APPARENT EXTIRPATION OF THE SOOTY GROUSE FROM THE SKY ISLANDS OF SOUTH-CENTRAL CALIFORNIA

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ABSTRACT: The Mount Pinos Sooty Grouse (*Dendragapus fuliginosus howardi*) is endemic to south-central California and a species of special concern to the California Department of Fish and Wildlife. Historically, it ranged from Kings Canyon in the southern Sierra Nevada of Fresno County (36° 45′ N) south and west to the Mt. Pinos region of Kern and Ventura counties (34° 46.5′ N). On the sky islands of Kern and Ventura counties it has not been sighted since 1993. Between 2002 and 2009, I surveyed in all known or potential historic habitat on these sky islands in spring, when males sing. I found no evidence of grouse in that region but did confirm the southernmost breeding sites in the main southern Sierra Nevada. Extirpation from the sky islands appears to have coincided with a proliferation of livestock grazing, timber harvesting, rural development, and fire suppression. Perhaps these activities altered the spatial pattern of seasonal habitats, increasing the grouse's exposure to predation, or perhaps the removal of large trees, which the grouse uses as territorial songposts, rendered the sky islands unsuitable.

The Mount Pinos Sooty Grouse (*Dendragapus fuliginosus howardi*), endemic to California, historically ranged from the vicinity of Kings Canyon in the southern Sierra Nevada of Fresno County (36° 45′ N) south and west to the Mt. Pinos region of Kern and Ventura counties (34° 46.5′ N) (Grinnell and Miller 1944). Reports from the San Jacinto Mountains, Riverside County (27 May 1971) and Big Pine Mountain, Santa Barbara County (8 June 1938) are anomalous and too poorly supported to be reliable (Garrett and Dunn 1981, Lentz 1993). North of Kings Canyon, subspecies *howardi* is replaced by the Sierra Sooty Grouse (*D. f. sierrae*). Dickey and van Rossem (1923) described *howardi*, distinguishing it from *sierrae* primarily on the basis of tail measurements (tail longer and more graduated) and plumage color and pattern (paler above, with coarser vermiculation and barring, and darker and browner below). In California, the Sooty Grouse is closely associated with forests where firs (*Abies*, *Pseudotsuga*) are an important component of the canopy (Grinnell and Miller 1944). Fir needles and buds are the species' primary foods, especially in winter (Zwickel and Bendell 2005). In the southern Sierra Nevada, north of Kern Gap (South Fork of the Kern River), where its habitat is generally contiguous, it occurs in small numbers at suitable locations (Bendell and Zwickel 1984, Bland 2008). South of Kern Gap, where its habitat is limited to isolated mountaintops in the extreme southern Sierra Nevada and northern Transverse Ranges—sky islands—it is considered extremely rare or possibly extinct (AOU 1957, Bland 2008). In 2005, the U. S. Forest Service (2005) assessed the Sooty Grouse as "historic/potential" in the Mt. Pinos area but "apparently secure" elsewhere. In 2008, the California Department of Fish and Wildlife classified *D. f. howardi* as a species of special concern throughout its range (Bland 2008). In this paper I report the results my surveys for the Mount Pinos

Sooty Grouse, review the scant literature on its historic status and habitat associations, and infer factors contributing to its decline in the sky islands.

STUDY AREA

The principal survey area was centered ~125 km northwest of Los Angeles, California, and spanned an arc of sky islands ~135 km long from the Piute Mountains in north-central Kern County to Pine Mountain in west-central Ventura County (Figure 1). I also searched immediately north of this area (north of Kern Gap, Figure 1) to confirm the southernmost breeding sites in the main Sierra Nevada (southern Tulare County). I delineated 10 survey sites in the sky islands by plotting a contour line at 1830 m (6000 ft) elevation, the approximate lower limit of white fir (*A. concolor*; Mayer and Laudenslayer 1988) around all mountains in the grouse's historic and potential range (from north to south, the Piute Mountains, Breckenridge Mountain, Bear Mountain, Tehachapi Mountains, Liebre Twins, Tecuya Mountain, Mt. Pinos and nearby peaks, Frazier Mountain, Alamo Mountain, and Pine Mountain). The Mt. Pinos survey site encompassed Mt. Pinos and Sawmill Mountain, Grouse Mountain, and Cerro Noroeste (Mt. Abel). All four of these peaks are located within an area approximately equal to the average annual home range of the Sierra Sooty Grouse (~12 km^2, Bland and Gardner 2013). In the Tehachapi Range, I delineated two survey sites, an eastern site encompassing Tehachapi Peak and Cummings Mountain and a western site at Liebre Twins (Blue Ridge) on Tejon Ranch. The types of conifer forest represented within the survey area included fir, mixed conifer-fir, mixed conifer-pine, ponderosa pine (*Pinus ponderosa*)–fir, sugar pine (*P. lambertiana*), Jeffrey pine (*P. jeffreyi*), and ponderosa pine (vegetation "alliances" on the U. S. Forest Service's vegetation maps). I consider the first five of these to be potential breeding habitat. Forests dominated by Jeffrey pine and ponderosa pine are generally too arid to be good breeding habitat.

METHODS

I surveyed between 15 April and 31 May, 2002–2005 and 2009, during peak "hooting" season for the Sooty Grouse (~mid-April–mid-June in central California, Bland 2013), when territorial males hoot throughout the day (Stewart 1967, Zwickel and Bendell 2004:156). Museum collectors of the 20th century recognized peak hooting as a good time to search for the Mount Pinos Sooty Grouse: 81% of the sky island specimens were collected from 15 May to 15 June (Table 1). The full hooting season extends from about March to August, with some regional variation (Zwickel and Bendell 2004:156). When actively singing, males emit a sequence of 5–7 hoots every 1–10 min; the hoots are audible for at least 300 m and as far as 1 km under ideal conditions (Doerr at al. 1984, Zwickel and Bendell 2004:151, Bland unpubl. data). I used a survey technique first reported by Niederleitner (1987), which I have adapted, standardized, and used successfully with low-density populations in the Sierra Nevada (Bland 2013), including those of *D. f. howardi* in the southern Sierra Nevada (Bland 1993). I walked (or occasionally drove) an elevation contour through suitable breeding habitat,

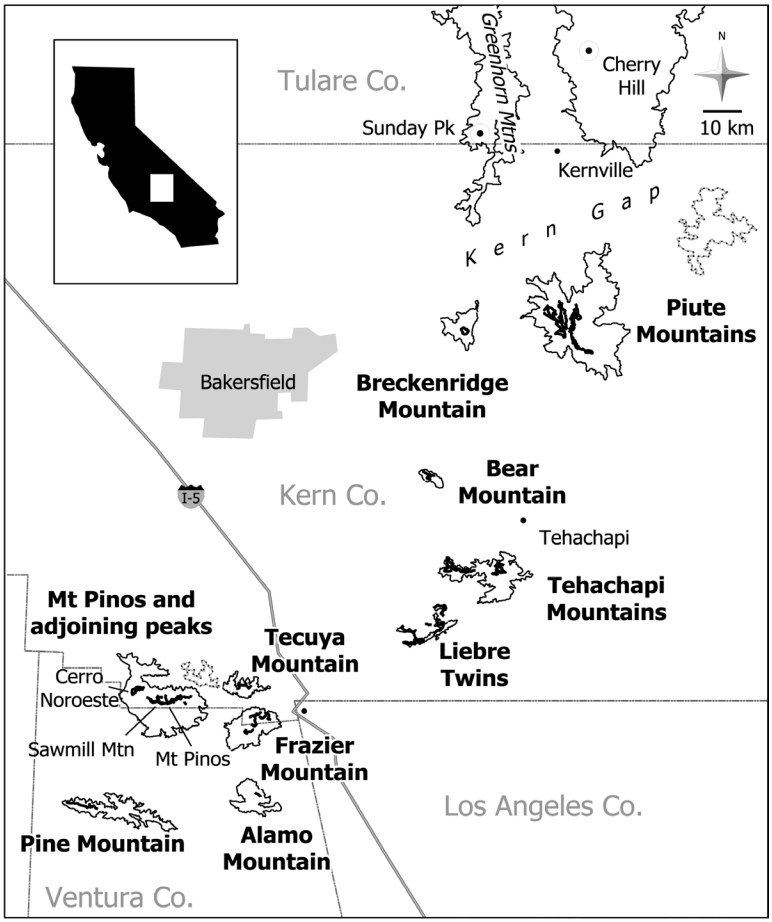

Figure 1. Survey area for the Mount Pinos Sooty Grouse. Names in bold are survey sites; thick solid lines, survey routes; thin solid lines, 1830 m elevation contour; thin dashed lines, mountains too arid to qualify for survey; circles enclosing dots, confirmed hooting sites.

stopping every 300 to 500 m at prominent spurs or vantage points to listen for hooting grouse and then to broadcast a recorded call of a female in each cardinal direction (22-syllable cackle call provided by J. Bendell, Univ. Toronto). Recorded calls of a female stimulate quiet territorial males to sing (Stirling and Bendell 1966, Bland 2013). As I walked, I scanned the ground for fecal droppings and feathers, especially under large trees. I initiated surveys before 08:00, took a 1- to 2-hr break mid-day, and continued until a given transect was completed.

Where patches of good habitat extended more than ~1000 m up or down

Table 1 Specimens of the Mount Pinos Sooty Grouse Collected from the Sky Islands and Cataloged in the Ornithological Information System[a]

Collection date	Sex	Collection location	Specimen no.[b]
10 July 1903	M	Tehachapi Peak	USNM 186760
2 July 1921	M	Mt. Pinos	UCLA 5388
2 July 1921	F	Mt. Pinos	UCLA 5389
2 July 1921	M	Mt. Pinos	UCLA 5390
28 May 1922	M	Mt. Pinos	CAS 66681
28 May 1922	M	Mt. Pinos	UCLA 6608
28 May 1922	F	Mt. Pinos	FMNH 157167
28 May 1922	M	Mt. Pinos	UCLA 6609
30 May 1922	M	Mt. Pinos	UCLA 6610
30 May 1922	M	Mt. Pinos	UMMZ 122240
15 May 1923	M	Mt. Pinos	UCLA 12691
17 May 1923	M	Mt. Pinos	MVZ 100092
18 May 1923	M	Mt. Pinos	AMNH 750626
18 May 1923	M	Mt. Pinos	UCLA 12709
5 June 1927	(chick)	Mt. Pinos	UCLA 21838
21 May 1928	(egg set)	Mt. Pinos, north slope	WFVZ 3098
29 May 1928	F	Mt. Pinos	UCLA 22588
29 May 1928	F	Mt. Pinos, near summit	MVZ 100091
29 May 1928	M (chick)	Mt. Pinos	UMMZ 122350
29 May 1928	F	Mt. Pinos	MCZ 253515
29 May 1928	F	Mt. Pinos	UCLA 22587
29 May 1928	F	Mt. Pinos	UCLA 22589
30 May 1928	M	Mt. Pinos	MCZ 253516
30 May 1928	M	Mt. Pinos, north slope	UCLA 22590
30 May 1928	M	Mt. Pinos, north slope	UCLA 22591
30 May 1928	F	Mt. Pinos, north slope	UCLA 22592
31 May 1928	M	Mt. Pinos, north slope	UCLA 22593
31 May 1928	M	Mt. Pinos, north slope	UCLA 22596
31 May 1928	M	Mt. Pinos	MCZ 253517
28 May 1929	M	Mt. Pinos, 1.5 mi ESE of summit	MVZ 54125
11 June 1929	M	Mt. Pinos, 2 mi NE of summit	MVZ 54126
11 June 1929	F	Mt. Pinos, 2 mi NE of summit	MVZ 54127
12 June 1929	M	Mt. Pinos, 2 mi NE of summit	MVZ 54128
13 June 1929	F	Mt. Pinos, 1 mi NE of summit	MVZ 54129
15 June 1929	F	Mt. Pinos	UCLA 27464
15 June 1929	M	Mt. Pinos	UCLA 27469
15 June 1929	F	Mt. Pinos	UCLA 27470
29 June 1929	F	Mt. Pinos	UCLA 27471
26 May 1930	(skeleton)	Mt. Pinos	LACM 21093
11 July 1931	F	Head of Cuddy Valley, ~2 mi. ENE of Mt. Pinos	MVZ 54131
2 Dec. 1933	F	Mt. Pinos, summit	FMNH 157168
23 Sep. 1976	F (feather)	Mt. Abel (Cerro Noroeste), north slope, 3–3.5 mi. WNW of Mt. Pinos	SBNHM AV10506

[a]Accessed through www.ornisnet.org, 30 June 2013. Richardson (1904) reported "one was taken" in the Piute Mountains "during the summer of 1903." However, no corresponding specimen exists in any major public museum, including the Museum of Vertebrate Zoology (C. Cicero pers. comm.), where Richardson was later employed. This bird might not have been prepared as a study skin.

[b]AMNH, American Museum of Natural History, New York; CAS, California Academy of Sciences, San Francisco; FMNH, Field Museum, Chicago; LACM, Natural History Museum of Los Angeles County, Los Angeles; MCZ, Museum of Comparative Zoology, Harvard University, Cambridge, MA; MVZ, Museum of Vertebrate Zoology, University of California, Berkeley; SBNHM, Santa Barbara Museum of Natural History, Santa Barbara; Dickey Collection, University of California, Los Angeles; UMMZ, University of Michigan Museum of Zoology, Ann Arbor; USNM, National Museum of Natural History, Smithsonian Institution, Washington, DC.

slope, I established an additional transect parallel to the first ~400 m further into the patch. On the steep north face of the ridge comprising Mt. Pinos, Sawmill Mountain, Grouse Mountain, and Cerro Noroeste, where many of the most reliable historic observations originated, I surveyed three parallel transects over two breeding seasons (2002–2003): one along the upper rim (~777–807 m elevation), a second ~200 m downslope, and a third where patches of appropriate habitat were present ~500–1200 m below the summits of Mt. Pinos and Sawmill Mountain.

North of the Kern Gap, I used line-transect methods as described above in the Greenhorn Mountains from Portuguese Pass south to Woodward Peak (23–24 April 2002) and located survey stations where habitat appeared suitable along major Forest Service roads in the main Sierra Nevada from Sherman Pass south to Bartolas Creek (29–31 May 2004).

For the historical review, I consulted published literature on the grouse's status and habitat associations and www.ornisnet.org for records of specimens held by major North American museums.

RESULTS

Survey

I completed 190 km of survey transects throughout the sky islands but detected no Sooty Grouse vocalizations, feathers, or fecal droppings (maps and GPS tracks of survey routes are available by request). North of the Kern Gap, I confirmed singing males at Sunday Peak in the southern Greenhorn Mountains (24 April 2002) and at Cherry Hill in the main Sierra Nevada (29 May 2004, Figure 1). These sites were the grouse's southernmost supposed breeding sites at the time of the surveys (B. Barnes and T. Benson pers. comm.).

Historic Status

Little information is available regarding the historic status of the Mount Pinos Sooty Grouse, particularly south of Kern Gap. North of Kern Gap, the Death Valley Expedition of 1891 (Fisher 1893) reported that Sooty Grouse were "nowhere common" (the expedition observed or collected the species at Monache Meadow, Independence Creek, Big Cottonwood Meadow, Olancha Peak, Halsted Meadow, Horse Corral Meadow, Mineral King, and elsewhere). Grinnell and Miller (1944) considered it "locally common in suitable parts of [the] main southern Sierra Nevada." In the late 1970s, Bendell and Zwickel (1984) ranked the density of Sooty Grouse at Crescent Meadow, northern Tulare County, as 3 on a scale of 0–5. In 1992, I counted only 0.5 hooting male/km along 24.7 km of line transects through known breeding habitat in northern Tulare County (Bland 1993).

Most information regarding the historic status of *D. f. howardi* south of the Kern Gap comes from the vicinity of Mt. Pinos. Grinnell and Miller (1944) surmised it was "always, within history, sparsely represented on the more southwesterly, outlying islands of occurrence." Presumably the "more southwesterly, outlying islands" included Mt. Pinos and closely adjoining Sawmill and Grouse mountains, Cerro Noroeste, Frazier Mountain, and

possibly the Tehachapi Mountains. Perhaps Grinnell and Miller reserved comment on status on the "northeasterly" islands (e.g., Piute Mountains, Breckenridge Mountain) because reliable information was not available. The only historic report from the Piute Mountains is by Richardson (1904), who observed Sooty Grouse "several times" in the summer of 1903. The only historic report from the Tehachapi Mountains is by L. Goldman, who observed and collected just a single male (Table 1) during three days' survey work "on the summit and lower slopes" (Smithsonian Institution archives, collection 7176, box 37, folders 7 and 8).

At Mt. Pinos, E. Nelson was the first to report "a few about the summit" in October 1891 (Fisher 1893). In autumn, Sooty Grouse are generally difficult to detect, being cryptic and silent, so observing "a few" in October could be interpreted as relatively abundant. In the summer of 1904, Grinnell (1905) noted "there must have been quite a number of them around though we actually saw but two" (he also observed many feathers, "dust-wallows," and other "grouse signs"). In 1928, Pemberton (1928) reported hearing grouse hooting "quite commonly on the flatter upper part of the mountain." He also noted, "many hooters" could be heard "well down on the cliff-like north slope." He conjectured, "there are not many [on Mt. Pinos] and I believe that the number is less than one hundred." On 21 May 1928, he photographed a nest on the north slope of Mt. Pinos and collected the eggs. Pemberton (1928) described the nest, eggs, and local environment. In the 13 years from 1921 to 1933, museum collectors took at least 40 specimens from Mt. Pinos (Table 1). Holt (1936) wrote that the grouse "was plentiful in bygone times on Mount Pinos and neighboring peaks. For the past six years, however, it has been feared that the bird was extinct here. As recently as last October, a U. S. Biological Survey party searched for two weeks without finding any indication that a single one remained. Then, on October 14, three hunters were caught with four Mount Pinos Sooty Grouse that they had shot on the northwest slope of Mount Pinos ... Were these the last four grouse in the Mount Pinos region? Probably not; it is a large, rugged area, and a few could easily escape the notice of searching parties. The hunters who took the birds state that a part of the flock was permitted to escape. If this observation is correct, and if grouse exist in numbers sufficient to enable them to withstand the depredations of natural enemies, they may repopulate the area in time. At best, however, their situation is critical."

The "two young hens and a pair of adults" mentioned by Holt were apparently prepared as study skins for the Santa Barbara Natural History Museum, but were lost along with all associated records in a fire on 12 April 1962 (P. Collins pers. comm.). No report of the survey Holt mentioned exists in the national archives (E. Alers pers. comm.). Grinnell and Miller (1944) reported that *D. f. howardi* was "said to have become very scarce of late years on Mount Pinos." The AOU (1957) listed the subspecies as "extremely rare (possibly extinct) in the Tehachapi Mountains, Mount Pinos, and Frazier Mountain areas." From 24 to 29 May 1964, Abbott (1965) reported hearing two grouse hooting on the northwest slope of Mt. Pinos, the only ones he had detected after searching Mt. Pinos, Cerro Noroeste, and Frazier Mountain "often" over the preceding 30 years. Abbott's report is the last evidence of breeding behavior on the sky islands. A feather collected by D.

Smith and J. Hamber on 23 September 1976 (Table 1) is the last physical evidence of the Sooty Grouse anywhere in the region.

Since 1965, there have been only three credible reports of sightings documented in detail sufficient to eliminate misidentification of the Band-tailed Pigeon (*Patagioenas fasciata*) or Mountain Quail (*Oreortyx pictus*) and placed on file at an appropriate institution: 23 September 1976 by J. Hamber and D. Smith at Cerro Noroeste (~5.5 km northwest of Mt. Pinos), 2 August 1992 by L. Allen at Sawmill Mountain (~1.8 km west of Mt. Pinos), and 1 May 1993 by R. Chichester also at Sawmill Mountain (Appendix). Other sightings reported since the 1970s (see Weiss 1979, Lentz 1993, and Bland 2008 for examples) lack documentation sufficient for a judgment of whether a Band-tailed Pigeon or Mountain Quail was misidentified, as frequently happens. Focused searches in the vicinity of Mt. Pinos in 1978 (Bendell and Zwickel 1984), 1979 (Weiss 1979), and 1988–1992 (Lentz 1993) failed to detect grouse.

Habitat Associations

Grinnell and Miller (1944) described the habitat of the Mount Pinos Sooty Grouse as "chiefly slopes clothed sparsely with white firs; but also other coniferous trees ... as well as open or brushy ground interspersed with, or adjacent to, forest." First-hand records of the grouse's habitat use in the sky islands are limited to the vicinity of Mt. Pinos (2697 m), where Grinnell (1905) found "grouse signs only among the firs on the north side" and Pemberton (1928) found grouse "only on the higher portions of the mountain ... where the silver fir [white fir] reaches its best development." Abbott (1965) "heard two grouse hooting in the heavy white fir on the northwest slope at about 8700 feet elevation" (2652 m). Pemberton encountered hooting males "on the flatter upper part of the mountain" and also "well down the cliff-like north slope." Grinnell (1905) described the upper slopes of Mt. Pinos as "gentle," "not heavily timbered," with "groups of Jeffrey pines ... being interspersed with openings, either bare or brushy. In places above 8000 feet there are extensive low thickets of [snowberry, *Symphoricarpos rotundifolius*] and, especially in moist spots, masses of gooseberry [*Ribes cereum* and *R. montigenum*], the latter more particularly on the shaded north side near springs." "Acres of a low composite shrub [*Chrysothamnus nauseosus*] cover the otherwise bare rolling area about the summit." Conversely, "the steep north slope, from the summit down about 2000 feet, is quite heavily timbered with California white fir," "with a few fox-tail pine [limber pine, *P. flexillis*] at the summit of the main ridge ... and down the north slope among the firs." Apparently, Pemberton was under the impression hooting males moved down slope as the hooting season progressed, but other researchers have shown that locations of adult males' breeding territories are static (Bendell 1955, McNicholl 1978, Bland 2013). Perhaps the males Pemberton heard early in the season were yearlings, which hoot for only a brief period early in the hooting season (McNicholl 1981, Bland 2013), often at low-quality sites (Jamieson and Zwickel 1983).

Where I have observed the Mount Pinos Sooty Grouse's breeding habitat north of Kern Gap (Sunday Peak, Poison Meadow, Sherman Peak, Big Meadows, Stony Creek, Big Baldy Ridge, Mineral King), it is similar in

most respects to that of the Sierra Sooty Grouse on the western slope of the central Sierra Nevada, where I have studied Sooty Grouse habitat in detail. At Pinecrest (Tuolumne County), males establish breeding territories on or near steep slopes in mature fir or mixed conifer forest with an open canopy and where some trees exceeding 1 m in diameter (at breast height) are available for use as territorial songposts (Bland and Gardner 2013). In the southern Sierra Nevada, such habitats occur on north-tending slopes down to ~1550 m elevation (U. S. Forest Service vegetation maps, fir and mixed-conifer forest types), in areas where large trees have not been eliminated by timber harvesting or catastrophic fire. Habitat associations south of Kern Gap were probably similar, although on the sky islands forests are drier, and the canopy is generally lower and more open.

The Mount Pinos Sooty Grouse is probably much less migratory than northern populations of the Sooty Grouse, many of which migrate altitudinally between separate breeding and winter ranges (Bendell and Zwickel 1984, Zwickel and Bendell 2004). Within the range of *D. f. howardi*, suitable habitat occurs in relatively narrow belts along the two main ranges of the southern Sierra Nevada (Great Western Divide and main Sierra Nevada) and around the peaks of the isolated sky islands, so substantial seasonal altitudinal migration is unlikely. Seasonal movements are probably similar to those of Sierra Sooty Grouse, which on the western slope winter and breed in one general area (Bland and Gardner 2013). The persistence of wintertime droppings (Zwickel and Bendell 2004:136) in males' breeding territories at Sunday Peak and Mineral King (pers. obs.) suggests there is little seasonal migration in the southern Sierra Nevada. At Mt. Pinos, the only museum specimen collected in winter was collected at the summit, where other specimens were collected during the breeding season (Table 1). Grinnell (1905) mentioned reports from Mt. Pinos of grouse "in the pines down even as low as the sawmill … in winter," but the site of the sawmill (today's McGill Campground, Kane 2008) is just 4.3 km east of the summit and well within potential breeding habitat (~2250 m, mixed conifer forest; U. S. Forest Service vegetation maps).

DISCUSSION

Given the results of my survey, and the lack of documented sightings since 1993, it can reasonably be concluded that the Mount Pinos Sooty Grouse has been extirpated from the sky islands. I believe I would have detected any breeding males present, since my methods have been effective for detecting territorial males in sparse populations throughout the Sierra Nevada, including those of *D. f. howardi* in northern Tulare County (Bland 1993). At Sunday Peak and Cherry Hill, males responded to my recorded cackle calls, and distances of initial detection ranged from ~375 to 525 m. At 20:15 on 23 April 2002, I heard hooting on Sunday Peak from the shoulder of Rancheria Road (USFS 24S15), from a distance of ~1.4 km. If a viable breeding population had been present in the sky islands, singing males should have been detected. Where population densities are low, male Sooty Grouse occur in clusters (Lewis 1985, Bland 2013) and countersing throughout the day (Stewart 1967, Zwickel and Bendell 2004:156),

making detection relatively straightforward. It is possible that one or more silent grouse could have gone undetected, but the lack of hooting during peak hooting season implies that any such individuals did not constitute a viable breeding population. Although I was unable to survey some patches of potential habitat at the Breckenridge Mountain, Tehachapi Mountains, Alamo Mountain, and Pine Mountain survey sites because of limited access or time, habitat conditions or the lack of prior records suggest these areas had low potential for occupancy.

In 2012, eight years after I surveyed the Greenhorn Mountains, N. J. Schmitt discovered a single male hooting ~1.5 km north of Shirley Peak in the southern Greenhorn Mountains, ~7.5 km south of the birds I recorded at Sunday Peak. The bird was observed by several other people, including myself, and was photographed by J. Dunn and A. Sheehey, 29 April–27 May 2012. It was heard hooting again by several people in 2013, between late April and early May (N. J. Schmitt pers. comm.). On 13 May 2012, I searched this area and found no evidence (accumulations of droppings) of additional territorial males, and only a limited area of potential breeding habitat (only a few trees in the area, also known as Sawmill Ridge, exceeded 1 m in diameter at breast height). I believe this is a lone individual that dispersed to Shirley Peak, possibly from nearby Sunday Peak, and does not represent a group breeding at Shirley Peak. Nonetheless, the area should be monitored to assess whether grouse do successfully recolonize the Greenhorn Mountains south of Greenhorn Summit.

The Mount Pinos Sooty Grouse could have been widespread ~1500–4000 yrs ago, when the region's climate was consistently cool and moist, and fir, the primary food of the Sooty Grouse, was more widespread and abundant (Laudenslayer and Skinner 1995). Recurrent droughts beginning ~1500 years ago (Graumlich 1993) might have contracted its range to the extent observed by early naturalists. As grouse habitat receded up the slopes of the sky islands, the population in smaller patches may have been reduced below the level of viability, being maintained only by emigration from larger patches. Perhaps no single island was large enough to sustain a population without genetic exchange with other islands. The three largest islands—Mt. Pinos and adjoining peaks, the Piute Mountains, and the Tehachapi Mountains—were known to be occupied by grouse at the beginning of the 20th century, although available records suggest few existed in the Piute and Tehachapi mountains. Second-hand reports suggest the fifth-largest island, Frazier Mountain, might also have been occupied by a few grouse (Willett 1933). The lack of early 20th-century records from other islands might be attributable to a lack of survey effort. Breckenridge Mountain supported an area of moist montane forest comparable to that of the largest islands, so it might also have supported grouse prior to heavy timber harvesting beginning in the late 1800s. Indigenous people or settlers could have extirpated grouse from the smaller islands by hunting before scientists became aware of them, or perhaps smaller islands were occupied only intermittently. Moist montane forest on Bear Mountain and the Liebre Twins might have been too little to support a persistent breeding population, but the locations of these islands suggest they could have served as stepping stones for dispersal between larger islands. Tecuya Mountain, Alamo Mountain, and Pine Mountain were

probably all too small and too arid to support breeding grouse in modern times. Reports submitted orally to the Forest Service from Alamo and Pine mountains in the 1970s (Weiss 1979) were probably of misidentified Band-tailed Pigeons or Mountain Quail.

Populations that persisted into the mid-1900s were small and isolated and could have been extirpated by unseasonal snowfall, catastrophic fire, or disease. Increased human activity could also have expedited their disappearance, including the effects of livestock grazing (Mussehl 1963, Zwickel 1972, Zwickel and Bendell 2005), timber harvesting (Bland and Gardner 2013), rural development (Zwickel and Bendell 2005), illegal hunting, and fire suppression. Livestock grazing was well established in the sky islands by the mid-1800s (Morgan 1914, Stephenson and Calcarone 1999, Gossard 2005). In the early 1900s, flocks of sheep numbering in the thousands grazed many areas (Gossard 2005:72, Morgan 1914:34, Kane 2008:174, 211). In 1891, Fisher (1893) observed "the destruction of vegetation by sheep [in the southern Sierra Nevada] is a potent cause of the scarcity of ground-inhabiting birds." In October, 1934, Grinnell (1935) noted, "there is ... potentially much moisture-loving vegetation [~10 km north of Greenhorn Summit]; but heavy grazing in an extra dry season had produced conditions by autumn of this year, distressingly barren on and about the little meadows." Bergerud (1988) demonstrated the importance of low herbaceous growth for the insect foods and escape cover needed by grouse chicks.

Timber harvesting began in the sky islands in the mid-1800s to serve the needs of mines, ranches, settlements, and the army outpost at Fort Tejon (Morgan 1914, Laudenslayer and Darr 1990, Kane 2008). Between 1875 and 1925, sawmills were operating on at least four of the sky islands (Breckenridge Mountain, Piute Mountain, Tehachapi Mountains, and Mt. Pinos and adjoining peaks; Gossard 2005, Morgan 1914, Kane 2008). Large-scale commercial logging commenced in the 1950s and 1960s, but it was very limited in Los Padres National Forest (Mt. Pinos and adjoining peaks, Tecuya, Frazier, Alamo, and Pine mountains; Baker and Stewart 1996, Stephenson and Calcarone 1999). Bergerud (1988) described how intensive timber harvesting and other alterations of habitat structure at a similar scale, including wildfire, can disrupt the "predator-cover complex" of grouse, heightening their risk of predation as they navigate through an altered mosaic of habitats. Timber harvesting is negatively associated with habitat occupancy by breeding male Sierra Sooty Grouse, in part because the trees they select for territorial songposts, averaging ~1 m in diameter at breast height, are valuable timber (Bland 2006). Perhaps a century or more of logging in the sky islands eliminated elements of habitat structure that were essential for grouse or fragmented the habitat to the extent that the grouse were exposed to unsustainable rates of predation.

Fire suppression since the early 1900s has also altered grouse habitats. Where fires are suppressed, undergrowth proliferates and large trees suffer increased mortality due to competition (Parsons and DeBenedetti 1979). Secondarily, where fires have been suppressed, successive wildfires are more frequent and more intense, often killing most or all trees. Historically, low-intensity wildfires at intervals of 15 to 30 years thinned forest understories and created patchy overstories (Taylor and Halpern 1991). This maintained

the fine-scale heterogeneity of the canopy of old-growth mixed-conifer forests of the Sierra Nevada (Fites-Kaufmann et al. 2007), to which southern populations of the Sooty Grouse have apparently adapted. With fire suppression, increasingly large areas of grouse habitat became either overgrown (e.g., Mt. Pinos) or ruined by catastrophic fires (e.g., Piute Mountains).

There are now substantial obstacles to natural recolonization from the southern Sierra Nevada. Habitat suitability in the sky islands continues to decline as a result of timber harvesting, wildlfire, and residential development. Drought and associated insect outbreaks have increased the mortality of conifers (Van Mantgem and Stephenson 2007, Bentz et al. 2010), creating an impetus to "sanitation log" afflicted trees (Graham et al. 1999). Under some scenarios of climate change, moisture- and temperature-sensitive elements of montane forest could be further eroded by a warming climate (Lenihan et al. 2003). The 2008 Piute fire caused substantial long-term damage to the first stepping stone to potential recolonization. Many decades, even centuries, will be necessary for the return of features of old forest such as trees >1 m diameter and large downed logs. The next major stepping stone, the Tehachapi Range, is rapidly being transformed by low-density residential development, even at higher elevations.

Reintroduction by translocation from the Sierra Nevada might also be problematic, even if habitat conditions improve. Miller and Benson (1930) considered the Mount Pinos Sooty Grouse phenotypically uniform across the Kern Gap. However, those from Mt. Pinos may differ to some extent in mitochondrial DNA haplotype from those from the southern Sierra Nevada (G. Barrowclough pers. comm.).

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APPENDIX

Documented observations of the Mount Pinos Sooty Grouse in the sky islands region since 1964. Written reports on file at an appropriate institution and including detail sufficient to exclude a misidentified Band-tailed Pigeon or Mountain Quail. Photocopies of these reports are available by request.

23 September 1976, J. Hamber, D. Smith, and M. Hasey, upper north slope of Mt. Abel (Cerro Noroeste), below the ski tow and lodge, with Camp Condor in view below, ~2135 m elevation (34° 51′ N 199° 12′ W).

D. Smith: "We heard the sound of a good-sized bird moving in a tree over our heads. I saw the bird fly to a nearby Jeffrey pine just down the side of the slope. The others heard it—sounding like the rustling of a shopping sack—as it landed, giving all of us a good profile of its full body. Bird was approx. size of a Rhode Island red chicken—large body, small head, good size, square end tail with a light band at end—body appeared to be speckled and dark. Gray with no warm color apparent to us. Saw for about 3 or 4 seconds—then bird flew, flapping 3 or 4 times then coasting, dropping rapidly down canyon, disappearing into trees below. Wings were curved steeply down at ends as it coasted. I heard no call as it moved out. Picked up a few body feathers from the slope [specimen AV10506, Table 1]—may or may not be associated. Appearance of the bird was definitely that of a galliform."

J. Hamber: "The bird was first seen by Dick Smith as it flew from one tree to the Jeffrey pine." "I moved upslope slightly and found the bird perched at an oblique angle on a bare area of a large branch of the tree about 40 feet from the ground and 6 feet from the trunk of a mature Jeffrey pine. The canopy of the tree shaded the bird, but no part was obscured by branches. In the binoculars [from ~15 m], I observed a large, 15- to 18-inch bird with a small head; small, stout bill; short neck, plump body and fairly long, wide tail—squared off on the end. Definitely a gallinaceous bird. The bird was dark, brownish gray all over with some lighter mottling on the back. The tail was dark with a light 1/2″–3/4″ band on the end of the tail. The bird was in view for about 10 seconds. It then left the branch, sailed down the ravine on decurved wings and was lost to sight a few seconds later."

2 August 1992, L. Allen, ~1 km SW of the peak of Sawmill Mountain, ~2600 m elevation (34° 49′ N, 119° 9′ W). "The bird flushed [at a distance of 7–8 m with very loud wingbeats … circled behind me and disappeared from view…. The head, dorsal surface of the body, and wings appeared mottled in no particular pattern but gave the overall impression of a medium-brown plumage. The tail was fanned as the bird banked; the dorsal color extended about halfway down the tail, beyond which the tail was a uniform dark brown, with a narrow, white (or pale) terminal band.

1 May 1993, R. Chichester, Upper northeast slope of Sawmill Mountain, ~2600 m elevation (34° 48.9′ N, 119° 9.6′ W). "The birds were 10–15′ away when I jumped

them. My observations were side view and mainly rear view as they flew over the crown of the hill. The color pattern of the tail and body of the birds was definitely that of grouse. I noted the banded color pattern of the tail as it was fanned out in flight." Afterward, a second person, M. Chichester, heard "several diagnostic booms" ... "followed by a few low clucks." R. Chichester conveyed orally to M. Chichester (in litt.) that the flushed birds produced an "explosive, frightening sound," were "double the size of quail," "brown/gray" overall, with a "fanned gray tail" that had a "band on the tip."

Male Mount Pinos Sooty Grouse (*Dendragapus fuliginosus howardi*), Giant Sequoia National Monument, California, 31 May 1992.

Photo by James D. Bland