Timber Harvest and Management Considerations

A multiyear study of the effects of logging on habitat quality and feeding by tassel-eared squirrels was conducted in Utah. The researchers compared squirrel feeding activities at a logged site with those at an unlogged site. Squirrels fed in only 26% of the sampled plots in the logged area compared with 43% of the sampled plots in the unlogged area. Squirrel recruitment was lower in the logged site. One conclusion reached was that clear-cut timber harvest prescriptions negatively affect tassel-eared squirrels (ref. 21). When trees are removed, canopy cover is reduced, causing squirrels to seek cover in the more densely forested areas surrounding the logged area, though they will return for seeds from ovulate cones (ref. 22, 23, 24).

Peter Ffolliott and David Patton developed a model to assist in decisions regarding the management of habitat for tassel-eared squirrels and for timber harvest. They proposed that if squirrels prefer certain sizes of trees for food and nesting, managers should allow trees to grow to at least those dbh values before harvesting (ref. 25).

A project using artificial nest boxes was conducted to determine if tassel-eared squirrels would use the boxes for nesting in areas that had been cut for timber. The hypothesis was that these nesting boxes would provide opportunities for squirrels to return to areas that had been harvested for timber or for new squirrel colonizations from the surrounding uncut areas. The project was begun in May 1974 with twelve nest boxes, and by October 1977 all twelve boxes had evidence of squirrel use. This is the only study conducted to artificially attract squirrels back into harvested areas (ref. 26).

It was reported in 1989 that in some timber harvests, guidelines for impacts on wildlife, specifically the northern goshawk and Abert's squirrel, were barely being met (ref. 27). In another study nine years later, Dodd and his colleagues explained that tassel-eared squirrels are sensitive to fragmentations and decreases in heterogeneity of ponderosa pine forests. Timber harvesting methods that result in an even-aged forest and that reduce interlocking canopies alter the squirrel habitat (ref. 11).

Forest managers who are concerned with timber yields as well as with forest wildlife issues should consider a compromise of leaving living Gambel oaks that are serving as den trees for Abert's squirrels (ref. 28). Ponderosa and Gambel oak snags should be left during timber harvesting activities since some of these snags are used by Abert's squirrels and cavity-nesting birds (ref. 20).

Heavy infections of dwarf mistletoe in ponderosa pine branches form tangled growths and distorted branches referred to as "witches' brooms." Abert's squirrels use these brooms as caching sites for food items, foraging sites for inner bark, and nest building sites (ref. 29, 30). A group of investigators recommended that forest managers making decisions about the removal of brooms or mistletoe-infected trees consider pruning the brooms to reduce wildfire risks and improve tree health while maintaining some brooms for squirrels. Trees with brooms that are not closed up enough to provide caching or nest sites and that are < 18 m above the ground could be harvested since they are not being selected by squirrels (ref. 29, 31).

Three different researchers have advocated that since several species depend on ponderosa pines for food, including tassel-eared squirrels, porcupines (*Erethizon dorsatum*), bark beetles (*Dendroctonus ponderosae*), and dwarf mistletoe, and since these specific species potentially offer multiple directions for selection within the forest stand, forest management practices should attempt to maintain the diversity of pines that these species require (ref. 32, 33, 34).

Ecological Considerations in Management

A "triangle-based relationship" between squirrel, ponderosa pine, and hypogeous fungi (see figure 11.1) was first described by J. S. States (ref. 35). The northern goshawk is now recognized as the fourth organism in this relationship, which could be viewed as a quadrangle. Goshawks are primarily found in ponderosa pine and spruce-fir forests in the southwestern United States (ref. 36). In ponderosa pine forests, goshawks feed on tassel-eared squirrels (ref. 36). Tassel-eared squirrels feed on the false truffles of the mycorrhizal fungi, which benefit the ponderosa pine trees, especially in environments with porous soils. The pine trees provide habitat for squirrels, goshawks, and hypogeous fungi. If one species is affected within this system, all are affected. John Muir said it best in his classic book *My First Summer in the Sierra*: "When we try to pick out anything by itself, we find it hitched to everything else in the universe" (ref. 37).

False truffles, sporocarps of mycorrhizal fungi, are specifically clustered under the more dense canopies of blackjack ponderosa pines rather than under the mature yellow pines (ref. 38). Squirrel recruitment is positively related to interlocking canopies and fungal inventories, and those relationships are positively linked to the basal area. This

positive correlation with denser canopy cover and mycorrhizal fungi production should be considered with any timber management practices (ref. 24).

Logging activities that concentrate on intensive thinning practices can damage or destroy root systems of pines left standing after logging has ceased because the soil is disturbed (ref. 21, 24). Damaged roots, packed soil, and more intense drying conditions caused by the removal of the shady overstory can decrease false truffle production (ref. 38, 39). Higher diversity and abundance of false truffles in unthinned and unburned sites in ponderosa forests in northern Arizona were reported in a 2004 study. Thinning and prescription burns can negatively affect tassel-eared squirrels because of the reduction of the fungal component of their diet (ref. 40).

A positive relationship with squirrel winter survival and a diversity of fungi in the diet has been demonstrated (ref. 24). When snow cover limits squirrel recovery of false truffles and buried cones, squirrels must increase their consumption of inner bark, which has a marginal nutritional status (ref. 41, 42, 43).

Forest restoration projects should avoid concentrated thinning practices that reduce interlocking canopies and false truffle production, both necessary components of tassel-eared squirrel habitat (ref. 24). Instead, forest restoration projects should recognize the important aspects of the habitat of the tassel-eared squirrel in light of its designation as a MIS.

Conservation

Koprowski conducted a literature review pertaining to various tree squirrel responses to forest management practices. Recommendations from this review for the conservation of the squirrels are based on the management of the forests that provide the habitat for the squirrels. Optimum habitats for tree squirrels are dense patches of trees with high canopy cover with many interlocking canopies. Forest management practices should leave these dense patches while thinning surrounding areas. The thinned areas with low densities of trees could serve as firebreaks and travel corridors for squirrels and other wildlife (ref. 44).

Since *S. a. kaibabensis* and *S. a. chuscensis* have extremely small habitats when compared with *S. a. aberti* and *S. a. ferreus*, conservation efforts for these two subspecies are particularly important. *S. a. chuscensis* is afforded protection by the Navajo Nation as it lives within its

boundaries, but logging activities have been allowed in the Chuska Mountains (ref. 45). *S. a. kaibabensis* is not protected within the Kaibab National Forest but does have federal protection within Grand Canyon National Park, 10% of its range. The two subspecies of tassel-eared squirrels in Mexico are considered rare and have a status of "species subject to special protection," but because of the paucity of research nothing is known of their population levels or what, if any, protection is really afforded them (ref. 46).

Management Conclusions

Interlocking canopies are an absolute requirement for cover, nest sites, and travel corridors for tassel-eared squirrels, and for shade for hypogeous fungi production. Uneven-aged stands of trees with a mixture of multiple dbh classes with a variable vertical structure and basal areas of at least > 35 m/ha are necessary for maintaining good-quality squirrel habitat. Forest managers should consider leaving cover trees around nest trees and providing corridors for squirrels to travel within fragmented areas. Reductions in the size of forested areas undergoing thinning treatments are consistently recommended. The range of tree dbh preferred by squirrels for feeding and nesting should be incorporated into management plans. Snags and mistletoe-infected trees are important for squirrels and other wildlife and should be considered in forest management planning.

Catastrophic forest fires resulting from years of fire suppression have ravaged the southwestern United States. Prescription fires to reduce fuel loads and forest thinning practices have been implemented to restore ponderosa pine forests to presettlement conditions. Tassel-eared squirrels, hypogeous fungi, goshawks, and the ponderosa pines have evolved together. Forest managers and wildlife biologists must work jointly to ensure that this ecosystem is removed from the endangered list.

Future Research

(1) Determine the impacts of hunting squirrels with emphasis on the age groups of the killed animals (ref. 11). (2) Determine the impacts of roads on squirrel population levels (ref. 11). (3) Develop a field test to determine the chemical composition of a tree, allowing immediate evaluation of its status as a FT or NFT. (4) Determine the maximum spacing between trees that would allow squirrels to remain within a restored site.