

Group Project: Copepod Survival

Background Copepods are tiny aquatic animals, some species of which have long lived in the brackish, salty waters near the mouths of rivers. At some point in the past fifty years, a few individuals from a population near the mouth of the St. Lawrence Seaway successfully invaded the fresh water in the Great Lakes and formed a new population in Lake Michigan. In their normal life cycle, copepods hatch from eggs as larvae, go through several rounds of moulting until undergoing a metamorphosis, and then go through additional rounds of moulting until developing into adults.

A biologist interested in the characteristics of invasive species conducts studies to explore differences between the saltwater and freshwater populations. In one experiment to compare survival rates to metamorphosis under two different food levels, the biologist take several clutches of eggs from each population, divides the eggs into four groups of as close to the same size as possible, and places assigns two groups each to a low and to a high food treatment. The response for each group is the number of individuals that survive to metamorphosis.

Data The data file `copepods.txt` contains data from this experiment. Here are some sample lines. For example, the first clutch from the fresh water population contained 39 eggs that the biologist divided into samples of sizes 9, 10, 10, and 10. The first two were given the high food level, resulting in 7 and 9 individuals that survived to metamorphosis. The second two groups were given the low food level and had 6 and 8 survivors.

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clutch population food size survive
1 Freshwater High 9 7
1 Freshwater High 10 9
1 Freshwater Low 10 6
1 Freshwater Low 10 8
2 Freshwater High 7 5
2 Freshwater High 7 7
2 Freshwater Low 7 4
2 Freshwater Low 6 3
...
19 Saltwater Low 5 4
19 Saltwater Low 6 1
20 Saltwater High 8 6
20 Saltwater High 8 7
20 Saltwater Low 9 1
20 Saltwater Low 8 3
```

The biologist wishes to compare survival probabilities between food levels within each population and to compare these differences between populations. She considers two different tests of the hypothesis of no interaction between food and population. In one test, she fits a logistic regression model and finds no significant evidence for an interaction between food and population ($p = 0.18$). In a separate test, for each clutch she computes the difference in survival proportions for the high and low food levels and compares these differences between

populations with an independent sample t -test. This test shows a significant difference between the populations ($p = 0.02$). The biologist finds it confusing that these two different tests for an interaction have such different p -values.

Questions Work with your group to address these questions.

1. Use the data to create a key graph that illustrates the possible interaction between food and population.
2. Find the total observed survival proportions for each food/population combination.
3. Replicate the biologist's logistic regression analysis. Comment on its appropriateness and consider alternatives.
4. Replicate the biologist's t -test and comment on its appropriateness.
5. Is there an interaction between food and population? Write a paragraph that summarizes the statistical evidence about the potential interaction and estimates its size and the uncertainty in these estimates.
6. Write a paragraph for the biologist that explains why the two tests give seemingly contradictory evidence about the interaction between food and population.

Your group is determined by randomization. Work with your group in class to complete as much of the assignment as possible. Turn in a single written response on paper to the questions for the group on **Thursday, October 11**. Include the names of all group members that contribute substantially to the assignment solution.