Galapagos ground finches of the genus *Geospiza* have fascinated biologists ever since Charles Darwin collected these little birds. He speculated that all species of finches on these islands derived from a single species that was blown onto this group of islands long ago and diversified into a multitude of species, each with unique bill shapes. When biologists went back to the islands and took a closer look at these finch species, it appeared as though populations of the same species occurring on different islands varied slightly in their bill morphology.

A bird’s beak represents a toolkit that is invaluable for the manipulation of objects in a bird’s life, especially when it comes to food items. Most finches are seedeaters, and their bills are generally stout and powerful, much designed like a nutcracker. It thus is not far-fetched to put forward a hypothesis that the variation in beak size (in this case measured as the depth of the beak) of Galapagos ground finches is related to local variation in the seed sources. It is well documented that ground finches of the genus *Geospiza* with small beak sizes are unable to crack the largest seed types found on the Galapagos Islands. It is assumed that conversely finches with large beaks are less efficient at handling small seeds, and are at an energetic disadvantage to small-beaked finches, probably largely as a result of longer seed-handling time, when restricted to very small seed types.

An unforeseen event, fortuitous in understanding these relationships, but a catastrophe for the Galapagos finch populations, occurred in 1977. A large drought in that year caused an almost complete crop failure of seed producing shrubs. Scientists measuring various attributes of finch populations on Daphne Island of the Galapagos recorded a precipitous decline in population size.

1. In the Excel sheet associated with this assignment you will find two datasets. The first of these represents data on population numbers through time of one of the *Geospiza* species found on Daphne Island (*G. fortis*), as well as data collected at the same time on seed abundance in terms of mass (in milligrams) per unit area (m$^2$).
   a. Which statistical test is appropriate to test the researcher’s hypothesis that reduced seed availability following the 1977 drought led to the die back in the local finch population? Why?
   b. Which is the independent variable? Which is the dependent variable? Are they categorical, discrete, or continuous?
   c. Analyze the data to test the H$_0$ that seed abundance did not affect bird population size. Report the statistical results. (Include a $p$-value in your answer.)
   d. What is your conclusion?

This event allowed the researchers a glimpse of underlying causes of the observed beak size variations in *Geospiza*. An event leading to food shortages of sufficient magnitude to result in a precipitous population decline is likely to lead to intense competition for the limited food resources. It is likely that the decline in seed resources led to the near depletion of seeds more easily accessible to individuals of this species early during the famine. If this is true, we might suspect that birds better able to manipulate difficult to access seeds stood a better chance at surviving the famine of 1977, something that might be reflected in their beak shapes or sizes.
2. Test this hypothesis with the second data set in this assignment’s Excel sheet. This data set consists of two columns, representing beak depth measurements of *G. fortis* individuals from Daphne Island prior to the drought (1976) versus individuals that survived the drought (1978).
   a. Which statistical test is appropriate to test whether there are significant differences in beak depth in this population of finches prior to and following the drought?
   b. Run the statistical test. Report your results. What do you conclude?
   c. Is the data symmetric for each of the two years? Which year shows greater skewness? How do you interpret that finding with respect to your conclusion from 2b?

3. If the assumptions we made in the hypothesis under 2) are correct, what does this imply regarding the population of seeds during the drought year? How would you propose to test whether this assumption is true?

References

Data for this exercise were adapted from Boag and Grant (1984) and Grant (1986).