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Saker Falcon (*Falco cherrug milvipes* Jerdon) mortality in Central Mongolia and population threats

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Abstract

This study is important because Mongolia is the main reserve country for breeding saker falcons in the world, where they play a key role in the steppe ecosystem as a predator of a rodent pest species. This is the first study to address factors influencing egg, chick and adult saker mortality in Central Mongolia. A total of 338 eggs, fresh remains and carcasses from 194 active nests in the study areas were collected and examined. Egg, chick and adult mortality in the study areas did not differ significantly between 1998 and 2004. Deserted clutches (35.1%) and infertile eggs (30.4%) were found to be the two main factors causing reduced hatching success. Factors causing chick mortality were not significantly different each year. In 1998 - 2004, natural causes accounted for 61.1% of total mortality of Central Mongolian sakers. Human or anthropogenic factors explained 26.4% of all saker deaths. The main predator of chicks was the Eagle Owl (*Bubo bubo*). Chick mortality caused by cleaning raptor nests from poles and HPEL pylons was 21.3%. No significant differences were found between factors influencing adult saker mortality. The highest percentage of total adult saker mortality was caused by electrocution (54%). Poisoning also reduced saker numbers. The number of exported sakers has dramatically increased over the last four years. saker numbers in Mongolia are relatively high and so trappers are increasingly concentrating on this reserve. A harsh winter in 2002 caused decreased Brandt's vole (*Microtus brandti*) numbers in two study areas. The number of saker breeding pairs decreased in these study areas in 2003. The results will provide an important data source for planning saker falcon conservation strategies and activities in Mongolia.

Key words: Saker falcon, mortality, *Falco cherrug milvipes,* Mongolia

Introduction

Mongolia has four natural habitat zones, taiga, forest, steppe and Gobi desert (Batjargal *et al.,* 1995). All study areas were located in the Middle Khalkh Arid Steppe region, which contain 403 species of grasses and 63 species of bushes, out of a total of 509 species of vascular plants. Mongolia is the main reserve country for breeding Sakers in the world. Saker falcon range within the country spreads from the Mongolian Altai to the western foothills of the Great Khyangan, excluding the forested zone of Khuvsgul lake, Khentii and some forested areas of the northern Khangai (Fig.1). The Saker occurs as a common bird in our study areas. Only adult birds winter in Central Mongolia. Clutch size of the Saker falcon in Mongolia varies significantly across years (Potapov *et al.,* 2002). The distribution, number, status, diet, breeding biology, home range and migration in Mongolia were investigated during several field expeditions and have been published by Przewalskii (1876); Bianki (1915); Tugarinov (1929 & 1932); Kozlova (1930); Sushkin (1938); Dementiev & Gladkov (1951); Tarasov (1960); Dementiev (1963); Dementiev & Shagdarsuren (1964); Kozlova (1975); Piechocki (1981); Shagdarsuren (1983); Baumgart (1990, 1991); Bold *et al.* (1996); Ellis *et al. (*1996); Ellis *et al. (*1997); Sumiya & Batsaikhan (1999); Potapov *et al,*(1999, 2001a,b, 2002); Badam (2001); Sumiya *et al.* (2001); Shagdarsuren *et al.* (2001); Gombobaatar *et al.* (1999, 2000a,b, 2001, 2003). There are only a few publications on Saker mortality in Mongolia (Bold *et al.* (1998); Ellis & Lish (1999); Potapov *et al.* (1999, 2001, 2002); Shijirmaa *et al.,* 2000; Gombobaatar *et al.*, 1999,

Fig.1. Range of Saker Falcon in Mongolia

2000a, 2003; Bold & Boldbaatar, 2001). General records of Saker falcon mortality in Mongolia were written in a few historical publications based on field notes. The goals of this study were to determine the most important factors influencing the deaths of Saker falcon eggs, chicks and adult birds and to compare the differences in egg, chick and adult bird mortalities between years.

Materials and Methods

A comprehensive mortality study of the Saker falcon in Mongolia was jointly undertaken by field team members from National University of Mongolia and National Avian Research Center under a cooperative agreement signed between the Environmental Protection Agency, Ministry of Nature and Environment of Mongolia, and Environmental Research and Wildlife Development Agency, National Avian Research Center, Abu Dhabi, United Arab Emirates in 1998. Low clutch size, hatching and breeding success were recorded when the numbers of main prey such as Brandt's vole and Midday Gerbil (*Meriones meridianus*) decreased. Cannibalism also occurs in the nest during times of prey deficiency. In late autumn, starved new fledglings are easily caught by Golden eagles (*Aquila chrysaetos*) (Bold *et al.*, 1998). The influencing factors on Saker falcon populations in Mongolia are categorized as biological, non-biological and anthropogenic or direct and indirect human causes (Gombobaatar *et al.,* 1999 & 2000a). Illegal and legal trapping, throwing chicks and eggs from nests, disturbance, electricians destroying nests containing clutches and collision with cars were all classified as direct human causes. Electrocution, entangling by nest materials, steppe fire and poisoning were grouped as indirect human factors. Non-biological (strong, cold winds, spring and early summer storms) and biological factors (starvation, prey deficiency, competition for suitable nest substrates, disease, siblicide and Saker

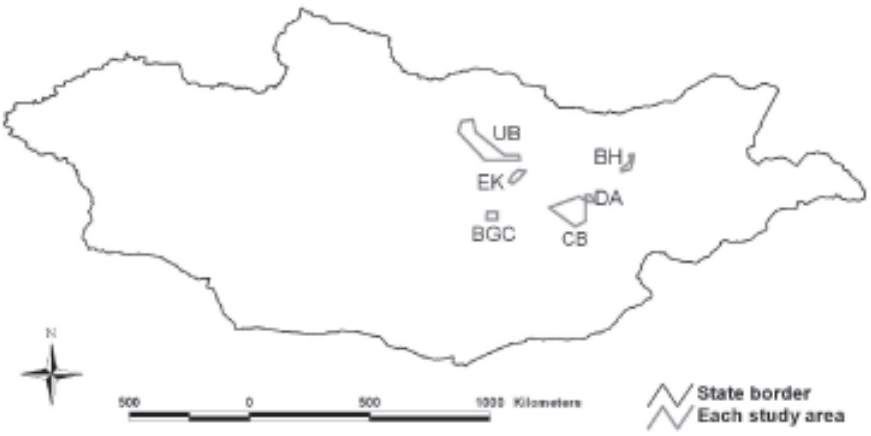

Fig.2. Location of study areas

Table 1. Collected and examined fresh remains and carcasses of Sakers in study areas from 1998 to 2004

Years	*Nests containing unhatched eggs, dead chicks and adults*	*Number of unhatched eggs*	*Number of dead chicks*	*Number of dead adults*
1998	9	7	7	3
1999	17	10	11	3
2000	23	25	7	6
2001	9	9	7	3
2002	55	39	49	23
2003	39	20	23	11
2004	42	38	32	5
Total	194	148	136	54

behaviour) were also the main reasons for mortality of both chicks and adults.

A total of 5 study areas (BGC, CB, UB, DA and BH) were established in Dundgobi, Gobisumber, Tuv and Khentii provinces in 1998 - 2000. In 2002, we additionally established a new study area, EK in Sergelen sum, Tuv province. The total size of Central Mongolian study areas was 13,411 km^2, which represents 1% of Mongolia (Fig. 2).

Study areas included hilly, 3 - 15 m high cliffs in EK, open plains along BH and DA, broken higher sand banks of the river in CB and BH completely isolated trees and bushes growing in the mountainous areas of Ulaanbaatar. There are also isolated stone columns 3 - 12 m high in the mountains of EK, wide valleys of dried steppe rivers, and rock massifs in BCG and CB These areas are the main habitat for breeding Sakers in the Central Mongolian steppe zones. In December, January, February, March and April of 1999, 2000, 2002 and 2003, we revisited each study area and checked all nests. Nest location, structure, materials used and nest site selection were recorded. Eggs, chicks and fledglings were measured, ringed and microchipped. Sakers in the study areas prefer to nest on cliffs, rocks and artificial substrates. Data were collected using a standard field protocol (Fox *et al.*, 1997).

Fresh remains and carcasses of dead young and adult Sakers in study areas were collected and examined at the Zoology Department at the National University of Mongolia. All remains were scanned for identification microchip numbers and were photographed. Infertile and deserted eggs were collected for future analysis to examine the incidence of poisoning. GIS 3.2, Microsoft Excel and Systat 10.0 statistical computer programs were used for GPS mapping and data analysis. The Kruskal-Wallis Test Statistic was used for analyzing egg, chick and adult Saker mortality in Central Mongolia in 1998-2004.

Improved methods for counting voles were used (Batsaikhan *et al*., 2001), for counting wintering colonies of Brandt's voles in 4 different nest sites in EK and BGC, in July 2002. Both study areas used the same counting method. In July 2003, we re-counted the wintering colonies of Brandt's voles at the same sites as in 2002, in the EK and BGC study areas.

Results

A total of 338 eggs, fresh remains and carcasses were found from 194 active nests and are shown in Table 1. We identified sex, age and death date of both chicks and adults based on measurements of dead eggs, chicks and adults. Due to the old and bad condition of some remains and carcasses, cause of death could not be identified and and were recorded as 'unknown'.

Egg deaths: According to field data, percentages of deserted clutches (35.1%) and infertile eggs (30.4%) were highest out of total egg deaths in study areas, in 1998 – 2004 (Fig. 3). There was no significant difference in factors causing eggs not to hatch between years (Kruskal-Wallis Test: df 6; P> 0.416). During the whole of April, a local electricity company had organised the cleaning of electric poles and HPEL pylons. They usually drop nests containing clutches of Saker falcon, Upland buzzard (*Buteo hemilasius*) and Northern Raven (*Corvus corax)* from the tops of poles and pylons. Dropping of nests containing fresh Saker falcon eggs, by electricians was frequent (10.1 %; n =16) during the study. A total of 8 eggs in 3 different nests were predated by Raven.

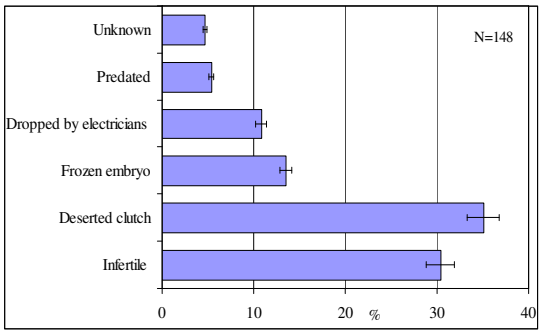

Fig. 3. Causes of egg deaths of Saker falcon in Central Mongolia (1998-2004)

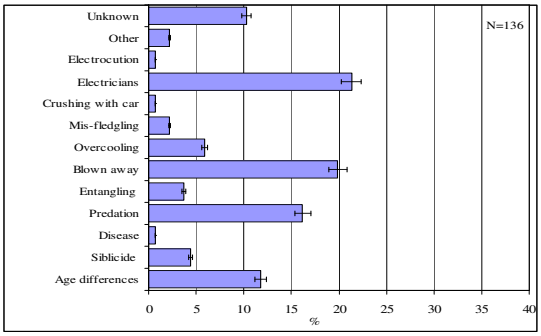

Fig. 4. Percentage of chick mortality across Central Mongolian study areas (1998-2004)

Chick mortality: Factors causing chick mortality did not differ significantly across years (Kruskal-Wallis Test: df 13; P> 0.44) Between 1998 - 2004 the highest percentage (61.1 %) of total mortality of Central Mongolian Saker was due to natural causes, which included: age differences (11.8%), siblicide (4.4%), disease (0.7%), predation (16.2%), overcooling (5.9%) and mis-fledgling (2.2%) (see Fig. 4). Mortality caused by human or anthropogenic factors explained 26.4%. The number of dead chicks caused by predation was found to increase since 2000. The main predator of chicks, in Central Mongolia was the Eagle Owl. We found bones, feathers and fresh remains of Saker chicks at Eagle Owl nests, located 250 - 1500 m from active Saker nests. Fresh remains of Saker and Upland buzzard chicks that were more than two weeks old were collected from Eagle Owl nests. A few nests containing clutches or chicks, on pylons and wooden poles of HPELs were blown away at the beginning of the breeding season. This factor explained 19.9 % of total chick mortality, with the highest mortality recorded in 2003. The third worse influencing factor on chick mortality was chick deaths caused by the dropping of nests containing small chicks. Mortality of chicks caused by the cleaning of poles and pylons of HPELs from raptor nests was high at 21.3%.

Adult mortality: Adult mortality factors did not differ significantly across years (Kruskal-Wallis Test: df 6; P> 0.4). The highest percentage of total adult Saker mortality was caused by electrocution (54%) and is shown in Fig. 5. Mass deaths of Sakers caused by electrocution occurred at three sites of wooden poles of HPELs. A total of 18 remains of electrocuted dead birds from 4 species (8 Saker falcons, 7 Upland buzzards, 2 Common Kestrels (*Falco tinnunculus*) and 1 Steppe Eagle (*Aquila nipalensis*) were found at the first site, 6 raptors from 3 species (3 Upland Buzzards, 2 Saker Falcons and a Common Kestrel) where found at the second site, and 4 remains of 2 different species (3 Saker Falcons and an Upland Buzzard) where found at the third site.

In 2002, during the study the following were found in an area where the rodenticide had been used - 1 Red Fox (*Vulpes vulpes)*, 1 Corsac Fox (*Vulpes corsac*) and 1 Pallas Wild cat (*Felis manul*) (listed in the Red Data Book of Mongolia) and 8 dead birds – 1 Golden Eagle, 2 Saker falcons, 2 Upland buzzards, 1 Herring Gull (*Larus argentatus*), 1 Daurian Jackdaw (*Corvus*

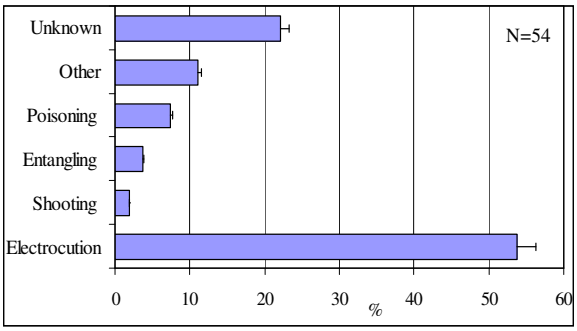

Fig 5. Percentage of adult Saker falcon mortality in 1998-2004

Fig. 6. Numbers of Saker Falcons exported under licence from Mongolia (1994-2004)

dauuricus) and 1 Skylark (*Alauda arvensis*). The percentage of adult Saker mortality caused by the poisoning incident was 7% of total adult Saker mortality.

Evidence of entangling was recorded once for an adult male Saker and three times for nestlings. Entangled birds suffer serious wounds on legs and wings and usually die. Entangling by nest material, accounted for 4 % of total adult Saker mortality.

Saker exports: Figure 6 shows the number of Saker falcons exported under licence from Mongolia to countries in the Middle East between 1994 and 2004. The number of exported Sakers has dramatically increased in the last 4 years. The Mongolian Government has given permits allowing Saker falcons to be exported to Arabian countries mainly to Saudia Arabia, Kuwait and UAE in compliance with Mongolian and CITES regulations since 1994 (Badam, 2001). In 2001, a total of 180 Sakers were exported to Arabian countries. The Ministry of Nature and Environment had initially planned to export 150 Saker falcons. In the end an additional 30 permits were assigned to allow Sakers to be exported to some Arabian countries. Besides the legal harvest there is a substantial and increasing illegal harvest of Sakers from Mongolia.

Vole numbers: The average number of counted wintering colonies of Brandt's Vole in 4 different nest sites in EK and BGC was calculated. In 2002, the average was 29±6.75 (average ± SD), range 24-42 (n=6) colonies per ha in EK; 20 ±5.32 (average ± SD), range 12-26, (n=6) colonies per ha in BGC study area. In 2003 however, no wintering colonies were found. Low temperatures and starvation in 2002, were the main causes resulting in decreased numbers of Brandt's voles in EK and BGC study areas. A decline in Brandt's Vole numbers led to the decline of breeding pairs in the study areas (Bold & Boldbaatar, 2001). In 2002, a total of 17 breeding pairs and 56 fledglings in EK and 11 breeding pairs and 43 new fledglings in BGC were recorded. The number of breeding pairs decreased to zero in these study areas in 2003 (Fig. 7).

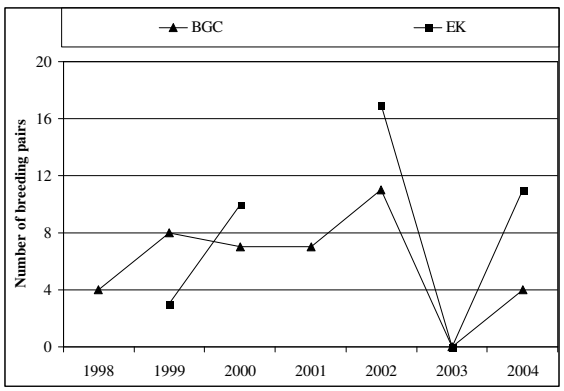

Fig.7. Number of breeding pairs in the BGC and EK study areas

Discussion

Incidence of egg mortality has not previously been documented in Mongolia and adjacent territories of Mongolia. Due to extremely low temperatures and strong winds during early spring, the incidence of deserted clutches of the Central Mongolian Saker has increased over the last few years. Egg mortality due to dropping of the nests containing clutches is probably higher over the whole of Central Mongolia, since the study sites only involved a small area of HPELs between provincial and sum centers.

In 1998 and 1999, the highest mortality of Saker falcon chicks in Mongolia was by overcooling (Potapov *et al.,* 1999). This result was based on chick mortalities caused by low air temperature and cold rain during the day in the high mountain areas of Western Mongolia, in late spring and early summer. In Central Mongolian study areas chick death due to overcooling was not such a major factor. The main predator of chicks in Central Mongolia was the Eagle owl (*Bubo bubo*). Fresh remains of Saker and Upland buzzard chicks that were more than two weeks old were collected from Eagle owl nests and weighed more than 400 grams. It is most likely that predation by Eagle owls depends on the body size of Saker and Upland buzzard chicks. Eagle owls do not predate small chicks of these raptors within their hunting territory. During early spring and summer very strong winds blow from northwest to southeast. All mortalities caused by chicks being blown away were observed at nests situated on artificial substrates.

Saker falcons usually use the "A" type wooden poles as nest substrates, where they can perch and shelter from strong winds and the bright sun all year around. This particular behaviour displayed by Saker falcons, in addition to the old structure of HPELs, was the main cause of electrocution. It has also been reported that the electrocution of Amur falcon (*Falco amurensis*), Greater Kestrel (*Falco rupicoloides*), Lanner Falcon (*Falco biarmicus*) and Peregrine Falcon (*Falco peregrinus*) is a function not only of raptor

behaviour but also the structure of the power line (Rooyen, 2000). But total mortality caused by electrocution in the region cannot be fully reflected by the data shown (Fig. 5). The occurrence of electrocuted Sakers in the study areas increased during spring and autumn. Particularly, during these seasons, the number of electrocuted new fledglings and first calendar year birds, which are less experienced with the wires and poles of HPELs increased. The terminal structure with a three phases transformer on wooden poles of HPELs (we named them "A" type), near the villages, TV antennae, gold mining sites and busy railway stations are the greatest threats for Sakers because there are four and sometimes eight electric wires, closely connected to each other from isolators on top of the pole. Due to close phases or a short cross arm between each wire and isolator, the electrocuted Sakers, Upland Buzzard and Northern Raven and occasionally small passerines (Hoopoe (*Upupo epops*) and Isabelline Wheatear (*Oenanthe isabellina*)) were found under the poles. Seven Saker falcons were found under the terminal structure with a three phases transformer on the wooden pole of an HPEL in Eastern Mongolia during a Saker falcon field trip in 2003 (Tseveenmyadag and Bold pers. comm.). Saker falcon mortality caused by electrocution is most likely to be widespread along the high power electric line network in Eastern and Central Mongolia.

A poisoning incident reported in 2002 and 2003 reduced Saker numbers (Gombobaatar *et al.,* 2003). This coincided with the use of the rodenticide bromadiolone for the past two years, by the Ministry of Agriculture to control Brandt's vole numbers on the Mongolian steppe. Bromadiolone (0.5%) is mixed with grain and is applied to the land by airplane and land machines. For the last two years, the rodenticide was sprayed by airplane covering areas with peak number in spring and autumn. The use of bromadiolone in the steppe zone, reduced the number of voles in some areas and many rare and common species of mammals and birds died in 2001 and 2002. Saker poisoning accounted for 2.69% of total adult Saker mortality in 2002 - 2003 (Gombobaatar *et al.,* 2003), but percentage poisoning has increased up to 7% of total adult Saker mortality in Central Mongolia in 2002 - 2004. Due to the extension of areas using rodenticide against Brandt's voles in the Central Mongolian steppe, the death rate of Saker falcons and other significant species of birds and mammals from the steppe ecosystem has increased over the last three years.

One of the main causes of low breeding success of Saker falcons in China was usage of pesticides and insecticides in 2002 (Xiaodi & Fox, 2003). Only a few adult Sakers overwinter in Mongolia, depending on snow depth and food supply (Sumiya *et al.,* 2001), most adult birds, new fledglings and young birds migrate to Tibet and China (Potapov pers. comm.). An important conservation measure for Saker falcons in both countries is to reduce the widespread usage of rodenticide and insecticide.

Cases of adult Saker deaths by entanglement have been reported (Potapov *et al*., 1999). Sakers prefer old nests of Upland buzzard and Northern Raven (Potapov *et al*., 2001a). These nest builders pick up string, rope and socks made by synthetic materials from the field and bring it to the nest. Both adult and young falcons occasionally become entangled. Death by entanglement has also been recorded in Kazakhstan (Levin, 2000).

Presently in Dagestan, trappers that catch and export rare species of raptors, including the Saker falcon pose a serious threat (Vilkov, 2001). Saker breeding numbers have declined since 1992 and the number of occupied nests has reduced to a critical level. The main reason for the decreasing Saker population in Kazakhstan is due to trapping for falconry (Levin *et al.,* 2000 & 2001). The biggest problem is thought to come from people robbing nests of both eggs and chicks and trapping adults, primarily the female (Gott *et al.,* 2000). Considering the overexploited Saker populations in Dagestan, Kazakstan, Kyrkyz, Uzbekstan (Kreuzberg-Mikhina *et al.,* 2001) and China (Xiaodi *et al.,* 2001 & 2003), we consider that the current level of exportation of Sakers in Mongolia is the main cause of the swift decline of the Saker falcon population in this reservior country. During the trapping season, blinded, broken winged, injured and starved, female and male Sakers, trapped by local people with little knowledge of falcons and falcon husbandry, were found in Ulaanbaatar. Most of these injured birds die. Saker mortality, resulting from injury and starvation will continue to increase due to the constantly increasing numbers of Saker allowed to be exported by the Government of Mongolia. East Ukraine, Central Kazakhstan and Chinese populations of Saker falcons have disappeared or have been severely overexploited (Barton, 2002).

In European Russia a major cause of the Saker population decline was the almost complete

disappearance of its principle food source namely two species of souslik (Galushin *et al.,* 2001). A decline in Brandt's Vole numbers led to the decline of breeding pairs in Mongolia (Bold & Boldbaatar, 2001). The reduction in the number of Saker breeding pairs caused by the disappearance of their main prey species was recorded in Central Mongolia in 2003. During the harsh spring and winter of 2002, all wintering colonies of Brandt's voles completely disappeared in the BGC and EK study areas. This was the main reason why Saker breeding pair numbers declined to "0" in two of the study areas in 2003 (see Fig.7). The main prey in the Central Mongolian Saker diet, include widely distributed steppe rodents such as Brandt's Voles, Mongolian Gerbils (*Meriones unguiculatus*), Midday Gerbils and Mongolian Marmots (*Marmota sibirica*), and various species of birds (Baumgart, 1991; Gombobaatar *et al.,* 2000a & 2001). There were no recorded cases of falcons starving in Central Mongolia when these rodents were numerous in 1998 - 2004.

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Хураангуй

Монгол улс бол зэрлэг идлэг шонхорын хувьд үржлийн дэлхийн цөм нутаг бөгөөд энэхүү зүйл нь хээрийн зарим мэрэгчдийн тоо толгойг цөөрүүлэхэд онцгой үүрэгтэй. Монгол орны төвийн бүсийн идлэг шонхорын үхэл хорогдол, түүний шалтгааныг өндөг, ангаахай ба бие гүйцсэн гэсэн насны ангиллаар ялгаж тогтоолоо. Хээрийн судалгааны явцад 194 үүрнээс нийт 338 өндөг болон эндсэн бодгалиудын үлдэгдлийг цуглуулж, тэдгээрийн үхлийн шалтгаан, нас, хүйсийг тодорхойлон боловсруулав. Өндөг, ангаахай болон бие гүйцсэн бодгалийн үхэл хорогдол, түүнд нөлөөлөгч хүчин зүйлсийн үйлчлэлийг 1998-2004 оноор харьцуулахад хоорондоо мэдэгдэхүйц ялгаа илрээгүй. Дарж буй өндөгөө орхиж гээснээр өндөг үрэгдэх (35.1%) болон үр тогтоогүй өндөг (30.4%) зэрэг хүчин зүйлс өндөгний хорогдолд давамгайлан нөлөөлжээ. Идлэг шонхорын ангаахайн үхэл хорогдолд шар шувууны (*Bubo bubo*) үзүүлэх нөлөө их байв. Мөн өндөр хүчдэлийн шугамыг цэвэрлэснээр үрэгдсэн ангаахайн тоо нийт хорогдлын 21.3% эзэлж байв. Түүнчлэн ангаахайн үхэл хорогдолд байгалийн хүчин зүйлсийн нөлөө их байсан ба энэ нь 1998-2004 оны ангаахайн нийт үхэл хорогдлын 61.1%-ийг эзлэж байв. Хүний нөлөө нийт хорогдлын 26.4%-ийн шалтгаан болжээ. Бие гүйцсэн шувуудын үхэл хорогдолд нөлөөлөгч хүчин зүйлсийг 1998-2004 оноор харьцуулахад мэдэгдэхүйц ялгаа илрээгүй болно. Харин өндөр хүчдэлд цохиулж үхсэн нь хамгийн өндөр (54%) байв. Мөн хордож үхэх, хууль болон хууль бусаар гадаадад гаргах зэрэг үйлдлүүд идлэгийн тоо толгойг цөөрүүлэх шалтгаанууд болдог. Судалгааны хоёр талбайд үлийн цагаан оготны тоо толгой 2002 онд эрс цөөрч “0” түвшинд хүрсэн нь 2003 онд эдгээр талбайд идлэг шонхорын үржлийн хосын тоо эрс цөөрч, “0” болох шалтгаан болсон байна. Бидний судалгааны эдгээр үр дүн нь манай улсад идлэг шонхорыг хамгаалах бодлогыг боловсруулах болон түүнийг хэрэгжүүлэхэд чухал баримт болох юм.

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