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# STATUS OF OWLS IN THE GLASS MOUNTAIN REGION, MONO COUNTY, CALIFORNIA

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In east-central California, avifaunal surveys have been conducted recently in the White–Inyo Range (Johnson and Cicero 1986, 1991) and in the Yosemite region and adjacent east slope of the Sierra Nevada (Gaines 1988). Knowledge of the distribution and abundance of most species of owls in these areas appears to be based on limited surveys or compilations of anecdotal observations. Shuford and Metropulos (1996) reported on the first five years of a breeding-bird-atlas project in the Glass Mountain region of Mono County, California. Here we present the results of intensive nocturnal owl surveys conducted as part of that atlas project in 1995 and 1996, supplemented by incidental observations of owls from diurnal surveys of all species from 1991 to 1996. We describe the distribution, elevational breeding limits, relative abundance, and general habitat requirements of owls in the Glass Mountain region, compare this knowledge to that of owls in nearby mountain ranges, and discuss factors that may limit owls in the region. Finally, we provide land managers in the region with a foundation of knowledge of owls, previously lacking, upon which to build more detailed studies needed to guide land-use decisions.

## STUDY AREA AND METHODS

### Study Area

The Glass Mountain study area is located in Mono County, California, on the western edge of the Great Basin desert and lies between the White–Inyo Range to the east and the Sierra Nevada to the west (Figure 1). The study area centers on Glass Mountain and its spur ridges and stretches from the Mono Craters and Adobe Hills on the north to the upper Owens Gorge on the south and from Highway 395 on the west to the east slope of the Benton

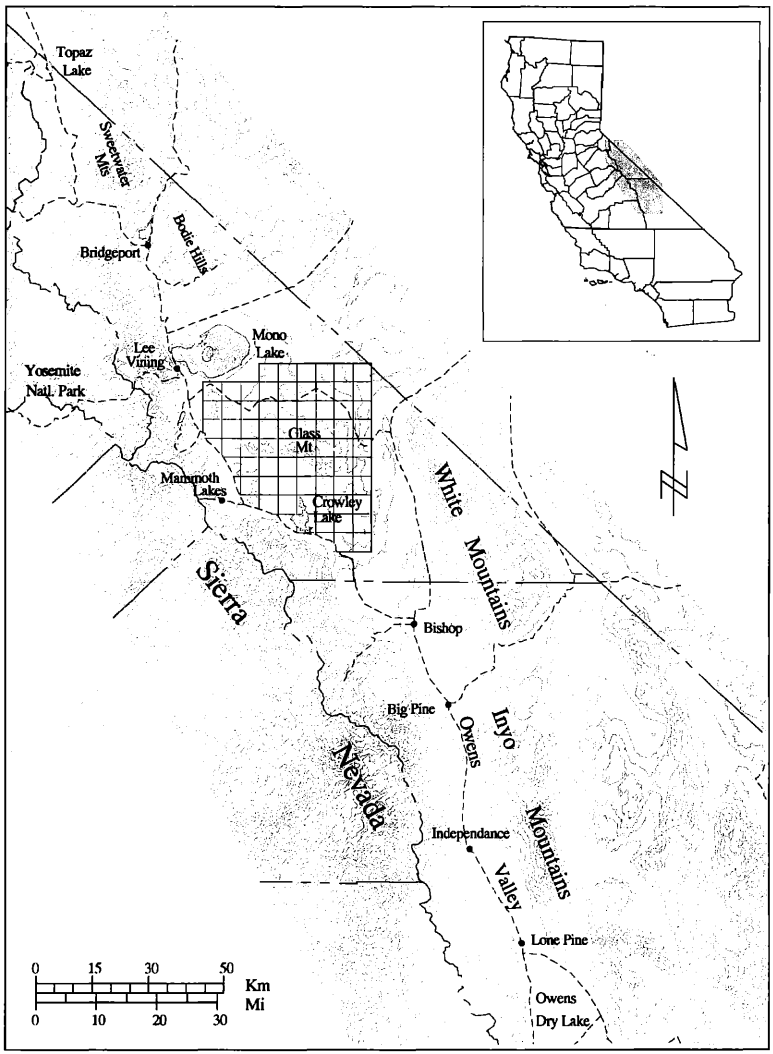


Figure 1. The Glass Mountain atlas grid in relation to nearby mountain ranges in east-central California. Contour interval, 1000 ft.

Range on the east (Figure 2). Elevations in the study area range from a low of about 5800 ft in the upper Owens Gorge below the Upper Power Plant to 11,140 ft on the south peak of Glass Mountain. Much of the region has been shaped by volcanic activity.

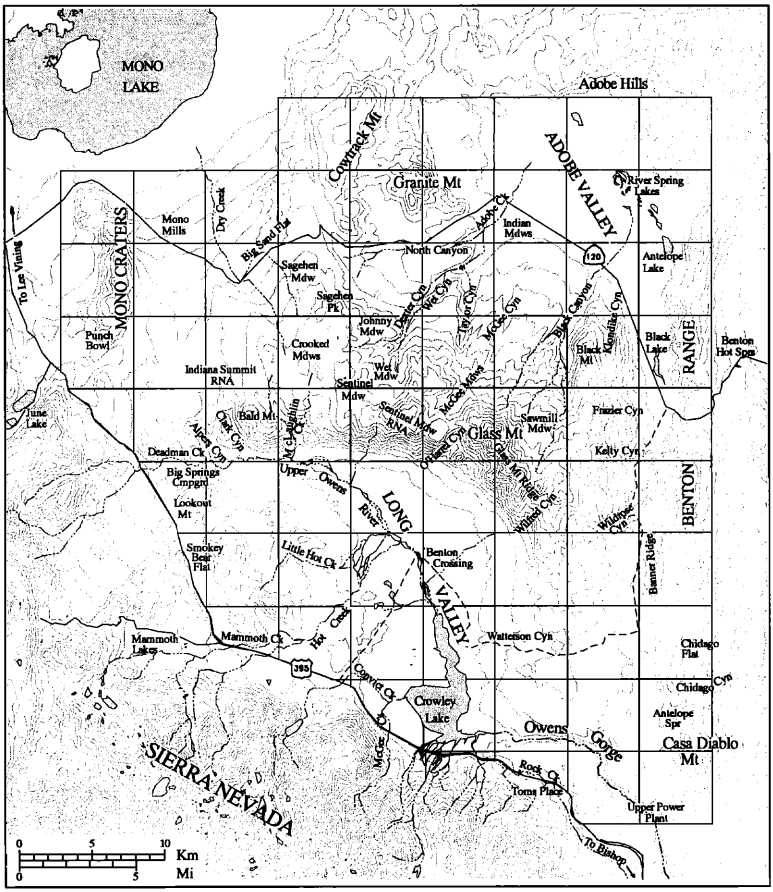


Figure 2. Glass Mountain region with 5-km atlas grid. Contour interval, 250 ft.

Major terrestrial habitats (adapted from USFS 1981) include

(1) Sagebrush scrub—a moderately open shrubland usually dominated by Big Sagebrush (*Artemisia tridentata*), but other species, such as Bitterbrush (*Purshia tridentata*) and rabbitbrush (*Chrysothamnus* spp.), may be dominants or co-dominants. On alkaline soils, Greasewood (*Sarcobatus vermiculatus*) may dominate, as may Rubber Rabbitbrush (*C. nauseosus*), which also colonizes disturbed areas. Other frequent shrubs include Green Ephedra (*Ephedra viridis*), Hop-sage (*Grayia spinosa*), Desert Peach (*Prunus andersonii*), and horsebrush (*Tetradymia* spp.).

(2) Pinyon woodland—an open woodland usually dominated by Singleleaf Pinyon Pine (*Pinus monophylla*). In this region, junipers (*Juniperus* spp.) are important at only scattered sites, such as low on the east slope of the

Benton Range. Curl-leaf Mountain-mahogany (*Cercocarpus ledifolius*) may mix with the pinyons locally, and Big Sagebrush and Bitterbrush are important understory shrubs.

(3) Mountain-mahogany woodland—a moderately closed short woodland dominated by Curl-leaf Mountain-mahogany; Big Sagebrush and Bitterbrush are important understory shrubs.

(4) Jeffrey Pine forest—an open forest dominated by pure stands of primarily second-growth Jeffrey Pine (*Pinus jeffreyi*) with an open understory of Bitterbrush and sagebrush.

(5) Mixed conifer forest—an open to moderately closed forest of mixed stands of White Fir (*Abies concolor*) and Jeffrey Pine or Lodgepole Pine (*Pinus contorta* ssp. *murrayana*). The understory may be of small White Firs and scattered shrubs. Of very local occurrence on the west side of the study area.

(6) Lodgepole Pine forest—an open to moderately dense forest dominated by Lodgepole Pine. Important understory shrubs are Big Sagebrush, Bitterbrush, and, locally, currant (*Ribes* spp.).

(7) Limber Pine forest—an open subalpine forest dominated by Limber Pine (*Pinus flexilis*) found locally on dry steep slopes at high elevations. At the lower extent of its altitudinal range, Limber Pine mixes with Lodgepole Pine. The understory may be open or of scattered Big Sagebrush bushes.

(8) Whitebark Pine forest/woodland—a short subalpine forest or woodland dominated by Whitebark Pine (*Pinus albicaulis*), found only in patches on the top of Glass Mountain.

(9) Riparian forest/woodland—a dense to moderately open forest or woodland dominated by deciduous trees or shrubs, including willows (*Salix* spp.), Quaking Aspen (*Populus tremuloides*), Black Cottonwood (*P. balsamifera* ssp. *trichocarpa*), Wild Rose (*Rosa woodsii* var. *ultramontana*), Water Birch (*Betula occidentalis*), and, locally, Buffalo Berry (*Shepherdia argentea*).

(10) Dry meadow—a meadow that supports bunch grasses, annual grasses, and some forbs and shrubs; sedges (*Carex douglasii*) and rushes (*Juncus* spp.) tolerant of relatively dry conditions may mix with the grasses. Saltgrass (*Distichlis spicata*) dominates on saline alkali flats. The underlying water table fluctuates seasonally.

(11) Sand flat—pumice sand flats are covered sparsely with perennial forbs, such as Pussypaws (*Calyptridium umbellatum*), Hulsea (*Hulsea vestita*), evening primrose (*Oenothera* spp.), Mono Lake Lupine (*Lupinus duranii*), and Mono Milkvetch (*Astragalus monoensis*).

(12) Wet meadow—a meadow thickly vegetated with relatively short perennial sedges, rushes, and grasses that occurs on level or gently sloping areas with a year-round source of water. Small forbs are also common.

(13) Perennial grassland—limited areas dominated by native grasses are found in the sagebrush zone where fire or other disturbance has occurred.

(14) Alpine fell-field—on the top of Glass Mountain dry open pumice soil supports scattered patches of various perennial herbs and grasses.

(15) Barren areas—include areas largely devoid of vegetative cover, such as rock outcrops, rocky cliffs, earthen bluffs, talus slopes, volcanic craters, and some sand or alkali flats.

Important wetlands—open water of lakes, ponds, and streams and associated marshes and wet meadows—are found in Adobe Valley to the north of Glass Mountain and to the west and south in the Owens River/ Crowley Lake drainage of Long Valley and the Owens Gorge.

The study area is managed primarily by the U. S. Forest Service/Inyo National Forest, Bureau of Land Management, and Los Angeles Department of Water and Power. Human habitation is minimal and clustered mostly in the Long Valley region in the southwestern portion of the study area, though human influence is widespread. Cattle grazing is extensive in meadows and riparian zones. Heavy logging, particularly of Jeffrey Pines, coupled with fire suppression over the last 100 years has greatly altered the remaining forests, leaving denser stands of smaller-diameter trees than existed historically (T. Higley pers. comm.).

## Data Collection

*Atlas grid.* As in many other California atlas projects, the study area was divided by a grid of 5-km (3.11 mi) squares or blocks based on the Universal Transverse Mercator grid tick marks on 15-minute USGS topographic maps. The study area thus comprises 63 complete and 11 partial blocks (Figure 2). These blocks were the basic units of field work and for mapping the distribution of all species of owls.

*Nocturnal surveys.* In 1995 and 1996, 14 observers spent about 190 hours conducting nocturnal surveys for owls; we accounted for 74% of this total. Surveys were conducted primarily by driving the extensive network of dirt logging roads in the study area and stopping at irregular intervals in seemingly suitable habitat to try to detect owls. Because of steep terrain and a virtual lack of two-wheel-drive roads above 9200 ft, Shuford backpacked overnight on 7 July 1996 to an unnamed peak at 9961 ft above upper Wilfred Canyon and on 9 July 1996 to the upper elevational limits of Sentinel Meadow Research Natural Area at 10,171 ft. At lower elevations, observers also occasionally walked up to 1.5 mi. off roads, particularly on nights of or close to full moons. Also, a few owls were encountered fortuitously at night at camp sites. All nocturnal surveys were conducted from 27 April to 29 July (Figure 3).

Although some owls were recorded from spontaneous vocalizations, observers attempted to elicit responses from owls by playing tape-recorded calls or making vocal imitations of the various species. Because observers were so few, we focused on spreading coverage throughout all atlas blocks and elevations rather than on standardized routes and call points aimed at randomizing observations and documenting call frequencies over the season.

*Diurnal coverage.* From 1991 to 1996, observers spent 1861 hours conducting multi-species diurnal surveys for breeding birds in the study area. Although not ideal for detecting nocturnal species, these diurnal surveys provided important supplemental data on certain species of owls. We were able to cover most habitats in all blocks, except in riparian or wetland habitat in parts of three blocks along about a 7-mile stretch of private land on the upper Owens River. Methods used were similar to those followed by most breeding-bird-atlas projects in North America (Laughlin et al. 1982, 1990), as summarized by Shuford and Metropulos (1996). For each block, observ-

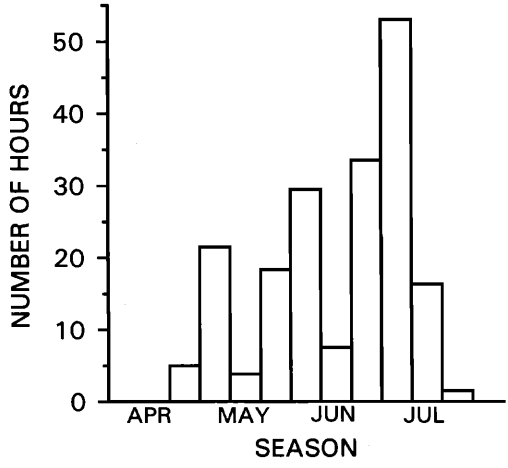


Figure 3. Number of hours spent on nocturnal owl surveys by 10-day periods from April through July, 1995 and 1996.

ers recorded the most conclusive type of breeding evidence observed for each species encountered. Observers attempted to obtain adequate coverage of each block by visiting all habitats present until knowledge of species–habitat associations suggested that further field work was unlikely to add many breeding species to a particular block (see Shuford 1993:46–48) Nevertheless, as in all atlas projects, no matter how thorough, we assumed that some breeding species likely were missed in many blocks, particularly difficult-to-survey species such as owls. Likewise, because habitat, climate, prey populations, and other conditions change over time, species recorded in a block during the atlas period may not necessarily be found there in subsequent years.

*Other information collected.* On each visit to a block, whether nocturnal or diurnal, observers recorded (1) the elevational breeding limits (to the nearest 100 ft) of all species encountered, (2) the number of hours spent in the field (to the nearest 1/4 hr) as a measure of observer effort, (3) a count or estimate of the number of each species observed or heard, and (4) details of all confirmed breeding records. Elevations were estimated in the field from topographic maps or a calibrated altimeter. Observers also recorded whether owls were detected aurally and/or visually and, to the best of their ability, the habitats from which owls were vocalizing.

*Incidental sightings.* We also accepted any breeding evidence observed outside of regular atlas surveys that could be accurately assigned to a specific block. Such information was obtained by atlas participants in the course of miscellaneous travels or other field work or by reliable observers who transmitted their observations to atlas participants.

*Relative distribution.* In species accounts the relative extent of each species' breeding distribution within the study area is described by means of

a ranking of the number of blocks in which the species occurred: very local = 1–15 blocks, local = 15–30 blocks, fairly widespread = 31–45 blocks, widespread = 46–60 blocks, and nearly ubiquitous = 61–74 blocks.

*Estimates of owl numbers.* The total numbers of each species of owl recorded on both nocturnal and diurnal surveys were converted to estimates of owl territories; these are *not* estimates of pairs of owls, as some territorial owls may not be paired, or of the total number of owl territories within the atlas study area. To make these conversions we assumed that (1) two owls calling at different pitches and cadences represented mated pairs on a mutual territory and (2) single adults, whether recorded by call or by sight, also represented one owl territory regardless if they were paired or not. Groups of fledglings, whether or not accompanied by adults, also obviously represented mated pairs on territory.

*Comparative data.* To obtain historical records of owls in the Glass Mountain area and information on the status of owls in nearby mountain ranges in California (White–Inyo Range, Mono and Inyo counties; eastern Sierra Nevada, Mono and Inyo counties; and Sweetwater Mountains, Mono County) (Figure 1), we searched the published literature, combed the unpublished files of the editors for the middle Pacific coast region of *National Audubon Society Field Notes,* corresponded with local experts, and obtained specimen and egg-set data from the Los Angeles County Museum of Natural History (LACM), Museum of Vertebrate Zoology (MVZ), San Bernardino County Museum (SBCM), San Diego Natural History Museum (SDNHM), Santa Barbara Museum of Natural History (SBMNH), and Western Foundation of Vertebrate Zoology (WFVZ). Records from *American Birds* are cited as AB: page number.

*Observers cited:* Al DeMartini (ADeM), Anthony Desch (ADes), Sam D. Fitton (SDF), Helen and Paul Green (H & PG), Mike McClaskey (MMcC), Debra Love Shearwater (DLSh), Dave Shuford (DS), and Emilie Strauss (ES).

## RESULTS AND DISCUSSION

We recorded seven species of owl in the study area and know of the historical occurrence of one additional species, the Short-eared. From our detection rates, the Northern Saw-whet was the most abundant, followed by the Great Horned, Long-eared, Flammulated, Western Screech, Northern Pygmy, and Barn. The first three were numerous and fairly widely distributed, whereas the others were rare and occurred very locally. Although we confirmed breeding of only the three most numerous species, circumstantial evidence suggests the remaining species also breed in the study area. A decline of breeding Short-eared Owls throughout California (see account) may explain our current inability to find this species. Alternatively, the species may breed in the study area irregularly, depending on upswings in cycles of rodent abundance (Clark 1975, Voous 1988), as we have observed elsewhere in California. Also, we documented a range extension of a subspecies of the Western Screech-Owl, presumably *Otus kennicottii inyoensis* (Grinnell and Miller 1944), if this is adequately differentiated from *aikeni* (Marshall 1967).

## Species Accounts

### Barn Owl (*Tyto alba*)

A very local breeder (possibly a transient) recorded in only 1 (1.4%) of 74 atlas blocks (Figure 4). Our only record was of a single individual heard on a nocturnal survey at about 6200 ft in the upper Owens Gorge above the Upper Power Plant on 4 May 1996 (SDF). The habitat on the slopes of the gorge is dominated by sagebrush scrub with scattered pinyon and Jeffrey pines; clumps of willows and wet sedge meadow line the river below. Numerous potential nesting cavities are present in the extensive rock cliffs of the Owens Gorge. This location may be at the upper elevational limit of this species' breeding in California. Grinnell and Miller (1994) listed the upper elevation of known "occurrence" as 5500 ft in the southern Sierra. Gaines (1988) considered the species a rare transient up to 6500 ft in the Mono Lake area, but his April to June records suggest the possibility of occasional breeding at that elevation. The species is a "fairly common" nesting bird to the south in the Owens Valley (T. and J. Heindel pers. comm.) but is unrecorded in the adjacent White–Inyo Range (Johnson and Cicero 1986, T. and J. Heindel pers. comm.). Likewise, we know of no records for the Sweetwater Mountains, though the species was seen on 10 September 1995 in the Bridgeport Valley (P. J. Metropulos pers. comm.) at the base of that range.

### Flammulated Owl (*Otus flammeolus*)

A very local breeder recorded in 4 (5.4%) of 74 atlas blocks (Figure 4). Representative locations were about 1.5 mi. NE of Indiana Summit Research Natural Area (8300 ft, calling adult, 25 June 1995, DS), Sagehen Meadow (8400 ft, calling adult, 25 June and 10 July 1995; DS, DLSh), Wet Meadow (8800 ft, calling adult, 4 July 96, SDF et al.), about 1 mi. N of Sawmill Meadow (8600 ft, agitated adults, 11 July 1995; ADeM, DLSh), and about 0.5 mi. NW of Sawmill Meadow (9200 ft, pair, 10 June 1995, SDF). On nocturnal surveys, we detected eight vocalizing birds (one subsequently seen) representing seven Flammulated Owl territories. Of these, five were in mixed groves of aspens and either Jeffrey or Lodgepole pines; two were in pure stands of Jeffrey Pine forest. On 13 June 1992, D. and J. Parker (in litt.) found the wing of a Flammulated Owl at 8000 ft in a mixed woodland of Quaking Aspen, Black Cottonwood, juniper, and Jeffrey Pine in an unnamed canyon southeast of O'Harrel Canyon; identification of the wing was confirmed by T. and J. Heindel (pers. comm.). Grinnell and Miller (1944) reported specimens collected on 20 and 22 June 1942 from 9 mi. W of Benton (8300 ft; MVZ 84823, 84824). A. H. Miller's field notes (MVZ library) indicate that on these dates he and W. C. Russell were camped out in an aspen grove off the road to Sawmill Meadow on the northeast flank of Glass Mountain. They heard Flammulated Owls calling in Ponderosa [Jeffrey] Pine both on the edge of the aspen grove and up the drainage about one-quarter mile.

Knowledge of the species' habitat requirements in California is still incomplete, and more work is needed to confirm the extent of the species' apparent strong association in our study area with aspen–pine groves. Grinnell and Miller (1944) described breeding habitat as open or broken forests of various conifers often mixed with California Black Oak (*Quercus kelloggii*) or Oregon Oak (*Q. garryana*). Though recognizing the vegetative diversity of the Flammulated Owl's breeding habitat, Winter (1974) reported its close association in California with yellow pine (*P. ponderosa* and *P. jeffreyi*). Black Oak, thought to be important for nest cavities, is a co-dominant with Ponderosa Pine in breeding habitat in northwestern California (Marcot and Hill 1980). Quaking Aspen is a key nesting tree in Idaho (Powers et al. 1996) and Colorado, where Webb (1982) also found a close association between this owl and the aspen–pine ecotone.

Gaines (1988) listed three May-to-August records from 6400 to 8200 ft in the eastern Sierra of Mono County; also, a specimen was obtained 3 May 1983 at 9000 ft at Lake George, Mammoth Lakes (LACM 103003). Similarly, T. and J. Heindel (in litt.)

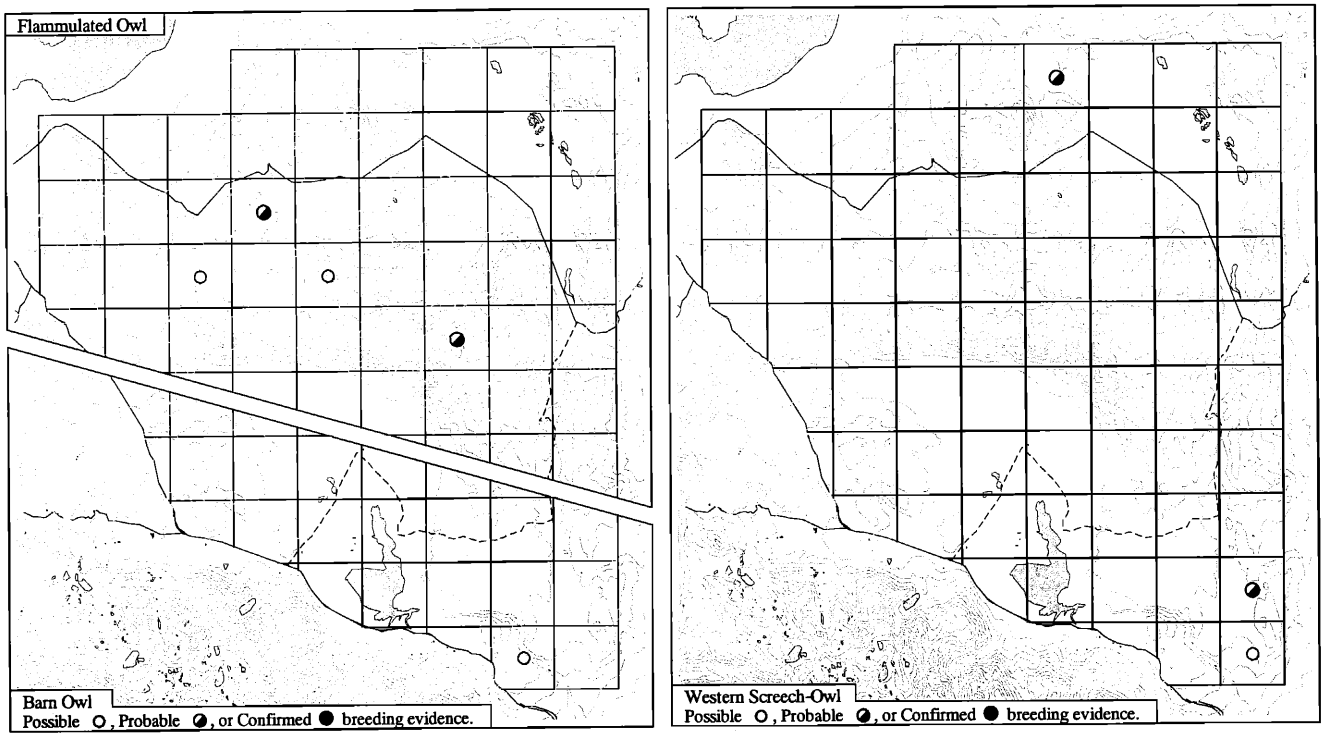


Figure 4. Breeding distribution of the Barn Owl, Flammulated Owl, and Western Screech-Owl in the Glass Mountain region. Contour interval, 400 ft. Possible breeding, male or female observed or heard singing in suitable nesting habitat during its breeding season. Probable breeding, pair observed in suitable habitat during their breeding season, permanent territory presumed through song at same location on at least two occasions seven days or more apart or through defense of territory (chasing individuals of same species), or agitated behavior or anxiety calls from adults. Confirmed breeding, used nest found, recently fledged young restricted to the natal area by dependence on adults or limited mobility, adults entering or leaving a nest in circumstances indicating occupied nest, or nest with eggs or young (seen or heard).

know of only three May-to-July records from 8200 to 9700 ft in the eastern Sierra of Inyo County. The Flammulated Owl is unrecorded from the Sweetwater Mountains (Winter 1974, Johnson 1975). Kenyon (1947) found a dead Flammulated Owl in a Lodgepole Pine forest at 9500 ft on the west slope of the southern Sierra, Fresno County. But far and away the highest-elevation breeding record is of a nest with two young observed from 10 July to 7 August 1990 in a Western Bristlecone Pine (*Pinus longaeva*) at 10,500 ft in Schulman Grove of the White Mountains, Inyo County (AB 44:1187, T. and J. Heindel pers. comm.); the species previously was unrecorded from these mountains (Winter 1974, Johnson and Cicero 1986, 1991). It is unclear if sites meeting the Flammulated Owl's insectivorous niche are localized at these higher elevations or if other factors explain the species' patchy distribution at these elevations in the Great Basin.

## Western Screech-Owl (*Otus kennicottii*)

A very local breeder recorded in 3 (4.0%) of 74 atlas blocks (Figure 4). Our only records were from 2 mi. NNE of the peak of Granite Mountain (7000 ft, duetting pair, 7 June 1996, DS), north-facing slope of Chidago Canyon about 1.5 mi. E of Antelope Spring (6400–6600 ft, two duetting pairs, 26 May and 28 June 1996, SDF), and 1 mi. WSW of the peak of Casa Diablo Mountain (6900 ft, calling adult, 5 May 1996, DS). On nocturnal surveys we detected seven vocalizing birds (one also seen) representing four screech-owl territories. Also, I. Mandelbaum (in litt.) heard a screech-owl in the Adobe Hills, about 8–9 mi. E of Mono Lake and 2–3 mi. S of Deep Wells, just north of our study area, on 10 April 1996. These records extend the range of the Western Screech-Owl about 40–50 mi. NNW to NW, respectively, of the previously known northern limits of the subspecies *O. k. inyoensis* in California near Bishop in the Owens Valley and the White Mountains, Inyo County (Grinnell and Miller 1944, Miller and Miller 1951, Johnson and Cicero 1986); the subspecies also occurs to the north in Nevada (Alcorn 1946).

All screech-owls were found in pinyon woodlands ranging from large, moderately dense to small, very open stands; the owl's densities were very low, as appears to be typical in this habitat elsewhere (Marshall 1967, J. Marshall pers. comm.). We did not detect screech-owls in groves of Black Cottonwood, Quaking Aspen, or willows, though the owl is found in deciduous trees at lower elevations in the Owens Valley (T. and J. Heindel pers. comm.).

Miller and Miller (1951) and Johnson and Cicero (1986) recorded the species up to 8250 ft in the White Mountains, where the latter authors considered the species "uncommon." Thus, the low densities we detected presumably reflect the status near the upper elevational limit of this subspecies. The few records of screech-owls on the east slope of the central Sierra Nevada, Mono County, appear to represent transient individuals (Gaines 1988), and the species is unrecorded in the Sweetwater Mountains (N. K. Johnson in litt.).

Efforts should be made to find screech-owls elsewhere in California east of the Sierra Nevada, as we know of observations of this species on the east slope of the Sierra, Inyo County (T. and J. Heindel in litt.), in Sierra Valley, Plumas County (L. Jensen pers. comm., Shuford pers. obs.), and in the Susanville–Janesville area, Lassen County (B. Stovall in litt.), outside the species' range as mapped by Grinnell and Miller (1944).

## Great Horned Owl (*Bubo virginianus*)

A fairly widespread breeder recorded in 41 (55.4%) of 74 atlas blocks (Figure 5). Locations ranged in elevation from 5800 ft (canyon in Benton Range above Benton Hot Springs, fledglings, 2 June 1992, DS) to 9200 ft (Sawmill Meadow, calling adult, 29 June 1996; SDF, ADes). We encountered about 61 adult-sized birds and 14 fledglings representing about 56 territories. Of these, 20 adult-sized birds and 9 fledglings were from daytime observations (13, 9) or from miscellaneous dusk or nocturnal sightings (7, 0), and 41 adult-sized birds and 4 fledglings were from nocturnal surveys.

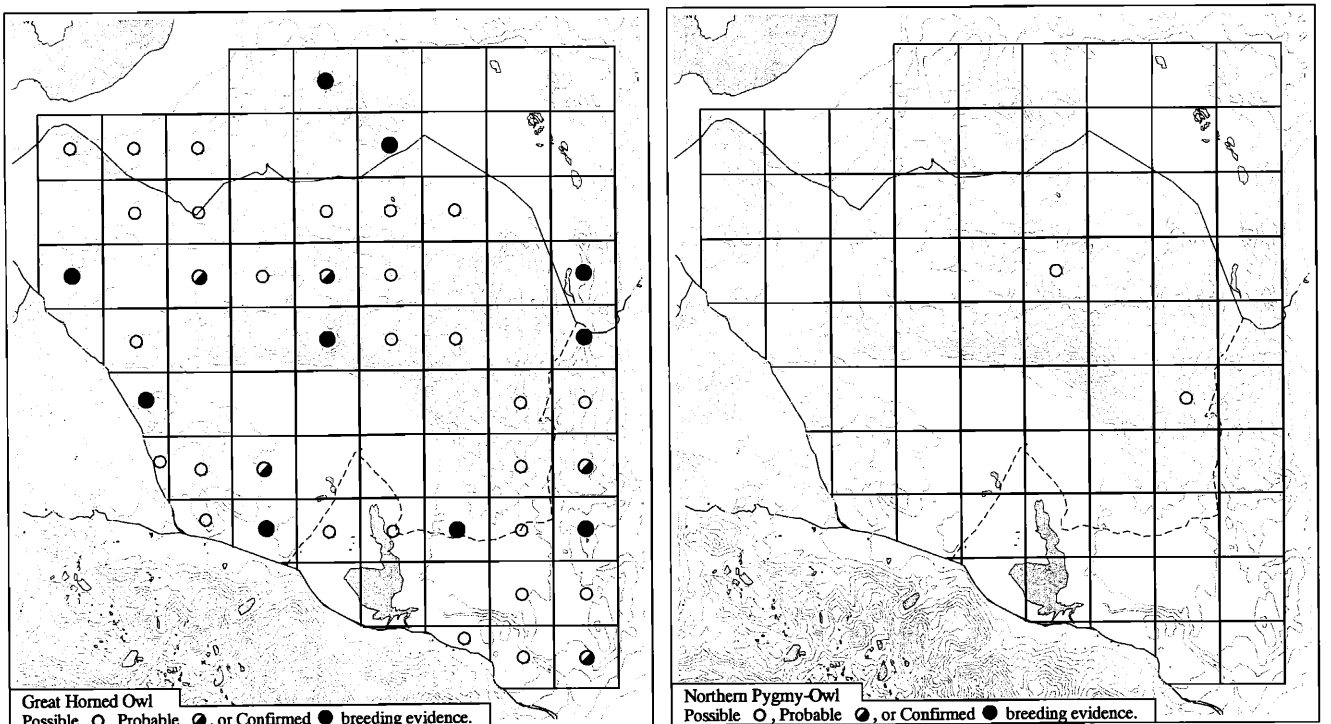


Figure 5. Breeding distribution of the Great Horned Owl and Northern Pygmy-Owl in the Glass Mountain region by level of nesting evidence. For definitions of possible, probable, and confirmed breeding, see Figure 4. Contour interval, 400 ft.

Of four nests found, one was in an old raptor nest in a large Jeffrey Pine and three were in cavities in rocky cliffs surrounded in two cases by sagebrush scrub and in the other by sagebrush and Jeffrey Pine forest. Of five additional fledged broods, one was seen in an aspen grove, two were seen in rocky canyons surrounded by either sagebrush scrub or pinyon woodland, and single juveniles were heard in pinyon woodland and Jeffrey Pine forest, in both cases with rocky cliffs in the vicinity.

Adult Great Horned Owls were found in almost all terrestrial habitats up into the lodgepole zone. Of 45 records with adequate habitat data, 14 were in pinyon woodland, 14 were in Jeffrey Pine forest, 8 were in sagebrush scrub or sand flats, 5 were in forests of Jeffrey Pine mixed with Singleleaf Pinyon Pine, Lodgepole Pine, or White Fir, 2 were in Lodgepole Pine forest, and 2 were in stands of various pines mixed with aspens.

Johnson and Cicero (1986) considered the Great Horned Owl a "fairly common" breeder up to 9500 ft in the White–Inyo Range, and Gaines (1988) termed the species a "fairly common resident below 7000 ft and uncommon resident or visitor to treeline" in the eastern Sierra Nevada. Gaines had records of calling birds at 10,000 ft in February, when birds should be pairing, but knew of no confirmed evidence of breeding above 7400 ft; subsequently, a successful nest was observed in spring 1990 at 8400 ft in the town of Bodie (P. Nicholson fide ES). Great Horned Owls also occur in the Sweetwater Mountains (e.g., 2 calling, 9400 ft, 3 mi. S of Lobdell Lake, 4 June 1996; ES, MMcC).

## Northern Pygmy-Owl (*Glaucidium gnoma*)

A very local breeder recorded in 2 (2.7%) of 74 atlas blocks (Figure 5). The two records are from Taylor Canyon (7300 ft, calling adult, 23–24 June 1994, DS) and Wildrose Canyon (7700 ft, calling adult, 12 June 1995; DLSh, ADeM). These individuals, both encountered during the day, were in aspen groves bordered either by pinyon woodland (heard only) or a mixed woodland of Jeffrey and pinyon pine (seen and heard). N. K. Johnson (in litt.) also collected a Northern Pygmy-Owl on 6 June 1970 at 8600 ft at Wet Meadow (MVZ 162393).

Gaines (1988) considered this species a "rare resident" on the east slope of the Sierra Nevada to 8000 ft and cited a suspected nesting location, in our study area, at 7800 ft at O'Harrel Canyon. Similarly, T. and J. Heindel (pers. comm.) know of only four records for the eastern Sierra of Inyo County, including a copulating pair on 8 April 1995 (E. A. Cardiff) and a family group on 12–13 July 1997 (S. Blanchard), both at 7800 ft at Glacier Lodge 8.5 mi. WSW of Big Pine. The species also seems relatively rare in the White–Inyo Range. Records for the Inyos include an individual seen at 7100 ft at Upper Addie Springs on 5 August 1975 (D. Juliani fide T. and J. Heindel pers. comm.), a specimen from a pinyon–juniper woodland at 7700 ft near Waucoba Mountain on 27 June 1977 (Johnson and Cicero 1986), and one in pinyon woodland at 8500 ft east of Lone Pine on 16 June 1978 (AB 32:1209). We know of only one valid record from the White Mountains, Inyo County: a bird calling at 8400 ft at Grandview Campground on 23 May 1987 (AB 41:1488). Hall et al. (1991) listed several reports for the White Mountains, but these need further confirmation given that these authors listed a number of questionable records for other species. The Northern Pygmy-Owl also occurs in the Sweetwater Mountains (Johnson 1975). We suspect the species' rarity in the Glass Mountain region and other nearby mountain ranges may reflect, in part, declining abundance with elevation, as it is numerous only to about 6000 ft nearby on the west slope of the Sierra Nevada (Gaines 1988).

## Long-eared Owl (*Asio otus*)

A fairly widespread breeder recorded in 33 (44.6%) of 74 atlas blocks (Figure 6). Notable records were from Antelope Spring (6500 ft, fledglings, 12 June 1994, H & PG), Sawmill Meadow (9100 ft, family group, 30 July 1992, J. Blanchard fide

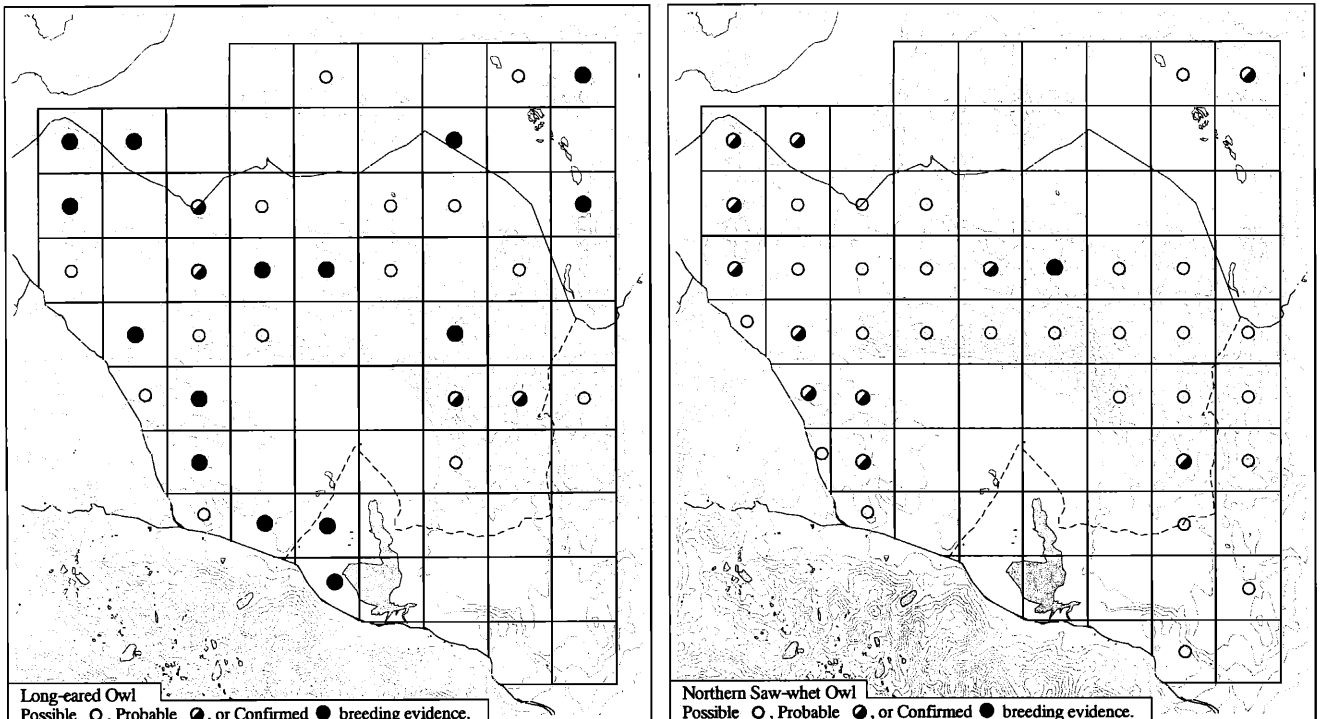


Figure 6. Breeding distribution of the Long-eared Owl and Northern Saw-whet Owl in the Glass Mountain region by level of nesting evidence. For definitions of possible, probable, and confirmed breeding, see Figure 4. Contour interval, 400 ft.

D. Parker), and unnamed peak above upper Wilfred Canyon (9900 ft, pair, 7 July 1996, DS). We encountered about 45 adult-sized birds and 21 fledglings representing about 42 territories. Of these, 28 adult-sized birds and 14 fledglings were from daytime observations (25, 14) or from miscellaneous dusk or nocturnal sightings (3, 0), and 17 adult-sized birds and 7 fledglings were from nocturnal surveys.

Of five nests detected, two were in old Black-billed Magpie (*Pica pica*) nests in willow–wildrose or Water Birch riparian bordered by wet meadow and sagebrush scrub, one was on a platform resembling an old squirrel nest in a Lodgepole Pine forest adjacent to a wet meadow, one was in an old corvid nest in one of a few dense pinyons on the edge of an open Jeffrey Pine forest bordered by Bitterbrush–sagebrush scrub, and one was in a cavity at the top of a Jeffrey Pine snag in a mixed stand of Jeffrey Pines and White Firs. Another probable nest site also was in a cavity atop a Jeffrey Pine snag in an open Jeffrey Pine forest near sagebrush scrub. Of six broods found out of nests, four were in willow–wildrose or Buffalo Berry riparian, one was in mountain-mahogany in a Jeffrey Pine–sagebrush matrix, and for one we lack specific habitat data. Although 50% of nests and broods with adequate habitat data were in lowland riparian groves, which provide the owls many nest platforms from old magpie nests and presumably a good prey base in adjacent meadows and sagebrush, we suspect these data overemphasize the importance of riparian habitats to these owls. First, riparian habitats, including aspen groves, account for less than 1% of the extent of potential Long-eared Owl habitat in the study area, and, second, owl nests and broods are much easier to find in the thin stringers of short riparian habitat that predominate in this region than in extensive stands of other forests and woodlands. When the owls did not nest in relatively open forests, the dense stands of trees where they nested were usually adjacent to or close to wet or dry meadows, sand flats, open sagebrush scrub, or other open foraging areas.

Of 29 other records of these owls with adequate habitat data, 7 were from Lodgepole Pine forest, 6 from Jeffrey Pine forest, 5 from sagebrush scrub, 4 from riparian thickets, 2 from pinyon woodland, 2 from mountain-mahogany woodland/sagebrush scrub edge, 1 from mixed Lodgepole-Jeffrey Pine forest, 1 from mountain-mahogany woodland, and 1 from a mixed aspen/lodgepole forest on a meadow edge.

Gaines (1988) considered the Long-eared Owl "a locally uncommon summer resident" to 8000 ft in the eastern Sierra Nevada, and Johnson and Cicero (1986) termed the species "an uncommon resident" to 9500 ft in the White–Inyo Range. Records from the White Mountains of single individuals on 26 May 1919 at an unspecified location at 10,500 ft, Mono County (Dawson 1923, Grinnell and Miller 1944), and on 18 July 1997 at 10,400 ft at Silver Canyon, Inyo County (T. and J. Heindel pers. comm.), suggest possible nesting at these elevations. The status of this species in the Sweetwater Mountains is uncertain, though habitat conditions suggest it is just as numerous there as it is near Glass Mountain. Large declines in breeding populations of the Long-eared Owl have led to the species' designation as a Bird Species of Special Concern in California (Remsen 1978, S. Laymon pers. comm.). Gaines (1988) documented historical declines near Mono Lake caused by habitat destruction, but this is likely a local effect given our recent observations nearby in the Glass Mountain area. Grinnell and Miller (1944) considered "the northern Great Basin territory" to be among the species' "centers of abundance" in the state. Our observations, showing the Glass Mountain region currently to be a center of abundance in the state, and those of others to the north and south (Remsen 1978, Johnson and Cicero 1986, T. and J. Heindel in litt.) indicate the species probably is still numerous in the Great Basin portions of California all along the Cascade–Sierra axis.

Bloom (1994) considered habitat loss from urban development and agriculture to be the main cause of population declines of breeding Long-eared Owls in coastal southern California. Besides residing in areas far from urban centers and large-scale agriculture, Long-eared Owls in the Great Basin of California may benefit from a diverse and abundant prey base. Species richness of mammals, the owl's principal

prey (Voous 1988), at the Great Basin–Sierra ecotone is among the highest in California (Howell 1924, Smith 1979) and in North America (Simpson 1964). Although the diet of Long-eared Owls near Glass Mountain is unknown, the area's small mammal fauna is not only rich but includes several heteromyid rodents, long-lived species with life histories that tend to dampen their population fluctuations (Brown and Harney 1993). In the deserts of Idaho, where Long-eared Owls are numerous and breed regularly (Marks 1986), the species preys on a wide variety of small mammals, but primarily on about equal proportions of deer mice (*Peromyscus*), pocket mice (*Perognathus*), and kangaroo rats (*Dipodomys*) (Marks 1984). These rodents are numerous in the Mono Lake–Glass Mountain area (Howell 1924, Harris 1982), and the diet of wintering Long-eared Owls in the southern California deserts is totally dominated by the two heteromyid genera *Perognathus* and *Dipodomys* (Barrows 1989). By contrast, in much of their range, where they depend on highly fluctuating populations of voles (*Microtus*), Long-eared Owl populations fluctuate correspondingly (Voous 1988).

### Short-eared Owl (*Asio flammeus*)

We did not record this species on our surveys of potential breeding habitat of marshes in Long and Adobe valleys. Dixon (1934) reported various records from "within a twenty-mile radius of June Lake," including a nest of a Short-eared Owl found on 15 June 1933. Although the exact location of this sighting is uncertain it may have been within the western boundary of our study area. Also, Rowley (1939) reported a Short-eared Owl nest found on 19 May 1926 in a meadow near McGee Creek, Long Valley (WFVZ 26579), which apparently was within or just outside the western boundary of our study area. The only recent evidence of breeding of this species east of the central Sierra Nevada is the observation of two birds courting at 6500 ft in Bridgeport Valley in 1984, though there are also a few breeding-season observations for 6400 to 6500 ft at Mono Lake (Gaines 1988; AB 45:493, 1158). A breeding-season record for the Owens Valley is of an individual seen 3 mi. NE of Big Pine on 20 June 1978 (T. and J. Heindel pers. comm.). We know of no records of this species from the Sweetwater Mountains, and its status in the White Mountains is uncertain (Johnson and Cicero 1986). Because of statewide declines of breeding Short-eared Owls, the species is listed as a Bird Species of Special Concern in California (Remsen 1978, S. Laymon pers. comm.).

### Northern Saw-whet Owl (*Aegolius acadicus*)

A fairly widespread breeder recorded in 38 (51.4%) of 74 atlas blocks (Figure 6). Notable records were from the upper Owens Gorge above the Upper Power Plant (6400 ft, calling adult, 4 May 1996, SDF), McGee Canyon (7800 ft, nest with young, 8–12 June 1995; DLSh, ADeM), and above Wilfred Canyon and E of Glass Mountain Ridge (9800 ft, calling adult, 7 July 1996, DS). We encountered about 84 individuals representing about 72 territories. All were on nocturnal surveys except for a pair at a nest hole 15 ft up in a Jeffrey Pine and an adult roosting in an aspen grove in the daytime. Gaines (1988) reported a record of a family group at 9500 ft on Glass Mountain, but that elevation is in error and probably was about 9000 ft (R. Stallcup pers. comm.).

Saw-whet Owls breed in a wide range of forests and woodlands of varying age, stature, and openness. Of 70 records with adequate habitat data, 27 were from Jeffrey Pine forest, 15 from pinyon woodland, 11 from Lodgepole Pine forest, 10 from mixed stands of Jeffrey Pine, Lodgepole Pine, or White Fir, and 7 from stands of Quaking Aspen or aspen mixed with Lodgepole or Jeffrey pine.

Gaines (1988) deemed the status east of the Sierra uncertain, but felt the species was "probably a rare summer resident" up to about 8500 ft. He listed a few nesting records for the east slope of the Sierra Nevada to which we can add two more: an adult

at a nest hole 8.2 ft up in an aspen tree near the Log Cabin Mine Road in lower Lee Vining Canyon (7800 ft, 6–10 June 1996, K. Farwell) and a nest with eggs and young about 40 ft up in a Jeffrey Pine snag cut down by a woodcutter at Glass Creek Campground (7500 ft, 15 May 1995, L. Trefry). In the eastern Sierra of Inyo County, two juveniles were found at 10,100 ft in Lodgepole Pine forest at Golden Trout Camp SW of Lone Pine 13–14 August 1984 (AB 39:98, T. and J. Heindel in litt.). Johnson and Cicero (1986, 1991) considered the species an "uncommon resident" to about 9000 ft in the White Mountains. Saw-whets also occur in the Sweetwater Mountains (Johnson 1975), where a specimen was taken on 3 July 1946 from Whitebark Pines at 10,000 ft in Sweetwater Canyon, Mono County (MVZ 98334).

## Species Limits

We suspect that the rarity of the Barn Owl, Flammulated Owl, Western Screech-Owl, and Northern Pygmy-Owl in the Glass Mountain region reflects a funneling of these species into fewer and fewer sites that meet their niche requirements as they reach or approach their elevational or ecological limits of breeding, perhaps as dictated by prey availability or climate. Of the four, the three species of small owls depend to varying degrees on insect prey (Voous 1988), the abundance of which may be reduced by colder temperatures at higher elevations. The Flammulated Owl seems further restricted primarily to aspen or aspen–pine groves, where insect abundance may be greater than in pure pine forests (Webb 1982). In Oregon, Flammulated Owls prefer warm east, south, or higher slopes, perhaps because prey are more abundant or active there (Bull et al. 1990). McCallum (1994) felt this owl's upper elevational limits might be set by low nocturnal temperatures (and/or high humidity) as well as food availability. In some areas, competition for nest sites with other species of small owls may restrict Flammulated Owls to aspen groves where nest cavities generally are more numerous than in conifers (Webb 1982). The Northern Pygmy-Owl occurs in the study area very locally at riparian or meadow edges, where small birds, and presumably other prey, are more numerous than in most other habitats. Although riparian edges may be appealing foraging areas for Pygmy-Owls, they themselves may be subject to predation by Cooper's Hawks, which in the Glass Mountain area breed in most major riparian groves at the elevations where the owls were recorded (Shuford pers. obs.).

Barn Owls may simply be limited by temperatures, which in the atlas area can drop below freezing in any month of the year, as the species is primarily a low-elevation and low-latitude breeder known to be affected by cold (Voous 1988). The Great Horned Owl appears to reach a slightly lower elevational breeding limit than the Long-eared and Northern Saw-whet owls, perhaps because the larger mammals that usually make up the bulk of the species' diet by mass (Jaksić and Marti 1984) occur in small numbers at higher elevations. High on Glass Mountain we saw few lagomorphs or ground squirrels, species important in the diet of Great Horned Owls in the Lahontan Valley, Nevada (Alcorn 1942). Over broad areas, nest sites appeared to be limiting to all owls, as few were recorded, despite good coverage, in Adobe and Long valleys, where there are few trees and only localized cliffs.

### Further Work

Much more work could be done to refine our knowledge of these difficult-to-study species. Because owls vary their vocal activity seasonally, tending to call most frequently in late winter or early spring (e.g., Great Horned Owl, Morrell et al. 1991), our concentration of field work in June and July may have somewhat skewed our understanding of the relative abundance of the various species. Surveying owls in the Glass Mountain region early in the season, though, will in most years be hampered by roads closed by snow. Also, because of the difficulty of conducting nocturnal surveys away from roads and on the steep slopes of Glass Mountain above 10,000 ft, we may have underestimated the upper elevational limits of breeding of some species of owls and missed covering some habitats at night that we surveyed in the day. Constraints of covering all atlas blocks with a few field workers likewise limited our ability to sample habitats relative to their availability, thus biasing our appreciation of the relative importance of various habitats to each owl species.

More studies are needed to elucidate the key habitat requirements of the various species so that land-management decisions can be made without threatening the viability of owl populations. Study of the effects of grazing and timber harvesting on owls would be especially valuable, as we know of no published studies on bird responses to these practices in this region. As most of the extensive Jeffrey Pine forest in the area has been logged, priority should be given to assessing the importance to owls of old-growth stands versus other seral stages and to the features of snags used for nesting. In Oregon, Flammulated Owls prefer to nest in mature forests in large-diameter snags (Bull et al. 1990). An important feature of Flammulated Owl territories in northwestern California is a locally dense clump of tall, mature trees located near a break in canopy closure and vegetation type; brush cover may provide insect prey and cover when the birds forage near the ground (Marcot and Hill 1980).

Finally, more diet studies should be undertaken. Little work has been conducted on owl diets in the Great Basin of California (e.g., Aigner et al. 1994), and almost nothing is known here about the trophic structure of the owl community relative to its prey base compared with such knowledge from similar habitats in Idaho (Marti et al. 1993).

## SUMMARY

As part of a breeding-bird atlas, we documented the distribution, elevational breeding limits, relative abundance, and general habitat requirements of owls in the Glass Mountain region of Mono County, California, on the western edge of the Great Basin desert. We recorded seven species of owls; one other species, the Short-eared Owl, occurred historically. Three species (the Great Horned, Northern Saw-whet, and Long-eared) were relatively numerous and widespread breeders; the abundance of the latter two species in this region was not previously known. Four species (the Flammulated, Western Screech, Northern Pygmy, and Barn) that were relatively rare and local breeders appear to reach their elevational limits for

breeding, perhaps as restricted by prey availability or cold temperatures. Also, we documented a 40- to 50-mile range extension of the Western Screech-Owl, presumably of the subspecies *O. k. inyoensis*. The status of owls in the Glass Mountain region is fairly similar to that in other nearby mountain ranges, but more surveys are needed, particularly in the Sweetwater Mountains. Habitat data suggested that riparian thickets, aspen groves, and meadows may be of particular importance to breeding owls by providing nest sites and abundant prey. More work is needed to determine the relative importance to owls of various seral stages of forests, particularly old growth, and to elucidate features of snags used for nesting.

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