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MATE AND NEST SITE FIDELITY IN A RESIDENT POPULATION OF BALD EAGLES[1]

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The faithfulness of birds to their mates and nesting places has long been of interest to ornithologists (Darley et al. 1971, Lenington and Mace 1975, Greenwood and Harvey 1976, Harvey et al. 1979, Ollason and Dunnet 1978). Rowley (1983) listed advantages for birds breeding in the same place with the same mate, including physiological and behavioral characteristics associated with the age of the partners, the best breeding sites, and efficiency of mating with a familiar partner. Improved reproductive success is often associated with age and experience, and remated pairs often produce more and superior young than first-time nesters (Greenwood 1980). Successfully nesting birds frequently have greater mate retention rates than birds that failed in a previous nesting attempt. Harvey et al. (1979) suggested that long-lived birds, and birds living in stable environments (e.g., Bald Eagles, *Haliaeetus leucocephalus*) may be more faithful to sites and mates than other birds.

Few data on mate and nest site fidelity of birds of prey are available, although Newton (1979) cites several examples of raptors that show a high degree of nest site fidelity. Newton and Marquiss (1982) reported strong site fidelity for a population of the Sparrowhawk (*Accipiter nisus*) in south Scotland; additional reports have been presented for the Flammulated Owl (*Otus flammeolus*) in Colorado (Reynolds and Linkhart 1987); the Ural (*Strix uralensis*) and Tawney (*Strix aluco*) Owl in Finland (Saurola 1987); urban-breeding Merlins (*Falco columbarius*) in Saskatchewan, Canada (Warkentin et al. 1991); and Ospreys (*Pandion haliaetus*) in the eastern U.S. (Poole 1989).

Stalmaster (1987) suggested that Bald Eagles are generally assumed to mate for life. Gerrard et al. (1992) reported high site fidelity for four adult Bald Eagles in Saskatchewan, with one female on her same territory for 13 years. Based upon nest defense behavior and egg size, Gerrard et al. (1992) also inferred mate fidelity at several sites. Other notes and comments on nest site and mate fidelity in Saskatchewan Bald Eagles appear in Gerrard et al. (1983) and Bortolotti and Honeyman (1985). In this paper, we report mate and nest site fidelity of 20 banded or color-banded resident Bald Eagles in California, monitored between May 1983 to May 1993. We also report seven instances of breeding adult replacement observed over this period.

All 20 banded Bald Eagles occurred as adults in one of 10 traditional nesting territories in the Pit River

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TABLE 1. Known nest site fidelity of 12 female and eight male resident Bald Eagles breeding in the Pit River drainage in north-central California.

Bird	Territory	Date first banded	Present status	Breeding seasons on territory
Females				
AF01	Two Knobs	5/83	Replaced by AF08 between 1983–1988	1–4
AF03	South Shore	6/83	Recaptured 7/89 Killed on territory 1992 Replaced by AF13 1992	10
AF04	Cayton Creek	6/83	Replaced by AF12 between 1983–1991	1–8
AF05	Pit Rim	8/83	Replaced by AF06 between 1983–1988	1–4
AF06	Pit Rim	6/88	Remains on territory	6
AF07	Dusty	8/88	Remains on territory	6
AF08	Two Knobs	8/88	Replaced 1992	5
AF09	Pit 3 Powerhouse	9/88	Killed on territory 4/90 Replaced by AF10 1990	3
AF10	Pit 3 Powerhouse	9/90	Left territory 3/91 Periodically returns Reestablished 1993	2
AF11	Pit 3 Powerhouse	9/91	Left territory 10/92 Periodically returns	1
AF12	Cayton Creek	9/91	Remains on territory	2
AF13	South Shore	10/92	Remains on territory	1
Males				
AM01	Hagen Flat	8/83	Shot on territory 2/86	4
AM02	Pit Rim	6/84	Recaptured 10/88 Remains on territory	10
AM03	Dry Lakes	5/88	Remains on territory	6
AM04	Pit 3 Powerhouse	6/88	Remains on territory	6
AM05	Cayton Creek	6/88	Remains on territory	6
AM06	Dusty	10/88	Remains on territory	6
AM07	South Shore	10/88	Remains on territory	6
AM08	Fall River Mills	6/90	Remains on territory	4

drainage in north-central California (Jenkins 1992). The Pit River originates in Modoc County, drains much of northeastern California, and is a major tributary of the Sacramento River system. The territories occur on 82 km of riverine and reservoir habitat on the Pit River in Shasta County. Forests in our study area are dominated by Ponderosa pine (*Pinus ponderosa*). Open stands are as tall as 70 m, while Sierran mixed coniferous forest is denser, often slightly taller (75 m), and composed of several species including Ponderosa pine, Douglas-fir (*Pseudotsuga menziesii*), incense cedar (*Libocedrus decurrens*), and sugar pine (*Pinus lambertiana*).

Eagles were trapped using variations on the noosed bait-fish technique described by Cain and Hodges (1989). Bait fish were anchored in shallow shoreline locations by a 4 kg weight attached to a 10 m length of 1 cm nylon cord and a 3 m length of shock cord. Bait sets were either laid out before dawn at important eagle foraging locations or placed near a foraging eagle. All eagles were banded with U.S. Fish and Wildlife Service (USFWS) aluminum leg bands. Beginning in 1988, 16 resident adult eagles (two recaptures) also were banded with anodized colored aluminum bands about 19 mm wide (McCollough 1990). Each resident pair of eagles received a different colored band; males were color-banded on the right leg and females on the left, with the USFWS band placed on the alternate leg. Birds were sexed on the basis of morphometric measurements collected in the field (Bortolotti 1984, Garcelon et al. 1985). Color bands were recorded opportunistically each breeding season from 1989 to 1993. We used a chi-square contingency test to determine if males and females differed in their nest site fidelity.

In the resident population of Bald Eagles on the Pit River, both males and females showed a high degree of nest site fidelity (Table 1). Two birds (AF03 and AM02) may have been located on the same territories for 10 years, if they remained on their territories between their original banding in 1983 and 1984, and their subsequent recapture in 1988 and 1989. Of nine resident adults color-banded in 1988 (four females, five males) six remained on their same territories as of May 1993 and are thus in their sixth breeding season; three of four other birds banded in 1989–90 remain on territory. All color-banded pairs showed a high degree of stability over the breeding seasons in which the pairs were observed (Table 2). Two pairs were later broken, both when the adult female was killed. Males exhibited greater nest site fidelity than females; eight of 12 females died or departed territories, as opposed to only one mortality (shot) of eight males ($\chi^2 = 5.67$, $P <$

TABLE 2. Mate fidelity of five pairs of resident Bald Eagles in the Pit River drainage in which both sexes were banded.

Pair	Territory	Year banded	Present status	Breeding seasons paired
AF03 × AM07	South Shore	1983 and 1988	AF03 deceased 1991	4
AF06 × AM02	Pit Rim	1988 and 1984	Together on territory	6
AF07 × AM06	Dusty	1988 and 1988	Together on territory	6
AF09 × AM04	Pit 3 Powerhouse	1988 and 1988	AF09 deceased 1990	3
AF12 × AM05	Cayton Creek	1991 and 1988	Together on territory	2

0.05). Greenwood and Harvey (1976) reported that males in many species of birds exhibit greater fidelity to the nest site than females.

Seven instances of replacement of breeding adults occurred since 1983. The first involved the shooting of a resident male (AM01) in February 1986. Subsequent surveys of the territory revealed two adult eagles present on 6 May 1986. A pair in this territory successfully produced young in 1987, although it was undetermined whether the original female (AM01's mate) remained in the territory afterwards. An adult female (AF01) nesting in a territory since 1983 was replaced sometime before the capture of her replacement (AF08) in 1988. A resident female (AF05) in 1983 also was absent by the time her replacement was captured on the same territory in 1988 (AF06). Similarly, female AF04, first banded in 1983, was not present when a replacement female (AF12) was captured on the territory in 1991. All three of these territories were occupied by two adults in each of the intervening years (1983–1991) indicating a maximum replacement period of less than one year. Female AF08 was replaced following the 1992 nesting season after five breeding seasons on her territory. All replacements were by unmarked adults and in no case did a banded adult ever change territories.

We were able to monitor two breeding bird replacements more closely. The first replacement occurred when female AF09 was killed by a conspecific and replaced immediately by a new female (AF10). Wounds consistent with intraspecific mortality were found on the carcass of AF09, but were not specifically attributed to her replacement (AF10). Eggs were present in the nest when AF09 was killed, and although the resident male (AM04) attempted to continue incubation, the new female did not assist, and the embryos died. Postupalsky and Holt (1975) reported nestling adoption in Bald Eagles, and Grubb et al. (1988) documented adoption of a clutch and brood by a replacement male. During the following breeding season, AF10 copulated with AM04, but subsequently strayed from the territory in March 1991. Although she has returned to the territory for brief periods since that time, an additional female (AF11) also has periodically returned and taken up residence in the territory at alternate times. The territory has remained occupied by the original male, and female AF10 returned to breed successfully in the territory in 1993.

The final observed mate replacement occurred when AF03 was killed in 1992, also in an intraspecific interaction, as evidenced by wounds on the recovered carcass. After breeding for 10 years on her same territory, AF03 was replaced immediately by a new female, AF13. AF13 raised young in the territory in 1993 with the former mate (AM07) of AF03, first color-banded on the territory in 1988, and thus in his sixth season on the territory. These two observed cases of intraspecific mortality and rapid mate replacement suggest that available nesting territories are in short supply and that a surplus of available breeders probably exists in our study area.

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