HOW MANY EAGLES ARE AT NAURZUM?

СКОЛЬКО ОРЛОВ В НАУРЗУМЕ?

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Abstract
Estimating population size is central to species-oriented conservation and management. Here we use non-invasive genetic sample collection from the non-breeding component of an endangered bird of prey population to estimate overall population size and to evaluate the impact of variability in population estimates on demographic models that underpin conservation efforts. In 2004, our comprehensive genetic and observational analyses determined that 414 imperial eagles (n = 308 non-breeders + 68 territory holders + 38 chicks) were present. This estimate was 326% larger than the 127 birds visually observed (n = 21 non-breeders + 68 territory holders + 38 chicks) and 265% larger than the population size predicted by demographic models with the same number of breeders (n = 156 ± 7.2; ±SE).

INTRODUCTION

Estimating population size is central to species-oriented conservation and management (Yoccoz, Nichols & Boulinier 2001). Although monitoring strategies have been the subject of extensive recent research, the cryptic and often non-breeding components of structured populations are almost never included in population estimates. We counted, visually and non-invasively with DNA fingerprints, the number of both breeding and non-breeding eastern imperial eagles (*Aquila heliaca*) and white-tailed sea eagles (*Haliaeetus albicilla*) at the Naurzum National Nature Reserve in north-central Kazakhstan. Here we genetically evaluate non-invasively collected feather samples from this component of the population to evaluate the impact of variability in traditional population estimates on demographic models that underpin current conservation efforts in the region.

MATERIALS AND METHODS

The Naurzum National Nature Reserve is located in the Kostanay Oblast (Kostanay administrative region) of north-central Kazakhstan (51°N, 64°E). Non-territorial eagles, nearly all in pre-adult plumage (i.e., juveniles and subadults), are regularly observed roosting communally between breeding territories. We evaluated field notebooks since 1978 and recorded the maximum number of individual birds seen leaving the roost by a single observer during opportunistic observations at these roosts. Breeding and non-breeding imperial eagles shed many feathers at this time of the year and we collected newly moulted and naturally shed eagle feathers from beneath roost tree clusters once in 2003 and four times over twenty days in July 2004. DNA was isolated from samples as described elsewhere (Rudnick et al. 2005).

Microsatellite profiles from feathers were used to group genetically identical samples. In 2003 we identified eagle species based on microsatellite profiles and in 2004 we identified eagle species using sequences from the mitochondrial cytochrome c oxidase I gene. We also compared genetic

profiles of feather samples collected at occupied eagle territories to distinguish territory-holders from non-territorial, communal roosting non-breeders and to identify origins of non-breders (Rudnick et al. 2005, 2008). A mark-recapture study was carried out to augment and evaluate the results of the non-invasive feather collection from 2004 (Rudnick et al. 2008).

We compared our genetic and observational count data to those generated by a stochastic, structured, and closed demographic model of Naurzum's imperial eagles (Katzner et al. 2007). A complete description of the model, including more detail on field techniques and parameter estimation, is provided elsewhere (Katzner et al. 2007).

We randomly picked 1,000 sets of initial parameter values from a range of observed or estimated parameter values. For each set of initial values we ran our demographic model to completion 10 times, thus producing a total of 10,000 model runs. We compared (a) the modelled and non-invasively estimated population sizes when the modelled number of breeders was the same as the observed number of breeders and (b) the modelled and observed number of breeders when the modelled population size was within 10% of the non-invasively estimated population size.

RESULTS

In 2003, we observed 17 non-breeding imperial eagles. In 2004 we observed 21 non-breeding imperial eagles and one non-breeding white-tailed sea eagle (Fig. 1). In 2004 we recorded occupancy by adults at 34 imperial eagle territories and we observed 38 fledged imperial eagle chicks.

Analysis of 109 non-invasively collected feathers from 2003 conclusively identified 47 non-breeding imperial eagles, 2.8 times more than were observed (Fig. 1).

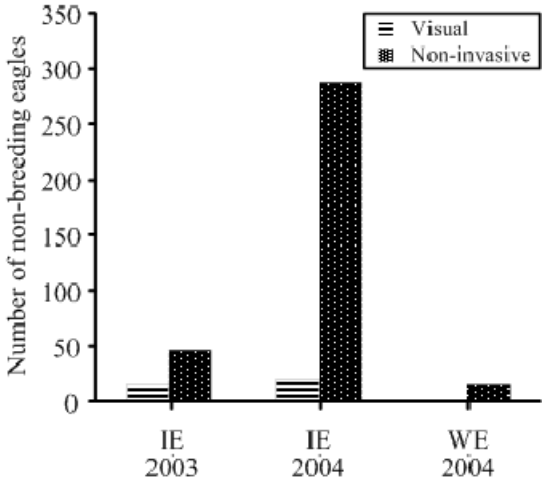

Figure 1. Visual and non-invasive counts of non-breeding imperial eagles (IE; 2003, 2004) and white-tailed sea eagles (WE; 2004 only) at a communal roost at the Naurzum National Nature Reserve, Kazakhstan. Monitoring in 2004 was longer duration and more thorough than in 2003.

Genetic analysis of 1146 feather samples from 2004 conclusively identified 287 non-breeding imperial eagles, 13.7 times more than observed, and 16 white-tailed sea eagles, 16 times more than observed (Fig. 1). Genetic profiles of roost feathers did not match those of any known territorial eagles. Only three (6.4%) of the non-breeders identified in 2003 and 11 (3.8%) of the non-breeders identified in 2004 (Rudnick et al. 2008) genetically matched profiles of chicks hatched in previous years at the reserve.

The most likely mark-recapture model estimated that 308 ± 8 eagles were present, 14.7 times more than were observed during any one visual survey (AIC_c Value = -1,440.4760; n = 4 parameters; Rudnick et al. 2008), but only 21 (7%) more than were "counted" genetically in all four sampling periods.

Of the 10,000 model runs, in 243 cases (2%) there were 34 female breeders in the model (the observed number of breeding females in 2004). However, only in 0.76% of the 10,000 cases was the modelled total population size within 10% of the total population size as estimated from mark-recapture analyses of collected feathers. The 414 imperial eagles (n = 308 non-breeders + 68

territory holders + 38 chicks) our genetic and observational analyses determined were using the reserve in 2004 was 326% larger than the 127 birds visually observed (n = 21 non-breeders + 68 territory holders + 38 chicks) and 265% larger than the population size predicted by demographic models with the same number of breeders (n = 156 ± 7.2; ±SE; Fig 2).

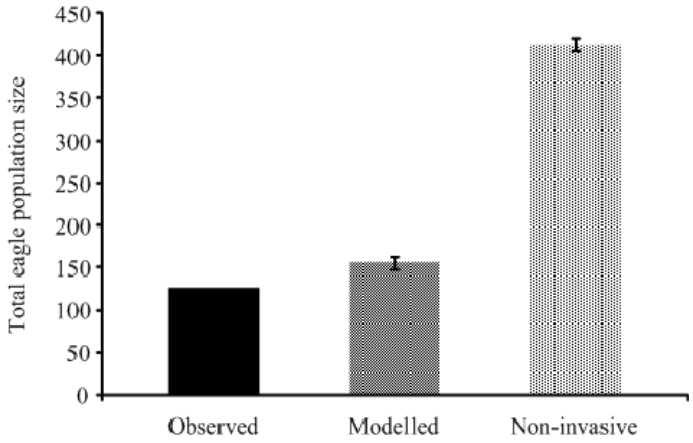

Figure 2. Estimated numbers (± SE) of imperial eagles at the Naurzum National Nature Reserve, Kazakhstan in 2004. "Observed" is the sum of the observed number of territorial eagles, chicks, and non-breeders. "Modelled" is the average number estimated in simulations based upon the observed number of breeders (which is a robust estimate because occupied territories are not missed by observers; error bars show the SE of the mean of the 243 cases considered). "Non-invasive" is the total population of birds in the reserve, where the number of non-breeders is estimated by non-invasive genetic techniques and the number of breeders by observation (error bars are SEs from the MARK population estimate).

DISCUSSION

Conservation assessments depend on biologically meaningful and statistically reasonable estimates of numbers of individuals. In the case of globally vulnerable imperial eagles and white-tailed sea eagles, non-invasive genetic monitoring identified 13 to 16-fold more eagles than were counted with visual monitoring. However, the methods used strongly influenced and improved the estimate of population size produced. Since the majority of the non-breeding eagles are pre-adults that we suspect will eventually hold territories elsewhere (there are only ~40 territories and ~300 floaters looking for nests), these results highlight this site's importance for imperial eagle conservation as a refugium for non-breeders and a source for future breeders (Ryabstev & Katzner 2007).

Historical monitoring of eagles at the Reserve has focused on observations of breeding that form the basis for conservation monitoring and management. These results suggest that even those latest models are built on an already outdated understanding of eagle population dynamics that misses a crucial life stage in the population and dramatically underestimates the number of birds that use the reserve. In spite of the potentially large size of non-breeder populations, most short term studies produce estimates for size of structured populations that do not account for cryptic non-breeders (Hunt 1998). This research shows that models and conservation management programs built around traditional monitoring approaches can misinterpret demographic structure and potentially form a weak framework for conservation efforts. Accurate and rapid estimation of the number of cryptic non-territory holders in structured populations of long-lived species should be a priority for future research and conservation.

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ПРИРОДООХРАННАЯ ДЕЯТЕЛЬНОСТЬ В РАЙОНЕ ОЗЕРА МАНЫЧ-ГУДИЛО

THE CONSERVATION ACTIVITIES AT THE TERRITORY OF THE LAKE MANICH-GUDILO

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Озеро Маныч-Гудило расположено в Кумо-Манычской впадине, протянувшейся от Каспия к низовьям Дона и Азовскому морю. В прошлом впадина неоднократно заполнялась водой и соединяла Каспийское море с Азовским и Черным морями. В центральной её части находится оз. Маныч-Гудило. На его акватории сходятся границы Республики Калмыкия, Ставропольского края и Ростовской области. Озеро занимает часть Пролетарского водохранилища, имеет длину 130 км, наибольшую глубину 4,5 м, ширину до 12 км, зеркало воды 620 км^2, объем 1150 м^3. Климат региона испытывает влияние Арало-Каспийской пустыни и характеризуется как очень засушливый, с суховеями, засухами, большими колебаниями температур. По рассматриваемой долине на запад расселялись и проникают в наши дни многие обитатели пустынных степей и пустынь, а на восток – растения и животные понтийских степей. Благодаря суровым климатическим условиям в районе оз. Маныч-Гудило значительные площади земель остаются не распахиваемыми, используются как пастбища и сенокосы. Озеро, характеризуясь большой акваторией, имеет множество редко посещаемых людьми островов, полуостровов и заливов, что создает хорошие условия для размножения, линьки, отдыха многих пернатых. Озеро и прилегающие к нему степи в ботаническом и зоологическом отношении относятся к наиболее богатым и ценным на юге России районам.

В 1963 г. для сохранения природных ресурсов на оз. Маныч-Гудило и прилегающих участках степи Совмином Калмыцкой АССР был организован природный заказник, который в 1975 г. распоряжением Совмина РСФСР преобразовали в государственный республиканский заказник РСФСР (69000 га). Постановлением Правительства России №1050 от 13.09.94 этот район получил статус водно-болотного угодья международного значения по Рамсарской конвенции с названием «Озеро Маныч-Гудило». Постановлением Правительства РФ №562 от 08.05.1996 калмыцкий участок озера площадью 27,6 тыс. га присоединили к заповеднику «Черные земли» в качестве его орнитологического филиала «Маныч-Гудило». Для этого филиала была создана охранная зона.

Заповедник «Ростовский» организован Распоряжением Правительства РФ №1292 от 27.12.95 на ростовском участке Маныч-Гудило. Он состоит из 4-х участков, удаленных друг от друга на 5–25 км с общей площадью 9464,8 га. Участок Островной (4591 га) находится на оз. Маныч-Гудило и включает акваторию озера (1090 га), материковый берег (10 га), острова