J Raptor Res. 32(2):178–180

A COMPARISON OF RAPTOR USE OF RECLAIMED SURFACE MINES AND AGRICULTURAL HABITATS IN PENNSYLVANIA

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KEY WORDS: *American Kestrel; Red-tailed Hawk; Rough-legged Hawk; Northern Harrier;* Buteo jamaicensis; Buteo lagopus; Circus cyaneus; Falco sparverius; *Pennsylvania; reclaimed surface mine.*

Although agricultural lands are decreasing in Pennsylvania due to farm abandonment and subsequent reforestation (Litvaitis 1993), over 300 surface mines averaging 157 ha in size occur in northcentral and northwestern regions of the state (Energy Information Administration 1989). If managed properly, reclaimed surface mines have the potential to provide a significant amount of breeding habitat for grassland raptors such as American Kestrels (*Falco sparverius*), Northern Harriers (*Circus cyaneus*), and Red-tailed Hawks (*Buteo jamaicensis*). Current procedures for reclaiming surface mines in Pennsylvania result in open grasslands dominated by herbaceous plant species interspersed with some woody plants. Reclaimed surface mines, however, are a relatively new habitat type in the eastern U.S. and little is known about their value as breeding habitat for raptors (Yahner and Rohrbaugh 1996). Our objective was to compare spring abundance of diurnal raptors associated with reclaimed surface mines and agricultural habitats in two geographic regions of northern Pennsylvania.

STUDY AREA AND METHODS

We selected two counties each in the northwestern (NW; Clarion and Butler Counties) and the northcentral (NC; Centre and Clearfield Counties) geographic regions of Pennsylvania. Clarion and Clearfield Counties represented areas with abundant reclaimed surface mine habitat; conversely, Butler and Centre Counties contained considerable agricultural habitat (Energy Information Administration 1989, Rohrbaugh and Yahner 1996, Yahner and Rohrbaugh 1996). Reclaimed surface mines were dominated by herbaceous plant species, such as fescue (*Festuca* spp.), orchard grass (*Dactylis* spp.), timothy (*Phleum* spp.), red top (*Agrostis* spp.), bird's-foot trefoil (*Lotus* spp.), clover (*Trifolium* spp., *Melilotus* spp.), and goldenrod (*Solidago* spp.) (see details in Yahner and Rohrbaugh 1996). Deciduous and coniferous trees, such as black locust (*Robinia pseudoacacia*) and Austrian pine (*Pinus nigra*), were planted on the mines in small plantations (<5 ha). In addition, reclaimed mines were associated with numerous human-created wetlands (e.g., cattail [*Typha* spp.] marshes) that were designed to leach metals from water and soil.

Agricultural habitat was characterized by crop species, such as corn (*Maze* spp.), grain (*Triticum* spp. and *Hordeum* spp.), soybeans (*Glycine max*), alfalfa (*Medicago* spp.), and mixed-herbaceous species used for hay production. Livestock pastures and confined feeding areas also were common throughout the agricultural survey routes. These agricultural areas were interspersed with fencerows, woodlots, and riparian forests

We chose 10 road survey routes per geographic region, giving five survey routes per habitat type (reclaimed surface mines or agricultural habitat) in each region. Routes were established by initially identifying unimproved and light-duty roads on 16 USGS topographic quadrangles (1:24 000 scale) that traversed either reclaimed surface mine or agricultural habitats in the four counties. We then drove along all 1-km sections of potential routes to determine if they were a suitable part of a survey route. A suitable section of a route was defined as one with relatively low rates of vehicular traffic, characterized by at least 150 m of open habitat (surface mine or agricultural) perpendicular and adjacent to the road edge that extended at least 1 km either on one or both sides of the road, and devoid of developed areas (e.g., urbanization) or active surface mine operations. The mean length of survey routes was 13 km (range = 8–18 km); the minimum distance separating survey routes was arbitrarily designated as 3 km (Yahner and Rohrbaugh 1996).

We established survey stations along each route at 0.8-km intervals; the mean number of survey stations per route was 16 (range = 10–20). Surveys were conducted by driving a vehicle along the route at slow speeds (16–40 km/hr) while looking for perched or flying raptors. In addition, we stopped the vehicle for 5 min at each station to scan for raptors (Yahner and Rohrbaugh 1996). We recorded species, sex, age, location, distance (m) at initial detection and behavior at initial sighting (e.g., flying or perched) of each raptor observed during surveys. We also noted time of day and weather conditions for each raptor sighting.

Spring surveys were conducted twice per month during April–June in both 1993 and 1994, yielding a total of 240 spring surveys. Two survey routes were driven

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Table 1. Number of Red-tailed Hawks, American Kestrels and Northern Harriers observed in reclaimed surface mines (SM) and agricultural (AG) habitat types of northwestern and northcentral Pennsylvania during spring.

Species	Habitat Type	Region				Total	
		Northwestern		Northcentral			
		No.	No./Hr	No.	No./Hr	No.	No./Hr
Red-tailed Hawk	SM	61	0.94	19	0.32	80	0.64
	AG	82	1.02	79	1.04	161	1.03
	Total	143	0.99	98	0.72	241	0.86
American Kestrel	SM	49	0.75	27	0.45	76	0.61
	AG	33	0.41	39	0.51	72	0.46
	Total	82	0.56	66	0.489	148	0.53
Northern Harrier	SM	14	0.21	5	0.08	19	0.15
	AG	1	0.01	3	0.04	4	0.03
	Total	15	0.10	8	0.06	23	0.08

per day, one each in the morning and afternoon; morning and afternoon surveys were initiated between 0700–0900 H and 1300–1500 H, respectively. Because of logistical constraints, all 10 routes in a given geographic region were surveyed during the same 5 days; furthermore, on a given day, the same habitat type was surveyed, but habitat type surveyed was alternated from one day to the next. Also, a given survey route was driven an equal number of times in morning and afternoon.

We stratified the number of sightings of each raptor species into four habitat-region types, including those in surface mines and agricultural habitats. Data were pooled from both springs to give a better measure of habitat-use patterns (Rice et al. 1984) and because numbers of sightings per species did not vary between years (Yahner and Rohrbaugh 1996). Numbers of raptor sightings per type were converted to number per hour, based on the amount of stationary survey time spent within each habitat and region, This enabled us to compare observation rates (no./hr) among habitat-region types.

We compared observed vs. expected numbers of sightings of each raptor species among the four habitat-region types using *G*-tests for goodness-of-fit (Sokal and Rohlf 1995). If a significant difference occurred among the four types, then a *G*-test for goodness-of-fit was used in the habitat-region type of interest. Expected numbers of sightings for a given species were calculated by multiplying the proportion of stationary survey time per type by the total observed numbers of sightings for that species.

Results and Discussion

We observed 412 raptors during our two spring surveys including 241 (58%) Red-tailed Hawks, 148 (36%) American Kestrels, and 23 (6%) Northern Harriers (Table 1). In addition, we noted 10 Cooper's Hawks (*Accipiter cooperii*), three Ospreys (*Pandion haliaetus*), two Broad-winged Hawks (*Buteo platypterus*), two Red-shouldered Hawks (*Buteo lineatus*), one Sharp-shinned Hawk (*Accipiter striatus*), and one Northern Goshawk (*Accipiter gentilis*).

The observed number of Red-tailed hawks, American Kestrels, and Northern Harriers each differed significantly from expected among the four habitat-region types ($G \geq 11.1$, df = 3, $P < 0.001$; Table 1). Red-tails were seen less often than expected at reclaimed surface mines in the northcentral region ($N = 19$, 0.32 hawks/hr; $G = 36.6$, df = 1, $P < 0.001$) but were more common than expected in each of the other types ($N = 61$–82, 0.94–1.02 hawks/hr; $G \geq 5.4$, df = 1, $P < 0.025$). Kestrels occurred more often than expected at reclaimed surface mines in the northwestern region ($N = 49$, 0.75 hawks/hr; $G = 15.3$, df = 1, $P > 0.005$) and less than expected in agricultural habitats in the northwestern region ($N = 33$, 0.41 hawks/hr; $G = 5.8$, df = 1, $P < 0.025$). In the northwestern region, more harriers than expected were observed at reclaimed surface mines ($N = 14$, 0.21 hawks/hr; $G = 16.1$, df = 1, $P < 0.001$), but fewer harriers than expected were seen in agricultural habitats ($N = 1$, 0.01 hawks/hr; $G = 9.4$, df = 1, $P < 0.005$).

Reclaimed surface mines seemed to be preferred habitat for spring populations of raptors, particularly those in the northwestern region of Pennsylvania. Perhaps this trend occurred because surface mines in the northwestern region tended to be larger and more abundant, thereby providing more breeding habitat (Yahner and Rohrbaugh 1996). Probable and confirmed breeding attempts of Northern Harriers, for example, have been shown to be significantly higher in regions of Pennsylvania containing abundant reclaimed surface mines (Rohrbaugh and Yahner 1996). Previous studies conducted in other regions of Pennsylvania, which are virtually devoid of reclaimed surface mines, have noted that breeding Red-tailed Hawks and American Kestrels prefer agricultural lands as

breeding habitat (Bednarz 1992, Rohrbaugh 1994, Rohrbaugh and Yahner 1997). Thus, our study indicated that grasslands created by surface mine reclamation in Pennsylvania may also serve as valuable breeding habitat for open-country raptors (see also Rohrbaugh and Yahner 1996).

Small mammals are major prey of the raptors observed in our study area (see Weller et al. 1955, Bart 1977). Meadow voles (*Microtus pennsylvanicus*) are quite abundant on reclaimed surface mines in the southcentral region of Pennsylvania (Alberici et al. 1989; Yahner and Rohrbaugh unpubl. data). Dormant or fallow agricultural fields often contained residual plant material and seeds, which probably provided cover and food resources for small mammal populations during winter (Yahner and Rohrbaugh 1996).

While they are important areas for grassland raptors, we must caution that larger reclaimed surface mines (>100 ha) may have a negative effect on forest-dependent raptors such as Broad-winged Hawks. They may also be important nesting habitats for the long-term conservation of a variety of grassland bird species such as the Bobolink (*Dolichonyx oryzivorus*) (Yahner and Rohrbaugh 1996).

RESUMEN.—Comparamos la abundancia de aves rapaces en primavera en terrenos de minería en recuperación y en zonas de agricultura en dos regiones geográficas del norte de Pennsylvania desde Abril–Junio en 1993 y 1994. De las 412 aves rapaces observadas, la más común fué *Buteo jamaicensis* (58%), *Falco sparverius* (36%) y *Circus cyaneus* (6%). Las tierras de minería en recuperación registraron mas aves rapaces que las de agricultura lo cual indica una posible preferencia por estas áreas. Las tierras de minería presentaron mayor abundancia de presas, tales como *Microtus pennsylvanicus*. Concluimos que las tierras de minera en reclamación de >100 ha proveen habitat de pastizales valiosos para aves rapaces en reproducción. Adicionalmente, estas superficies constituyen el habitat para la conservación a largo plazo de otras aves tales como *Dolichonyx oryzivorus*.

ACKNOWLEDGMENTS

Funding for this study was provided by the Pennsylvania Game Commission, the Pennsylvania Agricultural Experiment Station, and the Max McGraw Wildlife Foundation.

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Received 1 July 1997; accepted 15 February 1998