3-3-11 **BES 301** **EXAM 2 Answer Key** **Score = 100 / 100**

This exam is worth 100 points. The number of points possible for each question is given near the start of each question. Limit answers to the spaces provided - **material outside of those spaces won't be read!**

1. *(30 Pts)* Nitrate concentration (mg/L) of stream water is measured in two creeks at noon each day over 5 sequential days:

Date	Bear Creek	Swamp Creek
June 1	6.2	10.9
June 2	5.1	2.3
June 3	6.3	18.9
June 4	4.9	4.1
June 5	7.1	22.3

A) The measurements in Bear Creek were done by one technician, John; while the measurements in Swamp Creek were done by another technician, Mark. Do John's measurements indicate greater precision?

YES **NO** **UNSURE** ← ***Circle One*** *(10)*

Explain, including a definition of precision. *Although the variation is less in the measurements taken by John, there is no way to be certain that that variation is not due to actual variation in stream nitrate levels (environmental variation). Precision is the repeatability of measurements* ***relative to the actual values****. In this case it could be that John's values are always 82% of the actual stream nitrate values (highly precise) but the actual nitrate values are varying from day to day. Bottom line – no way to confidently discern whether the variability is due to real environmental variation or a lack of precision.*

B) My principle interest in these data is to see if there is a difference in the trends of how nitrate concentration changes over those five days. What kind of illustration should I use? Why? *(6)*

Kind of illustration: **Graph (Scatter plot)** *A graph is best used if the purpose is to display a relationship over time (a trend) rather than the exact numbers (which would be better displayed in a table). Display of trends may be especially important where differences in the slope (tends over time) might be subtly different. This is much easier to detect geometrically (figures) than in tables.*

C) Under what circumstances (e.g., a differing objective) might you want to use a different type of illustration than you identified in part (B) above? *(4)*

If your objective was to examine specific values of nitrate concentration (say an important threshold where damage might occur at any one day) then I would use a table that would display specific numbers. Other valid answers were accepted.

D) The researchers decided to summarize their data for the 5-day period with means and standard deviations for each creek (Bear Cr: 5.9 ± 0.9; Swamp Cr: 11.7 ± 8.8). What advantages are there of taking this step (identify at least two advantages) and what are some disadvantages? Explain. *(10)*

Advantage 1: Summarizing to means will allow you to use inferential statistics to see if there are likely real differences between the creeks in nitrate concentrations.
Advantage 2: It will also reduce the amount of information to an amount easily examined and presented.
Disadvantage: At the same time, reducing the data will remove detail about the spread and distribution that is valuable information to compare these creeks.

2. *(30 Pts)* A recent study examined the effects of construction of oil drilling platforms on caribou along the North Slope of Alaska. Caribou density was examined in 20 sites with drilling platforms and 20 comparable sites without drilling platforms. The results are summarized below:

Table 1. Density of caribou at sites with and without oil drilling platforms along the North Slope, Alaska during the week of August 12-18, 2006. Means (n = 20) are shown ± 1 SD. Different letters indicate significant differences (P<.05) between sites by Student's t-test.

	Drilling Platforms	**Without Drilling Platforms**
Number of Caribou / m^2	44.3 ± 17.3 a	32.2 ± 3.7 b

A) State the **specific alternate** hypothesis **that was tested here**. *(4)*

The presence of drilling platforms is associated with a change in the density of caribou. Or
There is a difference in caribou density at sites with drilling platforms as compared to sites without such platforms.

B) Write accompanying text for the table that would be found in a "Results" section of a scientific paper. Use all of the information in the table and include at least 2 **quantitative relative** comparisons. *(10)*

There is a 37.6% greater caribou population density associated with the presence of drilling platforms than without the platforms(Table 1) (or 27.3% less if you made the comparison in the opposite direction). Further, there is much greater variability (368%) in caribou population density with the presence of drilling platforms.

C) The result of the Student's t-test performed on the data was a P value of 0.035. Fill in the blanks:

I would have a **3.5** % chance of being wrong in stating that **the presence of drilling platforms is associated with a change in caribou population density.** *(5)*

D) In part (C) we saw there was a probability of making an incorrect conclusion. Why can you **not** make an absolutely definitive statement about the difference in caribou density on sites with drilling platforms as compared to sites without such platforms? *(6)*

We are drawing conclusions about the entire population of sites with and without drilling platforms from a sample of 20 sites of each type. We use statistical inferences on these sample groups to tell us how likely a numerical difference in the sample groups is representative of an actual difference in the full population.

E) Given that P = 0.035, can you conclude that drilling platforms **are associated with** an **ecologically significant** increase in caribou population density? Why or why not? *(5)*

No. The increase may or may not be ecologically meaningful (we don't know this form this information). Statistical significance does not automatically confer ecological significance. Small differences can be statistically significant but may not actually have an ecological effect. We do not know if a difference of 12 caribou/m^2 is ecologically significant for these populations. Secondly, this significant relationship does not establish causation (though the question itself asks about correlation, not causation) - it may be a simple correlation between platforms and caribou density (platforms may not "cause" increased density).

3. *(25 Pts)* I am designing an ecological restoration of a marsh near a saltwater shoreline. It is important for me to know how salinity of the soil varies throughout my marsh. I am able to borrow a meter with probes that can be inserted into the ground that will measure the electrical conductivity of the soil. I also know that there is a theoretical relationship between electrical conductivity and salinity in the soil. In the laboratory I mix up solutions with known concentrations of salt (g NaCl / L H_2O) and measure their electrical conductivity (mmhos / cm):

Salinity (g NaCl / L H_2O)	**Electrical Conductivity (mmhos / cm)**
0.75	1.40
1.50	2.75
2.25	4.20
3.00	5.40
3.75	7.00

A) What is the name of the process I am undertaking in the laboratory and why is it important to my study? *(4)*

Calibration (or Standardization). In order to assess what the salinity of the soil actually is, I need a reliable relationship between the thing I am measuring (conductivity) and the factor I want to express (salinity).This process also establishes the accuracy of the relationship.

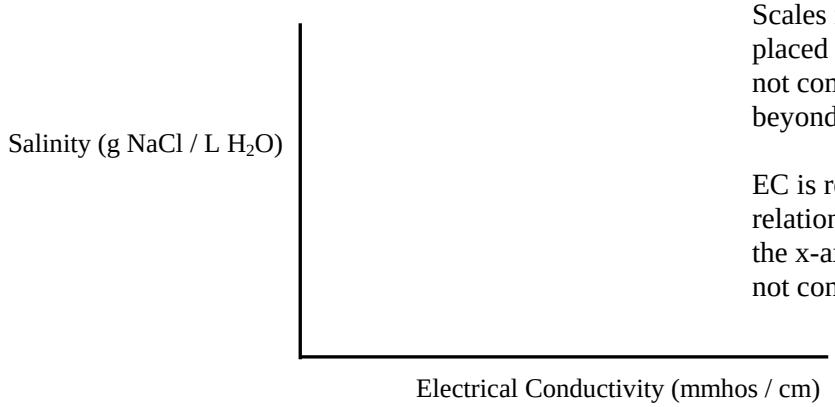
B) In the process described above I am using some **solutions known as "standards"**. What is a "standard"? Identify the standards I am using (**provide specific variable(s) and numbers**). *(5)*

The standards are the five known concentrations of salinity: 0.75, 1.5, 2.25, 3.0, 3.75 g NaCl/L H_2O that I have mixed up. A standard is a known value of a parameter that can be used to calibrate or verify an instrument or procedure.

C) How might these "standards" be used during the remainder of the study? *(4)*

These standards can be periodically inserted into the sample stream to check the validity of the meter readings – rechecking the calibration points. This checks the meter but not the full process. Some also mentioned that the initial relationship can be used to translate the readings into desired unit, but this was the point of the initial calibration procedure – not so much the "remainder" of the study.

D) Provide a **completely-labeled** graph of the relationship described by the data above (no caption). *(6)*



Scales must be numerically-labeled and points placed on the scatter plot (lines optional) – it is not complete here. Lines should not extend beyond the calibration points.

EC is really the independent variable in this relationship so that would most properly go on the x-axis (but as this is a debatable point I did not consider that in grading).

Continued from Question 3 on previous page:

E) In one area of the marsh I record the following four electrical conductivity readings: 0.7, 2.75, 5.0, 8.4 mmho/cm. Using the relationship established in part D above, provide the salinity of the soil at each of those readings **WHERE YOU CAN VALIDLY DO SO** (estimates are okay). If you cannot provide salinity for some conductivity numbers, explain why you cannot.

(6)

Reading of 2.75 mmho/cm = 1.5 g/L salinity
Reading of 5.0 mmho/cm = about 2.75 g/L salinity (can extrapolate within calibration range)
The relationship within the calibration points is very linear throughout and it is thus reasonable to extrapolate between calibration point within the range of calibration values used.

The readings of 0.7 and 8.4 mmho/cm are outside of the range of the original standards used in calibration and thus cannot be validly translated into values of salinity. We do not know if the nature of the relationship established holds constant outside of the bounds used to establish that relationship.

4. *(15 Pts)* A one-year study is investigating whether there is a difference in biological diversity between two different types of shoreline ecosystems: beach ecosystems and rocky intertidal ecosystems. The study will examine the biodiversity of these two ecosystem types along the North American coastline from Mexico (the Baja Peninsula) north through California, Oregon, and Washington states.

A) Would you expect the investigators to use sampling in their study design? Why or why not? *(6)*

Yes. It would be impractical to sample every beach and rocky shoreline in one year. Thus, a subset of these would need to be selected for data collection.

B) The investigators work on a study design to work across the geographic area of their question and target an equal number of samples of the two different ecosystems. Should the locations for the sample ecosystems in this investigation be **strictly** random? Why or why not?

(9)

Probably not strictly random given the large geographic range. It is likely that biodiversity inherently changes with latitude, so the sampling should be stratified by latitudinal categories. Within those categories, samples can be chosen randomly. This is called "stratified random sampling". Without stratification by latitude "random" selection could lead to a comparison of beaches mostly in Mexico with rocky intertidal mostly in Washington. Stratification takes into account uncontrolled variables that confound your results. Some answers also highlighted other environmental aspects that could be stratified, many of which change with latitude or site.