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REPRODUCTIVE ECOLOGY OF THE UPLAND BUZZARD (*BUTEO HEMILASIUS*) ON THE MONGOLIAN STEPPE

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ABSTRACT.—The breeding distribution of the Upland Buzzard (*Buteo hemilasius*) is restricted to the eastern Palearctic. In comparison to other *Buteo* species, little is known about this species' breeding ecology. The objectives of our study were to describe nest sites and reproductive success of Upland Buzzards in Mongolia. The average clutch size for 304 breeding attempts in 2001–07 was 3.49 eggs (±1.09 SD; range 2–8; total of 1061 eggs laid). For 215 breeding attempts, the average brood size was 1.95 nestlings (±1.53; range 0–6). We found that the nest materials and nest size varied greatly, probably corresponding to the availability of nesting materials within the territory. However, the variation in nest size may also reflect the fact that some of the smaller nests were built on human-made structures, such as electric pylons or roofs of small buildings.

KEY WORDS: *Upland Buzzard*; Buteo hemilasius; *Mongolia*; *reproduction*; *steppes.*

ECOLOGÍA REPRODUCTIVA DE *BUTEO HEMILASIUS* EN LA ESTEPA DE MONGOLIA

RESUMEN.—La distribución reproductiva de *Buteo hemilasius* está restringida al este del Paleártico. En comparación con otras especies de *Buteo*, se conoce poco sobre la ecología reproductiva de esta especie. Los objetivos de nuestro estudio fueron describir los sitios de anidación y el éxito reproductivo de *B. hemilasius* en Mongolia. El tamaño promedio de la nidada en 304 intentos reproductivos entre 2001 y 2007 fue de 3.49 huevos (±1.09 DE; rango 2–8; 1061 huevos puestos en total). En 215 intentos reproductivos, el tamaño promedio de la parvada fue de 1.95 pichones (±1.53; rango 0–6). Encontramos que los materiales y el tamaño de los nidos variaron enormemente, probablemente dependiendo de la disponibilidad de materiales para construirlos dentro de los territorios. Sin embargo, la variación en el tamaño de los nidos también puede reflejar el hecho de que algunos de los nidos más pequeños fueron construidos sobre estructuras hechas por el hombre, como torres eléctricas de alta tensión o techos de pequeñas construcciones.

[Traducción del equipo editorial]

The breeding distribution of the Upland Buzzard (*Buteo hemilasius*; also called Mongolian Buzzard) is limited to the eastern Palearctic (53°N–ca. 30°N; Ferguson-Lees and Christie 2001) and Ladakh, India (Naoroji and Forsman 2001), but Mongolia is the core region in which the species is known to breed. The species' breeding habitat usually comprises open steppe, plateaus, and wide rocky valleys, at altitudes exceeding 5000 m above sea level (Dementiev et al. 1966, Thiollay 1994).

In Mongolia, the Upland Buzzard breeds from the Altai Mountains to the western foothills of the Great Khyangan Mountains (Flint and Bold 1991). The species' distribution, population, status, and diet in Mongolia have been extensively studied (e.g., Przewalskii 1876, Kozlova 1930, Mauersberger 1980, Flint and Bold 1991, Bold and Boldbaatar 2001, Potapov et al. 2001, Gombobaatar et al.

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2006). However, there are few studies of the reproductive ecology of the species (e.g., Karyakin 2005, Karyakin et al. 2005, 2006, Gombobaatar et al. 2006, Gombobaatar et al. 2009).

The objectives of our study were to (a) describe nest sites of the Upland Buzzard, and (b) document reproductive success.

STUDY AREA AND METHODS

We conducted fieldwork during the breeding season (May to August, 2001–07), in central and western Mongolia, including Tuv, Dundgobi, Dornogobi, Gobisumber, Khentii, Bayankhongor, and Gobi-Altai provinces. During each of the breeding seasons, we searched for new nests and rechecked nests of previous years. All nests were marked on a 1:500 000 scale map; latitude and longitude were recorded with a handheld GPS receiver. Each nest in which eggs were laid was considered a breeding attempt and was checked two or three times during the breeding season. We calculated the hatching success, average clutch size, and average brood size for breeding attempts.

We recorded nest characteristics (orientation, nest materials, external height, external and internal diameter, internal depth, height of nest substrate, nest height above surrounding ground level), clutch size, and brood size. Nests were measured using a measuring tape (Fox et al. 1997). Because not all measurements were taken at all nests, the sample sizes for the different parameters differed. For ground-nesting pairs, nest height was considered ''0'' because the nest was either placed directly on ground, or on small crumbling rocks, or on very low *Caragana* shrubs.

Nest substrates were classified as either natural or artificial, and nest locations were classified as either remote (>2 km from urban areas) or urban (<2 km from urban areas). Nests were also classified as sheltered or unsheltered from inclement weather, based on location: nests placed on a concrete bank, on a wooden structure at a ground well, on a cliff face, or on a sandy precipice were considered sheltered.

We used Kruskal-Wallis, Wilcoxon, Chi-square, and ANOVA tests where appropriate to evaluate and describe the statistical differences among number of eggs/nestlings, and diameter, depth, and height of the nest.

Regression analyses were used to determine the relationship between natural and artificial substrates and their influence on clutch and brood size, clutch size across years, and number of nestlings by years (Krebs 1989, SYSTAT10.0, MS Excel 2003).

RESULTS

During the seven-year study we monitored a total of 304 breeding attempts (nests with at least one egg or nestling), in different natural zones including high mountains, forest, forest steppe, mountain steppe, and desert steppe in Mongolia (Fig. 1). In total, 52.6% of nests were placed on natural substrates (including the ground, 22.7%, $n = 69$; and natural elevated formations, 25.7%, $n = 78$), and 47.4% of nests were placed on artificial nest platforms or human-related substrates (Fig. 2).

Height of the Nest Substrates and Height of the Nest Locations. The average height of the substrate on which a nest was built was 5.1 m (±8.0 m, range 0–34 m, $n = 269$). The height of nest locations aboveground was 3.7 m (±5.35, 0–24, $n = 269$).

There was a significant difference (Kruskal-Wallis test, $Z = -7.3$, df = 1, $P < 0.001$) in the height of nest locations between natural and artificial substrates (2.1 m ± 2.9, range 0–12 m, $n = 125$ vs. 7.8 m ± 9.8, 0–34 m, $n = 144$, respectively). For artificial nest substrates, the highest nest (34 m) was located on a pylon of a high-voltage electric line, and the lowest (0.8 m) was on the ruins of a concrete building. Among natural substrates, the highest of the cliffs and columns in rocky outcrops averaged 12 m.

Nest Orientation. Most open nests ($n = 91$, 60.3%) faced skyward and were considered as 360° (Fig. 3). Forty-seven (31.1%) nests faced east (between 1° and 180°) and 13 (8.6%) nests faced west (181°–359°).

Nest Dimensions. The average outer diameter of the Upland Buzzard nest (±SD, range, n) was 908 mm (±369, 300–2000 mm, $n = 233$), internal depth of the nest cup was 51 mm (±399, 0–140 mm, $n = 214$), and external nest height was 317 mm (±191, 0–1800 mm, $n = 228$). Nest diameter was significantly influenced by the substrate on which it was placed (Kruskal-Wallis test, $Z = -8.3$, df = 1, $P < 0.001$). On natural substrates including the ground, the nest structure was bigger (1095 mm ± 34.5, 45–2000 mm, $n = 114$) than those on human-built substrates (730.3 mm ± 298, 300–1800 mm, $n = 119$).

Nest Materials. Nest materials found in the 304 nests included twigs of elm trees (*Ulmus fumila*), shrubs (*Caragana* spp.), animal hair, cotton, plastic bags, wires, cables, and other human-made materials. The proportions of different nest materials incorporated into the nests varied and were qualitatively associated with habitat type, surrounding

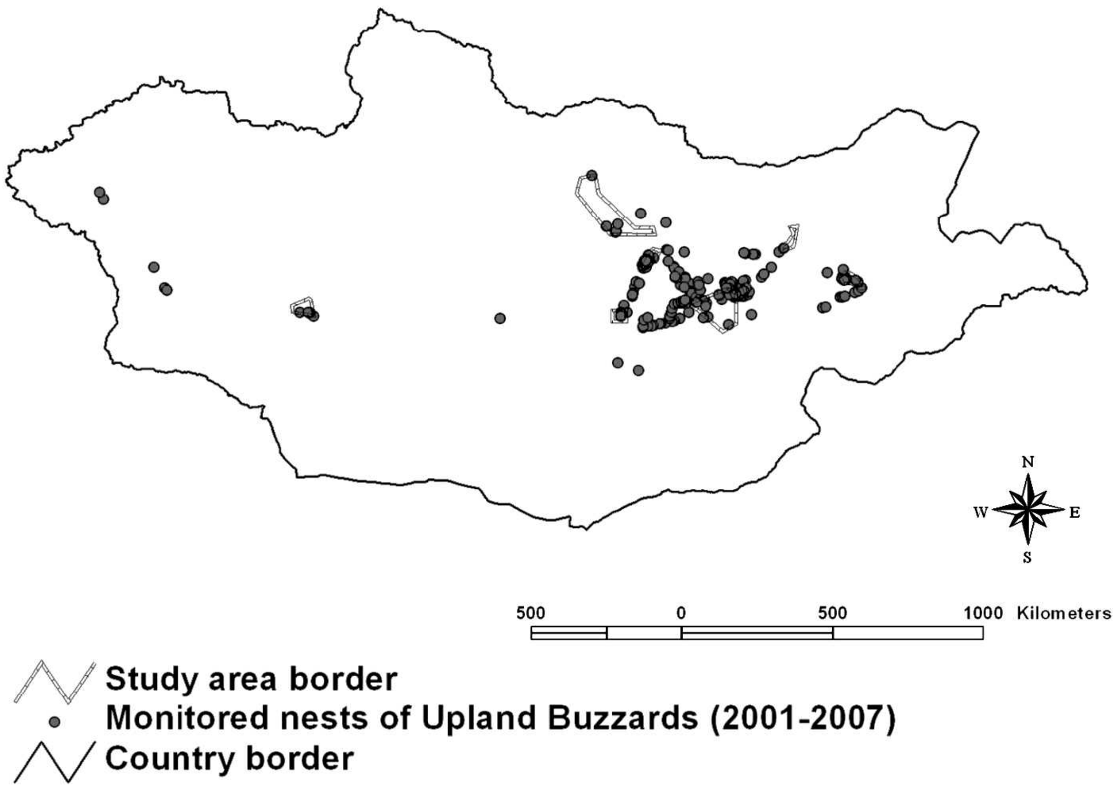

Figure 1. Locations of the monitored nests of Upland Buzzards (*Buteo hemilasius*) in Mongolia (2001–07).

vegetation, availability of materials, and proximity to urban areas. Nest materials in nests near urban areas (n = 15) usually consisted of 80–90% wires, cables, plastic bags, strings, and twigs. Nests (n = 289) in remote areas consisted only of twigs, branches, roots, dried grasses, etc.

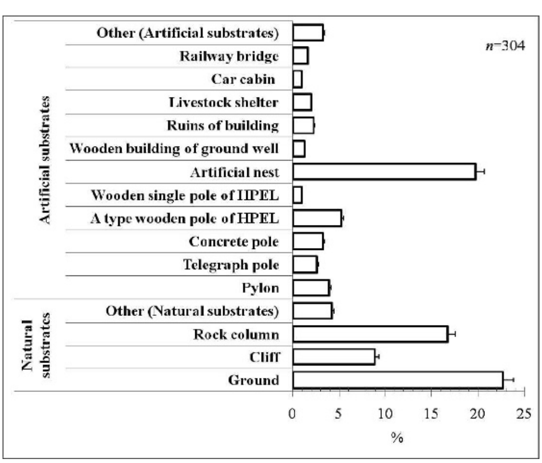

Figure 2. Type of nest substrates used by Upland Buzzard (*Buteo hemilasius*) on the Mongolian steppe (2001–07). HPEL indicates high-voltage electric lines.

Clutch Size. Average clutch size for the 304 breeding attempts in the years 2001–07 was 3.49 (±1.09, range 2–8); clutch size varied significantly among years ($ANOVA_{0.05}$: $F_{6,163} = 2.15$, $P = 0.001$). A total of 68 (22.4%) clutches failed to produce even a

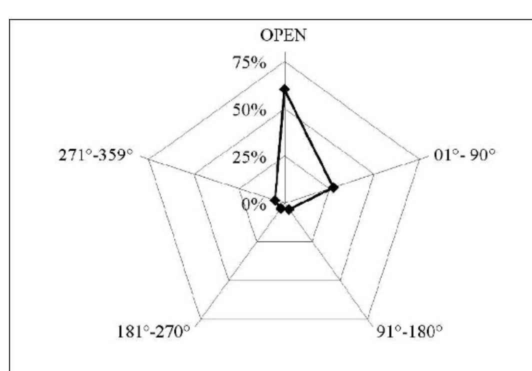

Figure 3. Nest orientation for Upland Buzzards (*Buteo hemilasius*) in Mongolia (2001–07). Scale is logarithmic.

Table 1. Average clutch and brood size of Upland Buzzards (*Buteo hemilasius*) in Mongolia on different nest substrates.

NEST SUBSTRATE	AVERAGE CLUTCH SIZE	RANGE	*n*	AVERAGE BROOD SIZE	RANGE	*n*
Natural substrates						
Rock columns	3.9 ± 1.15	3–4	36	2.8 ± 1.7	0–5	36
Ground	3.6 ± 0.87	2–7	54	2.5 ± 1.3	0–5	46
Cliffs	3.3 ± 0.67	2–8	14	1.6 ± 1.2	0–3	10
Sandy precipice	3.0 ± 1.4	2–5	2	1.5 ± 0.7	0–2	2
Artificial substrates						
Pylons	2.8 ± 0.64	2–3	2	2.0 ± 1.4	0–3	2
Concrete pole HPEL[1]	3.0 ± 0.0	3	6	2.5 ± 1.37	1–4	2
''A'' type wooden pole HPEL[1]	3.3 ± 1.2	2–6	9	2.4 ± 1.1	0–3	9
Telegraph pole	3.0 ± 0.89	2–4	6	2.4 ± 2.5	0–6	5
Artificial nest platforms	2.9 ± 0.69	2–4	46	1.1 ± 1.2	0–4	44
Abandoned buildings	3.7 ± 0.87	3–4	4	2.5 ± 1.3	2–4	4

[1] HPEL indicates high-voltage electric lines.

single hatchling. A total of 751 (70.8%) eggs hatched successfully.

Of 304 breeding attempts, only two nests (0.7%) had 8-egg clutches, both in 2002. In one case we found a ground-nesting pair with five nestlings more than 20 d old, while the female concurrently incubated three eggs at the edge of the nest. We assumed that these three eggs were a late addition to the initial clutch. None of the eggs in the second clutch for either nest hatched.

Brood Size. The average number of nestlings for 215 breeding attempts was 1.95 (±1.53, 0–6) in the breeding seasons of 2001–07. We could not verify brood size for 21 nests of breeding pairs located in inaccessible cliffs or remote areas.

Effect of Nest Substate on Clutch and Brood Size. Average clutch size, including second clutches in the same breeding season, was significantly higher ($\chi^2 = 24.1$, df = 1, $P < 0.001$) for pairs that nested on natural substrates in comparison to human structures (Table 1). The most frequent clutch size was three eggs for artificial nest substrate and four for natural substrates during our study (Fig. 4).

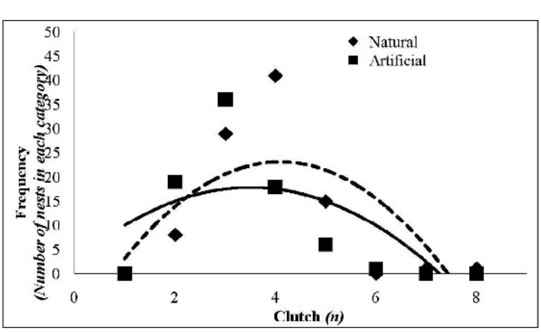

Figure 4. Frequency of clutch size for nests on natural and artificial substrates of Upland Buzzards (*Buteo hemilasius*) on the Mongolian steppes, 2001–07.

In addition, the average number of nestlings in nests on natural substrates was significantly higher ($\chi^2 = 24.9$, df = 1, $P < 0.001$) than that for artificial substrates (Table 1). However, if we excluded artificial nest platforms from the analyses, then there was no difference in brood size between natural or artificial substrates ($\chi^2 = 1.044$, df = 1, $P = 0.307$).

Sheltered and Unsheltered Nests. The advantage of a sheltered nest site was illustrated by the fact that although the average clutch size did not differ significantly between sheltered and unsheltered nests (sheltered 3.7 ± 1.4, $n = 25$ vs. unsheltered 3.3 ± 1, $n = 140$; Kruskal-Wallis $Z = 1.548$, $P = 0.121$), the average number of nestlings in the nest was significantly greater in the sheltered nests (2.5 ± 1.4, $n = 32$) than in the unsheltered nests (1.8 ± 1.4, $n = 211$; $Z = 2.216$, $P = 0.026$).

DISCUSSION

The Upland Buzzard nests in our study were highly variable; nests near urban areas contained wires, cables, plastic bags, strings, and other human-made materials. Conversely, nests in remote areas consisted almost exclusively of natural vegetation such as twigs and roots and fur or hair of grazing animals. The variety of materials used to build nests illustrated the opportunistic nature of Upland Buzzards.

Nest orientation was site-dependent and dictated by the substrate. Most nests placed on the ground had large open areas around them, which allowed the incubating or brooding hawk to watch the surrounding areas for potential predators or prey (Fig 3).

Nest diameter was also influenced by the substrate. On natural substrates, the nests were much larger than those on human-made structures. Ground-nesting allowed pairs to breed in the midst of Mongolian Gerbil (*Meriones unguiculatus*) and Brandt's vole (*Lasiopodomys brandti*) colonies on the open steppes, and the elevated position of the nests allowed the birds to hunt with ease (Gombobaatar et al. 2009).

An unusual case of a nest near a food source was observed after the extremely cold winter of 2002, when large numbers of cows and horses belonging to the local nomads died of starvation. In Central Mongolia, just before the onset of the breeding season of the Upland Buzzard, families removed dead cows from their cattle shelters and piled them up near their ger (tent) camps. In May, we found a pair incubating four eggs in a nest placed atop a pile of 17 cow carcasses. Three young were successfully fledged from the nest.

The adaptability of the species to the changing landscape of the Mongolian steppes was also demonstrated by the locations of other Upland Buzzard nests: in and atop abandoned cabins and vehicles. Another pair of Upland Buzzards built a nest on a gravel bank just 0.5 m from the busy tracks of the Trans Baikal railroad; although incubation of three eggs occurred, no young fledged, because of disturbance from trains and railway workers. On another occasion, two nests with three young each were located 0.3 m away from a dirt road.

In the Baikal region, Russia, Karyakin et al. (2006) found that if trees were present, most Upland Buzzard nests were placed in trees (96% of 48 nests were in trees). In the neighboring county of Tuva, which has open steppe landscape like that in our study, Karyakin (2005) found that the Upland Buzzard nested mainly on poles and pylons of the high-voltage electric lines, and on artificial nest platforms.

In addition, the proximity of prey species within the breeding territory also seemed to influence nest location. This apparently explained many of the unusual nest sites, use of artificial nest platforms, and the relatively high occupancy of nests on poles and pylons of the high-voltage electric line, telegraph poles, livestock shelters, and building ruins found in the midst of high-density areas of Brandt's Vole and Mongolian Gerbils (Gombobaatar et al. 2009).

Mainjargal (2006) reported that the largest clutch in the Upland Buzzard was six eggs. However, for the first time for this species, we documented two clutches of eight eggs. We believe that larger clutches are a function of prey availability (Cody 1966). This was further substantiated by the fact that during periods of prey population irruptions we also observed nearly twice as many second clutches on natural substrates (Gombobaatar et al. 2009). In raptors, the linkage of predator-prey cycles and raptor breeding success has been well documented for Snowy Owl (*Nyctea scandiaca*) and collared lemming (*Dicrostonyx groenlandicus*; Gilg et al. 2003, 2006). Similarly, Sundell et al. (2004) demonstrated that in Finland the breeding success of avian predators (Boreal Owl [*Aegolius funereus*], Ural Owl [*Strix uralensis*], Long-eared Owl [*Asio otus*] and Rough-legged Hawk [*Buteo lagopus*]) is highly dependent on the abundance of voles.

Gombobaatar et al. (2009) also found that Upland Buzzard pairs that reproduced successfully in a year of rodent abundance built their nests in the subsequent breeding season in the same areas. In early spring, food supply (i.e., voles and gerbils) was sufficient to sustain the breeding pair during nest-building and laying, because rodents that had successfully survived the harsh winter of the Mongolian steppes were active on the ground immediately after exiting wintering burrows or hibernation colonies (S. Gombobaatar unpubl. data). However, if inclement weather continued and transitioned into a harsh spring, rodents died *en mass* because of starvation and extreme cold. For breeding Upland Buzzards, this resulted in nest abandonment, desertion of clutches and broods, increased incidence of starvation, and also cannibalism.

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