Different methods of measuring diversity have been discussed in ecological literature for years. Recently, Lou Jost has revisited Hill's method of expressing diversities as an effective number of species, a concept based in information theory. Effective numbers of species, or Hill numbers, are transformations of common indices such as the Shannon-Wiener Index and Simpson concentration. Hill numbers possess intuitive mathematical properties that untransformed diversities do not. However, there has been no published work on how accurately Hill numbers estimate a community's true diversity in a realistic context; that is, an estimation based on a finite sample size. This study simulates sampling from a known population, and uses modified rarefaction curves to look for bias in the expected estimated diversity at all possible sample sizes. We found evidence for systematic underestimation for some diversity values (total diversity and inter-community diversity), and overestimation of others (intra-community diversity). These trends varied based on how heavily common species were weighted relative to rarer ones, but the systematic nature of these biases suggest that researchers should use caution when choosing Hill numbers over indices such as PIE, which have expectations that do not vary based on sample size.