LEHIGH VALLEY WATERSHED

ACADEMIC STANDARDS FOR ENVIRONMENT AND ECOLOGY
4.1. WATERSHEDS AND WETLANDS UNIT PLAN

Submitted by:
Therese Ehrenreich
Whitehall High School
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(610) 437-5081 ext. 1202
ehrenreicht@cliu.org
ehrenreicht.hypermart.net

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Part I - Lehigh Valley Watershed

Introduction to Watersheds and Wetlands Mapping, Multiple Functions, and Modeling

By Therese Ehrenreich

PART I (A) - ENVIRONMENTAL GEOLOGY AND MAPPING

Grade Level: 9th (may be adapted for higher or lower levels)
Time Frame: 3 blocks (or 1 week regular class time)
Resources: Teacher handouts, resource books; text books
Technical Components: Videos; internet sites (see lessons and Resources)

STANDARDS (OBJECTIVES): * The student will be able to…

4.1.A.10. THE STUDENT WILL BE ABLE TO DESCRIBE CHANGES THAT OCCUR FROM A STREAM'S ORIGIN TO ITS FINAL OUTFLOW.

A. Identify Pennsylvania's major watersheds and their related river systems.
B. Describe changes by tracing a specific river's origin back to its headwaters including its major tributaries.

4.1.B.10. EXPLAIN THE RELATIONSHIP AMONG LANDFORMS, VEGETATION AND THE AMOUNT AND SPEED OF WATER.

A. Analyze a stream's physical characteristics
B. Describe how topography influences streams.
C. Explain the influence of mountains on precipitation.
D. Explain how vegetation affects storm water runoff.
E. Delineate the boundaries of a watershed.
F. Describe factors that affect the quality of groundwater.
G. Explain how the speed of water and vegetation cover relates to erosion.

4.1.C.10. DESCRIBE THE PHYSICAL CHARACTERISTICS OF A STREAM AND DETERMINE THE TYPES OF ORGANISMS FOUND IN AQUATIC ENVIRONMENTS.

A. Describe and explain the physical factors that affect a stream and the organisms living there
B. Identify terrestrial and aquatic organisms that live in a watershed
C. Categorize aquatic organisms found in a watershed continuum from headwater to mouth (e.g. shredder, predator, decomposer).
D. Identify the types of organisms that would live in a stream based on the stream's physical characteristics.
E. Explain the habitat needs of specific aquatic organisms.

4.1.D.10. DESCRIBE THE MULTIPLE FUNCTIONS OF WETLANDS.

A. Describe wetlands in terms of their effects (e.g., habitat, flood, buffer zones, prevention areas, nurseries, food production areas).
B. Explain how a wetland influences water quality, wildlife and water retention.
C. Analyze wetlands through their indicators (e.g., soils, plants, hydrology).

4.1.E.10. IDENTIFY AND DESCRIBE NATURAL AND HUMAN EVENTS ON WATERSHEDS AND WETLANDS.

A. Describe how natural events affect a watershed (e.g., drought, floods)
B. Identify the effects of humans and human events on watersheds

MATERIALS:
Handouts Part I (A): Mapping – Key Terms; Mapping Activity; Pennsylvania Waterbasins; Maps (Lehigh and Luzerne Counties); Profile Activity

INTERACTIVE WATERSHED MAPS:
River Basin <http://www.dep.state.pa.us/river/_presentation3.htm>;
Surf Watershed <http://cfpub.epa.gov/surf/huc.cfm?huc_code=02040106>;
Interactive Watershed Map (Register as "Guest"; Password "Guest") < http://leo.lehigh.edu/envirosci/watershed/curricular/riverweb.html>

Photojournal <http://www.leo.lehigh.edu/envirosci/watersheds/pjournal/section3>
Pennsylvania Department of Environmental Protection: <http://www.dep.state.pa.us/educators/default.htm> Educators->On-Line Env. Ed.->Go DEP Inspector->Search "W" (Watershed->Notebooks)->Maps-><http:// www.dep. state.pa.us/dep/deputate/watermgt/wc/Subjects/WSNoteBks/shedtable.htm
Pennsylvania Fish and Boat Commission On-Line Activities and Publications < http://sites.state.pa.us/PA_Exec/Fish_Boat/pfbchom2.html>

PART I (A) Procedure:

1. **Same/Different/Label (Key Terms)**: Students will review the main concepts of watersheds and river systems. Students will label and use key terms. Students may use textbooks, internet and handouts.
2. **Operate (Activity)**: Understand and label maps. Students will be given a topographic map of the Lehigh River (Central Delaware Subbasin Number 2) and the Lehigh River headwaters. Students will delineate the watershed boundaries and describe factors that affect the quality of groundwater. They will analyze the stream's physical characteristics and describe how topography influences streams. Students will use a map to identify key zones, practice concepts, understand and label maps. They will also profile Blue Mountain.
3. **Going further (MATH)**: USGS Water Science for Schools -> How Flow is Measured <http://ga.water.usgs.gov/edu/measureflow.html>

ASSESSMENTS:
Oral Evaluation: To see if students understand concepts.
Written: Students will complete handouts.
Performance-Based: Students will use various media to study watersheds. They will use mapping skills. Students will also design, build, and experiment.

PART I (A) MAPPING - KEY TERMS – ANSWER KEY

1. **Mapping**:
   - A. Contour interval: The difference in elevation from one contour line to the next.
   - B. Elevation: Height above sea level.
   - C. Landform/Landform region: A feature of topography formed by the processes that shape Earth's surface. A landform region is a large area of land where the topography is similar.
   - D. Mountains: A landform with high elevation and high relief.
   - E. Plain: A landform made up of flat or gently rolling land with low relief.
   - F. Plateau: A landform that has a more or less level surface and is elevated high above sea level.
   - G. Profile: A cross-sectional view of a map showing elevation and relief.
   - H. Relief: The difference in elevation between the highest and lowest parts of an area.
   - I. Topography: The shape of the land determined by elevation, relief, and landforms.

2. **Watershed (Drainage basin)**: The land area that supplies water to a river system. Large basins can be subdivided into smaller ones.
   - A. Divide: A ridge of land that separates one drainage basin or watershed from another.
   - B. Drainage patterns:
     (1) Dendric: (tributaries along uniform rock form twig-like braches); (2) Trellis: (consequent--with slope; subsequent--at right angles to consequent stream; obsequent--opposite direction of consequent); (3) River capture: (headward erosion); (4) Accordant: (patterns along anticlines and synclines)
   - C. Floodplain: Flat topography along a stream in a river valley, produced by a combination of over-bank flow and lateral migration of meander bends.
   - D. Tributary: A stream that flows into a larger stream.
   - E. Wetland: An area of land that is covered with a shallow layer of water during some or all of the year.

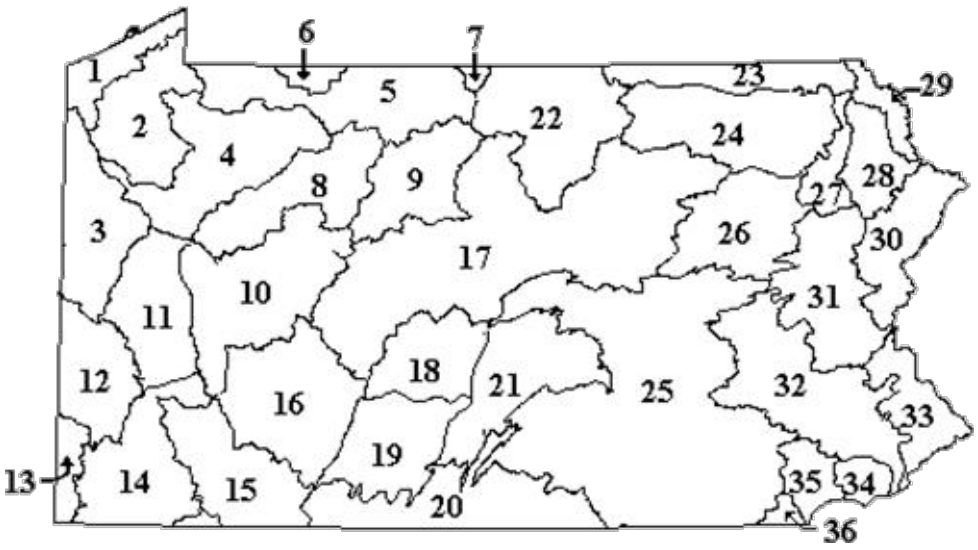
3. **Erosion**: The process by which water, ice, wind, or gravity moves fragments of rock and soil.
   A. Base level: The theoretical lowest elevation to which a river may erode (at or about sea level).
   B. Gully: A large channel in soil formed by erosion.
   C. Meander: A looping curve formed in a river as it winds through its flood plain.
   D. Oxbow lake: Crescent-shaped, cutoff body of water that remains after a river carves a new channel.
   E. Rill: A tiny groove in soil made by flowing water.
   F. Runoff: Water that flows over the ground surface rather than soaking into the ground.
   G. Slope: Relationship of the rise to the run
   H. Valley: Low-lying area
   I. Waterfall: Area of resistant rock creates cascading water.

4. **Stream Capacity and Deposition**: (As water's speed increases 2 times, its capacity to lift and carry material increases 64 times.)
   A. Alluvial fan: A wide, sloping deposit of sediment formed where a stream leaves a mountain range.
   B. Bed load: The material a stream carries (usually sand and gravel) along its bottom channel by rolling, sliding, or skipping.
   C. Capacity: The theoretical amount of material the water can hold.
   D. Delta: A landform made of sediment that is deposited where a river flows into an ocean or lake.
   E. Discharge: The quantity of water flowing past a particular point on a stream, usually measured in cubic feet per second (cf/sec) or cubic meters per second (cm/sec); V (velocity) = Q (discharge in m^3 per second) / A (area in m^2)
   F. Dissolved load: The part of the load that a river carries that results from chemical dissolution of rocks in the drainage basin.
   G. Suspended load: The amount of material (usually silt and clay) carried above the streambed by flowing water. About 90% of the load.

PART I (A) MAPPING ACTIVITY – ANSWER KEY

Materials: map, ruler, blue pencil, green pencil, red pencil

1. Name the map you are using. What type of map is it? Varies: (Lehigh River Headwaters; Upper Lehigh River); Topographic
2. Find the Lehigh River on this map and color it blue. If you canoed along this part of the Lehigh River, how far would you paddle? Varies
3. What is the highest elevation on this map? Headwaters (Big Pine Hill 2260 ft.); Lehigh Valley (Blue Mountain 1600 ft.)
4. Locate as many divides (mountains and hill tops) as possible. Use a green pencil to trace a path along these high points in the watershed. How many watersheds are on your map? Varies
5. Locate all the tributaries that feed into the Lehigh River and color them blue. There may be tributaries that are not shown on the map. Where do you think they would be located? Why? Tributaries come from higher elevations and underground springs. Scale limits maps are limited by scale.
6. In what type of environment will you find headwaters? Marshes, swamps, ponded areas, and other wetlands at a higher elevation. Groundwater seeps from rock fissures, forming brooks on steeper slopes.
7. Name three bodies of water on the map. Varies
8. Find the largest wetland on the map. Circle that area with a red pencil. Name the waterway(s) that border this wetland. Varies
9. There may be wetlands that are not shown on the map. Where do you think they would be located? Why? Wherever shallow water is located for all or part of a year. Again, the map is limited by its scale.
10. What types of natural resources that can be found by using a map? (Hint: Who or what were the towns named after?) Varies. There are many. Rocks and minerals, trees, water, vegetation, animals, people, etc.
11. Think carefully. How is the water being used? Use the map to help you list as many uses as possible. Varies: reservoir, fishing, scuba diving, swimming, agriculture, canoeing, etc.
12. How might the water have been used differently in the past? Transportation, grist mills (for energy), etc.
13. List the different types of pollutants that can affect the water. Varies: Heavy metals, biological, sediments, fertilizers, heat, etc.
14. What are some possible sources of pollution? Varies: runoff from urbanization; dumping; air circulation, acid rain, etc.
15. What type of testing is being done on your water? Varies (pH and coliform).



PENNSYLVANIA WATERSHEDS – ANSWER KEY

#	Watershed Name	#	Watershed Name
10	Allegheny River (Middle Redbank)	4	Allegheny River (Middle)
5	Allegheny River (Upper)	6	Conewango
35	Brandywine, Red Clay, White Clay Cr.	8	Clarion River
22	Chemung	16	Conemaugh/Kiskiminetas Rivers
11	Connoquenessins	34	Delaware River - Lower
2	French Creek	29	Delaware River - Upper
7	Genessee River (Headwaters)	36	Elk Creek/Northeast River (Hdwtr)
31	Lehigh River	1	Lake Erie
21	Juniata River-Lower	25	Lower Susquehanna
28	Lakawaxen River	26	Middle Susquehanna
30	Middle Delaware	33	Neshaming and Pennypack Creeks
14	Monongahela River	12	Ohio - Upper
13	Ohio River (Wheeling Creek)	20	Potomac River
19	Raystown	32	Schuylkill River
9	Sinnemahoning River	27	Susquehanna - Upper (Lackawanna)
3	Shenango River	17	Susquehanna River - Middle
23	Susquehanna River - Upper	24	Susquehanna - Upper (Tunkhannock)
18	Upper Juniata	15	Youghiogheny River

PART I (B) - MULTIPLE FUNCTIONS

Grade Level: 9th (may be adapted for higher or lower levels)
Time Frame: 2 blocks (or 1 week regular class time)
Resources: Teacher hand-outs, resource books; text books
Technical Components: Videos; internet sites (see lessons and Resources)

STANDARDS (OBJECTIVES): * The student will be able to…

4.1.C.10. Describe the physical characteristics of a stream and determine the types of organisms found in aquatic environments.

A. Describe and explain the physical factors that affect a stream and the organisms living there
B. Identify terrestrial and aquatic organisms that live in a watershed
C. Categorize aquatic organisms found in a watershed continuum from headwater to mouth (e.g. shredder, predator, decomposer).
D. Identify the types of organisms that would live in a stream based on the stream's physical characteristics.
E. Explain the habitat needs of specific aquatic organisms.

4.1.D.10. Describe the multiple functions of wetlands.

A. Describe wetlands in terms of their effects (e.g., habitat, flood, buffer zones, prevention areas, nurseries, flood production areas).
B. Explain how a wetland influences water quality, wildlife and water retention.
C. Analyze wetlands through their indicators (e.g., soils, plants, hydrology).

MATERIALS:

Handouts Part I (B): Wetland Environments; Aquatic Communities (Lotic and Lentic); Water Study; Soil Study; Watershed Indicators

Internet Access:

Know Your Watershed
http://www.ctic.purdue.edu/KYW/Brochures/Wetlands.html

Environmental Protection Agency Atlas (Understanding Wetland Indicators)
<http://www.epa.gov/iwi/iwi-overview.pdf>

Pennsylvania Fish and Boat Commission On-Line Activities and Publications <
http://sites.state.pa.us/PA_Exec/Fish_Boat/pfbchom2.html>

Wetlands Educational Resources
http://www.epa.gov/region4/water/wetlands/education/classroom.html

PART I (B) PROCEDURE:

1. **Key Terms**: Define wetlands and understand their purpose. Describe wetlands in terms of their effects (e.g., habitat, flood, buffer zones, prevention areas, nurseries, flood production areas).
2. **Activity**: Practice wetland terminology. Explain how a wetland influences water quality, wildlife and water retention. Correlate organisms and habitats.
3. **Going Further (LAB)**: Analyze the "health" of wetlands indicators (e.g., soils, plants, hydrology). Test water and soil samples. Use test kits to determine pH, dissolved oxygen, dissolved carbon dioxide. Test soil to determine nitrates, phosphates, and potassium.

ASSESSMENT:

Oral: Verbally check for comprehension.

Written: Students will use correct terms. They will use higher-order thinking skills to answer questions in the activities.

Performance: Students will design tests and perform experiments to solve problems.

PART I (B) WETLAND ENVIRONMENTS – ANSWER KEY

Wetlands form where water is trapped in low areas or where groundwater seeps onto the surface of land. They can range in size from a water-filled roadside ditch to an area covering thousands of square kilometers. Some wetlands are covered with water all year while others dry up over the summer.

Three common types of wetlands:

1. **Swamps**: Look like flooded forests, with trees and shrubs growing in the water; many swamps are located in the southern United States, where trees grow quickly in the warm, humid climate.
2. **Marshes**: Grassy areas covered by a shallow layer or stream of water; swamps contain cattails, rushes, and other tall grass-like plants.
3. **Bogs**: More common in cooler northern states, often form in kettle depressions left by melting ice sheets thousands of years ago. Bog water tends to be acidic. Many types of mosses and other plants thrive in bogs (ex: peat moss, cranberries, wild rice, blueberries, etc.)

BENEFITS OF WETLANDS

1. What features of wetlands make them good habitats for living things? Wetlands provide food, habitats, breeding grounds, and resting areas for a wide variety of wildlife and plants, including rare and endangered species.
2. Why are wetlands considered to be one of nature's natural filters? Wetlands are highly productive. Many nutrients and chemicals are naturally recycled. Wetlands break down, remove, use, or retain organic waste and sediment carried to the wetland. Plants may effectively trap sediment and toxins.
3. How do wetlands help control flooding? Freshwater wetlands are natural sponges. They help regulate water flow by storing water during floods and slowly releasing it during dry periods. Wetlands often recharge aquifers.
4. How do wetlands protect stream banks and shore lines from erosion? Coastal wetlands such as salt marshes provide a buffer for inland areas from coastal erosion associated with storms and high waves.
5. What do wetlands have to offer humans? Wetlands provide food, products, and other goods for humans. They provide a place for commercial fishing (including shellfish), waterfowl hunting, bird watching, photography, and outdoor education.

PART I (B) AQUATIC COMMUNITIES – ANSWER KEY

FLOWING WATER (LOTIC) COMMUNITIES: (ex: Lehigh River)

1. How would you best describe the water in this environment? What characteristic of this water determines the type of life found here? Running Water (Rivers and Streams). The continuous, one-way water flow governs much of the anatomy, physiology, and behavior of aquatic life.
2. Does this water tend to be relatively warmer or cooler? Cooler ($<70^0$ F)
3. Does this water tend to have a high or low oxygen content? Why? High, because the water is constantly moving, brining in oxygen. It also tends to be cooler, and cool water holds more oxygen than warm water.
4. What special adaptations would an organism need to make in order to live here? Why? Plants and animals are adapted to stay in position and avoid being carried downstream. The stream bedrock and the terrestrial communities along the watercourse will influence the abundance and diversity of life. Animals must maintain their position (some attach themselves with adhesives, nets or claws). Plants attach themselves to rocks.
5. Most streams have two different but interrelated habitats: riffles and pools. Compare and contrast these two communities.
    a. **Riffle**: Shallow, fast-flowing, well-aerated sections with rocky substrata. More abundant and diverse life than quieter pools. Base producers include algae, diatoms, and mosses. Microscopic proto-zoans, rotifers, flatworms, and segmented worms live in, on, and among the producers. Many "hatches" occur in late winter or early spring (brown stoneflies and dark brown caddisflies); other stoneflies, caddisflies, and mayflies emerge throughout the summer and fall. Larger members include insects, crustaceans, and fish (blacknose and longnose dace, darters, shiners, chubs, fallfish, small catfish, and white suckers. If stocked, include brook, brown, and rainbow trout.
    b. **Pool**: Quiet sections of the streams, with a less diverse assemblage of aquatic life. The slower velocity of the water allows silt and mud to settle to the bottom, covering the rocks. The most abundant invertebrate is the wormlike fly larvae (midges, cranes, and horseflies); damselfly and dragonfly nymphs, and burrowing mayfly nymphs. Fingernail clams are found. Larger members include riffle-type fish (chubs, shiners, fallfish, trout, white suckers, channel catfish, smallmouth bass, and various sunfish). Along the edges, water striders, water boatmen, and whirligig beetles can be found.

6. What are the two major types of streams found in Pennsylvania, limestone and flowstone? Of these, which is the best for trout? Why? Limestone streams may collect groundwater. Limestone and its salts ($CaCO_3$) makes the water less acidic (pH ~ 7.5 to 8.0) and extremely fertile. Abundant and diverse insect and crustacean populations are the rule. Mayflies, midges, crayfish, isopods, and scuds are abundant for trout to feed upon.
7. How are the banks, stream edges, and adjacent land areas important to the stream? Material carried into the stream from the adjacent land area is a major energy source for stream life. (90% of the energy)
8. Give examples of three energy sources and how they are used:
    a. **Coarse particulate organic matter**: leaves and woody debris; often colonized by fungi and bacteria.
    b. **Fine particulate organic matter:** leaf fragments, invertebrate feces, dissolved organic matter; stream insects (stoneflies, caddisflies, dipterans) – larvae and adults- will shred for food.
    c. **Dissolved organic matter**: materials seep through the subsurface from adjacent forests, fields, and lawns; invertebrates (ex: larval caddisflies, blackfies, and midges) will use filtering devices to trap these nutrients. Predators will enter the food chain here (ex: hellgrammites, dragonfly nymphs, and small fish).
9. How have human activities affected the watershed? What could be done to improve the situation? Farming, timbering, industry, and housing have added harmful runoff and wider temperature fluctuations. Severe soil erosion, excess nutrient load, poorly treated discharges, and increased warming affected the streams. Native brook and brown trout need cold water and are becoming rare. Wise management could mean the return of more "chalk water" (if you boil the water, a powdery residue remains). **Restoration**: Monocacy Creek Watershed Assoc., Wildlands Conservancy, Pennsylvania Rivers Conservation Program, along with local municipalities.
10. How long is the Lehigh River? What is being done to monitor the Lehigh River? The Lehigh River flows south from its headwaters for 103 miles before joining the Delaware River at Easton ("Forks of the Delaware"). The most extensive study of the Lehigh was conducted in 1968. It revealed that both fish and benthic communities were depressed in terms of biomass. Since them, spot surveys show a slight improvement. A healthy river is key to any long-range plan designed to sustain natural ecosystems, maintain or increase biodiversity, and assure outstanding recreational opportunities.

STANDING WATER (LENTIC) COMMUNITIES: (ex: Graver Arboretum)

1. How would you best describe the water in this environment? What characteristic of this water determines the type of life found here? Standing Water (Ponds and Lakes) are now man-made "impoundments."
2. Does this water tend to be relatively warmer or cooler? Ponds are warmer
3. How does the thermocline affect aquatic life? Water sinks (~39.2^{0}F). Fall and winter turnovers bring nutrients to the surface, causing algal blooms.
4. Does this water tend to have a high or low oxygen content? Why? Low, because the water still. Warmer water holds less oxygen than cold water.
5. How has plant life adapted to diverse conditions? Give supporting details.
    a. **Emergent (Near the water's edges)**: Plants start their growth while covered with water but soon extend into the air.
        i. **Example**: Cattails, bulrushes, sedges, arrowheads
        ii. **Leaves**: Spongy tissues float up and down.
        iii. **Roots**: Horizontally, stable interlocking pattern.
        iv. **Reproduction**: Seeds and shoots.
    b. **Floating Leaf (1-3 feet deep)**: Plants are anchored on the muddy bottom while their leaves float at or on the surface.
        i. **Example**: Spatterdock, water milfoil, and water lilies.
        ii. **Leaves**: Elliptical leaves resist tearing, protective cuticle
        iii. **Stalks**: Flexible stalks allow leaf movement.
        iv. **Reproduction**: Seeds and shoots. Free-floating (ex: duckweeds) sink in the fall and rise in the spring.
    c. **Submergent (Open water)**: Plants are below the surface of the water, ranging from the shallowest zone to several meters deep.
        i. **Example**: pondweeds, water milfoil, water celery.
        ii. **Leaves**: Flexible and finely divided, decreases resistance to water motion. May have more than one type of leaf.
        iii. **Roots**: The diversity of root systems allows a variety of submersed plants to grow in close proximity.
        iv. **Reproduction**: Expansion and overwintering. Annuals reproduce sexually. Others reproduce by cloning.
6. Steams and leaves of aquatic plants are home to other life. Give examples.
    a. **Phytoplankton**: Microscopic algae (green, blue-green, diatoms)
    b. **Zooplankton**: Live with phytoplankton and in the dark zones.
    c. **Nekton**: Swimmers. Use for food or refuge (ex: beetles, fish)
    d. **Benthos**: Bottom dwellers (ex: worms, larvae, tiny clams, and snails)
7. What is one of the smallest flowering plants in the world? Duckweed
8. What type of fish are you mostly likely to find in a warm water pond? Bass (largemouth and rock), bluegill, sunfish.
9. What type of amphibians are you most likely to find? Toads and frogs.
10. What type of reptiles are you most likely to find? Snakes and turtles.

PART I(B) WATER STUDY – ANSWER KEY

TEMPERATURE AND DISSOLVED OXYGEN:

1. As water temperature increases, what happens to the amount of dissolved oxygen in the water? How might this affect aquatic life? As temperature increases, the dissolved oxygen decreases. Fish and other life need oxygen to survive. Plants use oxygen at nighttime. In some instances, plant respiration at night may result in a large loss of life by morning,
2. Which type of fish requires the most oxygen to survive, coldwater or warmwater fish? Coldwater fish need more dissolved oxygen (6 mg/l and above). Warmwater fish require only 5 mg/l to survive.
3. What type of water generally has the most dissolved oxygen and is usually colder, flowing (lotic) or standing (lentic)? Flowing (rivers and streams).
4. Why might heat be considered a pollutant? Explain. Heat can alter the amount of dissolved oxygen in the water and harm aquatic life.
5. If the number of stoneflies on the Little Lehigh decreases, why should we be concerned? Stoneflies are indicators of water conditions. The greater the number of stoneflies, the better the water condition.

pH and Aquatic Organisms:

6. Categorize each as either acidic, neutral, or alkaline.
   a) pH 0-5: *acidic* b) pH 5-9: *neutral* c) pH 9-14: *alkaline*
7. If the pH were truly neutral, what number would it have? *~ 7.0*
8. **Environmental Impact**: Read the following statement. Find the organism on the chart below. Which factor(s) will have a negative impact on the animal? Identify the factor(s). Will the animal live? Answer Yes or No

   A new manufacturing company is moving into the Valley and are asking for approval to build along the Jordan Creek. They would pump warm, alkalinic water into the Creek. The emissions could raise the average summer temperature of the water by 5^0 (it averages 65^0 now) and raise the pH by 1.0 by in the discharge area (it averages 6.5). Also, they would need to remove a large section of the woods for a parking lot.

Organism	pH Range	Environment	FACTOR	Live: Yes/No
Brook Trout	4.5 to 7.5	Coldwater < 70^0 F	*Temp, pH*	*no*
Smallmouth Bass	5.5 to 7.5	Coolwater 65-75^0F	*Temp, pH*	*no*
Stonefly	5.5 to 7.5	Coldwater < 70^0F	*Temp, pH*	*no*
Wood frog	4.0 to 7.5	Moist/Wooded Area	*Dry area*	*no*

9. Would you give your approval for this project? Why or why not? Explain.
   Varies

PART I (B) SOIL STUDY – ANSWER KEY

SOIL: ORGANISMS AND COMPOST:

1. Soil organisms are nature's great recyclers. As they stir the soil, they help balance soil chemistry. Some act as buffers, neutralizing acidity or alkalinity. Others create the humus that prevents erosion. Fungi are the most versatile of all decomposers, while microscopic bacteria are the smallest and most numerous decomposers. List other ways organisms benefit the soil.
    a. **NITROGEN**: Releases the nitrogen and sulfur from organic matter; Fixes nitrogen (N_2) into usable ammonium (NH_4).
    b. **NUTRIENTS**: Helps maintain the correct balance of nutrients; Convert plant nutrients into readily available forms.
    c. **SOIL**: Improves and stabilizes it; Mixes soil and organic matter.
    d. **TOXINS**: Some may break down toxic compounds in soil.
    e. **VITAMINS**: Produce vitamins and growth hormones that benefit plants; Promote plant growth.
2. Microorganisms that produce compost need a balanced diet of carbon (energy) and nitrogen-rich protein. List some common sources for each.
    a. **Greens** (Nitrogen-Rich and Protein-Rich): Fresh grass, fresh manure, crushed eggshells, sour milk, human hair, coffee grounds.
    b. **Browns** (Carbon-Rich): Leaves, pine needles, sawdust, wood shavings, shredded newspaper, dry grass clippings, dry brown weeds and garden trimmings at season's end.
3. Why would you want to avoid adding these items to your compost pile?
    a. **Diseased plants**: May spread the disease
    b. **Weeds with seeds**: Seeds may sprout
    c. **Fresh sewage**: May carry infectious parasites and diseases
    d. **Toxic chemicals (pesticides) or any form of coal**: Could kill composting organisms; May contain toxic levels of sulfur or iron
    e. **Fats, oils, grease, meat scraps, bones, and cheese**: May attract animals; may prevent decomposition

SOIL: Problem Solving

4. Relate the amount of rainfall to the soil. Which type of soil is better?
    a. **Acidic soils (pH 6.3 to 6.8)**: Rainfall is abundant (not over limestone); Also occurs near sulfates or acidic compounds.
    b. **Alkaline soils (pH 7-8; above 8, not much will grow)**: Drier climates. Also occurs where salt or sodium is high.
5. Is it better to have slightly acidic or slightly alkaline soil? Why? Slightly acid soils are best; they ensure greater availability of essential nutrients.

6. If your soil becomes diseased or contaminated, what should you do? Add organic matter and keep the soil mulches; practice good garden hygiene; test for suspected contaminants; choose resistant or tolerant plants.
7. What are some signs of problem soils? Plants often show a combination of deficiency symptoms (nitrogen, phosphorus, potassium, calcium, magnesium).
8. If you have a problem soil, what is the best solution? Add organic matter to increase buffering; switch to fertilizers that do not increase the problem; choose tolerant plants; improve drainage.
9. If your soil is thin or stony, what should you do? Add organic matter; build raised beds or use containers; choose plants adapted to the local area.
10. List the following in order from smallest to largest: (pebbles, silt, sand, and clay) Clay, silt, sand, and pebbles.
11. How does particle size affect drainage? Particle size affects the way the material packs together, creating air/pore spaces of different sizes. Smaller particles pack closely together; larger particles are loose, have larger spaces and better drainage.
12. **Test soil drainage (Concept)**. You were asked to test the soil drainage in a low-lying area near Coplay Creek. After the litter was removed, you began to dig. You noticed that the soil size was very small and compact. It was difficult to push the shovel into the dirt. Finally, two holes were dug, each about one foot deep and one foot across, spaced several feet apart.
    a. **Measure**: You filled one hole to the top with water (measured and recorded the depth), then repeated with the second hole. After an hour, you measured and recorded the water level in both holes, and repeated after two and three hours. Your results were as follows:

Water Depth	Hole 1	Hole 2
Initial depth	12.0 inches	12.0 inches
After 1 hour	12.0 inches	11.5 inches
After 2 hours	11.5 inches	11.0 inches
After 3 hours	11.5 inches	10.0 inches

    b. **Calculate**: Calculate the average inches lost per hour by adding the six numbers for inches lost per hour (three from each hole) and dividing by six. (Well-drained soil drains about one inch per hour.)
    How fast did this soil drain? (3/6 = 1/2 inch per hour)
    c. **Conclusion**: Based upon the above data, what could you determine about this soil? This soil drains poorly; it is clay-sized and along the flood plain. It would not be safe to build there.

13. If your soil is heavy with clay and drains poorly, what should you do? Identify the cause (topography or soil structure; change the bedding); replace soil; add organic matter, or choose tolerant plants.
14. If your soil is compacted (hard) and drains poorly, what should you do? Loosen soil; add organic matter; replace the soil; grow deep-rooted plants.
15. What problem might you encounter with steep slopes, and how can it be corrected? Water speed increases with slope. The faster the water, the more sediment it can remove. Plant groundcovers or build terraced beds; add organic matter; minimize cultivation; cover exposed areas with mulch.

Recognizing Nutrient Deficiencies: (Common in acidic soils)

3 KEY Nutrients	Symptoms Appear	Symptoms of Deficiency	Fix the Problem
Potassium (K) helps strengthen cell walls	On older, lower leaves, then work up plant	Patchy yellow or dead spots; leaves normal size but tips and edges scorched; slender stems may fall over	Maintain good soil structure; add well-decomposed organic matter, encourage good root growth
Nitrogen (N) builds amino acids	On entire plant	Fades to pale green or yellow green; lower leaves turn yellow then brown but don't drop; new leaves smaller than normal; grows slowly	Abundant well-decomposed organic matter; good aeration and soil; pH 6.3-6.8
Phosphorus (P) needed for photo-synthesis and growth	On entire plant	Dark or bluish-green cast; leaves have reddish purple patches on undersides and tips; lower leaves yellow then dry and drop; fewer fruits and flowers; grows slowly	Add phosphorus; keep soil slightly moist; add organic matter; pH 6.5-7.0

16. An aloe plant is placed outside. The entire plant immediately fades to pale green. In a few weeks the lower leaves turn yellow but do not fall off. What is the problem and how can it be corrected? It is deficient in Nitrogen. Correct the pH; repot, adding decomposed organic matter.
17. An ivy plant is growing slowly, and the stem is thin and weak. The tips and lower leaves become patchy yellow, then dry and drop. What is the problem and how can it be corrected? It is a combination of potassium and phosphorous deficiencies. Add phosphorus and well-decomposed organic matter. Keep the soil moist.
18. Diagnose a plant. Explain a visible deficiency and how you would correct it. Varies

PART I (B) WATERSHED INDICATORS – ANSWER KEY

Environmental Protection Agency Atlas <http://www.epa.gov/iwi/iwi-overview.pdf>

What are Indicators? The conditions of aquatic resources and their vulnerability (conditions or activities that may place stress on the resources). (Check the Web site for more information.)

CONDITION INDICATORS:

1. **Assessed rivers meeting all designated uses established by state or tribal water quality standards** – percentage of waters that meet all uses established for water under the Clean Water Act Section 305(b).
2. **Fish and wildlife consumption advisories** – recommendations to restrict consumption due to the presence of contaminants.
3. **Indicators of source water quality for drinking water systems** – three data sets provide a partial picture of water condition: 1) state's assessment of surface waters for designated use; 2) water treatment and violation data; 3) significant levels of regulated chemicals.
4. **Contaminated sediments** – level of potential risk
5. **Ambient water quality data** – levels of four toxic pollutants (copper, hexavalent chromium, nickel, and zinc.
6. **Ambient water quality data** – levels of four conventional pollutants (ammonia, dissolved oxygen, phosphorous, and pH)
7. **Wetland loss index** – percentage of loss over an historic period (1870-198) and more recently.

VULNERABILITY INDICATORS:

8. **Aquatic/wetland species at risk** – high occurrences of risk
9. **Pollutant loads discharged above permitted discharge limits (toxic pollutants)** – a yearly percentage above or below the allotted amount
10. **Pollutant loads discharged above permitted discharge limits (conventional pollutants)** – a yearly percentage above or below the allotted amount
11. **Urban runoff potential** – estimated impact on impervious surfaces
12. **Index of agricultural runoff potential** – 1) nitrogen runoff potential; 2) sediment delivery to rivers and streams; 3) pesticide runoff potential
13. **Population change** – urbanization and stress-producing activities
14. **Hydrologic modification (dams)** – reservoir impoundment volume
15. **Estuarine pollution susceptibility index** – potential pollution based upon its physical characteristics and its propensity to concentrate pollutants.

PART I (C) – MODEL WATERSHEDS

Grade Level: 9th (may be adapted for higher or lower levels)
Time Frame: 2 blocks (or 1 week regular class time)
Resources: Teacher handouts, resource books; text books
Technical Components: Videos; internet sites (see lessons and Resources)

STANDARDS (OBJECTIVES): * The student will be able to…

4.1.A.10. THE STUDENT WILL BE ABLE TO DESCRIBE CHANGES THAT OCCUR FROM A STREAM'S ORIGIN TO ITS FINAL OUTFLOW.

C. Identify Pennsylvania's major watersheds and their related river systems.
D. Describe changes by tracing a specific river's origin back to its headwaters including its major tributaries.

4.1.B.10. EXPLAIN THE RELATIONSHIP AMONG LANDFORMS, VEGETATION AND THE AMOUNT AND SPEED OF WATER.

H. Analyze a stream's physical characteristics
I. Describe how topography influences streams.
J. Explain the influence of mountains on precipitation.
K. Explain how vegetation affects storm water runoff.
L. Delineate the boundaries of a watershed.
M. Describe factors that affect the quality of groundwater.
N. Explain how the speed of water and vegetation cover relates to erosion.

4.1.C.10. DESCRIBE THE PHYSICAL CHARACTERISTICS OF A STREAM AND DETERMINE THE TYPES OF ORGANISMS FOUND IN AQUATIC ENVIRONMENTS.

F. Describe and explain the physical factors that affect a stream and the organisms living there
G. Identify terrestrial and aquatic organisms that live in a watershed
H. Categorize aquatic organisms found in a watershed continuum from headwater to mouth (e.g. shredder, predator, decomposer).
I. Identify the types of organisms that would live in a stream based on the stream's physical characteristics.
J. Explain the habitat needs of specific aquatic organisms.

4.1.D.10. DESCRIBE THE MULTIPLE FUNCTIONS OF WETLANDS.

D. Describe wetlands in terms of their effects (e.g., habitat, flood, buffer zones, prevention areas, nurseries, food production areas).
E. Explain how a wetland influences water quality, wildlife and water retention.
F. Analyze wetlands through their indicators (e.g., soils, plants, hydrology).

4.1.E.10. IDENTIFY AND DESCRIBE NATURAL AND HUMAN EVENTS ON WATERSHEDS AND WETLANDS.

C. Describe how natural events affect a watershed (e.g., drought, floods)
D. Identify the effects of humans and human events on watersheds

MATERIALS:
Handouts Part I (C): Model Watersheds (Instructions and Answer Sheet)
Building Supplies: Simple model-building materials (see handout); Recycle materials from home.

PART I(C) Procedure:

1. **Activity**: Students will build a watershed model. Students will add at least three organisms to their model (these can be simple, hand-drawn sketches). Organisms must be placed in their correct location.
2. **LAB**: Students will test many aspects of a watershed with their model. Students will answer questions relating to watersheds. *Test the amount and speed of water flow at different angles. Add grass or other substances to slow-down the water flow. Determine sedimentation rates. Add a sponge to see how wetlands absorb water. Where does the pollution go?
3. **Going Further (Critical Skills)**: Students will design their own experiment.

ASSESSMENT:
Performance-Based: Students will build model, then answer questions. They will also design their own experiment.

PART I (C) MODEL WATERSHEDS – ANSWER KEY

Completion: Answer the following questions in complete paragraphs.

1. Describe how wetlands function to reduce flooding and retain sediments. Wetlands absorb excess water during wet periods and release it during dry periods. Less runoff means less erosion.

2. Explain how land covering affects the rate of runoff. Plant roots absorb excess water. They also help slow the water which is an important factor in how much work the water is able to do.

3. How does sediment get introduced into lakes and ponds? Sediments are carried from a higher elevation to a lower elevation by water. There is a greater sedimentation rate whenever ground cover is reduced, especially where the soil is exposed such as in an excavation site.

4. What happens when water is added to a source of pollution? Water will diffuse the pollution, spreading it to a wider area.

5. What would happen to water, sediments, homes, and wildlife if wetlands were destroyed? Flooding would become more frequent, bringing more sediments to low-lying areas. Homes would be destroyed. Wetland wildlife would lose their habitats.

6. How might all of this affect you? Flooding brings material into the watershed. It can pollute the water. It causes homes, buildings, and roads to be flooded and/or damaged. It costs money to repair the damage. People may be inured.

7. How can we prevent these undesirable affects? We need to maintain the watersheds and restore them to their natural state. While it is fine to have a nice path to walk on, we also need the wild plants and flowers that help control flooding and maintain a balanced ecosystem.

8. **Going Further**: Design your own experiment. Check with the teacher for approval. What is the question you hope to answer? Varies

PART II – FIELD TRIP

WATERSHED WHEELS – FLOWING AND STANDING

By Therese Ehrenreich
Sketches by Stacy Ehrenreich

PART II - FIELD TRIP
LEHIGH VALLEY WATERSHED

Grade Level: 9th (may be adapted for higher or lower levels)
Time Frame: 2 blocks (or up to 1 week) Preparation; a Few hours (including Transporation time on the day of the trip)
Resources: Teacher hand-outs; books, *The Lehigh Valley Natural and Environmental History*, internet, guest speaker(s)
Technical Components: Videos (Rivers and Canals) , Teacher-Generated PowerPoint, Internet Sites, and any other presentations
Ex: Lehigh River Watershed Photojournal and Fast Facts: Lehigh River & Canal at Jim Thorpe, PA
http://www.enter.net/~lvcc/river.html

STANDARDS (OBJECTIVES): * The student will be able to…

4.1.B.10. EXPLAIN THE RELATIONSHIP AMONG LANDFORMS, VEGETATION AND THE AMOUNT AND SPEED OF WATER.

A. Analyze a stream's physical characteristics.
B. Describe how topography influences streams.
C. Explain the influence of mountains on precipitation.
D. Explain how vegetation affects storm water runoff.
E. Delineate the boundaries of a watershed.
F. Describe factors that affect the quality of groundwater.
G. Explain how the speed of water and vegetation cover relates to erosion.

4.1.C.10. DESCRIBE THE PHYSICAL CHARACTERISTICS OF A STREAM AND DETERMINE THE TYPES OF ORGANISMS FOUND IN AQUATIC ENVIRONMENTS.

A. Describe and explain the physical factors that affect a stream and the organisms living there.
B. Identify terrestrial and aquatic organisms that live in a watershed.
C. Categorize aquatic organisms found in a watershed continuum from headwater to mouth (e.g., shredder, predator, decomposer).
D. Identify the types of organisms that would live in a stream based on the stream's physical characteristics.
E. Explain the habitat needs of specific aquatic organisms.

MATERIALS:

Handouts (PART II): Flowing Water (Lotic) Wheel; Standing Water (Lentic) Wheel; also Maps and other reference material from Part I

Reference books: For identification purposes

Riparian area: Land and vegetation adjacent or near the banks of water

PROCEDURE:

1. **Operate/Combine**: Students will journal or discuss what they expect to see on the trip (water speed, depth, quality, and surrounding life – plants and animals).
2. **FIELD TRIP**: Students will describe how the speed of the water and the vegetation cover relates to erosion. They will also compare a map version of a watershed to the "real" world. Students will describe and explain the physical factors that affect a stream and the organisms living there. Students will identify organisms in a watershed and will categorize aquatic organisms along a continuum.

ASSESSMENTS:

Oral: Evaluate in the classroom and in the field. Students will assemble their water wheels in the classroom and practice using them before going on the field trip.

Written: Students will make journal entries describing what they expect to find during the field trip. Later, they will compare their expectations to the real world. Quiz students on major concepts (have them practice any experiments prior in the classroom before doing them in the field.

Performance-Based: First, check the field book/field notes to verify learning; then spot-check students in the field (ask each group questions at random).

PART III – WILD THINGS

JOURNEY THROUGH TIME
BROCHURE

BY THERESE EHRENREICH

PART III – WILD THINGS BROCHURE

Grade Level: 9th (may be adapted for higher or lower levels)
Time Frame: Brochure due ~ 2 weeks after field trip (or Part II)
Resources: Handouts, textbook, reference books, Field book and/or notes
Technical Components: Publisher; Sample brochure; internet research

STANDARDS (OBJECTIVES): * The student will be able to…

4.1.C.10. DESCRIBE THE PHYSICAL CHARACTERISTICS OF A STREAM AND DETERMINE THE TYPES OF ORGANISMS FOUND IN AQUATIC ENVIRONMENTS.

A. Identify terrestrial and aquatic organisms that live in a watershed.
B. Identify the types of organisms that would live in a stream…
C. Explain the habitat needs of specific aquatic organisms.

4.1.D.10. DESCRIBE THE MULTIPLE FUNCTIONS OF WETLANDS.

A. Describe wetlands in terms of their effects (e.g., habitat, flood, buffer zones, prevention areas, nurseries, food production areas).
B. Explain how a wetland influences water quality, wildlife and water retention.

4.1.E.10. IDENTIFY AND DESCRIBE NATURAL AND HUMAN EVENTS ON WATERSHEDS AND WETLANDS.

A. Describe how natural events affect a watershed (e.g. drought, floods).
B. Identify the effects of humans and human events on watersheds.

MATERIALS: Handouts (Part III): WILD THINGS – JOURNEY THROUGH TIME © Worksheets and rubric; Sample Brochure.

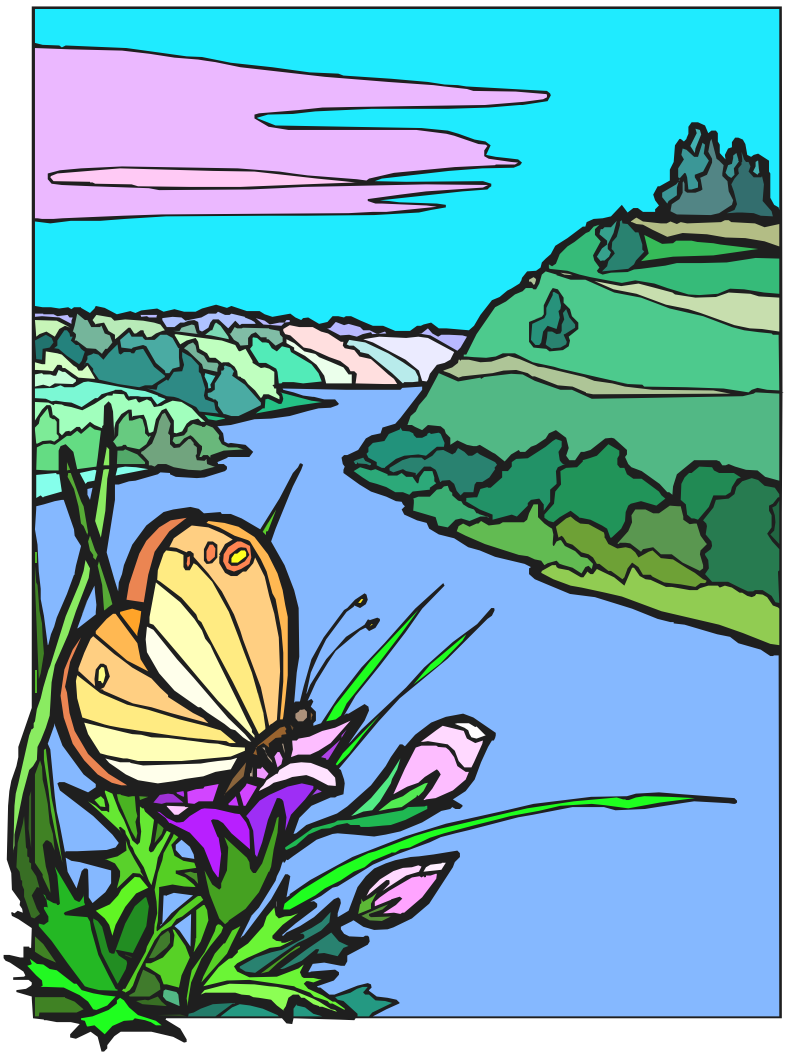
PROCEDURE:

1. **Follow-Up/Combine:** After visiting the Lehigh River and Lockhouse, listening to a guest speaker, and/or doing research, students will describe how natural events affect a watershed (e.g. drought, floods). They will also identify the effects of humans and human events on watersheds.
2. The brochure will also include the creation of an imaginary stream and/or wetland area, as they *Journey Through Time* © along the Lehigh River. They will identify the types of organisms that would live along the stream based upon the geologic and environmental conditions at that time. The brochure will also include the habitat needs of specific aquatic organisms at that time.

ASSESSMENT:

Performance-Based: Student-brochures will be evaluated using a rubric.

Part IV – Resources



Earth and Environmental Science

Internet and Reference Books

EARTH AND ENVIRONMENTAL RESOURCES

Visit my Web Site for additional Earth Science Lesson Plans and Resources (for best results, use Internet Explorer)

http://ehrenreicht.hypermart.net

Lehigh River Watershed (Subbasin Number 2)

Interactive Map:
http://www.leo.lehigh.edu/envirosci/watershed/gis/index.html
Photojournal:
http://www.leo.lehigh.edu/envirosci/watershed/pjournal/section3/
What's Happening in The Central Delaware (Subbasin Number 2):
http://www.dep.state.pa.us/dep/deputate/watermgt/WC/Subjects/WSNoteBks/ba02.htm
Wildland's Conservancy: Lehigh River Sojurn
http://www.wildlandspa.org/calendar/sojourn.html
Fast Facts about the Lehigh River
http://www.leo.lehigh.edu/envirosci/watershed/fastfacts.html
Lehigh River & Canal at Jim Thorpe, PA
http://www.enter.net/~lvcc/river.html

Other Environmental Sources

On-line Environmental Sources:
http://www.dep.state.pa.us/dep/deputate/enved/other_online.htm
U.S.G.S. Water Resources of PA
http://pa.water.usgs.gov/
U.S.G.S. Watershed Map
http://pa.water.usgs.gov/pa_digit_map.html
Environmental Protection Agency Watershed Indicators (see Atlas)
<http://www.epa.gov/iwi/iwi-overview.pdf>

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4. Conant, Roger and Collins, Joseph T., "A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed." Houghton Mifflin Company. New York, NY. 1998. 1998ISBN: 0-395-90452-8 Visit their bookstore at <http://www.hmco.com/trade>
5. Coombes, Allen J., "Trees." Dorling Kindersley, Inc., New York. 1992. ISBN 1-56458-072-5
6. Fisher, Dr. Bill, "Hatch Matcher." Dakota Press. 1994. Phone (530) 644-7226 Streamside Pocket Guide is available at the Little Lehigh Fly Fishing Shop.
7. Halma, Robert and Oplinger, Carl S., "The Lehigh Valley: Natural and Environmental History." Penn State Press, University Park, PA. 2001. ISBN: 0-271-02094-6
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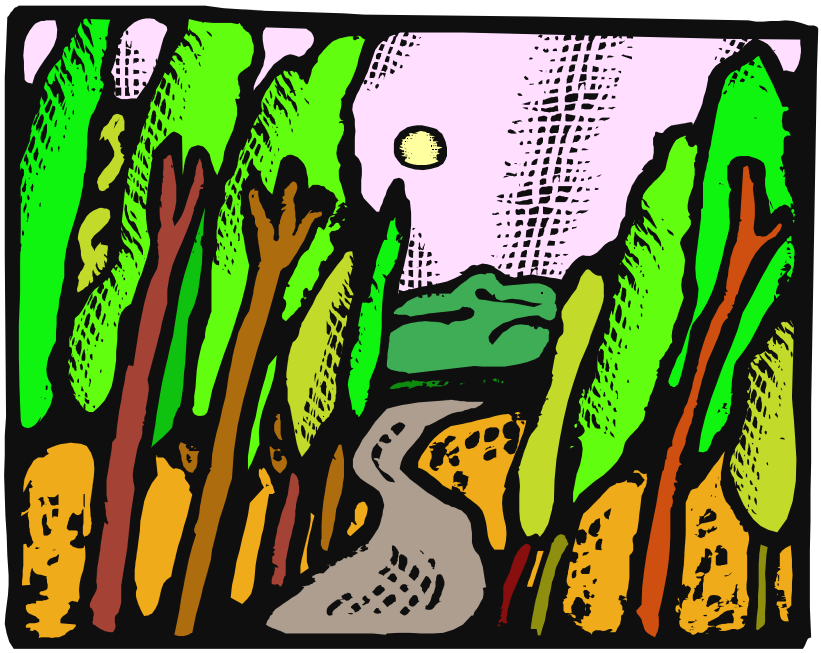
9. Mathews, Schuyler F., "Field Book of American Wild Flowers." Sterling Publishing Company. 2001. ISBN: 0-8069-9043-0.
10. Page, Lawrence M. and Burr, Brooks M., "A Field Guide to Freshwater Fishes." Houghton Mifflin Company, New York, NY. 1991. ISBN: 0-395-91091-9. Visit their bookstore at <http://www.hmco.com/trade>
11. Pennsylvania Fish and Boat Commission. "Pond and Stream Study Guide." FREE. Also Check for other free publications. < http://sites.state.pa.us/PA_Exec/Fish_Boat/pfbchom2.html>
12. Stell, Elizabeth P., "Secrets to Great Soil." Storey Communications, Inc., Canada. ISBN 1-58017-009-9 (hardcover); ISBN 1-58017-008-0 (paperback).Also, check the bookstore at Rodale Inc. of Emmaus.
13. Tekiela, Stan, "Birds of Pennsylvania: Field Guide." Adventure Publications, Inc., Cambridge, MN. 2000. ISBN: 1-885061-76-5.
14. "WOW – Wonders of Water." Environmental Concern, Inc. St. Michaels, MD.; The Watercourse, Bozeman, MT. 2000. ISBN: 1-888631-00-7

Name(s): _____ Block/Period: _____ Date: _____

Part V – Watersheds and Wetlands Handouts



By Therese Ehrenreich

Sketches by Stacy Ehrenreich

Name(s): _____ Block/Period: _____ Date: _____

MAPPING - KEY TERMS

1. **Mapping**:
   - A. Contour interval: _____
   - B. Elevation: _____
   - C. Landform/Landform region: _____
   - D. Mountains: _____
   - E. Plain: _____
   - F. Plateau: _____
   - G. Profile: _____
   - H. Relief: _____
   - I. Topography: _____
2. **Watershed (Drainage basin)**:
   - A. Divide: _____
   - B. Drainage patterns: _____
   - C. Floodplain: _____
   - D. Tributary: _____
   - E. Wetland: _____
3. **Erosion**:
   - A. Base level: _____
   - B. Gully: _____
   - C. Meander: _____
   - D. Oxbow lake: _____
   - E. Rill: _____
   - F. Runoff: _____
   - G. Slope: _____
   - H. Valley: _____
   - I. Waterfall: _____
4. **Stream Capacity and Deposition**:
   - A. Alluvial fan: _____
   - B. Bed load: _____
   - C. Capacity: _____
   - D. Delta: _____
   - E. Discharge: _____
   - F. Dissolved load: _____
   - G. Suspended load: _____

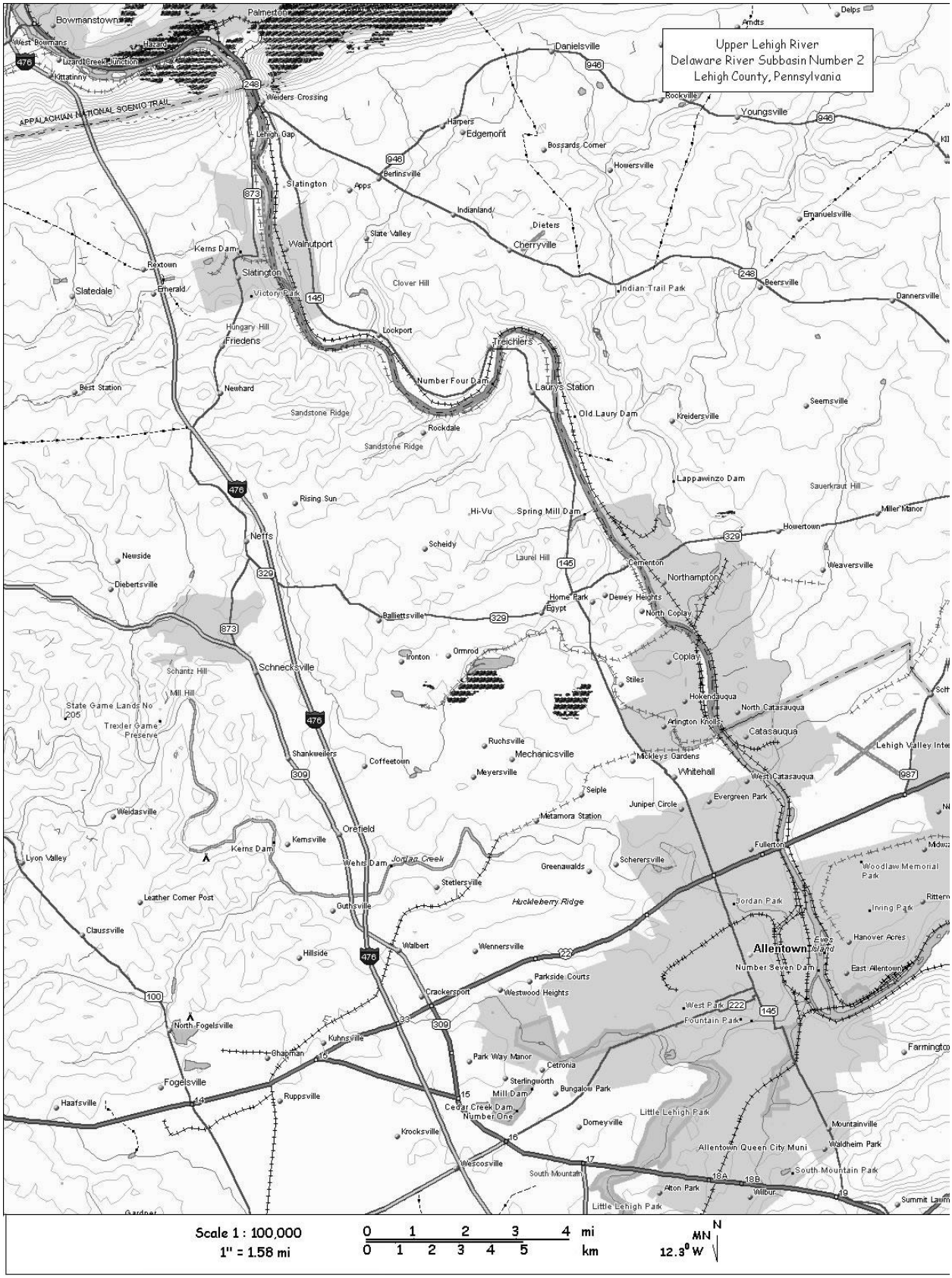
Name(s): _____ Block/Period: _____ Date: _____

MAPPING - ACTIVITY

Materials: map, ruler, blue pencil, green pencil, red pencil

1. Name the map you are using. What type of map is it? _____
2. Find the Lehigh River on this map and color it blue. If you canoed along this part of the Lehigh River, how far would you paddle? _____
3. What is the highest elevation on this map? _____
4. Locate as many divides (mountains and hill tops) as possible. Use a green pencil to trace a path along these high points in the watershed. How many watersheds are on your map? _____
5. Locate all the tributaries that feed into the Lehigh River and color them blue. There may be tributaries that are not shown on the map. Where do you think they would be located? Why? _____
6. In what type of environment will you find headwaters? _____
7. Name three bodies of water on the map. _____
8. Find the largest wetland on the map. Circle that area with a red pencil. Name the waterway(s) that border this wetland. _____
9. There may be wetlands that are not shown on the map. Where do you think they would be located? Why? _____
10. What types of natural resources that can be found by using a map? (Hint: Who or what were the towns named after?)_____
11. Think carefully. How is the water being used? Use the map to help you list as many uses as possible. _____
12. How might the water have been used differently in the past? _____
13. List the different types of pollutants that can affect the water. _____
14. What are some possible sources of pollution? _____
15. What type of testing is being done on your water? _____

Name(s): _____ Block/Period: _____ Date: _____



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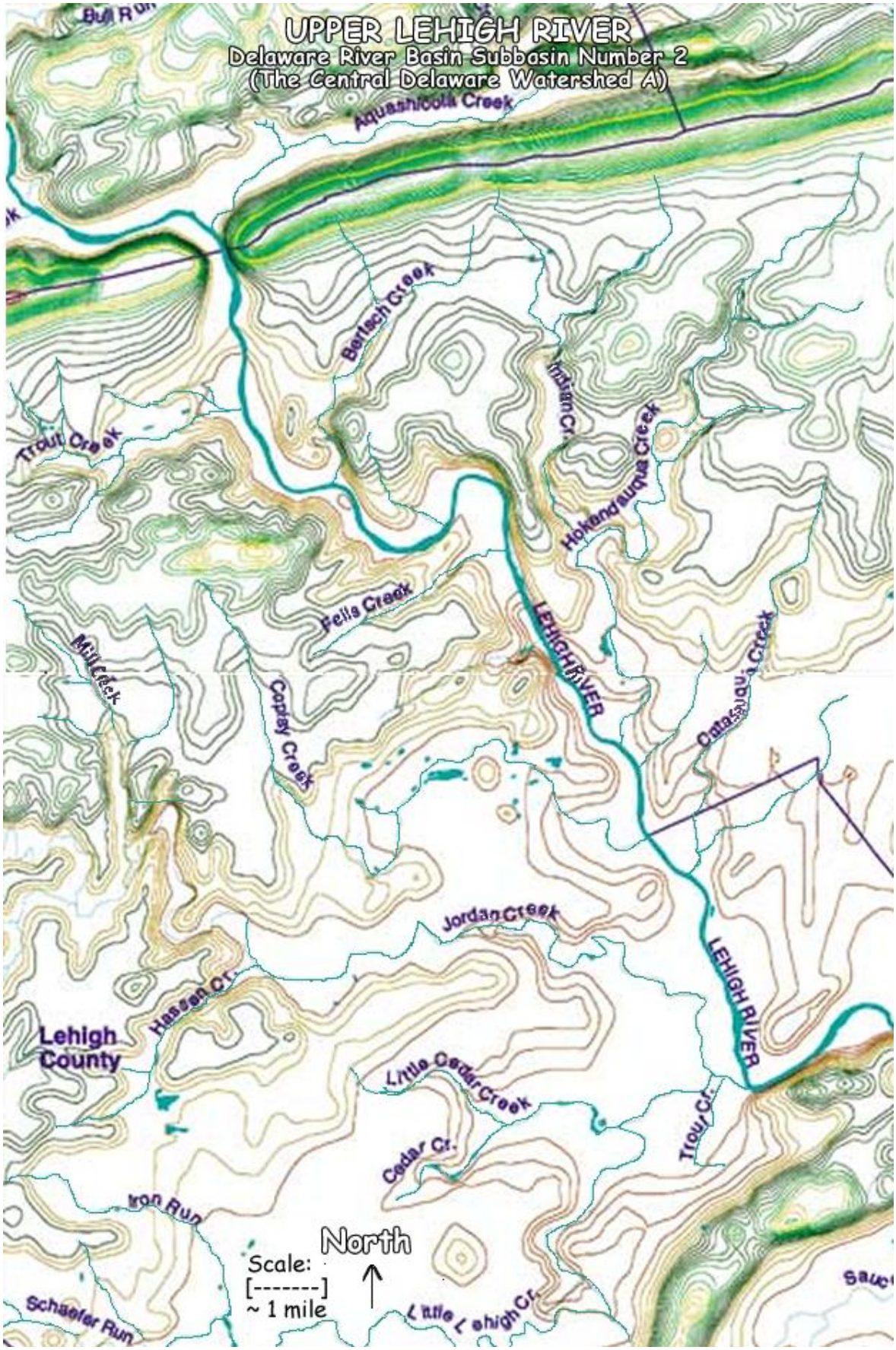
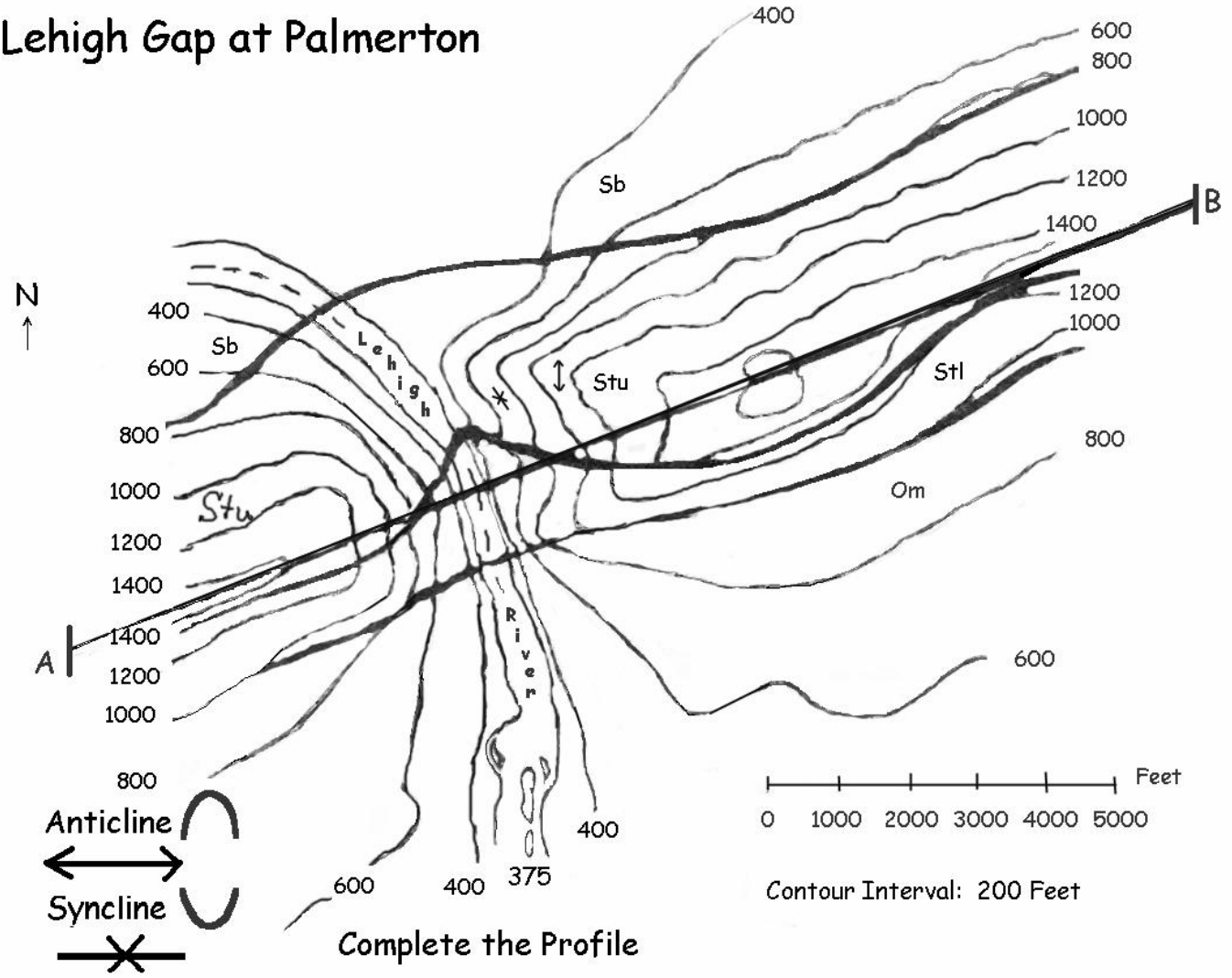
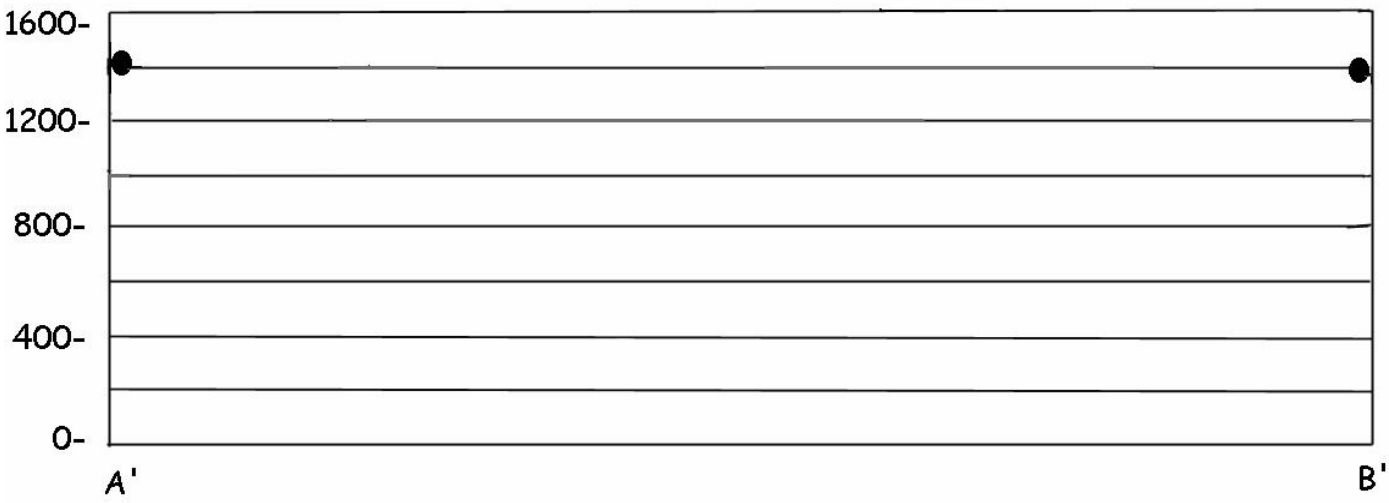


Name(s): _____ Block/Period: _____ Date: _____

Lehigh Gap at Palmerton



Complete the Profile



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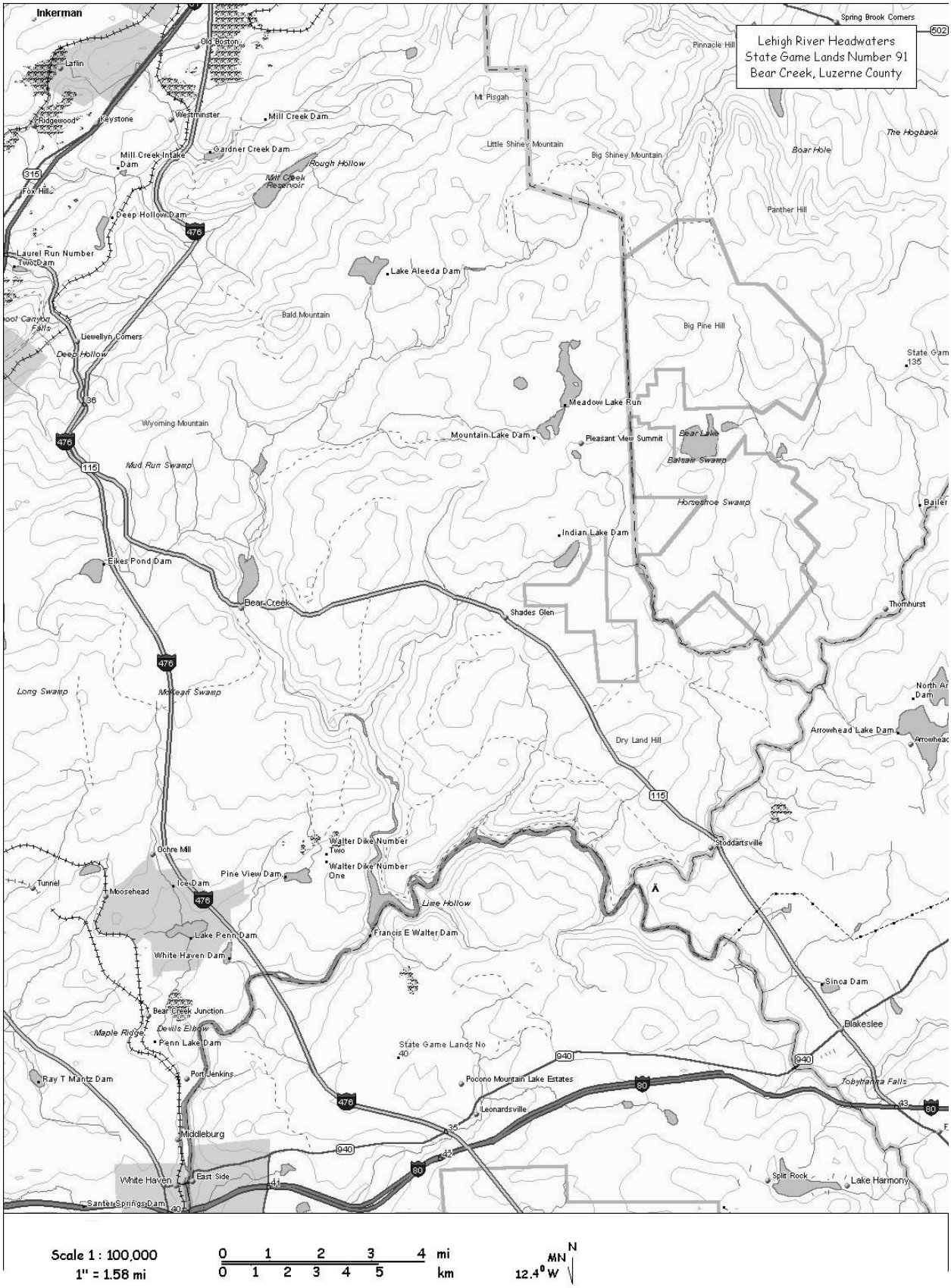

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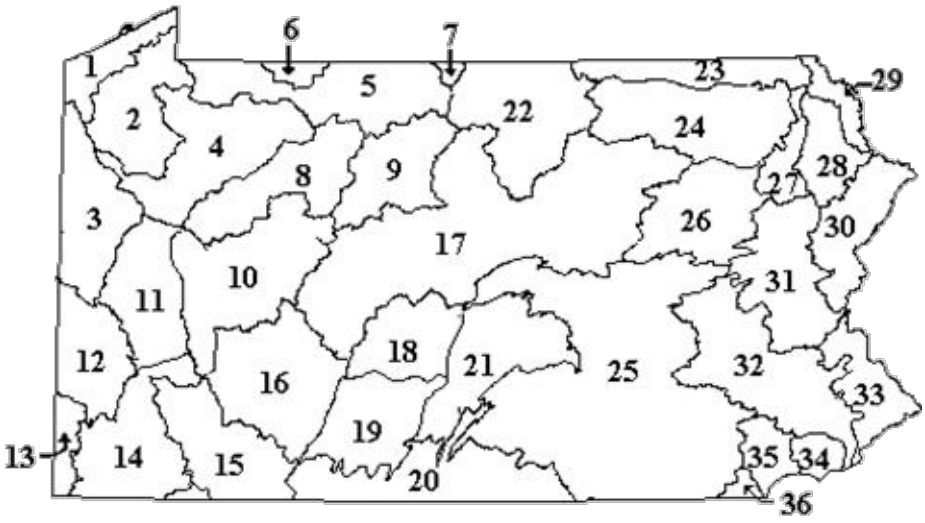


PENNSYLVANIA WATERSHEDS

#	Watershed Name	#	Watershed Name
	Allegheny River (Middle Redbank)		Allegheny River (Middle)
	Allegheny River (Upper)		Conewango
	Brandywine, Red Clay, White Clay Cr.		Clarion River
	Chemung		Conemaugh/Kiskiminetas Rivers
	Connoquenessins		Delaware River - Lower
	French Creek		Delaware River - Upper
	Genessee River (Headwaters)		Elk Creek/Northeast River (Hdwtr)
	Lehigh River		Lake Erie
	Juniata River-Lower		Lower Susquehanna
	Lakawaxen River		Middle Susquehanna
	Middle Delaware		Neshaming and Pennypack Creeks
	Monongahela River		Ohio - Upper
	Ohio River (Wheeling Creek)		Potomac River
	Raystown		Schuylkill River
	Sinnemahoning River		Susquehanna - Upper (Lackawanna)
	Shenango River		Susquehanna River - Middle
	Susquehanna River - Upper		Susquehanna - Upper (Tunkhannock)
	Upper Juniata		Youghiogheny River

Name(s): _____ Block/Period: _____ Date: _____

WETLAND ENVIRONMENTS

Wetlands form where _____
_____. They can range in size from _____
_____. Some wetlands are covered with water all year while others _____

Three common types of wetlands:

1. **Swamps**: _____
_____
2. **Marshes**: _____
_____
3. **Bogs**: _____
_____

BENEFITS OF WETLANDS

1. What features of wetlands make them good habitats for living things? ___
_____
_____
_____
2. Why are wetlands considered to be one of nature's natural filters? _____
_____
_____
_____
3. How do wetlands help control flooding? _____
_____
_____
_____
4. How do wetlands protect stream banks and shore lines from erosion? ___
_____
_____
_____
5. What do wetlands have to offer humans? _____
_____
_____
_____
_____

Name(s): _____ Block/Period: _____ Date: _____

AQUATIC COMMUNITIES

FLOWING WATER (LOTIC) COMMUNITIES: (ex: Lehigh River)

1. How would you best describe the water in this environment? What characteristic of this water determines the type of life found here? ___
   _____
2. Does this water tend to be relatively warmer or cooler? _____
3. Does this water tend to have a high or low oxygen content? Why? _____
   _____
4. What special adaptations would an organism need to make in order to live here? Why? _____
   _____
5. Most streams have two different but interrelated habitats: riffles and pools. Compare and contrast these two communities.
   a. **Riffle**: _____
      _____
   b. **Pool**: _____
      _____
6. What are the two major types of streams found in Pennsylvania, limestone and flowstone? Of these, which is the best for trout? Why? _____
   _____
7. How are the banks, stream edges, and adjacent land areas important to the stream? _____
   _____
8. Give examples of three energy sources and how they are used:
   a. **Coarse particulate organic matter**: _____
      _____
   b. **Fine particulate organic matter:** _____
      _____
   c. **Dissolved organic matter**: _____
      _____
9. How have human activities affected the watershed? What could be done to improve the situation? _____
   _____
   _____
   _____
   _____
10. How long is the Lehigh River? What is being done to monitor the Lehigh River? _____
    _____

Name(s): _____ Block/Period: _____ Date: _____

STANDING WATER (LENTIC) COMMUNITIES: (ex: Graver Arboretum)

11. How would you best describe the water in this environment? What characteristic of this water determines the type of life found here? ___
    _____
12. Does this water tend to be relatively warmer or cooler? _____
    _____
13. How does the thermocline affect aquatic life? _____
    _____
14. Does this water tend to have a high or low oxygen content? Why? _____
    _____
15. How has plant life adapted to diverse conditions? Give supporting details.
    a. **Emergent (Near the water's edges)**: Plants start their growth while covered with water but soon extend into the air.
        i. **Example:** _____
        ii. **Leaves**: _____
        iii. **Roots:** _____
        iv. **Reproduction:** _____
    b. **Floating Leaf (1-3 feet deep)**: Plants are anchored on the muddy bottom while their leaves float at or on the surface.
        i. **Example:** _____
        ii. **Leaves:** _____
        iii. **Stalks:** _____
        iv. **Reproduction:** _____
    c. **Submergent (Open water)**: Plants are below the surface of the water, ranging from the shallowest zone to several meters deep (depth is limited by sunlight).
        i. **Example:** _____
        ii. **Leaves:** _____
        iii. **Roots:** _____
        iv. **Reproduction:** _____
16. Steams and leaves are home to other aquatic life. Give examples.
    a. **Phytoplankton**: _____
    b. **Zooplankton**: _____
    c. **Nekton**: _____
    d. **Benthos**: _____
17. What is one of the smallest flowering plants in the world? _____
18. What type of fish are you mostly likely to find in a warm water pond? ___
19. What type of amphibians are you most likely to find? _____
20. What type of reptiles are you most likely to find? _____

Name(s): _____ Block/Period: _____ Date: _____

WATER STUDY

Temperature and Dissolved Oxygen:

1. As water temperature increases, what happens to the amount of dissolved oxygen in the water? How might this affect aquatic life? _____
2. Which type of fish requires the most oxygen to survive, coldwater or warm water fish? _____
3. What type of water generally has the most dissolved oxygen and is usually colder, flowing (lotic) or standing (lentic)? _____
4. Why might heat be considered a pollutant? Explain. _____
5. If the number of stoneflies on the Little Lehigh decreases, why should we be concerned? _____

pH and Aquatic Organisms:

6. Categorize each as either acidic, neutral, or alkaline.
   a) pH 0-5: _____ b) pH 5-9: _____ c) pH 9-14: _____
7. If the pH were truly neutral, what number would it have? _____
8. **Environmental Impact**: Read the following statement. Then find the organism on the chart below. Tell which factor would most likely have a negative impact on the environment. Reread the statement then answer, yes or no (will it live?).

   You are on the zoning committee. A new manufacturing company is moving into the Valley and are asking for approval to build along the Jordan Creek. They would pump warm, alkalinic water into the Creek. The emissions could raise the average summer temperature of the water by 5^0 (it averages 65^0 now) and raise the pH by 1.0 by in the discharge area (it averages 6.5). Also, they would need to remove a large section of the woods for a parking lot.

Organism	pH Range	Environment	FACTOR	Live: Yes/No
Brook Trout	4.5 to 7.5	Cold water < 70^0 F		
Smallmouth Bass	5.5 to 7.5	Cool water 65-75^0F		
Stonefly	5.5 to 7.5	Cold water < 70^0F		
Wood frog	4.0 to 7.5	Moist/Wooded Area		

9. Would you give your approval for the above project? Why or why not? Explain _____

Name(s): _____ Block/Period: _____ Date: _____

SOIL STUDY

SOIL: Organisms and Compost

1. Soil organisms are nature's great recyclers. As they stir the soil, they help balance soil chemistry. Some act as buffers, neutralizing acidity or alkalinity. Others create the humus that prevents erosion. Fungi are the most versatile of all decomposers, while microscopic bacteria are the smallest and most numerous decomposers. List other ways organisms benefit the soil.
    a. **NITROGEN**: _____
    b. **NUTRIENTS**: _____
    c. **SOIL**: _____
    d. **TOXINS**: _____
    e. **VITAMINS**: _____
2. Microorganisms that produce compost need a balanced diet of carbon (energy) and nitrogen-rich protein. List some common sources for each.
    a. **Greens** (Nitrogen-Rich and Protein-Rich): _____
    _____
    b. **Browns** (Carbon-Rich): _____
    _____
3. Why would you want to avoid adding these to your compost pile?
    a. **Diseased plants**: _____
    b. **Weeds with seeds**: _____
    c. **Fresh sewage**: _____
    d. **Toxic chemicals (pesticides) or any form of coal**: _____
    _____
    e. **Fats, oils, grease, meat scraps, bones, and cheese**: _____
    _____

SOIL: Problem Solving

4. Relate the amount of rainfall to soil type. Which type of soil is better?
    a. **Acidic soils (pH 6.3 to 6.8)**: _____
    _____
    b. **Alkaline soils (pH 7-8; above 8, not much will grow)**: _____
    _____
5. Is it better to have slightly acidic or slightly alkaline soil? Why? _____
_____
6. If your soil becomes diseased or contaminated, what should you do? _____
_____
7. What are some signs of problem soils? _____
_____

Name(s): _____ Block/Period: _____ Date: _____

8. If you have a problem soil, generally speaking, what is the best solution? _____

9. If your soil is thin or stony, what should you do?_____

10. List the following in order from smallest to largest: (pebbles, silt, sand, and clay) _____
11. How does particle size affect drainage? _____

12. **Test soil drainage (Concept)**. You were asked to test soil drainage in a low-lying area near Coplay Creek. After the litter was removed, you began to dig. You noticed that the soil size was very small and compact. It was difficult to push the shovel into the dirt. Finally, two holes were dug, each about one foot deep and one foot across, spaced several feet apart.
    a. **Measure**: You filled one hole to the top with water (measured and recorded the depth), then repeated with the second hole. After an hour, you measured and recorded the water level in both holes, and repeated after two and three hours. Your results were as follows:

Water Depth	Hole 1	Hole 2
Initial depth	12.0 inches	12.0 inches
After 1 hour	12.0 inches	11.5 inches
After 2 hours	11.5 inches	11.0 inches
After 3 hours	11.5 inches	10.0 inches

    b. **Calculate**: Calculate the average inches lost per hour by adding the six numbers for inches lost per hour (three from each hole) and dividing by six. (Well-drained soil drains about one inch per hour.) How fast did this soil drain? _____
    c. **Conclusion**: Based upon the above data, what could you determine about this soil? _____

13. If your soil is heavy with clay and drains poorly, what should you do? _____

14. If your soil is compacted (hard) and drains poorly, what should you do? _____

15. What problem might you encounter with steep slopes, and how can it be corrected? _____

Name(s): _____ Block/Period: _____ Date: _____

Recognizing Nutrient Deficiencies:

3 KEY Nutrients	Symptoms Appear	Symptoms of Deficiency	Fix the Problem
Potassium (K) helps strengthen cell walls	On older, lower leaves, then work up plant	Patchy yellow or dead spots; leaves normal size but tips and edges scorched; slender stems may fall over	Maintain good soil structure; add well-decomposed organic matter, encourage good root growth
Nitrogen (N) builds amino acids	On entire plant	Fades to pale green or yellow green; lower leaves turn yellow then brown but don't drop; new leaves smaller than normal; grows slowly	Abundant well-decomposed organic matter; good aeration and soil; pH 6.3-6.8
Phosphorus (P) needed for photo-synthesis and growth	On entire plant	Dark or bluish-green cast; leaves have reddish purple patches on undersides and tips; lower leaves yellow then dry and drop; fewer fruits and flowers; grows slowly	Add phosphorus; keep soil slightly moist; add organic matter; pH 6.5-7.0

16. An aloe plant is placed outside. The entire plant immediately fades to pale green. In a few weeks the lower leaves turn yellow but do not fall off. What is the problem and how can it be corrected? _____

17. An ivy plant is growing slowly, and the stem is thin and weak. The tips and lower leaves become patchy yellow, then dry and drop. What is the problem and how can it be corrected? _____

18. Diagnose a plant. Explain a visible deficiency and how you would correct it.

Name(s): _____ Block/Period: _____ Date: _____

WATERSHED INDICATORS

Environmental Protection Agency <http://www.epa.gov/iwi/iwi-overview.pdf>

What are Indicators? _____

_____

CONDITION INDICATORS: Define

1. **Assessed rivers meeting all designated uses established by state or tribal water quality standards** – _____

   _____
2. **Fish and wildlife consumption advisories** – _____

   _____
3. **Indicators of source water quality for drinking water systems** – ___

   _____
4. **Contaminated sediments** – _____
5. **Ambient water quality data** – _____

   _____
6. **Ambient water quality data** – _____

   _____
7. **Wetland loss index** – _____

VULNERABILITY INDICATORS: Define

8. **Aquatic/wetland species at risk** – _____

   _____
9. **Pollutant loads discharged above permitted limits (toxic pollutants)** –

   _____

   _____
10. **Pollutant loads discharged above permitted limits (conventional pollutants)** – _____

    _____
11. **Urban runoff potential** – _____

    _____
12. **Population change** - _____

    _____
13. **Index of agricultural runoff potential** – _____

    _____
14. **Hydrologic modification (dams)** – _____

    _____
15. **Estuarine pollution susceptibility index** – _____

    _____

Name(s): _____ Block/Period: _____ Date: _____

MODEL WATERSHEDS

PURPOSE: To build a working model of a watershed.

OBJECTIVE:

- ☆ Students will create a three-dimensional model of their area.
- ☆ Students will use their model to determine features and activities that affect water quality.
- ☆ Students will determine how wetlands function.
- ☆ Students will define point and non-point pollution.

SUGGESTED MATERIALS:

large baking pans	dark-powdered fruit drink mix	water, oil
small cups or blocks	cups and spray bottles	topo. maps
heavy aluminum foil	clear contact paper; green plastic	grease pencils
modeling clay	loose soil, fine sand; sponges, foam	food coloring
construction paper	grass, sticks, natural materials	cotton swabs
paint, newspaper	pine cones and needles, flower heads	animal sketches

PROCEDURE: Divide into groups and give each group the following directions.

1. **First**: Determine which part of the map you will be modeling. Use the grease pencil (or erasable marker) to mark the highlands and lowlands inside the pan. Now you are ready to begin your design.
2. **Mountains**: Tape or secure small cups or blocks in one end of the pan; prop this end up on a book or block of wood. This will become a high, mountainous area. Stuff with crumpled newspaper and cover with tin foil, green acetate, and/or modeling clay. Notice how slope and material affects runoff.
3. **River and Streams**: Tear off a piece of aluminum foil the size of the pan. Crinkle the foil to create dips and gullies. (Creases represent streams and rivers bordered by wetlands.) Make a basin/lake in the foil at the deep part to collect water from the tributaries. At the other end, make a valley between the hills. Be sure to arrange the edges so the water stays in the pan.
4. **Basin/Lake Life**: Pour a little water into the lake. Add organisms. Gently make it "rain" and observe how the water runoff flows into the lake.
5. **Sand/Soil**: Place a small pile of soil or sand near the stream. Pretend someone has bulldozed land nearby. Make it rain and watch how the soil is washed away. How might increased sediment affect boating?
6. **Runoff Race**: Use different materials to determine how fast the water runs.
7. **Pollution**: Add a drop or two of food coloring upstream to model a toxic waste spill. Use colored oil or paint to track an oil spill. Follow the pollution downstream. Backtrack. Determine point and non-point sources of pollution.

Name(s): _____ Block/Period: _____ Date: _____

MODEL WATERSHEDS

Completion: Answer the following questions in complete sentences.

1. Describe how wetlands function to reduce flooding and retain sediments.

2. Explain how land covering affects the rate of runoff.

3. How does sediment get introduced into lakes and ponds?

4. What happens when water is added to a source of pollution?

5. What would happen to water, sediments, homes, and wildlife if wetlands were destroyed?

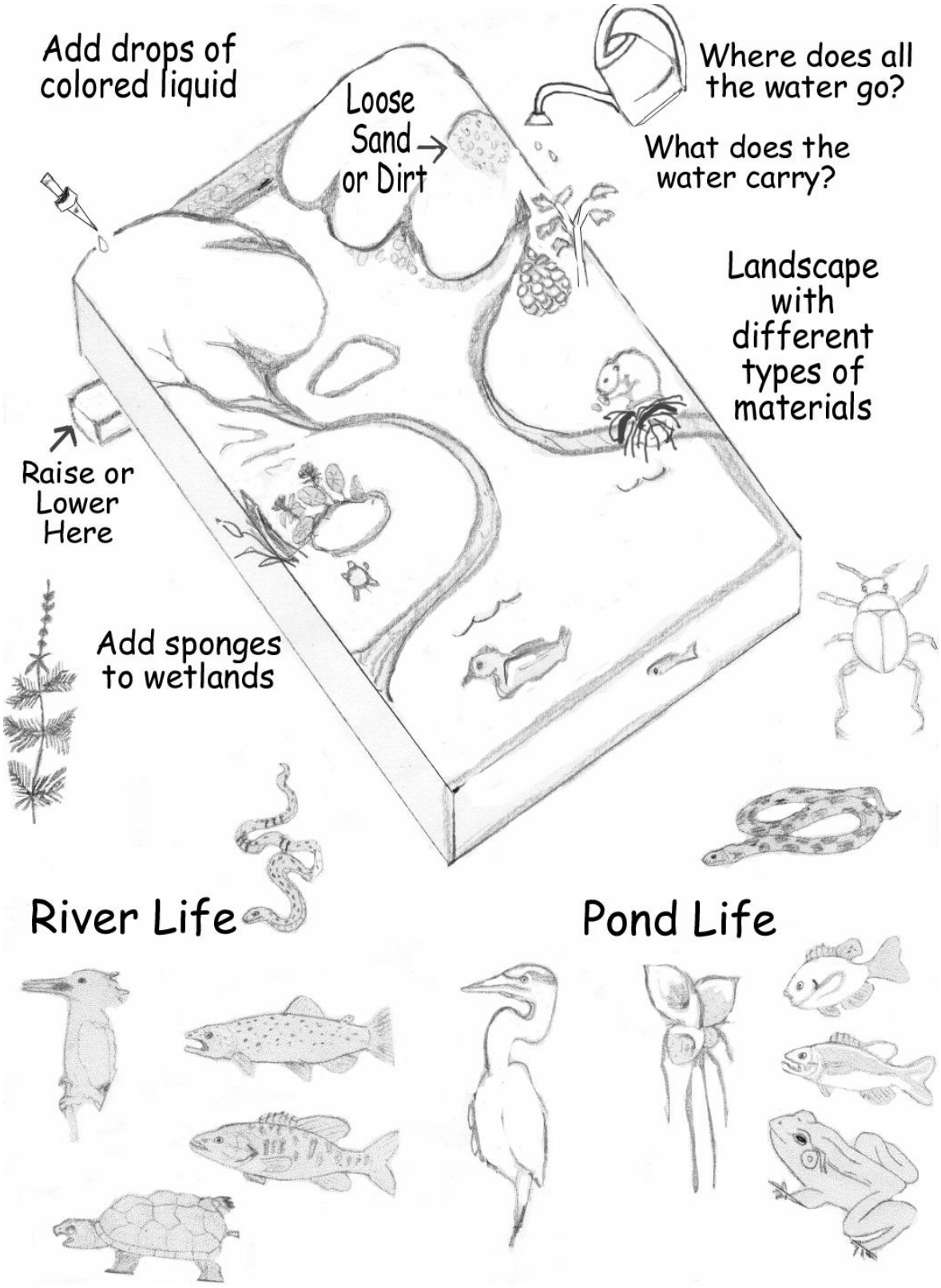
6. How might all of this affect you?

7. How can we prevent these undesirable effects?

8. **Going Further**: Design your own experiment. Check with the teacher for approval. What is the question you hope to answer?

Name(s): _____ Block/Period: _____ Date: _____

MODEL WATERSHEDS



Name(s): _____ Block/Period: _____Date: _____

Part II – Field Trip

Watershed Wheels – Handouts

By Therese Ehrenreich
Sketches by Stacy Ehrenreich

Name(s): _____ Block/Period: _____Date: _____

How to Make a Watershed Wheel

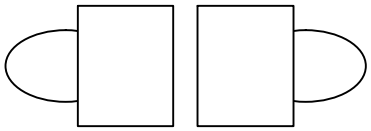
Materials:

Large Wheel #1	Small Wheel #1	manila folder or oaktag	glue, tape
Large Wheel #2	Small Wheel #2	rubber cement	scissors
(2) Cover Pieces	clear contact paper	1" paper fastener, pin	colored pencils

Note: You are welcome to use and share these wheels; however, you must leave the Ehrenreich name on each wheel for copyright purposes. Thank you.

Procedure:

1. **Copy** Large Wheel #1, Large Wheel #2, Small Wheel #1 and Small Wheel #2, and make **two** copies of the Cover piece.
2. **Cut** the Cover pieces along the solid lines. **Optional**: Glue the two Cover pieces to a manila folder or oaktag.
3. **Cut** out the pie-shaped sections to make windows. **Poke** a hole in the center of each Cover piece with a pin.
4. **Join** the two cover pieces at the top, making sure the centers match. **Optional**: Place the cover pieces face down, with the tops toward each other, onto the contact paper (removable book covers), allowing a 1/16 inch (2 mm) separation. Cut the paper, leaving 1/2 inch around the margins to fold under. Tape as needed.

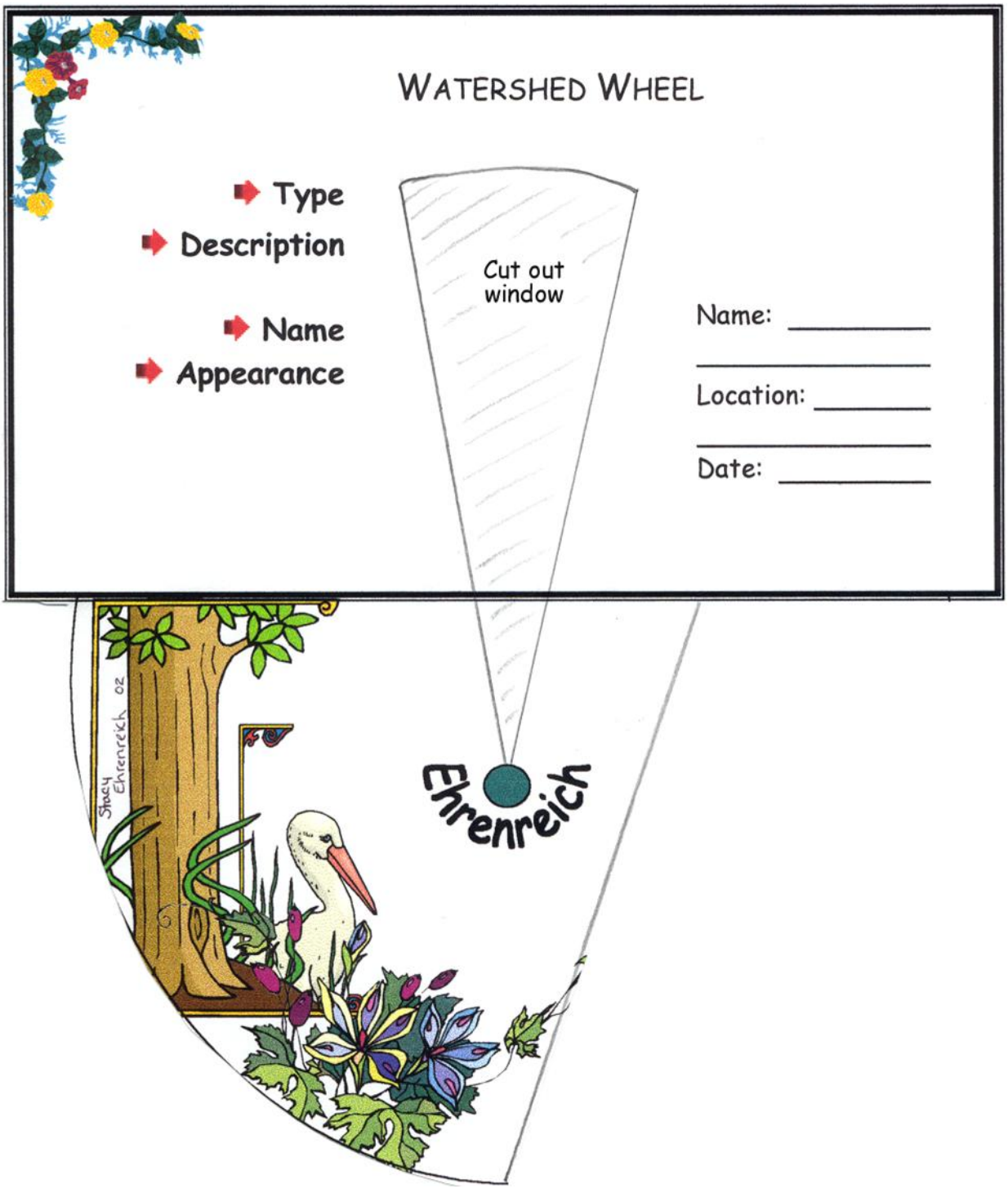


5. **Cut** the two Large Wheels along the solid line. **Poke** a hole in the center of each.
6. **Place** Large Wheel #1 (flora) and Large Wheel #2 (fauna) back to back (use the pin to line up the two wheels back to back). **Optional**: Glue the wheels back to back onto one piece of cardboard. First, glue one large wheel and cut it out. Then, attach the second wheel, making sure the centers match. Remove the pin.
7. **Cut** the two Small Wheels along the solid line. **Poke** a hole in the center of each. **Optional**: Glue each wheel to cardboard. Do not place them back to back (they will each be going in front of a large wheel).
8. **Poke** a hole in the center of each Small Wheel.
9. **Place** Small Wheel #1 (flora) in front of Large Wheel #1 (flora), and **Place** Small Wheel #2 (fauna) in front of Large Wheel #2 (fauna).
10. **Slide** all four wheels into the Cover piece. Line up the center holes.
11. **Fasten** all four wheels together by pushing the paper fastener through the center.
12. **Trim** excess paper off the wheels. **Optional**: When finished, color.

Name(s): _____ Block/Period: _____Date: _____

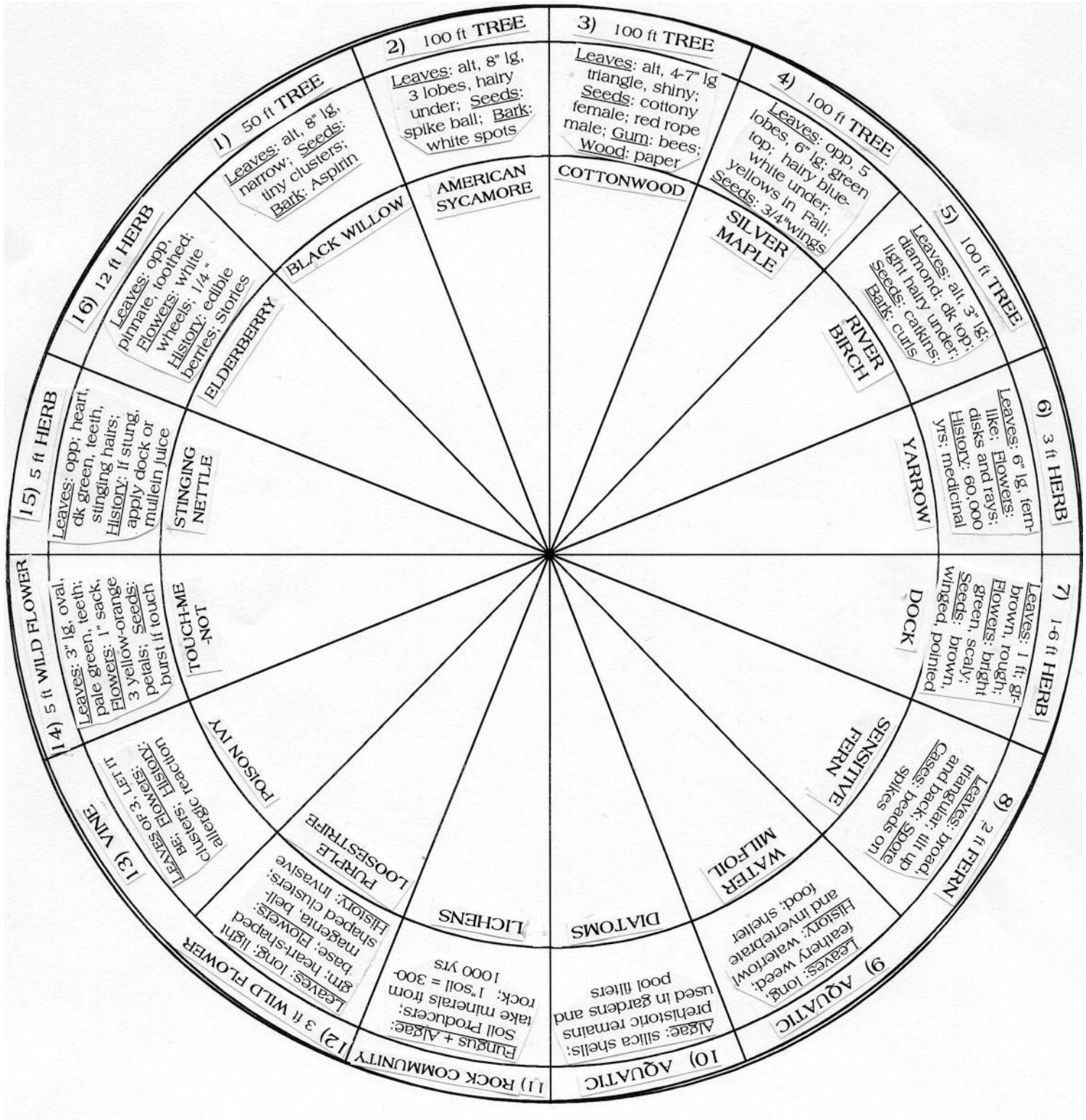
WATERSHED WHEEL - COVER

Make two (2) copies for each finished wheel; Cut along solid outline.



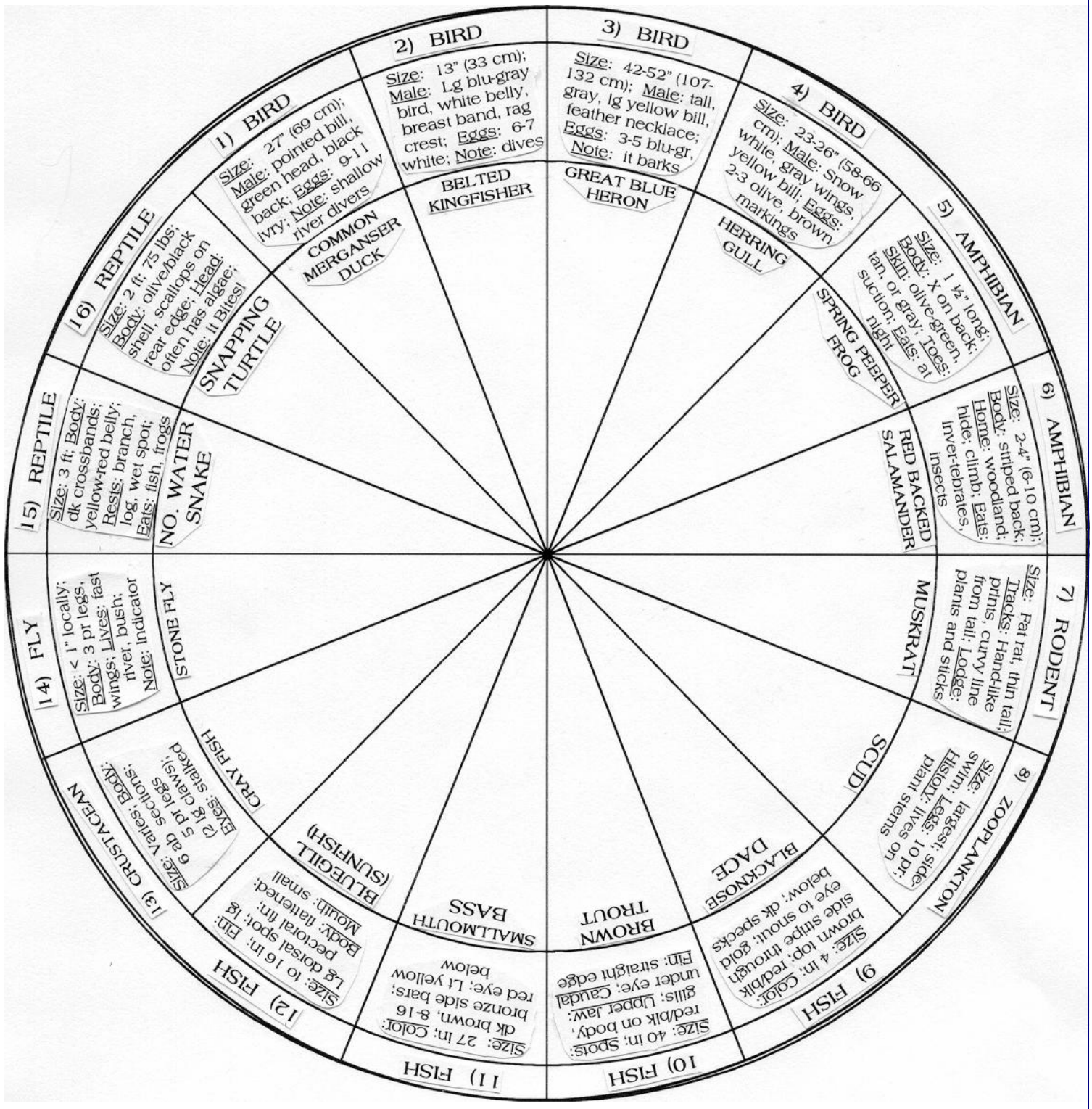
Name(s): _____ Block/Period: _____Date: _____

RIVERS AND STREAMS WATERSHED WHEEL
LARGE WHEEL #1: FLOWING WATER (LOTIC) PLANTS (FLORA)



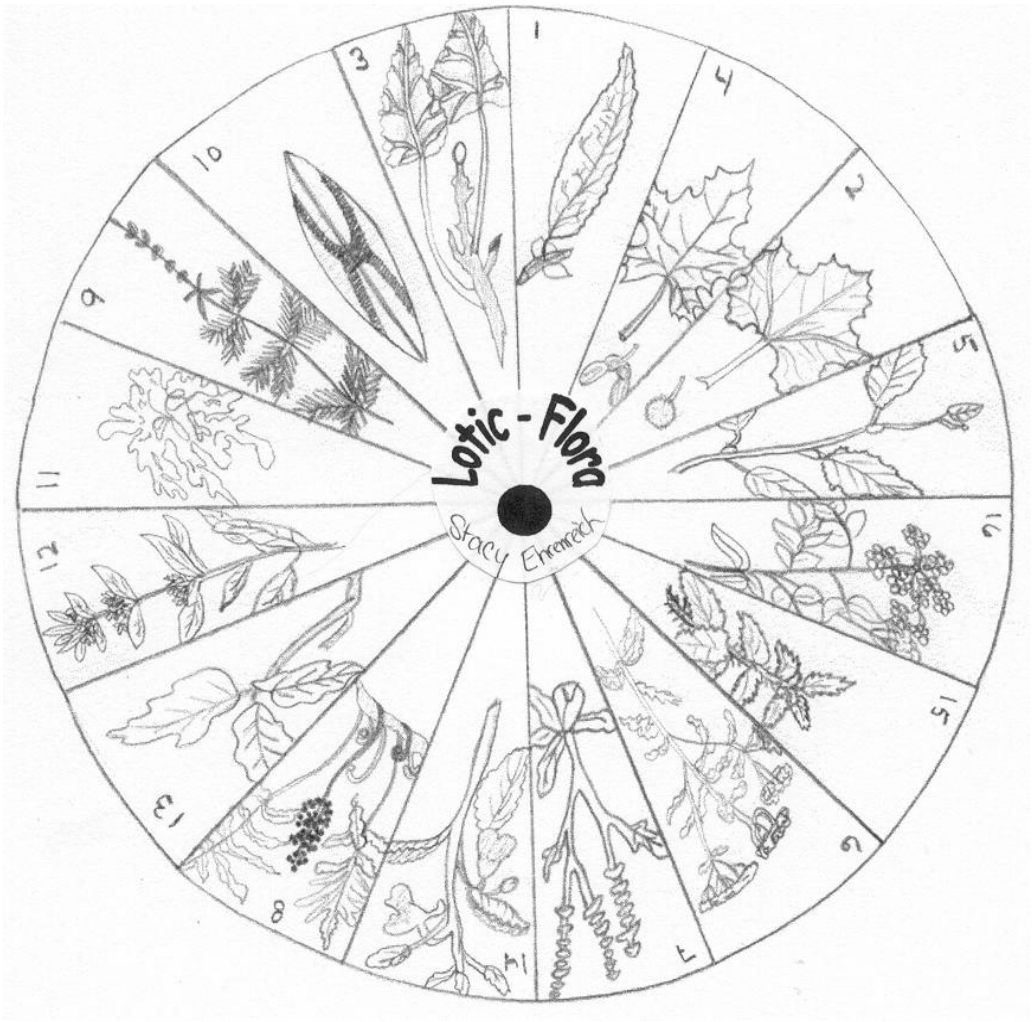
Name(s): _____ Block/Period: _____Date: _____

RIVERS AND STREAMS WATERSHED WHEEL
LARGE WHEEL #2: FLOWING WATER (LOTIC) ANIMALS (FAUNA)



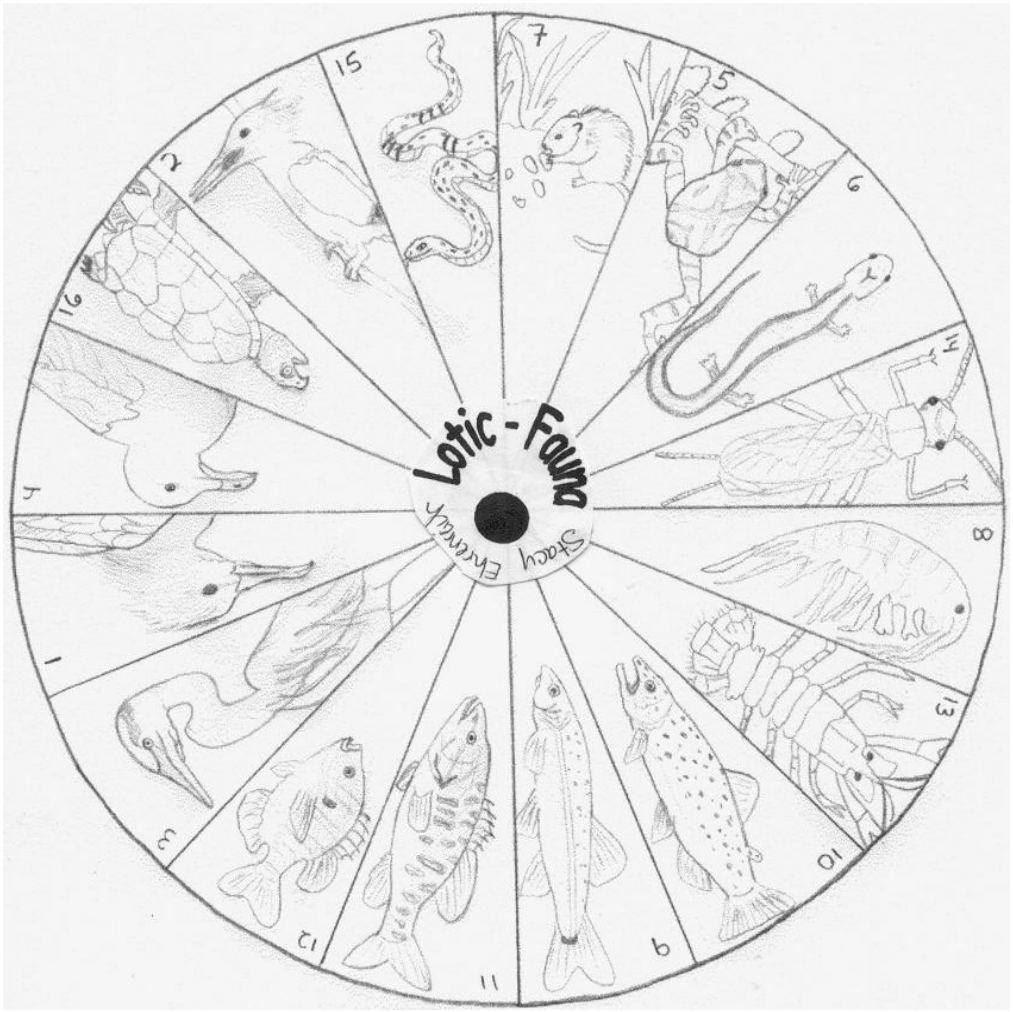
Name(s): _____ Block/Period: _____Date: _____

RIVERS AND STREAMS WATERSHED WHEEL
SMALL WHEEL #1: FLOWING WATER (LOTIC) PLANTS (FLORA)



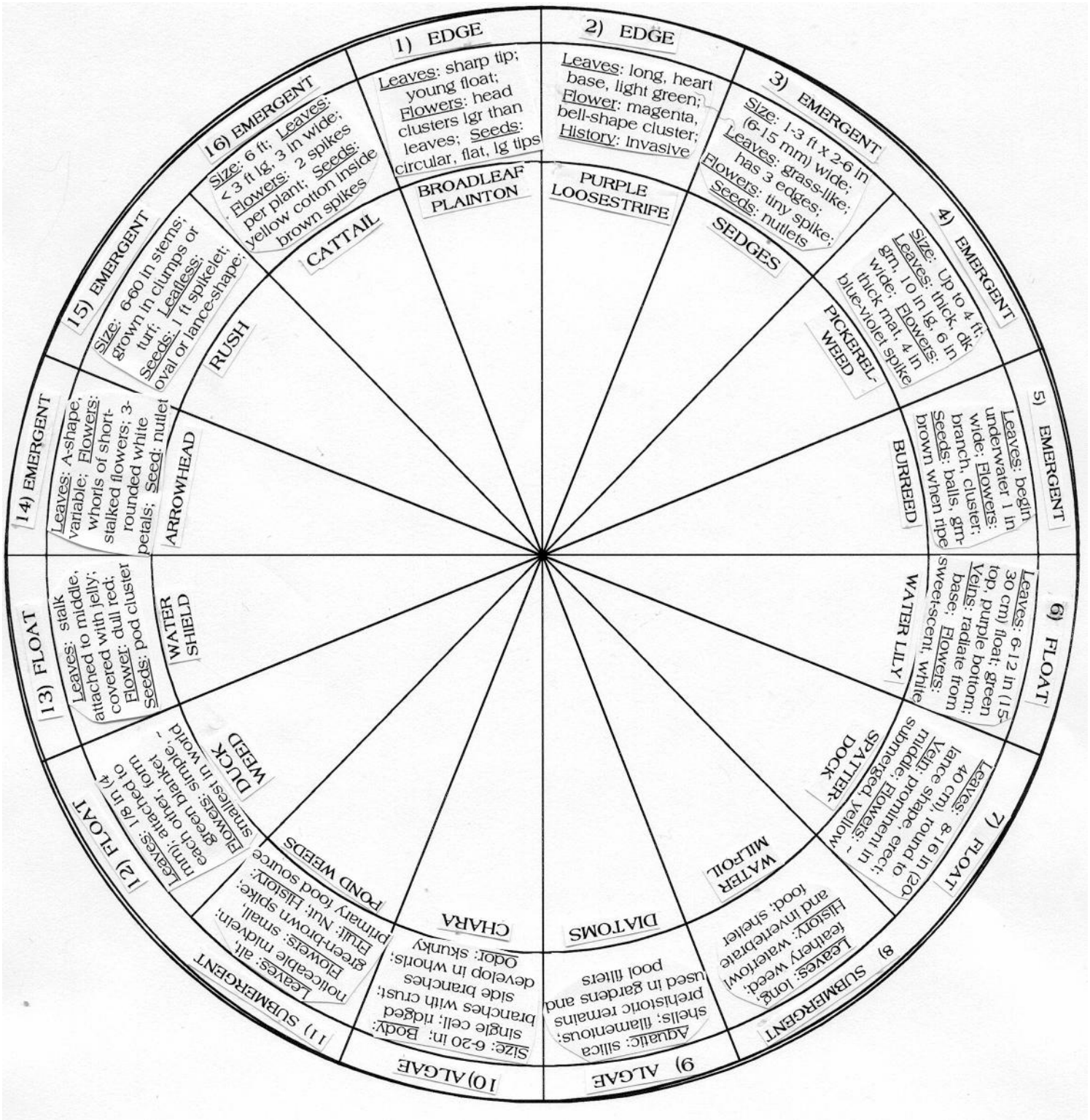
Name(s): _____ Block/Period: _____Date: _____

RIVERS AND STREAMS WATERSHED WHEEL
SMALL WHEEL #2: FLOWING WATER (LOTIC) ANIMALS (FAUNA)



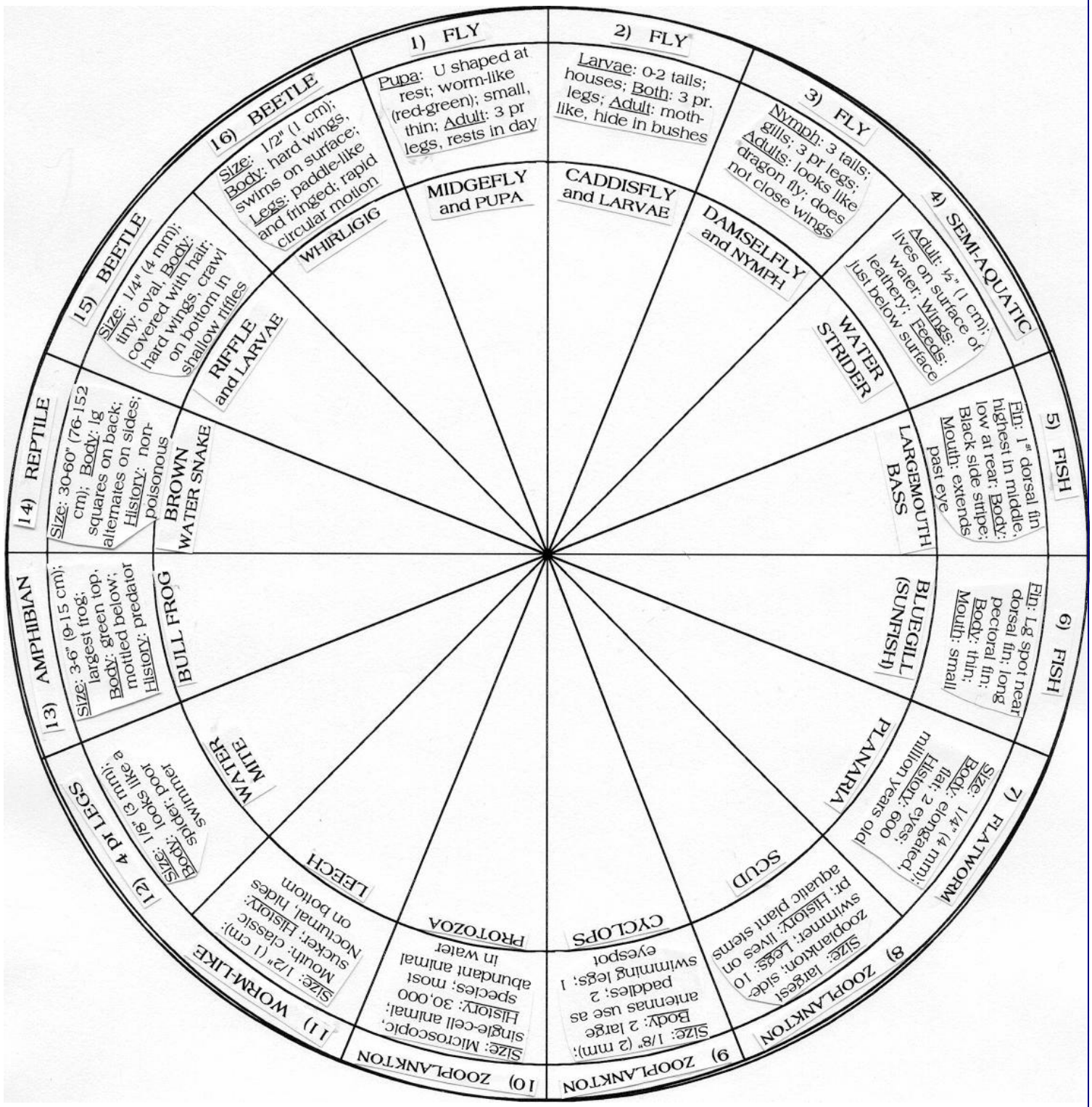
Name(s): _____ Block/Period: _____Date: _____

LAKES AND PONDS WATERSHED WHEEL
LARGE WHEEL #1: STANDING WATER (LENTIC) PLANTS (FLORA)



Name(s): _____ Block/Period: _____Date: _____

LAKES AND PONDS WATERSHED WHEEL
LARGE WHEEL #2: STANDING WATER (LENTIC) ANIMALS (FAUNA)



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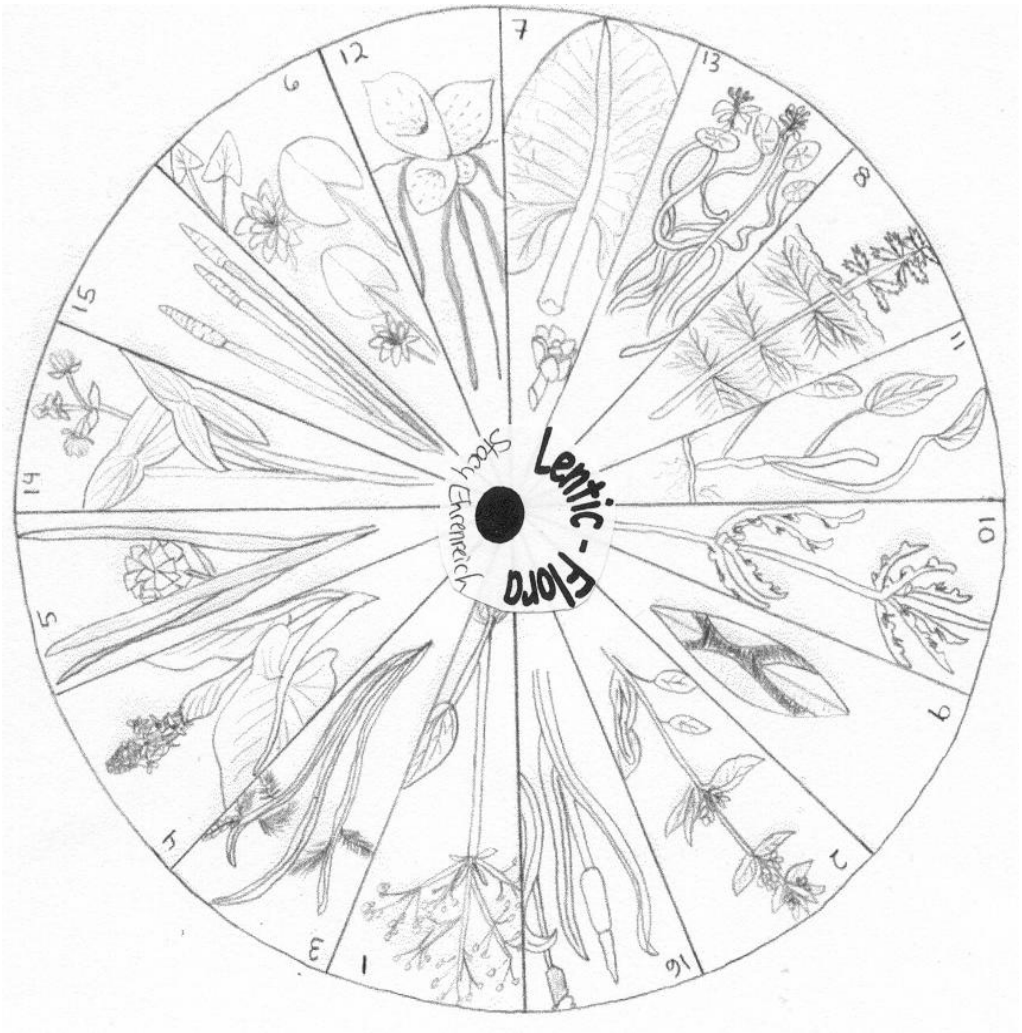
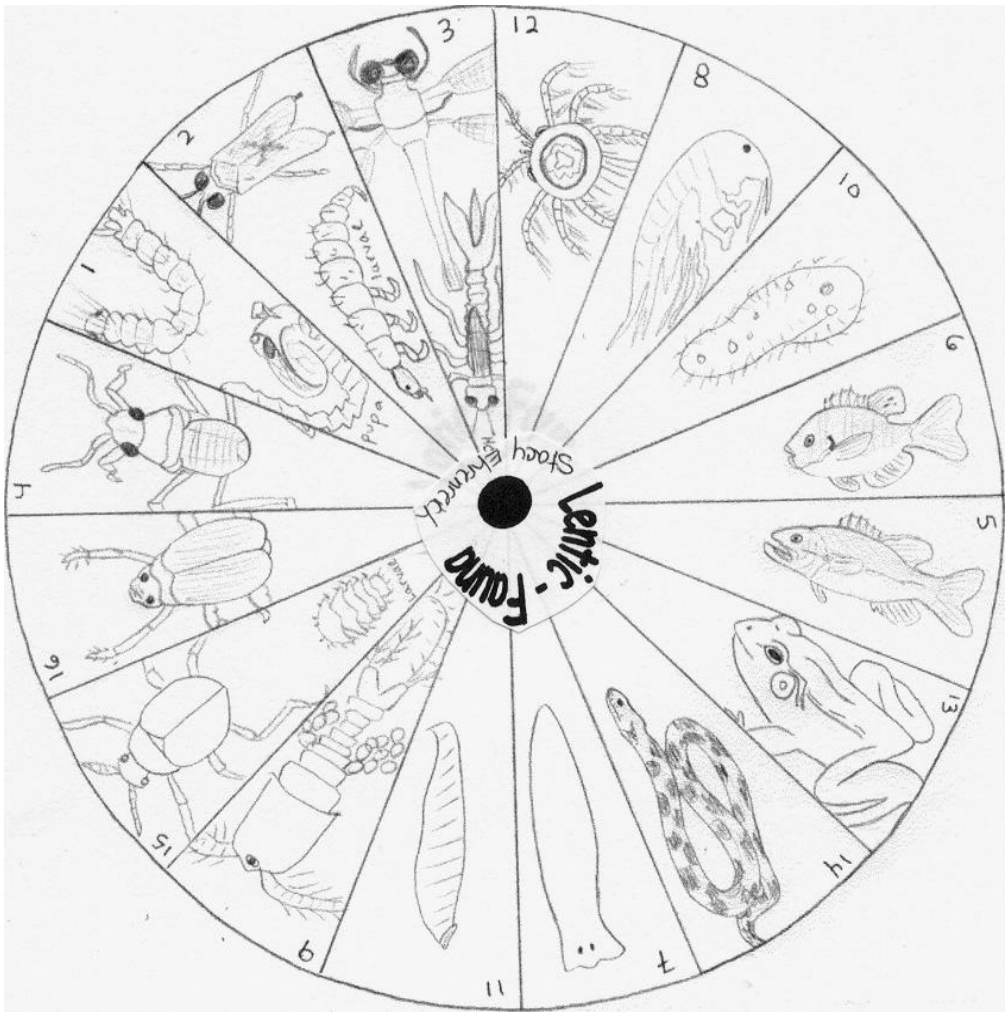
Name(s): _____ Block/Period: _____Date: _____

LAKES AND PONDS WATERSHED WHEEL
SMALL WHEEL #1: STANDING WATER (LENTIC) PLANTS (FLORA)



Name(s): _____ Block/Period: _____Date: _____

LAKES AND PONDS WATERSHED WHEEL – SMALL WHEEL #2: STANDING WATER (LENTIC) ANIMALS (FAUNA)



Name(s): _____ Block/Period: _____Date: _____

PART III – WILD THINGS BROCHURE

HANDOUTS

BY THERESE EHRENREICH

Name(s): _____ Block/Period: _____Date: _____

WILD THINGS – JOURNEY THROUGH TIME
BROCHURE

Purpose: Each student will create a **Lehigh Valley Watershed** brochure that gives a map of the area, describes the environment and climate, and explains at least **three types of organisms** found in or around the Lehigh River at some point in time. The watershed/wetland area may be an imaginary design; however, the organisms shown must be based upon and supported scientific evidence and/or facts.

Project Rules: Remember to focus as much as possible on the Lehigh River.

- **SCIENTIFIC: ENVIRONMENT AND ECOLOGY STANDARD 4.1.C.10: DESCRIBE THE PHYSICAL CHARACTERISTICS OF A STREAM AND DETERMINE THE TYPES OF ORGANISMS FOUND IN AQUATIC ENVIRONMENTS.** Become a local watershed expert. Illustrate and/or model 3+ different **life forms**, including diagrams of **land and/or marine geology** and **climate** conditions of that time period.
  A. Describe and explain the physical factors that affect a stream and the organisms living there.
  B. Identify terrestrial and aquatic organisms that live in a watershed.
  C. Categorize aquatic organisms found in a watershed continuum from headwater to mouth (e.g., shredder, predator, decomposer).
  D. Identify the types of organisms that would live in a stream based on the stream's physical characteristics.
  E. Explain the habitat needs of specific aquatic organisms.
- **THEME**: Keep your information accurate, yet fun. Make people WANT to travel through time to learn more about the wetland environment around the Lehigh River (Central Delaware Subbasin Number 2) during your time period.
- **SETTING**: Give some thought as to how you could BEST present the period. Twilight? Springtime? Island? Woodland? Swamp?
- **ILLUSTRATIONS:** Each person must illustrate 2+ scenes (including land and/or aquatic organisms). Scenes can be cartoon-like or realistic. They should be interesting, well-made, and accurate to the time period and wetland environment.
- **HISTORIC. ENVIRONMENT AND ECOLOGY STANDARD: 4.1.E.10**. IDENTIFY AND DESCRIBE NATURAL AND HUMAN EVENTS ON WATERSHEDS AND WETLANDS. IDENTIFY AND DESCRIBE NATURAL AND HUMAN EVENTS ON WATERSHEDS AND WETLANDS. Be sure to bring your time period "up to date" by adding some current river information.
  A. * Describe how natural events affect a watershed (e.g. drought, floods).
  B. * Identify the effects of humans and human events on watersheds.
- **SOURCES**: List all reference materials. Cite 2+ sources on back of brochure.
- **ASSESSMENT**: Check the rubric.

Name(s): _____ Block/Period: _____Date: _____

JOURNEY THROUGH TIME
IN THE LEHIGH VALLEY

CENOZOIC ERA: Beginning was warm, ending had Ice Ages (formed Grand Canyon)

1.6 **QUATERNARY:** *Homo Sapiens*, wooly mammoth, saber-tooth, *Mission to Mars* (Glacial till, stream and lake deposits)

66.4 **TERTIARY**: *Australopithicus*, grass, horses, mollusks, Alps and Himalayas

MESOZOIC ERA: **(LEHIGH VALLEY DINOSAURS INCLUDE: ALBERTOSAURUS, HADROSAURUS, THEROPODS, AND ORNITHISCHIANS)**: Extinction, Pangaea broken, Dinos Die, Global Winter

CRETACEOUS:

144 T-Rex ruled, magnolia flowers, mammals (Rocky Mountains form)

TRIASSIC AND JURASSIC: cycad and conifers, fish, mammals, dinosaurs and birds

208 Jurassic (western North America mountain building)

245 Triassic: *Anchisaurus* "dinosaur" (Atlantic Ocean forms, Pangaea breaks up):

Paleozoic Era

Supercontinent Pangaea Forms: Mass extinction, tropics became deserts, South Pole ice sheets

CARBONIFEROUS: Tropical forests (*lepidodendron* "scale tree", *sigillaria* "seal tree", *calamites* "a rush", *psaronius* "true fern", *medullosa* "seed fern", *cordaites* "ancestor of the conifers), swamps, reptiles, dragonflies and cockroaches

286 **PERMIAN**: Marine invertebrates extinction, glaciers retreat, *Osteichthyes* "~trout"

320 **PENNSYLVANIAN**: Swamps
(**Appalachian** Mountains; ProtoAtlantic Closes; quartz, sand, silt, shale, coal)

360 **Mississippian**: River and Swamps; Glaciers Form
(red shale and siltstone; yellow gray sandstone)

SILURIAN AND DEVONIAN: Land plants and animals, ferns, spiders, insects, and "sharks" *Pleurocanthus* and *Helodus*

408 **DEVONIAN**: Pterichthyodes "a type of *placoderm* – armored fish"
Alternating Shallow Marine and Near-shore Delta Deposits; (Red and green silt and sand / black shale and limestone)

438 **SILURIAN:** Shallow marine as Proto-Atlantic contracts
North America and Europe collide, building **APPALACHIAN MOUNTAINS**
(Red, green, and gray sandstone, shale, and siltstone from river, marsh, and beach deposits; quartzite and conglomerate beach deposit.)

CAMBRIAN AND ORDOVICIAN: Trilobites, crinoids, brachiopods, and jawless fish

505 **ORDOVICIAN**: Subduction zone off Continental Slope; *Echinoderms* "star fish"

544 **CAMBRIAN**: Shallow Marine as Proto-Atlantic expands (breakup of Rodinia)
(carbonate banks and reefs)

PRECAMBRIAN TIME:	**SUPERCONTINENT RODINIA FORMS**:
600 MYA	Bacteria and algae, jellyfish, sponges and worms (*Planaria*)
4.6 BYA to 570 MYA	Lava flows, mountain building; microfossils, photosynthesis

Name(s): _____ Block/Period: _____Date: _____

WILD THINGS - BROCHURE
WHO, WHAT, WHEN, AND WHERE ?

I. **First Meeting: Choose a time period and brainstorm.**

Each group will make their own, unique brochure. See teacher for ideas.

1. Select a period and theme that supports and enhances your ideas.
2. Each Group will become an expert on their time period.

II. **Second Meeting: Rough Draft (include work cited) and Begin Work.**

1. **SKETCHES AND NOTES**: Make a ROUGH DRAFT of your brochure. Also, complete the Data Sheet.
2. WORKS CITED: MUST APPEAR on the back of each brochure.
3. ILLUSTRATIONS: Must have at least two illustrations in brochure with three or more different types of organisms.
4. PRELIMINARY brochure. Have final copy finished before next meeting.

III. **Third Meeting: Prepare for Assessment (meet or exceed all criteria)**

1. It must be both attractive (neatly done) and scientifically accurate.
2. BONUS will be given to the top three brochures!

PROJECT TIME LINE (YOU NEED TO **WORK** AT **HOME**!) **DUE DATE**

1. 1st Meeting _____
   Notes: _____
   _____
2. 2nd Meeting _____
   Notes: _____
   _____
3. 3rd Meeting _____
   Notes: _____
   _____
4. Present brochure to class _____

Name(s): _____ Block/Period: _____Date: _____

WILD THINGS DATA SHEET

STATE FOSSIL: *Phacops rana* "trilobite"

1. **Brochure Title**: _____
2. **Geologic Time Period:** _____
3. Describe the general design of the time period: _____

   _____
4. **Scientific Information**: (Include Climate and any Geologic Events)
   A. Describe and explain the physical factors that affect a stream and the organisms living there. _____
   B. Identify terrestrial and aquatic organisms that live in a watershed. _____

      _____

      _____
   C. Categorize aquatic organisms found in a watershed continuum from headwaters to the mouth (e.g., shredder, predator, decomposer). _____

      _____

      _____
   D. Identify the types of organisms that would live in a stream based on the stream's physical characteristics. _____

      _____

      _____
   E. Explain the habitat needs of specific aquatic organisms. _____

      _____

      _____
5. **Historic Information**:
   A. Describe how natural events affect a watershed (e.g. drought, floods). _____

      _____

      _____
   B. Identify the effects of humans and human events on watersheds. _____

      _____

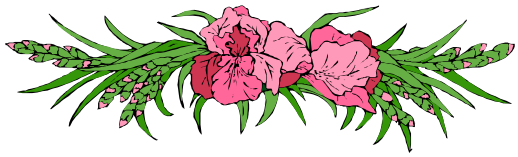
      _____
6. Describe the important illustrations **you** plan to make. _____

   _____

   _____
7. **SOURCES: (Must cite at least two different sources)**
   1. _____
   2. _____

SCORING RUBRIC

WEIGHT: _____	9 – 10 POINTS	6 - 8 POINTS	3 - 5 POINTS	0 - 2 POINTS
BROCHURE DESIGN **Design** **Neatness** **Illustrations** **Cites Sources (2+)**	**Creatively** designed with attractive headings and print. 2+ appropriate, well-made illustrations. Cites **2+** sources.	**Well-designed** with attractive heading and print. 2 appropriate and neatly done illustrations. Cites **1+** source.	Brochure is **fairly** well-designed and includes 1 appropriate illustration. 1+ or no sources cited.	Brochure is **poorly** designed and includes inappropriate illustrations or lacks illustrations. 0 sources cited.
Scientific Info: Describe the physical characteristics of a stream and determine the types of organisms found in aquatic environments.	**Accurate, well-written, interesting**. Includes **major scientific information**. Gives a **good** sense natural and environ-mental **science**.	**Accurate, interesting**. Includes **most** major stream (River) characteristics and organisms. **Fairly** good sense of history.	**Mostly accurate**. Includes **some** major geologic events of the time period. **Limited** sense of history.	**Mostly inaccurate**. Includes **few** major geologic events of the time period. **Poor** sense of history.
Historic Info: Identify and describe natural and human events on water-sheds and wetlands. Identify and describe natural and human events on watersheds and wetlands.	**Accurate, well-written, interesting**. Includes **major historic information**. Gives a **good** sense natural and environ-mental **history**.	**Accurate, interesting**. Includes **most** major events, both natural and human. **Fairly** good sense of history.	**Mostly accurate**. Includes **some** major natural and human events. **Limited** sense of history.	**Mostly inaccurate**. Includes **few** major natural and human events. **Poor** sense of history.
PRESENTATION **Each person will use their Travel Brochure to present their wetland (5 minutes)**	**Meets or exceeds** the obvious facts. **Compels** people to visit. **Interesting**, **clear**, **fun**, and **well-organized**. **Creative**.	Discusses **more** than the obvious. **Offers** things to visit. **Interesting** and **fairly well-organized**. **Good** use of info.	Explains **some** facts clearly. **Mentions** visits Shows **some** interest, clarity, organization. **Fair** use of info.	**Does not explain** info. Do **not** attract visitors. Presentation is **unclear** and **disorganized**. **Does not** use info.
TOTAL POINTS				



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