

Multi-species population indices for sets of species including rare, disappearing or newly occurring species

Multi-species indices (MSI) are widely used as ecological indicators and as instruments to inform environmental policies. Many of these indices combine species-specific estimates of relative population sizes using the geometric mean. Because the geometric mean is not defined when values of zero occur, usually only commoner species are included in MSIs and zero values are replaced by a small non-zero value. The latter can exhibit an arbitrary influence on the geometric mean MSI. We show how the compound Poisson and the negative binomial model can be used to obtain an MSI that has similar features to the geometric mean, including weighting halving and doubling of a species' population equally. These two statistical models can handle zero values in population sizes and thus accommodate newly occurring and temporarily or permanently disappearing species in the MSI. We compare the MSIs obtained by the two statistical models with the geometric mean MSI and measure sensitivity to changes in evenness and to population trends in rare and abundant species. We found that, in contrast to the geometric mean and the negative binomial MSI, the compound Poisson MSI is less sensitive to changes in evenness when total abundance is constant. The compound Poisson model can be influenced more than the other two methods by trends of species showing a low interannual variance. The negative binomial MSI is less sensitive to trends in rare species compared with the other two methods, and similarly sensitive to trends in abundant species as the geometric mean. While the two new MSIs have the advantage that they are not arbitrarily influenced by rare, newly appearing and disappearing species, both do not weight all species equally. We recommend replacing the geometric mean MSI with either compound Poisson or Negative binomial when there are species with a population size of zero in some years having a strong influence on the geometric mean MSI. Further, we recommend providing additional information alongside the MSI, for example, an evenness index in addition the compound Poisson MSI or the number of disappearing and newly occurring species alongside the negative binomial MSI.