The Influence of Mammals and Birds in Retarding Artificial and Natural Reseeding of Coniferous Forests in the United States

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FORESTERS have long been searching for an economical method of re-establishing trees on deforested lands. Three methods have been used, namely: the planting of nursery-raised stock and natural seedlings, direct seeding, and the encouragement of natural reproduction. To date the planting program has been given the most attention but the other two methods are older and considerable hope for their satisfactory use is always being expressed. Chief among the factors that have pushed reproduction by seeding into the background is the depredation of seed-eating rodents and birds.

This does not mean, however, that animals are the chief factors in preventing reforestation. Among the many other important factors are: availability of seed source, soil type and condition, prevalence of destructive insects and diseases, moisture supply, temperature, slope, and many others. So it should not be inferred that if rodent and bird pressures could be removed reforestation would always be successful. The role of mammals and birds in aiding reforestation is not discussed in this paper. Although actual consumption of coniferous seeds implies destruction, it must be recalled that in the process of feeding, mammals through caching, and birds by transportation and dropping of seeds may function as seed distributors.

The first known effort at direct seeding on a national forest in the United States was in 1901 (*11*) on the San Bernardino National Forest, California. This and several other trials (*12, 38*) failed due to a combination of factors, one of which was the activity of seed-eating animals. Periodic attempts at direct seeding were continued with little or no success through about 1912 (*6, 20, 27, 39, 59, 62*). In the early twenties an interest was again shown in this work (*30, 41, 42, 50*), but still one of the main obstacles to success was the animal factor. During the late thirties and up until the present time, a renewed interest has again been extended to this method of reforestation (*1, 2, 8, 10, 16, 25, 26, 32, 33, 34, 35, 36, 37, 40, 45, 46, 47, 48, 49, 58, 61, 63*).

It has been during this latter period that the authors and other workers in the Fish and Wildlife Service have been making extensive investigations of the relation of animals to the forest. Reproduction by seed and the animal pressure thereon has received considerable attention. It is the purpose of this paper to point out the degree and type of pressure exerted by birds and mammals on forest seeds, the tree species affected, and to describe methods of reducing or eliminating these losses.

Many Animal and Bird Seed Eaters

A large number of different mammals and birds feed on the seeds of coniferous trees, both when supplied naturally and when provided by planting procedures. From the literature and the authors' studies, a total of 44 mammals and 37 birds have been found to eat coniferous seeds (Table 1). This list could be materially lengthened if the data from unpublished stomach analyses in the files of the Fish and Wildlife Service were assembled. Van Dersal (*64*) lists the animals that feed on all species of conifers in the United States, but from his descriptions it is impossible to separate seed eaters from vegetative feeders.

Although the list of seed eaters is long, only a few species are of significance in forest regeneration. The tree squirrels, chipmunks, white-footed mice, and a few species of seed-eating fringillid birds are responsible for the greater part of all trouble caused by mammals and birds in regenerating forests by seeding. Habitat is the governing factor which determines which species of animal might be present to consume the seeds.

Tree squirrels (*Sciurus*) are not commonly found very far from trees with the result that their depredations are usually on the cones or on the seed dropping from them. On denuded areas that are being artificially reseeded, these squirrels are of minor importance except around the tree-fringed borders. On the other hand, they

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TABLE 1.—LIST OF BIRDS AND MAMMALS KNOWN TO EAT THE SEEDS OF CONIFEROUS TREES (AND THE AUTHORITY REFERENCE)[1]

Common name	Scientific name	Reference
Birds		
Blue grouse	*Dendragapus obscurus*	4
Sierra grouse	*Dendragapus fuliginosus sierrae*	52
Ruffed grouse	*Bonasa umbellus*	52
Bobwhite	*Colinus virginianus*	8
California quail	*Lophortyx californica*	52
Band-tailed pigeon	*Columba fasciata*	52
Eastern mourning dove	*Zenaidura macroura carolinensis*	8, 58, 60
Red-shafted flicker	*Colaptes cafer collaris*	57
Lewis woodpecker	*Asyndesmus lewis*	52
Canada jay	*Perisoreus canadensis*	59
Blue jay	*Cyanocitta cristata*	59
Steller's jay	*Cyanocitta stelleri*	52, 57
Crow	*Corvus brachyrhynchos*	52
Clark's nutcracker	*Nucifraga columbiana*	52
Winter wren	*Nannus hiemalis*	36
Robin	*Turdus migratorius*	15, 59
English sparrow	*Passer domesticus*	59
Southern meadowlark	*Sturnella magna argutula*	8
Red-wing blackbird	*Agelaius phoeniceus*	8
Rusty blackbird	*Euphagus carolinus*	8
Brewer's blackbird	*Euphagus cyanocephalus*	8
Blackbirds	No species named	15, 59
Cowbird	*Molothrus ater*	8
Bronzed grackle	*Quiscalus quiscalus aeneus*	15
Blue grosbeak	*Guiraca caerulea*	59
Evening grosbeak	*Hesperiphona vespertina*	52
California purple finch	*Carpodacus purpureus californicus*	36
Pine grosbeak	*Pinicola enucleator*	52
Redpoll	*Acanthis linaria*	59
Goldfinch	*Spinus tristis*	Text
Red crossbill	*Loxia curvirostra*	52
Towhee	*Pipilo maculatus*	36
Slate-colored junco	*Junco hyemalis hyemalis*	Text
Carolina junco	*Junco hyemalis connectens*	13
Oregon junco	*Junco oreganus*	36
Red-backed junco	*Junco phoeonotus dorsalis*	39, 52
Chipping sparrow	*Spizella passerina*	2
Song sparrow	*Melospiza melodia*	36
Mammals		
Cinereous shrew	*Sorex cinereus*	Text
Trowbridge shrew	*Sorex Trowbridgii*	37
Wandering shrew	*Sorex vagrans*	37
Baird's dusky shrew	*Sorex obscurus bairdi*	37
Yaquina shrew	*Sorex yaquinae*	37
Gibbs shrew-mole	*Neurotrichus gibbsii*	37
Columbia ground squirrel	*Citellus beecheyi*	23
Rock squirrel	*Citellus variegatus*	24
California ground squirrel	*Citellus beecheyi*	23
Fisher ground squirrel	*Citellus beecheyi fisheri*	52
White-tailed antelope squirrel	*Citellus leucurus*	24
Mantled ground squirrel	*Citellus lateralis*	24, 59
	Citellus lateralis arizonensis	57
	Citellus lateralis chrysodeirus	52
Western chipmunk	*Eutamias minimus*	52
	Eutamias minimus jacksoni	Text
	Eutamias amoenus	52
	Eutamias quadrivittatus	52
	Eutamias quadrivittatus speciosus	53
	Eutamias cinereicollis	52, 57
	Eutamias townsendii	26, 52
	Eutamias quadrimaculatus	52
	Eutamias sp.	12, 30, 49, 58, 61
Eastern chipmunk	*Tamias striatus striatus*	53
	Tamias striatus griseus	Text

are probably the heaviest consumers of coniferous seeds under natural conditions. Heavy cutting of sugar pine cones (even before they are mature) by the California gray squirrel was reported by Berry (*6*) and Jotter (*27*). As much as 70 to 75 percent of the seed crop was reported taken by these squirrels, and as many as 702 ponderosa pine cones were found under one tree.

Voracious Rodents Are Heavy Seed Consumers

The appetite for pine seeds by squirrels was shown by Hatt (*18*) when he reported one pair of captive red squirrels ate the seeds from 422 cones of eastern white pine in one week's time. Mollenhauer (*35*) found red squirrels clipped from 50 to 100 percent of the cone-bearing limbs of the table mountain pine. It was the opinion of Pulling (*41*) that red squirrels took all the white pine seed produced during a poor year in one area in New York State. An examination of three red squirrel stomachs from a jack pine slash area in Minnesota showed that they had consumed 1,178 jack pine seeds or an average of 392 seeds per squirrel. In this latter case, the squirrels were collected at the edge of the cutting area. None was observed in the main body of the clearing. This localization was further illustrated by Smith (*53*) when he wrote, "The greatest rodent damage occurred on the fully-timbered area where red squirrels invaded the quadrats several times searching for ungerminated seeds."

Ground squirrels (*Citellus*) are not commonly pests on sites requiring reforestation. These animals occur only in the western states in open types of habitat where reforestation is not likely to be practiced. However, these animals are known to retard forest regeneration at times, as Tinsley (*58*) reported the Columbian ground squirrel in Idaho to have consumed practically all the seeds (pondersosa and western white pine) sown.

One associated quite closely with the forest is the mantled squirrel. Throughout the ponderosa pine belt, this group is common and believed to be an important ponderosa pine seed consumer by Wahlenberg (*60*) and Taylor and Gorsuch (*57*).

Chipmunks play an important role in preventing the reseeding of forests. The western chipmunk (*Eutamias*) has been a greater factor in this respect than the eastern form (*Tamias*). Most seeding studies have been made in the West and in the Lake States where the western form is much more abundant. In the Lake States, both chipmunks occupy the same range, but *Eutamias* is found more in the logged or burned areas and is much more numerous over the whole area.

In northern Minnesota, chipmunks were found to be pronounced pine seed destroyers. The examination of stomachs from 88 chipmunks col-

Table I—(*Continued*)

Common name	Scientific name	Reference
Red squirrel	*Tamiasciurus hudsonicus*	*5, 9, 15, 26, 29, 41, 43, 49, 53, 56*
	Tamiasciurus hudsonicus baileyi	*41, 43, 49, 53, 56, 18*
	Tamiasciurus hudsonicus loquax	*65*
	Tamiasciurus hudsonicus ventorum	*21*
	Tamiasciurus hudsonicus richardsoni	*36, 54*
	Tamiasciurus douglasii	*36, 52*
	Tamiasciurus douglasii albolimbatus	*17*
	Tamiasciurus fremonti fremonti	*19*
Western gray squirrel	*Sciurus griseus*	*36, 52*
Flying squirrel	*Glaucomys sabrinus latipes*	*3*
Pocket mouse	*Perognathus fasciatus*	Text
	Perognathus parvus mollipilosus	*51*
Kangaroo rat	*Dipodomys heermanni*	*52*
White-footed mouse	*Peromyscus maniculatus*	*52*
	Peromyscus maniculatus gracilis	Text
	Peromyscus leucopus noveboracensis	*53*
	Peromyscus sp.	*55, 62*
Woodrat	*Neotoma fuscipes*	*14*
Red-backed mouse	*Clethrionomys gapperi*	Text
Meadow mouse	*Microtus montanus*	*58*
House mouse	*Mus musculus*	*53*

This list does not include species eating Juniper and Taxis, and includes references only from published articles and findings from the author's field work.

lected in a jack pine slash area revealed that 72 percent contained the remains of jack pine seeds. They averaged 31 seeds per stomach, but one chipmunk had eaten 796 and another had 204 in its stomach and 168 in its cheek pouches. The 88 animals had disposed of a total of 2,749 jack pine seeds. Although chipmunks formed only 39.5 percent of the rodent population, they consumed 61 percent of the jack pine seeds removed by rodents on this area.

Coniferous seed destruction by chipmunks has been reported by Dearborn (*12*) from the Black Hills, Tinsley (*58*) in the Northern Rocky Mountains, Korstian and Baker (*30*) in the intermountain region of Utah, Taylor and Gorsuch (*57*) in the Southwest, Willis (*62*) and Moore (*36*) in the Pacific Northwest, L. Smith (*53*) for the New England area, and Horn, in an unpublished (1932) report from California.

Mice as a group, because of their wide habitat and geographic distribution, are perhaps the greatest animal factor in retarding forest regeneration by seeds. A great many of the authors reviewed, mentioned mice as one of the chief offenders.

White-footed mice (*Peromyscus*) have been found by the authors to be the most widely distributed and the most influential species in their studies. Where other authors have specified species, the white-footed group are usually mentioned. According to Silver (*50*), white-footed mice damaged from 10 to 90 percent of the seed spots on a planting program in the Ocala National Forest, Florida, Willis (*62*) attributed 98 percent failure of seed spots of Douglas-fir on the Columbia National Forest to the work of mice, and cage tests showed that a mouse could consume 300 seeds of this species daily. In the Lake States white-footed mice were found to be second only to chipmunks in numbers and in the consumption of jack pine seeds. The examination of 30 stomachs revealed that 70 percent had eaten jack pine seeds and the whole lot averaged 19 seeds per stomach. The greatest number eaten by a single animal was 156.

Other mice known to feed on coniferous seeds are red-backed mice (*Clethrionmys*), meadow mice (*Microtus*), jumping mice (*Zapus*), pocket mice (*Perognathus*), and house mice (*Mus musculus*).

The red-backed mice are perhaps the most characteristic forest species, but their food preferences run more to succulent vegetation than to seeds. After a logging operation where most of the timber is cut, these mice are rapidly replaced by the white-footed species. That they can be a minor factor in seed consumption, however, is shown by the analysis of 59 stomachs of mice trapped on a jack pine slash area. Only 14 percent of them had eaten jack pine seed, the greatest number per individual being 25, and the average .6.

Birds Also Take Much Seed

Birds are more of an influence in seed consumption than is generally believed. Many workers have referred to seed destruction by birds and rodents but few have specified which birds are involved. As early as 1916, Toumey (*59*) listed mourning doves, redpoll, Canada jay, blue jay, English sparrow, robin, blackbird, finch, junco, and blue grosbeak as forest seed eaters. In the longleaf pine area of Mississippi, Burleigh (*8*) found heavy consumption of seeds by mourning doves, bobwhites, meadow larks, Brewer's rusty, and red-winged blackbirds, and cowbirds. He found that damage by these birds was most severe during years of heavy seed production and relatively light during scanty seed years, the explanation being that the seed crop when abundant attracted and held larger bird populations. Pearson (*39*) and Krauch in a 1937 report for the southwest named the junco as a cause of failure of seeding experiments.

In the northwest, Moore (*36*) found Douglas-fir seeds attractive to winter wrens, purple finches, song sparrows, towhees, and juncos.

Four juncos, eight chipping sparrows, eight goldfinches and one Brewer's blackbird were collected on a jack pine slash area in northern Minnesota. Of these 21 birds only three (chipping sparrows) had failed to feed on jack pine seeds. Most of these birds were present in fair-sized flocks, which could have been responsible for the consumption of a large part of the seed crop.

It is rather surprising to find such insectivorous mammals as shrews consuming coniferous seeds, but Moore (*37*) states, "They play a definite and deleterious part in natural reforestation." He lists five species of shrews that were found to eat Douglas-fir seeds. Jack pine seeds were found in the stomach of one long-tailed shrew in Minnesota.

Many workers have deplored serious losses of seed by rodents and birds without specifying the identity of the animals concerned. In fact, the writers have found it impossible to attribute

CRITERIA FOR GOLDEN EAGLE, FERRUGINOUS HAWK, AND PRAIRIE FALCON NEST SITE PROTECTION*

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Abstract

Establishment of buffer zones around raptor nest sites has become an important management tool in areas undergoing energy development or increasing recreational pressure. We conducted a survey of field researchers who had distributed Golden Eagle, Ferruginous Hawk, and Prairie Falcon during their research. Bases for and limitations of the use of buffer zones to protect nesting raptors are discussed.

Introduction

Energy development and other human activities can diminish raptor populations by altering habitat and by disturbing nesting activities. Disturbance of nesting raptors can result in complete desertion of nests, eggs, or young. Temporary departure by adults can cause overheating, chilling, or desiccation of eggs or young, predation on eggs or young, or missed feedings. Three studies of the Golden Eagle (*Aquila chrysaëtos*) found that 46, 71, and 85 percent of nesting failures were due to human disturbance (Boeker and Ray 1971, Camenzind 1969, D'Ostilio 1954). The effects of such disturbance range from loss of a year's reproduction to long-term loss of the nest site if the disturbance is chronic. Raptor researchers found that by disturbing birds they can jeopardize the reproductive activity being studied (Fyfe and Olendorff 1976).

Concern over disturbance has resulted in the establishment of spatial or temporal buffers (restriction of activity within an area or period of time) between some energy developments and raptor nest sites. Geothermal development proposals for sites in Utah and Idaho resulted in recommendations for buffers by federal agencies (ERDA 1977, Fisher 1978, USGS 1977). Buffer zones were established to protect raptor nest sites along the Trans-Alaska pipeline (Olendorff and Zeedyk 1978) and were recommended for the proposed Mackenzie gas pipeline (Jacobson 1974). These recommendations were based primarily on the experience of the individuals involved because of the absence of a body of literature on responses of the birds to these disturbances or any consensus of the raptor [illegible] community concerning control of disturbance. This study summarizes and examines the bases for such decisions relative to the Golden Eagle, Ferruginous Hawk [illegible], and Prairie Falcon (*Falco mexicanus*).

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Table 2. Recommended Buffer Zones for Golden Eagle, Ferruginous Hawk, or Prairie Falcon Nest Sites.

Distance	Species	Development type	Restriction	Source
1 km (0.6 mile)	Golden Eagle Prairie Falcon	Geothermal drilling	No drilling	ERDA 1977
0.5 mile (0.8 km) all year and 1 mile (1.6 km) March 1–July 15	Ferruginous Hawk	Geothermal drilling	No surface disturbance	Fisher 1978
1 mile (1.6 km)	All eagles	Pipeline		Olendorff and Zeedyk 1978
2 miles (3.2 km) all year	Golden Eagle	Pipeline	No construction	Jacobson 1974
2 miles (3.2 km) March 1–Sept. 1	Golden Eagle	Pipeline	No ground activity	Jacobson 1974
0.25–0.5 mile (0.4–0.8 km)	Golden Eagle	General		M. R. Fuller[a]
200–500 m	All three species	General		N. Woffinden[a]
0.5 mile (0.8 km)	Grassland raptors	General		R. P. Howard[a]
1 mile (1.6 km) line of sight	Golden Eagle	General		R. P. Howard[a]

[a]Suggestions received in response to the raptor disturbance survey.

sites. Ferruginous Hawks are more versatile, but most require a tree or rock outcropping. This use of elevated nest sites contrasts sharply with the open-land hunting habit of these species. The importance of nest sites is confirmed by Fyfe and Armbruster's (1976) and Anderson and Follet's (1978) success in increasing the productivity of Prairie Falcons and Ferruginous Hawks, respectively, by nest-site creation and manipulation (see also Howard and Hilliard 1980, White 1974).

Nest-site protection is only advantageous if the prey base remains adequate following development. Many types of development such as oil, gas, and geothermal exploitation, pipeline and road construction, and development of campgrounds and interpretive facilities on public lands remove vegetation from small areas. If important prey concentrations such as ground squirrel colonies are avoided, raptors should be able to coexist with these developments provided nesting sites are undisturbed. The responses to survey question 5 indicate that development should be kept at least 400 m from such prey concentrations.

Another objection to nest-site protection was that disturbance might occur because of the establishment of buffer zones. This disturbance could be caused by irate supporters of the development that would be restricted or by nest robbers, varmint shooters, amateur naturalists, or photographers who are attracted to identified nest sites. The location of nest sites should be revealed only to those who are directly involved in facility siting. Developers should be reminded that the nest site, not the individual birds, is being protected. Shooting the birds would not eliminate the need to restrict development near the site.

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