Name_____

Flood Frequency Analysis For The Winooski River:

Introduction:

During our first lab practicum this semester, we will be working with stream flow data from the Winooski River archived online by the U.S. Geological Survey. Using records of peak annual discharge for the past ~80 years, we will learn how to calculate and plot exceedance probabilities and recurrence intervals. Once completed, we will use these records of flows to make predictions about flows in the future, an indispensable tool for scientists and city planners alike. We will be able to answer questions such as *what is the probability of experiencing a 50-year flood this year?* or *how often would you expect to see a certain sized flood on the Winooski River?* In addition to flood analysis, this exercise will demonstrate the enormous quantity of water that moves through a moderately-sized river basin such as the Winooski.

To Hand In:

- Exceedance probability and recurrence interval plots.
- Written answers and calculations for all questions at the end of this lab.
- This lab is due next MONDAY 9/8 at the beginning of class.

Part 1 - Downloading the data:

We will be using part of the U.S. Geological Survey's **Water Resources Web Site** today. This is a tremendous online resource and it is definitely worth your time to investigate the information that is available for free on the site.

- To start, go to the following website: http://water.usgs.gov/
- Click the "**Real-Time**" link on the right hand side of the screen.
- Finding data for the Winooski River: There are a number of different ways to do this, but the easiest is to scroll to the state of Vermont in the "**Geographic Area"** pulldown menu in the upper right hand corner.
- Next, click the "**Statewide Streamflow Data**" link right in the middle of the page.
- Scroll down until you find the **Winooski River Near Essex Junction**. The station number is **04290500**. Click the link.
- Next, in the pulldown menu at the top, select "**surface-water: Peak Streamflow**."
- You should now see a screen with a chart showing the 78 peak annual flows for the Winooski, as well as several different output options. Click on the "**Tab-separated file**" option.
- You should now have a bunch of text in your browser screen. In the Edit pulldown menu, select "**Select All**" then "**Copy**."
- Open Excel and paste the data into a new worksheet.
- At this point, Stop. CONNECT TO YOUR ZOO DIRECTORY AND SAVE YOUR WORKSHEET. These computers are notorious for crashing while people are working, so **MAKE SURE TO SAVE YOUR WORK AS OFTEN AS POSSIBLE!!!**

Once you have completed this, come get one of us so we can make sure you downloaded the correct data.

Part 2 - Sorting and making calculations with water data:

USGS water data comes with all sorts of information at the top telling you what everything means. Take some time to figure out what each row and column is telling you about past flows on the Winooski River.

The two columns of data you are most concerned with are:

```
#  peak_dt       format YYYY-MM-DD
#  peak_va       Annual peak streamflow value in cfs
```

(cfs stands for cubic feet per second. This is a "flux" meaning volume per unit time)

- **Sorting the data:** You will need to rearrange the data such that all of it is sorted in descending order based upon discharge. Largest discharge at the top, smallest at the bottom.
- **Rank the data:** label a new column as "rank." Now label the largest flow as "1" the second largest as "2" and so on.
- **Calculate Exceedance Probability:** The exceedance probability of a given discharge is the probability or chance that it will be exceeded by a larger discharge. The largest flow will have a very low exceedance probability because there is nothing larger than it, and the lowest flow will have a very high probability because everything is larger than it. It is calculated as a decimal percent, meaning that 1 = 100%, 0.5 = 50%, and 0.01 = 1% etc. In the column next to rank, set up a formula that makes the following calculation:

  Ex Prob = *i/(m +1)*

  Where ***i*** is the rank of each flow and ***m*** is the max number of data points (80).
- **Recurrence Interval:** The recurrence interval is an estimate of how often you should expect to see a certain sized flood. The term 100-year flood is a recurrence interval. Statistically, there is a one in one hundred chance of experiencing a 100-year flood every year. In the column next to the exceedance probability, set up a formula to calculate:

  Re Interval = *1/(Ex Probability)*
- When you are done, your setup should look something like this:

peakannual_winooski.xls

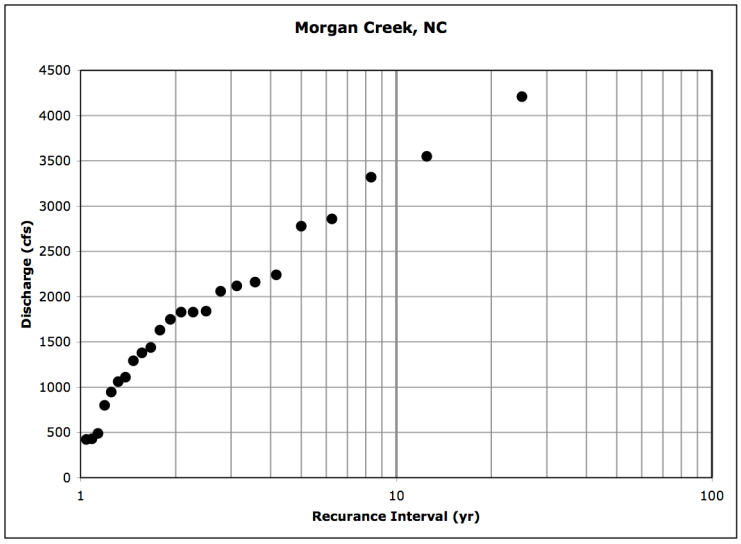
	B	C	D	E	F	G	H	I	J
1	site_no	peak_dt	peak_tm	peak_va	peak_cd	gage_ht		exceedance	Recurrence
2	15s	10d	6s	8s	27s	8s	rank	probability	Interval (yr)
3	4290500	11/4/27		113000	7	50.4	1	0.013	79.000
4	4290500	3/19/36		45300	6	23.54	2	0.025	39.500
5	4290500	4/19/33		34600		18.6	3	0.038	26.333
6	4290500	9/22/38		34300	6	18.72	4	0.051	19.750
7	4290500	3/14/77		32000	6	19.06	5	0.063	15.800
8	4290500	4/13/34		31600		17.32	6	0.076	13.167
9	4290500	1/10/35		30900	6	16.96	7	0.089	11.286
10	4290500	4/18/82		30300	6	18.28	8	0.101	9.875

Part 3 – Making Exeedance Probability and Recurrence Interval Plots:
YOU WILL HAND IN BOTH PLOTS, SO MAKE THEM LOOK GOOD

Calculations are done, but in order to use these data for predictions, you need to plot them.

- **Exceedance Probability:**
  - Plot Discharge (y-axis) against Exceedance Probability (x-axis).
  - Make your plots as "NEW OBJECTS" in excel.
  - Make sure all titles and axes are labeled correctly, and data points show up clearly. You will be graded on presentation.
  - The x-axis needs to be logarithmic with both major and minor gridlines showing.
  - Make sure to include a title, axis labels, and units where applicatble.

- **Recurrence Interval**:
  - Plot Discharge (y-axis) against Recurrence Interval (x-axis).
  - Make your plots as "NEW OBJECTS" in excel.
  - X-axis also needs to be logarithmic with major and minor grid lines.
  - When you are done your plots should look something like the one below:
  - Make sure to include a title, axis labels, and units where applicatble.



Part 4 – Discussing your graphs:

Q1: Are extremely low, moderate, or extremely high peak-annual flow events more or less likely to occur in any given year? Explain your answer using exceedance probability and recurrence intervals. *(2 pts)*

Q2: Stated as a percentage, what is the probability that the peak-annual flow this year will exceed 30,000 cfs? *(2 pts)*

Q3: Stated as a percentage, what is the probability that the peak-annual flow this year will be less than 35,000 cfs? *(2 pts)*

Q4: What peak-annual flow has a recurrence interval of approximately ten years? *(2 pts)*

Q5: How often (in years) would you expect the Winooski River to have a peak-annual flow of 20,000 cfs? *(2 pts)*

Q5: The flood of 1936 reached a peak discharge of 45,300 cfs. If we assume that this peak discharge was maintained for 3 hours:

a) how many **cubic feet (ft^3)** of water passed the Essex Junction gauging station during this period? SHOW ALL CALCULATIONS *(2.5 pts)*

b) how many **cubic meters (m^3)** passed the gauging station? (1m = 3.28 ft) SHOW ALL CALCULATIONS! *(2.5 pts)*

Q6: Flood frequency analysis is a statistical approach that enables us to make predictions as probabilities, not certainties. A perfect example of this is the flood of 1927, the flow of record for the Winooski River. The flood occurred early in November. With the help of the website listed below, as well as the reading available on our website, discuss the geomorphic conditions that combined to produce such a large and devastating flood.
http://www.erh.noaa.gov/btv/events/27flood.shtml

**MAKE SURE TO HAND IN YOUR PLOTS *(5pts each)*