however, we do not know if these lower latitude populations respond to cold in the same manner.

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PRAIRIE FALCON AERIE SITE CHARACTERISTICS AND AERIE USE IN NORTH DAKOTA[1]

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Key words: Falco mexicanus; *Prairie Falcon; North Dakota; aerie site characteristics; aerie use; nesting habitat.*

Stewart (1975) believed that in North Dakota, Prairie Falcons (*Falco mexicanus*) were uncommon and local in the badlands and on adjacent plains along the Little Missouri and Missouri rivers. However, there have been no comprehensive studies of the species in the state. Information about aerie sites will help to identify Prairie Falcon nesting habitat and aid comparison of aerie site characteristics to those in other places.

STUDY AREA

This study was conducted from 1982 to 1985 in an 11,250-km^2 area (Fig. 1). Dominant study area features are the Little Missouri River, easily eroded badlands, and large buttes. Mixed-grass prairie is the dominant vegetation. Small areas of short-grass prairie are found in the southwest and on the uplands of the Little Missouri River drainage. A xeric scrub grassland occurs in eroded areas in the extreme southwest (Stewart 1975). Forest covers less than 2% of the land (Jakes and Smith 1982). Ranching and dryland farming are traditional land uses, but recently there has been increased oil development in the study area.

METHODS

An aerie is a cavity in which Prairie Falcons nest or attempt to nest. "Aerie site" or "site" means an aerie and its surroundings. There may be more than one aerie in an aerie site, though each site is occupied by only one pair of Prairie Falcons in a nesting season.

During the nesting season each year, my assistants and I searched for aeries reported to the North Dakota Game and Fish Department or the U.S. Fish and Wildlife Service since 1975. We located seven previously unreported aeries. We determined aerie site and aerie characteristics when banding nestlings or after each nesting season. At each site we measured the length and height of the cliff face, aerie height above the base of the cliff, and aerie dimensions. Five cliffs were estimated to be at least 500 m long. Most aerie shapes were very irregular, so volumes for the natural aeries were estimated to be 75% of the product of the maximum aerie height, width, and depth. Relief, the vertical distance from an aerie to the lowest elevation visible from the aerie cliff, was determined from U.S. Geological Survey 7½′ topographic maps. The lowest visible elevation was usually less than 3 km from an aerie. Cliff aspects were assigned to the closest 45° compass bearing. We recorded cliff substrate, aerie placement (e.g., ledge, cavity, on stick nest, etc.), and land uses within approximately 2 km of each aerie. Char-

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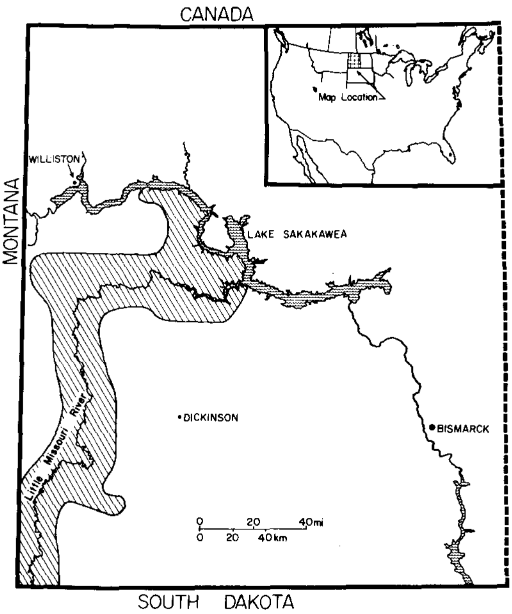

FIGURE 1. Location of the study area in western North Dakota.

acteristics of three man-made aeries constructed in the late 1970s (Crawford and Kohn 1981) and one excavated in 1983 (P. Mayer, pers. comm.) also were recorded. A log-likelihood test (Sokal and Rohlf 1981) was used to test for aspect availability and for preferences in aerie cliff aspect. For each aerie on a stick nest, I recorded the probable species that built the nest and whether or not nestlings would be protected from precipitation. At some locations I was unable to measure cliff or aerie dimensions, or both. I recorded as many characteristics as possible at 45 sites.

RESULTS AND DISCUSSION

I observed no unusual aerie sites for Prairie Falcons during this study. Thirty-two aeries (including the artificial aeries) were located in cavities, 11 were on ledges with good overhead protection from rain and snow, and two were on Golden Eagle (*Aquila chrysaetos*) nests on open ledges. Two aeries were on Red-tailed Hawk (*Buteo jamaicensis*) nests, one of which was built in a cavity. Some aerie ledges did not extend far into the cliffs, so the aeries were poorly protected from rain or snow blowing from the directions the ledges faced.

Aerie cliff length and height were variable (Table 1). The tallest and longest cliffs are located along the Little Missouri River. Long cliffs are also found atop many large buttes. All cliffs more than 100 m long (n = 10) were found in these locations. However, we found only 22% of the natural aeries along the Little Missouri River and 15% on large buttes. The majority (63%) of the natural aeries were located on small cliffs scattered throughout the study area. Three of the artificial aeries were located on small cliffs away from the Little Missouri River and one was on a large cliff next to the river.

Six aeries were in poorly consolidated sand or siltstone cliffs, 18 were in clay cliffs (including four artificial aeries), and 21 were in consolidated sandstone. Because many aeries were located in easily eroded cliffs, aerie longevity was quite variable. By the 1985 nesting season 8 of 45 (18%) natural aeries reported between 1975 and 1980 had eroded so that they were no longer useable, or the cliffs in which they were located had fallen. Adjacent to the Little Missouri River (where cliff erosion is most rapid) we were unable to locate some reported aeries that probably had eroded away. We had little time to look for aeries near those that had fallen, so the proportion of aeries along the river may be larger than I report.

The mean height of aerie cliffs (11.0 m, Table 1) was larger than the average (7.8 m) of the eight aerie cliffs measured by Edwards (1968) in Alberta, but smaller than mean cliff sizes recorded elsewhere in the western United States (Enderson 1964, Leedy 1972, Ogden 1973, Platt 1974, Denton 1975, Williams 1981, Runde and Anderson 1986). Many aerie cliffs in the study area are too small to appear on topographic maps. However, no cliffs in the study area are more than about 60 m tall, so use of the smaller cliffs is use of available sites.

Thirty-six of the natural aeries were not accessible by mammalian predators. One natural aerie used successfully in 1983 and 1984 was 1 m above the slope below. Seven other natural aeries were 4 m or less above the base of the cliff. Denton (1975), Ogden (1973), and Runde and Anderson (1986) reported nesting ef-

TABLE 1. Physical characteristics of natural Prairie Falcon aerie sites and aeries in North Dakota, 1982 to 1985.

Characteristic	Mean	Range	Standard deviation	Sample size
Cliff length (m)	103	5–500	121.0	31
Cliff height (m)	11	3–35	5.8	34
Aerie height above base of cliff (m)	7	1–27	4.8	33
Relief (m)	69	10–180	42.9	41
Aerie height (cm)	45	20–120	22.2	29[a]
Aerie width (cm)	86	25–210	41.3	31
Aerie depth (cm)	80	35–250	48.9	31
Aerie volume (m^3)	0.24	0.02–0.95	0.24	29[a]

[a] No measurement for two aeries on Golden Eagle nests.

forts 2.1 m, 2.4 m, and 2.9 m above the bases of the cliffs, respectively. Enderson (1964) and Platt (1974) suggested that inaccessibility by mammalian predators is critical in selection of aeries, and cliff height and aerie height above the base of a cliff are less important. My findings suggest that aerie distance above the base of the cliff need not be large.

Snow (1974) and Call (1978) suggested that aeries with a view of treeless terrain are preferred. At 9 of 41 aeries in North Dakota relief was 30 m or less, but usually there was at least 0.5 km of open terrain visible from an aerie.

The smallest aerie found (Table 1) was used successfully in the late 1970s (J. Crawford, pers. comm.). Four additional aeries were smaller than 0.06 m^3. Young fledged from these five aeries, but the percentage of young that fledged is unknown. Crowding of nestlings can be a serious problem in small aeries (Call 1979). S. Platt (pers. comm.) documented nestling mortality at an aerie in Colorado with a floor only slightly larger than 21 by 28 cm. As the brood grew, two of the four nestlings presumably were pushed from the aerie.

A random sample of slopes on topographic maps indicated that all aspects were equally available (n = 160, G = 5.616, df = 7, P = 0.585). However, cliff aspects for natural aeries were not evenly distributed, (G = 22.32, df = 7, $P < 0.01$), with 38% of the aeries facing SW. Other cliff aspects were: N—10%, NE—13%, E—5%, SE—15%, S—8%, W—8%, and NW—3%. One of the artificial aeries faced SE, two faced S, and one faced SW. With few exceptions, aerie aspect was the same as cliff aspect.

Re-use of aeries is shown in Table 2. It seems that there may be more re-use of aeries facing southeast to southwest than of aeries facing other directions, but further monitoring of nesting is needed to confirm this hypothesis. The tendency to have alternate aeries near each other has not been confirmed in North Dakota; only two pairs of alternate aeries are known.

Enderson (1964, Colorado), Porter and White (1973, Utah), Denton (1975, Oregon), Becker (1981, southeastern Montana), and Runde and Anderson (1986, Wyoming) reported that aeries facing south to west were most often used. Tyler (1923) found that most aeries in central California faced north. Leedy (1972) found no preference for cliff aspect in western Montana. Williams (1984) believed that aerie aspect may help moderate diurnal temperature extremes and allow falcons to time nesting so that development of young coincides with peak prey abundance. In New Mexico, Platt (1974) found that Prairie Falcon aeries were cooler than ambient temperatures during the hottest part of the day. Aeries in cliffs facing south and southwest are less likely to benefit from early morning insolation than those facing east or southeast, and young in these aeries are more likely to be exposed to direct sunlight during the hottest part of the day. However, in North Dakota, heat absorbed by cliffs facing southeast, south, or southwest may moderate low night and morning temperatures. Alternatively, aeries facing toward the south may be protected from the prevailing winds during the nesting season. As noted by Allen et al. (1986) and Runde and Anderson (1986), spring storms at northern latitudes may have severe impacts on Prairie Falcon nesting success.

TABLE 2. Re-use of Prairie Falcon aeries in North Dakota, 1982 to 1985.

Years used	Years surveyed			
	1	2	3	4
0	1[a]	5[b]	2	2
1	6[b,c]	6[b,c]	2	2
2		3[c]	5	2
3			4[b]	0
4				2

[a] Number of aeries. Aeries that had fallen before the study began are not included.
[b] Includes one artificial aerie.
[c] One aerie eroded away after it was checked this year.

Native rangeland used for grazing was the predominant habitat around natural and artificial aeries. At 17 sites agriculture also was a major land use. Five natural aeries were within 300 m of heavily used gravel or paved roads.

In North Dakota the majority of the aeries are in small cliffs. Cliffs facing southwest seem to be preferred, but some face each compass direction. Almost any small cliff in western North Dakota could contain an aerie. Most importantly, though many aeries are relatively permanent, about half are located in cliffs that are subject to much erosion. Some aeries are lost and some are created each year, so there may be a fairly constant movement to new aeries. These changes make efforts to survey the nesting population difficult. Also, there is very limited information about Prairie Falcon nesting activity and nesting success in North Dakota. Assessment of nesting habitat will require study of habitat around aeries and in areas not selected for nesting. Further research will be necessary to determine if some aerie or cliff characteristics are preferred or contribute to greater nesting success.

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SNOW BUNTINGS FEEDING ON LEAVES OF SALT-MARSH GRASS DURING SPRING MIGRATION[1]

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Key words: Snow Bunting; spring diet; grass leaves; Hudson Bay.

Snow Buntings (*Plectrophenax nivalis*) are considered to be granivorous birds (Parmelee 1968, Custer and Pitelka 1975) although their diet shifts to insects during the breeding season (Nethersole-Thompson 1966). There are few references to their feeding ecology during spring migration. In this paper I report on Snow Buntings eating newly grown leaves of salt-marsh grass (*Puccinellia phryganodes*) while on spring migration at La Pérouse Bay, Manitoba, Canada (58°04′N, 94°03′W). To my knowledge the observations reported here are the first indicating widespread feeding by Snow Buntings on plant leaves as well as seeds. I also compare the period of availability of this food source with that during which birds were present in 1984 at La Pérouse Bay.

Observations on Snow Buntings "grazing" on grass leaves were collected during a study of the response of *Puccinellia* to grazing by Lesser Snow Geese (*Chen caerulescens caerulescens*) which breed in willow tundra slightly inland at La Pérouse Bay. *P. phryganodes* and a sedge, *Carex subspathacea*, are the dominant plant species on the extensive coastal and estuarine salt-marsh flats, often forming pure stands. A sample of 133 *Puccinellia* shoots in four sites protected from Lesser Snow Geese by chicken wire exclosures (0.8 m × 0.8 m × 1 m high), was examined between 7 and 9 June 1984, 7 to 12 days after melt. Each shoot was examined once during this period. The exclosures were erected in June 1983 and the mesh size of the wire was

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