Name ____________________________ **Date** ________

Land Use & Stream Ecosystem Health

Step 1: Historic Land Use Change. How has our use of land changed over time? Use historic aerial photos to find out!

1. Place the transparency grid on top of the aerial photo. Count how many squares are covering the photo. This is your total # of squares: _________
2. Next, count how many squares are in each land use type. If a square contains two land use types, decide which land use type dominates, and count the entire square accordingly. To calculate % cover, count the number of total squares, and then divide the # of squares of each forest type by the total number of squares. An example is done for you.

Historic Land Use Photos	**# squares**	**% Cover (squares in each land use/total squares)**	**Current Land Use Photos**	**# Squares**	**% Cover**
Ex: Forest	*25*	*25/100= 25%*			
Farmland/fields			Farmland/fields		
Forest			Forest		
Developed			Developed		
Other:			Other:		
Other:			Other:		

3. Which land use was most common in the historic photos? _________ Least common? _________
   a. Most common in the current photos? _____________ Least common? _________

4. How has land use changed over time? ____
____

5. What impact do you think land use change may have on the ecosystem? Use the background readings “Streams and Impervious Surfaces” and “Macroinvertebrates” to help you.
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6. Brainstorm an experiment you could do to compare the impact of different land use on streams. What would you like to test? Outline your experiment below.
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7. What is the hypothesis for the experiment you described in #6?
____
____

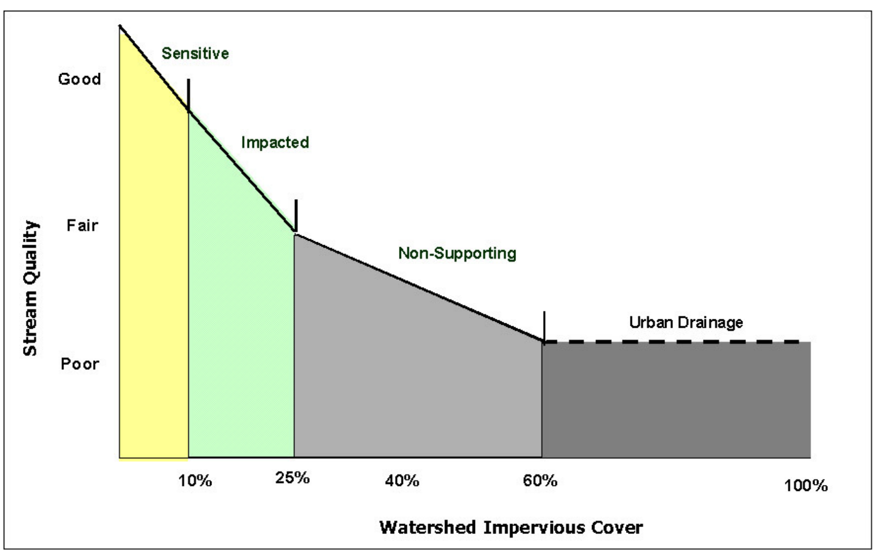
Step 2: Identify land use in your watershed

1. In what watersheds are you conducting your comparison study? If possible, try to get watersheds with different types of land use. List the names of your watersheds here:
   a. _________________________
   b. _________________________
2. Obtain land use maps of your watersheds. List the land use types in each watershed, if not identified in the chart below. Lay the transparency grid over the watershed map. How many squares does the transparency grid cover? ______ Then, use the transparency grid to count how much of each land use type exists.

Watershed A	**# squares**	**% Cover**	**Watershed B**	**# Squares**	**% Cover**
Ex: Forest	*25*	*25/100= 25%*			
Farmland/fields			Farmland/fields		
Forest			Forest		
Developed			Developed		
Other:			Other:		
Other:			Other:		

3. Which land use type is most prevalent?
   a. Watershed A: _________________
   b. Watershed B: _________________
4. What is the percentage of impervious surface in: Watershed A: _________? Watershed B: __________?

5. Use this graph to make a prediction about the results of your study, based on the amount of impervious surface in your study watersheds.



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6. Based on this information, which stream do you think will have higher numbers of pollution-**intolerant** invertebrates? Why?
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Step 3: Macroinvertebrate collection. Decide how you will collect macroinvertebrates, using the accompanying data sheets and identification guides. Then, enter your data below: the number of each invertebrate type you found.

Macroinvertebrate type	Watershed A	Watershed B
Mayfly		
Stonefly		
Caddisfly		
Crane fly		
Dragonfly		
Dobsonfly		
Snails		
Clams		
Leeches		
Flatworms		
Crayfish		
Scud (amphipods)		
Isopod		
Water strider (spider)		
Other:		

Step 4: Class data

1. How many different types of macroinvertebrate groups did you identify during your field trip? This will be used as "organism richness" in question #3.
   a. Watershed A: ______
   b. Watershed B: ______
   c. If you had collected 10 samples from each watershed instead of just one, what do you think would happen to your "organism richness"? ____________ Why? ___________________________________
   ____

2. How "even" were your samples? Species evenness tells us how evenly the species are distributed in the ecosystem, or the relative abundance of each species in an area. Look at the following example:

Tree Species	Habitat A (# of individuals)	Habitat B (# of individuals)
White pine	220	900
Red oak	300	50
Sugar maple	380	50

   a. Using the example table, what is the species richness in each habitat? A: _________ B: _______
   b. Using the example table, which habitat has greater species evenness? _________
   c. In your experiment, did you observe greater species (more accurately, "group") evenness in Watershed A or Watershed B? ___________
   d. If you had collected 10 samples from each watershed, what do you think would happen to your species "evenness"? __________________ Why? ____
   ____

3. Since we didn't identify species, just general groups, you can't calculate the exact species richness. However, we will use "group" or "organism" richness in this experiment, and that should give you enough information to make some decisions about the health of your watersheds.

Group	**Total # of groups in Watershed A**	**Dominant land use type**	**Total # of groups in Watershed B**	**Dominant land use type**
Example	*8*	*Developed*	*15*	*Forest*
Class Data Totals				

a. On average, which land use types had the highest group richness? _______________
b. Was this consistent in all of the groups? Why or why not?____________________________________
____

4. Now, we're going to look at specific groups of invertebrates: mayflies, stoneflies, and caddisflies. Scientists often collect all the macroinvertebrates they can in a stream, and then count the numbers of these organisms because they tend to be sensitive to pollution (with the exception of netspinner caddisflies, who can tolerate pollution and should not be used in your caddisfly count). The abundance of these common stream invertebrates, the mayflies (Ephemeroptera), the stoneflies (Plecoptera), and the caddisflies (Trichoptera), is called EPT, which stands for the first letter in the Order of the insects. As pollution and the amount of impervious surface increases, the numbers of these insects tend to decrease. EPT richness can be used to compare different test sites, and it is faster than identifying every animal, since you just have to sort the organisms into three major groups.

www.bugsurvey.nsw.gov.au

Mayfly larva

www.nc.water.usgs.gov

Stonefly larva

Caddisfly larva

Calculate the percentage of stoneflies, mayflies, & caddisflies you collected out of your class's entire sample. For instance, in if you collected 15 mayflies, 20 stoneflies, and 40 caddisflies, you would add that together and divide by the total # of invertebrates you collected. This tells you the abundance of these three groups of organisms in your sample.

Your Watershed A:

☐ ÷ ☐ = ☐

Total stoneflies/mayflies/caddisflies   Total # macroinvertebrates   Percentage

Your Watershed B:

☐ ÷ ☐ = ☐

Total stoneflies/mayflies/caddisflies   Total # macroinvertebrates   Percentage

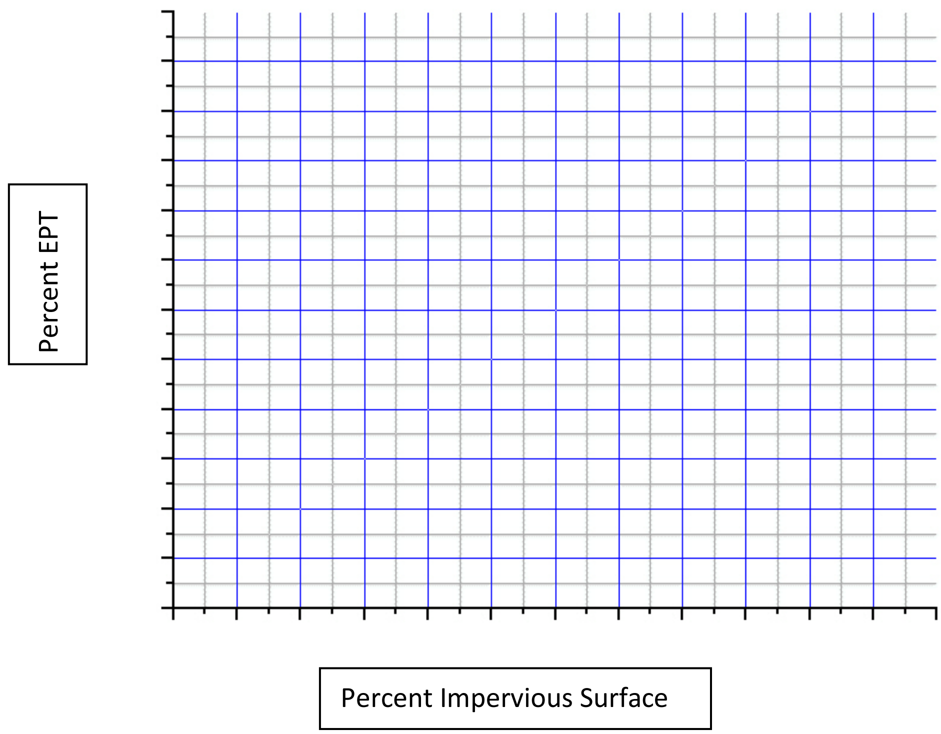
a. Which watershed has the highest percentage of stoneflies, mayflies, and caddisflies? ___________

b. How does this relate to the dominant land use type in each watershed? _______________________________
____
____

5. Each group in your class should calculate the percentage of stoneflies/mayflies/caddisflies, and report that percentage along with the percentage of impervious surface in each watershed.

Group	**Watershed A: Percent stoneflies, mayflies, and caddisflies**	**Watershed A: Percent impervious surface**	**Watershed B: Percent stoneflies, mayflies, and caddisflies**	**Watershed B: Percent impervious surface**
Example	*40%*	*5 %*	*10%*	*50%*

6. Create a graph showing the % of stoneflies, mayflies, and caddisflies (EPT) in relation to the % impervious surface. Graph all of the data from your class; be sure to label your axes correctly and create a title.



7. Based on your class's data, what can you conclude about the relationship between impervious surface and EPT abundance? ____
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8. Are you confident with your results? Why or why not? ____________________________
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9. What would you change if you repeated this experiment? ____________________________
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10. Ecologists often use a comparative experiment technique called "space for time substitution." In order to find out what an ecosystem was like in the past, ecologists compare two places that have the characteristics of what was thought to exist in the past, and what exists today. For example, if you wanted to find out what an ecosystem was like before the arrival of an invasive species like the plant "mile-a-minute", you would compare a place with mile-a-minute and a place without. Using the information from your experiment, could you hypothesize what the streams in your local town or city were like 100 years ago? Why or why not?
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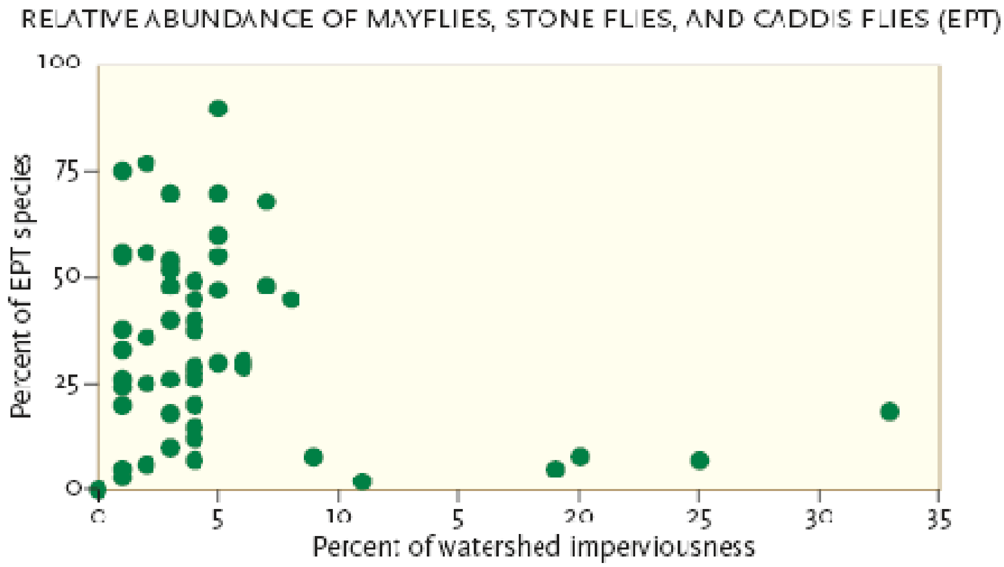
Step 5: Compare your data

Use the graph to answer the questions that follow.



The graph above shows the relationship between imperviousness and the abundance of the EPT stream invertebrates, the mayflies (ephemeroptera), the stoneflies (plecoptera), and the caddisflies (trichoptera). This work was done in 39 cold water streams with different levels of watershed urbanization in Wisconsin and Minnesota (Wang & Kanehl, 2003).

1. What happens as impervious surface increases? ____
____

2. Is there a specific amount of imperviousness that you think is the "cut off" for stoneflies, mayflies, and caddisflies to survive?
____
____

3. How do your data compare with what scientists found in the graph above? Explain why you think you got the results that you did. ____
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4. What experimental changes could the scientists make to show a clearer relationship between % imperviousness and % EPT abundance?
____
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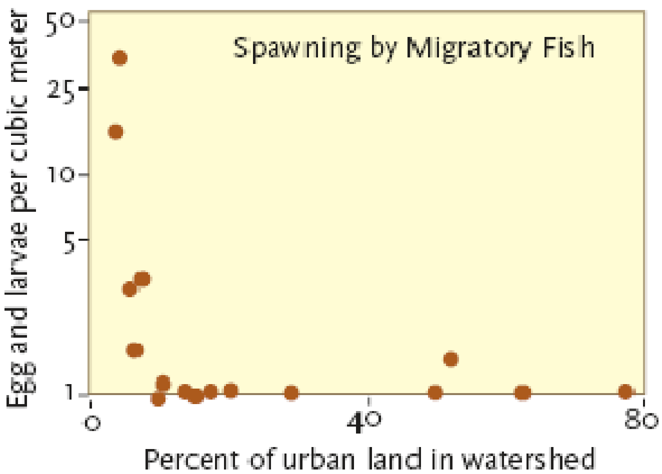
Use the following graph to answer the questions 5-7.



5. What does this graph tell you about the relationship between urban land use and numbers of anadromous fish eggs & larvae in the Hudson River watershed?

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This graph shows the natural log of mean densities (#/m3) of eggs and larvae fish in 16 Hudson River tributaries. Anadromous fish spawn in freshwater and live in salt water, migrating between the two. (Modified with permission from Limburg 1990)

6. Is this similar or different to the urbanization "threshold" in the study by Wang & Kanehl, above?

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7. If you were told that a building a new shopping mall would increase the impervious surface from 15% to 25% in a watershed, what would happen to the numbers of fish, based on the graph? Explain your answer.

____
____

8. If you were told that a stream had 75% EPT (stonefly, mayfly, caddisfly) abundance, and anadromous fish species density of 1.5, how much impervious surface would you expect? Why?

____
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9. If you were going to advise a local town on how much development could take place and still allow for stream organisms to survive, what would you tell them? Do you have enough evidence to say that there is a "threshold" above which development should not take place? Why or why not?

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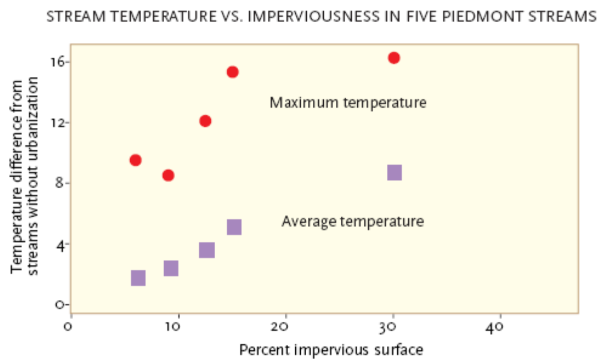

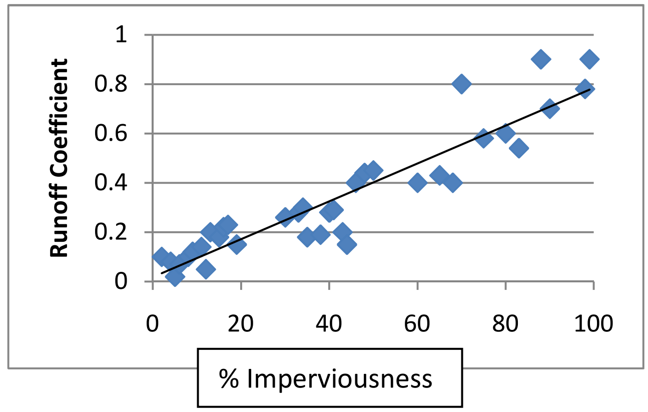

Graphs modified from Schueler & Holland, 2000.

10. How does impervious surface impact temperature?

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11. How is imperviousness related to runoff?

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____

12. Thinking back to the earlier graphs on fish density and EPT abundance, do the two graphs above explain the reasons why those organisms tend to decline with increasing impervious surface? Why or why not?

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13. A scientist proposes a hypothesis that when stream temperatures increase, EPT abundance and fish species richness decrease. Do you agree or disagree with this hypothesis? Under which conditions might it hold true?

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14. Based on these graphs and your understanding of urbanization, summarize the impact of increasing impervious surfaces on watershed streams.

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