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Measuring Biodiversity with Probability

ANSWERS TO ACTIVITIES

Activity 1

1. (*a*) 3/118 ≈ .025
   (*b*) 245/354 ≈ .692
   (*c*) 1 – (3/118 + 245/354) ≈ .282

2. (*a*) 119/555 ≈ .214
   (*b*) 52/185 ≈ .281
   (*c*) 1 – (119/555 + 52/185) ≈ .505

3. (*a*) $\dfrac{n_1(n_1-1)}{N(N-1)}$

   (*b*) $\dfrac{n_2(n_2-1)}{N(N-1)}$

   (*c*) $1-\dfrac{\left(n_1(n_1-1)+n_2(n_2-1)\right)}{N(N-1)}$

4. $1-\dfrac{\sum_{i=1}^{S} n_i(n_1-1)}{N(N-1)}$

5. The closer D is to 1, the higher the biodiversity. D corresponds to the probability that two individuals randomly selected from the population without replacement are of different species. More diversity (species evenness and species richness) among the individuals results in a higher probability that the two randomly selected individuals will be of different species.
6. To calculate D for the woods plot (Plot 1: Woods in **table 2**), find the numerator in parentheses first. Use each observation to get count n_i; multiply it by $(n_i - 1)$; and add those products together. So 50(49) + 36(35) + 35(34) + 55(54) = 7870. To calculate the denominator, recall that N = the total number of individuals (counting all species in your plot), so we add 50 + 36 + 35 + 55 = 176 = N. Then the denominator becomes 176(175) = 30800, and D = 1 – (7870/30800) ≈ .744. Thus, if two individuals are randomly selected in plot 1, there is a 74.4% chance that they will be of different species. Similarly, we obtain D = .585 for Plot 2: Field. Since .744 >.585, plot 1 is more diverse.

Activity 2

1. $D = 1-\dfrac{4(100)(99)}{400(399)} = 1-\dfrac{99}{399} \approx .752$

2. For n = 200, D = 600/799 ≈ .7509; and for n = 500, D = 1500/1999 ≈ .7503. As n increases, D decreases slightly.

3. $D = 1-\dfrac{4n(n-1)}{4n(4n-1)} = 1-\left(\dfrac{n-1}{4n-1}\right) = \dfrac{3n}{4n-1}.$

   Suppose that there are m individuals of 4 different species, where $n < m$. Then we can show that D decreases because $3n/(4n-1) > 3m/(4m-1)$ shows that D decreases.

4. $$\begin{aligned} D &= 1-\frac{(S)(n)(n-1)}{(S)(n)(Sn-1)} \\ &= 1-\frac{n-1}{Sn-1} \\ &= \frac{Sn-1-(n-1)}{Sn-1} \\ &= \frac{(S-1)n}{Sn-1} \end{aligned}$$

5. $\lim_{S\to\infty}\left(D(S,n)\right) = \lim_{S\to\infty}\left(\dfrac{(S-1)n}{Sn-1}\right) = 1$

6. $\lim_{n\to\infty}\left(D(S,n)\right) = \lim_{n\to\infty}\left(\dfrac{(S-1)n}{Sn-1}\right) = \dfrac{S-1}{S} < 1$