On the importance of considering the precision of the measuring instrument in the statistical analyses in ecology

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Abstract: Many statistical models widely used in ecology such as the three parameter lognormal, Weibull, and Gamma distributions involve a threshold parameter. These distributions have often been used to model waiting times between events of interest, the distribution of tree diameters, species abundance curves, the weight of individuals, and many other types of ecological data. For estimating the parameters of these distributions, the likelihood function, defined as the product of the density functions at the data, is traditionally used but it turns to be unbounded. Consequently, this has been interpreted to mean that no maximum likelihood estimates of the parameters are available (Smith, 1985).

A simple interval censored likelihood function is proposed here that solves the mentioned estimation problems; it is always bounded, incorporates the finite precision of the measuring instrument, and explains the possible occurrence of repeated observations of continuous random variables. All continuous random variables are measured in practice with instruments that have finite precision. When the continuous random variable X is registered as x, in reality this means that X is contained within the interval $(x-\varepsilon, x+\varepsilon)$, where 2ε is the precision of the measuring instrument. This explains why repeated measurements can arise in practice. When there are k observations falling within the interval $(x-\varepsilon, x+\varepsilon)$, they will all be registered as x and, consequently, there will be k repeated observations in the observed sample.

Three practical examples of biology, forestry, and rainfall data are presented where the proposed procedure was used successfully to estimate the parameters of the above mentioned distributions: a) waiting times of mammals to perform certain tasks, b) tree diameter measurements taken to estimate timber yield, and c) rainfall data from the ecological reserve of Chamela, Mexico, where two measuring instruments having different precision were used and where repeated measurements arose.

References

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