EDIBLE FROG HARVESTING IN INDONESIA: EVALUATING ITS IMPACT AND ECOLOGICAL CONTEXT

Thesis submitted by

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ABSTRACT

Frogs are harvested in Indonesia for both domestic consumption and export. Concerns have been expressed about the extent of this harvest, but there have been no detailed studies on the edible frog trade in Indonesia, or on the status or population dynamics of the harvested species. To investigate the possible impact of this practise, I collected data on harvesting and trading of frog legs in Java, Indonesia. I also investigated the ecology and population dynamics of the three species that are most heavily harvested: *Fejervarya limnocharis-iskandari* complex, *F. cancrivora* and *Limnonectes macrodon*.

The first step of the study quantified the extent of the Indonesian edible frog leg trade for export and domestic purposes. Harvesting is an unskilled job and serves as livelihood for many people. There is no regulation of this harvest, and species taken and size limits are governed by market demand. The most harvested species in Java are *F. cancrivora* and *L. macrodon*. Harvests occur all year long. The number of frogs harvested fluctuates and is controlled by natural forces such as dry/wet seasons, moon phase, and planting seasons. Records of the international trade in Indonesian frog legs are available from 1969 to 2002; the mass of frozen frog legs exported has increased over the years. I used data on the relative weights of frogs and their legs to estimate how many frogs were represented by the export records. In 1999-2002 an average of 3,830,601 kg of frozen frog legs were exported annually; this represents an export harvest of approximately 28 to 142 million frogs, all with masses greater than 80 g, the minimum size of animals that have legs considered suitable for export. I used data collected by following frog hunters in the field to assess their capture rates and the numbers and sizes of frogs captured. I found that only about one-eighth of frogs

captured are of sizes acceptable for export, and therefore estimate that the domestic market is approximately 7 times as large as the export market.

In the second step of the study, I used field data on *F. limnocharis-iskandari* complex*, F. cancrivora* and *L. macrodon* to gain greater understanding of the population biology and dynamics of the harvested species. Populations of *F. limnocharis-iskandari complex* and *F. cancrivora* were studied in six rice fields in West Java during the planting seasons of 2002 and 2003. Both *F. limnocharis-iskandari* complex and *F. cancrivora* were abundant in the rice fields, with estimated overall mean densities of 193.71 and 39.76 per hectare. The mean density of *F. cancrivora* was very similar to that of unharvested populations in Malaysia (8.6 – 91.2 per hectare) (Jaafar, 1994) and was much higher than the mean density (0.7 frogs/ha) found for *Rana tigerina*, the larger species of edible Indian paddy field frog investigated by Dash and Mahanta (1993). These comparisons suggest that densities of *F. cancrivora* in Javan rice fields are relatively high, despite ongoing harvesting pressure. *F. limnocharis-iskandari* complex and *F. cancrivora* were able to breed continuously all year without an apparent season. Both species showed sexual size dimorphism, with females larger than males. Both appear to be short lived.

The population dynamics of *L. macrocodon* were observed at two stream sites West Java: Cilember and Ciapus Leutik. The habitat at Ciapus Leutik is relatively heavily modified bu human activity, while Cilember is in a nature reserve and ls less disturbed. A mark recapture study was conducted once a month between June 2002 and May 2003 (a continuous 12 month sampling period), and in January, April and July 2004. Skeletochronological analysis of phalanges removed during toe clipping suggests that this species lives longer than *F. cancrivora* or *F. limnocharis-iskandari* complex. Recapture rates of *L. macrodon* in both locations were low and more frogs were

observed during periods of higher rainfall. In this study, more *L. macrodon* were found at Cilember than at Ciapus Leutik stream. It is unclear whether the low number of frogs at Ciapus Leutik was caused by over-harvesting or by other factors. There is a need for further monitoring to obtain a greater understanding of the population dynamics of this species.

In conjunction with my field work, I measured a number of parameters to determine the type and extent of pesticide residues present in rice fields, and to attempt to determine whether those and another potential stressor, drought, might be affecting the morphology, body condition, or developmental stability of frogs. I also surveyed populations of the rice field frogs and *L. macrodon* for the emerging disease chytridiomycosis, which could strongly affect the population dynamics of the frogs. Two types of pesticide residues were detected in water and soil: organochlorine (lindane, aldrin, heptachlor, dieldrin and endosulfan) and organophospate (chlorpyrifos and diazinon). Six organochlorines type (BHC, lindane, aldrin, heptachlor, dieldrin and endosulfan) and three organophosphates (propenofos, chlorpyrifos and diazinon) were detected in the livers and leg muscles of both frog species. Almost all pesticide residues were low compared to the Maximum Residue Limit set by WHO and the Government of Indonesia although a few individuals showed higher pesticide residues contents. Pesticide residue levels did not appear to be related to any measure of frog condition or stress. Both species of rice field frogs exhibited relatively low percentages of abnormalities, probably within the normal range. Only *F. limnocharis-iskandari* complex consistently exhibited levels of fluctuating asymmetry in excess of measurement error. Levels of asymmetry differed between characters. Higher limb asymmetries were elevated in 2002 compared to 2003, whilst body condition was lower in 2003. It is possible that the lower body condition in 2003 was caused by stress from

an environmental factor, in this case the drought in that year. It is clear that for both *F. limnocharis-iskandari* complex and *F. cancrivora*, fluctuating asymmetry is not a powerful indicator of stress. There was no sign of chytrid infection in any samples of the three species.

To assess the impact of harvesting, I used two approaches. I developed a model of the population dynamics of *F. cancrivora* and ran simulations for ranges of parameters including harvesting rate. The simulation indicated that current levels of harvest may be near the maximum level sustainable by the population. My second approach was to compare data on the population biology and distribution of both *Fejervarya* species to criteria for assessing the conservation status of the species, i.e. IUCN Red Categories and the CITES Res. Conf. 9.24 on the Criteria for Amendment of Appendices I and II.

My assessment using listing criteria showed that neither *F. limnocharis-iskandari* complex or *F. cancrivora* are qualified for inclusion into any IUCN Red List and CITES Appendices. On the other hand, more consideration needs to be given to *L. macrodon.* This frog is not qualified for inclusion in CITES Appendix I. At present, it is not possible to determine whether this species could be listed as vulnerable or in CITES Appendix II due to a lack of data, such as survivorship among stages, and habitat size, on the population biology of this species.

Recommendations for management of the harvest include: 1) regular monitoring of this trade especially in other islands such as Sumatra by the scientific authority of CITES (The Indonesian Institute of Science or Lembaga Ilmu Pengetahuan Indonesia, LIPI), 2) regular monitoring of the numbers of export companies and their middleman, 3) developing a simple identification key and distributing it to the middlemen to ensure correct identifications, 4) assessing the possibility of breeding local frogs for this trade

to replace the farming of the exotic frog *Rana catesbeiana*, and 5) ensuring that harvest is limited to species that are not adversely impacted.

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DECLARATION

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given

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