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NORTHWARD POST-FLEDGING MIGRATION OF CALIFORNIA BALD EAGLES

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ABSTRACT.—We radiotracked five Bald Eagles (*Haliaeetus leucocephalus*) on migration from natal areas in northern California. All flights were northerly in direction and were probably aimed at salmon carrion associated with spawning runs in British Columbia and Alaska. Two migrating juveniles traveled northwest to the Pacific Ocean, then north along the coast, and three eagles migrated north along the crest of the Cascade Mountains. These observations indicate a functional migration with food as its target.

Migración hacia el norte de Águilas Cabeciblancas (*Haliaeetus leucocephalus*) jóvenes que dejan el nido, en California

EXTRACTO.—Hemos radiocontrolado cinco Águilas Cabeciblancas (*Haliaeetus leucocephalus*) jóvenes que han dejado el nido, en migración desde su área natal en California del norte. Todos los vuelos fueron en dirección norte, probablemente en busca de carroña de peces salmón que desovan en Colombia Británica y Alaska. Dos de estas águilas migrantes viajaron en dirección noroeste hacia el Océano Pacífico, y luego hacia el norte a lo largo de la costa; y las otras tres de ellas, migraron hacia el norte a lo largo de la cumbre de las montañas Cascade. Estas observaciones indican migraciones funcionales que tienen el alimento como objetivo.

[Traducción de Eudoxio Paredes-Ruiz]

A northward migration of post-fledging Bald Eagles (*Haliaeetus leucocephalus*) from temperate latitudes has been suspected since Broley (1947) reported recoveries of birds banded as nestlings in Florida appearing in the northeastern United States and Canada. Beebe (1974:44) suggested that juvenile Bald Eagles from southern British Columbia leave natal areas soon after fledging and travel to salmon spawning runs along the coastal rivers of northern Canada and Alaska. Similarly, Servheen and English (1979) speculated that young eagles moved north with adults to early salmon runs after leaving nests on Puget Sound, Washington, and that the timing of salmon spawning influenced eagle movement in the region. Hodges et al. (1987) demonstrated that post-fledging eagles remained on their natal Chilkat River in southeast Alaska until salmon availability declined in December; the eagles then migrated southward. We describe post-fledging local movements, departure, and migration of five juvenile Bald Eagles radiotagged as nestlings in California. Results are consistent with the hypothesis of a northward, post-fledging migration, presumably directed at post-spawn salmon carrion in British Columbia and Alaska.

METHODS

During 15–20 June 1984–86, we attached radiotransmitters to five nestling Bald Eagles (age 8–10 wk) in their nests in California; three along the Pit River near Fall River Mills (40° 59′N 121° 28′W) and two in the Eagle Lake vicinity (40° 33′N 120° 46′W) near Susanville. All nests were in ponderosa pine (*Pinus ponderosa*) forests near water. The birds wore back-pack style, 2-stage transmitters weighing 18–28 g, attached by 13 mm-wide teflon tubular ribbon. Ribbons were connected over the carina with cotton thread to permit eventual transmitter loss. We monitored pre-migratory behavior from the ground, and used fixed-wing aircraft to track eagles from their natal areas. Upon locating an eagle *en route*, we landed at airports ahead of the eagles' course to reduce air time. We followed them until adverse weather or lack of airports prevented further tracking.

For supplemental information on post-fledging behavior and departure, we radiotagged 11 additional nestlings and one fledgling in northern California (11 June to 25 July 1983–86) with back-pack or single-stage tail-mount transmitters (5 g, tied/glued to a single tail feather at least two-thirds emerged from sheath). We did not track the migrations of these 11 birds.

RESULTS AND DISCUSSION

In the weeks following fledging in July, we monitored activities of the radio-tagged juveniles. They tended to remain near natal nests during the first week and utilized mostly snags and nest trees for perching. The young eagles soon moved to nearby lakes or rivers within natal territories during the day, often returning to roost in the vicinity of the nest. Their parents, year-long residents in northern California, provided food throughout the post-fledging period, but juveniles occasionally found carrion, usually fish. Some eagles were more precocious than others in making their first flights and in venturing to other parts of the territories. At 14–16 wk, juveniles began soaring during mid-day for days or even weeks prior to departing unexpectedly. Pre-migratory soaring flights were local in nature; the eagles always returned to the territory on the same day. We made no attempts to locate the outer ranges of these pre-migratory flights.

Fifteen of 17 juvenile eagles departed from their natal areas from 19 July to 22 August ($\bar{x}$ = 2 August) at an average age of about 16 wk (range 14–17). Of the remaining two birds, one had radio failure and probably departed after 3 August; the other eagle died, apparently drowning after 17 August as a result of a wing injury. Using 12 wk as a standard fledging age, the interval between fledging and departure averaged 3.5 wk (range 2–5 wk). In contrast, post-fledging Bald Eagles marked in central Saskatchewan (Besnard Lake) initiated "oriented migratory movements," generally to the south, seven or eight wk after fledging in mid-August at age 12 or 13 wk (Gerrard et al. 1974). Maine juveniles dispersed 5 to 10 wk ($\bar{x}$ = 7 wk), after fledging at 11–13 wk, and apparently moved southwest along the Atlantic seaboard (McCollough 1986).

All five birds tracked on migration departed between 1130–1330 H. Four, whose roosting places were located, traveled an average of 157 km (range 87–203 km, straight line distances between nest area and roost site) on the day of departure (Table 1). The onset of the northward migration for the California juveniles was triggered by unknown causes. The apparent lack of carrion fish, previously abundant during the early nesting cycle, may have affected their attachment to natal areas. The southward migrations of young eagles described by Hodges et al. (1987) in southeast Alaska and Harmata et al. (1985) in central Saskatchewan were apparently influenced by the decline of foraging opportunities.

Routes selected by migrating eagles (Fig. 1) showed preferred directions (Baker 1984), although physiography modified actual course. Harmata et al. (1985) speculated that physiography facilitated navigation of juvenile Bald Eagles moving along a preselected compass direction. Eagles 1 and 2 migrated along the crest and western slopes of the Cascade Mountains, respectively. Eagles 3, 4, and 5 moved northwest until encountering the Pacific coast which they followed northward.

Occasional sightings of migrating eagles from both ground and aircraft indicated that they traveled alone, suggesting that migratory directions were genetically influenced. Interestingly, the migratory paths of sibling eagles 4 and 5 were far more similar than those of the other three eagles (Fig. 1). Directional or *route* programs might be encoded most similarly in the genes of close relatives and within demes. Geographic differences in natal origin would likely demand appropriate differences in migration strategies.

Overall, eagles following the coast traveled more slowly ($\bar{x}$ = 130 km/d, N = 14 d) than those following the mountains ($\bar{x}$ = 184 km/d, N = 21 d). Slower travel may have been due to prevailing headwinds and coastal fog preventing thermal activity needed for soaring. Eagle 4, for example, contended with fog and northerly winds along the Oregon coast and averaged only 89 km per day (Table 1). Its daily travel increased to 231 km in Washington where clearer skies and more favorable winds prevailed. Harmata (1984) reported an average migration rate of 180 km/d (range 33–435) for adult Bald Eagles on northward spring migration from the San Luis Valley of south-central Colorado; no movement occurred on overcast days or when winds exceeded 56 km/hr prior to 0900 H.

All five California eagles migrated during warm periods of the day. They departed their roost sites in late morning (typically 1000–1100 H) and usually stopped migrating about 1700–1800 H, a schedule that coincided with thermal activity. This pattern is consistent with behavior of the adult spring migrants from the San Luis Valley (Harmata 1984). Daily flights of two juvenile Bald Eagles departing their

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Table 1. Roosting locations of five radio-tagged juvenile bald eagles during their northward migrations from California. Locations in parentheses indicate that the eagle was still soaring when radiotracking was terminated that day (times given). Distances in parentheses are 2-d totals.

DATE	LOCATION (N LAT. W LONG.)	KM MOVED
Eagle No. 1 (1984)		
8/06	Pit River near Burney, CA (40°59′ 121°45′)	Nest
8/07	Klamath Marsh, OR (42°52′ 121°40′)	208
8/08	18 km NNE Mt. Jefferson, OR (44°49′ 121°42′)	216
8/09	35 km SW Cle Elum, WA (47°01′ 121°19′)	247
8/10	10 km W Princeton, BC (49°28′ 120°40′)	257
8/11	20 km ESE Williams Lake, BC (52°10′ 121°52′)	305
8/12	11 km WSW Prince George, BC (53°54′ 122°55′)	199
Eagle No. 2 (1984)		
7/23	Fall River Mills, CA (40°59′ 121°28′)	Nest
7/24	24 km E Klamath Falls, OR (42°13′ 121°28′)	137
7/25	Hills Creek Reservoir, OR (43°36′ 122°28′)	175
7/26	10 km E Crabtree, OR (44°39′ 122°46′)	119
7/27	Mount Saint Helens, WA (46°10′ 122°11′)	176
7/28	(Fairfax, WA at 1711 H) (47°01′ 122°01′)	>94
7/29	11 km SW Darrington, WA (48°12′ 121°43′)	134
7/30	near Princeton, BC (49°26′ 120°50′)	152
7/31	(N of Kamloops, BC at 1750 H)	>160
Eagle No. 3 (1985)		
7/30	Baum Lake, CA (40°55′ 121°31′)	Nest
7/31	Probably near Montague, CA	—
8/01	25 km SW Corvallis, OR (44°23′ 123°25′)	(418)
8/02	12 km NNE Manzanita, OR (45°48′ 123°52′)	160
8/03	NE Tokeland, WA (46°46′ 123°55′)	108
8/04	Near Quinalt River, WA (47°24′ 124°03′)	72
8/05	Cape Flattery, WA (48°23′ 124°43′)	120
Eagle No. 4 (1986)		
8/16	Eagle Lake, CA (40°33′ 120°46′)	Nest
8/17	10 km NW Fall River Mills, CA (41°04′ 121°33′)	88
8/18	8 km SW Cave Junction, OR (42°08′ 123°44′)	218
8/19	Cape Sebastian, OR (42°19′ 124°25′)	57
8/20	10 km S Port Orford, OR (42°41′ 124°26′)	39
8/21	3 km S Coos Bay, OR (43°21′ 124°24′)	76
8/22	13 km SE Florence, OR (43°54′ 123°59′)	69
8/23	?	—
8/24	11 km S France, WA (46°28′ 123°25′)	(291)
8/25	6 km SE Seiku, WA (48°13′ 124°15′)	204
8/26	16 km SE Kelsey Bay, BC (50°17′ 125°48′)	258
8/27	(19 km S Kingcome, BC at 1340 H) (50°47′ 126°04′)	>60
Eagle No. 5 (1986)		
8/22	Eagle Lake, CA (40°33′ 120°46′)	Nest
8/23	6 km W Callahan, CA (41°18′ 122°54′)	197
8/24	5 km E Brookings, OR (42°05′ 124°14′)	144
8/25	5 km E Gold Beach, OR (42°25′ 124°22′)	40
8/26	10 km E Port Orford, OR (42°46′ 124°22′)	41

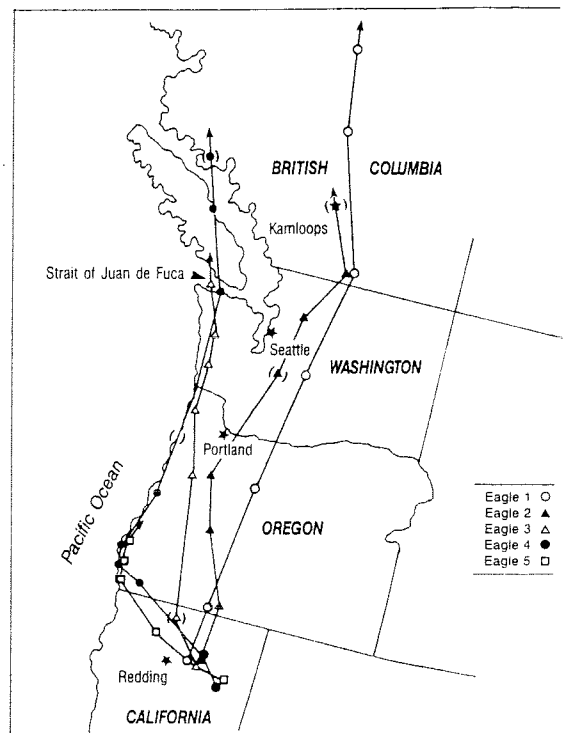

Figure 1. Roosting locations of five radio-tagged juvenile Bald Eagles during their northward migrations from California. Locations in parentheses indicate that when radiotracking was terminated for the day the eagle was still migrating (soaring). All eagles continued to migrate beyond the last point of detection.

natal Besnard Lake in central Saskatchewan were initiated between 1100–1300 H and terminated between 1400–1550 H (Harmata et al. 1985). The late morning timing for initiation of the eagles' daily migration contrasted with an adult, north-bound Arctic Peregrine Falcon (*Falco peregrinus*) in spring which began migrating each morning before dawn (W.G. Hunt, unpubl.).

The California juvenile eagles seemed to prefer wooded east-facing slopes for roosting, and mature conifers when available for perching. Eastern exposures were selected presumably because the sun would warm such terrain earlier the next morning and produce thermals. We estimated typical altitudes of migrants at 200–500 m above the terrain on clear, warm days. The altitude of migratory flights for migrating Saskatchewan juveniles reportedly ranged from 54–180 m, but weather conditions were mostly overcast (Harmata et al. 1985). We did not detect foraging activity along migration routes.

Eagle 1 departed after mid-day and roosted the first night at the Klamath Marsh, Oregon (Table 1). The mountainous route chosen by this bird continued along the ridge of the Cascades and passed close to the major peaks (Mt. Hood, Mt. Adams and Mt. Rainier). Five days after departure, Eagle 1's signal emanated from the heart of a significant thunderstorm near Princeton, British Columbia, and we last detected it at Prince George, British Columbia. Eagle 2 followed the western slope of the Cascades and was last detected on a 20° magnetic bearing from Kamloops Lake moving in the direction of a major thunderstorm.

Eagles 3, 4, and 5 migrated northwest to the Pacific Ocean and then north along the coast, although Eagle 3 reached the coastline further north than the others (Fig. 1). Eagles 3 and 4 roosted on the south shore of the Strait of Juan de Fuca, then crossed it the next morning. We lost contact with Eagle 3 in adverse weather after crossing the strait. Eagle 4 proceeded 258 km over the central mountains of Vancouver Island and reached the Strait of Georgia at Kelsey Bay, British Columbia. The next day we followed it across water to mainland British Columbia, but were obliged to turn back when the bird entered high mountains enshrouded in clouds. If the eagle maintained its course and speed it would have passed the Skeena River in the area of Terrace, British Columbia, the next afternoon, and by the following day it would have reached southeast Alaska. The region from the Skeena northwestward contains abundant salmon carrion from late July through October. Chum Salmon (*Oncorhynchus keta*) carcasses normally peak during the first week of August and Pink Salmon (*O. gorbuscha*) during the second and third weeks of August (K. Imamura, pers. comm.). Similarly, the courses of Eagles 1 and 2 would have taken them to salmon areas. From its last detection (12 August) at Prince George, British Columbia, Eagle 1 was in the vicinity of Stuart River tributaries, a part of the Frazer River system where spawning of a race of Sockeye Salmon (*O. nerka*) peaks in late July to early August (J. Adams, pers. comm.). Alternatively, Eagle 1 could have reached southeast Alaska within 2–3 d of its last radio detection.

Results on post-fledging movements of juvenile Bald Eagles presented here are evidence of a func-

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tional migration rather than dispersal. All eagles departed within a narrow time frame, traveled alone in the same direction, displayed strong course fidelity, and showed consistent daily activity patterns. Timing of migration coincided with the occurrence of salmon carrion in areas reached by the eagles within 1–2 wk after leaving natal sites. The paths of the five migrant juveniles suggested two routes to the northern salmon areas. Eagles 1 and 2 followed the Cascade Range into interior British Columbia; eagles 3, 4, and 5 flew northwestward to the coast and followed it northward. The mountain migrants moved faster but must have occasionally encountered extreme turbulence (thunderstorms). The coastal migrants moved slower, but were assured of reaching the salmon areas if they could survive a possible increase of migration time imposed by weather. Eagles apparently traveled without foraging or resting during the day, suggesting a substantial caloric reward at the final destination.

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