Range Improvement Practices and Ferruginous Hawks

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Highlight: *The implications of range improvement practices on ferruginous hawks (*Buteo regalis*) are discussed. During 1972 and 1973 the habitat requirements and breeding biology of 43 and 54 nesting pairs, respectively, were studied in northern Utah and southeastern Idaho. Utah juniper (*Juniperus osteosperma*) provided sites for 95% of observed nests. Desert shrub types and crested wheatgrass (*Agropyron cristatum*) seedings comprised the dominant vegetation around nest sites. Black-tailed jackrabbits (*Lepus californicus*) comprised 88.7 and 79.4% (by weight) of prey items collected from nests in the 2 years of study. Jackrabbit abundance may be a major determinant of the raptors' reproductive success in a given year, as suggested by a 47% decline in the number of young fledged per occupied territory between 1972 and 1973, concurrent with an estimated 79% decrease in jackrabbit numbers. Suggestions for minimizing or ameliorating the impact of range improvement practices on the hawks' prey base are given.*

The effects on birds of prey of large-scale range improvement programs conducted by land management agencies during the past two decades to convert shrub-dominated areas of the Intermountain West to grassland for livestock production are largely unknown. Present and pending habitat perturbations resulting from intensive agriculture and proposed energy development programs (e.g., strip mining, oil shale development, and geothermal exploration) also pose major threats to these birds.

The ferruginous hawk (*Buteo regalis*) was once a common raptor of ubiquitous distribution throughout the grassland and steppe-desert areas of the western United States and southern Canada. Its present status nationally is "undetermined" (U.S. Dep. Interior, 1968). However, the National Audubon Society defines the species' status as suffering from population declines and range diminuition in all or parts of its range (American Birds, 1972).

In 1972 the senior author undertook a study of the ecology of the ferruginous hawk in northern Utah and southern Idaho. Although not designed specifically to evaluate the effects of various range-improvement practices on the species, some aspects of the birds' habitat requirements in relation to these practices were revealed. In this report, we present the salient findings of that study with reference to the birds' food habits, nesting preferences, and reproductive success.

Study Area and Methods

The 2,800-km^2 study area comprises parts of two

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intermontane basins, Curlew and Raft River valleys, bisected by the Black Pine Mountains and the Utah-Idaho border. It is bounded on the east and west by the North Promontory and Raft River ranges, respectively. The area lies within the Great Basin Region, with "cold desert" (Odum, 1959) topography and climate prevailing below 1,700 m.

Vegetation in Curlew and Raft River valleys lies within the northern desert shrub biome and is delineated into three altitudinally defined zones (Cronquist et al., 1972). The "shadscale" (*Atriplex confertifolia*) zone occurs on saline valley soils at altitudes generally below 1,400 m. Black greasewood (*Sarcobatus vermiculatus*) is associated with shadscale around recently flooded mud flats and in dry streambeds. At higher elevations, usually above 1,500 m, big sagebrush (*Artemisia tridentata*) becomes dominant ("sage zone"), often as a monotypic stand. Other shrub components of this zone include black sagebrush (*A. nova*) and rubber rabbitbrush (*Chrysothamnus nauseosus*). Utah juniper (*Juniperus osteosperma*) and at higher elevations pinyon pine (*Pinus edulis*) comprise the third major zone ("pinyon-juniper zone"). Its elevation varies, but it is generally limited by lack of moisture to elevations above 1,500 m. Ground vegetation in these zones is characterized by a variety of forbs and grasses as enumerated in Cronquist et al. (1972).

Extensive crested wheatgrass (*Agropyron cristatum*) seedings have been established in both valleys. Agricultural crops include alfalfa and small cereal grains. Most farms are located in the sage zone.

From March through July of 1972 and 1973, systematic searches were conducted for ferruginous hawks attending nests. Their locations were plotted on a topographic map (1:250,000) and designated numerically. Since several nests with eggs in the early stages of incubation were abandoned after visitation in 1972, no nests were visted in 1973 until late May; they were, however, checked periodically at a distance for activity. Subsequent visits were made to nests to determine their reproductive status and collect prey items and pellets.

Since Curlew and Raft River valleys comprise discrete geographical units, hawk densities were computed independently for each. Productivity was calculated on the basis of young fledged per occupied territory. Presence of one or more eggs in a nest determined a nesting attempt. A successful nest was one from which one or more young were fledged. Densities were determined by dividing the total number of occupied territories by the total area of townships in which pairs were found. Since all occupied territories in the study area were not located, the estimates thus obtained are conservative, but comparable for the 2 years of the study since the techniques and relative effort employed in the location of nests was the same in both years.

In 1972 prey items and pellet samples were collected randomly from 19 nests. Seven nests were selected in 1973 for regularized collection of food habits data; four were located in crested wheatgrass seedings and three were located in desert shrub vegetation. These nests were visited every 4 days. Contents of pellets (skulls and teeth) and nonpellet items from the same nest were grouped for analysis (*vide*: Craighead and Craighead, 1956).

Percent frequency of occurrence for all prey items and biomass for the three major prey species was calculated for each year. Biomass was determined by using the following mean weights: black-tailed jackrabbit, 2,100 g (Stoddart, 1972a); Townsend ground squirrel (*Spermophilus townsendi*), 248 g (Scheffer, 1941); and northern pocket gopher (*Thomomys talpoides*), 100 g (Turner et al., 1973).

Gross composition of vegetation surrounding 63 ferruginous hawk nests was determined from aerial photographs (scale: 2.54 cm = 438 m) by means of a technique similar to the method described by Luttich et al. (1970) for classifying vegetation surrounding red-tailed hawk (*Buteo jamaicensis*) nests. Photography was not available for the entire study area. After nest sites had been located on the photos, a scaled circle (2.0 km^2, radius = 0.8 km) was drawn on a tracing paper overlay, using the nest site on the photo as the center. Of nine observed hunting forays by paired adults, eight (88.9%) were within 0.8 km of their respective nests. One foray was observed 1.9 km from the nest. The mean distance of these observations was used as the basis for arbitrarily defining a hunting territory.

Plant types were identified and mapped within the circle. General plant types included five categories: (1) desert shrub, comprising "shadscale" and "sage" zones; (2) crested wheatgrass treatments in varying stages of reversion to sagebrush; (3) juniper woodland; (4) alfalfa fields; and (5) cereal crops. Vegetative types on the photos were verified in the field. The circle was then cut into specific plant types and each segment weighed on a Mettler B-5 electronic balance. Percent composition of each vegetation type was calculated from the weights.

One problem associated with this approach is that territories are seldom if ever circular and probably not constant in size between years. However, lacking range data for all nesting pairs each year, a standard circle was employed. Moreover, since the circles were plane-projected, some biases due to irregular topography may have resulted. Their effect would, however, seem small when the results are employed only for comparative purposes.

Results

Density and Reproductive Performance

Forty-three and 54 pairs were found occupying territories in 1972 and 1973, respectively. Areal densities for occupied territories and successful nests on the study area are given in Table 1. The data shows a substantial increase in the area per successful nest from 1972 to 1973. This phenomenon may reflect changes in the territorial requirements of breeding pairs relative to prey abundance.

Of 65 nesting attempts observed in both years, 54 (83.1%) were successful (i.e., produced young). Nesting success in 1972 and 1973 was 82.6 and 85.2%, respectively. Mean clutch size in nests examined was identical in both years (2.8). These figures are low by comparison to those of other investigators. An earlier (1969) survey of 11 ferruginous hawk nests in Curlew Valley Platt (personal communication) reported an average clutch size of 3.5, while Smith and Murphy (1973) cited a mean clutch size of 3.2 for the period 1967–70 in west-central Utah.

Table 1. Density of occupied territories and successful nests for Curlew and Raft River valleys, 1972 and 1973.

Location and year	Breeding pairs	Successful nests	Density (km²) Per occupied territory	Density (km²) Per successful nest
Curlew				
1972	24	18	47.0	62.7
1973	25	13	48.5	93.2
Raft River				
1972	19	13	44.2	64.5
1973	29	13	21.1	71.7
Both areas				
1972	43	31	45.8	63.5
1973	54	26	33.8	82.5

Actual production of young differed considerably between 1972 and 1973. The number of young fledged per occupied territory represents the best estimate of young recruited into the population. Comparable values for this parameter were 1.9 and 1.0 in 1972 and 1973, respectively. The 47.4% reduction in the number of young produced in 1973 may be related to a major decline in jackrabbits as discussed later. In 1974, a brief survey was made to validate this reduction. From 40 nests 1.2 (48) fledged per occupied territory indicating continued low production.

Food Habits

A total of 197 prey items were collected from nests in 1972 and 1973. Based on percent frequency of occurrence 11 mammal species comprised 90.4% of the total prey items, while six bird species and three reptile species constituted 6.1 and 3.1%, respectively. Lagomorphs and rodents were the most important mammalian prey items. Again, based on frequency of occurrence, northern pocket gopher, black-tailed jackrabbit, and Townsend ground squirrel cumulatively comprised 85.0 and 76.4%, respectively, of all the mammalian prey items examined in 1972 and 1973. Although pocket gophers were more numerous in a frequency count, jackrabbits were the most important single prey item on a weight basis. Jackrabbits comprised 88.7 and 79.4%, respectively, of the biomass of the major prey species utilized by the hawks in 1972 and 1973 (Fig. 1). Pocket gophers constituted 5.4 and 6.6% during the respective years, while ground squirrels accounted for 4.2 and 6.6%. Smith and Murphy (1973) corroborated the importance of jackrabbits as a major prey item. In their study jackrabbits represented 95.0 and 93.0% of the total biomass of prey in 1969 and 1970.

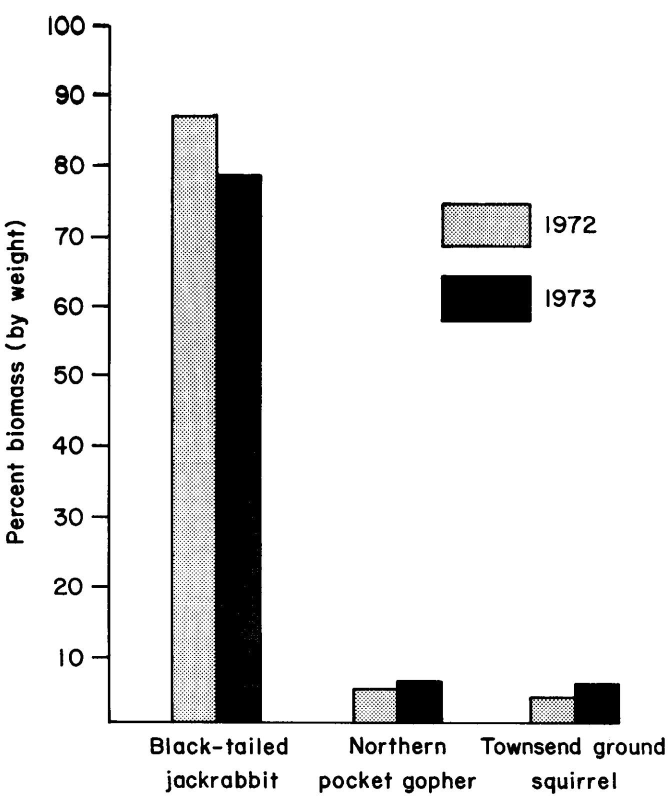

Fig. 1. *Changes in biomass of major prey species found in ferruginous hawk nests, 1972 and 1973.*

Table 2. Frequency of prey species from seven nests located in desert shrub and crested wheatgrass-alfalfa vegetation types, 1973.

Species	Desert shrub		Crested wheatgrass-alfalfa	
	No.	Percent	No.	Percent
Northern pocket gopher	0	0	50	57.4
Black-tailed jackrabbit	31	67.3	3	3.4
Townsend ground squirrel	2	4.3	18	20.6
Ords' kangaroo rat	4	8.6	0	0
Pygmy rabbit	1	2.1	1	1.1
Long-tailed weasel	1	2.1	1	1.1
Sagebrush vole	0	0	1	1.1
Mountain vole	0	0	1	1.1
Birds	3	6.5	10	11.4
Reptiles	4	8.6	2	2.2
Total	46	99.5	87	99.4

Mean jackrabbit density in Curlew Valley in the spring of 1972 was 47.1 per km^2 as compared to 9.7 in spring 1973 (Stoddart, personal communication). These figures indicate a drastic decline in the major prey species of 79%. At the same time the importance of jackrabbits in the hawks' diet decreased only 10.5% on a weight basis. This failure of the birds to shift to alternate prey species commensurate with the degree of reduction in the major prey species' numbers was probably a primary determinant in the reduced reproductive performance observed in 1973.

Some flexibility in food habits in relation to various habitat types is, however, indicated. Three nests in desert shrub vegetation and four in crested wheatgrass-alfalfa complexes were visited regularly in 1973 until the young fledged; prey items and pellets were collected. Totals of 46 and 87 prey items were identified from the respective types. Pocket gophers comprised 57.4% of the prey items in the crested wheatgrass type (frequency basis), while jackrabbits constituted a mere 3.4%. In the desert-shrub type, 67.3% of the prey items were jackrabbits. No pocket gophers were found (Table 2). Jackrabbit densities in Curlew Valley, as estimated by Stoddart and Anderson (1972), ranged from 2.6 to 3.0 per hectare in sagebrush types and 0 - 1.0 per hectare in crested wheatgrass types. These data suggest that the hawks' food habits may be influenced by relative abundance of various prey species in a given habitat type. The results may not, however, be strictly comparable, since jackrabbits were scarce in 1973 and relative densities of important alternate prey species in different habitat types are not known for either year.

Habitat preferences

Of 97 nest sites, 92 (95%) were located in juniper trees and three (3%) on the ground. Only one of the three ground nest attempts was successful. The incidence of ground nests on the study area is lower than that observed by Weston (1968) in Cedar Valley, Utah, where 41% of nests were located in trees, while 52% were on the ground.

Predominant vegetation types surrounding 63 nest sites examined in 1972 and 1973 were desert shrub and crested wheatgrass. The relative percentages of these types in the vicinity of successful nests was reversed in 1973 as compared to the previous year (Table 3). However, no major relocation of nests appears to have occurred. Of the 43 nests located in 1972, 30 (69.8%) were reoccupied in 1973. Five of the remaining 13 nests had been destroyed by wind in the winter of 1972-73. Old nests were found within 0.16 - 0.96 km from

Table 3. Composition (%) of important plant types surrounding ferruginous hawk nest sites.

Year and kind of nest	No. of nests	Plant types			
		Desert shrub	Crested wheatgrass	Juniper	Alfalfa
1972					
Attended nests	21	49	44	7	–
Nests with young	14	53	32	13	1
All nests	31	52	35	11	.06
1973					
Attended nests	11	54	41	5	–
Nests with young	16	32	56	9	4
All nests	32	42	48	8	2
Change (%) from 1972 to 1973 for nests with young		–40	+75	–31	–

14 nests occupied in 1972; six of these old nests were occupied in 1973. Only two new nests were known to have been constructed in 1973.

The observed shift in vegetation types around successful nests may again reflect the birds' response to low jackrabbit densities in 1973. Several investigators report that jackrabbits favor habitats providing an interspersion of tall cover and open spaces (Taylor and Lay, 1944; Lechleitner, 1958). Westoby and Wagner (1973) report that 70% of the jackrabbit utilization of crested wheatgrass seedings occurred within 300 m of its interface with the native desert shrub vegetation.

Crested wheatgrass treatments in various stages of reversion to original vegetation may increase the probability that hawks will produce young in years of low jackrabbit densities due to greater vulnerability of prey in these areas than elsewhere. However, a *t*-test revealed no significant difference between the relative percentages of crested wheatgrass in the vicinity of successful nests in 1972 and 1973, probably as the result of small sample sizes. These conclusions are not universally applicable. In other areas, where ground squirrels make up the major prey biomass, a different situation may exist (Olendorff, 1973). Additional data are needed to substantiate the above interpretation.

Cultivated areas contained no nest sites, although a trace of intensive agriculture occurred in the vicinity of one nest. Travener(1934) and Olendorff (1972) maintain that cultivation has a detrimental impact on ferruginous hawk nesting habitat.

Discussion

Much of the ferruginous hawk's present breeding range is administered by the Bureau of Land Management (Angell, 1968; Smith and Murphy, 1973; Howard, 1975). Management activities of this and other agencies may have considerable impact on the bird's welfare. As noted previously, this study was not designed specifically to evaluate the effects of land management activities on ferruginous hawks. Moreover, its short-term nature and the relatively small sample sizes involved preclude definitive and far-reaching conclusions. Some careful speculation may, however, be in order.

Unless modified to meet the hawks' biological requirements, the conversion of extensive tracts of native vegetation into monotypic stands—either as the result of large-scale brushland conversion programs or intensive agriculture—may reduce their densities and reproductive success due to: (1) increased disturbance; (2) loss of nesting sites; and (3) reduction of major prey populations.

During the incubation period, ferruginous hawks appear sensitive to human activity and even slight disturbances may cause nest abandonment (Olendorff, 1973). If habitat manipulation treatments are employed where hawks are nesting, treatment should be conducted either prior to the onset of incubation or after the young have fledged. Based on the breeding chronology observed in this study during 1972 and 1973, treatment should be deferred from approximately March 15 to July 15. Where treatment cannot be postponed and young hawks are present in the nest, the young may be transferred to another active nest with young of similar size. If an active ferruginous nest cannot be found, young may be transferred to an active Swainson's (*Buteo Swainsonii*) or red-tailed hawk nest. If treatment cannot be deferred and eggs are present in the nest, the clutch will have to be sacrificed. The clutch should not be transferred to another nest with eggs because of the high risk of causing the "foster" adults to desert.

The long-term implications of habitat manipulation practices on the birds must also be considered. Availability of nesting sites did not appear to be a limiting factor to the population under study, since juniper trees were plentiful (Platt, 1971). However, in chaining juniper communities some trees should be left on the perimeter of and interspersed in small islands throughout the treatment area to provide nest sites.

Density of the major prey species (black-tailed jackrabbits) appears to be the probable factor limiting this hawk population. Although composition of the birds' diet differed somewhat according to relative availability of various prey species in specific habitat types, the observed shift to alternate prey species in a year of jackrabbit scarcity was not commensurate with the magnitude of the lagomorph's decline (79%). This apparently resulted in decreased reproductive success in 1973. Kochert (1972) observed an analogous situation for golden eagles (*Aquila chrysaetos*) in southwestern Idaho. When jackrabbits, which comprised the bulk of the eagles' diet, declined significantly, the birds shifted to other prey species but not proportionately to the jackrabbits' numerical reduction. Under these circumstances, decreased reproductive output was also observed.

Jackrabbit numbers are generally greatest in the native desert shrub vegetation on the study area, although they may utilize the margins of crested wheatgrass treatments heavily (Westoby and Wagner, 1973). Results from the present study indicate that past crested wheatgrass seedings have not adversely affected reproduction of ferruginous hawks. Reversion to native vegetation occurring in these areas has created suitable habitat within a period of 6–8 years following treatment. Future treatments should, however, be designed to optimize the prey base for ferruginous hawks and other raptors. Maximization of edge and interspersion is the key factor in this endeavor. A pattern of treating small tracts, creating many interspersion areas, will be more beneficial than treating the same area in large blocks. In case of crested wheatgrass plantings, a minimum of 20% of the total area should be left in existing shrubby vegetation in the form of small islands scattered throughout the treatment. This design can produce optimum habitat for ferruginous hawks within 3 or 4 years after treatment.

In many areas of the Intermountain West, invasion of sagebrush-grass rangelands by juniper has resulted in the ultimate domination by the pinyon-juniper type (Cottam and Stewart, 1940; Woodbury, 1947; Blackburn and Tueller, 1970). These changes have been variously attributed to an early history of overgrazing and reduction of fires following settlement (Barney and Frischknecht, 1974).

Removal of these trees in range rehabilitation programs can effectively enhance the prey base. Baker and Frischknecht (1973) have demonstrated increases in small rodent numbers following chaining and reseeding of juniper range in central Utah. They observed statistically significant increases in numbers of deer mice (*Peromyscus maniculatus*) and pocket mice (*Perognathus purvus*) in the first 2 years following treatment on one area which was trapped prior to and for 3 years subsequent to treatment. Their findings with reference to lagomorphs were inconclusive since trapping methods were not conducive to trapping rabbits and hares; the authors maintained that their study underestimated numbers and importance of these animals, which would be of greater significance to ferruginous hawks. Whether or not renovation of dense and deteriorated juniper stands results in increased jackrabbit densities awaits additional investigation.

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