Notes on Great Horned Owls Nesting in the Rocky Mountains, with a Description of a New Subspecies

Authors: Dickerman, Robert W., and Johnson, Andrew B.

Source: Journal of Raptor Research, 42(1) : 20-28

Published By: Raptor Research Foundation

URL: https://doi.org/10.3356/JRR-06-75.1

J. Raptor Res. 42(1):20–28

NOTES ON GREAT HORNED OWLS NESTING IN THE ROCKY MOUNTAINS, WITH A DESCRIPTION OF A NEW SUBSPECIES

ROBERT W. DICKERMAN[1] AND ANDREW B. JOHNSON
Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM 87131 U.S.A.

ABSTRACT.—The Great Horned Owls (*Bubo virginianus*) of the Rocky Mountains were last comprehensively reviewed by Oberholser in 1904, who resurrected the name *B. v. occidentalis*. With minor modifications, this has been followed to date. With the suppression of *occidentalis*, which proved to be a synonym of *subarcticus* (Stone 1897 *Am. Nat.* 31:236; Dickerman 1991 *Auk* 108:964–965), the southern Rocky Mountain population, south of the Snake River in Idaho, was left without a name. Canonical discriminant analysis of 14 color and pattern characters provided 100% separation of the southern Rocky Mountain population nesting in higher elevation pinyon/oak/pine associations from those nesting at low elevations in Arizona and New Mexico (*B. v. pallescens*) and from the northern Rocky Mountain population north of the Snake River (*B. v. lagophonus*). Pair-wise comparisons showed that the mean vectors from each of the three populations were significantly different from each other ($P < 0.001$). We propose that the Great Horned Owls of the southern Rocky Mountains south of the Snake River of Idaho may now be known as *Bubo virginianus pinorum*, a new subspecies.

KEY WORDS: *Great Horned Owl*; Bubo virginianus; *mophometrics*; *population*; *Rocky Mountains*; *subspecies*; *taxonomy*.

NOTAS SOBRE *BUBO VIRGINIANUS* EN LAS MONTAÑAS ROCALLOSAS Y DESCRIPCIÓN DE UNA NUEVA SUBESPECIE

RESUMEN.—Las poblaciones de *Bubo virginianus* de las Montañas Rocallosas fueron revisadas de manera exhaustiva por última vez por Oberholser en 1904, quien resucitó el nombre *B. v. occidentalis*. Con algunas modificaciones menores, esta nomenclatura se ha mantenido hasta hoy. Con la eliminación de *occidentalis*, nombre que resultó ser un sinónimo de *subarcticus* (Stone 1897, *Am. Nat.* 31:236; Dickerman 1991, *Auk* 108:964–965), las poblaciones de las Montañas Rocallosas del sur, al sur del río Snake en Idaho, quedaron sin nombre. Un análisis discriminante canónico basado en 14 caracteres de color y patrón produjo una separación del 100% entre las poblaciones de las Montañas Rocallosas del sur que nidifican a elevaciones mayores en bosques de asociación de piñón/roble/pino, y las poblaciones que nidifican a altitudes menores en Arizona y Nuevo México (*B. v. pallescens*) y en las Montañas Rocallosas del norte, al norte del río Snake (*B. v. lagophonus*). Comparaciones pareadas mostraron que los vectores promedio de cada una de las tres poblaciones fueron significativamente diferentes entre sí ($P < 0.001$). Proponemos que las poblaciones de *Bubo virginianus* de las Montañas Rocallosas del sur, al sur del río Snake en Idaho, sean conocidas ahora como *Bubo virginianus pinorum*, una nueva subespecie.

[Traducción del equipo editorial]

The Great Horned Owl (*Bubo virginianus*) is common, widespread, adaptable, and geographically variable throughout North America south of the arctic tundra. Phenotypic variation in Great Horned Owls has often been at least partially attributed to polymorphism or color morphs. Oberholser (1904) wrote, ''With the exception of *occidentalis* and *wapacuthu* [both are synonyms of *subarcticus*; Stone 1897, Browning and Banks 1990] all [populations] seem to be strictly non-migratory, and thus any record may safely be considered as based on the resident bird.'' Thus he invoked ''dichromatism'' with light, dark, and ochraceous morphs to explain the variation within populations. That taxonomic revision of the subspecies of Great Horned Owls by Oberholser (1904) has, with minor modifications, been followed to date (AOU 1910, 1931, 1957, Ridgway 1914, Cory 1918, Peters 1940, Behle 1985, McGillivray 1989). In his revision of *B. virginianus*, Weick (1999), following Oberholser (1904), used the tri-

[1] Email address: bobdickm@unm.edu

nomial *B. v. occidentalis* which had been suppressed over a hundred years earlier (Stone 1897, Dickerman 1991, 2002), and mapped its range to include parts of the ranges of *B. v. pallescens*, *B. v. subarcticus*, and the new subspecies described herein. He used the name *B. v. wapacuthu* (suppressed by Browning and Banks 1990; also cf, Dickerman 1993) and left the range of the Rocky Mountain subspecies north of the Snake River, *lagophonus*, undesignated.

In Arizona, Phillips et al. (1964) recognized that birds from wooded areas tended to have darker feet, but felt that individual variation was so great that ''… no violence to the facts'' would be done to call all Arizona birds by the same subspecific name. Rea (1983) reviewed the situation in Arizona, recognizing color phases within *B. v. pallescens* and did not mention migration, except for a dark bird considered to be *B. v. saturatus* by K. Parkes, but re-identified as *B. v. lagophonus* (R. Dickerman unpubl. data; reference number MSB 14754).

In Colorado, Bailey and Niedrach (1965) used the names *occidentalis* and *lagophonus* for light and dark phenotypes (respectively). Burleigh (1972) recognized a light form in southern Idaho for which he used the name *occidentalis* and a darker form in northern Idaho for which he used *lagophonus*. Behle (1985) used *occidentalis* for the dark birds of northern Utah. These usages have thoroughly confused the subspecies taxonomy of the Great Horned Owls of the Rocky Mountains south of the Snake River.

During 1988 and 1989, the American Museum of Natural History received two shipments of winter-salvaged Scottsdale region Great Horned Owls from the Liberty Wildlife Rehabilitation Foundation of Scottsdale, Arizona. Included were pale gray and medium gray birds, and a single very dark bird. Similarly, in 1989, RWD studied the Museum of Southwestern Biology (MSB) series of 20 specimens from throughout New Mexico. Nearly half of the birds were pale, nearly half were medium gray, and two were very dark. When the localities of the pale and medium gray specimens were plotted on a map of New Mexico, a pattern was evident. All the pale birds, from various seasons, were from desert/grassland areas of southern and eastern parts of the state. The medium gray birds, from spring, summer and fall, were from forested regions (pinyon/oak or higher elevational plant associations) or were salvaged during winter months in the lowlands (and thus may have made elevational migrations). The two dark New Mexico winter specimens, like the dark salvaged bird from Scottsdale and the dark specimen reported by Rea (1983), matched well the specimens of *B. v. lagophonus* from eastern Washington, Idaho north of the Snake River, and interior mountains north to Alaska; thus, they were long-distance migrants (Dickerman and Harden in press). This exercise was later repeated with similar results with the larger series of specimens from Colorado in the Denver Museum of Natural History; from Utah in the Utah Museum of Natural History, Salt Lake City; and from the very large New Mexico series in the MSB, which has now grown to 224 specimens. This mapping exercise demonstrated that there was a distinct medium-gray colored population of the Rocky Mountains from southern Idaho to the higher elevations of Arizona and New Mexico that had no subspecific designation. Having handled hundreds of Great Horned Owl specimens, we believe that there are no color morphs or polymorphism in western North American Great Horned Owls (*contra* Oberholser 1904, Rea 1983, Weick 1999), and that color variation can be explained by the mix of the various subspecies, some of which undertake elevational and/or latitudinal migration.

In this report, we review geographic variation in Great Horned Owls in the Rocky Mountains (herein defined to include the interior ranges from Alaska south to the sky islands of Arizona and New Mexico), and we describe the medium-gray subspecies of the dry Rocky Mountain pine forests south of the Snake River Valley in southern Idaho.

MATERIALS AND METHODS

Materials. The color standards described were used to compare specimens in the following collections: Academy of Natural Science, Philadelphia, PA; American Museum of Natural History, New York, NY; Bird and Mammal Museum, University of Idaho, Moscow, ID; Charles R. Connor Museum, Washington State University, Pullman, WA; Denver Museum of Natural History, Denver, CO; Idaho Natural History Museum, Idaho State University, Pocatello, ID; Museum of Zoology, University of Michigan, Ann Arbor, MI; Museum of Texas Tech University, Lubbock, TX; National Museum of Natural History, Washington, DC; Texas Cooperative Wildlife Collection, Texas A & M University, College Station, TX; University of Alaska Museum, Fairbanks, AK; University of Arizona, Tucson, AZ.

Measurements were obtained on additional specimens from the following: Canadian Museum of Nature, Ottawa, Canada; Field Museum of Natural His-

tory, Chicago, IL; Slater Museum of Natural History, University of Puget Sound, Tacoma, WA; Natural History Museum of Los Angeles County, Los Angeles, CA; Stoval Museum, University of Oklahoma, Norman, OK; University of Nebraska State Museum, Lincoln, NE; and Vertebrate Collections, Cornell University, Ithaca, NY.

Methods. To quantify color values, and to a lesser degree the extent of pattern differences among populations, we selected a series of five specimens from the American Museum of Natural History that spanned the gradient of color variation from the palest to the darkest populations throughout the range of the species in North America (Fig. 1). From this reference series, 14 color or pattern characters were selected *a priori* and assigned a value of 1–5. The Rocky Mountain populations in this study did not span this entire range, with 1 being the palest and 3 or 4 the darkest value, depending on the character. (A score of 5 was not used as only *B. v. saturatus* reached that darkness and that subspecies does not pertain to this study because it is outside our defined geographic area.) Each specimen examined was scored for the 14 color and pattern characters by comparison with the reference series. Wing chord and tail length were measured to the nearest millimeter. All scores and measurements were by RWD. Rocky Mountain populations from Alaska to central Idaho, and dark long-distance migrants (Dickerman and Harden in press) were considered to be *lagophonus* Oberholser (1904, type locality: Walla Walla, Washington). Birds from southern Idaho southward to the higher elevations of Arizona and New Mexico were considered to be the undescribed form (named below). Populations from the deserts and grasslands of Arizona and New Mexico were considered to be *pallescens* Stone 1897, type locality: Watson Ranch, 29 km southwest of San Antonio, TX U.S.A. Nesting-season birds from those areas, and wintering birds that matched them morphologically were analyzed as the above three populations.

Statistical Analysis. Canonical discriminant analysis (SAS 9.1.1; PROC CANDISC) was used to generalize the two canonical discriminants, which were plotted against each other to visualize this 14-character dataset in two dimensions (Fig. 2).

No assumption of normality or equal variances was made for this data set, and nonparametric statistical methods were used. To test for differences among populations, a nonparametric MANOVA was conducted using the program PERMANOVA (Anderson 2005) based on methods outlined by Anderson (2001). The analysis was performed using a Euclidian distance matrix, and 9999 iterations were permutated to calculate the *P*-values presented. Pair-wise comparisons between groups were also made in PERMANOVA, again using 9999 iterations to generate the *P*-values for the pair-wise tests. The limitations of PERMANOVA necessitated that sample sizes for each population be equal, and that there were no missing values in the data matrix. Therefore the number of *pallescens* and the southern Rocky Mountain population used in the analysis were reduced to the same number as *lagophonus* ($N = 49$) by generating a series of random numbers and eliminating corresponding records so that each population sample contained 49 individuals. There was no observed sexual dimorphism in color or pattern within subspecies, so data were combined (Appendix).

RESULTS AND DISCUSSION

A plot of the first two canonical discriminants based on the 14 color and pattern characters showed good separation of lowland *pallescens* from montane populations of *lagophonus* from the new subspecies described below, but there was overlap between the two montane populations. Nine of the 14 color/pattern characters (Table 2), of which six were statistically significant, were diagnostically useful in distinguishing the three subspecies. Characters with the highest correlations for discriminant 1 were back-color, barring on flanks, and interscapular black spots; and for discriminant 2 were back-color, barring on toes, and color in outer vane of outer rectrix (Table 3).

There was a significant difference among mean vectors of the three populations ($F = 42.3$, df = 2,144, $P < 0.001$), and pair-wise comparisons showed that the mean vector for each subspecies was significantly different from the other two ($t = 3.6–9.1$; df = 96, $P < 0.001$). There were no differences in wing chord and tail measurements among the three subspecies from Arizona and New Mexico in the south through the northern Rockies (Table 4).

Because of the separability of these populations using both visual and statistical techniques, we propose that the Great Horned Owls of the Rocky Mountains south of the Snake River of Idaho may now be known as:

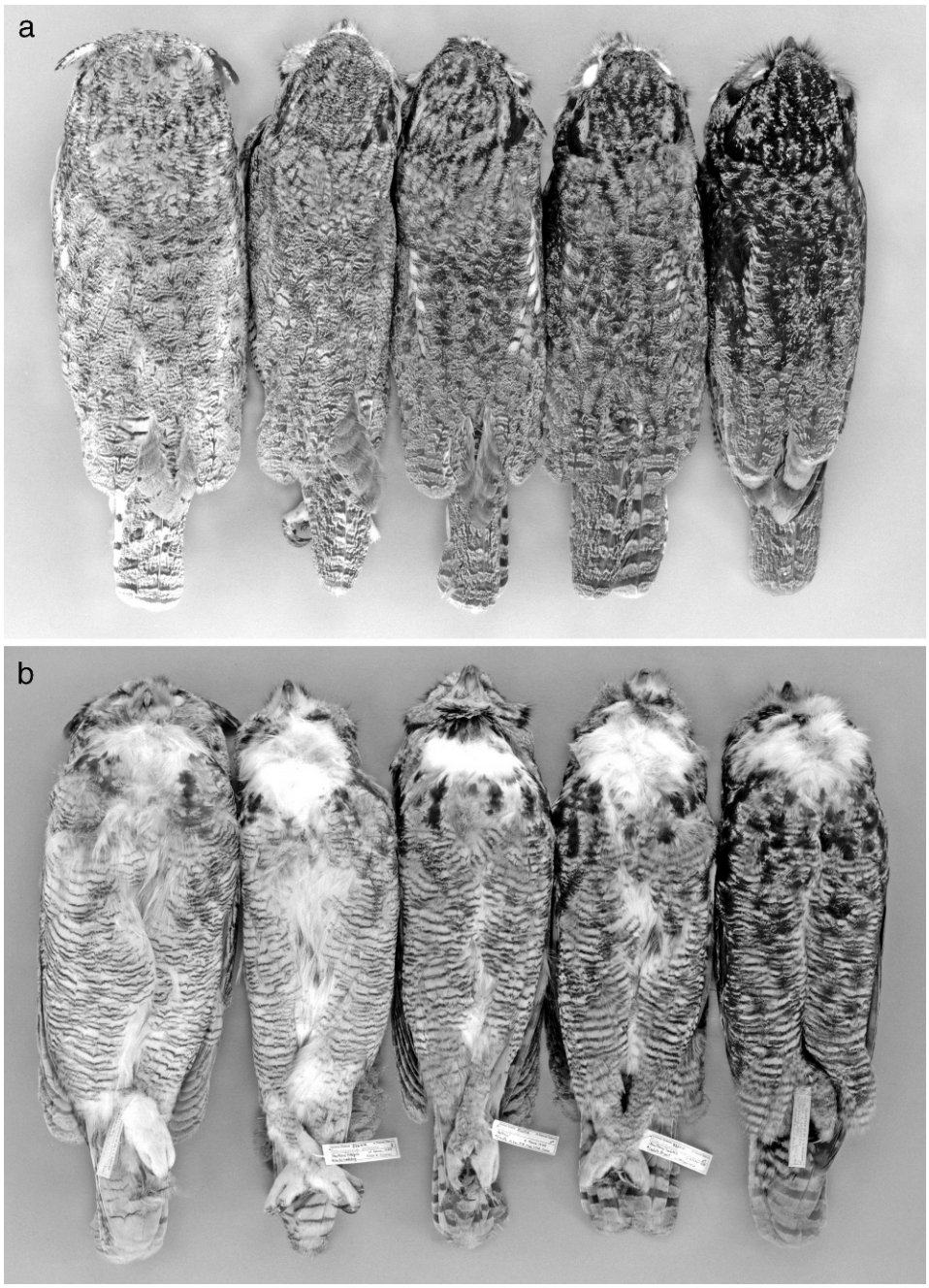

Figure 1. Specimens used as color standards, all from the American Museum of Natural History (from left to right): (A) *B. v. subarcticus* 753972, Winnipeg, Manitoba, 1900; (B) *B. v. pallescens* 8260141, 6.0 km SW of Lordsburg, Hidalgo Co., New Mexico, 15 January 1989; (C) *B. v. pinorum* 826016, Glorieta, Santa Fe Co., New Mexico, 8 March 1988; (D) *B. v. lagophonus* 826010, Santa Fe (airport), Santa Fe Co., New Mexico, 13 October 1988; and (E) *B. v. saturatus* 754056, Washington, 7 April 1894.

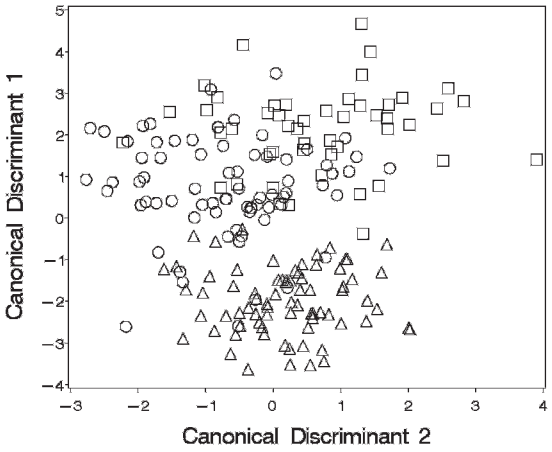

Figure 2. Scattergram of the first two canonical discriminants derived from the scores of fourteen plumage color and pattern characters from three subspecies of Great Horned Owls in the Rocky Mountains (see methods; triangles = *B. v. pallescens*, circles = *B. v. pinorum*, and squares = *B. v. lagophonus*).

Bubo virginianus pinorum, new subspecies

Holotype. MSB 23728. Female. New Mexico, Bernalillo Co., Sandia Mountains, Cedar Crest (35°6.4′N, 106°22.6′W; elevation 2042 m). Collected by J. David Ligon on 15 December 2002. Field number RWD 26222. Ovary 9 × 16 mm, very fat, mass 1246 g.

Diagnosis. Similar to *B. v. pallescens*, but with heavier barring ventrally and darker gray dorsally with larger areas of sooty black in the feathers of the crown and back; paler than *B. v. lagophonus*, with lighter barring on the venter and with weaker or no barring on the tarsi and toes, which are often pure white.

Etymology. The name is from the Latin, meaning ''of the pines.''

Distribution. Nests in dry coniferous forests from the plains of the Snake River of Idaho, south in the Rockies at increasing elevations, to Arizona and New Mexico. Occurs regularly at lower elevations in winter (Dickerman and Harden in press).

It is interesting that *pinorum* is morphologically more distinct from *pallescens* than it is from *lagophonus*, although the ranges of *pinorum* and *pallescens* may be only a few miles apart by air. Conversely, *pinorum* and *lagophonus* are less distinct, yet their ranges are separated, at least by the lowland plains of broad Snake River Valley in southern Idaho. Ponderosa pine (*Pinus ponderosa*) is the dominant species in the nesting range of *pinorum*, at least in Arizona, New Mexico, Utah, and Colorado. North of the Snake River is the more mesic spruce-fir-hemlock forest of the northern Rockies and the range of *lagophonus*.

During the course of this study, two specimens of *pinorum* salvaged during the nesting season were received from wildlife rehabilitators from the low-

Table 1. Fourteen color/pattern characters and the specimen upon which they were based, A–E (see Figure 1).

CHARACTER	COLOR VALUE 1	COLOR VALUE 2	COLOR VALUE 3	COLOR VALUE 4
Color, back	Palest A	Pale gray B	Medium-gray C/D	Blackest E
Barring, flanks	Light A	Medium B	Heavy C	Massive D/E
Interscapular black spots	None – reticulate A	Small B	Medium C/D	Large – often confluent E
Barring, tarsus	None A	Light – spotty B	Medium – broken D	Heavy E
Barring, toes	None A/B	Light – spotty C/D	Medium – broken D	Heavy E
Barring, under-tail coverts	None	Light A/B	Medium C	Heavy D/E
Color, crown	Palest A	Medium B/C	Darker C/D	Blackest E
Color, ears	Blackish to gray; ochraceous margins B	Largely black; white to ochraceous margins C	Massively black E	Massively black E
Color, basal breast	Pale buff to pale ochraceous A	Medium buff to ochraceous C	Deep buff to rich ochraceous D	Deep buff to rich ochraceous D
Color, tarsi and toes	White A/B	Buff B/C	Ochraceous D/E	Ochraceous E
Color, under-tail coverts	White A/B	Medium to buff B/C	Pale ochraceous D/E	Ochraceous E
Pattern, central rectrices	Medium – broken A/B	Strong bars C/D	Snake-pattern E	Snake-pattern E
Pale bars, second rectrix	White	Medium buff +/− gray C	Ochraceous +/− gray C/D	Pale to deep gray E
Outer vane, outer rectrix	Predominantly white A/B	White +/− buff and/or gray B/C	White and/or buff; ochraceous and gray D	Medium-gray E

Table 2. Major diagnostic color/pattern characteristics of three subspecies of Great Horned Owls.[1]

CHARACTERISTIC	*B. V. LAGOPHONUS*	*B. V. PINORUM*	*B. V. PALLESCENS*
Color, crown	Blackest; large black centers each feather	Feathers with small to large black centers	Palest, often vermiculate
Interscapular black spots	Blackest, often more than one heavy bar on each feather; little ochraceous of under-feathers showing	Intermediate, usually only one black bar on a feather; much ochraceous showing	Palest, black markings smallest; often little concentration of black; much ochraceous showing, this paler than in *pinorum*
Tail Rectrix	Barring darkest, and often irregular; paler spaces reduced; outer-web outer rectrix grey to white, often with ochraceous	Barring lighter, usually more regular; light bars wider, usually overlaid with grey; web outer rectrix usually pale gray w/wo ochraceous	Barring lightest; pale bars more distinct, often splotched with grey; outer-web outer rectrix often white
Barring, tarsi and toes	Both heavily barred over white, buff or dull ochraceous	Tarsi white to pale ochraceous with moderate broken bars; toes rarely barred, buff to white	Tarsi white to pale buff, lightly marked with broken bars; toes not barred, white
Barring, sides, flanks and cural feathers	Most heavily barred, dull ochraceous undertones	Barring lighter, with rich ochraceous undertones	Barring narrowest, with pale ochraceous undertones
Barring, under-tail coverts	Widest black bars, rest of feathers dull buff	Narrower black bars, usually some pale ochraceous	Narrow bars, pure white

[1] See Appendix: color/pattern scores for the six statistically diagnostic characteristics.

lands of New Mexico: a female found 11 March 1994 at Corrales (35°14.3′N, 106°36.3′W; elevation 1530 m), Sandoval Co. (MSB 18804) and a male found at Luis Lopez (33°59.5′N, 106°53.5′W; elevation 1414 m), Socorro Co., on 18 May 2002 (MSB 23756). Both of these localities in central New Mexico are near the Rio Grande nesting habitat of *pallescens*. The Corrales specimen was a first-year bird and may simply have been a late migrant. The Luis Lopez specimen was an apparently normal male with testes measuring 5 × 7 mm. An Arizona specimen of *lagophonus* taken 2 August 1974 (Rea 1983) had a pre-existing pellet hole on the skull between the eyes, an injury that may have prevented migration.

Because of the uniformity of the populations herein considered to be *B. v. pinorum*, short-distance,

Table 3. Observed variables of 14 color/pattern characters (see Table 1) and their weights on discriminate/canonical variables 1 and 2.

CHARACTER (in order of descending values)	DISCRIMINANT/ CANONICAL VARIABLE 1	CHARACTER (in order of descending values)	DISCRIMINANT/ CANONICAL VARIABLE 2
Color, back	1.251407	Color, back	−1.2205
Barring, flanks	1.005776	Barring, toes	1.123049
Interscapular black spots	0.907205	Outer-vane, outer rectrix	−0.96993
Color, basal breast	0.621327	Pale-bars, second rectrix	0.881739
Color, ears	0.509727	Color, under-tail coverts	0.817913
Barring, under-tail coverts	0.480515	Barring, under-tail coverts	0.612682
Barring, tarsal	0.44715	Color, ears	−0.44151
Outer-vane, outer rectrix	0.216763	Color, tarsi and toes	−0.36755
Pale-bars, second rectrix	0.196992	Color, crown	0.33198
Barring, toes	0.141781	Pattern, central rectrices	0.213856
Color, crown	−0.01161	Barring, tarsal	0.166105
Color, tarsi and toes	−0.28786	Interscapular black spots	0.159643
Pattern, central rectrices	−0.331	Color, basal breast	−0.12506
Color, under-tail coverts	−0.56951	Barring, flanks	−0.11137

Table 4. Wing chord and tail length for three subspecies of Great Horned Owls, all in basic plumage (number of specimens, mean, standard deviation, range, median).

	MALES				FEMALES			
CHARACTERISTIC	MEAN ± SD	RANGE	MEDIAN	*N*	MEAN ± SD	RANGE	MEDIAN	*N*
Wing Chord (mm)								
B. v. lagophonus	345.3 ± 8.69	330–358	345.0	23	368.4 ± 11.20	339–382	371	27
B. v. pinorum	345.5 ± 10.83	324–377	347	35	363.6 ± 8.35	350–397	364	34
B. v. pallescens	346.6 ± 9.04	327–367	346	38	363.5 ± 11.12	341–385	365	46
Tail Length (mm)								
B. v. lagophonus	208.7 ± 9.23	191–220	210	20	223.4 ± 11.14	196–242	225	24
B. v. pinorum	204.7 ± 8.66	178–226	206	44	216.0 ± 7.37	195–233	217	43
B. v. pallescens	204.6 ± 7.6	190–223	205	37	212.3 ± 7.0	327–367	213	46

elevational migration cannot be distinguished from long-distance, latitudinal migration. Elevational migration was demonstrated by a bird banded as a nestling 29 April 1988 in Sandia Canyon (elevation 2286 m) in the Jemez Mountains, Sandoval Co., New Mexico and found dead 19 December 1988 ca. 25 km distant near a bridge over the Rio Grande on the south side of Espanola (elevation 1704 m), Rio Arriba Co., New Mexico. We suggest that Great Horned Owls nesting in habitats that are affected by heavy snow conditions in the winter may perform elevational and/or latitudinal migration, at least to some degree.

Conclusions. The Great Horned Owls of the Rocky Mountains (as geographically defined in this paper) may now be considered to consist of three populations from north to south (Fig. 3): (1) *Bubo virginianus lagophonus* of the northern Rockies inhabits the more mesic spruce/fir/hemlock forests north of the Snake River in Idaho; (2) *B. v. pinorum*

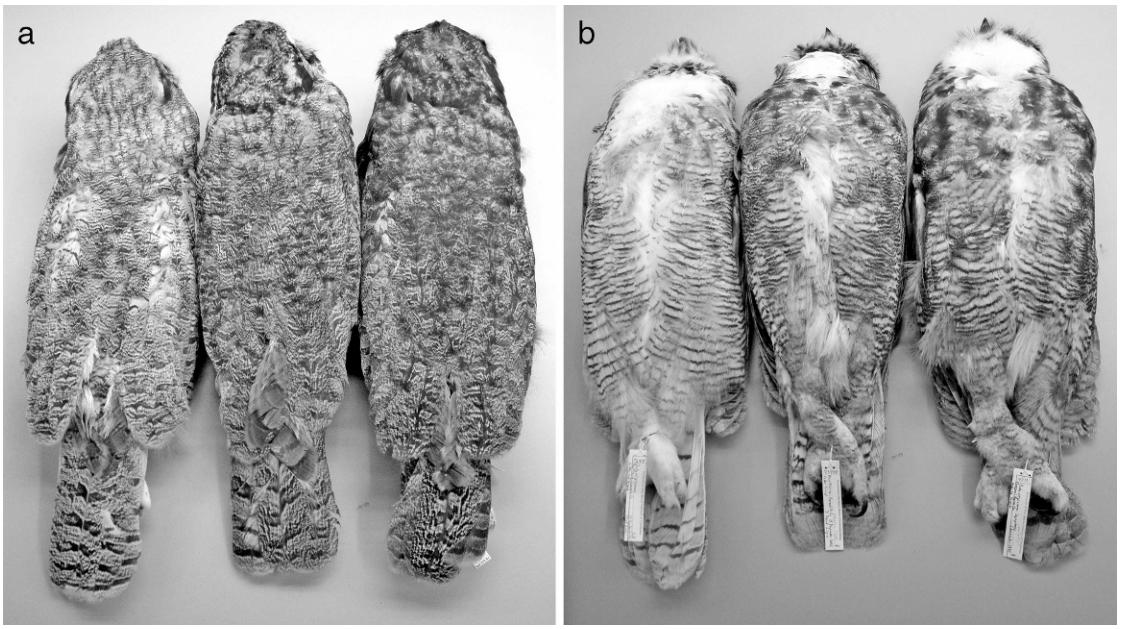

Figure 3. Dorsal and ventral views of three subspecies of Great Horned Owls from the northern to southern Rocky Mountains (left to right): (A) *B. v. pallescens* MSB 7684, female, New Mexico (Lincoln Co., ca. 32 km south of Corona), 29 September 1991. (B) *B. v. pinorum* Type, MSB 23728, female, New Mexico (Bernalillo Co., Cedar Crest), 15 December 2002; (C) *B. v. lagophonus* MSB 7011, female, Oregon (Union Co., near Grange), 3 December 1989;

nests in the dry coniferous forests at middle and high elevations in Arizona and New Mexico, in these habitats extending north of the southern Rocky Mountains to at least the Snake River of Idaho; (3) *B. v. pallescens* nests in the deserts and desert grasslands, and the lowland riparian areas of Arizona and New Mexico, extending north in suitable habitats into at least Utah and Colorado (as well as western Kansas and Oklahoma; Dickerman 1993). These three populations differ serially in color and are generally separated by habitat in the nesting season. In the winter, some individuals of *pinorum* and *lagophonus* withdraw from their nesting habitat, with *pinorum* undergoing elevational migration (with latitudinal migration probable but not yet demonstrated), and with *lagophonus* undergoing both elevational and latitudinal migration and occurring sporadically in the lowlands of Arizona, New Mexico, and Colorado (MSB specimens).

ACKNOWLEDGMENTS

We acknowledge the wildlife rehabilitators of Arizona and New Mexico, without whom this research could not have been conducted. Figure 1 was provided by the photography department of the American Museum of Natural History. Technical editing and formatting were provided by Janelle Harden. We gratefully acknowledge Maureen Leonard, Anne C. Russell, and Ernest Valdez for assistance with the statistical analysis done for this project. Lastly, this manuscript was greatly clarified by the reviews of Dwight Smith and C. Stuart Houston.

LITERATURE CITED

AOU (AMERICAN ORNITHOLOGISTS' UNION). 1910. Check-list of North American birds, Third Ed. American Ornithologists' Union, New York, NY U.S.A.

———. 1931. Check-list of North American birds, Fourth Ed. American Ornithologists' Union, Lancaster, PA U.S.A.

———. 1957. Check-list of North American birds, Fifth Ed. American Ornithologists' Union, Baltimore, MD U.S.A.

ANDERSON, M.J. 2001. A new method for non-parametric multivariant analysis of variance. *Austral Ecology* 25:32–46.

———. 2005. PERMANOVA, a FORTRAN computer program for permutational multivariate analysis of variance. Dept. of Statistics, Univ. of Auckland, New Zealand.

BAILEY, A.M. AND R.J. NIEDRACH. 1965. Birds of Colorado. Denver Mus. Nat. Hist., Denver, CO U.S.A.

BEHLE, W.H. 1985. Utah birds: geographic distribution and systematics. Occas. Publ. No. 6, Utah Mus. Nat. Hist., Salt Lake City, UT U.S.A.

BROWNING, M.R. AND R.C. BANKS. 1990. The identity of Pennant's ''Wapacuthu Owl'' and the subspecific name for the population of *Bubo virginianus* west of Hudson Bay. *J. Raptor Res.* 24:80–83.

BURLEIGH, T.D. 1972. Birds of Idaho. Caxton Printers Ltd., Caldwell, ID U.S.A.

CORY, C.B. 1918. Catalogue of birds of the Americas and the adjacent islands, Part 2, no. 1. Field Mus. Nat. Hist., Publ. 197, Zool. Series no. 13.

DICKERMAN, R.W. 1991. On the validity of *Bubo virginianus occidentalis* Stone. *Auk* 108:964–965.

———. 1993. The subspecies of Great Horned Owls of the central Great Plains, with notes on adjacent areas. *Bull. Kan. Ornithol. Soc.* 344:17–21.

———. 2002. The taxonomy of the subarctic Great Horned Owl, *Bubo virginianus subarcticus* nesting in the United States. *Am. Midl. Nat.* 148:198–199.

——— AND J.E. HARDEN. In press. Great Horned Owl. *In* J.L.E. Cartron [ED.], The raptors of New Mexico. Univ. New Mexico Press, Albuquerque, NM U.S.A.

MCGILLIVRAY, W.B. 1989. Geographic variation in size and reverse dimorphism of the Great Horned Owl in North America. *Condor* 91:777–786.

OBERHOLSER, H.C. 1904. A revision of the Great Horned Owls. *Proc. U.S. Natl. Mus.* 27:177–192.

PETERS, J.L. 1940. Check-list of birds of the world, Vol. 4. Harvard Press, Cambridge, MA U.S.A.

PHILLIPS, A.R., J.T. MARSHALL, AND G. MONSON. 1964. The birds of Arizona. Univ. Arizona Press, Tucson, AZ U.S.A.

REA, A. 1983. Once a river: bird life and habitat changes on the middle Gila River. Univ. Arizona Press, Tucson, AZ U.S.A.

RIDGWAY, R. 1914. The birds of North and Middle America, Part 6. *U.S. Natl. Mus. Bull.* No. 50.

STONE, W. 1897. Proper name for the western Horned Owl of North America. *Am. Nat.* 31:236.

WEICK, F. 1999. Zur Taxonomie der Amerikanishen Uhus (*Bubo* spp.). *Okpl. Vogel* 21:363–387.

Received 14 November 2006; accepted 24 October 2007

Appendix. Six statistically significant color/pattern differences scored categorically from 1–5, for three subspecies of Great Horned Owls; mean and standard deviation (SD), range, median, and number (*N*).

	Bubo virginianus lagophonus				*Bubo virginianus pinorum*				*Bubo virginianus pallescens*			
Variable	Mean ± SD	Range	Median	*N*	Mean ± SD	Range	Median	*N*	Mean ± SD	Range	Median	*N*
Barring, flanks	2.72 ± 0.42	2.00–3.00	3.00	51	2.32± 0.54	1.00–4.00	2.00	80	1.58 ± 0.42	1.00–2.50	1.50	86
Intrascapular black spots	3.01 ± 0.25	2.00–4.00	3.00	51	2.69 ± 0.51	1.00–4.00	3.00	80	2.06 ± 0.45	1.00–3.00	2.00	86
Barring, tarsus	2.77 ± 0.72	2.00–4.00	3.00	51	2.19 ± 0.60	1.00–3.00	2.00	80	1.88 ± 0.58	1.00–3.00	2.00	86
Barring, toes	2.06 ± 0.73	1.00–4.00	2.00	51	1.35 ± 0.51	1.00–3.00	1.00	79	1.24 ± 0.43	1.00–2.00	1.00	85
Barring, under-tail coverts	3.02 ± 0.59	2.00–4.00	3.00	51	2.37 ± 0.61	1.00–3.00	2.00	80	1.86 ± 0.55	0.50–3.00	2.00	86
Color, crown	2.63 ± 0.70	2.00–4.00	2.50	50	2.53 ± 0.54	2.00–4.00	2.50	80	2.00 ± 0.38	1.00–3.00	2.00	85