FINAL REPORT

AN ASSESSMENT OF POTENTIAL CONFLICTS BETWEEN NESTING RAPTORS AND HUMAN ACTIVITIES IN THE LONG PINES AREA OF SOUTHEASTERN MONTANA

-with special emphasis on uranium development-

Bureau of Baseline Studies

Montana Department of Fish and Game

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Abstract

A survey of nesting raptors was conducted during the 1977 and 1978 nesting seasons in the Long Pines area of southeastern Montana to outline potential conflicts between birds of prey and human activities, particularly uranium exploration and development. Observations were oriented toward locating nests of cliff-nesting Golden Eagles (*Aquila chrysaetos*) and Prairie Falcons (*Falco mexicanus*), but eight other raptor species were found to be actual or probable nesting species in the area. These were the Great Horned Owl (*Bubo virginianus*), Turkey Vulture (*Cathartes aura*), American Harrier (*Circus cyaneus*), Sharp-shinned Hawk (*Accipiter striatus*), Cooper's Hawk (*Accipiter cooperii*), Red-tailed Hawk (*Buteo jamaicensis*), American Kestrel (*Falco sparverius*), and Merlin (*Falco columbarius*). Five additional species, the Swainson's Hawk (*Buteo swainsoni*), Ferruginous Hawk (*Buteo regalis*), Burrowing Owl (*Speotyto cunicularia*), Long-eared Owl (*Asio otus*), and Short-eared Owl (*Asio flammeus*) were observed occasionally. The latter two species are likely nesting species in the study area.

Twenty Golden Eagle nests were found in the study area. One of these was known occupied in 1977 and fledged one bird. Four were occupied in 1978, and five young fledged from the three which were successful.

Fourteen Prairie Falcon aeries were found in the study area during the two seasons. Twelve young fledged from the three nests at which fledging success was determined in 1977. In 1978 production was 2.42 young per active aerie at 12 sites, and 4.14 young per successful aerie at the seven sites which fledged young.

Exposure of cliff nests was apparently correlated with the predominant cliffs of the study area, and nests were apparently chosen on the basis of nest site availability rather than on preferences for specific exposures.

Limited productivity information was also gathered for other species, including Cooper's Hawks, Red-tailed Hawks, Kestrels, and Merlins.

The extent of past and present activities in the study area was assessed. Mining has been limited, and surface or underground mining are unlikely to occur. Livestock grazing, timber harvest, recreation, and uranium exploration or mining are or may be important activities in the study area.

Suggestions for minimizing possible conflicts between these activities and nesting raptors were outlined. These included specific recommendations associated with particular activities, but also included general recommendations for disturbances near known cliff nest sites, as cliff nesting species are those which may be most affected by human activities. These recommendations include (1) avoidance of all activities around known Golden Eagle and Prairie Falcon nests at all times, (2) initiating mining or other activities after the nesting season when possible, and (3) establishing "no-disturbance" zones around nests of most raptors during the nesting season. Each conflict between proposed activities and the requirements of nesting

raptors should be considered individually.

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INTRODUCTION

Energy projections for the United States generally show steadily increasing per capita consumption in the future (Federal Energy Administration, 1976). This increase and the gradually growing U. S. population point to greater future demand for electrical energy in this country. Much of the future demand for electrical energy may be met with nuclear generating plants, but the development of electrical generating capacity based on nuclear energy is initially dependent in part on the supply of uranium, and a number of factors point to a possible shortage in the future (Stoller Corp., 1975). Projections of increased demand and rising prices have created a good market for uranium oxide, which has prompted greater exploration for uranium deposits recently in the United States (U. S. Energy Research and Development Administration, 1977). While most of the interest in energy development in Montana has centered around coal, there has also been extensive exploration for uranium in the state.

This project was an assessment of actual or potential effects of human activities, particularly uranium exploration and mining, on birds of prey in the vicinity of the Long Pines, and a summary of suggestions for minimizing problems that might occur. The Long Pines is a relatively undisturbed 26,300 ha segment of the Custer National Forest in Carter County, Montana. A search for commercially valuable uranium deposits was carried out there, largely by Mobil Oil Corporation (Mobil), from 1972 through 1977. Another firm may continue this exploration and may consider in-situ uranium mining for the area.

The potential environmental effects of activities such as mining must be documented in accordance with the National Environmental Policy Act of 1969. The management Environmental Impact Statement (E.I.S.) for the Sioux District (U. S. Forest Service, 1976b) did not deal with the impacts of specific activities such as mining, and the effects of extensive exploration and mining have yet to be assessed. The status of wildlife of the Long Pines area should be known before extensive uranium exploration or mining occur if adverse effects due to these activities are to be minimized. However, there has been little biological study conducted there. This study helped to outline the potential impacts of such activities on the raptors of the area.

Olendorff and Stoddart (1974) stated that:

> Most birds of prey are important components of balanced ecosystems and are pleasing to a growing number of people who appreciate birds and wildlife in general. As end-of-the-food-chain organisms, they have proven to be important barometers of environmental contamination.

Despite their value, declines in raptor populations have been noted, some of which are continuing (Fyfe et al., 1969; Nelson, 1970; Ratcliffe, 1970; Henny and Wight, 1972; Porter and White, 1973; Oliphant et al., 1975; Fyfe, 1976). Many reasons for these declines have been hypothesized or demonstrated, including use of the birds by falconers and zoos, increased disturbances by people interested in observing and photographing wildlife, and continued shooting, poisoning, and trapping of birds of prey. Except for isolated instances, however, these causes are probably insignificant when compared to a widespread use of chemicals in the environment, the continued emissions of pollutants in general, and the ever-increasing demand upon remaining areas of undisturbed habitat (Olendorff and Stoddart, 1974; Fyfe and Olendorff, 1976; Wils. Ornith. Soc. Cons. Comm., 1977; and Brown, 1977).

This thesis is a portion of a biological study begun in 1976 in the Long Pines area by the Montana Department of Fish and Game, following several years of preliminary uranium exploration. The study was undertaken to provide information on wildlife populations before initiation of extensive uranium exploration or mining. Stated in the proposal for the Department of Fish and Game study were the following objectives (Dusek, 1977):

1. To identify conflicts between in-situ mining techniques and wildlife populations and develop guidelines and methods for eliminating, reducing, or compensating those conflicts;
2. to furnish ecological data needed to monitor the effects of in-situ mining techniques on vegetation and wildlife resources;
3. to utilize the Long Pines as a model demonstration site for researching the compatibility of wildlife, vegetation, and in-situ mining;
4. to develop revegetation techniques or innovations necessary to replace wildlife habitat disturbed by solution mining or other "in-situ" mining procedures; and
5. to monitor secondary impacts from "in-situ" mining activities on wildlife populations and develop alternatives to reduce these impacts.

This thesis fits within the broad scope of the goals outlined for the study of the Department of Fish and Game, and is intended to aid in the management of the raptors of the Long Pines area, a site of abundant relatively undisturbed habitat. The specific goals of my study were (1) to gather baseline information on distribution, nest sites, and productivity of raptors of the Long Pines area so that future studies will be able to identify the effects of human activities such as mining or logging (if any) on the birds of prey, and (2) to combine this data with information on uranium exploration in the Long Pines area and in-situ mining, in order to recommend ways of reducing or mitigating habitat loss and disturbance to birds of prey.

STUDY AREA

This study was conducted in east-central Carter County, in southeastern Montana (Fig. 1). Carter County lies in the northern Great Plains, and ". . . presents wide tabular surfaces, traversed by the broad valleys of [the] Powder and Little Missouri rivers and locally more or less deeply cut by the narrower valleys of tributaries" (Bauer, 1924). Within the county are rolling hills and large flats, occasional deep gulleys, badlands, open buttes, and extensive high forested mesas. The area is largely drained by the Little Missouri River, which flows across the southeast corner of the county. Elevations range from approximately 975 to 1285 meters.

Both Carter County and Harding County, South Dakota, immediately to the east (which contains a small portion of my study area), are rural and agrarian. Carter County has an area of approximately 8550 sq km and a population of about 2000 people. Ekalaka, approximately 39 km northwest of the study area, is the county seat and the only community of any size within the county. Commercial activities in the county are primarily agricultural; major products are cereal grains, hay, and livestock. Sixty-five percent of the land within the county is privately owned, 28.4 percent is federally owned, and 6.6 percent is state owned. Land use in the county is shown in Table 1.

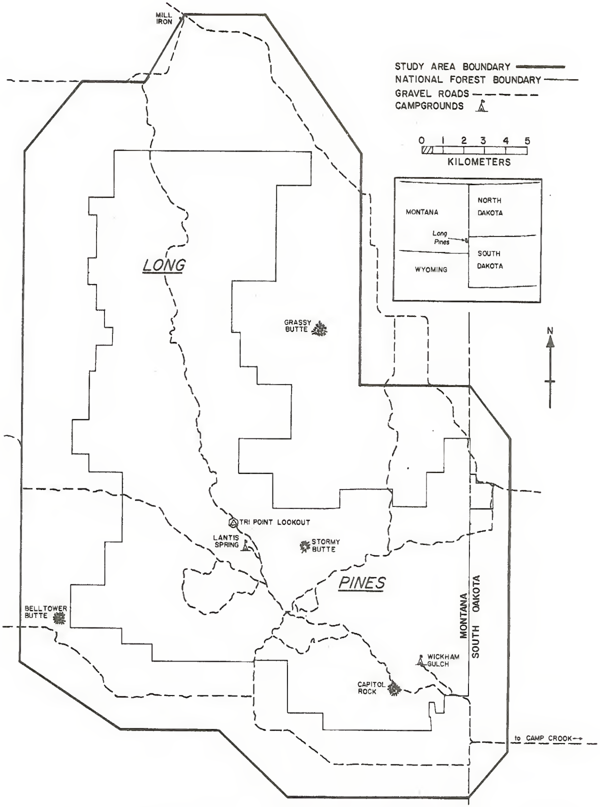

Fig. 1. Map of study area, showing main roads and topographic features.

Table 1. Land use within Carter County in 1976.[a]

Land Use	Percent of Total
Rangeland	88.23
Cropland	6.83
Pasture and Hayland	1.53
Forest Land	2.67
Other--farmsteads, farm roads, rural residences, country churches and schools, etc.	0.14
Urban and Built-up Areas (>4 ha)	0.32
Small Water Areas (.8-10 ha)	0.27

[a]From Carter County Board of Supervisors, 1976.

The sparsely vegetated buttes and forested mesas of Carter County are notable diversions from the surrounding rolling terrain, and include the Long Pines, Ekalaka Hills, and Chalk Buttes, all of which are portions of the Sioux District of the Custer National Forest. These mesas are sandstone remnants of Miocene formations which have been eroded away in the surrounding plains, and have been likened to islands rising above their surroundings.

Roughly "L" shaped, the Long Pines extend about 18 km from east to west and 29 km from north to south. The study area surrounds the National Forest land, and encloses approximately 600 sq km. Drainages on the east side of the study area flow directly into the Little Missouri River; those on the west drain first into Boxelder Creek. Most streams in the study area are intermittent, flowing only in the spring and after rains. Maximum elevation in the study area is approximately 1260 km.

The climate of the northern Great Plains prevails in the study area, with ". . . frequent winds, hot summers, cold winters" and a semi-arid continental climate (U. S. Forest Service, 1976b). Temperature and precipitataion for the study area can be estimated using figures for Ekalaka and for Camp Crook, South Dakota, approximately 19 km southeast of the center of the study area (Table 2).

The normal annual temperature range is about -34°C to 41°C; but wide daily, day-to-day, and seasonal temperature fluctuations are common. Over 60 percent of the annual precipitation

Table 2. Average precipitation and temperature for Ekalaka and Camp Crook.[a]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Ekalaka													
precipitation (cm)	1.17	1.04	1.60	3.30	5.72	9.32	4.80	3.81	3.58	1.86	1.45	1.02	38.66
temperature (°C)	-8.1	-5.3	-1.9	6.0	12.0	16.6	21.4	20.8	14.2	8.3	-0.3	-5.1	6.72
Camp Crook													
precipitation (cm)	0.89	0.83	1.13	2.22	5.66	8.10	3.23	2.89	2.04	1.63	1.02	0.74	34.73
temperature (°C)	-8.3	-6.1	-1.7	6.1	12.2	17.8	21.7	21.1	14.4	8.3	0	-6.1	5.89

Recorded temperature extremes:

	high	low
Ekalaka	42.2°C	-42.2°C
Camp Crook	45.6°C	-49.4°C

[a]From U. S. Department of Commerce, NOAA; 1976, 1977.

normally falls from April through July. The Long Pines receive more precipitation than do the surrounding plains. Snow accumulations are generally light, but the winter of 1977-78 was particularly severe, and caused deep snowdrifts in many locations.

Near normal temperatures and precipitation were recorded during the 1977 nesting season, but in 1978 temperatures were below normal and precipitation was well above average. Snow and inclement weather severely hampered field work in April and May 1978.

The Long Pines are part of what Bauer (1924) called the Ekalaka lignite field. This field lies in the southwestern part of the Williston Basin, in the unglaciated portion of the Missouri River Plateau of the northern Great Plains (Fenneman, 1931; Denson and Gill, 1965). The upper, nearly horizontal strata of this basin (which form all of the major topographic features of the region surrounding my study area) are of the Tertiary and Upper Cretaceous periods. Lillegraven (1970) described the Long Pines and other mesas in the vicinity as parts of ". . . a system of Tertiary erosional remnants standing above the Late Cretaceous rocks of northwestern South Dakota, southwestern North Dakota, and southeastern Montana." Predominant among these formations are sedimentary rocks consisting primarily of shale, sandstone, siltstone, and lignite.

The Long Pines are largely of the Oligocene White River formation which is capped by the Miocene Arikaree formation (Table 3). Sharp cliffs of the White River formation are dominant on the southern and western edges of the National Forest land in the Long Pines. At the edges of the White River formation

Table 3. Geologic formations of the Long Pines area.[a]

System	Series	Formation	Characteristics
Quaternary	Recent and Pleistocene	---	sand, silt, and gravel along stream channels
Tertiary	Miocene	Arikaree	sandstone and siltstone
	Oligocene	Chadron (White River Group)	claystone, sandstone, and siltstone
	Paleocene	Sentinel Butte (Fort Union formation)	bentonitic claystone and shale, sandstone
		Tongue River (Fort Union formation)	sandstone, siltstone, and shale
		Ludlow (Fort Union formation)	sandstone, shale, and lignite
	Upper Cretaceous	Hell Creek	claystone and sandstone
		Fox Hills	sandstone and shale
		Pierre Shale	bentonitic claystone and shale, some bentonite

[a]Modified from Denson and Gill (1965).

successively older formations are exposed, including the Paleocene Ludlow member of the Fort Union formation, which outcrops primarily to the north and east of the Long Pines, and the Upper Cretaceous Hell Creek, Fox Hills, and Pierre Shale formations, which are exposed in succession to the south and west (Bauer, 1924; Perry, 1935; and Denson and Gill, 1965). Much of the contrasting topography of the Long Pines and other mesa areas has been attributed to Tertiary Period landslides (Gill, 1952). Other studies in the area have been done by Dobbin and Reeside (1929), Gill and Moore (1955), Gill (1959), and Denson et al. (1959).

Groundwater resources were considered by Bauer (1924), and more extensively by Perry (1935), Mueller and Wirth (1971), and Karp and Botz (1973), and by the Montana Bureau of Mines and Geology. The chief water-bearing strata around the study area are the Lower Certaceous Dakota and Lakota formations, although Perry (1935) indicated the Lance, Fort Union, White River, and Arikaree formations all to be water-bearing. In the immediate vicinity of the study area, however, the Dakota and Lakota formations are too deep to provide easily obtainable water, and upper strata supply the water for the many stock ponds in and around the study area. These strata are recharged with water from the mesa tops which percolates down through the porous layers (Mueller and Wirth, 1971; Karp and Botz, 1973; and U. S. Forest Service, 1976a). Primary supply of water for human and stock use in the area comes from the Fort Union formation. Bauer (1924) considered the Fox Hills formation a potential source of water, and the

U. S. Forest Service (1976a) reported that the formation ". . . yields moderate quantities of good to poor quality water and can be developed more."

According to Bauer (1924), soils of the Ekalaka field in general, and the Long Pines in particular, are largely residual--they are derived from the formations upon which they lie. An exception is alluvium occurring along the Little Missouri River and along Boxelder Creek in the northwest corner of the study area. This alluvium is generally the best soil of the region. In the study area soils range from sandy and well-drained in Ponderosa Pine (*Pinus ponderosa*) areas, to finer and more dense in grasslands, to very poorly drained and shallow soils in grassland areas on tops of the mesas (U. S. Forest Service, 1976a).

The vegetation of the study area has been most expansively described by Jonas (1966). General descriptions have been added by Lampe et al. (1974) and the U. S. Forest Service (1976a, b). The ecology of Ponderosa Pine in similar habitat in North Dakota was studied by Potter and Green (1964). An analysis of vegetational communities in the Long Pines is part of the Department of Fish and Game Study, and within the Department's study area (which is slightly smaller than mine) twelve habitat types have been identified. These habitat types are (Dusek, 1977):

1. *Pinus ponderosa/Andropogon scoparius*
2. *Pinus ponderosa/Agrogpyron* sp.
3. *Pinus ponderosa/Rhus trilobata*

4. Pinus ponderosa/Symphoricarpos albus
5. Pinus ponderosa/Juniperus sp.
6. Agropyron sp./Stipa sp.
7. Artemesia sp./Agropyron sp.
8. Artemesia sp./Chrysothamnus sp.
9. Populus tremuloides
10. Populus tremuloides/Symphoricarpos sp.
11. Fraxinus pennsylvanicus-Acer negundo/Symphoricarpos sp.
12. Agricultural

Pinus ponderosa dominates the vegetation of the study area. It occurs in extensive stands on the tops of the mesas and occasionally extends down the slopes of the older geologic formations and onto the plains. Open mixed prairie tracts are more widespread in the northern one-third and along the edges of the study area. Drainageways are characterized by more diverse deciduous vegetation. The study area most closely resembles the Pinus ponderosa/Andropogon and Pinus ponderosa/ Agropyron Montana habitat types described by Pfister et al. (1977).

Apparently there has been little intensive study of wildlife in the Long Pines area. A study of Merriam's Turkey (Meleagris gallopavo merriami), introducted to the Long Pines in 1955, was conducted in the mid-1950's (Rose, 1956), and an extensive study of this population was carried out in the early 1960's (Jonas, 1966, 1968). A summary of Carter County mammal species was published by Lampe et al. in 1974. Much of the small mammal trapping for the study was done in the Long Pines. A summary of the mammal species of the county is included in Appendix A.

The Department of Fish and Game study is concentrating on the ecology of game species: Mule Deer (Odecoileus hemionus), White-tailed Deer (Odecoileus virginiana), and Antelope (Antilocapra americana) among game mammals, and Merriam's Turkey and and Sharp-tailed Grouse (Pediocetes phasianellus) among game birds. Hungarian Partridge (Perdix perdix) have also been observed in the study area (Dusek, 1977).

A survey of breeding songbirds was conducted in the study area in 1977 and 1978. A summary of study area nesting and summer bird species other than raptors observed during this study is included in Appendix B.

METHODS

Field work was carried out from 14 June through 20 July 1977, and from 7 April through 28 July 1978. My work in and around the study area largely followed the techniques of other studies in similar habitats (Olendorff, 1973a, b; O'Brien and Pulkrabek, 1974; Pulkrabek and O'Brien, 1975). Precises census techniques such as those used by Craighead and Craighead (1956), Ryder (1969), Boeker and Ray (1971), and Higby (1975) were thwarted by several factors: (1) lack of personnel, (2) restricted visibility from the ground in many portions of the study area due to extensive timber cover and rough terrain, (3) lack of easily travelled roads in many sections of the study area, and (4) a lack of opportunity to fly over the study area. Observation techniques were therefore oriented primarily toward two cliff nesting species, the Golden Eagle (*Aquila chrysaetos*) and the Prairie Falcon (*Falco mexicanus*). During the 1977 study period I attempted to locate potential Golden Eagle and Prairie Falcon nesting habitat, which is scattered throughout the study area. This habitat was surveyed from a vehicle or on foot, using binoculars and a 16-60X spotting scope. Probable nesting areas were inspected more closely on foot. Observations of Merlins (*Falco columbarius*) were generally incidental to these closer searches for Golden Eagle and Prairie Falcon nests, whereas observations of other raptor species were made at varying times and in many locations throughout the nesting season. In 1977 raptor species other than Golden Eagles and Prairie

Falcons were noted when searching for the eagle and falcon nest sites, or when travelling through the study area for any reason. In 1978 a more extensive survey of the study area was made on foot and from a vehicle, and I had more opportunity to search for nests of other raptors.

As the nesting season progressed and the inventory of Prairie Falcon and Golden Eagle nests was completed, more time was spent in search of nests of other raptors. Early season observations were hampered by extremely wet and cold weather during April and May 1978, however, and the loss of field time during this period meant that the inventory for other species was less complete.

The inventory of diurnal woodland nesting species such as accipiters was incomplete because neither time nor personnel were available for a nesting survey of these species. The Great Horned Owl (Bubo virginianus) was seen only occasionally because of its nocturnal activity and early nesting relative to other species.

In 1978 I was flown over part of the study area in a Piper PA-18 (Super Cub) to look for potential Golden Eagle and Prairie Falcon nesting habitat. This survey helped delineate those portions of the study area which required further investigation from the ground, but no nests were located from the air.

Nest sites and sightings of all raptors were initially plotted on U. S. Forest Service maps, but in 1978 locations of all nests located during both seasons were plotted on U. S. Geological Survey advance topographic maps of the study area. This provided much greater accuracy in locating nests relative to key study area features. Actual nest locations were recorded only when incubating adults or young birds were found on nests. Approximate nest locations were recorded when an adult was viewed carrying food to an area, when an adult's behavior indicated that a nest was nearby, or when recently fledged young were observed.

Clutch size, brood size, and fledging success were recorded when they could be determined. For all species general notes were made on nesting chronology, on age, health, size, and behavior of young, and on nest characteristics. For Prairie Falcon and Golden Eagle nests records were kept of cliff exposure (slope exposure for Golden Eagle tree nests), heights of nests above the ground, and the heights of the cliffs or trees in which nests were located. Measurements were made by lowering a rope marked at 1 m intervals from the cliff tops and having an observer indicate when the rope passed the nest and reached the ground at the base of the cliff. For tree nests, which could not be measured in this way, and at cliff nests where there was no other observer, I made visual estimates of heights.

No prey information was recorded because few visits were made to aeries and nests, and the sample of prey items would have been small.

Rappelling was used to check fledging success at Prairie Falcon aeries in 1977, and to check clutch size, brood size, and fledging success at Prairie Falcon and Golden Eagle nests in 1978. Visits to nests were delayed until the female had been incubating for at least two weeks. No nest visits were made in cold or inclement weather. Nests of species other than Prairie Falcons and Golden Eagles were visited only near the fledging dates of the young in most cases. Special care was taken to avoid disturbing Golden Eagle nests when an incubating adult or newly hatched young were present. Caution was exercised in all cases to avoid harm to eggs or promote nest abandonment due to visits by observers, and precautions for nesting studies identified by other researchers (Hamerstrom, 1970; Fyfe and Olendorff, 1976) were followed when possible. No known nest failures or losses of eggs or young resulted from this study.

U. S. Forest Service personnel conducted a raptor survey on the Montana portion of the Sioux District in 1977 and 1978. Sightings and nest locations they reported were combined with my observations. Sightings noted by the Department of Fish and Game Biologist or by the graduate student conducted the aforementioned songbird study were also added to my data.

Young were banded where possible in 1977 and 1978 with U.S. Fish and Wildlife Service bands by the U. S. Forest Service raptor biologist.

While in the field raptor observations were necessarily the most time consuming portion of my work. However, in order to determine the potential effects of uranium exploration or mining activities I located active mining claims and past and present uranium exploration activity sites. To locate mining claims I searched the records of both Carter and Harding counties for notices of assessment work on mining claims. Mobil Oil Corporation supplied maps showing their exploratory drilling sites within the study area for each year since the beginning of their uranium exploration there.

Locations withdrawn from mining activity and areas of special interest to the U. S. Forest Service were plotted on U. S. Forest Service maps.

Finally, locations of past mining and logging operations within the study area were recorded.

RESULTS

Raptor Survey

Seventeen raptor species were observed in the study area during 1977 and 1978. Two of these species winter in the study area. Nine species, and probably a tenth, nest there.

Bald Eagles and Rough-legged Hawks

Bald Eagles (*Haliaeetus leucocephalus*) and Rough-legged Hawks (*Buteo lagopus*) are wintering species in the study area. I observed only one Bald Eagle in the study area, in early April 1978, and saw no Rough-legged Hawks during either nesting season.

Swainson's Hawk

Immature and adult Swainson's Hawks (*Buteo swainsoni*) were observed along the perimeter of the study area during the 1977 and 1978 nesting seasons, but no nests or young were found. This species' preference for nesting in relatively open areas, and conflicts with Red-tailed Hawks (*Buteo jamaicensis*) reported by others (Bowles and Decker, 1934; Craighead and Craighead, 1956; Olendorff, 1973a; and Dunkle, 1977) suggest that nesting Swainson's Hawks are more likely to be found in open areas surrounding the study area. Skaar (1975-1978) reported this species nesting north and west of the study area, but it was apparently only a transient in the study area during this study.

Ferruginous Hawk

Ferruginous Hawks (*Buteo regalis*) were observed in the study area only once in each nesting season, but they nested in surrounding lands. Descriptions of Ferruginous Hawk nesting ecology (Bowles and Decker, 1931; Weston, 1969; Smith and Murphy, 1973; Powers et al., 1975; and Lokemoen and Duebbert, 1976) indicate that habitat within the study area is not typical of that preferred by this species. I believe that this buteo is no more than an occasional visitor to the study area.

Burrowing Owl

One Burrowing Owl (*Speotyto cunicularia*) was seen on the west edge of the study area in July 1978. Burrowing Owls may nest in Prairie Dog (*Cynomys* sp.) holes or Badger (*Taxidea taxus*) dens (James and Seabloom, 1968; Wedgwood, 1976), but sites such as Rock Squirrel (*Spermophilus variegatus*) burrows have also been used (Martin, 1973). The one Prairie Dog (*Cynomys ludovicianus*) town within the study area of which I am aware is apparently fairly small, and Badgers do not appear to be common. These factors and the single Burrowing Owl observation indicate that nesting in the study area is unlikely. Several large Prairie Dog towns exist to the north and west of the study area, and if Burrowing Owls are present there they may occasionally be found in the study area.

Goshawk

The Goshawk (*Accipiter gentilis*) is an uncommon nesting species in south central Montana in habitat similar to that of the study area (Phillips and Lockhart, 1976). This species may nest in the study area, but no confirmed observations of this species were made during either season of this study.

Long-eared Owl

One Long-eared Owl (Asio otus) was observed just west of the study area in 1978. Phillips and Lockhart (1976) found this an uncommon nesting species in south-central Montana, but its status in the study area was not determined. There are many sites in the study area similar to those preferred by this species in areas of other studies (Marti, 1969; Reynolds, 1970) and it may nest in the study area.

Short-eared Owl

One Short-eared Owl (Asio flammeus) was observed in the study area in 1978. Nesting in the study area is likely for this species, for nesting Short-eared Owls have been observed nearby (Mowbray, pers. comm.).

The above owls are considered uncommon nesting species within the Sioux District by the U. S. Forest Service (1976a).

Observations of nests or young in or near the study area indicate that ten raptor species nest there. These species are members of seven raptor genera, and demonstrate considerable diversity in nesting habits, activity patterns, prey, and life style. I defined the nesting season for these species to be the period from the initiation of courtship through the fledging of the young.

Great Horned Owl

Cameron (1907) and Seidensticker and Reynolds (1971) considered the Great Horned Owl a permanent resident in southeastern and central Montana respectively, and Skaar (1975-1978) reported nesting Great Horned Owls in most areas of the state. Nests were found within a few km of the Long Pines by U. S. Forest Service raptor survey personnel, and recently fledged young were observed in the Long Pines in 1978. These observations indicate that this species nests in the study area.

Several authors (Baumgartner, 1938; Smith, 1969; Seidensticker and Reynolds, 1971; and Smith and Murphy, 1973) described a variety of Great Horned Owl nesting situations which ranged from nests in low bushes or on the ground to nests in abandoned quarries and on cliffs. Other authors have described various aspects of the nesting of Great Horned Owls (Rockwell, 1908; Keyes, 1911; Errington, 1932; Gilkey et al., 1943; Craighead and Criaghead, 1956; and Mader, 1973). The wide variation in acceptable nest sites reported for this species indicates that many suitable sites exist in the study area.

Cameron (1907) felt that Great Horned Owls in southeastern Montana commenced laying about the third week of March. Baumgartner (1938) recorded complete clutches in Montana between late February and early March, and Seidensticker and Reynolds (1971) found that Great Horned Owls in south-central Montana began selecting territories in mid-February and started laying soon after. Baumgartner (1938) also suggested that Great Horned Owls ". . . may select nesting sites several months before eggs are laid." Franks and Warnock (1969) noted that one pair of Great Horned Owls was seen in the vicinity of its chosen nest site for approximately two months before the pair actually nested.

Nesting dates noted by these and other authors and evidence found during this study and by U. S. Forest Service raptor survey personnel in 1977 and 1978 indicate that the nesting season for this species extends from February through June.

Turkey Vulture

Turkey Vultures (Cathartes aura) were very common during the two nesting seasons, and were observed more often than any other species. One nest and an approximate nest location were found by the U. S. Forest Service raptor survey personnel approximately 15 km northwest of the Long Pines. The nest was located in a small hollow slightly above ground level along a low cliff. These observations indicate that nesting is likely in the study area.

A variety of nesting situations have been recorded for this species, including nests on the ground overhung by branches, in caves, in hollow logs and stumps, and even in sheds and barns (Coles, 1944; Brown and Amadon, 1968; and Andrusiak et al., 1971). Many suitable nest sites for this species, as described by these and other authors, exist in the study area.

The nesting season for this species, as indicated by interpretation of other records (Coles, 1944; Houston, 1969) and the nest and young observed near the Long Pines, is from April through late August or early September.

Harrier

The Harrier or Marsh Hawk (Circus cyaneus) is moderately common in the study area during the nesting season. Harriers were observed throughout most of the study area during searches for Prairie Falcon and Golden Eagle nests, but no nest was found until June 1978. Errington (1930), Breckenridge (1935), Sealy (1967), and Clark (1972) all described nesting conditions for this species which ranged from wet to dry conditions in areas of diverse vegetation.

The nest found in the study area and nests located in other portions of the Sioux District were located in dense Symphoricarpos patches, which are scattered throughout the minor drainageways of the study area. Sealy (1967) noted a number of Harrier nests in Symphoricarpos patches in Saskatchewan which maintained a high fledging success for three of four seasons during his study. Like Hecht (1951) noted, it was possible to come quite close to nests and still pass them by, and locating them was quite difficult.

Several pairs of Harriers were observed consistently during the 1978 season, but I did not have sufficient time to locate other nests. Pairs seen during the season were usually observed near Pinus ponderosa/Symphoricarpos savannah areas, and future studies should focus on this habitat for nests.

The nest in the study area had a clutch of six eggs, but hatching and fledging success were not determined.

Various authors have placed the incubation and nesting periods for Harriers at from 29 to 41 days and approximately 35 days, respectively (Breckenridge, 1935; Bent, 1937; Sealy, 1967; and Clark, 1972). Hammond and Henry (1949) found that Harriers arrived in North Dakota by mid-March and that clutches were started by late April or early May. In Alberta and Saskatchewan, Sealy (1967) found that clutches were complete by the end of May. Clark (1972) found that clutches in his Manitoba study were complete by mid-June.

Harriers were associated in pairs when I arrived in the study area in April 1978, and the hatching and fledging dates for the nests located in the 1978 nesting season indicate that egg laying was complete by early June. Dates for complete clutches in this and other studies are closely comparable; the nesting season for Harriers in the study area extends from mid-March through July.

Sharp-shinned Hawk

Sharp-shinned Hawks (Accipiter striatus) were observed occasionally in 1977 and 1978. An immature Sharp-shinned Hawk observed near Lantis Spring in 1977 by the U. S. Forest Service indicated that this species nests in the study area. Bent (1937) and Brown and Amadon (1968) reported that Sharp-shinned Hawks prefer to nest in thick groves of trees, and nests observed by Platt (1976) in Utah were ". . . characteristically in dense stands [of trees] with a well-developed canopy . . . ."

Bent (1937) noted that Sharp-shinned Hawks laid eggs between early April and late June in the midwest and Colorado and roughly a month later in Canada. More recently, Platt (1976) found that adults were present at nest sites up to four weeks before eggs were laid. He found that Sharp-shinned Hawks in Utah laid eggs during late May and early June. The nesting season for Sharp-shinned Hawks in the vicinity of the Long Pines probably extends from May through mid- or late July.

Cooper's Hawk

Cameron (1907) and Saunders (1931) apparently regarded the Cooper's Hawk (Accipiter cooperii) as rare in eastern Montana, and Skaar's (1975-1978) Montana distribution records agreed until 1977 and 1978, when he added the Cooper's Hawk to the list of nesting birds in southeastern Montana.

The preference of Cooper's Hawks for nesting in wooded areas, recorded by Bent (1937), Craighead and Craighead (1956), and Brown and Amadon (1968) appears to be the case in the study area. They also found that most Cooper's Hawk nests were substantial structures that were well maintained during the nesting season.

Cooper's Hawks were seen much more often in the study area than were Sharp-shinned Hawks, and one active Cooper's Hawk nest was found in the study area in each nesting season.

The nest found in 1977 was a flimsy structure approximately 15 m from the ground in the midst of a dense tract of Pinus ponderosa and occasional hardwoods. Though the behavior of the adult indicated that a nest was in the vicinity, searches on three separate occasions were required to locate the young. The Cooper's Hawk nest located in 1978 was also in a fairly dense stand of Pinus ponderosa. Three of the four young present at the nest site found in 1977 fledged. Three young found in the 1978 nest with an infertile egg are believed to have fledged.

Although Cooper's Hawks nest in the study area, gathering substantial nesting and productivity data would require a concerted effort directed at this species and considerable travel in the heavily forested portions of the study area.

Brown and Amadon (1968) indicated that the egg laying period for Cooper's Hawks in the northern United States ranges from April to June. Craighead and Craighead (1956) found that Cooper's Hawks started clutches as early as 26 April in Michigan, but not until 1 June in Wyoming. Average fledging dates for the two nests found during this study, as indicated by the ages of young found in 1977 and 1978, were 20 to 25 July. The incubation period for Cooper's Hawks ranges from 30 to 36 days, and the nestling period from 24 to 34 days (Craighead and Craighead, 1956; Brown and Amadon, 1968; and Reynolds and Wight, 1978). Using 65 days as the incubation and nestling period, the indicated beginning of incubation in the study area is mid- to late May.

Craighead and Craighead (1956) found that Cooper's Hawks in Michigan selected nesting territories roughly one month before they started clutches. The nesting season for Cooper's Hawks in the vicinity of the study area may therefore extend from mid-April through July.

Red-tailed Hawk

The Red-tailed Hawk was the only widespread buteo in the study area during the two nesting seasons.

In 1977 one nest and several approximate nest locations were found, but no productivity figures were gathered. In 1978 three nests which fledged four young were located. Numerous observations of adult Red-tailed Hawks during the 1978 nesting season suggested that the nests found were only a small portion of the total.

In nearby areas of South Dakota raptor surveys have been conducted since 1973, but little record has been kept of Red-tailed Hawk nesting information. O'Brien and Pulkrabek (1974) decided in the initial year of their survey that ". . . due to the density of these birds, no more formal [nesting] records would be kept." They felt that the Red-tailed Hawk population was very healthy.

Nests in the study area were built in *Pinus ponderosa*, as were those found on nearby National Forest lands. This was in contrast to the results of O'Brien and Pulkrabek (1974), who found seven of ten nests on cliffs. Other authors (Decker and Bowles, 1930; Andrle, 1969; and Pinel and Wallis, 1972) have mentioned cliff nesting, and Seidensticker and Reynolds (1971) found three nests on cliffs during their south-central Montana study.

Three of the nests found were in trees on the borders of grassland areas along the tops of ridges or at the bottoms of ridges or cliffs. The fourth nest was in the midst of a stand of *Pinus ponderosa* approximately 0.5 km from a grassland area. Two of the nest slopes faced east, one faced west, and the woodland nest was on a slight north-facing slope.

Immature Red-tailed Hawks fledged from late June through mid-July in 1977 and 1978. Using 75 days as the incubation and nestling period for this species (Hardy, 1939; Fitch et al., 1946; Luttich et al., 1971; and Johnson, 1975), clutches were completed from mid-April through early May. This corresponds closely to the dates noted by Seidensticker and Reynolds (1971) in south-central Montana and by Johnson (1975) in southwestern Montana. Johnson (1975), however, observed nest building as early as the first week of March. Hardy (1939) observed a pair of Red-tailed Hawks that was present for roughly three weeks before eggs were laid. Pairs of Red-tailed Hawks were observed in nesting territories by the U. S. Forest Service raptor biologist during March 1978. The nesting season for this species appears to extend from March through mid-July.

Golden Eagle

The Golden Eagle was a species of particular interest, and as mentioned previously, study efforts were directed toward Golden Eagle cliff nests.

Twenty nest sites were identified in the study area, 18 of which were on National Forest land (Fig. 2). All were within a short distance of adjacent private lands. Seventeen were on cliffs; three were found in *Pinus ponderosa*. One of the nests found in 1977 was active, while four were active in 1978.

Cliff nests were located on exposed portions of the Arikaree, White River, and Fort Union formations. Several were partially protected by overhangs, but most were built on ledges without the benefit of such protection.

McGahan (1968) found 62 percent of the nests in his Montana study on cliffs. Most of the rest were in trees; two were on the ground. Whitfield et al. (1969), Beecham (1970), and Boeker and Ray (1971) found most or all of the Golden Eagle nests they studied on cliffs. The distribution of nests in the study area appears to reflect the availability of suitable cliffs,

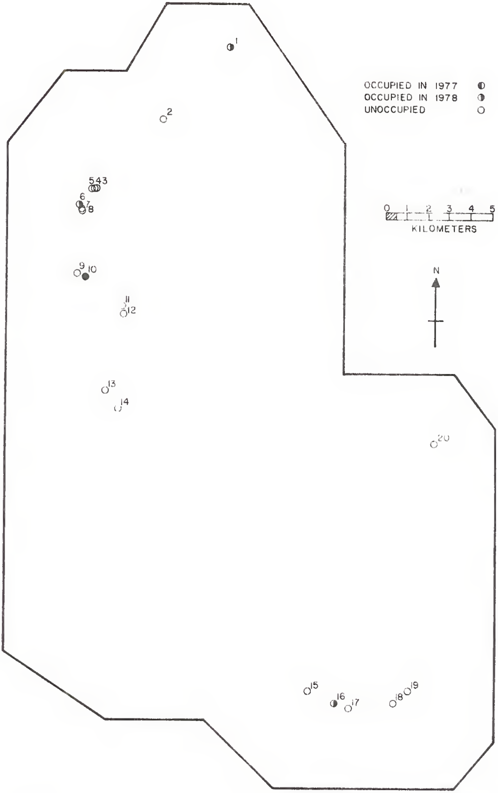

Fig. 2. Golden Eagle nest sites found in the study area in 1977 and 1978.

although observations are often biased toward the finding of a greater percentage of cliff nests than tree nests (Olendorff, 1973a). A panoramic view was an important consideration for Golden Eagle nests (Beecham, 1970).

Aspect (direction of nest exposure) varied considerably (Table 4). Mosher and White (1976) attempted to determine the correlation between nest exposure and elevation, but the size of my study area allowed no comparison, since all nest elevations were virtually the same. They suggested that nest location may be influenced by microclimate, which could lower thermal stress for juvenile birds. However, nests within the study area, particularly active nests, seemed to show little evidence of this. Two successful nests in 1978 faced south and provided no protection from the sun for several hours at mid-day.

McGahan (1968) suggested that Golden Eagle nest exposure in Montana was ". . . correlated with the direction of the sun's rays," an idea which Mosher and White (1976) believed important for Golden Eagle nests in Alaska and Utah. In my study there appeared to be no significant preference for a particular exposure, and all exposures except north were observed. There is more variation in potential Golden Eagle nest sites in the study area than in Prairie Falcon aeries, due to cliff structures, and I believe nest sites are chosen on the basis of availability rather than on a preference for a specific exposure.

Mean height of cliffs chosen for nests was 13.8 m, and nest heights averaged 9.6 m. For tree nests, mean estimated heights of trees and nests were 13.7 and 11.0 m, respectively.

Table 4. Exposure and height data for Golden Eagle nests in the study area.

Exposure	Cliff or Tree Height (meters)	Nest Height (meters)
Cliff Nests		
northeast	8	3
southeast	8	6
south	19	12
south	14	10
south	16	12
south	21	15
southwest	10[a]	5[a]
southwest	15	8
southwest	20[a]	17[a]
west	12	8
west	15	11
west	9[a]	6[a]
west	20[a]	18[a]
west	14	7
northwest	10[a]	6[a]
northwest	10	8
northwest	13.5	11
	mean: 13.8	mean: 9.6
Tree Nests		
northeast	16[a]	14[a]
east	14[a]	10[a]
southwest	11[a]	9[a]
	mean: 13.7	mean: 11.0

[a]Estimated

Kochert's (1972) method of determining nesting density produced a figure of 256 sq km per nesting pair. This is much higher than Kochert observed in his southwestern Idaho study (73 sq km). Phillips and McEneaney (1975) found an area of 48 sq km per nesting pair in south-central Montana using this method. These differences may reflect different land uses around nests, as was suggested by Reynolds (1969), or may be due to distribution of suitable nest sites.

Productivity information gathered was limited to fledging success data, which Postupalsky (1974) suggested is the best measure of productivity. One bird fledged from the active nest found in 1977, and five young fledged from three successful nests in 1978. The fourth active nest was abandoned in June, after considerable incubation. One apparently infertile egg was later found partly buried under debris in the nest.

The production of 1.20 fledglings per nest from the five active nests in this study (1977 and 1978) can be compared to the results of other studies shown in Table 5.

Productivity in the study area is comparable to that of most other areas. Kochert (1972) and Baglien (1975) indicated that they believed productivity was sufficient to maintain the populations they studied.

Baglien (1975) found that nesting activities for Golden Eagles in southwestern Montana begin in late February or March, and that egg laying begins as early as 16 March. McGahan (1966) recorded comparable dates. Adults were observed in territories in the study area by the U. S. Forest Service raptor biologist during March 1978. Indicated hatching dates for birds in nests

Table 5. Golden Eagle fledging success in other studies.

Study	Location	Number of nests	Number of young fledged per nesting attempt
Reynolds (1969)	southwestern Montana (6 years)	100	1.11
Boeker and Ray (1971)	New Mexico, Colorado, Wyoming (5 years)	213	1.39
Kochert (1972)	southwestern Idaho (6 years)	205	1.18
Olendorff (1973a)	northeastern Colorado (2 years)	33	0.97
Baglien (1975)	southwestern Montana (3 years)	22	0.91
Murphy (1975)	Utah (7 years)	61	1.31

in the study area are in the first two weeks of May, and young fledged during the first two weeks of July in both years. The nesting season for Golden Eagles in the study area extends from March through mid-July.

American Kestrel

The American Kestrel (Falco sparverius) seems to be the most abundant raptor of the study area. In 1977 one nest and three approximate nest locations were found. In 1978 five nests and seven approximate nest sites were recorded.

Kestrel nest site preferences have been described by other authors (Bendire, 1892; Tyler, 1937; and Smith et al., 1972), and have included holes in cliffs and banks, natural or excavated cavities in trees, and man-made structures. Four nests located during this study were found in excavated cavities in Pinus ponderosa snags. At these nests clutch or brood counts were difficult or dangerous to obtain due to the decayed conditions of the snags. One nest was found in a cavity in a live tree, from which the brood of four young is believed to have fledged. One egg of the clutch of five was apparently infertile. The final nest, found in a pothole in a cliff, contained a brood of five males, but fledging success was not determined. This nest was approximately 15 m from a successful Prairie Falcon aerie.

After fledging young were usually observed in groups. Young Kestrels fledged as early as 9 July. Other studies have indicated an incubation and nestling period of from 56 to 63 days (Sherman, 1913; Roest, 1957; Willoughby and Cade, 1964; and

Smith et al., 1972). These figures and observations from my study indicate that clutches may be complete by early May. This estimate is further supported by numerous observations of adults during April. Cade (1955) observed that courtship activities of American Kestrels lasted 12 to 14 weeks before completion of clutches and initiation of incubation. Such a courtship period would mean that courtship activities may have started by late April during this study. The courtship and nesting season for this species extends from April through mid-July, by which time immature Kestrels are widespread in the study area. The apparent high nesting density and fledging success of this species, as indicated by the number of newly fledged young observed, indicate that the nesting population is healthy.

Merlin

Craighead and Craighead (1940) observed that nesting Merlins could be found relatively easily in Minnesota, but I found the results of others (O'Brien and Pulkrabek, 1974; Ellis, 1976), who indicated that nests are difficult to find, more typical. Ellis (1976) reported that 11 of 12 Merlin nests he found in Montana were ". . . located on chance encounters." He found all nests in his study in old nests of either the Common Crow (*Corvus brachyrhynchos*) or the Black-billed Magpie (*Pica pica*), which was also true for nests in the study area or on nearby National Forest lands. Craig and Renn (1977) also found two Merlin nests in southern Idaho in Magpie nests, and many similar findings have been recorded (Bent, 1937). Because the canopied nests are built in clusters in numerous adjacent trees, it is very difficult to determine, once a nesting territory is found, which nest among many is in use by the Merlins.

I found three Merlin nests in 1978, and several approximate nest locations were noted during both 1977 and 1978. At least nine young fledged from the nests found in 1978. Nests located in the study area in 1978 and on nearby National Forest lands in 1977 and 1978 were all in timbered habitat. Merlin nests reported by Ellis (1976) in Montana were all in conifers, but he noted that Merlins will nest in deciduous trees when necessary. The nests located in the study area in 1978 were near the tops of Pinus ponderosa of from 11 to 15 m estimated height. Estimated nest heights were from 10 to 12 m. All nests and suspected nest areas were within 0.5 km of open rangeland habitat. Most of the nests studied by Ellis (1976) were also near ". . . flat or rolling grasslands."

Recorded incubation periods for Merlins vary from 28 to 32 and 25 to 35 days, respectively (Lawrence, 1949; Brown and Amadon, 1968; and Oliphant, 1974). During this study fledging dates were from 5 to 15 July, indicating that courtship and laying take place in April. Craig and Renn (1977) found a pair of Merlins defending a territory approximately one month before the clutch was complete, and Bent (1937) recorded this species as commonly arriving in Alberta by 1 April. The indicated nesting season is from April through mid-July.

The nestling period at two nests in the study area was particularly short. One nest found on 24 June contained four young entirely in natal down. When visited on 9 July all had fledged and three were capable flyers. The nestling period for these young may therefore have been less than 25 days. In the second case, a nest which contained four eggs on 17 June was empty on 9 July, and the young were flying in the vicinity of the nest. This indicates a nestling period of no more than 21 days for these birds.

Prairie Falcon

More time was spent gathering information on Prairie Falcon nesting than on most other raptors during this study. The results are comparable to those of nearby areas of South Dakota (O'Brien and Pulkrabek, 1974; Pulkrabek and O'Brien, 1975; Puklrabek, 1976; and Good, 1977). Most of the "occupied nesting territories" (Fyfe et al., 1969) were apparently in use during both nesting seasons.

Since Prairie Falcons nest almost exclusively on cliffs, study techniques combined looking for potentially suitable nesting cliffs in the study area and then searching them more closely for possible aerie sites or defensive adults.

Fourteen aeries were identified (Figure 3). Six were located in 1977; eight more were found in 1978. Thirteen of these aeries were located on National Forest land; nine were close to surrounding private land.

Like Golden Eagle nests, Prairie Falcon aeries were found in the Arikaree, White River, and Fort Union formations. One was found on a long overhung ledge on a cliff face, two were in large protected openings in cliffs, and 11 were in "potholes." The variety of nesting situations in which Prairie

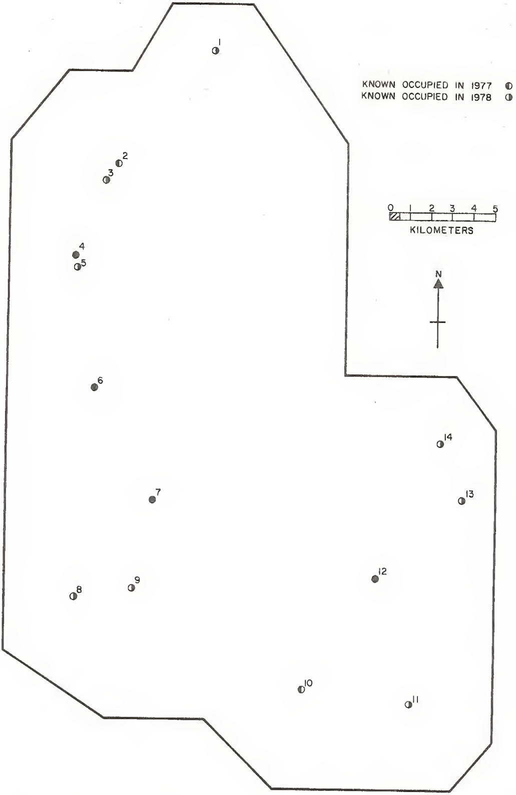

Fig. 3. Prairie Falcon nest sites found in the study area in 1977 and 1978.

Falcons have been found (Decker and Bowles, 1930; Enderson, 1964; Porter and White, 1973; and Denton, 1975) was not observed. In all but one case aeries were simply scrapes which had apparently been used only by the falcons. The exception was a large level area in a vertical crack which was apparently used as a Prairie Falcon aerie in both years of this study. Sticks and debris indicated that the site may have been used by other species previously.

Table 6 shows cliff exposures and cliff and aerie heights in the study area. In most cases aerie exposure was very nearly the same as the exposure of the cliff in which the aerie was located, but in one case an aerie with a west exposure was found in a cliff that faced south. This aerie was located along a fracture on an outward projection of the cliff.

Aerie cliff exposures ranged from east to west; 12 of 14 aerie cliffs had exposures from due south to due west. Enderson (1964) found that Prairie Falcon aerie cliffs faced all directions in southern Wyoming and northern Colorado, but found that 22 of 36 (61 percent) faced south. Porter and White (1973) found similar values; approximately 70 percent of the aeries for which they had data faced south or west. Leedy (1972), Denton (1975), and Ogden and Hornocker (1977) found aerie cliff exposure more variable.

The variation in aerie cliff exposure noted in other studies is probably more typical for the Prairie Falcon than are the results of this study. In the study area there is little possibility for such variation, since most cliffs face south and west, and few suitable aerie cliffs face east or north.

Table 6. Exposure and height data for Prairie Falcon aeries in the study area.

Cliff Exposure	Cliff Height (meters)	Aerie Height (meters)
east	31	24
southeast	11	9.5
south	11	6.5
south	9	5.5
south	22	13
southwest	20[a]	13[a]
southwest	10	5
southwest	11	6
west-southwest	9	6
west	10	8.5
west	30	26
west	17	13
west	20	11
west	8	5
	mean: 15.6	mean: 10.9

[a]Estimated.

Mean aerie height in the study area was 10.9 m, and mean aerie cliff height was 15.6 m. Edwards (1968) found eight aeries in Alberta on cliffs no more than 35 feet, or roughly 11 m, in height. Enderson (1964) found that aerie cliff height in his study averaged 15.8 m. Leedy (1972) found that the 45 aerie cliffs in his western Montana study ranged from 9 m to over 92 m in height, with an average of approximately 38 m. Mean aerie height in his study was approximately 25 m. In Oregon, Denton (1975) found aeries of over 123 m, but 59 percent of the 36 aerie cliffs he located there were less than 31 m in height.

The variation of the data reported in other studies and the results of this study seem to support the hypothesis suggested by Porter and White (1973) that Prairie Falcons select aerie sites on the basis of availability rather than on a preference for a specific exposure. This idea is further supported by the results of Ogden and Hornocker (1977) in Idaho, who found that no direction of exposure ". . . proved more favorable to nesting success." This hypothesis may also apply to aerie heights selected. Leedy (1972) and Denton (1975) both noted instances in which young birds were fledged in aeries very near the ground.

Partial productivity data was gathered at three 1977 Prairie Falcon aeries, from which at least 12 young fledged. More complete Prairie Falcon productivity data was obtained in 1978 (Table 7). Clutch counts were made at six aeries, and I considered the brood count at one aerie in which the young had just hatched as a clutch count. Five of these clutches contained five eggs and two contained four eggs, for a mean of 4.71 per clutch. This small sample shows a slightly higher value than did

Table 7. Productivity data for Prairie Falcons in the study area in 1978.

Clutch Size	Brood Size	Number of Young Fledged
?	≥ 2	0[a]
5	4	4
4	4	0[a]
5	≥ 4	0[b]
?	5	5
?	5	5
5	4	4
?	≥ 3	3
4	?	0[a]
5	≥ 3	≥ 3
5	≥ 4	0[b]
(?)	5	5

[a]Young disappeared.

[b]Young died.

Enderson (1964) in Colorado and Wyoming (4.5 for three years), Leedy (1972) in Montana (4.4 for two years), Denton (1975) in Oregon (4.03 for two years), or Ogden and Hornocker (1977) in southwestern Idaho (4.4 for two years), and is close to what Edwards (1968) found in Alberta (4.7 for one year).

Due to the time restrictions inherent in my study I did not record brood size in most cases, as I was generally unable to return to aeries except when young were banded. Some aeries were not found until after the young had hatched, and in such cases individual nestlings may already have died or disappeared. I assumed the brood size to be five in aeries where five young fledged. Except at aeries where fledgling counts were made, the number of young banded was considered to be the number fledged.

In 1978, 13 pairs of Prairie Falcons were found defending territories. Twelve of these pairs nested and hatched young birds. The exception occurred at an aerie site which was successful in 1977. In 1978 a pair of adult Prairie Falcons was present in the vicinity of the site on 20 April, but an adult Great Horned Owl was occupying the former aerie and the Prairie Falcons did not appear to have an alternate. On 2 June only one Prairie Falcon was present at the site, and no nesting took place.

Seven (58 percent) of the aeries were successful, and fledged at least 29 young. In one case three young of a clutch of five eggs were very close to fledging when banded, and some may already have done so, although no immature birds were observed near the aerie.

Fledging success in 1978 was 2.42 young fledged per nesting attempt, and 4.14 fledged per successful aerie. While the sample size for this study is small, the results indicate the productivity was comparable to that of other areas (Table 8). Barring unusual circumstances, this productivity is high enough to assure continued stability of the population.

Ogden and Hornocker (1977) noted that Prairie Falcon pairs were established at most territories by late February in southwestern Idaho. Most other studies have found the arrival dates to be slightly later. Leedy (1972) observed that Prairie Falcons arrived at nesting cliffs in western Montana in mid-March. This is comparable to the results of Webster (1944) in Colorado, Enderson (1964) in southern Wyoming and northern Colorado, Edwards (1969) in Alberta, and Denton (1975) in Oregon.

The results of this study indicate the Prairie Falcon pairs in the vicinity of the Long Pines are defending territories, and in some cases are incubating a clutch, by mid-April. Young hatched in the study area between mid-May and mid-June during 1977 and 1978. The nesting season therefore corresponds closely to the nesting season reported in other studies, and can be considered to take place from mid-March through mid-July.

Human Activities

Human activities in the study area have included mining, extensive grazing and logging, recreational activities such as camping and hunting, and the recent uranium exploration activities.

Table 8. Comparison of Prairie Falcon productivity.

Study	Location	Number of Nests	Number Fledged per Nest	Number Fledged per Successful Nest
Enderson (1964)	Colorado and Wyoming (3 years)	36	1.2	?
Fyfe et al. (1969)	Saskatchewan and Alberta (1 year)	62	2.5	3.57[a]
Leedy (1972)	western Montana (2 years)	58	1.9	2.9[b]
Olendorff (1973a)	northeastern Colorado (2 years)	27	3.42	?
Denton (1975)	Oregon (2 years)	43	2.49	2.98
Ogden and Hornocker (1977)	southwestern Idaho (3 years)	110	3.1	3.7
This Study (1977 and 1978)	southeastern Montana	15	2.42	4.14

[a]Nestlings.

[b]Excluding human interference.

Mining

Bauer (1924) mentioned two operating lignite mines in the southeastern corner of the Long Pines. These mines are no longer operating, nor have any other surface mines, other than gravel pits, been opened in the study area since then.

Livestock Grazing

Use of lands of the Sioux District for livestock grazing has occurred for almost 100 years, and grazing will continue to be an important industry. "The range resource management goal for the Custer National Forest is to maintain or improve the vegetation and soil components, while at the same time providing for livestock grazing" (U. S. Forest Service, 1976a). Approximately 15,400 animal unit months[1] of grazing were permitted on the National Forest land of the Long Pines in 1978. Extensive grazing also occurs on private lands in and around the National Forest.

Timber Harvest

"The timber of the [Sioux] unit has been harvested since the settlement of this region for firewood, posts, poles, and logs. Many if not all of the roads found on the Unit had their origin as logging or wood cutting roads. There was no pattern to this cutting, nor was any attempt made to select a particular size group of trees. Also during this early period, the southern end of the Long Pines was heavily cut over to provide ties for building of the Northern Pacific Railroad across western North

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[1]one animal unit month = one cow and calf grazing for one month, or the equivalent.

Dakota" (U. S. Forest Service, 1976a). For approximately the last 20 years the timber has been managed more strictly in the Long Pines. During this period there have been six sawtimber sales (Fig. 4), and numerous small sales of posts and poles. The management plan for the Sioux District allows the removal of approximately 500,000 board feet per year in the future (U. S. Forest Service, 1976a), most of which will come from the Long Pines.

Recreation

"Hunting was the most obvious form of recreation that occurred in the national forest portion of the study area [in 1976]" (Dusek, 1977). The Long Pines area supports a substantial number of White-tailed and Mule Deer which, together with the Merriam's Turkey, draw numerous hunters to the study area in the fall. There is also a Sharp-tailed Grouse hunting season in the area. Hunter use of the area is highest during the period from mid-September through November, but the spring Turkey season brings a number of hunters to the area in April. According to the U. S. Forest Service, hunters in the fall are the primary recreational users of the Montana portion of the Sioux District (U. S. Forest Service, 1976a).

Other recreational uses of the area include picknicking, camping, and horseback riding in the summer, and snowmobiling in the winter. Categories of recreation in the Montana portion of the Sioux District (which includes the Ekalaka Hills and the Chalk Buttes) and the use each received in 1976 are shown in Table 9. Most of the recreation occurs each year in the Long Pines.

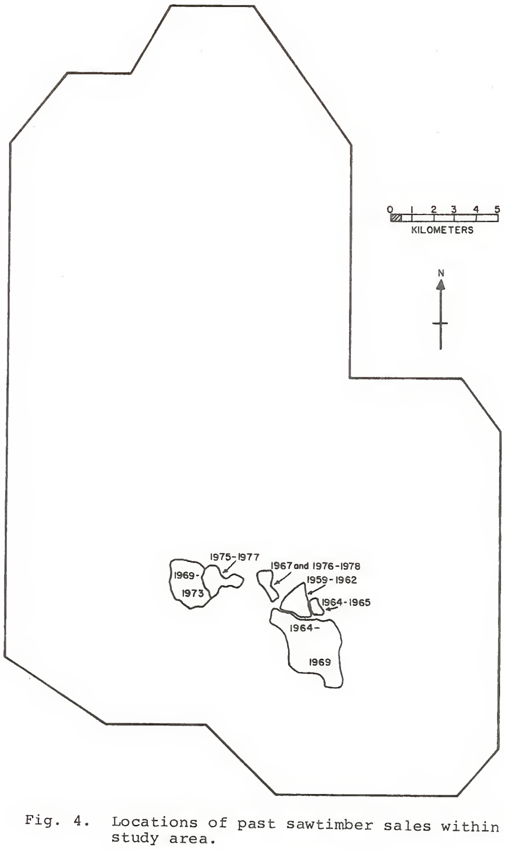

Fig. 4. Locations of past sawtimber sales within the study area.

Table 9. Recreation Visitor Days[a] expended in the Montana portion of the Sioux District in 1976.[b]

Activity	1000's of Recreation Visitor Days Expended
Hunting--big game and small game	8.6
Picknicking	2.7
Horseback Riding	2.0
Camping--hunters	1.4
Camping (except hunters)	1.2
Snowmobiling	.6
Hiking	.4
Fishing	.2
Motorcycling	.1
Miscellaneous	1.6

[a]Recreation Visitor Day = one visitor for 12 hours.

[b]Modified from U. S. Forest Service (1976a).

Uranium Exploration

Uranium exploration in the study area and its surroundings started approximately 20 years before Mobil Oil Corporation's recent exploration efforts. Several U. S. Geological Survey studies dealt with uranium in various strata of the study area and nearby lands.

Wyant and Beroni (1950) and Beroni and Bauer (1952) discovered low-grade uranium deposits in the Williston Basin of southwestern North Dakota, northwestern South Dakota, and southeastern Montana in 1948 and 1949. Gill and Moore (1955) recorded the occurrence of carnotite in the Chadron formation approximately 100 km east of the Long Pines in the early 1950's. Relatively high-grade uranium-bearing lignite and carbonaceous shale were discovered in approximately 55 km northeast of the study area in 1954 (Denson and Gill, 1965). Gill (1959) then reported the occurrence of uranium-bearing lignite in the Fort Union formation in the Ekalaka Hills.

A summary of information about uranium-bearing lignite in northwestern South Dakota and nearby areas was published by Denson et al. in 1959. Probably the most extensive study of uranium occurrences in the southwestern part of the Williston Basin was published by Denson and Gill (1965). They sampled 13 sites in and around the Long Pines and found two locations with relatively high-grade uranium concentrations. Most locations they sampled, however, were found to be only weakly radioactive and contained only small amounts of uranium.

These studies indicated a potential for commercial valuable uranium deposits in the Long Pines area, but were insufficient in themselves, for all were focused on strata above the Hell Creek formation.

In the late 1960's and the early 1970's a regional study by Mobil Oil Corporation indicated potentially valuable uranium deposits in the Hell Creek and Fox Hills formations (Farrar, pers. comm.). Following this discovery, Mobil initiated preliminary uranium exploration in Carter and Harding counties.

In 1972 Mobil staked 1831 claims in the Long Pines and began exploration by drilling in 10 locations. In 1973 and 1974, 51 and 61 holes respectively, were drilled within the Long Pines (Stellingwerf, 1975). This exploration work continued through 1977, and in the five year period of exploration Mobil drilled approximately 350 test holes within the study area and many more outside (Fig. 5).

The Fox Hills formation was the primary target of the exploration, but the Hell Creek formation was a secondary target (Farrar, pers. comm.). To be certain that the entire Fox Hills formation had been penetrated the exploratory holes were drilled into the Pierre Shale formation.

These drilling operations used small truck-mounted rigs, which drilled to depths of 100 to 400 m, depending on the depth of the Pierre shale. They required approximately 6000 gallons of fresh water for each hole, which came from a number of sources. "Stock ponds, range wells, beaver dams, and springs are all used as a water resource [for drilling]" (Stellingwerf, 1975). Roughly 1/20 ha was required for each site. From 1975 through 1977 portable pits were used. These pits reduced the damage to each site considerably. One large pit for the disposal of

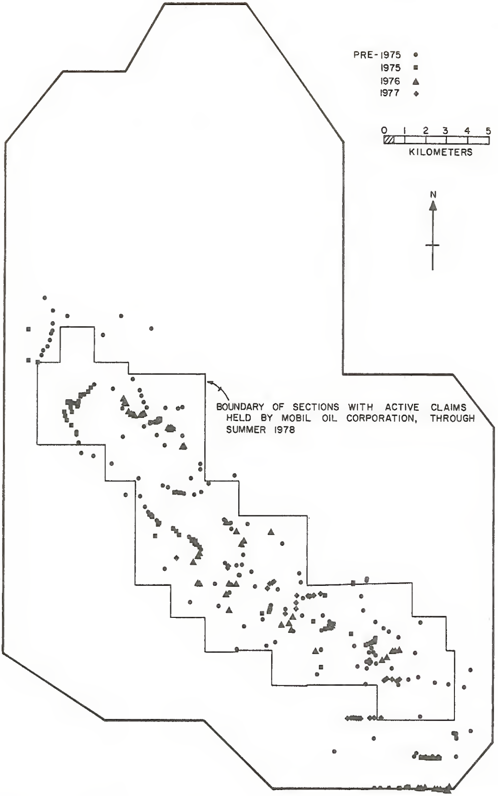

Fig. 5. Mobil Oil Corporation's uranium exploration drilling sites in the study area.

cuttings from the drill holes was constructed in 1973, and was filled and restored in 1978. Following the drilling of each hole, the radioactivity of the strata was logged and the hole was plugged. Plugging specifications were established by the U. S. Forest Service and the Montana Department of State Lands. A check of several sites in July 1978 indicated that the plugs seemed to be in place and holding and there was apparently no movement of water between different strata (Dusenbury, pers. comm.).

After completion of drilling, logging, and plugging the sites were restored by Mobil to the specifications of the U. S. Forest Service and the Montana Department of State Lands.

Mobil's work at these sites was conducted largely in July and August of each year.

A number of claims have been established by Transcontinent Oil Company in the southwestern portion of the study area, but no development of these claims has occurred.

Withdrawn and Special Interest Areas

Three areas within the Long Pines have been withdrawn from mining by the U. S. Forest Service (Fig. 6). Commercial development has been prohibited on approximately 97 ha around Capitol Rock and on approximately 32 ha at both the Wickham Gulch and Lantis Spring campgrounds.

Three Special Interest Areas in the Long Pines, also shown in Figure 6, have not been legally withdrawn from development. The Maverick Gulch area supports a relict population of Paper Birch (*Betula papyrifera*) which ". . . exists as a peripheral

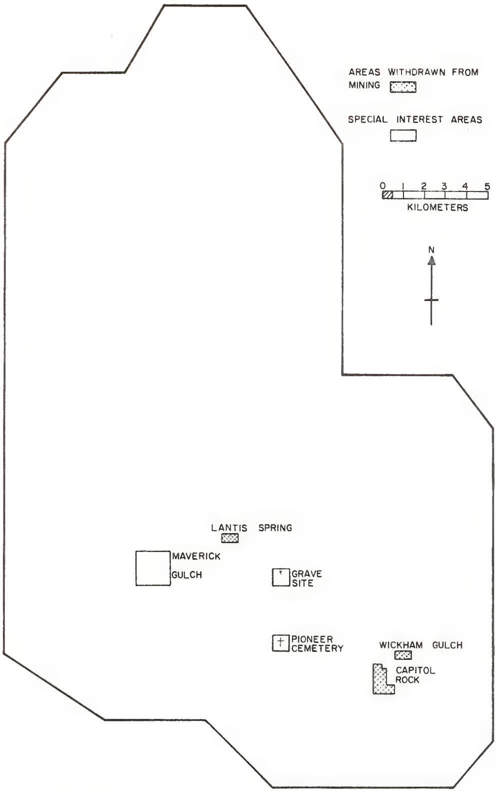

Fig. 6. Withdrawn and special interest areas in the study area.

species on the western edge of its natural range in western North Dakota, western South Dakota, and eastern Montana" (U. S. Forest Service, 1976a). The Forest Service presumably will take action to preserve this remnant population in the Long Pines.

The Pioneer Cemetery and the Grave Site are also areas of Special Interest which have not been removed from development.

There are also two research exclosures (of .8 ha and .4 ha) (which are too small to be shown in Figure 6) in the Long Pines in which development probably will not be allowed.

DISCUSSION AND RECOMMENDATIONS

Major activities considered in the Sioux District Management Environmental Impact Statement (U. S. Forest Service, 1976b) are presented in order of their priority in Table 10. An activity listed in the table will take priority over those listed below it.

The major activities mentioned previously are those which I believe have the potential for impacts on the raptor population of the Long Pines area. These activities include mining for minerals other than uranium, grazing, logging, recreational activities, and the development of uranium deposits.

Mining

Apparently only two mines operated in the study area in the past. Both were lignite mines located in the southeast corner of the Long Pines. They have long since ceased operation, and I was unable to determine their exact locations. I surveyed the area where they had been located, both from the air and on aerial photographs, but recovery of the vegetation of the area has apparently been sufficient to mask the former mine sites from casual observation.

Under Public Law 95-87, the Surface Mining Control and Reclamation Act of 1977, ". . . no surface coal mining operations may be permitted within the boundaries of the Custer National Forest." Further, according to the Forest Service (1976b),

Table 10. Major activities considered by the U. S. Forest Service for the study area.[a]

Activity	Priority
Special Interest Areas	1
Range Management and Supportive Activities	2
Dispersed Recreation and Supportive Activities	3
Deep Mineral Recovery and Supportive Activities	4
Wildlife Habitat Management and Supportive Activities	5
Timber Harvest and Supportive Activities	6
Oil and Gas and Supportive Activities	7
Utilities and Supportive Activities	8
Developed Recreation and Supportive Activities	9
Surface Mining and Supportive Activities	10

[a]From U. S. Forest Service (1976b).

surface mining operations of any type are not to be allowed on the National Forest lands of the Sioux District. As no further surface mining operations will occur on the National Forest lands of the Long Pines, consideration of disturbances to the nesting raptor population from this source can be dismissed. Surface mining could occur on surrounding federal, state, or private lands or on private inholdings (Fig. 7), however. The considerations discussed under minimizing disturbances due to in-situ uranium mining should be applied under such circumstances.

Livestock Grazing

Livestock grazing has been extensive on the Sioux District for approximately 100 years, and is considered second in importance among the major activities on the Sioux District. Range management includes managing livestock forage, but also includes surface structures, excavations, ponds, and other measures designed to improve range or livestock management. In the study area range improvements include wells, stock tanks and ponds, and fencing, all of which serve to more evenly distribute livestock on grazing allotments on the National Forest land.

Developments associated with grazing management may have beneficial effects for wildlife. Evans and Kerbs (1977) found that manmade livestock watering ponds in western South Dakota have not only achieved the goal of better distributing livestock grazing, but have also improved and created wetland habitats ". . . particularly suited for waterfowl and shorebirds." They found that the brood season for waterfowl in their study

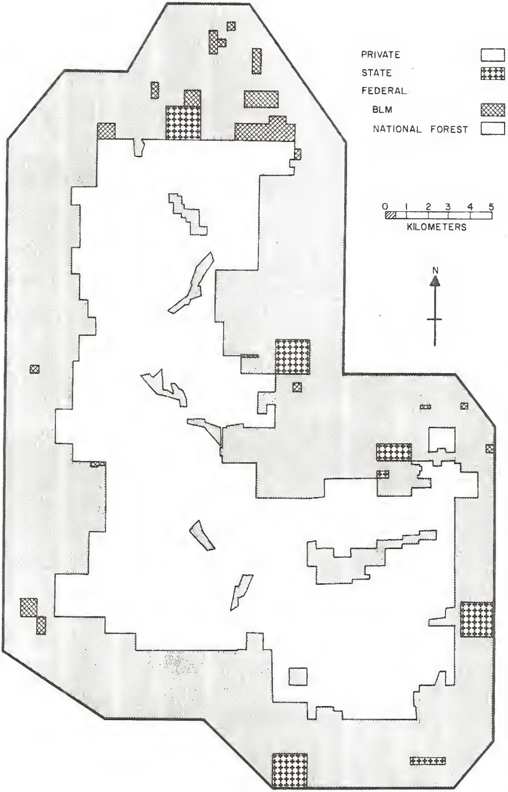

Fig. 7. Land ownership within the study area. From Bureau of Land Management, 1974.

extended from mid-June through July; there is therefore the potential for waterfowl to serve as prey for raptors during the critical portion of the nesting season if stock ponds exist near raptor nest sites. Becker (1977, 1978) found waterfowl remains in Golden Eagle nests in the study area, and I found partial remains of a Mallard (Anas platyrhynchos) in a Great Horned Owl roost in 1978. Bue et al. (1952), Smith (1953), Berg (1956), and Lokemoen (1973) also found that stock ponds can benefit waterfowl, and thus possibly raptors. In arid southeastern Montana and western South Dakota, livestock ponds can increase wildlife diversity.

While the measures designed to improve the distribution of livestock may aid raptor populations through increases in diversity and numbers of both birds and mammals, the effects of grazing may vary. Hodson (1978) found that grazed grasslands adjacent to Merlin nests in his southern Alberta study provided much of the prey selected by the Merlins, whereas abundant prey species present on undisturbed grasslands were not selected. Passerine species present in the two habitat types were probably different, as was found by Owens and Myres (1973) in a nearby area, but Hodson (1978) believed that easier hunting over grazed areas was the reason for the disparity he noted in habitat use by the Merlins. Thus, Hodson's study shows that grazing may determine preferences in hunting areas, at least for this species.

Grazing may change species and numbers of prey available. Falcons and accipiters may suffer from reductions in numbers of passerines, whereas the Golden Eagle, Red-tailed Hawk, and Harrier are more dependent on small mammals. Some studies have found that heavy grazing by livestock considerably reduces bird populations in mixed prairie (Smith, 1940) and woodlands (Dambach and Good, 1940; Dambach, 1944). Owens and Myres (1973) studied the effects of agricultural practices on native passerines in southern Alberta grasslands. They found that ". . . each increase in the intensity of agricultural use [from light grazing to fallow croplands] resulted in a reduction in the total passerine population present." They believed, however, that all native passerines could be expected to occur ". . . under grazing practices which are aimed at maintaining the range in good condition." Weatherill and Keith (1969) indicated that moderate grazing may benefit small animals in some cases.

Wiens (1973) found that ungrazed or lightly grazed plots in his northeastern Colorado grassland study ". . . generally appeared to have slightly more species and greater species diversity than heavily grazed plots . . . ." He found that grazing intensity rather than grazing season was responsible for changes in plant and animal density and biomass.

Roseberry and Klimstra (1970) found that overhead cover is extremely important for ground-nesting Eastern Meadowlarks (Sturnella magna). Deferred grazing systems, which do not allow livestock grazing on grassland areas until roughly the middle of the summer, can be favorable for this and other ground-nesting avian species (Buttery and Shields, 1975). Thus, both number and diversity of small bird species, and thereby the numbers of some raptors, may be affected by both the amount of grazing and the grazing management plan.

Populations of small mammal species of the study area may also be affected by grazing. For example, in the shortgrass prairie of northeastern Colorado, Flinders and Hansen (1975) found that Desert Cottontail Rabbits (Sylvilagus audobonii) were more abundant in pastures grazed moderately in summer and winter than they were in pastures grazed heavily, lightly, or not at all. However, they observed no correspondence between population levels of White-tailed Jackrabbits (Lepus townsendii) and grazing levels.

Livestock grazing is currently maintained at approximately 80 percent of the potential for the Sioux District (U. S. Forest Service, 1976a), and there appears to be a balance between the requirements of stockmen and nesting raptors in the study area. Continued use of the Long Pines for grazing should not seriously conflict with the birds of prey of the area.

The Management E.I.S. for the Sioux District (U. S. Forest Service, 1976b) calls for deferred grazing ". . . at least every other year on range allotments that are not under improved management systems." The requirements of ground nesting small birds and of small mammals which prefer more dense vegetation can probably be met in the study area if this plan is followed.

The management plan also indicated that range facilities which tend to concentrate cattle in hardwood draw areas of the planning unit should be relocated. "The removal of livestock grazing from certain productive habitats, especially the riparian community along streams, along reservoirs, and natural [sic] occurring lakes and marshes, can create a fantastic amount of additional diversity" (Kindschy, 1978). The hardwood draws occur primarily along the drainages of the study area, and ". . . produce a great variety of species because of the greater amount of moisture" (U. S. Forest Service, 1976a). "Riparian zones are primary activity centers of birds and contain higher bird densities than areas without a water influence (Gill et al., 1974). The removal of livestock concentrations from hardwood draw areas of the study area may serve to increase numbers and diversity of raptor species indirectly, and so should be accomplished where practical.

Since grazing will continue to be important on the Sioux unit, a goal of grazing management on the unit should be minimization of the effects of grazing on non-game birds and mammals. Wiens and Dyer (1975) stated that ". . . effects of grazing most often depend upon its intensity and localization. High intensity grazing profoundly alters breeding avifaunas from the 'natural' state, generally in the direction of decreased species numbers and 'complexity.'" Improvements in livestock distribution and reduced grazing in some parts of the study area could benefit the raptor population.

Timber Harvest

While timber harvest is considered less important than some activities, the U. S. Forest Service believes that timber produced in the Long Pines will continue to be an important economic boost to the surrounding area. Current plans for the Long Pines call for the sale of approximately 500,000 board feet of sawtimber each year (Nordberg, pers. comm.). Unlike sales before 1959, the boundaries of sawtimber sales shown in Figure 4 have been well defined. There have also been small sales of posts and poles and thinning projects (not shown in Fig. 4) scattered throughout the southern end of the Long Pines. If there has been no understory reproduction in the area of a sawtimber sale 12 to 50 mature trees per ha are left for cone production when an area is logged. In areas where there is good reproduction the mature overstory trees are selectively removed. Areas that have been recently logged are thus fairly open, but still provide some cover.

The sawtimber operation in the study area is probably beneficial to many forms of wildlife, but the effects of the operation, good or bad, are probably local in extent. The area cut each year is relatively small, and thus provides considerable ecotone area for its size. Edge areas have been found to support greater species diversities than either woodland or clearing areas (Leopold, 1933; Lay, 1938; Preston and Norris, 1947). In southern California forests, Kilgore (1971) reported that clearing and burning of brush and saplings changed the avian species composition of the area somewhat, but total avian biomass was not greatly altered. Hooper (1967, cited by Curtis and Ripley, 1975) concluded that thinning of canopy trees, such as is now done in the Long Pines, should increase breeding bird density. Webb et al. (1977) found that logging in hardwood forests in the Adirondack Mountains increased bird species diversity, and that "None of the species present were eliminated by logging, but a few were recorded only in logged stands." I believe that such results are likely following logging operations in the Long Pines when done under current Forest Service guidelines.

Control of fires in the study area has been practiced since approximately 1940. An apparent result of this control has been development of exceptionally dense stands of young *Pinus ponderosa*--especially in the southern portion of the Long Pines. Timber harvest and the associated timber management practices may benefit wildlife species by "opening up" these areas. This serves to enhance what Verner (1974) called the "structural complexity" of the vegetation by creating open areas which contast with nearby dense stands.

Like grazing, the logging operations in the Long Pines may thus indirectly benefit some raptor species through increases in the prey population. The species most likely to benefit from logging are the woodland hunting Sharp-shinned and Cooper's Hawks, and possibly the Red-tailed Hawk.

Two potential problems associated with logging and timber management practices such as thinning should be considered. The first is the possible loss of nesting habitat for accipiters. Miller (1978) has suggested that Goshawks are "significantly dependent" on mature or "old growth" mixed conifer or Ponderosa Pine forests in northeastern Oregon, an assessment with which Meslow (1978) agrees. Edgerton and Thomas (1978) and Meslow (1978) consider the Cooper's Hawk a species which nests in "young" to "mature" timber stages or "second growth" to "older second growth," respectively. The Sharp-shinned Hawk, according to Meslow (1978) nests primarily in what he calls "second growth" or older Douglas Fir (*Pseudotsuga menziesii*) (16 years old or more) in western Oregon. Goshawks (if nesting in the study area) and Cooper's Hawks are dependent on middle-age to mature stands of trees for nesting in the study area. Sharp-shinned Hawks probably use a greater range of seral stages for nesting. This judgment is supported by the nest locations found for Cooper's Hawks in the study area and by observations of other authors (Henderson, 1924; Dixon and Dixon, 1938; Schnell, 1958; Beebe, 1974; McGowan, 1975; and Platt, 1976). Thus, fairly dense middle-aged to mature stands of Ponderosa Pines should be maintained for the study area to support nesting accipiters. The second management consideration for birds in general, and for the American Kestrel in particular, has been considered in the management plan for the Sioux District (U. S. Forest Service, 1976b). Maintenance of snags for cavity nesting birds is very important in forest ecosystems. For example, Meslow (1978) noted that 37 of 84 birds species associated with Douglas Fir communities in western Oregon were hole nesting species. Twenty-nine of these 37 species were dependent on old second growth or mature trees for nests. Referring to the American Kestrel, Roest (1957) indicated that "the favorite nesting site is an old flicker hole or natural cavity." Smith et al. (1972) noted similar preferences. My observations indicate that Kestrels depend primarily on dead snags for nest sites (four of six nests located in 1977 and 1978). Maintenance of such snags appears necessary to maintain the nesting population of the Kestrels in the study area. While they will nest in potholes and other cavities, I suspect that these sites will often be hazardous for Kestrels due to the nearness of other raptors, or will be preempted by larger birds.

The Forest Service has recognized this fact, and has planned for the retention of snag trees wherever possible in the Sioux District. According to the Management Environmental Impact Statement (U. S. Forest Service, 1976b), "Cavity nesting and tree roosting wildlife and other snag users will be considered in silvicultural prescriptions." Adherence to this guideline and the maintenance of scattered older growth Ponderosa Pine stands in the Long Pines should prove beneficial to the raptors of the Long Pines area.

Recreation

Recreational activities other than hunting and camping while hunting probably have little direct impact on the raptor population of the study area. Most campers stop in either the Lantis Spring or Wickham Gulch campgrounds (Fig. 1). The majority of campers during the two nesting seasons of this study were observed during holiday weekends; Memorial Day and Independence Day. Other than during the Labor Day weekend, there seems to be little camping activity in the Long Pines at most other times.

As indicated in Table 9, however, hunting and camping while hunting comprise approximately 53 percent of the recreational activity on the Montana portion of the Sioux District. The majority of this hunting seems to occur in the Long Pines.

Fall hunting seasons in the Long Pines probably have little impact on raptor populations, but the three-week Turkey hunting season in the Long Pines in April may indirectly disturb nesting raptor species. By late April most raptor species of the

Long Pines area have established nesting territories, and several (Red-tailed Hawks, Golden Eagles, and Prairie Falcons) are incubating clutches. Nethersole-Thompson and Nethersole-Thompson (1944) suggested that the period just before laying and in early incubation is the period during which birds are most likely to abandon nesting attempts if disturbed, so disturbance during this time should be avoided. Even if a clutch is not abandoned, cold or inclement weather can destroy clutches if the adult is forced from the nest for more than a short time (Fyfe and Olendorff, 1976).

I suspect that most spring season Turkey hunters do not disturb the Prairie Falcon and Golden Eagle nests of the study area. Most are along the rimrocks on the borders of the forested area, outside what seems to me to be preferred Turkey habitat. Nevertheless, a few nests are in the midst of good Turkey hunting areas, and there is a great deal of vehicle travel along the unimproved roads of the study area during the Turkey season; there may also be a corresponding number of hunters on foot. There has been no apparent effect on the raptor population as a result of Turkey hunting over the past 20 years, but ideally this travel should be minimized during the early part of the raptor nesting season.

Uranium Exploration and Mining

A general assessment of potential conflicts between wildlife and uranium extraction was the major goal of both the Montana Department of Fish and Game study and my work in the Long Pines area. I initially planned to base my analysis of the potential effects of an in-situ mining operation in the Long Pines area on the premise that Mobil would develop uranium reserves in the near future. Mobil's withdrawal from uranium development there means not only that the future of uranium mining in the area is doubtful, but that my analysis must be based on the evidence from other in-situ uranium mining operations, and can therefore produce only general guidelines for uranium development. Such guidelines, however, may also apply to other industrial or commercial developments which might be considered for the Long Pines area.

"In-situ mining simply means the leaching of the ore in the geological formation in which it occurs" (Reed et al., 1976). In-situ mining (sometimes called solution mining) is a process in which a leaching solution (the chemical makeup of which depends on the ore-bearing body) is injected through surface wells into the uranium-bearing body. The leaching solution oxidizes and binds to the uranium in the rock, and is then extracted through recovery wells. The number and arrangement of these well clusters depends on the size and arrangement of the ore body and such factors as the flow rate of the solution or of groundwater through the strata and the chemical composition of the uranium-bearing body. At the surface the solution is collected in a surge tank, then put into a holding tank, and is then processed. Solids are removed from the solution, which typically is then put through an ion exchange process to extract the uranium. The effluent is rejuvenated and returned to the injection wells. The uranium-laden resin from the ion exchange columns may be processed at the site or may be transferred to a mill in another location. The arrangements for milling in any situation depend on the extent of the uranium ore body and the economics of the situation. In southern Texas, where most of the current in-situ uranium mining operations are taking place, the mills are located very near the mines, but I do not know if this would be the case for an in-situ mining operation in the Long Pines area.

A schematic representation of the uranium extraction process following in-situ mining is shown in Fig. 8. The milling process following in-situ extraction is conventional, except that only the processes which follow the separation of the uranium from the ore after conventional mining are required. A complete treatise of the uranium milling process was given by Merritt (1971). The environmental effects of in-situ uranium mining, such as surface disturbance or interference with groundwater and surface water quality are minimal when compared to other types of uranium mining (Rouse, 1974; Hunkin, 1975).

In-situ mining makes possible the development of ore bodies under lands that may not be disturbed, such as parks, roads, or, in the Long Pines area, National Forest lands. In-situ mining requires no large-scale disturbances of the land surface for mining or milling operations, and since the uranium comes from the ground in a solution many of the processes associated with uranium milling, such as crushing and grinding, liquid/solid separation, and tailings disposal are dispensed with (Hunkin, 1975). Land and equipment requirements are correspondingly lower than for underground or open-pit operations.

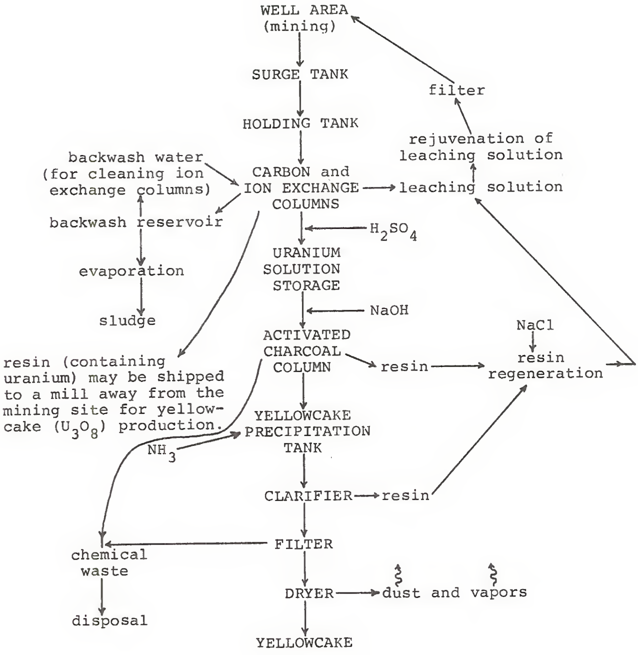

Fig. 8. Schematic representation of uranium extraction process associated with in-situ uranium mining as practiced at Clay West mine, George West, Texas. Adapted from White (1975) and Reed et al. (1976).

According to Hunkin (1975), ". . . solution mining of uranium complies with many of the National Academy of Sciences Comrate 1975 report recommendations for mineral recovery techniques of the future." In-situ uranium mining should be the technique most acceptable to all facets of society, because it is less expensive and less damaging than other mining techniques. This technique allows the mining industry to remove uranium which it might not otherwise be able to extract because of economic or environmental considerations.

Considerations in the development of a uranium ore body are simplified considerably in the Long Pines area because only in-situ recovery mining processes are allowed on the National Forest lands. Following the establishment of one of the first in-situ uranium mining operations, Anderson and Ritchie (1968) outlined some of the requirements for potential in-situ uranium mining operations. Among these are:

1. The mineralogy of the ore should be determined so that its amenability to the proposed process may be known;

2. The uranium ore should occur in a generally horizontal bed underlain by a relatively impermeable stratum;

3. The uranium ore must occur below the static water table; and

4. The direction and velocity of regional water flow must be known.

Sandstone formations such as the Fox Hills formation are the object of current in-situ mining operations in south Texas and elsewhere, and the Fox Hills formation is apparently equally amenable to in-situ extraction processes. There seems to be little question that the Fox Hills formation meets this requirement.

The other requirements are related to the potential for disturbance of ground water in or below the strata in which the uranium occurs. As indicated in the description of the study area, the water for the stock ponds in the study area comes from upper strata in most cases, but lower strata, such as the Dakota and Lakota formations are important water sources for much of southeastern Montana. There is some concern about potential damage to groundwater due to migration of in-situ leaching solution. While the Fox Hills formation is little used for water at present, maintenance of its quality is important.

The Pierre Shale, which lies below the Fox Hills formation is apparently sufficiently impermeable to limit the downward migration of leaching fluids, so contamination of lower strata appears unlikely if in-situ mining should take place in the study area.

Carnahan (1975) has indicated that an ore body located below the water table is necessary so that liquids can be withdrawn from the strata at a slightly greater rate than they are injected, so as to assure complete leaching solution recovery. The ground water flow must be known so that well placement and fluid flow rates can be determined. These factors have been previously determined to a great extent in the vicinity of the study area, and the exploratory drilling for uranium may add to this knowledge.

Under conditions suitable for in-situ mining there is apparently no significant loss or migration of leaching fluids. Wells surrounding the mining areas at in-situ operations in southern Texas have monitored for excursions of leaching fluid, and the Texas Department of Water Quality has maintained a watch on the operations, since their inception. To my knowledge there has been no significant problem with subsurface control of the leaching solution, or contamination of ground water. Extensive experience with in-situ leaching of copper deposits in the western United States also serves to indicate that control of the leaching process is practicable (Rouse, 1974).

My study of the in-situ process has led me to believe that in-situ uranium mining operation is technologically feasible in the Long Pines area, and that subsurface control of the leaching fluid and preservation of ground water quality are possible. If this is so, and if one assumes that conditions make in-situ uranium mining economically feasible in the Long Pines area, then the major impacts from any in-situ operation that might be developed would occur in the immediate vicinity of the mining. Without specific information about a proposed in-situ operation, however, I can state only very generally what sort of factors may be important considerations in my study area.

The surface environmental impacts of in-situ uranium mining operations are much less than those of other uranium mining operations, and have been outlined by Hunkin (1975) and Reed et al. (1976). If the uranium-laden resin from the ion-exchange columns is processed in a mill away from the mining operation disturbances to the area mined are obviously diminished. Surface construction or alterations required would the include the clearing of vegetation for the injection and extraction wells, for the surge tanks and holding tanks, and for the ion-exchange equipment, plus roads and maintenance or equipment areas. The areas immediately associated with the mining operations are not large. At the Clay West mine in southern Texas, for example, the initial injection and extraction well pattern occupied less than 1.25 ha (White, 1975). A newer well field at Bruni, Texas occupies approximately 4.1 ha (Engineering and Mining Journal, 1977). Even so, in a forested area such as the Long Pines forest removal should be minimized.

If a mill is established at the mine site the space required for the operation as a whole would obviously increase, and there are also impacts associated with any uranium milling process. The direct physical impacts associated with an in-situ process are limited to minimal gas emissions from the dryer, and ion exchange column sludge and chemical wastes that must be disposed of. There is also a question of radon gas and associated alpha and gamma radiation release at the surge tanks, but this is a very localized problem and is not yet well documented (Trippitt, pers. comm.).

It appears to me then, that the major problems associated with the development of an in-situ uranium operation in the Long Pines will be (1) removal of vegetation and construction of the in-situ operation, (2) possible physical disturbance of nesting cliffs, and (3) indirect impacts of human activities.

I consider five of the ten known nesting raptor species fo the study area to be most susceptible to disturbances such as in-situ mining. These species include the Prairie Falcon and the Golden Eagle, and the less obvious and less well known Merlin, Sharp-shinned Hawk, and probably the Turkey Vulture. Two species, the Cooper's Hawk and the Harrier, are, I suspect, slightly less susceptible to disturbance. Flath (1978) has listed the two accipiters, the Golden Eagle, the Harrier, and the two falcons as species of "Special Interest or Concern" in the Carter County area. These species are those which should receive greater consideration in the study area until their status is well known and they are determined to be maintaining their populations over a larger area. I feel that the Great Horned Owl, the Red-tailed Hawk, and the American Kestrel are more likely to tolerate human activities.

My nesting study concentrated on the Prairie Falcon and Golden Eagle, which are cliff nesting raptors of the Long Pines area. While most raptor species may change nesting sites in response to human activities if disturbed, the cliff nesting species are more likely to lose nesting sites and suffer reductions in nesting numbers because nesting habitat for these species may already be a limiting factor.

In the face of development in the Long Pines area the greatest effort should be made to preserve and protect Prairie Falcon aerie sites. While I have no estimate of the proportion of suitable Prairie Falcon aerie cliffs in use each year, I believe most preferred sites are occupied. High occupancy rates for Prairie Falcon nesting territories may be common. Ogden and Hornocker (1977), for example, found that 97 percent of the Prairie Falcon nesting territories in their southwest Idaho study were occupied in all three years of their study. There could perhaps be a shift to other less preferable aerie sites in the wake of disturbances such as uranium development, but territorial requirements for nesting pairs of Prairie Falcons and the apparently limited number of suitable sites would restrict such shifts. Therefore, I recommend that minimal physical disturbances such as clearing of vegetation, drilling, or construction occur in the vicinity of aerie cliffs. Schneegas (1975) indicated that the U. S. Forest Service felt a 10 chain (∿200 m) "no disturbance zone" should be maintained around nests of Spotted Owls (Strix occidentalis) and Bald Eagles; this may have been extended to other species. A 1/4 mile (∿0.4 km) buffer zone is commonly mentioned when considering disturbances around raptor nests, and may suffice at some Prairie Falcon aeries. Reactions of adults to disturbances during this study indicate that a 0.5 km buffer zone should generally be maintained, but individual aeries may require a greater distance.

The area of Mobil's uranium exploration extends from northwest to southeast across the lower part of the study area (Fig. 5). If future uranium development occurs, and if it is limited to this area (as seems likely), then Prairie Falcon aeries 1 through 5, 13, and 14 (see Fig. 3) are unlikely to be directly affected by mining activities. Aeries 6 through 12 are on National Forest land, so activities in the vicinity of these aeries can, and should be, carefully managed.

Golden Eagles are more versatile than Prairie Falcons in choosing nest sites, and may nest on cliffs or in trees. They seem to prefer cliffs for nesting in the study area (17 of 20 nests located). However, Becker (1978) has found that approximately one nest in four (11 of 42 nests) on the Montana portion of the Sioux District is a tree nest. Though Golden Eagles may

may be able to change from cliff nests to tree nests over time, they are still intolerant of human disturbances during the nesting season (Olendorff, 1973a). Golden Eagle nests 1 through 12, and nest 20 (see Fig. 2) are unlikely to be directly affected by uranium mining operations if they should occur in the area of past exploration, but nests 13 through 19 should be protected. These nests are located on National Forest land, although several are close to surrounding private land.

Golden Eagle nest sites are more obvious than are Prairie Falcon aeries, and the eagles also seem to be more susceptible to disturbances by humans during the nesting season. I have found that nesting Golden Eagles react to human disturbance at distances greater than 1 km, and that some birds may abandon the nest when approaching humans are still 1 km distant. As with Prairie Falcon aeries, I feel that activities near known Golden Eagle nests should be avoided during the nesting season; activities which will physically disturb the nesting area (construction, clearing of vegetation) should be avoided at all times. A buffer zone of 1 km seems a minimum necessary around Golden Eagle nests.

Merlins seem to return to the vicinity of past nest sites each year, but this may be a function of their use of corvid nests rather than an inherent species preference. While I have not indicated locations of Merlin nests found during this study, some of the probable locations of future Merlin nests are known. Activities in the study area should take into account past Merlin nest locations, and a 0.5 km buffer zone should be maintained during the nesting season around active Merlin nests. The adaptability of Merlins to human activities over time was shown by Oliphant's (1974) study of Merlins nesting successfully in downtown Saskatoon, Saskatchewan.

For Sharp-shinned and Cooper's Hawks I recommend that the older growth timber which these species apparently require be maintained, and that a 0.25 km buffer be established for nests of both. The adaptability of Cooper's Hawks may be sufficient to tolerate changes in the study area, for Nickerson (1976) and Clark (1977) have observed that Cooper's Hawks have adapted, at least in part, to cities in the east.

Turkey Vultures may use holes along low cliffs and other sites for nesting, as mentioned previously. I believe that a 0.25 km no disturbance zone should be maintained around nests be located in the future.

Harriers apparently prefer the more open Showberry draw habitat for nesting, and I feel that this should be preserved where possible. More study is required, however, to verify the nesting preference of this species. Breckenridge (1935) felt that Harriers ". . . tend to nest in the same general locations, if not on identical nest sites, on successive years," a belief shared by Sealy (1967). Harrier nest areas located in the future should be guarded from alteration where possible. Brown and Amadon (1968) indicated that an area of approximately 300 m from the nest may be defended by Harriers; a minimum distance necessary to prevent disturbance to nesting pairs should probably be 0.5 km.

Great Horned Owls are likely to be tolerant of human activities and less disturbed than other raptor species. The early Great Horned Owl nesting season means that there will usually be little human activity in the study area during nesting, since winter and spring travel in the study area is usually difficult. Further, in my experience and the experience of others, the Great Horned Owl seems to be fairly tolerant of human activities (Keyes, 1911; Kirkwood, 1925; Baumgartner, 1939; Franks and Warnock, 1969).

Red-tailed Hawks are also tolerant of human activities, and I suspect that they will do well in the face of development in the Long Pines area. Brown and Amadon (1968) felt that the Red-tailed Hawk had ". . . the widest ecological tolerance of any buteo, perhaps of any hawk in North America." Dunstan and Harrell (1973) found Red-tailed Hawks nesting quite near farms in South Dakota, and two of the nests found in my study area were located less than 100 m from the most heavily traveled roads. I suggest that a 0.5 km buffer zone be maintained around Red-tailed Hawk nests.

American Kestrels apparently adapt well to human activities, and may make use of man-made structures for nesting. Smith et al. (1972) may have best summarized this adaptability: "The proximity of human activity and dwellings did not appear to influence choice of [nest] sites as three were within 200 ft of farmhouses, and the kestrel population at Ironton in 1970 nested amidst the daily activities of dismantling the plant." These authors did feel, however, that in some instances the human activities reduced productivity, but theirs was apparently a rather extreme example of disturbance. In the study area I would suggest simply that efforts be made to avoid disturbance to Kestrel nests that might be found.

Construction and mining activities in the study area that may disturb nesting raptors should be limited when possible, particularly during incubation. Nest site tenacity generally increases following hatching, and human activities are then less likely to instigate nest abandonment. Restriction of human activities should not be a problem in most instances. Incubation extends from March through mid-June, and weather conditions often make travel in the study area difficult during this time. In general, major activities should not begin near raptor nests during the period from March through July if possible.

SUMMARY

The purpose of this project was to outline potential conflicts between nesting birds of prey and human activities, particularly uranium exploration and development, in the Long Pines area of southeastern Montana. This study was conducted in an area of approximately 600 sq km, including approximately 260 sq km of National Forest land, and surrounding private lands.

A survey of nesting raptors was conducted from 14 June through 20 July 1977 and from 7 April through 28 July 1978. Study techniques were primarily oriented toward locating cliff nests of Golden Eagles and Prairie Falcons. Initially, a general survey was made of potential nesting habitat for these species; likely nesting areas were then surveyed more closely on foot. Observations of other raptor species were usually made during these searches.

Twenty Golden Eagle nests were found during the two nesting seasons. Of these, 17 were on cliffs and three were in trees. One active nest was found in 1977; four were active in 1978.

Fourteen Prairie Falcon aeries were found during the study. Six were located during 1977, eight more were found in 1978.

Sixteen of the 17 Golden Eagle nests had exposure ranging from southeast to northwest; 13 of 14 Prairie Falcon aeries faced from southeast to west. These are the exposures of the predominant

cliffs of the study area. Nests reflected availability of nest sites rather than preferences for specific exposures.

Eight more raptor species were found to be actual or probable nesting species. These were the Great Horned Owl, Turkey Vulture, American Harrier, Sharp-shinned Hawk, Cooper's Hawk, Red-tailed Hawk, American Kestrel, and Merlin. Five additional species, the Swainson's Hawk, Ferruginous Hawk, Burrowing Owl, Long-eared Owl, and Short-eared Owl were observed only occasionally. The two latter are likely nesting species in the study area.

In 1977 limited productivity information was gathered. One bird fledged from the known active Golden Eagle nest and at least 12 young fledged from the three Prairie Falcon aeries at which fledging numbers were determined. In 1978 five Golden Eagles fledged from the three known successful nests. Twenty-nine Prairie Falcons fledged from the seven known successful aeries in 1978. Fledging success was 2.42 young per aerie from the 12 known nesting attempts, and 4.14 young per nest from the successful aeries.

Limited productivity information was also gathered for other species, including Cooper's Hawks, Red-tailed Hawks, Kestrels, and Merlins.

The extent of past and present human activities in the Long Pines area was assessed. Mining has been limited, and surface mining is unlikely to occur in the study area. Livestock grazing, timber harvest, and recreation have been, and will continue to be, important activities.

Grazing has been an important use of the study area for many years. Over 15,000 animal unit months of grazing are permitted each year on National Forest land in the Long Pines. Grazing is also extensive on surrounding private land.

Approximately 500,000 board feet of sawtimber are removed annually from the Long Pines. There are occasional small sales of posts and poles, and timber management often includes thinning of dense stands of trees. These activities are local in their extent.

The greatest recreational uses of the study area are hunting and camping by hunters during the fall, although a number of hunters come to the study area for the spring Turkey hunting season. Camping in the study area is also common during summer holiday weekends, but recreational use of the study area is light at most other times.

Uranium exploration was conducted in the study area by Mobil Oil Corporation from 1972 through 1977. This exploration involved drilling at over 350 sites with truck-mounting drilling rigs and examining samples and electric logs from the holes. The effects of this exploration have apparently been minimal, and exploration sites have been restored. Mobil has withdrawn from uranium development in the study area, and future uranium exploration and development are in doubt.

Management practices or restrictions on activities may help protect nesting raptors. Livestock grazing has been extensive for some time in the study area, with few apparent detrimental effects to most raptors. Developments associated with grazing may benefit raptors through better distribution of livestock and increases in prey. Livestock grazing seems well distributed and managed on the National Forest land of the study area, but is much heavier elsewhere. Lighter and more evenly distributed grazing on surrounding private lands may benefit nesting raptors through increases in prey and lessened disturbances of nests.

Timber management has apparently had little effect on raptors, due to the localized extent of logging in recent years. Timber management practices that may benefit raptors include maintenance of older growth stands necessary for nesting accipiters and maintenance of snags needed by Kestrels and other birds.

Effects on nesting raptors due to recreational activities are apparently minimal. Camping occurs largely at the campgrounds in the study area, usually after the critical portion of the nesting season. Turkey hunters during the spring hunting season could disturb nesting raptors, but there is no evidence that this occurs.

Restrictions on activities associated with development of uranium resources or other activities should be considered if impacts on nesting raptors are to be minimized. This is particularly true during the March through July nesting season. Most likely to be affected are cliff nesting species, specifically the Golden Eagle and the Prairie Falcon. While most raptor species can change nest sites readily from season to season, these species are more restricted. Recommendations for avoiding disruption of the nesting raptor population due to activities such as uranium mining include (1) avoidance of all activities around known Golden Eagle and Prairie Falcon nests at all times,

(2) initiating mining or other activities after the nesting season when possible, and (3) establishing "no disturbance zones" around most raptor nests when such development activities cannot be avoided during the nesting season. Each case of conflict between proposed activities and the requirements of nesting raptors should be considered individually.

Recommended "no-disturbance zones" are outlined in the recommendations section.

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APPENDIX A

CARTER COUNTY MAMMALS

APPENDIX A

CARTER COUNTY MAMMALS[a]

Existing Species

Scientific Name	Common Name
Sorex cinereus haydeni	Masked Shrew
Sorex merriami leucogenys	Merriam Shrew
Myotis evotis evotis	Long-eared Myotis
Myotis leibii ciliolabrum	Small-footed Myotis
Myotis lucifugus carissima	Little Brown Myotis
Myotis volans interior	Long-legged Myotis
Lasionycteris noctivagans	Silver-haired Bat
Eptesicus fuscus pallidus	Big Brown Bat
Lasiurus cinereus cinereus	Hoary Bat
Plecotus townsendii pallescens	Townsend's Big-eared Bat
Lepus townsendii campanius	White-tailed Jack-rabbit
Sylvilagus audubonii baileyi	Desert Cottontail
Sylvilagus floridanus similis	Eastern Cottontail
Eutamias minimus pallidus	Least Chipmunk
Spermophilus tridecemlineatus pallidus	Thirteen-lined Ground Squirrel
Cynomys ludovicianus ludovicianus	Black-tailed Prairie Dog
Sciurus niger rufiventer	Fox Squirrel
Tamiasciurus hudsonicus dakotensis	Red Squirrel
Thomomys talpoides bullatus	Northern Pocket Gopher
Perognathus fasciatus olivaceogriseus	Olive-backed Pocket Mouse
Perognathus hispidus paradoxus	Hispid Pocket Mouse
Dipodomys ordii terrosus	Ord's Kangaroo Rat
Castor canadensis missouriensis	Beaver
Reithrodontomys megalotis dychei	Western Harvest Mouse
Peromyscus maniculatus nebrascensis	Deer Mouse
Onychomys leucogaster missouriensis	Northern Grasshopper Mouse
Neotoma cinerea rupicola	Bushy-tailed Woodrat
Microtus ochrogaster hyadenii	Prairie Vole
Microtus pennsylvanicus insperatus	Meadow Vole
Lagurus curtatus pallidus	Sagebrush Vole
Mus musculus	House Mouse
Zapus hudsonius campestris	Meadow Jumping Mouse
Erethizon dorsatum bruneri	Porcupine
Canis latrans latrans	Coyote

Scientific Name	Common Name
Vulpes vulpes regalis	Red Fox
Procyon lotor hirtus	Raccoon
Mustela frenata longicauda	Long-tailed Weasel
Mustela nigripes	Black-footed Ferret (?)
Taxidea taxus taxus	Badger
Mephitis mephitis hudsonica	Striped Skunk
Odecoileus hemionus hemionus	Mule Deer
Odecoilus virginanus dacotensis	White-tailed Deer
Antilocapra americana americana	Pronghorn
Possible Species	
Sylvilagus nuttallii grangeri	Mountain Cottontail
Marmota flaviventris dacota	Yellow-bellied Marmot
Reithrodontomys montanus albescens	Plains Harvest Mouse
Peromyscus leucopus aridulus	White-footed Mouse
Vulpes velox	Swift Fox
Urocyon cinereoargenteus ocythous	Gray Fox
Mustela erminea muricus	Ermine
Spilogale putorius interrupta	Spotted Skunk
Lontra canadensis pacifica	Otter
Ondrata zibethicus	Muskrat
Mustela vison	Mink
Lynx rufus	Bobcat
Felis concolor hippolestes	Mountain Lion
Extirpated Species	
Canis lupus nubilus	Wolf
Ursus arctos horribilis	Grizzly Bear
Ursus americanus americanus	Black Bear
Cervus elaphus canadensis	Elk
Bison bison bison	Bison
Ovis canadensis audoboni	Bighorn Sheep

[a]As summarized by Lampe et al. (1974).

APPENDIX B

STUDY AREA BIRD SPECIES

APPENDIX B

STUDY AREA BIRD SPECIES

Bird species other than raptors seen in or near the Department of Fish and Game study area in 1977 and 1978, and their apparent nesting statuses (DuBois, pers. comm.).

Scientific Name	Common Name	Nesting Status[a]
Anas platyrrhynchos	Mallard	B, M
Anas strepera	Gadwall	b?, M
Anas acuta	Pintail	b?, M
Anas carolinensis	Green-winged Teal	b?, M
Anas discors	Blue-winged Teal	B, M
Mareca americana	American Widgeon	b?, M
Spatula clypeata	Northern Shoveler	b?, M
Pediocetes phasianellus	Sharp-tailed Grouse	B
Phasianus colchicus	Ring-necked Pheasant	b
Perdix perdix	Gray Partridge	b
Meleagris gallopavo	Turkey	B
Fulica americana	American Coot	b?, M
Charadrius vociferus	Killdeer	B
Numenius americanus	Long-billed Curlew	b
Partramia longicauda	Upland Plover	b
Actitis macularia	Spotted Sandpiper	b
Tringa solitaria	Solitary Sandpiper	M
Catoptrophorus semipalmatus	Willet	M
Totanus melanoleucus	Greater Yellowlegs	M
Steganopus tricolor	Wilson's Phalarope	b?, M
Columbia livia	Rock Dove	b
Zenaidura macroura	Mourning Dove	B
Coccyzus erythropthalmus	Black-billed Cuckoo	b
Phalaenoptilus nuttallii	Poor-will	B
Chordeiles minor	Common Nighthawk	b
Aeronautes saxatalis	White-throated Swift	b
Megaceryle alcyon	Belted Kingfisher	b
Colaptes auratus	Common Flicker	B
Melanerpes erythrocephalus	Red-headed Woodpecker	B
Dendrocopos villosus	Hairy Woodpecker	B
Dendrocopos pubescens	Downy Woodpecker	b
Tyrannus tyrannus	Eastern Kingbird	b
Sayornis saya	Say's Phoebe	b
Empidonax minimus	Least Flycatcher	b
Contopus virens	Western Wood Peewee	b
Eremophila alpestris	Horned Lark	b
Tachycineta thalassina	Violet-green Swallow	b

Scientific Name	Common Name	Nesting Status[a]
Stelgidopteryx ruficollis	Rough-winged Swallow	b
Hirundo rustica	Barn Swallow	b
Petrochelidon phyrrhonota	Cliff Swallow	b
Cyanocitta cristata	Blue Jay	B
Pica pica	Black-billed Magpie	B
Corvus corax	Common Raven	M?
Corvus brachyrhynchos	Common Crow	b
Gymnorhinus cyanocephala	Pinyon Jay	b
Nucifraga columbiana	Clark's Nutracker	b?(?)
Parus atricapillus	Black-capped Chickadee	B
Sitta carolensis	White-breasted Nuthatch	b
Sitta canadensis	Red-breasted Nuthatch	B
Certhia familiaris	Brown Creeper	b
Troglodytes aedon	House Wren	B
Catherpes mexicanus	Canyon Wren	B
Salpinctes obsoletus	Rock Wren	b
Dumetella carolensis	Gray Catbird	b?, M
Toxostoma rufum	Brown Thrasher	b
Turdus migratorius	Robin	B
Hylocichla fuscescens	Veery	M
Sialia currucoides	Mountain Bluebird	B
Myadestes townsendi	Townsend's Solitaire	b
Lanius ludovicianus	Loggerhead Shrike	b
Sturnus vulgaris	Starling	b
Vireo olivaceus	Red-eyed Vireo	b
Vermivora peregrina	Tennessee Warbler	M
Vermivora celata	Orange-crowned Warbler	M
Parula americana	Northern Parula Warbler	M (accidental)
Dendroica petechia	Yellow Warbler	b?, M
Dendroica coronuta	Yellow-rumped Warbler	b
Dendroica striata	Blackpoll Warbler	M
Seiurus laurocapillus	Ovenbird	B
Geothlypis trichas	Common Yellowthroat	b
Icteria virens	Yellow-breasted Chat	b
Setophaga ruticilla	American Redstart	b?, M
Passer domesticus	English Sparrow	b
Sturnella neglecta	Western Meadowlark	B
Agelaius phoeniceus	Red-winged Blackbird	b
Icterus galbula	Northern Oriole	b?, M
Euphagus cyanocephalus	Brewer-s Blackbird	b
Quiscalus quiscula	Common Grackle	b
Molothrus ater	Brown-headed Cowbird	b
Piranga ludoviciana	Western Tanager	b
Pheuticus melanocephalus	Black-headed Grosbeak	b
Passerina cyanea	Indigo Bunting	b
Passerina anoena	Lazuli Bunting	b
Spinus pinus	Pine Siskin	b?, M
Loxia curvirostra	Red Crossbill	B
Pipilo erythrophthalmus	Rufous-sided Towhee	b
Calamospiza melanocorys	Lark Bunting	b

Scientific Name	Common Name	Nesting Status[a]
Passerculus sandwichensis	Savannah Sparrow	b? M
Ammodramus savannarum	Grasshopper Sparrow	b
Pooecetes gramineus	Vesper Sparrow	b
Chondestes grammacus	Lark Sparrow	b
Junco hyemalis	Dark-eyed Junco	B
Spizella passerina	Chipping Sparrow	B
Spizella pusilla	Field Sparrow	b
Melospiza melodia	Song Sparrow	b

[a]B: definite evidence of breeding (nest or young observed).

b: circumstantial evidence of breeding (territories, singing, etc.)

b?: breeding recorded for the area, but breeding activity not observed in the study area.

M: present during migration.