Conservation Genetics of the Java sparrow (*Padda oryzivora*) and an analysis of its viability

Thesis submitted by

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ABSTRACT

The problem of how to conserve small and declining populations is currently receiving considerable attention in the ecological literature, particularly through the theoretical development of conservation biology and its application to endangered species conservation. This is true despite basic information on the natural history of most endangered species being very limited; not only for species that are very rare, elusive or living in remote areas, but also for species which occupy more accessible habitat (i.e. cultivated areas), such as the Java sparrow (*Padda oryzivora*).

In the research outlined in this thesis, field studies and molecular analyses were combined to establish the current population status, level of continued threat, contemporary connectivity among remnant populations and the genetic diversity of the endangered Java sparrow. Field work included intensive censuses at 6 sites across Central and East Java during the 2004 and 2005 breeding seasons. To gain information about the current scale of trading and trafficking of Java sparrows, the numbers of birds for sale were surveyed at 7 bird markets, mostly situated close to the bird census sites. Further interviews with bird trappers established the level of trapping and distribution of trapping sites.

DNA was extracted from both fresh whole blood (field samples) and tissue samples (museum specimens) and analysed using two different molecular marker systems – part one and two of the mtDNA control region and 5 independent nuclear microsatellite loci. MtDNA sequence data were used to infer phylogeography and historical demography of the Java sparrow, while, multi-locus microsatellite genotyping was used to assess contemporary connectivity and levels of genetic variation. In order to predict the future fate of the Java sparrow, a PVA and sensitivity analysis was also undertaken. Stochastic modelling was carried out using the program VORTEX.

The results of this study highlight that remnant populations of Java sparrow in Central and East Java are currently small and highly fragmented. Based on roost counts at 6 sites, population estimates range from 5.8 (± 0.2 SE) to 125.2 (± 1.7 SE). The total estimated population for Central and East Java did not exceed 1000

individuals. If other regions of Indonesia within the species' natural range have similar abundances, then the total Java sparrow population in Indonesia is likely to be at the lower end of the range of 2500 – 10,000 individuals that is currently used to classify the species as 'Vulnerable'.

The major threat from trapping and trading is still ongoing at a high level, with an average 59.3 % of the total population estimates being trapped during the study period. This threat is particularly severe in central Java, where market demands were mainly supplied by local wild caught birds. In contrast, in the east Java bird markets, introduced and captive bred birds were substituted to satisfy high market demand. These findings emphasize the potential abundance of Java sparrows that may occur in currently unstudied introduced populations on outer islands (e.g. Kalimantan), and the important role that introduced and captive bred birds currently have in mitigating further declines. They also highlight the potential usefulness of these introduced populations as part of future conservation schemes for the Java sparrow.

Analysis of mtDNA sequence data was used to infer the effects of historic habitat changes on population demography and genetic diversity in the Java sparrow. Despite an expectation that this species would have increased habitat availability during glacial maxima, analysis based on standard mtDNA mutation rates revealed that major climatic shifts have caused bottlenecking in Java sparrows similar to those observed in temperate species impacted by expanding ice sheets. Alternatively, using more recently derived and contrasting mtDNA mutation rates suggests the Java sparrow was bottlenecked during the expansion of rainforest in the early Holocene, and likely expanded during deforestation associated with the arrival of cultivation to Java. If correct, this finding adds to an increasing number of studies highlighting the impact of human colonization on the distribution and abundance of endemic species.

Microsatellite genotyping demonstrated that genetic variation in remnant Java sparrow populations was low, in the middle range of genetic variation observed for other endangered species. Levels of diversity among contemporary populations did not differ from historic samples. In addition, significant structuring was found among remnant but not historic populations, implying recent fragmentation and limited current inter-population movement. Therefore, it is likely that while recent

population declines have, as yet, had limited impact on genetic diversity, they have had a significant impact on levels of interpopulation gene flow.

Stochastic PVA modelling suggested that, under a best case scenario, Java sparrows would be able to recover. Sensitivity analysis revealed that the PVA models were most sensitive to mortality and fecundity schedules. However, the results highlighted that further field studies of these parameters are necessary to gain a more realistic assessment of the potential fate of the Java sparrow over both the short and longer term. PVA also suggested that if the current level of trapping continues Java sparrow will become extinct within a very short period of time. Given that terminating trapping seems an unlikely short-term management option, these findings highlight the immediate need to formulate a trapping/harvesting strategy that minimizes the risk of extinction.

The implications of the results of this research are as follows:

1. It is proposed that the conservation status of Java sparrow to be transferred from Vulnerable to Endangered (A2a,b,d; E). This research also provides a more robust, high quality data set that can be used for conservation status assessment.
2. Trapping remains the main threatening process and must be reduced before other conservation measures can be effective. The use of captive bred and/or introduced birds should be encouraged to meet market demands. Further population studies on introduced populations (e.g. in Kalimantan) are a necessity to develop the sustainable use of these resources.
3. For management purposes the Java sparrow can be considered as a single Management Unit. However, to develop a sound conservation strategy for this species, it is important to take into account the concept of "ecological exchangeability". For this purpose we need studies of behaviour, life history, and morphology relative to environment. Such studies will allow more meaningful assessment of biologically relevant differentiation among the remnant populations of the Java sparrow.
4. There is also a need for further research on demographic parameters and breeding biology to gain more realistic predictions of population viability.
5. There is a critical short-term need to formulate a trapping/harvesting strategy to minimize the extinction risk. Working thresholds need to be established as a

short-term management priority and as a basis for more effective and sustainable management strategies over the longer term.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES