J Raptor Res. 30(2):79–89

FLEDGING AND MIGRATION OF JUVENILE BALD EAGLES FROM GLACIER NATIONAL PARK, MONTANA

B. RILEY MCCLELLAND,[1] PATRICIA T. MCCLELLAND[1] AND RICHARD E. YATES[2]
School of Forestry, University of Montana, Missoula, MT 59812 U.S.A.

ELAINE L. CATON[3] AND MARY E. MCFADZEN[4]
National Park Service, Glacier National Park, West Glacier, MT 59936 U.S.A.

ABSTRACT.—During 1985–95, we documented fledging, migration, and subsequent locations of juvenile bald eagles (*Haliaeetus leucocephalus*) from Glacier National Park (GNP), Montana. The median fledging date was 1 August ($N = 29$). We radiotagged 11 fledglings, nine of which also received wing markers. The median date of migration from natal areas was 13 September ($N = 15$). The interval between fledging and migration varied from 32 to 70 d (median = 42 d, $N = 15$). Juveniles appeared to migrate alone, joining other eagles at foraging sites. GNP adults remained on their nesting territories when juveniles departed. One juvenile wintered 130 km from GNP. Others migrated as far as 1000 km. Six migrated to southern Montana, Idaho, Wyoming, and California. Three moved west to Washington or British Columbia. Two juveniles from the 1988 Lake McDonald nest migrated separately to the Pacific Coast. By 1991, one Lake McDonald adult had been replaced; the juvenile produced that year migrated south to Idaho. This contrast suggests that juveniles inherited distinct migration direction "programs" from different parents. Early autumn migration departures of GNP juveniles also may be genetically determined; we found no evidence that they remained locally to feed on autumn spawning runs of kokanee salmon (*Oncorhynchus nerka*) in GNP. At least 10 of the 11 radio-tagged juveniles survived their first winter. During spring migration, four juveniles passed through or near GNP. Nine summering sites or last known spring locations were in Alberta or British Columbia, Canada. There is no evidence to date of marked juveniles returning to breed in GNP natal areas.

KEY WORDS: Haliaeetus leucocephalus; *bald eagle; fledging; Glacier National Park, Montana; migration; telemetry.*

Volantones y migración de individuos juveniles de *Haliaeetus leucocephalus* desde el Glacier National Park, Montana

RESUMEN.—Durante 1985 a 1995, documentamos etapas de volantón, migración y subsecuentes localizaciones de individuos juveniles de la especie *Haliaeetus leucocephalus* desde el Glacier National Park (GNP), Montana. La mediana de la fecha de volanteo fue el primero de agosto (N = 29). Radiomarcamos 11 volantones, nueve de los cuales recibieron marcadores de alas. La mediana de la fecha de migración desde las áreas natales fue el 13 de septiembre (N = 15). El intervalo entre la etapa de volantón y la posterior migración varía entre 32 a 70 días (mediana = 42 d, N = 15). Los juveniles parecen migrar solitariamente, uniéndose a otras águilas en los sitios de forrajeo. Los adultos del GNP permanecen en sus territorios reproductivos cuando los juveniles parten. Un juvenil invernó a 130 km del GNP. Otros migraron a una distancia de 1000 km. Seis migraron al sur de Montana, Idaho, Wyoming y California. Tres se movieron al oeste de Washington o de British Columbia. Dos juveniles del nido Lake McDonald 1988, migraron separadamente a la Costa del Pacífico. En 1991, un adulto de Lake McDonald ha sido reemplazado; el juvenil producido ese año migró al sur de Idaho. Este contraste sugiere que los juveniles heredaron distintos "programas" de dirección migratoria, desde los distintos padres. El comienzo de la migración, a principios del otoño, de juveniles del GNP también puede ser determinada genéticamente. No encontramos evidencia sobre su permanencia en el sitio mientras *On-*

[1] Present address: Box 366, West Glacier, MT 59936 U.S.A.
[2] Present address: National Park Service, Glacier National Park, West Glacier, MT 59936 U.S.A.
[3] Present address: Department of Biological Sciences, University of Montana, Missoula, MT 59812 U.S.A.
[4] Present address: 441 Thatcher Street, Boise, ID 83702 U.S.A.

corhynchus nerka desarrollaba su carrera otoñal de desove en el GNP. Al menos 10 de los 11 juveniles radiomarcados sobrevivieron a su primer invierno. Durante la migración de primavera, cuatro juveniles pasaron a través o cerca del GNP. Nueve sitios de verano o las últimas localizaciones de primavera conocidas fueron en Alberta o British Columbia, Canadá. No hay evidencias como fechas de retorno reproductivo de juveniles marcados en áreas natales del GNP.

[Traducción de Ivan Lazo]

Our study began during long-term research (started in 1965) on bald eagles (*Haliaeetus leucocephalus*) at autumn concentrations in Glacier National Park (GNP), Montana (McClelland et al. 1982). Migrating bald eagles congregated at kokanee salmon (*Oncorhynchus nerka*) spawning runs in Lower McDonald Creek (LMC) in GNP during each autumn between 1939 and 1988. The peak count of eagles was 639 in 1981. Although 201 juvenile bald eagles were captured and banded in the migration phase of that study, between 1977–88 (McClelland et al. 1994), their natal areas were unknown. Migration of juvenile bald eagles has been documented from Saskatchewan by Gerrard et al. (1974, 1978) and Harmata et al. (1985), the Greater Yellowstone Ecosystem (GYE) of Wyoming, Idaho, and Montana by Swenson et al. (1986) and Harmata and Oakleaf (1992), California by Hunt et al. (1992a), and Texas by Mabie et al. (1994), but there was no information on dispersal and survival of juvenile eagles from GNP nests. Such data will increase knowledge of population relationships in these mobile birds and aid managers concerned with protecting resources used by migrating eagles.

Our objectives in this study included documenting fledging dates, tracking juvenile migration, and determining if GNP juveniles participated in autumn concentrations of eagles at LMC. The latter objective was partially compromised when the salmon population, which had often exceeded 100,000 spawners in LMC, began to collapse in 1986 (Spencer et al. 1991). By 1991, no salmon were observed in LMC.

STUDY AREA

Our primary study area was in and adjacent to GNP, in northwestern Montana (48°30′N, 114°00′W), although radiotracking took us into other western states and Canada. The northern boundary of GNP coincides with the Canadian border. The Continental Divide roughly bisects the Park, north to south. Juvenile bald eagles marked in our study were from five nests in GNP, a nest at Hungry Horse Reservoir (20 km southwest of GNP), and a nest at Cyclone Lake (4 km west of GNP). Nests were within 300 m of a lake. Lake elevations above sea level ranged from 961 m at Lake McDonald to 1366 m at Saint Mary Lake.

METHODS

During occupancy and incubation periods, we monitored nests intermittently from fixed-wing aircraft or from the ground. Precise hatching dates were not determined. Near the expected fledging (departure from the nest) time, observations were made on a daily basis until fledging occurred. Eagles that fledged prematurely (before being capable of self-sustained flight) were captured and marked on the ground. Others were captured in natal territories using padded leg-hold traps placed in shallow water and baited with fish, 3 to 4 wk after normal fledging.

Captured eagles were banded with U.S. Fish and Wildlife Service aluminum leg bands. Eleven fledglings received backpack transmitters (model 200, Telonics, Inc , Mesa, AZ) weighing about 54 g; batteries were expected to operate for a minimum of 15 mo. This enabled tracking some eagles during their second autumn migration. Nine fledglings also were fitted with orange patagial wing markers with black, alpha-numeric codes. Additional details on capture technique, markers, transmitters, and method of sex determination were presented in McClelland et al. (1994).

Local movements and migration routes were tracked from the ground whenever possible. When transmitter signals were lost, tracking resumed in fixed-wing aircraft, usually a Cessna 182. We used telemetry not only to document locations, but also to lead us to sites where marked eagles were observed from the ground. Harmata (1984) and others also have used this approach. We used aircraft only when necessary to relocate eagles, and we tried to avoid low-level flights over national parks and other ecologically sensitive areas. Tracking ended when ground searches for the signal were unsuccessful and weather or lack of funds prevented flights. Local winter and summer movements of three juveniles were documented by volunteers. In spring, we monitored for transmitter signals in the GNP area and on trips in various parts of northwestern Montana. When a signal was found, we tracked the eagle as long as funds were available. Sighting reports were used only if the wing marker code was read.

RESULTS AND DISCUSSION

Fledging. Fledging occurred between 14 July and 1 September (median = 1 August, $N = 29$). Gerrard et al. (1974) reported that most young eagles ($N = 14$) in their Saskatchewan study area (55°24′N) fledged in the second and third week of August. In the GYE (42°51′ to 45°25′N), mean fledging dates ($N = 35$) were as early as 7 July in

Table 1. Fledging, marking, and migration dates of 15 juvenile bald eagles from nests in and adjacent to Glacier National Park, Montana.

EAGLE NUMBER	SEX	YEAR	NEST LOCATION	FLEDGE DATE (HOUR)	MARK DATE	MIGRATE DATE (HOUR)	FLEDGE TO MIGRATE (DAYS)
01[a]	M	1985	Hungry Horse Reservoir	7 Aug[c]	8 Aug	26 Sep	50
02[a]	F	1986	Hungry Horse Reservoir	27 Jul (1347)	21 Aug	5 Oct	70
A-07[b]	M	1986	Logging Lake	29 Jul (1358)[c]	31 Jul	20 Sep (1942)	53
A-08	M	1986	Logging Lake	1 Aug (1140)	3 Sep	6 Sep (1242)	36
A-05	M	1988	Logging Lake	21 Jul (0540)	8 Aug	30 Aug (1300)	40
A-06	F	1988	Logging Lake	23 Jul (1115)	18 Aug	9 Sep	48
A-09	M	1988	Cyclone Lake	14 Jul[c]	14 Jul	22 Aug	39
A-52	M	1988	Lake McDonald	9 Aug	6 Sep	24 Sep (1230)	46
A-95	M	1988	Lake McDonald	31 Jul (0700)	22 Aug	1 Sep (1430)	32
A-14	F	1989	Bowman Lake	22 Aug (1046)[c]	25 Aug	3 Oct (1700)	42
A-93	M	1991	Lake McDonald	30 Jul (0657)	30 Aug	9 Sep (1645)	41
—[d]		1987	Waterton Lake	4 Aug (1120)	—	13 Sep (1030)	40
—[d]		1989	Cyclone Lake	27 Jul	—	16 Sep	51
—[d]		1991	Logging Lake	1 Aug (1730)	—	6 Sep (0730)	36
—[d]		1992	Saint Mary Lake	31 Jul (1000)	—	5 Oct	66

[a] Eagles 01 and 02 had black and white leg bands and transmitters, but not wing markers.
[b] Eagles with wing markers are identified by the marker's alphanumeric code ("A" followed by two digits).
[c] Eaglet fledged prematurely, prior to the time it could sustain flight.
[d] Fledgling not captured, banded, or marked.

four population units (Swenson et al. 1986). Although we expected fledging to occur during afternoon southwest winds that typically develop in the study area, eight of 11 (ultimately radio-tagged) occurred before 1200 H (median = 1140 H); one occurred at 0540 H (eagle 05) with no wind (Table 1). We captured and marked fledglings between 14 July and 6 September (median = 21 August, $N = 11$). Four eaglets fledged prematurely. Eagle 09 flew to perch trees after 2 d on the ground. Eagles 01 and 14 made their first sustained flights 5 d after premature fledging. By the end of day 5, they could maneuver in the forest canopy and returned to their nests.

Eagle 07's premature fledging at Logging Lake in 1986 involved an unusual sequence of events Winds blew the eaglet, estimated to be 10.5-wk old, from the nest on 29 July. It remained in dense foliage and received no food from the adults for 2 d. We brought the bird to the ground, made measurements, and equipped it with a transmitter. Its wing and tail feathers were 75% emerged. By 2 August, it had moved 0.5 km from the nest to a 45% slope under a forest canopy impenetrable to the adults. To prevent starvation, we carried the fledgling about 700 m, to the lake inlet. It was unable to fly for 2 wk. Often, when an adult landed on a shoreline perch, the fledgling ran down the shore-

Table 2. Telemetry and sighting locations of eight radio-tagged juvenile bald eagles during autumn and winter after departure from nesting territories in and adjacent to Glacier National Park, Montana. Distances in parentheses are for more than one day. Last known distances from nests are in bold. Locations on dates after short-distance movements are not listed. Locations for Eagle 14 are not shown; it moved south only 132 km, to Flathead Lake (see Fig. 3).

EAGLE NUMBER, YEAR MARKED, AND OBSERVATION DATES	LOCATION (NORTH LATITUDE WEST LONGITUDE)	km MOVED
Eagle 01 (1985)	Hungry Horse Reservoir, MT (48°14′ 113°50′)[c]	Nest
26–27 Sep 1985	Placid Lake, MT (47°07′ 113°31′)[c]	126
29 Sep[a]	Near Silver Star, MT (45°42′ 112°18′)	(184)
10 Oct[a]	10 km N Dillon, MT (45°17′ 112°45′)	(60)–**339**
Eagle 02 (1986)	Hungry Horse Reservoir, MT (48°14′ 113°50′)[c]	Nest
5–7 Oct 1986	Meadow Creek, South Fork Flathead River (47°52′ 113°26′)	52
8 Oct[a]	Near Anaconda-Pintlar Mtns., SW Philipsburg, MT (46°03′ 113°38′)	200
9 Oct	Near Bannock Pass, MT/ID border (44°48′ 113°19′)	143–**384**
Eagle 07 (1986)	Logging Lake, Glacier National Park, MT (48°46′ 114°01′)[c]	Nest
20 Sep 1986	Firefighter Mtn., Hungry Horse Reservoir, MT (48°19′ 113°52′)[c]	53
22 Sep[a]	Greenhorn Mountain, W Helena, MT (46°43′ 112°17′)	(212)
23 Sep	10 km N Ashton, ID (44°12′ 111°31′)[c]	289
25 Sep–1 Oct[a]	Teton Pass, WY (43°29′ 110°59′)[c]	(101)–**561**
Eagle 07		
19 Oct 1987	07's second fall; first located SW Kalispell, MT (48°11′ 114°29′)	soaring
21–22 Oct[a]	Along Clark Fork River, near St. Regis, MT (47°18′ 115°05′)[c]	(109)
23 Oct	Near Selway River, E Lowell, ID (46°06′ 115°16′)	134
26 Oct[a]	W "He Devil Mountain," OR (45°19′ 116°41′)	(163)
3 Nov	Near Malheur River, N Juntura, OR (43°46′ 118°06′)	(207)
5 Nov	8 km E Upper Alkali Lake, CA (41°40′ 120°01′)	(233)
7–8 Nov	28 km NE Mount Observation, NV (40°55′ 119°56′)	(105)
9 Nov	Soaring 15 km SSE from Mount Observation, CA (40°39′ 120°05′)	27–**1 021**
Eagle 08 (1986)	Logging Lake, Glacier National Park, MT (48°46′ 114°01′)	Nest
20 Jan 1990[b]	S Fork Boise River, below Anderson Dam, ID (43°22′ 115°32′)[d]	**600**
Eagle 09 (1988)	Cyclone Lake, MT (48°42′ 114°18′)	Nest
6 Jan 1989[a]	Lake Roosevelt, near Kettle Falls, WA (48°34′ 118°05′)[c,d]	**222**
Eagle 52 (1988)	Lake McDonald, Glacier National Park, MT (48°38′ 113°52′)[c]	Nest
24–27 Sep 1988[a]	21 km S Canada border, Koocanusa Reservoir, MT (48°49′ 115°09′)[c]	103
28 Sep	10 km N Sandpoint, ID (48°19′ 116°34′)[c]	110
29 Sep[a]	Selkirk Mountains, 16 km E Lake Roosevelt, WA (48°07′ 118°01′)[c]	110
30 Sep	Columbia River, 32 km NW Grand Coulee, WA (48°04′ 119°22′)[c]	101
1 Oct[a]	5 km NW Darrington, WA (48°16′ 121°39′)[c]	171
11–15 Oct	S end Skagit River Delta, WA (48°18′ 122°24′)	(131)
2 Dec–29 Jan[a]	Near Stillaguamish River, near Arlington, WA (48°10′ 122°03′)[c]	26–**608**
Eagle 95 (1988)	Lake McDonald, Glacier National Park, MT (48°38′ 113°52′)[c]	Nest
2–3 Sep 1988[a]	Koocanusa Reservoir, U.S./Canada border (49°01′ 115°10′)[c]	(109)
4 Sep[a]	Near Dewar Creek, 42 km W Kimberly, BC, Canada (49°39′ 116°34′)[c]	124
5 Sep	Near Trout Lake, BC, Canada (50°35′ 117°24′)	123
6 Sep	Columbia River, 7 km N Revelstoke, BC, Canada (51°02′ 118°13′)[c]	77
7 Sep	Adams River at Shuswap Lake, BC, Canada (50°54′ 119°34′)[c]	97
8–10 Sep[a]	Nicola Lake, BC, Canada (50°13′ 120°30′)[c]	112
11 Sep	Fraser River, 3 km W Hope, BC, Canada (49°22′ 121°29′)[c]	118
13–15 Sep	Squamish River, 55 km N Vancouver, BC, Canada (49°44′ 123°09′)[c]	(136)
16 Sep	Mountains W Squamish River, BC, Canada (49°53′ 123°20′)[c]	(154)–**685**

Table 2. Continued.

EAGLE NUMBER, YEAR MARKED, AND OBSERVATION DATES	LOCATION (NORTH LATITUDE WEST LONGITUDE)	km MOVED
Eagle 93 (1991)	Lake McDonald, Glacier National Park, MT (48°38′ 113°52′)[c]	Nest
10 Sep 1991	29 km WSW Pincher Creek, AB, Canada (49°26′ 114°18′)	(100)
11 Sep	Chain Lakes, AB, Canada (50°15′ 114°15′)	120
12 Sep	Soaring at W edge Calgary, AB, Canada (51°06′ 114°15′)	97
13 Sep[a]	E Bow Valley Provincial Park, AB, Canada (51°07′ 114°58′)[c]	58
14 Sep[a]	Soaring up Elbow River, AB, Canada (50°44′ 114°51′)	51
17 Sep	Near Tally Lake, MT (48°24′ 114°35′)	(274)
18 Sep[a]	S Swan Lake, Swan Valley, MT (47°53′ 113°51′)[c]	101
21–29 Sep	Lake McDonald, Glacier National Park, MT (48°38′ 113°52′)[c]	95
1 Oct	SE White Sulphur Springs, MT (46°27′ 110°50′)	(356)
3 Oct[a]	Hyalite Canyon, S Bozeman, MT (45°27′ 110°57′)	(152)
4 Oct	W Madison Jct., Yellowstone National Park, WY (44°39′ 110°56′)	90
5–19 Oct[a]	Near Henrys Lake outlet, ID (44°36′ 111°23′)[c]	37
22–29 Oct	Harriman State Park, Island Park Reservoir, ID (44°23′ 111°28′)[c]	26
1 Nov	Along Henrys Fork River, W Ashton, ID (44°04′ 111°30′)[c]	35–**555**

[a] Sighting and telemetry location on this date.
[b] Sighting only.
[c] Roost location.
[d] Autumn migration routes unknown.

line toward the adult, vocalizing continuously. During the first week, we occasionally placed fish on the lake shore, out of the juvenile's view, but at a location toward which it was moving. It found and ate most of the fish we left. Seven d after the premature fledging, the adults began to make prey deliveries along the lake shore. The fledgling's first sustained flight was on 12 August and on 19 August it returned to the nest. On 3 September we recaptured the fledgling, remeasured it, and fitted it with a wing marker (code A-07). Since its initial capture 34 d earlier, its weight had increased by 29% (from 4.2 to 5.4 kg). All feathers were fully emerged, increasing the wingspan by 25 cm and tail length by 8.5 cm. Ultimately, eagle 07 provided information during the subsequent two autumn migrations.

Before migration, all fledglings generally remained within 1 km of their nests and appeared to be totally dependent on adults for food. In the immediate postfledging period, adults often delivered food to the empty nest, after which the fledglings flew to it to eat. Wood (1992) also described bald eagle fledgling dependence on adults in Florida. Alonso et al.'s (1987:212) description of the relationship between adult and juvenile Spanish imperial eagles (*Aquila adalberti*) appropriately describes what we also observed: "As the young got older, the parents spent less time in their vicinity. Young were not seen hunting, but depended upon their parents for food. They begged and chased their parents throughout the postfledging period, with higher intensity at the end. Nevertheless, the adults became progressively more reluctant to feed them. . . ."

Initiation of Migration. Juveniles began migration from natal territories between 22 August and 5 October (median = 9 September, $N = 15$, Table 1). Departure time varied from 0730–1942 H, but seven occurred after 1200 H (median = 1300 H, $N = 9$). The interval between fledging and migration varied from 32 to 70 d (median = 42 d, $\bar{x} = 46$ d, SD = 9.0, $N = 15$). The mean interval for the four prematurely fledged eaglets also was 46 d. Mean intervals in other studies were 24 d in California (Hunt et al. 1992a), 49 d in Maine and Florida (McCollough 1986, Wood 1992), and 52 d in Saskatchewan (Gerrard et al. 1974).

Autumn Migration Routes and Wintering Areas. We documented autumn migration routes and/or wintering areas for nine juveniles (Table 2). Six juveniles moved primarily south and three moved predominantly west on their first migrations (Fig. 1). The southward routes were similar to those

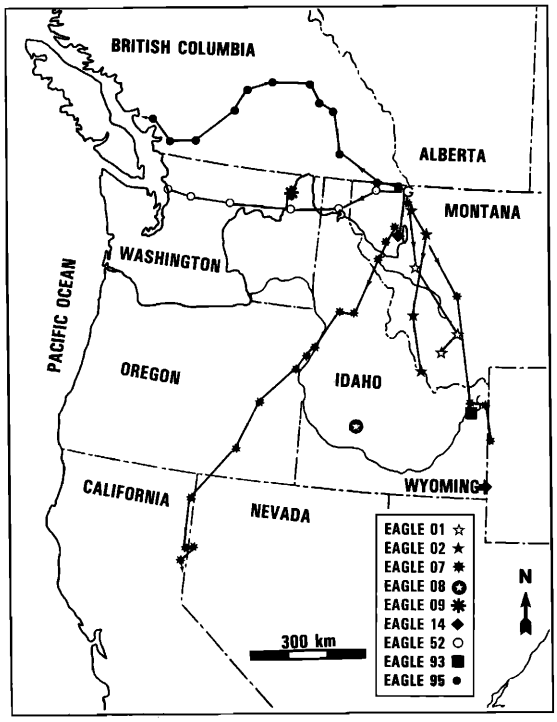

Figure 1. Autumn migration routes and last known autumn or wintering locations of bald eagles from natal areas in and adjacent to Glacier National Park (G symbol), Montana. Two routes are shown for eagle 07; the route farthest east is autumn 1986 (juvenile year) and the route farther west is autumn 1987 (second year). Migration routes for eagles 08 and 09 (wintering areas shown) were unknown. A more detailed route for eagle 14 is shown in Fig. 2. The migration route of eagle 93 is shown separately in Fig. 3.

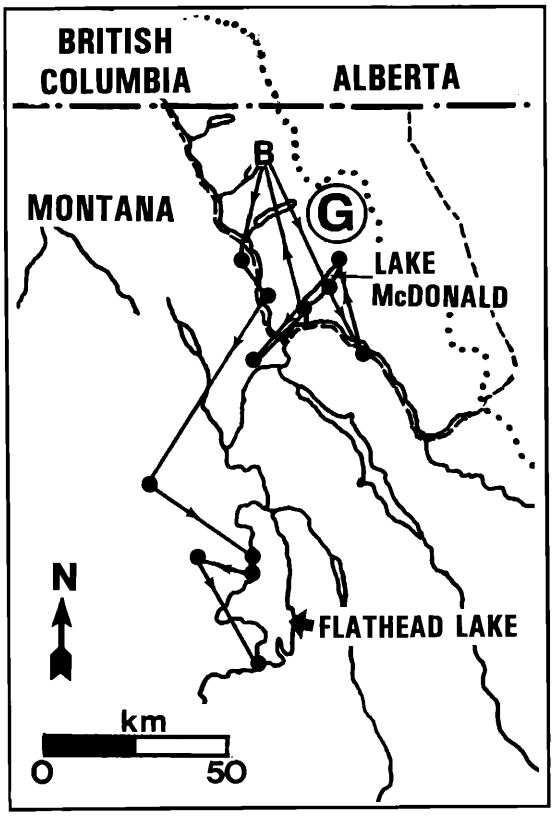

Figure 2. Autumn movements of juvenile eagle 14 in 1989, from the natal area at Bowman Lake (B symbol), in Glacier National Park (G symbol with boundary shown as dashed line), Montana, to wintering location at and near Flathead Lake, Montana. Note eagle 14's passage through the former kokanee salmon spawning area at Lake McDonald. Dotted line identifies the Continental Divide.

of juveniles previously radiotracked from autumn concentrations in GNP (McClelland et al. 1994). Only eagle 14 remained within the general vicinity of GNP, wintering near Flathead Lake, 132 km south of its natal area (Fig. 2).

Eagle 09's route west from GNP was unknown, but it was found at Lake Roosevelt during a midwinter waterfowl census of northeastern Washington (W.R. Radke, U.S. Fish and Wildl. Serv., pers. comm.). In the Kettle Falls District, where eagle 09 wintered, 98 bald eagles were observed on the 1989 winter count (G. LeBret, Natl. Park Serv., pers. comm.). Eagles 52 and 95, both from the 1988 Lake McDonald nest, were tracked west to Pacific coastal waters in Washington and British Columbia. Eagle 95 followed a curving path through British Columbia. During one period, we followed eagle 95's signal on the ground for 380 km through British Columbia, making frequent sightings. Eagle 52 took a relatively direct route, south of the Canadian border, to western Washington (Fig. 1) and it remained in the Skagit and Stillaguamish River areas throughout the winter. On some days, its transmitter signal was monitored from the headquarters building of North Cascades National Park in Sedro Woolley, Washington (C.R. Wasem, Natl. Park Serv., pers. comm.). Servheen and English (1979) and Hunt et al. (1992b) previously described eagle use of the Skagit Valley, the vicinity in which eagle 52 spent part of the winter. The westward migration of three GNP juveniles was

similar to the pattern described by Harmata and Oakleaf (1992). They reported that most of the 21 juveniles tracked from the GYE migrated westward, primarily to Washington and Oregon.

It is curious that both 1988 Lake McDonald juveniles moved independently westward from their natal area, whereas the 1991 juvenile moved north, then south. Harmata and Oakleaf (1992) and Hunt et al. (1992a) discussed the theory of genetic memory suggesting that juveniles may have a genetically-based propensity to migrate to a particular destination or in a particular direction. The 1988 and 1991 Lake McDonald juveniles were offspring of different male parents (fate of the first male was unknown). This may imply that the genetic code for migration direction is distinct in different parents, perhaps additionally suggesting disparate natal areas of the 1988 and 1991 male adults.

GNP juveniles moved west ($\bar{x}$ = 98 km/d, N = 16 d, two eagles) and south ($\bar{x}$ = 87 km/d, N = 35 d, five eagles) more slowly than northward migrating juveniles tracked from California ($\bar{x}$ = 130 km/d, N = 14 d, coastal route; and $\bar{x}$ = 184 km/d, N = 21 d, mountain route) by Hunt et al. (1992a). The five California eagles reportedly moved a considerable distance each day, whereas the GNP juveniles commonly stopped for one to several days at foraging sites. Eagle 93, from Lake McDonald, initially moved north (Fig. 3) on a route similar to that used by most spring migrants studied by McClelland et al. (1994). After traveling 408 km north in 5 d ($\bar{x}$ = 82 km/d), it reversed direction, returned to GNP ($\bar{x}$ = 74 km/d) for 10 d, then moved more typically southward, into Idaho ($\bar{x}$ = 106 km/d in 6 d).

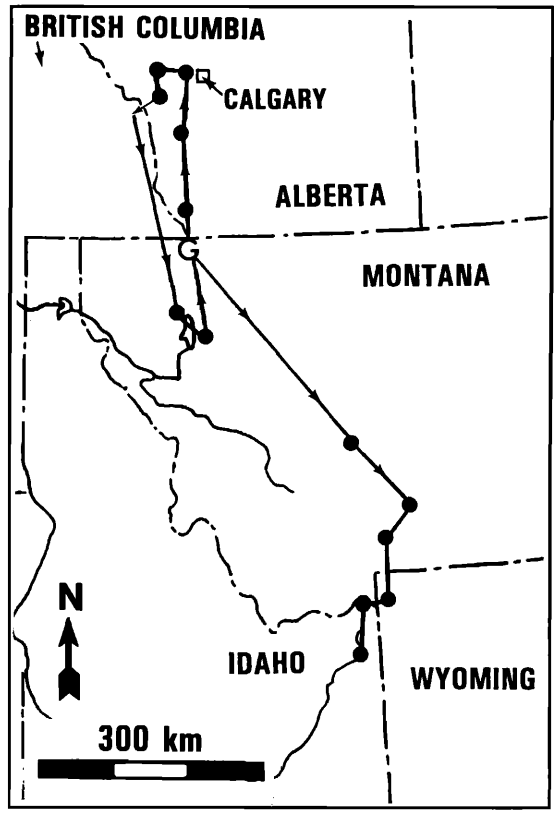

Figure 3. Autumn migration of juvenile eagle 93 in 1991, from the natal area at Lake McDonald, Glacier National Park (G symbol), Montana. After first moving 18 km east to Granite Park, GNP, eagle 93 traveled 408 km north, to the vicinity of Calgary, Alberta, Canada, then returned to Lake McDonald before southward migration to Idaho.

Lack of food in natal areas was not the major inducement for migration of GNP juveniles. Many juveniles migrating southward from Canada wintered in northwestern Montana, in some of the same vicinities that GNP juveniles vacated earlier in the autumn (McClelland et al. 1994). Additionally, the juveniles we tracked appeared to be migrating alone, apparently guided by instinct rather than following older eagles. Their parents remained on the nesting territories well beyond the juveniles' departure (Yates 1989). These factors also support the hypothesis of genetically determined migration patterns for most GNP juveniles.

Participation of GNP Juveniles at Autumn Concentrations in GNP. During the first year of our study (1985), migrating bald eagles from Canada continued to congregate at the autumn spawning run of nonnative kokanee salmon along LMC (McClelland et al. 1982, 1994). In 1985, there were an estimated 118,000 salmon in LMC on 29 October. Eagle 01, from the Hungry Horse nest only 20 km south of the salmon run, began migration on 26 September heading south away from the concentration when there were at least 10,000 salmon in LMC. However, in the early period of spawning, few salmon were dead or easily accessible to juvenile eagles (Bennetts and McClelland 1991). The peak eagle count (520) occurred on 5 November, when eagle 01 had moved at least 360 km south of the concentration (McClelland 1992).

In 1986, the salmon population in Flathead Lake

(from which the LMC spawning run came) began a precipitous collapse (Spencer et al. 1991). However, there were still 21,500 salmon in LMC at peak count on 7 October. Two juveniles from Logging Lake, 25 km north of LMC, were potential participants at the concentration. Eagle 08 departed on 6 September. Although its migration route was unknown, we monitored for its signal daily in GNP and it did not pass near LMC. Eagle 07 flew directly over LMC on 20 September, when there were >1,000 salmon in LMC, but it continued south without stopping. Eagle 02 left Hungry Horse Reservoir on 5 October when the salmon were nearing peak numbers in LMC, but it migrated southward away from LMC. Based on the movements of these four juveniles, there seemed to be no inherent attraction to the salmon in LMC. By 1988, when we tracked the departure of five juveniles (none of which went to LMC), the salmon population had collapsed and only 120 salmon were counted in LMC; in 1991, no salmon were recorded.

Only eagle 14, in 1989, exhibited movements that might be interpreted as searching the LMC area for salmon (Fig. 2). During 17–23 October 1989, eagle 05 (from the 1988 Logging Lake nest) joined other migrating eagles at a kokanee salmon spawning run at Kikomun Creek, near Elko, British Columbia, 100 km northwest of GNP.

We concluded that most GNP juveniles did not participate in the autumn bald eagle concentrations at LMC, even during the years of salmon abundance (1963–85). Migration from natal areas was initiated before the time most salmon were available at LMC. Most GNP juveniles seem to be programmed to migrate to wintering areas far from their natal areas. Juveniles migrating southward from Canada opportunistically participated in the GNP concentration (McClelland et al. 1994), which lasted only 50 yr; perhaps this was an insufficient duration to influence inherited migration patterns of GNP juveniles.

Survival, Spring Migration, Summering Areas. Ten of the 11 radio-tagged juveniles were known to survive at least through their first winter. The fate of one juvenile was unknown. Harmata and Oakleaf (1992) reported 80% first yr survival of juveniles in the GYE. We documented spring and/or summer locations for nine juveniles (Table 3, Fig. 4). Four juveniles passed through or within several km of GNP en route to Canada. On 6 April 1990, eagles 05 and 14, moving north from different wintering sites, were both at Kintla Lake, GNP. All juveniles moved into Canada or were moving north near the border when last located; they probably spent their first summer in Canada. Some could have returned to the U.S. after last documented locations, but we consistently monitored in GNP without success. The timing and routes of GNP juvenile migrations in spring were similar to juveniles, probably of Canadian origin, previously tracked from GNP autumn concentrations (McClelland et al. 1994). We had insufficient data to characterize the general rate of spring migration. However, eagle 06 traveled 826 km in 9 d, moving north into central Alberta from northeastern Montana. This rate ($\bar{x}$ = 92 km/d) is similar to the autumn movements we documented.

During summer 1989, eagle 52 (which had wintered in western Washington) stayed at the Creston Valley Wildlife Management Area, British Columbia, Canada. On many days, its signal was monitored from the visitor center or sightings were made providing special educational opportunities for Management Area visitors (D. Ransome, Area Interpreter, pers. comm.). Through summer 1995, no marked GNP juvenile had returned and remained in a natal area. Only eagle 14 was reported in adult plumage in GNP; it was observed at Saint Mary Lake on 26 April 1995 (G. Dicus, Natl. Park Serv., pers. comm.). It was not associated with a nest and was 37 km from the Bowman Lake nest, from which it fledged in 1989. Eagle 14 apparently did not remain for the summer. Harmata and Oakleaf (1992) reported that GYE juveniles that had wintered near the west coast returned in the spring to the GYE and remained through the following autumn. Mabie et al. (1994) reported that migratory juveniles from their study area in Texas exhibited fidelity to natal nesting areas for breeding.

Foraging During Migration. Although juveniles usually were observed alone during their migration flights, they often joined other eagles at foraging sites, especially where food was concentrated. Following radio-tagged eagles allowed us to observe previously undocumented food concentrations that attracted eagles. For example, during spring migration 1989, eagle 06 was observed along the Missouri River between Ulm and Cascade, Montana, with as many as 45 other bald eagles. They foraged on ground squirrels, fish, waterfowl, and carrion (Caton et al. 1989).

We did not quantitatively assess foraging, but during migration we documented eagles feeding on or perched near carrion of antelope (*Antiloca-*

Table 3. Telemetry and sighting locations of eight radio-tagged juvenile bald eagles from nests in and near Glacier National Park, Montana during spring and summer. Distances in parentheses are for more than one day. Last known distances from nests in bold. Eagle 14 locations (all near GNP) are not shown.

EAGLE NUMBER AND DATE	LOCATION (NORTH LATITUDE WEST LONGITUDE)	km MOVED
Eagle 01 (from the 1985 Hungry Horse nest)		
24 Apr 1986	15 km SSW Cardston, AB, Canada (49°05′ 113°23′)	**100**
Eagle 08 (from the 1986 Logging Lake nest)		
5 May 1988[b]	20 km NW Red Deer, AB, Canada (52°23′ 114°00′)	—
27 May–6 Jun[b]	21 km E Edmonton, AB, Canada (53°25′ 113°09′)	(113)–**528**
Eagle 06 (from the 1988 Logging Lake nest)		
18 Mar–1 Apr 1989[a]	Missouri River, near Cascade, MT (47°22′ 111°33′)	—
2 Apr[a]	Harwood Lake, 21 km SE Fort Benton, MT (47°45′ 110°25′)	97
3–5 Apr	Missouri River, near White Cliffs, MT (47°57′ 110°05′)	42
6 Apr[a]	Bearspaw Mountains, 20 km S Havre, MT (48°17′ 109°38′)	73
7 Apr	Soaring N at Milk River, Canada/U.S. border (49°00′ 110°35′)	106
12 Apr	Beaverhill Lake, 65 km E Edmonton, AB, Canada (53°24′ 112°25′)	(508)
13 Apr	40 km N Beaverhill Lake, AB, Canada (53°55′ 112°10′)	60
12–13 Jun[a]	Near Calling Lake, 89 km E Slave Lake, AB, Canada (55°20′ 113°22′)	(177)–**762**
Eagle 09 (from 1988 Cyclone Lake nest)		
13 Jun 1989	Columbia Lake, 8 km N Canal Flats, BC, Canada (50°14′ 115°51′)	**200**
Eagle 95 (from 1988 Lake McDonald nest)		
29 Apr 1989	Soaring N up Elk River, 5 km S Fernie, BC, Canada (49°28′ 115°04′)	**129**
Eagle 52 (from 1988 Lake McDonald nest)		
29 Apr–29 Aug 1989[a]	Creston Valley Wildlife Management Area, BC, Canada (49°10′ 116°35′)	**210**
Eagle 52 (from 1988 Lake McDonald nest)		
7 Mar 1990[b]	Pearrygin Lake, near Winthrop, WA (48°29′ 120°08′)	**466**
Eagle 05 (from the 1988 Logging Lake nest)		
28 Feb 1990[a]	Swan River, 8 km S Swan Lake, MT (47°51′ 113°50′)[c]	—
12–13 Mar	Park Creek, Glacier National Park, MT (48°18′ 113°36′)[c]	(105)
17–19 Mar	Soaring at Salmon Prairie, Swan Valley, MT (47°37′ 113°46′)	(77)
6 Apr	Kintla Lake, Glacier National Park, MT (48°57′ 114°08′)	(155)–**26**
Eagle 93 (from the 1991 Lake McDonald nest)		
15 Apr 1992	First located soaring E, 21 km W Polebridge, MT (48°48′ 114°33′)	—
16–17 Apr[a]	Tepee Lake, near North Fork Flathead River, MT (48°55′ 114°24′)	18
21 Apr	Soaring NW up Cabin Creek, BC, Canada (49°10′ 114°36′)	(52)
24–27 Apr[a]	Columbia River, 5 km N Harrogate, BC, Canada (51°00′ 116°30′)[c]	(255)
28–29 Apr[a]	Columbia River, 7 km S Spillimacheen, BC, Canada (50°51′ 116°21′)[c]	58
30 Apr[a]	Bobbie Burns Creek, 20 km W Harrogate, BC, Canada (50°58′ 116°43′)[c]	31
1 May	Spillimacheen River, 8 km WSW Harrogate, BC, Canada (50°57′ 116°34′)	11–**324**

[a] Sighting and telemetry location on this date.
[b] Sighting only.
[c] Roost location.

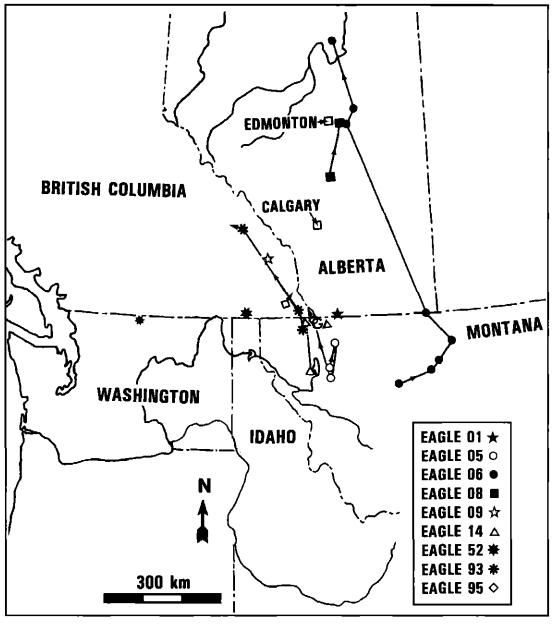

Figure 4. Spring migration routes and last known spring (or summer) locations for bald eagles from natal areas in Glacier National Park (G symbol), Montana. Large symbol for eagle 52 is 1989 summering site; small symbol is 1990 spring sighting.

pra americana), white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*); live and dead Richardson's ground squirrels (*Spermophilus richardsonii*); domestic cattle at a carcass dump; offal at a game farm; kokanee salmon; mountain whitefish (*Prosopium coulteri*); American coots (*Fulica americana*); and waterfowl.

ACKNOWLEDGMENTS

J. Ashley, C. Baker, M. Bishop, D. Boyd, J. Carlson, J. DeSanto, K. Dimont, M. Donofrio, S. Emmerich, S. Gniadek, S. Gregory, K. Gunderson, T. Jacobsen, R. Kuntz, G LaBrett, R. Mattson, T. McClelland, C. Murat, R. Paul, B. Pfhul, J. Potter, W. Radke, D. Ransome, M. Richards, R Richards, D. Stradley, M. Swanson, G. Vodenahl, C. Wasem, J. Watson, R. Williams, D. Worman, V. Wright and B. Zinn assisted as volunteers in various phases of the study. Pilots M. Strand and W. Warner safely flew us on extensive tracking flights. Funding was provided by the National Park Service; the U.S. Fish and Wildlife Service Montana Cooperative Wildlife Research Unit, University of Montana; and the School of Forestry, University of Montana. We thank S. Brodeur, R. Jackman and P.B. Wood for their reviews of the manuscript.

LITERATURE CITED

ALONSO, J.C., L.M. GONZALEZ, B. HEREDIA AND J.L. GONZALEZ. 1987. Parental care and the transition to independence of Spanish imperial eagles *Aquila heliaca* [now *A. adalberti*] Donana National Park, southwest Spain. *Ibis* 129:212–224.

BENNETTS, R.E. AND B.R. MCCLELLAND. 1991. Differences in the distribution of adult and immature bald eagles at an autumn concentration in Montana. *Northwest Sci.* 65:223–230.

CATON, E.L., M. DONOFRIO AND B.R. MCCLELLAND. 1989. Spring migration of a juvenile bald eagle from Glacier National Park, Montana: habitat use and management recommendations for the Missouri River. Unpubl. rep., Glacier Natl. Park Res. Div., West Glacier, MT U.S.A.

GERRARD, J.M., D.W.A. WHITFIELD, P. GERRARD, P.N. GERRARD AND W.J. MAHER. 1978. Migratory movements and plumage of subadult Saskatchewan bald eagles. *Can. Field. Nat.* 92:375–382.

GERRARD, P., J.M. GERRARD, D.W.A. WHITFIELD, AND W.J. MAHER. 1974. Post-fledging movements of juvenile bald eagles. *Blue Jay* 32:218–226.

HARMATA, A.R. 1984. Bald eagles of the San Luis Valley, Colorado: their winter ecology and spring migration. Ph.D. dissertation. Montana State Univ., Bozeman, MT U.S.A.

——— AND B. OAKLEAF. 1992. Bald eagles in the Greater Yellowstone ecosystem: an ecological study with emphasis on the Snake River. WY Game and Fish Dep. Rep., Cheyenne, WY U.S.A.

———, J.E. TOEPFER AND J.M. GERRARD. 1985. Fall migration of bald eagles produced in northern Saskatchewan. *Blue Jay* 43:232–237, with addendum in *Blue Jay* 44:1.

HUNT, W.G., R.E. JACKMAN, J.M. JENKINS, C.G. THELANDER, AND R.N. LEHMAN. 1992a. Northward post-fledging migration of California bald eagles. *J. Raptor Res.* 26:19–23.

———, B.S. JOHNSON AND R.E. JACKMAN. 1992b. Carrying capacity for bald eagles wintering along a northwestern river. *J. Raptor Res.* 26:49–60.

MABIE, D.W., M.T. MERENDINO AND D.H. REID. 1994. Dispersal of bald eagles fledged in Texas. *J. Raptor Res.* 28:213–219.

MCCLELLAND, B.R., L.S. YOUNG, D.S. SHEA, P.T. MCCLELLAND, H.L. ALLEN AND E.B. SPETTIGUE. 1982. The bald eagle concentration in Glacier National Park, Montana: origin, growth, and variation in numbers. *Living Bird* 19:133–155.

———, L.S. YOUNG, P.T. MCCLELLAND, J.G. CRENSHAW, H.L. ALLEN AND D.S. SHEA. 1994. Migration ecology of bald eagles from autumn concentrations in Glacier National Park, Montana. *Wildl. Monogr.* 125:1–61.

MCCLELLAND, P.T. 1992. Ecology of bald eagles at Hun-

gry Horse Reservoir, Montana. M.S. thesis. Univ. Montana, Missoula, MT U.S.A.

MCCOLLOUGH, M.A. 1986. The post-fledging ecology and population dynamics of bald eagles in Maine. Ph.D. dissertation. Univ. Maine, Orono, ME U.S.A.

SERVHEEN, C. AND W. ENGLISH. 1979. Movements of rehabilitated bald eagles and proposed seasonal movement patterns of bald eagles in the Pacific Northwest. *Raptor Res.* 13:79–88.

SPENCER, C.N., B.R. MCCLELLAND AND J.A. STANFORD. 1991. Shrimp stocking, salmon collapse, and eagle displacement. *BioScience* 41:14–21.

SWENSON, J.E., K.L. AULT AND R.L. ENG. 1986. Ecology of bald eagles in the Greater Yellowstone ecosystem. *Wildl. Monogr.* 95:1–46.

WOOD, P.B. 1992. Habitat use, movements, migration patterns, and survival rates of subadult bald eagles in north Florida. Ph.D. dissertation. Univ. Florida, Gainesville, FL U.S.A.

YATES, R.E. 1989. Bald eagle nesting ecology and habitat use: Lake McDonald, Glacier National Park, Montana M.S. thesis. Univ. Montana, Missoula, MT U.S.A.

Received 28 August 1995; accepted 28 December 1995