Habitat use by Red-tailed Hawks in surface-mined areas

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ABSTRACT
Habitat use by 4 radio-tagged red-tailed hawks (Buteo jamaicensis) was monitored during 708 transmitter-days in coal surface-mined areas in northern West Virginia and southwestern Pennsylvania in 1977 and 1978. Mean cumulative home range size for the 3 adults was 316.8 ha (3.2 km²). Red-tailed hawks showed significant (P<0.005) tendencies to elect certain habitats over others. Descending order of habitat selectivity was: 1) woods edge with open area not surface-mined, 2) woods edge with surface-mined area, 3) deciduous woods, 4) open area not surface-mined, and 5) surface-mined area. Red-tailed hawks' flexibility in niche requirements allowed them to exploit reclaimed area. Recommendations for surface mine reclamation are given.

INTRODUCTION
Loss of suitable habitat continues to be one of the greatest problems confronting wildlife populations. Habitat alteration in the form of surface mining for coal has already affected over 525,000 ha of land in the eastern U.S. Information concerning habitat use is needed to determine effectiveness and improvements needed in reclamation procedures to benefit wildlife.

Red-tailed hawks have a broad ecological tolerance, but their use of disturbed lands and the capability of reclaimed surface mines to support red-tailed hawks has not been measured. Objectives of this study were to quantify habitat use by red-tailed hawks in surface-mined areas, determine habitat selectivity and home range sizes, and offer management recommendations.

STUDY AREA
This study was conducted in an area 8 km by 4.5 km in northern Monongalia County, West Virginia, and southern Green County, Pennsylvania, USA (39°43'N, 80°00'W). Topography varied from steep to gently rolling hills, with isolated flat areas created by mountain to removal, contour and area surface mining. Principal land uses were hardwood timber production, crop and livestock farming, and coal surface mining. 37% of the study area was wooded while 26% was disturbed by surface mining.

Predominant tree species were: black cherry (Prunus serotina), red maples (Acer rubrum), sugar maple (A. saccharum), yellow-poplar (Liriodendron tulipifera), white oak (Quercus alba), black oak (Q. rubra), black locust (Robinia pseudoacacia), dogwood Common understory plants were greenbrier (Smilax rotundifolia), blackberry (Rubus allegheniensis), and wild grape (Vitis spp.).

Open areas consisted of pastures, croplands, old fields, logged areas, and surface-mined areas. Principal crops were corn and hay. For other details on vegetation see Mindell (1978). Vegetation found on reclaimed surface mines included tall fescue (Festuca arundinacea), red top (Agrostis alba), timothy, orchard grass, rye grass (Lolium perenne), oats (Avena sativa), crown vetch (Coronilla varia), sericea (Lespedeza cuneata), birdsfoot trefoil (Lotus corniculatus), red clover (Trifolium pratense), yellow sweet clover (Melilotus officinalis), scotch pine (Pinus sylvestris), and black locust. Plant combinations varied on different mines and on different portions of the same mine. The majority of reclamation sites on the study area were 2- to 6-year-old stands of grass and non-woody legume species. The study area contained 12 separate reclamation sites, ranging in size from 0.7 to 40.0 ha.

METHODS
Telemetry
Habitat was determined by following radio-tagged red-tailed hawks with portable receivers and hand-held yagi antennas. Two adult females, one adult male and one immature bird were followed. Fixes were taken within 1 km of the bird, and were later confirmed by observations. Hawk locations were recorded at 30 minute intervals during tracking days. A full tracking day consisted of following and recording the activities of a radioed hawk for 8 hours. The time span covered by a full tracking day was systematically rotated, in an attempt to equally sample all daylight hours. Radio-tracking was conducted during all 12 months of the year.

Radio packages consisted of SM 1 transmitters (AVM Instrument Co., Carbondale, IL). RM828T2 batteries (Mallory Battery Co., Tarreytown, NY), and Swiss flex wire whip antennas. Radio packes weighed 28 to 30 g and had a reception range of 1.5 to 3.2 km and a transmission life of 10.5 months. Radio packages were mounted as back-packs, with harness straps of 6 mm wide nylon athletic shoe lace. Hawks were trapped with modified bal-chatris using 2, 6-week-old chickens as bait.

Data Analysis
The entire 8.0 km by 4.5 km study area where all radioed birds occurred was gridded into 0.647 ha (1.6-acre) squares on large-scale topographic maps. Each square was classified as one of the following habitat types: 1) deciduous woods, 2) surface-


mined, 3) open area not surface-mined, 4) woods edge with open area not surface-mined, or 5) woods edge with surface-mined area. Squares containing two or more habitats were assigned the predominant habitat type. When a woods edge occurred in a grid, 1 of the 2 edge habitat types was assigned. Each telemetry fix was assigned the habitat code of the grid in which it occurred.

We used the "minimum area" and "grid fill" methods to determine home range sizes. Minimum area home range estimates describe the area inside a polygon formed by connecting the outermost points in a hawk's movement. Minimum area estimates are usually the largest as they often include areas where no actual locations were recorded.

Whenever grid squares containing fixes were separated by 5 or fewer empty squares (called fill squares) along either the horizontal or vertical axis, those fill squares were considered part of the home range. Grid fill estimates were determined by summing the number of squares containing 1 or more fixes, plus the number of fill squares, and then multiplying by 0.647 (area in hectares of 1 square). The linear distance of 5 squares represents 0.4 km (previously used by Nicholls or Fuller).

Grid method home range maps were used to determine intensity-of-use coefficients (IUC), a measurement of distribution of hawk locations. IUC values may range from 0.1 to 1.0 and equal the sum of the differences between the maximum percent use of a rid and the rest of the grids in the home range. Telemetry data were programmed for analysis using the University of Minnesota's Cedar Creek software library programs. Fixes at the nest site were not used in this analysis.

Chi-square tests were used to determine whether a habitat was used out of proportion to its availability. Expected number of fixes, that would have occurred had hawks entered the various habitats by chance alone, was obtained by multiplying the percent of the total acreage of each habitat type available (Grid-fill home range area) by the total number of fixes obtained for each hawk. Ivlev's electivity index (EI) provided a relative ranking of habitat use in relation to habitat occurrence by the following formula: \[ EI = \frac{Proportion \, Obs. - Proportion \, Exp.}{Proportion \, Obs. + Proportion \, Exp.} \]

Small Mammal Abundance

To obtain a relative index of small mammal abundance in different habitat types, the removal method was used. Small mammal populations were sampled in 4 habitats; deciduous woods, old field, and 2 classifications of grass and legume reclaimed surface mines. Reclamation "A" habitat had at least 80% ground cover after 2 growing seasons and bare areas not exceeding 0.1 hectare (.25 acres). Reclamation "B" was more representative of the mined sites, with less vegetation and larger bare areas than Reclamation "A" areas.

Reclamation "A", deciduous woods, and old field habitat were sampled in 3 different locations during each of 3 time periods; June-July 1977, October 1977, and March 1978. Reclamation "B" was sampled in 3 locations during June-July 1977, and in 1 location during October 1977 and March 1978. In each habitat type, at each location, 2 parallel trap lines were set. Eight trap stations (10.0 m apart), consisting of 3 back-break traps were placed along each line. Traps were baited and set for 4 consecutive nights. At each trap station, percent ground cover, tallest herbaceous plant, and litter depth were measured. All measurements were taken from within a steel hoop of 1 m diameter placed in the center of each trap station. Analysis of variance and linear regression tests were used to determine correlations between numbers of small mammals caught and the 3 vegetation variables.

RESULTS AND DISCUSSION

Habitat Use

Location data from 4 red-tailed hawks yielded a total of 1,501 fixes during 708 transmitter-days (Table 1). Habitat electivity, or preference, shown by a hawk is the likelihood of that habitat being used if offered on an equal basis with others. Thus, habitat electivity considers both frequency of use and habitat availability. During the entire study, 34% of the fixes occurred in deciduous woods, 29% in woods edge with surface-mined area, 23% in woods edge with open area not surface-mined, 8% in open area not surface-mined, and 6% in mined area habitat. Habitat availability in our 8.0 km by 4.5 km study area was as follows; 34% was deciduous woods, 29% was woods edge with surface-mined area, 23% in woods edge with open area not surface-mined, 8% in open area not surface-mined, and 6% in mined area habitat. Habitat availability in our 8.0 km by 4.5 km study area was as follows; 34% was deciduous woods, 17% was woods edge with mine area, 9% was woods edge with open area not surface-mined, 11% was open area not surface-mined and 29% was surface-mined area habitat.

Not all habitat types were used in proportion to their occurrence. Radio-tagged red-tailed hawks elected certain habitats over others. Based on EI rankings, descending order of habitat electivity was: 1) woods edge with open area not surface-mined, 2) woods edge with mined area, 3) deciduous woods, 4) open area not surface-mined, and 5) surface-mined area (Figure 1).

Table 1 Summary of study period dates, no. of transmitter days, and no. of fixes for the red-tailed hawks

<table>
<thead>
<tr>
<th>Red-Tailed Hawk</th>
<th>Age/Sex</th>
<th>Tracking Period</th>
<th>Transmitter Days</th>
<th>No. of Fixes</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ad. F</td>
<td>2-11-77 – 6-2-77</td>
<td>111</td>
<td>260</td>
<td>stopped transmitting</td>
</tr>
<tr>
<td>4</td>
<td>Ad. M</td>
<td>7-15-77 – 6-1-78</td>
<td>321</td>
<td>610</td>
<td>study ended/intermit. sig.</td>
</tr>
<tr>
<td>5</td>
<td>Imm.</td>
<td>8-9-77 – 9-5-77</td>
<td>27</td>
<td>102</td>
<td>hawk left area</td>
</tr>
<tr>
<td>8</td>
<td>Ad. F</td>
<td>9-14-77 – 5-21-78</td>
<td>249</td>
<td>529</td>
<td>study ended</td>
</tr>
</tbody>
</table>

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