Determination of Species Diversity and Abundance Using Owl Pellet Data Background Information

In this activity, barn owl pellet data are used to determine an ecosystem’s degree of biodiversity. The barn owl (*Tyto alba*) swallows small birds and rodents whole, and the resulting pellets generally contain the complete skeletons of the owl’s prey. While carnivorous mammals, such as bobcats and wolves, have teeth to grind up bones and claws and a digestive tract adapted to pass these ground parts, owls do not have teeth for grinding and cannot safely pass whole bones and claws through their digestive tract. Instead, these materials form a bolus (or pellet), which is surrounded by the hair or feathers of their prey and orally expelled. Barn owls can expel one to two pellets per day. Scientists take advantage of this adaptation by examining the pellet’s contents. Since barn owls are not very selective feeders, these pellets can be used to estimate the diversity of available prey within their feeding range. The contents are also a direct indicator of what an owl has fed on—information that is crucial for species management and protection. There are many genera of prey that occur in both the Northwest (Washington, Oregon) and Southeast (Mississippi, Alabama, Louisiana), as well as several that are exclusive to one of these areas. The owl pellet table seen below contains 14 mammalian prey types that account for approximately 95 percent of the prey found in each of the two habitats. Other prey consists of birds, bats, insects, crayfish, and small reptiles.

**Tasks, Questions and Critical Thinking**

1. Create an Excel Graph that communicates the data from the table. Title your graph using all variables, label the X & Y axes.
2. Which type of prey contributed the most by number for each region?
3. Did the same prey type contribute the most by number for both regions?
4. Which prey type contributed the most in biomass for each region?
5. Did this same prey type contribute the most in biomass for both regions?
6. If an owl needs 100 grams of food per day, how many *Sorex* does it need to capture? How many *Sigmodon*?
7. Is quantity or quality of prey more important? Why?
8. Use the Shannon Weiner Index to calculate the diversity of this ecosystem based on the owl pellet data.
9. What is the Shannon Weiner Index for each region?
10. Based on your data, make concluding statements about each regions biodiversity.
11. Would a crash in the shrew (*Blarina, Cryptotis, Sorex*) population seriously affect either region? Why?
12. Would a crash in the vole (*Microtus*) population seriously affect either region? Why?
13. Some owls produce 2 pellets per day. Assume each pellet represents 80 grams of biomass. Also assume that one 40 gram vole can cause 50 cents of crop damage to a farm per season. If a barn owl family of seven (2 adults and 5 young) lives on a farm for 12 weeks and feeds exclusively on voles, how much will the farmer save in crop damages?

Shannon-Wiener Index

The idea behind this index is that the diversity of a community is similar to the amount of information in a code or message. It is calculated in the following way:

H = -∑ Pi(lnPi)

where pi is the proportion of individuals found in species i. For a well-sampled community, we can estimate this proportion as pi = ni/N, where ni is the number of individuals in species i and N is the total number of individuals in the community. Since by definition the pi’s will all be between zero and one, the natural log makes all of the terms of the summation negative, which is why we take the inverse of the sum. Interpretation: Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon index increases as both the richness and the evenness of the community increase. The fact that the index incorporates both components of biodiversity can be seen as both a strength and a weakness. It is a strength because it provides a simple, synthetic summary, but it is a weakness because it makes it difficult to compare communities that differ greatly in richness.

**Sample Calculations:**

The Shannon-Wiener Diversity Index, H, is calculated using the following equation:

 H = -∑ Pi(lnPi) where Pi is the proportion of each species in the sample.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Species | # found | Pi | ln(Pi) | Pi ln(Pi) |
| 1 | 84 | 0.3281 | -1.1144 | -.03656 |
| 2 | 4 | 0.0156 | -4.1589 | -0.0650 |
| 3 | 91 | 0.3555 | -1.0343 | -0.3677 |
| 4 | 34 | 0.1328 | -2.0188 | -0.2681 |
| 5 | 43 | 0.1680 | -1.7840 | -0.2997 |
| Total | 256 | 1.0000 |   | -1.3661 |

In the example above H = 1.3661

The Shannon Wiener Index has a typical range of 1.5 – 3.5. Rarely the index will reach 4 and in species poor areas the index will be below 1.

**ACTION**: Re-create the above table in Excel and calculate the diversity index for both regions using the owl pellet data.