Species extinction threat underestimated due to math glitch, says study

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Extinction risks for natural populations of endangered species are likely being underestimated by as much as 100-fold because of a mathematical "misdiagnosis," according to a new study led by a University of Colorado at Boulder researcher.

Assistant Professor Brett Melbourne of CU-Boulder's ecology and evolutionary biology department said current mathematical models used to determine extinction threat, or "red-listed" status, of species worldwide overlook random differences between individuals in a given population. Such differences, which include variations in male-to-female sex ratios as well as size or behavioral variations between individuals that can influence their survival rates and reproductive success, have an unexpectedly large effect on extinction risk calculations, according to the study.

"When we apply our new mathematical model to species extinction rates, it shows that things are worse than we thought," said Melbourne. "By accounting for random differences between individuals, extinction rates for endangered species can be orders of magnitude higher than conservation biologists have believed."

A paper on the subject by CU-Boulder's Melbourne and Professor Alan Hastings of the University of California, Davis was published in the July 3 issue of *Nature*. The National Science Foundation funded the study.

Currently, extinction risk models are based primarily on two factors, said

Melbourne. One is the number of random events adversely affecting individuals within a population – the accidental drowning of a rock wallaby, for example. While a sequence of such random events in a small population can have a big impact, such events are far less likely to affect larger populations, Melbourne said.

The second risk factor used widely in extinction risk models is the impact of external, random events like temperature and rainfall fluctuations that can influence birth and death rates of individuals in a population, said Melbourne.

But two additional factors highlighted by the researchers in the Nature study -- sex ratio variations and physical variation between individuals within a population -- have been ignored or mischaracterized by most extinction risk modelers, he said. "There has been a tendency to misdiagnose randomness between individuals in a population by lumping it with random factors in the environment, and this underestimates the extinction threat," said Melbourne.

For the study, the researchers monitored populations of beetles in lab cages and the results were used to test the new mathematical models. "The results showed the old models misdiagnosed the importance of different types of randomness, much like miscalculating the odds in an unfamiliar game of cards because you didn't know the rules," said Melbourne.

Since natural animal populations are more likely to have larger differences in sex ratios and differences between individuals than the controlled beetle experiment by Melbourne and Hastings, "the effect we have uncovered here will be larger in natural populations," wrote the authors in Nature.

For some large, high-profile endangered species like mountain gorillas,

biologists can collect data on specific individuals to help develop and track extinction trajectories, he said. "But for many other species, like stocks of marine fish, the best biologists can do is to measure abundances and population fluctuations, and it's these species that are most likely to be misdiagnosed," said Melbourne.

"We suggest that extinction risk for many populations of conservation concern need to be urgently re-evaluated with full consideration of all factors contributing to stochasticity," or randomness, the authors wrote in *Nature*.

According to a 2007 report by the International Union for Conservation of Nature, a network of about 1,000 organizations with thousands of participating scientists, more than 16,000 species worldwide are threatened with extinction. One in four mammal species, one in eight bird species and one in three amphibian species are on the IUCN "Red List," indicating they are threatened with extinction.

Source: University of Colorado at Boulder