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SURVIVAL AND MOVEMENTS OF IMMATURE BALD EAGLES FLEDGED IN NORTHERN CALIFORNIA

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ABSTRACT.—We studied survival and movements of 13 radiotagged immature Bald Eagles (*Haliaeetus leucocephalus*) fledged in 1989 and 1990 from nests at Lake Britton in northcentral California. Initial observations were consistent with a previously-described postfledgling northward migration into Canada and Alaska. First-year eagles returned to northern California between January and May of the following year and moved extensively in the general region of northcentral California. Of the two cohorts, 10 birds were located within a year of fledging for a minimum first-year survivorship of 76.9%. Seven eagles returned to our study area. Five of these birds returned briefly to their natal territories. Three of 10 returning birds were not observed again in our study area but were recorded infrequently at distances of 50–190 km outside the study area. Two different movement patterns emerged within the 10 returning birds: five birds showed a high degree of affinity to the study area and five did not. In their second year of life, radiotagged immatures showed less affinity for our study area during late summer and fall. We could not determine if this disappearance indicated a regular or repeated migration, or merely an increased tendency to wander.

KEY WORDS: *Bald Eagle*; Haliaeetus leucocephalus; *movements*; *survival*; *mortality*; *radiotelemetry*; *California*.

Sobrevivencia y movimientos de juveniles de águilas calvas del norte de California

RESUMEN.—Estudiamos la sobrevivencia y movimientos de 13 águilas calvas juveniles (*Haliaeetus leucocephalus*) dotados de radiotransmisores nacidas en 1989 y 1990 en nidos del lago Britton en el centro-norte de California. Las observaciones iniciales fueron consistentes con la migración norte previamente descrita hacia Canadá y Alaska. El primer año las águilas regresaron al norte de California entre enero y mayo del año siguiente y se movilizaron extensivamente en la región centro-norte de California. De las dos cohortes, 10 aves fueron localizadas al año de haber nacido, para un mínimo de sobrevivencia del 76.9%. Siete águilas regresaron a nuestra área de estudio. Cinco de estas aves regresaron brevemente a sus territorios de natalidad. Tres de 10 aves que regresaron no fueron observadas nuevamente en nuestra área de estudio pero si infrecuentemente a distancias entre 50–190 km por fuera del área de estudio. Dos patrones distintos de movimientos emergieron a partir de las 10 aves que regresaron: cinco aves mostraron un alta afinidad al área de estudio y cinco no. En el segundo año de vida, los juveniles con radiotransmisores mostraron una afinidad menor al área de estudio durante el verano y el otoño. No pudimos determinar si esta ausencia indicó un repetido patrón de migración o si era una tendencia a deambular.

[Traducción de César Márquez]

Since Broley's (1947) pioneering studies of eaglet movements from Florida, various researchers have studied Bald Eagle (*Haliaeetus leucocephalus*) movements across North America (e.g., Southern 1963, Gerrard and Bortolotti 1988, McClelland et al. 1994). Studies of Bald Eagle movements have focused on migration of adults between breeding and wintering grounds (Gerrard et al. 1978, Hodges et al. 1987, McClelland et al. 1994), movements within breeding or wintering grounds (Buehler et al. 1991a, Gerrard et al. 1992, Garrett et al. 1993, Harmata and Stahlecker 1993) and movements of nestlings from their natal territories (Broley 1947, Gerrard et al. 1974, Harmata et al. 1985, Hunt et al. 1992, McClelland et al. 1996). Eagle movements may be affected by a wide variety of biotic and abiotic factors, including the age of birds, the distribution and behavior of various prey species or the prevailing environmental conditions such as climate, topography, and latitude.

Breeding Bald Eagles in North America include resident and migratory populations, or a combination, in which some birds are migratory and others remain on breeding territories in winter. Newton (1979) believed that residency is the preferred condition when prevailing environmental conditions, principally food supply, allow for year-round occupancy of a nesting territory. Milder winter climates in lower latitudes of North America appear to provide conditions necessary for residency, whereas harsh winters of northern latitudes induce breeding eagles to migrate south in search of dependable food supplies. Residency for breeding pairs appears the norm in California (Jenkins and Jackman 1993), southern Oregon, Florida and Chesapeake Bay, Maryland (Buehler et al. 1991a). Migratory breeding populations probably occur in most of the Canadian provinces (Gerrard et al. 1978, Gerrard and Hatch 1983) and Alaska. Sherrod et al. (1976, Alaska) and Swenson et al. (1986, Greater Yellowstone) provided two examples where some breeding eagles move in winter and others do not.

Available information now suggests, in general, that eaglets that hatch in the southern latitudes of North America migrate north, while those that hatch in northern latitudes migrate south. Broley (1947) first discovered a northward migration of Bald Eagle fledglings from their Florida nest sites. Immature Bald Eagles from Saskatchewan migrate south and move throughout the midwestern U.S. (Gerrard et al. 1974). Bald Eagles hatched in Maine similarly moved south down the Atlantic seaboard (McCollough 1986). Five fledglings followed from our study area in northern California in the mid-1980s all migrated northward, and four of five continued to British Columbia or southeast Alaska (Hunt et al. 1992). Mabie et al. (1994) also reported a northern postfledging dispersal pattern of fledgling Bald Eagles from nests in Texas. Broley (1947) first suggested that these northward migrations allowed eaglets to reach runs of anadromous fish in rivers of the northern portion of the continent in summer and early fall.

In 1989 and 1990, we monitored the movements of two cohorts of six and seven nestlings, respectively, in our northern California study area. We assumed that these eaglets would undertake the previously discovered northward migration (Hunt et al. 1992) and made no attempt to follow them after their initial migration. Our objectives were to locate these birds following their return from their northern migration, determine first year survivorship and monitor movements into their second year of life.

STUDY AREA AND METHODS

The Pit River originates in Modoc County, drains much of northeastern California and is a major tributary of the Sacramento River system. The Pit River Study Area (PRSA) consists of 78 km of the Pit River in Shasta County. Lake Britton is the system's largest reservoir; it is approximately 13-km long and less than 1-km wide in most places, and has a surface area of approximately 520 ha. Lake Britton supported six occupied Bald Eagle nesting territories during the study period. Three additional small reservoirs, all less than 50 ha in surface area, are found downstream from Lake Britton; four Bald Eagle nesting territories occurred at these reservoirs.

Our study area included an intergradation of habitat types characteristic of Cascade and Sierra Nevada mountain regions. The area around Lake Britton is dominated by ponderosa pine (*Pinus ponderosa*) forest, which occurred as open stands ≤70 m in height (Holland 1986). Downstream from Lake Britton, the Pit River canyon, including the three downstream reservoirs, was dominated by Sierran mixed coniferous forest. This habitat was similar to ponderosa pine forest, but was denser, often slightly taller (75 m), and composed of several dominant species, including ponderosa pine, Douglas-fir (*Pseudotsuga menziesii*), incense-cedar (*Libocedrus decurrens*) and sugar pine (*Pinus lambertiana*).

Nestlings were radiotagged in 1989 and 1990 backpack style with teflon ribbons over and under the wings, secured on the breast with one or more stitches of cotton thread. The thread was designed to eventually deteriorate, allowing the transmitter package to fall off in 3–5 yr. Transmitters weighed 65 g with a battery life expectancy of approximately 1000 d. All 13 nestlings were tagged in nests at Lake Britton at 8–10 wk of age. All

Table 1. Movements of 10 Bald Eagles radiotagged as nestlings at Lake Britton in 1989 and 1990.

BIRD	DATE RADIOTAGGED AS NESTLING	DATE OF FIRST DETECTION[a]	TOTAL NUMBER OF DETECTIONS	NUMBER OF DETECTIONS IN STUDY AREA	GREATEST DISTANCE (km) FROM STUDY AREA
JM25[b]	19 May 89	6 Feb. 90	17	13	105NE
JM26	4 June 89	19 April 90	21	20	110NW
JF27[c]	4 June 89	21 Feb. 90	2	1	115N
JM28	10 June 89	20 Feb. 90	25	24	80S
JM30	11 June 89	29 March 91	1	0	130NE
JF31	24 May 90	8 March 91	11	6	160S
JF32	24 May 90	8 Feb. 91	2	0	90SW
JM34	1 June 90	5 Jan. 91	2	0	190NE
JF36	7 June 90	29 March 91	2	1	135SW
JM37	9 June 90	23 May 91	38	25	50SW

[a] Following initial migration.
[b] Male.
[c] Female.

eaglets were banded with standard USGS aluminum leg bands. Birds were sexed on the basis of morphometric measurements (Bortolotti 1984, Garcelon et al. 1985).

Radiotagged eagles were monitored weekly in the study area with a scanning receiver and hand-held two- and three-element Yagi antennae. Two-element antennae were mounted on the wing struts of a fixed-wing aircraft for covering larger geographic areas. We conducted weekly helicopter surveys from March 1983–December 1984 (Jenkins 1992) and again from July 1987–July 1991. The age of each observed eagle was classified as adult, near-adult, subadult or juvenile following age class descriptions of McCollough (1989). To assist in data interpretation, birds not appearing in adult plumage were grouped in a category called nonadults. In addition to weekly helicopter surveys, fixed-wing aircraft surveys were conducted in 1989–92 at about monthly intervals over northern California and southern Oregon, outside the Pit River study area.

RESULTS

Of the six fledglings radiotagged in 1989 at Lake Britton, four birds were located the following year and a fifth bird was located in 1991. Seven additional fledglings were radiotagged in 1990 and five of these were located in 1991. The survival rate was 76.9% (10 of 13) for the first year of life. Our survival rate is a minimum estimate, because it ignores possible transmitter loss or failure, the possibility that fledglings were missed on aerial surveys over northern California and southern Oregon or that some eagles never returned to the region.

All 13 radiotagged juvenile eagles departed the study area by 1 September of the fledging year. Of the four immature eagles from the 1989 cohort relocated in northern California in 1990, three were first located in February and one in April (Table 1). A fifth bird from this cohort was first located in March 1991. Five of the seven nestlings from the 1990 cohort were subsequently located in 1991. The first of these birds was found in southern Oregon on 5 January 1991. Others from the 1990 cohort were first located in February, March, and May 1991 (Table 1). Returning birds wandered throughout our study area, northern California and southern Oregon during the subsequent monitoring period (Fig. 1).

Seven of the 10 surviving eagles actually (both cohorts) returned to parts of the PRSA. Five of these birds returned briefly to their natal territories and other locations on Lake Britton. Two of seven birds that returned to the PRSA also subsequently wandered distances over 100 km outside the PRSA (Table 1). Three juveniles that were frequently recorded in the PRSA after their initial migration disappeared for a time in the summer and fall of their second year of life but were recorded again in the PRSA a few months later. Three surviving fledglings were not recorded in the PRSA despite weekly helicopter and periodic ground surveys. These three birds were recorded infrequently at distances of 50–190 km from the PRSA. In previous studies, we recorded a marked juvenile Bald Eagle from the PRSA subsequently establishing a nesting territory. This eaglet, originally banded in our study area in 1983 at Lake Britton, later was trapped as a breeding adult on Shasta Lake in 1990, a distance of about 55 km southwest of Lake

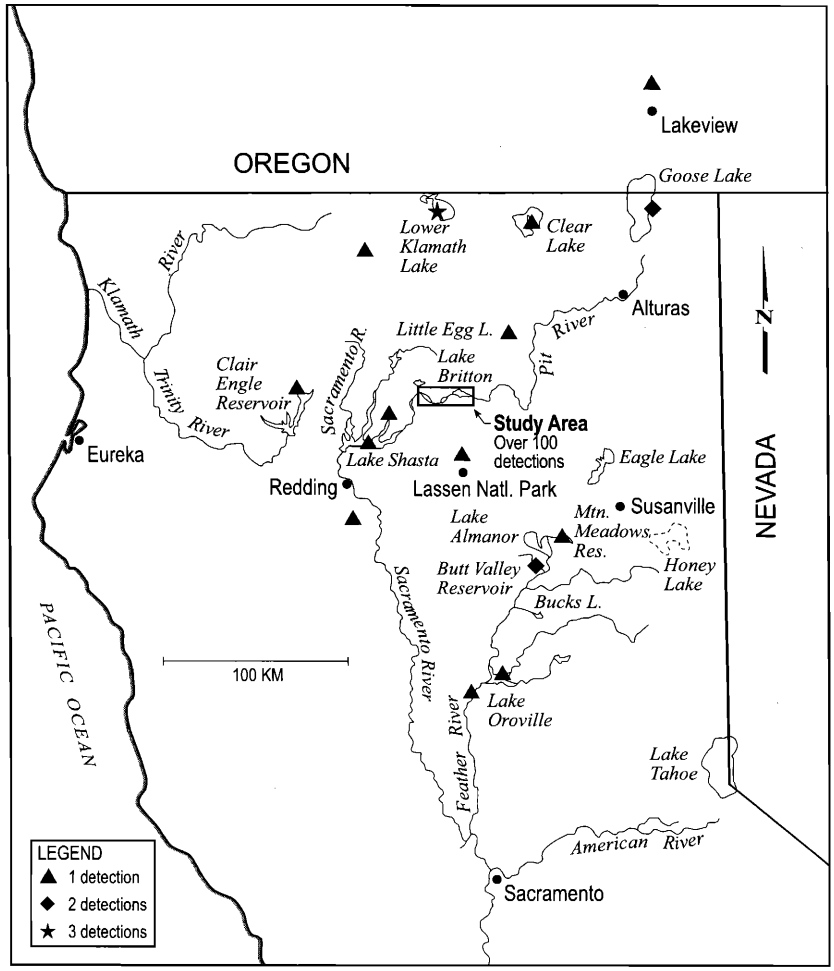

Figure 1. Locations throughout northern California of 10 radiotagged Bald Eagle nestlings fledged from nests at Lake Britton in 1989 and 1990.

Britton (Jenkins 1992). This is our only record of future breeding by a Bald Eagle fledged from our study area.

Based on weekly helicopter surveys, the total number of Bald Eagles recorded in nonadult plumage in the PRSA declined markedly during the late summer and fall but increased again beginning in December (Fig. 2). Three immature eagles radiotagged from PRSA nests visited the Klamath Basin in their second winter, about 100 air km from the PRSA. This area is one of the largest wintering congregations of Bald Eagles in the lower 48 states, supporting hundreds of migrant Bald Eagles which feed on migrating waterfowl.

DISCUSSION

McCollough (1986) estimated a minimum survival of first-year Bald Eagles in Maine of 54%, and a 73% survival for first-year birds when artificial feeding was provided. Gerrard et al. (1978) reported 37% first-year survival for 43 Bald Eagles wing-marked as juveniles in Saskatchewan. Sherrod et al. (1976) estimated that fewer than 10% of fledglings survived to breeding age on Amchitka Island, Alaska, and suggested that about 5.4% of the adult population died each year. Buehler et al. (1991b) recently estimated 100% survival for 39 radiotagged Bald Eagles through their first year of life in the Chesapeake Bay area. Similarly, Mc-

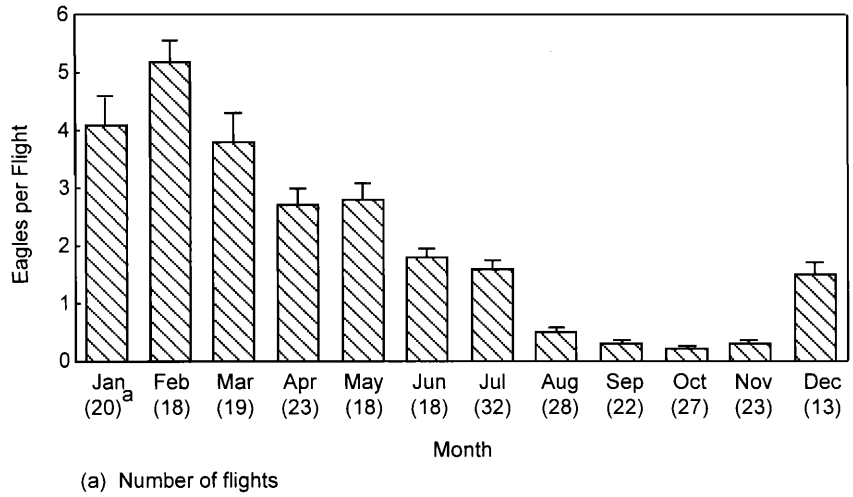

Figure 2. Mean number (±SE) of nonadult (immature, subadult and near adult) Bald Eagles recorded in weekly helicopter surveys of the PRSA, 1983–84 and 1987–91, shown by month.

Clelland et al. (1996) reported 10 of 11 (91%) juvenile Bald Eagles fledged from nests at Glacier National Park, Montana, surviving their first winter.

Our estimated survival rate of 76.9% (10 of 13) suggested a high degree of juvenile survival for the PRSA Bald Eagle population. Our survival estimate was consistent with the present growth of the breeding population of Bald Eagles in California. A population model recently reported by Jenkins (1996) using this value and an empirically-derived annual adult survival value of 94.6% indicates a 6–7% increase in the California breeding population, which is consistent with observed population growth during the past 15 yr (Jenkins et al. 1994).

It was unclear whether subadult eagles migrated like fledglings in their second and subsequent years. The number of nonadult birds in the PRSA was low from June through late summer and fall. It seemed likely that subadults had less affinity to the PRSA at this time of year, but it was not clear if this involved a regular and repeated migration or simply an increased tendency to wander. The fact that radiotagged eagles were not detected during fixed-wing aircraft surveys of larger areas of northern California, suggested that immature eagles undertook extensive movements during this period.

Our data indicated the movements of immature Bald Eagles were highly nomadic and variable with only some fledglings returning to their natal areas. The tendency of some birds to concentrate their movements around PRSA may have resulted from a sampling bias due to increased monitoring in the PRSA; subadult movements may have been even more extensive than indicated by our data. Extensive movements give subadults an opportunity to visit various water bodies across northern California and familiarize themselves with other breeding territories and potential habitat throughout the region.

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