

Ruling of the IUCN Red List Standards and Petitions Committee on the Listing of the Long-tailed Macaque, *Macaca fascicularis*

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The IUCN Red List Standards and Petitions Committee (SPC) received a petition on the listing of the Long-tailed Macaque (*Macaca fascicularis*) on March 4, 2024. The species was listed as EN A3cd (Hansen et al. 2022). The main issues raised in this petition involved generation length calculation, calculation of population reduction from a variable population trajectory, interpretation of evidence to support range-wide reductions, elicitation of expert opinion, and apparent bias in language used in the assessment.

Generation Length

The 2022 assessment specified generation length as 13.9 years, based on estimates of Pacifici et al. (2013), which in turn were based in part on longevity estimates from the AnAge database. The petitioners point out that some of these estimates come from animals in captivity where longevity may be longer, and that this species may be one of the "limited number of large-bodied species" mentioned by Pacifici et al. (2013) for which this is a possible source of bias. For the Long-tailed Macaque (LTM), Van Noordwijk and van Schaik (1999) appears to be the only source with an estimate of lifespan in a wild population. Although they report a maximum age of 28 years (their Figure 7), there is senescence, and the maximum age of reproduction is reported as 24. Given these data, generation length is likely to be about 10 years, shorter than the value used in the assessment (14 years), and longer than the value calculated by the petitioners (9 years). Generation length should be corrected as 10 years. Note that, if life span, and consequently generation time, is short in the wild because of human impacts such as exploitation, then pre-impact values must be used.

Population Reduction in a Protected Area in Cambodia

Although the assessment is EN A3 (i.e., based on projected future reduction), it is based on the apparent continuation of, and projected increase in, the threats faced by the species, and therefore can be considered as a projection of recent declines. Thus, although the species is not listed under criterion A2, recent declines are relevant to this assessment. One study that provides data on recent declines is Nutall et al. (2022), which is referred to by both the petitioner and the RLA. This study analyzed data from the population of LTM in a protected area in Cambodia from 2010 to 2020 (see also below about data reported by Agger 2022).

The 2022 assessment interpreted the data from this study to calculate a 50% reduction over 10 years, apparently focusing on the first and last data points of this rather variable time series. This is not the appropriate way to analyze a time series. When a linear or an exponential curve is fitted, the decline would be just under 30% (see below). In addition, the petitioners report a discussion on whether the data point for 2018 (the second-to-last point) is an outlier. A data point can be considered an outlier only if there is an objective reason (unrelated to its effect on the calculated trend) why it is particularly anomalous or unreliable.

On Statistical Significance

The petitioners focus on the conclusion of Nutall et al. (2022) that the LTM population studied is "stable." Note that stable is used by Nutall et al. to mean a trend that is not statistically significantly different from zero, but not in the more general, population-dynamic meaning of a tendency to return to an equilibrium after a perturbation or disturbance. Because of the variability in the data used in this assessment, there is a non-zero probability that the decline is due to chance and the population may not be actually declining.

Obviously, variability and uncertainty are important to consider in Red List assessments. However, traditional (and rather subjective) thresholds of probability used in significance tests (which mainly pertain to Type I errors) are not necessarily relevant to conservation assessments. For assessments under criterion A, the two possible errors are: deciding that there is a decline when there is actually no decline (Type I), and deciding that there is no decline when there is actually a decline (Type II). There is a trade-off so that, given a particular data set, minimizing one error necessarily increases the other. The commonly-used threshold of $P < 0.05$ typically minimizes Type I error, which is important when determining what conclusions to accept into the scientific canon. In contrast to decisions regarding scientific hypotheses, conservation decisions tend to follow the precautionary principle, and aim to find a balance between the two types of error that depends on their respective costs. Consequently, the Red List Categories and Criteria require decisions to be precautionary while also being realistic (IUCN 2012).

Nuttall et al. reported a trend to be "stable" if $< 95\%$ of replicates agreed on trend direction, corresponding to a Type I error rate of ≤ 0.05 . For the data on the LTM population, they found that 71% of the replicates agreed that the trend was negative; because this percentage was $< 95\%$, they labeled the LTM population as stable. Although the decline is not sufficiently certain to meet the traditional P level for statistical significance ($P < 0.05$), it is sufficiently certain to meet Red List requirements based on a precautionary but realistic interpretation of the evidence: there is 71% certainty to suspect a population reduction of $> 60\%$ if an exponential decline continues over three generations. Further, given that the declining population is in a protected area that has "benefited from a greater level of conservation investment than most other PAs in Cambodia" and has "one of the largest law enforcement teams within any Cambodian PA", it is reasonable to suspect that declines outside PAs might be at least as large.

Suspected Range-wide Reduction

"Suspected" is the lowest level of data quality that is acceptable for criterion A. Suspected population reduction can be based on any factor related to population abundance or distribution, so long as the relevance of these factors can be reasonably supported (IUCN Standards and Petitions Committee 2024). For example, reports of large numbers of individuals being hunted, poached or traded can be used to support reduction if it is suspected that the level of exploitation will impact the population size (IUCN Standards and Petitions Committee 2024). Nevertheless, the support for the relevance of the factors that contribute to the population reduction must include evidence that the intensity of these factors is likely to cause the magnitude of declines specified in the criteria.

For LTM, one issue that complicates assessment of range-wide reduction is the importance of, and the species' performance in, secondary and edge habitats. Based on the frequent observations of LTM in these habitats, the petitioners infer that the species could not possibly be at risk of extinction. The RLA interprets the use of secondary and edge habitats as a risk factor because of increased susceptibility to

disease and capture, increased risk of human-wildlife conflict, and decreased area-based protection in these habitats. They also present evidence that, although use of these habitats makes LTM more visible to humans, LTM population densities are actually lower in these habitats. Although there is substantial uncertainty, and although the species' use of these habitats is an indication of its flexibility, it appears to be also a factor that increases LTM's extinction risk.

The petitioners assert that some relevant sources of information are not cited, claiming in particular that failure of the assessment to cite Iqbal et al. (2023) and Sulistyadi (2023) was a glaring omission. The conclusion of Sulistyadi (2023) that the status of LTM is "positive" is based on a system of scoring that is unrelated to the IUCN Red List, and therefore is beyond the scope of SPC's consideration. Of course, information used in any reference may be relevant, but the SPC did not find any data in these references that would change the listing. Another dataset omitted from the assessment (Brotcorne et al. 2011) is relevant, but comes from a non-representative site (because of provisioning and intensive management, including medical care; Loudon et al., 2023).

As in many wide-ranging threatened species, there are populations of LTM that are declining, increasing, or have unknown trends. The 2022 assessment mentions some of these, but the information is not presented efficiently. Although a more organized arrangement of the available information would have provided a more straightforward interpretation (and thus should be provided; see below), SPC concludes that the available information appears to support suspected declines of at least 50% over the next three generations.

Recently Available Information

The assessors claim that recent information supports alarming levels of decline, larger than those considered in the 2022 assessment. However, some of the cited references are neither published nor available publicly. One cited report that is available (Agger 2022) appears to provide one additional data point (1344 individuals in 2022) to the data set discussed above (analyzed by Nuttall et al. 2022). This additional data point increases the recent population decline trend to over 4% per year. Thus, adding this information would strengthen support for the RLA's assessment outcome.

Emotive Language

The narrative of the 2022 assessment, including its style and language, does not follow the standards of objectivity expected of Red List assessments, and therefore undermines perceptions of the neutrality of the assessment. A Red List assessment is expected to outline the information that led to the specific category and criteria, and provide technical, objective support for the listing. What a primate specialist proposed, why this plea was likened to an extinct species, and speculation about what assumptions people are making about the species are among the topics that have no place in a Red List assessment. Subjective, emotive, value-laden language (e.g., "insidious", "ominous") should be replaced with objective and informative language. The required conservation actions should not be discussed as moral imperatives; rather, the ongoing, planned and recommended conservation measures should be listed and discussed with respect to their feasibility and expected conservation impact.

Conclusion

SPC concludes that, although there appears to be adequate evidence to support the current EN listing of the LTM, the lack of a clear organization of the available information and the value-laden language undermine the 2022 assessment. SPC therefore requests that a reassessment be submitted by the RLA within 8 months from the date of this ruling (or a different period as may be set by the SSC Chair). If a reassessment is not submitted by the end of this period, or the submitted reassessment does not pass review by the SPC, the current assessment will be retracted, and the species status will revert to that of the previous assessment. (If this is not feasible due to the technical constraints of the database, the category will be set to Data Deficient.) During the time allocated for the reassessment (and, if submitted, during SPC's review), the current assessment will remain, and will continue to have the label 'under petition' or another suitable label as determined by the RLU.

The reassessment must:

- Evaluate all available information, including information that has become available since the 2022 assessment, and information that contradicts the assessment conclusions;
- Document the levels of exploitation and the evidence that this level of exploitation is impacting population size;
- Use a more systematic approach to collating the information from different parts of the species' range. This should include a table documenting, for each region, the relevant information on threats, population trends, levels of exploitation, and other information relevant to the assessment. This table should organize both quantitative and qualitative information, including expert opinion;
- Use 10-year generation length;
- Be objective and informative, and avoid value-laden language;
- Calculate past reduction to determine if the data would allow an assessment under criterion A2;
- Document the methods of expert elicitation* and explain how subjective biases were addressed;
- State the range of plausible categories based on the available data.

*Expert elicitation is an appropriate method for estimating population parameters for assessment against the Red List criteria. Like methods of measurement, estimation from samples and indirect inference, estimates obtained from expert elicitation may be subject to errors. Where possible, these should be quantified (e.g. by reporting variation among experts) and methods of elicitation (e.g. delphi methods) should be employed to reduce errors such as subjective bias.

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