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## The Effect of Agriculture on Ferruginous and Swainson's Hawks

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### Abstract

Raptors are an important component of prairie ecosystems. I examined the effects of grassland conversion to agricultural fields on densities of nesting prairie hawks. Densities of Swainson's hawks were recorded for comparison. The 2 species of congeneric hawks responded differently to habitat loss despite considerable overlap in their use of resources. As cultivation on study plots increased, ferruginous hawks declined. Swainson's hawks were more abundant in areas of moderate cultivation than in grassland or in areas of extensive cultivation. Differences in the hawks' responses were attributed to differences in their ecology, primarily prey utilization. There was no evidence that soil quality affected hawk abundance.

**Key Words:** habitat alteration, raptors, abundance, density, grassland

Since settlement and the advent of modern agriculture in western Canada, prairie ecosystems have been radically altered (Mitchell 1984). This alteration has had 2 fundamental causes: grassland has been converted to cultivated fields, and grassland fires

have been suppressed thereby encouraging invasion of grassland by shrubs and trees (Vogl 1974). Associated changes in the distribution of mammals sought for fur or food have been documented (Mitchell 1984), but the presettlement distribution and abundance of raptors and their prey are poorly known.

In this paper I evaluate the effect of cultivation and the associated agricultural activity on hawk density in the prairie region of southeastern Alberta. The degree of tolerance shown by the hawks toward cultivation has not been assessed, although declines in abundance of prairie raptors have been attributed to grassland loss (Olendorf 1973; Gilmer and Stewart 1983, 1984; Houston and Bechard 1984; Schmutz 1984). An understanding of the hawks' responses to increased cultivation is important. The increasing food demands made by a growing human population are expected to be met by increasing productivity on currently cultivated land and by bringing yet more land into production (Barr 1981).

### Materials and Methods

I conducted 2 field studies. The size of ferruginous and Swainson's hawk populations were estimated using 80 plots in 1982 (Schmutz 1984). These quadrat plots were 41 km<sup>2</sup> and were randomly selected from a 73,964-km<sup>2</sup> area within the prairie region of southeastern Alberta. Land use on the plots was either cultivation or pasture. A second study area near Hanna, Alberta (Schmutz et al. 1980), equivalent to 7 quadrat plots with 2-25% cultivation, was studied more intensively. Since the availability of nest sites can

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limit hawk density (Schmutz et al. 1984) and this may obscure effects caused by land use, 12 of a total of 87 plots were excluded from the analysis because all available nesting territories were occupied. A nesting territory was considered available if a quarter section (0.64 km<sup>2</sup>) with trees or shrubs was not occupied by a nesting buteo.

All 75 plots were completely searched for occupied hawk nests. The search was conducted during the hawks' incubation and nesting periods between 18 May and 13 July. Most searching for nests was done by riding a motorcycle but some was done by walking or driving a truck through the plot searching for nests with a telescope or binoculars. Landowners were also asked for the location of hawk nests but these nests were recorded only if verified. Nests were considered occupied if at least a completed nest cup was found and a period of nest use was indicated by the presence of hawk feathers and droppings.

The proportion of cultivation per plot was also recorded. To elucidate the effect of soil quality on hawk density, plots were categorized as having soil of either "good" (Canada Land Inventory 1976, average rating 1-3) or "poor" (average rating 4-7) agricultural quality.

Counts of nests on plots represent discrete values which were often equal and these weaken statistical methods based on ranked data (Conover 1971). To overcome this problem, I used Chi-square tests after the number of nests on plots were evaluated as greater or lesser than the combined mean of those cultivation categories to be compared. The null hypothesis was rejected at the 0.05 significance level.

The 2 species of hawks were compared in terms of their responses to human activity, determined by recording the distance at which an adult left the nest in response to an observer approaching on a motorcycle or on foot. Although the hawks may exhibit different degrees of fear toward moving machinery, or toward a person on horseback than toward a person on a motorcycle, differ-

ences between species are considered important here and these differences may be preserved. Flushing distance was recorded during the incubation and early nesting periods (ferruginous: 15 May-15 June; Swainson's: 5 June-15 July).

## Results

The proportion of land on plots that was cultivated ranged from 0-98%. The density of ferruginous hawks declined with increasing cultivation (Fig. 1) (Spearman's  $\rho = -0.507$ ,  $n=75$ ,  $P < 0.001$ ) and this relationship approximated a straight line. In contrast, Swainson's hawk density did not vary in a linear manner but showed a bimodal pattern. To evaluate the different responses to degree of cultivation by Swainson's hawks, their density on plots of selected cultivation categories was compared. Swainson's hawks were more common ( $\chi^2=5.49$ ,  $P=0.019$ ) in areas of moderate cultivation (11-30%) than in grassland (0-10% cultivation) (Fig. 1). Ferruginous hawk densities on the same plots did not differ significantly between these categories ( $\chi^2=0.74$ ,  $P=0.609$ ). A second peak in Swainson's hawk density at 71-90% cultivation (Fig. 1) was not significantly different from the number of nests on plots with 31-70% cultivation ( $\chi^2=3.35$ ,  $P=0.067$ ).

To explore the possibility that the apparent bimodality in Swainson's hawk density was caused by differences in land productivity, I examined the relationship between soil quality and Swainson's hawk density. Swainson's hawk abundance did not differ whether the soil was of "good" (rating 1-3) or "poor" (rating 4-7) quality (Fig. 2). The second peak was probably the result of exceptionally high densities on only 5 plots which were located in the western prairie-parkland ecotone where nesting densities traditionally have been high (M.R. Lein, pers. comm.).

When all plots with greater than 10% cultivation were combined, Swainson's hawk density declined with increasing cultivation ( $\rho = -0.279$ ,  $n=$ ,  $P=0.013$ ) but density and degree of cultivation were less strongly correlated in this species than in ferruginous hawks. Swainson's hawk tolerated high levels of cultivation (91-100%), but ferruginous hawks did not.

Data on reproductive success of Swainson's hawks in relation to cultivation also suggested that the hawks fared better near cultivated fields than in extensive grasslands. In 1984, each pair of Swainson's hawks on the Hanna study area raised on average 1.3 young to fledging. Reproductive success of pairs nesting near fields was higher than those in extensive grassland. Of 37 pairs that nested within 1 km of a cultivated field, 57% raised 2 or more

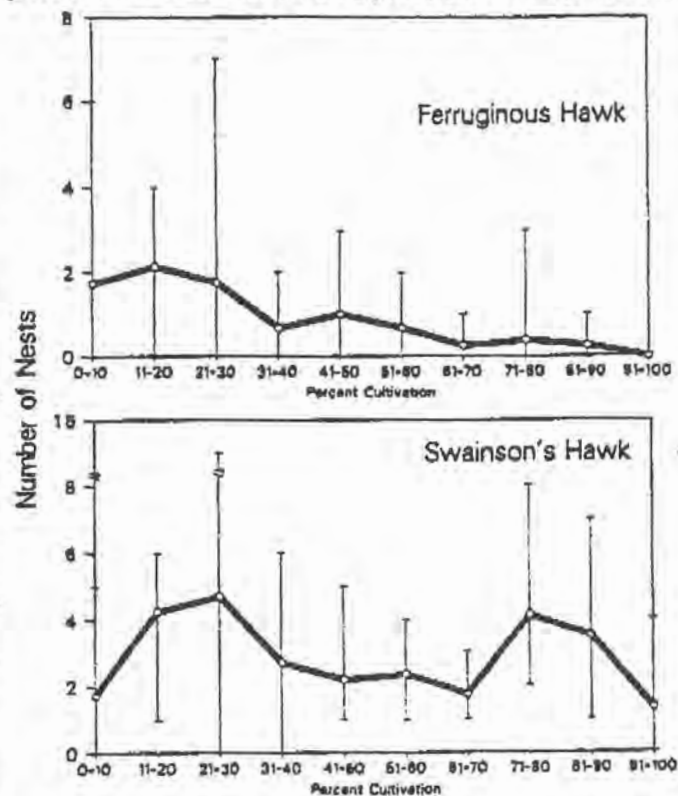


Fig. 1. The number of nests of ferruginous and Swainson's hawk are shown in relation to the extent of soil cultivation. The bars represent the range. The number of plots in each cultivation category was 11, 7, 8, 6, 6, 3, 4, 8, 3, 14 respectively.

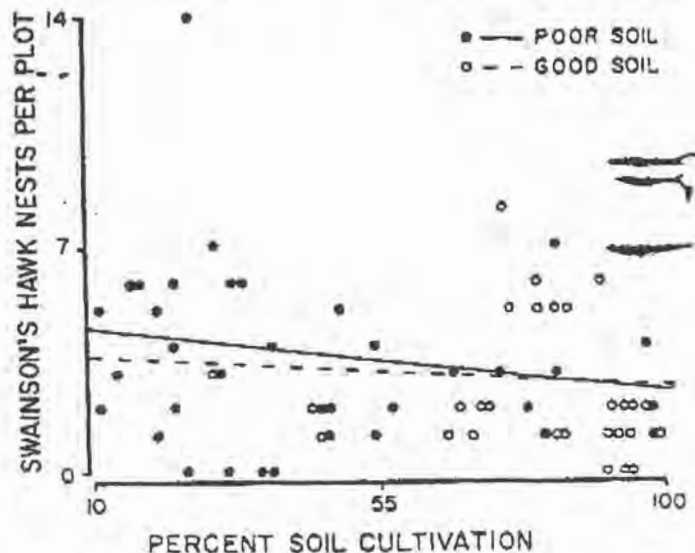


Fig. 2. Nesting density of Swainson's hawks relative to the extent of soil cultivation for "good" versus "poor" soil quality.

young. Only 28% of pairs farther than 1 km from fields raised 2 or more young ( $X^2=5.72, P=0.017$ ).

The higher frequency of human traffic associated with agricultural practices was less likely to affect Swainson's hawks than ferruginous hawks. Swainson's hawks flew from their nests at an average distance of 18 m when approached by an observer (range=2-100,  $n=52$ ) whereas ferruginous hawks flew at 110 m (range=4-400,  $n=34$ ). Significantly more flushing distances of ferruginous hawks (53%) than Swainson's hawks (11%) were greater than the mean distance for both species combined ( $X^2=17.52, P<0.001$ ).

### Discussion

Despite their similar use of resources (Schmutz et al. 1980; Gilmer and Stewart 1983, 1984), Swainson's and ferruginous hawks responded differently to loss of grassland. Ferruginous hawks declined consistently as percent cultivation increased. Swainson's hawks nested at higher density in areas of moderate cultivation compared to grassland or areas of extensive cultivation. Swainson's hawks also reproduced more successfully when nesting near fields in areas of moderate cultivation. Despite a slight negative effect on density accruing from extensive cultivation, Swainson's hawks, unlike ferruginous hawks, were remarkably abundant even in extensively cultivated areas.

Differences in ecological characteristics between these 2 hawks may account for the differences in their responses to cultivation. Ferruginous hawks exhibit a restricted distribution including arid grassland and desert shrub habitat (Brown and Amadon 1968, Schmutz and Fyfe 1987), suggesting an affinity for land with sparse and short vegetation. In such areas they nest on the ground where no trees are available. Ferruginous hawks often stalk their prey or crouch waiting at a burrow (Wakeley 1978), a habit which is only expedient in open country. Ferruginous hawks are more specialized in exploiting pocket gophers, ground squirrels and hares than are other prairie raptors (Howard and Wolfe 1973, Lokemoen and Duebbert 1976, Smith and Murphy 1978, Schmutz et al. 1980, Gilmer and Stewart 1983). Given these adaptations it is not surprising that ferruginous hawks avoid areas where grasses are replaced by dense and tall crops.

In contrast to ferruginous hawks, Swainson's hawks occupy aspen parkland and prairie where trees or shrubs are available for nesting. Swainson's hawks use a wide range of prey including mammals, birds, reptiles, amphibians, and insects (White 1966, Olendorff 1973, Littlefield 1973, Sexton and Marion 1974, Dunkle 1977, Schmutz et al. 1980, Gilmer and Stewart 1984). Although ground squirrels comprised 70% of prey biomass of Swainson's hawks on the Hanna study area (Schmutz et al. 1980), these rodents are near the upper limit of prey size that this medium sized hawk is able to subdue. This was evident during 3 observations when a Swainson's hawk released and lost a ground squirrel during a capture attempt. The feet of Swainson's hawks often bore substantial scars, suggesting injury during prey capture (personal observation). Thus, when ground squirrels are relegated to small fragments of grassland and decline in numbers as cultivation becomes the dominant land use, Swainson's hawks probably shift to feed on voles and mice. These small rodents are more common in the ungrazed grassy borders of ponds, roads, and farmsteads than in intensively grazed pastures. Swainson's hawks also hunt over fields after harvest (Bechard 1982), undaunted by the activities of man and machinery.

The greater reproductive success of Swainson's hawks nesting near fields is probably attributable to an increase in prey abundance in response to artificially increased plant productivity in the presence of nearby cover. The fields were bordered by strips of dense grassland which, in combination with nearby pastures, provided adequate cover for prey. The density enhancing effect of greater soil quality, demonstrated for woodland raptors (Newton et al. 1977), was not evident in this study.

The results of this study have implications for the management of ferruginous and Swainson's hawks. Because Swainson's hawks did not decline drastically in response to cultivation, they should respond well to relatively minor conservation efforts. If small patches of natural or seminatural cover containing trees or shrubs are strategically distributed in agricultural areas, Swainson's hawks are likely to remain in reasonable numbers. Although Swainson's hawks have declined dramatically in California, this decline was only partially attributed to agricultural development (Bloom 1980). Ferruginous hawks, in contrast, require grassland and this hawk will probably only persist where cattle or sheep grazing remains the dominant land use.

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