

## MORBIDITY, SURVIVAL AND PRODUCTIVITY OF REHABILITATED PEREGRINE FALCONS IN THE UPPER MIDWESTERN U.S.

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**ABSTRACT.**—We examined morbidity, survival and breeding success of 168 free-ranging, midwestern Peregrine Falcons (*Falco peregrinus*) submitted to The Raptor Center, University of Minnesota, for veterinary care during 1986–94. Field data and returns of banded birds were used to compare postrelease survival and productivity of rehabilitated Peregrine Falcons to survival and productivity of nonrehabilitated wild peregrines. Falcon morbidity and treatment outcomes were analyzed from medical records. Approximately 81% ( $N = 137$ ) of Peregrine Falcons suffered traumatic injuries consisting of fractures, dislocations and soft tissue trauma. Most injuries were caused by collisions with buildings, motor vehicles and utility lines. Forty-one percent ( $N = 66$ ) of 161 Peregrine Falcons were successfully treated, rehabilitated and released into the upper Midwest. Minimum estimated survival rates of rehabilitated peregrines were approximately 20% for  $\geq 3$  mo and nearly 14% ( $N = 9$ ) for  $\geq 1$  yr. The 1-yr estimated minimum survival rate was similar to that of banded, nonrehabilitated peregrines from the same population. Over 10% ( $N = 7$ ) of rehabilitated Peregrine Falcons formed territorial pairs, and 6% ( $N = 4$ ) nested, producing 24 fledglings over 1–5 yr. Mean brood size at fledging was 3.0 young, similar to the average brood size of successful peregrine pairs throughout the Midwest. This study demonstrates that, with proper veterinary care and physical conditioning, some injured Peregrine Falcons can be restored to good health and compete successfully in the wild. Rehabilitation of endangered raptors may enhance population growth during early stages of species recovery.

**KEY WORDS:** *Peregrine Falcon; Falco peregrinus; morbidity; survival; productivity; rehabilitation effectiveness; U.S.A.*

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Morbidoso, supervivencia, y productividad de *Falco peregrinus* rehabilitados en el oeste del medio, Estados Unidos

**RESUMEN.**—Nosotros examinamos morbilidad, supervivencia, y éxito de cría en 168 *Falco peregrinus* admitidos al Centro de Rapace en la Universidad de Minnesota, con atención veterinario durante 1986–94. Datos del campo en pajaros marcados que regresaron fueron usados para comparar la supervivencia y productividad de *Falco peregrinus* rehabilitados contra la supervivencia y productividad de *Falco peregrinus* no rehabilitados. Los resultados del halcon muertos por enfermedades y tratamiento fueron analizados de registros medicos. Aproximadamente 81% ( $N = 137$ ) de *Falco peregrinus* sufrieron herida traumáticas consistiendo de fracturas, dislocada y trauma de tejido tierno. La mayoría de herida fueron causados en colisiones con edificios, coches y línea de servicio. Cuarenta y uno porcentaje ( $N = 66$ ) de 161 halcones fueron tratados, rehabilitados y libertados dentro de el oeste del medio. La frecuencia de supervivencia estimada mínima de halcones rehabilitados fueron aproximados 20% para  $\leq 3$  meses y case 14% ( $N = 9$ ) para  $\geq 1$  año. La frecuencia de supervivencia estimada mínima por el año fue parecido como los halcones marcados no rehabilitados en la misma población. Arriba de 10% ( $N = 7$ ) de halcones rehabilitados formaron pares territorial, y 6% ( $N = 4$ ) hicieron nido, produciendo 24 pajaritos en 1–5 años. El promedio de la cría fue 3.0 juvenes, parecido el éxito de promedio en crías de pares de halcones en todas partel de oeste de medio. Este estudio mostro que, con atención veterinario y condicionamiento físico unos halcones pueden estar restaurados ha buena salud y competir con éxito en el monte. Rehabilitación de rapace en peligro de ser extinto puede mejorar el crecimiento de población durante los primer pasos de recuperación de la especie.

[Traducción de Raúl De La Garza, Jr.]

Peregrine Falcon (*Falco peregrinus*) restoration in the midwestern U.S. began with the release of eight juvenile falcons in 1977–78 by The Peregrine Fund. The goal was to reestablish 40–60 breeding pairs that had been extirpated within the upper Mississippi valley and western Great Lakes region (Redig and Tordoff 1988a). Although peregrine releases were terminated due to Great Horned Owl (*Bubo virginianus*) predation, they were resumed in 1982 under the Midwest Peregrine Falcon Restoration Project. Together with independent releases in Ontario and Manitoba, this project has produced a self-sustaining Peregrine Falcon population that, by 1994, numbered 62 territorial pairs, 51 of which nested and fledged 116 young (Redig and Tordoff 1994).

The Raptor Center (TRC) at the University of Minnesota has supplied veterinary medical care for the Midwest Peregrine Falcon Restoration Project as part of its raptor rehabilitation program. A primary assumption of raptor rehabilitation is that a significant percentage of released birds will survive and enter the breeding population (Martell et al. 1991). Limited data on longevity and breeding success of rehabilitated raptors have come from band returns (Duke et al. 1981, Redig and Duke 1995) and from a few studies of radiotagged birds (Hamilton et al. 1988, Martell et al. 1991, Csermely and Corona 1994). However, there have been no comprehensive studies comparing postrelease viability of rehabilitated raptors with that of nonrehabilitated wild birds (Redig and Duke 1995).

Since 1982, all captive-bred Peregrine Falcons released in the upper Midwest, and the majority of wild-produced midwestern peregrines, have been marked with individually-coded, anodized aluminum and colored leg bands. This banding program and extensive field observation has led to the identification of >90% of the breeding population of midwestern peregrines, including some rehabilitated birds. In this paper we explore the effectiveness of Peregrine Falcon rehabilitation by examining morbidity, survival and breeding success of 168 midwestern peregrines admitted to TRC from 1986–94. Peregrine Falcon morbidity and treatment outcomes were analyzed from medical records. Data from sightings and band returns were used to compare postrelease survival and productivity of rehabilitated peregrines with survival and productivity of nonrehabilitated wild peregrines. This study has implications for conservation of

free-ranging raptors, particularly endangered species in early stages of recovery.

#### STUDY AREA AND POPULATION

The expanding midwestern peregrine population occupies a region from southern Manitoba to central Missouri, and from eastern North Dakota to eastern Ohio. Approximately 70% of the breeding population inhabits urban or semiurban areas, nesting on tall buildings, bridges and smokestacks. This distribution is markedly different from that of the original midwestern peregrines, which, prior to their disappearance in the 1950s, nested on lowland cliffs along the Mississippi River and its tributaries (Redig and Tordoff 1994). Although Peregrine Falcons have recolonized natural cliffs along the shores of Lake Superior and Michigan's upper peninsula, they have not reclaimed their original habitat along the Mississippi. This is thought to be due largely to predation by Great Horned Owls (Tordoff and Redig 1988).

Demographic parameters of midwestern Peregrine Falcons are similar to those reported for other populations of this species. Moen and Tordoff (1993) estimated mean ages of first breeding for midwestern peregrines of 2.4 yr for males and 1.8 yr for females. Approximately 75% of all observed nesting attempts in the Midwest produced fledglings, averaging 2.1 fledglings per attempt. The sex ratio of wild-hatched peregrines was 1:1. Estimated annual survival of adult midwestern peregrines was 83%, with survival of adult females slightly greater than that of adult males. Estimated survival of first-year peregrines was 33–43% (Moen and Tordoff 1993).

Redig and Tordoff (1994) documented 281 cases of morbidity and mortality among Peregrine Falcons in the upper Midwest. Collisions with buildings, motor vehicles and utility lines accounted for nearly 50% of all injuries and deaths of known cause. Additional hazards included aircraft collisions (including one falcon that survived bilateral wing amputation by an airplane propeller), building entrapment, starvation and disease, avicide poisoning, owl depredations and territorial conflicts.

#### MATERIALS AND METHODS

Midwestern peregrines were treated for a variety of medical emergencies. Patients were initially evaluated by body weight measurement, physical examination, survey radiographs and blood analysis. Time and location of rescue and any preexisting treatments were noted. Seriously ill birds received intravenous or subcutaneous fluids (lac-

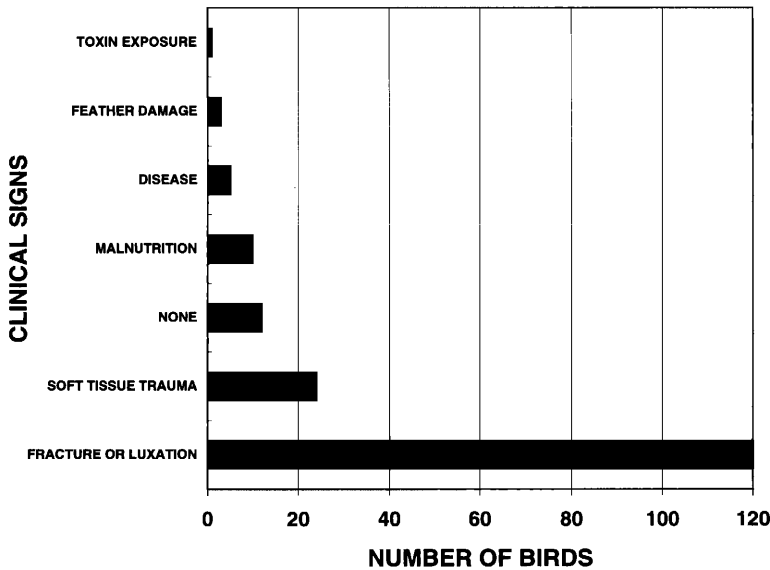


Figure 1. Primary clinical signs in free-ranging Peregrine Falcons received at The Raptor Center, University of Minnesota, 1986–94.

tated Ringer's solution) mixed with B-complex vitamins and dexamethasone. This was followed by intramuscular injection of iron dextran and antibiotics. These procedures were generally done under isoflurane anesthesia. Wounds were treated by removing dead tissue and irrigating with a warm, dilute solution of povidone iodine in saline. Feathers were plucked around wounds and a semi-permeable dressing was applied. Limb fractures were temporarily immobilized by bandaging and splinting, and a tail sheath was applied to minimize feather breakage. Patients were housed in a warm, dark cage, and were supported as necessary with fluids, steroids, antibiotics and wound treatment. Once stabilized, patients were fed skinned cut-up quail or rat, which is nutritious and devoid of indigestible feathers and fur (Redig 1993).

Most fractures were surgically repaired, except closed midshaft fractures of the ulna and metacarpal bones, which were stabilized by bandaging and splinting. Preoperatively, the surgical site was aseptically prepared by removing feathers (except the large flight feathers attached to the ulna and metacarpal bones), irrigating with sterile saline and scrubbing with povidone iodine (Redig 1993). Fractures were repaired by external fixation or by intramedullary pinning, stabilized as needed with cerclage wire and bone cement (Redig 1986). Repaired fractures usually required bandaging until a fibrous callus formed at about 3 wk. Soft tissue surgeries were generally limited to cleansing and suturing of wounds caused by trauma.

Patients were kept singly in padded cages (dimensions approximately 50 x 50 x 70 cm) and were fed quail or rat with water provided *ad libitum*. Bandages were changed 2–3 d after surgery to look for signs of infection, and again at the end of the second wk to start passive physical therapy. Postoperative radiographs were gener-

ally made during the third wk after surgery. Surgical fixation was removed once there was radiographic evidence of a well-mineralized callus, usually about 5–6 wk after surgery (Redig 1993).

Once fractures and soft tissues had healed adequately, birds were given limited flight exercise in an inside corridor. Patients progressing well at this stage were moved to a small flight room. Flight conditioning continued for several wk according to established protocols (Chaplin et al. 1993), first indoors and later outside on a nylon creance attached to jesses. Some birds were flown by conventional falconry methods. Peregrines were released, mostly in cities, when progress was satisfactory and when environmental conditions were favorable. Territorial birds were released at their nest sites if there was no evidence of replacement, whereas juveniles were generally rehacked. In one case, a juvenile peregrine was repatriated with its parents that were still on territory in mid-November.

#### RESULTS

Birds  $\leq 1$  yr of age comprised 77% ( $N = 124$ ) of 161 peregrines for which age estimates were available. Males ( $N = 84$ ) slightly outnumbered females ( $N = 77$ ), not a statistically significant difference from 1:1. Seventy-five percent (124 of 166 peregrines) were admitted during summer and early fall, with peak admissions occurring in mid-July to mid-August and mid-September to mid-October. Approximately 81% ( $N = 137$ ) of peregrines suffered traumatic injuries consisting of fractures, dislocations and soft tissue trauma (Fig. 1). Nearly

Table 1. Distribution of fracture types among injured Peregrine Falcons received at The Raptor Center, University of Minnesota, 1986–94.

FRACTURE TYPE	NUMBER OF BIRDS	PERCENT
Radius and/or Ulna	33	30.0
Humerus	23	20.9
Carpometacarpus	14	12.7
Coracoid	7	6.4
Mandible	7	6.4
Femur	6	5.5
Tibiotarsus	6	5.5
Tarsometatarsus	5	4.5
Scapula	3	2.7
Pelvis	3	2.7
Digit	2	1.8
Keel	1	0.9
TOTAL	110	100.0

64% ( $N = 70$ ) of 110 fractures involved wings, while leg and digital fractures accounted for 17% ( $N = 19$ ) (Table 1). Seven percent ( $N = 12$ ) of peregrines were admitted without any clinical signs other than being recovered on the ground. These birds, mostly fledglings, were apparently unhurt or were suffering mild trauma after colliding with buildings or being harassed by aggressive older peregrines.

Forty-one percent (66 of 161 peregrines) were successfully treated and released after an average

rehabilitation of 103 d (range 1–692). Approximately 45% ( $N = 72$ ) died or were euthanized, and 14% ( $N = 23$ ) were permanently disabled and placed in zoos, research facilities or breeding programs. These figures are similar to mortality and release rates reported for other species of raptors treated at TRC (Duke et al. 1981, Martell et al. 1991).

Of 66 peregrines rehabilitated and released from 1986–94, 74% ( $N = 49$ ) were first-year birds. Sightings and band returns yielded minimum post-release survival estimates for 13 falcons, 12 of which were from urban locations (Table 2). Approximately 20% ( $N = 13$ ) were known to have survived  $\geq 3$  mo after release, while nearly 14% ( $N = 9$ ) were resighted or readmitted after  $\geq 1$  yr. One bird was still alive after  $>5$  yr. Over 10% ( $N = 7$ ) of rehabilitated peregrines formed territorial pairs, and 6% ( $N = 4$ ) nested, three of which fledged a total of 24 young over 1–5 yr. Average brood size at fledging was 3.0 young.

#### DISCUSSION

A large majority of Peregrine Falcons admitted for medical treatment were first-yr birds recovered in urban areas. Most had traumatic injuries acquired soon after fledging or during fall migration. The prevalence of injuries in young peregrines is not surprising, considering the high level of performance required for independence. Within a few wk of fledging, juvenile peregrines must become

Table 2. Injuries, treatments, and postrelease survival of 13 free-ranging Peregrine Falcons rehabilitated at The Raptor Center, University of Minnesota, 1986–94. Twelve falcons were from urban sites.

BAND #	AGE	SEX	INJURY	TREATMENT	SURVIVAL	COMMENTS
576-87052	$\leq 1$	M	Metacarpal fracture	Supportive	$\geq 36$ mo	Paired 1988–90
816-21950	Ad	M	Metacarpal fracture	Supportive	$\geq 63$ mo	13 fledglings 1992–96
2206-13731	Ad	M	Metacarpal fracture	Supportive	$\geq 8$ mo	2nd injury
816-21983	$\leq 1$	M	Ulnar fracture	Supportive	3 mo	Fatal car collision
2206-25401	$\leq 1$	M	Radial fracture	Supportive	$\geq 22$ mo	3 fledglings 1996
2206-13771	$\leq 2$	M	Radial-Ulnar fracture	Euthanized		2nd injury
2206-13731	$\leq 1$	M	Humeral fracture	Surgery	$< 1$ mo	1st injury
877-42531	$\leq 1$	F	Humeral fracture	Surgery	$\geq 12$ mo	1st injury, paired 1988
2206-13872	$\leq 1$	M	Humeral fracture	Surgery	$\geq 12$ mo	
2206-13855	$\leq 1$	M	Tibiotarsal fracture	Supportive	$\geq 34$ mo	0 fledglings 1994
2206-18507	$\leq 1$	M	Metatarsal fracture	Surgery	$\geq 15$ mo	Paired 1995
2206-13771	$\leq 1$	M	Coracoid fracture	Surgery	$> 13$ mo	1st injury
877-42531	Ad	F	Soft tissue trauma	Supportive	Unknown	2nd injury
987-20796	$\leq 2$	F	Soft tissue trauma	Supportive	$\geq 22$ mo	8 fledglings 1992–93
2206-13809	$\leq 2$	M	Soft tissue trauma	Supportive	3 mo	Found dead
816-58295	$\leq 1$	M	Feather damage	New primaries	$\geq 6$ mo	

skilled aerial hunters while coping with a multitude of natural and artificial hazards, including strong and unexpected wind gusts, tinted and mirrored glass buildings and human disturbance (Cade and Bird 1990). This supports previous work showing collisions with manmade objects are the leading cause of injury and death among midwestern peregrines (Redig and Tordoff 1994).

A few midwestern peregrines have been injured or killed in territorial conflicts. In 1995, a nine-year-old Minneapolis falcon was found dead in her nest box from wounds inflicted by an adult female from a nearby territory who took her place (Redig and Tordoff 1995). Fatal combat between territorial birds was observed also at two other midwestern sites. And at a site in Wisconsin, a second-year male killed two of its offspring in aerial attacks (Redig and Tordoff 1988b). Despite these hazards, the longevity of some individual urban peregrines along with their continued population growth in cities, attests to the adaptability of this species and the overriding importance of prey and nest-site availability (Cade and Bird 1990).

Data were obtained on postrelease survivorship of 13 Peregrine Falcons encompassing 16 separate medical emergencies. Small sample size and the irregular nature of postrelease data recovery limit conclusions about the relationship of injury type to survival of rehabilitated peregrines. Injuries occurred to all major parts of the skeleton, and survivors were represented among nearly all injury categories.

The minimum estimated survival rate of released, rehabilitated peregrines in the Midwest was approximately 14% for  $\geq 1$  yr. This was comparable to the 10–11% resighting rate reported for banded, nonrehabilitated peregrines from the same population, both in southern Canada (Holroyd and Banasch 1990) and in the upper midwestern U.S. (Moen and Tordoff 1993). Territorial pair formation by >10% of rehabilitated peregrines in our study, and reproduction by three falcons (one for 5 yr), demonstrates that, even after serious injury, some Peregrine Falcons can be restored to good health and compete successfully in the wild.

Between 1986–94, The Midwest Peregrine Falcon Restoration Project produced a total of 1048 fledgling peregrines (Redig and Tordoff 1994). Sixty-four percent ( $N = 673$ ) were reared in captivity and released by hacking, and 36% ( $N = 375$ ) were fledged by wild nesting pairs. Excluding a few peregrines that may have originated outside the

Midwest, TRC received 16% and rehabilitated >6% of the total midwestern Peregrine Falcon population during this period. The finding that released, rehabilitated peregrines had normal survival rates, and that some birds formed pairs and raised young, suggests that raptor rehabilitation efforts were moderately beneficial to Peregrine Falcon restoration in the Midwest.

Within a few yr, the midwestern peregrine population should reach carrying capacity. Already there is evidence of stability in urban nest territories typical of established populations (Redig and Tordoff 1994). In Minneapolis-St. Paul, Minnesota, four falcon territories have been occupied continuously for >8 yr, despite turnover of individual resident birds. While reproduction and survival of Peregrine Falcons in the Midwest are now substantially greater than adult mortality, new territories are being established at only a moderate pace. An expected outcome is that the population of nonterritorial peregrines will expand, leading to increased competition for nest territories and quicker replacement of lost breeders (Redig and Tordoff 1994). Should this occur, survival and breeding of rehabilitated peregrines, as well as that of wild nonrehabilitated falcons, will decline as competition for suitable territories and mates intensifies.

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#### LITERATURE CITED

- CADE, T.J. AND D.M. BIRD. 1990. Peregrine Falcons, *Falco peregrinus*, nesting in an urban environment: a review *Can Field-Nat.* 104:209–218.
- CHAPLIN, S.B., L.R. MUELLER AND L.A. DEGERNESS. 1993. Physiological assessment of rehabilitated raptors prior to release. Pages 167–173 in P.T. Redig, J.E. Cooper, J.O. Remple, D.B. Hunter and T. Hahn [Eds.], *Raptor biomedicine*. Univ. Minnesota Press, Minneapolis, MN U.S.A.
- CSERMELY, D. AND C.V. CORONA. 1994. Behavior and activity of rehabilitated buzzards (*Buteo buteo*) released in northern Italy. *J. Raptor Res.* 28:100–107.
- DUKE, G.E., P.T. REDIG AND W. JONES. 1981. Recoveries and resightings of released rehabilitated raptors. *Raptor Res.* 15:97–107.

- HAMILTON, L.L., P.J. ZWANK AND G.H. OLSEN. 1988. Movements and survival of released, rehabilitated hawks. *J. Raptor Res.* 22:22-26.
- HOLROYD, G.L. AND U. BANASCH. 1990. The reintroduction of the Peregrine Falcon, *Falco peregrinus anatum*, into southern Canada. *Can. Field-Nat.* 104:203-208.
- MARTELL, M., P. REDIG, J. NIBE, G. BUHL AND D. FRENZEL. 1991. Survival and movements of released rehabilitated Bald Eagles. *J. Raptor Res.* 25:72-76.
- MOEN, S.M. AND H.B. TORDOFF. 1993. The genetic and demographic status of Peregrine Falcons in the upper Midwest. Prep. for USDA Fish and Wildlife Service and Minnesota Department of Natural Resources, Nongame Wildlife Program. Bell Museum of Natural History, Univ. Minnesota, St. Paul, MN U.S.A.
- REDIG, P.T. 1986. Basic orthopedic surgical techniques. Pages 596-598 in G. Harrison and L. Harrison [EDS.], *Clinical avian medicine and surgery*. W.B. Saunders Co., Philadelphia, PA U.S.A.
- . 1993. *Medical management of birds of prey: a collection of notes on selected topics*. 3rd ed., revised. The Raptor Center, Univ. Minnesota, St. Paul, MN U.S.A.
- AND G.E. DUKE. 1995. The effect and value of raptor rehabilitation in North America. *Trans. 60th No. Am. Wildl. & Nat. Res. Conf.*:162-172.
- REDIG, P.T. AND H.B. TORDOFF. 1988a. Peregrine Falcon reintroduction in the upper Mississippi valley and western Great Lakes region. Pages 559-563 in T.J. Cade, J.H. Enderson, C.G. Thelander and C.M. White [EDS.], *Peregrine Falcon populations: their management and recovery*. The Peregrine Fund, Inc., Boise, ID U.S.A.
- . 1988b. Midwest Peregrine Falcon restoration project report. Univ. Minnesota, St. Paul, MN U.S.A.
- . 1994. Midwest Peregrine Falcon restoration project report. Univ. Minnesota, St. Paul, MN U.S.A.
- . 1995. Midwest Peregrine Falcon restoration project report. Univ. Minnesota, St. Paul, MN U.S.A.
- TORDOFF, H.B. AND P.T. REDIG. 1988. Dispersal, nest site selection, and age of first breeding in Peregrine Falcons released in the upper Midwest, 1982-1988. *Loon* 60:148-151.

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