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Injuries to Birds of Prey Caught in Leghold Traps

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173 birds of prey, including 32 Bald Eagles, have been treated for trapping injuries at the University of Minnesota Raptor Research and Rehabilitation Program since 1972. These were birds caught primarily in "open" bait leghold sets incidental to furbearer trapping in the Minnesota region. The differential outcome of the injuries with respect to crippling or mortality is presented for large versus small raptors, toe versus leg injuries, and fracture of the leg versus soft tissue damage only.

There is only limited potential for mitigating the effects of trapping injuries to raptors because of the irreversible soft tissue damage usually associated with such injuries, which results in the loss of the extremity. The extent of soft tissue damage usually cannot be determined at the time the bird is found, as the signs of necrosis require several days to develop. The inadvertent trapping of raptors should therefore be prevented by the restriction of open bait sets.

Raptor Research and Rehabilitation Program

From 1972 through 1980, 1,856 birds of prey (*i.e.*, raptors: eagles, hawks, owls, and falcons) were presented for treatment to the Raptor Research and Rehabilitation Program within the College of Veterinary Medicine at the University of Minnesota (St. Paul) (Table 1). Most of the raptors were wild birds from Minnesota and neighboring states admitted for traumatic injuries, such as a fractured wing resulting from collision with powerlines or moving vehicles, or injuries from projectiles (Table 2). Approximately 35% of the raptors were successfully rehabilitated and returned to the wild, most of them having required intensive veterinary care and the provision of food and shelter over a period of a few months. Another 30% were birds that survived but could not be released; these have played a valuable role in breeding programs, nature exhibits, public education programs, and research (Table 4) (Redig and Duke, 1978).

Vulnerability of Raptors to Open Bait Ground Sets

As carnivorous birds, raptors are also opportunistic scavengers, especially during the winter months when inclement weather and migration through strange territories increase the difficulty of catching live prey. They are visually attracted to exposed carrion and thus can be inadvertently caught in leghold traps set for furbearers when exposed bait is placed in the immediate vicinity of the trap, the so-called "exposed" or "open" bait set (Robinson, 1961; Leopold, 1964; Cain *et al.*, 1972; Beasom, 1974; Fuller *et al.*, 1974; Cooper, 1977).

173 raptors have been admitted for trapping injuries since 1972 (representing about 9% of total admissions), including 32 Bald Eagles and 7 Golden Eagles (Table 3). After the use of pole traps (steel traps set on a post specifically for avian predators) in Minnesota was restricted in 1976 (Fig. 1), trapping injuries declined

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Figure 1 Great Horned Owl suspended from a pole trap by one of its feet. Even if such a bird is found still alive, the soft tissue damage will invariably lead to loss of that portion of the limb distal to the injury.

from about 11-21% to about 4-9% of total annual admissions. The Great Horned Owl has shown the largest reduction since 1976 in percentage of admissions due to trapping injuries. Minnesota prohibited the placement of exposed carrion within 20 feet of a set starting with the 1980-81 season; trapping admissions should therefore continue to decline. However, raptors injured by traps are also received from other states, including Wisconsin, Michigan, and South Dakota, which do not have such a regulation.

A majority of the Bald Eagles received for trapping injuries have been adult birds (at least 4-5 years old), roughly in a proportion similar to the age structure of the Minnesota winter Bald Eagle population (James D. Fraser, pers. comm.). Thus, the Balds were apparently trapped randomly with respect to age, in contrast to the increased vulnerability of immature birds normally associated with injuries from

projectiles and accidents (Newton, 1979). Further, admissions of Bald Eagles for trapping injuries have increased over the years, and it is now the species most commonly received in this injury category.

TABLE 1. Species & Numbers of Raptors Admitted (1972-1980)

*Red-tailed Hawk	335	Sharp-shinned Hawk	27
*Great Horned Owl	302	*Short-eared Owl	24
American Kestrel	235	Peregrine Falcon	23
*Bald Eagle	159	Cooper's Hawk	22
*Broad-winged Hawk	138	*Northern Harrier	18
*Common Screech Owl	93	*Red-shouldered Hawk	17
*Barred Owl	84	Gyrfalcon	9
*Rough-legged Hawk	71	Swainson's Hawk	9
*Northern Goshawk	49	Turkey Vulture	8
*Snowy Owl	47	Ferruginous Hawk	6
*Golden Eagle	39	Great Gray Owl	6
Prairie Falcon	37	Merlin	4
Long-eared Owl	36	Harris' Hawk	1
Saw-whet Owl	28	Burrowing Owl	1
Osprey	27	Boreal Owl	1

TOTAL: 1,856

*Species admitted for trapping injuries

TABLE 2. Cause of Admission (1856 Raptors: 1972-1980)

Leghold Trap	9.3%
Projectile	18.4
Accident	44.3
Orphan	10.7
Other	17.3
	100.0%

Difficulty of Assessing Severity of Trapping Injuries

The leghold trap has been described as "unique among all predator control procedures because of its selectivity, enabling the capture of a specific target animal and the release of unwanted animals" (Bell, 1976). This is a common theme; namely, that selectivity is determined not so much by the capture of a low proportion of nontarget animals, but rather by the ability to release those animals "without serious injury." Henderson's and Boggess' (1977) description of the Kansas Extension Service predator control program emphasized the need to promote "control methods which are as safe, efficient, economical, humane and selective as possible." They stated that one of the key factors in such a program, to the extent that steel traps are employed, is to use offset-jawed traps so that many of the nontarget animals can be "released unharmed."

Interpretation of the seriousness of the animal's condition if found alive varies among authors, but it has traditionally been based on the assessment of the animal's condition at the time it is found in the trap (Beasom, 1974). The criteria of evaluation are usually limited to whether a leg has been fractured by the trap, which presumes that birds incurring only lacerations of the leg(s) or toe(s) can be released. Information on adverse medical complications that may subsequently affect the chance of survival of an animal that has been trapped is sparse.

This report is intended to fill a void in the understanding of the impact of furbearer trapping on birds, especially raptors, with regard to their survival or crippling rate if found still alive in the trap. If the birds we received had injuries typical of raptors that are found alive in traps, then any raptor that has been in a leghold trap overnight should be considered seriously injured unless determined otherwise based on a period of medical observation, regardless of how innocuous the injury may appear when the bird is found.

TABLE 3. Number of Raptors by Species Admitted for Trapping Injuries (1972-1980) and Nature of Injury Upon Admission in Relation to Size of Raptor

Species	Avg. Wt. in grams of Adult*	# Trapping Admissions	Trapping Injuries as % of Total Admissions by Species	Leg Injuries as % of Trapping Injuries by Species**	Fractures or Amputations as % of Leg Injuries by Species***
Bald Eagle	4,800g	32	20.1%	57%	26%
Golden Eagle	4,300	7	17.9	50****	33
Snowy Owl	2,000	3	6.4	67	50
Great Horned Owl	1,750	74	24.5	71	35
Northern Goshawk	1,140	4	8.2	100	100
Red-tailed Hawk	1,125	22	6.6	88	73
Rough-legged Hawk	1,010	12	16.9	83	67
Barred Owl	700	8	9.5	100	60
Red-shouldered Hawk	625	2	11.8	100	50
Northern Harrier	520	1	5.6	100	100
Broad-winged Hawk	455	1	0.7	100	-0-
Short-eared Owl	375	1	4.2	100	100
Screech Owl	215	6	6.5	100	67
		173			

*Approximate average weights for diurnal species taken from Brown and Amadon (1968); nocturnal species from McKeever (1979).
**Trapping injuries are classified as either "toe injuries" or "leg injuries."
***Leg injuries are classified as involving either "fracture or amputation" or "soft tissue damage only."
****One of the seven injuries, a primary injury to a wing, is not accounted for by this figure.

Trapping Conditions

Most of the raptors were admitted between October and January, corresponding to the regional furbearer trapping season. The trapping conditions were not known in all cases. Most of the traps were reported as toothless, unpadded fox sets, sizes 1½ or 2. Other types of trap sets included muskrat, mink, otter, raccoon, and coyote.

The raptors probably were in the trap only overnight in most cases, but it was usually another day or two before they were presented for treatment. Several of the eagles and Great Horned Owls had flown for several days with the trap still attached to a toe or leg before they could be caught.

The vast majority of the raptors were caught by the toe(s) or leg(s) in a ground set baited with a carcass. However, Cooper (1977) concurs with our findings that raptors are also attracted to traps where no exposed bait is used if there is activity from other animals at the set. For instance, a Screech Owl was caught in a muskrat set baited with corn which had probably attracted small rodents and, in turn, the owl. A Great Horned Owl was found *with* a raccoon in a fox trap. In rare instances raptors can also be trapped in underwater sets, as in the case of a Bald Eagle that was caught by an underwater otter set that had been baited with a fish placed under a rock; the eagle was apparently attracted by the floating fish scales. (The Bald Eagle is primarily a fish eater.)

TABLE 4. Outcome of Trapping Injuries

		Released	Crippled	Died
All Admissions	All Birds (1,089)	35.0	29.4	35.6
(wild raptors only:	Eagles (131)	45.8	26.7	27.5
1975-1979)	Non-Eagles (958)	33.5	29.7	36.8
All Trapping Admissions	All Birds (130)	38.5	16.9	44.6
(1972-1980)	Eagles (36)	33.3	19.5	47.2
	Non-Eagles (94)	40.4	16.0	43.6
Toe Injuries	All Birds (34)	73.5	5.9	20.6
	Eagles (16)	56.3	12.5	31.2
	Non-Eagles (18)	88.9	-0-	11.1
Leg Injuries	All Birds (92)	23.9	20.7	55.4
	Eagles (20)	15.0	25.0	60.0
	Non-Eagles (72)	26.4	19.4	54.2
Leg Injuries: Fracture	All Birds (43)	20.9	14.0	65.1
	Eagles (6)	16.7	16.7	66.6
	Non-Eagles (37)	21.6	13.5	64.9
Leg Injuries: Soft Tissue	All Birds (41)	29.3	31.7	39.0
	Eagles (11)	18.2	36.3	45.5
	Non-Eagles (30)	33.3	30.0	36.7

Anatomical Considerations

There are a number of anatomical differences between birds and mammals that warrant separate consideration of the severity of trapping injuries to birds (Nickel *et al.*, 1977; Cooper, 1978). First and most importantly, birds have a very limited amount of soft tissue in the distal portion of the leg. The muscle mass of mammals which can serve to cushion injury to blood vessels, nerves and bones is replaced in birds by a system of long tendons. The vascular supply to the extremities is also reduced. Thus, birds have limited ability to fight infection of the foot. A fracture of the distal part of the leg is less likely to heal (immobilization of the fracture is required in any case), and as the vascular supply to the extremities is easily cut off by constriction of the leg by a leghold trap or snare, the limb is likely to freeze overnight even without gross indication of injury.

Second, as predatory and perching birds, the full use of both feet is important to a raptor's survival in the wild. The hallux (the opposable toe) and at least one or two other toes of the same foot are necessary for grabbing and holding onto prey. Proper distribution of the bird's weight requires that the bird have both feet to stand on to prevent deterioration of the epithelium of the foot pad (Cooper, 1978; McKeever, 1979).

Third, the wings must be free of fractures, injuries to the joints, or damaged flight feathers. A raptor that cannot fly with speed and maneuverability must rely on finding carrion.

Description and Outcome of Injuries

The nature of the trapping injuries upon admission with respect to species size is presented in Table 3, and the outcome of those injuries in terms of release, crippling or mortality is presented in Table 4. The release rates reflect superior veterinary care; the likelihood of survival without medical treatment or the provision of food and shelter during convalescence would have been far lower. Release data are further broken down in Table 5 to account for the proportion of raptors released without the extremity. (See later section, "Problems Faced by One-Footed Raptors.") Tables 4 and 5 are based on only about 130 of the 173 trapping admissions, as some of the early medical records are incomplete. As part of the analysis of injury and

TABLE 5. Trapping Admissions Released With Regard to Amputation of the Limb

	Eagles	Non-Eagles
Toe Injuries		
Total Released:	56.3% (8)	88.9% (12)
Released Without Amputation of Toe(s):	21.1 (3)	22.2 (3)
Leg Injuries		
Total Released:	15.0% (3)	26.4% (17)
Released Without Amputation of Foot:	5.0 (1)	15.5 (10)

outcome with respect to bird size, data on eagles are compared to that of the other, smaller species, countering the incorrect assumption that eagles are more tolerant of trapping injuries because of their larger size.

Toe injuries

Toe injuries represented a minority of trapping injuries. Large raptors were more likely than small raptors to be caught by just a toe rather than by the foot or leg; 44% of the eagles versus 19% of the smaller raptors were caught by just a toe(s) (Table 3). Toe injuries can involve toe(s) of both feet.

Raptors with toe injuries were held on the average for about a month before they were released. The major complication was infection of the foot, which as mentioned earlier is extremely difficult to treat in raptors (Fig. 2). Several birds required intensive veterinary care for up to 6 months or more to combat infection. Chronic infections of that duration often lead to arthritic changes or destruction of the nerves or tendons, resulting in the loss of function of the foot or toe(s) (Cooper, 1978).

Most of the raptors with toe injuries were released (74%). Fewer eagles were released than other species (56% and 89%, respectively). Only about one fifth of the raptors with toe injuries could be released with all toes still intact and functional. Toe injuries represented a very low rate of permanently crippled birds (6%); if they survived problems of shock and infection they could usually be released. Even so, 21% of raptors with toe injuries (31% of the eagles) died in spite of what might be considered an inconsequential injury, usually from a secondary bacterial infection (Table 4).

Figure 2 Golden Eagle with severe wound infection resulting from amputation of a toe by a ground set. After several months of intensive treatment the infection was eradicated, but the epithelium of the other foot had irreparably deteriorated. The eagle eventually died from complications related to the trapping injury.

Leg injuries: fracture or amputation

Most of the raptors were caught by the leg (Table 3), and in many instances both legs were fractured or lacerated. The larger raptors were less likely than the smaller species to incur a fracture (or amputation) of the limb if caught by the leg (35% of the eagles versus 54% of the other species) (Table 3). A leg fracture requires immobilization for the bone to heal; thus it would not be expected that a raptor with a leg fracture would survive if released without treatment. Raptors with leg injuries were detained for an average of 1½ months and sometimes much longer. A fracture usually requires 3-4 weeks to heal, and there may be other complications to be corrected before the bird is in a condition suitable for release. 17% of the eagles and 21% of the other species admitted with leg fractures were released, mostly as one-footed birds. Mortalities were very high, claiming 65% of all the birds in this category (Table 4).

Cooper (1977) cited a very high mortality among raptors with fractured or severed legs; they were more likely to be found dead in the trap or, if found alive, to die in spite of attempts at rehabilitation. He believed that the circumstances involving a leg fracture were accompanied by greater stresses, which would compound the likelihood of the raptor dying from shock, exhaustion or exposure. In Cooper's study, the hawks and owls (as the smaller species) were more likely to incur fractures and to be found dead in the trap than were the eagles.

Leg injuries: soft tissue damage

Irrespective of whether the leg is fractured, there will usually be soft tissue damage to the leg at the point where it was trapped and therefore to the extremity as well. The soft tissue damage that results in the loss of the extremity is usually due to impairment of the vascular supply by the constriction of the leg while in the trap, vascular injury resulting in thrombosis, or laceration of the blood vessels. Thus, offset-jawed traps and leg snares will also cause soft tissue injury by constriction of the leg if the bird is not removed in time (Cooper, 1978).

The initial sign that the foot has been destroyed is a swelling of the tissues and a dark orange discoloration appearing a few days after the bird has been trapped. Over the next week or two the foot gradually shrivels and turns black, and the epithelium dries out and starts to peel. The foot will then snap off. By the time a raptor with this kind of injury has been presented for treatment, it is too late to save the foot.

Of the raptors received for leg injuries involving only soft tissue damage and which survived long enough for assessment of the severity of the injury, 85% had irreparable damage that would result in loss of the foot. Unfortunately, persons who are unfamiliar with the serious nature of this kind of injury would probably assume that they could release these birds from the trap "without serious injury."

A similar pattern of necrosis results if the foot has frozen due to vascular impairment combined with an inability to shelter the entrapped limb. Frozen tissue does not regenerate. Further, frostbite or septicemia can cause cardiovascular lesions in birds (Angrist *et al.*, 1960; Wallach and Flieg, 1969; Redig, 1979) which will shorten their expected life span. Death can also result from exposure and limb necrosis due to injury from the cold (Wallach and Flieg, 1969).

The mortality from soft tissue injury to the leg was less than that from leg fractures; only 45% of the eagles and 37% of the other birds died compared to 67% and 66% respectively, for leg fractures. This decrease in mortality was countered by a 126% increase in the crippling rate, but only a 40% increase in the proportion of raptors released. More of these birds can be kept alive (pending the complications

encountered by one-footed birds), but there is little that can be done to save the foot.

Thus, for about 93% of the raptors (eagles or others) admitted for leg injuries, the leg was either fractured or completely severed, or irreversible damage to the soft tissue had occurred. Therefore, even before accounting for mortality from wing damage, shock, exposure, exhaustion, or other complications, very few of the raptors caught by the leg could have survived if released from the trap without treatment.

Wing injuries

Some of the raptors had incurred sufficient damage to the wings to make them unable to fly at the time they were found. Even if these birds could have recovered without veterinary treatment, they would have starved without the provision of food and shelter during convalescence.

Wing damage is usually a secondary injury incurred while thrashing about in the trap. If the bird is not removed from the trap in time, such behavior will result in bruising of the wrist joints (the metacarpals), broken feathers, and sometimes broken bones. Bald Eagles and other raptors have been found moribund several days after having been released from a trap (the injuries having been judged to be inconsequential) because the wings were too damaged to permit flight. The chance of successfully rehabilitating such a bird is compromised by the delay in admission and the resultant aggravation of the bird's debilitated condition.

In one case a Golden Eagle incurred primary injury of one of its wings after the wing tripped the set and cut off six of the primary flight feathers (essential for flight). The eagle was released six months later after new feathers grew in. It was otherwise in excellent condition, but it would have starved to death if left in the wild.

Problems Faced by One-Footed Raptors

A one-footed raptor faces two major problems. First, the ability to use both feet is an important part of its weaponry in the wild. An older bird with extensive hunting experience may be able to cope with the loss of a foot; the fact that a few adult one-footed birds have been admitted to the clinic for other reasons over the years attests to this possibility. However, such a bird must rely more on scavenging, and therefore has a greater chance of being killed, either from poisoned bait, from a car collision while feeding on a roadkill, or from being trapped once again. Inexperienced one-footed raptors have virtually no chance of survival and should not be released.

The second problem affects the bird's chance of survival regardless of whether it is released or kept in captivity and therefore makes the advisability of releasing one-footed raptors, experienced or not, highly questionable. Many rehabilitators advise against it entirely (Cooper, 1978; McKeever, 1979). The additional weight borne by the good foot invariably leads to deterioration of the foot pad and allows infection to invade. As mentioned earlier, a foot infection is extremely difficult to treat, especially if it occurs in the only foot the bird has to stand on. One-footed raptors that have developed an infection in the remaining foot usually must be euthanized.

A similar situation occurs for two-footed raptors when one of the feet is temporarily bandaged because of an infection or fracture (a situation that occurs in treatment for trapping and other injuries). During the healing period the other foot bears most of the weight and may deteriorate before the raptor can use both of its feet again. Avoiding foot problems of this nature is the single largest management problem in treating or holding raptors in captivity. Thus, one-footed raptors held in captivity that have survived the initial period of shock and infection and are other-

wise in good health can be expected to develop complications leading to their death or requiring humane destruction.

Release Considerations and Mitigation Potential

It is necessary to hold for at least one week any raptor suspected of having been caught in a leghold trap to determine the extent of soft tissue damage and to stabilize the bird's condition. If the raptor has been injured by the trap, there are a number of factors which must be satisfied before it can be released (McKeever, 1979; Cooper *et al.*, 1980):

1. The bird should have full use of both feet, although the loss of one or more toes may be tolerated if the raptor can kill prey. Anything less compromises its ability to compete in the wild, and, in the case of the loss of a foot, also subjects the bird to deterioration of the remaining foot.
2. Fractures of the leg or wing must have completely healed, and the appropriate physical therapy must be undertaken to assure full use of the limb.
3. Infection must be eradicated, or it will quickly worsen after the bird is released.
4. The wings must be in good condition, and the bird must be a strong and able flyer.
5. The bird must have achieved a suitable weight, and be free of disease, excessive parasite loads, and the hematological disorders that can accompany starvation or chronic infection.

Only highly qualified facilities are likely to be able to release such a raptor to the wild in the condition necessary for it to have a reasonable chance of survival. (Rehabilitation of wild animals requires state and federal permits.)

Anderson (1979) cites as one of the goals of the federal Migratory Bird Program "to minimize losses of migratory birds to... illegal kill, crippling, and other adverse influences." Similarly, Redig (1979) and Redig and Duke (1978) state that rehabilitation of raptors provides a tool for mitigating the effects of unnatural mortality, especially with regard to endangered species. However, considering the high incidence of mortality and loss of an appendage associated with trapping injuries, the mitigation potential of treating raptors with trapping injuries is rather limited. Further, the seemingly innocuous appearance associated with soft tissue injuries would dissuade the public from presenting many of those birds for treatment. Even many of the regional wildlife managers, who for years have willingly brought us injured raptors and are aware of our views about the seriousness of trapping injuries, are reluctant to consider a trapping injury as a matter requiring veterinary care.

Rehabilitators may be tempted to release one-footed raptors, despite a very guarded prognosis, so that some of the trapping admissions might have a chance in the wild again. However, the release of a one-footed bird is quite different from one admitted for a wing fracture (such as from a projectile injury or collision); depending on factors such as the age and location of the fracture, most fractures can be repaired by qualified personnel so that the raptor will have full use of its wing again and its survival in the wild will not be compromised. It should nevertheless be recognized that many of the birds with trapping injuries will be released in a degenerating condition, which means that release data on trapping admissions will tend to inflate the percentage that was truly rehabilitated. Thus, not only are fewer raptors successfully treated for trapping injuries than for other problems commonly

associated with rehabilitation admissions, but fewer survive as permanently crippled birds that could replace healthy individuals in zoos, research, or breeding programs.

Conclusions and Recommendations

A far greater rate of crippling and mortality of raptors results from leghold trap injuries than might be expected based on initial examination of the bird at the time of capture. Because of the limited soft tissue of distal regions of the avian leg, the blood vessels are easily constricted or damaged, invariably causing irreversible damage to, and loss of, the extremity. Therefore, "serious injury" as applied to raptors must include consideration of soft tissue damage as well as the fracture or amputation of the leg. Any raptor caught by a leghold trap in the course of furbearer trapping activities, especially one that has been in the trap overnight, should be considered seriously injured, regardless of how inconsequential the injury may appear when the bird is found, as the absence of irreparable soft tissue damage cannot be determined for several days. The larger raptors, which would be less likely to incur leg injuries or leg injuries involving fractures, are as susceptible as the smaller species to the soft tissue damage that results in the loss of the limb or the development of a severe wound infection.

Raptors are most often caught in open bait land sets. Therefore, the main deterrent to the capture and thus the crippling or mortality of raptors in leghold traps is prohibition of the use of open bait sets (Beasom, 1974; Cooper, 1977). Smaller, padded or offset-jawed traps or leg snares are not acceptable, as they will also cause disruption of the vascular supply even though the incidence of fractures might be lower. A number of western states regulate the use of open bait sets specifically to reduce the high incidence of raptor deaths, especially eagles. (See list in Nilsson, 1980 of states which prohibit or restrict exposed bait sets.) Any state that permits the use of land traps for furbearers should adopt a regulation prohibiting the use of exposed carrion within approximately 25 feet of the trap. Andrus (1979) recommended that open bait sets not be used in the federal Animal Damage Control program.

Persons involved in the setting or checking of traps, such as trappers, state game wardens and other members of the public or wildlife agencies, should be educated as to the serious nature of trapping injuries to birds and encouraged to use trapping methods that will not attract raptors and to present for rehabilitation or humanely destroy any raptors found in a leghold trap rather than releasing them from the trap.

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