Breeding Ecology of the Steppe Eagle (Aquila nipalensis) in Mongolia

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Front cover photographs:
Upland Buzzard *Buteo hemilasius*,
by Gombobaatar Sundev

Back cover photographs:
Mongolian Accentor *Prunella kozlovi*
Mongolian Ground-jay *Podoces hendersoni*
Mongolian Gull *Larus mongolicus*
Mongolian Finch *Bucanetes mongolicus*
Mongolian Lark *Melanocorypha mongolica*
by Gombobaatar Sundev

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THE ASSESSMENT OF HIGH RISK UTILITY LINES AND CONSERVATION OF GLOBALLY THREATENED POLE NESTING STEPPE RAPTORS IN MONGOLIA

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Abstract: On the steppe, these raptors prefer to nest on the concrete or wood poles and pylons of high-power electric lines. These old power line structures cause a high number of avian deaths through electrocution or collision. Field work was conducted on 110 kilovolt (kV) and 220kV transmission lines and 6kV, 10kV, 15kV, and 35kV distribution lines in the Tuv, Dundgobi, Gobisumber, Dornogobi, and Khentii aimags of Central Mongolia from 2007 to 2009. During that time, a total of 207 individuals belonging to 13 globally threatened raptor species died in the study area from electrocution, and mortality rates are increasing. The reason for the high electrocution rate on power lines is due to the configuration of the tangent and strain poles. Recent avian safety measures (e.g., spikes, tape) implemented by electric companies are not sufficient to protect birds in open habitat. Electrocution of birds on 15kV power lines is a serious concern on a national and international level; therefore, immediate measures must be implemented to retrofit poles to minimize these impacts. Although collision with power lines normally kills fewer birds than electrocution, a large number of Pallas's Sandgrouse were killed in 2008 after colliding with wires during an unusual seasonal movement in the study area. Wire markers (e.g., Swan Flight Diverters or Bird Flight Diverters) should be placed so they are visible to birds from a long distance.

Key words: *Mongolia, breeding raptors, power line, pole, conservation*

Introduction

Since the beginning of the last century, electrical power has been widely used in Mongolian homes, industries, and other developments. Electricity generated at power stations is distributed to users through an electrical power transmission grid. Transmission power lines are designed for high voltages (110kV and 220kV). Transmission lines carry power long distances and feed into electric substations where power is stepped down and run to distribution lines; these distributions lines are operated at lower voltages (6kV, 10kV, 15kV, and 35kV). Because of the voltage differences between transmission and distribution lines, pole structures vary greatly (BirdLife International 2003, Gantumur 2003, BirdLife International 2007, Marcus 2008).

Poles and pylons offer raptors a place to nest, roost, and rest (Kruger and Rooyen 2000, Rooyen 2000, Gombobaatar 2006, Gombobaatar *et al.* 2006). Certain power line configurations provide a suitable nesting structure for raptors (Kozlova 1930, Brown and Amadon 1968, Kozlova 1975, Cramp *et al.* 1980, Piechocki *et al.* 1981, Ferrer *et al.* 1991, Baumgart 1978, Ellis *et al.* 1997, Harness and Wilson 1999 and 2000, Harness and Gombobaatar 2008, Harness *et al.* 2009, Potapov *et al.* 1999, 2001 and 2002, Kruger and Rooyen 2000, Rooyen 2000, Shijirmaa *et al.* 2000, Fergussen-Lees and Christie 2001, Bold *et al.* 2003, Gombobaatar *et al.* 2005, 2006, 2007, 2008a, 2008b, 2010 and 2010b; Gombobaatar 2009, Rubolini *et al.* 2005, Gombobaatar 2006, Karyakin *et al.* 2008 and 2009). However, some configurations provide inadequate electrical clearance for large birds such as raptors and contribute to high electrocution rates (Gombobaatar *et al.* 1999, Harness and Wilson 2000, Harness and Gombobaatar 2008, Gombobaatar *et al.* 2009).

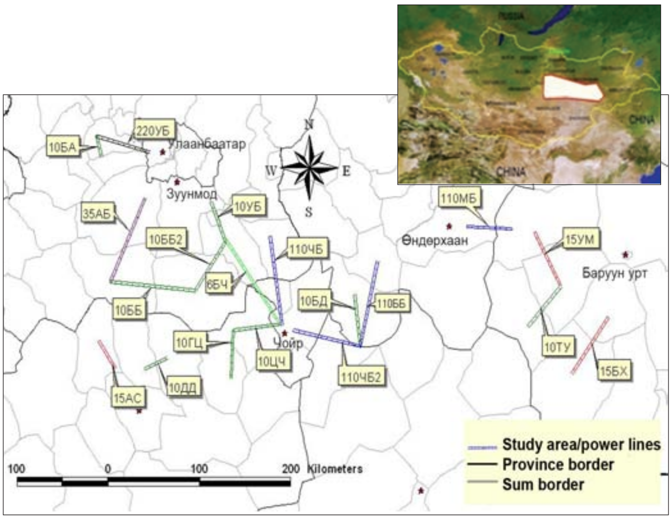
In order to determine the negative impact of power lines on birds, many countries are conducting long-term studies to provide a foundation for conservation and protection plans. Currently, there are few publications describing the effects of power lines on birds in Mongolia.

The main goals of this study were to determine the negative impacts of transmission and distribution power lines on birds of the steppe during the breeding season and migration, to clarify the causes of electrocution and collision, and to design and implement bird-friendly retrofitting measures.

Study Areas

Research was conducted on 110kV and 220kV transmission lines, and 6kV, 10kV, 15kV, and 35kV distribution lines located in Tuv, Dundgobi, Gobisumber, Dornogobi, and Khentii aimags (administrative unit consists of sums) of Central Mongolia from 2007 to 2009 (Figure 1).

Figure 1. Location of the study areas



Names were assigned to power lines; these names consisted of the number of kilovolts, followed by the first two letters of the location name. The following names were used to distinguish the lines: 6UB/УБ, 10BA/БА, 10DD/ДД, 10GTs/ГЦ, 10TsCh/ЦЧ, 10BB/ББ, 10BB2/ББ2, 10ChE/ЧЕ, 10BD/БД, 10UB/УБ, 10TU/ТУ, 15BH/БХ, 15UM/УМ, 15AS/АС, 35AB/АБ, 110ChB/ЧБ, 110BB/ББ, 110ChB2/ЧБ2, 110MB/МБ, and 220UB/УБ (Figure 1).

The power lines were randomly selected based on the following:

a) Power lines with different voltages in similar habitats were selected in order to estimate the mortality by electrocution and collision on the steppe.

b) Lines that the authors have regularly monitored since 1998 were chosen over those that hadn't been monitored.

c) All 15kV power lines were included because these lines were installed during the last 3 years on the steppe.

Methods and Materials

Initially, every substation was inspected at each sum centre (a small village and administrative unit of the country, occupied by 1,000 to 3,000 people). Using the substations as starting points, the authors drove parallel to the power lines at 10 to 20 kilometers (km) per hour and collected dead birds found near the wires (suspected collisions). From the base of every pole, a 15-meter radius was scanned for dead birds (suspected electrocutions).

Access to the power lines was excellent and the vegetation was less than 20 centimeters tall, allowing carcasses to be easily found from the vehicle.

Data collection and analysis followed the study methods described by EDM International, Inc. (2004) and Harness and Gombobaatar (2008); these references included discussions on GPS waypoints, digital photos, power pole configurations (e.g., transformers, arresters, cutouts), retrofitting measures, signs of raptor usage/mortality/nesting, species name, sex/age, contact points (burn marks), habitats, topography, and land use.

Between 2007 and 2009, surveys conducted at 6kV, 10kV, 15kV, 35kV, 110kV, and 220kV power lines resulted in the collection of 948 bird remains; age, sex, location, and the suspected cause of death were documented. Birds collected in September 2007, 2008, and 2009 were likely killed during the breeding season (May – July) or fall migration (August – September), while those collected in June 2009 probably died during spring migration (April – May) or the breeding season (May – June) (Table 1).

In order to understand the reason of high mortality by electrocution on 15 kV power lines, average body length of the electrocuted birds was measured in the field and was alternatively used the data in references as Svensson *et al.* (1999), Shimba (2007), and Brazil (2009).

Based on ecomorphological features, all carcasses found in the study areas were grouped as follows: Columbiformes (COL, includes Pigeon, Turtle Dove, Pallas' Sandgrouse), passerines (PAS, includes all passerines, Hoopoe, woodpeckers), raptors (RAP, includes only diurnal raptor species), cranes (CRA, includes only Demoiselle Crane), water birds (WAT, includes Great Cormorant, Ruddy Shelduck, Common Shelduck, Common Teal, Goldeneye), waders (WAD, includes Pacific Golden Plover, Pin-Tailed Snipe, Mongolian Gull), and owls (OWL, includes Eagle Owl, Little Owl, Long-eared Owl). The number of species killed by electrocution or collision was compared with the species list of birds in Mongolia, recently updated by Gombobaatar (2009). The distance between two poles for each power line in the study areas was measured in addition to the distance between the dead bird and the closest pole. The location of each carcass was recorded on a map using the OZI Explorer 4D, ARC View GIS 3.2 programmes

Table 1. Name, size, and length of power lines in the study area (2007-2009)

No	Name of study area	Voltage	Power line length (km)	Date
1	6UB	6	96	June and September 2009
2	10BA	10	20	September 2008 and June-September 2009
3	10DD/10GTs/10TsCh	10	32/45/56	September 2008
4	10BB/10BB2/10TU/35AB	10/10/10/35	99/66/58/79	June 2009
5	10BD	10	41	September 2008 and June 2009
6	10UB/15BX	10/15	46/70	September 2009
7	15AS	15	30	September 2008
8	15UM/110MB	15/110	61/40	June and September 2009
9	110BB/110ChB2	110	78/69	September 2008, June 2009
10	110ChB/220UB	110/220	58/60	September 2008 and June -September 2009

Statistical analyze. ANOVA (multivariable analysis), Kruskal-Wallis Test and χ^2 (non-parametric comparable data), Spearman correlation, descriptive analysis of the Jump 5.0, SYSTAT 10.0, and MS Excel's Data analysis were used for statistical analysis.

Results and Discussion

Mortality of bird electrocution

A total of 948 carcasses belonging to 54 species were examined and documented during the four field trips in 2007, 2008, and 2009 (Table 2).

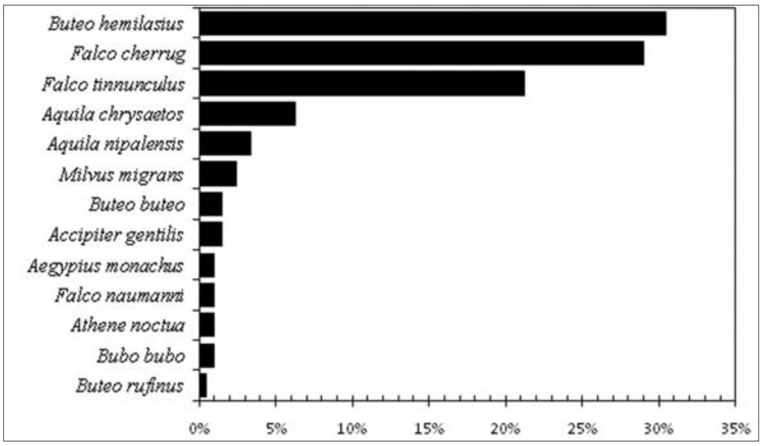
Among the 388 electrocuted birds, 227 individuals (59.7%) were raptors. All electrocuted birds of prey are listed in the appendices of the international conventions such as CMS and CITES. According to the International Union for Conservation of Nature (IUCN) Red List, the Lesser Kestrel is listed as Vulnerable (VU), the Saker Falcon as Endangered (EN), and the Cinereous Vulture as Near Threatened (NT). Electrocution mortality of the Upland Buzzard (29.1%), Saker Falcon (27.8%), and Common Kestrel (21.6%) were comparatively high among all recorded raptor species (Figure 3).

Table 2. Number of electrocuted and collided birds in 2007-2009

No	Species name	Number of individuals	
		Electrocution	Collision
1	Great Cormorant (*Phalacrocorax carbo*)	-	1
2	Ruddy Shelduck (*Tadorna ferruginea*)	-	1
3	Common Shelduck (*Tadorna tadorna*)	-	1
4	Common Teal (*Anas crecca*)	-	1
5	Goldeneye (*Bucephala clangula*)	-	1
6	Oriental Honey-buzzard (*Pernis ptilorhyncus*)	-	1
7	Black Kite (*Milvus migrans*)	5	1
8	Goshawk (*Accipiter gentilis*)	3	-
9	Upland Buzzard (*Buteo hemilasius*)	66	6
10	Long-legged Buzzard (*Buteo rufinus*)	1	-
11	Common Buzzard (*Buteo buteo*)	3	-
12	Steppe Eagle (*Aquila nipalensis*)	7	1
13	Golden Eagle (*Aquila chrysaetos*)	13	1
14	Cinereous Vulture (*Aegypius monachus*)	2	2
15	Saker Falcon (*Falco cherrug*)	63	1
16	Amur Falcon (*Falco amurensis*)	-	1
17	Lesser Kestrel (*Falco naumanni*)	11	-
18	Common Kestrel (*Falco tinnunculus*)	49	-
19	Japanese Quail (*Coturnix japonica*)	-	1
20	Demoiselle Crane (*Anthropoides virgo*)	-	9

21	Pacific Golden Plover (*Pluvialis fulva*)	-	1
22	Common Snipe (*Gallinago stenura*)	-	1
23	Mongolian Gull (*Larus mongolicus*)	-	2
24	Pallas's Sandgrouse (*Syrrhaptes paradoxus*)	-	407
25	Rock Dove (*Columba livia*)	-	1
26	Oriental Turtle-dove (*Streptopelia orientalis*)	-	3
27	Eurasian Eagle-owl (*Bubo bubo*)	2	-
28	Long-Eared Owl (*Asio otus*)	-	1
29	Little Owl (*Athene noctua*)	2	-
30	Hoopoe (*Upupa epops*)	13	-
31	Greater Short-toed Lark (*Calandrella brachydactyla*)	-	2
32	Mongolian Lark (*Melanocorypha mongolica*)	1	35
33	Horned Lark (*Eremophila alpestris*)	1	21
34	Skylark (*Alauda arvensis*)	-	1
35	Blyth's Pipit (*Anthus godlewskii*)	-	22
36	Olive-backed Pipit (*Anthus hodgsoni*)	-	2
37	Brown Shrike (*Lanius cristatus*)	-	1
38	Red-billed Chough (*Pyrrhocorax pyrrhocorax*)	17	-
39	Daurian Jackdaw (*Corvus dauricus*)	2	-
40	Northern Raven (*Corvus corax*)	113	7
41	Taiga Flycatcher (*Ficedula albicilla*)	-	2
42	Northern Wheatear (*Oenanthe oenanthe*)	2	1
43	Isabelline Wheatear (*Oenanthe isabellina*)	9	10
44	Siberian Rubythroat (*Luscinia calliope*)	1	2
45	Siberian Blue Robin (*Luscinia cyane*)	-	1
46	Eye-browed Thrush (*Turdus obscurus*)	1	-
47	Wood Nuthatch (*Sitta europea*)	-	1
48	Rock Sparrow (*Petronia petronia*)	1	1
49	Little Snowfinch (*Pyrgilauda davidiana*)	-	1
50	Duck (*Anas sp.*) and Harrier (*Circus sp.*)	-	2
51	Woodpecker (*Dendrocopus sp.*)	-	1
52	Short-toed Lark (*Calandrella sp.*)	-	2
53	Pipit (*Anthus sp.*)	-	1
	Total	388	560

Figure 3. Percentage of electrocuted raptors



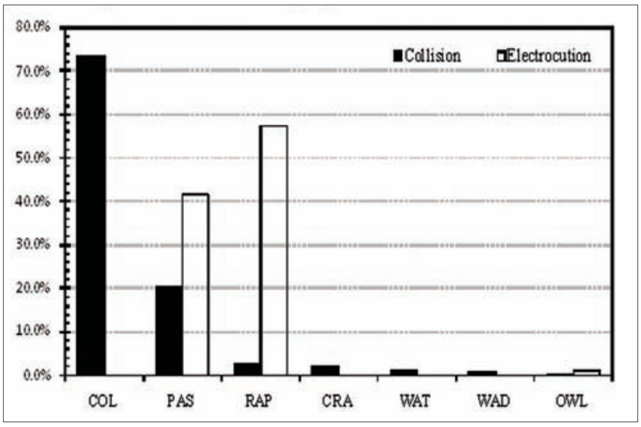
During this study, birds killed by power lines belonged to 54 species, which comprises 11.1% of all Mongolian bird species. Diurnal raptors (57.5%), corvids (34%), and others (8.5%) were the highest percentage of electrocuted birds, while the Pallas' Sandgrouse (COL) (73.4%) was the species most often killed by collision (Figure 4).

Electrocution by voltage

Bird mortality by electrocution greatly differed by voltages of the power line that we inspected during the surveys.

6kV Power line: Of approximately 960 wooden poles inspected along 96 km of the power line in the 6BCh study area, the remains of 27 birds belonging to 11 species were found in June and September 2009. The total of 27 individual carcasses was only detected under the lateral lines off the raptor-friendly main line, which serves railroads, mines, and settlements. The increase of carcasses found at the 6kV power line's wood poles was likely due to insulators and hot wires that were located near each other and placed on a grounded metal base. The species with the most individuals killed on this power line was the Red-Billed Chough (19.35% of fatalities), followed by the Lesser Kestrel (11.1%), which is listed as vulnerable on the IUCN Red List. The mortality rate of this line is 0.28 bird/km for all electrocuted birds and 0.21 bird/km for electrocuted raptors.

Figure 4. Percentage of electrocuted and collided groups



10kV Power line: Along 418 km of 10kV power lines with wood poles, the remains of 31 birds belonging to seven species were found in 2008 and 2009. There was no statistical difference between the number of electrocuted birds found during the breeding season or those found during migration (χ^2=1.54, df=1, p<0.21). The carcasses most often found were those of the Northern raven (19.35% of all carcasses recovered) and Lesser kestrel (19.35%). The Saker falcon was the third –most encountered species (6.45%). However, the mortality rate was higher in study areas 10ChE, 10BA, and 10UB. The Common Raven and Lesser Kestrel had the highest mortality rate (19.35% each), followed by the Saker Falcon (6.45%). Of the 31 carcasses, 42% (n=13) were found at strain poles, 26% (n=8) at substations, 19% (n=6) at A-type tangent poles, and 13% (n=4) at tangent poles. The mortality rate was 0.07 bird/km for all electrocuted birds and 0.03 bird/km for electrocuted raptors.

15kV Power line: Along 283 km of 15kV power lines with concrete poles, the remains of 323 birds belonging to 19 species were found during the four field trips in 2007, 2008, and 2009. Of these, 19.8% (n=64) were found at strain poles and 79.6% (n=257) at tangent poles. Strain poles comprise 5% of the total poles in the study area, therefore, the mortality was higher at strain poles than at tangent poles (Kruskal-Wallis test, Z=4.76, df=1, p<0.001). The overall mortality rate was 1.14 bird/km for all electrocuted birds and 0.73 bird/km for electrocuted raptors.

In order to understand a reason for high mortality by electrocution on the 15 kV power line, average body lengths of the electrocuted birds were compared. The average body length of the suspected electrocuted birds was 45.1±22.6 cm (min.15, max. 100, n=19), the largest was the Cinereous Vulture and the smallest was the Isabelline Wheatear. The size of body length for electrocuted birds was more than 15 cm. The electrocution rate was not associated with body length of the dead birds (Spearman correlation, ρ=0.14, df=18, p>0.2).

According to Harness and Gombobaatar (2008), Harness *et al.* (2009), Gombobaatar *et al.* (2009), and Amartuvshin *et al.* (2010), there are three main reasons for electrocution at 10kV and 15kV power lines in Mongolia:

1). Contact with an energized wire and the grounded concrete pole (phase to ground).

2). Contact with a hot wire when the bird is on a grounded steel crossarm (phase to ground).

3). Contact by larger raptors (e.g., Cinereous Vulture, Steppe Eagle, Golden Eagle) with two energized wires (phase to phase)

35kV, 110kV, and 220kV Power Lines: Seven electrocuted Northern Ravens were found beneath the 110kV power line poles. It is unclear what caused these electrocutions, however, this will be studied so future electrocutions may be avoided. There was no evidence of electrocutions along the 35kV or 220kV power lines. The number of electrocuted birds was statistically different between power lines with different voltages (χ^2=62.3, df=5, p<0.0001). Of the birds electrocuted on the 15kV line, 64.1% were raptors.

Based on the IUCN classification, 31% of raptor species found along all studied power lines are listed as threatened whereas 33% of raptors recorded along the 15kV are listed as threatened. These results indicate that power lines particularly 15kV are lethal not only to threatened raptor species but also to other birds in Mongolia.

Collision

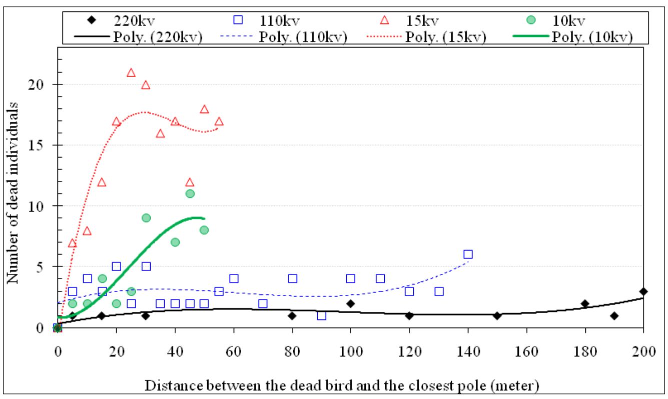
From 2007 to 2009, of the 560 birds (belonging to 43 species) killed after colliding with power lines or related structures, the Pallas' Sandgrouse was the species most frequently found in 2008 (72.5%, n=407). The large number of Pallas' Sandgrouse killed in 2008 was caused by an unusual seasonal movement.

6kV and 10kV Power Lines: In the previous year field surveys, single individuals of the Rock Sparrow, Mongolian Lark and Isabelline Wheatear were found with a sign of the collision on the 6 kV power line. In 2007 and 2009, no carcasses of these birds were recorded.

The remains of 55 birds belonging to nine species were found along the 10kV power lines in the study area in 2008 and 2009. Of the 55 individuals, 92.7% (n=51) collided in 2008 and 7.3% (n=4) in 2009. The Pallas's Sandgrouse was the species most frequently found (80%, n=44) in 2008. The distance was measured between the location of the bird remains and the nearest pole; 79.2% of the carcasses were found 21 to 50 meters from the nearest pole, while 17.8% were found 0 to 20 meters from the nearest pole. There was a high positive correlation between the number of dead birds and the distance between the carcass and the nearest pole (Spearman correlation, ρ=0.87, df=9, p<0.0009) (Figure 5).

15kV Power line: The remains of 206 birds belonging to 16 species were found along the 15kV power line in the study area between 2007 and 2009. The Pallas' Sandgrouse was the species most frequently found (80.1%, n=165) in 2008. The distance between the closest two poles of the 15kV power line is 110 meters. Most carcasses (73.3%) were found 21 to 55 meters from the nearest pole, while 26.7% of the carcasses were found 0 to 20 meters from the nearest pole. There was a high positive correlation between the number of dead birds and the distance between the carcass and the nearest pole (Spearman correlation, ρ=0.62, df=11, p<0.029), indicating that most birds collided mid-span (Figure 5).

Figure 5. Number of dead birds and distance between poles in 10kV, 15kV, 110kV, and 220kV

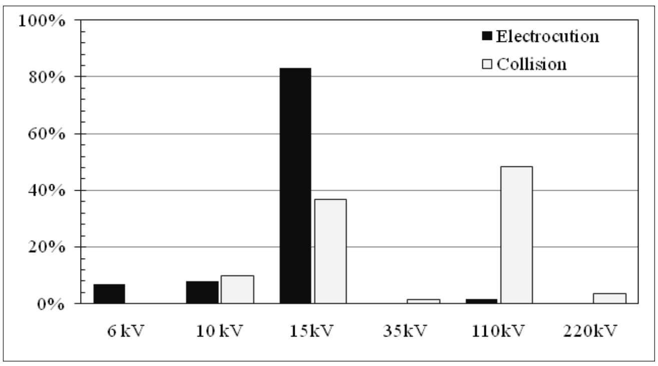


110kV Power line: Along 548 km of 110kV power line, the remains of 270 birds belonging to 20 species were found in 2008 and 2009. The Pallas' Sandgrouse was the species most frequently found (72.6%, n=196) in 2008. The distance between the closest two poles of the 110 kV power line is 300 meters. Most carcasses (62.2%) were found 0 to 60 meters from the nearest pole, while 37.8% of the carcasses were found 61 to 150 meters from the nearest pole. There was low positive correlation between the number of dead birds and the distance between the carcass and the nearest pole (Spearman correlation, ρ=0.30, df=40, p<0.06). However, when the Pallas' Sandgrouse was excluded from the number of dead birds, there was a higher positive correlation between the number of dead birds and the distance between the carcass and the nearest pole (Spearman correlation, ρ=0.61, df=28, p<0.0005) (Figure 5).

220kV Power line: Along 180 km of 220kV power lines, the remains of 20 birds belonging to 13 species were found in 2008 and 2009. The Demoiselle Crane was the species most frequently found (30%, n=6).

The distance between the closest two poles of the 220kV power line is 400 meters. There was a high positive correlation between the number of dead birds and the distance between the carcass and the nearest pole (Spearman correlation, ρ=0.67, df=10, p<0.023); however, the small sample size should be noted (Figure 5). The number of birds killed from collision differed significantly by the type of power lines (Anova$_{0.05}$: $F_{1,52}$=1.92, p=0.0048) during the study years (Figure 6).

Figure 6. Number of electrocuted and collided birds in the power lines with different voltages



Comparison of electrocuted birds and birds killed in collisions with power lines

The number of birds killed from electrocution and collision along the 15kV power line was statistically higher (Anova$_{0.05}$: $F_{5.318}$=2.2, p=0.009) than for any other type of power line all periods of this study (Figure 6).

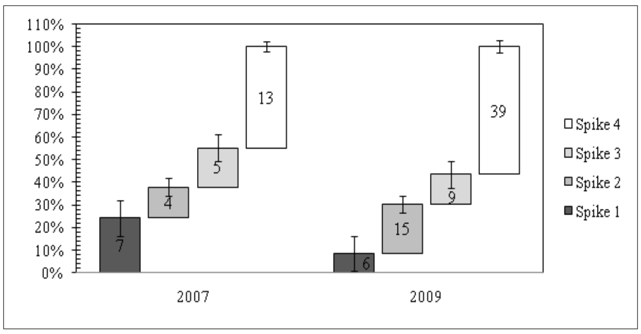
Ineffectiveness of recent bird protection measures

In 2004 and 2006, the electric companies retrofitted some of the poles on their 15kV distribution line in an attempt to reduce the electrocution hazard. One to four anti-perching spikes with plastic bases were installed on steel crossarms, and energized wires were wrapped with plastic tape.

Spikes were installed on 122 of the 527 poles along the 61-km line in the 15UM study area. During this study, a significantly higher number of birds were electrocuted on poles with spikes compared to poles without spikes (Kruskal-Wallis test, Z=71.16, df=1, p<0.001). There was a high correlation between the number of spikes on the crossarms and the number of dead birds found there (Spearman correlation, ρ=0.8, df=3). The increase in the number of spikes on these poles was one of the reasons for the large number of dead birds (Figure 7).

Along the 70-km line in the 15 BH study area, energized wires located 70 to 80 cm from each insulator were loosely wrapped with plastic tape. Fifty-seven dead birds belonging to six species were found underneath poles with covered wires, whereas 19 dead birds representing six species were found at the poles without covered wires. The number of dead birds found at the poles with covered wires was 3 times higher than without covered wires.

Figure 7. Comparison between electrocuted birds and number of spikes on the crossarms



Discussion

Electrocution

The number of individuals and species of electrocuted birds discovered during the field surveys in 2007, 2008, and 2009 was almost the same as results published in Ferrer *et al.* (1991), APLIC (1996), Harness and Wilson (1991 and 2000), Janss and Ferrer (1999), Rooyen (2000), Rubolini *et al.* (2005), Karyakin and Barabashin (2005), Harness and Gombobaatar (2008), Harness *et al.* (2009), Karyakin *et al.* (2008 and 2009), Malovichko (2009), and Amartuvshin *et al.* (2010). The mortality rate of the Upland Buzzard, Saker Falcon, and Common Kestrel was high among raptor species in all study years due to Upland Buzzard's preference to nest on the top of the pole and crossarm, while falcons (Saker Falcon and Lesser Kestrel) perch and roost on the pole and crossarm (Kozlova 1930 and 1975; Piechocki *et al.* 1981, Baumgart 1978, Ellis *et al.* 1997, Potapov *et al.* 1999, 2001 and 2002, Shijirmaa *et al.* 2000, Saker falcon census in Mongolia 2002, Bold *et al.* 2003, Gombobaatar *et al.* 2005, 2006, 2007, 2008a, 2008b, 2010 and 2010b, Gombobaatar 2006, Karyakin *et al.* 2008 and 2009).

The number of electrocuted birds varied between the breeding and migration seasons and is likely associated with prey abundance (Benson 1981, Gombobaatar 2006). According to Gombobaatar (2006), the number of Saker Falcons killed by collision or electrocution increased in areas with a high density of Brandt's Vole, a primary prey species. It is likely that the high number of raptors killed in during this study also is related to an increase in the number of Brandt's Voles; however, this should be confirmed during future surveys.

A relatively high number of raptor carcasses was detected along the distribution line with concrete poles and grounded steel crossarms. According to the studies by Ferrer *et al.* (1991), Rooyen (2000), Harness and Wilson (2000), Karyakin and Barabashin (2005), Harness and Gombobaatar (2008), Harness *et al.* (2009), Karyakin *et al.* (2008 and 2009), Malovichko (2009), and Amartuvshin *et al.* (2010), birds landing on a concrete pole with a grounded steel crossarm can easily become electrocuted by touching a single hot wire. Therefore, to minimize the risk to birds, poles should not be equipped with steel crossarms or, if they are, the exposed wire should be insulated according to recommendations by Harness and Gombobaatar (2008) and Harness *et al.* (2009). In addition, the distance between hot wires (phase to phase) should be greater than 152 cm to minimize potential impacts to large raptors such as the Cinereous Vulture, Golden Eagle, and Steppe Eagle. A few additional improvements will be necessary in the future, such as properly placing jumpers on strain poles under the steel crossarms, covering the insulators with specially designed insulator covers, and retrofitting the crossarms with nonconductive covers.

The use of spikes may actually have contributed to the large number of dead birds (Figure 7). According to observations made during this study, spikes actually shifted some birds to birds perch on top of the crossarm insulator and they then stepped on to the grounded crossarm, or the spikes shifted them to land on the steel crossarm between the outermost spikes and insulator, where they were likely to contact a hot wire. In both cases the spikes caused the birds to perch closer to the hot wires, where the electrocution risk is greater.

More dead birds were found under poles with energized wires wrapped with plastic tape than under poles without wrapped wires. Based on these results and those provided in Karyakin *et al.* (2009), Harness and Gombobaatar (2008), and Harness *et al.* (2009) spikes and tape are inefficient measures for bird protection. Field surveys described in Potapov *et al.* (2003) and Gombobaatar (2006) indicate that nesting material (e.g., twigs, branches, and textiles) in artificial nests attract birds such as the Upland Buzzard and Northern Raven. After the plastic cable ties are damaged by ultraviolet radiation (Sun), rain, and freezing temperatures, plastic tape flapping on wires appeared to attract breeding birds to nest on the pole. Consequently, Upland Buzzards, Northern Ravens, and Saker Falcons were electrocuted in high numbers on this 15 kV power line. Mortality rates are associated with ecomorphological groups of birds (Rubolini *et al.* 2005). Due to the spacing of energized portions of the transmission line, large species are more likely to be electrocuted than small species (e.g., Isabelline Wheatear, Mongolian Lark). The number of dead birds from collision and electrocution along the 15kV power line was high (Figure6). This result shows that the 15kV power line configuration is highly lethal not only raptors but also to migrating birds.

Collision

The mortality rate of birds killed by collision along the 35kV, 110kV, and 220kV power lines in this study was similar to that described in Crivelli *et al.* (1988), Shimada (2001) and Bevanger and Brøseth (2004). Ferrer *et al.* (1991), Savereno *et al.* (1996), Bevanger (1999), Janss and Ferrer (1999), Janss and Ferrer (1999), and Rubolini *et al.* (2005) describe a higher collision rate for species with lower maneuverability (e.g., cranes and herons) than smaller, more maneuverable birds. The high mortality of Pallas' Sandgrouse (72.7%) by collision was directly associated with an unusual seasonal movement of this species in September 2008. During September 2008, 11,000 birds per hour were observed flying fast at low altitudes toward the 15kV, 35kV, 110kV, and 220kV power lines. The collision of Pallas' Sandgrouse has been regularly recorded in Mongolia. Bold and Tulgat (2005) observed that flocks of Pallas' Sandgrouse flew over power lines at higher speeds during the dusty days. This high speed and reduced visibility resulted in an increased danger of collision. Researchers from the Veterinary Institute of Mongolia found 2,300 dead birds near the power lines in Uvurkhangai and Dundgobi provinces in 2008 (Sh. Enhtuvshin pers. comm.). McNeil *et al.* (1985), Crivelli *et al.* (1988), Shimada (2001), and Bevanger and Brøseth (2004) suggested that power lines located between roosting and nesting sites are more dangerous for birds occupying these habitats. According to our surveys, carcasses of the Pallas' Sandgrouse, Mongolian Lark, Horned Lark, Blyth's Pipit, and Isabelline Wheatear were found in high numbers in vegetated valleys between dry steppe (breeding and feeding sites) and small rivers, springs, and saline lakes (drinking sites). The number of birds colliding with power lines without wire markers or diverters was higher than with markers or diverters (Morkill and Anderson 1990, Savereno *et al.* 1996, Janss and Ferrer 1998, Marcus 2008). Wind speed and direction also affect collision rates (Morkill and Anderson 1990, Savereno *et al.* 1996). According to S. Gombobaatar's field observations in 1998 to 2005, recently killed birds were discovered along power lines more frequently after windy and dusty days (S. Gombobaatar pers. comm.). Based on the discovery that most birds died near mid-span, it is suggested that wire markers or diverters (e.g., Swan Flight Diverters or Bird Flight Diverters) are installed near mid-span. According to Morkill and Anderson (1990), Savereno *et al.* (1996), Janss and Ferrer (1998), and Marcus (2008), installation of wire markers or diverters near mid-span effectively prevents birds from collision.

Recommendations for retrofitting measures

To minimize adverse impacts to birds from electrocution, steel crossarms and energized wires must be properly retrofitted. In collaboration with Canadian Cantega, EDM International, Inc., the Mongolian Ornithological Society, and the Ornithological Laboratory of the National University of Mongolia, scientists and specialists have designed retrofitting equipment specifically for 15kV lines in Mongolia including jacket covers for steel crossarms, insulators made from special plastic, wire covers, and jumpers made from UV-resistant insulating polymers. This equipment will be reduced bird electrocutions on power lines, especially when these items are used at the same time.

Conclusions

-Power lines in the study area resulted in the death of globally threatened raptors. Electrocution deaths have been increasing. The number of birds killed by collision was lower than those killed by electrocution. However, in 2008, a great number of Pallas' Sandgrouse on an unusual seasonal migration collided with power lines in the study area.

-The high mortality rates on the 6kV, 10kV, and 15kV power lines are due to the configuration of tangent and strain poles. On the 6kV and 10kV power lines, poles have grounded steel crossarms; on the 15kV power lines, poles have upright insulators and grounded steel crossarms, and strain poles have jumpers above the crossarm.

-The improper use of recent protection measures (e.g., tape and spikes) has resulted in an increase in avian mortality. Wire markers (e.g., Swan Flight Diverters or Bird Flight Diverters) should be placed so they are visible to birds from a long distance. Placement of the wire markers is variable, depending on the type of power line.

-Electrocution of birds on 15kV power lines is a serious concern on a national and international level; therefore, immediate measures must be implemented to retrofit poles to minimize these impacts.

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Хураангуй

Монгол орны хээрт махчин шувууд өндөр хүчдлийн мод болон цемент шон дээр үүрлэнэ. Бүтцийн хувьд эртний буюу шувуудад сөрөг нөлөө үзүүлдэг эдгээр шон, өндөр хүчдлийн улмаас олон зүйл шувуу хүчдэлд цохиулж, утас мөргөн олноор эндэж байна. Судалгааны ажлыг 6КВ, 10КВ, 15КВ, 35КВ, 110КВ болон 220 КВ шугамыг хамруулан Төв, Дундговь, Говьсүмбэр, Дорноговь, Хэнтий аймгийн зарим нутагт 2007, 2009 онд гүйцэтгэв. Судалгааны явцад бид хүчдэлд цохиулж эндсэн нийт 13 зүйлд хамаарах 207 бодгаль махчин шувууны үлдэгдлийг олов. Эдгээр махчин шувууны ихэнх нь бүс нутаг болон олон улсын хувьд ховордож буй зүйлүүд болно. Эндэж буй махчин шувуудын тоо жил бүр өсөж байна. Хүчдэлд цохиулан эндэж буй махчин шувуудын үндсэн шалтгаан нь өндөр хүчдлийн шугамын бүтцийн "буруу" буюу шувуудад сөрөг нөлөөгүй байх үндэслэлийг буруу тооцоолон барьсантай холбоотой. Одоогоор авч хэрэгжүүлж буй шувуу үргээх аргууд (хадаас, сэнс, утсыг ороосон тууз) нь үр дүн маш муутай байгааг бидний судалгаа харуулав. Шинээр барьж буй 15 КВ-ын шугам нь махчин шувуудыг хөнөөх байдлаараа үндэсний төдийгүй олон улсын анхаарлыг татаж байна. Ийм учраас энэхүү сөрөг нөлөөг бууруулах, арилгах арга хэмжээг цаг алдалгүй авах шаардлагатай. Шувуудын утас мөргөж эндэх хорогдол нь хүчдэлд цохиулж эндэхээс харьцангүй бага. Говийн ногтрууны ер бусын улирлын шилжилтээс хамааран тэд нэн олон тоотойгоор 2008 онд утас мөргөж хорогдов. Энэхүү хорогдлыг багасгахын тулд өндөр хүчдлийн утсанд шувуудад алсаас харагдах тод өнгийн бөмбөлөг мэтийг өлгөх шаардлагатай.

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BREEDING ECOLOGY OF THE STEPPE EAGLE (*Aquila nipalensis*) IN MONGOLIA

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Abstract: The Steppe Eagle is a migratory species in Mongolia that breeds in the forest, high mountains, and different types of steppes. We studied 49 breeding pairs for a decade, 1998-2007. Of the total of 49 nests evaluated, 22 (47.8%) were placed on the ground, 15 (32.6%) were on rock columns and large boulders, 4 (8.7%) on cliffs, one on a tree (2.2%), and 4 (8.7%) on artificial substrates (2 on abandoned car cabins, 1 on a car tire and 1 on an artificial nest platforms). The year did not affect nest site selection and there was no difference between type of nest site and clutch size or the number of young fledged successfully. Steppe Eagles are mostly ground nesters and their diet is comprised mostly of Brandt's Vole (*Lasiopodomys brandti*). Breeding pairs prefer to nest in the midst of 20-30 cm high rocks or rock columns on top or on the side of hills in the center of active colonies of voles. Only one pair occupied a nest platform from among the 100 platforms built by our team in 2002. Average clutch size was 1.9 (±0.6 SD, 1- 3, n=43) and the number of young fledged per pair was 0.89 (±0.8, 0-3, n=37). All nests were located between 1,100 - 2,500 m a.s.l. (0 ground - 25 m cliffs). Altitude, height of nest location and nest size (nest diameter, depth, and height) did not influence the number of eggs layed and young fledged successfully.

Key words: *Steppe Eagle, Aquila nipalensis, reproduction, steppes, Mongolia*

Introduction

The Steppe Eagle, (*Aquila nipalensis*), is a large bird of prey with a total body length of 620-740 mm, a wingspan of 1650-1900 mm, and body mass of 2400 to 3900 gr. It breeds from West-central Eurasia from Romania to South-West and South-central Russia. In central Asia it is found from central-South Russia to Mongolia, western China and South-West Siberia. The European and Central Asian birds winter in Africa, and the eastern birds in India. The eastern race *A. n. nipalensis* is larger and darker than the European and Central Asian *A. n. orientalis*.

The Steppe Eagle was once considered to be closely related to the non-migratory Tawny Eagle, *Aquila rapax*, and the two forms treated as conspecifics. They were split based on pronounced differences in morphology and anatomy and molecular analysis indicates that these birds are not even close relatives. The allopatric Steppe Eagle and Tawny Eagle exhibit clear differences in ecology and behavior, as well as being diagnostically different in anatomy, structure and plumage (Brooke *et al.* 1972, Clark 1992, Olson 1994, Sangster *et al.* 2002). Clark (1992) reported differences in plumage, overall size and proportions, structure of beak and gape, and ecological niche – including breeding habitat and prey, as well as hunting, social and migratory behavior. The plumages differ considerably in all age groups. Olson (1994) described differences in the cranial anatomy which were also consistent with treatment as separate species.

Most studies of Steppe Eagles are either at the wintering grounds in Arabia (eg., Ostrowski *et al.* 2001, Meyburg *et al.* 2003) or Africa (Harrison *et al.* 1997), or while on migration between the breeding and wintering grounds (eg., Shirihai & Christie 1992, Spaar & Bruderer 1996, DeCandido *et al.* 2001). Some of these surveys have reported that they are declining in numbers, especially on the migration surveys conducted at Eilat (Yosef and Fornasari 2004), while others consider an increase in the number of Steppe Eagles in the Arabian Peninsula to be a possible explanation that could have contributed to the fluctuations observed (Meyburg *et al.* 2003).

The western part of the Steppe Eagle's range has contracted over the past 50 years mainly due to modern agricultural practices and cultivation of grassland steppes, electrocution, and human disturbance at nests (Tucker & Heath 1994). And yet, the greatest lack of knowledge for the species is from the breeding grounds. Most studies that do exist either remain unpublished, or published in obscure and local journals, or in languages that are not international, and with no translations.

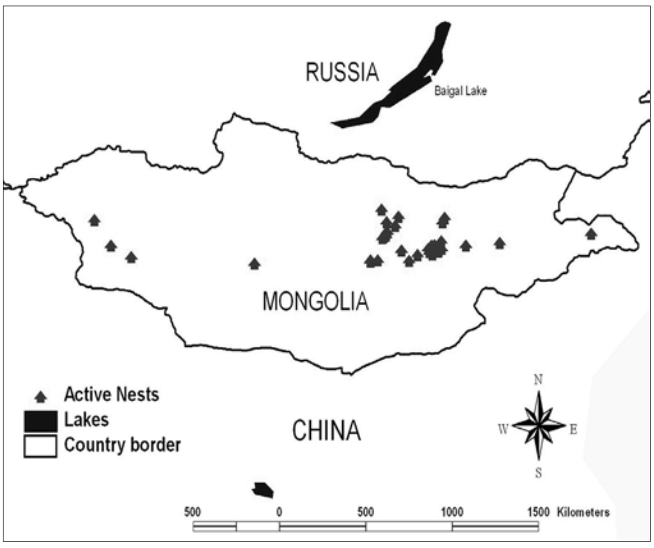
Mongolia is one of the two core countries for the breeding population of the Steppe Eagle in the World. The other is Kazakhstan. As per present knowledge, most individuals migrate to China (Bold & Boldbaatar 1999) and experienced adults winter in Mongolia depending on food availability and resources. The distribution of the Steppe Eagle in Mongolia extends from the Mongolian Altai mountains in the east to the western foothills of the Great Khyangan Mountains in the west (Flint & Bold 1991).

The distribution, numbers, status, diet, and migration of the species in Mongolia have previously been studied by Bianki (1915), Bold *et al.* (1996), Dementiev (1963), Flint & Bold (1991), Kozlova (1930, 1975), Mauersberger (1980), Minoransii (1962), Pevtsov (1883), Piechocki *et al.* (1981), Przewalskii (1876), Sumiya & Batsaikhan (1999), Stephan (1994), Sushkin (1938), Tugarinov (1932). However, there are few publications about the breeding biology (Bold&Boldbaatar 1999, Gombobaatar *et al.* 2005&2006, Karyakin 2006, Karyakin & Novikova 2006, Shagdarsuren 1964&1983). Our aims of the study were to describe nest site selection and types of nest substrate; explain the relationship between nest substrate and clutch size, and the number of fledglings; elucidate hatching and fledging success; understand the factors that influence the number of eggs laid, and hatching and fledging success.

Study area, Methods and Materials

During the breeding seasons (May - August) of 1998-2007 we monitored a total of 49 active nests of the Steppe Eagle in different parts of Mongolia, in five different habitats (Figure 1).

Figure 1. Location of active nests of Steppe Eagles (*Aquila nipalensis*) studied in Mongolia.



Study areas included high mountains, forest, forest steppe, mountain steppe and desert steppe.

The size of study area surveyed was 121,232 sq km. All nests found in the study areas were monitored and re-checked each year. Owing to the fact that we did not trap and color mark each individual of the pairs included in this study, we are unable to state if pairs that bred in the same territory in subsequent years were the same pairs or different individuals. However, because we used a digital camera 5MioPixels and a Leica televid 707 scope to digiscope adult birds in the nests for three subsequent years, the comparison of plumage specifics in the digital photos showed that these birds were the same individuals as in previous breeding seasons.

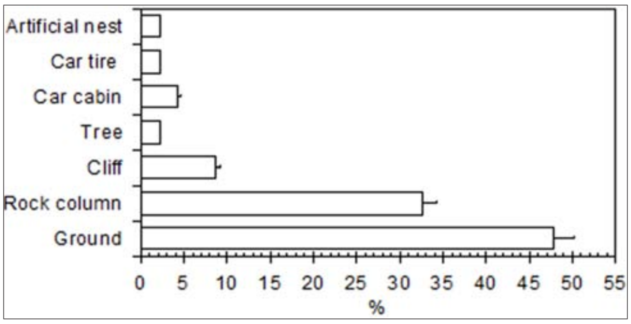
At each active nest found we measured the bearing of nest, the habitat (nest substrate), height of nest above ground level, and altitude of nest location (Above Sea Level); in addition we measured the physical dimensions of the nest, which included height, length, and depth (in mm). Reproduction parameters evaluated were clutch size, nestlings and fledglings for each nest (cf. Fox *et al.* 1994). All nest substrates were classified as natural or artificial based on the origin of the substrates. We used descriptive analyses for the measurements of nest height, nest diameter, clutch size, number of chicks, hatching and fledgling success. Kruskal Wallis, Correlation and regression analyses (Fowler & Cohen 1986, Jump 5.0, MS Excel 2003) were used for evaluation and statistical differences between factors affecting nest substrate and hatching and fledging success; changes in number of eggs laid and young fledged between years; egg and nestling mortality. In order to understand breeding effort (number of eggs laid) and success (number of young fledged) we estimated vole numbers in a 1-km radius of the nest site. Brandt's Vole density was estimated using methods of Batsaikhan *et al.* (2001), Avirmed (2003&2005), Munkbaatar & Munkbayar 2005, and Gombobaatar (2006). Avirmed (2003) estimated that the minimum number of voles in a single wintering colony was 8. At each nest we attempted to identify the prey taken by the parents and consumed by the young at the nest by checking the nest and a 0.5 m surrounding area for prey remains.

Results and Discussion

Nest Substrates

A total of 7 different types nest substrates were selected by the successful breeding pairs. Of the total of 49 nests evaluated, 22 (47.8%) were placed on the ground, 15 (32.6%) were on rock columns and large boulders, 4 (8.7%) on cliffs, one on a tree (2.2%), and 4 (8.7%) on artificial substrates (2 on abandoned car cabins, 1 on a car tire and 1 on an artificial nest platforms) (Figure 2).

Figure 2. Type of nest substrates of breeding Steppe Eagles (*Aquila nipalensis*) in Mongolia (1998-2007)



The number of nests of breeding pairs thatwere placed on the ground was significantly greater than that for all other substrates (Kruskal-Wallis Test, H=43.0, p< 0.000).

There was no statistical significance in nest substrates selected by breeding pairs in any given season and by those in subsequent years ($ANOVA_{0.05}$: $F_{8,62}$ =2.13, p=0.3).

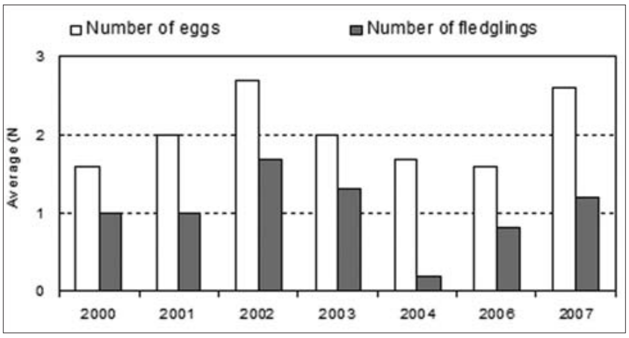
Breeding pairs preferred to place their nest in the midst of 20-30 cm high rocks platforms, or on crumbling rock columns, that were 2-7 meters high, on top of hilly slopes overlooking active colonies of rodents, mostly Brandt's Vole (*Lasiopodomys brandti*). They rarely placed their nests on old, abandoned lorry cabins or car tires even when available within their territory. Only one artificial nest platform was occupied by a pair of Steppe Eagles from among 100 that were placed on the steppes in 2002. In contrast, in Kazakhstan Steppe Eagles built nests on concrete pole (27.3%) or on the ground (30.4%; Karyakin & Novikova 2006). Similarly, it was reported that in Russia the Steppe Eagle breeding density in Kalmykia, and between the Volga and Ural Rivers, was 1-4 km between pairs and was dependent on the density of the Little Sousliks (*Citellus pygmaeus*) which may form up to 98.5% of its diet (Varshavski *et al.* 1983). Steppe Eagles were reported to feed on middle-sized mammals or dead Saiga Antelope (*Saiga tatarica*) during years of Souslik scarcity (Davygora 1992). In Transbaikalia they feed mostly on Bobac Marmots (*Marmota bobak sibirica*; 54-77%) and Daurian Pika (*Ochotona daurica*; 11-37%). Russian Steppe Eagles are also reported to preferably nest in stick nests placed on the ground on gentle slopes, in low bushes or on old hay-stacks (Davygora 1991, Muntjanu 1977, Lindeman 1983).

The eagle nests contained twigs of elm tree, shrubs (*Caragana* sp.), tail hair of horses and cattle, wool and fur of sheep, goat and camel, cotton, plastic bags and other man-made materials. The percentage of the materials included in the nest varies and depends on habitat type, vegetation, cattle density, and distance from urban areas. The outer diameter of the nest was 1467 mm (± 46 SD, 60-250, n=34), nest depth 68 mm (± 4.4, 0-14, n=33), nest height 256 mm (± 15.8, 10-70, n=34). Nest diameter ($F_{1,37}$=0.068; R^2=-0.05, p=0.7) and nest height ($F_{1,37}$=0.2; R^2=0.07, p=0.6) did not affect clutch size. There is no correlation between the number of nestlings and nest diameter ($F_{1,32}$=0.6; R^2=-0.1, p=0.4), and nest height ($F_{1,32}$=0.1; R^2=0.01, p=0.7). Occasional nestling mortality was caused by entanglement in nest materials such as synthetic string and women's nylon socks. Steppe Eagle pairs build 2 or 3 nests that are located close to each other on rock columns or raised outcrops and offer an elevated view of the surrounding flat steppe. Distance between these nests was between 260 - 300 m. No alternative nests were found if the pair built their nest on the ground.

Nest Substrate, Clutch Size and Fledglings

Average clutch size was 1.9 (± 0.6 eggs, 1-3, n=43) per breeding attempt. A total of 10 (23.3%) pairs laid only one egg, 25 (58.1%) laid 2 eggs, and 8 (18.6%) laid 3 egg clutches (Figure 3). Number of eggs (Kruskal-Wallis Test, H=18.8, p< 0.001) and chicks (Kruskal-Wallis Test, H=23.3, p< 0.003) was significantly varied across years in study period (Figure 3).

Figure 3. Fluctuation of the total number of eggs laid and fledglings across years in 45 Steppe Eagles (*Aquila nipalensis*) nests studied in Mongolia.



All unhatched eggs were removed and candled in order to determine the developmental stage of each embryo. Most were found to either have a dead embryo in very early developmental stage (N=11), or were infertile (N=5).

The average number of young successfully fledged per breeding attempt was 0.89 (± 0.8, 0-3, n=37). A total of 20 (40.8%) pairs fledged no young during the study; 15 pairs fledged one young, 6 pairs fledged 2 young, and 2 pairs fledged 3 young. Only 3 of the 10 1-egg clutches fledged successfully, 15 of the 2-egg clutches fledged at least one young, and five of the eight 3-egg clutches fledged young. It is of interest that pairs that laid only one egg had 30% breeding success as compared to 40% for 2-egg clutches, and 42% for 3-egg clutches.

Our findings are similar to Shagdarsuren (1964&1984) and Bold & Boldbaatar (1999) who found that clutch size varied from 1 to 3 eggs in Mongolia; and to Karyakin *et al.* (2003) who described the same average clutch size and fledglings in Russia.

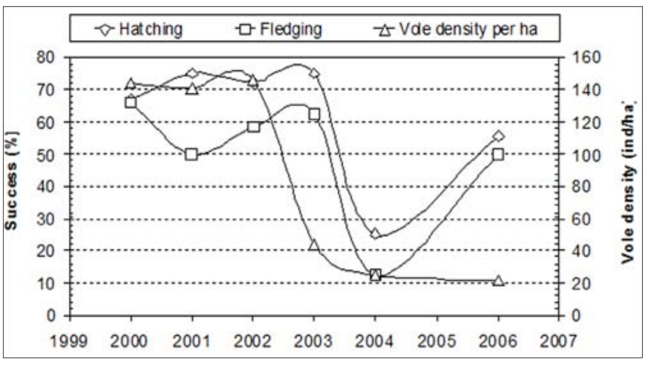
Nest Substrate, Hatching and Fledging Success

Average hatching success was 54.8% (±43.3, 0-100, n=45) and fledging success was 42.2% (±38.9, 0-100, n=45). Hatching success (65.1%±39, 0-100, n=4) and fledging success (50%±35.6, 0-100, n=4) for cliff nesters was comparatively high and we assume that it is due to the well sheltered location from inclement weather, fewer disturbances from nomadic herders, and is inaccessible to the steppe predators. In contrast, hatching success (37.5%±47.9, 0- 100, n=4) was always low for breeders on artificial substrates such as artificial nest platform, car tire, and abandoned car cabins. This is a result of disturbance to the nests in the proximity of busy roads, the smaller dimensions of the nest platform that limits nest size, and reduced prey abundance resulted in lower hatching success.

Hatching success was equal across the years (Kruskal-Wallis Test, H=6.0, p>0.4). We averaged Brandt's Vole numbers counted in the study areas and three randomly selected plots (for techniques see Batsaikhan *et al.* 2001, Avirmed 2003, 2005 and Munkbaatar & Munkbayar 2005).

Based on the estimation of Avirmed (2003), we found that vole density was 144 individuals per hectare (ind/ha) in 2000, 140.8 ind/ha in 2001, 145.8 ind/ha in 2002, 44 ind/ha in 2003, 24.8 ind/ha in 2004, 11.2 ind/ha in 2005 and 22 ind/ha in 2006. In the study area, the number of voles declined from 144/ha in 2000 to either 22/ha or 0 in some areas in 2006. We found that vole density significantly affected hatching (F=20.5, R^2=0.6, p=0.006) and fledging success (F=17.9, R^2=0.58, p=0.008) (Figure 4) across study years.

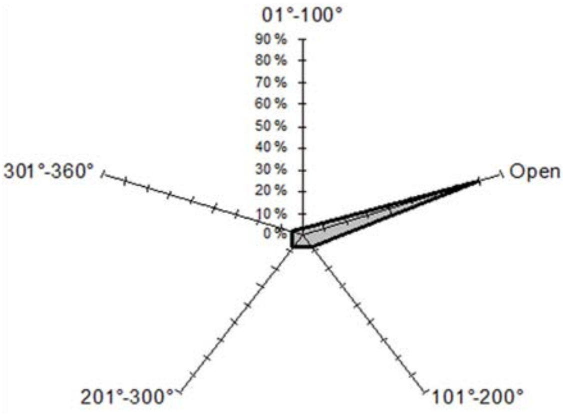
Figure 4. The affect of Steppe Eagle hatching success on Brandt's Vole (*Lasiopodomys brandti*) density



Nest Substrate and Bearing of Nests

Steppe Eagle in the Mongolian steppe prefers to build nests in areas of high vole density (Bold & Boldbaatar 1999, Gombobaatar *et al.* 2005). Bearing of nest locations was measured for each nest substrate. 79% of total observed nests were on top of rock columns and open ground with good visibility around the nest site (Fig. 5).

Figure 5. Bearing of Steppe Eagle nests on the steppes in Mongolia



The scarcity of trees, rocky columns or outcrops on the Mongolian steppes force most of the Steppe Eagle pairs to nest on the ground or on very low bushes. Also the low densities of predators, except Grey Wolf *Canis lupus,* allows for greater breeding success on the steppes. Also the very dispersed nature of the nomadic herders reduces disturbance to ground-nesting pairs, and it is possible that the ground nesters are phenotypically adapted for such behavior.

Nest height above ground level and altitude

Height of nests above surrounding areas was on average 2.28 m (± 4.7 SD, 0-25, n=38). All surveyed nests were located at an average altitude of 1415 m Above Sea Level (± 275.3 SD, 1100-2429, n=46). We found no relationship between height of nest and clutch ($F_{1,21}$=1.5; R=-0.2, p=0.2) or brood size ($F_{1,15}$=0.2; R^2=0.1, p=0.5).

Nest placement habitat, egg and nestling mortality

Egg and nestling mortality was a dependent on nest placement and the habitat surrounding the nest. Egg and nestling mortality were a result of desertion (N=11, 36.7%), infertile eggs (N=5, 16.7%), predation (N=2, 6.7%), starvation (N=3, 10%), cannibalism (N=1, 3.3%) and unknown reasons (N=8, 26.7%). The majority of these occured in ground-nesting pairs. The clutch desertion and egg and nestling mortality was most likely due to human or other mammalian predators. In May of 2003, we observed the desertion of a freshly hatched, and a day old sibling, following a short visit of several children to the nest. However, on one of our visits we observed that while both the parent eagles were hunting at a distance of ca. 300 m from the nest, a Raven flew to the nest and left carrying an egg in its beak.

Karyakin (2006) in Tuva found lower egg and nestling mortality in comparison to our study. This discrepancy can be explained by the location of the breeding territories of Steppe Eagle in Tuva which are in remote and inaccesibale areas; and wherein predation by Grey Wolf *Canis lupus* played a major role in nest falure. Minoranskii (1962) also reported that wolves and dogs were the main predators in his study.

We found that pairs that nested on the ground were mostly situated in areas with a high density of Brandt's Vole in the spring. In years with harsh winters vole survival was extremely low and resulted in cannibalism and siblicide in the ground nesting Steppe Eagle pairs. We observed a parent eagle eating its chick near the nest after the number of Brandt's vole crashed in the area. Bold & Boldbaatar (1999) have previously found that siblicide was common during periods of low food supply. However, during the same period, a comparatively low percentage of egg and nestling mortality was observed in pairs that nested in high and elevated substrates such as rock columns, cliffs, or pine trees that are elevated and look down upon the surrounding steppes.

Prey remains at the nest

We discovered that the Steppe Eagle are capable of capturing and bringing to the nest a wide range of steppe species. The majority of the prey were mammals that included remains of Siberian Marmot *(Marmota siberica*), Corsac Fox (*Vulpes corsac*), Tolai Hare (*Lepus tolai*), Brandt's Vole, Long-tailed Souslik (*Spermophilus undulatus*), Daurian Hedgehog (*Mesechinus dauuricus*), domestic goat (*Capra hircus*). Avian remains were of Skylark (*Alauda arvensis*), Hoopoe (*Upopa epops*), Mongolian Lark (*Melanocorypha mongolica*), and Rock dove (*Columba livia*).

In conclusion, we found that on the Mongolian steppes prey availability influenced reproductive success in Steppe Eagles, and in years with greater prey abundance a greater number of young were fledged. Increased prey density also influenced nest placement, and in areas of vole colonies eagles nested on the ground more frequently than in years of scarcity. During a season of prey population crash we observed cannibalism and siblicide.

Our study suggests that there may be a large floater population of Steppe Eagles on the Mongolian steppes. It appears that a stable population, with a high site fidelity, breeds on the rock outcrops that are scattered across the steppes and that overlook the surrounding areas. It may be that it is the floaters that attempt to breed on the ground during years of prey abundance.

The fact that fledging success was higher for rock-column nesters suggests that ground nesters may represent sporadic attempts of individuals unable to find suitable habitats and establish territories. Our inability to age the birds once they attain sexual maturity, which is assumed to be at 5 years of age, makes it difficult for us to understand if it is younger birds that attempt to be ground nesters. It is possible that the older and more experienced birds that have established territories and that show a high degree of fidelity to their rock-column nest sites, which are the epi-center of the hunting territory on the steppes, are the ones who are better established and have greater fledging success.

The above is also most probably true for pairs that try to place their nests on human artifacts abandoned on the steppes, or deserted old car cabin, roof of cattle shelters. These nest substrates are found mostly near areas with greater human activity, and thus greater disturbance potential for the breeding effort, resulting in a larger portion of the nests being abandoned and significantly lower fledging success.

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Хураангуй

Тарважи буюу хээрийн бүргэд нь манай орны нүүдлийн махчин шувуудын нэг бөгөөд ой, ойт хээр, өндөр уулсын салбар нуруud, хээрийн ялгаатай олон янз орчинд үүрлэнэ. Бид хээрийн бүргэдийн нийт 49 хосын үржлийн биологийг 1998-2007 онд судлав. Энэ зүйл бүргэдийн хосууд ялгаатай үүрлэх биет дээр үүрээ зассан бөгөөд 47.8% нь газар дээр, 32.6% нь гозгор хад чулуу, 8.7% нь хадан цохио, 2.2% нь мод, харин 8.7% нь хүний гараар бүтсэн биет (машины орхигдсон кабин, машины дугуй, хиймэл үүр) дээр үүрлэжээ. Үүрлэх биетийн сонголт нь хосуудын хувьд оноор ялгарахгүй байв. Өндөг болон нисгэл ангаахайн тоо нь үүрлэх биетийн хэлбэрээс үл хамаарна. Газар дээр үүрлэж буй хосуудын үндсэн идэш тэжээл нь үлийн цагаан оготно (*Lasiopodomys brandti)* байв. Үржлийн хосууд үлийн цагаан оготны идэвхтэй, өндөр нягтшилтай колони доторх нам уулсын хажуу болон орой хэсгийн 20-30 см өндөр бүхий борсгор чулуу, үхэр хадны оройд үүрээ засна. 2002 онд барьсан 100 ширхэг хиймэл үүрний зөвхөн нэгд нь энэ зүйл бүргэд үүрлэсэн. Өндөгний дундаж тоо 1.9 (±0.6 стандарт хазайлт, 1- 3, n=43) ба нисгэл ангаахайн дундаж тоо нь 0.89 (±0.8, 0-3, n=37) байв. Судалгаанд хамрагдсан бүхий л үүр далайн төвшнөөс дээш 1,100 - 2,500 м өндөрт байршсан. Үүр байрласан биетийн далайн төвшнөөс дээших өндөр, газраас дээш үүр байрласан биетийн өндөр, үүрний гүн, өндөр, гадаад болон дотоод голдоч нь энэ зүйл бүргэдийн өндөг болон нисгэл ангаахайн тоонд нөлөөлөхгүй.

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SOURCE-SINK POPULATIONS OF THE STELLER'S SEA-EAGLES (*Haliaetus pelagicus*) IN THE NORTHERN PART OF THE SEA OF OKHOTSK: ECOLOGICAL TRAPS AND THEIR CONSERVATION IMPLICATIONS

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Abstract: For the past 18 years, we have monitored the numbers and breeding output of the Steller's Sea-eagles in Magadan District and the adjoining administrative territories. Every year, we checked 20–133 territories in constant 'model' study areas located near Magadan, amassing data from a total of 1,130 potential breeding attempts, 490 at home ranges which produced eggs (at least) in most years. The majority of eagle nests were found along the sea coasts (70%), the rest along rivers. The eagles breed more successfully along the sea coast than on the rivers, suggesting the existence of source-sink population dynamics. The total number of chicks fledged per successful pair was more or less stable across the years, with lower values along the rivers. The net chick output from all constantly monitored areas showed a statistically insignificant increase in the coastal environment, while on the rivers chick output declined significantly. We documented zero breeding success in the Kava- Chelomdja portion of the Magadan Reserve and along the upper stretch of the Tauy River in 2009. In view of these long-term data it appears that the breeders along the rivers are a 'sink', as they continuously produce fewer offspring than needed to maintain a constant population level. In contrast, the sea coast territories are a 'source' population, producing more chicks than necessary for population stability. Satellite tracking of young eagles revealed presence of naturally occurring ecological traps along the migration routes. These traps were areas of the fish-rich rivers which remained open while other sections of the rivers and the sea froze over as winter progressed. The eagles that stayed too long in these places were eventually unable to feed themselves due to diminishing food availability and were cut off from the wintering grounds by the frozen sea, and died. Conservation implications of these findings are discussed.

Key words: *Steller's Sea-eagle, Sea of Okhotsk, ecological traps, source-sink, satellite telemetry, population dynamics.*

Introduction

The Steller's Sea-eagle (Steller's Sea Eagle) *Haliaetus pelagicus*, as one of few true endemics of the Russian Federation, enjoys a state and international protection status. It is listed in the Red Data Book of the Russian Federation and Appendix II of CITES. Its range is limited to a narrow strip along the coast of the Sea of Okhotsk and of Kamchatka. Nests in coastal territories are on trees and cliffs, while riverine nests are exclusively on trees (Potapov *et al*. 2000a, Lobkov 1986). Relatively small population size and limited breeding range mean that Steller's Sea Eagle is potentially vulnerable. The human population within the breeding range concentrates near the major rivers and in many cases these are places where intensive salmon fishing occurs. This situation poses a risk to this species in the form of potential persecution and long-term reduction in food availability.

Methods and Materials

We carried out annual surveys along the sea shore and rivers of the Magadan District on foot, using a motor-boat (and image stabilizing binoculars) and from a micro-light aircraft (Utekhina 1995). We determined whether territories were occupied and whenever possible determined the number of chicks produced. The latter usually involved climbing into nests. Every year, we surveyed breeding eagles within the Kava-Chelomdja and Koni Peninsula portions of the Magadan State Reserve. When possible, we extended the surveys to areas surrounding these model areas. As a result, we checked 20 - 133 territories per year near Magadan. Areas surveyed in most years included the Tauy River, Motykley Bay and the coastline adjoining it and Odyan Bay (for a detailed description of the study area see Potapov *et al.* 2000b).

Satellite telemetry was used on 22 nestling and one adult eagles using Toyocom (Toyocom Inc. Japan), North Star (Maryland, USA) and Microwave (Maryland, USA) Doppler PTTs (Platform Terminal Transmitters) (n=17) and Microwave GPS PTTs (n=6). All transmitters were fitted as backpacks using Teflon ribbon (Bally Ribbon Mills, USA). Some results of the satellite telemetry have been published earlier (McGrady et al. 2000 and 2003). Import of both GPS and Doppler fixes and subsequent processing were carried out within ArcGIS 9.2 (Redlands, CA, USA) using the Argos-tools extension (Potapov and Dubinin 2003, Potapov and Hronusov 2005). The tracks of eagle movements were overlaid with ice data provided as shape files by the National Ice Center, NOAA (http://natice.noaa.gov).

Results

Since 1991, we have recorded occupancy and productivity from 1,130 potential breeding attempts, including data from 490 attempts at territories that were occupied in most years and usually produced eggs.

In the northern part of the Sea of Okhotsk, the majority of eagle nests were found along the sea coasts (70%), while the rest were along rivers. Eagle breeding rate was higher for coastal territories than for those on rivers, F=9.04, $p<0.01$ (Figure 1) and coastal eagles had larger broods (Figure 2).

Figure 1. Average number of chicks fledged per successful pair on the sea coasts and rivers of Magadan District, Russia

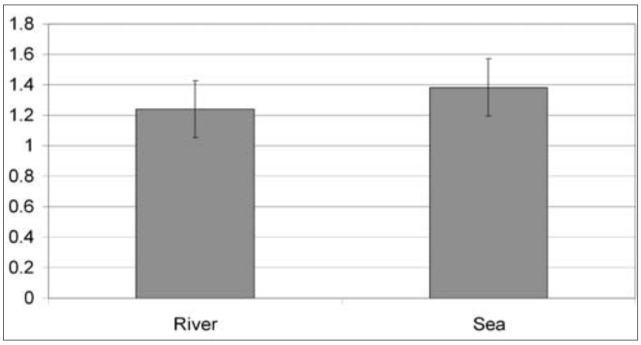
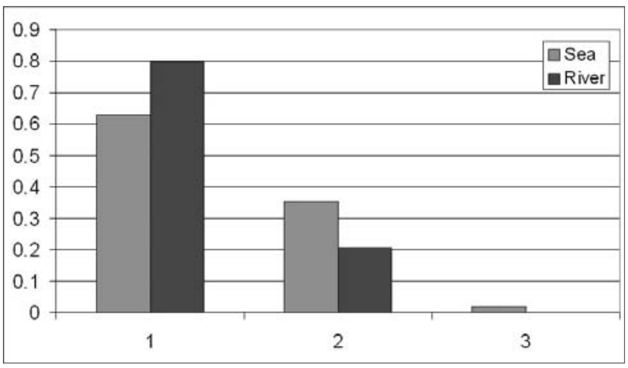
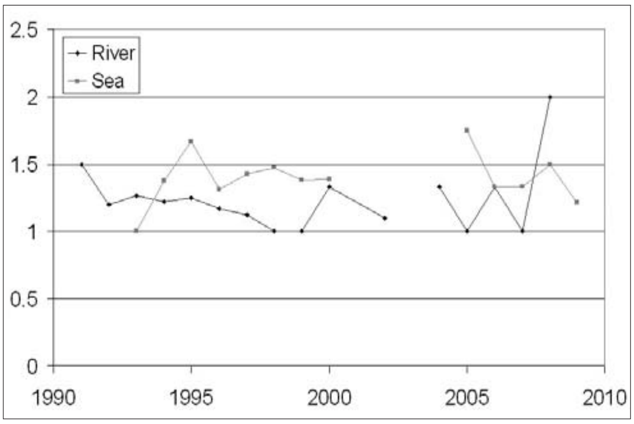


Figure 2. Brood size distribution for rivers and the sea coast in Magadan District, Russia



The total number of chicks fledged per successful pair was more or less stable across the years, with lower values being recorded for pairs nesting on rivers (Figure 3).

Figure 3. Number of fledglings per successful pair at coastal and riverine nests in Magadan District, Russia.
In 2008 there was a single successful nest along the rivers (in the Kava-Chelomdja portion of the Magadan Reserve) and it produced two fledglings.



The percentage of pairs that attempted to breed was lower on rivers than along the coast area (Figure 4) and consequently the number of chicks fledged on rivers was lower than on the coast (Figure 5). The percentage of territory holding eagles that attempted to breed declined significantly over time on the rivers ($y = -2.4817x + 57.356$, $R^2 = 0.4652$, F=9.7, $p<0.01$); the percentage of breeders on the sea coast also declined, but that decline was not significant.

Figure 4. Percent of territorial pairs that attempted to breed on the coast and along rivers

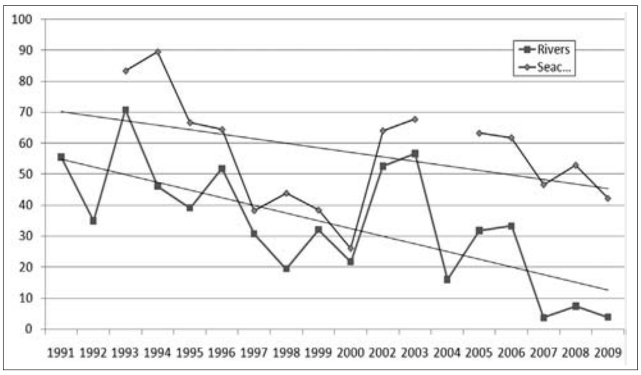
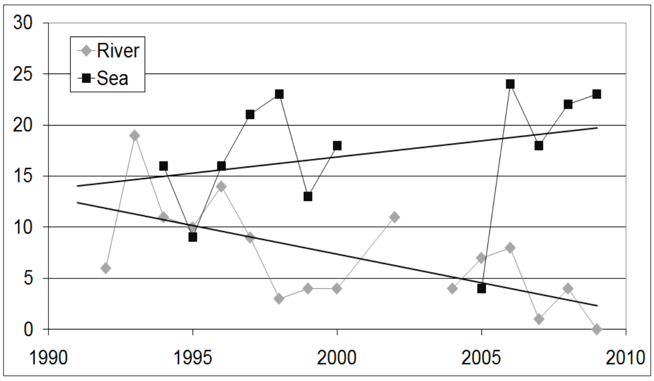


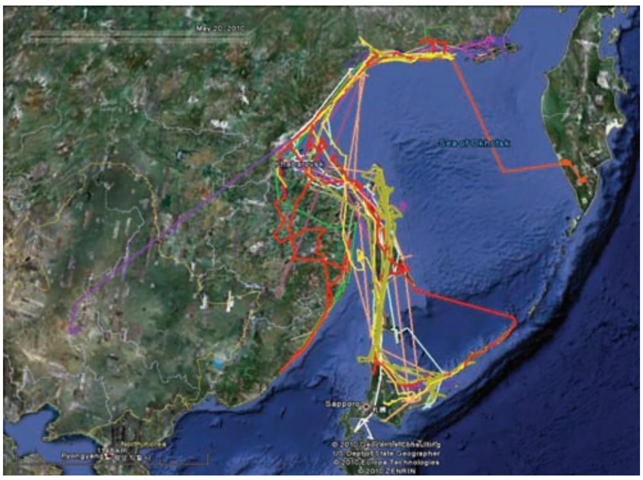
Figure 5. Total number of young fledged along the rivers and sea coast



Net annual chick production from all constantly monitored areas (Figure 5) showed an increase (not significant) in the coastal environment, while on the rivers chick output declined significantly ($F=9.08$ $p<0.01$). In 2009, no successful breeding occurred in the Kava-Chelomdja portion of the Magadan Reserve (river) or along the upper stretch of the Tauy River, although most territories were occupied and nests were refurbished.

The migration routes of satellite-tracked eagles are shown in Figure 6. Most eagles migrated through or spent their winters on Sakhalin Island, the continental coasts of the Tatar Strait, Hokkaido and the Kuril Islands. Migration was mostly along the coast, but the routes of some birds included some inland stretches.

Figure 6. Tracks of the one adult and 22 young Steller's Sea Eagles



We lost contact with instrumented birds when they either died from apparently natural causes or when to batteries expired. Some eagles died from human-related causes. For some eagles, we were able to determine the cause of death (Table 1).

Table1. Causes of transmitter losses

Causes	Number
Bear predation	1
Wire collision	1
"Natural traps"	3
Shot	6
Natural causes or expected battery depletion	10

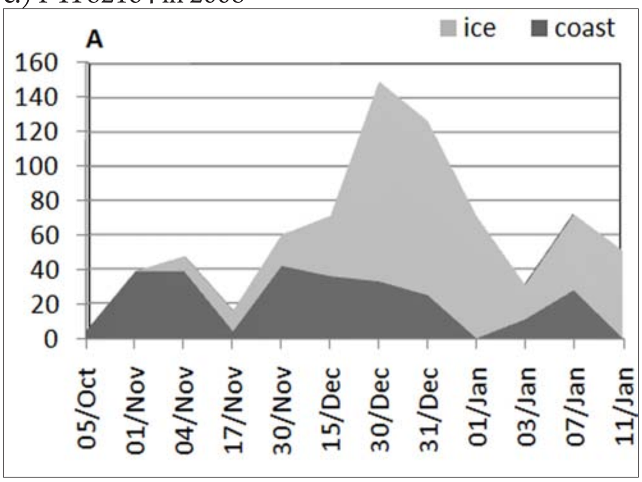
In one case a bear climbed into the nest prior to the eaglets fledging, removed a chick with a transmitter and possibly wounded its sibling. One bird lost its way during migration and ended up in inland China, where it collided with an electric wire. An alarming total of 6 birds are believed to be have been shot, as the last transmitted fixes were close to settlements. We are confident that at least two birds in Magadan District (one in Motykley Bay another at Yana river fishing camp) were shot since we recovered one transmitter which had been cut from the eagle and discarded, and the other was carefully moved from the fishing camp and placed in a remote valley in January. Transmittered eagles were shot near Fedorovskoye (2) and Chumikan villages (2) in the Khabarovsk Administration District. At Fedorovskoye an eagle died in 1998 and later a transmission was detected in the open sea, suggesting the PTT was on a boat. Another GPS PTT was placed at a cliff near a settlement. Birds killed in the Chumikan area were shot at a fishing camp some 15 km NW, and later placed at a lighthouse near the village. One PTT sent a signal from an oil platform off the Sakhalin coast some months after its signal being initially lost.

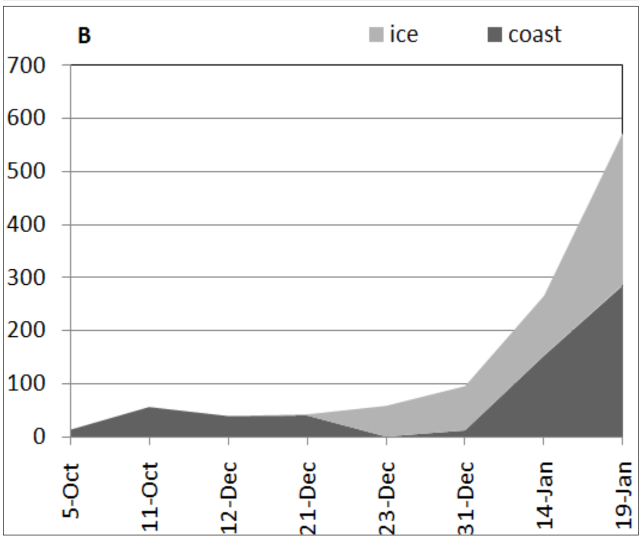
Three birds were apparently lost when they stopped over on a river where salmon were migrating and where the river does not freeze over until late winter due to hot springs, much later than most rivers in the region. When this river did freeze over and food became unavailable the eagles moved to the coast in an apparent attempt to continue their migration. However, by the time this happened the sea was also frozen and the eagles were trapped. The three eagles showed different responses to their predicaments: one flew back to its natal grounds and died in January, another flew south along the shore, and died in late December (probably starvation), and the third flew inland, presumably in search of food, and died in the mountains on 14 January. In all three cases when the eagles left the river area and moved to the shore there was at least 10-20 km of sea ice already formed (Figure 7 and 8). All birds which migrated before the formation of sea ice made it to the wintering grounds, unless they were shot.

Discussion

We attribute the decline in productivity of the river-breeding part of the population to the increase in the frequency, duration or intensity of spring floods, which in some years lasted until the end of July. High river levels and murky waters caused by the floods prevented eagles from hunting efficiently (even though we do not think overall abundance of food declined). In 2009, the snow accumulation in the coastal zone of the Magadan/ Khabarovsk Districts reached unprecedented levels. Official figures (Bulygina *et al.* 2010) showed a +200 cm anomaly in the region contrasted with negative anomalies in the European parts of the country. Given the documented marked increase in the snow depths in eastern part of Siberia since 1966 (Bulygina *et al.* 2009) as a result of global warming (Bulygina *et al.* 2009 and 2010), we predict that the increased snow depth in winter will cause more frequent spring flooding, which might disrupt the breeding of Steller's Sea Eagles, and may also affect the spawning conditions of the Pacific salmon on the rivers of the region.

Figure 7. Distance (km) from the instrumented birds to the coast and from the coast to open water in autumn and winter. a.) PTT42680 in 2007, b.) PTT82512 in 1998, and c.) PTT82164 in 2008





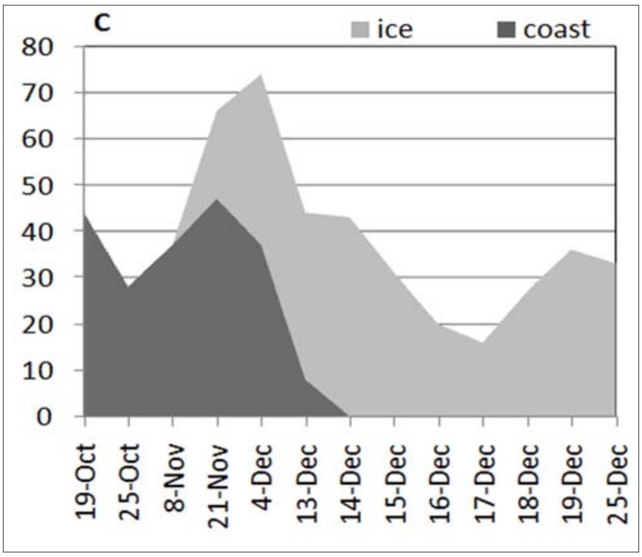


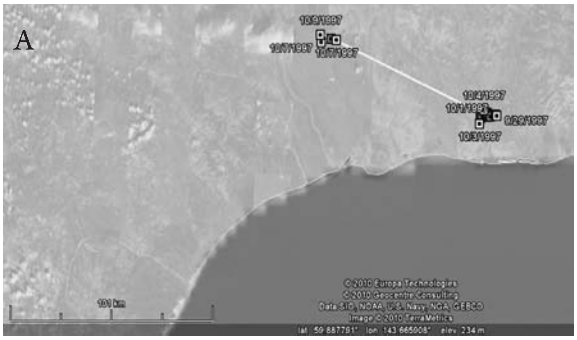
Figure 8. Movements of eagle 82512 as it stops over on the Okhta and Kukhtuy Rivers, flies to the coast after sea ice formation and flies back inland

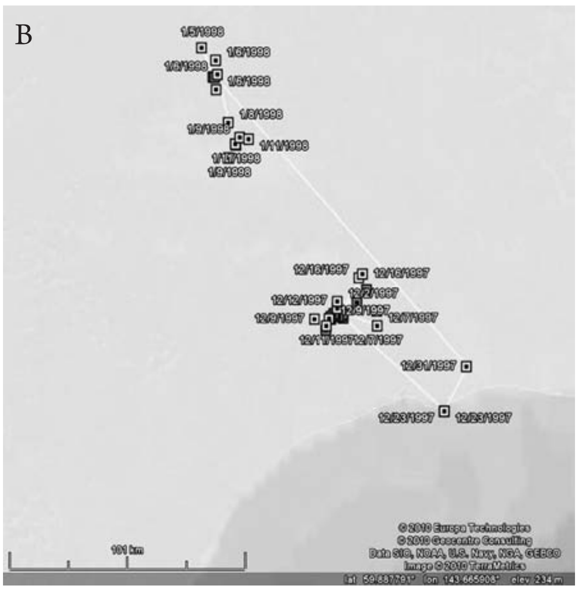
A. September – October, bird disperses from the Ulbeya River to Kukhtuy River.

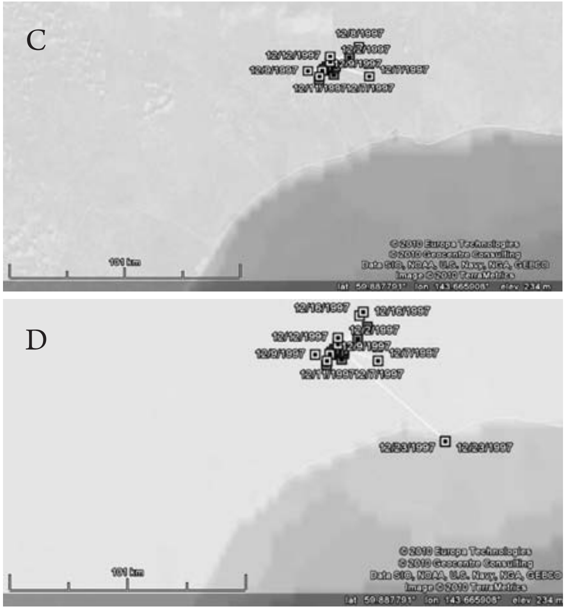
B. October-November, bird stays at the Okhota and Kukhtuy Rivers. Ice starts to form at the coastline.

C. 23 December: bird moves to the shore (as river ice and snow cover increase) only to encounter a 58 km strip of coastal sea ice.

D. Bird flies inland and settles in mountains where it dies on 14 January).







Most surprising is the suggestion of a link between increasing snow deposition trends in North-Eastern Siberia and spring flooding on the rivers where Steller's Sea Eagles breed and the resulting poor productivity that results from such flooding. If flooding becomes more common, the riverine part of the population will contribute less and less in terms of breeding output, which might affect the vulnerability of the species.

Romanov and Masterov (2008) showed that because Steller's Sea Eagle must survive for many years before reaching a reproductive age (5 years) and because of their low breeding rate, the overall population balance is exceptionally fragile. Even with the adult survival rate of 0.95, small decrease in the breeding rate to 0.42 individuals per pair might reduce numbers by half in <50 yrs. If the model suggested by Romanov and Masterov (2008) is applied to our data, it turns out that the population that breeds along the sea is just about at the break-even point, meaning slight population increase. However, the low productivity of the eagles which we observed on the rivers pushes the overall population growth coefficient down, so overall balance of the population is negative, which, in turn suggests the population shrinkage according to the Moffat's principle (Hunt 1998).

In the view of this long-term data set it appears that the breeders along the rivers currently comprise a 'sink' population, as they continuously produce fewer offspring than needed to maintain a constant population level. In contrast, the sea coast territories are a 'source' population, producing more chicks than necessary for population stability. This conclusion provides solid evidence for the hypothesis first expressed by Lobkov and Zuyeva (1983), which stated that the inland territories are more susceptible to the impacts of natural variation in environmental conditions, such as deep snow cover and floods which affected the breeding performance of the eagles. This hypothesis was formulated based on a relatively limited dataset from Kamchatka, which covered predominantly inland eagles. The wide spread breeding of the Steller's Sea Eagles at the Magadan sea coast suggests that the sea offers more stable conditions for eagle breeding. If this is indeed the case, then a decline in numbers of occupied territories in the 'sink' area may potentially mean that the eagles are not doing well in the (more extensive) 'source' part of the population. Therefore, monitoring occupancy of the river portions of the population may provide an early warning system for the population as a whole.

Satellite telemetry revealed several areas where migrating Steller's Sea Eagles are illegally shot. The remoteness of these places makes it difficult to enforce any protection and since fishing will continue there it is likely that this problem will persist for some time.

Satellite tracking also demonstrated the existence of apparent "ecological traps" where eagles settle at a site of plentiful food only to be trapped later when food supplies are reduced and sea ice hinders feeding and migration.

The idea of ecological traps has been recently discussed in detail (Battin 2004). Most typically ecological traps are defined as low quality habitats that animals prefer over high-quality habitats (Dwernychuk and Boag 1972), and the majority so far identified are related to human activity (Battin 2004). In our study we found evidence of another sort of ecological trap, one in which temporally good quality habitat (high availability of food) is surrounded by areas of habitat of rapidly deteriorating quality (which blocks migration to the wintering grounds and access to more local feeding areas). Other existing ecological traps similar to the one at the Okhota River elsewhere remain unclear.

The existence of natural ecological traps is not totally surprising, but that the one that we identified has trapped such a large proportion (3 of 23) of the birds we tracked is. Lack of infrastructure in such a location makes it difficult to assess the feasibility of undertaking conservation action aimed at ameliorating this problem. Theoretically the problem might be solved by organising a feeding station at the Okhota river, but lack of an active human population and the remoteness of the region makes this an extremely difficult task.

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Хураангуй

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ECOLOGY & CONSERVATION OF THE GREY-HEADED FISH-EAGLE (*Ichthyophaga ichthyaetus*) AT PREK TOAL, TONLE SAP LAKE, CAMBODIA

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Abstract: The Grey-headed Fish-eagle (*Ichthyophaga ichthyaetus*) is a poorly-studied raptor ranging from north east India, down the Thai-Malay Peninsula, to Indonesia. The species is in apparent population decline and until recently, virtually nothing was known of its specific ecological requirements in any part of its range. In 2005 we discovered a high-density breeding population at Prek Toal, part of the seasonally flooded swamp forest surrounding Tonle Sap Lake in Cambodia. We suggest this is a regionally significant population, after reported declines in neighbouring Thailand, Vietnam, Laos PDR, Myanmar and Malaysia. We have undertaken research on the species' breeding and foraging ecology over the last five years, demonstrating that this fish eagle population requires relatively tall nest trees with an open-canopy structure, situated close to permanent water (as opposed to the seasonal temporary water that recedes from the forest during the eagles' breeding season). This population is partially reliant on water snakes, as well as fish. We have identified two main threats to this population's stability: (a) the unsustainable mass harvesting of water snakes - an estimated 6.9 million snakes are removed from the swamp forest each year for human consumption, food for thousands of captive crocodile farms around the lake, and for the illegal medicinal trade in Southeast Asia; and (b) the development of large hydropower dams in the upstream reaches of the Mekong River in China, Laos, Thailand and Cambodia, which not only have the potential to cause significant changes to the seasonal flood regime, affecting the productivity of the Tonle Sap ecosystem, but also the potential to deposit large quantities of mercury into this important wetland area. Our on-going studies include colour-banding juveniles, mercury sampling, and rapid assessment surveys for fish eagles in other parts of this vast swamp forest. We also continue to provide training and support for local field staff.

Key words: *Grey-headed Fish-eagle; Ichthyophaga ichthyaetus; Tonle Sap Lake; Cambodia; monitoring; water snake; hydropower dam*

Introductioin

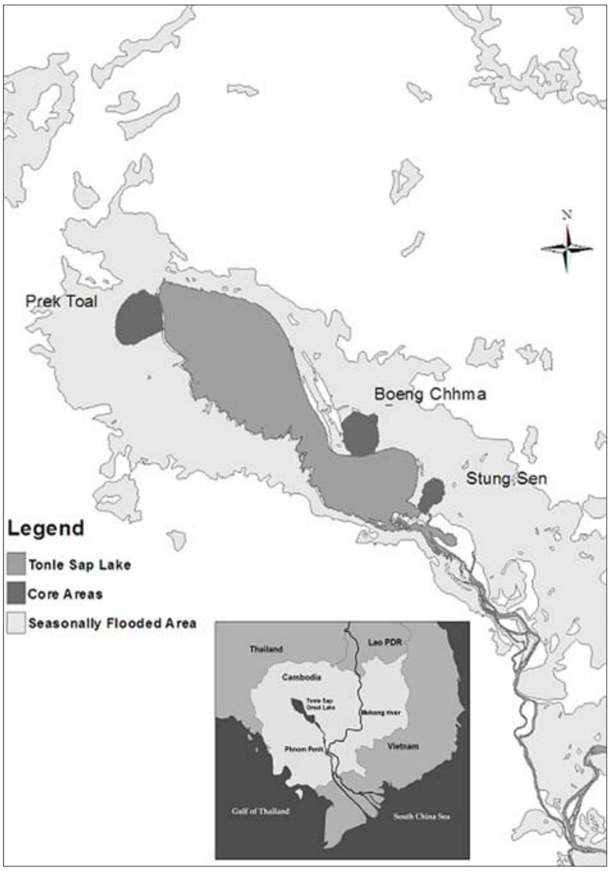
Little is known about the ecology of the Grey-headed Fish-eagle (GHFE) (*Ichthyophaga ichthyaetus*) despite it being a formerly widespread species throughout Indo-Malaya (Ferguson-Lees and Christie 2001), in apparent decline (Samant *et al.* 1995, Grimmett *et al.* 1998), with a conservation status of globally near-threatened (IUCN 2010). Several researchers have suggested that causes of population decline may include deforestation, pesticides, and anthropogenic disturbance (BirdLife International 2001, Baral and Inskipp 2004), but this is speculation mostly based on anecdotal sources. However, if the apparent population decline is to be addressed through effective conservation planning, it is essential that conservation decisions are based on a thorough understanding of the species' ecological requirements.

In 2005 we discovered a high-density GHFE breeding population in the Prek Toal Core Area of Tonle Sap Lake, Cambodia. We have since undertaken annual monitoring surveys and gathered quantitative ecological data on this poorly-understood species. In addition, we have provided training and support for local biologists and government conservation rangers. This paper provides an overview of our research findings to date, and reports on our continuing studies.

Methods and Materials

Study site. The Tonle Sap Lake (12° 25' to 13° 25' N; 103° 25' to 104° 40' E; Fig. 1) covers 2500 km^2 in the dry season (January to May), expanding to 12 000 km^2 during the wet season (June to October; Rundel 2000; Figure1).

Figure 1. Location of the three Core Areas on Tonle Sap Lake, Cambodia, and the extent of the seasonal floodwater.



The Tonle Sap River connects the Tonle Sap Lake to the Mekong River, making the lake a highly productive wetland ecosystem (Campbell *et al.* 2006) that supports one of the largest freshwater fisheries in the world (Hortle *et al.* 2004). The dominant floodplain habitat is described as freshwater swamp forest and is characterized by the seasonality of the flooding, as opposed to the permanent flooding of the classic swamp forest of Southeast Asia (Rundel 2000). This unique ecosystem forms a large vegetation belt 7 – 40 km wide surrounding the open water surface and is estimated to cover approximately 3600 km^2 (Rundel 2000). It is adapted to withstand seasonal water-level variation of up to 10 m and is of relatively simple floristic composition, comprising three main vegetation types: short-tree scrublands, gallery forest, and aquatic herbaceous vegetation (Campbell *et al.* 2006). The Tonle Sap Lake contains three designated core protected areas: Prek Toal (21 342 ha), Boeng Chhma (14 560ha) and Stung Sen (6355 ha). The Prek Toal Core Area (13° 07' N, 103° 39' E), where our study is based, is situated at the northwestern end of Tonle Sap and is considered one of the most intact areas of swamp-gallery forest around the lake (Chan *et al.* 2004). Prek Toal supports large waterbird colonies, discovered in the mid-1990s, which are of global conservation significance (Clements *et al.* 2007).

Data Collection. Boat surveys for GHFE were conducted annually from 2005 - 2009 between 1 October and 31 December. Data were collected on distribution, foraging ecology, breeding phenology, nest-site characteristics and prey availability (see Tingay *et al*. 2006, Tingay *et al.* 2010 for details of methods).

Results

GHFE at Prek Toal feed on fish and at least four species of watersnake (Tingay *et al.* 2006).

During our study period, between 60 - 80 GHFE nests were occupied annually; most positioned within the Prek Toal Core Area but some located outside of Prek Toal within a few km of the boundary. GHFE nests were more likely to be found in relatively tall trees with an open crown structure, and close to permanent water such as main river channels, as opposed to the temporary flooded forest. We attribute this to potentially greater prey availability in the permanent water (Tingay *et al.* 2010).

The GHFE breeding season coincided with the peak of the floodwater (Oct/Nov/Dec) although there was a large variation in GHFE breeding phenology, as some nests in mid-December contained ~6 wk old chicks (therefore egg-laying occurred in late Sept/early Oct) whereas neighbouring nests contained freshly-laid eggs. There was apparently no difference in timing of breeding according to distance to permanent water (Tingay *et al.* 2010).

Measuring GHFE productivity (as the number of successfully-fledged chicks) is difficult to achieve at Prek Toal due to reduced site access once the floodwaters begin to recede from mid-December onwards. During our fieldwork, we have only observed five individual juveniles, all of which were soaring high above the study area and not obviously associated with a particular nest site.

Discussion

We propose that the Prek Toal GHFE population is regionally significant (Tingay *et al.* 2010), considering the reported GHFE declines in neighboring Thailand, Malaysia, Myanmar, Laos and Vietnam (Wells 1999, Robson 2000, Fuchs *et al.* 2007). This population is at least partly dependent on water snakes as prey and may be threatened by the unsustainable mass-harvesting of water snakes by the local human population (Tingay *et al.* 2006), because an estimated 6.9 million snakes are removed annually from the lake for human and captive-crocodile consumption, as well as for the medicinal wildlife trade in Southeast Asia (Brooks *et al.* 2007). GHFE at Prek Toal may also be threatened by the upstream construction of hydro-power dams in China, Laos, Thailand and Cambodia (Tingay *et al.* 2010) which have the potential to alter drastically the Tonle Sap Lake flood cycle (Kummu and Sarkkula 2008).

As hydro-power dams can increase the amount of mercury absorbed by fish due to the flooding of dry soils (Morrison and Therien 1995), and mercury contamination is a well-documented problem for other fish eagle species (e.g. Jagoe *et al.* 2002), our on-going studies include tissue sampling of GHFE and their prey (fish and watersnakes) at Prek Toal to assess dietary exposure to mercury and to assess whether mercury contamination is affecting GHFE productivity, which may explain the relative absence of juvenile GHFE in the study area.

Alternatively, due to the high-density of breeding GHFE at Prek Toal, juveniles may be dispersing to other areas of the Tonle Sap Lake to use as a pre-breeding 'nursery' area, so our on-going studies also include colour-banding of GHFE nestlings at Prek Toal, and surveys for GHFE in other parts of the swamp forest surrounding the lake, particularly in areas that are not currently afforded 'protected' status.

We have been invited by the government's Ministry of Environment to submit a GHFE monitoring protocol that can be incorporated into the wider biodiversity conservation strategy at Tonle Sap Lake. In addition, we have provided practical training workshops on basic avian survey and monitoring techniques for the government's conservation rangers. In 2007, the local field biologist at Prek Toal completed a four-month conservation science internship at Hawk Mountain Sanctuary, USA, and we supported his attendance at the 2008 ARRCN conference in Vietnam. He now coordinates the annual GHFE monitoring surveys at Prek Toal.

Acknowledgements

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ANALYSIS OF LOCATION DATA FOR CONSERVATION OF RAPTORS

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Abstract: Raptors face many threats in the environment, many of which are very obvious. However, the effects of habitat change can be difficult to quantify unless the true nature of a species habitat-use is known. Radio-tracking can supply less biased results than visual tagging and surveys because the raptors can be found at all times; not just when the birds are at in their nest or soaring in plain sight. However, whilst these benefits have been appreciated, the analysis of radio-tracking data is often severely limited or incorrect. Here we use radio-tracking data from Common Buzzards (*Buteo buteo*) to investigate habitat use as an example to highlight problems and provide solutions for widespread errors, such as: insufficiency and misuse of sample size, the efficient collection of data using incremental analysis, how the distribution of locations within the home range can be used to choose a core area of activity more objectively, and compositional habitat analysis. The buzzard data showed how transformations were needed to properly establish the difference in home range sizes between juveniles and first year birds. A scaled approach to what buzzards were using and what was available then demonstrated how the meadow was selected in the core of the range whilst arable land and coniferous woodland was more common in the surrounding area; thus buzzards were selecting meadow habitats.

Key words: *Common Buzzard, Buteo buteo, radio-tracking, location, habitat analysis*

Introduction

Many species of raptors are threatened throughout the world and require conservation. Some threats are direct and obvious, e.g. collisions with vehicles and wires, electrocution, drowning, poisoning, killing by those wishing to protect livestock etc., whereas others are far more subtle, such as contaminants leading to egg-shell thinning or the lack of suitable nesting sites. One of the more difficult and complex threats to study is the ever changing environment. Whilst sometimes the loss of resources is clear, at other times it is less easy to work out what is wrong. For example some raptors are happy to live in an urban environment, so it is not always as simple as the loss of original habitat. Land use will keep changing, so to conserve raptor populations it is important to establish what is critical to their survival and productivity.

Radio-tracking provides a way of collecting information about habitat requirements with less bias than traditional sighting methods because it allows researchers to find individuals at any time, not just when birds display or when visibility allows. Because of this advantage, radio-tracking has become well established over the last 30 years and data analysis has developed with it (for important reviews see Harris *et al.,* 1990, Kenward, 1987, 2001, Millspaugh & Marzluff, 2001, White & Garrot, 1990). Unfortunately, whilst radio-tracking is a powerful tool, many researchers present articles with fundamental mistakes that diminish the prospects of useful publications and, more importantly, can result in wrong decisions for conservation.

This paper aims to highlight some of the most common mistakes made in project design and analysis. For illustrative purposes, data collected from radio-tracking the Common Buzzard, *Buteo buteo*, in southern England are used. We have specifically avoided any biological interpretation of the data to avoid confusion with the main aim of discussing problems and possible solutions of collecting and analyzing radio-tracking data, whilst biological interpretations can be found in other publications from the same project. A recent review by

Lõhmus (2004) pointed out that of 896 papers on raptor habitat studies, 90% were in North America or Europe. The principles we highlight are just as relevant in Asia where landuse is changing faster and raptors may be more threatened.

Methods and Materials

Data Collection

We radio-tagged buzzards from nests within a 5 km x 21 km strip, south-east Dorset, England. This area contained mixed habitats of approximately 45% grassland, 24% woodland, 13% arable land, and 10% heathland. The remaining 8% comprised small areas of marsh, quarries and buildings. During 1990 – 1994 we fitted juvenile buzzards with 30-g backpack radio-tags (Biotrack Ltd., 52 Furzebrook Rd., Wareham, Dorset, BH20 5AX, UK) while the juveniles were still in the nest (Kenward *et al.* 2001a). The tags lasted for up to 4 years, so comparisons between age classes were possible.

We tracked the buzzards during late October and early November, during which time they were settled after their late summer dispersal (Walls and Kenward, 1998). For the analysis in this poster we only used data from 1994, because this was when the largest number of buzzards (n = 28) were tracked within a month, i.e. under the same conditions (weather, nest density etc.) so that seasonal and annual variation were constant. Buzzard locations were recorded by triangulation of bearings taken from within 1 km of a buzzard, providing a position to within 100 m. We used a Landrover fitted with a 6-m telescopic mast (Clark Masts, 20 Ringwood Rd., Binstead, Isle of Wight, PO33 3NX, U.K.) with a 5-element Yagi antenna connected to a receiver (Advanced Telemetry Systems Inc., 470 First Ave. Box 398, Isanti, MN 55040, USA) to conduct the work.

Habitat information came from the Land Cover Map of Great Britain, developed by supervised likelihood classifications of combined winter and summer Landsat Thematic Mapper scenes imaged in November 1989 and July 1990 (Fuller et al. 1994 a, b). This map provided us with 25 x 25 m rasters of 25 habitat types that we grouped into 15 major classes (Walls *et al,*. 1999).

Sample Size

The most common and fundamental mistake that researchers make when designing and analyzing radio-tracking studies is thinking that the sample size is related to the number of locations. It is not. The sample size is the number of individuals you have tracked. Locations from the same individual are pseudo-replicates because individual raptors within the same species have varied behaviours and so may use habitats differently, thus all the locations from an individual are not statistically independent. You may track one individual for hundreds of locations and find that it always sticks to pasture rather than going onto nearby arable fields, but others in the population may always use arable fields. Likewise, the large sexual dimorphism in many raptors may lead to the different sexes exploiting different resources. To conserve a population, you must know about that population; thus sufficient samples from that population are very important.

In this poster we analyse only 10 juvenile and 9 yearling buzzards, so our total sample size is 19. Often very large sample sizes of raptors are impractical within the resources available to researchers, so this poster is designed to demonstrate that even with such small samples, statistically significant and interesting results can be achieved. Where possible larger sample sizes should be collected and in other publications from the same project we have combined data from several years and had samples of over 100 (Kenward *et al.,* 2001b, Walls *et al.* 1999, Walls & Kenward, 2001). It is far better to know what real information can be gained from a small sample size than pool data from different individuals and end up with false confidence in the results.

KEY ISSUE: Sample size is the number of individuals you track.

Number of Locations and Efficient Collection.

As the sample size is the number of individuals, continuous tracking of individuals will only accumulate samples slowly. If possible, it is much better to track several birds simultaneously by recording locations of each individual intermittently. This may mean that you only take 1 – 5 locations a day, but this is not a problem for most home range analyses and also avoids potential problems of autocorrelation. Autocorrelation is the degree of spatio-temporal dependence of locations. Data are considered too autocorrelated if animals have not had enough time to move between recorded locations, or the animal keeps returning to the same places (time-tabling), or the animal does not move. If data are too correlated, the lack of dependence between locations breaks the assumption of independence of probabilistic home range models (Dunn & Gipson, 1977), and, just as importantly, will not give a true representation of all the places an animal uses in its normal activities. Swihart & Slade (1985) were the first to provide a way of objectively testing for autocorrelation. Their method calculates a time to independence (TTI). Therefore continuous tracking of a few birds in the pilot project can usefully be run though autocorrelation analyses, so that the minimum interval between consecutive locations (TTI) on the same animal can be estimated. However, after that initial phase, it is inefficient to track continuously when trying to record home ranges for habitat analysis, although continuous tracking may be essential for other studies, *e.g.* activity budgets.

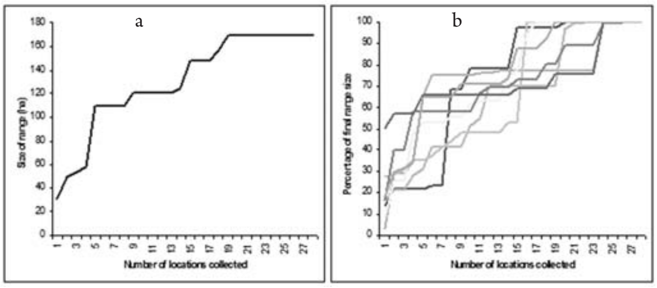
KEY ISSUE: Track many individuals simultaneously to increase sample size and avoid autocorrelation.

If you track several individuals simultaneously you may not be able to get around all your tagged individuals, e.g. the distances may be too time-consuming. Therefore it is important to know when you have collected enough information so that you can move on and record another set of birds. For example, in 1994 we had a total of 28 marked birds, but could only manage a maximum of 16 at a time. Incremental analysis can be used to evaluate when sufficient locations have been collected.

Incremental analysis plots the increase in range size against the number of locations collected (Figure 1).

Figure 1. a) Incremental analysis of one buzzard showing that collecting more than 20 locations did not increase the home ranges size

b) Incremental analysis of 8 ranges showing how many ranges had reached their maximum by 30 locations



Initially each new location adds to the size of the range, but when locations occur within the bounds of those already collected, no increase is seen. Therefore the graph initially rises quickly, but if animals are settled (not drifting or dispersing) eventually it asymptotes, at which point collecting additional locations will not alter the range size significantly. At this stage there is no need to collect more information on that individual. It is better to increase the sample size and move onto new birds. In some cases more locations can improve the detail of the internal range structure and may lead to better habitat analysis, but nevertheless by the time the graph asymptotes you will have the area that the animal usually traverses, the concept of the home range (Burt, 1943).

The results of incremental analyses depend on the home range model that you use. There is not space to elaborate on all the different techniques in this poster, but reviews can be found in Gipson & Dunn (1977), Harris *et al.* 1990, Kenward (1987, 2001), Millspaugh & Marzluff (2001), Robertson *et al.* (1998), White & Garrot (1990) and a detailed comparison in (Kenward *et al.*, 2001c). Here we use the most commonly and readily understood Minimum Convex Polygon (MCP) that draws a line around the outermost locations.

Analyses of ranges prior to 1994 showed that MCP ranges asymptoted by 30 locations that could be collected three times per day over a ten day period. Thus the 28 birds were separated into two groups and one group was tracked in the last two weeks of October and the second in the following two weeks. There was an efficient way to go around the buzzards but we didn't want to take locations for particular birds at the same time each day, in case they had a routine and we would miss an important part of their daily movements. Therefore a different individual was picked at random to be the start point each day.

KEY ISSUE: Use incremental analysis to improve the efficiency of home range collection.

Choosing a Range Core

Home range estimates such as MCP can be very sensitive to peripheral outlying locations, such that one location can greatly increase the home range size, despite being a rare place for the animal to visit. This is especially true of raptors that can quickly fly long distances. Therefore, to compare what individuals are usually doing it is preferable to discard these peripheral locations and look at the core of the range, where individuals spend the majority of their time. Then there is the problem of deciding what percent of peripheral locations to discard. Some choose arbitrary core percentages, but ideally the choice should be based both on the distribution of the locations and on the technique used to estimate the home range.

Utilization graphs are a good way of identifying which core percentage should be used. In the case of the MCP model, the area of the home range is plotted against the percentage of locations included (Figure 2), discarding those furthest from a range centre, e.g. the arithmetic mean centre (average x and y values).

Figure 2. Utilisation plot of one buzzard, showing that the outlying 10% of locations more than doubled the home-range size

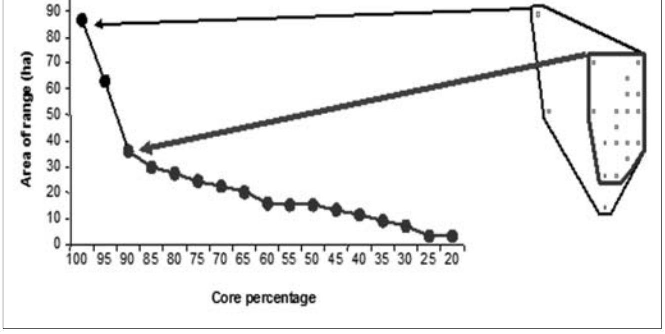


Figure 2 shows an example working from the range size including 100 percent of locations, discarding 5% in a stepwise way down to 20%. If outlying locations have a large influence on the home range size then, as locations are discarded the range area drops quickly, before declining less steeply. The core is then chosen at the first discontinuity between the steep drop and the gradual decline. If there is no discontinuity there is no need to choose a core.

KEY ISSUE: Use methods that take account of the distribution of the locations and the home range estimator when choosing a range core.

Habitat Selection Analysis

It is important to find habitat selection, rather than simply its use. Habitat use is the proportions of habitats an animal has within its range (or the time that it spends within each habitat). Selection assesses whether animals spend disproportionately more time in a habitat than what is available (Manly *et al*. 2002). A raptor may spend all its time within woodland, but there may be no other habitats nearby, therefore its use is not necessarily selection, but simply where the bird is. Thus habitat selection is about comparing what is Used to what is Available and finding a statistic that expresses how much more a habitat is used compared to how much the habitats would be visited by random movements. Selection is as far as we can go with radio-tracking studies. Preference, the likelihood of a raptor choosing a habitat if it was offered in equal proportion to another habitat, is an unrealistic experiment in the natural world.

Used habitat can be estimated from the habitat within the MCP, or more likely the core, as explained above. With sufficient detail to the habitat map and location data it is also possible to employ locations for what is Used at a finer scale. It is important to consider the resolution of your locations. For example, some raptors use edge habitats. If the habitat at the location is employed only one habitat will be picked up. It is more sensible to use the habitat within half the resolution distance, because you cannot be sure that the bird is at a particular point. In our case the resolution was 100 m, therefore when calculating Used we took all habitats within a 50 m radius centered at the location.

Available habitat could be what is within the MCP, since you now that the ability to fly enables a raptor to reach all parts of that range. However, that may obscure the fact that a bird has chosen to have its range in a particular area, either because of a particular resource, or because it is excluded from other territories. Using the study area as available habitat is a poor method, because it is arbitrarily defined. It is much better to use the habitat within a particular distance of the range centre of the bird. We chose 500 m, 1 km, 2 km and 5 km from the arithmetic mean centre, knowing that buzzards can easily go 5 km and back within a day, but understanding that different scales may show different results.

Like home range estimates there are many ways of statistically assessing selection and these are addressed in many books and publications. Here we chose to use compositional analysis (Aebischer *et al.* 1993), a popular method that avoids the problems of unit sum constraint and yet is more sensitive than older non-parametric ranking techniques. Seven of the 15 habitat classes with availability of less than 5% were discarded before analysis, because they can cause false positive results (Bingham & Brennan, 2004). Analyses were run with 1000 randomization iterations. No weighting was needed because ranges had a standard number of locations. The results are shown as the probability against random locations, in case the distribution of log-ratios was not multivariate normal.

KEY ISSUE: Use a method that statistically quantifies the selection of habitats.

Home range estimates, incremental analysis, utilisation and habitat analyses were performed in Ranges 8 (www.anatrack.com), the compositional analyses in Compos Analysis v6.2 (www.smithecology.com) and all other statistical tests in Minitab (www.minitab.com).

Results

Inspections of utilization plots showed that the most common discontinuity was at 90%, i.e. discarding 10% of the locations farthest from the arithmetic mean centre. Thus for consistency, all 10 juvenile and 9 yearling range sizes were compared using both the outer MCP and the 90% core range (labeled X_r90 after Kenward *et al.* 2001c).

Range sizes were not normally distributed (Kologorov-Smirnov: $p < 0.001$) thus the first comparison used non-parametric statistics. MCPs did not differ between yearlings (median 129.5 ha) and juveniles (median = 87.0 ha) (Mann Whitney U-test: W = 71, $p = 0.131$). The X_r90 cores of yearlings (median = 86.5 ha) were significantly larger than those of juveniles (median = 43.5 ha) (Mann Whitney U-test: $p = 0.025$). A log transformation of the range sizes normalized the data (Kologorov-Smirnov: $p > 0.15$) and so parametric tests could be performed. Boxplots in Figure 3 show how the transformation of the data resulted in a clearer separation of the groups. However, despite the graphical separation and the increased power of the parametric comparison the results were very similar with MCPs, not differing significantly (t-test: t = 1.78, $p = 0.098$), while yearling X_r90 cores were again significantly larger than the juvenile cores (t-test: t = 2.43, $p = 0.027$).

Figure 4 shows a histogram of which habitats were within buzzard MCPs, Xr90 cores and within 50 m of their locations showed that they spent over 80% of their time in meadow, pasture and deciduous woodland. These were also the most common habitats within 1 km of the buzzard's range centres (Figure 5). By combining the two in Figure 6, it is apparent that buzzards were using less arable and coniferous woodland than was available further from the range centres (2 – 5 km), especially if the habitat within 50 m of locations was considered the measure of habitat use.

Figure 3. Boxplots illustrating the difference in range size between juvenile buzzards and those in their first year. Left-hand graphs show untransformed data and results of non-parametric tests, and the right-hand graphs show Log transformed ranges and the results of parametric tests. See text for details of how the MCP and Xr90 core were estimated

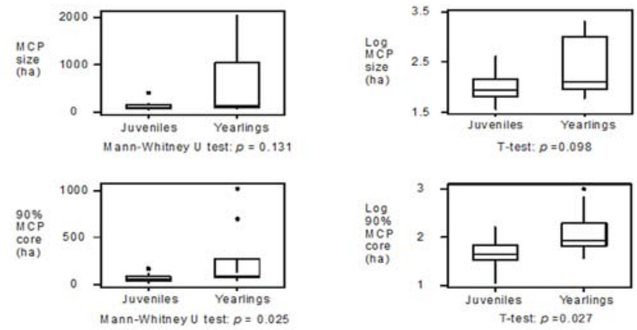


Figure 4. The top 6 habitats used by 19 radio-tagged buzzards, shown as percent of each habitat type within the MCP, Xr90 core or within 50 m of each location

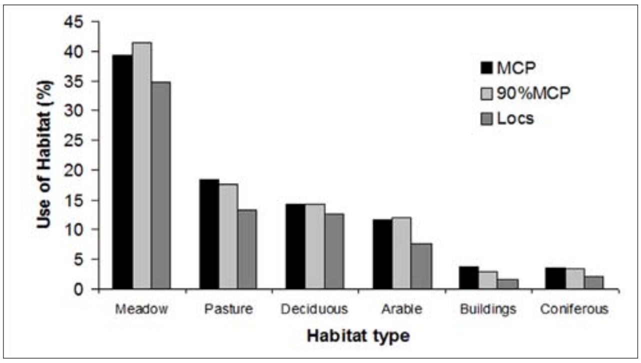


Figure 5. Availability of the top 6 habitats for 19 radio-tagged buzzards, shown as the percent of each habitat within 0.5, 1, 2 and 5 km of the arithmetic mean centre of each range

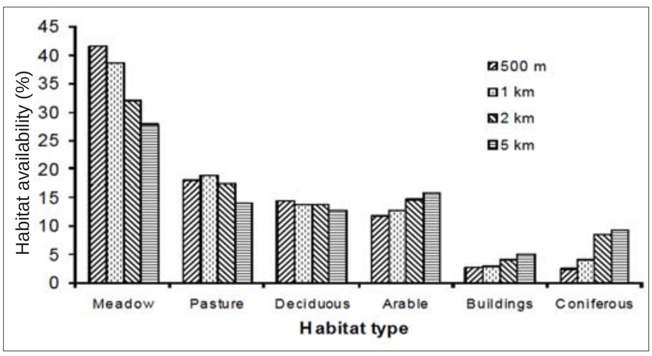
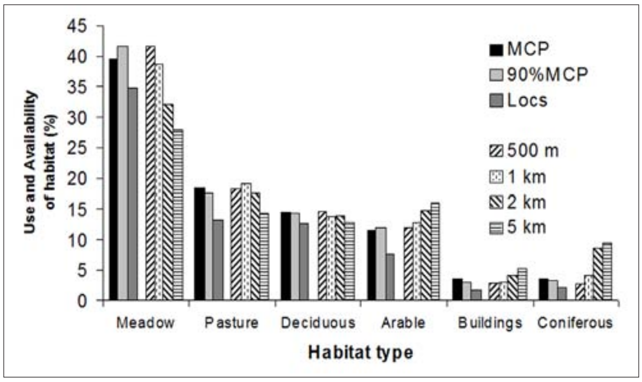


Figure 6. Histogram of use and availability of the top 6 habitats for 19 radio-tagged buzzards. Use is shown as percent of each habitat type within the MCP, Xr90 core or within 50 m of each location. Availability is shown as the percent of each habitat within 0.5, 1, 2 and 5 km of the arithmetic mean centre of each range



Further inspection of the histogram showed that buzzards were using less arable and coniferous woodland than was available further from the range centres (2 – 5 km), especially if the habitat within 50 m of locations was considered the measure of habitat use.

Compositional analyses revealed very similar trends but with the added advantage of quantifying that difference indicating whether the buzzards were using the habitat more significantly more than would be expected by chance given availability. Table 1 shows that whichever parameter was used to represent habitat "use" (MCPs, X_r90 cores and within 50 m of their locations) no estimate differed to the habitat within 500 m of their range centers. The geometric mean area of all the buzzard's 90% core ranges was mean 76 ha and a circle of this area would have a radius of 492 m. Thus the area within 500 m of the range centre was what the buzzard was usually traversing. If habitat that was further from the range centre was considered as "available", the habitat used became significantly more different, especially if habitat within 50 m of the locations that were considered as habitat use (Table 1).

Table 1. Summary of compositional analyses testing whether 19 radio-tagged buzzards used habitats significantly more than what was available within 0.5, 1, 2 and 5 km from the buzzard's arithmetic range centre. Habitats columns show the order of selection, >>> indicating a significant selection over the adjacent habitat for urban (Urb), coniferous woodland (ConWo), arable (Arb), meadow (Mead), pasture (Past), heathland (Heath) and deciduous woodland (DecWo).

Availability within	Used MCP	
	p	Habitats
0.5 km	0.53	Urb>ConWo>Arb
1 km	0.38	Mead>Urb>Past
2 km	0.01	Mead>>>Past>Heath
5 km	0.00	Mead>Past>Heath

Availability within	Used Xr90 core	
	p	Habitats
0.5 km	0.711	Mead>DecWo>Arb
1 km	0.479	Mead>Past>Arb
2 km	0.068	Mead>Past>DecWo
5 km	0.030	Mead>>>Past>Dcwo

Availability within	Used within 50 m of locations	
	p	Habitats
0.5 km	0.108	Mead>Past>DecWo
1 km	0.028	Mead>>>Past>DecWo
2 km	0.007	Mead>>>Past>DecWo
5 km	0.005	Mead>>>Past>DecWo

Discussion

Much of the value of this paper is in the methodology, which explains the common pitfalls of range and habitat analyses. The results elaborate on this by illustrating the improved analyses with a genuine limited dataset from a raptor.

Many researchers use MCPs because they have been used before and they are easy to understand. Here the results clearly show how MCPs are badly affected by distant outliers that make their sizes extremely variable. This increased variance means that any analyses between populations are very unlikely to show a significant result. Identifying a core and using utilization plots reduced this variance and then showed that juveniles had significantly smaller core ranges than yearlings. Note that once an appropriate core percentage was identified it was applied to all ranges to maintain consistency between samples, in the same way that the same number of locations was collected for each range. Nevertheless it was important to use a utilization plot that showed patterns in the data rather than choosing an arbitrary core size, which is less likely to work as well. We would urge researchers to explore the different home range models to find out what is most appropriate for their data, rather than rely on what others have used before.

The transformation of the data to normalize the distribution appeared to separate the groups in the graphs shown. However in this case it did not improve on the non-parametric results. In some cases this normalization can help to highlight differences between populations. It should be noted that boxplots are not the usual way to illustrate normal distributions, however in this case they were used to make the comparison with the non-transformed data which would have been impossible to see if a different graph had been used. What is more important is that the appropriate statistics are given for the data and medians are given for non-normal distributions, not arithmetic means that should be saved for normal distributions.

The habitat analyses used remote sensing data, a technique that might be far more efficient than ground surveys in Asia where large tracts of land are often remote and difficult to navigate. Interesting results were obtained using this remote data, but interpretation should be cautious until the remote data is ground-truthed for particular areas. The compositional analyses demonstrated resource selection, rather than just habitat use, quantifying it and giving a statistical significance that tells us how much confidence we should place in the results. Only by doing this science with appropriate sample sizes (individuals) will we be able to make rational decisions about the way in which to conserve raptors, not just in Asia, but worldwide.

Conclusion

Radio-tracking can contribute enormously towards the conservation of Asian raptors by providing rigorous scientific analysis from which appropriate actions can be planned with confidence. However, the analysis must be robust and this article has highlighted some of the more common mistakes so that they can be avoided in future studies.

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GOLDEN EAGLE IN THE ALTAI-SAYAN REGION, RUSSIA

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Abstract: The paper presents information on distribution, numbers, and breeding biology of the Golden Eagle (*Aquila chrysaetos*) in the Altai-Sayan region based on surveys carried out in 1999–2009. During the surveys 324 breeding territories of the Golden Eagle were discovered. In 227 of these territories 272 nests were found, while 97 were empty. However, juveniles were observed in 16 territories (14 records of juveniles with adults), pairs were noted in 57 territories, and lone birds in typical breeding habitat were recorded in 24 territories (9 records of males displaying courtship behavior, 5 records of birds carrying a prey). In 1999–2000 we carried out surveys of the Golden Eagles from car routes (4120 and 3754 km respectively with54 birds recorded (48 records): 28 eagles (26 records) in 1999 and 26 eagles (22 records) in 2000. A total of 1411–1881 pairs (average 1646) are estimated to breed in the Altai-Sayan region. The Golden Eagle prefers to hunt in the following landscapes: mountain dry steppes: 49.3%, mountain tundra: 12.1% and typical steppes: 11.9%. The average elevation of nest locations was 1512.87±796.98 m (n=272; range 151–2966 m). In the Altai-Sayan region the eagles build their own nests on cliffs (66.54%) and only a third of pairs nest on trees (33.46%). The preferred nesting tree species is larch (74.73%; n=91). Golden Eagles tended to build nests in the middle of a tree (42.86%), in the bottom, or middle part of a tree crown. The average height of nest location was 12.03±4.76 m (n=91; range 2–27 m). The cliff nests (n=181) were located on rocks on the tops of mountain ridges (29.83%), on the cliffs surrounding river valleys or depressions (29.28%), on riverine cliffs (27.07%), and on rock outcrops (13.81%). The average height of the nest placing was 38.59±40.58 m, ranging from 3–4 m to 150 m from the foot of the cliff. The majority of nests were placed on open ledges (79.01%). Majority of the nests were located in the upper third of a cliff (63.54%), 25.41% of nests were placed in the middle part of a cliff, others (11.05%) – in the bottom third. The average clutch size was 1.67±0.52 eggs (n=6), ranging from 1 to 3 eggs, typically 2 eggs. The average egg size was 80.59±5.13x62.52±2.71 mm (n=9; range 73.7–88.9x59.0–65.9 mm). The average brood size was 1.4±0.4 nestlings per successful nest and 0.98 nestlings per occupied nest (n=114; range 1–3 nestlings). The remains of the second nestling were found in 36.62% of nests with one nestling (n=71). Occupied nests comprised 69.71% of all nests (n=208), others were empty unoccupied nests. The main prey species of the Golden Eagle were marmots (*Marmota sp.*) – 20.7% and hares (*Lepus sp.)* – 15.59%. Mammals in the diet made up 63.71% (n=372). There is no dominant species among birds in the diet of the Golden Eagles, however a somewhat larger share of crows (9.95%) and grouse (9.41%) should be noted.

Key words: *birds of prey, raptors, Golden Eagle, Aquila chrysaetos, distribution, number, breeding biology, Altai-Sayan*

Introduction

Although the IUCN gives the Golden Eagle (Aquila chrysaetos) status 'Least Concern", it is treated as a rare species in the Russian Federation and is listed in the Red Data Book. Despite of a rather large range, there is little detailed information on the species of individual populations. To the date it is known that it has disappeared from the populated areas such as Leningrad (Malchevskiy and Pukinskiy 1983) and Moscow Districts, severely declined in Tver district (Galushin 2000), and is considered threatened in many countries of Western Europe. In the past the total number of the Golden Eagles in the Altay region was estimated as more than 100 pairs (Galushin 2000). The Sayan-Altay region was considered a stronghold of the Golden Eagles in Russian Federation because of low development rate in the area and large areas of winderness. However there were no precise surveys of the species in the region.. The study areas are located in the zone of intergradations of two subspecies of the Golden Eagle –*Aquila chrysaetos chrysaetos* L., 1758 and *A. chrysaetos kamtschatica* Sev., 1888.The paper presents information on distribution, numbers, and breeding biology of the Golden Eagle (*Aquila chrysaetos*) in the Altai-Sayan region based on surveys carried out in 1999–2009 and provide a review the published data available from literature and other sources.

Methods and Materials

The study area is the Russian part of the Altai-Sayan mountain region and adjacent flatlands within the Novosibirsk and Kemerovo districts, Krasnoyarsk and Altai Krays, Republics of Altai, Tyva and Khakassiya. The study area is 751,379.7 km². In 1999–2009 the authors surveyed virtually every steppe depression, as well as some taiga and high mountain regions. During the research that was predominantly carried out from May to June, the most likely habitation territories of the Golden Eagle were surveyed. The total length of survey routes was more than 90,000 km. In total we set up 43 study plots with a total area of 49,192.4 km² (Figure 1).

Figure 1. Location of the Study plots. See table 5.

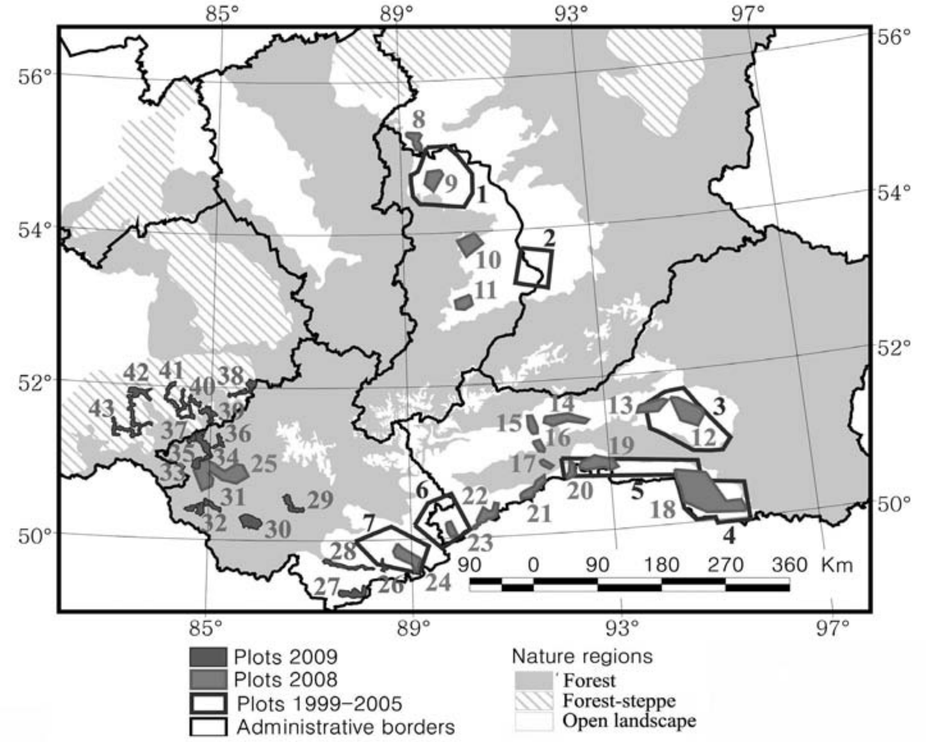
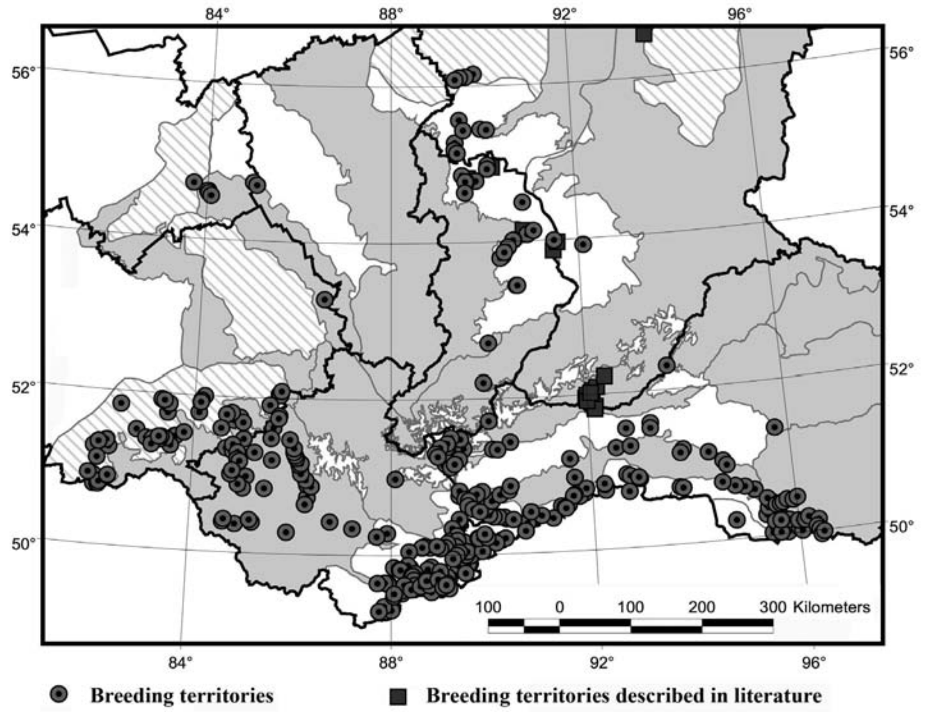


Figure 2. Distribution of the Golden Eagle in the Altay-Sayan region



The population estimates were performed using GIS software (Arc View 3.3 ESRI) based on the map of typical habitats obtained through the verification of Landsat ETM+ space images and analysis of 1:200,000 scale topographic maps. All available published information on records of nests or pairs of Golden Eagles was analyzed using GIS software.

The extrapolation of counts was based on following general principles:

- density rates were recognized as valid if they were not higher than estimations of the observed saturation of habitats with the species,
- calculations of the observed saturation of habitats with the species were based on the areas of the territories occupied by the counted pairs and on the nearest-neighbor distances (Delaunay triangulation),
- extrapolation was based on average instead minimal rates of density,
- extrapolation was based on several study plots with similar characteristics of habitats,
- calculations were carried out only for habitats which were recorded in study plots,
- estimated numbers were verified by creating distribution maps of the potential breeding territories in different habitats based on the average nearest-neighbor distances in those habitats.

Distances between nearest neighbors were calculated by using Nearest Features v. 3.8b (Jenness 2004) extension for ArcView. Maps were generated and analyzed using an extension Spatial Analyst, Kernel method (ArcView 1999). The diet was studied by analysis of the remains in nests (a total of 372 items).

Results and Discussion

Distribution

During the breeding season we recorded 507 adult eagles and 39 immature birds (excluding juveniles), 476 of them in breeding territories. We found 324 Golden Eagle breeding territories (Table 1, Figure 2), and nests were found in 227 of them. No nests were revealed in 97 breeding territories; however, adult birds were observed in 24 of those territories (9 records of males displaying courtship behavior, 5 records of birds carrying a prey), as well as pairs and fledglings – in 57 and 16 territories, respectively.

In the literature there were only 19 breeding records of the Golden Eagle in the Altay-Sayan region (Table 2, Figure 2), and most of these are from the Sayano-Shushenskiy State Nature Reserve (Stakheev *et al.* 1985, 2003).

Of the 343 breeding territories of the Golden Eagle known in the region, 41.11% (141 territories) were located in the mountain forest zone, 40.82% (140) in steppe depressions including South-Eastern Altai and South-Western Tyva, 15.16% (52) in mountain forest steppe, 2.92% (10) in the alpine zone excluding South-Eastern Altai and South-Western Tyva.

Numbers

In 1999–2000, during the Golden Eagle car surveys (4,120 and 3,754 km respectively) 54 eagles were recorded (48 sightings): 28 eagles (26 sightings) in 1999 and 26 eagles (22 sightings) in 2000. The width of the count transect that has been calculated on the basis of all records

Table 1. All known breeding territories of the Golden Eagle (*Aquila chrysaetos*) in the Altai-Sayan Region

	Administrative Region							Altai-Sayan Region
	Novosibirsk District	Altai Kray	Kemerovo District	Republic of Khakassia	Krasnoyarsk Kray	Republic of Tyva	Republic of Altai	(All administrative regions)
	HO	AK	KO	PX	KK	PT	PA	
Area (thousands km^2)	30.3	116.1	95.8	61.7	185.5	168.8	93.1	751.4
Known breeding territories following data of our research	4	47	2	18	12	110	131	324
Known breeding territories following published data*		1		3	12	2	1	19
All known breeding territories	4	48	2	21	24	112	132	343

* – included only territories which we were able to georeference and were not able to visit during our study.

Table 2. Status of known breeding territories of the Golden Eagle in the Altai-Sayan Region

Administrative Region	Known breeding territories	Known breeding territories with nests	Known breeding territories with living nests	Known breeding territories with empty nests, dead clutches and broods, destroyed nests	Known breeding territories with abandoned old nests	Not checked nests*	Fledglings on breeding territories without known nests	Pairs	Adult birds with breeding behavior in nesting habitat
Novosibirsk District	4	4	4						
Kemerovo District	2	2	2						
Altai Kray	47	35	15	12	6	2	7	4	1
Republic of Altai	131	79	46	27	3	3	3	36	13
Republic of Tyva	110	81	58	19		4	6	13	10
Republic of Khakassia	18	15	12	2		1		3	
Krasnoyarsk Kray	12	11	8	3				1	
Total	324	227	145	63	9	10	16	57	24

* Nests observed through binoculars but not climbed.

Table 3. Results of the Golden Eagle counts on vehicle routes in the Altai-Sayan Region. Numbers of plots correspond to the numbers given in Figure 3.

Year	Length of routes (km)	Effective width of transect (m)	Individuals	Records	Density (ind./100 km of route)	Density (records/100 km of route)	Density (ind./100 km^2 of total area)	Density (records/100 km^2 of total area)	Density (pairs/100 km^2 of total area)
1999	4120	2600	28	26	0.68	0.63	0.26	0.24	0.26
2000	3754	2600	26	22	0.69	0.59	0.27	0.23	0.24
1999–2000	7874	2600	54	48	0.69	0.61	0.26	0.23	0.25

was 2,600 m (1,300±400x2). The density was 0.24–0.26 pairs, at an average of 0.25 pair/100 км^2 (Table 3). Minimal density was observed in the mountain-forest zone of the northern slope of the Sayan Mountains (0.03 pairs/100 km^2) and in the center of the Tuva and Minussinsk steppe depressions (0.04 pair/100 km^2), while the highest was observed in South-Eastern Altai (0.87 pair/100 km^2) and the low mountains of the Altai Kray (0.52 pair/100 km^2). In 2002, during a short car survey with a length of 415.19 km through forest-steppe foothills of the Altai Kray, 3 breeding territories of the Golden Eagle were discovered. At width of the count transect of 1.5 km the density was 0.72 pair/100 km of the route or 0.48 pair/100 km^2.

According to count data from study plots in 1999–2009 the density varied from 0.05 to 1.43 pair/100 km^2. The lowest density was noted in the central part of the Tuva depression (0.05 pair/100 km^2), where the Golden Eagles were recorded only on the northern slope of the Tannu-Ola Mountains. In other plots, the Golden Eagle was present, and its density varied from 0.12 pairs/100 km^2 (Chulym-Yenisey depression of the Minussinsk depression) to 1.45 pairs/100 km^2 (upper reaches of the Anuy river) (Table 4, Figure 3).

The average inter-nest distance (Table 5, Figure 4) was 7.51±3.25 km (n=190; range 1.85–17.84 km; *Ex* (Kurtosis)=0.04).

About half of the pairs (47.89%) kept a distance of 4–8 km to nearest neighbors, while about a third of the pairs

Figure 3. Golden eagle density in the Altay Sayan Region

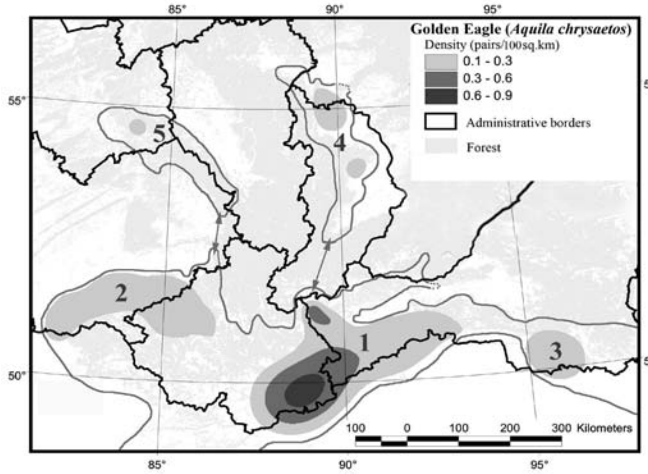
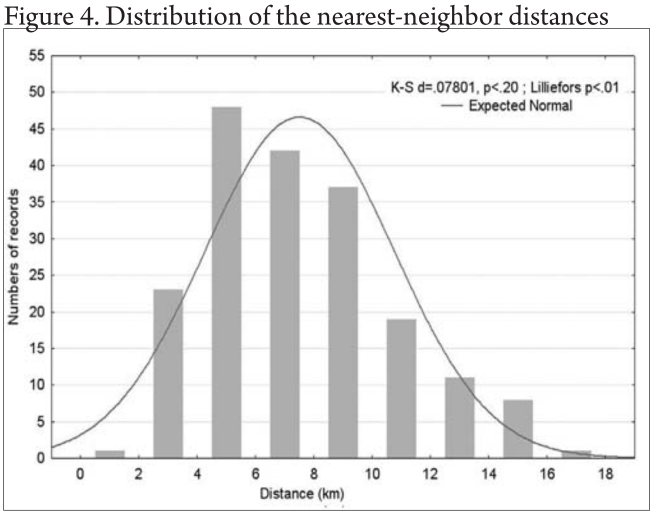


Figure 4. Distribution of the nearest-neighbor distances



(28.95%) – a distance of 8–12 km. The minimum distance of 3 km between nests was noted in 4.74% of records: on the Saylugem Ridge (2 records), and on the South-Chuyskiy Ridge (2 records), in the Arzayty and Mogen-Buren river valleys in the south-west of Tyva and in the mountainous forest-steppe of the Altai Kray near the Berezovka village (1 record each). In the latter case the distance between occupied nests of the Golden Eagle, located on a cliff and on a birch, was 2.9 km.

Because the central areas of a mountain-forest zone were not surveyed, and the most records of the Golden Eagles were made in a zone of contact of taiga and steppe and/or taiga and alpine zone, we have excluded these suboptimal habitats from extrapolation of parameters of density of the Golden Eagle populations. In GIS we generated a buffer for the zone of contact of forests and open habitats. Width of the buffer was calculated according to distances between the observed breeding territories of the Golden Eagle and the border of forest/steppe and forest/alpine zone. All the territories which remained outside this buffer were excluded from extrapolation of "normal" parameters of density of the Golden Eagle. As a result we generated a map of potential nesting (Figure 5).

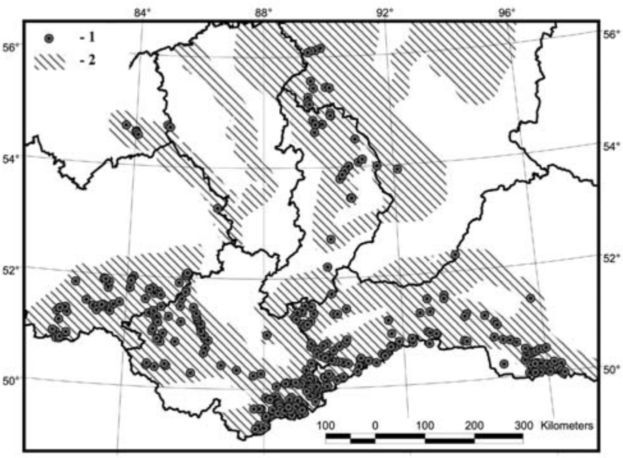
Table 4. Results of the Golden Eagle counts in study plots. Numbers of plots in the table correspond to the numbers in Figure 2.

Plots	Area	Known breeding territories	Density (pairs/100 km^2)
1,9	5922.60	7	0.12
2	2358.85	0	-
3,12,13	6601.72	3	0.05
4,5,18,19,20	10141.77	21	0.21
6,23	3563.89	21	0.59
7,24,26	4236.10	36	0.85
8	300.09	3	1
10	639.41	4	0.63
11	353.92	0	-
14	630.32	0	-
15	257.90	0	-
16	163.76	1	0.61
17	114.34	1	0.87
21	394.12	4	1.01
22	462.47	2	0.43
25,33,34	1883.85	6	0.32
27	386.02	3	0.78
28	306.38	4	1.31
29	266.76	1	0.37
30	454.92	1	0.22
31	174.79	2	1.14
32	253.91	3	1.18
35	348.85	5	1.43
36	131.11	1	0.76
37	93.25	1	1.07
38	279.59	3	1.07
39	266.62	3	1.13
40	125.43	1	0.8
41	551.34	2	0.36
42	315.56	3	0.95
43	678.30	7	1.03
Total (without plots where the species was not found)	39056.95	16	0.38
Total (including plots where the species was not found)	42657.92	16	0.35

Table 5. Nearest-neighbor distances.

№	Region	Plots	n	Nearest-neighbor distance (km), M±SD (lim)
1	Sayan Mountains		1	7.26
2	Kuznetskiy Alatau Mountains	10	5	8.31±3.06 (4.08–11.62)
3	Salair Mountains		3	5.0±1.7 (3.3–6.7)
4	Sengilen Mountains	4, 18	30	7.48±2.6 (2.32–12.8)
5	Tannu-Ola Mountains	3, 4, 5, 18, 19, 20, 21	13	8.47±3.32 (4.67–9.3)
6	North-Western and Central Altai	25, 28, 31, 32, 33, 35	23	7.64±3.42 (3.41–15.5)
7	Solgonskiy Mountains		1	8.27
8	Achinskaya forest-steppe		3	9.16±2.37 (6.98–11.69)
9	North-Western Altai Mountains		31	8.25±3.48 (2.9–17.84)
10	Minussinskaya Depression	1, 8, 9	7	11.13±4.16 (5.76–15.62)
11	South-Eastern Altai Mountains and South-Western Tuva Republic	6, 7, 22, 23, 24, 26, 27	65	6.15±2.67 (1.85–14.3)
12	Alpine zone of the Altai-Sayan Region		13	9.52±3.45 (5.36–15.58)
13	Altai-Sayan Region		190	7.51±3.25 (1.85–17.84)

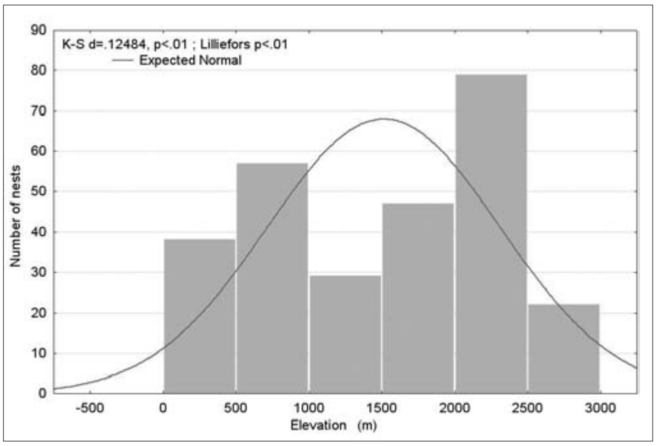
Figure 5. Habitats for which the density estimates were extrapolated.
1. – Breeding territories, 2 – Habitats



The area that includes optimum habitats for the Golden Eagle was measured to be 37,864 km^2 (50.39 % of a total area of the surveyed region). Results of extrapolation of survey data are presented in Table 6. For the area that covers suboptimal habitats and non-surveyed territories, where the status of Golden Eagle is not known, the minimal parameters of the density, which have been calculated on the basis of the average count data in study plots and car surveys, were extrapolated.

A total of 1,411–1,881 pairs (1,646 pairs on average) of Golden Eagles are estimated to breed in the Altai-Sayan region. 56–257 pairs (157 pairs on average) breed in habitats suboptimal for the species, outside of the discovered areas of the dense breeding groups (i.e. in a half of the region) (Table 6).

Figure 6. Elevations of the nest locations of the Golden Eagles



Breeding biology

Elevations that are preferred for the Golden Eagle nesting in the region are limited only by glaciers and snowfields. The average elevation of the nest locations was 1,512.87±796.98 m (*n*=272; range 151–2,966 m; E_x=-1.43). The average elevation of all sightings was close to this number (1,495.69±790.54 m; *n*=446; range 146–2,966 m; E_x=-1.39). The strong negative excess in both samples shows that their distribution is bimodal (Figure 6), and confirms that the most sightings occurred either below 1000 m or above 1800 m a.s.l. At the average

Table 6. Estimated numbers of the Golden Eagle breeding pairs in the Altai-Sayan Region. Numbers of nature regions in the Figure 1.

№	Nature region	Density (pairs/ 100 km²)	Administrative Region							All administrative regions
			Novosibirsk District	Altai Kray	Kemerovo District	Republic of Khakassia	Krasnoyarsk Kray	Republic of Tyva	Republic of Altai	
			HO	AK	KO	PX	KK	PT	PA	
1	Sayan Mountains	0.201				13 (11–16)	58 (49–69)	20 (17–23)		92 (77–107)
2	Kuznetskiy Alatau Mountains	0.385			91 (85–98)	52 (48–55)				143 (134–154)
3	Northern Altai Mountains	0.201							14 (12–17)	14 (12–17)
4	Salair Mountains	0.400	18 (16–19)	32 (29–34)	25 (23–27)					75 (68–80)
5	Obrucheva Mountains	0.201						8 (7–9)		8 (7–9)
6	Sengilen Mountains	0.411						54 (46–63)		54 (46–63)
7	Tannu-Ola Mountains	0.870						131 (124–138)		131 (124–138)
8	North-Western and Central Altai	0.432		41 (37–44)					141 (129–153)	182 (166–198)
9	between Biya and Katun rivers	0.211		5 (4–6)						5 (4–6)
10	Solgonskiy Mountains	0.385					28 (26–30)			28 (26–30)
11	Forest and forest-steppe plains of the Ob' river right side	0.201	6 (5–7)							6 (5–7)
12	Achinskaya forest-steppe	0.385			28 (24–32)		48 (41–54)			76 (66–86)
13	Krasnoyarskaya forest-steppe						39 (33–45)			39 (33–45)
14	North-Western Altai Mountains	0.527								154 (147–162)
15	Minussinskaya Depression	0.367			12 (11–13)	58 (54–61)	122 (114–130)			192 (179–205)
16	Turanskaya Depression	0.201						4 (3–5)		4 (3–5)
17	Tuvinskaya Depression	0.201						35 (29–40)		35 (29–40)
18	Ubsunuurskaya Depression							23 (20–27)		23 (20-27)
19	South-Eastern Altai Mountains and South-Western Tuva Republic	0.717						40 (46–63)	139 (130–147)	179 (168–190)
20	Alpine zone of the Altai-Sayan Region	0.510				14 (12–16)	3 (2–4)	16 (13–18)	19 (16–21)	51 (44–59)
	Altai-Sayan Region	**0.393**	**24 (21–26)**	**232 (217–246)**	**156 (143–170)**	**137 (125–148)**	**298 (265–332)**	**331 (305–386)**	**313 (287–338)**	**1491 (1355–1624)**
	Suboptimal habitats	**0.042**	**10 (3–16)**	**28 (10–47)**	**23 (8–38)**	**9 (3–15)**	**35 (13–58)**	**37 (13–61)**	**13 (5–21)**	**155 (56–257)**
	All nature regions		**34 (24–42)**	**260 (227–293)**	**179 (151–208)**	**146 (128–163)**	**333 (278–390)**	**368 (318–447)**	**326 (292–359)**	**1646 (1411–1881)**

altitudes (1,000–1,800 m a. s. l.) the sightings and nests of the Golden Eagle were rare, because of the dense forest cover. The Golden Eagle is the only large raptor species competing with the Lammergeier (*Gypaetus barbatus*) for nesting sites in the alpine zone of the Altai-Sayan region. The Lammergeier prefers to breed at altitudes from 1,851 to 2,941 m a. s. l. (Karyakin *et al*. 2009a).

Hunting habitats of the Golden Eagle are all types of open landscapes, inhabited by its main prey species: Hares (*Lepus sp*.), Marmots (*Marmota sp*.), Grouse, and small mammals.

A total of 272 nests were found in 227 breeding territories of the Golden Eagles. The majority of eagles in the Altai-Sayan region prefer to nest on rocks and cliffs (66.54 %) and only a third of pairs nests in trees (33.46 %). The majority of nests in trees were found north-west of Altai, in low mountains of the eastern slope of Kusnetskiy Alatau, the forest-steppe regions of the Minussinsk depression, and the Achinsk forest-steppe.

Occasionaly the Golden Eagles switch between cliff and tree nesting sites. In the last 10 years there have been two cases where the eagles shifted their nest from trees to cliffs, and in one case the pair has moved from a cliff to a tree for nesting. We don't know the reason of such movements.

Tree-nesting eagles (*n*=91) build their nests on larches (74.73%), birches (3.30%, only in foothills of North-Western Altai), pines (21.98%, generally in the western part of the region: Salair Ridge and low mountains of North-Western Altai). Nests were located on forested mountain slopes (inside forest) – 64.84%, on trees on the top of mountains, but also inside forest, – 16.48%, on forested mountain slopes at the edge of forest – 14.29% (such nest location is more typical of the Imperial Eagle), on single trees (only in the mountain-steppe or subalpine landscape) – 4.4%. The latter type of nest location is more typical of the Steppe Eagle and less for the Imperial Eagle (this species does not inhabit a subalpine zone).

Tree-nesting Golden Eagles (*n*=91) build their nests at the middle part of a tree in the bottom or middle part of a crown (42.86%), in the upper third of a tree (36.26%), in the bottom part of a tree often under the crown (9.89%) and on the tree top (9.89%).

When building their nests on trees, Golden Eagles often use forks of branches (46.15%), the bases of branches at a trunk (42.86%) and very rarely lateral branches further from the trunk (6.59%) and at the tops of broken trunks (4.4%).

The nests were placed 2–27 m above the ground (at average 12.03±4.76 m, *n*=91); the height depends on the tree species and location of the tree.

Cliff-nesting Golden Eagles (*n*=181) used rock at the top of mountains (29.83%), cliffs surrounding river valleys and depressions (29.28%), riverine cliffs (27.07%), and rock outcrops (13.81%) as their nesting substrates. The nests were placed at a height of 38.59±40.58 m, ranging from 3–4 m to 150 m. The minimal height was noted for nests located on small outcrops in an alpine and mountain-forest zone. Nesting on small rocks located on mountain slopes the Golden Eagle prefers rocks or cliffs in the upper third of a slope at a height 100–500 m above a valley. In any case nests were placed very rarely below 5 m (7.73%), about half of the Golden Eagle's nests were placed at a height 5–25 m (50.83%). Other eagles were noted to nest at a height of more than 25 m (41.44%).

Golden Eagles prefer to occupy cavities or niches for nesting in the region, however large niches and cavities are rather rare in cliffs in the region, and only 4.4% of known nests were in niches. The majority of the nests were on open ledges (79.01%), others on ledges protected by overhangs or semi-niches (16.57%). A total of 63.54% of nests were placed in the upper third of cliff, 25.41% – at the middle of cliff, 11.05% in the bottom part of cliff.

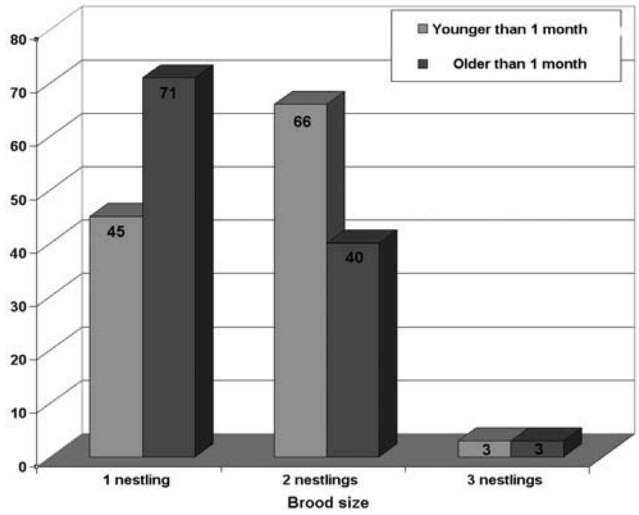
The egg-laying in the Achinsk forest-steppe, as well as in the Minussinsk depression and the mountains surrounding it, usually starts between February 20th and March 10th. Nestlings started to hatch between April 5 th and 23rd, the fledgling date was June 12th– July 2. Breeding occurred slightly later in the Salair ridge, North-Western, Central and South-Eastern Altai, Sayan, Tannu-Ola and Sengilen in Tyva at altitudes below 2,500 m a. s. l.: dates of egg-laying were between February 25th and March 20th; hatching of nestlings occurred April 10th– May 5th, and fledging dates were June 15th– July 15th. The latest dates of breeding were noted in the alpine zone of South-Eastern Altai and South-Western Tyva at altitudes above 2,500 m a.s.l.: dates of egg-laying were March 20th– April 8th, hatching was reported during May 5th-20th, fledging– 14-30 July.

The earliest record of fledged young was in the south of the Minussinsk depression: a juvenile was recorded on June 8th, 2000. The latest nestling in the nest was registered in the alpine zone of South-Eastern Altai (2,700 m a.s.l.) in the upper reaches of the Zhumalu river on July 26th, 2006.

Clutches of the Golden Eagles most frequently contain 2 eggs with a range of 1–3 eggs. We recorded 6 clutches, including dead, consisting of 1–2 eggs, at average 1.67±0.52 eggs. The average egg size was 80.59±5.13x62.52±2.71 mm (*n*=9; range 73.7–88.9x59.0–65.9 mm). Unfertilized eggs were smaller that fertilized ones: 77.0–76.2x59.0–59.8 mm, in average (*n*=3) 75.63±1.72x59.37±0.4 mm and 79.0–88.9x61.8–65.9 mm, in average (*n*=6) 83.07±4.35x64.1±1.66 mm respectively.

The average brood size of the Golden Eagle was 1.4±0.4 nestlings per successful nest (*n*=114; range 1–3 nestlings). The number of broods consisting of one nestling amounted to 62.28%. Carcasses of second nestlings were found in 36.62% of the nests with one nestling (*n*=71). Therefore,

Figure 7. Golden Eagles brood size distribution at the time of beginning and end of the breeding period



two-nestling broods at early stages of development are common; they were recorded in 57.89% of all cases (Figure 7). Furthermore, it is quite possible that in many cases the death of the second nestling at an early stage of development (before the beginning of fledging) was not recorded because its carcass fell out of the nest, and was carried away or consumed by predators. Broods with three nestlings were observed in the Republic of Altai and in the Altai Kray, in the latter case those being juvenile birds.

The percentage of empty and inhabited nests was 30.29 and 69.71%, respectively (n=208). Only in 11.11% (n=63) of one third of those nests, which were referred to as empty, the total brood loss was recorded. However, it is possible that at least in one third of them either the clutch or nestlings died at an early stage of development. All of these nests were considered active, therefore, the average brood size being 1.4 nestlings per successful nest, there were 0.98 nestlings in average per active (occupied) nest. Among the prey items, whose remains were found in nests, Marmots (20.7%) and Hares (15.59%) were predominant. In general, mammals comprised 63.71% (n=372). There were no obvious dominants among birds in the Golden Eagle diet, although the ratio of Ravens (9.95%) and Grouse (9.41%) birds was the highest (Table 8). The death of birds through electrocution was also recorded.

Threats

Many herders have been shooting the Golden Eagle. In conversations with the local population, we recorded at least 36 such cases. Moreover, in 12 cases it was proved by demonstrations of stuffed birds, paws, or wings of procured birds. There were much more reports on shooting of the Golden Eagle, however, in many cases other eagle species and Black Vultures were procured being mistaken for the Golden Eagle.

In the South-Eastern Altai, the cases of removal of fledglings from the nests nearest to the Kosh-Agach town situated on the Kurayskiy Ridge were recorded in 2002. Young and adult birds were found in the luggage of a Moscow resident during his boarding of the Abakan–Moscow train on December 7, 2007. It appears that this incident was not a singular event; the true scale of poaching remains unknown. Anyway, the illegal catching of the Golden Eagle and its export from the region is considerably lower than that for the Saker Falcon.

To increase the Golden Eagle numbers we recommend retrofitting power lines with bird-protecting devices, especially in steppe depressions in the Altai, mountainous part of the Altai Kray, the Kuznetsk and Minussinsk depressions in the Kemerovo district, and the Republic of Khakassia. Another measure is the installation of artificial nests in the periphery of steppe depressions and in forest steppe, especially in the Altai Kray, as it appears that the eagles in these areas are nest-site limited.

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SPATIAL AND TEMPORAL CHARACTERISTICS OF RAPTOR MIGRATION IN THE SOUTH BAIKAL CORRIDOR

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Abstract: The South Baikal flyway is located along the western bank of Lake Baikal (Irkutsk Region, Russia) and is most active in the autumn. In total 7,616–14,639 raptors of 22 species were counted here in five seasons, (1996, 1998, and 2001–2003), with an average of 130–276 and a maximum of 816–1893 birds per day. Birds preferred to fly along slopes next to the lake shore at altitudes of 300–500 m (to 1.5 km) rather than cross Lake Baikal directly. Daily dynamic chart was symmetrical on sunny days, with a maximum about midday, but had variations on cloudy days and among several species. On rainy days the birds did not migrate. Average flight speed within the flyway corridor was estimated as c. 25 km/hr, which was more than outside the pass; the maximal speed may reach 65 km/hr. Five to seven migratory peaks were recorded per season, and three migration periods were apparent: late August to 12–13 September (c. 30% of all migrants), the remainder of September (65%), and October (3–5%). The numbers varied significantly between years (CV = 15–33% in Eastern Buzzard *(Buteo buteo japonicus)*, Black Kite (*Milvus migrans*), and Northern Goshawk (*Accipiter gentilis*), and 82–96% in Eurasian Sparrowhawk (*A. nisus*) and Oriental Honey-buzzard (*Pernis ptilorhyncus*).

Key words: *birds of prey, Lake Baikal, Siberia, autumn migration*

Introduction

The South Baikal migratory corridor is situated along the western banks of Lake Baikal (Irkutsk, Russia, on the border with Mongolia, Figure 1), with the most bird numbers reported in its south-westernmost part in autumn. Other local raptor migration routes are known in the region (Mel'nikov et al. 2000), with the South Baikal passageway being the most permanent and intensive. The presence of the flyway in this place is determined by three main factors: the presence of a large lake which the birds of prey avoid crossing, south-facing slopes and cliffs forming an updraft thermal air flow in evident abundance, and a high abundance of migratory passerines as prey for some species like Sparrowhawks, etc. Some data about bird numbers, species composition, and their dynamics since 1980s were published (Ryabtsev et al. 1991 & 2001, Potapov 1995, Durnev *et al.* 1996, Fefelov *et al.* 2004, Alexeyenko *et al*. 2009), mainly in Russian, but migration dynamics require more presentation for details.

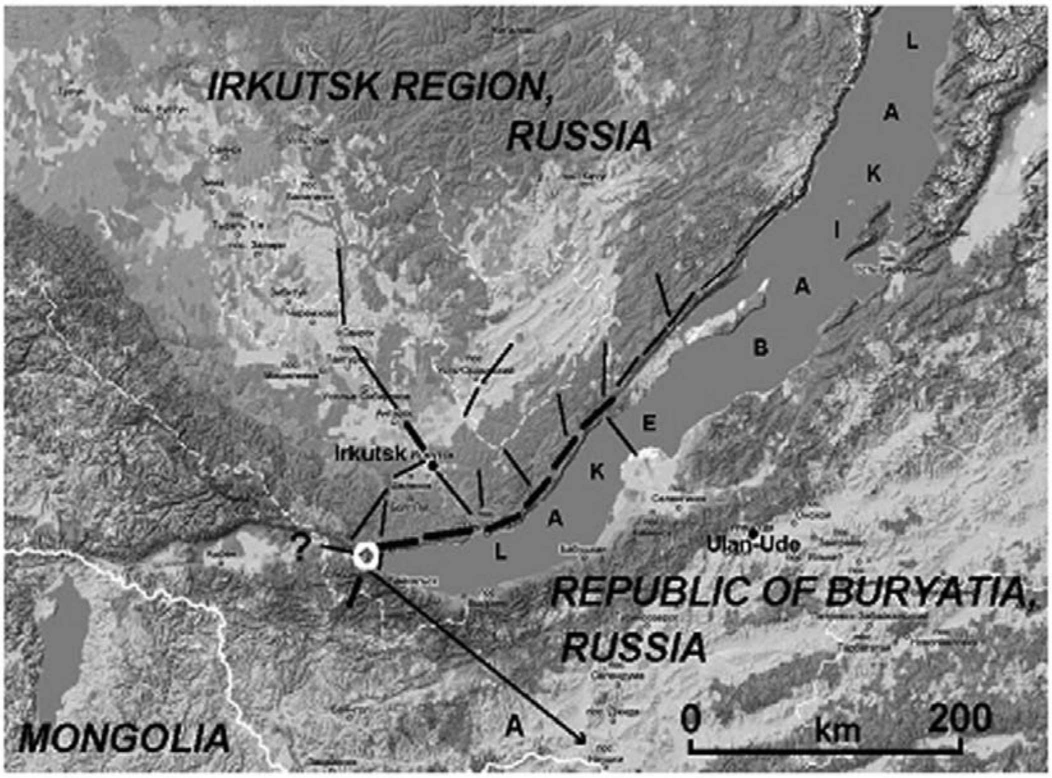
Methods and Materials

Migration was observed in the southernmost flyway point near the village of Kultuk (Irkutsk Region, Russia; 51° 44' N, 103° 42 E) (Figure 1) in 1994–2009. In the same period, short-time observations were carried out in other parts of Lake Baikal.

In this place physical geographic features concentrate birds to a narrow, very visible area. Observations were carried out from 21–29 August to 10–17 October. In 1996, 1998, and 2001–2003 the main migration period was totally covered by observations (30 to 53 working days per season) with daily counts, except during rainy days which had virtually no migration. The counts were carried out from 10:00 to 18:00 (local summer time: UTC+9) and in some days up to 19:00 if the migration was powerful and late. Binoculars 8x, 10x, and 12x, and a spotting scope 20-60x were used.

Meteorological data (daily average temperature, precipitation, and cloud cover index) from the Kultuk meteorological station were used and then were compared with daily numbers of migrating raptors by using correlation analyzes. The cloud cover index varied from

Figure 1. South Baikal migratory pass and known directions of autumn raptor movements (marked with black lines with the thickness according bird numbers).
White circle – the main observation point (Kultuk).
? – possible temporary route of raptors to W to the Tunka Valley.
A – known route of young Imperial Eagles after passing south Baikal (Ueta & Ryabtsev 2001).



0 (no clouds) to 10 (fully covered clouds). Coefficient of variation (CV = SD/M*100, %) was used for how number of bird varied by time. It was calculated for each species from five dominant raptors based on number of individual of each species and their summarized numbers, and also for each of three separate phases of migration and whole season of their migration (from August to October). Flight speeds were determined using observations on the same individually distinguishable bird by two observers situated at distances of 0.8–2.2 km, sometimes up to 54 km from each other, or by direct observation on a time that a bird spent flying a previously measured distance (0.8–1.5 km) between two points. Flight altitudes were determined by comparison of bird positions with mountain tops which the birds flew closely by, or calculated using the distance to the bird and its angle of elevation.

In total, 7,616–14,639 raptors of 22 species were counted in five fully-covered seasons, with the maximum numbers reported for 2002. Average number of migrants per day varied from 130 to 276 individuals in different seasons, with maximum numbers of 816–1,893 individuals.

Results

Species composition and its variation

The most abundant migrating species were: Common (Eastern) Buzzard *Buteo buteo japonicus* (57.9%), Black Kite *Milvus migrans lineatus* (17%), Oriental Honey-buzzard *Pernis ptilorhynchus orientalis* (9.4%), Northern Goshawk *Accipiter gentilis* (6.5%), and Eurasian Sparrowhawk *A. nisus* (5.8%). Percentages of other species did not exceed 1%. Numbers and ratios of Black Kite, Eurasian Sparrowhawk, Oriental Honey-buzzard, Booted Eagle *Hieraaetus pennatus*, and Steppe Eagle *Aquila nipalensis* increased since 1980s to 2000s (Fefelov *et al.* 2004, Alexeyenko *et al.* 2009). The last three species are increasing as summer visitors in the southern part of Irkutsk Region in 2000s. Ratios of other species did not vary significantly in the last 15 years.

Numbers of migrants were variable by years. A coefficient of variation (CV) calculated for five fully-covered seasons was usually less for the total migratory amount than for any single species, and less for total season than for some phase of a season (Table 1).

Table 1. Coefficients of Variation (CV, %) for dominant species in the South Baikal migratory corridor between years (1996, 1998, 2001-2003, n = 5).

Species	CV for numbers of migrants in the 1st phase of migration	CV for numbers of migrants in the 2nd phase of migration	CV for numbers of migrants in the 3rd phase of migration	CV for numbers of migrants throughout autumn
Eastern Buzzard	35	41	49	33
Black Kite	30	25	83	24
Oriental Honey-buzzard	95	114	140	96
Northern Goshawk	48	22	24	15
Eurasian Sparrowhawk	94	73	65	82
Summarized number of all dominant species	36	39	34	38

Forming of the migratory flyway

North of Baikal Lake, raptors were migrating generally S coming to the western Baikal bank, turning along it to the SW, and even W at the southernmost part of the lake (see Figure 1).

In cloudy weather many birds were seen crossing the southern part of Baikal (Bay of Kultuk) and the Listvennichny Bay at ca 5–13 km over the water, and even cross Lake Baikal itself near the Selenga River delta (25 km). However, raptors usually avoided crossing the water, like they do near seas (Meyer *et al.* 2000), and migrated along the shoreline at a distance of not more than 2–3 km from the lake and at an altitude of mainly 300–500 m, rarely up to 1–1.5 km above the Baikal water table. Average speed during flight along the pass was 25 km/hr (n=51) while speeds sometimes rose to 65 km/hr in flapping flight and gliding. The bird speed outside the corridor was much less than within the corridor (c. 5-10 km/hr) as outside it the birds may be seen soaring for a long time without any visible movement over the ground. Leaving Kultuk, birds were heading S-SE, crossing Khamar-Daban mountain range (2,000–2,300 m a.s.l.). A movement of birds to W to the Tunka Valley, reported by Durnev et al. (1996), was never seen during our observations. Then the raptors head to Mongolia and further south. Four young Imperial Eagles *Aquila heliaca* tracked with satellite in 1998–1999 (Ueta & Ryabtsev 2001; Figure 1) confirm this.

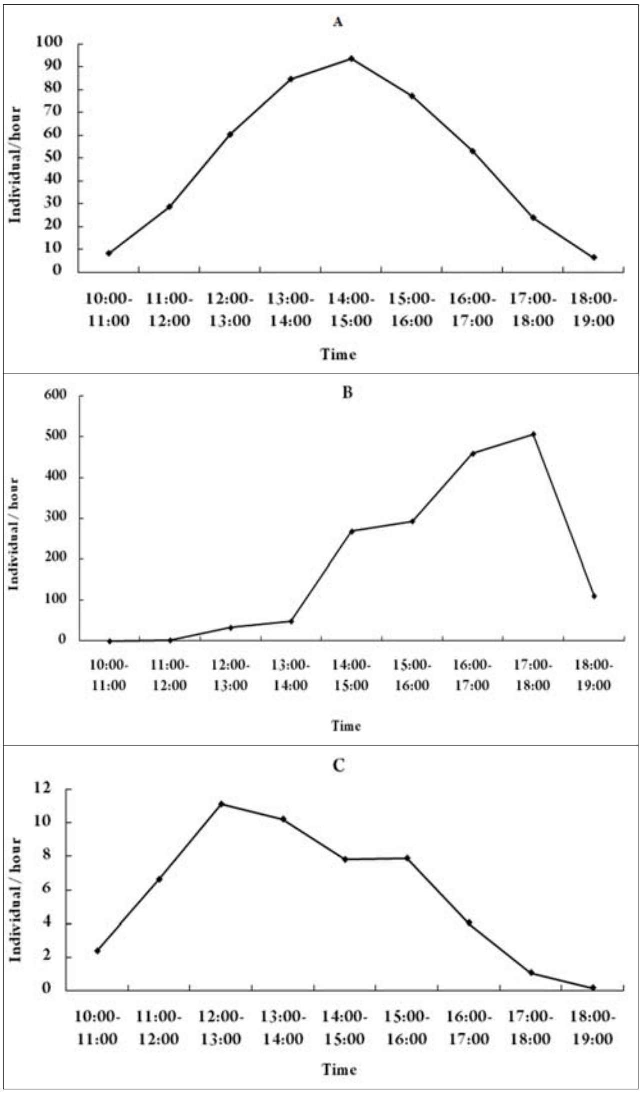
Migration terms

Three migration phases could be seen in the species composition and number dynamics. The 1st phase was from the end of August to 12–13 September, and covered c. 30% of autumn migrants (including 80% of all Oriental Honey-buzzards). The 2nd phase had the most significant number of birds, with peak numbers up to 1,500–1,800 individuals per day. It follows the 1st phase and lasts until the end of September, or sometimes the beginning of October, including c. 65% of birds. The 3rd phase happened in the first half of October (3–5% of migrants). There were seven migration peaks. Five main ones took place annually with the 4th and 5th peaks being most intensive, and 5th one was most prolonged (c. 16–23 September). Two additional irregular peaks, the 1st and the 7th, appeared not every year, but 400–600 birds may be observed in the peak day; the 1st one may be formed with Oriental Honey-buzzard (up to 480 birds during a day). Daily migratory graphs for the five fully-covered seasons showed all three species preferring soaring flight (Oriental Honey-buzzard, Black Kite, and Eastern Buzzard) had a strong and significant correlation with each other in each season, which is possibly being induced by regional weather effects.

Daily dynamics of migration

A general migration chart was symmetric with a maximum at 14:00–15:00, about and immediately after the astronomic noon (Figure 2, A). However, the daily dynamics varied with the weather. On sunny days, the birds flew actively between 12:00 and 17:00, with the intensity of 90 bird/hr and more; the daily chart does not differ from the general one. On days with variable cloudy cover, the migration occurs most actively between 13:00 and 17:00, with less intensity (c. 55 bird/hr). On completely cloudy days, the migration occurs with little intensity (on average c. 6 bird/hr) and without any obvious maximum in midday. During the migration wave on days with bad weather in the morning and good weather in midday and afternoon, the migration may increase dramatically in the second half of the day (Figure 2, B). Soaring species like the Eastern Buzzard peaked about midday. However, the Oriental Honey-buzzard and Eurasian Sparrowhawk, which often used flapping flight, were not so dependent on sunny weather to migrate, had a peak before noon (Figure 2, C). In some species like the Booted Eagle, Greater Spotted Eagle *Aquila clanga*, and falcons there were two or more migration peaks with some decrease of intensity of migration about midday.

Fig. 2. Intensity of raptor migration in the South Baikal migratory corridor by hours within a day.
A – all raptors on a sunny day (average data for 1995–2004)
B – all raptors on the peak day with cloudy beginning and sunny afternoon (14 September 1996 as a sample)
C – Oriental Honey-buzzard (average data for 1995–2004)



Migration and weather

A typical migration pattern with an increasing trend until the 2nd half of September followed by a somewhat rapid decrease appeared in years with warm autumns with little precipitation, and a predominance of sunny days (e.g., 2002). In more cloudy autumns, bird numbers may be more stable during the season. In autumns with severe and long cloudy periods (e.g., 1998) there was a strong decrease of migrant numbers in the 2nd half of September as the birds began to migrate on a wide front without concentrating in the Baikal corridor. Significant numbers of them flew across Irkutsk and then to the SW along the Irkut River valley.

In two of four seasons there were positive correlations between the number of migrating raptors and the mean temperature of the day in Kultuk (Spearman's rank correlation: $r_s = 0.27$, $P = 0.03$ in 1998 and $r_s = 0.59$, $P = 0.003$ in 2002). In all seasons (1998, 2001, 2002, 2003) there were positive correlations between the migration and the cloud cover index (accordingly, $r_s = 0.30$, $P = 0.02$; $r_s = 0.49$, $P = 0.001$; $r_s = 0.43$, $P = 0.001$; $r_s = 0.29$, $P = 0.02$). Perhaps it happens due to a concentration of migrating birds near "cumulus"-type clouds to soar, which we did observe.

Discussion

The South Baikal migratory pass supports a large number of birds of prey, and variations in count results may reflect a general situation in many species in the area northwest of Lake Baikal. However, to track such variations the observations must cover the entire migratory period due to a strong short-time variation in migration peaks. Some species (Oriental Honey-buzzard, Eurasian Sparrowhawk) were more variable in numbers by years than others; it is not known if that happens because of the shifts in their migratory routes and speeds or due to real population fluctuations. The variability of the species numbers in their main migratory period was less than in periods near the beginning and end of migration. Using the speed measurements we estimated the daily distance that raptors were flying before the corridor and inside it in favorable weather as 100–200 km, possibly up to 250 km inside the corridor. There was more than one migration peak during the day in eagles and falcons, which was not surprising, as these species were less dependent on soaring flight.

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CURRENT STATUS AND DISTRIBUTION OF DIURNAL RAPTORS IN MALAYSIA

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Abstract: Malaysia consists of two territories, Peninsular Malaysia at the southernmost tip of continental Asia and East Malaysia, on the island of Borneo. Malaysia has a rich diversity of diurnal raptors as a consequence of its location in the tropics of the Oriental region and also because the country is situated on the migration routes of many migratory birds. At least 44 species of diurnal raptors are currently known to have been reliably recorded. Of these, 21 and 26 species are resident and migratory respectively, including three species represented by both resident and migrant populations. Two species, Mountain Serpent-eagle (*Spilornis kinabaluensis*) and White-fronted Falconet (*Microhierax latifrons*) are Bornean endemics, with their ranges almost confined within East Malaysia. Eight species are listed as globally threatened: four species each categorized as Vulnerable (VU) and Near Threatened (NT). Three migratory raptors Oriental Honey-buzzard (*Pernis ptilorhyncus*), Black Baza (*Aviceda leuphotes*) and Chinese Sparrowhawk (*Accipiter soloensis*) occur annually in significant numbers. Raptors have not been well studied in Malaysia, with only limited information available on a few species. This paper assesses the current conservation status and distribution of diurnal raptors in Malaysia based on data obtained from the Bird-I-Witness database maintained by Malaysian Nature Society and on information from the author's field observations. Notes on habitat preference and breeding of selected species are also presented.

Key words: *conservation, status, distribution, raptors, habitat, breeding, Malaysia*

Introduction

Malaysia is located in South-east Asia, between $1^{O} - 7^{O}$ N and $100^{O} - 109^{O}$ E (Figure 1). The country is divided into two regions by the South China Sea: Peninsular (West) Malaysia (11 states, land area of 13.16 million ha) on continental Asia and East Malaysia, consisting of Sarawak (12.30 million ha) and Sabah (7.37 million ha) states, on the island of Borneo.

The climate can be classified as moist tropical, with daily temperatures in the lowlands ranging from 25 ^{O}C – 35 ^{O}C. Annual precipitation averages around 3,000 mm, with heaviest rainfall occurring from October to December. The predominant vegetation types are mangroves along the coast, freshwater swamp forests on the plains, tropical rainforests in the lowlands and montane evergreen forests in the mountainous interior.

With territory in mainland Asia as well as on Borneo, Malaysia has two regionally distinctive components of the Sunda Shelf biodiversity. As a result of this zoogeographical coverage and its location on the flyways of many migratory birds, the country has a rich avifauna of some 750 species, including at least 44 species of raptors.

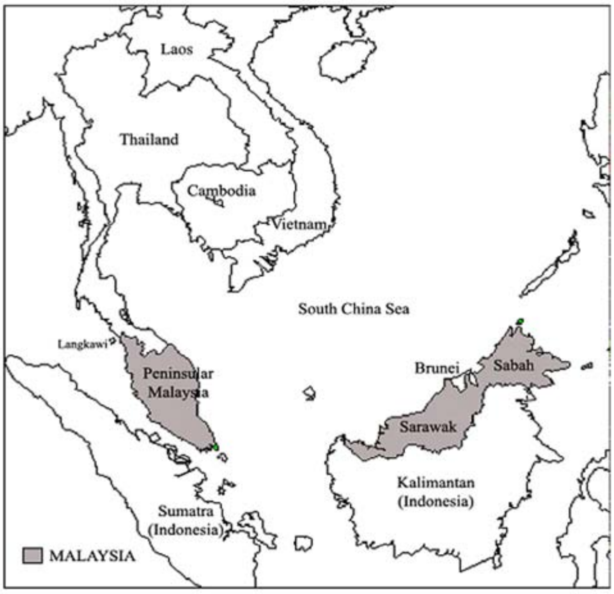
The current status of these raptors is not well understood but it is believed that the populations of many species have declined due to destructive changes in the environment. The current status, distribution and conservation of the raptors of Malaysia are presented here based on the data and information obtained.

Methods and Materials

Two main methods were employed for this study. The first method involved accessing the Bird I-Witness (BIW) databank, maintained by the Malaysian Nature Society (MNS). BIW provided raptor records dating from January 1988 to April 2010. The second method involved sourcing for raptor information from the published and unpublished literature, personal records, reports by bird observers and the internet.

Relative abundance of raptors was obtained by ranking encounter frequency of each species reported in BIW. Abundance was ranked as very common (VC) if there were 300 records or more; common (C) for 150 to 299 records; uncommon (UC) for 50 to 149 records; rare (R) for 10 to 49 records and very rare (VR) for less than ten records.

Figure 1. Location of Malaysia in relation to South-east Asia



Breeding seasonality is reported for each month during which the nest was actually in use. Taxonomic sequence and nomenclature generally follow Inskipp *et al.* (1996) with a few exceptions to reflect current acceptance.

Results

Status, abundance and habitats

To date, at least 44 species of raptors have been reliably recorded in Malaysia. They comprise 37 species in family Accipitridae and seven species in family Falconidae. Of these, 18 species are resident, 16 species are passage migrants and winter visitors, three species are represented by both migratory as well as resident populations and seven are considered vagrants. Three species, White-rumped Vulture (*Gyps bengalensis*), Long-billed Vulture (*G. indicus*) and Red-headed Vulture (*Sarcogyps calvus*), are deemed locally extinct and are not included in this paper.

On a regional basis, 40 species have been recorded in Peninsular Malaysia and 26 species each in Sabah and Sarawak. Two species, White-fronted Falconet (*Microhierax latifrons*) and Mountain Serpent-eagle (*Spilornis kinabaluensis*) are Bornean endemics, the former presently found only in Sabah. The disparity in raptor diversity between the two regions is explained by the fewer number of migratory species reaching Borneo. Species distribution according to region, seasonal status, protection status and threat categories according to the International Union for Conservation of Nature (IUCN), are shown in Table 1.

Vagrants and passage migrants are briefly treated here as the former comprise species that very rarely occur while the latter are transient species seen only for a short time of the year. There have been sporadic records of vultures, including one Himalayan Griffon (*Gyps himalayensis*) in early 2010, and two records of Cinereous Vulture (*Aegypius monachus*). Most vulture records are of immature birds captured after being found exhausted from hunger. The only two confirmed records of Oriental Hobby (*Falco severus*) have come from Sabah and its status remains unclear. Reports of suspected Eurasian Hobby (*Falco subbuteo*) remained unconfirmed until one was photographed on migration in 2008. The three records of Amur Falcon (*Falco amurensis*) have all been of single birds seen in open habitats. The scarce records of Short-toed Snake-eagle (*Circaetus gallicus*) include two recent sightings of singles in sub-montane forest. Eurasian Sparrowhawk (*Accipiter nisus*) is a new addition to the Malaysian avifauna.

Chinese Sparrowhawk, Black Baza and Oriental Honey-buzzard (migrant race) occur in large numbers during the migration season. Chinese Sparrowhawk is an exclusive passage migrant, with a high count of some 12,700 birds recorded passing through in autumn 2009 (pers. obs.). The main bulk of Black Baza (c 30, 000 in autumn 2009, MNS unpublished report) and Oriental Honey-buzzard (c 63, 000 in spring 2010, MNS unpublished report) are also passage birds.

The remaining resident raptors and winter visitors can be divided into groups based on the following broad habitat categories: wetlands (including lakes, artificial water bodies, rivers, marshes, mangroves, coasts); open country (including grasslands, ricefields, sugar canefields); woodlands (including orchards, parkland, tree plantations); lowland forests; and montane forests.

Four of the five species associated with wetlands are residents. White-bellied Sea-eagle (*Haliaeetus leucogaster*) and Brahminy Kite (*Haliastur indus*) are two of the commonest raptors while Lesser Fish-eagle (*Ichthyophaga humilis*) and Grey-headed Fish-eagle (*Ichthyophaga ichthyaetus*), occur mainly along inland rivers and near large waterbodies. The migrant Osprey (*Pandion haliaetus*) sometimes shares the same habitat with the two fish eagles.

The majority of the 13 open country and four woodland raptors are winter visitors, except for the resident Black-shouldered Kite (*Elanus caeruleus*) and Crested Goshawk (*Accipiter trivirgatus*). Fallow ricefields and sugarcane fields are important hunting grounds for at least nine migrant raptors including three species each of harriers and *Aquila* eagles. Black Bazas are often seen in small flocks in woodlands while Japanese Sparrowhawk (*Accipiter gularis*) can occur almost anywhere during the winter months. Shikra (*Accipiter badius*) is probably under-reported due to identification problems.

All 15 raptors associated with forests are residents. Lowland forest's species include several which are likely to be most affected by deforestation, such as Jerdon's Baza

Table 1: Species distribution, seasonal, protection and IUCN status of raptors in Malaysia

Species & IUCN status	Distribution & seasonal status			Protection status		
Order Falconiformes /Region	PM	SW	SB	PM	PM	SB
Family Accipitridae (37 species)						
1. Osprey *(Pandion haliaetus)*	M	M	M	TP	P	P
2. Jerdon's Baza *(Aviceda jerdoni)*	R	R	R	TP	P	P
3. Black Baza *(A. leuphotes)*	M	–	–	TP	–	–
4. Oriental Honey-buzzard *(Pernis ptilorhyncus)*	R&M	R&M	R&M	TP/P	P	P
5. Bat Hawk *(Macheiramphus alcinus)*	R	R	R	TP	P	P
6. Black-shouldered Kite *(Elanus caeruleus)*	R	R	R	TP	P	–
7. Black-eared Kite *(Milvus lineatus)*	M	M	M	TP	P	P
8. Brahminy Kite *(Haliastur indus)*	R	R	R	TP	P	P
9. White-bellied Sea-eagle *(Haliaeetus leucogaster)*	R	R	R	TP	TP	–
10. Lesser Fish-eagle *(Ichthyophaga humilis)*	R	R	R	TP	P	P
11. Grey-headed Fish-eagle *(I. ichthyaetus)*	R	R	R	TP	TP	P
12. Himalayan Griffon *(Gyps himalayensis)*	V	–	–	P	–	–
13. Cinereous Vulture *(Aegypius monachus)*	V	–	–	–	–	–
14. Short-toed Snake-eagle *(Circaetus gallicus)*	V	–	–	TP	–	–
15. Crested Serpent-eagle *(Spilornis cheela)*	R	R	R	TP	P	P
16. Mountain Serpent-eagle *(S. kinabaluensis)*	–	R	R	–	P	P
17. Eastern Marsh Harrier *(Circus spilonotus)*	M	M	M	–	P	–
18. Hen Harrier *(C. cyaneus)*	M	M	M	TP	P	–
19. Pied Harrier *(C. melanoleucos)*	M	M	M	TP	P	–
20. Crested Goshawk *(Accipiter trivirgatus)*	R	R	R	TP	P	P
21. Shikra *(A. badius)*	M	–	–	TP	–	–
22. Chinese Sparrowhawk *(A. soloensis)*	M	M	M	TP	P	–
23. Japanese Sparrowhawk *(A. gularis)*	M	M	M	TP	P	–
24. Besra *(A. virgatus)*	–	R	R	TP	P	P
25. Eurasian Sparrowhawk *(A. nisus)*	V	–	–	TP	–	–
26. Grey-faced Buzzard *(Butastur indicus)*	M	M	M	TP	P	–
27. Common Buzzard *(Buteo buteo)*	M	–	–	TP	P	–
28. Black Eagle *(Ictinaetus malayensis)*	R	R	R	TP	P	P
29. Greater Spotted Eagle *(Aquila clanga)*	M	–	–	TP	–	–
30. Steppe Eagle *(A. nipalensis)*	M	–	–	–	–	–
31. Eastern Imperial Eagle *(A. heliaca)*	M	–	–	TP	–	–
32. Booted Eagle *(Hieraaetus pennatus)*	M	–	–	TP	–	–
33. Rufous-bellied Eagle *(H. kienerii)*	R&M	R&M	R&M	TP	P	–
34. Changeable Hawk-eagle *(Spizaetus cirrhatus)*	R	R	R	TP	P	–
35. Mountain Hawk-eagle *(S. nipalensis)*	R	–	–	–	–	–
36. Blyth's Hawk-eagle *(S. alboniger)*	R	R	R	TP	P	–
37. Wallace's Hawk-eagle *(S. nanus)*	R	R	R	TP	P	P

Family Falconidae (7 species)						
1. Black-thighed Falconet *(Microhierax fringillarius)*	R	R	–	TP	P	–
2. White-fronted Falconet *(M. latifrons)*	–	–	R	–	–	P
3. Common Kestrel *(Falco tinnunculus)*	M	M	M	TP	P	P
4. Amur Falcon *(F. amurensis)*	V	–	–	–	–	–
5. Eurasian Hobby *(F. subbuteo)*	V	–	V	–	–	–
6. Oriental Hobby *(F. severus)*	–	–	V	–	–	P
7. Peregrine Falcon *(F. peregrinus)*	R&M	R&M	R&M	TP	P	P

Legend: Distribution - Peninsular Malaysia (PM); Sarawak (SW); Sabah (SB)
Seasonal status - Migrant (M); Resident (R); Vagrant (V)
Protection status - Totally protected (TP); Protected (P).
IUCN status - Near-threatened (NT); Vulnerable (VU)

(*Aviceda jerdoni*), Wallace's Hawk-eagle (*Spizaetus nanus*), Bat Hawk (*Macheiramphus alcinus*) and the two falconets. Lowland forest is also important for the resident races of Oriental Honey-buzzard, Rufous-bellied Eagle (*Hieraaetus kienerii*) and Peregrine Falcon (*Falco peregrinus*). Of the five montane forest species, three have restricted distribution: Mountain Serpent-eagle and Besra (*Accipiter virgatus*) only occur in the highlands of East Malaysia while Mountain Hawk-eagle (*Spizaetus nipalensis*) is only found on Langkawi Island off northwest Peninsular Malaysia. The complete list of raptor species and their relative abundance and details of associated habitats is shown in Table 2.

Breeding seasonality of resident raptors

The breeding ecology of many resident raptors is currently poorly known, for example, there are no nesting records for Jerdon's Baza, Rufous-bellied Eagle and Mountain Serpent Eagle to date. Crested Serpent-eagle (*Spilornis cheela*) is the commonest raptor, yet only a handful of nests have been reported. Information on breeding seasonality would be the first step in leading to the study of the ecology of raptors in order to understand their conservation needs. Table 3 lists the breeding seasonality of raptors, reported in terms of each month of active nesting (here defined as incubation to fledging of chicks), with additional notes on nest site, brood size (maximum reported) and other breeding aspects.

Threats

Habitat loss: From 1970 to 1992, natural forest in Malaysia was reduced by 19.3 % (National Policy on Biodiversity 1998, unpublished report). In the decade from 1990 - 2000, forest loss occurred at a rate of 78,000 ha per year, increasing to 140,000 ha per year in the following five years up to 2005 (Global Forest Resources Assessment 2005). By 2007, only about 60 % of the land area of Malaysia remained forested. Habitat loss, including deforestation, disturbance and fragmentation, is a major factor causing population declines in raptors (Newton 1990). Irham (2005), in a study in Java, reported that habitat disturbance had a strong effect on the diversity of raptor species and individuals, with more species and individuals in the less disturbed areas compared to the highly disturbed areas. van Balen & Nijman (2000) during surveys of various fragmented forest blocks in Java, found that the largest blocks supported the most number of raptors.

Forest loss in Malaysia, as documented the above, undoubtedly have had similar impacts on raptor populations, particularly on species dependent on lowland forest such as Wallace's Hawk Eagle (Wells 1999). In Borneo, Davison (1999) believed that forest loss from 1960 to 2000 caused an estimated 20 % decline in the population of lowland birds. Degradation of habitat by logging and road construction, and the human intrusions that follow, also affect breeding raptors, causing species such as Bat Hawk and Blyth's Hawk-eagle (*Spizaetus alboniger*) to abandon long-held nesting trees (pers. obs.). The decline of woodpeckers and barbets when forests are destroyed may in turn affect the *Microhierax* falconets, which use their old nest holes for breeding and roosting.

Recent raptor surveys in East Malaysia have suggested that previous large scale deforestation may have seriously impacted on raptors. Species that were reported as common, particularly migratory species, were not seen in apparently ideal habitats. Large trees were scarce and the few that remain more often than not had a nesting raptor, even if situated next to a highway, suggesting a severe lack of suitable nesting sites (pers. obs.). Surveys are needed to locate important sites for raptors so that these can be given adequate protection.

Pesticides: Pesticide bio-accumulation in raptors and its consequent result of reproductive failure and death in these birds have been well documented in many countries. Raptors, by their hunting technique, are at high risk of secondary poisoning from eating preys which have unassimilated pesticides in their bodies. Death can also occur through scavenging on carcasses of animals poisoned by pesticides, with many reported cases of eagles being victims (Wobeser 2004).

The period of heavy forest loss in Malaysia coincided

Table 2. Species, relative abundance and habitat use by raptors in Malaysia

Habitat category and species	R.A.	Habitat use
Wetlands (5 species)		
1. Osprey	UC	Winters on coasts, near large rivers, flooded mine-workings, reservoirs, fish-ponds
2. Brahminy Kite	VC	Mangroves, fishing villages and off-shore islands. In East Malaysia, also occurs inland over forest.
3. White-bellied Sea-eagle	VC	Coasts and islands. Also seen inland over reservoirs and fish-ponds.
4. Lesser Fish-eagle	UC	Favours closed canopy waterways and secluded reservoirs with forested banks.
5. Grey-headed Fish-eagle	UC	Forested waterways, flooded mine-workings, swamps, reservoirs and fish-ponds.
Open country (13 species)		
1. Black-shouldered Kite	C	Ricefields, scrub and semi-open areas such as plantations and the landward side of mangroves
2. Black-eared Kite	UC	Winters in ricefields, mangroves and along rivers. Scarce recent records from East Malaysia.
3. Eastern Marsh Harrier	UC	Winters in ricefields. Most often encountered harrier, but with few recent records from East Malaysia.
4. Hen Harrier	VR	Winters in ricefields but rarely reported.
5. Pied Harrier	UC	Winters in ricefields. Scarce in East Malaysia although formerly reported to be common.
6. Grey-faced Buzzard	UC	Winters along roads, in farms and tea estates in the highlands. Also overgrown plantations and parkland in the lowlands.
7. Common Buzzard	R	Winters in the highlands along roads, in tea estates, farms and near garbage dumps.
8. Greater Spotted Eagle	UC	Adults and immatures winter in fallow ricefields. Maximum count of 8 birds at one site.
9. Steppe Eagle	R	Winters in fallow ricefields. Only a few records, all of immature birds.
10. Eastern Imperial Eagle	R	Winters in fallow ricefields. Only a few records, mostly single immature birds.
11. Booted Eagle	R	Singles seen wintering in fallow ricefields, sugarcane fields, grassland and scrub.
12. Common Kestrel	R	Regular winter visitor in sugarcane fields, less often seen in ricefields and in the highlands..
13. Peregrine Falcon	UC	Migratory race japonensis favours coastal areas but can be seen almost anywhere including ricefields, cities, forests and in the highlands.
Woodlands (4 species)		
1. Black Baza	C	Wintering birds occur in small flocks on the edge of mangroves, in overgrown plantations and woodland.
2. Japanese Sparrowhawk	C	Winter in semi-open agricultural areas, forest edge, well-wooded scrub and parkland, up into the mountains.
3. Crested Goshawk	UC	Forest edge, woodlands and parkland in the lowlands, occasionally in the sub-montane zone.
4. Shikra	VR	Winters in scrub and semi-open agriculture. Scarcity may be due to identification problems and confusion with other similar-looking species.

Lowland forest (10 species)		
1. Jerdon's Baza	R	Often in logged forest, plantations; also in hill forest.
2. Oriental Honey- buzzard	UC	Resident torquatus race is found in forests at all altitudes and occasionally in parkland.
3. Bat Hawk	UC	Mainly adjacent to limestone areas where caves provide bats, its main prey.
4. Crested Serpent-eagle	VC	Commonest raptor; in all elevations in a range of wooded and forested habitats, including mangroves and agriculture.
5. Rufous-bellied Eagle	UC	All elevations mainly in forests or areas adjacent to forests. Numbers are augmented by migrant birds.
6. Changeable Hawk-eagle	C	High tolerance to habitat disturbance but is seldom found far away from patches of tall forest. Also in swamp forest and mangroves. Occurs in two colour forms, pale and dark
7. Wallace's Hawk-eagle	R	Peat swamp, relict forests along rivers and bordering plantations as well as in wood pulp plantations. More often seen in East Malaysia
8. Black-thighed Falconet	C	Forest edge, gaps and clearings but occasionally in parkland and the land-ward side of mangroves.
9. White-fronted Falconet	R	Endemic to Sabah. Occurs mainly along forest edges, gaps and clearings, rarely in mangroves.
10. Peregrine Falcon	UC	Resident ernesti race prefers the vicinity of forested limestone hills but there are records in lowland and hill forests.
Montane forest (5 species)		
1. Mountain Serpent-eagle	VR	Endemic to Borneo. Few reports, possibly due to its remote distributional range in the hill and montane forest of East Malaysia.
2. Besra	VR	Scarce resident, reported from lowland as well as montane forests.
3. Black Eagle	UC	Forested valleys and ridges in Peninsular Malaysia but in East Malaysia, also occurs in degraded lowland forest and plantations.
4. Mountain Hawk-eagle	R	Resident only on Langkawi Island in north Peninsular Malaysia, at the southernmost limit of its range in Asia.
5. Blyth's Hawk-eagle	C	Usually in the hgher latitudes but occasionally wanders into the lowlands.

Legend: Relative abundance (RA); Very common (VC); Common (C); Uncommon (UC); Rare (R); Very rare (VR)

with the rapid expansion of oil palm planted area which increased by 166 % from about 2.03 million ha in 1990 to 3.37 million ha in 2000, mostly in East Malaysia (Teoh 2002). The oil palm industry boom and the modernization of rice planting have resulted in a rapid increase in the volume and variety of pesticides used to control rats which cause serious damage in plantations and ricefields. Warfarin, a relatively safe rodenticide, was initially widely used in oil palm plantations but due to resistance build-up in rats, second generation anticoagulants such as bromadiolone and brodifacoum, reportedly very toxic to Barn Owl (*Tyto alba*), are increasingly being used (Hafidzi 2001). The continuing use of pesticides in ricefields and oil palm plantations, the latter often situated adjacent to forest, is of concern and suggests that poisoning of raptors on an unknown scale may be happening.

Hunting: Direct human persecution of raptors in Peninsular Malaysia, such as trapping and hunting, is believed to be generally low. Only occasionally are there media reports of illegally obtained raptors, such as in 2002 when a Changeable Hawk Eagle in an exhibition was confiscated, and in 2008 when a large number of owl carcasses, among which were two dead Crested Serpent Eagles, was seized.

In Borneo, hunting and trapping of birds was formerly among the most severe in South-east Asia. This activity, traditional but increasing, has now been compounded by the onset of sports hunting for recreation, which may be seriously threatening raptors in Sabah (Sheldon 2001). Although there are laws governing gun ownership and species hunted, enforcement is difficult in remote areas and is complicated by cultural and economic factors. The people of Borneo are fond of trapping birds to keep as pets and, in Sabah, these have included Changeable Hawk-eagle, Oriental Honey-buzzard and Crested Goshawk (Davison 1999). Recently, an immature Brahminy Kite was seen in

Table 3. Breeding seasonality of resident raptors in Malaysia

Species	Breeding seasonality	Remarks
Oriental Honey-buzzard	Jan.-Mar., Nov.- Dec.	Only one nesting record (over several years) in golf course trees. Brood = 2.
Bat Hawk	Feb.- Oct.	Forest emergent in lowland forest. Brood = 1.
Black-shouldered Kite	All months of the year	Nest in tree but occasionally on metal pylon crossbars. Brood = four.
Brahminy Kite	Jan.-Aug., Dec.	Trees in mangrove. Brood = 2
White-bellied Sea-eagle	Jan.-May, Oct.-Dec.	Nest in tall tree, often on hill top. Also on tops of pylon and telecommunication towers. Brood = 1, sometimes 2.
Lesser Fish-eagle	Jan.-Feb., May, Nov., Dec.	Nest on riverine trees, including dead trees. Brood = 1.
Grey-headed Fish -eagle	Jan. -Apr., Oct., Dec.	Nest in trees in swampy ground, also trees near forested shores of lakes. Brood = 1.
Crested Serpent -eagle	Mar.-Jun.	Nest often well hidden in forest trees; one in coconut palm. Brood = 1, one record of 2
Crested Goshawk	Jan.-May, Aug.	Reported taking over old Large-billed Crow (Corvus macrorhynchos) nest. More nests are being reported in urban parks.
Besra	Jun.	One historical record.
Black Eagle	Jan.-Apr.	Nest in tree on steep slopes in the highlands. Brood = 1.
Changeable Hawk-eagle	Jan.-Jun., Sep.	Nest in tall emergent in forest. Nesting on pylon reported. Brood = 1.
Mountain Hawk-eagle	April, May.	Only one record of nesting, on emergent on a slope in hill forest. Brood = 1.
Blyth's Hawk-eagle	Jan.-Apr., Sep.-Dec.	Nest in forest emergent on hill slope. Brood = 1.
Wallace's Hawk-eagle	Jan.-May, Aug., Sep., Dec.	Nest in crown of forest emergent in lowland forest. Brood = 1.
Black-thighed Falconet	Jan.-Jun., Sep.	Nest in old barbet or woodpecker holes. Other sites have included brickwork hole and recesses in limestone face. Brood = 4
White-fronted Falconet	Mar., Jun., Nov.	Nest in old woodpecker hole. Brood = 2.
Peregrine Falcon	Feb.-May	Nest in recesses or ledge of limestone face. Brood = 2

Sabah, tied up in a boat (pers. obs.).

Conservation

Legal protection for raptors is governed by three regional legislations, namely the Wildlife Protection Act 1972 for Peninsular Malaysia, the Wild Life Protection Ordinance 1998 for Sarawak and the Wildlife Conservation Enactment 1997 for Sabah. Although these legislations provide protection or total protection to raptors (Table 1), they have their own schedules of protected species.

The protected areas system in Malaysia provides a network of raptor habitats throughout the country. As of 2007, about 6 % of the country (some two million ha) are protected as national parks, wildlife sanctuaries and wildlife reserves (4the National Report to the Convention on Biological Diversity 2009, unpublished report).

Malaysia is a signatory to the Convention on International Trade in Endangered Species of Flora and Fauna in Commerce (CITES) and the Convention on Biological Diversity (CBD), under which the country has adopted a National Policy on Biological Diversity. These international agreements in essence require Malaysia to protect raptors and their habitats.

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NEST-SITE SELECTION OF THE CRESTED SERPENT-EAGLE *(Spilornis cheela)* IN KOLLI HILLS, TAMILNADU, INDIA

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Abstract: Nest-site selection of the Crested Serpent-eagle *Spilornis cheela* was studied in the Kolli Hills during May 2005 to May 2007. In total, 27 active nests were identified, but accessibility to collect nest-site details was possible for only 16 nests. Nest construction was shared by both sexes. No crested serpent eagle was found constructing a new nest during the study period. Serpent eagles renewed or altered the old available nests in the study area largely in December. Both the sexes were involved in the renewal activities. The clutch size was single and the mean incubation period was 38.5 days. The mean fledging period was 62 days. For the present study, habitat variables were collected at three levels: nest variables, nest-tree variables, and nest-patch variables. Random plots were also established to study the nest site selection. Nests were found largely along the riverine patches on tree species namely *Terminalia bellirica (6), Dalbergia latifolia (8), Tectona grandis (1), Lagerstroemia lanceolata (5), Mangifera Indica (6),* and *Bombax ceiba* (1). The nests were placed at a mean height of 17.5 m from the ground level. Some nest site characters differed significantly from random-sites and reflected the importance of the size and the age of the tree, and proximity to water. The results indicate that mature and less disturbed riverine forests with large-sized trees are needed for the conservation of this species.

Key words: *Crested Serpent-eagle, Spilornis cheela, Kolli Hills, India nest site selection*

Introduction

Nest-site selection involves discrimination between alternative sites that provide different sets of habitat characteristics affecting survival and reproduction. Thus, understanding nest-site selection is helpful for the management of species of concern. However, in India, nest-site selection of birds is scantily examined. Raptors are one of the most threatened groups of birds and thus knowledge on their nest-site selection is very helpful for directing conservation activities. The Crested Serpent-eagle *Spilornis cheela*, classified as a raptor of least concern (Birdlife International 2009), is one the medium-sized, widespread and fairly common raptors on the Indian subcontinent and except for a behavioural description by Naoroji and Monga (1983) no attempt has been made to study the ecology on this species. An attempt was made to study the nest-site selection of Crested Serpent-eagle in Kolli Hills, Tamilnadu during 2005 -2007. It is also one of the commonest raptor species found chiefly in places where natural vegetation occurs in Kolli Hills.

Study area

Kolli Hills lies geographically between 11 ^{0} 11' to 11 ^{0} 30' N and 78 ^{0} 16' to 78 ^{0} 29' E and covers an area of about 485 km^2. Average rainfall ranges from 786.9 mm to 910 mm in the plains while it varies from 1188.8 mm to 1333.3 mm in the hills. On the plateau portion, temperature fluctuates from 10^0 C to 30^0 C, but in the foothills and the adjoining plains it varies from 20^0 C to 40^0 C. The total human population of Kolli Hills is about 37, 516 and a homogeneous community (about 97% of the total population), the *Malayalis*, have largely been managing the landscape of Kolli Hills. The majority of them are directly involved in agricultural activities. Among the crops cultivated, the *Cassava* dominates some parts while Millet dominates other areas. The encroachment of forests by the local people, bauxite mining, land use pattern, disturbance of water regimes, and clogging of stream channels are the prime existing threats to the fauna and flora of Kolli Hills. However, the aggressive hunter-gathering nature of the local inhabitants may not be overlooked in this issue. The following forest types have been observed in Kolli Hills. Shola forest occurs between the altitudes of 900 and 1,370 meters a.s.l. and receives ample rainfall during the north-east monsoon. *Memecylon edule, Persea marmacranth* and *Memecylon umbellatum* are the dominant tree species. The tropical dry evergreen forest occurs between 900 and 1,200 meters a.s.l. and *Ammora canarana, Canarium strictum, Syzyium cumin* and *Filicium decipiens* are the dominant tree species. Semi-evergreen forest occurs between 400 and 1,200 meters a. s. l. and *Persea macrantha, Epiprinus mallotiformis* and *Terminalia bellarica* dominate this forest type. Thorn forest occurs between 220 (foothills) and 1,100 meters a. s. l.. The dominant species is *Moringa concanensis*. Besides natural forests, plantations of eucalyptus, bamboo, tamarind and silver oak are also seen in Kolli Hills.

Methods and Materials

Searches were made on foot for nest structures by examining trees and substrates suitable for nesting. An active nest was corroborated if adults were seen performing breeding activities (nest-building or renovation, incubation, feeding the young etc.,) in or adjacent to the nest. Date of presence of eggs in the nests was recorded to measure the breeding seasonality of serpent eagles. Variables were measured at three levels: 1. Nest variables: nest-height (m), nest-length (cm), and nest-width (cm) 2. Nest-tree variables: nest-tree-height (m), and girth breast height (cm), 3. Nest-patch variables: ground-cover (%), shrub-cover (%), distance to water (rank), distance to settlement (km), and canopy-closeness(%).

The nest-patch variables were measured within a 0.07 ha circular plot centred at the nest-tree as suggested by Titus & Mosher 1981. Percentage of vegetation cover (shrub and ground) was visually estimated. The percent canopy-cover immediately over the nest was measured using a hand mirror marked with a grid. The shaded area was estimated as canopy cover (Martin & Roper, 1988). All parameters except nest measurements were compared with similar measurements at randomly selected sites to identify the factors responsible for selecting a nest-site. Random sites were selected on the basis of a place having potential as nest-site and should also be close enough to the used sites. The study area was divided into 50 x 50 m grids and numbered on an enlarged topographic map. Ten grids were selected using lot method and were identified in the study area. Once the approximate grid or site was located, the nearest tree or shrub was made the centre of the random plot. Analysis of variance (ANOVA), Mann-Whitney *U* and other simple statistics (Mean and SD) were used wherever appropriate (Sokal & Rohlf, 1981). Mann-Whitney *U* was performed on ranked variables to compare nest-sites and random sites. Results are reported significant if associated with a value of $p < 0.05$.

Results and Discussion

Although 27 nests of Crested Serpent-eagle were located in Kolli Hills, the present work was based on 16 nests only as they had good accessibility to study. No nest was constructed afresh by Serpent eagles during the entire study period but old nests were found renovated for use (N=16). All the nests were renovated mostly in December with fresh twigs and branches. Fresh green leaves were found inside the nest in some cases (N=9) during the initial period of incubation and in all the cases during the later stage of incubation. Replacement of old leaves with new during the fledgling period was also observed. Reason for the use of green material inside the nest concurs with Nores & Nores (1994) that it may be a strategy to diminish infestation by ectoparasites. Traditional use of the same nest-site every year by the same individual has also been observed by Collias & Collias (1984). This strategy is adopted probably to avoid spending energy in constructing massive nests. Both the sexes were involved in the nest renovation activity. Clutch size was invariably single for all the cases. The mean incubation period was 38.5 days (range 37 to 42 days, N=16). Incubation was done purely by the female. The male often guarded the nest when the female left the nest for foraging. The mean fledging period was 62 days (range 59-65 days, N=16).

Nests were found largely along the riverine patches on tree species, namely *Terminalia bellirica (6), Dalbergia latifolia (8), Tectona grandis (1), Lagerstroemia lanceolata (5), Mangifera Indica (6),* and *Bombax ceiba* (1). Nests were mostly located in the upper one-third portion of a tree where two or more lateral branches extended from the trunk to form a platform. The nests were placed at a mean height of 17.5 m (range 15.4 to 23.4 m, N=16) from the ground level (Table 1). The mean length and width of the nests were 104.5 cm and 59.8 cm respectively (Table 1).

Analysis of variance and other non-parametric statistics indicated that the Crested Serpent-eagle did not select nest-sites randomly in Mudumalai Wildlife Sanctuary. The sites were selected to fulfill specific nesting requirements. Of the environmental variables, except ground cover and shrub cover, all others (nest-tree height ($F=18.55$, $p=0.0004$); nest-tree girth at breast height ($F=6.0375$, $p=0.0244$); distance to water ($U= 12.0$, $p=0.0006$); distance to settlement ($U= 12.0$, $p=0.0048$); and canopy-closeness ($U=0.5$, $p=0.0001$)) differed significantly between nest-sites and random-sites (Table 1).

These results indicate that the Crested Serpent-eagle selects the site with microhabitat features such as availability of larger and broader trees, open space, proximity to water source, and farther from human settlement. The explanation for selecting the broader (larger GBH) and taller trees concur with earlier studies reporting that the

Table 1. Nest-site characteristics of the Crested Serpent-eagle in comparison with random-site characteristics.

Variables	Nest-plot (n=16)		Random plot (n=16)		p=
	Mean	SD	Mean	SD	
Nest-height (m)	17.5	2.8	-	-	-
Nest-length (cm)	104.5	47.5	-	-	-
Nest-width (cm)	59.8	12.8	-	-	-
Nest-tree-height (m)	22.1	2.3	15.6	3.3	<.01
GBH (cm)	298.7	60.5	208.75	90.2	<.05
Ground-cover (%)	23.6	14.8	44.62	33	ns
Shrub-cover (%)	41.4	16.2	42.75	17.9	ns
Distance to water (rank)	1	0	1.75	0.4	<.01
Distance to settlement (km)	3.7	1.5	1.4	0.8	<.01
Canopy-closeness (%)	77.6	4	42.12	15.5	<.01

ns=not statistically significant

larger Accipiters apparently use larger trees to support the massive nests (Shiraki, 1994; Siders & Kennedy, 1996). Moreover, nest placement between tree branches and trunks facilitates adults to make frequent trips to nests with food, and young to fledge. Brown & Amadon (1968) stated that a nest was in a situation allowing the parents free flight into and out of the nest. The Crested Serpent-eagle needs wider avenues of approach to the nest and thus nests were positioned higher in the forest canopy for the improvement of accessibility. Moreover, the eagle is a perch hunter and selection of open habitat would facilitate its accessibility and vigilance over the nest and also the prey. Selas (1997) reported that for larger species, nest-site selection may be a response both to nest predation risk, microclimate, foraging habitat and food supply.

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BARN OWL PREDATORY BEHAVIOR AND RESPONSE TO PREY ABUNDANCE: TOWARDS AN ECOLOGICALLY-BASED AGRICULTURAL PRACTICE

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Abstract: Although Malaysian Barn Owls (*Tyto alba javanica*) were once considered vagrants, they are now the most common owl species in Malaysia. Their proliferation is largely due to the expansion of agricultural lands in which prey is abundant and nest boxes are made available for them to roost and breed. However, their role in regulating rodent populations is not fully understood and chemical control of rodents is concurrently being used in most plantations leading to other environmental problems including secondary poisoning and bait resistance. This study aimed to detect differential predation and functional and numerical responses of Barn Owls to changes in prey abundances, which are important determinants of effective biological control agents. Over 25,200 trap-nights in an oil palm plantation, a total of 1,292 individual rats were captured; these were mostly *Rattus rattus diardii*, followed by *Rattus argentiventer* and *Rattus tiomanicus*. Based on 203 owl pellets, the birds fed primarily on *R. r. diardii*, the species that was most frequently trapped. There was no clear selection of prey by Barn Owls with respect to size and sex of prey. There was a significant positive relationship between the relative abundance of rats and the number of owl pellets collected, and higher rat abundances during the owls' breeding months. This suggests a functional and a numerical response of Barn Owls to changes in prey abundance. Although we found no evidence of differential predation by Barn Owls they did show functional and numerical responses to prey numbers. Hence they could provide successful biological control of rodents and this should be properly accounted in ecologically-based management of the oil palm agroecosystem which would minimize the adverse effects of chemical usage.

Key words: *Tyto alba, Rattus rattus diardii, prey selection, predatory responses, oil palms, Malaysia*

Introduction

Although the Malaysian Barn Owl (*Tyto alba javanica*) was first considered as a vagrant in Peninsular Malaysia, birds began to proliferate following the increase in rats with the advent of oil palm plantations (Lenton 1980b and 1984). Biological control of rats in oil palm plantations using Barn Owls has been assumed to be successful, as their diet consists principally of rats (Lenton 1980a, Smal 1990). At present, however, many agricultural enterprises still rely on chemical control of rats. Long term poisoning may not be practical because it leads to the development of resistant rat populations (Hafidzi 1994, Baker *et al.* 2007) and kills non-target animals (Stone *et al.* 1999, Baker *et al.* 2007).

In the wild predators that demonstrate a predatory preference, i.e. with respect to prey size and sex may affect prey numbers and community structure (Dickman *et al.* 1991) and thus disrupt population dynamics. In addition, the impact of predators on their prey is also determined by how the predators respond to changes in prey numbers, both functionally and numerically. The response of individual predators to changes in prey densities, usually in terms of their feeding behaviour, is known as the functional response (Caughley and Sinclair 1994). The numerical response describes the way in which predator population size responds to the changes in prey density either through reproduction, immigration and/or emigration.

Both functional and numerical responses in addition to differential predation are important factors in the regulation of prey numbers (Sinclair *et al.* 1990, Pech *et al.* 1992, Sinclair and Pech 1996). Hence, this study aimed to detect differential predation and functional and numerical responses of Barn Owls to changes in prey abundances, which are important determinants of the effectiveness of biological control agents.

Methods and Materials

The study was conducted in the Labu Estate (2°45'N, 101°49'E) in the southwest of Peninsular Malaysia. The 2,569 ha plantation has nest boxes installed at a density of one nest box per 10 ha for Barn Owls. A total of six 5 ha study plots located more than 800 m apart, were established in the plantation. A total of 200 cage traps (280 x 140 x 100 mm; 10-20 mm mesh) was set at each study plot for three nights during each trapping session, with trapping sessions conducted every eight weeks (from November 2007 to December 2008). Traps were arranged in pairs in a 10 x 10 lattice, with pairs of traps 30 m apart. Animals captured were identified, measured, marked and weighed. An index of the relative abundance of rats was calculated based on the number of unique individuals trapped during each trapping session. An occupied nest box that was present in each plot was monitored and had the clutch sizes and numbers of eggs hatched and nestlings recorded.

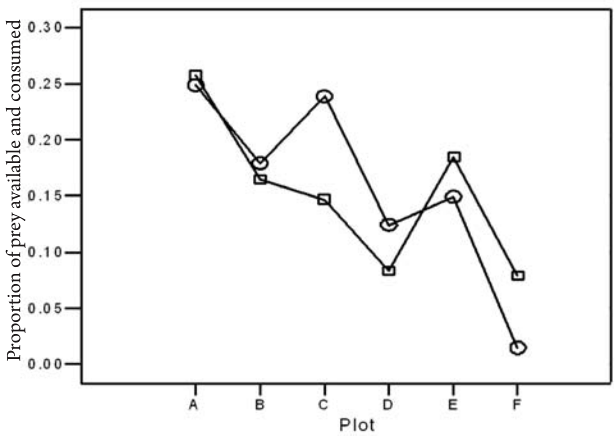
Another 112 animals trapped over 2,400 trap nights in the same year were euthanized and used as reference specimens. These animals were weighed to the nearest gram and major bones from these specimens were retrieved and measured. Owl pellets were collected over the same period (November 2007-December 2008) from all nest boxes and put into plastic bags labeled by date and nest box. Pellets were dried at 60°C for at least 48 hours, and then soaked in 0.5 M NaOH before they were teased apart and their contents examined. Predictions of weight (Morris 1979, Yalden 2003), size, and sex (Brown and Twigg 1969, Moyer *et al.* 1984, Dickman *et al.* 1991, Trejo and Guthmann 2003) of *R. r. diardii* found in pellets were made based on bone measurements, i.e. dentary length, femur length, and dimensions of pelvises of the reference specimens.

Results

Over 25,200 trap-nights, a total of 1,292 individual rats were captured and 203 pellets were collected from the six plots. The majority of captures were of *Rattus rattus diardii* (64.16%), followed by *Rattus argentiventer* (31.66%) and *R. tiomanicus* (3.46%) (Table 1). The male : female ratios in captured and pellet samples were 0.920 and 0.571 respectively. There was no significant difference between these sex ratios ($\chi^2 = 2.238$, $p = 0.135$). Predicted body weights using 62 jaw and 84 femur bones from pellets ranged from 16.23-261.94 g, with a mean of 117.97 ± 4.43 (SE) g. Over the trapping period 829 *R. r. diardii* that were live-trapped had weights ranging from 21.00-280.00 g, with a mean of 135.37 ± 1.36 g. There was no significant difference between the distributions of weights estimated from pellets and those measured from the actual rats captured (Kolmogorov-Smirnov *Z* statistic = 0.769, $p = 0.596$).

Partial correlation analysis indicated a significant positive relationship between the indices of rat abundance and the numbers of pellets recorded at each plot for each trapping session ($r = 0.339$, $p = 0.035$). The relative proportions of prey species available to the owls as measured by trapped samples, and proportions of prey taken based on pellets, also varied between study plots. A clearer pattern in the proportions of prey available and consumed by owls at each plot was observed when data from both trapped animals and pellets were pooled (Figure 1).

Figure 1. Proportions of prey available to and consumed by Barn Owls based on pooled data from trapped samples (□) and pellets (○).



This suggests that the proportion of prey consumed in each plot was similar to the proportion of prey available based on the total number of pellets and rats obtained in all plots combined; there was a positive but non-significant correlation between the two sets of (arcsine square-root transformed) proportions ($r = 0.771$, $p = 0.072$).

At this study site one owl breeding cycle was completed at the end of each year thus two breeding seasons were recorded in this study (Table 2). At the first breeding event, eggs were found in four out of the six occupied nest boxes with four to six eggs in each nest and a mean number of young surviving to fledging of 3.3 ± 0.97 SE. During the second breeding round, four out of the six nest boxes were occupied but only one active nest with four eggs was recorded. All eggs in that nest successfully hatched

Table 1. The numbers of the rats captured and their measurements (means ± SE)

Species	Sex	n	Weight (g)	Head-body length (mm)	Tail length (mm)	Hind foot length (mm)
Rattus rattus diardii	M	392	125.9 ± 41.8	165.4 ± 25.9	161.7 ± 20.8	32.6 ± 2.7
	F	426	144.2 ± 45.4	165.1 ± 21.6	176.8 ± 24.0	32.6 ± 2.4
Rattus argentiventer	M	180	132.1 ± 58.8	163.4 ± 32.6	159.9 ± 26.3	32.4 ± 3.5
	F	226	128.7 ± 48.0	151.7 ± 24.5	163.2 ± 26.9	32.0 ± 3.1
Rattus tiomanicus	M	25	109.0 ± 32.5	161.2 ± 25.2	155.2 ± 17.0	32.3 ± 2.7
	F	19	124.9 ± 35.1	157.3 ± 18.4	174.4 ± 17.5	32.4 ± 2.8

Table 2. Breeding statistics for each nest box during each breeding season

	First breeding round			Second breeding round		
Plot	Adults	Clutch size	No. of hatchlings	Adults	Clutch size	No. of hatchlings
A	Present	4	4	Present	0	0
B	Present	4	3	Present	0	0
C	Present[a]	0	0	Present	0	0
D	Present[a]	0	0	Absent	0	0
E	Present	6	6	Present	4	4
F	Present	4	0	Present[b]	0	0

Abbr.: [a]Pairing of birds was observed;
[b]Although no birds were observed at time of survey,
their presence was evidenced by fresh pellets collected at nest box.

and fledged. Indices of rat abundance were significantly higher during the bird breeding months than during non-breeding months (breeding: mean of abundance indices = 7.3 ± 3.2; non-breeding: 4.9 ± 4.5; Mann-Whitney Z = -2.542, p= 0.011).

Discussion

The Barn Owls in the studied plantation did not show a clear selection of prey by size or sex classes, at least for *R. r. diardii*. Nonetheless, this study suggested that Barn Owls showed some degree of functional and numerical responses to rat abundance in this oil palm plantation. A functional response was suggested by a positive and significant relationship between the relative abundance of rats captured and number of pellets regurgitated in nest boxes. This implies that there is a tendency for owls to take more rats when rats were abundant. However, an empirical study involving manipulation of the number of rats available to the owls is needed to confirm a functional response. A comparison between study plots using pooled data indicated that the owls fed proportionally according to prey availability over different plots (Figure 1).

A numerical response of Barn Owls was suggested by higher breeding records when rat abundances were significantly higher during breeding events. This implies a tendency for the owls to breed when rats were abundant. However, it should be noted that the owls in the study site only breed once a year and this may, to some extent, reduce the ability of the owls to respond numerically to the rats. A study in Peninsular Malaysia (Lenton 1984) indicated that at some specific sites the owls' breeding season occupied several months, but also that across all sites there was breeding by owls in all months of the year. The reasons for this remain unknown and await further investigation. At the first breeding round in this study, clutch size ranged from four to six with a mean of 3.3 ± 2.5 (1 SD) young surviving to fledging, which is similar to that recorded in Lenton (1984) (3.7 ± 2.2). In addition, the fledging rate was higher at study plots where rat abundance was high.

The contents of about one third (33.50%) of the pellets collected were unidentifiable. Regardless of whether the pellets were produced by adults or chicks, many pellets were fragmented and this caused difficulties in identification. In some cases Barn Owls have been known to decapitate and feed only on the head of a prey item (Lenton 1984). Pellets consisting of juvenile prey may often have been fragile and broken when recovered. Thus, pellets may underestimate both the feeding rate of owls and the proportion of smaller prey (Lowe 1980). It should be stressed that analyses in this study were solely based on pellets retrieved at nest boxes with the assumption that the same bird or pair roosted in the same nest box and pellets were deposited evenly across roosting points besides nest boxes. Although further investigation is needed due to the low sample sizes, this study suggests that the feeding and breeding of Barn Owls may vary according to changes in rodent numbers. This response of Barn Owls to rodent abundance suggests that the birds provide a practical option for rodent pest management in this commercial oil palm plantation, at least as part of a multi-pronged pest control program.

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CURRENT STATUS OF DIURNAL RAPTORS IN INDONESIA AND ITS CONSERVATION CHALLENGES

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Abstract: There are 81 species of diurnal raptors found in Indonesia and, depending on taxonomic views, 10 to 17 of these are endemic. This high endemism among raptor species reflects diversity and uniqueness of their habitats, which is dominated by tropical rainforests. Indonesia is also the wintering area of many raptor species from the northern third of eastern Asia. Unfortunately, rampant habitat loss and illegal trade have resulted in threatened status (IUCN, 2009) for some species. Two are listed as Critically Endangered (Flores Hawk-eagle *Spizaetus floris* and Bawean Serpent-eagle *Spilornis baweanus*), one Endangered (Javan Hawk-eagle *Nisaetus bartelsi*), and four Vulnerable (New Guinea Harpy Eagle *Harpyopsis novaeguineae*, Greater Spotted Eagle *Aquila clanga*, Wallace's Hawk-eagle *Spizaetus nanus*, and Mountain Serpent -eagle *Spilornis kinabaluensis*). Further, four species are listed as Near Threatened (Gurney's Eagle *Aquila gurneyi*, Lesser Fish -eagle *Ichthyophaga humilis*, Grey-headed Fish-eagle *Ichthyophaga ichthyaetus* and White-fronted Falconet *Microhierax latifrons*). This paper will describe and discuss two main raptor related topics, current status of all diurnal raptors in Indonesia highlighting species account, endemism and migration, and population threats to raptors in the country.

Key words: *diurnal raptor, endemic, migration, threats and conservation status*

Introduction

Indonesia is an archipelagic country comprising 17,508 islands. Indonesia's size, tropical climate, and geography, support the world's second highest level of biodiversity (after Brazil), and its flora and fauna is a mixture of Asian and Australasian species. The total number of birds listed in the recent Indonesian Bird Checklist (IBC) published by the Indonesian Ornithologists' Union (Sukmantoro *et al*. 2007) stands at 1,592 species, ranking fourth in the world. Of this, 372 (23.28%) are endemic and 149 (9.32%) are known to be migratory. IBC listed 70 species of diurnal raptor with 10 endemic species found in Indonesia. Bildstein *et al*. (1998) and Ferguson-Lees and Christie (2005) listed 16 and 17 species of raptors respectively being endemic to Indonesia. This raptor endemism is the highest in the world and reflects biodiversity richness possessed by the region. More importantly, this archipelago should be viewed as being the world's top priority for conservation of the tropical rainforests on which those raptors are exclusively dependent.

In this paper, I will discuss principle raptor related topics: current status of all diurnal raptors in Indonesia highlighting species account, endemism, migration and population threats to raptors. Their status will be assessed to find out the existing conservation problems, challenges facing the species and necessary actions on their behalf.

Methods and Materials

To assess the status of the raptors in Indonesia, we read all relevant ornithological literatures available, including on-line resources. For this paper, species account is arranged following Ferguson-Lees and Christie (2005) but in order to be consistent and compatible with the regional list (IBC), which is based on Peters (1934-1986), we added the number of species (superscript) applied by IBC to each species for further cross-checking. While species with asterisk (*) means that it is new to the list or not in IBC. This is also meant to be practical in view of conservation as well as to accommodate newly published findings. For the endemism and migratory status we additionally refer to Zalles and Bildstein (2001) and Bildstein (2006). To assess the conservation status of a species, we apply the IUCN Red List category (2009) which is also adopted by BirdLife International (2009) and the Global Raptor Information Network (GRIN 2010).

Results and Discussion

Species accounts. In Indonesia, 81 species of diurnal raptors, 10-17 of which are endemic to the country, are known to occur (Bildstein *et al.* 1998, Ferguson-Lees and Christie 2005, Sukmantoro *et al.*, 2007), and about 60% are forest-dependent raptors being dominated by members of the genera *Accipiter, Falco*, *Spilornis* and *Spizaetus.* Given high bird diversity and endemism, the country needs to set a nationally consistent taxonomic checklist to be used as the basis for much of its conservation priority setting. In reality it is difficult. BirdLife's checklist (BirdLife International 2009) for instance, which has been adopted in many bird conservation publications in Indonesia (i.e., BirdLife's Endemic Bird Area project, and subsequently for BirdLife's Important Bird Areas programme) is mainly based on Sibley and Monroe (1990, 1993) but Indonesian ornithological journal (Kukila) and the IBC use a species list based on Peters (1934-1986). This difference could potentially affect conservation priorities designed by the country, in particular when having to deal with endemism and migratory status. We follow the raptor species list by Ferguson-Lees and Christie (2005) to be used as the basis to describe raptor diversity in Indonesia (see Table 1).

This is simply done for two reasons: Ferguson-Lees and Christie (2005) include quite comprehensive raptor information of the country and the resource is specificly based on raptors.

We have updated the list proposed by van Balen (1998a) who listed 68 species. Two additions to van Balen's list are *Spilornis kinabaluensis* and *Spizaetus floris* (Sukmantoro *et al.* 2007). *S. kinabaluensis* was known to be endemic to northern Borneo outside of Indonesian territory but recent findings (van Balen 1998b) have revealed that the species is found in the Indonesian territory. *Spizaetus floris* which has been given a new genus name: *Nisaetus* (Haring *et al.* 2007), was a subspecies of *Spizaetus cirrhatus floris* but has been raised to full species by Gjershaug *et al.* (2004). A third new addition is the White-fronted Falconet *Microhierax latifrons* that occurs only in NE Borneo (Dickinson 2003, Ferguson-Lees and Christie 2005), and which has been discovered by Irham (in pers. com.) in E Kalimantan. Then, the fourth addition to the list is Himalayan Griffon *Gyps himalayensis* on Sumatra (Li and Kasorndorkbua 2008). Relevant note on the species from Sumatra is also to be published by Iqbal (in press.).

Ferguson-Lees and Christie (2005) listed 79 species found in Indonesia but we added two species (Table 1). The list also includes Eastern Honey-buzzard *Pernis orientalis,* five members of the Crested Serpent-eagle complex (*Spilornis abbotti*, *S. asturinus*, *S. sipora*, *S. natunensis* and *S. baweanus*). Further, two Accipiters, Varied Goshawk *Accipiter hiogaster* and Grey-throated Goshawk *Accipiter griseogularis*, and one member of genus *Spizaetus* (Simeulue Hawk-eagle *Spizaetus vanheurni*). These nine species are still treated as subspecies by Sukmantoro *et al.* (2007).

Endemism. Here, endemic species are raptors whose overall ranges are limited to one or two countries (Bildstein 1998). Endemism in the region is high. Falconiforms in rainforests comprise 111 species and 280 subspecies (Thiollay 1985). Ninety-one percent of all endemic tropical raptors (51 of 58 species) occur on the islands, mainly in the Indian and South Pacific oceans, Indonesia (17), Papua New Guinea (14), and Madagascar (11) (Bildstein *et al.* 1998, Ferguson-Lees and Christie 2005). Dickinson (2003) recognized 42 subspecies of raptors exclusively inhabiting the islands of Indonesia. Endemic raptors found in Indonesia are presented in Table 1.

Raptor Migration. At least 162 (55%) and possibly as many as 193 (67%) of the world's 294 species of raptors are migratory (Bildstein *et al.* 2006). Kerlinger (1989) classified this migration into three types: complete migrants (19 species), partial migrants (104 species), and local migrants (60 species). Asia holds the highest number of migratory raptors (66 species) and in Indonesia. Forty-two species (26%) of diurnal raptors (complete 6, partial 27 and irruptive 7) are believed to migrate in at least part of their range (Zalles and Bildstein 2000) as shown in Table 1. Data on this raptor migration are still largely lacking from the eastern part of the archipelago.

Before arriving in Indonesia, migratory raptors from breeding areas in the northern third of eastern Asia take two major routes (Germi *at al.* 2009, Bildstein 2006): the East Asian Continental Flyway (EACF) and the East Asian Oceanic Flyway (EAOF). The latter flyway is still largely unknown (White and Bruce 1986, MacKinnon and Phillipps 1993, del Hoyo *et al.* 1994, Coates and Bishop 1997, Ferguson-Lees and Christie 2001). Just recently, Germi *et al.* (2009) published his study on migratory raptors held on Sangihe island, northern Sulawesi. For EACF, rather systematic counts for Sumatra, Java, and Bali have been carried out by Indonesia Raptor Research and Conservation Network and committed individuals (Nurza *et al.* 2009, Sukmantoro *et al.* 2009).

Species and Threats. Based on the traditional-six avifaunal regions of Indonesia, Sumatra (S), Kalimantan (K), Java (J), Sulawesi (S), Maluku (M), Nusa Tenggara (NT), and Papua (P), we discuss threats to these raptors and conservation challenges in each region (Figure 1).

Table 1. List of raptors of Indonesia based on Ferguson-Lees and Christie (2005).

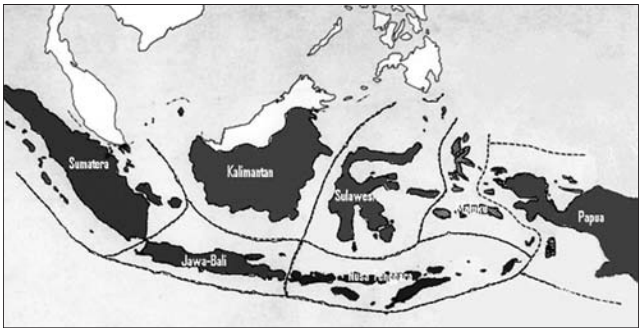
No	Falconiformes	Scientific Name	CE	Migration			IUCN	Sources and notes
				C	P	I		
1	Osprey[73]	*Pandion haliaetus*		+			LC	1
2	Jerdon's Baza[74]	*Aviceda jerdoni*			+		LC	1
3	Pacific Baza[75]	*Aviceda subcristata*			+		LC	1
4	Black Baza[76]	*Aviceda leuphotes*			+		LC	1
5	Long-tailed Honey-buzzard[77]	*Henicopernis longicauda*					LC	1
6	Eastern Honey-buzzard*	*Pernis orientalis*		+			LC	1 as *Pernis ptilorhyncus*
7	Indomalayan Honey-buzzard[78]	*Pernis ptilorhynchus*					LC	1
8	Barred Honey-buzzard[79]	*Pernis celebensis*					LC	1
9	Bat-hawk[80]	*Macheiramphus alcinus*					LC	1
10	Black-shouldered Kite[81]	*Elanus caeruleus*			+		LC	1
11	Black Kite[82]	*Milvus migrans*			+		LC	1
12	Whistling Kite[83]	*Haliastur sphenurus*			+		LC	1
13	Brahminy Kite[84]	*Haliastur indus*			+		LC	1
14	White-bellied Fish-eagle[85]	*Haliaeetus leucogaster*				+	LC	1
15	Lesser Fishing-eagle[86]	*Ichthyophaga humilis*			+		NT	1
16	Grey-headed Fishing-eagle[87]	*Ichthyophaga ichthyaetus*					NT	1
17	Himalayan Vulture*	*Gyps himalayensis*						1,2,3
18	Short-toed Snake-eagle[88]	*Circaetus gallicus*		+			LC	1
19	Crested Serpent-eagle[89]	*Spilornis cheela*				+	LC	1
20	Simeulue Serpent-eagle*	*Spilornis abbotti*	+				DD	2
21	Nias Serpent-eagle*	*Spilornis asturinus*	+				DD	2
22	Mentawai Serpent-eagle*	*Spilornis sipora*	+				DD	2
23	Natuna Serpent-eagle*	*Spilornis natunensis*	+				DD	2
24	Kinabalu Serpent-eagle[90]	*Spilornis kinabaluensis*	-				VU	1,2
25	Bawean Serpent-eagle*	*Spilornis baweanus*	+				CR	2 (As *S. baweanus* is regarded as a race of the widespread Spilornis cheela by BirdLife International, its conservation status is not treated by them)
26	Sulawesi Serpent-eagle[91]	*Spilornis rufipectus*	+				LC	1
27	Western Marsh Harrier[94]	*Circus aeruginosus*			+		LC	1
28	Eastern Marsh Harrier[95]	*Circus spilonotus*			+		LC	1
29	Australasian Marsh Herrier[96]	*Circus approximans*			+		LC	1
30	Spotted Harrier[92]	*Circus assimilis*			+		LC	1
31	Pied Harrier[93]	*Circus melanoleucos*			+		LC	1
32	Crested Goshawk[97]	*Accipiter trivirgatus*				+	LC	1
33	Sulawesi Crested Goshawk[98]	*Accipiter griseiceps*	+				LC	1
34	Shikra[99]	*Accipiter badius*			+		LC	1
35	Chinese Sparrowhawk[100]	*Accipiter soloensis*		+			LC	1
36	Spot-tailed Sparrowhawk[101]	*Accipiter trinotatus*	+				LC	1
37	Grey Goshawk[103]	*Accipiter novaehollandiae*					LC	1
38	Varied (Variable) Goshawk*	*Accipiter hiogaster*					LR	2 (it is treated as subspecies of *A. novaehollandiae* by Dickinson (2003). LR=Lower Risk
39	Grey-throated Goshawk	*Accipiter griseogularis*					DD	2
40	Brown Goshawk[102]	*Accipiter fasciatus*				+	LC	1

41	Black-mantled Goshawk[104]	*Accipiter melanochlamys*					LC	1
42	Moluccan Goshawk[105]	*Accipiter henicogrammus*	+				LC	1
43	Grey-headed Goshawk[106]	*Accipiter poliocephalus*					LC	1
44	Japanese Sparrowhawk[107]	*Accipiter gularis*			+		LC	1
45	Besra[108]	*Accipiter virgatus*			+		LC	1
46	Sulawesi Small Sparrowhawk[109]	*Accipiter nanus*	+				NT	1
47	Mollucan Sparrowhawk[111]	*Accipiter erythrauchen*	+				LC	1
48	Collared Sparrowhawk[110]	*Accipiter cirrhocephalus*					LC	1
49	Vinous-breasted Sparrowhawk[112]	*Accipiter rhodogaster*	+				LC	1
50	Meyer's Goshawk[113]	*Accipiter meyerianus*					LC	1
51	Chestnut-shouldered Goshawk[114]	*Erythrotriorchis buergersi*					DD	1
52	Doria's Hawk[115]	*Megatriorchis doriae*					NT	1
53	Rufous-winged Buzzard-hawk[116]	*Butastur liventer*					LC	1
54	Grey-faced Buzzard-hawk[117]	*Butastur indicus*		+			LC	1
55	Common Buzzard[118]	*Buteo buteo*			+		LC	1
56	New Guinea Eagle[119]	*Harpyopsis novaeguineae*					VU	1, 2
57	Indian Black Eagle[120]	*Ictinaetus malayensis*			+		LC/ LR	1/ 2
58	Greater Spotted Eagle[123]	*Aquila clanga*		+			VU	1
59	Gurney's Eagle[121]	*Aquila gurneyi*					NT	1
60	Wedge-tailed Eagle[122]	*Aquila audax*				+	LC	1
61	Bonelli's Eagle[124]	*Hieraaetus fasciatus*			+		LC	1
62	Booted Eagle[125]	*Hieraaetus pennatus*			+		LC	1
63	Little Eagle[126]	*Hieraaetus morphnoides*				+	LC	1 Papuan race weiskei given species status by Gjershaug *et al.* (2009)
64	Rufous-bellied Hawk-eagle[127]	*Hieraaetus kienerii*			+		LC	1
65	Changeable Hawk-eagle[128]	*Spizaetus limnaeetus*				+	LR	2
66	Simeulue Hawk-eagle*	*Spizaetus vanheurni*					LR	2 as *S. cirrhatus vanheurni*
67	Flores Hawk-eagle[129]	*Spizaetus floris*	+				CR	1
68	Blyth's Hawk-eagle[132]	*Spizaetus alboniger*					LC	1
69	Javan Hawk-eagle[130]	*Spizaetus bartelsi*	+				EN	1
70	Sulawesi Hawk-eagle[131]	*Spizaetus lanceolatus*	+				LC	1
71	Wallace's Hawk-eagle[133]	*Spizaetus nanus*					VU	1
72	Black-thighed Falconet[134]	*Microhierax fringillarius*					LC	1
73	White-fronted Falconet	*Microhierax latifrons*					NT	1, 4
74	Common Kestrel[136]	*Falco tinnunculus*			+		LC	1
75	Mollucan Kestrel[137]	*Falco moluccensis*	+				LC	1 (Distributed in nearly all parts of Indonesia and East Timor)
76	Australian Kestrel[138]	*Falco cenchroides*			+		LC	1
77	Northern Hobby[139]	*Falco subbuteo*		+			LC	1
78	Oriental Hobby[140]	*Falco severus*			+		LC	1
79	Australian Hobby[141]	*Falco longipennis*			+		LC	1
80	Brown Falcon1[35]	*Falco berigora*			+		LC	1
81	Peregrine Falcon[142]	*Falco peregrinus*			+		LC	1

Abbreviations: CE=Country Endemic, C=Complete migrant, P=Partial migrant, I=Irruptive migrant.
Species with numbers are also listed in IBC (Sukmantoro et al. 2007) and species with asterisks are not.
1= IUCN Red List of Threatened Species (2010), 2= Global Raptor Information Network (2010).
3= Li and Kasorndorkbua (2008), and 4=Muhammad Irham (in prep.)
CR=Critically Endangered, EN=Endangered, VU=Vulnerable, LR=Lower Risk, NT= Near Threatened,
DD=Data Deficient, and LC=Least Concern.

Sumatera. The larger part of the Sumatran lowland rainforest has been logged or is under a production regime (van Balen 1998a). Sumatra was also the hardest hit by the destructive tsunami in 2004, but the negative impacts of such events on raptor populations are still unclear. The fate of a Nias island endemic subspecies, *Spizaetus nanus stresemani* seems to have been overlooked and no recent information is available. Comprehensive studies focused on the species and their dependence on forests are needed, in particular on small islands with some endemic raptors (see Table 1). Sumatra, i.e. Rupat island, is also an important passage and wintering area for southern bound migratory raptors from northern temperate regions. Migratory raptors the Eastern Honey-buzzard was reported passing through this island in large numbers by Sukmantoro (in pers. com.). The newest finding is a breeding pair of Shikra in Aceh that confirms the presence of a small resident population in northern Sumatra (Nurza *et al.* 2009). Habitat loss by logging, illegal trade and hunting are major threats on the island.

Figure 1. Six avifaunal regions of Indonesia (Sukmantoro *et al.* 2007)



Kalimantan. Still extensively logged and converted into plantations. The island's endemic raptors, the Mountain Serpent-eagle and White-fronted Falconet which are restricted to the north and poorly studied in the Indonesian part of the island could be affected by such logging activities. Habitat loss by logging, illegal trade and hunting are major threats to raptor population.

Java and Bali. Largely deforested and it is now essentially a mosaic of paddy fields, cities, and villages in the lowlands. The remaining forest blocks (c. 10%) are now in the form of national parks, protected forests, and recreational forests (Sujatnika *et al.* 1995). Because of extreme habitat fragmentation and illegal trade, the endemic Javan Hawk-eagle is considered to be Endangered (Collar *et al.* 1994). The other endemic Bawean Serpent Eagle (Ferguson-Lees and Christie 2005) is even classified as Critically Endangered (GRIN 2009). The latter species is not recognized as a full species by BirdLife International (2009), and IBC treats it as a subspecies. Regular monitoring is necessary in this region to make sure that the existing blocks of forest remain intact. Habitat loss, hunting, illegal trade and pesticide use are dominant threats to raptor populations on the island.

Nusa Tenggara (Lesser Sundas). This region has a newly listed Critically Endangered raptor, the Flores Hawk-eagle but the typical park landscapes seem to favor a relatively diverse raptor fauna including Short-toed Snake-eagle, Bonelli's Eagle, Variable Goshawk, and Brown Goshawk (van Balen 1998a). Habitat loss and hunting are threats to raptors on the island.

Sulawesi. Lowland and hill rainforest still covers central Sulawesi (van Balen 1998a) and montane forest is relatively untouched, although some encroachment occurs on the lower slopes (Sujatnika *et al.* 1995). The formerly common Black Kite in southwest Sulawesi for instance has now decreased in numbers (Meyburg and van Balen, 1994). This island with rich endemism of raptors should be a region priority for raptor study and conservation to enable us to assess its conservation status. Habitat loss and hunting are major threats to all species of raptors on the island.

Maluku (Moluccas). Lowland forests have rapidly disappeared, and little virgin forest remains (van Balen 1998a). These areas support Rufous-necked Sparrowhawks, Moluccan Goshawks and a number of endemic races. Given the high raptor endemism, the island should also be a region top priority for raptor study and conservation. Habitat loss and hunting are dominant threats to raptors on this island.

Papua. Beehler *et al.* (1986) wrote that no species of Papuan birds appeared truly endangered, but with one species being listed as Vulnerable (New Guinea Eagle), it indicates that environmental changes have been going on and are threatening the species' existence. Given the lack of raptor studies to assess their status, it is necessary to conduct species monitoring to ensure that they continue to survive, and conservation management should focus on preservation of the habitat (Beehler *et al.* 1986).

The main threat to raptors throughout Indonesia is the incredibly rapid habitat destruction, and the existing forests are by far the most important for all raptor species in Indonesia. Therefore, we have to encourage a comprehensive regional strategy to slow down and stop this current rate of deforestation which is the highest among all the world's major tropical regions (Sodhi *et al.* 2004).

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Short Notes

THE MONGOLIAN BIRD TAXONOMY AND RARITIES COMMITTEE AND ITS ROLE

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The Mongolian Bird Taxonomy and Rarity Committee was established in Ulaanbaatar, Mongolia in collaboration with the Mongolian Ornithological Society, Ornithological Laboratory at the National University of Mongolia, Mongolian Academy of Sciences, Mongolian Foundation of Birds of Prey, and experts of Germany and USA in February of 2011.

The committee board consists of seven members from the domestic organizations and international experts. There is more information about the board members at http://www.mongoliabirdsraritycommittee.mos.mn.

This committee generates the following activities in Mongolia;

-Accept or reject any newly-found species
-Accept or reject the record of rare species
-Review and update the Mongolian annotated bird list
-Decide the taxonomy and nomenclature of birds
-Update the National Bird Database
-Create and update the Bird Image Database
-Develop the future of the committee.

The Committee will receive all information and data on the species that were newly-found in Mongolia and records for rare birds within the country. In the field, it is important to know the species with rare and vagrant status in Mongolia. In Mongolia, a total of 65 species of vagrants were recorded (Table 1). You can also download the list of vagrant species at http://www.mongoliabirdsraritycommittee.mos.mn.

Table 1. List of vagrant species in Mongolia

Scientifc name	English or Common Name	Vagrant Status
Ixobrychus eurhythmus	Schrenck's Bittern	VA1
Nycticorax nycticorax	Black-crowned Nigth Heron	VA1
Butorides striatus	Green Heron	VA1
Bubulcus ibis	Cattle Egret	VA1
Egretta garzetta	Little Egret	VA1
Threskiornis melanocephalus	Black-headed Ibis	VA1
Phoenicopterus roseus	Greater Flamingo	VA1
Dendrocygna javanica	Lesser Whistling-duck	VA1
Aythya baeri	Baer's Pochard	VA1
Histrionicus histrionicus	Harlequin Duck	VA2
Pernis apivorus	European Honey Buzzard	VA2
Accipiter badius	Shikra	VA1
Butastur indicus	Grey-faced Buzzard	VA1
Spizaetus nipalensis	Mountian Hawk-eagle	VA1
Hieraaetus fasciatus	Bonelli's Eagle	VA1
Neophron percnopterus	Egyptian Vulture	VA3
Falco vespertinus	Red-footed Falcon	VA1
Turnix tanki	Yellow-legged Buttonquail	VA2
Porzana exquisitus	Swinhoe's Rail	VA2
Amaurornis phoenicurus	White-breasted Waterhen	VA2
Burhinus oedicnemus	Eurasian Stone Curlew	VA1
Rostratula benghalensis	Greater Painted Snipe	VA1
Chettusia gregarius	Sociable Lapwing	VA3
Heteroscelus incana	Wandering Tattler	VA2
Phalaropus fulicarius	Red Phalarope	VA1
Calidris melanotos	Pectoral Sandpiper	VA1
Limnodromus scolopaceus	Long-billed Dowitcher	VA1
Stercorarius pomarinus	Pomarine Jaeger	VA2
Stercorarius parasiticus	Parasitic Jaeger	VA1
Larus brunnicephalus	Brown-headed Gull	VA2
Larus genei	Slender-billed Gull	VA1
Larus hyperboreus	Glaucous Gull	VA1
Larus crassirostris	Black-tailed Gull	VA1
Rissa tridactyla	Black-legged Kittiwake	VA1
Rhodostethia rosea	Ross' Gull	VA1
Sterna paradisaea	Arctic tern	VA2
Eurystomus orientalis	Oriental Dollarbird	VA1
Halcyon pileata	Black-capped Kingfisher	VA1
Merops apiaster	European Bee-eater	VA2
Dendrocopos hyperythrus	Rufous-bellied Woodpecker	VA2

Melanocorypha leucoptera	White-winged Lark	VA1
Melanocorypha yeltoniensis	Black Lark	VA1
Dendronanthus indicus	Forest Wagtail	VA2
Lanius schach	Long-tailed Shrike	VA2
Dicrurus macrocercus	Black Drongo	VA1
Oriolus chinensis	Black-naped Oriole	VA2
Acridotheres cristatellus	Crested Myna	VA1
Bombycilla japonica	Japanese Waxwing	VA1
Rhopophilus pekinensis	White-browed Chinese Warbler	VA1
Pycnonotus flavescens	Flavescent Bulbul	VA1
Acrocephalus stentoreus	Clamorous Reed Warbler	VA2
Sylvia atricapilla	Blackcap	VA1
Phylloscopus armandii	Yellow-streaked Warbler	VA1
Ficedula hypoleuca	European Pied Flycatcher	VA2
Muscicapa griseisticta	Grey-spotted Flycatcher	VA2
Erithacus rubecula	European Robin	VA1
Luscinia sibilans	Rufous-tailed Robin	VA1
Suthora webbianus	Vinous-throated Parrotbill	VA1
Serinus pusillus	Red-fronted Serin	VA1
Chloris chloris	European Greenfinch	VA2
Rhodospiza obsoleta	Desert Finch	VA1
Emberiza elegans	Yellow-throated Bunting	VA1
Emberiza tristrami	Tristram's Bunting	VA1
Emberiza melanocephala	Black-headed Bunting	VA1

Abbr.:
"VA1"-only one documented or accepted record.
"VA2" -2-3 records for the country.
"VA3" -4-5 records within Mongolia.

Researchers, bird watchers, bird lovers, and other field biologists from Mongolia and overseas should send information and data on the newly- found and rare species for Mongolia to the international coordinator (S.Gombobaatar; mongolianbirds@mail.com), natioinal coordinator (Sh.Boldbaatar; boogii51@yahoo.com), and assisstant (D.Usukhjargal; usukhjargal2001@yahoo.com) of the committee after filling out the recording form at http://www.mongoliabirdsraritycommittee.mos.mn. After receiving your filled form, the coordinators and assisstant will respond to your file and document. The coordinators and assisstant distribute the file and documents to the rest of board members in order to assess your record. The board members of the committee organizes the board members' annual meeting in Ulaanbaatar in November of each year. During the board members' annual meeting, the members will make the conclusion of acceptance and rejection for every record and update the annotated Mongolian bird list.

Official information on your record's acceptance or rejection will be promptly sent to you and posted on the website, http://www.mongoliabirdsraritycommittee.mos.mn after the annual meeting. The procedure of the acceptance or rejection of your record by the committee board members will be posted at http://www.mongoliabirdsraritycommittee.mos.mn.

In order to submit your record, receive new posts and records from others, and get the updated and annotated bird list, we recommend the following:

a). send your records to the coordinators and assisstant using these email address: mongolianbirds@mail.com, boogii51@yahoo.com, usukhjargal2001@yahoo.com;

b). join in the group, mongoliabirdsyahoo.group after moderator invite you. You are able to post your records in to the group

c). write down and fill out the recording form and send your records to the Mongolian Ornithological Society, P.O.Box 537, Ulaanbaatar 210646A, Mongolia.

The annotated bird list of Mongolia and your records will be annualy published in the journal, Ornis Mongolica with your full copyright and authorship. However, in order to become an author of a drafted paper, you would edit and improve the drafted paper. Your newly-found species and records of rare species within Mongolia will be added to the annotated Mongolian bird list and Mongolian National Bird Database with your coopyright only through the acceptance of the Committee.

Conference, Meeting, Workshop , and Event

THE INTERNATIONAL SYMPOSIUM ON ASIAN RAPTORS: RAPTOR MIGRATION AND CONSERVATION IN ASIA.

ASIAN RAPTOR RESEARCH AND CONSERVATION NETWORK. 3-16 JANUARY, 2012.

The 7 International Symposium on Asian Raptors initiated by the Asian Raptor Research and Conservation Network was held in South Korea on 13-16 January, 2012. The Korean National Park Research Institute and Ornithological Society of Korea hosted the Symposium. This Symposium's title was the Raptor Migration and Conservation in Asia. From Mongolia, a total of six presentations were given on different aspects of birds in Mongolia. All presentations were published in the abstract book of the Symposium. You can download it from http://www5b.biglobe.ne.jp/~raptor/ and www.mos.mn

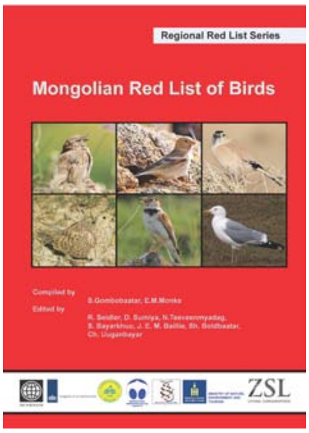
THE INTERNATIONAL SYMPOSIUM ON "BIODIVERSITY RESEARCH IN MONGOLIA" IN HALLE (SAALE), GERMANY. 25-29 MARCH 2012.

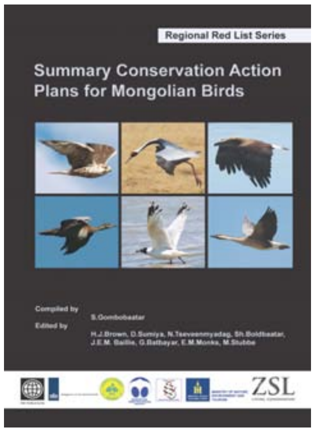
The International Symposium on "Biodiversity Research in Mongolia" was held in Halle(Saale), Germany on 25-29 March 2012. Martin-Luther University Halle Wittenberg hosted the Symposium. This Symposium was one of the largest International Symposium for Mongolian Biodiversity ever had in overseas. More than 30 delegates participated in the Symposium from Mongolia. All abstracts were published in "Erforschung Biologischer Ressourcen der Mongolei" in 2012.

New Publications

MONGOLIAN RED LIST OF BIRDS
Compiled by S.Gombobaatar and Monks, E.M. (compilers), Seidler, R., Sumiya, D., Tseveenmyadag, N., Bayarkhuu, S., Baillie, J. E. M., Boldbaatar, Sh., Uuganbayar, Ch. (editors) (2011). R*egional Red List Series Vol.7. Birds.* Zoological Society of London, National University of Mongolia and Mongolian Ornithological Society. Ulaanbaatar. Mongolia 1036 pp. (in English)

SUMMARY CONSERVATION ACTION PLANS FOR MONGOLIAN BIRDS
Compiled by Gombobaatar, S. (compiler), Brown, H.J., Sumiya, D., Tseveenmyadag, N., Boldbaatar, Sh., Baillie, J.E.M., Batbayar, G., Monks, E.M., Stubbe, M. (editors) (2011). *Summary Conservation Action Plans for Mongolian Birds. Regional Red List Series* Vol. 8. Zoological Society of London, Mongolian Ornithological Society and National University of Mongolia. 145 pp. (in English)





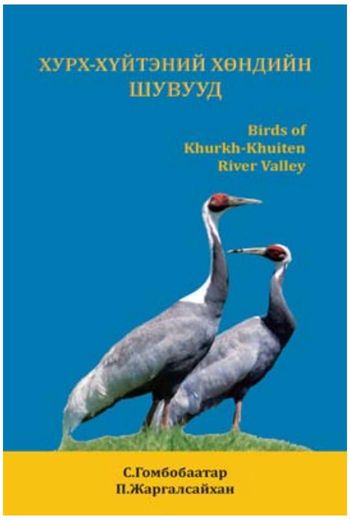
Since the first International workshops on the birds of Mongolia in 2009, authors, experts, and editors have compiled one of the challenging works on Regional Red List for Mongolian Birds. In 2011, two books, "Mongolian Red List of Birds" and "Summary Conservation Action Plans for Mongolian Birds" were published in English in Mongolia. A total of 476 species of birds were assessed using IUCN redlist criteria and categories. From the total species occurring in Mongolia, 36 species were categorized as Regionally Threatened including Near Threatened category.

All information and data for every single species occurring in Mongolia are included in the Mongolian Red List of Birds. This book also has an updated dis-

tribution map with breeding and non-breeding ranges and photographs for identification in the field for each species. The book is one of the more comperhansive books on birds of Mongolia published in English during the last century. Biology, ecology, threats and conservation measures in place and near future for every threatened species in Mongolia are given in the book, Summary Conservation Action Plans for Mongolian Birds.
You can download these books at www.mos.mn.

A FIELD GUIDE TO THE BIRDS OF KHURKH-HUITEN RIVER VALLEYS

By Gombobaatar, S. and Jargalsaikhan, P. (2011).
A Field Guide To the Birds of Khurkh-Huiten River Valleys. Mongolian Ornithological Society, National University of Mongolia, and Ministry of Nature, Environment and Tourism. Ulaanbaatar, Mongolia. 99 pp. (in Mongolian).

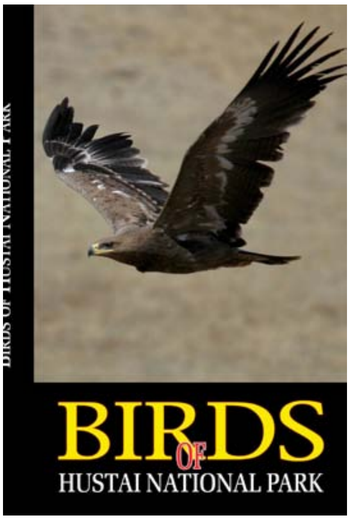


This field guide book for the region is dedicated to all the people who live in the area all year round. This book is one of the collaborative works between Mongolian Ornithological Society, Ministry of Nature, Environment and Tourism, National University of Mongolia, National Committee of Ramsar Convention, and East-Asian Australia-Asian Flyway Partnership. The colour book contains the field descriptions, status, distributioin and photographs for field identification on the most common species at the site. The guide book is written in Mongolian. Some detailed information on the book is available at www.mos.mn.

BIRDS OF HUSTAI NATIONAL PARK

By Gombobaatar, S. and Usukhjargal, D. (2011).

Birds of Hustai National Park. Hustai National Park and Mongolian Ornithological Society. Ulaanbaatar, Mongolia. 231 pp. (in English).



This field guide book is dedicated to the 20 years anniversary of the Takhi reintroduction programme in Mongolia. This book is the first field guide to the birds of the protected area in English. The book contains Breeding Information, Global and Regional Status, Food, Habitats, Body Size, Field Identification Photographs, and Distribution Maps of 200 species that occur in Hustai National Park.

INSTRUCTIONS FOR CONTRIBUTORS

TITLE (Arial 14, Caps lock, Bold)
Author's full name (Arial 14, Bold, centre)
* before corresponding author
Affiliation and address (Arial, 12, italic)
E-mail: (Arial, 12, italic)
Corresponding author (*)

Abstract: (Please write your abstract here. No more than 500 words)

Key words: (Arial, 12 italic)
Include some words from the title and others that identify:
1) common and scientific names of principal organisms in the manuscript;
2) the geographic area, usually the state, province, or equivalent, or region if its name is well known;
3) phenomena and entities studied (e.g., behavior, populations, radiotelemetry, habitat, nutrition, density estimation, reproduction);
4) methods (only if the manuscript describes a new or improved method);
5) other words not covered above but useful for indexing.

Introduction (Arial 12, Bold)
It starts with the publication name and contains a concise synthesis of literature specific to the manuscript's main topic. In the latter part of this section, state the objectives of the study and the hypotheses tested.

Methods and Materials (Arial 12, Bold)
o Methods should be clear and brief and include dates, sampling schemes, duration, research or experimental design, and data analyses.
o Cite previously published methods without explanation.
o Identify new or modified methods and explain them in bit detail.
o Include all materials, substances, apparatuses and techniques used in sufficient detail to allow other investigators to reproduce the study.
o Avoid overlapping text with information in tables and figures.
o Give references to established methods, including statistical methods (results of statistical analysis should justify the interpretations and conclusions).
o Always try to describe the magnitude of the biological effect in addition to the results of statistical analyses. That is, terms such as "fewer" or "smaller" tell us little, and stating that something was "statistically different ($p < 0.01$)" without giving the actual difference conveys little meaning to the reader.
o The preparation method, equipment, and measurements will be expressed by SI units. Avoid using trademarks and brand names of equipment and reagents.

Results (Arial 12, Bold)
o Summarize the data collected and their statistical treatment. Include only relevant data, but give sufficient detail to justify your conclusions. Use equations, figures, and tables only where necessary for clarity.

Discussion (Arial 12, Bold)
The purpose of the discussion is to interpret and compare the results.
o The discussion provides an opportunity for interpreting data and making literature comparisons.
o Begin the discussion by synthesizing your results with regard to your objectives and then relate your work to other literature and research.
o Please consider the following; relate your results to current knowledge in the issue and to your original purpose in undertaking the project: have you resolved the problem? What exactly have you contributed? Briefly state the logical implications of your results. Suggest further study or applications if warranted.
o Present your results and discussion either as two separate sections or as one combined section if it is more logical to do so.

Conclusion (if needed) (Arial 12, Bold)
o The purpose of the Conclusion section is to put the interpretation into the context of the original problem.
o Do not repeat discussion points or include irrelevant material. Your conclusions should be based on the evidence presented.

Acknowledgements (Arial 12, Bold)
o The Acknowledgments section appears immediately before References section. As simply as possible, thank those persons, other than coauthors, who added substantially to the work, provided advice or technical assistance, or aided materially by providing equipment or supplies.

References (Arial 12, Bold)
Each entry in the list should use the style Reference.
o The reference list follows The Chicago Manual of Style, fifteenth edition (Chicago: University of Chicago Press, 2003) and is organized alphabetically by the author's name.
o Article titles use the "Sentence case" style from MSWord.
o Italicize the name of a book or journal. Where URLs (web addresses) are cited, the web address may be set in Courier font. Note the following examples:
-Chiva-Gomez, R. 2003. The facilitating factors for organizational learning: Bringing ideas from complex adap-

tive systems. *Knowledge and Process Management* 10 (2): 99–114.
-Holt, J. 2004. UML for systems engineering. *A pragmatic guide to business process modelling.* Swindon: The British Computer Society. INCOSE 2006 systems engineering handbook - a guide for system life cycle processes and activities, Version 3. ed. Cecilia Haskins.
-Kamlani, D. 2005. ICT standards and the new arms race: The rule of 3 (+N). In *The standards edge: Future generation*, ed. S. Bolin, 261–68. Ann Arbor, MI: Bolin Communications.
-Temple, P., R. Witt, and C. Spencer. 2005. Standards and long-run growth in the U.K. In *The empirical economics of standards.* UK.
-Urie, A. 2005. The standardization ecosystem: Understanding organizational complexity. In *The standards edge,* ed. S. Bolin. Ann Arbor, MI: Bolin
- Bold, A. Birds of Ugii lake, Mongolia. *Amphibians, Reptiles and Birds* 2:45-51. (in Mongolian)

CITATION

(Mankins 1995); (Temple *et al.* 2005) or Temple *et al.* (2005); (Urie and Sheard 2005) or Urie and Sheard (2005)

TABLES AND FIGURES

Tables

o Submit only essential tables and figures.
o Use a Microsoft Word tabe.
o Use Arial font if use different software for the table.
o The Table shall be placed at the end of text with a title above the table.
o Each table, numbered with Arabic numerals in the order in which they are to appear, must be on a separate page with the table number and an appropriate stand-alone caption.
o Tables should have titles and sufficient experimental detail in a legend immediately following the title to be understandable without reference to the text.
o Do not submit tables if the information overlaps with information presented in the text, can be easily printed in the text with less journal space, or presents the same data in another table and a figure.
o Number tables and figures independently.
o Reference tables and figures parenthetically (Table 1, Figure 3) and avoid statements such as, "The results are shown in Tables 2-9."
o Table and figure titles must include the species or subject of the data studied and when and where (region/state and country) the data were collected.
o Do not include statistics (e.g. p-values) or other statements of results in the titles.
o Do not prepare tables for small data sets, those containing many blank spaces, zeros, repetitions of the same number, or those with few or no significant data. Put such data or a summary of them in the text.
o For data that must be shown in a table, items that provide the most important comparisons usually read vertically, not horizontally.
o Construct tables for column-width no wider than 85 mm (~3.5 inches) printing.
o Do not combine multiple tables or figures on one page.

Figures

o Should have titles and legends containing sufficient detail to make the figure easily understood.
o Begin figure on a new page immediately following the References. Each figure should have its own title, placed on the top of the figure.
o Figure size for a maximum width is 210 mm. A maximum page length would be 290 mm.
o For lettering use Arial font, 14 pt (12-14 pt inside figures is acceptable).
o Thickness of lines (including boxes) should be 0.5 pt (vary for contrast if necessary).
o Contrast between grey shades/patterns must be distinct.
o Graphs and histograms should preferably be two-dimensional with scale marks turning inwards. Most figures are either line (or computer) drawings or pictures.
o Do not submit color figures unless you are able to pay for printing. Figure captions tend to be longer than table titles because figures are not footnoted. The caption may be several sentences and include brief suggestions for interpreting the figure content.

LINE DRAWINGS AND PICTURES

o Line drawings, and scanned pictures must have sharp focus in the most important parts of the image, have high tonal contrast, and have a reference scale if size is important (if it is essentially needed).
o Letters, scales, or pointers can be drawn on the prints, but they must be of professional quality.
o All image files must have a resolution of >300 dots per inch (dpi) and for black line drawings must be 600 dpi. We will tend to not retouch or resize photos, so submit only print-quality images.

REVIEW PROCESS

o Upon receipt, the editorial staff examines a manuscript for proper style, format, and appropriate subject matter.
o If style and format are seriously flawed, the paper likely will be returned for revision. Editor's reviews are submitted electronically to authors via Scientific Committee (SC).

ACCEPTANCE AND REJECTION POLICIES

o Decision on final acceptance of manuscripts is made by editors and SC. Once a manuscript is accepted, it enters the queue for publication.

o Based on editors and SC members decision, a manuscript that is seriously flawed, poorly written, and improved after more than two revisions will be published as abstract only (not full paper).

o Page proofs of each paper are created by the Mongolian Ornithological Society and National University of Mongolia and sent to each corresponding author.

o During the page proof stage, press deadlines are fast approaching and author corrections to page proofs are urgently needed, preferably within 48 hours of their receipt.

o It is important that authors clearly communicate their recommended changes, mark proofs clearly, or describe changes in detail. Make only essential changes to page proofs.

TAXONOMY AND NOMENCLATURE

Use English and scientific names as presented in Dickinson, E. C. (ed.) 2003: The Howard and Moore Complete Checklist of the Birds of the World: Third Edition. — Princeton University Press. 1056 pp. or check BirdLife international website.

AFTER ACCEPTANCE

All manuscripts within the scope of the journal are reviewed by at least two reviewers. Authors will generally be notified of provisional acceptance or rejection within two months. The Author(s) should consider all suggestions proposed by the referees and the Editor, and make appropriate changes. Major changes pre-suppose a new review process. The Editor retains the right to modify the style and length of a manuscript; for major changes the Author(s) will be consulted. The correspondence author will receive a page proof for approval. Extensive alterations are not allowed at this stage. The journal provides a free electronic offprint in PDF format.

SAKER FALCON -NATIONAL BIRD FOR MONGOLIA

This is the first announcement of the National Bird vote result in Mongolia.
Saker Falcon (*Falco cherrug*) is the National Bird for Mongolia.

Members of the Mongolian Ornithological Society and Ornithological Laboratory of the National University of Mongolia organized a vote to decide the National Bird covering Mongolian citizens living in different provinces and cities with different age, sex and education for the last 3 years.

The results of the vote indicate Saker falcon was favored (47.5%), Mongolian Lark (15%), Gyr Falcon (12.2%), White-naped Crane (4.6%), Steppe Eagle (3.2%), Whooper Swan (2.7%), Golden Eagle (2.2%), Cinereous Vulture (1.0%), Northern Raven (0.8%), Pallas's Sandgrouse (0.6%) etc...