

1 You want to know if the arsenic concentration in Bellingham drinking water differs significantly from the EPA arsenic limit of 10 ppb. You randomly sample tap water around the city and obtain the following data. Test the null hypothesis that mean [As] = 10 ppb. Use a significance level of $\alpha = 0.05$.

Using the same data, test the null hypothesis that mean [As] \leq 10 ppb. Explain why the result differs.

[As] (ppb): 10, 11, 9, 11, 10, 9, 11, 12, 10, 11, 13, 9, 10, 11, 12

2 You want to know if sea cucumber densities differ at two different tidal heights on the same nearshore habitat. You establish two transects, at -0.3m MLLW and at 0.4m MLLW. You count sea cucumbers within 10 randomly placed 1 m² quadrats in each transect. You obtain the following counts.

- 0.3m : 6, 3, 5, 2, 3, 5, 1, 3, 6, 8

0.4m: 1, 1, 3, 2, 1, 0, 5, 0, 0, 1

Test the null hypothesis than mean densities are equal. Use a significance level of $\alpha = 0.05$

3 Does average length of theses written by graduate students in Biology and Chemistry differ? Eight theses selected at random from each department contained the following numbers of pages.

Biology: 94, 89, 84, 98, 93, 82, 80, 75

Chemistry: 128, 137, 95, 141, 68, 102, 90, 72

a) Perform a statistical test to answer the question, using $\alpha = 0.10$.

b) Determine the 95% confidence intervals on the mean length of Biology theses.

4 Does eelgrass biomass differ among three tidal elevations in the Padilla Bay estuary? You measure eelgrass biomass (grams of dry weight per square meter) at randomly selected quadrats along transects at the three tidal elevations, and obtain the following data. Answer the research question as precisely as the data allow, using $\alpha = 0.05$.

| Low Transect | Middle Transect | High Transect |
|--------------|-----------------|---------------|
| 1222 | 905 | 602 |
| 1301 | 869 | 654 |
| 1502 | 1122 | 555 |
| 1303 | 1209 | 701 |
| 1335 | 894 | 596 |
| 1462 | 789 | 658 |
| 1522 | 998 | 869 |
| 1289 | 689 | 465 |

5 Answer question 4 if independent data show that variance in eelgrass biomass differs markedly among tidal elevations.

6 Your considerable experience in statistical analysis wins you a consulting contract with a hospital. In your current project, you are advising hospital administrators about a diagnostic procedure. The current procedure costs \$1200 per patient, and has rates of false positive detections of 5% and false negatives of 10%. Using newly developed and more sensitive reagents would increase the cost to \$5000 per patient without affecting the rate of false positives, but reducing the false negative rate to 1%.

a) Would you recommend the hospital switch to the new reagents, if the procedure detects a treatable condition that costs an extra \$10,000 to treat if not detected early? Justify your answer using both statistical and ethical reasoning.

b) Would you recommend the hospital switch to the new reagents, if the procedure detects a disease that can be cured if treated (detected) early, but that leads to certain rapid premature death without early detection. Justify your answer using both statistical and ethical reasoning.

7 (How much) Do songbird body mass and wing chord length co-vary? (Do heavier birds have longer wings and vice-versa?) You obtain the following data selected at random from records at a banding station. Perform a statistical test to answer the question.

| Body mass (g) | Wing chord (mm) |
|---------------|-----------------|
| 93 | 134 |
| 22 | 69 |
| 37 | 79 |
| 45 | 85 |
| 10 | 65 |
| 8 | 59 |
| 11 | 57 |
| 12 | 52 |
| 28 | 94 |
| 73 | 73 |
| 26 | 68 |
| 9 | 49 |

8 (How strongly) Does wetland area affect the number of salamander egg masses found in a wetland? You count egg masses in and measure areas (m²) of 20 wetlands, producing the following data.

| | | | | | | | | | | | | | | | | | | | | | |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Area | 10 | 10 | 12 | 12 | 13 | 15 | 15 | 15 | 18 | 18 | 20 | 22 | 22 | 22 | 22 | 25 | 26 | 27 | 27 | 27 | 30 |
| Count | 3 | 2 | 7 | 4 | 10 | 3 | 7 | 4 | 5 | 8 | 2 | 8 | 9 | 8 | 10 | 11 | 11 | 11 | 13 | 12 | 15 |

- Which statistical test would best answer the research question?
- Write a linear model for the test named in your answer to (a).
- Create a scatterplot of the data.
- Which assumption(s) of the test named in (a) do the data satisfy and which do the data violate?
- Without discarding any data, how could you address any violations identified in (c)? Demonstrate the effectiveness of your approach with a new scatterplot.
- Use “altered” data from (d) to answer the research question. Use a significance level of $\alpha = 0.05$.
- How many egg masses would you expect to find in a wetland with 21m² area?

9 Human foot traffic disturbs the ground frequently adjacent to forest trails, and disturbance frequency decreases with distance away from trails. (How strongly) Does distance from trails (i.e., trampling frequency) affect the density of Herb Robert (an invasive forb)? Herb Robert densities were recorded in 1 m² quadrats located along transects oriented perpendicularly to trails in Sehome Arboretum, intersecting the trails at random locations. This sampling effort produced the following data.

| | | | | | | | | | | | | |
|----------------------------------|------|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| Distance (m) | 1.0 | 1.0 | 1.0 | 5.0 | 5.0 | 5.0 | 10.0 | 10.0 | 10.0 | 30.0 | 30.0 | 30.0 |
| Density (plants/m ²) | 100. | 80. | 50. | 20. | 10. | 15 | 5 | 2 | 1 | 1 | 2 | 0 |

- Which statistical tests could answer the research question?
- Which test from (a) would provide the most informative answer? Explain why.
- Create a scatterplot of the data.
- Which assumption(s) of the test named in (a) do the data satisfy and which do the data violate?
- Without discarding any data, how could you address any violations identified in (c)? Demonstrate the effectiveness of your approach with a new scatterplot.
- Use “altered” data from (d) to answer the research question. Use a significance level of $\alpha = 0.05$.
- How many Herb Robert plants (per m²) would you expect to find 3.0 meters from a trail in the Arboretum?