Relationship Between Prairie Falcon Nesting Phenology, Latitude and Elevation

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The relationship between timing of reproduction, latitude and elevation is a well known biological phenomenon: birds in northern areas breed later than birds in southern ones (Alee et al. 1949; Johnston 1954; Morton 1978). The Peregrine Falcon (*Falco peregrinus tundrius*) showed delayed nesting in North America with increasing latitude (White 1964). The Prairie Falcon (*Falco mexicanus*) in New Mexico (Platt 1974) and Oregon (Denton 1975) showed delayed nesting with increasing elevation. However, the cumulative effect of latitude and elevation on reproductive phenology has not been examined for any of the large falcons. It would be of general interest to know to what extent the variation in timing of reproductive phenology can be influenced by latitude and elevation. Additionally, an analysis of this phenomenon may elucidate general trends and/or physical limitations that determine the breeding range of large falcons.

The Praire Falcon presents an ideal study case for an examination of this phenomenon. It breeds over a wide range of latitudes, from 25.5° N (Lanning and Lawson 1977) to 54° N (Fyfe pers. comm.), and elevations, from near sea level (D. Boyce pers. comm.) to 3688 m (Marti

Table 1. Mean values for latitude and clutch completion date, sample size, and source study for 20 local populations of the Prairie Falcon.

°N Latitude	Clutch Completion	Breeding Pairs	Source
25.5	23 March	5	Lanning and Lawson 1977
32	10 March	1	Mader pers. comm.
32.5	29 March	1	Porter pers. comm.
34.2	9	1	Porter pers. comm.
35	26 March	24	Boyce pers. comm.
37	14 April	15	Platt 1974
40	13 April	10	Porter and White 1973
40.5	25 April	36	Enderson 1964
40.5	17 April	17	Olendorff 1973
41	17 April	9	Craig pers. comm.
41	3 May	23	Williams 1980
42.5	13 April	68	Ogden and Hornocker 1977
43	12 April	5	Johnstone 1980
44.5	16 April	49	Denton 1975
45.5	27 April	66	Becker and Ball 1981
47	6 April	6	Monk 1981
48	28 April	38	Leedy 1972
51	3 May	7	Edwards 1968
52.5	26 April	17	Fyfe pers. comm.
54	10 May	1	Fyfe pers. comm.
GROUP (X ± S.D.)			
43.1° ± 4.5°	18 April ± 10d	n = 401	

Table 2. Mean values for elevation and clutch completion date, sample size, and source study for 20 local populations of the Prairie Falcon.

ELEVATION (m)	CLUTCH COMPLETION	BREEDING PAIRS	SOURCE
700	6 April	8	Monk 1981
700	13 April	68	Ogden and Hornocker 1977
700	26 April	17	Fyfe pers. comm.
700	10 May	1	Fyfe pers. comm.
1030	26 March	24	Boyce pers. comm.
1100	27 April	66	Becker 1981
1180	29 March	1	Porter pers. comm.
1200	10 March	1	Mader pers. comm
1200	16 April	49	Denton 1975
1200	3 May	7	Edwards 1968
1500	12 April	5	Johnstone 1980
1500	13 April	10	Porter and White 1973
1500	28 April	38	Leedy 1972
1700	17 April	17	Olendorff 1973
1700	14 April	15	Platt 1974
1800	25 April	36	Enderson 1964
2000	17 April	9	Craig pers. comm.
2510	9 April	1	Porter pers. comm.
2720	3 May	23	Williams 1980
2800	23 March	5	Lanning and Lawson 1977
GROUP (X ± S.D.) 1320 ± 540 m	18 April ± 10 d	N = 401	

and Braun 1977). However, observations of Prairie Falcons nesting at elevations greater than 3000 m are few and do not permit analysis of the effects of high elevation on nesting phenology. Nevertheless, the Prairie Falcon has been well-studied and data are available from local nesting populations for latitudes 25.5° - 54° N (Table 1) and elevations 700 - 2800 m (Table 2). Data from the source studies (Tables 1 and 2) were reported in highly varied forms, therefore it was not possible to calculate standard deviations or standard errors for many of the mean values listed. The sequential events in the reproductive phenology of large falcons (e.g., territory establishment, copulation, hatching and fledging) are difficult for the researcher to observe and to record accurately with regards to time. It is relatively easy, however, to age young nestlings in the eyrie (see Fowler 1931; Moritsch 1983) and establish hatch dates. Traditionally, clutch completion dates have been calculated by backdating 30 days from hatching dates (Olendorff 1973). I employed this method for studies listed in Tables 1 and 2, unless specific data or different methods were provided by individual authors. In this study, therefore, mean clutch completion dates (Tables 1 and 2) were used as the data base for statistical analysis and were assumed to be representative of the timing of the Prairie Falcon's reproductive phenology in each locality reported.

On this basis, I tested the prediction that Prairie Falcons nest at higher elevations in southern latitudes and at lower elevations in northern latitudes by dividing the reported breeding range (25.5° - 54° N latitude, Table 1) into quartiles. Weighted mean elevations for the quartiles were compared using ANOVA (SAS 1982) with the southernmost quartile ($\bar{x} \pm$ s.d. = 2340 ± 786 m) differing significantly ($F = 10.5$, $P < 0.0001$) from the 3 more northern quartiles. Although the mean elevation of the northernmost quartile ($\bar{x} \pm$ s.d. = 1177 ± 376 m) was the lowest of the means, it did not differ significantly (Duncan's Multiple Range, $P < 0.05$) from the central 2 quartiles (south-central $\bar{x} \pm$ s.d. = 1344 ± 567 m).

Multiple regression techniques (SAS 1982) for linear and non-linear models were applied to the combined data from Tables 1 and 2. A linear model (clutch completion = 5.361 + 2.036 latitude + 0.012 elevation) provided the best fit ($R = 0.85$, $P < 0.001$) with latitude accounting for

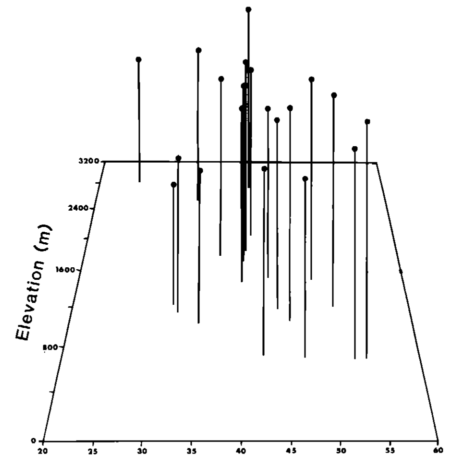

Figure 1. Clutch completion dates by latitude and elevation for 20 breeding populations of the Prairie Falcon. Clutch completion dates (range 10 March - 10 May) are depicted by circles atop vertical lines where height of line increases with increasing date. See Tables 1 and 2 for date.

64% of the variation in clutch completion dates and elevation an additional 21%. A general trend is observable in Figure 1 in which the mean elevation of nesting Prairie Falcon populations decrease with increasing latitude. The strong relationship of clutch completion date with latitude is easily seen in Table 1. Two studies (Lanning and Lawson 1977; Williams 1980) that do not appear to conform to the relationship had mean elevations greater than 2700 m (Table 2), which may have delayed clutch completion date.

The relationship of clutch completion date with elevation is not as apparent (Table 2). It is interesting to note that the 2 populations nesting north of 52° N latitude (Fyfe pers. comm.) (Table 1) both nested at 700 m (Table 2), the lowest nesting elevations considered in this study. Conversely, the southernmost population (25.5°N latitude (Table 1)) nested at 2800 m, the highest elevation considered in this study. It seems, therefore, that these patterns may represent the extremes of the Prairie Falcon's breeding range and nesting phenologies, with birds in the south using the cool mountain tops in Mexico (Lanning and Lawson 1977) and Canadian prairie birds utilizing escarpments along low-lying prairie river systems (Fyfe pers. comm.). In both situations, specific nesting localities may provide a climate more equitable for breeding Prairie Falcons than the prevailing climate at that latitude. Falcons in northern regions may be utilizing behavioral and ecological adaptations to augment their nesting attempts, such as choosing south and/or east facing eyries (see Williams 1984) rather than being restricted to nesting on low-elevation escarpments along river systems. Such diversity in nesting phenology could provide a means of range expansion or a means of utilizing a variety of habitats to accomplish reproduction.

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Recapture of a Non-breeding Boreal Owl Two Years Later

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On 22 April 1984, while mist-netting owls at Whitefish Point, Chippewa County, Michigan, I recaptured a Boreal Owl (*Aegolius funereus*) that was banded at this location by Warren A. Lamb on 3 May 1982. There are no known summer or breeding records for this species in Michigan, though fair numbers are captured at Whitefish Point during most springs (Payne 1983). Thus, this bird was apparently moving north during both years it was captured following a southward movement during the preceding fall or winter.

Periodic southward movements of the Boreal Owl have received previous attention (Anweiler 1960; Bent 1961; Mysterud 1970; Catling 1972; Evans and Rosenfield 1977). However, to my knowledge this is the first time a Boreal Owl has been recaptured in North America in a subsequent year following a southward movement. Recapture in a subsequent year of owls banded during migration is not a common occurrence as shown by the low recapture rate of the highly migratory Northern Saw-whet Owl, *Aegolius acadicus* (Woodford 1959).

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