ARIZONA GAME AND FISH DEPARTMENT
HERITAGE DATA MANAGEMENT SYSTEM

Animal Abstract **Element Code:** AMAFB08011
Data Sensitivity: Yes

CLASSIFICATION, NOMENCLATURE, DESCRIPTION, RANGE

NAME: *Tamiasciurus fremonti grahamensis*
COMMON NAME: Mount Graham Red Squirrel

SYNONYMS: *Tamiasciurus hudsonicus grahamensis* (Allen, 1894)
Sciurus hudsonicus grahamensis Allen, 1894

OTHER COMMON NAMES: Mount Graham Chickaree; Mount Graham Spruce Squirrel
FAMILY: Sciuridae

AUTHOR, PLACE OF PUBLICATION: *Sciurus hudsonicus grahamensis* J.A. Allen, 1894. Bull. Amer. Mus. Nat. Hist. 6:347-350. Species level: [*Sciurus vulgaris*] *hudsonicus* Erxleben, 1777:416. Type locality "mouth of Severn River, Hudson Bay, Ontario." Based on "Hudson Bay Squirrel" of Pennant (Cited in Howell, 1936). *Tamiasciurus hudsonicus* Polock, 1923:213, first use of current name combination.

TYPE LOCALITY: Graham Mountain, Graham County, Arizona.

TYPE SPECIMEN: Am. Mus. Nat. Hist. #9013/7308. Adult female collected August 18, 1894 by W.W. Price and B.C. Condit.

TAXONOMIC UNIQUENESS: *Tamiasciurus fremonti* is one of three species in the genus, all found in North America. *T.f. grahamensis* is an endemic subspecies in Arizona, and one of 2 subspecies in *T. fremonti.* The other subspecies of *T. fremonti*, *(mogollonensis)* also occurs in Arizona. (Wilson and Reeder, 2005).

Formerly considered *T. hudsonicus,* Southwestern red squirrels were assigned to *T. fremonti* following evolutionary dynamic work by Hope et al. (2016). The classification has been acknowledged by the U.S. Fish and Wildlife Service (USDI, FWS 2021).

DESCRIPTION: A small diurnal tree squirrel easily recognized by its reddish dorsum and white ventor. The dorsum and ventor colors are usually demarcated by dark lateral lines, especially in the summer. The reddish or ferruginous brown dorsum color often with yellowish or reddish-yellowish interspersed. Total length is 28.0-35.0 cm (11.02-13.78 in), length of tail 9.5-15.0 cm (3.74-5.91 in), and weights from 140-250 g (4.94-8.82 oz). Red squirrels have large eyes and a bushy tail, often smaller and flatter than other tree squirrels. The dark colored tail is shorter than the body. White stripe present above and below the eye; ears without a pronounced tuft of hair; skull rounded in dorsal profile. No sexual dimorphism between adults has been determined.

AIDS TO IDENTIFICATION: *T. f. grahamensis* is generally slightly smaller, and has a shorter body, hind foot, and skull than *T. f. mogollonensis*, the only other red squirrel in Arizona. The skull of *mogollonensis* is also narrower than that of *grahamensis*. Color is not a reliable distinguishing characteristic. Its explosive ratchet-like "chr-r-r-r" call is unique to the species, and serves to identify it even when it is not seen.

ILLUSTRATIONS:
Color photo (O'Brien 1990)
Color photo (Cancalosi 1994)
Color photo of species (Whitaker 1996)
Color photo of species (James Anderson, *in* Wilson and Ruff, 1999: p. 460)

TOTAL RANGE: Pinaleno Mountains, Graham County, Southeastern Arizona, above 8,700 feet elevation.

RANGE WITHIN ARIZONA: See "**Total Range**."

SPECIES BIOLOGY AND POPULATION TRENDS

BIOLOGY: Red squirrels across their range in North America are known to be very vocal and highly territorial. In Arizona, *T. f. grahamensis* is more secretive and much quieter than the other red squirrel (*T. f. mogollonensis*) found here. Red squirrels are diurnal with a bimodal activity pattern, generally exhibiting the most activity about 2 hours after sunrise and before sunset. This pattern is observed during the spring, summer and fall months; unimodal pattern is observed in the winter. Bad weather may reduce their activity, but they are unlikely to remain in the nest for more than a day. They exhibit two annual molts, spring and fall. Have two distinctive calls, the characteristic bark and chatter (rattle) call. The chatter is a territorial call and is the first line of defense, especially in defending their food supply. The bark call is a sign of aggression, used against intruders, including humans.

This species is known to build and utilize two, and possibly three, types of nests. They use cavities in trees for nests, but also construct exposed spherical 'ball' nests from twigs, grass, and lichen in dense foliage (may be a nest of loosely held twigs and leaves in the branches of a tree in good weather). They may even use underground nests in burrows at times. It is not known if this subspecies uses all three kinds of nests or not.

Examining active "middens" found under preferred trees is used as a tool to estimate population size. These middens are utilized during winter months, can be kept active for years, and are aggressively defended. They are typically used by successive generations. The squirrel creates these middens when they strip scales from spruce-fir cones to get at the seeds. The scales fall to the ground around the feeding site and accumulate in mounds averaging ten inches or more deep and five to ten feet across. Red squirrels bury cones and other foodstuffs in these piles

where moisture and coolness are maintained by layers of insulation. An unopened cone buried in a midden will mature slowly allowing seeds to be consumed later than if they were not buried.

REPRODUCTION: When ready to breed, a female abandons her territorial behavior and allows males to enter her territory without opposition for a single day. After initiating a 'mating chase' and breeding with 1-2 males, females are no longer receptive and return to their territorial ways. One to two litters of 2 to 5 young (up to 7 in some areas) are produced every year. In the southwest, red squirrels may produce two litters per year. Generally, they have one litter per year. After a gestation period from 35-40 days, young are born helpless. In the nest, they are nursed and cared for by the mother for 6-8 weeks. The mother provides nothing other than milk and protection from other squirrels. Young red squirrels are weaned at 7-11 weeks, and begin establishing their own territories at 9-12 weeks. Juvenile mortality (likely linked to over-wintering) is high at 67%, and most squirrels do not live past 2-3 years of age.

FOOD HABITS: Pine seeds are a big component of their diet, which they also store in caches of unhusked cones. MGRS eat seeds and store live cones from Englemann spruce, white fir, Douglas-fir, corkbark fir, and white pine. Midden surveys indicate that Engelmann spruce and Douglas-fir are the most common tree species utilized (USFWS 2018). They may eat a variety of other seeds, acorns, mushrooms, fungi, buds and fruit. Sometimes, the fungi are also stored in the middens.

HABITAT: Primarily occurs in higher conifer forests of high humidity, and a closed canopy. These factors produce a suitable microhabitat needed for middens. Habitat for the Mount Graham Red Squirrel covers about 6,460 hectares at upper elevations of the Pinaleno Mountains, characterized by a series of rolling areas surrounded by steep edges and narrow canyons, especially along the northern and eastern edges. The Mount Graham red squirrel is very selective when choosing an area, not only for midden placement, but also for general activities.

ELEVATION: 8,700 - 10,200 feet (2,654 - 3,111 m). At one time, they were found as low as 6,000 feet (1,830 m) on north facing slopes.

PLANT COMMUNITY: Spruce-fir and mixed conifer communities.

POPULATION TRENDS: Perhaps more common in former times. At one time, the Mount Graham red squirrel was thought to be extinct until Dave Brown (AZGFD) and others found them in 1980. Dr. Donald Hoffmeister believed that the introduction of Abert's Squirrel (*Sciurus aberti*) between 1941-1943 played a significant role in the population decline of the Mount Graham red squirrel due to competition (AZGFD 1996).

Past red squirrel midden surveys suggested populations varying from approximately 100 to almost 400 animals. Red squirrel surveys are conducted by visiting a random number of known middens, which are areas where red squirrels store or cache their cones. From 1991-1997, Mount Graham red squirrels had a population of around 350 individuals. A 1998 survey by the

US Forest Service estimated the population at 462 squirrels, an increase of 25% from the previous survey (USFS Biological Assessment, accessed 2003). The 1999 fall survey results were 528 squirrels, while the fall 2000 survey showed a decline in the number of squirrels to 474 (Arizona Game and Fish Department 2001). Between 2001 and 2009, the number has fallen to somewhere around 250 individuals; 263 (plus or minus 11) squirrels estimated in 2008, and 250 (plus or minus 11) estimated in 2009. The fall 2010 estimate by the Arizona Game & Fish Department and U.S. Forest Service shows 214 individuals. A combination of drought, poor cone crops, fires, and insect tree infestation may have caused reductions to the population.

In 2016, the population was estimated to be 252. However, after the catastrophic Frye Fire, the 2017 count was only 35 squirrels. Given the dispersal of animals caused by the fire, it is possible that the standard survey methodology yielded inaccurate results. Evidence of the Frye Fire was observed in 95% of the locations surveyed, with 80% exhibiting at least some habitat loss, with 44% being completely burned (AGFD 2017). The 2018 survey documented a significant 91% rebound to a total minimum estimate of 67 squirrels.

SPECIES PROTECTION AND CONSERVATION

ENDANGERED SPECIES ACT STATUS: LE (USDI, FWS 1987)
Critical Habitat established (USDI, FWS 1990)

STATE STATUS: 1 (AZGFD, AWCS 2022)
[1A (AGFD SWAP 2012)]
[WSC (AGFD, WSCA 1996 in prep)]
[State Endangered AGFD, TNW 1988]

OTHER STATUS: Not FS Sensitive (USDA, FS Region 3, 2007)
[Forest Service Sensitive (USDA, FS Region 3, 1988)].

MANAGEMENT FACTORS: Threats include low numbers, extremely limited distribution, intense summer fires, possible competition for habitat with the introduced Abert's squirrel, and the development of astronomical observatories and related facilities and roads. Alterations of closed canopy forests, from logging activities and/or insect infestations, could affect the microenvironment critical for maintenance of middens.

Other management activities funded by the US Forest Service (Coronado National Forest) include tree planting in areas impacted by severe fires, and red squirrel research conducted by the University of Arizona. In 2014, the Pinaleno Ecosystem Restoration Project was initiated. This project, over 10-15 years, will entail forest thinning on some 2700 acres, and fuel treatments on 850 acres, and is intended to improve red squirrel habitat and reduce the risk of wildfires (Doug Kreutz, 2014).

The introduction of the Abert's squirrel into the Pinaleno Mountains in the 1940s was not a fortuitous event for the Mount Graham red squirrel. Although it has been suggested that this successful introduction has been a cause of the red squirrel decline, and is quite probably a factor, it has not been definitively proven. Edelman and Koprowski (2009) provide a detailed review of the adaptation and potential impact of the Abert's on the red squirrel and conclude that the most probable negative impact mechanisms are directly through resource competition for food and space, and indirectly by increasing predator density (the combined squirrel populations provide more available prey to attract more predators). They also opined that given the very limited numbers of red squirrels, and the continued loss of habitat from fires and insect outbreaks, any possibly detrimental impacts from the Abert's squirrel should not be ignored. In 2018, the USFWS released their final Biological Opinion for the Abert's Squirrel Removal Project which was conducted from July 1, 2018 – June 30, 2019 (USFWS 2018).

In 2013, Fitak and Koprowski published the results of their genetic analysis of the Mount Graham red squirrel. Both nuclear and mitochondrial DNA analyses revealed an extreme reduction in measures of genetic diversity, and suggested that the isolated subspecies has either experienced multiple bottlenecks or a single long-term bottleneck. The study also found a high degree of relatedness (i.e., inbreeding). The results suggest that the subspecies may lack the genetic variation necessary to respond to a changing environment, and this finding is especially important given that the southwest U.S. is expected to experience profound effects from global climate change (Fitak and Koprowski 2013).

PROTECTIVE MEASURES TAKEN: In addition to be listed Endangered (1987), critical habitat was also designated under the authority of the Endangered Species Act in 1990, and includes the Hawk Peak-Mount Graham Area, Heliograph Peak Area, and Webb Peak Area (for a total of about 1,900 acres). The major constituent element is dense stands of mature spruce-fir forest.

In September 2014, a 10-year pilot breeding program for the Mount Graham red squirrel was launched. The Phoenix Zoo will coordinate this program, which is expected to expand to the Miller Park Zoo in Illinois. Other partners include the US Fish and Wildlife Service, US Forest Service, and the Arizona Game and Fish Department. Initially, there were three pairs of squirrels. Females are in estrus for only approximately eight hours each year, making it challenging to determine the proper time to bring males and females together to breed (Phoenix Zoo 2014).

As previously cited (USFWS 2018), there is also an effort to remove the introduced Abert's squirrel from the Pinaleno Mountains.

SUGGESTED PROJECTS: Due to its rarity and precarious situation, the Mount Graham red squirrel is a very intensively studied and managed animal. It has held the Endangered status for many years, complete with critical habitat. It is regularly surveyed. There are numerous ongoing studies; there is a campaign to remove a probably competitive and introduced species (Abert's squirrel) and a captive breeding program has been initiated. Forest management (thinning and fuel load reduction) has also been underway for the past half-decade (since 2014).

There is probably not much more that can be done to preserve this unique subspecies. Nonetheless, the devastating impact of the Frye Fire (on both habitat and seemingly actual squirrel numbers) and the envisioned impact of climate change on this animal that occurs in a remnant, high elevation forest in the Sky Islands, does paint a rather bleak picture for its future.

LAND MANAGEMENT/OWNERSHIP: USFS Coronado National Forest (Mount Graham in the Pinaleno Mountains).

SOURCES OF FURTHER INFORMATION

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MAJOR KNOWLEDGEABLE INDIVIDUALS:

John L. Koprowski, Wildlife and Fisheries Science in the University of Arizona's School of Natural Resources & the Environment.

Merit Alanen, US Fish and Wildlife Service, Lead Arizona Biologist, Phoenix

ADDITIONAL INFORMATION:

Per Steele (1998), "*Tamiasciurus* is derived from the Greek words *Tamias*, meaning animal who caches food, *Skia*, meaning shadow, and *oura*, meaning tail." Steele (1998) also refers to the species *T. hudsonicus* as Pine Squirrel instead of Red Squirrel, distinguishing this species from the European Red Squirrel (*Sciurus vulgaris*), which is often referred to as red squirrel in the literature.

Revised: 1992-02-25 (JSP)
1992-05-07 (BKP)
1996-06-19 (SMS)
2003-05-16 (AMS)
2011-03-01 (SMS)
2019-08-27 (BDT)
2023-03-15 (MBL)

Arizona Game and Fish Department. 20XX **(= year of last revision as indicated at end of abstract)**. X...X **(= taxon of animal or plant)**. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. X pp.