

THE *DHO-GAZA* WITH GREAT HORNED OWL LURE: AN ANALYSIS OF ITS EFFECTIVENESS IN CAPTURING RAPTORS

PETER H. BLOOM, JUDITH L. HENCKEL AND EDMUND H. HENCKEL
Western Foundation of Vertebrate Zoology, 439 Calle San Pablo, Camarillo, CA 93010

JOSEF K. SCHMUTZ
Department of Biology, University of Saskatchewan, Saskatoon, SK, Canada S7N 0W0

BRIAN WOODBRIDGE
Gooseneck Ranger District, U.S. Forest Service, 37805 Hwy 97, Macdoel, CA 96058

JAMES R. BRYAN
P.O. Box 861, Silverado, CA 92676

RICHARD L. ANDERSON
California Energy Commission, 1516 Ninth Street, Sacramento, CA 95825

PHILLIP J. DETRICH
U.S. Fish and Wildlife Service, 2800 Cottage Way, Sacramento, CA 95825

THOMAS L. MAECHTLE AND JAMES O. MCKINLEY
Greenfalk Consultants, 8210 Gantz, Boise, ID 83709

MICHAEL D. MCCRARY
Zoology Department, California State University, Long Beach, CA 90840

KIMBERLY TITUS
*Alaska Department of Fish and Game, Division of Wildlife Conservation,
P.O. Box 240020, Douglas, AK 99824*

PHILIP F. SCHEMPF
U.S. Fish and Wildlife Service, P.O. Box 021287, Juneau, AK 99802

ABSTRACT.—Trap effectiveness and potential factors affecting success of the *dho-gaza* with Great Horned Owl (*Bubo virginianus*) when used as a lure were examined for 11 species of diurnal raptors and 3 species of owls: Black-shouldered Kite (*Elanus caeruleus*), Northern Harrier (*Circus cyaneus*), Cooper's Hawk (*Accipiter cooperii*), Northern Goshawk (*A. gentilis*), Red-tailed Hawk (*Buteo jamaicensis*), Red-shouldered Hawk (*B. lineatus*), Swainson's Hawk (*B. swainsoni*), Ferruginous Hawk (*B. regalis*), Prairie Falcon (*Falco mexicanus*), Merlin (*F. columbarius*), American Kestrel (*F. sparverius*), Spotted Owl (*Strix occidentalis*), Great Gray Owl (*S. nebulosa*), and Great Horned Owl. The technique was successful for most species when targeting a territorial pair during the reproductive cycle. Important conditions necessary for good trapping success were placement of the lure owl in an obvious location, shade for lure owl and net, shrubs or trees in which to hide net poles and channel the raptors, short distance between observer and net, site preparation, small number of observers, and low wind. Play-back of audio-taped recordings of Great Horned Owls or conspecifics usually reduced the amount of time necessary to facilitate capture. Swainson's Hawks and Ferruginous Hawks showed no increased aggression toward the lure owl that might be related to age of young, brood size, presence of food in the nest, or time of day.

La *Dho-gaza* con Búho Cornado Americano como señuelo: un análisis de su efectividad en la captura de aves rapaces

EXTRACTO.—La efectividad de la trampa y los factores potenciales que afectan el éxito de la *Dho-gaza*, cuando rapaces de la especie *Bubo virginianus* fueron usadas como señuelo, han sido examinados para 11 especies de raptors diurnas y 3 especies de búhos: *Elanus caeruleus*, *Circus cyaneus*, *Accipiter cooperii*, *A. gentilis*, *Buteo jamaicensis*, *B. lineatus*, *B. swainsoni*, *B. regalis*, *Falco mexicanus*, *F. columbarius*, *F. sparverius*, *Strix occidentalis*, *S. nebulosa*, y *Bubo virginianus*. La técnica dio buen resultado para la mayoría de las especies cuando tuvo como blanco una pareja de aves rapaces en su territorio y en su ciclo reproductivo. Importantes condiciones necesarias para una exitosa trampa fueron: la colocación del búho-señuelo en una ubicación obvia, sombra para el búho-señuelo y la red, arbustos o árboles para ocultar los palos de la red y encaminar las raptoras hacia la trampa, cortas distancias entre observador y red, preparación del sitio, pocos observadores, y viento leve. Reproducciones de grabaciones del ulular de los búhos (*B. virginianus*) o de su especie usualmente redujeron el tiempo necesario para facilitar la captura. Las raptoras *B. swainsoni* y los *B. regalis* no demostraron un aumento de agresión hacia el búho-señuelo que pudiera ser relacionada con la edad de los jóvenes, el tamaño de la nidada, la presencia de alimentos en el nido, o lo hora del día.

[Traducción de Eudoxio Paredes-Ruiz]

A variety of traps have been applied to capture raptors (Bloom 1987). Few traps equal the success of a *dho-gaza* with a live Great Horned Owl (*Bubo virginianus*) lure. The technique, first developed by Arab and Persian falconers (Meredith 1943), was first used extensively in North America by Fran Hamerstrom (1963, Bub 1991). The Hamerstroms used the trap with great effectiveness in their study of Northern Harrier (*Circus cyaneus*) ecology in Wisconsin. A minimum of 18 species, including both nocturnal and diurnal raptors, have been caught using this technique (Bloom 1987). While design and general use of the *dho-gaza* with Great Horned Owl have been well described (Meredith 1943, Hamerstrom 1963, Bloom 1987) its success rate and application have not. In this paper we describe the overall success and applicability of the *dho-gaza* when used on 14 species of raptors.

STUDY AREAS AND METHODS

Trapping took place in four of the western United States and one Canadian province. Most studies were unrelated, conducted over multiple years (1981–92), and conducted by the co-authors working independently or in various combinations. As a result, some differences in trap design and application exist. In general they follow a blend of designs and procedures outlined in Hamerstrom (1963) and Bloom (1987). With the exception of Prairie Falcons (*Falco mexicanus*) in Idaho trapped during incubation, most trapping bouts were conducted after hatching, but before dispersal of young.

PHB, EHH, JLH, BW, PJD, JRB, RLA and MDM used a standard 2.1 m × 5.5 m mist net (210 denier, 2 ply, 10.2 cm mesh; Avinet Inc., Dryden, NY), occasionally two nets in V-shape. Mist nets have the advantage of being large placing poles far apart and can be purchased ready-made (Bloom 1987). The mist net was lightly attached to

the poles with clothes-pins and smooth tape tabs (Bloom 1987) or a small piece of limp wire (Hamerstrom 1963) so that the net detached as the bird struck it. The degree of "hair triggering" necessary is dictated by wind conditions and size of the raptor. Placing more tape inside the clothes-pin generally requires more mass, or a stronger wind to pull the net down. JKS used whole mist nets, hand tied nets, or nets made from gill netting with a border added. The smaller handmade nets (ca. 1.5 × 3 m) were attached to wooden poles with clips; the larger mist nets remained attached to poles that collapsed fully or partially on capture. For Merlins (*F. columbarius*), KT and PFS used a single five-tiered mist net 2.1 m × 9.1 m (6.1 cm mesh) attached to three poles with rubber shock absorbers to form a "V" shaped net. This modified mist net did not break away or slide (Clark 1981) like a *dho-gaza* so as to avoid repeated net damage and repairs from tanglement in low brushy vegetation. TLM and JOM made a V-shape using two handtied nets 1.2 m by 1.8 m (10.2 cm mesh) for Prairie Falcons.

The lure owl was centered just out of reach of the net, tethered with a swivel and leash to the ground, a 0.3 m tall log or a portable ring perch 0.5 m above the ground. Observers were in a blind <15 m away, concealed under camouflage 5–100 m away or in a vehicle 0.1–>1 km.

Many territories were trapped at repeatedly; hence trapping the same territory for 3 yr equaled three territories. However, multiple trapping attempts at the same territory in the same year were considered as one territory. When possible, we evaluated the success of our trapping efforts using two techniques. We defined "territory trapping success" for a species as the total number of individuals captured divided by the total number of possibilities, where possibilities equaled both individuals of a pair at a territory. "Raptor trapping success" was the number of individuals captured, divided by the number of birds that made contact with the net. Raptor trapping success does not reflect instances when a raptor made a pass over or around a net, was vocal but made no pass, or was present, but engaged in other activities such as copulation, incubation, or territorial defense from other avian competitors.

The sex of raptors was determined by wing length, body mass, brood patch evaluation, behavior, relative size compared to their mates, and the literature (Clark and Wheeler 1987).

Trapping of Black-shouldered Kites (*Elanus caeruleus*; EHH, JLH, PHB, MDM, RLA), Cooper's Hawks (*Accipiter cooperi*; PHB, EHH, JLH), Northern Goshawks (*A. gentilis*; PHB, BW, PJD, RLA, EHH, JLH), Northern Harriers (PHB, EHH, JLH), Red-tailed Hawks (*Buteo jamaicensis*; EHH, JLH, PHB), Red-shouldered Hawks (*B. lineatus*; PHB, EHH, JLH, MDM), American Kestrels (*F. sparverius*; JRB), Great Horned Owls (PHB, EHH, JLH), Spotted Owls (*Strix occidentalis*; PHB, PJD) and Great Gray Owls (*S. nebulosa*; PHB) occurred in California. Swainson's Hawks (*B. swainsoni*) were trapped in California (PHB, BW, PJD, RLA, EHH, JLH) and Alberta (JKS). Ferruginous Hawks (*B. regalis*) were trapped in Alberta (JKS). Prairie Falcons were trapped in Idaho (TLM) and Colorado (JOM). Merlins were trapped in central Alaska (KT, PFS).

JKS captured 414 Swainson's Hawks and 146 Ferruginous Hawks during the 12 years between 1975 and 1991. In 1985-86, trapping time and hawk response was recorded on data sheets; these data form the basis for the Alberta Swainson's and Ferruginous Hawk analyses.

RESULTS AND DISCUSSION

Black-shouldered Kite. Southern California kites nest in oak woodland and riparian communities and hunt primarily in grasslands. They act aggressively toward any larger raptor during the breeding season. Of 22 kites attempted at 11 territories by EHH, JLH, MDM, RLA and PHB, 15 were captured including four pairs. Territory trapping success was 68% and raptor trapping success was 100%. Eight kites were caught in <15 min, two required 30 min, and no escapes occurred. Two other Black-shouldered Kites aggressively attacked the owl but were aware of the net and avoided it. One male was recaptured 2 months later at a new territory.

Northern Harrier. Northern Harriers nest on the ground in grasslands, marshes, estuarine habitats in low vegetation. When faced with a Great Horned Owl near the nest they attacked promptly, initially avoiding the net for several passes until caught, possibly because in most situations there were no trees or shade to disguise the net.

PHB, EHH and JLH attempted to capture six harriers at three territories and caught five which included two pairs and a female. Territory trapping success was 83% and raptor trapping success was 100%. The male of the pair at the third territory could not be caught, possibly because he had been previously trapped in a *dho-gaza* the year before. In both instances where pairs were caught, the female

was captured first within 30 min of trap placement. Males were caught within 1 hr of the time the net was reset.

Cooper's Hawk. Cooper's Hawks are aggressive accipiters that nest in oak woodlands in southern California. Their smaller size contributes to their speed and agility giving them the ability to dodge some nets or escape when a net gets entangled in understory vegetation. The odds of capture are balanced by their persistent aggressiveness. EHH, JLH and PHB trapped at 31 territories yielding a territory trapping success of 52% (32) and a raptor trapping success of 76%. Twenty-two females and 10 males were captured including 5 pairs; of which the female was caught first in 4 of the pairs. There were ten escapes, eight females and two males. Four other escapes were followed by capture minutes later. One male, after having its mate caught in the first 2 min, escaped twice and made four other passes before being captured in 40 min. One female escaped after 5 min, then 50 min later both male and female hit the two nets simultaneously but escaped. Nine days later the female was captured in 10 min. She had been captured in the same territory in the two preceding years. Two males and five females were captured twice and two females were captured three times over a 4 yr period.

Capture times of eight males averaged 27.3 min (SD = 23.9, range 2-60 min). Three males were captured in <5 min and five required 30-60 min because either they escaped, the female was caught first, or the set was made at a nearby Red-shouldered Hawk nest. Capture times for 13 females averaged 21.5 min (SD = 20.2, range 1-60 min). Four females were captured in <5 min and six were caught in 10-25 min. Three required 45-60 min after escapes or sets made at nearby Red-shouldered Hawk nests. Capture times were not recorded for the remaining 12 hawks. Two pairs were captured in <5 min. In one case, the female hit a net as the male was removed from the other net. He was the only Cooper's Hawk to be captured twice in the same year. Of the five pairs captured, the female was captured first on four territories.

Northern Goshawk. Goshawks are legendary for their aggressive displays when defending their nests (Bent 1937). They nest in dense coniferous forest, so it is not difficult to hide the net and poles or to keep the owl shaded and cool.

BW trapped at 27 territories in northern California (1986-91) yielding a territory trapping suc-

cess of 76% (41); 21 females and 20 males including 15 pairs. Two fledglings were also caught. Raptor trapping success for 51 goshawks was 86% (44). In the majority of instances when only one member was caught, it was due to the absence of the mate. Males were absent on five occasions and females on two occasions. In one instance each, a male or female left the nest area, and in two instances the female, though present, would not attack the owl. The fastest successful trapping attempt involving a pair was 1 min for the female and 2 min for the male. Time to first capture was <1 hr for 19 of 24 attempts and ranged as high as 155 min. Time to the capture of the mate (following reset) was <1 hr for 7 of 11 attempts and went as high as 180 min before quitting the effort. Most male captures occurred within 1 hr of sunrise before they began hunting and left the nest area. The presence of females at the nest was more dependable, particularly when young were less than half grown.

PJD trapped in northern California at 25 territories yielding a territory trapping success of 54% (27); 6 pairs and 15 individual females. No birds were captured in three territories. Nine females had been captured in *dho-gazas* in previous years. The lower territory trapping success of this effort relative to others reported for this species may be due to the large number (frequently >4) of observers. Raptor trapping success was 96%.

In northeast California, PHB, RLA, EHH, and JLH (1981–91) trapped at 51 territories yielding a territory trapping success of 67% (68); 45 females and 23 males including 17 pairs. One fledgling was also caught. One male from 2 yr earlier and one female from 8 yr earlier were recaptured. Many goshawks were recaptured the same day or within the same week when attempting to capture a mate. Raptor trapping success was not measured, but was estimated at 80–85% of the hawks that hit the net. Reasons for escapes included perching on the net poles causing the net to detach, tearing through the net, striking the top of the net, and becoming disentangled. One particularly tenacious female tore through the net and escaped three times in 2 hr, only to be caught on her fourth attempt. Minimum capture time for a pair at a previously untrapped territory was 10 min, which included net replacement time. Some goshawks required up to 5 hr to capture. Freshly killed nestling and fledgling passerines and piciformes were found in the net with the goshawk on several occasions.

Few comparative studies of trapping success have been described for the many different types of traps available (Bloom 1987). However, the work of Karlbom (1981) and Kenward and Marcstrom (1983) using compartment traps and bow nets provides useful data for comparisons of the effectiveness of different traps. Whereas time to capture goshawks using Great Horned Owls and *dho-gazas* was measured in minutes or hours, time to capture using compartment and automatic bow-nets has been measured in trap-days (Karlbom 1981, Kenward and Marcstrom 1983).

Red-tailed Hawk. In southern California, Red-tailed Hawks nested in oak and riparian woodland habitats. In contrast to the other three *Buteos*, Red-tailed Hawks responded poorly to a Great Horned Owl and net near their nest site. EHH, JLH, and PHB trapped at eight territories (in 1986 and 1992) yielding a territory trapping success of 13% (2) and a raptor trapping success of 100%. Both hawks, a male and female, required ≤ 5 min.

In northern California Red-tailed Hawks nested in juniper-sage habitat. BW trapped at nine territories (1990) yielding a territory trapping success of 17% (3) and a raptor trapping success of 100%. Time to capture for the two females and one male was 10–60 min. One other Red-tailed Hawk made an aggressive stoop at the owl, missed the net, and ceased attacking.

Red-shouldered Hawk. Red-shouldered Hawks in southern California nest in oak and riparian woodlands. Most hunting is from perched positions under the forest canopy where long distance visibility is limited (McCrary 1981, Bloom 1989). As a result Red-shouldered Hawks usually do not locate the owl immediately in the same way a Swainson's or Ferruginous hawk could from their aerial positions.

PHB, EHH, JLH and MDM trapped at 132 Red-shouldered Hawk territories (1979–91) yielding a territory trapping success of 75% (199); 102 females and 97 males including 53 pairs. Raptor trapping success for 87 attempts was 95% (83). Four escapes included two males and two females. Of 20 pairs, females were caught first on 5 occasions, males on 15.

Capture time for 23 female Red-shouldered Hawks unfamiliar with a *dho-gaza* averaged 76.1 min (SD = 73.9, range 5–300 min) and 10 males averaged 63.5 min (SD = 53.4, range 5–180 min). Recapture time in the same or different years was considerably longer. Ten females averaged 181.0 min (SD = 138.3,

range 30–525 min) and seven males averaged 124.3 min (SD = 109.5, range 5–290 min).

Swainson's Hawk. Swainson's Hawks are a *Buteo* of open habitats, frequenting deserts and agricultural areas with sparse trees. As a result, camouflaging the net and poles is usually difficult and sometimes impossible. Even with a net erected with no trees to hide it, many Swainson's Hawks stooped on the owl, sometimes from several hundred meters high or from a nearby perched position. Good sets allow placement of one or both poles next to or between two trees, particularly if shaded. The drawbacks of trapping in arid situations are heat on the lure owl during midday, and the winds that frequently occur in desert areas in the late afternoon. Winds cause the net to detach or billow and become more obvious. Because some territories were composed primarily of rock fields, we sometimes had to place the trap 150 m from the nest tree to find a safe landing area for the hawk.

Most Swainson's Hawks are very aggressive toward Great Horned Owls placed within 100 m of the nest. Of 132 Swainson's Hawks attempted by BW (1985–91) 98 were captured yielding a raptor trapping success of 74%; 44 females and 52 males including 32 pairs. Of 32 pairs, females were captured first 19 times and males 13 times. At two territories both polyandrous males were caught first. On six occasions no hawks were captured because of wind and absence of hawks. Hawks with territories in poor quality habitat (Woodbridge 1991) seemed less tenacious and less likely to be present to defend the territory.

In northeast California (1981–88) PHB, EHH and JLH trapped at 58 territories yielding a territory trapping success of 63% (73); 30 females and 43 males including 17 pairs. Of 17 pairs, females were first into the net on 8 occasions and males on 9 occasions. Raptor trapping success was not quantified but was estimated at 75–85%. Escapes from nets occurred most frequently in the first years of trapping when we used vehicles as blinds and parked 0.25–1.0 km from the net. The few minutes travel time to the net allowed >10 individuals to escape. Escapes were reduced in later years by using a blind.

In the Central Valley of California (1985–91) RLA and PJD trapped at 54 Swainson's Hawk territories yielding a territory trapping success of 62% (67); 33 females and 34 males including 17 pairs. At least one member of a pair was captured in 50 of 54 territories. Of the 17 pairs captured,

females were caught first on 13 occasions and males on 4. Raptor trapping success was not measured but was estimated at 80–90%. Thirteen Swainson's Hawks previously trapped in *dho-gazas* were later recaptured for transmitter replacement or removal.

Of 194 trapping attempts over two years at 192 Swainson's Hawk territories in Alberta, JKS captured 34% (129) of a possible 384 hawks. This low territory trapping success of 34% may be because in this study an attempt was made to capture a large number of hawks. Trapping in any one territory was rarely repeated within one year. During the first 30 trapping attempts in 1985, raptor trapping success was 68%.

When time from leaving the setup to capture was considered, females were captured sooner than males in Alberta. When considering a particular sex that was caught alone or caught first in the case of a pair, 46 females were caught on average in 7.2 min (SD = 5.8, range 0–45 min) and 63 males in 13.2 min (SD 12.8, range 0–45 min). The later capture of males was not significantly different ($\chi^2 = 5.94$, $df = 2$, $P = 0.051$) and may have been due to some males arriving at the nest after the *dho-gaza* had been set up. Combining data from all trapping of Swainson's Hawks revealed that for a total of 86 pairs captured, females were caught first on 46 occasions (53%) and males first on 40 occasions (47%).

Ferruginous Hawk. A tree and cliff nesting raptor of open country, desert and grasslands, the Ferruginous Hawk was more timid than the Swainson's Hawk when defending the nest against a Great Horned Owl as a lure. In Alberta, JKS trapped at 177 territories a total of 191 times yielding a territory trapping success of 19% (66); 27 females and 39 males including five pairs. Of all pairs females were caught first. Raptor trapping success for the first 30 Ferruginous Hawks captured in 1985 was 68%. Distance between a well hidden observer and net should be small since Ferruginous Hawks frequently broke free from the net. After trap setup and departure, females took on average 17.0 min to be caught (SD = 14.1, range 3–55 min); males averaged 16.2 min (SD = 16.2, range 0–62 min).

Prairie Falcon. Accounts of the ferocity with which Prairie Falcons attack owls during the nesting season are well known and mortal strikes are not uncommon (Bent 1937). Fortunately, because the lure owl does not fly, the risk of physical contact from the falcon is minimal. Another concern is for the safety of the falcon; since rocks are commonly

found near the cliff trapping location. The area where the falcon will likely land after entanglement should be free of rocks.

Owing to the focus of the study (radio telemetry), TLM attempted to trap only one member from each pair in the Idaho Great Basin Desert, resulting in 16 females and 6 males captured (Marzluff et al. 1991). Average length of time needed to capture a falcon was 40 min for 26 attempts and ranged from 5–180 min. In the Colorado Pawnee Grasslands (1976–78) where the objective was to capture both members of each pair, Steven W. Platt and JOM caught 14 pairs, 34 individual female and 18 male Prairie Falcons (Platt 1981). Of 47 attempts to recapture marked falcons, 5 (11%) were successful. Less than 10% of the falcons escaped after striking the net in either study, yielding a raptor trapping success of approximately 90%.

Merlin. Merlins were trapped on open tundra, white spruce taiga and riparian willow shrub communities in central Alaska. KT and PFS (1987–89) trapped at 43 nest territories yielding a territory trapping success of 90% (77). Eight males and one female were not captured. Two males were not present during trapping so no chance existed for their capture. The uncaptured female had been caught in a previous year. Five females and six males previously trapped with a *dho-gaza* were recaptured. Raptor trapping success was 100%.

In the typical situation the female was captured within a few minutes and usually held until the male was caught to avoid her recapture. Males were often initially absent. If the female was present, the male arriving with prey presented it to her and left before discovering the owl. In the absence of the female the male would remain in the nest vicinity, possibly cache the prey item, and attack the owl as soon as it was discovered. Freshly killed passerines were often recovered from the net or picked up nearby.

Even on windy days the antagonism Merlins demonstrated toward Great Horned Owls overcame their reluctance to fly into the nets. Merlins frequently struck the nets, bounced out, and were caught on the next pass.

American Kestrel. In this study American Kestrels nested in oaks, and sycamores surrounded by grasslands. They responded quickly to an owl in their breeding territory and usually were caught if they struck the net. In fact several of us inadvertently caught kestrels when attempting to capture other species. JRB attempted 118 kestrels (1983–90) and

captured 115 for a raptor trapping success of 97%. Six other kestrels aggressively stooped on the lure owl but did not make contact with the net. Because kestrels lacked the mass necessary to easily dislodge corner tabs of a mist net, the tabs must be “hair triggered” to detach easily. Using smooth tape and weakened clothes-pin springs was important. This causes some problems on windy days but greatly increased trapping success.

Spotted Owl. Spotted Owls show a strong affinity toward mature coniferous forests where shade is an inherent part of the territory. Site preparation involves removal of branches in adjacent trees and the area on the ground where the owl would come to rest after striking the net. Placement of the net was normally accomplished with adults nearby.

PJD and PHB made eight diurnal attempts at four territories that yielded three pairs with none captured at the remaining territory. Territory trapping success was 75% (6) and raptor trapping success was 100%. When there was no response from either adult Spotted Owl after 30–60 min, a “branching age” Spotted Owl chick (one of their young) was held near the Great Horned Owl in front of the net and in six attempts six owls were caught. However, one adult owl was caught without a young owl in hand the day after its mate was caught. While young of branching age were present in the trees at the fourth Spotted Owl territory, only the female responded, with four passes over the net. Even though the lure owl was less than 50 m from the branching owlets, the lack of an immediate threat (relative to the above three instances) to its young and the more advanced age of these young relative to those in the above territories may have diminished the defense response.

Great Gray Owl. In California Great Gray Owls nest in tall snags in upper elevation coniferous forests and meadows of the Sierra Nevada Mountains. PHB made single diurnal net sets at three Great Gray Owl nests. Adult female Great Gray Owls were captured on all three occasions in <3 min. Territory trapping success was 50% and raptor trapping success was 100%. Although present on two occasions, no male Great Gray Owls attempted to strike the lure owl. Great Gray Owls responded very aggressively, sometimes with the intent of binding to the lure owl, even with the observer <5 m away.

Great Horned Owl. In coastal southern California Great Horned Owls most frequently nest in oak and riparian woodlands, using abandoned nests or

sandstone potholes. Of 16 attempts at 8 Great Horned Owl territories PHB, EHH and JLH captured 4 females and 1 male. Territory trapping success was 31% (5) and raptor trapping success was 56%. Four other owls escaped after brief entanglement. All captures and escapes were <15 min after setup, except for one male which escaped 75 min after its mate escaped. All attempts were made at dusk except for one early morning capture of the male.

Several setups were removed after the initial attempt owing to the difficulty of extricating an owl from a tangled net and replacing nets after dark. The lure owl was vulnerable to attacks by wild owls which at times attempted to bind to it. The researcher's visibility is also reduced in the darkness.

Raptor Response in Relation to Age of Young.

Both sexes of Swainson's and Ferruginous hawks in Alberta exhibited slightly decreased but statistically non-significant declines in capture success as their young grew older (Fig. 1; for Swainson's Hawk females $\chi^2 = 4.30$, $df = 2$, $P = 0.116$, for males $\chi^2 = 0.74$, $df = 2$, $P = 0.691$; for Ferruginous Hawk females $\chi^2 = 0.06$, $df = 2$, $P = 0.972$, for males $\chi^2 = 1.66$, $df = 2$, $P = 0.437$). Aggression by adults seemed strongest when small to half grown young were in the nests. When young were beginning to fledge ("branchers"), fewer adults responded. This was also noticeable with other species, especially goshawks.

Raptor Response in Relation to Brood Size.

A body of theory suggests that a parent's investment in reproduction (including nest defense) may be affected by a balance between past versus future expectations of reproductive fitness (e.g., Trivers 1972). There was no evidence that the Swainson's ($\chi^2 = 0.13$, $df = 2$, $P = 0.935$) or Ferruginous hawks ($\chi^2 = 0.40$, $df = 2$, $P = 0.821$) studied in Alberta in-

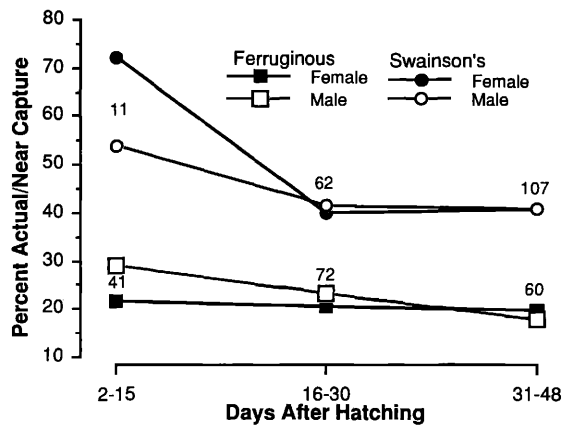


Figure 1. Percent of Ferruginous and Swainson's hawks in Alberta that exhibited strong aggression toward a Great Horned Owl, in relation to age of nestlings. Percent actual/near capture refers to hawks that were either aggressive enough to be caught or aggressive but aware of the net which they maneuvered to avoid. Numbers represent the total number of pairs of each species in each time period.

creased the intensity of defense based on past investment as reflected in brood size (Table 1). It is conceivable that Great Horned Owls represent less danger to young of large buteos as the young approach adult size.

Raptor Response in Relation to Food in the Nest.

Hawks may defend their nest more strongly when food is present (Pascual and Santiago 1991). JKS found that protection of food in addition to young probably was not a contributing factor. Of 60 attempts to capture Swainson's Hawks while prey were present in the nest, 29 hawks (48.3%) were caught. Of 124 attempts while prey were absent, 78

Table 1. Success in capturing one or both members of a pair of Ferruginous or Swainson's hawks in relation to the number of young fledged. Percentages are in parentheses.

ONE OR MORE ADULTS	NUMBER OF FLEDGLINGS				
	1	2	3	4	5
Ferruginous					
Caught	4 (6.7)	11 (18.3)	20 (33.3)	21 (35.0)	4 (6.7)
Not caught	8 (6.6)	21 (17.4)	46 (38.0)	42 (34.7)	4 (3.3)
Swainson's					
Caught	22 (20.4)	52 (48.1)	31 (28.7)	3 (2.8)	
Not caught	18 (22.5)	37 (46.3)	25 (31.3)	0	

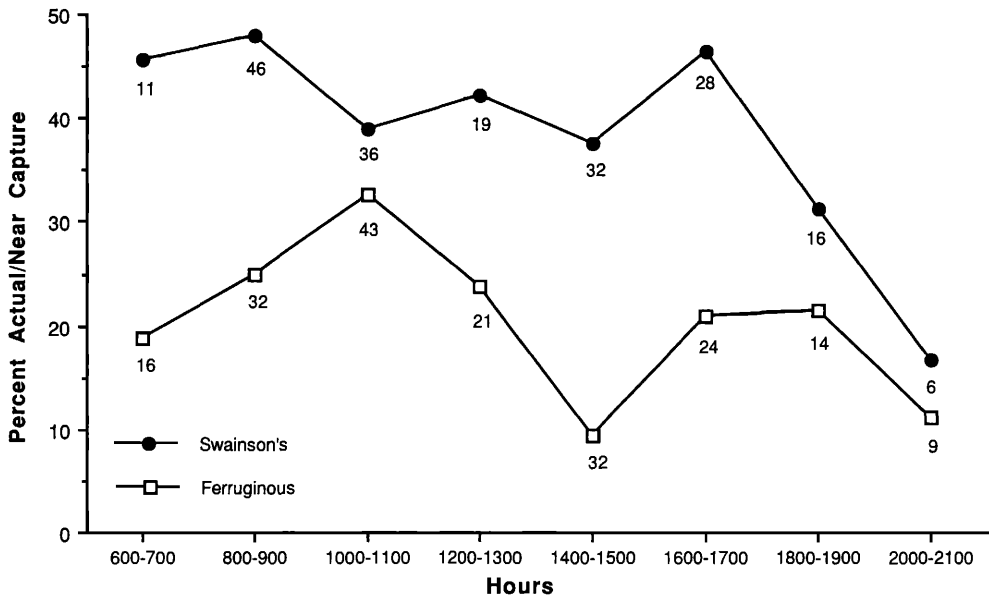


Figure 2. The proportion of Ferruginous and Swainson's hawks in Alberta that were sufficiently aggressive to be either caught or only narrowly avoid capture in relation to time of day. Numbers below data points represent the number of trapping attempts in this time period.

(62.9%) were caught ($\chi^2 = 3.53$, $P = 0.060$). Likewise, Ferruginous Hawks did not respond more aggressively to the lure owl when food was in the nest with young. Of 78 attempts to capture Ferruginous Hawks while food was present in nests with young, 21 (26.9%) were successful; of 98 attempts when food was absent 34 (34.7%) resulted in capture of one or more adults ($\chi^2 = 1.22$, $P = 0.270$).

Aggression in Relation to Time of Day. In Alberta, most of the trapping took place between 0600–2000 H. Within this time span, Ferruginous Hawks exhibited a bimodal pattern of aggressiveness (Fig. 2). The reduced aggression early and late in the day was surprising since Ferruginous Hawks were crepuscular, at least those nesting west of the Rocky Mountains (Smith and Murphy 1973). Swainson's Hawks seemed to exhibit reduced aggressiveness late but not early in the day (Fig. 2).

Care of the Lure Owl. The lure owl is the most critical component of the trap and should be treated as though priceless. A wood stump or log for the owl to stand on or hide behind affords the owl some protection from unusually fierce attacks. Jesses and tether (1 m) should be long enough for the owl to comfortably move about or defend itself should a hawk or owl attempt to bind to the lure owl. Trap-

ping in hot weather should be done only in the early morning or late afternoon and preferably in the shade. The owl can be cooled by regularly misting with water from a spray bottle, and rehydrated by squirting a minimum 40 cc/day (avoid trachea; M.J. Gibson pers. comm.) of Gatorade from a syringe into its mouth. It is preferable to have the owl in sight of the observer to monitor its behavior to determine stress from weather, or the presence of predators including the target raptor.

Of the raptors we attempted to trap, the most serious threat to the lure owl was from the Northern Goshawk, Red-shouldered Hawk, Great Horned Owl and Great Gray Owl. We sustained one injury and four lure owl mortalities. The injury was due to a puncture wound to the head from a Northern Goshawk. Mortalities were incurred from a Bobcat (*Felis rufus*) attack despite the presence of a blind 15 m away, a blow from a Red-shouldered Hawk, and dehydration ($N = 2$). On several occasions Northern Goshawks and Great Horned Owls have bound talon to talon to our lure owl without any apparent injury to either bird. A nearby blind greatly reduced arrival time of the observer and the chance of an injury to the owl. Nearly 1400 kites, hawks, falcons, and owls in these studies were captured with

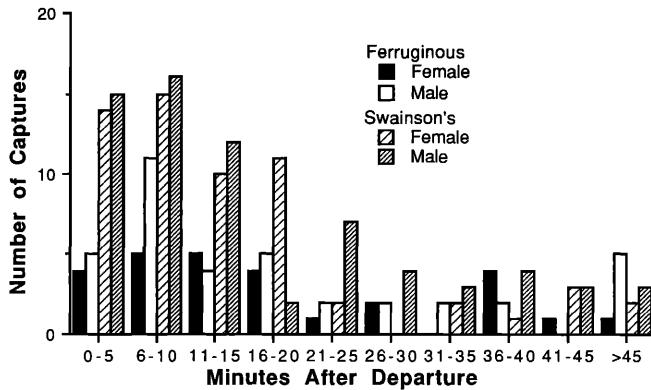


Figure 3. The number of captures of Ferruginous and Swainson's hawks in Alberta in relation to the time after the *dho-gaza* was left at a nest.

the *dho-gaza* without injury to the target raptor. Although a few lure owl mortalities may be unavoidable, with care the *dho-gaza* with lure owl is a reasonably humane and very effective live trapping device.

Using Raptor Lures Other Than Great Horned Owls. Raptors that have been captured before, escaped, or had unrewarding experiences with traps may become "trap-trained" (Bloom 1987). Even when trap-trained to a lure owl, certain individuals may still attack if the lure bird is replaced with a new species. When trapping Red-shouldered Hawks PHB, EHH, JLH, and MDM used an adult Red-tailed Hawk (McCrary 1989) in 15 territories to capture three female and four male Red-shouldered Hawks that previously could not be recaptured with a Great Horned Owl. Similarly, a Red-shouldered Hawk was used in five Red-shouldered Hawk territories that resulted in the recapture of three trap-trained hawks that would no longer respond to a lure owl. No injuries or mortalities occurred to the lure hawk.

Trapping During Winter. PHB attempted to capture two Black-shouldered Kites, two Northern Harriers, three Red-tailed Hawks, one Ferruginous Hawk, and two Prairie Falcons during winter with no success. The two kites, two harriers, and one Prairie Falcon responded by stooping to within 5 m of the net, but never made contact. Under less open situations with better camouflage the *dho-gaza* may have worked. One Sharp-shinned Hawk (*A. striatus*) was trapped by EHH and JLH on its wintering grounds in southern California, and BW captured

one Rough-legged Hawk (*B. lagopus*) in northern California.

Improving Raptor Trapping Success. It is important to minimize the time spent at a nest. Some species and individuals are more tolerant than others. Some raptors are more vulnerable to disturbance at certain periods in the breeding cycle, particularly incubation. The researcher's experience and ability to assess the effects of weather, time of day, presence or absence of the target raptor, and behavior of the individual during the various stages of the reproductive cycle will determine the amount of time spent at the nest. This may ultimately determine the success or failure of both the trapping and nesting attempt. Of 300 trapping attempts on several species of raptors in southern California, 5 resulted in failures (*A. cooperi*, *B. lineatus*) during incubation. We suspect that these could be attributed to our disturbance.

JKS's experience in Alberta with Swainson's and Ferruginous hawks was that if capture was not accomplished quickly the likelihood of success decreased substantially (Fig. 3). This decline in aggression could be due to the hawks' aggression being simply of short duration, due to the hawks detecting the unusual way in which the owl (lure) invaded their territory, or both. In some rare cases hawks were captured after 1 hr, but if the object was to capture as many hawks as possible and not necessarily specific individuals, it proved more efficient to go to another territory after 30 min rather than wait for a response. This may not be the case when targeting specific individuals or woodland raptors that may take longer to see the owl.

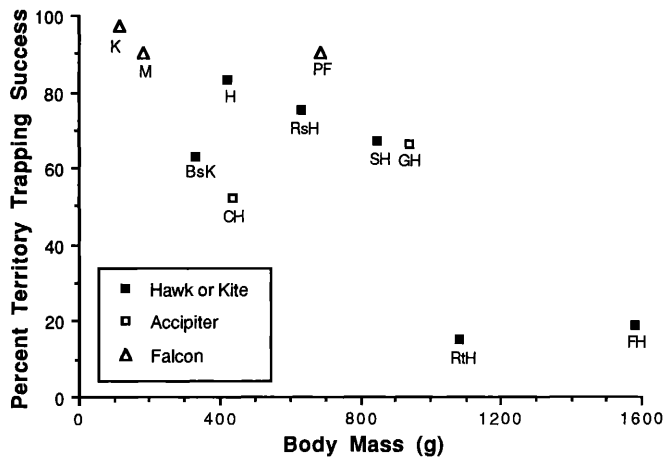


Figure 4. Territory trapping success of the species studied in relation to body size.

While we did not attempt to quantify the effects of human disturbance at trap sites, several of us feel that trapping success and/or time necessary to capture hawks can be affected by the number of participants. Only 1–3 people should attend a trap site. This is particularly true of forest dwelling raptors, which, while present and vocal on arrival of a small group, may disappear if the assemblage increases (Speiser and Bosakowski 1991).

Site selection is critical to trapping success. The owl should be placed in the most visible location possible which also allows for good placement of the net in terms of camouflage, shade and directing the raptor into the net. Proper placement greatly decreases the time to capture. As a rule, the closer the trap is to the nest the stronger the response from the hawk. When possible, nets should be placed between two trees so that the net poles become less apparent and the attacking raptor is forced to fly into the net and not parallel. Shade is equally important, both in terms of keeping the lure owl cool, and hiding the net which is very visible in full sunlight.

Observer position and site preparation are important for capturing individuals who are only loosely caught. The best situation is a portable blind (e.g., Leonard Rue Enterprises, Inc., Blairstown, NJ) placed within 25 m of the net. In the case of break-away nets, the area in which the raptor is going to fall should be cleared of all large branches, rocks, shrubs and pine cones. This is necessary for the raptor's safety, to ensure a catch and to facilitate removal of the raptor from the net. If the second

member of a pair is to be captured, a replacement net can be set and the first bird can be disentangled at another location.

If a breeze is blowing the net should be placed perpendicular to the wind since most raptors attack into the wind. The net can become entangled on the pole and clothes-pins if placed parallel to the wind direction.

Tape recorded vocalizations of either a Great Horned Owl or the target species can decrease the time needed to attract a raptor, particularly woodland species which may not be aware of the lure owl even though only 100 m away. It was noted that some individual goshawks, particularly males, seem intimidated by the call and may leave the area. Once a lure owl has been habituated to the set and refuses to move, a monofilament line attached to its jess can be lightly tugged to create the added stimulus that will cause the raptor to attack.

There was a strong trend for the larger raptors to be more difficult to capture than smaller ones (Fig. 4). Larger raptors also broke free from the net more often which reduced raptor trapping success. Several possible reasons could be advanced for this lowered success with increasing raptor size; among them is the possibility that the nestlings of large raptors may pose a danger for a Great Horned Owl, especially when the nestlings are more than half grown. The primary limiting factor in capturing Swainson's and Ferruginous hawks in Alberta was a lack of response by the hawks toward the owl (Fig. 5). Both members of a pair were almost always present, only a few

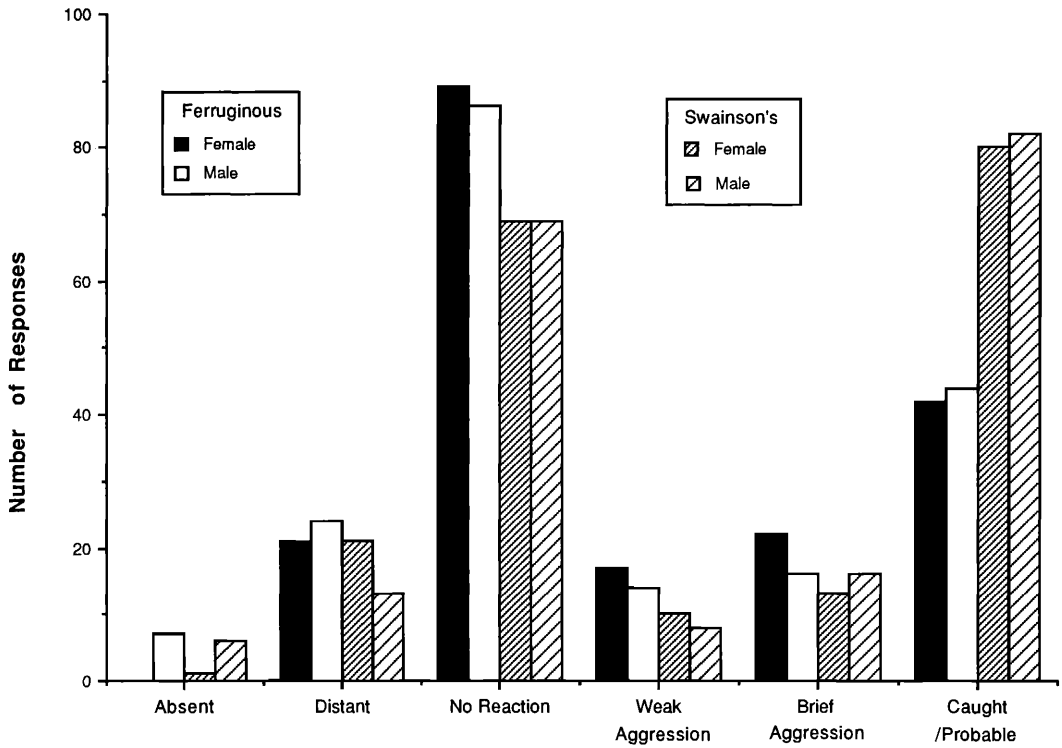


Figure 5. Types of responses by Ferruginous and Swainson's hawks studied in Alberta. Some hawks, usually males, never appeared near the nest, some remained distant (>300 m from the *dho-gaza*) and others exhibited reactions of varying degree. The "caught/probable" category includes those that presumably saw and avoided the net.

remained at a distance unwilling to approach the nest site, but the majority simply failed to respond aggressively.

Another explanation for lowered trapping success and attacks from larger raptor species on the lure owl could be that the more vigorous attacks from smaller raptor species would seem predictable since these species likely have taken the brunt of predation by large *Bubos* over evolutionary time relative to larger raptor species. Further evidence for this theory is available in the form of the lack of instances of Golden Eagles (*Aquila chrysaetos*) observed stooping at the lure owl during this study, even though Golden Eagles nested on our study areas and attacks by other non-target raptors on lure owls were not uncommon. However, the distance between the *dho-gaza* and Golden Eagle nest sites may have been too great to elicit an attack. None attacked the lure owl suggesting that for Golden Eagles, the largest of buteonine raptors in North America, the Great Horned Owl may only pose a modest threat.

In conclusion, very few traps yield the success of the *dho-gaza* and Great Horned Owl when used in the spring at a raptor's nesting territory (Bloom 1987). Many researchers have used this technique as the number of co-authors, wide region of use, and number of species in this article will attest. Trapping success for a given species may depend upon the individual's aggressiveness and probably a great deal on the individual trapper's experience, techniques and patience. The early development and publication of the use of the *dho-gaza* by Fran and Frederick Hamerstrom (Hamerstrom 1963) has led to use of this technique across North America on a wide variety of raptors and has facilitated research and conservation of birds of prey in important ways. We salute them for bringing this technique back from the many centuries it lay essentially dormant in the Old World.

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