5. TESTING HYDRAULIC HYPOTHESES

50 Points

After reading scientific literature related to your hypothesis on stream channel geometry and hydraulic conditions, you should have some expectation as to whether your hypotheses should be true or false. The purpose of this exercise is to test your hypothesis with the field data we collected on the Tomorrow River using Excel, to write a discussion of what your results show, and to write a discussion regarding the confidence you have in the accuracy and validity of our field data as this may impact the way you interpret your Excel work..

YOU SHOULD BE ABLE TO:

- Use field data to test relationships between stream channel geometry and flow conditions by calculating basic statistics and creating plots or graphs in Excel;
- Write a discussion of your results that describes the Excel work you did an that compares your Excel results to the scientific literature you read;
- Write a discussion that evaluates the validity and accuracy of our field data given on our field methodology and site characteristics compared to procedures outlined in the scientific literature, and that assesses any associated impacts on your test results; and,
- Arrive at a conclusion regarding the truth of your hypothesis in light of your experimental results and the existing scientific literature.

PROCEDURE

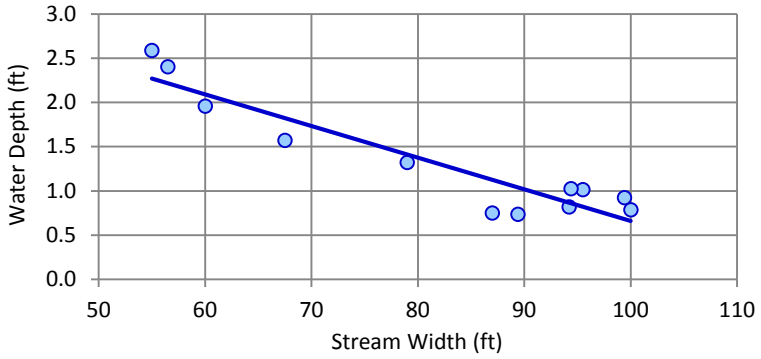
Each team member is individually responsible for testing and writing up one hypothesis. You may test your hypothesis by creating scatter plots, line graphs or bar charts in Excel, and by calculating numeric descriptive statistics such as the average, range, standard deviation, and correlation. If you have a background in statistics, you may calculate a test to compare means or ranks, or do a regression analysis, but only if you know how to interpret the results of such a test correctly. The type of chart or statistic or test most appropriate will depend on your hypothesis and on the nature of our data.

Excel

Scatter plots are appropriate for showing whether a relationship exists between two variables, such as width and depth (Figure 5.1). Excel allows you to add a trend line, or best-fit line, which may help show the strength of the relationship between the two variables. The closer the points are to the trend line, the stronger the relationship between the two variables. Figure 5.1 shows a negative correlation between stream width and depth: as width increases, depth decreases. If no relationship existed between these two variables, the trend line would be horizontal (or nearly horizontal), indicating that although one variable is increasing, the other variable is not changing in a systematic way. Excel allows you to add an equation for the trend line as well as an r^2 value; however, if you have not had a statistics course and cannot fully explain the equation or the r^2 value, you should not include them on your plot. If you do include them, you must discuss their meaning and significance.

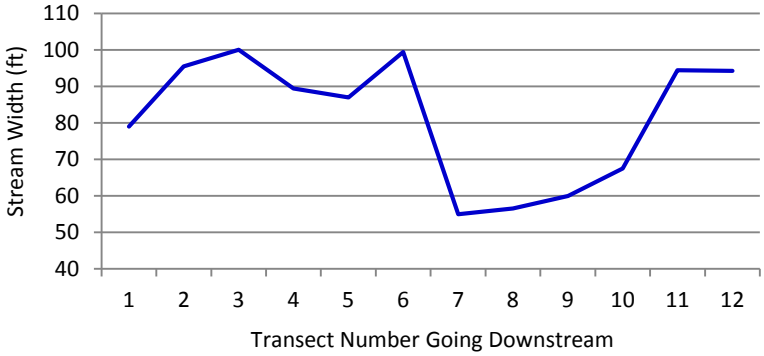
Correlation coefficients provide another way of assessing the strength of the relationship between two variables (=correl function). The correlation coefficient between stream width and depth is –0.94, a very strong correlation. The value of the correlation coefficient can range from –1.0 for a perfect negative correlation to +1.0 for a perfect positive correlation. A correlation coefficient of 0.0 indicates absolutely no relationship exists between the two variables. To keep things simple, and because statistics is not a prerequisite for this class, we will call correlation coefficients ranging from +0.5 to +1 and from –0.5 to –1 meaningful – they indicate a relationship exists between the two variables. We will call correlation coefficients between +0.5 and –0.5 insignificant – they indicate no relationship exists between the two variables. Note that correlation coefficients and r^2 values are not the same and should not be used interchangeably.

FIGURE 5.1 Relationship Between Stream Width and Water Depth



Line graphs are most appropriate for showing a change in a single variable, as opposed to a relationship between two variables. For example, you could create a line graph to see whether stream width changed in a systematic way moving from the most upstream transect to the farthest downstream transect (Figure 5.2). In this case, the transects are evenly spaced along the x-axis; if the actual distance between the transects was important, you would create a scatter plot, not a line graph. Figure 5.2 does not reveal any particular trend for changes in stream width, but it suggests that the upstream transects are wider than the downstream transects.

FIGURE 5.2 Variability in Stream Width along a Stretch of the Tomorrow River



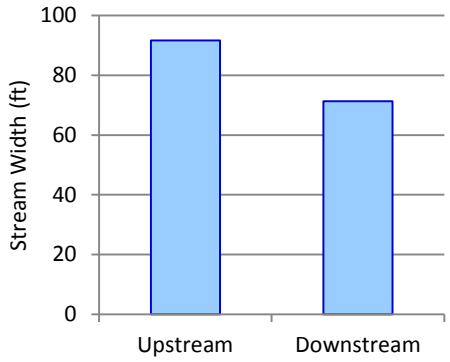
All graphs and plots must have axis labels that include units (if appropriate). Note that the graph origin in Figures 5.1 and 5.2 is not 0,0. The minimum value for stream width in Figure 5.1 is 50 feet and the minimum value in Figure 5.2 is 40 feet. If the axes for stream width started at zero, there would be a large blank region on the graphs. It is acceptable for the minimum value on one or both axes to be greater than zero, which often makes it easier to see whether or not a relationship exists.

Numeric descriptive statistics, such as the average, range, and standard deviation, are useful for describing different sections of our field site. After creating Figure 5.2, you might decide that you want to test the hypothesis that riffles are wider than pools. To do that, you could calculate the average channel width and the range of widths for the upstream and downstream transects (Table 5.1). These numbers confirm that the upstream (riffle) transects are wider than the downstream (pool) transects, although there is more variability in the width of the downstream transects. Although Table 5.1 does a fine job comparing channel width for the two stretches, a column chart (Figure 5.3) provides a picture of the differences in the width and may be more appropriate for a poster than a table.

TABLE 5.1 Comparison of Stream Width along Two Separate Stretches of the Tomorrow River

	Upstream Transects	Downstream Transects
Average width (ft)	91.7	71.3
Range of widths (ft)	21.0	39.4

FIGURE 5.3 Comparison of Stream Width Along Two Separate Stretches of the Tomorrow River



Each of you needs to determine the best way to test your hypothesis in Excel. If you are unsure how to proceed, please ask for help. Although you will be working individually on your hypotheses, all of your charts, graphs, tables and other information from Excel will end up on the same poster with those from the rest of your team. As a result, you need to decide, as a team, how you want to format your Excel work. Formatting includes selecting fonts and colors. Your poster needs a consistent look. The formatting is not critical for this particular lab, but is something you will eventually need to deal with. If you deal with it now, you don't need to deal with it later.

Results Write-Up

Individual Work. Each of you needs to write up your results. Your write-up should consist of one- to three-paragraphs. Your first paragraph should start with (1) a statement of your hypothesis. Following that, you should (2) state what your expectation is – do you expect the hypothesis to be true or false – and you must (3) provide support for your expectation by including citations to the literature you read. After establishing your expectation, you need to (4) describe what your charts or tables or statistics show. For example, with regard to Figure 5.1, I could write:

> Figure 5.1 shows a negative correlation between width and depth – as width increases, depth decreases. All the points fall close to the line indicating a strong relationship between these two variables.

After describing your results, you need to (5) discuss how well your results match your expectation (i.e. how well do your results match the results of other researchers). You should conclude with (6) a statement of your final decision regarding your hypothesis – is it true, is it false, or are your results inconclusive? Grammar, spelling, and organization all count.

Team Work. After each of you has finished testing and writing about your hypothesis, you need to work with your team members to create *a single Word document* that contains all of your results. Please name this file TeamX_results so I can find it easily. You need to paste all your Excel charts into this Word document. When you paste Excel charts into Word, you can use *Paste – Special – keep formatting and link chart to the spreadsheet.* This will allow you to modify the chart while you're in Word without having to go back to your Excel file. After pasting the chart, set the text wrapping to either "in front" or "in back" of text. This will allow you to move the chart freely around the document.

The rule regarding where to position charts and tables in scientific writing is that the charts and tables always come *after* they have been referred to. For example, if you go back to Figure 4.1, you will see that this figure is mentioned in the paragraph above the chart. Never put a chart in a document and then put the discussion of the chart afterwards. Every chart or table needs a figure number (e.g. Figure 1, Figure 2, etc.); figures are numbered separately from tables. When you discuss your chart in your paragraph(s), refer to the chart by its figure number. Do not write "the chart below" shows… Instead, write "Figure X" shows…

Discussion

As a team, you need to assess the accuracy and validity of our field measurements. This is particularly important if your hypothesis expectations were not met. Even if your hypothis expectations were met, this is still very important. Go back to the literature you read on standard field procedures for stream wading and determine how well our field site met the suggested criteria and how well we followed recommened procedures for taking measurements. If we fell short in some regard, and if you believe this shortcoming resulted in our data being inaccurate, you need to describe what we could (or should) have done differently that would have improved the accuracy of our data. If we followed procedures as best as possible, but you still think inaccuracies may exist in our data, you should discuss why this might be the case. For example, are there certain characteristics of our field site that make it difficult to take accurate measurements?

As a team, you need to write one- to three- paragraphs discussing your confidence in our field data and your confidence in your hypothesis test results. You must include citations to the literature you read. Incorporate your hypothesis test results into this discussion. Include the discussion in the same Word document as your hypothesis test results. Make sure you include a reference list.

GRADING RUBRIC

	Excellent (9-10 points)	Good (7-8 points)	Satisfactory (5-6 points)	Unsatisfactory (3-4 points)	Failing (0 points)
Individual Excel charts/ graphs & statistics 25% (10 points out of 40)	Excel charts/ statistics totally appropriate for hypothesis tested;	Excel charts/ statistics appropriate for hypothesis tested;	Excel charts/statistics not totally appro-priate; better ways exist to analyze data;	Excel charts/ statistics are inappropriate for hypothesis tested;	Excel work missing.
	Charts/tables clearly and appropriately labeled;	Charts/tables are labeled;	Charts/tables missing some labeling;	Charts not labeled or incorrectly labeled;	
	Charts well-designed and look good (easy to under-stand; effective use of color; appropriate sizing of chart elements, etc.)	Charts are reasonably well-designed and look good.	Charts are not very well designed and are only marginally attractive.	Charts are poorly deisgned and are unattractive.	
Write-up associated with Excel work 25% or 10 points out of 40	Hypothesis stated clearly and concisely;	Hypothesis is stated;	Statement not completely clear; too terse or wordy;	Statement is unclear;	Hypothesis not stated;
	Expectation is stated clearly and concisely, and contains multiple appro-priate literature citations;	Expectation is stated, and contains appro-priate literature citations;	Expectation not very clear (terse/wordy); citations not totally appropriate;	Expectation is un-clear; literature citations are inappro-priate or missing;	Expectation is not stated or is unin-telligible; no citations;
	Accurate, clear, concise description of Excel work; statistics interpreted correctly; all important points are discussed;	Description of Excel work accurate; minor mistakes interpreting data or omissions don't detract from conclusion;	Inaccuracies in descrip-tion of Excel work, some significant mis-takes interpreting data; misses important points;	Description of Excel work is inaccurate; work is incorrectly interpreted; major points missing;	Excel work is not described or interpreted;
	Decision regarding hypothesis is clearly stated and is supported by Excel work.	Decision regarding hypothesis is stated and is supported by Excel work.	Hypothesis decision not stated clearly and/or not completely supported by statistcs.	Decision not stated or stated but state-ment not supported by statistics.	No decision.
Group Excel work 10% or 4 points out of 40	All charts and tables consistently formatted;	Minor inconsistencies In chart/tableformatting;	Moderate inconsis-tencies in formatting;	Significant inconsis-tencies in formatting;	No consis-tency in formatting;
	Consistent use of color, font face & size, symbols, labeling.	Minor color, font, symbol, labeling variations don't detract significantly from charts/tables.	Moderate color, font, symbol, labeling variations detract from overall presentation.	Major color, font, symbol, label variations greatly detract from overall presentation.	No consistency.
Discussion of field procedures and degree of confidence in test results 25% or 10 points out of 40	Field methods critically assessed & correctly compared to recommended procedures; all key points addressed;	Field methods assessed & correctly compared to recommended procedures; key points addressed;	Assessment of field methods uncritical; comparison to reco-mended procedures misses some key points or contains superficial or irrelevant criticisms;	Assessment of field methods uncritical; comparison to recommended procedures incorrect, superficial or irrelevant;	Field methods not assessed;
	All relevant strengths & weaknesses of our field methods are correctly identified;	Relevant strengths & weaknesses of field methods are correctly identified;	Most revelant field methods strengths/ weakness identified; some key points missing;	Important strengths &/or weaknesses of field methods not identified; many key points missing;	Major strengths &/or weaknesses not identified;
	Degree of confidence in results clearly stated; level of confidence is reasonable and appropriate given discussion of strengths and weaknesses.	Degree of confidence in results stated; level of confidence mostly reasonable & appropriate given discussed strengths and weaknesses.	Level of confidence unclearly stated or not completely reasonable or appro-priate given discussion of strengths and weaknesses.	Degree of confi-dence not clearly stated, or is inappropriate given discussion of strengths and weaknesses.	Degree of confidence not stated.

Grammar 15% or 6 points out of 40	No grammatical errors, no spelling errors;	Minor grammatical errors or a few spelling errors;	Significant grammatical errors; some spelling errors;	Numerous grammatical and spelling errors;.	Major grammatical errors; lots of misspellings;
	Paragraphs well organized; logical flow to information; introductory and concluding sentences clearly guide reader;	Paragraphs organized; slight reorganization would improve flow of information; introductory and concluding sentences present;	Could be more well organized; flow of information not totally logical; some introductory/conclu-ding sentences missing or unhelpful for guiding reader;	Paragraphs unorganized; flow of information is unclear; no intro-ductory/concluding sentences;	Complete disorganization;
	Writing style is clear and consistent; neither wordy nor terse.	Writing style is mostly clear and consistent; neither wordy nor terse.	Writing style not always clear or con-sistent; tends to be too wordy or terse.	Writing style often unclear or inconsistent; very wordy or terse.	Writing style unclear and inconsistent.