A response to Ocampo-Peñuela *et al*. (2016); *Science Advances*

Ocampo-Peñuela *et al*. (2016) represents a fundamental misunderstanding of the application of the IUCN Red List categories and criteria, and the authors are incorrect in concluding that their analysis shows that many more species are threatened than currently assessed on the IUCN Red List. The IUCN Red List of Threatened Species remains the most reliable indicator of the global threat status of species.

In a widely publicised paper, Ocampo-Peñuela *et al*. (2016) argued that 210 bird species (43% of those they studied) are incorrectly classified on the IUCN Red List and belong in a higher category of threat than the one in which they are currently listed, concluding that there are “substantially more species at risk than what the IUCN currently asserts”. Unfortunately, their conclusions are flawed, owing to the authors’ misapplication of the IUCN Red List Categories and Criteria, as outlined below.

Ocampo-Peñuela *et al*. (2016) misapplied the IUCN Red List Categories and Criteria by applying a novel measure (extent of suitable habitat remaining within each species’ distribution) to IUCN criterion B1 instead of criterion B2. As the B2 thresholds are one order of magnitude smaller for each category threshold than B1, far fewer species than the authors propose actually qualify for listing as threatened under criterion B.

For a sample of 586 endemic and threatened forest bird species from six regions, Ocampo-Peñuela *et al*. (2016) followed established procedures to calculate the extent of suitable habitat (hereafter termed ESH; i.e. the area of tree cover within each species’ altitudinal preferences) remaining within each species’ distribution. The authors then applied this value to the thresholds for extent of occurrence (EOO) under criterion B1 of the IUCN Red List Categories and Criteria to determine which category each species should qualify under, and concluded that many of these species should be listed as more threatened on the IUCN Red List.

However, it is incorrect to apply estimates of ESH to the thresholds for EOO under criterion B1 of the IUCN Red List. Instead, they should be applied to the thresholds for criterion B2 (Area of Occupancy; AOO), as they represent the maximum possible values for AOO for each species (ESH is not an actual estimate of AOO, because it does not follow the methods recommended in the IUCN Red List Guidelines; Standards and Petitions Subcommittee 2016). As the B2 thresholds are one order of magnitude smaller for each category threshold, far, far fewer species than the authors propose would qualify for uplisting or would do so to much lower categories of extinction risk.

The IUCN Red List Guidelines (Standards and Petitions Subcommittee 2016) and Joppa *et al*. (2016) have clarified that EOO has to be calculated as the minimum convex polygon around the mapped range – it estimates the spatial spread of extinction risk, not range extent or range occupancy. The area of suitable habitat within the area of mapped range (i.e., ESH) should be applied to the B2 thresholds as an estimate of the maximum possible area of occupancy (AOO), or used in combination with population density data to inform maximum potential population sizes and applied to criterion C1, C2 and D1 (see e.g. Buchanan *et al.* 2008, Tracewski *et al.* 2016).

It is also important to emphasize that simply meeting the area thresholds for EOO or AOO under criteria B1 and/or B2 is not sufficient: the assessed taxon must then also meet at least TWO of the three subcriteria concerning (i) number of threat-defined locations and/or severe fragmentation, (ii) continuing decline and (iii) extreme fluctuations. It is not evident that Ocampo-Peñuela *et al*. applied these subcriteria.

The authors do acknowledge that "what our methods produce are neither extent of occurrence nor areas of occupancy but something intermediate" but then state that they "err on the conservative side and use the extent of occurrence". In reality, this approach is not conservative, but drastic. As extent of suitable habitat will generally be considerably smaller than the area of mapped range, and even smaller again than extent of occurrence, it is inevitable that many species will appear to qualify at higher categories of threat. While the authors "are not surprised that, in refining ranges, more species fall below any given threshold", they "find that when we refine the ranges of some species currently deemed non-threatened, their ranges become as small as those of species currently deemed threatened". As pointed out in Collen *et al*. (2016) and Akçakaya *et al*. (2006), it is not meaningful to modify the carefully defined parameters used in the IUCN Red List system and then apply them to the same thresholds. This is particularly true if you then make recommendations for uplisting species or comparisons with the published categories of species, as is the case in Ocampo-Peñuela *et al*. (2016). An analogy is to take the FTSE 100 or Dow-Jones Index, which represent the average value of a set of stocks, measure the value of stocks in a different way that produces a much lower index value, and then say that everyone is now much poorer because the index has gone down.

Ocampo-Peñuela *et al*. incorrectly state that the IUCN does not take advantage of new technologies. In reality, IUCN *is* making best use of new technologies; for example, Tracewski *et al*. (2016) analysed all forest-dependent birds, mammals and amphibians species worldwide (>11,000 species) and calculated extent of suitable habitat using high resolution tree-cover data; they simultaneously took account of remotely sensed forest loss data to inform estimates of rates of population decline.

The authors conclude that "an organization as important as the IUCN needs to take advantage of new technologies, algorithms, information, and automation of processes". Fortunately, IUCN already has. Several months before Ocampo-Peñuela *et al*. (2016) published their analysis from a handful of hotspots, Tracewski *et al*. (2016) published an analysis of over 11,000 species—*all* forest-dependent birds, mammals and amphibians worldwide—calculating their extent of suitable habitat using the same high resolution tree-cover data but correctly comparing the results with the B2 rather than B1 thresholds. A key component of this study is that it took account of forest loss (not just forest cover) data derived from remote sensing to inform extinction risk assessment, with rates of forest loss being used to inform estimates of rates of population decline under the Red List criterion A (and see Buchanan *et al*. 2008). Indeed, we see the greatest value in the application of remote sensing to the Red List in standardising measurement against criterion A. Tracewski *et al*.'s co-authors included representatives from BirdLife International and from the Global Mammal Assessment programme at Sapienza University of Rome (who coordinate the assessments for all birds and mammals, respectively, on the IUCN Red List), and the results are feeding into updates of the IUCN Red List that will be published in 2017 (birds and mammals) and 2018 (amphibians). The authors collaborated with engineers at Google's Earth Engine to develop freely accessible code to run the analysis, and the collaboration paved the way for a formal partnership between Global Forest Watch (who annually update the deforestation data based on analyses of satellite imagery), IUCN, BirdLife International and others to automate these analyses in future and to feed them automatically into the database underpinning the IUCN Red List.

Ocampo-Peñuela et al. (2016) have created unwarranted confusion and undue scepticism of the IUCN Red List.

Besides the issues discussed above, the authors remark that "there should be an additional threshold for the extent of suitable habitat." Whether we need a new subcriterion under criterion B that has thresholds for extent of suitable habitat is not a straightforward issue. In order to be a useful predictor of extinction risks, such a criterion would need standards for distribution modelling to ensure consistency; ensuring correct application of those would likely be far more challenging than the correct application of AOO and EOO. In addition, the need for such a new criterion is far from clear, because the IUCN Red List system already includes several ways of using estimates of the extent of suitable habitat, including:

i) as an upper bound of AOO estimates, as explained above;
ii) inferring rates of population decline from estimated changes in extent of suitable habitat under criteria A1c and A2c, as mentioned above;
iii) inferring continuing declines under criteria B and C;
iv) inferring severe fragmentation under criterion B;
v) using the habitat suitability data to structure and test spatially explicit models to estimate extinction risks under criterion E.

Initiatives to provide more precise maps of species distributions, and that encourage the use of new technologies and datasets in Red List assessments are sorely needed. However, the application of these new approaches by Ocampo-Peñuela *et al*. (2016) is not consistent with the established thresholds and guidelines. While IUCN and its Red List Partners welcome constructive criticism, the conclusions of this study are unfortunately flawed, and do not help further our aim of making the IUCN Red List a better Barometer of Life.

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IUCN Red List Committee, IUCN Standards and Petitions Sub-committee and BirdLife International (serving as the Bird Red List Authority)