MOUNT GRAHAM RED SQUIRREL

Tamiasciurus hudsonicus grahamensis

RECOVERY PLAN

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Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1992. Mount Graham Red Squirrel Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 172 pp.

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EXECUTIVE SUMMARY

Current Species Status: The Mount Graham red squirrel (Tamiasciurus hudsonicus orahamensis) is restricted to the coniferous forest areas of the Pinaleno Mountains in southeastern Arizona. Depending upon food resources and possibly other factors, the population experiences large fluctuations. The current estimated maximum habitat capability is approximately 650 squirrels. During cone crop failures the estimated adult population has been estimated to drop below 150 squirrels. Species status is unknown. The recovery priority is 9C.

Habitat Reauirements and Limiting Factors: Both food resources and habitat suitable for winter food caches are considered limiting. General habitat requirements include a mature forest with sufficient cone bearing trees to provide a winter food supply. The habitat characteristics most important for Mt. Graham red squirrel middens are foliage volume, canopy cover, log volume, and density of large snags. The middens are usually under a closed canopy. The closed canopy provides the cool, moist forest floor and soil needed to preserve cones and encourage mushroom growth. The closed canopy provides a system of interlocking branches for squirrel escape routes. Suitable snags or cavities in live trees for Mt. Graham red squirrel nests near the cone storage areas may also be limiting.

Objective: To increase and stabilize the existing Mt. Graham red squirrel population by protecting existing habitat and restoring degraded habitats.

criteria: Recovery criteria for the Mt. Graham red squirrel have not been determined. Due to the very restricted geographic range and low populations, the existing population must first be increased and stabilized. The recommended stabilization criteria is to provide sufficient habitat to maintain a population of squirrels, never fluctuating below 300 adults, distributed throughout the Pinaleno Mountains.

Actions Needed for stabilization:

1. Protect and monitor existing population and habitat.
2. Determine life history and habitat parameters.
3. Reclaim previously occupied habitat.
4. Integrate species and habitat protection actions for the Pinaleno Mountains.

costs ($000):

Year	Need 1	Need 2	Need 3	Need 4	Total
1993	66.6	140.0	62.0	71.1	340.7
1994	12.5	221.0	70.0	51.6	355.1
1995	12.5	199.0	55.0	38.3	304.8
1996	12.5	39.0	55.0	40.3	146.8
1997	12.5	39.0	55.0	38.3	144.8
1998	12.5	39.0	55.0	38.3	**144.8**
1999	12.5	39.0	55.0	38.3	144.8
2000	12.5	39.0	55.0	38.3	144.8
2001	12.5	39.0	55.0	38.3	144.8
2002	12.5	39.0	55.0	38.3	144.8
Total Cost to Stabilize	179.1	833.0	572.0	432.1	2016.2

Date of Recovery: Because the recovery requirements are not totally known, the date to recovery can not be estimated. At least 10 years will be needed to stabilize the Mt. Graham red squirrel population and at least 100 to 300 years will be needed to restore Mt. Graham red squirrel habitat.

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I. INTRODUCTION

Red squirrels (Tamiasciurus hudsonicus) inhabit boreal, mixed conifer, and deciduous forests, ranging from the northeastern United States and Canada westward across North America to Alaska, and south through the Rocky Mountain region into New Mexico and Arizona. In the southern part of its range, the red squirrel is restricted to montane forests. There are twenty-five recognized subspecies (Hall 1981). This plan is for the Mt. Graham red squirrel (T. h. orahamensis), a subspecies that was listed as an endangered species pursuant to the Endangered Species Act of 1973 (as amended) on June 3, 1987 (52 FR 20997).

The red squirrel is a small, grayish-brown arboreal rodent with a rusty to yellowish tinge along the back (Spicer et al. 1985). The tail is fluffy and the ears are slightly tufted in winter (Spicer et al. 1985). In summer, a black lateral line separates the upper parts from the white underparts. The cheek teeth number 16 (P1/1, M3/3), are low crowned and tuberculate, and the skull is rounded, with the postorbital process present (Hoffmeister 1986). The species ranges from 270-385 mm (10.8-15.4 in) in total length, and from 92-158 mm (3.7-6.3 in) in tail length (Gurnell 1987). There are two recognized subspecies in Arizona (Figure 1).

Description

First described in 1894 by J. A. Allen, the Mt. Graham red squirrel type specimen is from the Pinaleno Mountains, Graham County, Arizona. Allen (1894) designated it as a separate subspecies based on pelage differences and its isolation for at least 10,000 years from other populations. The Mt. Graham red squirrel is slightly smaller than the Mogollon red squirrel (T. h. moaollonensis), the other red squirrel found in Arizona in body measurements, including body, hind foot, and skull length (Hoffmeister 1986). The skull is also more narrow postorbitally than that of T. h. moaollonensis. Hoffmeister (1986) found no sexual dimorphism in measurements of adult Mt. Graham red squirrels. Based on measurements from ten specimens, Hoffmeister (1986) calculated an average total length of 331.5 mm (13.3 in), body length of 196.0 mm (7.8 in), and tail length of 135.5 mm (5.4 in). Average adult weight from nine specimens was 236.4 g (8.3 oz) (Froehlich 1990).

Although Hoffmeister (1986) thought the subspecies was not strongly differentiated from the Mogollon red squirrel, the subspecies designation was retained by both Hall (1981) and Hoffmeister (1986). Recent research with both protein electrophoresis (Sullivan and Yates, in press) and mitochondrial DNA (Riddle, Yates and Lee, in press) has provided data which in conjunction with morphological and ecological considerations, has demonstrated that the Mt. Graham red squirrel is a distinct population that likely deserves subspecific status.

Distribution

Found in the southernmost portion of the species' range, the Mt. Graham red squirrel inhabits only the Pinaleno Mountains of Graham County, southeastern Arizona (Figure 1). Its entire range lies within the Safford Ranger District of the Coronado National Forest, U.S. Forest Service (USFS). The Mt. Graham red squirrel resides in upper elevation mature to old-growth associations in mixed conifer and spruce-fir associations above approximately 2,425 m (8,000 ft). It may inhabit drainage bottoms where the mixed conifer association reaches lower elevations. Historically, the Mt. Graham red squirrel was common above 2,590 m (8,500 ft) but is currently seldom found below 2,804 m (9,200 ft) (Spicer et al. 1985, USDA, Forest Service, unpubl. data). As recently as the 1960s, the species ranged

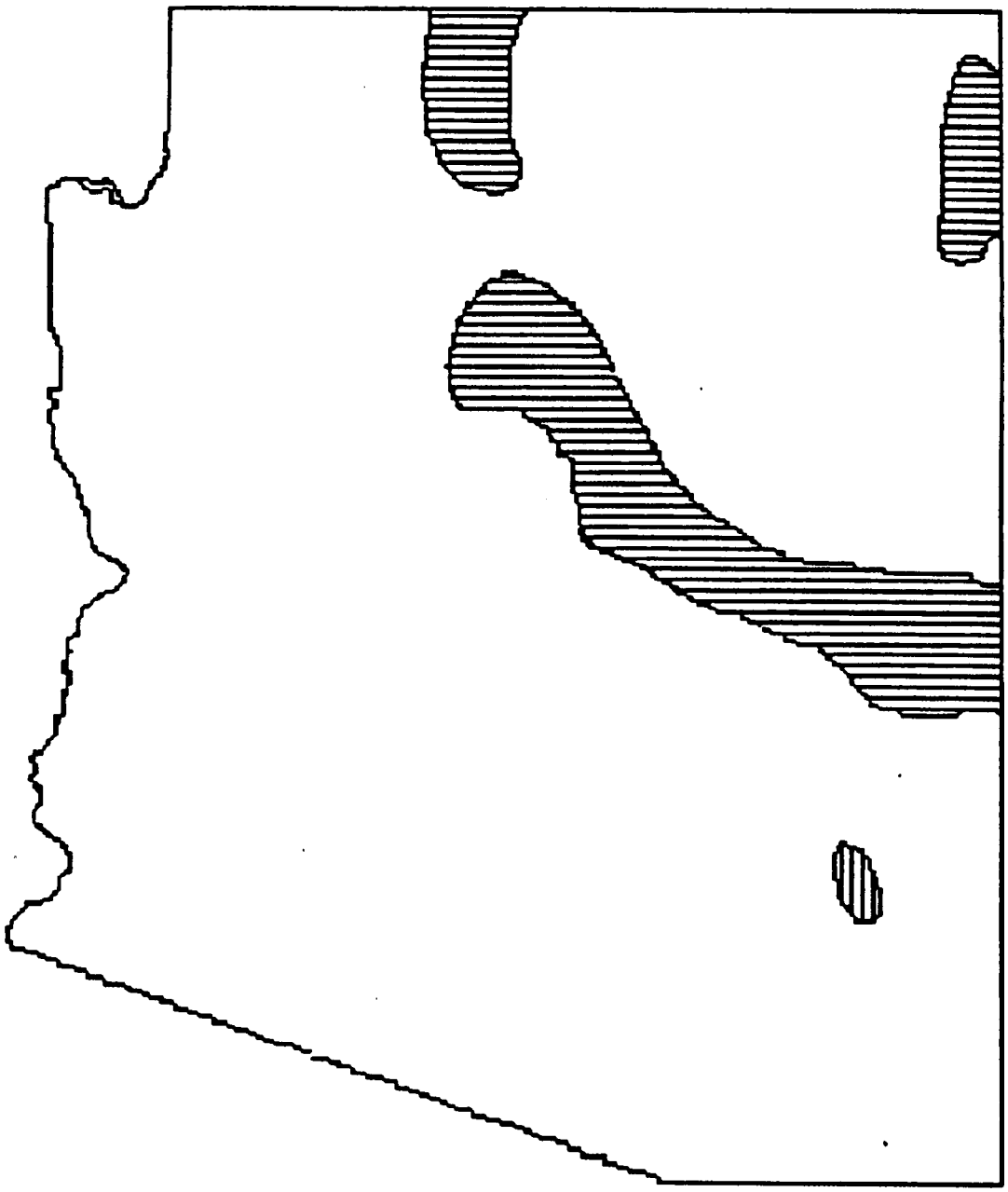

Figure 1. Range of the two subspecies of red squirrels in Arizona.

possibly as far east as Turkey Flat and as far west as West Peak but currently is found only as far west as Clark Peak. It is believed a local extinction occurred on West Peak, possibly due to a fire in the mid-19708 that both isolated the West Peak subpopulation from the rest of the range and caused losses to available habitat.

Currently, the highest densities of middens (cone debris piles used for winter food caching) are in the upper elevation Engelmann spruce (Picea engelmannii) and corkbark fir (Abies lasiocaroa var. arizonica) associations. Lower densities of middens are found in mixed conifer stands dominated by Douglas-fir (Psuedotsuaa menziesii), with white fir (Abies concolor) and Mexican white pine (Pinus strobiformis) sub-dominants and little to no spruce. The transition between the two associations occasionally contains red squirrel densities equal to those in the spruce-fir associations [P. Young, University of Arizona (UA), unpubl. data]. The spruce-fir is generally found at elevations above approximately 3,110 m (10,200 ft), although it extends lower on north-facing slopes. The transition varies widely in elevation depending upon aspect but generally grades into mixed conifer associations with little to no Engelmann spruce and/or corkbark fir, at about 2,835 m (9,300 ft) elevation. Mixed conifer associations extend down to approximately 2640 m (8000 ft) elevation.

The red squirrel is highly territorial (C. Smith 1968), and the concept of one squirrel per midden is widely accepted and used for red squirrel management (Vahle 1978). Occasionally, conditions arise where more than one squirrel occupies a midden, or a squirrel uses more than one midden (Froehlich 1990), but these are likely exceptional cases and usually occur only when food is extremely abundant or rare.

In 1986 and 1987, agency and volunteer biologists participating in multi-agency cooperative midden surveys systematically surveyed 1,846 ha (4,614 ac) for red squirrel middens in the Pinalenos (USDA, Forest Service 1988) (Figure 2). Black dots on this map indicate the location of a midden. These surveys represented 21% of the estimated 9,083 ha (22,436 ac) of potential red squirrel habitat (the entire forest above 2,425 m [8,000 ft] elevation). The surveys were carried out in all vegetation associations and habitat qualities, ranging from natural meadow areas through old-growth forest stands.

A habitat analysis (USDA Forest Service 1988) determined that only 4,750 ha (11,733 ac) of the 9,083 ha (22,435 ac) analyzed was suitable red squirrel habitat. Surveys in pure ponderosa pine (Pinus ponderosa) stands did not locate any red squirrel middens. Pure stands of ponderosa pine are considered too open and dry to contain suitable midden locations and were listed as having no potential as red squirrel habitat. Densities of middens were calculated for the various vegetation associations inhabited by red squirrels. The amount of habitat was multiplied by the midden densities in each vegetation association for an estimated 444 total midden areas on the mountain, both active (currently occupied) and inactive. Habitat quality (excellent, good, fair, poor, and very poor) was then ranked based on the midden density in each vegetation association (USDA, Forest Service unpublished data, Coronado National Forest files).

Habitat capability was evaluated using a U. S. Forest Service (USFS) Habitat Capability Model (HCM). That computer model produced an 1986 estimate of the existing habitat supporting up to 502 squirrels.

In 1990 and 1991, an additional 2,191 ha (5,412 ac) were intensively searched by USFS biologists for red squirrel middens (Figure 2). As of October 1991, a total of 549 active, inactive and abandoned midden locations have been found in the Pinalenos (USFS unpub. data) (Figure 2). Active middens are those currently occupied by a red squirrel. Abandoned middens are inactive middens where all or most of the cone scale debris

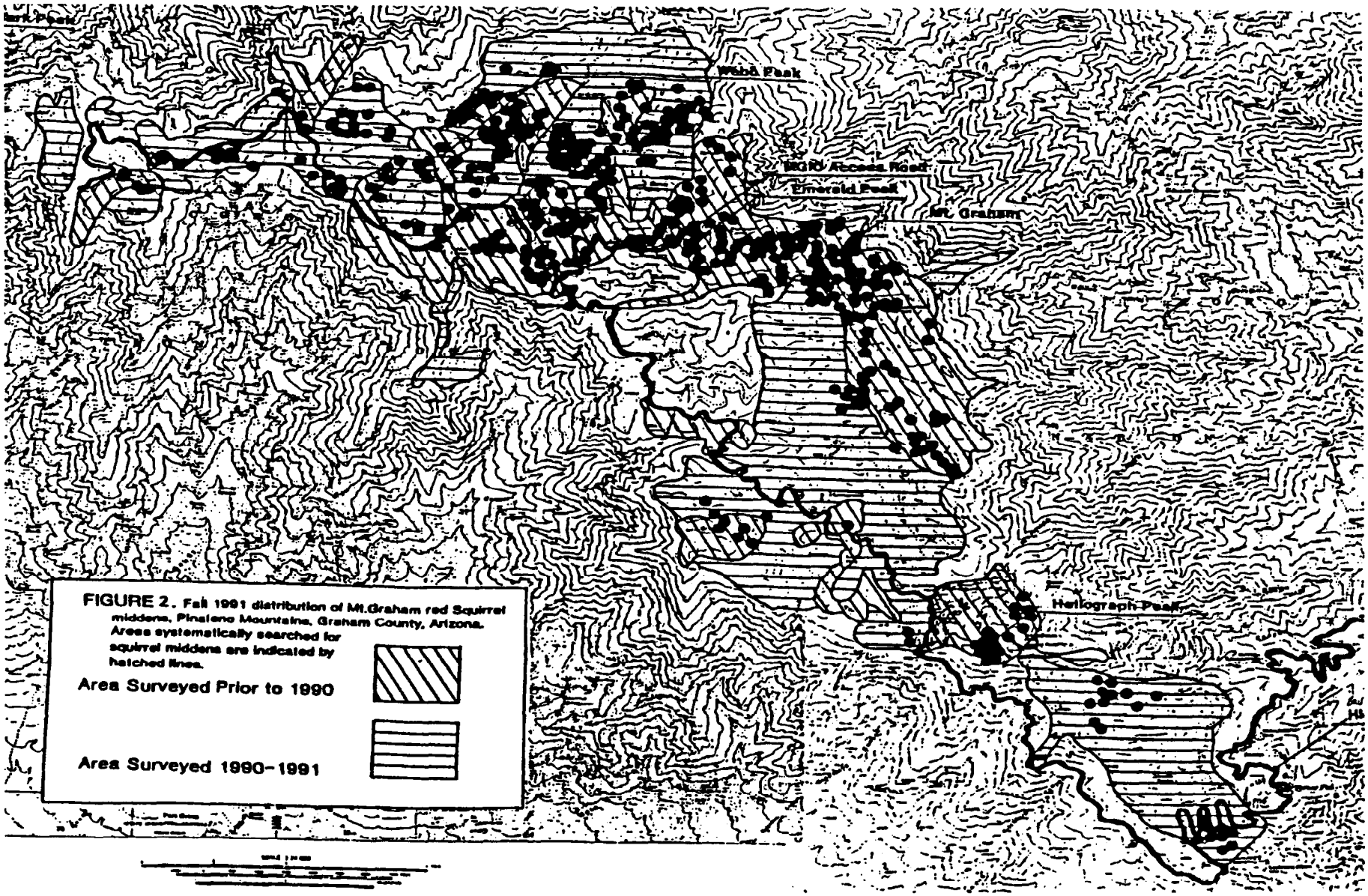

FIGURE 2. Fall 1991 distribution of Mt.Graham red Squirrel middens, Pinaleno Mountains, Graham County, Arizona. Areas systematically searched for squirrel middens are indicated by hatched lines.

that forms the midden has disappeared. Criteria to determine when a midden should be removed from the list will be identified during implementation. Removal or addition of middens has an effect on population estimates. The majority of red squirrel habitat (85%), in particular the more mature forested stands, has already been surveyed. Some additional middens are likely to be found in the 15% of the habitat that is not yet surveyed. Most of the remaining unsurveyed area consists of either disjunct stands of upper elevation mature conifer associations, drainage bottoms containing pockets of mixed conifer associations, young regenerating stands, or areas that are not currently suitable (e.g. clear cuts and fire areas that have little to no regeneration). These areas have high future potential as red squirrel habitat due to potential tree species composition and topography. Many stands that currently provide no habitat for the red squirrel have gentle slopes, are adjacent to mixed conifer stands, and have high potential for reforestation.

Based on updated habitat and midden information from 1991, the USFS estimated current and future habitat capability for the Pinalenos using the HCM. The estimate showed that under optimal conditions, the existing habitat may support approximately 650 red squirrels (USFS unpub. data). The HCM was also used to determine future habitat capability on the Pinalenos for red squirrels, assuming natural forest succession. Assuming natural succession, with no catastrophic events, the model predicted that in 200 years the habitat capability would increase to approximately 900 squirrels. Silvicultural treatments (such as planting of artificially created clearings, thinning, and understory removal that might speed growth of overstory trees and thus increase canopy cover) might increase the habitat capability more quickly. In addition, natural succession will also increase the habitat capability. However, natural or human-caused catastrophes such as insect outbreaks, fires, and possible climatic shifts due to global warming, may alter and affect habitat.

In 1991, approximately one-half (268) of all known middens were located within the transition vegetation association (Table 1). The Engelmann spruce and corkbark fir associations contain 37% (203) of the currently known middens, located within 18% of suitable red squirrel habitat. Mixed conifer associations, including the associated transition association, contain 63% (346) of red squirrel middens within 82% of suitable habitat. The transition association may vary widely in elevation, depending upon aspect and other factors. Total areas of the transition and mixed conifer vegetation associations have not been determined at this time.

As of 1991, 7% (39) of the currently known active and inactive middens are located below 2,743 m (9,000 ft) elevation; 31% (171) are located between 2743 m (9,001 ft) and 2,896 m (9,500 ft); 31% (168) are located between 2,896 m (9,501 ft) and 3,048 m (10,000 ft); and 31% (171) of the known middens are located above 3,048 m (10,000 ft).

Typically, the same midden will be used and reused in succeeding generations of squirrels, so to some degree, the use of middens becomes historical (Hatt 1943). However, the distribution and use of particular middens by red squirrels is dynamic and not static. This could eventually result in changes in the pattern of midden distribution over the mountain range due to changes in the habitat, differences in local habitat quality, and the behavior of the squirrels in recognition and re-occupancy of previously used sites. Even during periods of good food supply, such as 1986 and 1990, some recorded middens have remained inactive (USDA, USFS, unpubl. data). Conversely, some new midden sites have been created.

Habitat Requirements

Habitat suitability for the Mt. Graham red squirrel depends on the ability of the forest to produce reliable and adequate conifer cone crops for food as well as microclimate conditions suitable for storage of closed cones.

Table 1. Vegetation association surrounding known Mt. Graham red squirrel midden locations, Pinaleno Mountains, Graham County, Arizona, 1986 through 1991.[1]

	Mixed Conifer	Transition	Spruce-Fir	Total
Known Middens - Spring 1986				
Number of Known Middens	9	80	118	207
(Distribution of Middens by Vegetation Association)	(4%)	(39%)	(57%)	(100%)
Cunulative Hectares [Acres] Surveyed	1,151 ha [2,845 ac]			
Known Middens - Spring 1990				
Number of Known Middens	21	124	145	290
(Distribution of Middens by Vegetation Association)	(7%)	(43%)	(50%)	(100%)
Cunulative Hectares [Acres] Surveyed	1,867 ha [4,614 ac]			
Known Middens - Fall 1990				
Number of Knom Middens	51	214	167	432
(Distribution of Middens by Vegetation Association)	(12%)	(49%)	(39%)	(100%)
Cunulative Hectares [Acres] Surveyed	3,047 ha [7,530 ac]			
Known Middens - Fall 1991				
Number of Known Middens	78	268	203	549
(Distribution of Middens by Vegetation Association)	(14%)	(49%)	(37%)	(100%)
Cumulative Hectares [Acres] Surveyed	4,058 ha [10,028 ac]			

[1] New middens have been Located by systematic searches and by accident. As each midden is Located and mapped, the vegetation association at and immediately surrounding the midden is classified, and the midden is added to the current data base. The table shows the distribution of known middens from 1986 through 1991, including all newly located middens found during systematic surveys in the summer of 1990 and 1991. The U. S. Forest Service is currently developing criteria for removing middens from the data base once they have been inactive for long periods of time, but no midden has been removed from the list at this time.

These conditions have been met in western red squirrel habitats by mature to old-growth stands that have closed canopies (Finley 1969, Vahle 1978, Mannan and Smith 1991). Closed canopy forests may have increased fungal food supplies. Other elements that increase the quality of habitat are downed logs, snags and interlocking branch networks (Froehlich 1990, Mannan and Smith 1991). These habitat characteristics provide red squirrels with adequate food resources, perching, storage and nesting sites, runways that allow cone retrieval in the winter, and escape routes for avoidance of predators (C. Smith 1968, Vahle 1978).

The Pinaleno peaks are at about 33° north latitude, the southernmost latitude for both the red squirrel species and the spruce-fir association. The range also has the lowest dewpoint isohyte of red squirrel localities (50°F mean dewpoint) (USDA, Forest Service 1988), which is an indication of low water vapor density in the atmosphere. Because of their southern latitude, the Pinalenos experience the highest direct beam solar radiation (insolation) of all T. hudsonicus habitats (USDA, Forest Service 1988). High solar radiation may restrict or eliminate red squirrel use of some vegetation types in the Pinalenos, such as the ponderosa pine belt, that are known to be inhabited year-round in more northern latitudes (Ferner 1974). It may also increase the need for canopy closures that exceed 60% (USDA, Forest Service 1988). Mt. Graham red squirrels may be particularly selective about midden placement in order to avoid the negative effects of insolation (Froehlich 1990, Mannan and Smith 1991). Canopy closure from the top and from the side appears to be a crucial element of habitat selection for midden sites among western subspecies of T. hudsonicus (Halvorson 1980, Vahle and Patton 1983, Warren 1986, Mannan and Smith 1991).

Vegetation associations inhabited by the Mt. Graham red squirrel include mixed conifer, transition, and spruce-fir. In the Pinalenos, unbroken expanses of mature and old-growth spruce-fir, as well as old growth Douglas-fir intermixed with Engelmann spruce or corkbark fir (transition), appear to provide the best habitat based on 1986-1991 survey information. Old-growth mixed conifer stands dominated by Douglas-fir and white fir also provide habitat, although selection for midden placement may limit red squirrel use of mixed conifer stands (Froehlich 1990).

Habitat use by Mt. Graham red squirrels varies with associations on the Pinalenos (Froehlich 1990). In the mixed conifer association, red squirrels appeared to select for habitat features in midden placement. Discriminant function analysis selected slope, aspect, number of downed logs and the presence of large snags (≥ 40 cm [16 in]) diameter at breast height (dbh) near the midden as the most important features distinguishing midden sites from random sites (Froehlich 1990). Canopy cover at midden locations may be greater than at random locations. Habitat selection may play a major role in midden density variation among habitat types.

Recent research has shown that Mt. Graham red squirrel midden locations in the spruce-fir and transition associations are found in patches with unusually dense foliage volumes and canopy cover (Mannan and Smith 1991). Two hundred fifteen randomly selected middens and 201 randomly selected 0.01 ha plots were classified by vegetation association and compared for forest characteristics (Table 2).

Canopy cover was >70% at 96% of all middens measured (Mannan and Smith 1991). In addition, the mean foliage volume at 24% of spruce-fir middens and 27% of transition middens was greater than the maximum foliage volume from all random locations. Only 16% and 4%, respectively, had foliage volumes less than the mean foliage volume at random sites within the vegetation associations (Mannan and Smith 1991). Discriminant function analysis selected foliage volume, canopy closure at the center of each 0.01 ha plot, log volume, and density of large snags (>40 cm, 16 in dbh) to best distinguish midden locations from random locations in both associations (Mannan and Smith 1991).

Mean age of dominant trees (based on increment cores taken at breast height) averaged at midden plots in the transition association was 183

Table 2. Average physical and vegetational characteristics of red squirrel middens (typical size of midden = 0.031 ha, 0.078 ac) in spruce-fir and transition zone forests, Pinaleno Mountains, Arizona (Mannan and Smith 1991).

Variable	Spruce-fir midden sites	Transition midden sites
Canopy Closure ≥ x %	85	85
Number of Snags >40 cm (16") OBH	1.5	1.0
Number of douned Logs 40 cm (16") around and 10 m (33') Long	8.6	8.0
Number trees >40cm (16") DBH	3.3	4.1
Number trees 21-40cm (8"-16") DBH	13	12
Number trees ≤20cm (8")DBH	51	33
Basal Area, m^2/ha (ft^2/ac)	67 (293)	74 (322)

years (Mannan and Smith 1991). Tree age at random plots in the spruce-fir measured about the same age as trees in spruce-fir midden plots, while trees in midden plots in the transition zone were significantly older than the mean age of trees in random sites (Mannan and Smith 1991).

The forest of the Pinalenos have been subjected to modification, clearing, opening, and fragmentation that has reduced suitable habitat acreage to approximately 4,680 ha (11,700 ac) (USDA, Forest Service 1988). Of this, only 1,093 ha (2,700 ac) is currently considered good to excellent quality, based on habitat score cards developed by the USFS (USFS, unpubl. data). Red squirrels rely on particularly dense stands of conifers for midden placement within the forest. Mannan and Smith (1991) predicted that developments that open the forest canopy, remove large trees, or reduce amounts of dead and downed wood will reduce the number of potential middens for red squirrels in the Pinaleno Mountains.

Red squirrels in the Pinalenos are placing middens in stands with high canopy cover, foliage volume, and large amounts of dead and downed wood. The same characteristics are preferred in all vegetation associations. The mixed conifer and transition zones also have higher numbers of middens on north and east facing slopes than expected from random (Froehlich 1990, Mannan and Smith 1991). Management of stands should include reforestation and/or rehabilitation of old harvest, wildfire locations and fuel breaks to increase the amount of habitat with dense canopy cover and other old-growth characteristics. This management should increase the habitat capability of the Pinalenos and help ensure the continued existence of the red squirrel.

Foods

Observations from the Pinalenos indicate the foods of the Mt. Graham red squirrel include: (1) conifer seeds from closed cones, (2) above-ground and below-ground macro-fungi and rusts, (3) pollen (pistillate cones) and cone buds, (4) cambium of conifer twigs, (5) bones, and (6) berries and seeds from broadleaf trees and shrubs. Fledglings of birds, bird eggs, mice, young rabbits, carrion, bones, juniper berries, oak acorns, aspen seeds and ash seeds have also been reported as food items for other subspecies of red squirrel (Warshall 1986). Each food is used seasonally: pollen and buds in the spring; bones by females during lactation; fungi in the spring and late summer; and closed cones low in lipids in the early summer, and closed cones high in lipids are used for winter-time storage (C. Smith 1968).

Although not the only influence on population size and composition, the closed cone seed crop seems to explain more red squirrel demographics than any other single variable (Gurnell 1987). For red squirrels in general, it has been shown that conifer seed from stored closed cones likely influences the length of the breeding season, number of adult females bearing two litters, number of adult and yearling females that breed, longevity of adults, dispersals, diet switches, and perhaps the mean, long-term density of the population (M. Smith 1968, Rusch and Reeder 1978, Gurnell 1983, Halvorson 1986). Millar (1970) believes food availability also influences pre-implantation embryo losses.

In the Pinalenos, the red squirrel has been observed eating seeds and storing cones from Engelmann spruce, white fir, Douglas-fir, corkbark fir, and white pine. Probably due to microclimate considerations, the Mt. Graham red squirrel use of ponderosa pine seeds or caching ponderosa pine cones, is extremely limited. Cone caching and consumption of such seeds has been reported in more northerly latitudes (Hatt 1943, Finley 1969, Ferner 1974). The number of mature seed trees needed to supply the red squirrels' food needs on Mt. Graham have not been determined. A recent study of Mt. Graham red squirrel food items (Miller 1991) indicated that nutritional values of seeds from several conifer species in the Pinalenos vary both seasonally and by tree species.

Vahle (1978) noted the importance of single old growth Douglas-fir trees in home ranges of red squirrels in the White Mountains, Arizona but also stated that at least nine to fourteen mature seed trees within a red squirrel's home range (average .40 ha [1 acre]) ensured an adequate food supply. In general, large dominant trees are the best cone producers. Red squirrels usually concentrate their cone cutting for winter storage on the few trees in a stand that are the best cone producers (Finley 1969). Froehlich (1990) found that Mt. Graham red squirrels tended to concentrate foraging bouts on the few trees within a squirrel's home range (average 3.62 ha or [8.9 ac]). The mean dbh of these "forage trees" was significantly larger than other adult trees of the same species within the home range (Froehlich 1990). Most of the "forage trees" were the dominant trees in the stands.

In the Pinalenos, observations at middens during USFS surveys indicate Engelmann spruce and Douglas-fir are the most common species of trees supplying food to the Mt. Graham red squirrel. Douglas-fir, in general a consistent cone producer (Finley 1969), is important in the Pinalenos, especially in areas where it co-exists with Engelmann spruce. It might be increasingly important in years when the spruce cone crop fails (such as 1987, 1988, and 1989), but Douglas-fir still produces adequate numbers of cones. Douglas-fir is a more widespread species on Mt. Graham but is more often found in logged and broken habitats at lower elevations where microclimates to support middens may not be as suitable as at higher elevations. This may reduce its overall contribution to the food supply of the red squirrel population.

C. Smith (1968) recorded T. hudsonicus in British Columbia eating 42 different species of fungi, with a preference for small false truffles. In two examples, Smith noted that mushrooms and false truffles supplied more than half the squirrels' daily calories. Ferron and Prescott (1977) observed red squirrels spending up to 20% of their time harvesting fungi in season. By volume, fungi were 77% of red squirrels' diets in western Oregon (Maser et al. 1978). Mt. Graham red squirrels have been observed to readily utilize fungi as food (Froehlich 1990). Miller (1991) recently analyzed the nutritional content of three above-ground species of mushrooms eaten by Mt. Graham red squirrels. Percent crude protein and percent digestible protein was higher than'all conifer seeds except Engelmann spruce in summer (Miller 1991). C. Smith (1968) found that truffle protein content was also as high as some conifer seed per unit weight. Mushrooms and truffles may take less effort to eat than extracting seeds from cones. Combined with information on nutritional values, this may explain in part their relative importance in the diet.

In the Pinalenos, above-ground mushrooms appear during spring snowmelt and after summer rains begin. Because of their exposed gills, these species are better suited for drying and red squirrels have been observed harvesting, drying and storing these species (G. Froehlich, Coronado NF, pers. comm.). Because of their anatomy, below-ground truffles must be eaten as harvested. Fungal food resources are utilized according to seasonal availability. Observations have confirmed mushroom harvesting and storage in trees and middens of more than eight mushroom species (P. Warshall, UA, G. Froehlich, Coronado NF, pers. comm.).

Population Ecology

Population ecology of the Mt. Graham red squirrel is largely unknown. Except a few anecdotal observations, little life history (litter size at birth, age at first reproduction, birth rates, mortality rates, sex ratios) is known. This section briefly reviews population studies of other subspecies of Tamiasciurus and the present knowledge of the Mt. Graham red squirrel population.

Red squirrels breed generally from February through early April in most populations studied. Nests can be in a tree hollow, a hollow snag, downed log, or among understory branches of a sheltered canopy. Nests may be built in natural hollows or in abandoned cavities made by other animals, such as woodpeckers, and enlarged by the squirrels. Snags are important in the Pinalenos for cone storage as well as nest location, both nest and stored cones have been found in the same log or snag. Froehlich (1990) found that Mt. Graham red squirrels built 60% of their nests in snags, 18% in hollows or cavities in live trees, and 18% in logs or underground. Only 4% of nests were of the bolus grass type built among the branches of trees. The female has only one day of fertility during each breeding period (Flyger and Gates 1982). Individuals of some populations have begun breeding in January (Layne 1954) and two breeding seasons per year have been reported in a few populations (Layne 1954, C. Smith 1968, Millar 1970, Lair 1985), including the populations in central Arizona (Uphoff 1990). One female produced two litters during one year in the Pinalenos (Froehlich 1990). The triggering mechanism for the onset of breeding is not well understood but has been related to the quality and quantity of the spring bud crop on conifers (Lair 1985). It is unknown what percentage of females might produce two litters per year.

The gestation period is 35 to 40 days (Woods 1980). Litter size ranges from two to eight, with a mode of three to five (see USDA, Forest Service 1988). Hoffmeister's (1986) analysis of one female Mt. Graham red squirrel indicated that Mt Graham red squirrels may have three young/litter. Warshall (1986) observed one mother with three young. Froehlich (1990) observed eight litters in 1988 and 1989, with one to five young surviving into the fall. In 1990, researchers with the University of Arizona Red Squirrel Monitoring Program observed six litters, with a mean of 2.7 (range 2-3) young at emergence from the nest. In 1991, these researchers reported six litters in which young had emerged (mean 2.5 young, range l-4) by June 30, 1991.

First reproduction for females occurs after their first winter. The proportion of yearling and adult squirrels that breed varies widely from year to year. Rusch and Reeder (1978) and Wood (1967) found "yearling" reproductive rates (number of yearling females producing young) to vary from 24% to 88%. Yearling rates were always lower than adult female rates. After the second winter, all squirrels are considered adults. The proportion of adult females that breed varies widely from year to year. The proportion that produce two litters/year is likely to be highly variable. The proportion of juvenile and adult females that breed each year is unknown for the Mt. Graham red squirrel.

Survival rates of the Mt. Graham red squirrel are unknown. Halvorson and Engeman (1983), Rusch and Reeder (1978), and Kemp and Keith (1970) generally agree that massive mortality occurs between weaning and first reproduction ("winterkill"), followed by a plateau in adult mortality, ending in an increased mortality in older age classes. Survival rates vary markedly over years, presumably related to the supply of closed cones available for storage (Halvorson and Engeman 1983). The semi-annual midden population estimate conducted by the U. S. Fish and Wildlife Service (USFWS), USFS, and Arizona Game and Fish Department (AGFD) may give some indication of over-winter mortality trends, but more direct research is needed. The red squirrel monitoring program currently being conducted by the University of Arizona and other future research may help clarify the population ecology of the Mt. Graham red squirrel.

Although little is known about the population ecology of the Mt. Graham red squirrel, the total population size has been estimated. The population size has been estimated thirteen times (Table 3). Originally, the average occupancy rate for all middens was multiplied by the estimated number of middens of the mountain, 444 (USDA, Forest Service 1988). In the fall of 1990, different occupancy rates for each vegetation association were used.

Table 3. Original and revised population estimates for the Mt. Graham red squirrel, Pinaleno Mountains, Graham County, Arizona, 1986-1991. Sample sizes are the number of midden Locations visited. Where two estimates are given, they are the minimum and maximum estimated range. See the text for explanation of methods used to determine estimates.

Survey	Sample Size	Original Estimate (95%CI)	Revised Estimate (95%CI)
Hay/June 86	207	328 (+/- 55)	348 (+/- 55)
Oct. 87	150	246 (+/- 40)	235 (+/- 40)
March 88	45	207 (+/- 62)	210 (+/- 62)
Oct. 88	45	178 (+/- 62) 226 (+/- 62)	194 (+/- 62) 258 (+/- 62)
Jan/Feb 89	45	197 (+/- 63)	210 (+/- 63)
June 89	166	116 (+/- 29) 167 (+/- 32)	146 (+/- 29) 221 (+/- 32)
Oct. 89	267	162 (+/- 15) 185 (+/- 15)	191 (+/- 15) 204 (+/- 15)
May 90	271	132 (+/- 15) 146 (+/- 161	152 (+/- 15) 169 (+/- 16)
Oct. 90	396		260 (+/- 7) [1] 265 (+/- 7) [1]
June 91	208		272 (+/- 13) 280 (+/- 13)
Oct. 91	236		380 (+/- 13) 400 (+/- 13
June 92	250		370 (+/- 16) 383 (+/- 16)
Oct. 92	217		306 (+/- 16) 355 (+/- 19)

[1] Does not include approximately 40 newly created middens uhere squirrels (probably young of the year) might be present.

The percent of occupied middens is multiplied by the estimated number of middens within that vegetation association. Assumptions for both methods are: (1) squirrel occupancy can be determined from signs of recent caching, digging, and the condition of midden material, even when squirrels are not directly observed, and (2) one squirrel occupies only one active midden at a time. Further information on these population estimates is available from the Coronado National Forest.

Present Status

Because of past logging, fires, and development, habitat for the Mt. Graham red squirrel has been lost both directly and indirectly (e.g., by fragmentation and edge effects from clearings). The main cause for the decline of the sub-species has been a cumulative loss of habitat. As stated earlier, only about one-half of the original coniferous forests are still considered suitable habitat for the Mt. Graham red squirrel.

Population estimates indicated a decline in red squirrel numbers between spring 1986 and spring 1990 (Table 3). Spring population figures are a better representation of the potential breeding population and are thus more useful indicators of population status than fall population figures. In spring 1986, the population was estimated at 348 +/- 55 squirrels, but by 1989 numbers had fallen, presumably due to poor cone production by conifers between 1987 and 1989. However, during the summer of 1990 almost all conifer species produced good cone crops (USFS, unpubl. data), and the population appears to have had good recruitment that fall. Over winter survival in 1990-91 appeared high, as evidenced by the estimate of the population, in spring 1991, of 259-293 Mt. Graham red squirrels (Table 3). The October 1991 population estimate of 380-400 reflects the increase in juveniles from one 1991 breeding season. Over winter survival in 1991-92 appears to have been high. Survival over 1992 was not as high as 1991, probably due to low cone crops.

Reasons for Listing

The U. S. Fish and Wildlife Service (USFWS) listed the Mt. Graham red squirrel as endangered in 1987 under the Endangered Species Act of 1973 (52 FR 20997). Critical habitat for the Mt. Graham red squirrel was designated on February 5, 1990 (55 FR 425). This section outlines the suspected reasons for the squirrels' decline and addresses current concerns about present and future activities related to the decline.

Although the Mt. Graham red squirrel has historically been restricted to a relatively small area, both its range and numbers have declined during the past century. Early accounts of the species abundance used descriptions such as "common" and "abundant" (Hoffmeister 1986, Mearns 1907). By the 1950s, the population was described as "not abundant anyplace in the Mountains" (Hoffmeister 1956), and by the mid-1960's was rare enough that Minckley (1968) believed it extirpated. An observation report by USFS personnel from the Coronado National Forest from the early 1960's suggests that the species once occupied the western most peaks of the range (West Peak and Blue Jay Peak), but no additional records of red squirrels from the western portion of the range have been verified since.

Although not precisely documented, the decline of the Mt. Graham red squirrel may be attributed to the expansion of logging operations in the Pinalenos (USFS, unpubl. data). By 1973, most accessible and marketable timber had been cut, thereby altering the age structure and density of much of the red squirrels' forest habitat. Logging operations and road building to accommodate harvests resulted in areas of windthrow that destroyed additional habitat for the squirrel. Additional losses of old-growth coniferous forest resulted from both natural and man-caused fires, ice

storms, recreational development, road construction, and establishment of summer homes, an administrative center and a horse pasture. These direct losses not only reduced the amount of habitat but also resulted in forest fragmentation that may have reduced the quality of habitat since forest edges have a reduced capability to provide the proper microhabitat characteristics for cone storage. This fragmentation might have also isolated some pockets of the squirrel population and prevented successful dispersal and/or movements between areas, thus reducing genetic flow within the population.

It has also been suggested that the Mt. Graham red squirrel may have suffered from competition with the Albert's squirrel (Sciurus aberti). This species was introduced into the Pinalenos in 1941 and 1943 by the AGFD. The Albert's squirrel now occupies much of the coniferous forest in the Pinalenos but is most commonly found in the lower, more open, warmer, and drier ponderosa pine forests. Unlike the red squirrel which stores its winter food, the Albert's squirrel does not store food and gathers its food during the winter. This squirrel is adapted to relatively mild winter climates in which winter snows seldom remain on the ground for more than a few days at a time, thus enabling this squirrel to forage throughout the winter. In contrast red squirrels typically occupy higher elevations, with closed canopy forests of spruce, subalpine fir, or Douglas-fir which are subjected to severe winter climates with deep snow.. The red squirrel is well adapted to such severe conditions and concentrates its winter food supplies in cool, moist middens from which it feeds while the forest floor is covered with deep snow for six or more months of the year. The red squirrel is also territorial and highly protective of its middens. If competitive interaction occurs it is most likely to occur where the ranges of the two squirrels overlap such as in transitions between their preferred habitats or where logging has opened up mixed conifer forests.

Although little is known about interactions between these two squirrels, some authorities have suggested that competitive exclusion and ultimately the decline of the red squirrel may have resulted from these interactions (Brown 1984, Gehlbach 1981, Minckley 1968). The history and biology of these two species in the Pinalenos are reviewed in Spicer et al. (1985) and USDA, Forest Service (1988). Because there is a possibility that competitive interactions may have influenced the reduction in red squirrel range and numbers, research is needed to determine the extent to which competition may be affecting red squirrel populations.

Present or future land management practices that will result in further losses of red squirrel habitat include: construction of a major astrophysical facility; road construction and improvement; recreational development in coniferous forests (including picnic areas, campgrounds, and snow play areas); and collection of dead and down wood. Mushroom collection might reduce food sources for the squirrel. Additional losses to red squirrel habitat could result from forest fires, disease outbreaks, and windthrow (both natural and related to construction).

Any additional habitat disturbance must be recognized as a serious threat to the continued survival of the Mt. Graham red squirrel. The cumulative effects of direct and indirect (e.g., drying of forest edge) habitat loss, as well as forest fragmentation, could be severe over time. These losses to habitat have affected the viability of the Mt. Graham red squirrel population to some unknown degree. If viability has been significantly reduced, the Mt. Graham red squirrel may not withstand any more habitat loss and fragmentation. Thus, there may be both short-term (next 20-60 years) and long-term crises. Stabilization efforts must address both short-term and long-term (e.g., reforestation) crises.

Conservation Measures

Management of the forest has been altered in recent years. The USFS stopped all harvesting of timber, fuelwood, and Christmas trees, and restricted campfire wood gathering in some areas. The AGFD halted red squirrel hunting in 1986. The USFS, in conjunction with the AGFD, the USFWS, and various volunteer organizations, have monitored the red squirrel population and cone crop production since 1986. The University of Arizona (UA) is monitoring potential construction impacts of the astrophysical complex on the red squirrel, with oversight and review of the monitoring program by the USFS, USFWS, and AGFD. In addition, searches of previously unsurveyed areas for red squirrel middens are being conducted. A revised and detailed classification and inventory of vegetation associations is planned by the USFS to help delineate vegetation associations, and to update habitat quality maps using information from recent habitat research (Mannan and Smith 1991).

The USFWS issued a Biological Opinion on development of the Mt. Graham International Observatory in July 1988, in response to a request for formal consultation from the USFS. "Reasonable and Prudent Alternative 3" of that Biological Opinion was later used as the basis for Sec. 602-608 of the Arizona-Idaho Conservation Act (P.L. 100-696). The Act directed the Forest Service to grant the University of Arizona a permit to construct three telescopes and consider future applications for up to four additional telescopes. Several features required by Alternative 3 have changed management direction on the Pinalenos. These include: (1) closing the areas around Emerald, Hawk and High Peaks above 3,048 m (10,000 ft) and the area around Plainview Peak above 2804 m (9800 ft) to all camping, hiking, and other recreation uses, creating a Red Squirrel Refugium; (2) closing several Forest Service roads in red squirrel habitat to all vehicular traffic; (3) constructing a new access road to the astrophysical complex; (4) reforestation of potential habitat; and (5) obliteration and reforestation of FR 669 and 507. In addition, Alternative 3 provides for monitoring the impacts of construction of the astrophysical observatory on the red squirrel population. Lastly, Alternative 3 requires that studies be funded by the University of Arizona on red squirrel life history and ecology. Research funding should be available for a period of ten years (1989-1999). A Red Squirrel Study Committee currently develops priorities and oversees research on the red squirrel. Currently funded projects include a study of fire history by the Tree Ring Laboratory (UA); foraging ecology of the Mt. Graham red squirrel, Brown University; habitat characteristics of middens, UA; trapping and marking techniques for red squirrels, Pennsylvania State University; and a study on the antiquity of the spruce-fir forest, Northern Arizona University.

Strategy for Increase and Stabilization

The Mt. Graham red squirrel is in a survival crisis apparently caused by cumulative effects of habitat loss and fragmentation. The naturally limited distribution of this subspecies increases risks associated with habitat loss and fragmentation. The current population size suggests a considerable short-term risk of extinction from demographic and environmental (e.g., food) stochasticity (see Stabilization Objectives).

The strategy for stabilizing the Mt. Graham red squirrel will conserve a wide variety of species that use and/or are dependent upon mature upper-elevation forest ecosystems on Mt. Graham. A closed-canopy forest also promotes growth of mushrooms that are used as food by many species.

The most important step in preventing short-term extinction is to protect existing habitat from further loss or fragmentation. Protection of suitable habitats will be a major priority in efforts to increase and stabilize the Mt. Graham red squirrel population. Even small losses of

habitat are of concern, especially in light of habitat losses to natural causes that are likely to occur and the precarious situation of a fragmented forest.

Protection that may prevent the extinction of the squirrel includes (1) establishment of Habitat Management Zones (See Appendix A), (2) implement management plans to increase and stabilize the red squirrel population, (3) determining the usefulness to red squirrel recovery of the designation of Essential Habitat by the USFS, (4) road and/or area closures, (5) forest management to reduce the probability of habitat destroying fires, and (6) public education to increase understanding of how the conservation effort will help the ecosystem.

Essential to recovery of the species is to provide a strategy for the long-term recovery of degraded and currently unsuitable forests and to provide a scheme that will provide for mature forests and suitable habitat over time. However, when devising such a strategy, the natural ebb and flow of forest seral stages must be taken into consideration. It is not realistic to assume that regeneration of degraded habitats will be a straight line process; natural factors such as fire, insects, small mammals (e.g. gophers), different soils, aspects, and slopes will all affect the pace of regeneration and reforestation. But, the general outlook for the species in the long-term could be promising if the forest habitat were restored, maintained, and perpetuated. Reforestation of degraded habitats will eventually provide a wider and more secure land base for the species and thus, is a major priority for recovery.

In order to provide for long-term survival of the red squirrel, it is necessary to provide habitat (mid-aged, mature and older forests) in perpetuity. Forests are dynamic, not static entities. Trees, like all living organisms, are mortal. Thus, it is important to consider the dynamics of the forest associations on the Pinaleno Mountains and determine strategies to insure mature forests into the long-term (100-200 years and beyond).

The major forest associations of concern are the spruce-fir, mixed conifer and the transition between the two types. Recent studies of the spruce-fir forest and the Pinaleno indicate that in the old growth areas the spruce and fir species are "well represented in many size and age classes, indicating continuing recruitment under a mature canopy by both species" (Stromberg and Patton 1991).

Before the arrival of European settlers, forests throughout western North America were burned by frequent low-intensity, lightning-caused ground fires. These fires were particularly prevalent in ponderosa pine forests, to a lesser extent in the mixed conifer forests, and were infrequent and rare in the spruce-fir forests. Accordingly, fire plays a corresponding role in the ecology of each of these forest types.

Wildfire suppression since the early 1900's has greatly reduced fire frequency and in many areas entirely eliminated fire from these forests. On Mt. Graham, wildfires (both man-caused and natural) still occur but active suppression occurs due to the present potential for catastrophic fires.

In the spruce-fir forest, small partial disturbances from events such as windthrow, natural mortality, disease and lightning strikes will likely serve as the mechanism providing mid-seral succession and thus forest regeneration and perpetuation. Total stand replacement and regeneration from events such as logging or catastrophic fires are not needed or desired. Spruce and true firs are not fire adapted (i.e., they are thin barked) compared to pine and Douglas-fir species which are fire tolerant (i.e., they have thick bark) to moderate understory burning.

Within the mixed conifer forest and transition forest, logging, which occurred some time ago, ha's resulted in the reduction of large, dominant Douglas-fir trees in some stands. The logging took the form of both overstory removals and regeneration cuts which essentially took sites to younger seral stages (early successional grass/forb/shrub stage or in the case of an overstory removal to a younger forest stand of seedlings, saplings or poles). Sites that were historically forested (old harvest areas, fuel breaks, abandoned roads, etc.) should be the priority areas targeted for reforestation and silvicultural treatment.

In some cases these sites are having difficulty returning to stocked forest conditions because of the site dominance and competition of the herbaceous material (grasses primarily). These early successional sites are where assistance would most likely facilitate and speed up the succession process in order to provide earlier recovery of the area to mature forest with relatively closed canopies. We are acquiring a better understanding of habitat requirements for midden sites so that land managers can attempt to provide for red squirrel needs. The intent is to reforest formerly forested areas, and it is not desirable to attempt to reforest sites that are natural openings (cienegas, wet meadows, etc.).

Some concern has been expressed that reforestation will occur to the extent that early seral stages will be severely lacking which will impact early seral stage wildlife species. Forests are dynamic entities where continuing disturbances can be expected, and it is also unlikely that reforestation efforts would be so successful that early seral stages and openings will be lost in the landscape to the extent that other wildlife populations would be greatly affected or eliminated. In fact, in order to provide mature forests in perpetuity, it will be necessary to provide for all seral stages over time. It is likely that these stages will be provided naturally in small patches naturally through the landscape over time, rather than in larger harvest units or blocks.

Management strategies for insuring older forests in perpetuity in the mixed conifer and transition vegetation types will be much more complex than in the spruce-fir type. The complexity is a result of more tree species being involved, a more significant role of fire in the ecology of these forests, -the past history of logging, the greater potential for catastrophic wildfires, fuels management needs, and the greater interface with human development. Because of the associated complexity, management strategies will need to be developed on a site-specific level (individual forest stands and conditions). This will require integration of forest silviculture, fire management, and squirrel biology. First priority should be given to assisting sites that are in early successional stages. Second priority needs to be given to sites in mid-successional stages (seedling-sapling and poles). Third priority needs to be given to mature and old forest sites that are currently suitable. These mature and old forest sites will change over time in both structure and tree composition and in some cases actively managed and manipulated in order to maintain the desired forest characteristics long-term. Management of these sites would normally not require logging or mature tree removal. Management would tend to include practices such as low-intensity prescribed fires (maintaining snag and downed log characteristics), thinning from below of younger tree classes in order to promote a developing overstory, and perhaps occasional interplanting, etc. The goal should be to maintain the existing older forest character while providing for recruitment of future overstory species. In many cases little or no active management will be needed in the near future.

Reforestation efforts will require:

1. A detailed understanding of how macro- and micro-habitat correlates to squirrel abundance and productivity;

2. An ecological classification and inventory of vegetation;

3. Habitat Capability/Habitat Suitability Index model based on (1) and (2);

4. A long-term habitat recovery (restoration) plan based on all of the above.

Adaptation, implementation, and monitoring of the restoration efforts will be required. The habitat recovery plan must also include the flexibility needed to adapt changes that may be necessary based on new information and monitoring results. Some stands will require complete reforestation, while others may require varying amounts of silvicultural management. The average midden characteristics in spruce-fir and transition zones (Mannan and Smith 1991) will help provide guidelines for desired future conditions within each vegetation association.

A Mt. Graham red squirrel population viability analysis (PVA) is essential to predict short- and long-term persistence of the species. Continual refinements of the PVAs likely are the best tool for understanding management needed to increase and stabilize the squirrel population. Close monitoring of population trends, construction and recreation impacts, and habitat management efforts will be essential if the effort is to be successful. A detailed monitoring plan should be developed.

A comprehensive fire management plan must be developed. Additional information regarding population biology, habitat requirements, foods and foraging, and other aspects of red squirrel biology are necessary to the population increase and stabilization efforts.

II. STABILIZATION

Endangered species conservation strategies must plan for viable populations through time. Viable populations are those that are not likely to become extinct over a set time interval. The ultimate goal of maintaining population viability is to ensure continued existence. Since land managers and scientists can not conceive and consider all influencing factors that affect a species in the short or long term, conservation biology must focus on a manageable period of time, such as a hundred years. To establish management that may lead to species recovery, a detailed population viability analysis (PVA), using research information for the Mt. Graham red squirrel and its habitat, is needed. While there is some general information available to develop an initial PVA, specific information needed to refine PVAs is lacking. Collection of these data and continued use of PVAs to guide stabilization strategies is a top priority.

A. Assessment of Population Viability

I. Introduction

The goal of a PVA is to identify the risks of extinction. The computer models used simulate responses to estimated parameters. The goal of viability planning is to maintain adequate estimated numbers and distribution to ensure the continued existence of a well-distributed population. Continued existence implies a population that has a high probability (usually 95%) of existence for a specified time frame, generally 100 years or more.

This assessment attempts to summarize current knowledge of the ecology of the Mt. Graham red squirrel and its habitat in relationship to the population's viability. The assessment includes: (1) an overview of the

amount and distribution of current and projected habitat available for the Mt. Graham red squirrel; (2) an estimate of the habitat's capability to support the population; and (3) identification of the various types of risks that may increase the probability of extinction for this species.

Probabilities of persistence are defined as follows (from Marcot and Holthausen 1987). All terms are subjective rather than specific probabilities.

High: High likelihood of continued existence of a well-distributed population on the Pinalenos for 100 years. There is limited latitude for catastrophic events that will affect the population, or for biological findings that the population is more susceptible to demographic or genetic factors than was assumed in the analysis.

Moderate: Moderate likelihood of continued existence of a well-distributed population on the Pinalenos for 100 years. There is no latitude for catastrophic events or biological findings that the population is more susceptible to demographic or genetic factors than was assumed in the analysis.

Low: Low likelihood of continued existence of a well-distributed population on the Pinalenos for 100 years. It is probable that catastrophic, demographic, or genetic factors will cause extirpation from parts or all of its geographic range.

Very Low: Very low likelihood of continued existence of a well-distributed population on the Pinalenos for 100 years. It is highly probable that catastrophic, demographic, or genetic factors will cause extirpation of the species from parts or all of its range.

II. Habitat [1]

II.1 Distribution

The Mt. Graham Red Squirrel is found only in the Pinaleno Mountains. Restricted to one small mountain range, it is inherently vulnerable to extinction.

Most suitable habitat and red squirrels are found in the central eastern portion of the mountains, where highest elevations occur. The squirrel was once present in the western portion of the Pinalenos. If degraded habitat areas are restored, the red squirrel could expand into habitats in the west and in lower elevations between 2,400 m (8,000 ft) and 2,898 m (9,500 ft).

II.2 Current Habitat Capability

The Pinalenos contain approximately 8,900 ha (22,000 ac) of mixed conifer forest and spruce-fir forest communities. Based on a review of FS habitat mapping information (USDA, Forest Service 1988) and other data available in FS files, approximately 1,090 ha (2,700 ac) is estimated to be good to excellent habitat. Another 3,100 ha (7,700 ac) is estimated to be very poor to fair habitat. The remaining area either

[1] All acreages listed are estimates used to explore nianagement options. The acreage numbers are different from those listed in the Expanded Biological Assessment (USDA,' Forest Service 1988) and the Biological Opinion (USDI, FWS 1988) and should not be used for more detailed analysis, such as computing impacts of developing small amounts of habitat.

has little potential to become suitable or is currently in an unsuitable condition.

Extensive surveys have located, identified, and followed the history of midden sites on the mountain. Midden numbers have been used to estimate the possible squirrel population. Using the most recent habitat and density information derived from surveys, we estimate the habitat can support approximately.650 red squirrels under optimal circumstances. The population has not recently approached this level.

II.3 Future Habitat Situation

Habitat capability for the future has been estimated using the current acreages and estimated succession to predict future forest conditions. Assuming no losses of habitat, it is estimated that in the long term (100-200 years), a total of approximately 1,820 ha (4,500 ac) of good to excellent habitat could be available and an additional total of 3,560 ha (8,800 ac) of very poor to fair habitat could become available.

Using estimated future habitat conditions and applying squirrel density estimates, we predict future maximum habitat capability for approximately 900 squirrels in the long term (100-200 years into the future). If sufficient amounts of fair quality habitat develop into good to excellent quality habitat (attaining canopy closures greater than 60 percent), then it may be possible to reach or exceed a habitat capability for 1,000 squirrels.

III. Risks of extinction

III.1 Demography

In many small mammal species, large fluctuations in population size may occur from year to year. For the red squirrel in the Pinaleno Mountains, these fluctuations are largely driven by the availability of conifer cones. Conifer species produce cones on multi-year irregular cycles, with wide variations in production in any particular year. Different conifer species and different stands within a forest are on different cycles and are influenced greatly by environmental variables.

Red squirrel populations in the Pinalenos are dependent on conifer cone crops for their primary food supply. When cone crops are good, red squirrel numbers are likely to increase due to improved juvenile and adult survival. When cone crops are poor, red squirrel numbers are likely to decrease due to increased juvenile and adult mortality. These fluctuations in numbers are normal. Overlying these fluctuations based on food supply are restraints based on habitat capability. The population cannot exceed the capability of the habitat. Thus, actual increases in numbers are restricted. Decreases in numbers are not restricted. For the Mt. Graham red squirrel, habitat capability is very limited. Natural fluctuations in population around that capability may result in populations below the levels needed for viability. Until the capability of the habitat improves, thus easing the restrictions on population increases, normal population decreases will be a cause for concern.

The mosaic effect of food availability compounds this problem. If a cone crop from a single species forms, red squirrels in those areas should have a higher survival and reproductive probability. Because of limited habitat, some percentage of the squirrels may not find suitable midden sites and will not survive. Over the short-term, this results in concentrations of red squirrels in areas with cones, and significantly fewer squirrels between those areas. This situation can create partial

or complete isolation of subpopulations and increased risks of local extinction.

Reduction of available habitat by human actions has resulted in significantly increased risks to the species. Because of reduced habitat capability, the potential population will fluctuate at a reduced level. Low points in the cycle may be below population viability. The best protection against such fluctuations is to provide suitable habitat in all vegetation associations to promote higher population among habitats.

III.2 Genetics

Genetic variation within a population, effects of small population sizes on genetic drift, and inbreeding depression play a role in the survival and reproductive probabilities of individuals in a population. Research in population viability has developed the concept of the effective population size. This is defined as the size of the ideal population that would have the same amount of random genetic drift as the actual population. The effective population size takes into account the non-breeding individuals in the population, thus to maintain a given effective population size, the size of the total population must be larger. The size of the effective population is influenced by many demographic and environmental factors. Male-skewed sex ratios, high variance in progeny survival, age structure of the population, spatial distribution, and variation in population sizes over time all contribute to a smaller effective population size compared to total population size. If the actual effective population size is below the size calculated to maintain existing genetic variability, some of that variability would be lost. Over time, this loss may have significant contributions to the level of risk generated by other factors.

The Mt. Graham red squirrel has several characteristics which may contribute to a lowering of effective population size. The total population size is limited and undergoes wide fluctuations. Due to variance in cone crops and the effects upon reproduction, age structure of the population may not be consistent with maintaining large numbers of reproductively active individuals. In times of low population size, small, perhaps isolated groups of individuals may be present. Sex ratios and age of individuals in the group influence how many will actually breed. These factors indicate an increased risk of loss of genetic variance by the Mt. Graham red squirrel if the required effective population size cannot be met.

III.3 Predation

Predation rates on the Mt. Graham red squirrel are unknown. Principal predators include raptors and mammals. The best strategy to ameliorate predation is to provide high quality habitat for the red squirrel. High quality habitat should ensure favorable reproduction and survival rates that can withstand losses to predation. Predator control is unnecessary, expensive, and would most likely be ineffective.

III.4 Competition

The extent to which the Abert's squirrel competes with the red squirrel is unknown and needs to be determined. There is a potential for both habitat use and dietary overlap between the species. If significant competition exists, measures to reduce competition would be explored.

III.5 Disease

There is no information available that diseases play a major role in red squirrel population regulation. The territorial behavior of red squirrels may help reduce spreading of diseases.

III.6 Catastrophes

a. Catastrophic Wildfire

Some wildfires create conditions which enhance or preserve the desirable attributes of red squirrel habitat. Others degrade the attributes, sometimes severely. Fires that kill mature tree stands are of concern. Initial fire-fighting attack times can be upwards of 8-10 hours because of the remoteness and ruggedness of the terrain (J. Schulte, Coronado National Forest, pers. comm.). There likely are differential risks of catastrophic fires depending on vegetation association. The mixed conifer association, which contains most of the recovery habitat, is likely to lose habitat in the future. The spruce-fir association is less susceptible to catastrophic fire because of its inherent moist condition. In the 1950's two catastrophic fires, the Nuttall and Outlaw fires, burned more than 15,000 acres of which 10,000 acres is estimated to have been red squirrel habitat. If losses of habitat continue at this rate, at least 25,000 acres may be lost during the next 100 years. Catastrophic wildfires will continue to be a significant threat to Mt. Graham red squirrel survival.

b. Drought

Periodic and prolonged drought can negatively impact food resources and increase the threat of catastrophic fires. Severe droughts may also reduce forest regeneration and increase tree disease and insect infestation impacts. Periodic drought probably influences cone crop production. Cone crop failures can lead to large red squirrel population fluctuations. Drought may contribute substantially to the risk of extinction.

c. Global Warming

The Pinalenos contain relict montane conifer and spruce-fir associations that have retreated up the mountain in elevation since the Pleistocene glacial period. Global warming might cause a further retreat of the forests up the mountain greatly reducing or eliminating red squirrel habitat.

IV. Summary and conclusions

The Mt. Graham red squirrel is restricted to a single isolated mountain range and dependent on a relatively small land base within that range. The population is isolated. The population is inherently vulnerable to extinction. With aggressive habitat protection and restoration during the next 100 years, it may be possible to increase the habitat capability by 35-40% (to approximately 1000 squirrels).

Natural or man-caused catastrophes could cause extinction. Catastrophic fire (both natural and human caused) and human development projects within the habitat are the most immediate threats that will likely affect suitable habitat. Global warming could cause retreat of the Pleistocene relict forest and reduce the squirrels' chances for survival over the long-term. Insect or tree disease outbreaks are also significant treats to suitable habitat.

The sub-species population fluctuates widely. To date, the population has remained below the estimated maximum predicted by habitat capability. Population size may become dangerously low, which may result in increased risk of extinction as a result of natural variations in birth and death rates and associated genetic risks.

Based on habitat capability estimates of a maximum population of approximately 650 squirrels, the potential for chance extinction is a real and potentially imminent threat (M. Schaffer, The Wilderness Society, pers. comm.). The chances of long term persistence of the Mt. Graham red squirrel must be classified as moderate to low. However, the squirrels' status is not hopeless or irreversible. With aggressive habitat protection and restoration and an improved distribution of red squirrels on the mountain, relative security could be possible. Circumstances which do not allow for protection of existing habitats and successful restoration of degraded habitats lower the opportunities to achieve relative security.

B. Stabilization objectives

Because a detailed PVA has not been prepared and the preliminary PVA shows reason to consider the species at considerable risk, specific downlisting or delisting criteria are not included in this plan. A formal PVA has been recommended in the implementation schedule of this plan.

Immediate needs are to provide sufficient habitat to allow the red squirrel population to (1) increase (population lows should exceed 300 adult squirrels), (2) become more evenly distributed spatially, and (3) stabilize. The USFWS will consider population lows to be meeting or exceeding the 300 adult squirrel criteria when the joint interagency census figures have shown the population to exceed 300 squirrels consistently, for a minimum of eight years consecutively. This monitoring period must have covered at least one year of widespread poor cone crops across either the spruce-fir and/or mixed conifer communities. These criteria may be modified by the USFWS as improved information on the species and its viability is obtained. Because high quality habitat is critical to Mt. Graham red squirrel survival, a Habitat Management Zone map (Appendix A) delineates areas of high value as habitat zones 1, 2, and 5. For the squirrel to survive, habitat loss must not occur in these zones. Degraded habitat areas in these zones must be recovered. The following actions are needed to stabilize the Mt. Graham red squirrel population:

1. Protection and restoration of habitat
   - 11. Physical protection
     - 111. Administrative actions
       - 1111. Designate essential habitat
       - 1112. Road and area closures and other use restriction
   - 12. Management
     - 121. Habitat management zone implementation
     - 122. Reforestation
       - 1221. Prepare a mountain-wide reforestation plan
       - 1222. Reforestation plan implementation
       - 1223. Rehabilitation efforts monitoring
     - 123. Inventory of vegetation associations
       - 1231. Monitoring habitat quality
     - 124. Recreation
       - 1241. Develop recreation management plan
       - 1242. Monitoring recreation impacts
     - 125. Population monitoring
       - 1251. Long-term population monitoring
       - 1252. Midden surveys
       - 1253. Restoration habitat needs evaluation
     - 126. Cone crop monitoring

127. Road kill reduction
128. Management flexibility

13. Fire suppression
131. Fire management plan

14. Law enforcement

15. Interagency cooperation

2. Research

21. Mt Graham red squirrels
211. Population dynamics/life history
212. Population viability analyses
213. Midden characteristics
214. Interspecific interactions

22. Short-term contingency plans
221. Supplemental feeding
222. Captive breeding
223. Emergency plans for habitat catastrophes

3. Public education

31. Education programs
311. Develop pamphlets
312. Develop trail signs
313. Develop campground interpretive programs
314. Develop volunteer programs

32. Columbine visitor information station
321. Develop interpretive signs and exhibits

C. Narrative Outline

1. Protection and restoration of habitat. This is the most important factor for continued survival of the Mt. Graham red squirrel. Because habitat is limited, further habitat losses could cause extinction in the near future. Many areas of potentially suitable habitat are degraded. Restoration of degraded areas is essential.

11. Physical protection. Signs, road closures, restrictions, and other measures must be provided to limit disturbance to squirrels and their habitat.

111. Administrative actions. Actions required to protect the habitat.

1111. Designate essential habitat. Essential habitat is defined (USFS Manual 2670.5) as habitat possessing the same characteristics as critical habitat.

1112. Road and area closures and other use restrictions. When determined necessary to prevent direct or indirect impacts to squirrels-and habitat, closures or restrictions should be used as needed.

12. Manauement. The USFS should amend the Coronado National Forest Plan to include the appropriate tasks recommended by the recovery plan. Short and long-term management actions that protect and restore habitats and the squirrel population are essential. Plans should provide continued protection of habitats, reforestation and rehabilitation of potential habitats, and long-term monitoring of the squirrel population and its habitat on the Pinaleno Mountains.

121. Habitat management zone implementation. A map and recommended management guidelines have been prepared (Appendix A). Recommendations contained therein should help prioritize areas for habitat management and/or restoration

(see Appendix A). Implementation of habitat management zones is essential to provide the framework needed to stabilize the Mt. Graham red squirrel population.

122. Reforestation. Reforestation is the most important long-term stabilization action. In combination with existing habitats, restored forests will provide a more secure habitat and help buffer the species from catastrophic occurrences.

1221. Mountain-wide reforestation plan. A comprehensive plan for reforestation and/or improvement of degraded areas should be developed by the USFS. The plan should concentrate on areas previously logged in habitat zones 2 and 3 (see Appendix A). Reforestation should be prioritized and prescriptions included for each area. Prescriptions may include natural or artificial regeneration or other silviculture methods needed to improve stands for red squirrel habitat. Reforestation of closed roads should be included in the plan.

1222. Reforestation plan implementation. This action includes the needed silviculture actions.

1223. Rehabilitation efforts monitoring. Monitoring should provide information on seedling growth rates and the affects of thinning. Monitoring results will be used to modify reforestation efforts.

123. Inventory of vegetation associations. Quantitative habitat assessment of all areas on the mountain is essential for monitoring success of reforestation and determining current and future red squirrel carrying capacity. A vegetative analysis that accurately delineates forest stands by vegetative type and structural stage is the first step. Vegetative maps should be combined with information on red squirrel habitat needs to assess habitat quality. One method may be the Geographical Information System (GIS).

1231. Monitorins habitat auality. Monitoring red squirrel habitat should take place on a regular basis and include occupied habitats and silvicultural efforts. GIS habitat maps should be updated regularly.

124. Recreation management plan. The Mt. Graham red squirrel habitat management zone concept should be accepted and implemented by USFS as part of any recreation plan. The USFS should develop a long-term (at least 20 years) comprehensive recreation plan for the Pinalenos. The plan should outline all proposed recreational developments and assess potential conflicts that may develop within red squirrel habitat. Potential conflicts must be resolved to prevent further threats to red squirrel survival.

1241. Monitoring recreation impacts. A plan for monitoring developed and dispersed recreation sites should be developed and implemented. Monitoring results will be used by the District Ranger to modify management strategies as needed.

125. Population monitoring. Monitoring the red squirrel population will require a long-term commitment of regular

censuses and periodic analyses of the population distribution.

1251. Long-term population monitoring. A comprehensive Interagency Population Monitoring Plan should be developed that includes monitoring to provide data on population trends. Semi-annual monitoring should continue until the population has increased and stabilized.

1252. Midden surveys. The USFS should intensively survey all unsurveyed areas on the Pinaleno Mountains. Middens should be located, mapped, and information on the surrounding forest recorded. As necessary, areas should be re-surveyed to locate new middens. The Global Positioning System should be evaluated in documenting midden locations. GIS midden distribution data should be regularly updated.

1253. Restoration habitat needs evaluation. Habitat that has potential for supporting red squirrels should be monitored regularly to ensure that it is developing in the correct way.

126. Cone crop monitoring. Long-term monitoring of cone crop production is needed to provide a better understanding of cone crop periodicity, predict when seed for reforestation should be collected, and provide insight on red squirrel population trends. Used in conjunction with weather stations, information gathered may eventually allow accurate prediction of cone crops.

127. Road kill reduction. Automobile traffic is expected increase. To reduce traffic, consideration should be given to the use of shuttles. This issue will be discussed under the recreation management plan.

128. Management flexibility. New research information should be incorporated into management actions as soon as possible.

13. Fire suppression. The USFS should practice vigorous fire suppression of all unplanned fires in all Mt. Graham red squirrel habitat areas and in areas where fire could spread to habitat areas.

131. Fire management plan. The USFS should develop a comprehensive fire management plan that minimizes fires in all red squirrel occupied areas and in any areas where fire might spread into red squirrel habitat. Specific methods to control fires and should be outlined and long-term plans should address fuel loading and fuel management within red squirrel habitats. Strategies for fuel management should retain large snag and log components in the landscape.

14. Law enforcement. Enforcement of appropriate laws and regulations is essential to the success of increasing and stabilizing the Mt. Graham red squirrel population.

15. Interagency cooperation. Interagency cooperation has been a successful part of the initiation of the stabilization process. The recent agreement between the AGFD and USFS on funding population surveys is one example. A multi-agency Mt. Graham red squirrel management team should provide technical assistance in

implementing the stabilization effort and ensure continued cooperation among the agencies.

2. Research. Reliable PVA models require accurate parameters. Data is needed on the population biology, habitat requirements, and limiting factors for the Mt. Graham red squirrel. Habitat use and productivity among different vegetation associations are not well understood.

   21. Mt Graham red squirrels. Additional information on the biology of the squirrel is essential to stabilize the population. Most reproductive parameters are unknown.

      211. Population dynamics/life history. Safe methods of marking red squirrels should be used in detailed population studies in all habitats. Comparison among different habitats in the Pinalenos can then proceed.

      212. Population viability analyses. Evaluations of population distribution, exchange rates between subpopulations, and monitoring data are needed to provide guidelines to stabilize the population over the long-term. Improved PVAs and genetic studies are needed.

      213. Midden characteristics. After an accurate vegetation map is produced, habitat research should be used to update habitat quality ratings. Habitat capabilities can then be further refined and stabilization goals quantified and updated.

      214. Interspecific interactions.

         2141. Albert's squirrels. Research into possible competitive interaction with Abert's squirrels is necessary to determine if competitive exclusion from some habitats, or competition for food resources, is depressing red squirrel numbers. If significant competition is found, control of Abert's squirrels may be considered.

         2142. Predation. Identification of potential predators and their population levels is needed. Predation rates should be determined and, if significant, options to reduce predation explored.

   22. Short-term contingency plans. Plans should be developed to allow special management procedures if the red squirrel population should reach critically low numbers or other special management needs are identified.

      221. Supplemental feeding. Guidelines and procedures regarding potential for supplemental feeding should be developed in the event such actions become necessary to ensure survival of the wild red squirrel popuiation.

      222. Captive breeding. A plan should be developed to take Mt. Graham red squirrels into captivity to develop culture techniques should captive reproduction be necessary in the future.

      223. Emergency Plans for habitat catastrophes. A plan outlining strategies to be implemented in the event of catastrophic loss of habitat should be prepared.

3. Public education. The public should be made aware of the red squirrel and actions needed to protect the species. Positive aspects of red

squirrel survival should be stressed. These aspects include information about the role of the squirrel in forest ecosystem.

31. Education programs. Public education should be ongoing. Publication and distribution of pamphlets, campground interpretive programs, and installation of interpretive signs would help raise public awareness. In addition, programs should be developed for various interested public groups, both locally and regionally.

    311. Develop pamphlets. Develop two levels of brochures on red squirrel ecology. One should be **for** the general public **and** the other for special interest groups.

    312. Develop trail sisns. Signs along trails and at the boundaries of habitat management zones will increase public awareness and inform users of ways to minimize disturbance and habitat degradation.

    313. Develop campground interpretive programs. The USFS should develop an interpretive program for campgrounds in conjunction with other summer campground programs, emphasizing the importance of the red squirrel and other threatened or endangered species.

    314. Develop volunteer programs. A volunteer program should be established at local and regional **schools to help with** specific monitoring efforts. A program with college students from local colleges and other universities would help raise public awareness and provide students with field experience.

32. Columbine Visitor Information Center. The USFS **has provided an** interpretive center on the forest, a portion of which should **be** devoted to promoting public awareness. By stressing the importance of the red squirrel in the ecosystem, a positive public awareness and public support may be achieved.

    321. Develop interpretive sions and exhibits. **Exhibits should** emphasize the importance of the red squirrel in the ecosystem, describe how recreation uses can be compatible with red squirrels, and aspects of red squirrel biology.

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IV. IMPLEMENTATION SCHEDULE

Priorities in Column 2 of the following Implementation Schedule are assigned as follows:

Priority 1 — An action that must be taken to prevent extinction or the prevent the species from declining irreversibly in the foreseeable future.

Priority 2 — An action that must be taken to prevent a significant decline in species population, habitat quality, or some other negative impact short of extinction.

Priority 3 — All other actions that must be taken to provide for full recovery of the species.

KEY

Duration: Numbers are years, + indicates ongoing or continuing duration. An ongoing task is already being implemented. A continuing task will continue once implemented.

Lead Agency: USFS = United States Forest Service, AGFD = Arizona Game and Fish Department, USFWS = United States Fish and Wildlife Service

Comments
1 First year costs include LandSat photo purchases
2 Current per acre cost estimate
3 Fuel load management may increase costs in later FYs
4 Cost highly variable depending on desired product
5 Includes reprint costs
6 Includes maintenance
7 Includes costs for 5 presentations per year
8 Includes costs for 12 presentations per year

Implementation Schedule

Task #	Priority#	Duration	Lead Agency	K$ FY 93	K$ FY 94	K$ FY 95	K$ FY 96	K$ FY 97	K$ FY 98	K$ FY 99	K$ FY 00	Comments
1111	1	1	USFS	5								
1112	1	+	USFS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	
121	1	+	USFS	10	10	4	4	4	4	4	4	
122	1	1	USFS	25	15							1
1221	2	1	USFS	37								
1222	2	10	USFS		50	50	50	50	50	50	50	
1223	2	+	USFS		5	5	5	5	5	5	5	
123	2	+	USFS		5	5	5	5	5	5	5	
1231	2	+	USFS	2	2	2	2	2	2	2	2	
1241	2	1	USFS	4								
1242	2	+	USFS	4	4	4	4	4	4	4	4	
1251	1	+	AGFD	25	25	25	25	25	25	25	25	
1252	2	+	USFS	25	5	5	5	5	5	5	5	
1253	2	+	USFS	2	2	2	2	2	2	2	2	
126	2	+	USFS	5	5	5	5	5	5	5	5	
127	3	+	USFS	1.5	1.5	0.5	0.5	0.5	0.5	0.5	0.5	
13	1	+	USFS	3	3	3	3	3	3	3	3	2
131	1	1	USFS	10								3
14	2	+	USFS	25	25	25	25	25	25	25	25	
15	2	+	USFS	2	2	2	2	2	2	2	2	
211	1	1-3	FWS	60	60	60	60					
212	1	0.5	AGFD			50	50					4
213	2	+	FWS	21	21							
2141	2	1-3	AGFD		25	25	25					
2142	2	1-3	AGFD		25	25	25					
221	2	1	FWS		5							
222	1	1	FWS		20							
223	2	1	USFS		5							
311	3	1	AGFD	10	2		2					5
312	2	1	USFS	5	2	2	2	2	2	2	2	6
313	3	1	AGFD	2.1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	7
314	3	+	USFS	2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	8
32	3	+	USFS	2	2							

APPENDIX A. MT. GRAHAM RED SQUIRREL HABITAT MANAGEMENT ZONES

The USDA Forest Service should adopt these zone descriptions and management objectives to help guide the Mt. Graham red squirrel recovery efforts. The following management objectives do not advocate that all areas in the Pinalenos be managed exclusively for Mt. Graham red squirrels. Many other specie5 dependent on, or living in, coniferous forests in the Pinalenos will also benefit from these management methods.

Vahle (1978), Froehlich (1990), and Mannan and Smith (1991) were used to estimate the habitat conditions needed for middens and foraging areas. The management intent is to maintain suitable habitat conditions for the Mt. Graham red squirrel (Conner 1979).

The following habitat descriptions should be considered to be the future desired condition of the forests. In the spruce-fir and mixed conifer vegetation associations, the forest structure should consist of a nearly continuous multi-layered forest with overhead canopy closure greater than 80%, basal area of at least 65 m^2/ha (275 ft^2/ac) with groupings of 0.031 ha (0.078 ac) of large dominant trees ≥ 40 cm (16 in) diameter at breast height (dbh) associated with ≥ 5-8 logs and l-2 standing snags ≥ 40 cm (20 in) dbh (Mannan and Smith 1991). In general, 10-15 snags/ha (4-6 snags/ac) that are ≥ 40 cm (16 in) dbh need to be maintained. Also, as many large logs as possible need to be maintained, especially those in the later stages of decay. The goal for each zone is to strive towards the stand characteristics listed above, which will provide optimal habitat for a wide variety of wildlife. The stand characteristics above are descriptive of older seral stages of coniferous forests. Excellent red squirrel habitat is currently defined as those areas possessing the above characteristics. Suitable habitat generally contains many, but not necessarily all, of the optimal characteristics. Habitat requirements included for the future desired condition may be modified pending results of further research and monitoring.

Management of recreational uses of the habitat management zones will be an important component in meeting objectives. Recreational use of all zones is allowed, although certain activities may be restricted in specific zones. The USFS, USFNS and AGFD should meet to discuss the recreational restrictions, necessary monitoring and future management direction.

Visitor education on the protection of red squirrels and their habitat is essential. Visitor use must not displace or modify important red squirrel habitat. Informational sign5 at major access points to zones containing important red squirrel habitats should explain management practices. Signing should be the minimum needed and primarily for resource protection.

Zone Descriptions (see accomoanvina map):

Zone 1

These areas are currently occupied by red squirrels. These areas have relatively high densities of red squirrel middens in good cone crop years and are critical to prevent extinction or irreversible decline of red squirrels in the short term (20 to 60 years). Habitat in Zone 1 is highly sensitive to direct (e.g., midden disturbance, squirrel harassment) and indirect (e.g., removal of dead and down wood, soil compaction) impacts.

Management of these areas should focus on maintaining optimal red squirrel habitat characteristics. The maximum level of habitat protection for management and recovery should be emphasized and include maximum levels of catastrophic fire and disease control. Because these areas are critical to preventing the extinction or irreversible decline of the Mt. Graham red squirrel, they are the most important areas for short-term stabilization and no habitat 1055 should occur.

Pedestrian day use (hiking, hunting, birding, fishing, picnicking, etc.) and camping are acceptable. Pets will be leashed at all times. Trails should be well maintained to discourage cross-country travel. Snowmobiles are not allowed. Leave-no-trace camping ethics will be utilized. Loss or depletion of dead and downed woody habitat components must be prevented. Human use impacts should be evaluated annually to determine future management needs. If necessary, recreation use may be managed by further restriction (e.g. permit camping only, restrict hiking to trails, campstove use only).

Zone 2

These areas contain currently suitable and occupied habitats, but the density of squirrels is less than in Zone 1. This zone also includes areas thought to be important dispersal corridors, but, due to topography or other factors, they are not permanently occupied by squirrels.

Zone 2 management will be similar to management for Zone 1. The emphasis will be placed on maintaining red squirrel habitat characteristics, including protection from habitat loss caused by fire and disease. No habitat loss should occur. Silviculture treatments may be necessary as determined from habitat analyses and outlined in a comprehensive silvicultural plan.

Pedestrian day use (hiking, hunting, birding, fishing, picnicking, etc.) and camping are acceptable. Horses and mountain bikes are allowed, off-road vehicle use (including snow mobiles) is not allowed. Pets must be leashed at all times. Trails should be well maintained to discourage cross-country travel. Leave-no-trace camping ethics will be utilized. Loss or depletion of dead and downed woody habitat components must be prevented. Human use impacts should be evaluated annually to determine future management needs. If necessary, recreation use may be managed by further restrictions(e.g. permit camping only, restrict hiking to trails, campstove use only). Roads currently in the area will be maintained to current levels or reforested as determined in the reforestation plan.

Zone 3

These areas have currently or potentially (within 20 to 60 years) suitable habitat and have widely scattered middens or are not currently occupied by squirrels. These areas have a high short-term potential for habitat recovery.

Zone 3 should be managed to provide suitable red squirrel habitat within 50 years. Silviculture techniques should be used to improve the habitat. These areas are compatible with all types of dispersed recreation. Recreation use and impacts should be evaluated yearly to determine management needs. During silvicultural treatments, access may be temporarily closed. Trails should be maintained at or above current levels. Roads currently closed should be reforested according to schedules developed in the reforestation plan.

Zone 4

These areas have high long-term (perhaps 100 to 200 years) potential. They may need intensive management to attain their full potential as habitat for red squirrels.

Management options for these areas include natural regeneration and intensive silvicultural efforts to provide suitable red squirrel habitat. Recovery is expected to require more than 25 years and may require more than 100 years. Areas are compatible with dispersed recreation. Some developed campgrounds may be compatible, but they will need to be evaluated individually.

Zone 5

These are fragments of areas of occupied red squirrel habitat. These areas should be protected from degradation and evaluated for their value as red squirrel dispersal and recolonization areas. Surrounding areas should be evaluated for potential to provide corridors from the fragmented areas to the main red squirrel population areas. If the areas are judged to provide suitable corridor habitat, then they should be moved to the Zone 2 management schedule. Day and walk-in camping are compatible uses. Recreation use in the areas should be monitored regularly. No habitat should be lost in Zone 5.

Zone 6

These areas are above 8,000 ft elevation and have little or no potential as red squirrel habitat. They include natural meadows, open stream-side habitats, cienegas, cliff areas, and areas dominated by tree species not used by red squirrels (e.g., ponderosa pine). Management of these areas will focus on uses other than red squirrel habitat.

Zone 7

These areas have human caused disturbances and developments (e.g., developed recreation sites). These areas have little current value as red squirrel habitat. These areas do not need to be recovered for red squirrel habitat.

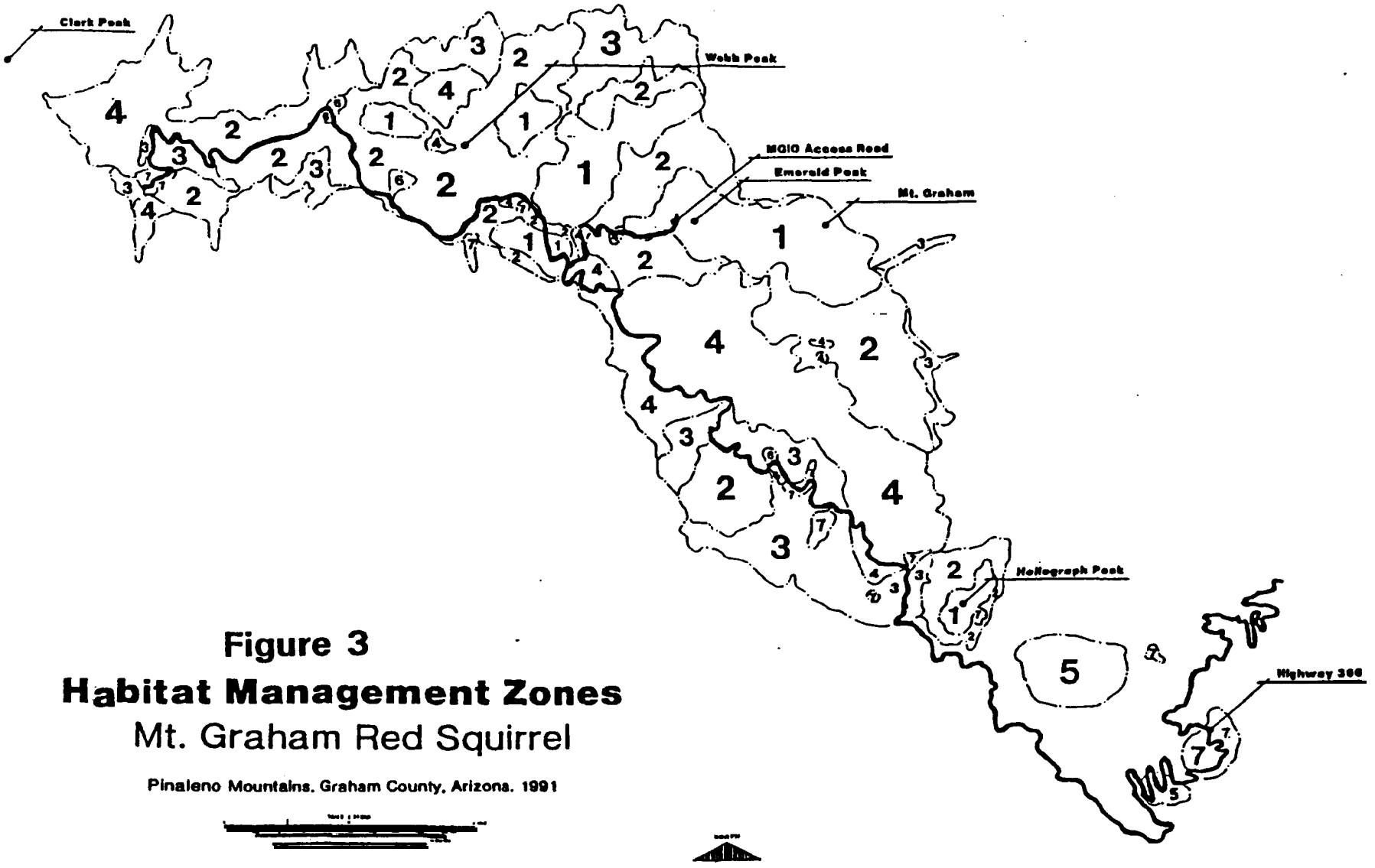


Figure 3

Habitat Management Zones

Mt. Graham Red Squirrel

Pinaleno Mountains, Graham County, Arizona. 1991

APPENDIX B. List of Reviewers - Preliminary Draft

Peter F. Brussard, Department of Biology, University of Montana

Michael Gilpin, Department of Biology, University of California, San Diego

Daniel Goodman, Department of Biology, Montana State University

Bruce G. Marcot, Pacific Northwest Regional Office, U.S. Forest Service

Mark L. Shaffer, The Wilderness Society, Washington, D.C.

Dr. Michael E. Soulé, Santa Cruz, California

Appendix C

Public Review

The draft recovery plan was advertised in the Federal Register on July 17, 1992. A 60-day comment period was provided. Review copies were sent to Recovery Team members and consultants, affected agencies, institutions and individuals. Review copies were provided to other parties upon request. An asterisk (*) indicates those parties which submitted comments on the draft plan.

Copies Sent To

Arizona Congressional delegation members
- Senator Dennis DeConcini
- Senator John McCain
- Representative Jim Kolbe, District 5

Federal agencies
- Michael J. Spear, Regional Director, Fish and Wildlife Service, Albuquerque, New Mexico
- * Larry Henson, Regional Forester, USDA Forest Service, Albuquerque, New Mexico
- James Abbott, Forest Supervisor, Coronado National Forest, Tucson, Arizona
- Rich Kvale, District Ranger, Safford Ranger District, Coronado National Forest, Safford, Arizona

State agencies
- * Duane Shroufe, Director, Arizona Game and Fish Department, Phoenix, Arizona
- * Dr. Michael Cusanovich, Vice President for Research, University of Arizona, Tucson, Arizona

Recovery Team members and consultants
- Randall Smith, Team Leader, USDA, Forest Service, Coronado National Forest, Tucson, Arizona
- Terry B. Johnson, Arizona Game and Fish Department, Phoenix, Arizona
- Lesley Fitzpatrick, Fish and Wildlife Service, Arizona Field Office, Phoenix, Arizona
- Genice Froehlich, USDA, Forest Service, Coronado National Forest, Safford, Arizona
- R. Barry Spicer, Arizona Game and Fish Department, Phoenix, Arizona
- Dr. Norm Smith, Cooperative Fish and Wildlife Research Unit, University of Arizona, Tucson, Arizona
- Dr. Russell Davis, Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, Arizona
- * Dr. Christopher Smith, Division of Biology, Kansas State University, Manhattan, Kansas
- Curt Halvorson, Fish and Wildlife Service, Ft. Collins, Colorado

Interested parties
- * Charles Babbitt, President, Maricopa Audubon Society, Phoenix, Arizona
- Dr. Robin Silver, Phoenix, Arizona
- * Dr. Rolf Koford, Northern Prairie Wildlife Research Center, Fish and Wildlife Service, Jamestown, North Dakota
- * Dr. Paul Young, Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, Arizona

Cooies Requested By

- Howard Merrill, Green Valley, Arizona
- Dr. H. Paul Friesema, Center for Urban Affairs and Policy Research, Northwestern University, Evanston, Illinois
- Patrick Conner, Fish and Wildlife Service, Austin, 'Texas
- * Dr. Roger Angel, Stewart Observatory, Tucson, Arizona
- Mike Seidman, Phoenix, Arizona

Margie Douglas, Phoenix, Arizona
Rosemary Maddock, Tucson, Arizona
Jodi Barnhill, Springfield, Illinois
Phyllis Conner, Phoenix, Arizona
Carol Jones, SEC Donahue, Greenville , South Carolina
Doris Parker, Vinson & Elkins, Austin, Texas
Chris Driscoll, State Press, Arizona State University, Tempe, Arizona
Joe Marshall, Smithsonian, Washington, D.C.
Dr. Carol L. Rowe, Tucson, Arizona
Susie Brandis, Grand Canyon Chapter, Sierra Club, Tucson, Arizona
Dr. Margie McGonagill, Office of Federal Relations, University of Arizona, Tucson, Arizona
Ted Fickes, The Wilderness Society, Washington, D.C.
Frances Werner, Tucson, Arizona
* Dr. Ron Schmoller, Safford, Arizona
Robert Ames, Sportsman Gun Club, Scottsdale, Arizona
Harley Krager, Sportsman Gun Club, Scottsdale, Arizona
Dee Jaksich, Graham County Chamber of Commerce, Safford, Arizona
* Al Dorazio, Tucson, Arizona
Jorge Guido, Douglas, Arizona
David Hoy, Phoenix Gazette, Phoenix, Arizona
Steve Yozwiak, Arizona Republic, Phoenix, Arizona
* Jack Fraser, Fountain Hills, Arizona
Donna Knipschild, SEC, Inc., Sedona, Arizona
Dwight Metzger, Tucson, Arizona
* Ben Avery, Phoenix, Arizona
Richard Wilbur, Tucson, Arizona
Alan Lipman, Tucson, Arizona
Carol Williams, Fish and Wildlife Service, Dexter, New Mexico
Tara Meyer, Arizona Wildcat, University of Arizona, Tucson, Arizona
Clem Anthony, Merchant Marine and Fisheries Committee, House of Representatives, Washington, D.C.
John Korolsky, Phelps-Dodge Morenci, Morenci, Arizona
L.L. Hankla, Andrews & Kerthe, Washington, D.C.
Lori Ruitt, NFPA, Washington, D.C.
Kerry Pasquarelli, Project Learning Tree, Washington, D.C.
* Jonathon Lunine, Tucson, Arizona
John Daugherty, Tucson Newspapers, Tucson, Arizona
D.J. Schubert, The Fund for Animals, Silver Spring, Maryland
Beth Haviland, The Humane Society of the United States, Washington, D.C.
Jerome Pratt, Sierra Vista, Arizona
Lisa Jones, Tucson, Arizona
G. Donald Kucera, Tucson, Arizona
Jim Ericson, Arizona Daily Star, Tucson, Arizona
Anita Allen, CH2M Hill, Reston, Virginia
* Dr. Peter Warshall, Tucson, Arizona
Alan Parolini, FB&D Technologies, Houston, Texas
Fred C. Schmidt, Documents Department, Colorado State University, Ft. Collins, Colorado
Richard Tobin, Springfield, Virginia
Thomas Eugene Terry, Birmingham, Alabama

Comments Also Received From

* C.D. Cochran, Graham County Chapter of People for the West, Safford, Arizona
* Darryl Weech, Safford Arizona
* I.H. Barnett, Tucson, Arizona
* Dr. Neville Woolf, Tucson, Arizona
* Alan B. Weech, Safford Rotary Club, Safford, Arizona
* Delbert Householder, Graham County Board of Supervisors, Safford, Arizona
* Michelle H. Brown, Tucson, Arizona

Appendix D

COMMENTS RECEIVED

A total of 21 letters of comment were received on the Mt. Graham red squirrel recovery plan. All personal letters of comment are reproduced in this Appendix. All comments were thoroughly reviewed and considered. Responses to comments were dealt with in two ways: (1) editorial comments, corrections of factual errors were incorporated directly into the text of the plan; or (2) comments concerning plan content were addressed in specific responses, although similar comments were grouped together and answered as one. Specific Fish and Wildlife Service (USFWS) responses are in the section of the Appendix following the reproduced letters of comment. **Numbers** in the margins of the letters refer to the appropriate response or responses for that comment. Comment letters are arranged in the order they were received by the USFWS.

August 5 '92

To Whom it May Concern,

I am appalled, to think that with the economy as bad as it is, with unemployment at an all time high, that a suggested 1.8 million dollars has been deemed suitable to save about 400 Red Squirrels.

Albeit over a 10 year period. But still for 400 Red Squirrels?

Are the animals so much more important than

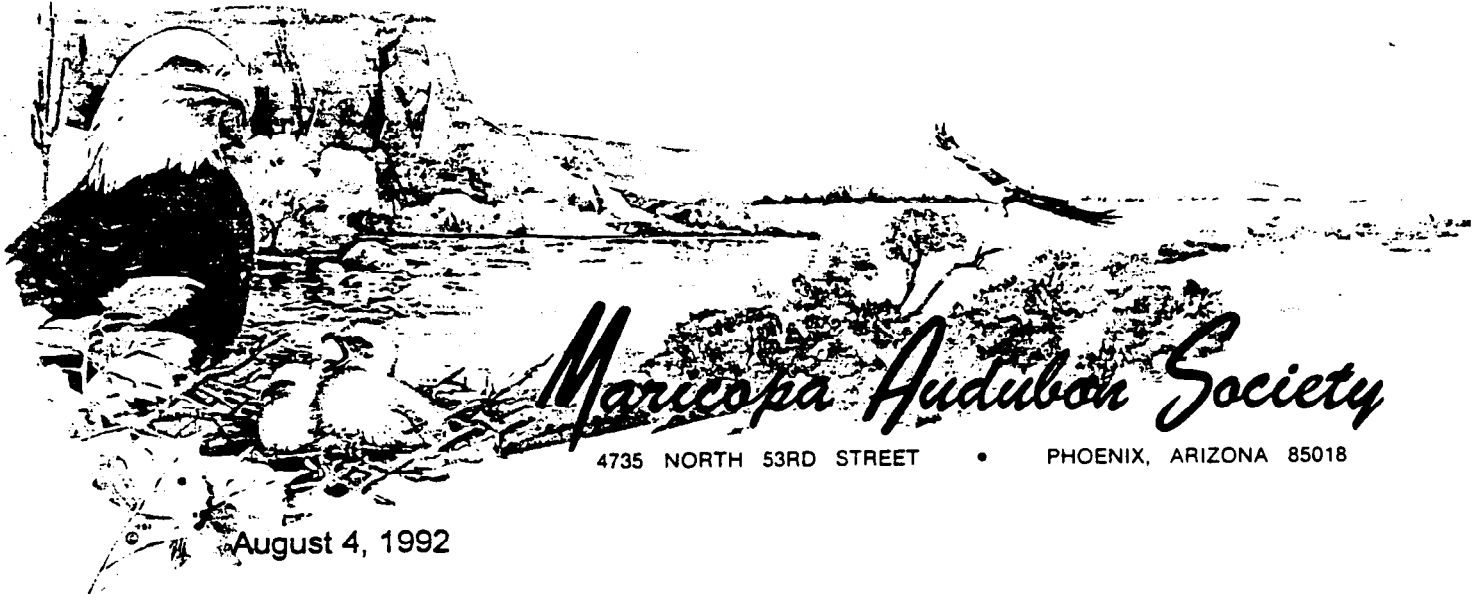
those Human Beings in our State who need food, shelter, jobs and better schools?

What has happened to our values and priorities?

Yes, I do like animals but I love my fellow man far more.

Sincerely

Mrs. D.H. Barnett



Maricopa Audubon Society

4735 NORTH 53RD STREET • PHOENIX, ARIZONA 85018

August 4, 1992

Sam Spiller, Field Supervisor
U.S. Fish and Wildlife Service
3616 W. Thomas, Suite 6
Phoenix, AZ 85019

Dear Mr. Spiller:

We have received a copy of the draft recovery plan for the Mt. Graham red squirrel. We are happy that you have included such renowned scientists as Peter Brussard and Micahael Soule on your review committee. They have opposed the construction of telescopes and further habitat destruction on Mt. Graham. They lend some credibility to the U.S. Fish and Wildlife procedural process. But, we are quite surprised that the committeee appears to contain no scientists familiar with the Mt. Graham biodiversity or the squirrel.

In particular, you appear to have deliberately cut out many of the best informed biologists. This includes Dr. Peter Warshall from the University of Arizona who has been the most constructive critic of the USFS, UA and USFWS biology concerning the squirrel; Drs. Duncan Patten and Julie Stromberg (Center for Environmental Studies, ASU) who made the major pre-project survey of the forest now being destroyed by the astronomical project; C.H. Halvorson of the USFWS who is considered the world's field expert on monitoring red squirrel biology; and Dr. Rolf Koford of USFWS who was selected by USFWS to be the major biologist in reviewing the flawed, improper and fraudulent Biological Opinion that was tampered with by your former regional director, Michael Spear.

3

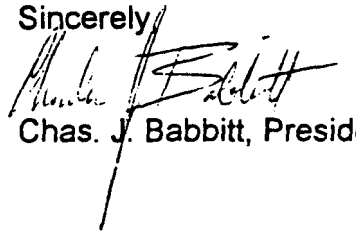
Your comment that it will be at least 100 years to restore the red squirrel is contradictec by recent studies on the mountain by University of Arizona scientists. The Mannan anc Smith studies of Sept. 1991 outline regeneration of reforested habitat as "at least 230 years and may be as great as 290 years." The transition zone ecosystem at lower habitat where the logging has historically occurred is "a projected regeneration time of up to 260 years" or some 30 years longer. It requires a longer time because of the warmer, dryer habitat at the lower transition zone.

4

AUG 7 1992

From our point of view, it looks as if you want a pro-forma recovery plan that will squeeze by legal challenges and not a recovery plan that will actually have some power and help the squirrel's recovery. We request you consider the suggested personnel addition of the above to your review panel.

Sincerely,



Chas. J. Babbitt, President

KSU
KANSAS STATE UNIVERSITY

Division of Biology

Ackert Hall
Manhattan, Kansas 66506-4901
913-532-6615

August 7, 1992

Mr. Sam F. Spiller, Field Supervisor
U.S. Dept. Interior, Fish and Wildlife Service
Ecological Services
3616 W. Thomas, Suite 6
Phoenix, AZ 85019

Dear Mr. Spiller:

I read with much interest the Draft Recovery Plan for the Mount Graham Red Squirrel that you sent me. The introductory section on the squirrel biology was accurate and conservation measures and strategy for stabilization seemed quite reasonable. The situation with the Mount Graham Red Squirrel is unique in many ways: 1) The subspecies has been isolated at a low population level (probably 1000 to 3000) for 10,000 years so that it has had time to evolve to its isolated and endangered situation at a population size not too different from its present endangered size of (150 to 400); 2) Individual squirrels live on easily defined middens in the center of defended territories so that populations are relatively easy to census and study; 3) The University of Arizona's interest in putting telescopes in the heart of squirrel habitat has led to a large budget for studying the status of the squirrel. These three factors make the Mount Graham Red Squirrel population an ideal case study for long-term maintenance of endangered populations. Some scientists should be hired to coordinate and write up the whole study from the broad and general perspective of how to manage an endangered species. That should include prime responsibility for the research on the squirrel in section 21 on page 38. This should be someone more established and with more clout than Paul Young. I do not understand the interagency responsibilities well enough to know how such a person would be given his/her authority, but there is a unique opportunity to do a fundamental case study on an endangered species and it would be a shame to miss the opportunity.

5

Sincerely yours,

Christopher C. Smith

Christopher C. Smith
Professor

CCS:dc

AUG 1 0 1992

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Northern Prairie Wildlife Research Center
Route 1. Box 96C
Jamestown. North Dakota 58401

7 August 1992

Memorandum

To: Field Supervisor, Ecological Services, Phoenix, Arizona

From: Wildlife Biologist, Northern Prairie Wildlife Research Center

Subject: Comments on Draft Recovery Plan for the Mount Graham Red Squirrel

My editorial suggestions are on a copy (attached) of the subject document. The general focus of the draft plan is well-placed, emphasizing habitat protection and restoration while pointing out the critical needs for research and monitoring. The biological background, in particular, is organized and presented well. Some aspects of the document, however, could be stronger.

A major objective is to "stabilize" the population. I had two reactions. First, in some places the plan treats this objective as separate from the objective of increasing the population (e.g., "to increase and stabilize" [p. iii]) and in other places the plan seems to subsume increasing under stabilization (e.g., one "stabilization objective" is to allow the population to increase [p. 37]). I got the impression that the objective of increasing the population was added at some time in the development of the document; the Table of Contents left it out of the heading for the section that begins on p. 25. Some additional thought might be
6 given to these two objectives and how they relate.

Second, stabilization implies reduction in the amplitude of population fluctuations. Because wide fluctuations are inherent in red squirrel population dynamics, this objective (never having the population fluctuate below 300) may not be achievable, even with an increased population. The increased population far in the future may be only 35-40% above current levels, judging by the estimated increase in carrying capacity (p. 36). With populations at this somewhat higher level, I would think regular dips below 300 should be expected. If the population can be increased by this much, is a separate stabilization objective needed?

The relevance of the habitat capability modeling of the "carrying capacity" was not stated clearly. The concept of a carrying capacity is usually associated with populations regulated by density-dependent factors. I know of no evidence that the Mt.
1 Graham red squirrel is usually regulated by such factors. The goal of presenting the current estimated carrying capacity (650 in 1991)

may have been to provide a basis for comparison with future estimates (e.g., 900 in 2191), allowing an inference about how much the average population size might be expected to increase in the future under optimal conditions. If so, perhaps that should be stated.

1

The speculation that the population "may be homozygous" (p. 33) adds little and could be interpreted to mean that future population declines probably do not pose a genetic risk due to inbreeding depression. With today's genetical techniques, researchers may be able to use tissue samples from living individuals (and perhaps museum study skins) to determine the level of heterozygosity levels now and in the recent past, eliminating the need for speculation. I recommend deleting this speculation.

The definition of effective population size (the number of breeding individuals) is simplistic and incomplete. A more complete definition and some suggestion of why the ratio of N_e to N is only 0.5 would help the reader interpret the meaning of this estimate. Effective population size has a specific meaning in population genetics, referring to an equivalent "ideal" population size that would lose genetic variation through genetic drift at the same rate as the natural population. If the population is homozygous (lacks genetic variation), one could argue that it does not matter what the ratio is. The presentation on p. 33 and the statement that N_e "may become dangerously low" (p. 36) imply that N_e changes with N. As used in population genetics, however, N_e is a summary measure that takes into account population fluctuations. I recommend using the expression correctly and revising the text as required.

An important habitat that should be protected and restored is dispersal habitat. This is barely recognized in the current document. Explicit mention of dispersal corridors is found only in Appendix B (pp. 56, 57). The Mt. Graham red squirrel has a meta-population structure, with isolated subpopulations (e.g., Grant Hill, Heliograph Peak) subject to local extinctions. The relevance of this population structure as it affects population vulnerability and the importance of suitable dispersal habitat could be discussed.

7

Recent experience indicates that we can expect to face again a population decline that will lead to supplemental feeding. This document calls for a small expenditure to develop guidelines and procedures for such feeding. Ideally, research (and a larger expenditure) should precede development of these guidelines. This research should determine the effect of such feeding on aggressive interactions with tassel-eared squirrels, chipmunks, and other seed consumers and on red squirrel mortality. A properly designed experiment, with adequate replication, would provide a sound basis for management decisions. The experiment could be conducted on squirrels in the White Mountains, thus avoiding unnecessary risks to Mt. Graham red squirrels. Personally, I would place this need above the development of captive breeding techniques in the budgetary process.

8

Finally, I note that 1-3 years of research on population dynamics and life history will likely be insufficient to provide all the data needed for a good population viability analysis. Additional research on levels of genetic variation would also be very helpful. Recognizing that budgets are limited, I will stop there. 9

Please contact me if you want me to elaborate on any of these comments or if I can be of further assistance.

Ralf R. Kobak

Attachment

GRAHAM COUNTY BOARD OF SUPERVISORS
GRAHAM COUNTY COURTHOUSE - 800 MAIN STREET - PHONE 428-3250
SAFFORD, ARIZONA 85546

SUPERVISORS
DELBERT HOUSEHOLDER. CHAIRMAN
REX BARNEY, MEMBER
HAYNES MOORE. MEMBER

JOE CARTER, COUNTYMANAGER
BARBARA FELIX. CLERK

August 13, 1992

Sam F. Spiller
Field Supervisor
U.S. Fish & Wildlife Service
3616 W. Thomas, Suite #6
Phoenix,Arizona 85019

RE: Mt. Graham Red Squirrel Draft Recovery Plan

Dear Mr. Spiller:

Thank you for the opportunity to comment on the Draft Recovery Plan for the Mt. Graham Red Squirrel. Graham County has reviewed the document and forwards for your consideration the following comments.

RE: Page iii -In reviewing the Executive Summary, it appears that the cost factors associated with the Ten Year Recovery Plan are in excess of $1.8 million dollars. As public officials who have a fiduciary responsibility for the most efficient use of public funds, we would hope that any plans for such expenditures are well thought-out. In other words, if the expenditure of those funds are for a variety of uses related to stabilization of the habitat area, we hope you would involve specialists not only in forest management, but scientists and others for a thorough evaluation of the expected benefit prior to the expenditure of such large sums. 2

RE: Page 55 - The proposed management plan for the squirrel habitat area, (Appendix B, Zone 1), is consistent with our view on the habitat area since the squirrel was listed. We have always believed that day use for those activities identified on page 55 would not negatively impact the squirrel's survival. We hope that such use of the area will be a component of the final document. 10

Again, thank you for the opportunity to comment on the proposed plan.

Respectfully,

GRAHAM COUNTY BOARD OF SUPERVISORS

Delbert Householder

Delbert Householder, Chairman

Rex O. Barney

Rex O. Barney

Haynes Moore

Haynes Moore

AUG 20 1992

AUG 19 1992

Phoenix, Az.
Aug. 20, 1992

U.S. Fish and Wildlife Service
Phoenix, Az.

I am sending my comments on the Mount Graham Red Squirrel Recovery Plan to this office and I wish to make this protest:

This so-called recovery plan has not been prepared through any public input and very few citizens will be able to comment on it outside of the radical environmentalists. 1

In my opinion this plan will terribly undermine the confidence of the public in wildlife management and in the long run harm the credibility of the profession of wildlife management.

Sincerely,

Ben Avery

I am retired and have no title but for many years I edited the outdoor pages of the Arizona Republic and worked for many years to build up scientific wildlife management in Arizona and the U.S. Ben

From: Ben Avery
3128 W. Willow Ave.
Phoenix, Az. 85029

Comments on Mount Graham Red Squirrel Draft Recovery Plan:

Having read and reread portions of the Mount Graham Red Squirrel Recovery Plan, I would like to comment on that proposed plan from the standpoint of my 83 years residence in Arizona and a lifetime, starting as a youngster, in hunting rodents from prairie dogs, rabbits, ground squirrels to tree squirrels in this state.

I cannot believe that a team of biologists would make the recommendations found in this report concerning the "recovery" of a rodent population, particularly a squirrel. Certainly they did not examine from a broad perspective. I hope they did not engage in an exercise just to bolster the political endangerment of the red squirrels on Mount Graham to block development of the University of Arizona astronomy project.

Historically squirrel populations in the Southwest, particularly Arizona, have fluctuated tremendously. I am particularly cognizent of severe low populations of squirrels in the late 1930s-early 1940s, and the 1960s. In this study it is noted that the red squirrel on Mount Graham was so scarce in the 1960s that Dr. H.L. Minckley of Arizona State University was led to conclude that they had become extinct in 1968.

There is probably no doubt the extremely low populations of squirrels and other rodents results to some extent from drouth, but it has been my experience to find very low populations following every population explosion of these creatures.

This would indidate to me that large populations result in die-off from disease. I think some of these diseases are spread by a flea or mite.

There is no doubt that squirrels are affected by predation, but I have never felt that predation was a problem. If anything it may benefit all rodent species by tending to become greater when the rodent populations are high, thereby becoming a leveling factor.

It is not my purpose to tear the recovery plan apart because I recognize much work has gone into it. But from a broad perspective the only recommendation in that plan that will help assure the long term continued existence of the Mount Graham Red Squirrel is the restoration of habitat caused by logging and blowdowns. yet apparently the recovery team allocates only $77 ~~million~~ thousand over a two-year period to this task.

The other actions needed, according to the report, would not be needed at all as far as the red squirrel is concerned.

Let us be honest. 1. Protection and monitoring existing population and habitat. 2. Determining life history and habitat ecology. 4. Integrating species and habitat protection actions for the Pinaleno Mountains will do nothing but provide jobs for the many unemployed biologists that can be expected to grow with time and far exceed the nearly $2 million listed in the report.

Such wasted money could better be allocated to species that are really endangered.

Sincerely,
Ben Avery

August 19, 1992

Lesley A. Fitzpatrick, member
Mt. Graham Red Squirrel Recovery Team
U.S. Fish and Wildlife Service
Phoenix, AZ

Dear Ms. Fitzpatrick;

I recently received a copy of the Mount Graham Red Squirrel Draft Recovery Plan from your office and would like to include my comments regarding it along with those others acquired as part of the public comment stage of the document. However, my comments have little to do with "improvement" of the draft because I find it to be complete and accurate as well as, informative. But rather, I would like to briefly state what the document tells me, a member of the public, on what needs to be done for the Mt. Graham Red Squirrel in order to insure its existence into the future. Precisely because of the fact that this stage of the recovery process for the red squirrel allows for the public to express its concerns, I am taking advantage of the time to state my support for some of your "first draft" decisions, add my doubts to some others and demonstrate my interest for the survival of the Mt. Graham Red Squirrel.

I am familiar with the Pinaleno Mts. and the squirrel issue having worked there as a Forest Service fire suppression technician for three years and as the University of Arizona intern assigned to Barry Spicer during his 1985 summer status survey of the Mt. Graham Red Squirrel. I also have a bachelor's degree in Wildlife Biology and am currently seeking a master's degree in Renewable Natural Resources, both from the University of Arizona. Simply, I would like to commend the recovery team as well as, support their decisions regarding their plans to continue managing essential habitat, continue monitoring the squirrel's and associated habitat's condition into the future (including population dynamics, midden characteristics and cone crops), creating an emergency plan for habitat catastrophes and designing a public education program. I would especially like to give my support for the reforestation plan to take place within designated critical habitat and throughout potential habitat. Without habitat restoration, improvement and espansion, I believe the food source for a healthy population of red squirrels may never become available naturally and in regards to the future, the red squirrel population itself may reach a genetic bottleneck.

I do have some apprehensions, however, over a specific stated plan - that of allowing day use (ie. hiking, hunting, bird -watching, fishing, picnicking) within Zone 1 and Zone 2. From a biological standpoint, I believe that the added disturbance of recreation could prove detrimental to the squirrel's health and daily activity requirements. Furthermore, the Mt. Graham issue

has been so highly publicized that I am positive that, once these zones are opened, the public will immediately begin to seek out red squirrels and their middens. From experience, the squirrels are very territorial and will attempt to defend their middens from even the largest creatures (ie. humans). This added, needless stress will only use up valuable energy that should be used in foraging, food storage, reproduction, nest preparation and territorial defense against the tassel-eared squirrel. There is also the potential problem of recreators directly disturbing middens in such a way that cones are displaced and become
15 unavailable for the squirrels when winter sets in. I urge you to reconsider this plan and continue restricting recreation to zero within these zones, at least until the squirrel has the chance to begin expanding its range. Even though it was mentioned that day use will be "managed through restrictions", there is still no effective control over all who would visit these areas.

My other concern is with the telescope facility. Throughout the document, it was made quite evident that habitat loss has, is and will be one of the main factors of the squirrel's decline. And, even though I understand the telescope facility has gotten the OK to move forward from the U.S. government, I cannot let the point go by that this type of habitat destruction, although declared of scientific value, is still habitat destruction and will prove just as harmful to the continued existence of the red
16 squirrel as any small scale clear cut operation. This is especially true now when the red squirrel is still considered "in danger" and is still relaying on a fairly small area for its necessities AND because the telescope facility is to be built exactly within this critical habitat. Therefore., I would like to reinstate my objection to the telescope facility to be located on the top of Mt. Graham as I have always done in the past and am now even more convinced of after reading the Mt. Graham Red Squirrel Draft Recovery Plan.

Thank you very much for the opportunity to remain involved in the red squirrel issue and, after reading the Draft Recovery Plan, becoming more informed of its progress and your future plans for its continued existence. If you have any questions or comments regarding this letter, please feel free to contact me. I genuinely wish the recovery team luck.

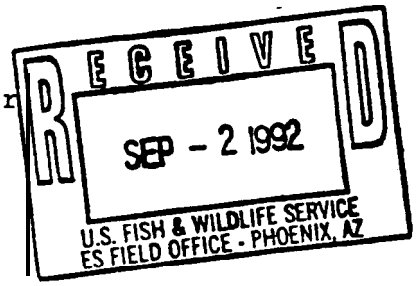
Sincerely,

Michelle H. Brown

Michelle H. Brown
4741 N. Palisade Dr.
Tucson, AZ 05749
(602)749-1905

R. R. Schmoller
Rt 2 Desert Hills #16
Safford, AZ 85546
(602) 428-5885

Editor,
Eastern Arizona Courier
Safford, AZ 85546



August 24, 1992

Dear Editor,

The proposed U.S. Fish & Wildlife Service's Draft Recovery Plan for the Mount Graham Red Squirrel has one main fault which is easily correctable. High Peak Road (FS 507) should be re-opened rather than kept closed as U.S. Fish & Wildlife suggests. The public (local and recreational tourists) should have access to the unique environment on top of Mt. Graham.

The Draft Recovery Plan calls for "Reforestation of [the recently1 closed roads..." though no real arguments are presented as to why. The High Peak Road is so narrow that only minimal. 18 microclimatic edge-effect damage has occurred. It would take over 100 years for the roadway to be reforested, by which time the tiny gain would be insignificant and irrelevant.

In addition, most of the road is not in an area of prime squirrel habitat. Seventy-five to eighty percent of FS 507 is rated in the proposal as either squirrel zone 4 where even "Some developed campgrounds may be compatible..." or zone 2 where "Roads currently in the areas will be maintained...". Only the 19 last mile or so of the road, near the summit, is in zone 1 where "Day use.. .and walk-in camping use are compatible,", but camping and trail-resticted hiking could be imposed.

The Mount Graham Red Squirrel, according to the proposal, has been confirmed to be quite unique, perhaps the most different subspecies of all 25 subspecies of red squirrels in North America. It may even be a distinct, as yet unnamed, species (see page 3). "Our" squirrel has been isolated on Mount Graham-- away from other red squirrels-- for at least 11,000 years. The Mount Graham Red Squirrel is co-evolved or co-created with Mt. Graham's unique mountain top ecosystems, and ". . .helps ensure survival of the ecosystem."

The squirrel is still in real danger of extinction. Past lumbering, and current observatory construction threaten its survival. While, "The chances of long-term persistence. . .are moderate to low." the squirrel's situation ". . . . is not hopeless or irreversible."

One of the best ways to give hope to the survival of our unique Mount Graham Red Squirrel is by local and mountain-visitor support and enthusiasm. The public deserves to see our outstanding mountain top but not everyone can hike uphill for several miles at high altitude. We should remove the roadblock to public access to the top of Mt. Graham so we can all better 20 appreciate, be proud of, and thereby help protect our planet-wide "famous" squirrel. At the same time we should all learn to

food storage areas, vital to their overwintering and long term survival. We should avoid trampling or digging into these cone-storage sites.

21 We don't close down Main Street because someone might break a window, do we? Without unobstructed public access to the top of Mt. Graham (via High Peak Road) some of the public is more apt to resent, unfairly, the innocent squirrels, rather than love and appreciate Mt. Graham and all her creatures.

Sincerely,

R. R. Schmoller, Ph.D.
formerly a principal high-altitude
scientist with the U.S. International
Biological Program

cc: KATO
Graham County Chamber of Commerce
Graham County Board of Supervisors
Sal-ford City Council
San Carlos Apache Tribal Council
Huachuca Audubon Society
Tucson Audubon Society
Grand Canyon Chapter, Sierra Club
Arizona Game & Fish Commission, Non-Game Animals
Coronado National Forest
U.S. Representative Jim Kolbe
U.S. Senator Dennis DeConcinni
U.S. Senator Albert Gore

George

J.C. Fraser
14956 E. Windyhill Rd.
Fountain Hills, Arizona 85268
(602) 837-3026
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RD
DRD
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AFF
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APA
AHR
Flatland
File
Action
CL 8-18-92

August 22, 1992

Lynn Starnes
Acting Regional Director
U.S. Fish and Wildlife Service
P.O. Box 1306
Albuquerque, N.M. 87103

Dear Ms. Starnes:

Attached is a copy of my comments to the Phoenix Office of Ecological Services on their undated draft Recovery Plan for the Mt. Graham red squirrel. You will note that I have asked that all review comments be made a part of the draft to be submitted to your Regional Office and that I be provided with a copy of that draft.

Importantly, I ask your office to issue a pre-adoption draft for public review before final decision on the Recovery Plan. That pre-adoption draft should reflect any changes proposed by the Regional Office and include all comments received by the Regional Office additional to those received by the Phoenix Office. I request that your office provide me with a copy of such a pre-adoption draft for my review and comment. This process should be accomplished expeditiously. It is unfortunate that it has taken so many years to produce this draft but a few more days to improve its acceptability is more than justified.

Through this process public understanding and confidence in the adoption procedures will be improved. I will be grateful for your implementation of these procedures.

Sincerely,

Jack C. Fraser

cc: Arizona Game and Fish Department
USFWS, Phoenix
Maricopa Audubon Society
Sierra Club
Arizona Wildlife Federation

AUG 26 '92

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ES FIELD OFFICE-ALBUQ., NM

Rec'd
FWS - Region 2
AUG 26 '92
DRD

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August 22, 1992

Sam Spillar, Field Supervisor
U. S. Fish and Wildlife Service
3616 West Thomas Road Suite 6
Phoenix, Arizona 85019

Dear Mr. Spillar:

The purpose of this letter is to convey my review comments on the Service's undated Draft Recovery Plan for the Mount Graham Red Squirrel. It is my understanding that public comments will be received by your office until September 15, 1992.

First, I would like to request that all review comments received by your office, including mine, be made a part of the draft report to be sent to your Regional Office in Albuquerque for approval.

Secondly, I ask that I be provided with a copy of the report as it is sent to the Regional Office, including all comments received and any comments of your office on the comments received on the draft. The inclusion of comments received should include any received from the six reviewers listed on page 53 of the draft Recovery Plan.

Thirdly, in submitting your office's draft to the Regional Office in Albuquerque please relay the request that before adopting the
22 Recovery Plan the Regional Director issue a draft of his or her proposed adoption version for public review. The proposed adoption draft would reflect the Regional Director's proposed changes in the draft submitted from your office and include all comments that may have been received additional to those received by your Phoenix Office. This process should be done expeditiously so as not to unduly prolong the adoption action. It has taken too many years to reach this stage but a few more days to insure adequate public review and acceptance is important.

Your special attention to these requests will be appreciated and if, for any reason, you cannot satisfy them I would be grateful for your notification and the reasons therefore.

My comments specific to the undated draft Recovery Plan follow:

1. Recreation Uses: The allowed recreation uses in Zones 1 and 2 constitute a significant relaxation regarding potential disturbance factors for the red squirrel. I see no problem with day use for hiking, bird watching, etc. at present levels of recreation use but if recreation use increases in the next few years in Zones 1 and 2, hunting, overnight camping, fishing and presence of pets (even with a leash requirement) could conceivably result in undesirable
15 disturbance before red squirrel population recovery reaches stabilized conditions.

Recommendation: Provide for a specific review of allowed recreation uses in Zones 1 and 2 at the end of the first three years of implementing the Recovery Plan.

2. Overly Optimistic Habitat and Population Projections: Perhaps the most important weakness of the report is its overly optimistic projections of red squirrel habitat restoration and population recovery. Currently the prime habitat for the Mt. Graham red squirrel is limited and much of its former habitat (upon which recovery through restoration depends) has been seriously impaired by fires, logging, developments, etc. Old-growth, large tree, closed canopy spruce and fir forests with considerable dead and downed trees at elevations above 8,000 ft. are habitat requirements. To produce such forests through restoration of impaired habitat areas on Mt. Graham and thereby creating sufficient new habitat to stabilize the red squirrel population at 900 to 1000 in less than 200 to 260 years is unrealistic. Such optimism is unwarranted and cannot be substantiated. To say that the current 1991 habitat capacity is approximately 650 red squirrels is unsubstantiated by actual population estimates in the last ten years. A number of statements in the draft reflect this unwarranted optimism:

a. Page iv: "At least 10 years will be needed to stabilize the Mt. Graham red squirrel population and at least 100 years will be needed to restore Mt. Graham red squirrel habitat."

b. Page 7: "--- the USFS estimated current and future habitat capability for the Pinalenos, and determined a current 1991 capacity of approximately 650 red squirrels (USFS unpub. data)." "Assuming natural succession, with no catastrophic events, the model predicted that in 200 years the carrying capacity would increase to approximately 900 squirrels."

c. Page 31: "Using the most recent habitat and density information derived from surveys, a current carrying capacity of approximately 650 red squirrels may be possible under optimal conditions and applying squirrel density estimates a predicted future maximum carrying capacity of approximately 900 plus squirrels can be maintained in the long term (100-200 years into the future)."

d. Page 32: "Restoration of higher population levels will be possible only when several successive years of good or heavy cone crops occur. Currently, the small amount of habitat available to the red squirrel ensures

that even in times of good food availability, populations will not greatly expand. Unless the habitat is improved, population fluctuations could occur that would result in numbers falling below viable levels." (Note that this statement conflicts with the unwarranted optimism on habitat restoration and population projections elsewhere in the report)

e. Page 36: "The population is isolated. The population is inherently vulnerable to extinction. With aggressive habitat protection and restoration (during the next 100 years) it may be possible to increase the carrying capacity by 35-40% (to approximately 1000 squirrels)." "With a current estimated maximum sustained population of approximately 650 squirrels, chance extinction is a real and potentially imminent threat (M. Schaffer, The Wilderness Society, pers. comm.). The chances of long term persistence of the Mt. Graham red squirrel must be classified as moderate to low. With aggressive habitat protection and restoration, and an improved distribution of red squirrels on the mountain, relative security could be possible." 4

f. Page 56: "Zone 3 should be managed to provide suitable red squirrel habitat within 50 years."

g. Page 57: (In reference to Zone 4) "Management options for these areas include natural regeneration and intensive reforestation efforts to provide suitable red squirrel habitat. Recovery is expected to require more than 25 years and may require more than 100 years." (This implies recovery between 25 and perhaps 125 years which is overly optimistic).

The following statement on Page 33 appears to be an accurate assessment of the current population and habitat situation and hardly substantiates the current habitat capacity estimate of 650 red squirrels: "Because of reduced habitat and subsequently the carrying capacity of the remaining habitat, the population will fluctuate around lower average population. Low points in the cycle may be below population viability."

Prevention of such fluctuations by providing high quality habitat in all vegetation associations as proposed in the last sentence of paragraph 1 on page 33 cannot be fully achieved in the next 50 to 100 years as suggested in other places in this draft. Even if present habitat can be fully protected from further impairment by development and natural catastrophes, the time to produce mature, canopied forests with downed trees will make early stabilization of

the red squirrel population highly questionable within the time frames suggested in this draft.

The following quote from the September, 1991 paper of R. William Mannen and Andrew A. Smith (Identification of Distinguishing Characteristics Around Middens of Mount Graham Red Squirrels) is indicative of the time span needed to regenerate old growth habitat on Mt. Graham:

> "Regenerating potential midden sites will require long periods of time. For instance, the mean age of dominant trees, based on ages from breast height, was 212 years at spruce/fir middens, and it probably took these trees 20 to 30 years to reach breast height (Stromberg and Patten 1989). An additional 50 years might be necessary to produce the largest decayed snags and logs (Harmon et al. 1989). Thus, the total time to naturally regenerate sites suitable for midden establishment is at least 230 years and may be as great as 290 years. In the transition-zone forest, similar calculations lead to a projected regeneration time of up to 260 years."

4 Even if we consider that some degraded areas may have already started on the path of regeneration it cannot account for the optimistic forecasts implied in the report. Early logging (1890 to 1946 was mainly in ponderosa pine. From 1946 to 1963 there was no logging. The last major logging (1963-1972) occurred only 20 to 30 years ago so regeneration is still in its infancy. Many areas on Mt. Graham may take well over 300 years to regenerate to the point of providing good habitat for the red squirrel.

Restoration of Mt. Graham red squirrel habitat is a slow process and it is irresponsible to assume it can be accomplished in a short period of time. This is why it is so very important to preserve every acre of existing habitat if the Mt. Graham red squirrel is to be saved. The viability of the population that may be improved by habitat restoration is, unfortunately, dependent on the habitat now existing, not that which can be hoped for 200 years or more from now. Reliance on unrealistically short restoration times to project overly optimistic population increases is a disservice to the task of protecting an endangered species. The Recovery Plan should clearly face the issue - saving the species is dependent first on preserving every bit of existing habitat and in the long term its recovery to an out-of-danger healthy population will depend on enlarging its existing habitat through restoration and improvement programs that may take 200 or more years to achieve.

Recommendation: The habitat restoration and population recovery times and numbers be revised to reflect at least a 200 year

requirement to produce suitable red squirrel habitat from former but degraded, destroyed, damaged or deforested habitat areas and that an estimate of current habitat carrying capacity reflect a more realistic appraisal based on past population estimates and the current near-extinction level of the population. The Recovery Plan should clearly differentiate between the immediacy of habitat preservation and the long-term achievements of degraded habitat
4 restoration. Its readers and the public should not be misled by repeated optimism based on unrealistic projections of population increases resulting from "silviculture treatments", reforestation, etc. The Recovery Plan should make it clear that realizing the benefits of degraded habitat restoration will only come if existing habitat is preserved to carry the species through the next approximately 200 or more years.

3. **"Mitigating" Future Habitat Losses:** On Page 27, paragraph 2 there appears to be an unintended application of the word "mitigated" to both past and future habitat losses incurred as the result of both natural and development losses. Protecting the small amount of existing habitat is absolutely the most imperative management action if this endangered species is to be saved. Throughout the draft Recovery Plan emphasis is placed on protecting
1 existing habitat. However, this last sentence of paragraph 2 implies that future habitat losses must be "mitigated" which conflicts with the need to "protect" existing habitat. This sentence should be revised.

Recommendation: Revise the last sentence, paragraph 2, Page 27 to read: "Habitat lost or impaired by natural catastrophes or past development must be mitigated and future habitat losses from development prevented."

4. **Recovery Plan Meaningless Unless Implemented:** Unless the USFS implements a Recovery Plan by incorporating it in its Forest Management Plan and follows through on administrative actions and aggressively seeks the necessary appropriations to carry out its provisions the Plan could become an unused, useless document. The Recovery Plan text should recognize this weakness and specifically recommend that the Recovery Plan be implemented by the Forest Service through appropriate revisions and incorporation in the
23 Forest Management Plan. Further, the Recovery Plan text could appropriately suggest that an interagency implementation group (such as was established for the bald eagle) be established to advise the USFS on implementation as a means of carrying out the intent of Section 7 of the Endangered Species Act which requires consultation.

Recommendation: Add a #4 "Implementation" to page 38 with a sub entry 32 reading: "411. Implementation via USFS Forest Management Plan". On Page 47 add an entry #4 "Implementation" with a sub heading: "411. Recommend implementation through revisions in the Forest Management Plan of the USFS to incorporate the provisions of the Recovery Plan. The process could be aided by establishment of
23 an interagency implementation group with representatives of the USFS, USFWS and the Arizona Game and Fish Department."

5. Captive Breedintz - Pase 45, #222: At this stage, with the near extinction status of the Mt. Graham red squirrel, the all-important management action is to preserve existing habitat and maintain the existing population in as natural, undisturbed condition as possible. To remove Mt. Graham red squirrels from the present low population for captive breeding is to place the remaining population in further jeopardy of extinction. If habitat loss is going to be the cause of extinction then captive breeding has little value except possibly to preserve a gene pool for undetermined uses elsewhere. It will not save the Mt. Graham red squirrel on Mt. Graham. Captive breeding could actually detract from the concerted efforts needed to protect existing habitat. It could become a crutch upon which improper reliance is placed to the
24 detriment of habitat protection. Captive breeding should not be considered until it is determined that the habitat cannot be protected and restored to maintain the population. When that decision is made is the time to consider a captive breeding program. The argument that it then may be too late to preserve the gene pool is academic.

Recommendation: Delete Section #222 on Page 45.

'6. Supplemental Feeding - Page 45. #221: Supplemental feeding results in an artificial support of the population carrying with it the dangers of artificial food dependency, and increased disease and predation problems. It can also become a crutch upon which management might rely to the detriment of vigorous habitat protection and restoration. There should be no detraction from the absolute necessity of protecting the remaining habitat and enlarging that habitat through restoration of impaired areas.
8 Supplemental feeding will do nothing for saving and restoring habitat on Mt. Graham. Supplemental feeding has no place in the Recovery Plan for the Mt. Graham red squirrel.

Recommendation: Delete Section #221.

7. Weakness of Text Regarding Habitat Protection Measures: In
25 pages 39-47 there appears to be a high degree of specificity regarding recommended management programs, research and public education compared to habitat protection actions. Since habitat

protection is the most important management action for the survival of the Mt. Graham red squirrel it would improve the Recovery Plan if more emphasis was placed on it in pages 37 and 39 rather than leaving it almost entirely to Appendix B. Habitat protection actions in Appendix B are generally good but their main points should appear in the body of the Plan. If for some reason either
25 the USFWS or USFS should alter the Habitat Management Zone concept of Appendix B some of its important habitat protection actions could be lost.

Recommendation: Strengthen the Recovery Plan management action sections on pages 37 and 39 (particularly the narrative section starting on page 39) with respect to habitat protection by adding the principal habitat protection measures set forth in Appendix B without reference to the Zone concept per se.

8. The Habitat Manasement Zones Map (Figure 3, Paae 59) Is Inadequate: The map on page 59 is extremely difficult to relate red squirrel habitat and geographical features to the proposed zones.

Recommendation: Revise Figure 3 into a larger map of the zones overlaying more detailed geographical features and midden locations or provide two maps, one showing zones overlaying more geographical features and one overlaying midden locations.

9. The Manaaement Zone Descriptions in Appendix B Are Inadequate: It is impossible to determine what habitat types, locations and importance to the Mt. Graham red squirrel are intended by the various zone descriptions. Some descriptions are nice sounding but
26 couched in vague language (e.g. For Zone 4: "These areas have high long-term [perhaps 100 to 200 years] potential" -- "Recovery is expected to require more than 25 years and may require more than 100 years.") This entire Appendix B needs improvement for clarity. The Zone descriptions should be sufficiently clear to stand by themselves without reference to a map (which, in this case is also inadequate) and they should relate to geographical and habitat features important to recovery of the Mt. Graham red squirrel and have clear, distinguishing management actions for recovery.

It is not clear what is meant by: "The management intent is to maintain average suitable habitat conditions for the Mt. Graham red squirrel --" appearing on the first page of Appendix B. If this has some special meaning to the Recovery Plan then it needs amplification. In its present form it has little meaning.

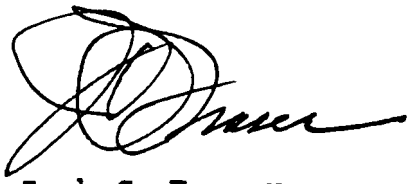
Recommendation: Rewrite Appendix B to improve clarity, particularly the Zone Descriptions which should describe each Zone

in terms of geography, habitat type, importance to the red squirrel and proposed recovery management objectives and actions. (As noted elsewhere, the habitat protection measures should also be spelled out in more detail in the main text on page 39)

In summary, the draft Recovery Plan constitutes, in general, and with the exceptions noted above, a reasonable proposal for management action to save the Mt. Graham red squirrel. Weakening rather than strengthening the habitat protection aspects of this draft through subsequent revision or by inadequate implementation could render the Plan ineffective. Significant improvement of the Plan could be achieved by strengthening its habitat protection thrust and placing less reliance on overly optimistic results from restoration efforts.

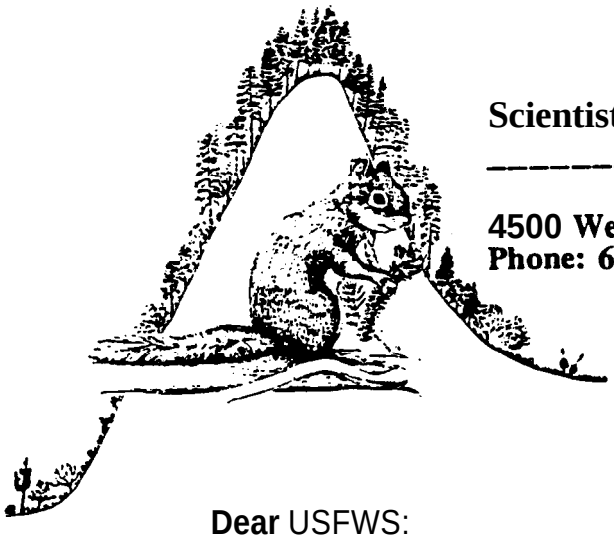
I appreciate the opportunity to provide these comments and I trust they will receive consideration.

Sincerely,



Jack C. Fraser

cc: Regional Director, USFWS, Albuquerque
Maricopa Audubon Society
Arizona Game and Fish Department
Sierra Club
Arizona Wildlife Federation



Scientists for the Preservation of Mt. Graham

4500 West Speedway • Tucson . AZ. 85745
Phone: 602 - 622 - 8988 . Fax: 602 - 624 - 5406

Dear USFWS:

Enclosed is a paper by Dr. Peter **Warshall** that reviews the recovery plan (RP) for the Mt. Graham red squirrel (RS). Because of your deadlines and costs, it is impossible to send this paper to all 350 members of Scientists for the Preservation of Mt. Graham. We cannot claim unanimity of agreement. SPMG has sent copies to your reviewers -- many of whom are members of SPMG or have provided affidavits related to SPMG concerns.

In Part 1, we have reviewed the Recovery Plan (RP) from the point of view of the USFWS "Policy and Guidelines for Planning and Coordinating Recovery of Endangered and Threatened Species." In Part 2, we have reviewed the general gaps in presentation. In Part 3, a detailed page-by-page critique of the RP is given. A summary of major points is provided and crucial points are highlighted in bold face type.

Thank you for an opportunity to review the RP.

Pete Warshall

REVIEW OF THE RECOVERY PLAN FOR THE MT. GRAHAM RED SQUIRREL

AUGUST 24, 1992

PREPARED BY:
PETER WARSHALL, CHAIRMAN
SCIENTISTS FOR THE PRESERVATION OF 'MT. GRAHAM
4500 West Speedway
Tucson, Az 85745
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SUMMARY OF MAJOR COMMENTS

1. Recovery Plan (RP) does not meet policy guidelines of USFWS.

2. There is a serious lack of measurable criteria for declassification (endangered to threatened to delisting) and reclassification (increasing, decreasing, stable). The benchmarks or targets for declassification and reclassification are not as specific as possible as recommended by USFWS. For instance, there are no clear criteria of how to distinguish annual population flux from clear trends in population size. No criteria and methods for determining changes in the probability of extinction are given.

3. The main technique for monitoring appears to be the bi-annual midden inventory. Major issues arise in using this inventory as the sole or predominant indicator for declassification or reclassification. For instance, are new midden sites replacing abandoned midden sites at equal rates? Are alternative census techniques available: to assess midden site stability? to determine the proportion of squirrels using two middens? and to determine the relationship between cone crop production (for each vegatative association) and the proportion of multiple midden use by a single squirrel? Are the density of midden distributions homogenous in each vegetative type? How does lack of homogeneity skew population size assessment?

4. Some relevant background material is missing or its relationship to recovery is not explained (e.g., decadal losses from lightning, windthrow, deadfall, ice storms, and tree disease in forest patches; dispersal distance, corridors, and distance required to find mate; lack of understory food; insect larvae reduction of cone crop; cone sterility; activity areas and density estimates: in-situ vs. in-migration replacement of dead squirrels).

5. The RP lacks a discussion of habitat losses per decade (magnitude, area, predictability, frequency). These setback recovery rates. They should be a priority research task.

6. The RP lacks a clear baseline on the status of habitat quality assessement: map scale; ground-truthing vs. aerials; confidence in acreage surveyed and habitat quality score cards: etc.

7. The RP mixes up results from simulation models with results from fieldwork research without enough explanation of the biological and mathematical assumptions in the simulation models. This is particularly true for the Habitat Capability Model and the "model" implied in the extrapolation of active middens/expected middens to total population size.

8. The recovery tasks are not clearly delineated and justified as recommended by USFWS guidelines. That is, it is not clear how the required research will move recovery torward targetted goals or how they fit into a declassification strategy. The three-tier priority evaluations for recovery tasks need extensive revision.

9. The management actions are not as specific as possible as recommended by USFWS. There are very few site-specific management actions. Suggestions are provided.

10. The available options for land protection are not addressed as recommended bu USFWS guidelines. Example options are suggested.

11. There are no risk management stategies with clear criteria and measurable 'triggers" for emergency actions, damage control, and mitigation.

12. The section on inter-agency cooperation hides a major threat to recovery: lack of agreement between agencies; the veto power of the USFS over recommendations of USFWS and the AGFD; disagreements on Sectios 4, 7 and 9 of the Endangered Species Act: lack of cooperation on the inter-agency district team in assessing "maintenance" tree cutting, dog control and other limitations on dispersed and drive-in recreation.

13. There is an overuse of "boiler-plate" language with such buzz words as stabilize, viable, and recovery.

PART 1: POLICY AND GUIDELINE PROBLEMS WITH THE RECOVERY PLAN

1 1. What is the status of the Mt. Graham red squirrel (RS) in the USFWS 'Species Recovery System?' Please add to RP.

27 2. Was a Recovery Outline prepared sixty days after listing? If so, please send a copy. If not, when was it prepared? Please send copy.

28 3. Have any Species Status Reports or Recovery Expenditures Reports been issued? When? Please send copies. These should be cited in RP.

29 4. Did the Species Status Report list the RS as improving, declining or stable? This should be cited and reasons for assessment provided.

5. Page 2 of the P & G document (Policy and Guidelines) requires that USFWS be "as specific as possible" as to goals, recovery tasks, duration and costs and responsible parties and interests. Page 3 states that the "RP must identify site-specific management actions." Page 4 states that there should be 'measurable criteria" and 'trackable recovery tasks." It goes on to state that research and management actions should be delineated, justified, and given schedules. **These criteria have not been met.**

30 What are the criteria that will allow the RS to be declassified from "endangered-to-threatened" or 'threatened-to-safe?' Please state these in simple language as required by P &G document and page I-11. Will the criteria for declassification to threatened be different than delisting?

Does the USFWS believe that the RS will never be declassified because of natural losses to habitat and the chronic shortage of habitat? If so, please state this explicitly.

Are the criteria for declassification: 95% probability of persistence at a reproductively **effective** population of 300 in the spring census for 100 years? If not, why not? What replaces this criteria?

If this or some similar criteria are the goal, when might they be achieved? State optimistic and pessimistic time-frame.

How will the USFWS measure the components of this goal: what model? what census technique? what confidence interval? Is the POPDYNE model to be used? If not, what model of population dynamics? What data are most important for model selected? Have research priorities included the data most needed for a pop dynamics model of persistence? **There is no RP discussion of** models and **criteria for species status declassification nor bi-annual reclassification nor a discussion of models and their ability to track population status. There are no research tasks to specifically address choice of models to be used in tracking recovery measurements.**

While the census technique appears to be an extrapolation of population size from active middens/expected total middens for each vegetation association, **there appears to be no research task to assess the pros and cons of this mathematical "model." Why?** This should be a priority as many experts in population censusing of RS have doubts about the extrapolation process (e.g., how well does one active midden reflect one living squirrel? What is inter-observer reliability of midden status assessment? When does one squirrel/one midden criteria break down? When is a midden site considered abandoned and removed from the statistical equations estimating population size?).

31

What other census techniques are being considered to help verify the validity of the present measurement technique? The RP does not directly address this dilemma nor set research goals to resolve it. Without resolution, the measurement of real population change is impossible.

Will the USFWS use the "total adult population in the spring census" or the "effective population in the spring census" or some other criteria? Why?

What other "measurable criteria" will be used to assess stable vs. decline vs. increase in the effective population (the annual "reclassification")? Will any of these be used in the declassification process?

How will the USFWS determine a "real" trend in population size that is part of recovery vs. a flux in population size from short-term (decadal) fluctuations in cone crops and other variables? If the trend

must be decadal, is there funding available to track this change in population size?

What measurement will be used? Running average of active middens? Harmonic mean? Arithmetic mean? Other?

What confidence limits and variance will be used for each criteria employed in the Species Status Report effort?

Which bio-statisticians were consulted to establish these criteria?

What measurements will be used to track increases or decreases in "carrying capacity units(ccus)" for the RS? Are you tracking ccus by the changes in population and the population by assumed changes in ccus? Have you attempted to separate these out?

What mapped area will be re-surveyed for changes in quality of habitat? What sort of random sampling of vegetative associations
31 will be used to track recovery? What schedule is set for this tracking? Which individuals in which agencies are the responsible parties for tracking changes in habitat quality? What is the cost? As noted, the 'RP must identify site-specific management actions."

Will the USFS "habitat scorecard" be used to assess habitat quality? Please send a copy. Will it be revised? If so, by whom and when? **There is no discussion in RP of this crucial measurement task.**

Is USFWS relying on the Habitat Capability Model to track ccus? If so, there should be a research task to verify its validity and drawbacks. It requires two steps with "expert opinion" and only two variables out of the six-to-eight of crucial importance to RS survival. It requires some major assumptions about successional stages when used in a predictive manner. The USDA (1988) lists many of its drawbacks. **If not the HCM, what other measurement of ccus** is under consideration? What other models?

Are the results of any habitat quality model to be used in the declassification process? Which?

Who is in charge of determining changes in quality of habitat for USFWS? What projects have been funded to address "measurable criteria" and "trackable recovery tasks" for habitat quality change on the mountains?

Density measurement type should always be defined. Very confusing use of terms (e.g., p5¶3 uses crude density by cluster analysis; p12¶1 is unclear; p20). Will density measurements be used in
31 Species Status Reports? Will they be used to determine population flux vs. longer-term changes? Will they be used to trigger emergency feeding? Will they be used to determine midden densities by vegetative association and, indirectly, population size? Are crude densities the best density measurement for all these purposes (see Warshall, 1991)?

What criteria trigger each of the emergency measures: supplemental feeding, captive breeding, relocation? Has USFWS considered criteria based on cone crops? and consecutive years of cone crop failures?

6. P &G guidelines (page 4) request a 'cost of complete recovery."
32 Where is this? Is this possible? Please address this explicitly.

7. Page 2 (P & G) states: "Coordination...is the most essential ingredient." The RP lacks any real discussion of coordination as it relates to Section 4, Section 7, and Section 9 of the ESA. It pretends all is going well. Yet, there are major conflicts between agencies, especially on the Section 7 issue. **Conflicts between agencies have prevented implementation of recovery plans with other endangered species (e.g., black-footed ferret). The RP should not hide these conflicts or they will never be resolved. In fact, an important funding project may be a**
33 **"conflict resolution" seminar.**

Please state the position of USFWS, USFS, and AGFD on the following potential sources of conflict:

a. Re-initiation of consultation under Section 7 on the basis of "new information that reveals the astrophysical or other project may affect the RS in a manner or extent not previously considered."

b. Re-initiation of consultation under Section 7 on the basis of 'modifications of the astrophysical or other USFS actions that cause an effect not considered in the biological opinion.'

c. Re-initiation of consultation under Section 7 on the basis of 'an affect to critical habitat designated since the biological opinion." **For** example, **there is no habitat and environmental assessment of the 14 summer cabins and Church of Christ Bible Camp and road removal as required by Section 605 (b) of AICA. This should be a task of the RP.**

d. Criteria for tracking and measuring "incidental take" as suggested in the biological opinion. **The incidental tack as presently defined is not trackable nor measurable. Better criteria for incidental take are available.**

33

e. The importance of dispersal habitat not covered in the biological opinion. The USFWS blue-ribbon team (USFWS, 1990) has pointed to this omission. **There is no research project and no site-specific discussion of dispersal areas in the RP. Why?**

f. The critical habitat designation is based on out-of-date information (see Warshall letter to USFWS, 1987 and USFWS, 1990). There is a conflict between agencies about altering critical habitat boundaries. USFS "essential habitat" needs to be reconciled with **USFWS** critical habitat.

Conflicts between desired goals of AGFD and USFWS and the enforcement or implementation acceptable to USFS is perhaps the major issue. **Since USFS .has the ability to veto USFWS and AGFD recommendations (and has), this veto power is perhaps the major driving force abetting extinction and preventing recovery. These differences should be defined carefully and listed under "Inter-agency cooperation."** Other issues will be listed in Parts 2 and 3.

8. P & G (page l-14) states that the RP consider "available options for land protection.' It also calls for a "set of strategies" and some "preliminary targets." I could find no section of the RP that addressed options, especially for Zones 1 and **2. Where are the strategies (e.g., no habitat destruction in Zone 1 and conflicts preventing implementation) listed?**

34

Please include options such as "elimination of the Columbus Project" in Zone 1; elimination of any further habitat destruction in Zone 1 and 2 (e.g., additional telescopes); a District Interagency requirement that any tree cutting (including single trees) in zones 1 and 2 receive prior approval of all agencies involved; the narrowing of the road to Heliograph Peak by reforestation; the elimination of any further development of Heliograph and re-arrangement of
34 structures to increase reforestation potential: the reforestation of Columbine; the inter-agency review of any indirect activity that could hurt recovery rates (e.g., snow plowing and seedling burial; culvert installation with possible downstream erosion or interference with midden placement); the management of cienagas for wetlands vs. forest; the fencing of RS habitat at Riggs Lake from access to dogs and humans, etc. As noted, the 'RP must identify site-specific management actions." For each action, the responsible parties and time-frames should be stated.

35 9. The discussion of Priority Ratings can be found in Part 3. They do not follow P & G definitions.

10. While the RP does not require a NEPA document, certain actions recommended by the RP may require a NEPA document. Which ones?
36 How will the recovery team decide? How will the public know before the project begins? Will the visitor center at Columbine require a supplemental EIS?

PART 2: GENERAL COMMENTS ON THE RECOVERY PLAN

37 *Many terms are used without any standards, thresholds or measurable definitions. In particular, "viable" and 'stabilize" are foggily expressed (e.g., p27, p32, p33. p37). Can you clarify the meanings on these and other pages?

• A glossary concerning the following terms is needed: midden site, midden area, midden location, activity area, home range, territory. There is much confusion p5, p8, p23.

1 • Be more careful distinction between subspecies studies and extrapolation to *grahamensis (e.g.,* pl ,¶2). Microclimate, different numbers and species of food trees, topography, lack of understory food supply, two rainfall seasons, lack of mammalian tree predators, and many other factors such as genetics may make generalizations unreliable.

38 * In general, slope limitations on midden siting are not mentioned. What is limiting slope in USFWS opinion: 60% or 45%?

*There appears to be no environmental baseline, research or monitoring addressing dispersal corridors. Why?

39 *The minimal distance required to find a mate is not known. This should be mentioned in RP as many of the more isolated squirrels may not participate in reproduction. This lowers the effective pop. It may require a special research program to determine effective vs. total pop.

*Throughout the report, the scale of mapping is not stated. Some recovery tasks can be a waste of money without proper scaling.

40 *A Table is required or, at least, a statement qualifying your assertions about the confidence USFWS feels in using any particular piece of data. For instance, are you confident that 2700 acres is excellent to good habitat or not confident or just don't know? Are you confident of your future habitat situation (p30) and what would increase confidence or make you not so confident.

41 ***There appears to be a confusion within the document between environmental baseline and risk management.** There is a lot of baseline info but no work on risk management. In other

words, risk management includes a chart of driving forces, uncontrollable forces, tasks required for prevention of habitat loss, damage control, mitigation possibilities, and unresolved issues that either increase or decrease risk. For instance, which type of habitat losses are uncontrollable? which can be prevented and how? which can be mitigated and how? and which can only be subject of damage control? This framework will create a much more coherent strategy than the present report. Probably a risk management expert could help organize the recovery program in a more direct manner.

41 ***A major gap in Recovery Plan Is estimation of decadal losses of habitat that will subvert any regeneration gains.** There is no focus on "piecemeal" losses from windthrow, ice storms, localized tree diseases, indirect destruction from roadwork and culvert repair, lightning strikes, and bear-caused tree mortality. For instance, I estimated a piecemeal loss from lightning of 20 to 30 acres in a thirteen year period. Others have estimated as much as a 20% loss of subalpine fir from bear girdling with some competitive release to surrounding trees. **No research is proposed on area, magnitude of destruction, frequency, and predictability of these setbacks to regeneration.** Turnover rate of various vegetative associations need better definition.

1 • In natural losses and human induced losses of habitat, windthrow and ice storm losses are never mentioned. Why?

'Why do research on **Abert's,** if nothing can be done? Strategies that are **not** mentioned include: local extirpation of **Abert's** on West Peak
41 and re-introduction of **RS;** experimental hunting in habitat that appears to be **useable** by RS; general reduction of numbers. If research is to be done, then these strategies (not "pure science") is goal. Should **p34** read differently? Why does competition need to be determined for risk management?

• Dogs are not mentioned in text. Many dog breeds tree squirrels, reduce RS food and travel time and cause stress. **Zones 1 and 2 should have no dogs on trails. The "on leash" law Is unenforceable.** Having walked many USFS trails with leash laws
42 (e.g., south Fork of Cave Creek in the Chiricahuas), I have rarely seen a dog on a leash and have watched them tree the Chiricahua squirrel numerous times. The situation also occurs adjacent to heavy use areas (e.g.. Riggs Lake) where squirrel numbers may be limited by dogs. No **mention of fencing parking lot at Riggs Lake or**

closing road to Riggs as specified in Arizona-Idaho Act is mentioned. Please add this and "no dogs" in Zones 1 and 2 to report.

42 Fencing around drive-in and high-use campsites adjacent to RS should be considered. Or closing the campsite. Dogs need to be prohibited in these areas. Nowhere addressed.

• Effective population is more important than total population for recovery purposes. The use of "effective population" is crucial in all press releases from USFS or other agencies as part of their

43 educational efforts. Use of total active middens gives the wrong impression.

'There is no discussion of activity area and home range or territory and its relationship to understanding densities. No mention that activity area found by Froehlich, estimated by me and others (about

44 10 acres) is largest for species -- requiring special attention to tree cutting even at relatively far distances from midden site. The UA monitoring program does not monitor size, shape nor changes in activity areas.

PART 3: SPECIFIC COMMENTS ON THE RECOVERY PLAN

EXEC SUMMARY: This needs to be re-written from comments enclosed. In particular, criteria for declassification (endangered to threatened) and reclassification (increasing, decreasing, stabilized)
30 and measurements triggering crisis strategies need to be added. In addition, the difference between simulated populations and actual field reconnaissance should be made absolutely clear.

p3¶2 -- I believe third sentence should say 'and more different than Douglas squirrel is from Baja squirrel.' As written it implies that Douglas squirrel is not a valid species vs. red squirrel.

p3¶2 -- This speculation should probably be cut. Alternate theory might state that the Mt. Graham RS is the source population for the
1 White Mountains.

p4¶1 -- Fourth sentence should read "as far east as Turkey Flat and as far west as West Peak."

45 p4¶1 -- West Peak area has only been inventoried twice since 1970s. My search was half a day. It is possible one or two RS remain.

p5¶1 -- This paragraph is controversial. It is not widely accepted that one squirrel per midden should be the basis for RS management and Vahle (1978) does not state this. How "exceptional" the use of more than one midden (as defined by various biologists) is used by one RS has never been sampled on a year-to-year basis with large
46 numbers. Wells, not cited here, found midden sharing and division of the home range in some of her RS work. In addition, use of more than one midden by a single squirrel may be more common when food is rare (contrary to your sentence).

P7 -- The Squirrel Habitat Equivalent Density Assessment (SHEDA) and the Habitat Capability Model (HCM) are very different estimate techniques. HCM is a crude -- utilizing only two variables -- structural stage and vegetation type, while SHEDA has six additional
47 variables. HCM is dependent on values assigned for cover and food by experts at an early stage on our understanding. It requires expert opinion of an "optimal density" which has not been re-evaluated from filed data since 1988.. HCM determines "theoretical upper limit" of carrying capacity units (not RS numbers). Literature shows (USDA,

!988, p115) that actual maximal occupation of ccus may be 55% to
47 ~85%. Therefore, the theoretical upper limit could be as low as 358 or 553. The "650' is unjustifiable without further explanation. 'Similarly, the old "502 maximal was stated to be between 276 and 426.

3rd sentence should read: "As of October !991, 549 active, inactive and abandoned sites have been inventoried. The number of abandoned
48 sites is unknown and inflates the total by an unknown number." Similar care should be taken on p8¶1.

2¶ -- First sentence should state "by HCM model." The confidence that USFWS has in model of "natural succession with no catastrophic events" is crucial to its "recovery goal" of 900 as the theoretical upper limit of carrying capacity units (NOT squirrels). Again, this
1 200-year population projection is more likely between 550 and 850 (assuming 1,000 ccus) given the crude model inputs and lack of knowledge about "natural succession."

p8¶3 -- I have not read Hatt study in a while but I do not remember him following middens for "succeeding generations." How long a study was this in order to justify such a strong statement about midden occupancy?

49 Pattern of midden distribution is also an social phenomena with mothers subdividing or even leaving midden sites to young. Socio-demography should be added to 4th sentence.

p9 -- Last sentence is crucial in all your population estimates. It should be moved to text and, if possible, a discussion of its impact
1 on pop assessment made.

p10 -- The discussion of canopy closure is confusing. RS in more northern latitudes do not need as much or any canopy closure. I have seen RS in Fairbanks with no canopy closure and in Idaho with
50 minimal closure. Should state that closed canopy (85%+) needed only in southern part of range.

p11¶1 -- same as above. Fairbanks and Idaho are in western range.

p11¶2 -- Denise's study was in Doug Fir. This should always be
51 mentioned. Spruce-Fir is unknown.

p13¶3 -- Not mentioned are gentler slopes, cold air drainages. Not mentioned are any understory plants, especially blackberries and
52 vaccinum. Especially in the Plain View Peak area, these may be important. I have seen RS harvesting blackberries. **Why are understory plants not part of recovery strategy?**

p14 -- Foods. Qualify remarks on food use by subspecies and
1 location of RS populations throughout this section. Remarks may not apply to Mt Graham RS. Holvorson study is better than Gurnell for
53 assessing time lags and importance of closed cone seed crops.

1 word is 'epigeous' not 'epigenous.'

No discussion of calcium/phosphorus limitation and
54 **possibility of providing bones to middens as strategy to improve diet.**

1 p16¶1 -- Mushrooms make up 10-40% of diet as measured by what?

1 p17¶3 -- I believe Hoffmeister only looked a one female. "Embryos" implies larger sample.

p18¶1 -- Combined data indicate a smaller average litter size than
51 species as a whole and a constraint on speed of recovery. Mention this?

p18¶3 -- The language needs to be more precise. 'semi-annual
1 midden population estimate" should be replaced. What is the difference between midden inventory and population estimate? If you look at recent data, there is a proposed zero mortality (no winterkill) for 1991-1992. Frankly, this is unbelievable and runs contrary to much more precise (actual population) studies. There is something highly inaccurate about midden census conversions
56 between fall and spring estimates. **If midden census is to be centerpiece of recovery population and mortality estimates, than understanding midden census accuracy is highest priority research need.**

Similarly, the UA monitoring program as of 1991 is not useful in most aspects of the study of population ecology (Warshall, 1991). The "will help" should minimally be changed to 'might help" or RP
1 needs a chart showing which aspects of UA monitoring program will actually help understand recovery. **A revision of monitoring**

protocols should be of highes? priority to recovery program since the UA program is such a drain on finances but will
1 **be the basis for the greatest amount of habitat destruction in Zone 1.**

57 ¶4 -- Should 'estimated' be "indexed?"

1 p19 -- Pop size has not used "random stratified sampling" twelve times as indicated by second sentence. Please correct.

Many more assumptions which heavily influence results are not mentioned. For instance: (1) The total N in estimates includes some middens that have been abandoned. This exaggerates pop estimate. (2) The proportion of middens within each vegetation association is held constant between years. This has not been verified. (3) The
46 density of middens within mapped vegetation associations is considered homogeneous. This has not been verified. In addition, no study of inter-observer error in assessing 'active' vs "inactive" is known to me. As stated, one squirrel/one midden assumption may not be valid for years of poor cone crop production.

58 In Table, should footnote '1' also be used for Oct 91. If not, why not?

1 p20 -- For all pop estimates, indicate whether they are spring or fall. **A sentence should be added about why fall estimates are not useful for recovery criteria.**

59 ¶2 -- Qualify all Paul Young's work with "with spruce-fir or transition zone". Do not generalize to whole mountain.

p22 -- Discussion of Abert's needs to focus on recovery strategy. How big is transition zone where RS and Abert's overlap Doug fir cone harvests? If I remember the overlap zone would allow a maximum number of 40 RS to replace Abert's (assuming that there is competitive exclusion in these areas and RS home ranges average about 10 acres). At the moment, it is doubtful that there is competitive exclusion. It is more likely that adult RS cannot live in
60 "overlap" areas because of adverse microclimate. It was concluded in USDA (1988) that separation of Abert's and RS is a matter of size, microclimate tolerance, physiology (use of ponderosa sap), nesting sites, etc. In other words, competitive exclusion was not a reasonable hypothesis,, only select resource partitioning (mushrooms, Doug fir and white fir cones). A small study in one

overlap zone (e.g., Grant Hill) indicated to me that most Abert's habitat was poor RS microclimate. RS remained in "Abert's habitat" in any grove of trees that provided a suitable microclimate.

Abert's may limit *speed of recruitment of young* by preventing winter-time use of Ponderosa for dispersed fledglings. That is, pop may fluctuate in greater amplitude because of inability of RS young to over-winter in ponderosa. This speculation would imply that a major reduction in overwintering habitat occurred after the 1940s.
60 This may only be of historical interest because extirpation of Abert's does not seem to be a reasonable task (only in China!). On the other hand, heavy hunting of Abert's may allow a small incremental increase in overwintering population.

p23¶2 -- Third sentence does not make sense. "Viable" and
6 "stabilize" need to be defined in measurable ways. See general comments.

p24¶1 -- The question is not what the UA monitoring program says its doing but whether it will have any meaningful results for understanding. the planned destruction of Zone 1 forest. The AGFD has issued a protest
61 against this monitoring program as in violation of the requirements of the management plan and AICA. A major issue is adequate monitoring before further habitat destruction occurs. The present course appears to be: Let's waste the money fighting it out in court.

1 ¶2 -- State years that research funding will be available. Are you sure funding is available through 2002?

p25¶5 -- **How does defining "essential habitat" help recovery?** Is there any regulation that accompanies "essential habitat?" Can USFWS enforce this regulation? How does USFWS get agreement with USFS to determine essential habitat and put teeth
62 into any regulations concerning essential habitat? This is crucial to reducing habitat loss, the most salient factor cited by USFWS.

Has USFS agreed to Habitat Management Zones? How does USFWS go
63 about gaining agreement? What is enforcement mechanism? Will adoption of HMZ require a new EIS or addendum *to* the existing EIS?

Who has authority to close roads or areas? USFS has not closed roads requested in AICA? Does USFWS have any power to influence

USFS? Can **you** insert:. **Conflicts between agencies are a major**
63 **constraint on stabilization and recovery process.** If not, why not?

What does "immediate extinction" mean? Please give years included in "immediate."

1 Crown fires are not the only concern. Floor fires that reduce the number of logs or snags are equally important. Please change.

64 Does immediate extinction include "dog control?" Not mentioned.

p26¶2 -- The "is promising" cannot be said at the moment. You have
65 not calculated decadal losses (see below) from natural phenomena. Decadal losses may now exceed regeneration rates. This should be stated as an unknown.

1 Please include your understanding of successional stages. For instance (early = 160 years: mid = 160 to 240 years).

There is a need to know what is the youngest patch or
66 **grove of trees or basal area (by type) that can support a RS. This task is not listed within your document. Only this** threshold will provide accurate habitat recovery data.

p27 There already are all kinds of monitoring. Please summarize these in a Table and indicate which are "pure science" and which have relevance to stabilization and recovery and why. No
67 **monitoring of impacts of road building on adjacent trees has been proposed (see USFWS, 1990, page 14) and no monitoring of insect infestations and heart rot (page 11).**

RP requires chart of which projects are funded and importance to recovery. Please insert.

68 p28 -- Is 95% probability for 100 years, the standard adopted by USFWS? If not, what standard is being used?

Does USFWS have a goal for a well-distributed population?
69 Is it mapped? If not, what is its goal? Is there a special task to define such a map? At what scale?

P29 -- The Marcot statements are descriptive. They are not "probabilities of persistence." Please give probabilities of
70 persistence for 100 years at 95% Cl or some other standard or rewrite sentence.

This descriptive scenarios should include **sentences such as : Decadal "natural" piecemeal losses are** (much greater, somewhat greater, equal, less, significantly less) than **regeneration rates of mature and old growth habitat. Natural and human-caused catastrophic losses are** (much
71 greater, somewhat greater, equal, less, significantly **less) than regeneration rates of mature and old growth habitat. Will** any of the scenarios include any habitat losses in **Zone** 1 and **2?** Any in other zones? **Are piecemeal losses from arson and accidental fires considered significant (how many acres) in any of the scenarios?**

p30¶3 -- "could be" has no place in a recovery plan. What is confidence that acreage increase might occur? What are driving forces that will let you reach or not reach this goal? My confidence
72 is low because the RP lacks explanation of the successional time frames and decadal "setbacks" from piecemeal destruction. See general comments about confidence in data within recovery plan.

p31¶1 -- The HCM estimate should be lowered to 85% level. If not, why not? The population has not recently approached this level is not the fault of the squirrels. It may be the inadequacy of the model!

73 ¶2 -- as above, cite HCM model and use 85% estimate as optimum. Again, why are you using adult population in spring index and not effective population?

p32¶4 -- This sentence appears totally unjustified. No one has measured survival rates! What justifies -this sentence? References? Please send data?

The question is: **What level of flux triggers what risk**
1 **management task? This is not addressed.**

p33¶1 -- "a lower average population" has not been discussed? What "average?" Harmonic mean, running average, median, arithmetic mean. **A major unaddressed issue in the Recovery Plan is what are the best 'bio-stat measurements** to **use.** This is the

Achilles heel of the UA monitoring program and appears to be continued in the Recovery Plan.

1 By "high quality" habitat, do you mean Zone 1 or Zone 2 levels? If not, what is high quality mean?

p34¶3 -- What are your references for this? Is there simply a lack
13 of evidence or strong negative evidence?

P35 -- What is your evidence that spruce-fir is less susceptible to catastrophic fire? Catastrophes may be less frequent, but are they of smaller magnitude? Fuel buildup is very high on the forest floor and a series of drought years may increase risk? Has there been **a** tree ring study or something else?

If 10,00 acres have been lost in 4 decades, then an average loss **of** 2,500 acres per decade or 25,000 acres per century is a possible risk. This appears greater (by a factor of ten?) to regeneration rates. This is truly a gloomy scenario requiring fire prevention and damage
1 control as the highest priority.

¶1 states that 15,000 acres may be lost in the next century. But, the arithmetic says 25,000. Is this a typo? If not, explain?

¶2 -- The response to uncontrollable drought can only be
74 **food supplements. This risk scenario requires a high priority but is given only a mid priority in your table. Why?**

p36¶1 -- The third sentence appears unjustified. It relies on the HCM model which includes no catastrophes and a 20% (if the model is
75 the same as 1988) setback from decadal losses. Anything "may be possible." A rational assessment gives the probability that it may be possible.

¶2 -- add "arson or accidental fires' after "wildfires." Remember **the use of diesel generators within Zone 1 increases risk. Increased astro-tourism increases risk. These have NOT been mentioned.**

1 ¶3 and 4 -- "estimated maximum carrying capacity" should be changed to the "upper limit of the HCM's model theoretical carrying capacity." USDA (1988) appendices discuss other limitations to **HCM.**

I think a good case could be made for "low to very low". RP optimism comes from not considering increased fire risks
1 **from diesel and tourism, decadal piecemeal losses and optimistic assumptions about reforestation.**

p37 -- Why **isn't** 123 given a priority? Why does 1111 have a high
76 priority, if no regulations related to recovery can be attached to this task? What are the tasks in **121?**

p38 -- Why is no priority given to **1253?** Has repopulating West Peak been considered? Why is 126 a mid priority when it is crucial to
77 understanding population flux dynamics and setting emergency
74 measures? **Nowhere in the report is determination of seed set (cone fertility) mentioned. This is definitely a high priority in terms of food supply.**

Why is 15 not given a priority? This is top priority (see **p44).**

Why is 213 a mid priority? Determining when a **midden** is abandoned
74 is crucial to improving the **midden** index.

Why is 223 a mid priority? Emergency plans for drought and tree disease control and possible squirrel epidemics should be a **major** goal to prevent habitat loss.

p39 -- I don't understand "essential habitat.' Does it include any enforcement? Why not revise Section 4 (ESA) and change critical
62 habitat with new info available. The old critical habitat boundaries
78 were out of date at time of designation and did not include update I (and others) sent to USFWS. The issues were not addressed in Federal Register.

Which of these tasks requires 'reconsultation" and which can be done
36 without reconsultation? Why?

As stated, dogs and fences at Riggs Lake should be added to "physical
42 protection."

p41 -- see comments on measurement and scaling for 123 and 1231.
79 GIS should not be singled out without more justification. Why not low altitude aerial photos?

80 **p42 --** Does "semi-annual" mean 'bi-annual?'

p44 -- The words "successful" have no evidence whatsoever. This is a controversy with agency pitted against agency. The AGFD disagrees with the USFS and UA on monitoring and Alternative 3 but has no enforcement power. The USFWS has requested a section 7
81 reconsultation and opposed by the USFS. The GAO has tangled with the Justice Department. **Inter-agency cooperation on Zones 1 and 2 is the major obstacle to a recovery plan as the USFS will not commit to preventing the third and four more telescopes -- contrary to recommendations in this report.** They do not, as far as I know, report tree cutting to a "District Inter-agency Team" and, as far as I know, held no meeting on recent cutting outside the astrophysical fence line, cutting trees along Swift Trail or work on culverts that might impact trees downstream. They have not followed the strict letter of AICA as far as road closures. They will not support Congressional bills to allow NEPA and the ESA to follow due process. **Their plans for recreational development may be the biggest indirect threat to habitat loss in the short-term.** It **appears that the ability to implement remains the major obstacle and conflict resolution between agencies remains the most important cause. Ignoring** this in the recovery plan will simply increase the chances of extinction, This occurred with the black-footed ferret as well as many other inter-agency activities with endangered species.

82 p44 -- In 211 what does "productivity" mean in terms of any measurement? Litter size? Densities?

83 p45 -- In 22, what are "critically low numbers?' Please give a number, not a definition.

84 In 223, list types of emergencies of concern. Tree disease, insect outbreaks, fires, consecutive years of drought?

1 P55 -- Qualify second sentence: "..densities of RS middens in good to excellent cone crop years...'

42 p55 -- See comments about unenforceable rules. Zones 1 and 2 should have no dogs.

85 p58 -- The cienagas may have invasions of spruce. There is an important management question: manage for cienaga or spruce? This is not addressed.

86 Zone 7 is very controversial and not at all clear in plan. For instance, should Columbine be reforested? Should road to Heliograph be narrowed with reforestation? Should top of Helio be reforested and how much? Should Riggs Lake have fencing or no cars and dogs? What gets included in Zone 7 must be accepted by USFS. What is process of acceptance in the USFS Land management Plans?

Bibliography

USFS. 1988. Mt . Graham Red Squirrel: An Expanded Biological Assessment. 130 pg.

USFWS. May 1990. “Policy and Guidelines for Planning and Coordinating Recovery of Endangered and Threatened Species.” 14 pg plus four appendixes.

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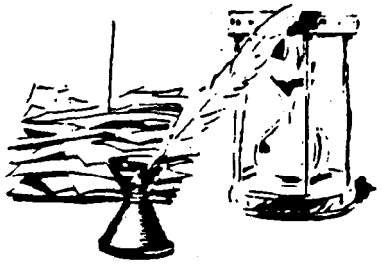
Warshall, P. 1991. “Memorandum on the Mt. Graham International Observatory Monitoring Program.’ Prepared for the Arizona Game and Fish Department, Non-Game Branch. 25 pg.

Memo



FROM THE DESK OF

AL DORAZIO

24 AUGUST 1992

GENTLEMEN —

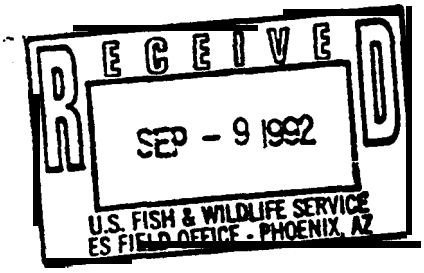
I HAVE REVIEWED THE "MOUNT GRAHAM RED SQUIRREL - DRAFT RECOVERY PLAN"

I RECOMMEND THE IMPLEMENTATION OF LINE ITEM 1 UNDER, "ACTIONS NEEDED FOR STABILIZATION:," ONLY, AT A PROJECTED COST OF $69,000.00 THROUGH THE YEAR 2002. THAT IS, PROTECT AND MONITOR EXISTING POPULATION AND HABITAT — THE OTHER $1.4 MILLION ARE AN UNNECESSARY EXPENDITURE OF THE TAXPAYERS DOLLARS THAT COULD BE BETTER SPENT OR, BETTER YET, NOT SPENT —

SINCERELY —

Al Dorazio

SEP 8 1992



August 11, 1992

United States Department of the Interior
Fish & Wildlife Service
Ecological Services
3616 W. Thomas Suit 6
Phoenix, Arizona 85019

Gentlemen:

I have been authorized to make comments on your Draft for the recovery Plan for the Mt. Graham Red Squirrel for the Safford Rotary Club. These are a group of 30 influential business and professional men, several of whom have summer home permits on Mt. Graham and the rest are interested in keeping and caring for our main source of recreation in Graham County and the surrounding areas.

My qualifications to write this response are as follows: My Grandfather Hyrum Weech along with Mr. John M. Moody, Sr., and Ebenezer Bryce, Sr. (he is the Bryce who first found and settled in the Bryce National Canyon area of Utah) were the first men to explore the mountain ten years after Lt. Wheeler of the Army of the West surveyed it in 1872. They. on horseback, went up what is now Nuttall Canyon and rode all the way to the top of High Peak finding the rock monument left by Lt. Wheeler. His description of the mountain left no doubt that it was wide open spaces and open meadows with little dead and down timber and trash vegetation. A very descriptive record of this journey was published in his life story as written by him in a book entitled "Our Pioneer Parents.

His son and my father. David H. Weech was the managing partner of the Ash Creek Lumber Company that they established around the turn of the century. It was he who built the flume to carry the lumber from the mill in Ash Creek.

The Weech family has had summer homes in the Columbine area since 1890. Grandma Weech gave it it's name. I have had a summer home permit since 1946. My father and I built the log cabin that was his summer home in the Coiumbine Fiat in i937 and has been occupied by Weech families since that time. I spent every summer from 1928 through 1940 with my family at this cabin site. We moved up and spent the entire summer from June to September there. I covered the entire mountain from Taylor pass on the west to Shannan and Hospital Flat on the east by foot on my daily hikes in the entire area that is supposed to be the home of the Red Squirrel. I hunted them during the depression years with a bean shooter. I have trapped them and made pets out of them. I have spent hours observing them while hiking in all parts of the forest. I have had the privilege of hearing the many stories of my father and grandfather of their experiences on the mountain. My father kept a journal from before the turn of the century until just months before his death in 1958. I have this record.

As for comments on your Draft for the Recovery of the Red Squirrel, lets start from the beginning. From my above background. I can say without hesitation that there never has been any danger
87 of the Red squirrel becoming extinct. They are just as many squirrels on the mountain now as there were back in the 1930' and

and '40's. You remark in your draft that you do not have enough information in your file to be able to make any definite decisions.
87 In other words you have not been able to tell if the Squirrel is in danger of extinction or not. We all know that this squirrel was picked out as an endangered species by those dead set against the Telescope project to use as a weapon against the Telescope. The squirrel was picked out because they had to have something that they thought no one knew anything about so that they would be more likely to make the charge stick. This was based on your estimates on their population. Accepting your present count as accurate, there has never at anytime in my 62 years of observation, been over 400 squirrels on the mountain. You are correct when you say they fluctuate and this because of the weather and the cone crop which is beyond anyone's control. You are wrong however in stating the kind of habitat they like the best. Back in the 1932 to 1945 time area the forest was open and had clear meadows. Many of the trees were standing and alive. Forest fires had kept them clean. The squirrel population was as good or better than it is now. At the present time we have few meadows and they are closed up with unburned trash and with a 15 to 20% of dead standing trees. In
88 many places there are dead and down trees two and three or more logs deep and small trees so thick that few of them can grow to maturity. Most of these are useless cork bark trees. The squirrels have spread out to a greater area to find food. It is interesting to note that a good share of this immigration has been into the area of the big 1956 fire.

For the present let us say that all of your draft summary objectives are right;

1. <u>We do need to protect-and monitor existing population and habitat.</u> The forest needs to be cleaned up to prevent a catastrophic fire that could happen at any time and wipe out the entire squirrel population. Contrary to some beliefs squirrels like people and are disposed to being friends. It might be helpful in lean years for them to be given some artificial food caches to supplement the natural food. If you are so strong on reforestation, why not clear out a good share of the trash or non-productive vegetation so the cone bearing trees can grow.

2. <u>Determine the life history and habitat ecology.</u> This should have been done BEFORE the squirrel was put on the endangered
89 list. Check with the few who are still left who know about these things, those who have been in a position to have observed the squirrel over the years. Check the available histories and articles that tell what the habitat has been in the past.

3. <u>Reclaim previously occupied habitat.</u> I think you will find that most of your squirrels will be found in the area that was logged during the time period from 1900 to 1926. In this area you will find that the forest is not as bad as the areas in the rest of the forest. The logging that was done during the 1960's has not had a chance to grow back yet and reforestation might be helpful however the roads built into these areas at that time should be left open and cleared on both sides. They make excellent fire breaks to limit burn area if a bad fire in a dry weather time should get started before things can be cleaned up. There are a

lot of over-aged Ponderosa pine and Douglas fir that needs to be logged out and open spaces made for growing of new cone bearing trees.

4. Integrate species and habitat protection actions for the Pinaleno Mountains This is fine if a program can be set up that will improve the area. If you are going to spend 1.8 million dollars of the tax payers money at least put it where some good might come of it. Since the Red Squirrel was never been endangered and since it has failed in its original purpose, which was to stop the telescopes, lets drop it as a condition for normal life on Mt. Graham. Open up our recreational roads and let the people of the area help with cleaning up the forest by using the dead and down wood. This would help in making it possible for the squirrels to exist better and also make it better for the deer and other animals that need open, grassy meadow who are the really more endangered than the squirrels. Many of the clearings proposed for reforestation were intentionally created as wildlife openings in the 1960's and 1970's to provide ecological diversity. Deer and other such wildlife have needs also. Reforestation of many of these sites will be nearly impossible because the sites are southern and western facing slopes and by nature are hot and dry.

89

Note: Check your forest in Europe, England, Scotland and Ireland that have existed for thousands of years with people in and around them. They have learned how to take care of them. They know how to used their natural resources and still leave what is needed by mother nature to meet all it's requirements. Maybe we could learn something from them.

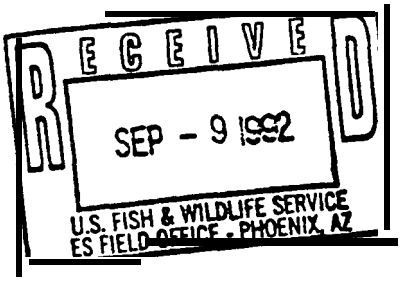
Thank you for this opportunity to express my opinion on this matter.

Sincerely,

Allen B. Weech, Sec.

As a member of this Rotary Club I wish to add my name to the above remarks.

Jonathan I. Lunine
7234 East Beverly Drive
Tucson AZ 85710
602-298-7249



September 7, 1992

US Fish and Wildlife Service
Region 2
Albuquerque, NM

Re: Draft Recovery Plan for Mount Graham Red Squirrel

I am pleased to have the opportunity to respond to the Draft Recovery Plan for the Mount Graham Red Squirrel. The authors are to be commended for a very clearly developed summary of the recent history of the mountain, with particular reference to the combination of natural and human effects which have conspired over the past several decades to restrict severely the habitat of the Mt. Graham Red Squirrel.

I was most encouraged by the discussion of the various Habitat Management Zones, in which non-motorized recreational uses (day-use hiking and walk-in camping) are recommended as compatible in essentially all the zones, including those now comprising the refugium which is off limits to the public.

I very strongly urge your agency and the Forest *Service* to take those steps necessary to reopen the refugium to the public as soon as possible. Most straightforward would be to initially allow hiking into the refugium, with a high profile monitoring of the area through use of backcountry Forest Service personnel (and/or uniformed volunteers). These individuals could educate the hiking public regarding the special ecological values of the area, as well as on proper hiking techniques for the area.

If desired, monitoring of the number of hikers per day could be achieved through installation of self-serve permit stands at the trailheads (or at the trail intersections with the refuge boundary). Hikers would be responsible for filling out the permits and carrying a copy with them on the trail. Use of the stations would be encouraged through spot-checking of permits on trail by backcountry personnel. This system has been employed in heavily-used national forests of California and provides a minimum of inconvenience for the hiker while allowing usage numbers to be tracked.

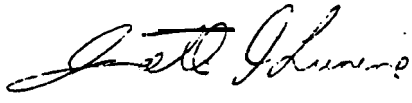
Opening of the refuge to hiking is absolutely essential to educating the public regarding the unique environmental values of the high reaches of the Pinalenos mountains. Currently, closure of the area is misunderstood by much of the public. Many individuals think that the Refugium <u>is</u> the Astrophysical Observatory, are confused about acreage involved in each and how

the refuge differs ecologically from other parts of the mountain. Few would recognize its distinction as the highest conifer forest in Southeastern Arizona, containing rich stands of Engelmann Spruce and other species which are rare or nonexistent in the other sky island ranges. Permitting the public to experience the area through hiking, while providing appropriate information (through brochures or personal contact on trails) calling out its special values, would do more than any other activity to allay misunderstanding and build public trust in the ongoing restoration activities.

As a side benefit, reopening of the refugium would reintegrate a good trail system which was badly fragmented by the 1988 closure.

10 In summary, I believe it is time to allow limited public activities again on the highest reaches of the Pinalenos. Hiking and wildlife observation, properly augmented by education-oriented contact with land stewards on the trails, would become a powerful method for deepening our understanding of this unique and precious mountain ecosystem. I urge you to implement a reopening of the refugium.

Sincerely yours,



Jonathan I. Lunine

cc: USFS, Coronado, Tucson, AZ

united States Department of Agriculture
Forest Service
Southwestern Region
517 Gold Avenue SW.
Albuquerque, NM 87102-0084
FAX: (505)842-3800

Reply To: 2670

Date: SEP 14 1992

Mr. Sam Spiller
Ecological Services
U.S. Fish and Wildlife Service
3616 W. Thomas Road, Suite 6
Phoenix, AZ 85019

Dear Mr. Spiller:

This letter provides our comments to the draft Mt. Graham red squirrel (MGRS) recovery plan. Technical and editorial comments are enclosed in a separate document. We are willing to assist the U.S. Fish and Wildlife Service (USFWS) in revision and finalizing this document.

Overall, the document provides a reasonable strategy for conservation and stabilization of the species. Unfortunately, it does little to resolve the difficult task the Forest Service has to face in order to manage for the species in the context of multiple-use land management. As you are aware, the Forest Service has been committed to recovery and has accomplished many actions toward that goal in recent years. These actions have included reforestation, population monitoring and many changes in various land management practices. The issues surrounding this species, the mountain and astrophysical development have been extremely polarized in recent years and as a result have made practical management of the mountain and its uses extremely difficult. This recovery plan more clearly defines the long-term needs for providing significant protection for the species and displays the information in a manner that will improve our framework for planning and consultation. It brings the stark realities of managing for endangered species into the light of day, especially when those species are ones with extremely limited distribution and small population size.

We believe that the document needs to be expanded under the section called "Strategy for Increase and Stabilization" to include a more lengthy discussion on forest dynamics and the extremely complex job of providing for mature forests over time. We suggest that the following be included:

1 Essential to recovery of the species is to provide a strategy for the long-term recovery of degraded and currently unsuitable forests and to provide a scheme that will provide for mature forests and so suitable habitat over time. However, when devising such a strategy, the natural ebb and flow of forest seral stages must be taken into consideration. It is not realistic to assume that regeneration of degraded habitats will be a straight line process; natural factors such as fire, insects, small mammals

(e.g., gophers), different soils, *aspects*, and slopes will all affect the pace of *regeneration* and reforestation. But, the general outlook for the species in the *long-tern could* be promising if the *forest* habitat were restored, maintained, and perpccuated. Ref orestation of degraded habitats will eventually provide a wider and more secure land baee for the species, and thus is a major priority for recovery.

In crder to provide for long-term survival of the MJRS, it is necessary to provide habitat hid-aged, mature and older forests) in perpetuity, Forests are dynamic, *not* static entities. Trees, like all living organism, *art* mortal. Thus, it in important to consider the dynamics *of* the forest associations *on* tht Pinaleno Mountains and determine ttrattgitt to insure mature forests into the long-term (100-200 years and *beyondl*.

The *major* forest asseciations of concern are the spruce-fir, nixed conifer and the transition between these two types. Recent studies of the epruct-fir forttt of the Pinaleno icdicatt that in the old-grovth areas the spruce and fir species are "well represented in many size and age classes, indicating continuing recruitment under a mature canopy by both species" *(Stromberg* and Patton 1991).

Before tht arrival of European settlers, forests throughout western North America were burned by frequent low-intensity, lightning-caused ground fires. These fires were particularly prevalent *in* ponderosa pint forests, to *a* lesser extent in the mixed conifer forests and *were* infrequent and rare in tho spruce-fir forests. Accordingly, fire plays 4 corresponding role in the ecology of each of these forest types.

1 Wildfire tupprtotion since the ttrly 1900' a has greatly reduced fire frequency and in many areas entirely eliminated firm from these fortttt (Weaver 1961, Ditttrich 1983, McCune 1983, Stein 1998, Keane et al 1990). On Mt. Graham, wildfires (both man-cawed and natural) still occur but active suppression occurs due to the present potential for catastrophic fires.

In the spruce-fir forest, small partial disturbances from events such as windthrow, natural mortality, disease and lightning strikes will likely serve as *the* mechanism providing mid-seral succession and thus forest regeneration and perpetuation. Total stand rtplactmcnt and regeneration from events such as logging or catastrophic fires are not *needed* or dtrirtd. Spruce and true fire are not fire adapted (i.e., they are thin barked) compared to pine and Douglas-fir species which *are* fire tolerant (i.e., they have thick bark1 to moderate understory burning.

within the mixed conifer forest and transition *foreet*, logging, which occurred some time ago, hae resulted in the reduction of large, dominant Douglas-f ir trttr *in* some stands. The legging took the form of both overstory removalo tnd regeneration cute which essentially took mites *to* a younger teral stages *(early* successional grass/forb/shrub ttagt or in the case of an overstory removal to a younger forest stand of cttdlingo, saplings or poles). Sites that were historically forested (old harvest areas, fuel breske, abandoned roads, etc.1 should be the priority areas targeted *for* reforestation and rilviculturai trtataent.

In some cases these sites are having difficulty returning to stocked *forest* conditions because of the site dominance and competition 02 the herbacecuo material (grasses primarily). These early successional sites are where assistance would moet likely facilitate and speed up the succession process Ln order to provide earlier recovery of the area *Co* mature forest with relatively closed canopies. We are acquiring a better understanding of habitat requirements for midden eitee so that land managers CM attempt to provide for red squirrel needs. The intent is co reforest formerly forarted areas and it is *not* dasirable to attempt to reforest sites that are natural openings (cienagas, vet meadows, etc.).

Some concern has been expressed chat reforestation will cccur to the extent that early seral stages will be severely lacking which will impact early seral stage wildlife apacica. Forests are dynamic entities vhete continuing disturbances CM be expected, and it in also unlikely that reforestation effort8 would be so successful that early seral stages and openings will be *lost* in the landscape to the extent that other wildlife populations would be greatly affected or eliminated. In *fact,* in order to provide mature forests in perpetuity, it will *be* necessary to provide for all seral stages over time. It's likely that these stages will be provided naturally in small patches naturally through the landscape over *time,* rather than in larger harvest units or blocks.

Management strategies for insuring older forests in perpetuity in the mixed conifer and transition vegetation types will be much more complex than in the spruce-fir type. The complexity is a result of more tree species being involved, a more significant role 02 fire in the ecology of thaae forests, the past history of logging, the greater potential for catastrophic wildfires, fuels management needs, and the greater interface with human development. Because 02 the associated complexity, management strategies will need to be developed on a rite-rpecifio level (individual forest stands and conditions). This will *require* integration of forest silviculture, fire management, and squirrel biology. First priority should be given to assisting sites that are in early successional stages. Second priority needs to be given to sites in mid-successional otagea (seedling-sapling and poles). Third priority needs to be given co mature and old forest sites that arc currently suitable. These mature and old forest rites will change over time in both structure and tree composition, and it is these sites that will eventually naad to be reviewed, monitored, and in some cases actively managed and manipulated in order to maintain the desired forest characterirticr long-term. Management 02 these sites would normally not *require* logging or mature tree removal. Management would tend to include practices ouch as low-intensity prescribed fire6 (maintaining snag and downed log characcerietica!, thinning from below of younger tree classes in order to promote A developing overstory, perhaps occasional interplanting, etc. The goal rhould be to maintain the existing older forest character while providing for recruitment of *future* overstory. In many cases little *or* no active management will *be* needed in the near future.

1

Reforestation efforts will require:

1. A detailed understanding of how macro- and micro-habitat correlates to squirrel abundance and productivity;

2. An ecological classification and inventory of vegetation;

3. Habitat Capability/Habitat Suitability Index model baaed on (1) and (2);

4. A long-term habitat recovery (restoration) plan based on all of the above.

1

Adaptation, implementation, and monitoring of the restoration efforts will be required. The habitat recovery plan must also include the flexibility needad to adapt changes that may be necessary based cn new information and monitoring results. Some stands will require complete reforestation, while others may require varying amounts of silvicultural management. The average midden characteristics in spruce-fir end transition zones (Mannan and Smith 1991) will help provide guidelines for desired future conditions within each vegetation reeociation.

The habitat management zone concept should be useful for communicating red squirrel prioritiitr, habitat needs end for conducting planning and consultations. In reviewing the management objectives, particularly as it relates to recreation management, we observed some inconsistencies. For example, trail maintenance is discussed for zone 3 but not zones 1 and 23 In zone 2 itstates that all types of dispersed recreation ate compatible, but zonia 4 states that these areas are compatible with most types of dispersed recreation. Which dispersed recreation uses would not be compatible, end if zone 4 in currently unsuitable habitat then why would it be more restrictive than suitable habitat? Would mountain bike use or horseback riding be acceptable in zones 1 and 2? We would suggest that a meeting be held between the USFWS and the Forest Service (with recreation personnel involved) to redraft this section. A sample redraft of the second *paragraph* for zone 1 might read like this:

Pedestrian day use *(hiking,* hunting, birding, fishing, picnicking, etc.) and camping are acceptable. Pets will be under reliable voice control or physical roettaint. Horses and mountain bikes are allowed only on trailn. Trails should be well maintained to discourage cross-country travel. Snowmobilesare not allowed. Leave-no-trace camping ethics will be utilized. Loss or depletion of dead and downed woody habitat component8 must be prevented. Human use impacts ehould be evaluated annually to determine future management naedr. If necessary, recreation use may be manage& by Further restrictions (e.g. permit camping only, restrict hiking to trails, campstove use only). Visitor education on the protection of red squirrels and their habitat is essential. Visitor use must not displace or modify important red squirrel habitat, Informational signs at major access points to the zone should explain management practices. Signing should be the minimum needed and primarily *for* resource protection.

1

1 The concept of allowing some levels 0: recreational use of the refugium is alluded tc through the Habitat Management Zone appendix but is not directly addressed. Given the level of public interest on thit specific aopoct, it merits direct discussion.

90 On page 39, item 1112 alludes to further closures and other use raetrictions. Given the number cf actions that have already been takon, we believe it merits recognition of these actions and that further closures are unlikely and would only be used when a clearly demonstrated need occurs.

91 The otabilitation goal of increasing the habitat *to* exceed 300 adult squirrels even during population lows is not completely clear. Over what period of time will be used at the measure of when this goal has bctn achieved? How long is it estimated to take, 5 years or 50 years? What: will happen when that goal is achieved? What is the precision that must be obtained in measuring the population; after all, *the* current numbers are only estimates?

10 Given the polarieation of issues surrounding *Mt.* Graham and the red squirrel, it is extremely important that red squirrel *management* is based *on* biology of the species alont. This is especially important givtn the importance of the mountain to a variety of uses and the *fact* that scarce resources (both natural *and* financial) must bt wisely used.

fr: LARRY HENSON
Regional Forester

Enclorurt

cc:
Coronado NF
Safford RD

Technical and Editorial Comments
for
MT. GRAHAM RED SQUIRREL DRAFT RECOVERY PLAN

COMMENT

"Hudsonicus" should be lower cam.

Need t o add an explanation for how the 1991 capacity of approximately 650 red squirrels was developed.

Global warming impacts would not really slow forest oucceeeion in as much as it may affect and alter vegetation types. Suggest stating it as "climatic shifts, due to global warming, may alter and affect habitat."

The last sentence of the firet paragraph is unclear.

In the last paragraph replace "have been abandoned" to "remained vacant. "

Table 1 "Total" column header is misplaced.

Table 2 It is unclear what the 0.31ha size actually is. Doss distance " around" for loge equate to DBH?

L3 The term "original" forest *used* in the second paragraph gives the impression that forests are a static rather than dynamic entity. Do you mean "pre-settlement" Lortet and even then do we know what that was? Suggcot just changing it to "The forests of the Pinalenos..."

Replace "to decrease the number of artificially maintained openings within the forest and" to "of old harvest areas and wildfires to".

14 In the fall of 1992 Mount Graham red squirrels were observed to cache and utilize ponderosa pine for tte first time. This occurred when the cone crop was limited and ponderosa pine was one of the few species producing cones.

1

16 In the second paragraph change "excavations" to "harvesting". Consider adding a statement stating that mushroom may take less effort to eat than extracting seeds from cones, which may explain in part their relative importance.

19 It states that the population has been estimated 12 times and rsfercncae table 3. Table 3 contains 11 sets of population information. The information from spring 1992 would make 12 sets but wan not included.

20 In the first paragraph add specific elevation reference to clarify.

In tht second paragraph replace the words "little" and "heavy" to "poor" *and* "good" respectively.

23 In the first paragraph the term "high elevation" means different things to different people depending on who you are and where you are at on the mountain. Add specific elevational ranges to clarify.

24 The rcferenca to research funding for the "next" 10 years could cause confusion since we are already several years into the 10-year funding.

25 The term "crisis" might *b e* considered inflammatory by some. In this first paragraph it may warrant making further reference again *to* the naturally limited distribution of the squirrel.

The term "natural habitat losses" is unclear.

1 26 The ooction on "Three forest site assistance priorities..." in confusing. Needs extensive revision. Please utilize the discussion supplied earlier in ths body of our comment letter.

25 The use of an "essential habitat" *designation* is uncertain. Although the current Forest Service manual contains reference to thio policy, it does not appear to be a designation and procedure that is regularly used. Further investigation on use of thin designation is needed. The overlap and/or inconsistency vith critical habitat boundaries would need to be addressed.

Suggest revising "implementing management plans to affect increasing and stabilizing the red squirrel population" to read "implement management plans to increase and stabilize the red *squirrel* population."

27 PVA's may not be the best "tool" for undarotanding management per se. Rather, the PVA's will *need* refinement over time to better evaluate the
10 viability of the species as both an improved knowledge of the species develops and as management improves the *habitat* capability.

The reference to mitigation in the second paragraph is unclear. If all suitable habitat is protected and if nearly all potentially suitable
1 habitat is managed for ths species, then what ocher mitigation is possible?

36 Delete the word "sustained" from the first sentence of the laat paragraph.

37 The statement "For the squirrel to survive, habitat loss must not occur in these zones", is ovorotated. Change to "Zones 1, 2, and 3 are
93 currently the moat important habitat areas and habitat losses should be prevented in these areas." The same comment goes *for* similar wotding of "unacceptable" f ound on page 56, second paragraph.

42 The long-term population monitoring may be reduced *to* one time per year.
94

The term "re-population" is awkward and unclear.

43 References here and elsewhere to fire suppression and elsewhere should be made clear that the concern is related to catastrophic, stand-
1 destroying type fires and that prescribed fires both inside and outside of red squirrel habitat may be needed to manage and protect red squirrel habitat.

93 44 Drop the word "reliable" in item 2.

Haven't the studies of Smith and Mannan accomplished much, if not all,
95 of the current needs on middsn characteristics?

1	45	Under item 3, change the word "succession" to "ecosystem" and end the sentence.
96	46	The need and use for two different brochures is unclear.
1	47	Item321 should be made more positive by changing "how recreational use can disturb middens" to "how to recreate in a manner compatible with squirrels."
	48	The Conner 1979 literature citation is not listed.
93	52	This tab28 ie difficult to read and use without the actual task names.
1	55	The conversions from English to metric and vice versa seem to often be in error. Suggest that they all be carefully rechecked using original numbers. In some cases original numbers were metric, in other cases English. Probably a typo in this particular case, but 10-15 snags/ha is 24.7-37.1 snags per acre, not 406.
97	57	In Zone 2 it is described how currently closed roads should be rsf orascod. Some of thesercads are needed for administrative access for fits suppression purposes and, therefore, it in not desirable to reforest *all closed* roads.
1		Change "District Interdisciplinary Team led by the District Biologist" to simply "interdisciplinary team."

9/14/92

Dear Mr. Spille,

Please find attached my comments on the recovery plan for the Mt. Graham Red Squirrel

Sincerely

Mindy Wall

SEP 15 1992

RECOVERY PLAN FOR THE MOUNT GRAHAM RED SQUIRREL

I. Introduction

The purpose of a recovery plan is not stated. I assume that the purpose of a recovery plan under the Endangered Species Act may often be to ensure the survival of the threatened species in the wild -- that is without need for artificial support. Such a goal makes sense when the primary threat to the species results from pre-existing or future human actions. It makes no sense if the primary threat to the species arises from natural causes. In that case, it is only through human intervention that the species can be saved. It is, of course, essential that the true nature of the threat be recognized before implementing the recovery plan if there is
98 to be any hope of helping the species in question. In the case of the Mt Graham red squirrel the principal threat arises from natural but nonetheless extreme fluctuations in food supply. The recovery plan recognizes this in principle but fails to provide corresponding actions. It focuses instead on correcting relatively unimportant impacts on habitat as if motivated by other concerns than saving this subspecies. The wrong medicine may well be worse than no medicine at all. This is my motivation for commenting on the draft recovery plan.

Actions under the Endangered Species Act must also be considered not only for the preservation of an individual species, but also for the preservation of other species through the survival of the Act. This was noted by Regional Director Michael Spear in his testimony before a Congressional Committee as the basis for his actions on' the conservation of the Mt. Graham Red Squirrel. The presentation of a recovery plan is one such action. It has to be able to withstand public and scientific scrutiny and also, if necessary, to stand up in court.

Early actions to preserve a species are usually taken in a hurry. There is need to lean over backwards to preserve the creature against
99 possibilities of a threat, regardless of whether a threat is real or not. Particularly important in early actions is to gather information to sort out the reality of presumed threats, and to discover whether other risks, assumed relatively unimportant, have been given adequate attention.

In contrast, a recovery plan is one in which the most likely scientific conclusions can be allowed to dominate. Early caution can be reconsidered in the light of new knowledge, and the cautionary steps properly taken in the early stages can be re-evaluated. Only those restrictions found to be necessary need be retained. But equally, other actions and other restrictions may need to be implemented.

As stated above, it is vital for a recovery plan to correctly identify the threat to the species, to recommend appropriate actions and to provide an explanation that can withstand scientific and public scrutiny. The draft recovery plan does not satisfy these criteria and has been the motivation to look, not at details of the presentation, but at the overall basis for the plan.

One approach to a recovery plan would be to:

1) determine the principal aspects of the environment that put the creature at risk;

2) divide these into those which can be changed significantly and thosethat will largely remain as they are;

3) develop a plan aimed at those factors that can provide significant improvement in the condition of the species and reject those previously instituted measures which do not provide any benefit to the species.

4) optimize the plan for overall environmental impact and cost effectiveness. This process will necessarily involve trade-offs both for the benefit of the species concerned and in relation to other species (including humans) using the area. The guiding principle should be to select those actions that have the highest likelihood of success at the minimum cost.

99

Clearly, the above considerations should be based on the best available data and in particular incorporate new information available since the species was first listed. In the case of the Mt. Graham red squirrel this represents a substantial body of new data.

The current draft of the plan does **not cover** the above points adequately and focuses inordinately on the preservation of even the smallest **areas** of habitat. It fails to provide analysis to support even this decision. Finally it does not make use of the data now available.

II. Threats to the Mt. Graham Red Squirrel

We are fortunate that the Mt. Graham Red Squirrel Biological Update Team convened by the USFWS provided a list of all such concerns in a memorandum dated August 1 st. 1990. The potential threats to the red

squirrel include: 1) inadequate habitat and hence food supply; 2) adverse effects of human presence; 3) fires; 4) disease 5) windthrow; 6) predation; 7) catastrophes; 8) low density effects; 9) global climatic change; 10) construction impacts (from the observatory); 11) population inconsistencies; 12) trade-off of long term versus short term effects. Many of these are related and we chose to group them into the following categories:

1) Natural Limitations

2) Effects Of Human Actions

3) Global Disasters

Obviously only human action will preserve the red squirrel from the effects of natural limitations (category 1). On the other hand if human action (category 2) is threatening the species, then change is required. Global disasters can of course only be dealt with in a global fashion, so we would not expect these to figure prominently in a recovery plan for the red squirrel. These overall categories will form the basis of the subsequent discussion. We first review basic information (some of it only recently acquired) that appears relevant to this discussion and which is, for the most part, missing from the recovery plan.

III Natural Limitations

3.1 Sky Island Populations

The tree squirrels of the sky islands of S. Arizona all exist in a marginal habitat, which is barely able to support a single species. The smaller sky islands have no tree squirrels at all, even though colonization from one sky island to another nearby has been demonstrated to occur. Further, this state existed at the time of the first biological investigations, and shows that man is not responsible for this marginal habitat.

These squirrel populations are likely to be essentially homozygous. This means that an extinction event is not a two stage event as with a heterozygous population, first reducing genetic variety, and then, as a result of reduced viability, a decline into extinction. Here instead there is

expected to be a single key precipitating circumstance. In the case of the Mt. Graham red squirrel, the availability of food is likely to be the key factor.

Huge population swings in response to changing food availability are well known for squirrels especially at the geographical limits of their range. They are well documented for Mt. Graham red squirrels, especially within the spruce/fir habitat where population has responded directly to the cone crop since monitoring began in 1986. In a small habitat with strongly varying food supply, the population may fail to retain a breeding pair, and so becomes extinct. The surviving population decreases far faster than the food supply, because those that starve to death, also eat before they die. It is clear that even a relatively large population, as large as Mt. Graham could support under current climatic conditions (500 - 1000), is not immune to an extinction event caused basically by food shortage.

For the Mt. Graham Red Squirrel, the near-extinction event of the late 1950s appears to be associated with food shortage due to extreme drought and one or two resultant large forest fires. Indeed the squirrel was not seen for several years and was thought to have been extirpated. The population must have been substantially below the 150 squirrels estimated for the spring of 1989. The squirrel nonetheless made a rapid recovery and became quite prevalent during the early 1970s. Similarly the population recovered rapidly after 1990 when there was a very good cone crop. Food supply rather than human influences seems to be crucial. Thus, for example, red squirrels were also very rare in 1929 when very little forest cutting had taken place, and human activity on Mt. Graham was still insignificant. It is also possible that disease could weaken the population so that a single somewhat less severe circumstance could precipitate extinction, but this does not negate the point.

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But near extinction events are not expected to be common. Indeed, the population has survived for the last 25 years without any significant assistance even after substantial alterations to its habitat (see section IV). And, of course it has probably survived for approximately 10,000 years before. The situation is similar to other small mammal populations of S.W. mountain islands, where there is evidence of continuing extinction events between the end of the Pleistocene and today. Even with no human presence on the mountain, the Mt. Graham red squirrel would be threatened. Its survival can only be guaranteed by human intervention at times of extremely short food supply. However, if the squirrel is given

occasional assistance at times of greatest need, it can survive in the wild for essentially as long as man desires.

The draft states that the stabilization criterion is to provide sufficient habitat to maintain a population of squirrels never fluctuating below 300 adults distributed throughout the Pinalenos. There is no evidence in the report that this can be achieved without continuing human intervention and much evidence from the historical record that it cannot. Such a goal can be achieved only if food supply is guaranteed in times of extended and general cone crop failures. The absence of any discussion of supplementary feeding is a serious weakness of the draft and should be corrected in the final - or alternatively the stated goal should be revised.

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3.2 Relative Habitat Quality/Squirrel Population Distribution

In developing the recovery plan, the natural population and distribution of squirrels is a key ingredient since it provides important data on the relative quality of different habitat. At the time of the Biological Opinion resulting from the Mt. Graham International Observatory proposal, the USFWS conservatively assumed that the spruce/fir forest, where the observatory was to be located, was critical to the survival of the red squirrel. Initial surveys also focused on this region above approximately 10,000 feet. The squirrel population figures were estimated on this basis (using a habitat quality index which reflected expected population density). Estimated population figures fell below 150. The "refugium" and the adopted critical habitat largely cover this same area, although there is little scientific evidence to support either designation.

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In subsequent years, it has been possible to study the distribution of squirrels more thoroughly albeit only down to an elevation of roughly 9000 feet, well above the lowest known squirrel middens. It is now possible to provide some reassessment of these original assumptions. The draft document contains some of this new information on total population but not in a form which permits local changes in population density to be separated from changes in total area surveyed. However, in the absence of additional information, analysis of table 1 suggests some remarkable conclusions.

For the 1986 survey, 1151 ha were studied, and a mean density of 0.18 middens per ha were found. To spring 1990, an additional 716 ha were surveyed, and the middens known were increased by 83, or 0.12

middens per ha. By fall of 1990, a further 1180 ha were surveyed, and the number increased by 141, again 0.12 middens per ha. In the fall of 1991, a further 1011 ha had been surveyed, and a further 117 middens were found, again at a rate of 0.12 middens per ha. Thus the rate of discovery has not appreciably decreased, even though the area surveyed has increased almost fourfold and now includes nearly all the area that was previously deemed to have any potential at all as squirrel habitat. The data as presented would suggest that further extension of the area surveyed could substantially increase the squirrel counts. Indeed, the map on p.6 seems to show that although the squirrel distribution is spotty, and sometimes in streamers, the squirrels extend out to the limits of the surveyed area as though it is the survey that limits the numbers rather than the total population. This appears to be particularly true of the population on the NE side of the range.

It would be helpful to know how much of the increase in midden numbers occurred in previously surveyed areas. It would then be possible to give a prediction of the numbers of middens remaining to be discovered in all areas. Certainly the numbers suggest that an effort should be made to survey the regions between 8000 and 9000 feet.

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The data can then be used to assess true habitat quality and to decide whether the population density (habitat quality) in newly explored territory is essentially as good as the higher elevations as would appear, prima facie, to be the case . It is stated that this data change will be reflected in a new map that shows habitat suitability. Certainly the current distribution does not fit well with habitat suitability previously shown. This is important because the current data, and the discussion below both suggest that the lower elevations are more important to the survival than previously thought and perhaps more important than the spruce/fir. (Winter aerial photographs of the Pinalenos seem to show a much more distinctive appearance with foliage density, and it would be worth exploring the use of these photographs for habitat typing.) The concern is reflected in the changing number of middens assumed to be on Mt. Graham. Currently (table 1) there are 549 middens known on Mt. Graham, with some 85% of the area mapped where squirrels are expected. On this basis one might expect about 650 middens on the mountain. This is compared to the habitat analysis on p. 5 which is too low by 50%, because habitat formerly assumed to be unsuitable has been found to be suitable. One wonders whether enough assumed "unsuitable" habitat has been surveyed to assure us that it is indeed unsuitable.

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101 *The recovery plan would be significantly improved through inclusion of statistics of squirrel population per region surveyed and should if possible contain revised estimates of habitat quality.*

In any event, the observations (e.g. Froehlich and Smith(1990)) suggest that the population of red squirrels is substantial in areas other than the spruce-fir "refugium". Thus, both observation and theoretical analysis lead us to question whether the spruce-fir is critical to the survival of the red squirrel when times are difficult. Although spruce appears to be a favorite food for red squirrels, it is at its geographic limit on Mt. Graham. Even in climatically favorable areas, spruce is a highly unpredictable crop, so on Mt. Graham it swings erratically between boom and bust - with factors of around 100 in annual cone crop and hence food supply. Further, the spruce forest provides little alternative for the squirrel during the "bust" years. The spruce/fir squirrel population can be expected and is observed to vary wildly and in particular to crash after two or three successive years of poor cone crops -- a not uncommon occurrence. The number of middens in the spruce is then a reasonable measure of boom periods, but it is not a predictor of the importance of the spruce when the squirrel is at greatest risk. The spruce/fir middens then
102 become the squirrel equivalent of a ghost town. Instead we must expect that those areas with the greatest variety of squirrel foods will be important at critical times because cone crops of different trees will have a degree of independence. Thus one expects that the mixed conifer forest would be the region where the squirrel would have the greatest chance of surviving. It may not have such a high density of middens, because trees will be out of synchronism at their boom periods as well as their bust.

The observations collected by Spicer (1986) appear to confirm this analysis. The squirrel population in the spruce fir *on* Mt. Graham was abundant in 1918, and in the late 1970s and early 1980s. At other times, mammologists have been unable to find squirrels there, while signs or squirrels have been found at lower elevations, typically between 8,000 and 9,500 ft. where there is mixed conifer. (Unfortunately it is in exactly this area where survival competition between Abert's squirrels and Red squirrels is most likely to occur: see the discussion below). The most recent confirmation of the importance of the mixed conifer in critical times comes from the observations of the UA squirrel monitoring team led by Paul Young, which found substantial numbers of squirrels in the mixed conifer at times when the spruce/fir squirrel population was very low.

From the perspective of habitat quality, it appears that the spruce forest is almost irrelevant to the survival of the squirrel. Its population fluctuates too erratically with cone crop. Survival depends on the steadier food supply at lower elevations. If so, the principal reason for the "refugium" and critical habitat designation of the spruce/fir forest requires re-evaluation.

3.3 Fire

Fires are one of the greatest present risks to the red squirrel. At present the Forest Service has a policy of strict fire suppression. However, experience indicates that such a policy is not proof against development of a catastrophic fire. The recovery plan correctly focuses attention on reducing the risk of fire in the mixed conifer which is most important to the survival of the squirrel. This is an example of human intervention
103 benefitting the squirrel. However, it requires that potential squirrel habitat be made available for fire breaks, access etc. and a suitable compromise must therefore be reached with the requirement to extend habitat.

It is also possible to contemplate establishment of a separate population as protection against a disastrous fire. This should be addressed in the recovery plan and potential sites identified. One possibility is at the N.W. end of the Pinalenos in the region of Blue Jay Peak.

3.4 Disease

Direct transmission of disease from one squirrel to another tends to be limited by the territorial behavior of red squirrels. For this reason, the highest risk is likely to come by some other animal or bird carrying the disease. Fortunately the isolated characteristics of sky islands tends to make the transportation of disease less likely.

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The possibility of transporting disease must be taken into account in planning where to set up a second red squirrel population if this is undertaken. It is the one reason that the N.W. peaks of the Pinalenos may be less desirable than more distant peaks.

3.5 Predation

Predation is a self-limiting process where the reduction in numbers of the prey results in a succeeding loss in numbers of the predators. Because
104 the red squirrel is so sparsely scattered over Mt. Graham, it is not a principal food for any other species, and it can be expected to be taken incidentally.

To date squirrel birth rates appear adequate to deal with current rates of predation, and still provide for rapid expansion of the population in times
8 of food excess. Certainly when the population becomes very small, predation becomes a possible mechanism for extirpation. However, provision of food can ensure that the population is not permitted to reach such low levels that occasional predation becomes critical.

3.6 Windthrow

Windthrow on Mt. Graham is of possible concern for those areas most exposed to high winds. These tend to be places where the ground is very rocky with limited soil, and where the prevailing westerly winds hit exposed areas. This applies to the western peaks and ridges of the mountain. Even here the effect seems to be small compared to other impacts on habitat.
102

In contrast, the squirrel critical areas for survival tend to be in mixed conifer habitat as discussed above, which is lower on the mountain. At these lower elevations, middens are preferentially found *on* northern and eastern exposures where the natural refrigeration action preserves cones from sprouting and spoilage.

It is concluded that wind throw is irrelevant to the survival of the squirrel.

IV The Effect of Human Intervention

A number of human activities have affected or can potentially affect the red squirrel. As interest in the red squirrel grew following the proposal for the MGIO, these concerns have tended to focus primarily on loss of habitat from logging, construction or recreation activities and potential disturbance to the squirrel directly from human presence (eg noise

generation etc). Indeed part of the purpose of the "refugium" recommended in the Biological Opinion was to provide a region where the squirrel would not be bothered by human presence in case such disturbance should prove to be an important factor. Other human impacts include the Abert's squirrel which was introduced to the mountain in the 1940's, presence of vehicular traffic, fire management policies etc. We examine some of these in the following.

4.1 Habitat Loss

The most extensive loss of habitat has arisen from logging activities which took place mainly in the 1960s although it began in the last century. In comparison, habitat loss to other human activities, such as recreation, access roads,construction etc. has been relatively modest. While clear cut area is relatively modest, selective cutting of mature trees was widespread. A total of some 2000 ha may well have been affected and is now in varying stages of recovery. The effect of this on the squirrel is still uncertain but, as noted above, the squirrel population did recover rapidly in the 1970s, after its near extinction event of the late 1950s/early 1960s even though most of the logging had by then taken place. This is consistent with the view expressed above, that the squirrel is threatened not by the extent of its habitat but by the fact that from time to time this habitat fails to produce anywhere near an adequate supply of food. While reforestation of logged areas will bring some benefit to the
98 squirrel -- and should be undertaken for more general reasons -- it can bring at most a factor 1.5 increase in squirrel habitat. This is a trivial factor in the face of the gigantic fluctuations that can occur in cone crop. The basic problem would remain *even* if every acre of land were returned to its natural state. There is, a fortiori, no reason to insist that the relatively minor areas used for fire management, access, organized recreation or scientific research should be sacrificed, because the areas involved amount only to a few percent of the total and will bring no real benefit to the squirrel in times of difficulty. They will of course raise by a few percent the number of squirrels when food supplies are plentiful and when the squirrel is in no difficulty.

It is concluded that the benefits to the squirrel of reforestation have been overstated in the draft recovery plan and are unlikely to have any significant impact on the survival of the squirrel. In their extreme form (no tree cutting for any purpose) they appear to be largely punitive.

It is also appropriate to consider reforestation policies in different habitats. From the discussion of section 3.2, it is clear that any reforestation efforts would best be focused on the mixed conifer and transition zones which provide the more stable squirrel habitat and which therefore play a key role in the survival of the squirrel. By contrast, the spruce/fir is so unstable in food supply that increased acreage in this region is unlikely to be of any help to the squirrel in times of difficulty. Modest tree cutting in this region should be viewed as entirely acceptable in regard to the survival of the squirrel.

The recovery plan errs in stating that further tree cutting in the spruce/fir is to be avoided. In reality, such cutting would have virtually no impact on squirrel survival. In so far as restrictions on tree cutting serve any useful survival function, they should apply to the mixed conifer zone.

4.2 Disturbance Caused by Human Presence

Part of the concern expressed in the Biological Opinion was in regard to possible adverse effects of human presence in squirrel habitat. Such concerns were one reason for establishing the 'refugium". As a result of studies that have taken place in the last four years, in particular the observations of the squirrel monitoring team under the leadership of Dr. Paul Young, it is now known that human presence appears to have no significant adverse effects on the squirrel. The results were obtained during the construction of the new observatory road, clearing telescope sites, and excavating and building foundations for telescopes, activities which have surely been more disturbing than a the transit of pedestrians across red squirrel territory. And yet the squirrel was not measurably disturbed by these activities. (Indeed, the greatest attention the squirrel paid to a disturbing noise was to the overflight of a helicopter!)

This is consistent with the behavior of red squirrels elsewhere. We therefore concur with the conclusion of Appendix B of the draft, that there is no need to restrict hiking, camping and similar activities in the "refugium" and question the need for a **"refugium"at** all.

*Restrictions on the public use of the "refugium" can be relaxed for two reasons. First as noted above, the spruce/fir habitat of the "refugium" is nor **particularly** important to the survival of **the** squirrel -- contrary to previous belief. Second, the squirrel does not appear to need protection from disturbance through normal human activities. In the absence of any coherent reason for maintaining the "refugium", the recovery plan should recommend that it be eliminated.*

4.3 Barriers to Migration.

There have been concerns that human activity may have resulted in the erection of barriers to migration and that this might affect breeding and hence squirrel survival. Those concerns might even be enhanced from those models of the squirrel population which assume that the population may be limited mainly by breeding statistics (demographic stochasticity). These concerns can be allayed in regard to the red squirrel.

First, observations of the squirrel population have included a recovery from poor cone crops in which the population has made a rapid expansion. Such a recovery would be a long drawn out affair if the population were limited by breeding statistics. Instead, the observed rapid recovery shows that the squirrel population is limited by food availability, and can rapidly expand if more food becomes available (see section 3.1). Thus there are possibilities or rapid expansion regardless of migration, and a small population is more secure than might have been previously assumed.

It also appears that concerns about the migration of squirrels being limited by human action have been overdrawn. Barriers to migration are
106 those things that prevent squirrels from migrating rather than those things we might imagine as being barriers. Only empirical studies can reveal what barriers are real and what are imaginary. There are now direct observations that suggest that most previously assumed barriers on Mt. Graham are not problem barriers for the squirrel. · The first concerns the migration of squirrels over fire breaks in the spruce/fir forest near the observatory site during the phase of rapid population growth in 1990. The monitoring team noted no significant effect of such a barrier and even reported sightings of squirrels in the open area. The second involves the relatively isolated population between Ladybug Saddle and Turkey Flat. This group is over a mile away from the nearest other population at the top of Wet Canyon. But the Wildlife Staff Officer of the Coronado Forest observed juvenile squirrels even further away. These were near the Swift Trail, below Turkey Flat at an elevation of 7,200 ft. Between them and their source, presumably above Turkey Flat, lay the S-bends of the Swift Trail, and the 80 summer cottages of Turkey Flat, with their human inhabitants and pets. Yet the juveniles apparently negotiated these barriers. Also there have been observations reported of red squirrels in relatively open areas, so that open areas are apparently not a severe barrier either.

Another observation has been that small isolated groups appear to persist even when the overall population is greatly reduced. Thus the presence of a population near Turkey Flat has been known since 1929, and the population on Grant Hill has been known since 1952, both of them being times at which the overall population was small. If travel between colonies was reduced, one would expect that statistical breeding accidents would eliminate these populations first at times of difficulty for the creature. The observations show that this is not the case.

106 Some observations do show barriers to migration. The West Peak/Blue Jay Peak area was reported in use by the squirrel in the 1960s, but this area appears to have remained unpopulated for the past several years. However, this area of the mountain is isolated by a long rocky ridge, that represents a more severe barrier than any constructed by human activity.

I conclude that there is no evidence for significant limits to migration of red squirrels arising from barriers created by human activity.

4.4 The Abert's Squirrel

In the 1940s, the Abert's (tassel-eared) squirrel was introduced to Mt. Graham and has since established itself throughout the coniferous forest. It seems to have taken over the ponderosa pine at lower elevations but has been observed throughout the mixed conifer and the spruce/fir (see recovery plan). It thus extends over some 12,000 ha. It also eats the same cones as the red squirrel and has been observed to rob red squirrel middens although the red squirrel owner usually succeeds in driving it away. There seems to be little doubt that the Abert's squirrel has a significant impact on red squirrel food supply. For a species that is food supply limited this is a serious matter. The possibility exists that it may have driven the red squirrel out of the ponderosa pine zone
107 although it is not yet known whether this would seriously impact the survival of the red squirrel.

More seriously, the sky island sites in the south west are apparently capable of supporting naturally at most one species of tree squirrel. The best evidence comes from the application of an Area-Species plot. This reveals that the size of minimal habitat for natural retention of a single tree squirrel species is not much less than the size of the Mt. Graham forest. Such an analysis obviously includes the effects of population fluctuations. It then follows that, in the absence of further human

intervention one of the two species there at present will die out. Deliberate extirpation of the Abert's population seems difficult if not impossible.

107 *The conclusion is that preservation of both red squirrels and Abett's squirrels on Mt. Graham can only occur with monitoring and occasional intervention. The recovery plan for the red squirrel should include plans for monitoring the interaction between it and the Abert's squirrel, a policy on whether to preserve the endemic species and, if so a means for so doing.*

4.5 Global Catastrophes

A catastrophe is an event of such magnitude and unexpectedness that planning for it is impossible. Thus in event of nuclear war, for example, all schemes for the preservation of endangered species are likely to fail. Equally, if there is a collision of a small asteroid with the Earth as happened at the end of the Cretaceous, massive extinctions can be expected to occur. The Endangered Species Act is not planned to cover such eventualities. (In the past, such massive extinctions have occurred,
108 but Nature has adequately restocked the Earth with new species.)

Global climatic change can have natural as well as man made origins. It has been a constant of the Earth's history. If it occurs slowly enough it will result in the Mt. Graham forest migrating up or down the mountain side, and the squirrel will move with it as it has done in the past. If, however, it occurs on a rapid time-scale, the scene will be catastrophic and well beyond anything that can be regulated by the Endangered Species Act. Certainly neither scenario is reasonable content for this recovery plan.

VI. Principal Conclusions

The Mt. Graham Red Squirrel is threatened principally by natural but large fluctuations in food supply, not by past or planned actions of humans.

A recovery plan for the Mt. Graham Red Squirrel can at best restore it to a position where it is for the bulk of its time without need of intervention. The key ingredient of a recovery plan must, therefore, be readiness to intervene.

Intervention must include supplementary feeding at times of very poor cone crop; such intervention is not expected to be needed frequently.

An essential requirement for occasional but successful intervention is a continuing monitoring program.

While it is appropriate to reforest areas previously impacted by logging, fires, or other means, it is not essential and perhaps even detrimental to carry out such reforestation to the exclusion of other considerations (eg. fire suppression, monitoring access).

Reforestation efforts should focus on the mixed conifer rather than the spruce/fir in view of the latter's unstable and unreliable cone crop production. It should also focus on Northern and Eastern slopes where midden natural refrigeration is most effective.

From the perspective of red squirrel survival, there is no reason either of habitat quality or of need for isolation from human disturbance to retain the "refugium". The recovery plan should recommend its elimination.

There is no evidence that normal human activities pose a threat to the squirrel. Such activities should accordingly be permitted to resume.

A decision is required on whether intervention to ensure the survival of the red squirrel against the introduced Abet-t's squirrel is possible and/or appropriate.

If the purpose is to ensure the survival of the squirrel, consideration should be given to establishing a separate population as a back-up in case of accidental failure. The optimum for this is to maintain a separate population on a second isolated smaller forest. Such a group will of course require a higher level of intervention, but it can still remain essentially in the wild. It is suggested that the northernmost peaks of the Pinalenos could themselves serve as home for such a back-up colony.

It is necessary to plan for a proper development of the forest, so that fire risk is not unacceptably high, and that fires will remain small.

N.J. Woolf September 1992

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U.S. FISH AND WILDLIFE SERVICE
C/O Rich Kvale, District Ranger
Coronado National Forest
Safford, Arizona

The people of Graham County have and will continue to assert our rights of access on roads that were fully available to our vehicular use prior to 1990. This report and draft appears designed to further degrade our way of life 2nd flies in the face of our protection under the 9th 2nd 10th amendments of the constitution.

We welcome biclogical study and involvment of the sciences on Mt. Graham but not to the exclusion of human freedom to access 2nd the traditional uses this area has provided for generations.

109 This study and proposal goes to far in its access denials based on its own admissions cf incomleteness and the presumption of what habitats the squirrel may or may not be adaptable to.

Again I state that Graham County citizens 2nd all humans should first have full access rights restored as they were with the squirrel's habitat held in the second position.

Finally concerning any further road or are2 restrictions, we demand a full review cf any such proposals be held with our county officials 2nd a public forum be called with our citizens as well as complying with all NEPA regulations.

Cordialy,

C.D. Cochran, President
Graham County Chapter of People For The West
Safford Arizona

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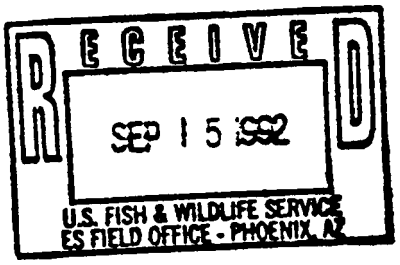

Mr. Sam F. Spiller
Field Supervisor
U.S. Department of Interior
Fish and Wildlife Service
3616 W. Thomas, Suite #6
Phoenix, AZ 85019

Dear Sam:

The University of Arizona was most pleased to receive a copy of the draft Recovery Plan for the Mt. Graham Red Squirrel. We have reviewed your draft recovery plan in substantial detail and will comment through several venues.

First, and probably most important to the technical aspects of the plans you will be receiving a detailed critique from the Mt. Graham Red Squirrel Biology Team. As you are aware, the Biology Team has substantial first hand experience with the Mt. Graham Red Squirrel and will provide some very useful comments which should greatly facilitate having an effective recovery plan. In addition I would like to address several more generic issues in order to contribute to the recovery plan in a constructive and productive fashion.

The recovery plan only makes brief mention of the Arizona-Idaho Conservation Act (Public Law 100-696) and does not mention at all the one-hundred fifty (150) acre "Mount Graham International Observatory Site" referred to and described in article 601(b) of the Act. This area is depicted on the Forest Service Map adopted by article 601(b) and should be included, preferably superimposed, on the map of the Habitat Management Zones. In addition, specific mention of the Observatory site and the University's right to use up to twenty-four (24) acres within that site for astrophysical research purposes should be mentioned and provided for in the recovery plan. It is important that the recovery plan acknowledge and incorporate into its fabric the reality of the Mt. Graham International Observatory and the management opportunities presented by the monitoring teams data base as well as the research opportunities afforded by the funds made available to the Biological Study Team.

The plan as currently drafted does not set forth specific "down-listing or de-listing criteria", this is unusual for recovery plans since most contain trigger points at which an endangered species will be down-graded to threatened and a further point at which threatened species will be removed from the list altogether. This omission is of pivotal importance since, no matter how many Red Squirrels inhabit the mountain, we will never know whether the population is viable unless specific criteria are established.

As discussed above the draft plan fails to mention its relationship to the Arizona-Idaho Conservation Act (AICA). Moreover, no mention is made of the Forest Service Special Use Permit and the Observatory Management Plan mandated by the Act. Since the Recovery Plan is subsidiary to the AICA and its provisions, it must not contravene them in any way that substantially interferes with the intent of Congress and the passing of the Conservation Act.

110 Specifically, the AICA provides for construction of three telescopes, roads and facilities. The Act also provides the criteria for future approval of additional observatory facilities, up to seven telescopes using up to 24 acres of Red Squirrel Habitat. The Recovery Plan cannot impose a general prohibition on approved tree cutting in the designated Observatory Site.

The plan appears unduly focused on total habitat conservation for a single species. While the restoration of squirrel habitat is appropriate in so far as it provides a significant increase in food supply, it is simplistic to insist that no trees at all should be cut down in the future. The marginal benefit of a few extra trees must surely be compared with other factors, such as access for fire management, which may be far more beneficial to the squirrel. The use of
111 acreage for other purposes, including access for recreation, scientific research and forest management purposes should be assessed on a cost benefit basis. Such use should also be placed in perspective with natural losses of habitat, due to fire, damage by storms, bears etc. which, on a cumulative basis, are far more significant to the squirrel. In any event, these considerations should be documented in the recovery plan.

We would prefer to see the plan acknowledge the need to preserve the right of Native Americans to exercise their religious activities if they desire to. We realize that by removing constraints on access to the "critical habitat" this will be accomplished defacto. However, it is our belief that a statement addressing this important point needs to be in the plan. We would also like to stress that we are extremely pleased that during the first three years of multi-agency cooperation between the Fish and Wildlife Service, Arizona Game and Fish, Forest Service and University of Arizona, the official census figures for the red squirrel have more than doubled. Having spent over $600,000.00 in the last three
10 plus year for squirrel monitoring and squirrel biology, we are committed to continue working with federal and state agencies on biological matters relating to the Observatory site. It is my view that these expenditures have created to date a data base unparalleled in the monitoring and study of endangered populations. This coupled with the proposed University of Arizona expenditures over the next six years provides a unique opportunity to obtain high quality quantitative data on an endangered subspecies and its recovery.

We trust that our comments concerning the recovery plan will be considered and incorporated as appropriate. We share with you the strong belief that an adequate recovery plan will go a long ways towards maintaining the Mt. Graham Red Squirrel and developing approaches that will be applicable with other endangered populations. Please feel free to contact me if I can provide any further information on the points raised here.

Sincerely,

Michael A. Cusanovich
Interim Sr. Vice President for Academic Affairs and Provost

MAC/ft

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8 September 1992

Mr. Sam Spiller, Field Supervisor
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Phoenix, AZ 85019

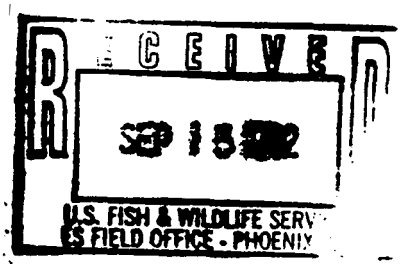
Dear Sir:

We appreciate the opportunity to review the July 22, 1992 Draft Recovery Plan for the Mt. Graham red squirrel. Unfortunately, we have found it a difficult task because the document lacks comprehensive organization. The writing style is awkward and verbose; many statements are redundant. It does not follow the GPO Style Manual guidelines, nor do literature citations follow the recommended format. The document contains an overwhelming amount of imperative, unsubstantiated, biased, or emotional statements, which are not appropriate for a document released by the Federal Government for public review.

Some data and information sources are poorly or inaccurately cited, which prevents retrieval of references. For reader information, the location of unpublished sources should be specified. Data collected by the University of Arizona - Mt. Graham Red Squirrel Monitoring Program were inaccurately represented and inappropriately attributed to personal communication. The appropriate report(s) from the monitoring program should be cited as the source(s) of the authors' information.

The authors are inconsistent in their use of units of measure and have made conversion errors. Similarly, references to forest habitats are inconsistent, alternately referred to as "associations", "types", or "zones". No source is cited for the vegetation classification system, nor do the authors provide a description of the vegetation. There is also inconsistent use of common names for Tamiasciurus hudsonicus grahamensis and for Sciurus aberti.

The Draft Recovery Plan contains considerable speculation about potential hazards to the Mt. Graham red squirrel population with little or no reference to supporting documentation. There are no specific management goals, only ambiguous statements. Management and recovery goals must be clearly stated so there is no dispute when they are achieved. Obscurely stated goals have the potential for manipulation.



There is no plan, other than habitat rehabilitation through reforestation, to increase or expand the range of the red squirrel population on the Pinaleño Mountains. The considerable
31 body of literature on the management of tree squirrels has not, apparently, been accessed. "Further study" is an unacceptable criterion when the Coronado National Forest is commanded to begin immediate action on various land closures, reforestation, etc.

The absence of any discussion concerning the current and future plans for astrophysical development on the Pinaleños is conspicuous. Because the development of the Mt. Graham International Observatory is a very controversial topic, potential problems associated with the project should be specifically addressed in the plan.

61 The U.S. Fish and Wildlife Service has the responsibility to provide clearly defined objectives and goals, based on the best available information, that will most likely lead to the recovery of the Mt. Graham red squirrel. We do not feel that this Draft Recovery Plan provides that direction.

Sincerely,

Paul J. Young
Asst. Research Scientist

H. Reed Sanderson
Resident Biologist

Dept. of Ecol. & Evol. Biology
University of Arizona
Tucson AZ 85721

cc: Dr. M. Cusanovich, VP for Research, U of A

Please note: Enclosed are our detailed comments regarding the Draft Recovery Plan for the Mt. Graham Red Squirrel

Review and Comments of Mt. Graham Red Squirrel
Draft Recovery Plan

Prepared by:
Paul J. Young, University of Arizona
H. Reed Sanderson, University of Arizona

Numbers refer to specific comments indicated by circled numbers on copy of Draft. Some editorial comments have been noted directly on the copy of the Draft:

1 This is an imperative statement that does not allow for exceptions.

1 2 Define "habitat ecology".

3 How can a Recovery Plan be written without knowing, or at least hypothesizing, the requirements for recovery? The fact that the plan was written suggests that some of the requirements for recovery are known.

112 Some logged habitat will have. sufficiently mature trees to support red squirrels in much less time than 100 years. Why is there no comparison with red squirrel populations on nearby mountain ranges in logged habitat?

94 4 Either delete, due to irrelevance, or move to paragraph on the following page with other size description.

5 Figure 1 shows the distribution of red squirrels in Arizona, this paragraph compares the size of two subspecies. Change figure to depict size, delete it, or refer to it in the first paragraph of this page, which describes the distribution.

6 "In press" infers that it has been accepted for publication,
1 yet no journal or publisher is listed in the literature cited.

7 The squirrels are not "confined" to the upper elevation. They are concentrated there, but are free to move around or expand into other areas.

45 8 Is the West Peak population isolated or ~~locally extinct~~? This sentence is contradictory and speculative. Map (Figure 2) does not show that West Peak or Blue Jay Peak have been surveyed.

113 9 What is the source of the density data? How current is it? Do areas used for the calculation of density include non-suitable habitat? This information is contrary to the

findings of the University of Arizona - Mt. Graham Red Squirrel Monitoring Program (UA-RSMP).

10 No data was solicited from Dr. Young and he did not provide any unpublished data directly to the Recovery Team. What is
113 the source of this data? The sentence is inaccurate and misleading based on current UA-RSMP data.

(11 Inconsistent use: are they forest associations or zones?

1

12 What is the elevation of the mixed-conifer association/zone?

13 Froehlich (1990) has insufficient data to determine whether this is "exceptional" or not. Her study was conducted
114 during a period of low food availability in spruce-fir, and no period of abundant food availability. The sample size in the study is small (9 squirrels, 29 middens).

14 Figure 2 is of very poor quality and virtually useless.
115 What do the black dots indicate? Why are West Peak and Blue Jay Peak not included? Were they surveyed?

15 How much habitat is potentially suitable for red squirrels?: 9083 ha in this paragraph, only 4750 ha in the following
1 paragraph. Later statements suggest that 85% of the potential habitat has been surveyed for **midden** sites, it is important to be consistent about how much habitat there is, or to indicate that such conclusions are tentative.

16 Has this been verified? How much of **the ponderosa** pine habitat was surveyed? Red squirrels on the Mogollon Rim,
116 White Mountains, and Sacramento Mountains use ponderosa pine. Why don't the Mt. Graham squirrels? Cite the source of the information, or indicate that such conclusions are speculative ***or*** tentative.

17 Inconsistent use of units of measure, SI units are used elsewhere.

1

18 What is the source for determining habitat quality on the basis of **midden** density? How was **midden** density determined, by transects, or survey,? Is density a reliable measure of habitat quality? (refer to Van Horne, B. 1983. J. Wildlf. Mngt. **47:893-901).** If density is used to estimate habitat quality, shouldn't the density of squirrels be used rather than **midden** sites, some of which may be abandoned? U.S. Forest Service personnel recently requested that the UA-RSMP not use these habitat rankings because they are "inaccurate".

2

19 What is "the habitat"? How many hectares? Cite source for
117 Habitat Capability Model.

20 Location of unpublished data? Title of report?

1 21 85% of ***9083 or 4750*** ha?

22 **Midden** establishment and abandonment is a normal occurrence.
How often are areas re-surveyed for newly established
118 **middens?** If areas are not re-surveyed, how does that affect
population and density estimates?

119 23 Does "remaining area" = unsurveyed area?

24 If these areas have "little or **no"** regeneration, how can
1 they be assessed for species composition?

25 How, or where, do food resources figure into estimates of
carrying capacity? Numerous studies have demonstrated the
120 regulation of red squirrel populations by food supply. Food
resources should be included in the analysis.

26 Will global warming **"slow"** succession or drastically alter
the entire habit? It seems likely that global warming could
shift plant communities to higher elevations. Is global
warming a realistic factor within the time frame of this
plan? If so, what can be done to mitigate its effects?
1

27 18% of 9083 or 4750 ha?

28 Is Transition part of mixed-conifer, or **a** separate
association?

29 Habitat zones or associations?

30 Inconsistent use **of** units of measure.

31 This paragraph is irrelevant and redundant. **Midden**
distribution is discussed previously, relative to habitat
121 type/association/zone, and habitat is discussed relative to
elevation.

32 Table 2 has no information on **midden** distribution by
1 elevation. This reference is not relevant to Table 2.

33 The discussion of **midden** use is discontinuous; first on page
93 5; then again on page 8. What is the purpose **of** this
discussion? That red squirrels change criteria for
selecting.midden sites, that **midden** site quality changes, or

that distribution of midden sites change with changes in habitat or other resources?

117 | 34 Location of source of data?

122 | 35 Are "new" middens newly established, or just newly discovered by surveys? Distinguish between these two possibilities.

1 | 36 Put total in separate column. Does inventoried mean "surveyed"?

123 | 37 Cite source of data (Mannan and Smith, 1991). Include values for random sites. Sample sizes and a measure of variance (standard deviation or range) should be included so the reader can determine the quality of the data.

1 | 38 Does habitat depend on these conditions, or do the squirrels?

93 | 39 Define closed canopy. What % canopy coverage in "closed".

1 | 40 The Mannan and Smith study was conducted in the Pinalefios, not in "other" red squirrel habitat.

124 | 41 Increased from what? Where is the comparison? Cite source for this statement.

| 42 Cite source of information.

1 | 43 The range of the red squirrel in the Pinaleño mountains lies roughly between 32°37'30'' and 32°45'00'' North latitude and, therefore, is closer to 33° than to 32°.

125 | 44 Figure 1 has no latitude (or longitude) reference. Cite source of information. This would be more appropriate in the discussion of distribution - page 3.

1 | 45 Cite source of information. Is this data collected from the Pinalefios? If so, where is the recording station?

126 | 46 Cite source. How much "greater" is insolation on the Pinaleño Mountains than at nearby areas such as the Mogollon Rim, White Mountains, Mogollon Mountains, Black Range, or the Sacramento Mountains? The Sacramento Mountains have red squirrel populations overlapping in latitude with the Pinalefios.

127 | 47 Speculative, cite data to support this contention.

'48 Speculative, neither of these studies examined the selection of **midden** sites by red squirrels. They describe
127 characteristics of sites relative to random sites.

49 What kind of nests, red squirrel ***nests?*** The first two
1 sentences would be better placed in behavior ***or*** ecology.

50 This study had a very small sample size (29 **middens** and only 9 squirrels). Grass nests may disintegrate rapidly,
128 therefore unoccupied **middens** may no longer have grass nests at them. Data from UA-RSMP indicates that the use of grass nests is common.

51 This should be based on the densities of squirrels and on food resources, not on the density of **midden** sites. This
1 statement contradicts a previous statement about the highest density of **middens** occurring in spruce-fir.

52 Froehlich (1990) suggests this, but has no data on the
127 availability of potential **midden** sites to support this statement; consequently, it is speculation.

53 Are these vegetation types, zones, or associations? Inconsistent reference to the mountain range, is Mt. Graham synonymous with Pinalefio? Mt. Graham is only one peak in the range according to U.S. Geological Survey topographic maps. **Pinaleño** Mtns. and Graham Mtns. may be acceptable synonyms, but not **"Mt.** Graham.
1

54 How does this differ from upper elevation mixed-conifer? Upper and lower mixed-conifer are not defined.

55 Unclear. **"As** the most important features" for distinguishing **midden** sites from random sites?

56 Habitat selection, or availability of suitable **midden** sites?
127 We do not know of any studies regarding habitat selection by Mt. Graham red squirrels.

57 See **Mannan** and Smith (1991): $\bar{x}$ canopy cover at **middens =** 85% (table 2 this document), and is the same as random sites
1 in Froehlich (1990). This is a contradiction that indicates a possibility of error.

58 Both paragraphs are awkward, rambling, and verbose; they
93 should be condensed and combined. Values for random sites are not included in Table 2.

59 How is the age of a "midden plot" determined? This should read "trees on midden plots". Why is there a range given for the average? There can be only one mean value; give the mean and a measure of variance.

1

60 Awkward wording. This reads as though the random plots were measuring something. Were the trees on the random plots found to be about the same age as those at midden sites in spruce fir, but not in mixed-conifer?

129 61 Is this paragraph a summary? It repeats the discussion on page 5.

52 In comparison to what? What was expected? Are middens disproportionately distributed in respect to orientation? What is the lower-elevation mixed conifer?

53 Cite source of statement.

54 Citation style differs from others for USDA-Forest Service. Have all of these food items been documented for Mt. Graham red squirrels, as implied? If not, cite sources of original data, not a review of the sources.

65 What is it about conifer seed that influences these life history traits: the amount of seeds, nutritional value, chemical composition? Cite the source of this information. What are eruptive dispersals?

1 66 Inconsistent reference to mountain range. This implies that the observation applies to only one peak on the range.

67 170 of what type of cones? The amount of food available to a squirrel from a cone varies greatly from one species of conifer to another. Miller's report does not distinguish between cones of different species. His estimate of the number of cones required is not based on data from the Pinaleños, but is derived from two other sources and is based on the average number of seeds in a lodgepole pine cone (not present on the Pinaleños). His estimate of the daily metabolic energy requirement of red squirrels is speculative and refers to no source. Such data, however, is available in the published literature.

68 Inconsistent use of units of measure.

69 Froehlich's (1990) behavior data is mostly anecdotal in nature. No standard methods were used to determine the amount of time a squirrel spent in any particular tree or

how many trees were used for food sources. Is this the average home range size, or the average number of trees used per hectare? Include sample size.

70 Cite source.

71 Why is it "unique"? Why "especially" in areas where Douglas-fir co-exists with Engelmann spruce? Cite source. The *use* of Douglas-fir cones by red squirrels is not uniaue to the Pinaleños, nor dependant on the presence of Engelmann Spruce. Red squirrels use Douglas-fir wherever it is available, see Finley, 1969.

72 "More widespread" compared to what?

73 What are broken habitats? Does this mean fragmented?

74 Why does this reduce its contribution to the food supply? If Douglas-fir occurs where red squirrels occur, it will contribute to the food supply. Just because red squirrels do not occupy all the habitat with Douglas-fir in it, does not reduce its contribution to the food supply in areas where red squirrels are present.

75 Cited source does not indicate this. Per cent values given in Froehlich (1990) refer to the number of times squirrels were seen feeding on fungi relative to the total number of times squirrels were seen feeding, and these data provide no basis to determine how much of the diet was fungi.

76 Cite source.

77 Cite source.

93 78 Inconsistent with other references to mountain range.

79 Unpublished data? Wouldn't it be more appropriate to quote this "personal communication" as "personal observation"? Are there data available to show preference? Preference should not be confused with availability, suitability, or necessity.

1 80 What does "most important season for mushrooms" mean? Is the season important for the mushrooms, or are the mushrooms important to the squirrels during this season? "Most important" is imperative; what data support this? Cite source.

93 81 Unpublished data? See 77 above. What are the species, is there a list? How are excavations of mushrooms by red squirrels distinguished from those by **Abert's** squirrels, chipmunks, or rock squirrels?

82 Discussion is disjointed; part of this discussion is at top of page.

83 February is not early spring. Cite source(s).

84 "Specialized" in what respect? Many rodents in temperate climates have only one day of receptivity during each oestrus cycle, and most mammals have comparably short oestrus cycles.

85 **Uphoff** (1990) conducted research on the **Mogollon** Rim in Arizona. **"The Rim"** is more appropriately described as
1 "central" and not "northern" Arizona.

86 Be specific; this is based on <u>one</u> ~~female~~ in ~~one year~~. Does this really mean two breeding seasons per year, or **do** some females have two litters during the breeding season in some years?

87 Don't confuse litters with breeding seasons (as per 86 above).

130 88 Cite original source. USDA 1988 is not original data.

89 Analysis of embryos, or examination of reproductive tracts?

30 Inconsistent usage; are these the **Pinaleño** squirrels or Mt. Graham squirrels? Does **Pinaleño** squirrels include the introduced **Abert's** squirrel and the rock squirrel?

91 Dr. Young was not asked for, and did not provide, any unpublished data to the Recovery Team. What is the source for this data? Cite specific **UA-RSMP** report, if that is the
1 source.

32 What observers? Cite source of the data.

33 Inaccurate. Squirrels may be sexually mature and breed for the first time following their first winter.

94 **"Virgin"** squirrels? Try **"primiparous"** for a less anthropomorphic approach, that emphasizes copulation and not sexual maturity.

131 95 Compare proportions of breeding adult and yearling squirrels. Cite source.

1 96 Cite source.

132 97 Delete, or specify how this data will be gathered.

98 This statement is nonsense! Hundreds of thousands of rodent population sizes have been estimated, many of them more accurately than the Mt. Graham red squirrel population. Population size estimates are a key component of almost every study of population ecology. Does this mean a complete count of the population size? Why is the Mt. Graham red squirrel so specifically unique from other red squirrels, that information from other populations does not
1 apply?

99 Table 3 lists only 11 population estimates. Which one is missing?

100 Why are there "original" and "revised" estimates? Which is correct? What is different for "minimum" and "maximum" estimates? The text does not explain how they are different
133 and does not imply that there should be a minimum and maximum estimate. How are two estimates derived from one sample?

101 Why were 40 middens arbitrarily excluded? Were all young-of-the-year excluded from the estimate? Were all newly created middens excluded, and if so, why3 Have the 40
134 excluded middens been included in subsequent estimates?

102 Table would be more useful if population sizes were given by habitat type/association/zone. The discussion of midden
133 distribution stresses the differences between habitats, but the discussion on population size avoids it. Include per cent occupancy in the table.

103 "Most biologists", have all biologists been surveyed or polled? Do 51% of them agree?

104 This statement elevates the sub-species to specific status. On what basis, cite source.

105 Why aren't population densities presented here? Midden
1 densities are equally in need of updating "using the most current data", and they are presented in the document.

106 Table 3 shows this to be 348 squirrels.

1 | 107 "extremely low" implies comparison; compared to what?

135 | 108 Cite specific source of data. The document implies that this work has been done since 1989, are there no reports on cone crops?

| 109 Dr. Young has had no personal communication with the Recovery Team since the autumn of 1989. Cite the source of this data - UA-RSMP report?

1 | 110 "also" implies comparison, or in addition, to something.

| 111 Explain how this "reflects" the increased population available for the 1991 reproductive season.

136 | 112 If population increase in 1990 was due to good cone crop, and the population continued to increase in 1991, what explanation is there for the decrease in numbers following the good spruce cone crop of 1986?

93 | 113 There are no solid data on historical numbers or distribution of squirrels in the Pinaleño Mountains. It should be made clear this is speculative, though it is pretty reasonable speculation.

| 114 Cite source, location of record?

| 115 "Also" implies in combination or comparison, with what?

| 116 This reads as though the logging and windthrow were done on behalf the squirrels. Is this is what was intended?

1 | 117 Inconsistent use of units of measure.

| 118 The forest edge does not provide the proper microhabitat, but middens occur in relatively dry sites -- including along forest edges.

137 | 119 Cite source. Is there data to show that narrow roads or small openings pose barriers to dispersal of red squirrels?

1 | 120 Inconsistent; these squirrels are also referred to as Abert's squirrels.

123 | 121 Cite source.

1 | 122 What do they do the rest of the year? This implies that they only gather food in the winter.

123 Cite source. On the Pinaleño Mtns., some Abert's squirrels live year-round at higher elevations (even on "High Peak"), where snow accumulation can exceed 3 meters. UA-RSMP
138 personnel have observed Abert's squirrels during every month of the year in spruce-fir habitat, they feed extensively on the cambium of spruce trees, and have been observed taking food (mushrooms and cones) from red squirrel midden sites. (This may be cited as "P. Young, U of A, pers. comm.).

139 124 "Severe" compared to what? Subjective wording. What "such severe conditions"? The conditions are not described at all.

127 125 Cite source.

126 The point of this sentence is not clear.

127 Wording is evasive, delete some qualifiers, make it more definitive.

1 128 "Potential" development can not result in habitat loss. Only actual development results in habitat loss.

127 129 How extensive is mushroom collecting on the Pinalefio Mtns? Is there any indication, or data, to show that this could be a problem?

1 130 Explain what this means: is the population viable or not? Was it not viable in the historical past? And if so, then how did it survive? Was it more viable before? This is a very confusing statement, what is the "historical evidence" used as a basis for the statement?

127 131 What support exists for this speculation?

1 132 Inconsistent use of units of measure and designation of habitat/vegetation types/associations/zones.

133 Conversion between SI and English units is not correct here, and elsewhere in the document. Which elevation is it?

61 134 What roads were closed and how many? How does building another new road help the red squirrel? add: "..new access road to the astrophysical complex that was specifically designed to minimize the impact on the red squirrel population and replaced FR 507 and 669."

1 135 Why reforest red squirrel habitat? Should this mean "to recover potential habitat"?

136 Be specific. What construction is being monitored? Construction of the visitor center, new camp ground, and equestrian area is not being monitored.

137 Define "survival crisis". What data are available to support the claim of detrimental effects of forest fragmentation on red squirrel populations? Cite sources.

138 Cite source.

139 Redundant. By preventing further habitat loss, fragmentation is already prevented. If this action is imperative ("The most important..."), why are new campgrounds and other recreational facilities being planned and constructed? This paragraph states an absolute need to protect even small pieces of habitat but does not seem to match current management practice, which is expansion of recreation sites. Define "suitable habitat".

140 Appendix B does not refer to squirrel densities. The zone designations in Appendix B are based on habitat structure. Data regarding squirrel densities are not provided anywhere in the document.

141 Define "Essential Habitat".

142 What is the basis for the road closures? Where are the data to support that road closures will benefit the squirrel population?

143 Reduction in the probability of crown fires involves removal of understory fuel and litter accumulation - perhaps by controlled burns? What effect will the removal of the understory and litter have on the red squirrel?

144 Are all unsuitable forests to be restored, or only those with potential to become red squirrel habitat? Is there information to suggest that reforestation is a viable action in all areas?

145 What does this statement mean? It implies that priorities have been made for something (not clear what), then lists forest successional stages. What is the point?

146 It is not always necessary to know how something works, just knowing that it does work is enough.

147 It is not clear why this is necessary, or how it will benefit the squirrel.

145 148 Define and describe what PVA is. Model based on estimated population parameters and resource characteristics.

149 This is a repeat of the last paragraph. Reorganize to delete duplication.

150 What does mitigation have to do with monitoring efforts? Give examples of how mitigation could be achieved.

146 151 Shouldn't a fire management plan be a part of this document (Recovery Plan)?

152 It is not necessary to know everything before proceeding with a recovery project. The knowledge currently available
147 should be used to initiate the plan, with adjustments made as necessary.

148 153 What makes 100 years a manageable period of time? Has any previous management plan ever endured for 100 years?

93 154 Repeats first paragraph on this page.

155 States information to produce a PVA is lacking, then proceeds to produce one.

156 Should explain that PVA's are based on computer simulation
1 and estimated parameters.

157 Reference is not listed in the Literature Cited.

158 Define "high" likelihood and "limited" latitude. Are there
149 specific probabilities or are they subjective? (Also applies to subjective statements in the following three paragraphs).

159 Footnote shows up in the middle of the next page.
1

160 How do the red squirrels expand their habitat? Should this say "the population might expand into new areas"?

161 What is the reason for having different estimates of the
150 size of the habitats?

151 162 Explain why they shouldn't be used for such a purpose.

163 Inconsistent habitat classification. New terminology
1 introduced here, but not defined.

152 164 Is USDA 1988 the review that is referred to? If not, then the source should be cited. Is there a separate report on this? If not, then include the review of the data in this document.

153 165 List size of "unsuitable" habitat.

154 166 It isn't clear where this 3560 ha is to come from. Is it part of the 4710 ha of unsuitable habitat above, or different areas?

1 167 This implies that midden sites move around, or else they wouldn't have to be tracked. Should this say "mapped"?

1.55 168 There are no squirrel density estimates in this document.

156 169 Evasive wording; there either *is* an estimate of carrying capacity or there isn't. What is the basis for using midden site density to estimate carrying capacity? Source? Shouldn't food resources be a part of this equation?

157 170 Evasive wording. Why does this section use squirrel densities to predict future carrying capacity, when the previous section used midden densities? Good to Excellent habitat is finally defined here - based, apparently, only on % canopy closure.

1 171 This statement is not clear. What is "expected fair quality habitat"?

158 172 Cite source.

159 173 This sentence is not clear. What are "multi-year irregular cycles"? Cycles implies regularity. Does wide variations in production refer to individual species or to the combined cone crop?

160 174 This paragraph is highly speculative. Table 3 shows an increase of 30% in 1990, concurrent with the good cone crop in that year, and a further increase over-winter. The population increased even more in 1991, without the benefit of a good cone crop.

1 175 Be more specific. What is "great expansion"? This paragraph starts by discussing food resources, then implies that habitat improvement is imperative for the survival of the sub-species. Based on the rest of the paragraph, this statement should refer to reducing the variability of the food resource.

161 I 176 This statement implies that conifer species are segregated into monotypic stands. Is this what was intended?

127 I 177 Speculation only. Is there any evidence to support such a scenario? If so, cite source.

162 178 Is this based on population dynamics modelling? If so cite source. What are **"small"** amounts ***of*** variation, and in what "factors"? What are **"large"** fluctuations in population growth rate? Annual variation in growth rates are normal for small mammal populations, and do not imply an unhealthy population.

127 179 This discussion is rambling, repetitive, and verbose. It should be condensed and reorganized to be more readable. Subjective terms, such as "greatly", **"large"** and **"small"** should be replaced by more precise figures or estimates, or the speculative nature of the conclusions should be made clear.

163 180 Replace subjective qualifiers.

1 I 181 Lower than what?

164 I 182 If this happens, then by definition the population is going extinct.

165 I 183 The Literature Cited section does not indicate where this reference is in press. Include publisher or journal.

184 Delete jargon or define what **"bottlenecked"** and **"homozygous"** mean.

185 Explain, N_e more fully; is it the number of breeding individuals as stated, or the number of breeding females as implied. Cite source for derivation of $N_e=0.5$. Cite sources of data used to calculate N_e. Re-write without

1 using jargon.

186 Inconsistent reference to Sciurus aberti. "Tassel-eared squirrel" is used previously.

i87 Delete **"spatial";** habitat is spatial in nature.

166 188 Seems very non-committal in light of the fact that the tassel-eared squirrel is introduced. What is **"significant"** competition? If the tassel-eared squirrel **is a competitive**

threat to the red squirrel, shouldn't efforts be made to remove or reduce their population?

1 | 189 Implies that the role of disease in the regulation of red squirrel populations has been investigated. If so, cite source, if not, reword to remove implication.

158 | 190 Cite source of information on the impact of fire on red squirrel habitat.

167 | 191 Is this a realistic response time considering the use of smoke jumpers, helitack crews, or aerial fire retardant drops?

1 | 192 Verbose and unsubstantiated. Cite source of fire risk in different habitats. Inconsistent reference to habitat type or zone.

168 | 193 Can't this be documented more precisely than "probably"? Cite source. How can 15,000 acres over 100 years be extrapolated from *10,000 acres over 40* years? This also infers that burned areas do not recover. Inconsistent use of units of measure.

93 | 194 Redundant.

127 | 195 Inconsistent reference to habitat types. Is there any authoritative source for this information?

163 | 196 Verbose and redundant.-

1 | 197 Carrying capacity is not static; it varies through time with the available resources, such as food supply.

127 | 198 Cite source. Potential for another ice age? Effect of continental drift? Volcanic activity?

169 | 199 Estimated maximum carrying capacity is based on habitat composition and number of known middens. Food resources should be incorporated as well as known distribution of squirrels.

200 Risk of what? This is not clear. Paragraph mentions no risk, so what is being increased?

1 | 201 Is this the same as carrying capacity?

163 | 202 Is this a personal opinion, or is it based on an analysis of some data base? Why wasn't this referred to in earlier treatment of PVA?

| 203 The entire summary and conclusion section uses evasive wording. Conclusions must be more specific if the Recovery Plan is to be useful.

170 | 204 It is not clear why the critical nature of habitat to the red squirrel requires the designation of management zones.

140 1205 Define "essential" habitat.

1 | 206 Does this plan exist? If not, why is it not included for development in this section?

171 | 207 Define "re-population" habitat.

172 | 208 Define "management flexibility". Is this a separate component of management?

163 | 209 It would be more appropriate to include PVA in the "management" section. It is a management tool, not research.

| 210 This is more appropriate under management.

31 | 211 This section develops many things, but implements nothing.

1 | 212 Immigration of habitat? Paragraph is awkward, verbose, and makes no clear statement.

173 | 213 What other measures; list them.

174 214 "Essential habitat" is not defined in this document; neither is "critical habitat".

170 | 215 How will designating management zones help stabilize the red squirrel population, and why is such designation "essential"?

1 | 216 This implies that current habitat does not provide security for the red squirrel population, and only recovered habitat will do so. Is this what was intended?

31 | 217 Schedule for implementation? The sentence becomes nonsensical by the use of "action(s)" twice.

218 Why only "monitor seedling growth rates and [e]ffects of thinning"? Thinning is not previously mentioned. What is the objective of thinning?

175

219 What is the objective of the proposed "quantitative habitat assessment"? The rest of the paragraph implies that a forest type map is all that is needed.

176

220 What is the objective of this statement? There are a variety of GIS formats;. it is not one system as implied here. The plan does not call for the collection or compilation of data for a GIS system. Use of a GIS system appears to be an afterthought.

31

221 What is the time frame for "regular" monitoring? Why only monitor occupied habitats?

222 Of what will such monitoring consist? What are the specific goals or objectives?

223 This section does not include any manaaement, only monitoring of the squirrel population and midden sites.

1

224 The title, "Monitoring" plan, implies that monitoring is included. It isn't clear why it is essential that monitoring be done by more than one agency.

177

225 At what point will the monitoring be discontinued; at what point will the population be increased and stabilized?

31

226 Previously surveyed areas should be re-surveyed to locate new middens. There is inconsistent reference to midden sites - now these are referred to as "food caches".

1

227 What are the objectives of this evaluation? Is it to be used to alter or adjust reforestation techniques? How often is "regularly"?

31

228 What are the objectives of this section? Is this to be used to implement supplemental feeding?

229 Road kill is not discussed in this document. How serious is it? Will the use of shuttles apply to all use of the mountain?

1

230 How does the suppression of fires fit in with the reduction of the potential for catastrophic fire? Are controlled burns not considered?

31

231 Nonsensical sentence.

232 What is "the stabilization process" and what has been "successfully" stabilized? Any management team for Mt. Graham red squirrel recovery should include personnel with experience and expertise in squirrel management.

233 List specifically what data are needed. When are these likely to be obtained? Will the time frame for collecting these data allow their use in implementing the recovery plan?

234 Inconsistent reference to forest association/type/zone.

235 How will this information affect the "stabilization" plan, which centers around protecting already identified "good to excellent" habitat? What can be done with this knowledge? How will knowing reproductive parameters influence the plan?

236 Population studies typically use the safest methods for trapping and handling the subject animals; to do otherwise jeopardizes the study. The methods used are determined by the objectives of the study.

237 Productivity of the habitat, or the squirrels? It isn't clear. Life history includes much more than "productivity".

238 Verbose and redundant.

239 Expand to explain how "improved" PVA's will be used, and include the objectives of genetic studies.

240 This paragraph makes no mention of midden characteristics. Didn't Mannan and Smith (1991) describe midden characteristics?

241 The objectives are vague: to determine the level of interspecific competition between tassel-eared squirrels and red squirrels, particularly concerning habitat partitioning and food resources? Again, inconsistent common name reference to Sciurus aberti. The currently accepted common name is Abert's squirrel (Jones, et al. 1992. Revised checklist of North American mammals north of Mexico. Occ. Papers, The Museum, Texas Tech University, 146:1-23)

242 The only habitat mentioned where tassel-eared squirrels are currently found, and red squirrels are not, is ponderosa

pine. This habitat falls into Zone 6, which indicates that it is not to be managed for red squirrels.

243 The critical low number should be specified, or else there is no objective for this section.

31

244 Supplemental feeding should be considered as a management tool for increasing the population, not as a last resort.

179 245 Delete "wild", it is unnecessary as the entire population is free-ranging.

163 246 Wording is not to the point; we suggest: Captive breeding techniques need to be developed now to insure success should this be determined to be necessary in the future.

180 247 The only catastrophe discussed is fire. Either suggest other potential catastrophes, or include this section in management.

248 Education efforts might raise public awareness but may not necessarily increase public support.

1 249 These should be implemented as well.

250 The use of inexperienced volunteers for monitoring could jeopardize the quality of the data collected. The use of volunteers should be limited and supervised.

251 Visitor Center is already operational. .

181 252 Redundant; signs already included in section 312.

165 253 As indicated above, "in Press" implies that the manuscript has already been accepted for publication. The journal or publisher should be identified to facilitate retrieval when it is finally published.

163 254 Redundant: extinction = declining irreversibly.

255 Define "significant".

133 256 Recovery requirements are not defined in this document.

1 257 Reference is not listed in Literature Cited. There is no Literature Cited for Appendix B.

163 258 Redundant. By definition, forest canopy is "overhead".

259 10 to 15 snags/ha = 4 to 6 snags/acre (not 406/ac).

260 Entire paragraph is poorly referenced. Good, poor, fair habitat not defined (only excellent is). Good to excellent habitat was earlier defined as having ≥ 60% canopy closure; this seems inconsistent with this definition.

182

261 The red squirrels' requirements are not likely to be modified by further research; our understanding and definition of them might change.

1

262 From the map, it appears that Zone 1 is defined on the basis of elevation and possibly on midden density. How do red squirrel densities correlate with elevation and midden density? What criteria were used to determine densities of middens? How were boundaries between zones determined? "High" densities is subjective, what are the specific criteria used to designate zones. Sensitivity to "direct" and "indirect" disturbances are mentioned for Zone 1, but not for subsequent Zones. What is the source for determining sensitivity to disturbance? Again, midden densities are an inappropriate substitute for actual squirrel densities.

183

263 What is the basis for this statement? What is the source for information on dispersal?

184

264 The Map shows some areas of existing human developments (Columbine Work Center, campgrounds, Turkey Flats are cabins) designated as Zone 7, but does not show other existing developed areas (Columbine summer homes, Bible camp, Heliograph Peak communications complex, Mt. Graham Observatory). Why are some developed areas considered while others are ignored?

185

MEMORANDUM

September 15, 1992

TO: Sam F. Spiller
U. S. Fish and Wildlife Service

FROM: Dr. Roger Angel, FRS
2730 E 9th St
Tucson, Arizona 85716

RE: Comments on the draft recovery plan for the Mt. Graham red squirrel

10 1. I agree with your proposal to reopen Mt. Graham to the public. This makes good sense, given that most squirrels live outside the "refugium".

2. The Draft reads like some ideas on how to write a plan, rather than a plan itself. I am amazed that the results of so much money spent on squirrel studies over the past ten years could not have been put together to make a scientifically based plan. For example, we are told that a population viability analysis is essential to predict short and long term persistence of the species, This sounds fine, it would be great to see a plan based on such an analysis. Instead, the few specifics of the plan seem to be points of dogma, rather than of reasoning.

186 Another example - short term contingency plans, on page 45. No plan is given at all, only urgings that plans, guidelines, procedures and a plan outlining strategies to be implemented be prepared.

In my career as a scientist I have written over 200 scientific papers, and reviewed hundreds of papers and gram proposals. In my field, the expenditure of this much public money could never be justified on such thin material,

Sept. 14, 1992

To whom it may Concern,

SEP 15 1992

My knowledge, experience, and feelings on the Recovery of the Red squirrel is as follows. The squirrel has no need to recover from anything, due to a lack of data. The many middens encountered near Roads and Trails, in my estimation, blows the theory that man is in any way causing a demise of population #'s

Having also encountered numerous squirrels in previously logged areas of the mountain tells me that those who have come up with the "Recovery" and "Restrictions" which the Beautiful mountain has fallen prey to are completely wrong and the politics of it all have robbed me of my Ancestors trails and histories.

I feel strongly that All Roads and TRAILS be opened to public use immediately. What has occured is wrong!

Daryl Weech

187

Maricopa Audubon Society

4619 EAST ARCADIA LANE • PHOENIX. ARIZONA 85016

Sept. 14, 1992

Sam Spillar, Field Supervisor, USFWS
3616 W. Thomas, #6
Phoenix AZ 85019 Additional Preliminary comments: Draft Recov. Plan MGRS

Dear Mr. Spillar:

Upon approval of the Draft Recovery Plan there must be financing for the team to ca out implementation of these otherwise wasted suggestions. Please let us know how can insure that the people of this country can best facilitate implementation financir Dedicated line item allocations for the peregrine and condor have been employ previously. Without implementation financing one can abandon hope for the survival this species in its tormented, abused habitat.

Regarding your report's comment that the population may stabilize in 10 years, and ta at least 100 years to restore habitat: we ask: are there other studies than Mannan a Smith that we are not aware of that give midden, canopy, overhead foliage density a downed log old-growth parameters? We are aware of Patten's and Grissino Mayer's da showing boring data but these do not evaluate midden requirements etc.

4

Mannan and Smith state that: "230 yrs. and maybe as great as 290 years" are required regenerate spruce-fir habitat. They say that in transition communities there may be "up 260 years." They say their estimates may be conservative because they do not:

> "include in our calculations time needed to establish seedling trees, although t could be reduced by planting young trees. Second, trees with the largest dbh m not always be the oldest trees around middens. And third, dominant trees fr which we could not obtain core samples - i.e. those with heart rot - often w among the largest trees we encountered and would likely have increased the me age of dominant trees at midden and random sites."

As the public becomes more aware of saving those last fragments of old-growth in t nation, there is a developing body of literature saying 500 years or 1000 years or lon

may be needed to create these relict forest ecological storehouses of biodiversity. Barry Spicer (pers comm) has stated that the south-facing midden-producing ecosystems on Mt. Graham may require more than 250 to 500 years and may never recover in the foreseeable future. This is the southernmost boreal forest in N. American facing the harshest, driest latitude and humidity and solar azimuth.

The USFS has said that 23 million Pinaleno board feet were removed between 1890 and 1946; and 27 million between 1963 and 1972.

Average the logging between 1890 and 1946 to year 1918 (84 yrs. ago) and Mannon's regeneration time to 260 years. Then, expect the most optimistic midden habitat return in 186 (260-84) years if you ignore Mannan's qualifiers. For those logged areas cut between '63 and '72 (avg. 1968) conclude 260 minus 25 years or 235 years. Since the Endangered Species Act gives the species the benefit of the doubt by law we don't know what the basis was for using the 100 year figure. We are equally unwilling to accept the unwarranted optimism of page 35 -- talking about a carrying capacity of 900 squirrels long term and 650 individuals short term.

4 And since there was hardly any logging in the Spruce-Fir, and less in transition than in mixed conifer, the requirements for regeneration time in these lower altitude drier, lower altitude less productive logged habitats. heavily logged forests would be assumed to be greater for creating suitable humid canopies and environments. We are well into centuries, not 100 years.

Could you please describe and/or map the areas where you believe regeneration will occur within 100 years on a map? Please provide the forest type, exposure, slope and altitude? The zone map in the recov. plan is almost impossible to read and understand because of its reduced size.

How much of the above mentioned historical logging occurred in mixed conifer, and how much in so called transition (Doug fir, Engleman, Corkbark/) ecotonal areas, and how much in pure Engleman-Corkbark? Would you conclude the regeneration time would be different for each of these habitats? Which zones offer the most promise for regeneration?

Of the 2,500? acres burned per decade in the past four decades, what life zones and tree species is the recovery draft referring to? How much of what burned was in good, fair,
188 poor, or excellent squirrel habitat? None of it was in spruce-fir since there has not apparently been fire there for some 300 years. How much of the fire was in mixed conifer? What is the fire cycle incidence in spruce-fir, ecotone, mixed conifer, transition, and pine-oak chaparral? Is it correct to assume approximate spruce-fir fire cycles of 200 years, and ten year cycles in mixed conifer?

This may have management considerations for explaining the importance of spruce-fir in the long term survival of the spruce squirrel. The campaign of the University of Arizona to

deny and belittle the longterm role of the spruce-fir in squirrel survival is an attempt to justify the destruction of that very small 400-600 acre ecosystem. Hoffmeister said:

> "Some time in the not too distant past red squirrels must have been present on other mountain ranges in southeastern Arizona-Chiricahuas, Santa Catalinas, Huachucas-and they may have been most closely related to those in the Grahams."

We would like to compliment the draft report for concluding that no more habitat disturbance should occur in management zones one and two. This must remain a key
10 portion of the recovery plan if this species is to survive the battering and fragmentation and subdivision and fenestration its key boreal habitat has received recently.

How many acres of zones one and two have been commercially logged -- or deforested for other reasons? How many deforested acres are there involving 507 and 669? What are the plans for that rehabilitation? How much has been rehabilitated to date and with
189 what success? How many years of follow up have there been for scoring planting survival rates? We have heard glowing public relations statements about revegetation and reforestation from the University of Arizona but we have not seen any supporting data.

The draft's zone maps are very difficult to read. Dividing the map into at least four separate maps and then using USGS overlays for the peaks, landmarks and trails, streams and roads and for the altitudes would greatly help to make them more meaningful. We find it difficult to comprehend and find zones 3,4, 5, 6, and 7 to see what habitat it is they represent. There should also be a set of easy to ready maps of the life zones. The good and excellent, fair and poor habitat markings in the maps of the BA were helpful.
26 The shadings on them were stippled *or* crosshatched in a confusing manner but today's computer technologies should pick a pattern that reproduces better on photocopy. There should be squirrel midden locations on a separate set of maps. Without the midden site data neither the public nor the team could comprehend the decision-making process.

[The map on page two, fig. 1 is not a range map of red squirrel distribution. This is the range map of the mixed conifer habitat in Arizona-- a life zone which encompasses a much lower altitudes than the red squirrel. If you will note the red squirrel distribution dots or site records in Hoffmeister, it can be seen that the 'spruce' squirrels cluster close
190 to the boreal cores of the state, namely the Kaibab, Chuska, San Francisco, Greer/Blue/Baldy, Pinaleno and Chiricahua areas (Hoffmeister incorrectly includes the Chiricahuas for this forest type). Only the Mogollon rim area seems to depart from those spruce-fir cores and that in is a few high areas of dense, moist forest above the rim at e.g. Hutch Mountain and General Springs. The recovery plan spruce squirrel range map should add the spruce-fir areas on the red squirrel range map. That squirrel range map should perhaps be, as in Hoffmeister, based on real sitings, but certainly not the rang8 map of Arizona's mixed conifer. The draft's map gives the impression there is a massive area and expanse of red squirrels in the Chuskas, Pinalenos, and Kaibab which is not true and misleading to the public who is trying to learn geographic distribution of this species in Arizona. The boreal map of Hoffmeister on page 30 shows the extreme scarcity of this

forest type. If the Tucson optical industry had seen how little of this habitat type there is in Arizona, and that it is at its southernmost U.S. limit in the Pinalenos, the species and its forest habitat today might have been spared its recent fragmentation and subdivision.

This report does not tell the number of middens which have been abandoned and which are no longer being counted. How many have disintegrated or been abandoned or lost each year? Conversely, what is the total of active ones which have been found each
191 year? Are squirrels using or sharing more than one midden causing overcounting or undercounting?

The Draft report is lacking on historic artificial revegetation data or discussion of it. The 1988 BO said that revegetation by UA transplanting and treeplanting teams would help to offset the losses caused by UA chainsaws.
1. How many trees were transplanted or planted, and
2. What species and what ages (sizes) were they, and
3. Where were they planted? A map of the plantings would be easier than a description.
61 4. What was the survival rate? Were any transplanted on 507 or 669? Have other trees been planted in the mixed conifer? by the USFS? on Webb? peak and/or elsewhere? Please describe the location and the success rate and the number of trees and species and the life zones involved?

We think the public is long overdue access to the refugium. Campers, hikers, hunters, nature buffs do not cut trees and destroy canopy and build roads and cause year round noise and disruption of wildlife in this remote area. Astronomers clearly do. This is one of the most unique ancient forest ecosystems in the world. It is the southernmost forest of its type in North America. Students of forestry, botanists, birdwatchers, all can marvel at this small but priceless wonder. At only 480 to 615 acres of pure spruce-fir, this delicate, diminutive boreal treasure will be a biological and evolutionary classroom for students throughout Arizona and the nation. That the University of Arizona and the collaborators were able to lobby and litigate their exemption from all applicable U.S. environmental and cultural protection laws and then destroy and fragment major portions of this irreplaceable ancient, relict forest gem is unthinkable. This boreal summit forest grove shall be a monument to the arrogance of mankind and the hypocrisy of a Church.

10 Wood gathering, fire rings and ground disturbing activities would not be anticipated. There are many areas in this nation where people must carry their own fuel stoves and respect the forest and plant life for special reasons. The 200 year fire cycle of spruce-fir suggests the area is surprisingly fire resistant so a prohibition of self-contained stoves would seem inappropriate.

We find no problem with hunting and welcome these users of the outdoors. Deer and bear and other game, and fishing, in season, should be allowable as they were historically. The more citizens use and learn about this wondrous place, the more there will be a cadre of citizens realizing this cannot become a city of telescopes above the law.

Overnight camping in this fragile, miniature, boreal classroom can be uniquely educational and inspirational. But less than inspirational to the outdoors nature observer, hunter or hiker will be the noise and commotion of the astrophysical facility's diesel generators, construction crews, cement mixers, welding and jack hammering, blasting, truck backing beepers, busses, maintenance vehicles, heliport, snowblowers, and the 8000 annual astrotourists and astrotourist busses which UofA's March 28, 1990 position paper boasts they will attract. 10

The Maricopa Audubon Society would ask how many people visited the summit area before and after UofA's road grading of 507 in the mid 80's? To reiterate: How many visited the area when it was a very poor, essentially 4WD road compared to after it was graded by UofA? These figures would be baseline data for the recovery plan to put in perspective what hiker and astrotourist impacts might be in the summit use equation. 192

Regarding maintenance of summit trails: treefalls and windfalls should not be sawed in half and relocated or disposed. Hikers should be capable of climbing over or walking around the summit's relatively small diameter Engleman-Corkbark trees. Trails can be marked. These downed logs are an important part of the fragile, humidity-requiring ecosystem. These rules will educate the public and encourage their respect for this very small boreal gem- which is presently under piecemeal dismemberment by the UofA, and foreign institutions of "higher" learning, and a Church. 193

The educational benefit of allowing the public to walk into this relict forest ecosystem is immense. The thrill of being at the Hudsonian summit of a mountain having more life zones than any other (solitary) U.S. mountain will be electrifying to many. None of Arizona's other "sky islands" possess a boreal summit. Imagine teaching the public about passing through Lower Sonoran or Chihuahuan grassland or desertscrub to Oak woodland, to Oak Pine, to Transition, to Canadian, and finally climbing on foot to true boreal or Hudsonian! This is the equivalent of a walk from the Mexican border to Alaska in life zones and vegetative communities. 10

The discussion of artificial breeding broaches some complex philosophical areas and you are to be commended for considering this important aspect of recovery plan options. Where is the supplemental feeding data which was developed a few years back? Could we please see it? What conclusions can be made from it pertaining to recovery? 194

Thank you for this opportunity to respond. We will be most appreciative of your replies and response to our comments and questions.

Sincerely,

Robert A. Witzeman

Robert A. Witzeman, M.D., Conservation Chairperson
Maricopa Audubon Society

5

THE STATE OF ARIZONA

GAME & FISH DEPARTMENT

2221 West Greenway Road. Phoenix. Arizona850234399 (602) 942-3000

Fife Symington

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Deputy Director
Thomas W. Spalding

November 2, 1992

Lesley A. Fitzpatrick
Ecological Services Field Office
U.S. Fish and Wildlife Service
3616 W. Thomas Road
Phoenix, Arizona 85019

Dear Lesley:

Enclosed are the Arizona Game and Fish Department review comments on the Mount Graham Red Squirrel Draft Recovery Plan.

Sincerely,

Carl L. Russworm

Carl L. Russworm
Wildlife' Specialist

:cr

Enc. Comments on MGRS Recovery Plan

ARIZONA GAME AND FISH DEPARTMENT
INTER-OFFICE MEMO

TO: Rich Glinski
Endotherms Supervisor

FROM: Dave Belitsky
Nongame Mammalogist

SUBJECT: Comments on MGRS Recovery Plan

DATE: September 15, 1992

I have reviewed the *most* recent draft of the MGRS Recovery Plan and provide the following comments.

Under Assessment of Population Viability, paragraphs II.3 and III.2 are so speculative that they should be deleted. Both paragraphs are preceded by predictive statements about the potential habitat and MGRS population levels which satisfy the requirements of the assessment, The recovery plan should not be used to predict carrying capacities in excess of any known population estimates. Especially when the predictions ignore all the resistance factors
195 identified in the historical *review* such as wildfire, drought, blowdown, global warming and the fact that "the population has remained below the estimated maximum carrying capacity". On page 36, the last sentence in the first paragraph should be changed accordingly.

In Appendix B, the habitat management recommendations assume a single species approach. The statement "Many other species dependent on, or living in, coniferous forests in the Pinalenos will also benefit from these management methods" ignores the fact
196 that several high priority species which occur in the Pinalenos do not utilize mature, old growth forest. For example, the white-bellied vole (*Microtus longicaudus leucophaeus*) and the Pinalenos pocket gopher (*Thomomys bottae grahamensis*), which are restricted to the Pinalenos and associate with other habitat types.

In the Narrative Outline, under Interagency Cooperation (p. 44), include the recently finalized collection agreement between the
1 Department and the Forest Service to share in the implementation of the semi-annual red squirrel midden surveys. Also, supplemental feeding as a potential management strategy should be deleted from this section because the effectiveness of the procedure, even under emergency conditions, lacks support. The only attempt to implement supplemental feeding was never evaluated. Captive breeding would be
197 the more likely procedure implemented in case of a catastrophic emergency.

Table 3 on p. 19 should include midden survey results from June, 1992.

The footnote on p. 30 under Habitat Analysis should be formatted as a footnote.

The citation on p. 28 (Marcot et al. 1988) is not included in the
1 Literature Cited section.

Page 22, para. 2, first sentence, "these" is misspelled.

Also, please cc:Gerhart.

DWB:ms

Enc.Recovery Plan, Comments on previous drafts.

Appendix E

RESPONSES TO COMMENTS

1. Comments were incorporated into the plan.

2. The Endangered Species Act of 1973 (as amended) requires the U.S. Fish and Wildlife Service (FWS) to develop recovery plans for listed threatened and endangered species. These plans identify actions that should be taken to recovery the species. Estimates of the costs associated with implementing these actions are also included in the plan. The plan does not itself authorize or allocate any federal funds to be spent. Implementation of any specific action requires federal budgetary approval and appropriation.

3. Copies of the draft plan were sent to all the biologists mentioned with the exception of Drs. Patton and Stromberg.

4. The FWS does not disagree with the data presented. The time required for recovery of red squirrel habitat (forest regrowth) varies greatly depending upon the aspect, elevation, soil type tree species involved and the residual site conditions. Not all currently degraded habitats are devoid of trees. In fact, much of' the area that is anticipated to recover to suitable condition is currently in a forested condition, often in a post, pole or early mature growth stage. Such areas may become suitable habitat in a comparatively short time. Areas largely devoid of trees are likely to take longer than 100 years to recover. The term "at least 100 years" used in the plan is used to convey that red squirrel habitat recovery is a long term proposition but not one that will show no benefits for 200 to 300 years.

5. Once the recovery plan is adopted by the FWS, development of a coordinated approach to research can be considered.

6. The term "stabilize" in this context refers to recovery efforts for species whose current situation does not allow for true recovery to occur. These species are seen to be at high risk of extinction in the short term and declines in population or habitat are likely to continue. The wide fluctuations in population numbers characteristic of the red squirrel contributes to its vulnerability. The intent is to increase the habitat base, and thus the potential population to better accommodate the natural fluctuations. As information is obtained through plan implementation, population target levels are likely to be adjusted.

7. Potential dispersal corridors are largely protected under the zone concept. 'Where possible, zone 1 and zone 2 habitats have a land connection. Sufficient information on the metapopulation structure and degree of isolation is not available. Future research will provide information on dispersal. The FWS recognizes that species with small, isolated subpopulations are more at risk when dispersal habitats are reduced.

8. Some information from monitoring of trial supplemental feeding is available for the species. This information will be evaluated to determine feasibility and research needs for supplemental feeding. This need is recognized in the stabilization objectives.

9. The implementation schedule currently calls for four years of population dynamics/life history study. Additional efforts in this area will be pursued as appropriate.

10. your support for this action is noted.

11. The draft recovery plan was available for public comment for 60 days. A notice of availability was published in newspapers in Safford, Tucson and Phoenix. A news release was issued by the FWS Regional Office in Albuquerque. Arizona newspapers did run stories on the plan and its availability. These actions were taken to provide the public with the opportunity to comment on the draft. All comments received were reviewed and considered in the development of the final plan.

12. Red squirrels experience significant population fluctuations. Research has shown that food availability, which *may* be affected in some ways by drought, is one driving force **of** these fluctuations. The review of the literature on red squirrels throughout their range does not indicate that disease is a major force driving fluctuations. Continued observation of the population may provide additional insights.

13. Reforestation and silvicultural activity is planned to continue through the year 2000 at a total expenditure of **$350,000.00** dollars.

14. Knowledge of population biology and habitat ecology is needed to understand the characteristics habitats must have to be considered restored. Protection of existing habitat is needed to maintain red squirrel populations until degraded habitats are restored.

15. The recovery plan recommends that any recreation plan developed under the zone concept include provisions to monitor day use and determine if adverse effects are occurring. Additional restrictions would be employed as necessary to protect red squirrels and their habitats.

16. The recovery plan zone concept recommends no additional loss of habitat in zone 1.

17. The recovery plan zone concept allows pedestrian access to High Peak and surrounding areas.

18. Road openings, while narrow, have considerable effect on the adjacent forests. These edge effects may penetrate over 25 meters into the forest, changing moisture and wind patterns. Windthrow becomes *more* likely if susceptible trees are now on the edge of the forest. Fragmentation of suitable habitat is another effect. Patches of habitat created may not be as suitable due to size or edge effect degradation. The Forest Service (USFS) prepared the road bed and adjacent fuel breaks *for* natural regeneration in 1990. Restoring the forest along FR507 will take time, but the gains are not insignificant.

19. Seventy five percent of FR507 is in zones 1 and 2.

20. Vehicle access eventually will be available to Emerald Peak vicinity via Steward Observatory shuttles. Pedestrian access would be available under the zone concept to Emerald, Hawk, High and Plain View Peaks.

21. Public education is an important part of any recreation plan implemented in the Pinalenos.

22. All comments received during the public review period of July **15-** September 15, 1992 have been reviewed and changes made to the draft recovery plan as appropriate. These comments have not resulted in significant changes to the content or the direction of the final recovery plan. All comments received are included as an appendix to

the final plan. Copies of the final plan will be sent to all those who provided comments.

23. These recommendations were in the recovery plan.

24. The recovery plan recognizes the need to address captive breeding but stresses the need to protect and restore habitats.

25. Habitat protection is adequately addressed in the body of the recovery plan and the stabilization objectives.

26. The map has not been improved or enlarged. Detail at the level requested is not feasible at this scale. Detailed maps are available for view at FWS and USFS offices. The FWS feels the zone descriptions are adequate. If implementation identifies problem issues, modifications will be considered.

27. A recovery plan outline was not prepared for this species. The red squirrel was listed prior to this requirement being established.

28. The species status has been included in the Executive Summary. There have been no Recovery Expenditure Reports for this species.

29. Species status is unknown. Recent significant population fluctuations have made determination of actual population trend difficult.

30. The Recovery Policy and Guidelines states that this information will be contained in the recovery plan "to the maximum extent feasible." Information to set these goals and criteria is not available. Such information will be obtained as part of the plan implementation. The FWS has issued other recovery plans that do not contain many of these same criteria. It is prudent to go forward with a plan in some form to attempt to develop more specific information than to wait for such information to be developed then prepare a plan. The FWS has made no judgements about reclassification or delisting criteria.

31. These questions relate to development of specific project actions under the oversight of the recovery plan. Answers to these questions cannot be provided at this time.

32. This is a stabilization plan. The cost of this plan has been estimated to be $2,016,200.00. Costs of recovery actions not in the plan have not been estimated.

33. Interagency coordination under Sections 4, 7, and 9 is not at issue in this recovery plan. Sections 4 and 9 have very little overlap with recovery planning at this level. Section 7 consultation is required for all recovery actions implemented. Issues directly relating to section 7 consultation are not part of this plan.

34. Options and strategies for land protection as described in the Policy and Guidelines are designed more for those situations where ownership of species habitats is split among several entities. Non-federal ownership of habitat is a concern here also. The zone concept is our best design for habitat protection in this case where all the habitat is owned by the USFS. The issues raised in this comment are beyond the scope of the *recovery* plan but could be included in implementation actions.

35. Priority descriptions in Part IV are the same as in the Policy and Guidelines.

36. All implemented recovery actions require both section 7 consultation under the Endangered Species Act and documentation under the National Environmental Policy Act (NEPA). All public notifications under NEPA apply. The visitor center at Columbine was covered under an Environmental Assessment.

37. Terms have been more clearly defined in the text and the number of terms used has been reduced. See also response #6.

38. The USFS model used to develop these figures uses 60 percent.

39. These specific studies would be developed under the research section of the plan.

40. Figures for habitat acres and red squirrel numbers are based on the best data currently available to the FWS. The origins of these figures is referenced in the text of the plan. Implementation of the plan actions will provide information to revise these figures.

41. The recovery plan is a planning document that provides direction to develop the type of specific habitat protection/development plan proposed. The recovery plan is not required to specify each item of research that may be done under the broad headings provided.

42. Dogs are mentioned in the text. Monitoring of recreationists will determine if management actions to further restrict dogs would be needed. Placement of fences at recreation sites is an issue to be addressed in USFS recreation management plans.

43. Decisions on population size indicator to be used in a specific situation will be made as part of implementation.

44. Sample sizes of home range data are too small to make such comparisons. Additional data would be collected during implementation.

45. The extinction on West Peak is believed to have occurred. There is no definite data to support any argument for or against the existence of red squirrels on Webb Peak.

46. The FWS believes one squirrel per midden to be a widely accepted standard. Wells (1987) in her dissertation found that midden sharing was more likely to be among family members.

47. The SHE method of analysis was developed for use with site specific data in the preparation of the Expanded Biological Assessment (USDA, USFS 1988). Data at that level was not available for the rest of the red squirrel habitat area. Recalibration of figures will be done when additional information is available.

48. The footnote on page 9 has been modified. The reference on page 8 is not squirrel based but midden based so there is no estimate of population made. Record sheets on each known midden contain information on midden status.

49. Surveys from the Pinalenos from 1985 to 1992 support the historic use of middens. Filopatry is a recognized phenomena of red squirrels and has been described in the recovery plan.

50. The FWS recognizes that red squirrels throughout their range have different requirements for canopy closure. The Mt. Graham red squirrel may be more selective of canopy closure to protect middens from higher insolation in these southern latitudes.

51. Genice Froehlich's work was in both Douglas-fir and spruce-fir habitats.

52. Understory plants may be important where they are available, especially raspberries and blueberries. High canopy closures found at Mt. Graham red squirrel middens preclude the establishment of most understory plants. Additional information on the importance of understory plants will be developed during implementation.

53. Both Halvorson and Gurnell studies were referenced.

54. Mention of bones as a food item has been added. The possibility of providing bones as a strategy to improve diets would be addressed as part of explorations of supplemental feeding.

55. There is insufficient data to speculate further.

56. It is possible for over-winter mortality rates to be sufficiently low so that population estimates do not detect the over-winter mortality. It is also possible that dispersing individuals counted in the fall survey may occupy middens during the winter and be counted in the spring survey. This is speculative. Refinements of the population monitoring program will likely undergo refinements.

57. "Estimate" is defined as "to determine roughly the size, extent, or nature of" (Webster's New Collegiate Dictionary, 1979, G hi C Merriam and Company). The use of the term in the plan is appropriate.

58. Footnote 1 should not be used for October 1991 figures in Table 3, because a large number of newly created middens were not included.

59. Dr. Paul Young's information applies to all three vegetation types and was a generalization.

60. This discussion of Abert's squirrel is given to provide the reader insight into their potential role in red squirrel ecology. Interspecific interactions are identified as a research need in the plan.

61. This is not a recovery plan issue.

62. Essential habitat is a designation under USFS policy (Forest Service Manual 2670.5) that provides protection equal to that given to designated critical habitat. This provides additional recognition for these areas in project planning. The FWS has no regulatory authority over essential habitat designations.

63. The recovery plan represents the official position of the FWS. Once the plan is finalized, it will be transmitted to the USFS. The USFS may or may not implement any part of the plan. The FWS has no enforcement authority. Interagency cooperation is the key to successful implementation. This is recognized in the plan.

64. Consideration of dog control needs are incorporated in development of management plans.

65. The statement "is promising" is qualified by the addition of "if forest habitat is restored, maintained, and protected."

66. Age of trees is not necessarily as critical as 'size. Size and other structural attributes of red squirrel habitat have already been researched and documented (Mannan and Smith 1991).

67. The need to develop a detailed monitoring plan is identified in the plan.

68. The recovery plan defined continued existence as a population that has a high probability (usually 95%) of existence for a time frame of 100 years or more.

69. A specific goal for a well-distributed population has not been defined. In general terms, the Habitat Management Zone map conveys the anticipated areas for development of a well distributed population. West Peak will be evaluated for habitat potential during implementation.

70. These statements are intended to be qualitative rather than qualitative.

71. Sufficient information to create meaningful criteria are not available.

72. Recovery plans are intended to estimate time frames for accomplishing species recovery and estimating available habitat into the future is an important component. There are numerous factors, both natural and human related, that will influence the time needed to accomplish recovery.

73. The recovery plan recognizes the HCM as being a maximum number under optimal conditions. The total number of known middene tends to corroborate the current habitat capability estimate of 650. The recent revisions the HCM model runs (that produced the current capability of 650 and the future capability of 900) took into account the fact that densities of red squirrels across a landscape do not approach maximum densities for a variety of reasons.

74. It is not reasonable to rank all risk factors as top priority. Lower priority ranking does not mean the risk factor is not significant.

75. This is a summary statement. More details are included in the text of the recovery plan.

76. Items 123 and 1231 have been added to the table. Designation of essential habitat has recovery importance for the red squirrel. See response #63.

77. Priority added for 1253. See response to #74

78. Revision of critical habitat boundaries could occur in the future if listing priorities allow. Designation of essential habitat may be more timely. See also response #62.

79. The GIS system enables the use of computer imagery for three dimensional work and inclusion of data sets. Other methods of graphically showing data will be considered.

80. No, it does not.

81. Interagency cooperation has achieved several goals, including halting of timber sales and wood collection in red squirrel habitat, continuation of the survey efforts, cone crop monitoring, and experiments on supplemental feeding. The USFS, Arizona Game and Fish Department (AGFD) and FWS provided support for staff members to participate in the Recovery Team. Implementation of recovery plane is always a good faith effort of all parties involved.

82. Productivity includes these measurements and others such as whelping rates.

83. These numbers will be developed during implementation.

84. Types of emergencies considered are described in the plan.

85. Management of cienegas is intended to be left to natural processes and cycles.

86. As described, zone 7 habitats are areas of human development. Decisions on the future of these areas are beyond the scope of the recovery plan.

87. The listing of the Mt. Graham red squirrel was made on the basis of the best biological data available. That data clearly showed the red squirrel had lost considerable habitat due to human activities, a potential competitor had been introduced, and significant fluctuations in population were likely bringing red squirrel numbers down to very low levels. The status survey work on the red squirrel was initiated by AGFD for the FWS before the telescopes became an issue.

88. Survey information and specific data on midden locations show that closed canopy forests with snags and extensive areas of downed timber are preferred habitats for red squirrels in the Pinalenos (Mannan and Smith, 1991). Corkbark fir is an important species for red squirrel, producing large cones with many seeds.

89. Recommendations for implementation of specific actions in the plan will be available for use as those actions are developed.

90. All future use restrictions will be based on the results of monitoring studies and would be implemented only if needed.

91. The stabilization goal of 300 adult red squirrels at population lows is a preliminary estimate of desirable population size. There is no time period to achieve or maintain this goal given in the plan because sufficient information is not available to set these criteria. As the plan actions dealing with population are implemented, information to answer these questions will be developed.

92. The typical size of a red squirrel midden in the Pinalenos is 0.031 hectare. For fallen trees, the distance around the log is measured. Since breast height on a fallen log is not known, DBH cannot be used.

93. The FWS retains the original wording.

94. Development of a long-term monitoring program under the recovery plan will address this issue.

95. Mannan and Smith (1991) have provided considerable baseline information on red squirrel habitat. Other issues such as cone crops, availability of other food resources in the habitat, and effects of other species on the habitat parameters remain unclear.

96. Two pamphlets are mentioned to deal with the needs of two different groups. The general public is not likely to be as interested in the specific research or biological information that a school biology program could use. Similarly, the school does not need basic information on what middens look like, proper behavior at middens and so on.

97. Decisions on specific roads to be reforested will be developed during implementation.

98. The recovery plan recognizes the natural causes of red squirrel population fluctuations. The human developments and disturbances in red squirrel habitat that have removed or degraded the forest have resulted in a lower habitat capability. Thus, fewer total squirrels can be supported in the overall area. Natural population fluctuations are significant. The loss of habitat capability may or may not have a direct influence on the magnitude of the fluctuations. Even without any influence from the change in habitat, if the total population is lower, and the magnitude of fluctuation is the same as under natural conditions, the real numbers of animals remaining at the low point of the fluctuation is lower than would be expected under natural conditions. Numbers may be low enough to cause a significant increase in extinction risks. With this information, it is clear that maintaining low point population levels as high as possible is critical to survival. This requires that population highs be as high as possible. The maximum size of an animal population is controlled by several factors. Perhaps the most important is the amount of habitat available. Habitat capability is a measure of habitat available. Reductions in habitat capability reduce the maximum size of the population that can be supported. Population lows are lower as a result. This scenario assumes that the habitat loss or degradation has not had an effect on the magnitude of fluctuations. If availability of food resources is driving the fluctuations, any change to the habitat that directly or indirectly reduces the capacity of the remaining habitat to produce food likely will affect the magnitude of fluctuations. Habitat capability cannot be separated from food resource production or population levels.

99. The best available biology is the only information used in the development of the recovery plan. Provision is made for re-evaluation of approaches and actions contained in plans as additional information is developed. Technical comment is solicited to ensure the information is sound, and the best approaches to the problems are identified. Where information is lacking, extra precautions against adverse effects must be taken. There is no place for trade-offs in the recovery plan. It is meant to present the program that in the best of all possible worlds would be implemented to recovery the species.

100. Additional information developed since the preparation of the biological opinion for the Mt. Graham International Observatory (MGIO) has shown that the transition and mixed conifer forests are important red squirrel habitat. This does not change the fact that spruce-fir habitats are important to the red squirrel. The USFS surveys include areas of suitable habitat between 8000 and 9000 feet. Surveys have been completed in 4058 hectares of the suitable habitat available. Approximately 620 hectares of suitable habitat remain unsurveyed. Most of this is poor quality habitat. In completed surveys, poor quality habitat had fewer middens than better quality habitats. Thus, it is not possible to assume that 15% of all middens have not been found if only 85% of the habitat has been surveyed. Since each survey took place in a range of habitat qualities, it is not impossible for the average of middens per hectare to be similar. This survey information has been used in the preparation of the recovery plan. For specific questions on the surveys, please contact the USFS directly.

101. The FWS believes that the criteria used to determine suitable habitat are reasonable and are supported by recent studies (Mannan and Smith, 1991). The figures used in the plan for hectares of habitat are not

underestimated by 50%. As maps of the habitat improve, the information on-habitat quality will be used in implementation of the plan.

102. The recovery plan recognizes the importance of all forest types (spruce-fir, transition and mixed conifer) to the long-term survival of the red squirrel. We have been observing the red squirrel in the Pinalenos for less than ten years. We have been seriously studying the habitat values and potentials for even less. There is insufficient information to support your conclusions on the importance of spruce-fir to the red squirrel.

103. The USFS is developing a fire management plan for the Pinalenos that will provide protection for all forest types. Population relocations will be addressed under task 1253.

104. Predators and predation levels will be addressed in implementation.

105. The USFS reforestation plan will deal with these issues.

106. Available biological information does not support such sweeping statements and conclusions. Studies on dispersal will provide biological information to answer these points.

107. Studies on the interrelationships between red squirrels and **Abert's** squirrels are covered under task 2141 in the recovery plan. There is not sufficient biological information to support such sweeping statements and conclusions.

108. The recovery plan uses "catastrophe" to describe events that eliminate significant portions of the available habitat of the red squirrel. Major fires and long-term droughts are specifically mentioned. The FWS must look at events or conditions that may preclude recovery of the species. Restoration of some forested areas may take 200 to 300 or more years. If global warming is occurring and continues, then there may be effects to the forests of the Pinalenos. We recognize there is little we can do about global warming, but it has a reasonable probability of occurring so should be mentioned.

109. The Arizona-Idaho Conservation Act of 1988 mandated the use restrictions currently in force in the Pinalenos. The recovery plan does recommend a loosening of some of those restrictions.

110. The recovery plan is an advisory planning document to direct agency efforts to recovery the species. The presence of the **MGIO** on Emerald Peak is noted. Any expansion beyond the current project will require both NEPA and ESA-Section 7 consultation. The recovery plan does not interfere with any part of the Arizona-Idaho Conservation Act of 1988.

111. Decisions on restoration, fires management and needs of other species will be addressed during the implementation period.

112. This plan has as its objective stabilizing the red squirrel population. Specific requirements for recovery will be developed as information is obtained. The issue of time to habitat recovery is addressed in response 41. Any valid comparisons with red squirrels elsewhere will be part of implementation.

113. Density date is from 1990 USFS unpublished data. Density calculations do include some areas of unsuitable habitat such as meadows and cienegas. The University of Arizona densities are based

on study areas with artificially created boundaries that are not necessarily reflective of the larger areas used in the plan.

114. Froehlich (1990) documented the use of more than one midden by a single red squirrel and more than one red squirrel using a single midden. These occurrences, based on other studies (Smith, C.C. 1968; Vahle 1978) are rare and are likely exceptional cases.

115. This figure is meant to show the general distribution of red squirrels in the Pinalenos. The black dots show the general pattern of midden distribution.

116. To date, no Mt. Graham red squirrel middens have been found in pure ponderosa pine stands. We have no quantification of the amount of this forest type surveyed to date. We do not know why Mt. Graham red squirrels do not use ponderosa pine, but we speculate on the reasons in the section on Distribution.

117. Coronado National Forest files, Tucson and Safford, Arizona

118. The Forest Service plans to resurvey "no potential" habitat every five years. The next such survey is planned for 1993.

119. Yes, areas have been walked through but not systematically inventoried.

120. The USFS based the analysis strictly on forest structural stage and assumed that food resources will, to a large extent, be provided by mature forest conditions.

121. We chose to display midden data by both habitat and elevation.

122. Newly located middens might be newly created or newly discovered. Many times it is difficult to determine which is the case.

123. The source is cited adequately. Please refer directly to source for additional information.

124. This speculation is based on observations from the Pinalenos.

125. Because latitude influences vegetation associations present and thus the distribution of habitat, this discussion is in the appropriate section.

126. This specific information is not available.

127. The use of the word "may" implies that this is speculation.

128. Froehlich (1990) was the only data available. Data from your monitoring has not been made available for use in this document.

129. No mention of reduction of habitat by any causes is made on the page mentioned. This paragraph asserts that some habitat has been degraded and that further degrading of habitat by development will reduce the number of potential middens.

130. For the summary of information presented in this document, use of USDA, Forest Service 1988 in the citation is adequate.

131. It is not relevant to compare proportions because of wide variation and lack of evidence of correlation to population under discussion.

132. These statements point out that current and future research will help clarify some of the unknowns in the plan.

133. The recommended detail is beyond the scope of this plan.

134. The fall 1990 survey was unusual in that it appeared that young red squirrels were creating small middens very close to other, more established, middens. The survey leaders determined to arbitrarily delete the 40 middens due to questions about occupancy of the new and established middens by the same or different red squirrels. Each of the 40 locations was revisited in the spring of 1991, and if still visible as a separate midden, was added to the midden data base.

135. Cone crop reports are in the files of the Coronado National Forest.

136. The decline in population estimates between 1986 and 1987 are believed related to a failure of the Englemann spruce cone crop. There are, however, no quantitative data were collected.

137. This sentence does not mention narrow roads or small openings. It is speculation that some isolation "may" have occurred via fragmentation of the forest from several sources, including fires, that degraded large areas.

138. Source is Brown 1984. This paragraph speaks on general terms about differences between Abert's squirrels and red squirrels. Given the proximity of high elevations to more "usual" Abert's squirrel habitat, it is not surprising the Abert's are seen at higher elevations. Thank you for providing this information.

139. In this example, severe implies greater snow cover and colder temperatures over a longer periods of time than in a mild winter area.

140. Essential habitat is defined in the Forest Service Manual 2670.5 as habitat possessing the same characteristics as critical habitat. See also response #62.

141. Road and area closures provide opportunities to control access while effects of human use on red squirrels and red squirrel habitat are evaluated.

142. Management to reduce habitat destroying fires may involve removal of some understory fuel and litter. It is not known what effect such actions will have on the red squirrel population. Efforts will need to be planned for small test areas and monitored for several years before any large scale efforts are undertaken. Several types of fuels management are likely to be tested.

143. Potential red squirrel habitat will be restored. Some areas, such as old clearcuts on south facing slopes, will require longer to regenerate than others and may not be suitable for planting. All degraded habitat areas will be analyzed by silviculturists as part of the reforestation plan.

144. Classification and inventory of forest stands is an essential step in developing a reforestation plan.

145. A Population Viability Analysis (PVA) is a statistical model based on estimated or known population parameters and resource characteristics that predicts the probabilities of short and long-term persistence of the population.

146. Specific plans to be completed by other agencies are listed in the implementation schedule.

147. The Recovery Plan'contains on the ground actions that should be initiated immediately. Some projects must await a specific plan development prior to implementation, in order that resources be properly utilized in implementation. Research allows fine tuning of specific actions or plans over the life of the Recovery Plan.

148. Because the recovery and reforestation efforts are considered long-term projects, planning to accomplish them must also look at the long-term. All planning for actions beyond a very few years in the future has the same uncertainty for accomplishment.

149. All terms are subjective.

150. Estimates were based on the most current knowledge of red squirrel presence and of habitat considered suitable or potential. This information is available in the Coronado National Forest files.

151. Area estimates used in the plan are not refined enough to be used for detailed analysis of small areas.

152. Reviewing of data consists of remeasuring areas on maps and other calculations are part of implementation and thus do not need to be specifically discussed in the plan. For example, some areas previously considered poor habitats have recently (1990-1992) been inventoried and reevaluated based on updated aerial photography. This is important information for implementation but does not require inclusion in the plan. All area figures given in the plan are estimates based on grid overlays.

153. The calculation of habitats as currently unsuitable and with no potential are lumped together until further analysis by silviculturists can segregate the acreages of each.

154. Part of the fair to poor habitat is from areas, such as small clearcuts, scattered among currently occupied habitats and part is from areas naturally regenerating from fires. Most estimates were generated from computer models of succession. Data is in the Coronado National Forest files.

155. This is correct. All density estimates are in the Coronado National Forest files.

156. Habitat characteristics, topography, elevation and a subjective estimate of long-term densities were used to make the estimate. Food resources are extremely difficult to estimate and were not used in the equation.

157. Red squirrel density estimates should remain approximately the same in the same quality of habitat. It is assumed that the habitat determines long-term red squirrel density. Thus, as forest structure changes, red squirrel densities will change.

158. This statement does not require citations to validate it.

159. Wide variations in yearly cone crop production occur in conifer species. Each conifer species has its own cycles and overall cone crops depend on the cone production level of each species present in the area.

160. The red squirrel population cannot increase over the winter as there is no reproduction and no immigration from other ranges. Estimatea for June 1991 overlap with estimates from October 1990, indicating high over-winter survival. Any perceived increase in population over

the winter is likely due to red squirrel movements between areas in the Pinalenos.

161. No. The sentence refers to one conifer species out of the several that may be in the habitat.

162. Data on population modeling is in the Coronado National Forest files.

163. Wording is correct as written.

164. Yes, the probability of extinction is much higher but determining certainty of the event is problematic.

165. This paper had been submitted to more than one journal at the time the draft recovery plan was developed.

166. Reductions or removals of Abert's squirrels from the Pinalenos will depend upon the results of competition studies. The degree of threat to the red squirrel posed by the Abert's squirrel will be determined in those studies.

167. Response times are dependent upon many factors and may be shorter or longer than stated as a result.

168. The USFS does not have specific acres or hectares lost in each fire over the last 40 years.

169. Maximum carrying capacity assumes that food resources are not limiting at that level. Distribution of red squirrels is important for evaluating effective breeding population and other parameters, but we have no data showing its relevance here.

170. Designation of management zones provides a framework to define the needs of similar and different habitats and allow for differing uses and controls.

171. Re-population or restoration habitat is habitat currently not in excellent condition that will be restored to its highest potential quality for red squirrels as part of this plan.

172. Defined in narrative of step-down outline.

173. Measures will be identified and implemented as appropriate.

174. Essential habitat is defined at response 140. Critical habitat is defined in the Endangered Species Act as "...(i) the specific areas within the geographic areas occupied by the species, at the time it is listed in accordance with the provisions of section 4 of this Act, on which are found those physical and biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protections; and (ii) specific areas outside the geographical areas occupied by the species at the time it is listed in accordance with the provisions of section 4 of this Act, upon a determination by the Secretary that such areas are essential for the conservation of the species."

175. Thinning is a silvicultural technique which, along with other techniques, may be included in the reforestation plan. That plan will contain any objectives for which thinning is the prescribed tool.

176. Mapping is a necessary component of any quantitative habitat evaluation.

177. Several agencies have responsibility for the red squirrel and all should be participants in this program.

178. Use of information from Mannan and Smith (1991) is assumed in this statement.

179. Use of the word "wild" is appropriate in the event that a captive population is established.

180. Fire is the most likely catastrophe to occur. Emergency plan development would include other potential problems, such as tree disease outbreaks, that may affect red squirrel habitat.

181. Signs included in this category are for the displays in the interpretive center. Those in section 312 are for roads, trailheads and campgrounds.

182. The paragraph defines the desired future condition of the forest based on all currently available knowledge and research. Specific management recommendations made by Mannan and Smith (1991) were incorporated whenever possible. The number of snags and logs per hectare was developed by the Recovery Team, taking Mannan and Smith's (1991) work, as well as fuels loading for fire danger, into account. The paragraph is consistent with earlier discussions of habitat quality.

183. Zone 1 was defined on the basis of midden densities (at least 2 middens per hectare) as determined using the then current midden maps. All boundaries other than those bordering Zone 1 were based on aerial photography and/or personal knowledge of the topography. The boundaries between zones are approximate and will be better clarified using vegetation maps as soon as they are available and ground inspections.

Red squirrel densities vary considerably among years depending upon many factors. As discussed earlier, density is not the best indicator of habitat quality, especially short-term densities of animals. The Recovery Team determined that midden density is the most reliable criteria of habitat quality available at the current time.

Sensitivity to disturbance in Zone 1 is based on: 1) past reports of direct disturbance to middens, such as from the University of Arizona Monitoring Team (data in Coronado National Forest files) and other researchers; and 2) current knowledge of midden locations in relationship to indirect disturbances such as removal of dead and downed material from campgrounds.

184. These are assumed to be dispersal corridors since they are between two areas of occupied habitat. Since we do not know anything about red squirrel dispersal, this is speculation, as we indicated by the word "assumed".

185. The two telescopes currently being built should have been included in Zone 7. The master map includes Heliograph Peak communications area in Zone 7. Because the Columbine summer home area and the Bible Camp may, depending on future studies, be recovered as red squirrel habitat, they were not included in Zone 7.

186. The recovery plan is a broad-based planning document. It exists to direct agency efforts to develop specific actions from the broad concepts presented. The implementation phase is where the specific studies, programs and management plans are developed.

187. The FWS supports behind the biological information used in the listing of the red squirrel as endangered. The recovery plan does not call for additional access restrictions beyond those imposed by the Arizona-Idaho Conservation Act.

188. Fires have affected mixed conifer forests of unknown habitat quality. The fire history of the three forest types is not currently known, but there are ongoing studies exploring these issues.

189. Information on acreage logged or deforested in each forest type is not available. The USFS has done preliminary work on reforestation. Questions regarding that effort should be directed to them.

190. The map used in the recovery plan was copied directly from Hoffmeister's (1986) range map. The exact accuracy of the scale is not known. Red squirrels may be found in areas of suitable habitat outside of the concentrations of location records on the map. These dots do not represent all records of red squirrels in those habitats.

191. No middens have yet been dropped from the survey pool. Decisions on how middens will be dropped will be made during implementation.

192. The FWS does not know if the USFS has any baseline data on recreation use of the upper elevations of the Pinalenos. If this information does exist, it should be used in the recreation plan.

193. Comments will be referenced for inclusion in the recreation plan.

194. A final report on the supplemental feeding program has not been received by the FWS.

195. It is appropriate in a discussion of population viability to extrapolate to the future condition. This is speculation, and language has been added to reflect that those figures do not assume any habitat losses over the period.

196. The goal of the habitat management efforts is to restore the forests to a normal successional cycle. This does not mean that all areas in the Pinalenos would be directed toward old growth forest. The needs of meadow and younger forest stand-dwelling species will be addressed in all appropriate plans.

197. The recovery plan should include as many potential management actions as possible. During the implementation of the plan, decisions on the appropriateness of any action will be addressed. The USFS does have data on the supplemental feeding effort from 1989 but has not finalized a report.