Two weeks later, one of us (PHB) returned to the nest site and recorded evidence of successful fledging and flight of all three young eagles.

Nest 4. On 22 May 2016, two of us (DAB, JED) visited a Golden Eagle nest situated in a eucalyptus tree (*Eucalyptus* spp.) in a grassland of low rolling hills in the northern portion of the APWRA, approximately 6 miles SW of Byron, CA. We retrieved a single nestling of approximately 7 wk old from the nest. We observed that its down, contour and flight feathers were lightly oiled such that the bird felt "greasy" when handled; down feathers were discolored, and feather barbs were matted. On one side of the nest were the layered remains of 44 California ground squirrels and two Audubon's cottontails (*Sylvilagus audubonii*), ranging in status from fresh to putrid to desiccated.

We removed the prey carcasses and oiled nest materials, banded the nestling with a U.S.G.S. aluminum band, outfitted the nestling with a 70-g GSM/GPS backpack transmitter manufactured by Cellular Tracking Technologies, LLC (Rio Grande, NJ U.S.A.), and returned the bird to its nest. On 1 June 2016, we revisited the nest, again cleaned light oiling from the bird, removed more oiled nest material, and removed 22 new California ground squirrel carcasses provisioned during the 10 d since the previous visit. Telemetry data suggested that the nestling fledged on about 12 June 2016. On 24 June 2016, PHB observed the eagle in flight > 3 km from the nest tree.

DISCUSSION

Our observations highlight an unexpected and occasional potential threat to individual eagles. In each case, the nestling eagles appear to have been oiled via prey brought to the nest by parents. Although there are reports of natural non-anthropogenic oiling of wildlife via consumption of marine prey (see citations below), this is, to our knowledge, the first published report of nestling raptors oiled by terrestrial mammalian prey. Furthermore, and uniquely, the fact that the rotten food that created the oils on the nestlings was uneaten suggests that apparent overprovisioning by adult eagles was the likely cause of this occurrence.

Oiling of eagles from Sciurid prey does occasionally occur in nests of Imperial Eagles (*Aquila heliaca*) in Kazakhstan (from *Marmota bobak*, or *Spermophilus* spp.; E. Bragin pers. comm.). Likewise, in the 1970s, PHB observed a similar instance of oiling of Golden Eagle nestlings apparently caused by dead yellow-bellied marmots (*Marmota flaviventris*) in a nest in Washoe County, NV U.S.A. In other instances, oiling of raptors by seabirds has been reported, especially from Europe. Procellariiforme birds can store in their digestive tract large quantities of oil (Warham et al. 1976) that they eject as a defense mechanism onto their predators (Broad 1974). The resulting oiling of the attacker can be so severe that predatory birds of many species, including White-tailed Eagle (*Haliaeetus albicilla*), Honey Buzzard (*Pernis apivorus*), Osprey (*Pandion haliaetus*), Peregrine Falcon (*Falco peregrinus*), gulls (*Larus* spp.), Grey Herons (*Ardea cinerea*), owls (*Asio* spp.) and corvids (Family Corvidae), have been rendered flightless and eventually died as a consequence of this oiling by seabirds (Dennis 1970, Broad 1974, Clarke 1977, Mears 1983).

Golden Eagles sometimes bring excess food to the nest, and rarely remove that excess food (Kochert et al. 2002). Although some eagle food is very lean (e.g., Lagomorphs and Galliformes have little fat), Sciurid prey (especially those that experience torpor) are often laden with fats. Because of their colonial nature, Sciurids may also provide raptors the opportunity to kill more prey than they can eat. As these prey remains decompose in a nest, they may release oils that can coat offspring. Furthermore, there is thought to be adaptive benefit to bringing back more food than young raptors can eat (e.g., as a buffer against temporary food shortages; Roulin 2004), and many eagles, hawks, harriers, and falcons overprovision. Because Sciurids that hibernate are an important prey resource for many of these species, oiling from overprovisioning is likely relevant to many non-eagle raptors.

We suspect that regardless of whether or not we intervened, after leaving the nest and during the branching period, the lightly oiled birds we observed would have preened excess oil from their feathers and oiling would probably have been of little consequence to their survival. However, the severely oiled birds we observed at Nest 3 each required nearly 60 min of manual cleaning with dish soap. We suspect that these birds would have been unlikely to be able to preen such a large amount of oil from their feathers and the oiling they experienced would likely have been fatal. Thus, our report illustrates an unexpected potential cost that raptor parents in hot climates may pay for overprovisioning in years or locations with a plentiful food supply.

Although anthropogenic oiling of wildlife is a substantial concern for conservation, natural oiling such as we observed is unlikely to present a significant threat to most wildlife populations. However, in rare cases, it may threaten success of specific nests or the well-being of a small number of individual raptors. Although treatment of wildlife injured by human activities is often seen as ethical (Kirkwood and Sainsbury 1996, Moore et al. 2007), there is less discussion or agreement as to whether animals injured by natural processes should be treated. Likewise, there are no standard guidelines for treatment of naturally oiled birds. As such, researchers who encounter oiled raptors, adults or nestlings, may wish to consider prophylactic actions to improve survival outcomes, such as removal of excessive carcasses and oiled nest contents, and cleaning of oiled birds. Those researchers who encounter oiled nestling raptors and prefer not to take such action may also wish to monitor whether untreated birds are able to successfully fledge, as this information would be of use to future scientists and wildlife rehabilitators who encounter natural oiling.

EMPETROLADO DE ORIGEN NO ANTRÓPICO CAUSADO POR LA DIETA EN AVES DE PRESA

RESUMEN.—El empetrolado de las aves puede tener consecuencias importantes a nivel individual y poblacional. Aunque la mayoría de los ejemplos publicados sobre empetrolado se refieren a la exposición a fuentes antrópicas de hidrocarburos, el empetrolado puede ocurrir naturalmente. Describimos cuatro casos de empetrolado natural de siete pollos de *Aquila chrysaetos* así como nuestra intervención para mitigarlo. En todos los casos, el aceite en estas aves provino casi seguro de sus presas, en su mayoría ardillas terrestres (*Otospermophilus beecheyi*), aportadas por águilas adultas en cantidades mayores de las que los polluelos podían consumir. Algunos pollos solo fueron empetrolados levemente. Otros fueron empetrolados tanto que la función de las plumas se vio comprometida a un nivel en el que, sin nuestra intervención, la supervivencia de estos pollos de águila seguramente hubiera sido afectada. Hasta donde sabemos, este es el primer informe publicado sobre empetrolado de rapaces como consecuencia de un sobre aprovisionamiento.

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