

MOVEMENTS AND SURVIVAL OF RELEASED, REHABILITATED HAWKS¹

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ABSTRACT.—During 1985 and 1986, nine rehabilitated hawks [eight Red-tailed Hawks (*Buteo jamaicensis*); one Red-shouldered Hawk (*B. lineatus*)] were radio-tagged and released in an area of bottomland hardwoods and agricultural lands in southeastern Louisiana. Four Red-tailed Hawks survived for more than two wk after release and were thought to be acclimated to the wild. One Red-tailed Hawk died, and the Red-shouldered Hawk was shot. Adverse weather may have contributed to the Red-tail's death. Telemetric contacts ranged from less than one d-60 d. Loss of radio contact with released birds may have been influenced by migration, dispersal from release site, transmitter failure and/or transmitter range.

A 1978 survey revealed that approximately 225 active wildlife/raptor rehabilitation programs exist in the United States with a combined potential of treating 7000 raptor patients/yr (Duke et al. 1981). Many birds are rehabilitated and released back into the wild; however, few quantitative data on survival and movements of released raptors exist (Servheen and English 1976, 1979; Duke et al. 1981; Daniels 1984; Kimmel and Zwank 1983). We here report on post-release movements and survival of rehabilitated hawks in southern Louisiana.

METHODS

During 1985 and 1986, personnel at Louisiana State University (LSU) School of Veterinary Medicine Raptor Rehabilitation Unit made available nine rehabilitated hawks for release: eight Red-tailed Hawks (*Buteo jamaicensis*) and one Red-shouldered Hawk (*B. lineatus*) (Table 1). Raptors were considered releasable when in the opinion of the attending veterinarian birds demonstrated proper flight skills and sufficient foot and leg strength for prey capture. Two Red-tailed Hawks and the Red-shouldered Hawk were equipped with an 11-g tail-mounted transmitter with a 28 cm whip antenna (Wildlife Materials, Inc., Carbondale, Illinois; mention of brand names does not imply endorsement by the U.S. Government) (Table 2). Two Red-tailed Hawks were each instrumented with a 25-g, two-stage tail-mounted transmitter equipped with a 28-cm whip antenna. Advertised range of the lighter transmitters was 1.6-2.4 km; estimated battery life was 250-300 d. Heavier transmitters had an estimated battery life of 150-180 d and an advertised range of 9.6-12.8 km. Tail-mounted transmitters were sutured to the ventral surface of central rectrices following procedures established by Kenward (1978). Antennas of lighter transmitters were tied to the rachis of a central rectrix at 10-15 mm intervals. Antennas were not attached to a rectrix of Red-tailed Hawks equipped with heavier transmitters.

Four Red-tailed Hawks were equipped with 23-g, two-stage transmitters (Telemetry Systems, Inc., Mequon, Wisconsin) equipped with a motion-sensitive mercury switch and a 44.5-cm whip antenna. Range and battery life were comparable to 25-g transmitters. Due to frayed and broken rectrices, transmitters were attached using a back-pack configuration (Dunstan 1972) consisting of a 0.64-cm wide elastic harness. Transmitters were attached at least three hr prior to release. Aluminum U.S. Fish and Wildlife Service leg bands were also fitted to each bird prior to release.

Radio-tagged birds were released on the LSU Ben Hur (Ben Hur) Biological Research Area located approximately 7 km south of Baton Rouge. The study area consists of approximately 943 ha of agricultural croplands (cereal grains), aquacultural ponds, bottomland hardwoods and improved pasture grazed by sheep, cattle and horses. The area surrounding Ben Hur is primarily croplands (cereal grains) and improved pasture grazed by cattle and horses except for a residential area along the northwest boundary and the Mississippi River to the south. Raptors observed or heard in the area included Red-shouldered Hawk, Red-tailed Hawk, Broad-winged Hawk (*Buteo platypterus*), Sharp-shinned Hawk (*Accipiter striatus*), Northern Harrier (*Circus cyaneus*), American Kestrel (*Falco sparverius*), Mississippi Kite (*Ictinia mississippiensis*) and Barred Owl (*Strix varia*). Although the Great-horned Owl (*Bubo virginianus*), Common Barn-Owl (*Tyto alba*) and Eastern Screech-Owl (*Otus asio*) were never observed or heard, Lowery (1974) stated that all are permanent residents in Louisiana and thus could have been present in the study area.

Rehabilitated birds were released on six separate occasions (Table 2) at three different sites (A, B, and C) on the study area. Release Site A was located on a levee between bottomland hardwoods and aquacultural ponds. Site B was on the edge between a pasture and a 57-ha tract of bottomland hardwoods, and site C was in an area dominated by pasture interspersed with trees. Released raptors were monitored at least every two hr during the initial 48 hr post-release. Attempts were made to relocate each transmitterd bird at least four d/wk at random times during daylight hours. Visual contact was attempted if birds had not moved substantially during one wk.

Telemetry locations were determined by triangulation.

¹ Approved for publication by the Director of the Louisiana Agricultural Experiment Station as manuscript number 87-22-1105.

Additional locations were recorded when telemetered birds were observed. When radio contact was lost, an aerial survey of the area was conducted (1985 only). Locations and movements were recorded on USGS topographic maps. Habitat use was determined visually.

RESULTS

Two Red-tailed Hawks (No. One and Two) and the Red-shouldered Hawk (No. Three) were released during July 1985 (Table 2). The transmitter attached to hawk No. One was operating at the time of release; however, contact after release was never established. Following release, hawk No. Two remained within 0.6 km of the release site in an area of clearings and bottomland hardwoods for two d. Contact was lost for the next four d and on 20 July the bird was relocated 3.0 km to the southwest of the release site near the Mississippi River. For the next eight d No. Two remained along the river and adjacent pastures. The hawk was observed three times during the period and flight did not appear impaired. On 29 July hawk No. Two was 1.9 km west-northwest of the release site in an agricultural area 0.5 km west of a residential community. After this date, extensive ground and air searches, extending to a radius of 10 km from the last known location and along both sides of the Mississippi River for 50 km, failed to relocate the bird. Hawk No. Two was tracked a total of 15 d.

During the first three d following release, hawk No. Three remained along a powerline right-of-way that traversed a forested area between the release

Table 1. Clinical history of eight Red-tailed Hawks and one Red-shouldered Hawk rehabilitated by the Louisiana State University School of Veterinary Medicine Raptor Rehabilitation Unit.

SPECIES	I.D. NUMBER	REASON ADMITTED
Red-tailed Hawk	1	Fractured ulna from gunshot
Red-tailed Hawk	2	Penetrating wound of orbit requiring enucleation
Red-Shouldered Hawk	3	Juvenile that had fallen from nest; admitted with inflammation of the iris and a thiamine deficiency
Red-tailed Hawk	4	Lost forward toe in leg-hold trap
Red-tailed Hawk	5	Found along roadside with compound fracture of radius and ulna
Red-tailed Hawk	6	Confiscated by Louisiana Department of Wildlife and Fisheries
Red-tailed Hawk	7	Soft tissue injury of the left wing
Red-tailed Hawk	8	Wing fracture
Red-tailed Hawk	9	Confiscated by Louisiana Department of Wildlife and Fisheries

Table 2. Data on radio-tagged, rehabilitated hawks, released at Ben Hur Biological Research Area, East Baton Rouge Parish, Louisiana, 1985-86.

SPECIES	I.D. NUMBER	ADMISSION DATE	RELEASE DATE	AGE AT RELEASE	WEIGHT AT RELEASE (G)	TRANSMITTER TYPE	ATTACHMENT TECHNIQUE	LENGTH OF TRACKING PERIOD
Red-tailed Hawk	1	7 Jan 85	15 Jul 85	Juvenile	1145	I ^a	tail	0 days
Red-tailed Hawk	2	14 Apr 85	15 Jul 85	Adult	1070	I ^a	tail	15 days
Red-shouldered Hawk	3	10 May 85	22 Jul 85	Juvenile	500	I ^a	tail	59 days
Red-tailed Hawk	4	10 May 85	24 Oct 85	Juvenile	1315	II ^b	tail	14 days
Red-tailed Hawk	5	15 Feb 85	24 Oct 85	Juvenile	1425	II ^b	tail	5 days
Red-tailed Hawk	6	25 Apr 85	6 Mar 86	Juvenile	1167	III ^c	back-pack	48 days
Red-tailed Hawk	7	10 Dec 85	6 Mar 86	Juvenile	1321	III ^c	back-pack	60 days
Red-tailed Hawk	8	Jan 86	8 Mar 86	Juvenile	unknown	III ^c	back-pack	30 days
Red-tailed Hawk	9	25 Apr 85	13 Apr 86	Juvenile	1000	III ^c	back-pack	0.2 days

^a Wildlife Materials, Inc., 11-g, 1-stage.

^b Wildlife Materials, Inc., 25-g, 2-stage.

^c Telemetry Systems, Inc., 23-g, 2-stage, mercury switch.

site and a residential area. From 26–30 July the bird remained near powerlines adjacent to the southeast corner of a residential area. From there No. Three moved southeast 0.5 km into an area of clearings and scattered trees and remained for one wk. Subsequently, contact as lost for 14 d. The bird was relocated in a wooded area 0.6 km west of its last location and remained there from 22 August until 4 September. No. Three was observed flying near the residential area numerous times. Contact was again lost for 10 d, and on 14 September the bird was relocated 0.7 km to the northwest in a recently cleared area adjacent to a residential backyard. On 17 September, No. Three was observed flying over the residential area, and later that day a resident of the community found the bird with a gunshot wound in one wing. The bird had survived 59 d after release and was recovered 0.7 km west of the release site. Except on one occasion, No. Three was always located within 0.4 km of the residential area and never farther than 1.6 km from the release site.

Red-tailed Hawks No. Four and Five were released during the fall of 1985 (Table 2). Hawks No. Four and Five remained within a 0.5-km area for five d after release. Radio contact was lost with No. Five on 28 October and never reestablished. Hawk No. Four was found dead on 11 November 0.5 km north of the release site where it had remained for 17 d. Cause of death could not be determined. The bird appeared to have been dead only a few days when recovered. Hurricane Juan passed through southern Louisiana on 25 October with strong winds and heavy rains which affected the area for seven d.

Red-tailed Hawks No. Six and Seven were released on 6 March 1986 (Table 2). During the first day after release, hawk No. Six did not move more than 0.3 km from the release site. During the second day, however, the bird was observed catching and eating prey and interacting aggressively with a resident Red-tailed Hawk. The resident hawk failed to immediately chase No. Six out of the area during the encounter; yet by the end of the second day, No. Six had moved 0.7 km to the north. This encounter was the only aggressive display witnessed during the study. For the next 47 d hawk No. Six remained along a 1.0 km section of a small, tree-lined bayou adjacent to pastures and croplands. Contact was lost after 22 April and never reestablished. Hawk No. Six was last located 1.1 km from the release site.

During the first two d post-release, hawk No. Seven's movements were limited to occasionally flying

between two trees 50 m apart. On 9 March hawk No. Seven was observed on the ground as if attempting to capture prey; however, success could not be determined. Hawk No. Seven remained within 0.8 km of the release site for 21 d, except for 28 March when the bird was located 1.3 km southeast of the release site. From 1–9 April locations were widely scattered. Distances between subsequent locations averaged <1 km with one distance measuring 3.2 km. After 9 April, hawk No. Seven was located along a 3.0 km section of the Mississippi River and remained within 0.7 km of the river until contact was lost after 4 May. Final location was 3.9 km southwest of the release site.

Red-tailed Hawk No. Eight was released 2 d after Nos. Six and Seven (Table 2). Movements centered around aquaculture ponds located west of the release site from time of release to 6 April when contact was lost. Hawk No. Eight remained within 1.4 km of the release site for the entire 30 d observation period. Final location was 1.2 km west of the release site.

Hawk No. Nine, an immature Harlan's Red-tailed Hawk (*B. j. harlani*) was released at 0900 H on 13 April 1986. At 1155 H the bird was observed soaring over a pasture 0.3 km south of the release location. By 1250 H only a very weak radio signal could be heard from the northwest. An extensive ground search extending to a radius of 8.0 km from the release site and 24 km to the northwest failed to relocate hawk No. Nine.

Length of monitoring period ranged from 0–60 d (Table 2). One Red-tailed Hawk had died, and the gunshot Red-shouldered Hawk had to be readmitted to the rehabilitation unit. Four Red-tailed Hawks lived for at least two wk after release. For each Red-tailed Hawk monitored more than one d, the longest distance traveled ranged from 0.5–4.8 km ($\bar{x} = 2.1$, $N = 6$). For Red-tailed Hawks monitored for at least 30 d ($N = 3$), modified minimum area home ranges (Harvey and Barbour 1965) were 0.46–4.00 km².

DISCUSSION

Five (55%) of released rehabilitated raptors (one Red-shouldered Hawk and four Red-tailed Hawks) successfully acclimated after release based on mortality studies that show Red-tailed Hawks die within two–three wk without food (J. C. Dobbs, Univ. Calif., Davis, pers. comm.); however, the Red-shouldered

dered Hawk was sufficiently debilitated to require veterinary care 59 d post-release. One released hawk died. Ultimate status of the remaining three Red-tailed hawks could not be assessed.

Except for two Red-tailed Hawks, all released, rehabilitated hawks remained near release sites for the first few days. Lack of muscle tone due to captivity could have limited early activities (Servheen and English 1976, 1979), as activity range eventually increased. Additionally, unfamiliarity with release area and pre-release feeding may have affected post-release hunting behavior.

Duke et al. (1981) noted that season of release had a marked effect on average movements of rehabilitated hawks. Hawks released during migration periods were recovered at much greater distances from their release site (\bar{x} = 486 km) than were hawks released during nonmigratory periods (\bar{x} = 23.4 km). Migratory urge may have been the impetus for hawk No. Nine to leave the area immediately after release on 13 April 1986. Harlan's Hawks breed in Alaska and some parts of Canada (Mindell 1983), winter in the south-central United States (Mindell 1985) and rarely remain past late March in Louisiana (Lowery 1974).

Hawk No. Six encountered a resident Red-tailed Hawk that was apparently defending a territory (Janes 1984). Territorial attacks from resident hawks could also be responsible for dispersal of rehabilitated birds from release sites and could potentially affect the fate of introduced rehabilitated raptors. Release of rehabilitated raptors during fall and winter when territorial defense may be less intense (Craighead and Craighead 1956) could reduce intraspecific conflicts. Additionally, fall and winter releases of rehabilitated migrant raptors would allow time for birds to strengthen and hone hunting skills before migrating. Redig and Duke (1978), however, advocate release of rehabilitated raptors as soon as birds are medically and physically fit, unless adverse weather conditions exist (e.g., winter in northern climates). Retention of rehabilitated hawks for extended periods in captivity could increase vulnerability of birds at release (Duke et al. 1981).

Short reception ranges of lighter transmitters rendered long-term contact with released birds impossible. Signal range (100–700 m) was less than most movements recorded and much less than the advertised range (1.6–2.4 km). Reduced transmission range was partially an artifact of forested habitats used by released raptors as heavy foliage attenuates signal

strength (Cochran 1980). Longer range transmitters would be especially important for investigation of woodland raptor species, such as Red-shouldered hawks and Great-horned and Barred Owls (Oberholser 1938; Lowery 1974).

Range of larger transmitters (approximately 10 km) used with six of the rehabilitated Red-tailed Hawks was much greater. Nonetheless, contact was lost with five birds. Loss of contact may not have been due to monitored raptors leaving the area but could have been due to transmitter failure or impairment. Great-horned Owls will remove transmitter antennas while preening which results in greatly reduced transmitter range (P. J. Zwank, unpubl. data).

Hurricane Juan (25–31 October 1985) could have contributed to the death of hawk No. Four. Adverse weather may also have been responsible for loss of contact with hawk No. Five (28 October). Newton (1979) stated that adverse weather can increase mortality rates among raptors because food requirements for individual birds may increase while the bird's ability to procure food is hampered. Additionally, a raptor's susceptibility to disease also increases with bad weather (Newton 1979).

What prolonged effect various injuries had on survival or behavior of birds could not be assessed. Prey capturing proficiency of Red-tailed Hawk No. Four with a forward toe missing may have been impaired; however, Servheen and English (1976) suggested that as long as no more than two forward toes were missing on released rehabilitated Bald Eagles (*Haliaeetus leucocephalus*), survival should not be adversely affected. Ingram (1983) speculated that birds with only one eye could be released and survive if given an adequate chance during captivity to adjust to loss of depth perception based on the release and survival of a one-eyed Golden Eagle (*Aquila chrysaetos*). Red-tailed Hawk No. Four was often observed landing accurately on perches during the two wk following release and apparently had adjusted to loss of depth perception.

The Red-shouldered Hawk was not released any closer to a residential area than any of the other hawks but was the only individual to remain in and around a suburban community. The bird had developed skills to survive in the wild; unfortunately, the conspicuous soaring and perching habits of many raptor species make them especially vulnerable to human persecution (Newton 1979). We suggest releasing rehabilitated raptors in localities where hu-

man encounters would be the least frequent in order to increase chance of survival.

McCrary (1981) considered transmitter weight the most important factor in a telemetry study, and transmitter packages on Red-shouldered Hawks that were 4.5% or less of body weight caused no noticeable effects. Dunstan (1977) determined that transmitters weighing 6% of body weight can be tolerated by most raptors. In our study U.S. Fish and Wildlife Service authorization limited transmitter weight to 3% or less of body weight on all rehabilitated hawks. We did not notice any adverse effect due to the transmitter package and have no reason to suspect that transmitter weight adversely impacted released birds.

ACKNOWLEDGMENTS

Project funding was by Louisiana Department of Wildlife and Fisheries and the School of Veterinary Medicine, Louisiana State University. Research was conducted under the auspices of the Louisiana Cooperative Fish and Wildlife Research Unit (USFWS) and the School of Veterinary Medicine, Louisiana State University.

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Received 15 March 1987; accepted 2 November 1987