

Contamination in Easleyville

Testing Data

EVS 430 Advanced Quantitative Methods

1 Introduction

The small town of Easleyville, LA, is the site of Hampton Industries, which produces the fungicide *scratchumiacum*. Until the 1970s, the waste liquids produced in association with production of *scratchumiacum* was disposed of in *evaporation pits*, in which little evaporation and a lot of infiltration took place. Changes in environmental laws led to the closing of the ponds approximately 25 years ago. The ponds were graded over, but no soil material was removed from them. Many of the ponds onsite have been located from historical records, including aerial photographs. Now chemical contamination is appearing in nearby domestic water supply wells. In particular, benzene has been found in some wells to be above the legal limit for drinking water.

You have been hired to conduct a more exhaustive study of water quality. As part of the study, you will be required to evaluate existing data and results from a pilot study.

2 Evaluation of Existing Data

10 offsite wells were sampled for a suite of organic chemicals, including benzene and *scratchumiacum*. Water samples were split and sent to two labs (a primary and a secondary lab) to obtain duplicate analyses.

2.1 *Scratchumiacum*

The average *scratchumiacum* concentration in the 10 wells was 8.32ppb, with a standard deviation of 3ppb, based on the data from the primary lab. For the purposes here, assume that the concentrations are normally distributed. However, state in a single sentence how you would test for normality. Then determine what would be the probability of finding a sample that has a concentration exceeding the legal threshold of 15ppb if we were to do additional sampling in the area. Perform any needed calculations.

2.2 Benzene

The average benzene concentration was 3ppb in the 10 wells with a calculated standard deviation of 4 ppb, based on the data from the primary lab. Can we be 95% sure that the average benzene concentration is below the legal threshold of 5ppb for benzene? (In other words, is the upper bounds on the mean below the legal threshold?) Perform any needed calculations.

2.3 Splits

The mean concentrations of benzene reported by each of the labs was 3ppb. Though the primary lab's data had a standard deviation of 4ppb, the secondary lab's data had a standard deviation of 5ppb. Is there a statistically significant difference in the precision of the two labs at the $\alpha = 0.05$ level? Perform any needed calculations.

3 Pilot Study

Of the evaporation ponds identified, two were chosen randomly for additional soil sampling. The purpose is to determine the distribution of *scratchumiicum* still present in the soil.

3.1 Comparison of Ponds

The soil in each pond was sampled in eight locations. The data from Pond 1 have a mean value of 205ppb and a standard deviation of 57ppb. The data from Pond 2 have a mean value of 253ppb and a standard deviation of 67ppb. Explain the steps you would use to determine if the two ponds have significantly different means, but do no calculations.

3.2 Spikes

Twelve samples with known concentrations were sent to the primary lab, part of the quality assurance program. The table below shows the results in mg/L of those analyses for *scratchumiicum*.

Known Conc	Lab Result	Known Conc	Lab Result
5.0	4.8	10.0	11.2
20.0	22.3	25.0	29.0
40.0	37.5	50.0	30.5
75.0	81.6	100.0	91.7
120.0	138.6	150.0	139.9
500.0	448.0	1000.0	1115.3

Explain how you would set up a test to see if the lab is, on average, accurately reporting *scratchumiicum*. Tell what statistic you would use, and what the critical value would be at the $\alpha = 0.05$ level. (Use the tables attached.) Do not actually calculate values.

4 Other Potential Sources of Contamination

Hampton Industries is not the only potential source of *scratchumiicum* contamination in wells. Individual homeowners may apply *scratchumiicum* to yards in humid climates to slow the growth of mushrooms (in particular, the stinkhorn mushrooms, such as *Phallus imperious*, and no, I'm not making up that name!) Nationwide approximately 10% of wells at rural homes may be contaminated with *scratchumiicum*. If we sample 15 rural wells for the presence of *scratchumiicum*, what is the probability that no more than one of those wells will be contaminated? Use the tables to estimate your answers.