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Eastern Imperial Eagle in Russia and Kazakhstan: Population Status and Trends

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Abstract: The paper is based on field surveys of 2000-2009. We found a total of 1534 breeding territories of the Eastern Imperial Eagle (*Aquila heliaca* Savigny 1809) (1122 territories within Russian Federation and 412 territories in Kazakhstan). We documented 1347 nests, including 81 nests with clutches and 285 nests with broods. All nests were plotted in GIS, their habitat linkages and geospatial locations were analyzed. We estimated the total numbers of the Imperial Eagle in Russia as 3000-3500 breeding pairs and 3500-4000 breeding pairs in Kazakhstan. The paper discusses habitat preferences of the Eastern Imperial Eagle, nesting place description and breeding success. The species is rather undemanding in its habitat preferences. Brood size and breeding success are sufficiently high in large populations. Negative population trends were recorded only in isolated peripheral breeding groups.

Keywords: Raptors, Eastern Imperial Eagle, distribution, population, breeding, Russia, Kazakhstan

Introduction

The Eastern Imperial Eagle is listed in 2010 IUCN Red List Category (as given by BirdLife International) as Vulnerable. The Eastern Imperial Eagle is a typical species of in arid and semi-arid landscapes of Russia and Kazakhstan. The most part of its breeding range is located within the territory of Russia and Kazakhstan, thus making this Russian and Kazakhstan portion of the range a key territory for its survival. This paper deals with the result of the first large scale monitoring effort of this species, which is crucial to the survival of this species, as well as for an understanding of the further steps towards its conservation.

In the Volga-Ural region of Russia the largest breeding groups of Eastern Imperial Eagles are registered in the forest-steppe of the south edge of the Ural Mountains (500 pairs), on the Bugulminsko-Belebeevskaya upland (200 pairs) and in the Middle Volga (150 pairs) (Belik, Galushin, 1999, Borodin *et al*. 1999, Karyakin, 1998, 2007, Karyakin, Pazhenkov, 2008, M. V. Korepov, unpubl. data). The largest breeding group in Western Kazakhstan is located in the Volga-Ural sands (near 600 pairs) and Tobol-Turgai Region (near 200 pairs) (Fig. 1a, b) (Bragin, 2006, Karyakin *et al*. 2006a). A large breeding group seemed to be located in the Northern Caucasus (near 200 pairs) (Belik, 2008).

In the eastern part of the studied region the fol-

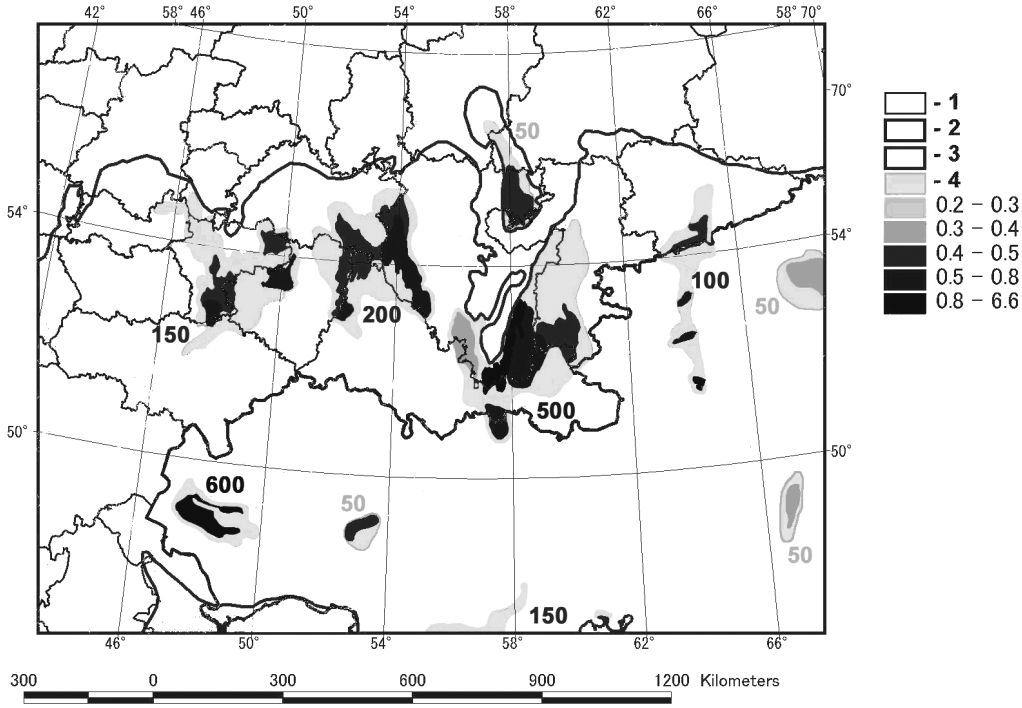

Fig. 1a Breeding clusters of the Eastern Imperial Eagle in the east of European part of Russia and Western Kazakhstan

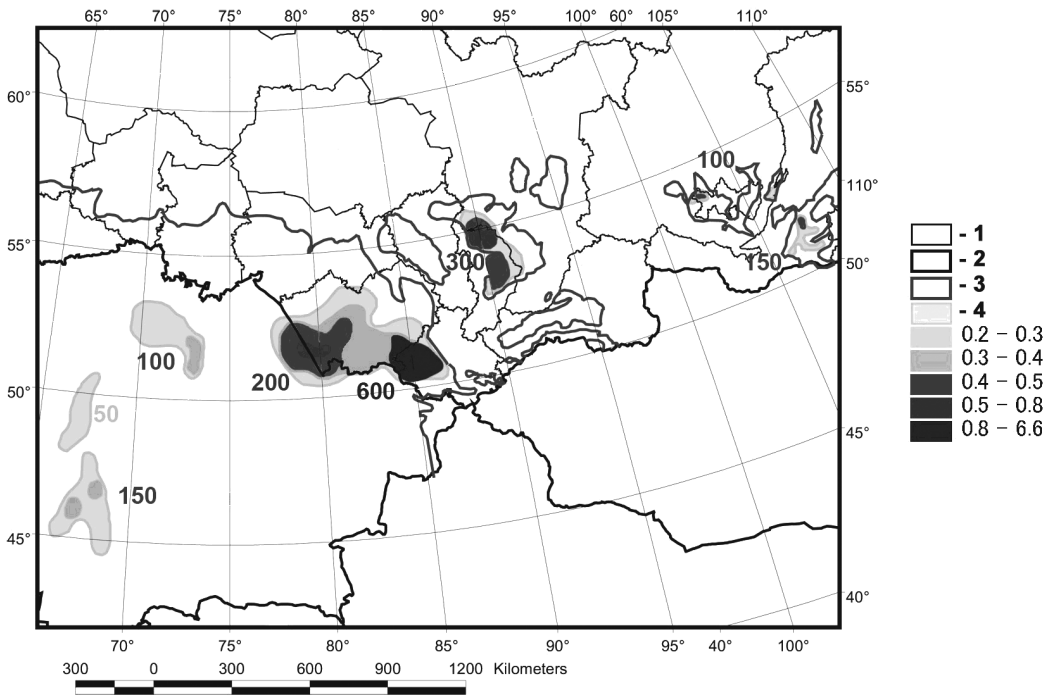

Fig. 1b Breeding clusters of the Eastern Imperial Eagle in the Siberia and Eastern Kazakhstan. Legend: 1 – borders of districts, 2 – borders of countries, 3 – border of Imperial Eagle's breeding range, 4 – clusters of the Imperial Eagle constructed as density kernels

lowing large breeding aggregations were found. In the plain part of Western Siberia Imperial Eagles were found in pine forests between the Irtysh and the Ob' rivers (200 pairs) (Karyakin *et al*. 2005a, Karyakin *et al*., 2005b). The area is at the border between Russia and Kazakhstan. In the mountains

of Southern Siberia Eagles inhabit forest-steppe depressions of Altai-Sayan and Baikal regions. The largest breeding groups are located in Western Altai – 600 pairs and Minusinsk depreshion – 300 pairs, as well as Fore-Baikal (near 100 pairs) and Trans-Baikal (near 150 pairs) regions(Karyakin *et al*. 2006 b, Karyakin *et al*. 2009). The largest breeding groups in the eastern part of Kazakhstan inhabit the Sarysu river basin – 150 pairs, the western edge of Kazakh Upland in the Ulutau mountains (50 pairs) and in Ereymentau and Kokchetav uplands (100 pairs) (Fig. 1b) (Karyakin, Barabashin, 2006, Karyakin *et al*. 2008). Recently the Eastern Imperial Eagle was noted breeding in swamps in the taiga zone in Western Siberia (Moshkin, 2009, Sorokin, 2009) and recorded during the breeding season in the Amur River basin (Smirensky, 2003).

Material and Methods

For the last 10 years of intensive field work we have been studying the distribution and numbers of the Eastern Imperial Eagle in the area including Russia and Kazakhstan from the Volga basin up to Lake Baikal. For now more than 40% of area of the Imperial Eagle habitats have been surveyed on more than 88 study plots with a total area of 22 300 km^2.

In the course of the surveys, we searched for eagles visually and, where possible, we searched for their nests. The typical search pattern for Imperial Eagle nests included travel by car along a route in the steppe which provided best views of the of forested mountain slopes. Every 200-400 m the group would stop and inspect the forested slopes with binoculars in search for nests or perching eagles (Karyakin 2004). Inspection of small depressions were carried out by observing them for 30 min-5 hours from dominating hilltops or from mountain passes. We used of 12-60 x binoculars in our surveys. Records of bird and nest locations were fixed with Garmin GPS units and the coordinates were logged into a data base. The density and the total numbers of breeding pairs were calculated within GIS-software (ArcView GIS 3.3 ESRI). We created habitat maps based on satellite imagery (Landsat ETM+) with ground verification, analysis of topographic maps (scale 1:200000) and digital elevation models (DEM). Based on the breeding records of Imperial Eagle we created a GIS-model of the Imperial Eagle distribution. The model was built up as follows. For the known nests we measured the following list of parameters: 1. nesting tree species, 2. Type of forest, 3. Forest age, 4. Maximum height difference measured in DEM for 1 km line across steepest gradient, 5. Slope aspect, 6. Nest aspect, 7. Distance to the nearest open space, 8. Distance to forest if the nest is outside forest patch, 9. Distance to nearest river, 10. Distance to nearest field, 11. Distance to nearest pasture, 12. Distance to nearest pond, 13. Distance to nearest settlement, 14. Distance to a livestock farm. These parameters after entering them into attribute table were subjected to descriptive statistics. Those parameters whose Standard Deviation is less than 30 % of the average are considered to be suitable for analysis. Based on the chosen parameters we create buffer zones for every chosen parameter and create buffer layers for every parameter separately. E.g. if the buffer zone around a livestock farm was say 2 km, the buffer shape then was constructed around every farm known for our maps. Then using standard geo-processing command Union we created one buffer layer from all constructed buffers. Then using X-Tool extension (DeLaune 2000) we then clip the habitat map, which gives us nest suitable habitat for the entire area. The map model for the potential nesting territories was constructed as follows: an extension Nearest Features was used to determine the nearest neighbor distances between known nests. These distances are plotted. Using extension Edit Tools (Tchoukanski 2004) we remove geometrical duplicates of the nearest neighbor lines. For each nesting cluster we measure the means and standard deviation of the nearest neighbor distance. Then using extension Repeating Shapes (Jenness 2005) and the measured means of the nearest neighbor distances generate hexagonal polygons which model the distribution of potential breeding territories. Then using known nest locations correct the above model using ShapeWarp (McVay 1998) extension by moving the centers of the hexagons to the existing nesting sites. Then using XTools extension (Delaune 2003) we create a new centroid layer. The resulting layer of potential breeding territories is constructed using this centroid layer and the measured nearest neighbor distances. The total eagle numbers was estimated by counting the number of centroids. The nesting clusters were determined as follows. First we generate

the parameters of the nesting clusters. For this we imported the attribute table of the existing nests with 14 parameters listed above into Statistica 5.0 (StatSoft, Inc) and run Discriminant analysis (DA) using Forward stepwise selection. Based on the ordination plot we select clustered attributes in the shape file for mapping these clusters. The chosen by ordination parameters with the maximum loading are then used in constructing to Thiessen polygons using Editools Extension (Tchoukanski 2004). Of the Thiessen polygons we construct a working layer of the nesting clusters noting any overlays if present. Then using X-tools extension (Delaune 2003) we identify the habitat map by joining the attributes from the work layer. By using the new attribute we then re-classify the habitat map thus extrapolating the nesting clusters map onto the entire potential nesting area.

The habitat which had more than 50% of the total number of eagles nested in a region was classified as 'excellent', the habitats which had less than 50% but more than 30% was classified as 'good', and the habitats with less than 30% – 'suboptimal habitats'. This classification of the habitats was performed on the habitat maps. Total eagle numbers were estimated by counting the number of centroids.

During field surveys we were inspecting nests if they were accessible staying no longer that10 minutes during periods of egg incubation and no more than 30 minutes at the period of chick development. We recorded clutch and brood sizes during these visits and record nest parameters.

The diet was studied by analysis of pellets and food remains collected in and near the nests during these visits. In total we recovered 2856 identifiable prey items from 357 nests.

Results and Discussion

We found1122 breeding territories within the Russian Federation, of which a total of 913 nests are located. In Kazakhstan we found 412 breeding territories and 480 nests. In total we recorded 1347 nests, and inspected 81 nests with clutches and 285 nests with broods.

We estimate the total number of the breeding birds in Russia and Kazakhstan as 6500-7500 pairs. Within Russia there are somewhat 3000 to 3500 pairs and from 3500 to 4000 pairs in Kazakhstan. It appears that the Eastern Imperial Eagle populations of Russia and Kazakhstan constitutes of a bulk of the total numbers of this species estimated as 5.200 – 16.800 pairs (Birdlife International 2010).

General distribution of the Eastern Imperial Eagle in the Russian Federation and Kazakstan is given in Fig. 2. Eagles breed from the semi-desert zone to steppe-forest biome both on plains and in mountains. In the marginal parts of its range the eagles breed extremely irregularly, and is perhaps nest site and/or prey limited.

The species range occupies a large territory and its numbers seem to be larger than our estimate. However, since we have not carried out surveys in some territories, our estimation may be treated as a minimum figure, which should be corrected in the future.

Fig. 2 demonstrates that the population structure of Eastern Imperial Eagle's area in Russia and Kazakhstan is extremely non-homogeneous. It is characterized by a great variety of breeding clusters with its own dynamics, natural history and area specific factors.

Eastern Imperial Eagles inhabit different habitats in the surveyed region. In Russia habitats with different nesting conditions for eagles are as follows: Excellent habitats in the Volga-Ural region are covered with pine forests on hilltops with steppe areas on foothills used as pastures. In Southern Siberia excellent habitats are low mountains, covered with larch forests with steppe pastures in depressions. In excellent habitats the density of breeding places is at the highest. The distance between nests is 2–4 km and sometimes as low as 1-2 km. In 'good habitats' the density is less than in "excellent habitats". However the eagles inhabit such territories quite steadily. The distance between nests in such areas is 7-10 km. In the Volga-Ural region these habitats are steppe hills with groups of trees on foothills or pine forests on plains. A similar situation is typical for Southern Siberia: steppe mountains with single trees in depressions and large mountains covered with forest intersected by small steppe valleys.

Eagles also breed in small steppe areas atop of mountains in Southern Ural and vast flat steppes, but very un-regularly.

At the small steppe areas in Southern Urals the Imperial Eagles are outcompeted by larger Golden Eagles (*Aquila chrysaetos* Linnaeus 1758) and they

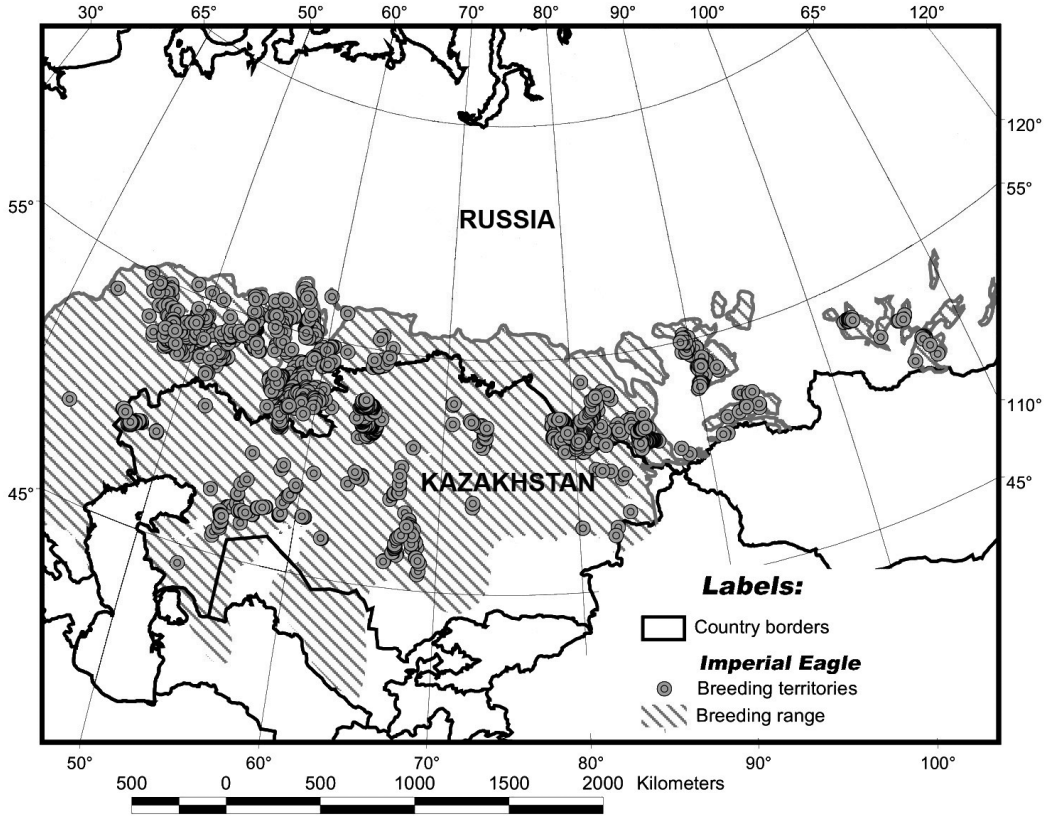

Fig. 2 Distribution of Eastern Imperial Eagle in Russian Federation and Kazakhstan

appear food limited. In flat steppes, the Imperial eagles lack nesting sites (no trees) despite the abundance of food.

Habitats of the Eastern Imperial Eagle in Kazakhstan are more diverse than in Russia. Here the excellent habitats are pine forests in different landscapes in steppe-forest, steppe and semi-desert biomes. Good habitats in the steppe zone include deciduous forests of low mountains and forests along rivers within low mountains. Good habitats in deserts are forests at the edge of sands and trees along rivers.

Saxaul forests on the plateau and trees along cliff-faces of plateaus are also good for Imperial Eagles (oleaster and willow trees). Imperial Eagles inhabit all steppes and deserts of Kazakhstan; however absence of trees is the main reason of unequal distribution.

In Russia the Eastern Imperial Eagles preferred to nest mainly on coniferous trees such as pine and larch. We found 78% of nests on coniferous and 27% – on deciduous trees like birch, poplar, oak and others. Nesting trees of the Eastern Imperial Eagles in Kazakhstan were divided equally between the deciduous and coniferous trees. This fact can be explained by the dominance of deciduous forests in most areas of Kazakhstan (oleaster, Russian olive, poplar, birch, saxaul, elm, aspen, willow and alder).

Fig. 3 shows the amount of nests on different kinds of trees in the whole investigated region. The Imperial Eagles prefer pine as their favourite tree. Moreover, the highest density in large parts of the Imperial Eagle's range in Russia and Kazakhstan is noted for breeding groups nesting on pines and larches.

Building nests at the top of a tree is a character feature of the Imperial Eagle. A total of 66% of known 1304 nests were found at the top or at the fork under the top of a tree. Fig. 4 shows that the vast majority of nests are situated in the top third of a tree trunk. However, eagles build nests in the middle part of a tree as well, but such events are rare. It happens if there is a lack of trees with tops suitable for the nest building.

As noted above, the pine is a favourite tree species for Imperial Eagles in most parts of the range in Russia and Kazakhstan. On plain landscape eagles

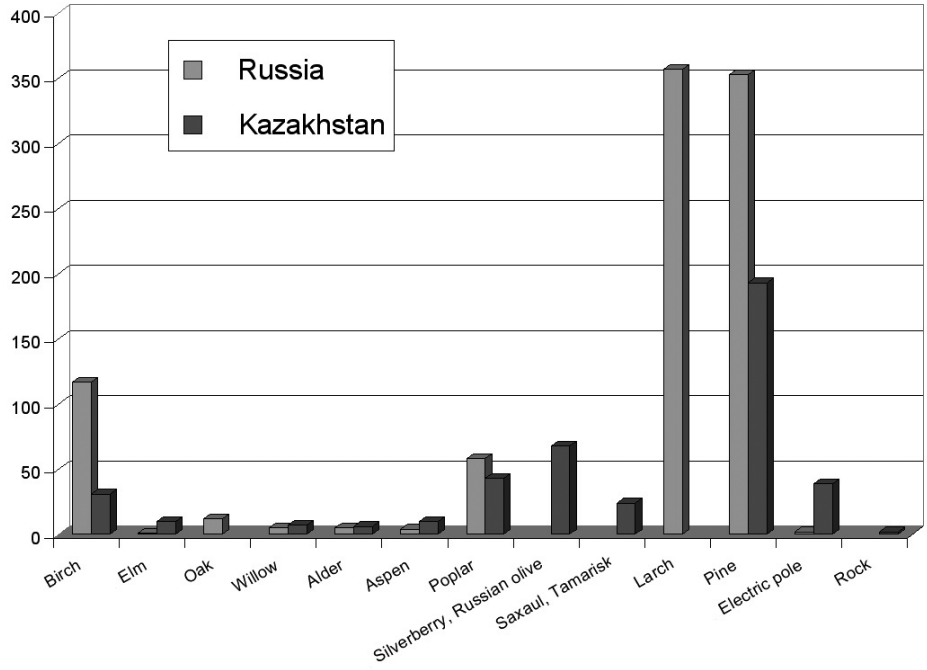

Fig. 3 Total number of nests of the Eastern Imperial Eagle in Russia and Kazakhstan by nesting tree species

prefer to nest on the pines growing at the edge of forests. Eagles inhabiting mountains prefer to nest generally on highest trees also known as 'lighthouse pines' that grow in the upper part of slope. Seventy three percent of nests located on pines are built at the top of a tree. Twenty one percent of nests located on pines are built at the fork under top of a tree. Only 6 of the nests are located inside the crowns of pines. It happens when there is a lack of trees suitable for nesting. It is an example of the eagle's adaptation to unusual breeding conditions.

In Southern Siberia more than 70% of eagles nests are on larches. Only 18% build nests at the tops, and 44% – at the fork under the top of a tree. This fact is connected with the specific structure of the larch crown.

When a number of old trees are insufficient, nests are noted to be built on younger trees, but in the middle parts of their crowns, as young trees cannot not support heavy structures on top. The spatial analysis of different types of nest locations in forest-steppe illustrates the following. When the density in excellent habitats becomes higher than a certain threshold, the species begins to occupy habitats where it's difficult to build nests.

The first period of adaptation to a new habitat is the use of other tree species whereas nesting preferences are still strong. The first version of adaptation is nest building in the upper part of a deciduous tree, growing in the upper part of the forested mountain slope. The second version of the adaptation is nest building in the upper part of a deciduous tree, growing in the bottom part of the mountain slope covered with poor forest. The third version of the adaptation is nest building in the upper part of a deciduous tree, growing in the depression between woodless mountains. The fourth version is nest building in the middle part of a deciduous tree, growing either in the depression between woodless mountains or amongst flat steppe.

The map on Fig. 5 shows 2 primary types of eagle's breeding groups in the Volga-Ural region. We can find out several trends of nest distribution when the Imperial Eagle spread to nest on deciduous trees in forest-steppe. In this case 90% of nests are located between breeding groups of eagles, nesting on coniferous trees and the highest density is noted in breeding groups located either in hilly landscapes between extensive pine forests or in larch forests in low mountains. In general the density of the eagles in deciduous forests is always lower than the density of breeding groups in the nearest coniferous landscapes.

The desert zone in Kazakhstan is characterized by poor development of tree type vegetation.

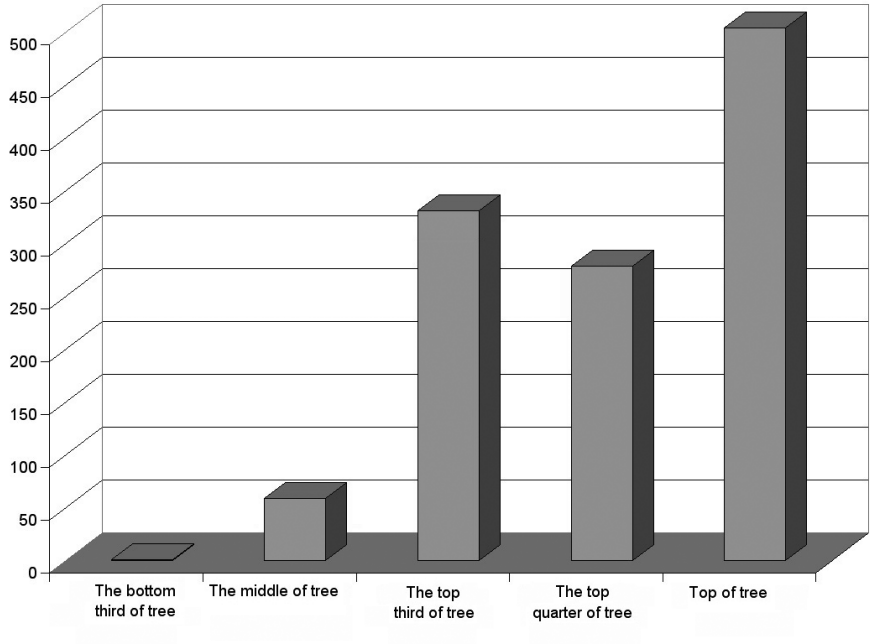

Fig. 4 Location characteristic of the Eastern Imperial Eagle's nests on trees

Thus Imperial Eagle nests in high trees as well as in small saxaul trees. Building nests in trees of different sizes, eagles prefer to build them at the top of a tree. The type of nest location at the top of trees absolutely prevails. So we suppose that the type of nest location in the middle part of a tree crown is secondary. Spreading through windbreak forest strips along fields in the steppe zone eagles prefer to build their own nests at the top of trees too. There are some extreme cases with the nests located at electric utility poles in woodless landscape. Using electric poles by eagles began at edges of large breeding clusters in semi-desert and steppe zones. Then it expands both to the north and south – to forest-steppe and desert

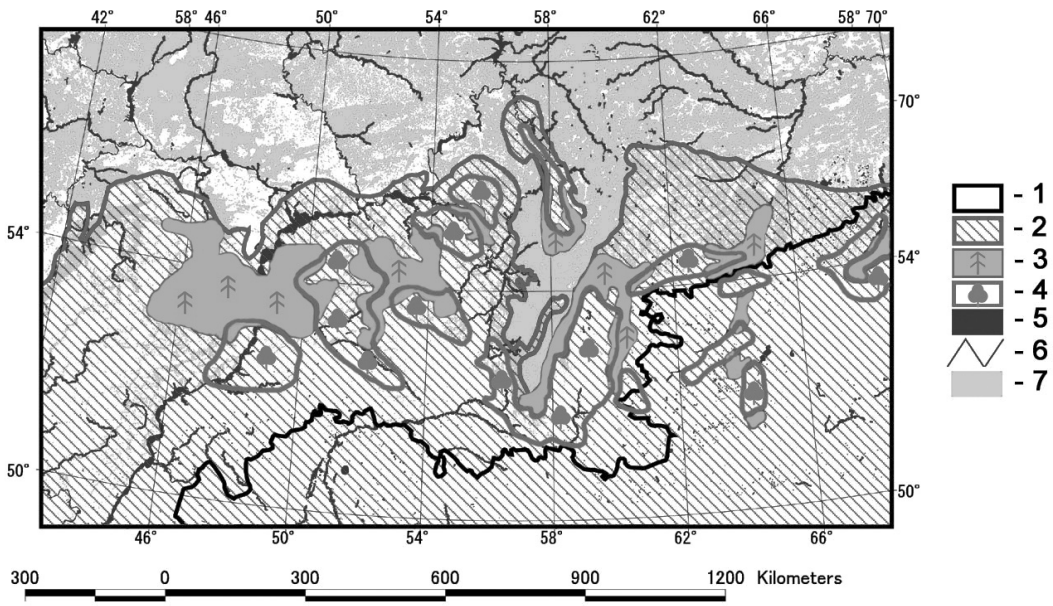

Fig. 5 Nesting clusters of the Eastern Imperial Eagle differentiated by dominant types of nesting on coniferous trees or deciduous trees. Legend: 1 – borders of countries, 2 – breeding range of the Imperial Eagle, 3 – clusters of the Imperial Eagles nesting on coniferous trees, 4 – clusters of the Imperial Eagle nesting on deciduous trees, 5 – water body, 6 – rivers, 7 – forest

zones. The first nest on an electric pole in the forest-steppe zone of Russia was found in 2007. At the moment 3.04% of nests are located on electric poles in Russia and Kazakhstan.

Clutches of the Imperial Eagle contain from 1-3 eggs (n=81; average 2.1±0.57 eggs). We found 2 eggs in 66.7% of surveyed clutches. Infertile eggs in clutches occurred very rarely. Usually chicks hatch out from all eggs. Clutches with 3 eggs were recorded for 21% of the total numbers of pairs breeding near large colonies of Sousliks, which is the main prey of the eagles. Cases of this clutch size usually occur at the edge of dense breeding groups of eagles. Brood size varies from 1 to 3 chicks (n=285; average 1.6±0.59 chicks). Annually the most successful breeding pairs have in general 2 chicks which we observed in 49.5% of broods. Only 5.6% of broods contain three chicks. Broods with 3 chicks are generally noted for pairs in which clutches perish more often. Broods with 1 chick are often (40% of findings) the result of death of the second chick from starvation. Chicks that die from starvation are frequently found under or in the nest.

While monitoring study areas in South Ural and Altai we have got the following statistics:

– Successful breeding was noted in 83% of records, and the average number of fledglings was 1.42 per occupied nest.

– The highest density and breeding success were recorded in territories intensively used for cattle grazing.

Sousliks are the main prey in the Imperial Eagle's diet. Cattle grazing seem to benefit the Eagles since it promotes good conditions for Souslik population growth. In addition, grazing makes eagle hunting more successful. So, there is direct positive correlation between the dynamics of the Imperial Eagle and cattle grazing.

As a result of agricultural decline in the countries of the former USSR from the 1980s, the Eastern Imperial Eagles demonstrated an increase in numbers which slowed down at the beginning of XXI century in the northern parts of the range. However, the catastrophic decline of cattle numbers in the Russian Federation by 70 % in the period from 1990 to 2008 caused a crash in the Sousliks population in the vast area of forest-steppe and steppe zone, and in turn has had a negative impact on the eagle number dynamics.

The trend in population numbers is shown in Fig. 6. Stable decline of Eagles numbers occurs

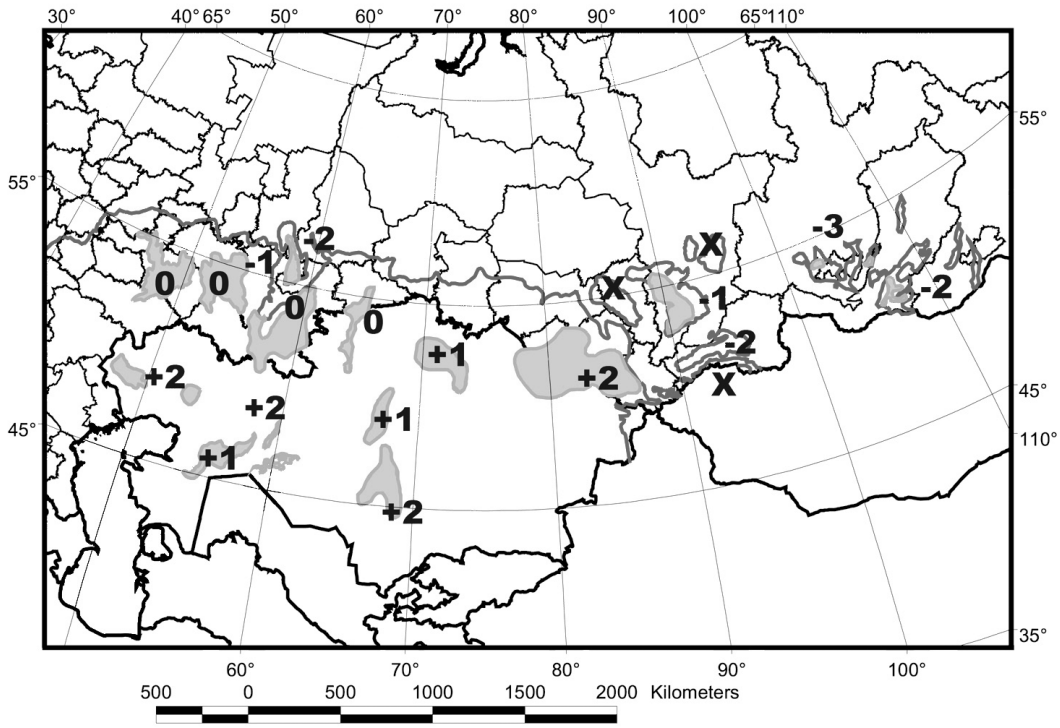

Fig. 6 Imperial Eagle population trends in Russia and Kazakhstan

in the northern and eastern parts of the area – Pre-Baikal and Trans-Baikal regions, in Tuva and the Middle Ural Mountains (Karyakin *et al*. 2006b, Maleev, Popov, 2007, Ryabtsev, Voronova, 2006). Crosses on the map show the places where the species has become extinct. These are the Krasnoyark forest-steppe, the Kuznetsk and Ubsunur depressions. At the same time, the stabilization of number occurs in the Eastern part of the area including the Volga and Ob' rivers basins. This trend is substantially determined by the current status of agriculture in particular regions of Russia.

We can find an opposite tendency in Kazakhstan. Here the Yellow Souslik (*Spermophilus fulvus* Lichtenstein 1823) expansion is believed to be related to climate changes in arid areas. The climate gets moister there (Baigarin *et al*. 2008). That results in high growth rates of the Eastern Imperial Eagle numbers in semi-deserts and deserts. Moreover we found out that inhabiting electric poles and saxaul savannah in clay semi-deserts is accompanied with the exclusion of Steppe Eagles (*Aquila nipalensis* Hodgson 1833). The number trend in Kazakhstan is generally positive for the entire range. This makes the overall trend of the Eastern Imperial Eagles as positive.

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Източният Царски орел в Русия и Казахстан: популационен статус и тенденции

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(Резюме)

Статията се базира на полеви проучвания проведени в периода 2000-2009. Регистрирани са общо 1534 гнездови територии на Източния Царски орел (*Aquila heliaca* Savigny 1809) (1122 територии в Руската Федерация и 412 територии в Казахстан). Документирани са 1347 гнезда, включително 81 гнезда с яйца и 285 гнезда с малки. Всички гнезда са нанесени в ГИС; анализирани са хабитатните връзки и географските координати. Общата численост на царския орел в Русия се оценява на 3000-3500 гнездящи дв. и 3500-4000 гнездящи дв. в Казахстан. Статията разглежда хабитатните предпочитания на царския орел, гнездовите територии и гнездовия успех.

Видът е в голяма степен непретенциозен по отношение на хабитатните предпочитания. Размерът на люпилото и гнездовият успех са достатъчно високи при големите популации. Негативни популационни тенденции са регистрирани само в отделни периферни гнездови групи.