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Agricultural Development and Its Influence on Raptors in Southern Idaho

Abstract

The U.S. Bureau of Reclamation has proposed an extension of their North Side Pumping Diversion in Minidoka and Jerome counties, Idaho. The project would result in 3885 ha of rangeland being converted to irrigated agricultural production. This study examined the influence of agricultural development on raptor abundance and diversity on the project area. Road surveys for raptors were conducted through a mix of agricultural and range land in 1986 and 1987. Eleven species of raptors were recorded during observations along 780 km of road surveys. Raptors were significantly more abundant on land that was not highly developed for agriculture in all seasons except the fall migration, when abundance was equal between agricultural and range lands. Raptor diversity varied by season and was higher on undeveloped lands during summer and fall migration. Most raptor species observed made some use of agricultural lands and species richness was similar for both the agricultural and rangeland types. However, species distribution on developed lands was skewed towards a few species that tolerated agricultural development well. Individual species responded differently to conversion of native rangelands to irrigated agricultural production. As a community, raptors exhibited decreased abundance and lower diversity in areas highly developed to irrigated agriculture.

Introduction

Thousands of acres of native western rangelands have been converted to irrigated cropland in the intermountain west. Raptor response to agricultural development has been studied in the more mesic habitats of the Great Plains (Schnell 1968, Gilmer and Stewart 1983, Schmutz 1984). Although some work has been done on nest site selection (Howard *et al.* 1976, Howard and Sather-Blair 1983, Rich 1986), little is known about the effects of agricultural development on raptors using the dryer rangeland habitats of the intermountain region. This study was done in connection with the United States Bureau of Reclamation's proposed extension of the North Side Pumping Diversion. Under the recommended development plan, approximately 3885 ha of rangeland vegetation would be converted to irrigated agricultural production. This study examined the effects of agricultural development on raptor abundance and diversity in the project area.

Study Area

The study area was located in the shrub-steppe/grassland zone (Davis 1952) of the Snake River Plain north of U.S. Interstate 84 in eastern Jerome and western Minidoka counties, Idaho (U.S. Bureau of Reclamation 1986). Vegetation consisted of shrub-steppe and grasslands interspersed through irrigated farmland. Major agricultural crops were alfalfa, barley, wheat, dry beans, corn, potatoes, and sugar beets. Rangeland grasses were dominated by cheatgrass (*Bromus tectorum*), Sandberg's bluegrass (*Poa sandbergii*), blue bunch wheatgrass (*Agropyron spicatum*), and squirrel tail (*Sitanion hystrix*). Big sagebrush (*Artemesia tridentata*), and rabbit brush (*Chrysothamnus spp.*) were the dominant shrubs.

Topography of the area was gently rolling with elevation varying from 1230 m near the Snake River in the south to 1540 m in the north. Annual precipitation averaged 23 cm.

Methods

Field work was conducted from June 1986 to May 1987. Road surveys were conducted twice a month, at about two week intervals, along a 32.5 km census route through a mixture of agricultural land and undeveloped rangeland. Survey data were collected by one or two observers. The same primary observer was present on all surveys and only two different secondary observers were used. Observers scanned out to 400 m on both sides of the road while traveling at speeds of 8-24 km/hour. The number of observers was not considered an important factor in data collection. Travel speed was adjusted to ensure a thorough count was obtained and all surveys were treated equally in the analysis. When a raptor was spotted the vehicle was stopped, a positive species identification was made, and species and transect segment were recorded. Surveys began between 0800 and 0900 hours and lasted 2.5 to 4.0 hours. Successive surveys were conducted in opposite directions to reduce any time bias. Binoculars and a 15-60 variable power spotting scope were used when identifying raptors. Seasons were defined by julian dates as summer (152-212), migration (213-258), fall (259-334), winter (335-74), and spring (75-151).

The survey route was divided into 20, 1.6 km segments. At 160 m intervals, the amount of agricultural and rangeland in each segment was subjectively determined in a 400 m strip on both sides of the road. This resulted in 20 (10, 160 m intervals x 2 sides of the road) cover classifications for each 1.6 km segment. The resulting classifications were summed to determine the proportions of rangeland and agricultural land in each segment. Segment composition varied from 100% rangeland vegetation to 100% agricultural crops. Eleven segments were $\geq 50\%$ developed to agriculture (developed) and averaged only 24% rangeland vegetation. Nine remaining segments were $\leq 50\%$ developed to agriculture (undeveloped) and averaged 75% rangeland vegetation. These two groups were used to examine the effect of agricultural development on the raptor community.

An index of seasonal abundance of raptors was calculated as no. birds/100 km of road survey. A G-test (Sokal and Rohlf 1981) on frequency of occurrence was performed to compare raptor abundance on developed and undeveloped land. I tested for independence of raptor distribution and segment type using chi-square analysis (Sokal and Rohlf 1981). A Bonferroni Z statistic was used to identify how the four most common summer and winter resident raptors species (comprising 74% of all observations in both seasons) used developed and undeveloped survey segments relative to what was expected from their availability (Nue *et al.* 1974). Diversity of the raptor community was calculated using the Shannon-Weaver function and Pielou's equitability index (Hair 1980). Differences in diversity were examined using the Hutcheson t-test (Zar 1984).

Results

Eleven species of raptors were recorded during observations along 780 km of road surveys (Table 1). During migration a group of 127 Swainson's hawks (*Buteo swainsoni*) were seen circling a freshly cut hay field. I considered this an outlier observation and it was excluded from all analyses. Overall, raptor abundance was lowest during the winter, increased through spring and summer, reached its peak at fall migration, and declined through the fall to winter levels.

Raptors were significantly more abundant ($P < 0.01$; $G=28.28$, 11.8, 7.40, 9.36; d.f.=1; respectively for summer, fall, winter, and spring) on the undeveloped segments during all seasons except the fall migration when densities were equal ($P > 0.25$; $G=0.2$; d.f.=1).

Raptor species did not use developed and undeveloped segments in proportion to their availability during any season, including fall migration when raptor densities were not different between segment types ($P < 0.01$; $X^2 = 46.01$, d.f. = 6; $X^2 = 35.99$, d.f. = 7; $X^2 = 25.95$, d.f. = 6; $X^2 = 28.25$, d.f. = 7; $X^2 = 21.35$, d.f. = 6; for summer, fall migration, fall, winter, and spring respectively). During summer red-tailed (*Buteo jamaicensis*) and Swainson's hawks ($P < 0.05$) and northern harriers (*Circus cyaneus*)($P < 0.1$) used undeveloped segments more than expected, while burrowing owls (*Speotyto cunicularia*) used developed segments more than expected ($P < 0.05$). During winter northern harriers and prairie falcons (*Falco mexicanus*) used undeveloped segments more than expected from availability ($P < 0.05$). Red-tailed and rough-legged (*Buteo lagopus*) hawks used segments in proportion to their availability ($P > 0.1$).

Diversity varied among seasons. Summer and winter were the seasons of greatest raptor diversity while fall migration was the season of lowest raptor diversity (Table 2). Within seasons species diversity was higher on undeveloped segments during summer and fall migration ($P < 0.05$; $t = 2.31$, d.f. = 83; $t = 3.07$, d.f. = 312, respectively) and equal during fall, winter and spring ($P > 0.1$; $t = 1.41$, d.f. = 124; $t = 1.59$, d.f. = 80; $t = 1.54$, d.f. = 88, respectively).

Discussion

An implicit assumption of the road survey technique is equal sightability of raptors among both species and cover types. However, differences in the size and behavior of species as well as vegetation structure result in differences in detectability among species (Millsap and Le Franc 1988). Caution should be used in comparing relative abundance among different species.

The burrowing owl was the only major resident species to demonstrate an affinity for highly developed sites. This association of burrowing owls with cultivated land has been previously documented in southern Idaho (Rich 1986). My

TABLE 1. Seasonal relative abundance of Minidoka project extension land raptors on land developed for agriculture, undeveloped, and all survey segments combined, expressed as birds/100 km of survey.

	Summer N=4			Migration N=3			Fall N=5			Winter N=7			Spring N=5		
	Dev.	Und.	Comb.	Dev.	Und.	Comb.	Dev.	Und.	Comb.	Dev.	Und.	Comb.	Dev.	Und.	Comb.
Burrowing Owl	20.98	6.84	14.62	5.59	4.56	5.14	0.00	0.00	0.00	0.00	0.00	0.00	11.19	28.72	19.08
Ferruginous Hawk	0.00	0.00	0.00	1.86	2.28	2.06	0.00	1.37	0.62	0.00	0.98	0.44	0.00	0.00	0.00
Golden Eagle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.74	1.23	2.40	7.81	4.83	0.00	0.00	0.00
Kestrel	4.20	10.26	6.92	11.19	15.95	12.31	3.36	8.21	5.54	4.80	1.98	3.51	5.59	8.21	6.77
Northern Harrier	13.99	32.48	22.31	27.97	31.91	29.75	11.19	23.25	16.62	0.80	12.70	6.15	5.59	8.21	6.77
Merlin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.43	0.00	0.00	0.00
Prairie Falcon	0.00	1.71	0.77	3.73	4.56	4.09	3.36	6.84	4.92	3.20	12.70	7.48	1.12	2.74	1.85
Red-tailed Hawk	2.80	37.61	18.46	20.51	84.33	49.23	19.02	41.03	28.92	5.59	8.79	6.58	1.12	2.74	1.85
Rough-legged Hawk	0.00	0.00	0.00	0.00	0.00	0.00	10.07	31.45	19.69	15.98	21.49	18.89	4.48	25.98	14.15
Short-eared Owl	5.59	11.97	8.46	0.00	2.28	1.02	0.00	0.00	0.00	0.00	0.00	0.00	4.48	4.10	4.31
Swainson's Hawk	1.40	22.22	10.77	261.80	25.07	215.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unidentified	0.00	13.68	6.15	39.16	43.30	42.06	6.71	9.57	8.00	2.40	6.84	4.40	8.95	1.37	5.54
Total	48.96	136.77	88.46	374.81	214.24	364.09	53.71	124.46	85.54	35.97	73.28	52.74	42.52	82.07	60.31

1. N = the number of 32.5 km surveys conducted during that season.

TABLE 2. Summary of raptor diversity indices on developed and undeveloped land and both types combined reported by season.

	Undeveloped			Developed			Combined		
Season[1]	Number Species	H'	J'	Number Species	H'	J'	Number Species	H'	J'
$Summer_a$	7	1.6764	0.8615	6	1.4585	0.8140	7	1.7480	0.8983
Migration	7	1.2821	0.6589	7	0.8255	0.4240	8	1.0672	0.5132
$Fall_b$	7	1.5438	0.7933	5	1.4148	0.7271	7	1.5126	0.7779
$Winter_{a\ b}$	7	1.6829	0.8648	7	1.5202	0.7812	8	1.7054	0.8201
$Spring_{a\ b}$	7	1.5785	0.8112	7	1.7278	0.8879	7	1.6627	0.8544

1. Diversity indices of seasons subscripted by the same letter were not different ($P < 0.05$).

findings indicated that the other major summer and winter resident raptor species are less abundant on lands highly developed to agriculture. In Idaho, Howard and Sather-Blair (1983) studied two raptor communities along the Snake river canyon and found significantly lower nest densities in agricultural habitat. They concluded that lower prey densities in agricultural areas were responsible for the difference in raptor nesting densities. Howard *et al.* (1976) inventoried nesting raptors at seven sites in southern Idaho. They also noted that nesting density varied with prey abundance. On my study area Kessler (1979) found the relative abundance of small mammals on rangelands was greater than on dry and irrigated farmland. Prey densities may help to explain the difference in the abundance of raptors between developed and undeveloped segments.

Significant reductions in the abundance of raptors on agricultural land have been reported in other areas of North America. Schnell (1968) reported decreased use of intensively cultivated land by red-tailed and rough-legged hawks during the winter in the midwest. Nesting density of ferruginous (*Buteo regalis*), but not Swainson's hawks, declined with increasing percentages of the landscape under cultivation in southeast Alberta and North Dakota (Gilmer and Stewart 1983, Schmutz 1984).

The undeveloped survey segments included one more species during summer than the developed segments due to a single observation of a prairie falcon. Although this observation did contribute to the significantly higher H' value on the undeveloped habitat, a more even distribution of species was responsible for most of the difference. This was born out by the higher J' value for the undeveloped segments. Similarly, during fall migration both segment types had the same number of species. Differences in evenness of species distribution were entirely responsible for differences in diversity. It appeared that most raptors in this area made some use of agricultural land and that species richness on developed and undeveloped land was similar. However, species distribution on developed land was more skewed toward a few species that tolerate agricultural development well.

Seasonal changes in diversity showed fall migration was the time of lowest diversity regardless of the fact that species richness was as great or greater than in other seasons. The low H' value was due to the large number of Swainson's hawks in the raptor community at this time. Migrating Swainson's hawks represented only 12.5% of the species but accounted for 60% of the observations during this season. This unevenness was the primary reason for the low diversity index. The pattern of highest diversity during winter and summer with reduced diversity during spring and fall may reflect a temporary perturbation to the community during the transition between summer and winter residents.

Some of the variation in raptor responses to agricultural development might be attributed to over-simplification of the cover type classifications. Row crops, cereal grains, and hay were all combined into the agricultural type but they almost certainly influence raptor abundance in different ways. Similarly, rangelands included both grasslands and shrublands which experienced varying degrees of grazing. Working on the same study area Leptich (1987) reported small mammal abundance in rangeland habitats was reduced by grazing.

Differences in vegetation structure and small mammal prey bases were additional contributors to variability in raptor responses within types. Regardless of this variation, the results suggest that the current mix of agricultural crops does result in decreased raptor abundance and diversity. This is probably modified by crop composition which in turn is influenced by the agricultural economy. Furthermore, rangelands on the study area are recognized as being in generally poor condition as a result of overgrazing (U.S. Bureau of Reclamation 1986). Had these lands provided higher quality habitat, it is possible that the disparity in abundance and diversity between developed and undeveloped lands would have been even greater.

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