FACTORS AFFECTING THE USE OF HUNTING SITES BY FERRUGINOUS HAWKS

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Even under the most favorable conditions, the use of space for foraging by free-living animals is difficult to study. This is especially true for the large avian predators, most of which are highly mobile and may range widely in their search for prey. Some investigators have obtained useful information through radiotelemetry (Nicholls and Warner 1972), but that technique has the disadvantage that foraging movements often cannot be distinguished from other activities.

This paper reports on a study of the food-searching behavior of free-living Ferruginous Hawks (*Buteo regalis*). It examines the searching patterns of hawks in relation to spatial variations in vegetation type, cover density, and prey distribution within their foraging ranges. It also considers the influence of previous experience on the birds' searching patterns.

STUDY AREA

The study area was located in Curlew Valley, Idaho, about 8 km N of Snowville, Utah. It consisted of the home ranges of two adult male Ferruginous Hawks, designated as Male 1 in 1974 and Male 2 in 1975. I judged the two males to be different individuals from plumage differences, although both birds may have had the same mate. Observations were made during the nestling stage of the nesting season, when Male 1 had three young and Male 2 had two. Range boundaries were determined by drawing a line around the outermost sightings of each bird. I believe that nearly all of the birds' diurnal movements occurred within those boundaries. The two hawks occupied ranges of similar size and shape and nested less than 1 km apart (Fig. 1). Each nest was located about 3 m above the ground in the crown of a Utah juniper (*Juniperus osteosperma*) tree. Males 1 and 2 occupied ranges of 21.7 and 17.2 km², respectively.

Most cultivated fields in the study area were laid out in 16-ha squares which formed a convenient grid system for recording the location of the hawks' activities (Fig. 1). Each grid square was designated by its row and column headings (e.g., E-5) and had the same designation in both years.

The study area was divided into eight vegetation types (Fig. 1). Most plant names were determined from Holmgren and Andersen (1971).

Bare ground. Plowed fields without vegetation. Included some hard-packed dirt areas.

Pasture. Areas of grass or forbs cropped closely by livestock grazing. Common species were *Agropyron cristatum, Bromus tectorum, B. mollis, Taraxacum officinale, Eragrostis hypnoides, Salsola kali, Descurainia sophia, Kochia scoparia, Grindelia squarrosa, Lepidium perfoliatum,* and *Hordeum jubatum.*

Grass or grain. Cultivated grain (barley, wheat) or ungrazed crested wheatgrass (*Agropyron cristatum*) fields; these were combined into a single vegetation type due to their similar structure.

Alfalfa. First-growth alfalfa (*Medicago sativa*) fields. None was harvested during the observation periods.

Old field. Previously cleared or cultivated land which had reverted to weedy vegetation. Common species in some or all of these fields were *Bromus tectorum, B. mollis, Ranunculus testiculatus, Lepidium perfoliatum, Tragopogon dubius, Salsola kali, Lappula redowski, Medicago sativa, Camelina microcarpa,* and *Agropyron cristatum.*

Grass-shrub. Open shrubland with grass understory. Shrubs were mainly *Artemisia tridentata* in the west and *A. tridentata* and *Chrysothamnus nauseosus* in the east. Major grasses were *Agropyron cristatum* in the west and *Bromus tectorum* in the east. All areas contained *Ranunculus testiculatus* and *Lepidium perfoliatum.*

Juniper. *Juniperus osteosperma* forest with some *Artemisia tridentata* and a sparse *Bromus tectorum* understory.

Rush-grass. Wet-meadow area surrounding Deep Creek. Dominant plants were *Juncus balticus, J. torreyi, Agropyron smithii,* and *Hordeum jubatum.*

METHODS

To minimize the risk of nest abandonment, I started observing after the young had hatched. Observations began on 19 May in 1974 and on 26 May in 1975, when the hawks' nestlings were about 1 and 2 weeks old, respectively. In each year, the observation period lasted four weeks, although some additional data were collected during a fifth week in 1975. During each week of observation, all hours of the day were sampled, from 06:00 to 21:00 MDT. Sunrise and sunset occurred at about 06:15 and 20:30, respectively. An average of about ten hours per day was spent watching the hawks, five days per week. Observations were made from a blind in 1974 and from the cab of a pickup truck in 1975. In each year, the observation post was about 300 m from the nest.

During each foraging bout, I recorded the hawk's location relative to the grid at 2-min intervals. Data were taken until the bird either captured a prey item, returned to the nest without prey, or was lost to view. Occasionally the bird captured one prey item, ate it, and continued to hunt without returning to the nest. In that case, the next search effort was recorded as beginning at the place of capture of the first prey, after that item had been consumed. Each time the hawk attempted to capture a prey item, I noted the time, grid location, vegetation type, and success.

In 1974 and 1975 respectively, 1,916 and 1,637 location records were classified as prey searching. These records were tabulated to give an estimate of the percentage of a hawk's foraging time spent in each grid square. Flights for purposes other than for food searching, such as those to repel intruders or to carry prey to the nest, were not included in the distributions.
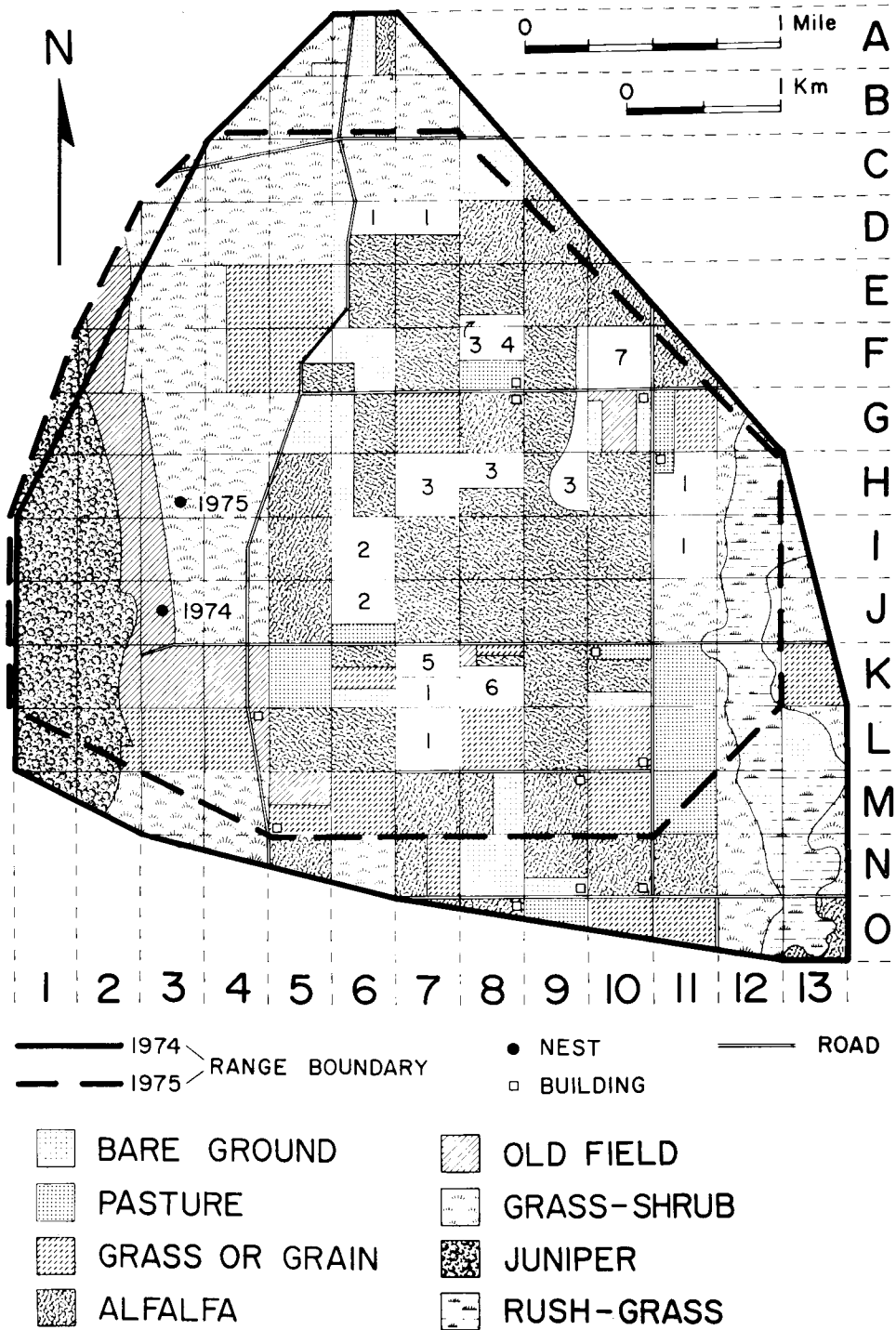
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FIGURE 1.   Vegetation map of the study area. Numbered fields changed vegetation between 1974 and 1975, respectively, as follows: (1) grass or grain to bare ground, (2) bare ground to grass or grain, (3) alfalfa to grass or grain, (4) alfalfa to pasture, (5) grass or grain to pasture, (6) old field to grass or grain, (7) old field to bare ground.

Data on a hawk's movements may have been biased toward those activities occurring closer to me, but I do not believe that this problem was serious. When I lost sight of a bird I was often able to find it again even at a distance. In addition, some of the flights most difficult to follow took place directly over the observation post. Parallax problems made it difficult to determine the grid location of a distantly flying hawk. However, position estimates could be checked and adjusted whenever the bird landed. The location of a perching hawk could be pinpointed exactly.
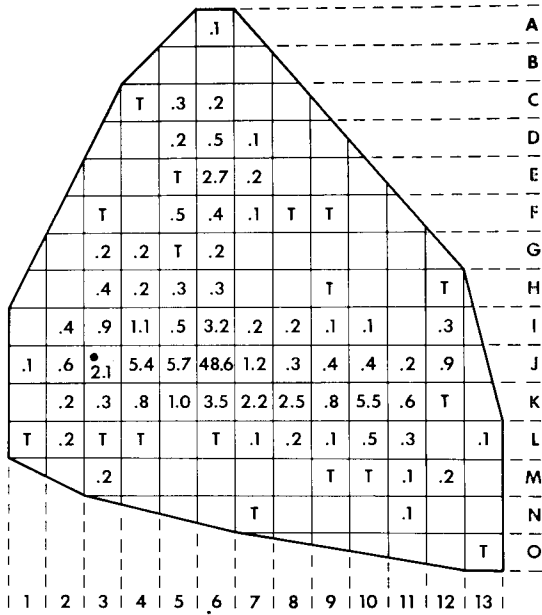
FIGURE 2. Percentage of searching time spent by Male 1 (1974) in each grid square (n = 1,916 records of position or 64 h of observation time). T denotes <0.1%. Solid circle marks nest site.
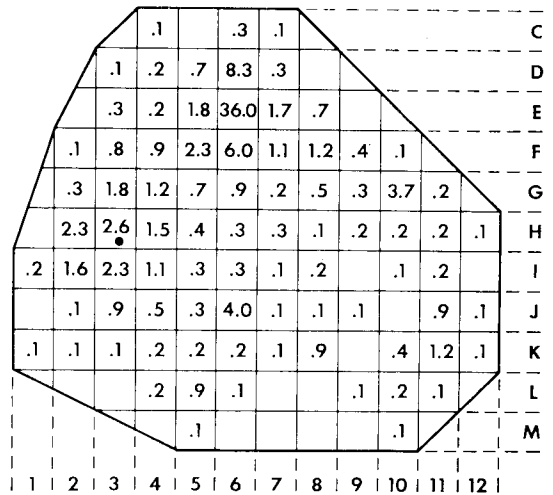
FIGURE 3. Percentage of searching time spent by Male 2 (1975) in each grid square (n = 1,637 records of position or 55 h of observation time). Solid circle marks nest site. Only data from the 4-week observation period are included.

At the close of the 4-week observation period, rodent populations were sampled throughout the study area. Although the number of small mammals in the area probably increased during the observation period, I assumed that their relative densities did not change appreciably from one vegetation type to another in that time.

Rodents were sampled with snap-trap lines of ten traps each and an intertrap distance of 10 m. Traps were baited with rolled oats and peanut butter and were checked morning and evening for three days. A rodent index based on biomass of animals captured per 24-h trapping period was calculated for each trapline, and indices for each vegetation type were averaged. Fifty-eight lines were set in 1974 and 15 were set in 1975.

Traplines were effective for sampling all rodents except pocket gophers and ground squirrels. On 31 May 1975, I surveyed gopher populations by counting mounds that had accumulated since snowmelt. Mounds were counted on 0.1-ha circular plots, four of which were located at random within each of 11 sampled fields. Ground squirrels were sparsely and unevenly distributed in the range and were difficult to survey. Their occurrence was noted whenever they were seen. Lagomorphs were essentially absent from the study area. Only one, a mountain cottontail (Sylvilagus nuttalli), was sighted in the juniper forest. No lagomorph remains were found in or near the hawks' nests.

I estimated the density of vegetative cover in selected fields throughout the study area, using a simplified point-quadrat technique (Greig-Smith 1964, Kershaw 1964). A 1-m² wooden frame was laced with string, forming a 5 × 5 grid of sample points 20 cm apart. At each sampling station in a field, the grid was held above the vegetation and the number of points whose vertical projection intercepted vegetation before reaching the ground was determined visually. Twenty sampling stations were located at random within each of 14 fields. The percentage of sample points which intercepted vegetation provided an estimate of cover density. An estimate of variance was calculated by comparing the results obtained at each of the 20 sampling stations per field. In the remainder of the study area, the density of vegetation was estimated visually.

RESULTS

During the observation periods in both years, only the adult male hawks hunted. Their mates and young fed exclusively on prey brought to the nest areas by the males. These observations contradict those of Cameron (1914) and Angell (1969) who witnessed hunting behavior by both sexes of nesting Ferruginous Hawks. The adult female captured her own prey for the first time during the fifth week of observations in 1975, when the young were less than one week from fledging age. However, the female apparently restricted her hunting to the immediate vicinity of the nest and did not forage with the male.

DISTRIBUTION OF SEARCHING TIME

Figures 2 and 3 show the spatial distribution of food-searching time by each hawk. In each year, one grid square received a disproportionate amount of the bird's total searching time. In 1974, I saw Male 1 48.6% of the time in square J-6 and no more than 5.7% in any other square (Fig. 2). In 1975, Male 2 was seen 36.0% of the time in E-6 and 8.3% or less in other squares (Fig. 3). In neither year was
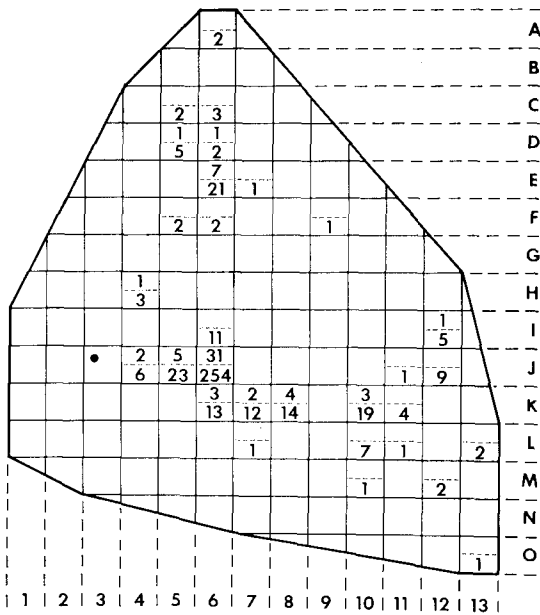
FIGURE 4. Distribution of observed strikes (n = 430) by Male 1 (1974). In each square, upper figure denotes number of successful strikes and lower figure denotes total number of strikes. Solid circle marks nest site.

FIGURE 5. Distribution of observed strikes (n = 378) by Male 2 (1975). In each square, upper figure denotes number of successful strikes and lower figure denotes total number of strikes. Solid circle marks nest site. Only data from the 4-week observation period are included.

the hawk's foraging activity centered at the nest.

Because the birds frequently hunted by sitting and waiting (Wakeley 1978), there was a good chance that a hawk would spend several consecutive 2-min intervals in the same grid square. However, the manner in which data were recorded does not allow an accurate estimate of this probability.

DISTRIBUTION OF OBSERVED STRIKES

In 1974 and 1975 respectively, I observed 430 and 378 attempts at prey capture, of which 61 and 68 were known to be successful. More than half of the strikes in each year were concentrated in one grid square, J-6 in 1974 and E-6 in 1975 (Figs. 4 and 5).

The search distributions (Figs. 2 and 3) and their respective strike distributions (Figs. 4 and 5) were highly correlated. The linear correlation coefficients (r) were 0.99 for 1974 and 0.98 for 1975. By eliminating the data from the most influential square in each year (J-6 in 1974 and E-6 in 1975), the correlation coefficients were reduced to 0.81 and 0.83, respectively, which were still highly significant ($P < .001$).

Because they are so highly correlated, either the distribution of searching time or the distribution of strikes should reflect a hawk's use of space for foraging. The strike distribution,
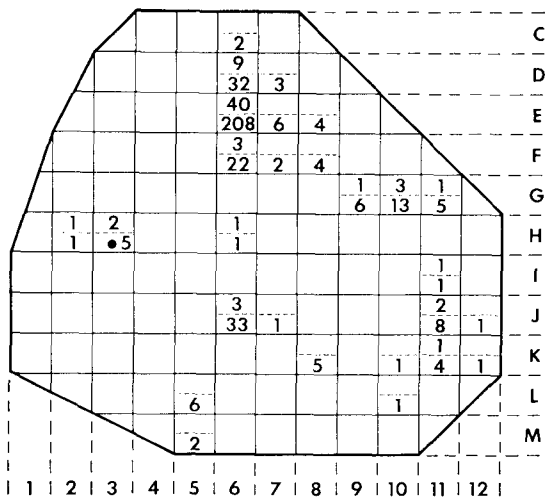
however, gives a clearer picture of the bird's use of vegetation types for hunting, because strike locations could be determined exactly. The position of a searching bird, especially one that was soaring, often was difficult to estimate to within one grid square. For that reason, strike distributions are used in the rest of this analysis to indicate the hawks' foraging patterns.

EFFECT OF VEGETATION TYPE

To determine if each hawk was selective in the types of vegetation where it hunted, I compared the number of strikes in each vegetation type with the number of strikes expected on the basis of the area of each type in the bird's range. The method of Neu et al. (1974) was used to determine which cover types were significantly over- or under-used. In both years, availability and use of vegetation types were significantly different in every case ($P < 0.05$).

Males 1 and 2 were very similar in their use of vegetation types (Fig. 6). Both birds hunted in bare ground and pasture areas significantly more than expected and hunted in grass-shrub, grass or grain, old field, juniper, and rush-grass areas significantly less than expected. The two birds differed only in their use of alfalfa fields. Male 1 showed a significant under-use of such areas, whereas Male 2 showed the opposite. This contradictory result was due almost entirely to Male 2's heavy use of the alfalfa field in grid square E-6.
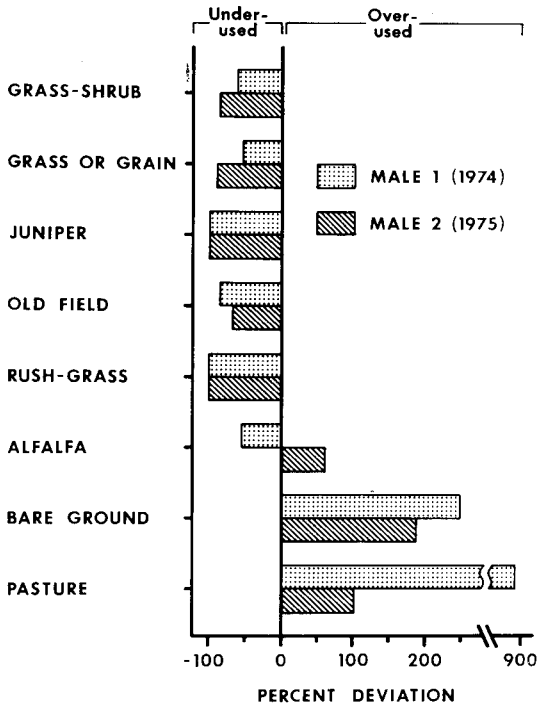
FIGURE 6. Deviation from expected use of vegetation types. Expected use, based on area of each type, is represented by the vertical line. Observed use is based on number of strikes. Deviations are expressed as a percentage of the expected level of use. All deviations are significant at the 5% level.

Reasons for this behavior by Male 2 will be discussed later.

EFFECT OF PREY DISTRIBUTION

Ferruginous Hawks are diurnal foragers. Because of this, I originally intended to use a daytime trap index to rodent populations and to ignore nighttime captures. But most traplines (80%) caught nothing during the day. Prey remains collected during the observation periods showed that the hawks caught rodent species during the day which the traps captured only at night. Apparently, all rodents in the study area were at least occasionally active diurnally, although some were not vulnerable to daytime trapping, perhaps because they were not feeding. Consequently, I devised an index based on biomass of rodents captured per 24-h trapping period.

All trapped rodents were weighed and identified as to species. The numbers, species, and weights in grams (mean ± SD) of rodents captured in traplines were: 314 *Peromyscus maniculatus* (20.23 ± 4.68), 26 *Eutamias minimus* (32.65 ± 3.61), 4 *Perognathus parvus* (18.00 ± 2.16), 4 *Microtus montanus* (41.00 ± 10.23), 3 *Dipodomys ordi* (49.67 ± 11.68),
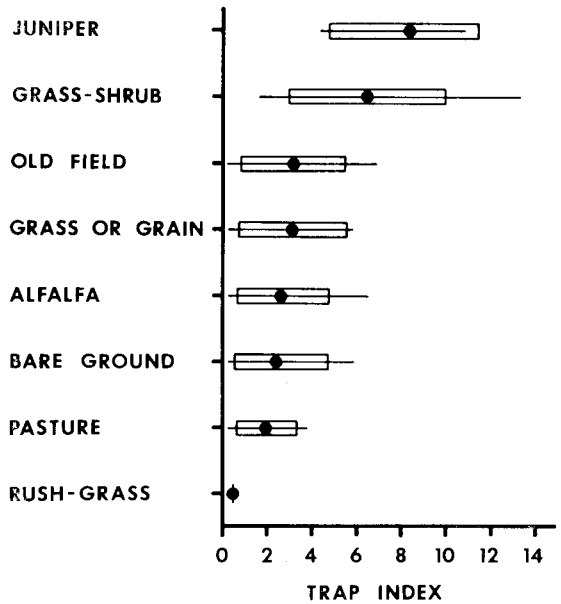

FIGURE 7. Relationship between rodent biomass index and vegetation type. Solid circles, lines, and boxes denote means, ranges, and standard deviations of trap indices, respectively.

2 *Eutamias dorsalis* (52.50 ± 2.12), and 1 *Spermophilus townsendi* (146.0). Traplines run in 1974 and 1975 were combined because differences in trap indices within years were greater than those between years.

Within each vegetation type, and even within individual fields, trap indices were extremely variable (Fig. 7). Only the rush-grass and juniper vegetation types differed significantly in their trap indices ($P < 0.05$). Thus the significant differences in use of vegetation types by the hawks could not be explained on the basis of trap indices alone.

Counts of mounds made by northern pocket gophers (*Thomomys talpoides*) revealed that only alfalfa fields contained appreciable gopher populations (Table 1). Townsend's ground squirrels (*Spermophilus townsendi*) were apparently present only in areas that were relatively free from disturbance, especially from plowing. Squirrels seemed to be most abundant in grass-shrub vegetation but were also seen in old fields, pastures, and crested wheatgrass fields.

The hawks preyed upon at least four species in the area: *Thomomys*, *Spermophilus*, *Microtus*, and *Peromyscus* (Wakeley, in press). I could not judge the importance of each species in the diet because small animals were probably under-represented in regurgitated pellets, due to the more complete breakdown of their remains. However, it appeared that the hawks exploited prey of various sizes, al-

TABLE 1. Mean number of pocket gopher mounds in 0.1-ha circular plots. Four plots were located at random within each field.

Grid location	Vegetation type	Number of mounds per plot (Mean ± SD)
E-6	Alfalfa	80.0 ± 29.2
F-5	Alfalfa	44.8 ± 43.5
J-8	Alfalfa	8.3 ± 10.7
K-7	Pasture	1.0 ± 2.0
G-5	Bare ground	0 ± 0
D-6, E-6	Bare ground	0 ± 0
F-5	Grass	0 ± 0
H-4	Grass-shrub	0 ± 0
K-11	Pasture	0 ± 0
J-2	Juniper	0 ± 0
K-4	Old field	0 ± 0

though they may have concentrated on the larger species (*Thomomys* and *Spermophilus*). In Alberta, Schmutz (1977) found that Ferruginous Hawks caught mostly Richardson's ground squirrels (*Spermophilus richardsonii*) and captured relatively few of the smaller mammals that were known by trapping to be present on his study area.

My sampling procedures were generally inadequate to show significant differences in rodent biomass among vegetation types. Nevertheless, the data suggest that the juniper, grass-shrub, and alfalfa cover types were highest in total prey biomass. However, all three types were significantly under-used by Male 1, and the first two types were significantly under-used by Male 2 (Fig. 6). If one considers only the larger prey species (*Thomomys* and *Spermophilus*), again the grass-shrub and alfalfa cover types were highest in prey biomass, but generally were under-used by the

hawks. The lack of a direct relationship between rodent biomass and use by foraging hawks suggests that some factor other than prey density was critical to the birds' choice of hunting areas.

EFFECT OF COVER DENSITY

Fields were grouped into four cover-density classes which generally coincided with groupings of the eight vegetation types. The four density classes were: dense (>75% covered), moderate (20 to 75% covered), sparse (5 to 20% covered), and absent (<5% covered). Table 2 gives the results of measurements in 14 fields, grouped into their respective cover-density classes. A low coefficient of variation (SD/mean) indicates homogeneous cover, whereas a high coefficient of variation indicates patchy cover.

Relative availability (based on area) versus use (based on number of strikes) of cover-density classes was compared by the method of Neu et al. (1974), and in both years the "absent" cover class was used by the hawks significantly more than expected by chance ($P < 0.05$) (Fig. 8). All other density classes were used less than expected ($P < 0.05$), except for the "dense" class in 1975 which was significantly over-used ($P < 0.05$), again due to Male 2's heavy use of the alfalfa field in square E-6.

EFFECT OF PREVIOUS EXPERIENCE

If previous experience were an important influence on a predator's foraging patterns, and if prey animals were clumped in their distribution, one would expect to see the preda-

TABLE 2. Density of vegetative cover in measured fields.

Cover-density class	Grid location	Vegetation type	Cover density (%) (Mean ± SD)	SD/Mean
Dense	J-9	Alfalfa	94.6 ± 11.7	0.124
	K-9	Alfalfa	94.6 ± 8.3	0.088
Moderate	K-10*	Alfalfa	71.2 ± 33.1	0.465
	K-6*	Alfalfa	49.4 ± 16.9	0.342
	K-8	Old field	23.2 ± 18.1	0.780
Sparse	F-5	Grass	15.2 ± 9.1	0.598
	D-5	Grass-shrub	13.6 ± 15.4	1.132
	K-5*	Pasture	12.8 ± 9.5	0.742
	D-5	Grass-shrub	10.8 ± 18.2	1.685
	J-4	Grass-shrub	9.8 ± 12.3	1.256
Absent	J-6	Pasture	4.2 ± 3.6	0.857
	K-11	Pasture	0.0 ± 0.0	....
	J-6	Bare ground	0.0 ± 0.0	....
	D-6, E-6	Bare ground	0.0 ± 0.0	....

* Fields measured particularly because the density of their vegetation appeared appreciably different from the average density for that vegetation type.
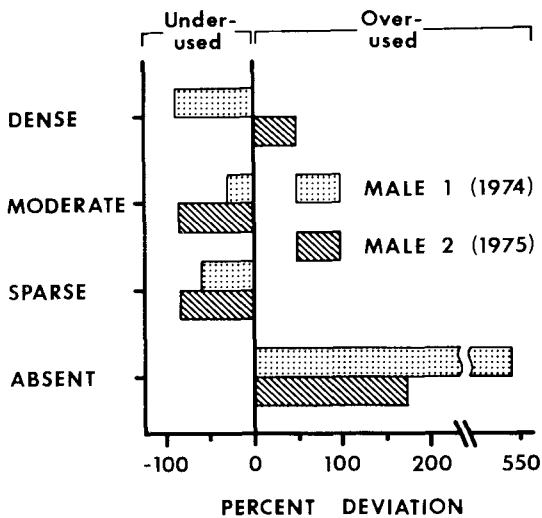
FIGURE 8. Deviation from expected use of cover-density classes. Expected use, based on area of each class, is represented by the vertical line. Observed use is based on number of strikes. Deviations are expressed as a percentage of the expected level of use. All deviations are significant at the 5% level.

tor return directly to sites of previous captures. Both Ferruginous Hawks did this.

On 40 occasions in 1974 and on 55 occasions in 1975, I observed enough of the next hunting effort after a prey capture to determine whether or not a hawk returned to the site of its last success (Table 3). In all, 52% of captures were followed by a direct return to the same grid square on the next hunting effort and 14% were followed by a direct return to one of the eight squares immediately adjacent to the first. In only 23% of subsequent hunts was the previous capture site ignored.

Often I was able to see where the hawks caught prey on consecutive hunting forays and thus I was able to compare the sites of one capture and the next. In 1974 and 1975, I witnessed a total of 64 such pairs of prey captures (Table 4). In 38 of these, the second prey was caught in the same square as the first. In only 12 was the second prey cap-

tured in a square more than one square removed from the first. Thus, there was a 59% chance that a capture observed at random would be followed by a capture in the same square on the hawk's next foray.

As expected, the frequency of direct return to the site of the last capture was highest for the birds' major hunting sites (i.e., J-6 in 1974 and E-6 in 1975). These frequencies were 80 (16/20) and 65 (22/34)%, respectively. However, the combined frequencies of direct return to all other squares (19% in 1974 and 33% in 1975) were significantly higher than would be expected by chance, given that each square occupied less than 1% of a bird's total range (chi-square test; $P < 0.001$).

These data show that there was a high probability that a hawk would return to the site of a previous capture, suggesting that immediate prior experience influenced the birds' choice of hunting sites.

SWITCHING OF MAJOR HUNTING AREAS

The time Male 1 spent foraging in various parts of its range did not change appreciably during the observation period in 1974. Square J-6 was consistently its most important hunting area. Male 2, however, showed a definite shift in its foraging pattern, so I continued observations for a fifth week in 1975.

Figure 9 shows, by weeks, the spatial distribution of observed strikes by Male 2, expressed as a percentage of total strikes seen each week. The shift in emphasis from E-6 to J-6 is unmistakable. Data from weeks 1 and 2 were combined because in both weeks E-6 was most important and J-6 was not used. In week 5, one strike occurred in F-12, outside the range boundary which had been determined from the hawk's movements during weeks 1 through 4.

During weeks 1 through 3, square E-6 was the hawk's most important hunting area, receiving more than half of all strikes seen each week. By week 5, however, J-6 was receiving 63% of observed strikes. Week 4 was a period of transition, when the hawk hunted

TABLE 3. Frequency of return on the next hunting foray to the grid square in which the hawk made its last prey capture (percentages in parentheses).

Bird and year	Sample size	Direct return to same square	Direct return to adjacent square	Indirect return to same square	No return
Male 1 (1974)	40	20 (50)	6 (15)	4 (10)	10 (25)
Male 2 (1975)	55	29 (53)	7 (13)	7 (13)	12 (22)
TOTAL	95	49 (52)	13 (14)	11 (12)	22 (23)

TABLE 4. Location of consecutive prey captures by Ferruginous Hawks (percentages in parentheses).

Bird and year	Number of consecutive captures observed	Grid square in which second capture was made		
		Same	Adjacent	Other
Male 1 (1974)	32	20 (62)	6 (19)	6 (19)
Male 2 (1975)	32	18 (56)	8 (25)	6 (19)
TOTAL	64	38 (59)	14 (22)	12 (19)

more widely, concentrating no more than 28% of its strikes in any one square. This was evidently a time of active investigation and testing of new hunting areas.

Although square E-6 received a large part of the hawk's hunting time through week 4, the bird's rate of capture in that square fell off after week 3 (Fig. 10). The hawk apparently was forced to switch hunting areas due to declining success in its old hunting site. Possible reasons for the decline will be discussed later.
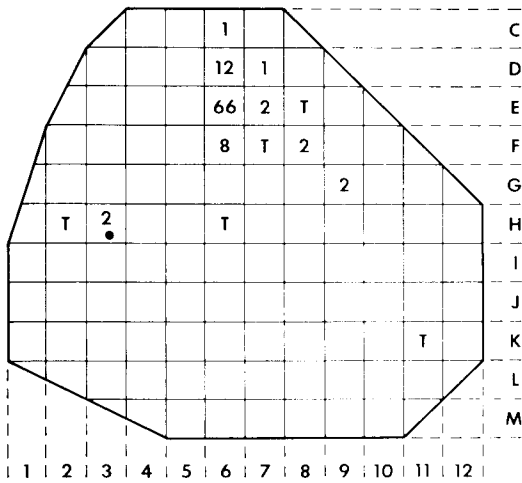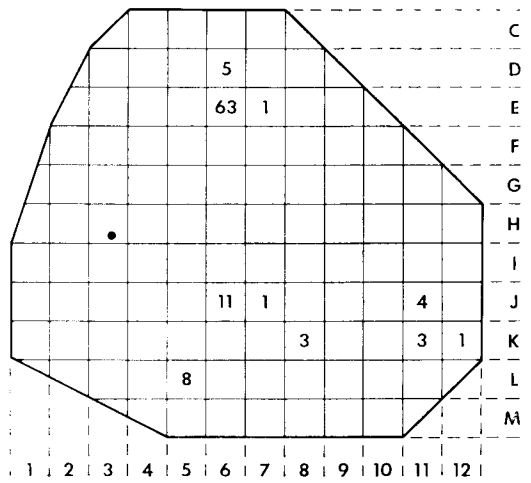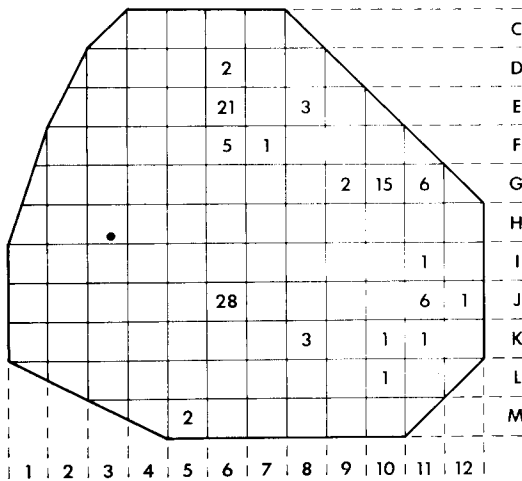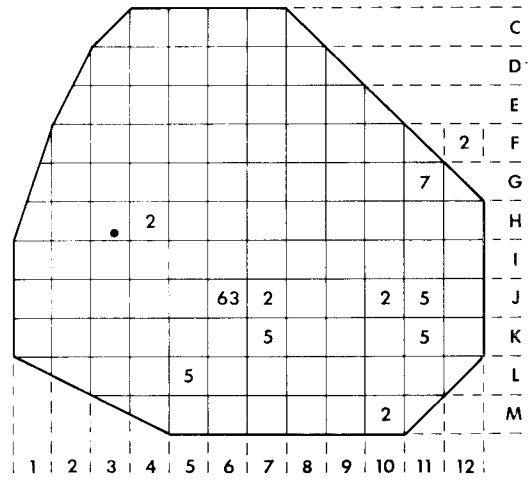
FIGURE 9. Strikes by Male 2 (1975) in each grid square expressed as a percentage of total strikes seen each week. T denotes <0.5%. Solid circle marks nest site.
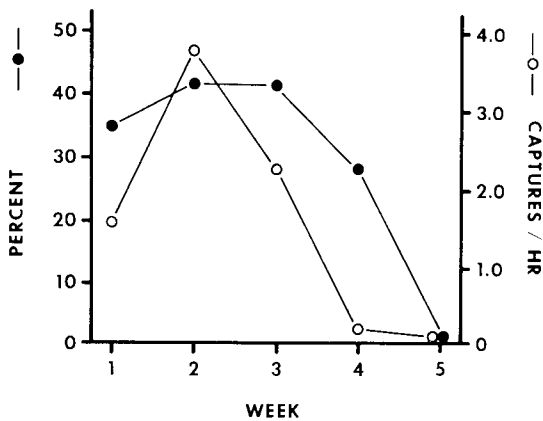
FIGURE 10. Comparison between the percentage of foraging time (solid circles) spent by Male 2 in grid square E-6 and its capture rate (hollow circles) in that square.

DISCUSSION

My results indicate that the density of vegetative cover was a more critical factor in the hawks' choice of hunting sites than was prey density. Both hawks hunted in areas of bare ground and pasture more than expected by chance, despite the low prey populations which these areas apparently contained. Both birds under-used the juniper, grass-shrub, and other vegetation types that contained higher densities of rodents. However, bare ground and pasture were the only vegetation types which were free of cover that would conceal prey animals.

Foraging patterns of the hawks also did not coincide with the distribution of any one species of prey animal, as might be expected if the birds were highly specialized in their choice of food. Several prey species were exploited by both hawks (Wakeley, in press); yet the spatial distribution of the predators' foraging efforts did not correspond to the distribution of their prey. Provided that at least some prey were present, areas that were free of cover apparently were more attractive hunting sites to the hawks. Many of the prey animals captured in these bare areas probably were transients from surrounding fields with better cover. Elsewhere, I examine the food habits of the hawks and estimate their energy intake and expenditures (Wakeley, in press).

In addition to the preference for areas of "absent" cover, Male 2 showed a slight but significant preference for the "dense" cover class. This was due largely to the bird's concentration on the alfalfa field in square E-6. A likely reason for this intensive use was the large number of pocket gophers in the field. More gopher mounds were counted there than in any other sampled field. Despite the relatively high cover density, mounds were exposed when upthrown soil parted or flattened the surrounding vegetation, making gophers vulnerable to attack from the air. Late in the observation period, however, the diggings were concealed by overhanging vegetation. At that time, the hawk switched its emphasis to other hunting areas with less concealing vegetation. The bird's second major hunting area was the well-grazed pasture in square J-6, which had been used intensively by Male 1 the previous year.

Craighead and Craighead (1956:177) speculated that vulnerability of prey animals to raptor predation depended mostly upon prey density, modified by a factor which they called "prey risk." This factor included, among other things, the presence of protective cover. My results suggest that cover was a more important factor than density in affecting the vulnerability of the hawks' prey. Southern and Lowe (1968) came to similar conclusions regarding Tawny Owl (Strix aluco) predation upon wood mice (Apodemus sylvaticus). They found that wood mice were distributed about equally in all cover-density categories but were captured by owls in greater numbers in bare areas.

The role of immediate prior experience in the hawks' feeding behavior probably was to reduce the amount of time and energy spent in searching for profitable hunting areas. Other studies have shown that an avian predator often will return to the site of its last prey capture (Morris 1954, Tinbergen 1960, Croze 1970, Royama 1970, Smith and Sweatman 1974), and the behavior is advantageous when food items are clumped in their distribution. When birds capture two or more prey items in a single hunting sortie, after encountering the first item they modify their searching in ways that increase the probability of finding further prey (Baker 1974, Smith 1974). Similar behavior was reported earlier for insect predators and parasitoids (Laing 1937, Varley 1941, Fleschner 1950, Banks 1957, Chandler 1969). Furthermore, both captive and free-living birds are known to concentrate their food-searching efforts in areas where they can gather more food per unit of energy expended (Heatwole 1965, Goss-Custard 1970, 1977, Smith and Dawkins 1971, Smith and Sweatman 1974, Zach and Falls 1976a, b).

Another way in which a predator could reduce the energetic cost of food searching is to use the nearest suitable hunting areas, thereby

cutting costly travel time. Both hawks intensively hunted in the patch of pasture vegetation that was closest to their nests (i.e., square J-6), with the exception of the pasture in K-5 which probably was ignored because of its higher-than-average cover density for that vegetation type (Table 2). The birds' use of other vegetation types was more scattered, however, and did not seem to be related to distance from the nests.

SUMMARY

The spatial distribution of the food-searching efforts of two adult male Ferruginous Hawks in Idaho was studied by direct observation during the nesting seasons of 1974 and 1975. The birds' home ranges consisted of 21.7 and 17.2 km² of agricultural land with heterogeneous vegetation. The hawks hunted more than expected by chance in areas that contained little or no vegetative cover, and hunted in all other vegetation types less than expected, with the single exception of "dense" cover in 1975. In general, foraging patterns were not related to prey density. Previous experience was important in the hawks' choice of hunting areas, in that both birds tended to return directly to the sites of their last prey captures.

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