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

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

3. 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.
   ____
   ____
   ____

4. 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.
   ____
   ____
   ____
   ____
   ____

5. 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. 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.

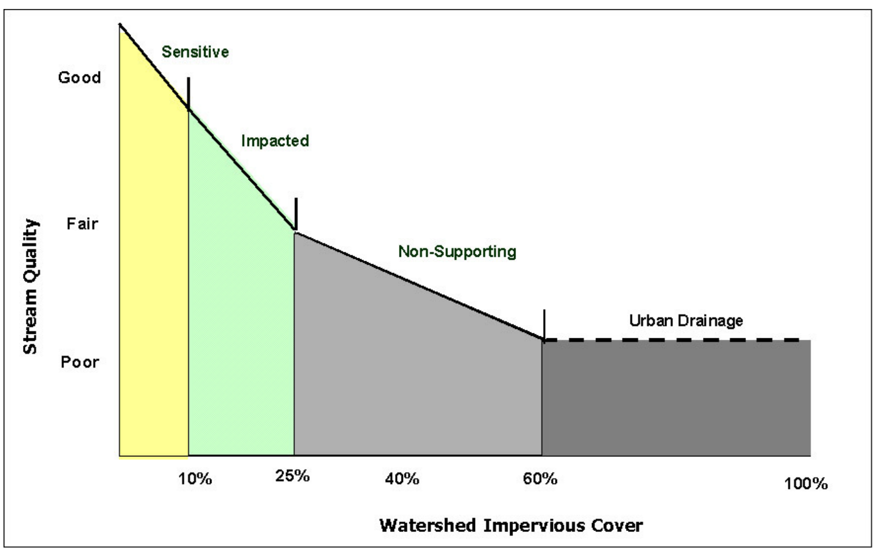
Watershed A	**# squares**	**% Cover**	**Watershed B**	**# Squares**	**% Cover**
Ex: Forest	*25*	*25/100= 25%*			
Undeveloped			Undeveloped		
Developed			Developed		

3. Which land use type is most prevalent?
   a. Watershed A: _________________
   b. Watershed B: _________________

4. An **impervious** surface is impenetrable to water, so the water runs off over the surface instead of soaking into the ground. Developed land is the amount of impervious surface in your watershed.

   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?
____
____

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? _________
   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 Name	**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				

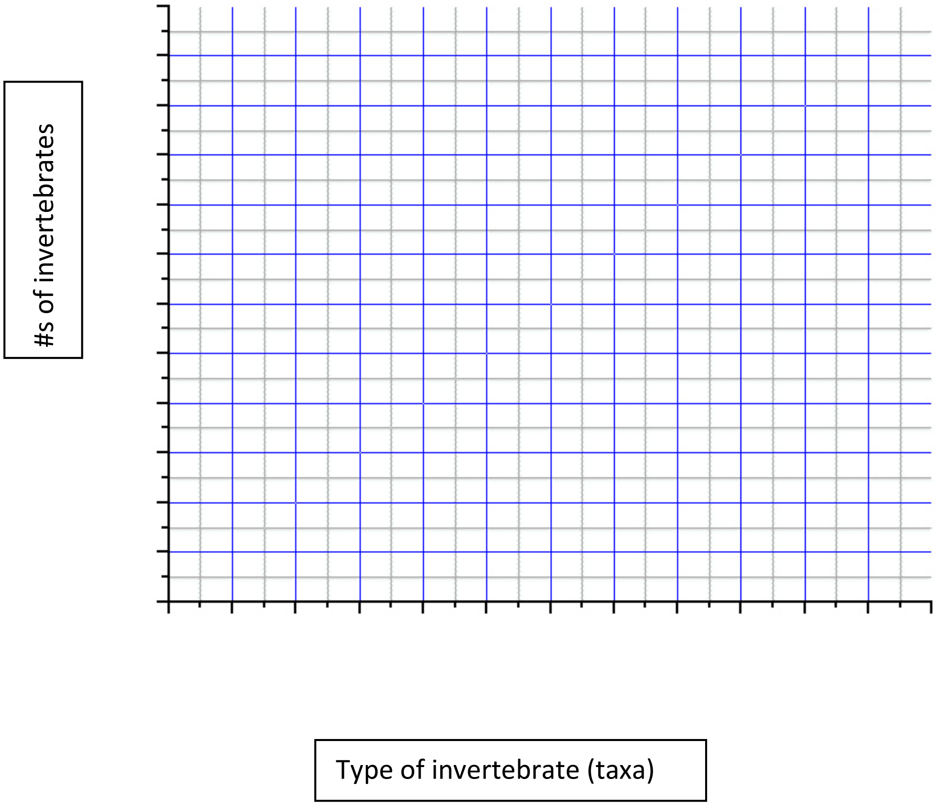
a. On average, which watershed had the highest group richness? _______________
b. Was this consistent in all of the groups? Why or why not?______________________________________
____

4. Next we're going to look at the pollution tolerance values for the different animals you collected. Use the accompanying data sheet and copy the tolerance values you calculated here:

a. Total water quality score for Watershed A: ________
b. Total water quality score for Watershed B: ________
c. How does this relate to the dominant land use type in each watershed?
____
____
____

5. Based on your class's data, what can you conclude about the relationship between land use (or impervious surface) and the health of the two watersheds you investigated?
____
____
____

6. Create a graph showing numbers of different taxa for the two watersheds. Graph the class data.



7. Are you confident with your results? Why or why not? ____

____

____

8. What would you change if you repeated this experiment? ____

____

____

9. 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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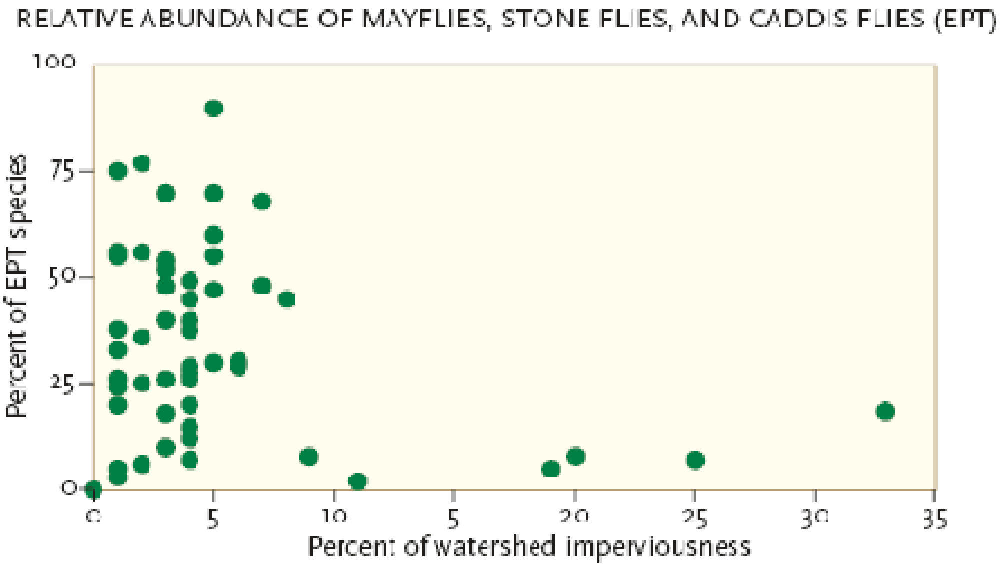
Step 5: Compare your data

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). 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 the caddisfly count). 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. 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 percentage of imperviousness that you think is the "cut off" for stoneflies, mayflies, and caddisflies to survive?
____
____

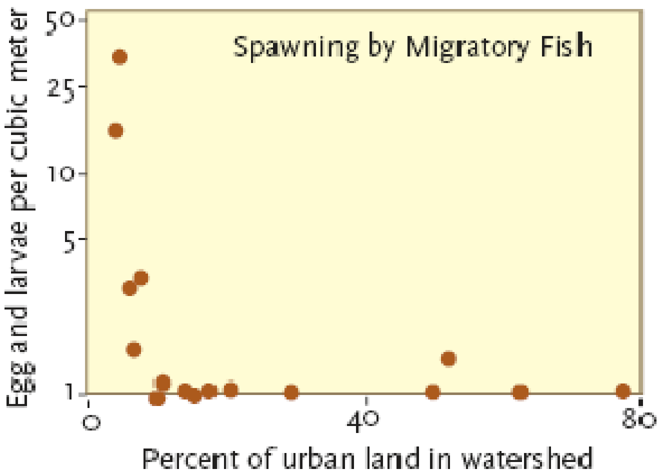
3. How do your data compare with what scientists found in the graph above?
____
____
____

4. What experimental changes could the scientists make to show a clearer relationship between % imperviousness and % EPT abundance?

____

____

Use the following graph to answer the questions 5 & 6.



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 numbers 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 there a similar cutoff, or "threshold" of urbanization in this study and the study by Wang & Kanehl, above?

____

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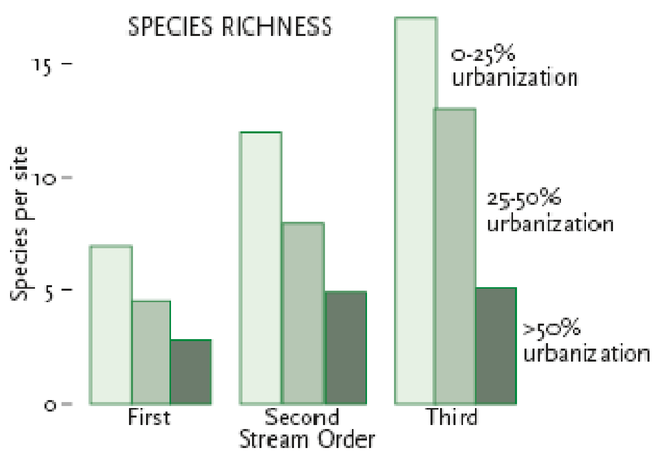
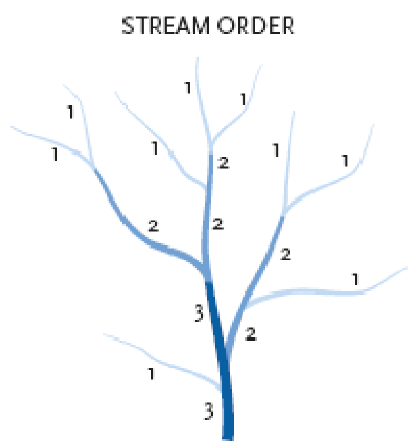
Use this graph and diagram to answer question #7.

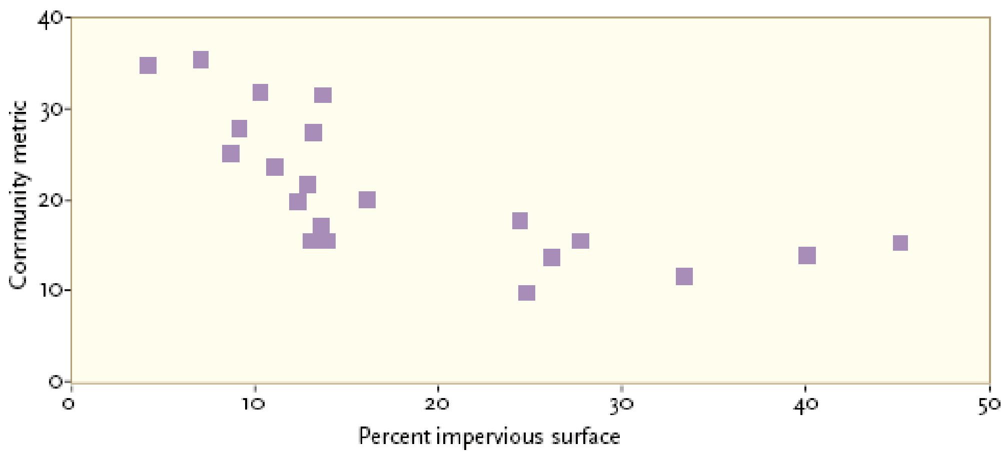




This graph shows the species richness of fish in streams in Maryland, with different levels of urbanization. Stream order refers to the relationship of the stream to its origin. When two first order streams come together, they form a second-order stream. First order streams are the first part of the watershed. Data from Morgan & Cushman, 2005.

7. How does fish species richness change with increasing urbanization?

INVERTEBRATE COMMUNITY STRUCTURE VS. IMPERVIOUSNESS IN THE HEADWATERS OF THE ANACOSTIA RIVER, MARYLAND



The community metric combines measures of EPT diversity, overall diversity of families and genera, and abundance of chironomids. Drom Schueler, T., and Galli, J., 1992, "Environmental impacts of stormwater ponds," cited in Schueler, T. R. and H.K. Holland, 2000, "The importance of imperviousness." *Watershed Protection Techniques*, 1 (3): 100-111.

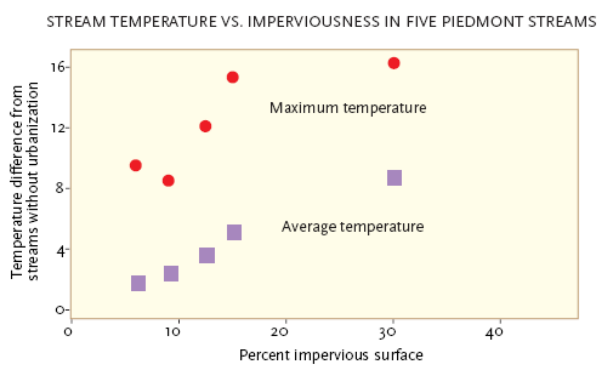
8. What does the graph of invertebrate community structure versus imperviousness tell you about the headwaters of the Anacostia River in Maryland?

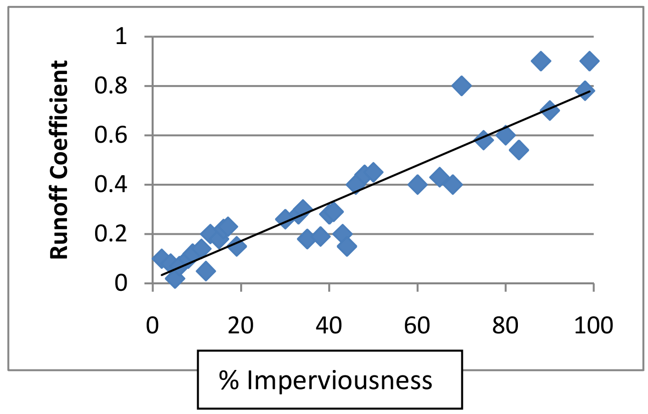
9. How does this graph compare with your data?

10. 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.

11. 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?

12. 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?





Graphs modified from Schueler & Holland, 2000.

13. How does impervious surface impact temperature? Runoff?

14. 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?

15. 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?

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