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EYE INJURIES IN LONG-EARED OWLS (*ASIO OTUS*): PREVALENCE AND SURVIVAL

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Abstract.—Thirty-eight eye injuries and abnormalities were noted over a 22-yr period studying Long-eared Owls (*Asio otus*). Injury frequency, distribution per eye, shape, size, and directionality, are reported. The prevalence rate was low (2.05%), as only 31 of 1510 owls had noticeable injuries to the iris. Seven other noticeable eye abnormalities are also described. There was no significant difference between the number of injuries in the left versus right eye; however, there were significantly more injuries in the bottom half of the eye verses the top, suggesting some directionality. Nine of the owls with iris injuries were recaptured between 2 wk and 3 yr later, with four of the nine recaptured 1–3 yr later. Two owls with noticeable eye abnormalities were recaptured 2 mo and 4 mo later. This suggests the ability of some individuals to survive with ocular trauma.

Key Words: *Long-eared Owl*; Asio otus; *eye injuries*; *injuries*; *recapture*; *survival.*

LESIONES OCULARES EN *ASIO OTUS*: PREVALENCIA Y SUPERVIVENCIA

Resumen.—Treinta y ocho lesiones y anormalidades oculares fueron registradas durante un estudio de 22 años sobre la lechuza *Asio otus*. La frecuencia de las lesiones, la distribución por ojo, la forma y la direccionalidad son reportadas. La tasa de prevalencia fue baja (2.05%) pues sólo 31 de las 1510 lechuzas tuvieron lesiones notables en el iris. Otras siete anormalidades oculares son descritas también. No hubo diferencias significativas entre el número de lesiones en el ojo izquierdo y derecho, pero hubo significativamente más lesiones en la mitad inferior del ojo que en la superior, lo que sugiere algo de direccionalidad. Nueve de las lechuzas con lesiones en su iris fueron recapturadas entre 2 semanas y 3 años después, con cuatro de las nueve recapturadas 1 a 3 años más tarde. Dos lechuzas con anormalidades oculares notables fueron recapturadas 2 y 4 meses más tarde. Esto sugiere que algunos individuos tienen la habilidad de sobrevivir con traumas oculares.

[Traducción del equipo editorial]

Vision is one of the most important of the five senses, and some researchers believe that vision has shaped the evolution of animals more than any other organ (Land and Nilsson 2002). In the avian eye, birds see in color, black and white, ultraviolet, and infrared (Martin 1990, Gill 1995, Land and Nilsson 2002). Vision is probably important for a variety of life history strategies such as foraging or sexual selection. Factors that inhibit normal vision could affect these behaviors.

Many of the world's owls are active in low light levels or at night, and nocturnal vision is one of their most important senses for survival. Specialized adaptations in the morphology of the owl eye include large eyes in relation to their body size, a tubular-shaped eye that is convex on each pole of the lens, a high degree of binocular vision, and a high ratio of rod versus cone photoreceptor cells. These adaptations are believed to aid owls in gathering more ambient light to project a brighter image on their retina during low light or nocturnal foraging. Owls probably see most of their world primarily in shades of black and white (Burton 1973, Norberg 1987, Martin 1990). Given this apparent specialization, eye injuries could affect visual acuity, retinal illumination, binocular vision, depth perception, and consequently, survival.

The Long-eared Owl is a nocturnal species whose distribution covers a wide range in North America and Europe (Marks et al. 1994, Holt et al. 1999, Konig et al. 1999). It is considered a nocturnal spe-

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cies and specializes on small mammalian prey for food. Its morphology is consistent with other avian species that are adapted for life in open country and have highly migratory or nomadic habits (Holt 1997). Herein we report incidences of noticeable iris injuries and noticeable eye irregularities in Long-eared Owls, and provide additional information regarding survival of owls in the wild with these injuries.

STUDY AREA

Our study area is located in west-central Montana. Within this area, DWH has conducted research in the Bitterroot, Mission, and Missoula valleys. The open valleys are a mosaic of native and introduced grasslands, ponds, marshes, small creeks, and large rivers. Most of the native shrubs and trees are deciduous, including black cottonwood (*Populus trichocarpa*), chokecherry (*Prunus virginiana*), hawthorn (*Crataegus* spp.) and willow (*Salix* spp.). Native coniferous trees include ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), and Rocky Mountain juniper (*Juniperus scopulorum*). Introduced species include Russian olive (*Elaeagnus angustifolia*), Siberian elm (*Ulmus pumila*), and caragana (*Caragana aborescens*).

METHODS

Since 1987 DWH has conducted research on various aspects of Long-eared Owl ecology. To identify individual owls, we used mist-nets to trap, band, and record measurement data. As of this analysis, we have banded 1510 Long-eared Owls and located 193 nests from 1987 to 2008. During these 22 yr iris color, iris injuries, and eye abnormalities of various types were recorded when the owls were captured.

For all injuries and abnormalities, a pencil image of the eye, and shape and relative position of the injury were drawn in field notebooks. In general, owls do not have the ability to rotate their eyes more than 1–2 degrees; thus, to assess whether the eye was visually functional, we placed a pencil in front of the owls' eyes and moved it from side to side to elicit a head movement response. To test if the pupils dilated or constricted, we covered the eyes separately to vary the amount of light entering the eye, and we noted the pupillary response. However, this method may not always be reliable as a bright light is needed to evaluate the pupillary response, and a detailed laboratory examination is preferable (Davidson 1997). All our data and trials were recorded in the field as we encountered owls; thus, our techniques have some inherent limitations when compared to laboratory options.

We described the observed injuries and abnormalities and compared the frequency of occurrence in the left versus right eye. We reported the number of injuries annually and compared the prevalence rate of the injuries to the number of owls banded over the past 22 yr.

To investigate if there was any pattern in the directionality of these injuries, we compared the data at many levels of resolution. The eyes and pupils of owls are relatively spherical or circular in shape. Therefore, the eye was analyzed from a circular perspective. First, a diagram showing the dispersion of all the injuries was drawn. We then divided the eye into four quadrants of a circle, similar to the four cardinal compass directions. The quadrants (Q) were assigned in a clockwise direction as follows: Q1 = 1°–90°; Q2 = 91°–180°; Q3 = 181°–270°; Q4 = 271°–360°. The eye was further divided into halves and analyzed vertically/side-by-side (Q1 and Q2 compared with Q3 and Q4) and horizontally/top-to-bottom (Q1 and Q4 compared with Q2 and Q3). Because the data were nominal, we calculated the confidence interval for a proportion. We then used a *G*-test and William's Correction factor (adj) for *G*, to examine if there were significant differences between the left versus right eye, and the quadrants. Alpha levels were set at 0.05.

RESULTS

Of the 1510 owls examined, 38 had noticeable eye injuries and abnormalities. Of these, 31 were apparent injuries to the iris, and seven were apparent abnormalities involving the eye region. No other signs of trauma were noted around the facial region or other areas of the body. The 31 iris injuries had many shapes and were described as circular, linear, teardrop, comma, blobbed, or forked (Fig. 1). In some cases, the injury extended from the pupil distally to the edge of the iris. In other cases, the injury appeared as a small hole or two in the iris between the pupil and edge of the iris. The injuries appeared to be the result of trauma that tore, punctured, or ruptured the iris. Only rarely could we detect what appeared to be physical trauma to the cornea, suggesting a perforation through the cornea, anterior chamber, and iris. Although a few iris injuries were recorded in most years, five each were noted in 1989 and 2001. Over the 22 yr, the iris injury prevalence rate was low: 31 of 1510 = 0.020 (2.05%; 99% CI = 0.020 ± 0.010). Thus, the proportion of these injuries in the population probably ranges between 1.0 and 3.0%. The eye abnormality prevalence rate was

Figure 1. Example of an iris injury in a Long-eared Owl from Montana, U.S.A.

also low: 7 of 1510 = 0.004 (0.46%). Sample size was too small for statistical analysis.

Of the owls with iris injuries whose sex was positively known, four were males and one was female. There were 16 injuries to the left eye and 15 injuries to the right eye (G_1 adj = 1.149, df = 1, $P > 0.05$). Similarly, there were no significant differences in the number of injuries among the four quadrants (G_1 adj = 5.452, df = 3, $P > 0.05$), or between the two sides of the eyes (comparison of Q1 and Q2 with Q3 and Q4; G_1 adj = 0.787, df = 1, $P > 0.05$). There was, however, a significant difference in the injury dispersion between the horizontal compartments of the eye (comparisons of Q1 and Q4 with Q2 and Q3; G_1 adj = 3.926, df = 1, $P < 0.05$). In 29 of the 31 injuries to the iris, a pupillary light response did occur, indicating the pupil could dilate and constrict. Although we inspected the corneas for physical signs of injury, all but one appeared to be uninjured. In this one case, it appeared the cornea had a lesion, but we could not ascertain whether it was an old scar or present injury.

Sixteen of the 38 owls were later recaptured. Of these, nine (26.6%) of the 31 owls with iris injuries were recaptured. The time interval between capture and recapture ranged from 2 wk to 3.17 yr later. Five of the nine owls with iris injuries were captured between 11 mo and 3 yr later. One of the nine owls did not have an iris injury when initially captured, but did have one when recaptured 4 mo later; this owl was recaptured for the third time 1.5 mo later and appeared to be thriving.

The remaining seven of the 38 owls had a variety of noticeable eye abnormalities. Three of the seven owls were known to be females. Two of the seven had abnormalities in their left eyes, two in their right eyes, and two in both eyes. No left or right data had been recorded for the seventh owl. The most interesting abnormality of these seven owls was an asymmetrical appearance of the pupils in one bird. In this case, the pupils were off-center, with the left pupil higher and the right pupil lower. Both pupils, however, appeared to dilate and constricted normally. A second interesting case was an eye that appeared dead: it was recessed within the orbit of the eye, and the iris had a burnt orange coloration, and the pupil did not dilate or constrict. This may represent phthisis bulbi, a condition in which the eye withers due to an infection caused by trauma or chronic disease (W. Meier pers. comm.). Two other owls also showed a ring of crusty scales around the inside rim of the eyelids. This condition was bilateral in one owl. In the second owl, the crusty scales appeared on the right eye, and the eye was discharging fluid. One owl's eyes appeared normal except that they appeared excessively wet, with a great discharge of clear fluid. In the last two owls, one had an apparent scratch or old scar on the cornea and the second owl appeared to have a corner piece of the iris missing or deformed in shape. One of these seven owls was recaptured 2 mo later and the condition appeared to be the same. For the 31 owls with iris injuries and the seven with eye abnormalities, sample sizes were too small to test for differences between the sexes.

DISCUSSION

In wildlife research, we often wonder if and how wild animals survive with injury. Furthermore, we ask the same questions regarding animals released back into the wild after apparently successful rehabilitation. In birds of prey, trauma is a common cause of disability or death and the most common cause for these birds to be admitted to veterinary or wildlife clinics (Boydell and Forbes 1996, Ress and Guyer 2004). In most of these cases, trauma has been associated with human factors such as motorized vehicles, structures, and shooting (Murphy et al. 1982, Cousquer 2005, Kelly and Bland 2006, Williams et al. 2006). Indeed, approximately 80% of owls brought to clinics in one study had collided with motorized vehicles (Cousquer 2005). Furthermore, ocular lesions resulting from trauma have been reported in approximately 14% of 931 injuries of wild raptors admitted to avian clinics in North America (Murphy et al. 1982). Other forms of ocular disease are believed to be of developmental origin (Buyukmihci et al. 1988). There are different opinions on the survival rate of rehabilitated raptors released back into the wild after trauma (Cooper 2002, Davidson 1997, Williams et al. 2006), but few data available on post-release survival of rehabilitated wildlife (Sharp 1996, Goldsworthy et al. 2000, Kelly and Bland 2006, Carter et al. 2007). Cousquer (2005) released 17 Tawny Owls (*Strix aluco*) with corneal pathology; however, no post-release tracking was conducted. Post-release monitoring is essential in determining the success of rehabilitated wildlife, yet rarely done.

Most studies investigating the causes and degree of ocular trauma in raptors are clinical (Buyukmihci 1985, Davidson 1997, Murphy et al. 1982). In our study, however, ocular trauma was recorded in wild owls captured and recaptured during field research. Furthermore, most of the raptors in the clinical studies were either hit by motorized vehicles or shot, and probably would not have survived in the wild, had they not been rescued. The eye injuries reported herein do not appear to have originated from either of the above causes, primarily because these injuries appeared as punctures or scratches, and were concentrated in the eye region. (Automobile injuries usually show head and wing trauma; rifle injuries show significant entry wounds and far more tissue damage; shotgun wounds usually show shearing of the flight feathers and sometimes pellet entry wounds in the body.)

It does not appear that the injuries described herein occur very often, as indicated by the prevalence rate. In this study, there was no significant difference between the number of injuries to the left versus right eye. Similar results have also been reported (Buyukmihci 1985). We have never observed these eye injuries in nestling Long-eared Owls despite banding >500 (D. Holt unpubl. data). Thus, perhaps some of the injuries occur after the young have left the protected nest, but are still flightless. In our study, Long-eared Owl nestlings leave their nests when they are ca. 22 d old, and weigh ca. 248 g (Seidensticker et al. 2006). They do not fledge or attain coordinated flight until they are approximately 34 d old and weigh 270 g (Seidensticker et al. 2006). During the pre-fledging period, the young owls move about in the surrounding trees. They use their bill, feet, and wings to grasp, balance, and traverse or jump among the branches. They are uncoordinated at this age and often trip or fall from branches. The significant prevalence of injuries in the lower half of the eye may be explained by flightless nestlings falling forward, with the head and face the first area to contact branches or thorns. It is also reasonable to expect that Long-eared Owls of any age could accidentally incur an eye injury as a result of living in thick vegetation.

Owls appear to suffer more ocular trauma than other raptors (Cousquer 2005). Indeed, of 931 raptor injuries reported by Murphy et al. (1982), five of the seven species incurring the most injuries were owls. Although the reasons are not known, the large head, large protruding eyes, and relatively flat face of owls may make them more susceptible to ocular injuries.

There are cases of ''functionally'' one-eyed raptors and raptors with previous injuries that have been captured apparently in good physical health (Buyukmihci 1985, Davidson 1997, Bedrosian and St. Pierre 2007), suggesting an ability of some owls to survive with injury. Regardless of how the injuries occurred in this study, the recaptures of injured individuals indicate that some individual Long-eared Owls can survive in the wild with ocular trauma involving the iris and anterior portion of the eye.

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