Application of Confidence Intervals in Fisher Listing Determination

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Dr. John R. Skalski & Dr. Michael Clawson
Columbia Basin Research
School of Aquatic and Fishery Sciences
University of Washington
1325 Fourth Avenue, Suite 1515,
Seattle, Washington 98101-2540

Executive Summary

For any stationary population, a 95% confidence for the finite rate of population change (λ) will most likely include the values both above and below the value of 1, denoting a constant population trajectory. This inherent statistical uncertainty should be interpreted in the larger context of other available demographic information. A weight-of-evidence approach should be used that also takes into consideration changes in carrying capacity, expansions or contractions in species range, changes in population age structure, survival or recruitment, and the success or failure of efforts to stabilize habitat availability and reduce extraneous risks.

Analysis

Demographic assessments of the status and trends of wild populations are generally difficult to perform even under best conditions because the geographic scope is large, temporal and spatial variability can be great, and the costs of data collection high. In the case of threatened or endangered species with small numbers and low density, obtaining precise estimates of λ can be even more difficult because sample sizes may be small.

Estimates of the finite rate of population increase (λ) are one element in quantitatively determining whether a population is increasing (i.e., $\lambda > 1$) or declining ($\lambda < 1$). A value of $\lambda = 1$ implies a stationary population with constant abundance over time. Interval estimates of λ are typically used to convey the parameter estimate and the associated uncertainty about the estimate. A statistical paradox is that in order to prove a population has stationary abundance, this interval estimate must indicate the population is actually increasing (i.e., $\lambda > 1$) or equivalently, a test of hypothesis must reject the null hypothesis H_0: $\lambda \leq 1$ in favor of the alternate hypothesis H_a: $\lambda > 1$.

In most cases where a population is stationary and $\lambda = 1$, the confidence interval will include values of λ both above and below values of 1. The interpretation of what the estimated values of λ imply for population trajectory depends on the width of the interval estimate and how close λ is to the value 1. These are necessary considerations because not all values inside an interval estimate are equally likely. The most likely value of λ is the point estimate itself. The farther away from the midpoint of the interval estimate, the less likely are the possible values of λ. This uneven probably space is the result of the interval estimates being based on a standard normal distribution.

Plus or minus one standard error from the mean of a normal distribution encompasses 68.2% of the area under the bell curve. Plus or minus two standard errors adds an additional 27.2% converge for a total of 95.4% of the area under the curve. Finally, plus or minus three standard errors adds an additional 4.3% coverage, for a total of 99.9% of the area under the bell curve as illustrated below in Figure 1.

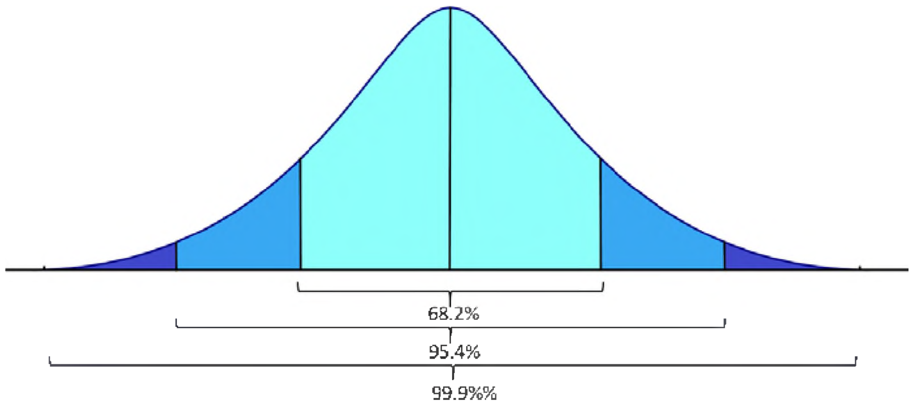

Figure 1. The implication in interpreting an interval estimate is that values of λ closer to the center of the confidence interval are more likely than values near the outside boundaries (tails).

Because interval estimates of λ for stationary populations are generally going to include both values $\lambda < 1$ and $\lambda > 1$, the proximity of the point estimate to the stationary population value of 1 is important as is the width of the interval estimate. Narrower interval estimates indicate better sampling precision than wider interval estimates. For all else being equal, the farther λ is above the value 1, the more likely the population may be stationary. However, highly imprecise value of λ just above the value 1 may be less persuasive than a very precise value of λ just below the value 1. Again, this apparent contradiction is because not all values within an interval estimate are equally likely to have occurred.

The USFWS Final Species Report (2016) for fisher describes in much detail the inherent problems in obtaining reliable and precise estimates of λ over reasonable time scales and subpopulations of western fishers. The problem is made more difficult because biological estimates of λ may not apply to other subpopulations because of either short- or long-term differences in trends. In addition, survey results from less costly techniques such as occupancy modeling do not necessarily reflect the actual trends in fisher abundance. Supplemental information may therefore be crucial in order to properly interpret the available quantitative measures of the status and trends of fisher populations.

Because of these inherent limitations in the existing fisher demographic data, decisions concerning fisher population status should be based on an integration of the best quantitative and qualitative information available. The interpretation of population status and trends data needs to be based on a weight-of-evidence approach that includes information on known changes in carrying capacity, expansions or contractions in species range, changes in population genetics, changes in age structure of the population, and the success of interagency efforts to stabilize habitat availability, and reduce extraneous risks to wildlife. Changes in habitat availability or quality will directly affect the carrying capacity and may lead to corresponding changes in population trajectory. Changes in a species range or occupancy may also be indicators of population trajectory. Changes in the age structure of a population can also be an indicator of change with growing populations generally having younger age distributions. Any one source of demographic information may be ambiguous. Alternatively, several demographic indices all suggesting the same population trend is increasingly persuasive. Thus, all available sources of information should be used in concert with a distributional view of the estimated population growth rate (λ) to determine the most likely trajectory of the population. In this larger context of a weight-of-evidence approach, equivocal quantitative information can be a valuable component in the overall interpretation of the available information and help assure proper protection of wild populations and sustainable resources.

Literature Cited

U.S. Fish and Wildlife Service. 2016. Final Species Report, Fisher (*Pekania pennati*) West Coast Population. U.S. Fish and Wildlife Service, March, 2016.