

# Easternmost Eastern Imperial Eagle Population in Crisis

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**Abstract:** The area surrounding Lake Baikal is home to the easternmost population of the Eastern Imperial Eagle (*Aquila heliaca* SAVIGNY 1809). Until recently, this was one of the largest populations in the whole of Russia. However, in recent years its numbers have declined dramatically and it is now extremely small, fragmented and vulnerable. Early observations of the population at Baikal attest to the fact that in the 1960s, in the west of the Baikal region, there were approximately 300 pairs of eagles, by the start of the 1980s – 150-200 pairs, in 1999-40 pairs, and in 2005-2007 – 25-30 pairs. Fertility over the period 1980-1990s changed insignificantly. The most reasonable explanation for the observed slump in numbers is the increased rate of fatalities outside the breeding period. Satellite-assisted radio tracking has shown that the eagles of the Baikal population pass the winter in China on the Yunnan plateau, and also in neighbouring regions of Burma and northern Thailand. Action for the conservation of the given population must first and foremost be directed towards reduction of winter mortality. An expedition to the eagles' wintering area is necessary to understand the reasons for mortality increase.

**Key words:** Eastern Imperial Eagle, Lake Baikal, population crisis, non-breeding mortality

## Introduction

The Eastern Imperial Eagles in the area of Lake Baikal in eastern Russia (including the Irkutsk and Chita administrative regions and the Buryat Republic) are among the easternmost populations of this species (Fig. 1). In this area Imperial Eagles are found between the upper reaches of the Angara River, 150–300 km from the city of Irkutsk, and the Onon River of Chita Region (VASILCHENKO 1986, GOLOVUSHKIN, OSIPOVA 1988, STEPANYAN 1990). The eastern border of the range corresponds with the eastern edge of the distribution of the Siberian Ground Squirrel (*Spermophilus undulatus* PALLAS 1778), which is the primary prey of Baikal's Imperial Eagles (RYABTSEV 1999). To the south, the distribution of the species extends into northern Mongolia, albeit apparently at relatively low population densities (HEIDECKE *et al.* 1992, BOLDAVATAR 2003).

The Baikal population of Eastern Imperial Eagles is also geographically isolated – it is at least

600 km east of the nearest known population in Russia, found near the Minusinskaya depression, south of Krasnoyarskii Krai (Krasnoyarsk administrative division). During Soviet times the Baikal population of Imperial Eagles was also one of the best studied populations in the world (SONIN 1969, SONIN, LIPIN 1980, RYABTSEV 1984, 1989, 1999, 2000). However, most of that literature is in Russian and remains inaccessible to non-Russian speakers. In addition to being well studied, the Baikal population of Imperial Eagles was, only two decades ago, one of the largest such populations in Russia. However, in recent years it has declined dramatically in size and it is now extremely small, fragmented and highly threatened (RYABTSEV 1999). Other populations in Russia have not shown similar declines; most were stable and some, such as those in the Ural region and the Lower Povolgye river region, have even been increasing (BELIK, GALUSHIN 1999).

## Materials and Methods

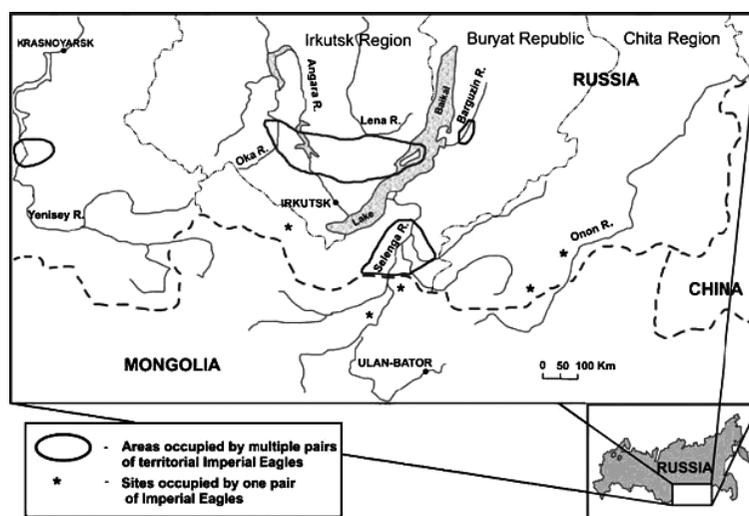
This research was conducted west of Lake Baikal in the western part of the Baikal region of Russia ('western Pribaikalye'). Forest-steppe is represented on the banks of the Angara River (now – Bratsk water reservoir) in its upper stream, in the Angara-Lena inter-stream area, in the middle part of the western shores of Lake Baikal (Priolkhonye) and on the Baikal Island of Olkhon. The forest-steppe in these areas does not form a solid zone and is represented by isolated islands, divided by low mountain ridges, taiga massifs and the Bratsk water reservoir.

Climate here is severe and continental; average annual temperatures range from about 23.3 °C to 0.7 °C and average precipitation varies from 101 to 423 mm. Local topography is generally flat, being composed of broad river valleys with terraced sides. Elevation averages about 650m above sea level, and ranges from 300 to 1000 m (BOYARKIN 1985). The surface of Lake Baikal is 456 m in elevation. Habitat in western Pribaikalye includes forest, forest-steppe and wetlands. River valleys are composed of wet meadows, bogs and marshes. River terraces and warmer valley slopes are most often covered by steppe vegetation.

These steppe landscapes, which are located in the south-eastern and central parts of western Pribaikalye, have been disconnected and fragmented by both natural and anthropogenic processes. Forests,

which cover just over half of the region, are primarily coniferous, with pine Scots Pine (*Pinus sylvestris*, L.) on flat terrace bottoms and south- and west-facing slopes and Siberian Larch (*Larix sibirica* LEDEB) on north-facing slopes. Local steppe habitats are relics of dry Mongolian grasslands that once extended throughout Siberia. Currently this habitat is composed of several different types of steppe including grasslands (dominated by *Stipa* sp. and *Festuca* sp.), shrub-steppe (primarily *Artemisia* spp.), wet meadows (of *Calamagrostis* sp., *Bromopsis* sp., *Agrostis* sp. and *Elytrigia* sp.) and mountain-steppe (dominated by *Festuca* sp., *Thymus* sp., *Oxytropis* sp. and *Chamaerhodos altaica* LAXM.). The steppelands of the basin of Lake Baikal are unique among these relics in that their vegetation is composed primarily of legumes (e.g. *Oxytropis* sp., *Hedysarum* spp. and *Astragalus* sp.).

Because of the complicated relief of the area, only 30-50% of the total area of forest-steppe in western Pribaikalye has been ploughed (this is considerably less than in some other agricultural areas of the former Soviet Union; (V. Ryabtsev, unpubl. data). Since the collapse of the Soviet Union, the area used for agriculture has been reduced by about 50-75% and grazing by domestic livestock, primarily cattle, has decreased by approximately 80-90% (V. Ryabtsev, unpubl. data). However, because planting is rotated among fields, re-colonization by native flora on farmed habitat is slow. Within the Baikal Basin itself, less than 10% of the steppe was



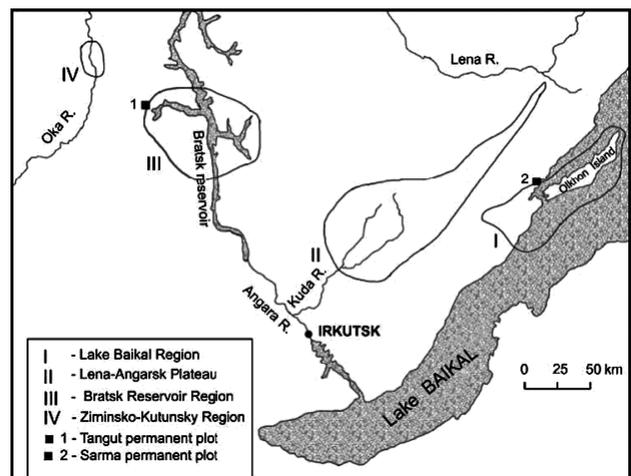
**Fig. 1.** Map of Russia showing the Baikal area and the areas occupied by Imperial Eagles in and around Lake Baikal. The large central area including the Island of Olkhon and areas west of Lake Baikal is referred to as 'western Pribaikalye'

ploughed before 1980 and even less is currently used for agricultural purposes. Further protection was afforded in 1986, when nearly all these Baikal Basin steppe lands (112,000 ha) were included in the newly created Pribaikalskii National Park, which has a total area of 417,300 ha. Forested habitats are threatened primarily by fires and to a lesser extent, illegal logging.

Eastern Imperial Eagles in western Pribaikalye were studied between 1978 and 2007. Research effort, which was not consistent throughout this period, was determined by logistical and financial constraints. Data collection was particularly detailed in four periods: 1981-1983 and 1998-1999, 1996-1997 and 2000-2007. Data collection occurred at two spatial scales with focused study on two intensively monitored study areas (near the villages of Tangut [53°45' N, 102°40' E] and Sarma [53°05' N, 106°50' E] and more general surveys throughout the entire region. We also compare our data with those from the westernmost population of Baikal's Imperial Eagles, in the Ziminsko-Kutunskii region (FEPELOV 2003).

Nesting behaviour (chronology, density, fecundity) of eagles was closely monitored in the two intensively studied plots from 1981 to 1983. The first and larger of these study areas covered 60 km<sup>2</sup> and was located to the west of the Bratsk Reservoir, near the village of Tangut. About 20 km<sup>2</sup> of this plot was forested. The second of these study areas covered 30 km<sup>2</sup> on the western coast of Lake Baikal, near the village of Sarma; about 10 km<sup>2</sup> of this area was forested (Fig. 2). During these studies, nest-searching was conducted by a single observer on foot. The Tangut area was searched for 131 days between April and August over a 3-year period, 1981-1983. The Sarma area was searched for 32 days in May-June of 1982-1983 and again for 14 days in 1996 and 15 days in 1999. Nests were climbed late in the breeding cycle to minimize disturbance, reproductive output was verified and chicks were banded with aluminium rings. Encounter rates of individual eagles (indicators of relative density) were monitored in these same two areas in 1981-1983, 1996 and 1999. On these surveys a single observer (V. Ryabtsev) on foot counted all birds observed from May through June. In total, surveys covered 1667 km and lasted 632 h. Encounter rates

for each region were calculated separately for open habitats (steppe, agricultural fields, etc.) and for forested habitats. These surveys are not useful for indicating population density, but they can provide a mechanism for comparing relative densities among regions (NERONOV 1962). In this case these surveys were particularly appropriate because they could be compared with data collected by Sonin, who used the same technique in 1959-1965 (SONIN 1969). A considerable area of the western Pribaikalye region outside these study plots was searched from four-wheel drive vehicles during the breeding seasons in 1981-1983 (covering about 4000 km in this period), in 1998 (4760 km), in 1999 (6050 km), in 2005 (3790 km), in 2007 (4903 km). Observations, which were focused on areas I-III (Fig. 2), were also made from roads and hilltops. Because the local network of unpaved roads is dense and because eagles are highly visible in this area, it is likely that a large proportion of the nesting pairs in the area were identified. To understand our results in the context of historical trends, we also evaluated all previously published reports on Eastern Imperial Eagles of the Baikal region (SONIN 1969, SONIN, LIPIN 1980). We used standard parametric and non-parametric statistics (T-tests, Mann-Whitney test and Kruskal-Wallis tests) to compare demographic statistics among regions and time periods.



**Fig. 2.** Detail of the study area showing the entire western Pribaikalye region – from the Oka river through Lake Baikal. Regions I, II, III and IV correspond to areas where vehicle, walking and observational surveys were conducted. Tangut (1) and Sarma (2) were the sites of intensively monitored plots

## Results

### Population dynamics Bratsk Reservoir region

In the 1950s and 1960s, surveys on foot in open habitats during the migration period (April, May and September) covered 156 km (52 hours) and 64 eagles were encountered (an average of 1.23 birds per hour; SONIN 1969). In 1964 in 12 km<sup>2</sup> of forest in the Tangut study area there were five Eastern Imperial Eagle nests with nearest-neighbour distances of 1.5-2 km between them (SONIN, LIPIN 1980). From 1981 to 1983, and again in more recent years, Imperial Eagles were studied in the same 20 km<sup>2</sup> study area near Tangut where SONIN (1969) carried out his studies. In 1981-1982 4 pairs were settled in 20 km<sup>2</sup> of forest with nearest-neighbour distances of 2-5 km between the nests (RYABTSEV 1984). In 1981-1984 walking surveys in and around the study area near Tangut covered 808 km (333 h) during which 64 eagles were encountered. Hourly encounter rates were also less than in the 1960s. In open habitats in April and May (64 hours of observation during migration) 0.17 eagles were seen per hour of observation, and from the middle of June to the beginning of August (66.5 breeding season hours) 0.47 birds were seen per hour.

### Lake Baikal region

At and around Lake Baikal, Imperial Eagles inhabit only the forest-steppe part of Baikal's western coast (Priolkhonye) and the forest-steppe of the Island of Olkhon. The number of nesting territories on the Island of Olkhon decreased over the course of the study until this subpopulation disappeared altogether. In 1982-1983 in the southern part the island 6 Imperial Eagle pairs were nesting. Active nests were found in 4 of these birds' territories. Additionally, a large number of inactive nests (some 20) were found in this area, most spaced at 1.5-2 km intervals, that corresponds with Sonin's and Lapin's data (1980) for the Bratsk reservoir. If the number of abandoned nests is an indicator of the density of the eagle population, then in that period there were from 2 to 2.5 times the number of birds than at the beginning of the 1980s, i.e. 12-15 pairs. This implies a fall in the eagle population before the time of the present study. Since individual territories of Baikal's eagles usually have 1-3 nests that are 0.05-2 km apart, the number and

spacing of inactive nests provides a rough indicator of past eagle densities. By extrapolating from densities of abandoned nests we estimate that there were once at least 12-15 pairs of eagles on Olkhon. This implies breeding populations at least 2 to 2.5 times greater than in the early 1980s and suggests that the declines we report here have been ongoing for many years.

The number of territorial Eastern Imperial Eagles in the Priolkhonye area near Sarma also declined dramatically over the course of this study, from a high of 10, in the early 1980s, to a current low of 2. The total number of confirmed breeding pairs at and around Lake Baikal declined from an average of 15.5 in 1982-1983 to 4.25 in 1993, 1996 and 1998-1999, to 2.5 in 2003-2007. Differences among these periods were statistically significant (Kruskal-Wallis test,  $jH_{adj}=15.35$ ,  $p>0.02$ ) (RYABTSEV, KATZNER 2007).

### The Ziminsko-Kutunskii region

The westernmost nesting group of the Baikal Imperial Eagle population inhabits the Ziminsko-Kutunskii forest-steppe region (total area about 2500 km<sup>2</sup>) and has been quite stable in recent years. Between 1998 and 2004, 4-6 pairs continuously occupied territories here, most in the 400 km<sup>2</sup> valley of the Oka River (FEFELOV 2003).

### The entire Western Pribaikalye

Over 1978-1983 during car and foot counts all over the territory of western Pribaikalye, 37 pairs of Imperial Eagle were noted. In 21 cases nesting was observed; breeding status of the other 16 pairs was not confirmed. The nesting density of these birds varied. In the outskirts of forest-steppe massifs there were from 5 pairs per 100 km<sup>2</sup>; in central, sparsely forested, parts of forest-steppe massifs – 2 pairs to 100 km<sup>2</sup>; in wooded parts where areas of field and pasture made up no more than 30% – 0.25 pairs to the 100 km<sup>2</sup>.

In 1998-1999 car counts were made of all western parts of the Baikal region. In this study all previously observed nests and nesting sites were surveyed again. It was found that of the 21 active sites found previously, only 5 remained active, but 12 new territories were found. Thus, in all, 17 occupied territories were found. Over 2003-2007, at least 7 of these 17 territories turned out to be empty (or abandoned, not active). In 2007, 5 active nests were found, 1 pair

kept close to an empty nest, and 1 other adult eagle, possible one of a pair occupying the nesting ground (RYABTSEV, MILLER 2008). All these nests were discovered for the first time in previous years, no new nests were found in 2007.

### Fecundity and nesting success

In 6 years of observations, between 1979 and 1984, 29 of 41 observed nesting attempts were successful (71%) and in 5 years of observations between 1993 and 1999 (no data 1994-1995), 13 of 25 observed nesting attempts were successful (52%). Success rates in these periods were not significantly different ( $\chi^2=1.61$ ,  $p>0.05$ ) (RYABTSEV, KATZNER 2007). In 1993 failure of all three nests observed may have been due to an epizootic plague in the ground squirrel population (RYABTSEV 1995).

Between 1984 and 2004 nests were visited irregularly and reasons for nest failure are poorly known. Generally, unsuccessful nests contained dried pine and larch branches and fragments of egg-shell, suggesting that these nesting attempts failed at the egg stage.

Altogether in the western part of the Baikal region between 1978 and 1983 there were on average  $1.1\pm 0.05$  ( $\pm$ SE) fledglings per nesting pair per year and  $1.53\pm 0.17$  fledglings per successful pair. Between 1996 and 1999, there were  $1.02\pm 0.12$  fledglings per nesting pair per year and  $1.70\pm 0.17$  fledglings per successful pair. The difference in average productivity per pair and productivity per successful pair between these two periods is not statistically significant ( $t=0.46$ ,  $p>0.05$ ;  $t=0.50$ ,  $p>0.05$ ) (RYABTSEV, KATZNER 2007). Because sampling efforts in these 5-year periods were not equivalent, we also considered two 2-year periods, 1982-1983 and 1998-1999,

during which sampling effort was almost identical. In contrast to the 5-year trends, these data show clear decreases with time in the average number of occupied and breeding territories (Table 1). Success rates and number of chicks produced at those territories also appear to decline, but these declines are less well defined (RYABTSEV, KATZNER 2007).

Recent simulation modelling of Eastern Imperial Eagles in Kazakhstan suggests that long-term changes in productivity can affect population size slowly, but that only increased mortality can explain faster declines of the type we have observed in the past 15 years at Baikal (KATZNER *et al.* 2006).

## Discussion

Eastern Imperial Eagle population numbers for the whole Baikal region was estimated based on extrapolation of data for different study sites and also from data collected during car counts (1998, 1999, 2005, 2007). Despite the fact that data collected with this method does not permit statistically precise estimates, they do give the possibility of assessing the scale of the population decline of the eagle. Early estimates of the Baikal population by SONIN (1969) and the author (observations of numbers of abandoned nests in the region) are evidence of there having been some 300 pairs of eagle in Western Pribaikalye in the 1960s (RYABTSEV 2000). By the beginning of the 1980s this population comprised 150-200 pairs (RYABTSEV 1984), in 1999 it was estimated to be 40 pairs (RYABTSEV 1999), and in 2005-2007 – 30-25 pairs (RYABTSEV 2006, RYABTSEV, MILLER 2008). In 1999 the entire eastern (Baikal) population occupying the area from the river Oka to the river Onon, was estimated at 70-90 pairs (RYABTSEV 1999).

**Table 1.** Data on nests of Imperial Eagles from the western Pribaikalye, Russia from a 2-year period in the early 1980s and a 2-year period in the late 1990s. (Ryabtsev, Katzner 2007)

Year	Occupied territories observed	Breeding attempts monitored	Nests with one fledgling	Nests with two fledglings	Nests with three fledglings	Success rate	Fledglings per nest (av.)	Fledglings per Successful nest (av.)
1982	21	17	6	3	3	0.71	1.24	1.75
1983	16	12	4	4	1	0.75	1.25	1.67
1998	10	9	3	3	0	0.67	0.90	1.5
1999	9	8	0	3	0	0.38	0.54	2

As breeding success over 1980-2004 did not change noticeably, the more likely reason for the drop in numbers of the Eastern Imperial Eagle population was non-breeding mortality (RYABTSEV, KATZNER 2007).

At the same time, the long-term decline in population has taken place particularly intensively over the past two decades. Use of satellite-assisted transmitters, which were attached to 4 young eagles in 1998-1999, showed that eagles of the Baikal population winter in China on the Yunnan plateau and also in adjoining areas of eastern Burma and northern Thailand (UETA, RYABTSEV 2001). Other populations in Russia whose wintering is not connected with south-east Asia have remained stable over recent decades and some have even increased (BELIK, GALUSHIN 1999). Action for conservation of the Baikal population should, first and foremost, be directed at decreasing eagle mortality during winter. An expedition to the wintering area of the Baikal eagles in order to clarify the cause of increased mortality is essential (RYABTSEV 1999, RYABTSEV, KATZNER 2007).

However, there is another appraisal of the situation with the eastern Imperial Eagle population. In the opinion of KARYAKIN *et al.* (2006) the species numbers in 2005 in Irkutsk Region amounted to 96-112 pairs, and in Buryatia – 150-176 (246-288 pairs altogether). The reasons for such considerable discrepancy have been analysed (RYABTSEV 2007). Data on Imperial Eagle nesting density were obtained by Karyakin at study areas with optimal habitat characteristics then extrapolated over a wide area with different natural conditions, character and degree of anthropogenic impact. For the territory of Buryatia a gross error in calculation has been brought to light (RYABTSEV 2007). In the data on distribution of these birds of prey Karyakin includes long-abandoned nests, nests occupied by other species of birds of prey, and sightings of individual birds, all this also results in an over-assessment of nesting intensity. Besides, there are numerous examples (RYABTSEV *et al.* 2000, RYABTSEV 2007) when territories not visited were included amongst those investigated by this author.

Having been in Western Pribaikalye for only 10 days, I. V. Karyakin ascertained, in his opinion, the reasons for the fall in the Eastern Imperial Eagle population. For the Bratsk reservoir area a reduction

in ground squirrel numbers occurred as a result of changes in pasture vegetation caused by a dramatic reduction in pasture load. But the considerable fall in Imperial Eagle numbers was taking place here in the 1960-1980 period (RYABTSEV 1984, 1989, 1999), i.e. at a time of maximum pasture load for this area (and a high ground squirrel population), as a consequence of extensive development of collective farms. I.V.Karyakin stresses that all the empty eagles' nests were situated opposite recently abandoned summer livestock camps, while all active nests were next to operational farms and summer livestock camps, or by settlements. Without doubt, reduction in head of livestock leads to a fall in ground squirrel numbers – the main Imperial Eagle prey. But according to the data of Karyakin himself, in the Bratsk reservoir area part of the empty Imperial Eagle nesting sites had been occupied by other birds of prey that feed on the same rodents – the Saker Falcon (*Falco cherrug* GRAY, 1834) and Steppe Eagle (*Aquila nipalensis* HODGSON, 1833). Over the period of my observations, very many empty Imperial Eagle nesting territories are situated close by pastures utilised today, especially in the vicinity of villages. In the Ust-Ordynskii Buryat autonomous district alone (in western Pribaikalye) there are 325 rural settlements and only some 20 eagle pairs are nesting there at present. In 2005, in the eastern part of the district, one pair, near whose nest we shot a film, successfully reared three fledglings despite the low pasture load and relatively high grass cover. Thus, the statement on the main role of lack of food, caused by changes in pasture vegetation, in the fall in Imperial Eagle numbers in western Pribaikalye, contradicts the facts.

For the Imperial Eagle inhabiting Priolkhonye, I.V.Karyakin agrees with my explanation of the fall in numbers (loss during wintering), but he adds to this the disturbance factor at nesting sites for this bird that is sacred for local (Buryat) inhabitants. He explains that while previously offerings to the eagle were brought to a spot some distance from the nest, recently the tendency of “sacrificing” alcoholic drinks right under the nests can be observed. This is illustrated by photographs of an eagle's nest with bottles under it. I know this nest that is situated in the Pribaikalskii National Park. It was built in 1983, by the end of the 1980s it was no long used, and

the bottles began appearing under it over the past decade, i.e. they were not the reason for the disappearance of the eagle pair. And over 20 years ago I found active and very old eagles' nests with piles of bottles under them in Priolkhonye (RYABTSEV 2000). Sometimes the females would let me come right up to the nesting tree without taking off. All the more so, the familiar shepherds, bringing their glass offerings with a bow, were not a disturbance factor for them. Buryat ceremonies have not changed over recent years and have not become a source of disturbance for the eagles.

The estimate of Eastern Imperial Eagle population for Baykal region given by KARYAKIN *et al.*

(2006) differs from the data presented by RYABITSEV (1995, 1999, 2000, 2006, 2007) and RYABITSEV, KATZNER (2007). The overestimation reported by KARYAKIN *et al* (2006), is probably due to a difference in the methodology used during the research on the species' distribution and abundance in that particular region, as well as to the insufficient duration of the study period.

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## Най-източната популация на Източния Царски орел в криза

*В. Рябцев*

### (Резюме)

Най-източната популация на Източния Царски орел (*Aquila heliaca* SAVIGNY 1809) е разпространена на територията около ез. Байкал. Доскоро, това бе една от най-големите популации на вида в цяла Русия, но през последните години нейната численост е намаляла драстично и сега тя е изключително малка, фрагментирана и уязвима. Предходни наблюдения на Байкалската популация свидетелстват, че през 1960-те в западната част на Байкалския регион е имало приблизително 300 дв. орли, към началото на 1980-те – 150-200 дв., през 1999 – 40 дв., а в периода 2005-2007 – 25-30 дв. През периода 1980-1990-те плодовитостта не се е променила значително. Най-логичното обяснение за регистрирания спад в числеността е повишеният брой на смъртни случаи извън размножителния период. Сателитно радио-проследяване показва, че орлите от Байкалската популация презимуват в Китай в платото Юнан, а също и в съседните региони на Бирма и Тайланд. Действията за опазване на дадена популация трябва да са насочени преди всичко към намаляване на смъртността през зимата. Необходимо е провеждането на експедиция до местата за зимуване на орлите, за да се разбере причината за повишената смъртност.