The Deerfield Dilemma
(Stream Superheroes Post-Lesson)

Audubon Center of the North Woods

Purpose: Sometimes the tiniest, most unexpected creatures can teach us BIG, important lessons. In this class we will don our detective hats and investigate a creek with a declining fish population. By sampling the creek for macroinvertebrates, will we be able to tell what is happening to Deerfield Creek?! This game will be played in the style of *Clue*, *Crack the Case*, *Mind games*, and other sleuthing games.

Concepts:
- Macroinvertebrates are an indicator species for water quality.
- Human activities along streams can alter ecosystems.

Learning Outcomes: Students will be able to
- Recognize pollution tolerant/intolerant macroinvertebrates.
- Indentify the differences between point and non-point pollution.
- Hypothesize solutions to stream pollution problems.

Minnesota Academic Standards:
Science: 5.4.4.1.1 – Give examples of beneficial and harmful interaction with natural systems.

5.1.1.2.2 – Identify and collect relevant evidence, make systematic observations and accurate measurements, and identify variables in a scientific investigation.

7.4.4.1.2 – Describe ways that human activities can change the populations and communities in an ecosystem.

For Background Information see end of lesson

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CLASS LENGTH: 50 MINUTES

AGES: GRADES 4-8

SEASON: ALL

GROUP SIZE: UP TO 30 STUDENTS

SAFETY: No major safety concerns. This is a classroom activity.

Materials:
- 1 large board (white, chalk, smart, cork, etc),
- markers (dry erase, chalk, etc),
- tape or other adhesive or push-pins (cork board only)
- water quality indicator id sheet for students
- board pieces (invertebrates, farm, housing development, hydroelectric plant, stream (optional))

PRE-CLASS PREP (15 MIN):
- Cut out game pieces from PowerPoint file.
- Laminate game pieces (Optional).
- Pre-tape back of game pieces (optional).
- Draw creek and tributaries on board: same as what is on student worksheet
- Read background and support materials.
- Copy water quality indicator id sheet for all students (or 1 for every 2 students).
- Copy Deerfield Creek – worksheet for every student

CLASS OUTLINE: (Class sequence of events)

I. Introduction - _5__ min.
   A. Lesson Preview
   B. Grabber – describe the activity and rules

II. Class experience - _35__ min.
   A. The Deerfield Dilemma

III. Assessment - _10__
   A. Written hypothesis of how to fix Deerfield Creek

I. Set-up

A. Read through lesson plan.

B. Print out game pieces from PowerPoint file and cut out each piece.

- Slides 1 – 6 are the macroinvertebrates found in Zone 1 of the creek (see worksheet).
- Slides 7 – 10 are the macroinvertebrates found in Zone 2 of the creek.
- Slides 11 – 12 are the macroinvertebrates found in Zone 3 of the creek.
- Slides 13 – 14 are the sources of pollution for Deerfield Creek.

C. Put tape on the back of the game pieces.

D. Draw on a white board (or other type of board) the same diagram students will have on their worksheet; the creek and tributaries.

E. Place the macroinvertebrates for Zone 3 on the creek. Keep all other pieces hidden until students gather this information.

II. Introduction (_5__ min)

A. **Lesson Preview** – Let kids know that they will become detectives for the next hour. They need to get their thinking hats on and observation goggles out. They will be playing a game similar to *Crack the Case, MindGames, or other sleuthing games.* They will be given basic information and by asking educated questions, they need to figure out what is happening to their favorite fishing creek. Tell students to take notes because they will be turning in a short paper at the end.

B. **Grabber** – Students will take information learned at Audubon Center of the North Woods (ACNW) and use it to help them solve a mystery. **THE STORY – Introduction READ THIS TO STUDENTS**

Uh oh! Your favorite fishing hole on Deerfield Creek has not been as productive as usual. Something must be happening to the fish. You don your detective hats and attempt to figure out what is going on. They recently learned how to sample for aquatic macroinvertebrates at ACNW. They sample their fishing hole and they find: phantom midge larvae (x10), mosquito larvae (x20), blood midge (x5), and leeches (x2). What you know: the layout of the stream, the fish population is declining, and the macroinvertebrates you found after sampling the creek at the fishing hole. Now you must discover has happened to Deerfield Creek! Detectives I salute you!

III. Class Experiences (35 min)

A. **The Deerfield Dilemma** – After using the intro as a grabber, allow students to start asking questions. As the instructor/teacher you will act as a moderator. The goal is that the students discover there are point and non-point pollution sources coming from both tributaries, causing the water quality to decrease. From here the students need to ask questions to come to the solution. When the students ask pertinent questions information can be given. EX: IF they ask what macroinvertebrates are found after the first tributary, the moderator can add those macroinvertebrates to the stream. Pertinent questions invoke some thought; students should not ask you to give an answer. What macroinvertebrates did we find in Zone 2? Vs. What is causing the fish to die?

How helpful the moderator wants to be is up to their discretion. If students are struggling to get to the answer, then the moderator can help with leading questions. In the end, students must come to the conclusion that there is a housing development on Tributary A, and both a farm and hydroelectric plant on Tributary B. If they get this far, the moderator may decide to explain what problems each pollution source is causing. Ideally, student will ask what macroinvertebrates are found in each zone. They will notice that there is a greater variety of macroinvertebrates as they go upstream. The decreasing variety occurs only after tributaries enter Deerfield Creek. Therefore, whatever is decreasing the water quality must be entering Deerfield Creek from these tributaries.

THE FULL STORY: Only the moderator will know the whole story. The students need to figure out the following information:

Deerfield Creek is a healthy creek, as seen by the macroinvertebrates found in Zones 1 and 2 (see attached *Water Quality Indicator sheet)*. After the first tributary (Tributary A), the diversity of macroinvertebrates decreases (lose group I), while the quantity of group II and III increase. After the second tributary (Tributary B), the diversity decreases again (losing group II), and group III quantity increases. The students' favorite fishing hole is below the mouth of Tributary B. The students learn which macroinvertebrates are found in Zone 3 as

part of their basic info.

Tributary A has Green Acres, a housing development, near the mouth. It turns out that there is not a buffer zone between the houses and the water, thus there is nothing to stop runoff of lawn fertilizer and street water. This increases nutrient pollution, which cause group I macroinvertebrates to die. This type of pollution is nonpoint pollution, because it comes from a large area.

Tributary B has both a cattle farming operation and a small hydroelectric plant on it. The cattle are free to wander in and out of the stream. They increase the nitrogen levels as well as possibly increasing bacteria levels in the water. The hydroelectric plant discharges heated water into the stream. Both of these issues cause the group II macroinvertebrates to die. Temperature increases and nutrients can result in excessive plant growth and subsequent decaying organic matter in water that depletes dissolved oxygen levels and consequently stressing or killing vulnerable aquatic life. Microorganisms can be hazardous to both human health and aquatic life. Both the farm and the hydroelectric plant are point sources of pollution.

When the polluted water finally reaches the Fishing hole, there are only a few pollution tolerant macroinvertebrates left. Due to the pollution affecting the fish directly and affecting their food source, the fish are leaving or dying.

After they figure out that pollution is entering the water from the three areas then the teacher can cover point vs. nonpoint pollution. The source of point pollution is from one, easily recognizable source, like a leaking pipe. Nonpoint pollution comes from a large area where a specific source is difficult to identify (See Background information for more information). Then the students will need to figure out the causes of the poor water quality. Their assignment will then be to write their ideas on how to fix the water quality of Deerfield Creek.

IV. Assessment (~10 min in class, plus reading time)

A. Once the students have come to the solution, have them take 5-10 minutes to brainstorm in small groups and then individually write their hypothesis on what can be done to solve the Deerfield Dilemma. There should be no more than 1 paragraph per pollution source. Expected basic answers should be similar to: Tributary A: Build a buffer zone to clean water of extra nutrients before it enters the tributary. Tributary B: Talk the hydroelectric plant into cooling water before it is discharged into the tributary; also talk the farmer in to putting fence up to keep the cattle directly out of the water, plus plant a buffer zone to help slow and clean nutrient/nitrogen rich runoff before it reaches the tributary.

- If students are younger, these answers may be more technical then they can come up with. Instead of an individual paper, talk together as a group and talk in-depth about the issues.
- Older students may be able to research ideas to write about to make it a more challenging assignment.

V. Conclusion (2-5 min)

A. Remind students that even the littlest critters can have a big impact on the world. They were able to find a problem and with a little sleuthing, they were able to identify the source of the troubles. Perhaps their ideas would or would not work in this hypothetical situation, the point is: Yes, even you can make a difference!

VI. Extensions/Variations

A. Sample a local body of water after this game and identify macroinvertebrates.

VII. Background Information

Buffer Zone

A buffer zone is an area between water and yards. Acting like a sponge, a buffer zone is usually made up of native plant species that help:
(http://www.dnr.state.mn.us/lakescaping/index.html)

- Provide habitat for a wide variety of wildlife
- Filter out pollutants and runoff that degrade water quality
- Prevent shoreline erosion by absorbing wave action
- Enjoy abundant nature: flowers, shrubs, trees, aquatic plants, fish, insects, birds

- More leisure time to relax and enjoy the nature of life at the lakeshore

The lack of a buffer zone can help lead to these problems:

- Shoreline erosion and lake sedimentation
- Algal blooms and excessive aquatic plant growth
- Loss of wildlife habitat, but an increase in nuisance animals

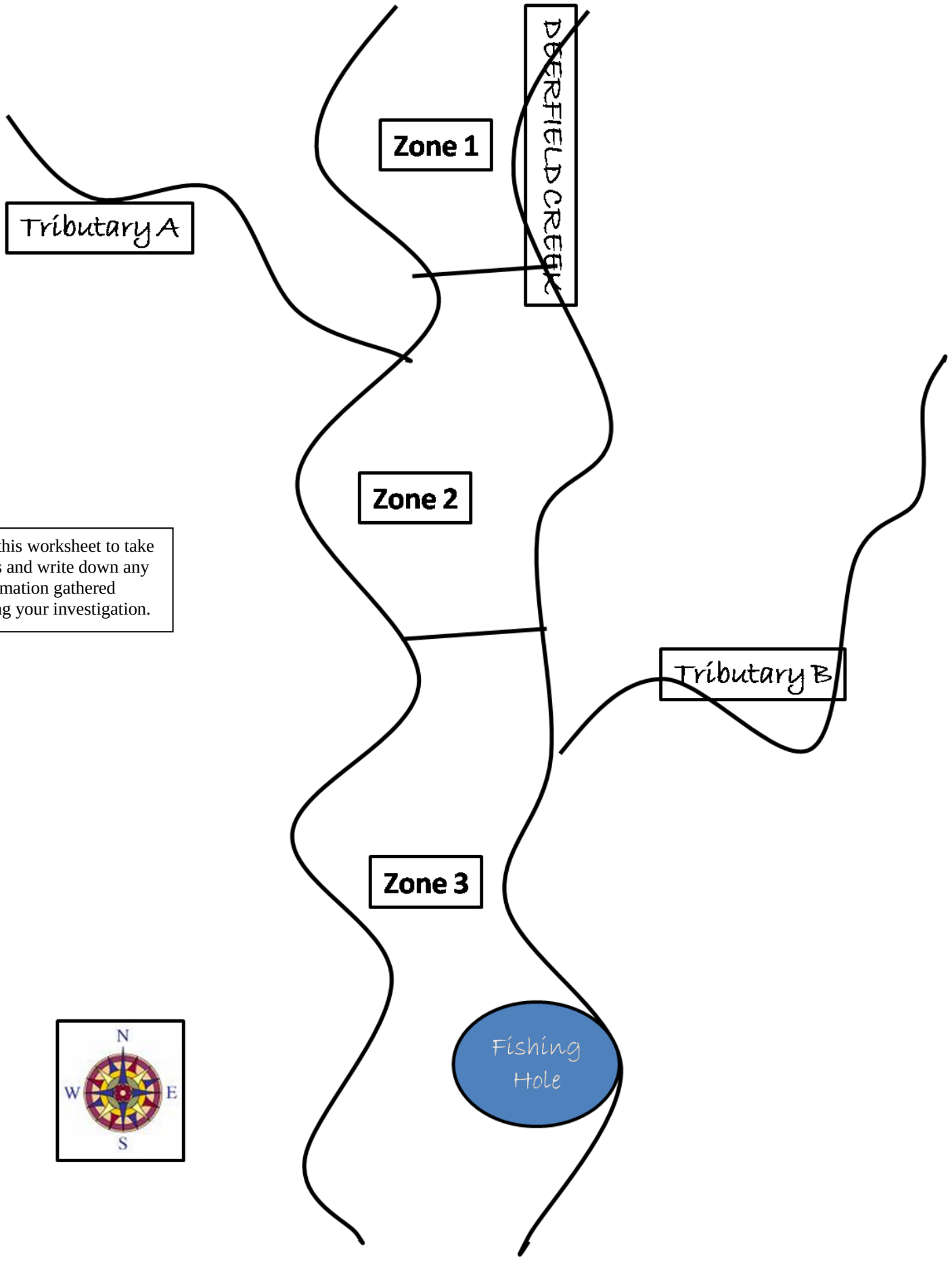
Point Sources (From: http://www.waterencyclopedia.com/Po-Re/Pollution-Sources-Point-and-Nonpoint.html)
Point-source pollutants in surface water and groundwater are usually found in a plume that has the highest concentrations of the pollutant nearest the source (such as the end of a pipe or an underground injection system) and diminishing concentrations farther away from the source. The various types of point-source pollutants found in waters are as varied as the types of business, industry, agricultural, and urban sources that produce them.
The most common point-source pollutants in surface water are:
•High-temperature discharges;
•Microorganisms (such as bacteria, viruses, and Giardia); and
•Nutrients (such as nitrogen and phosphorus).
Temperature increases and nutrients can result in excessive plant growth and subsequent decaying organic matter in water that depletes dissolved oxygen levels and consequently stressing or killing vulnerable aquatic life. Microorganisms can be hazardous to both human health and aquatic life. Pesticides and other toxic substances can also be hazardous to both human health and aquatic life, but are less commonly found in surface water because of high dilution rates.
Nonpoint Sources
Nonpoint-source pollution occurs as water moves across the land or through the ground and picks up natural and human-made pollutants, which can then be deposited in lakes, rivers, wetlands, coastal waters, and even groundwater. The water that carries nonpoint-source pollution may originate from natural processes such as rainfall or snowmelt, or from human activities such as crop irrigation or lawn maintenance.
Nonpoint-source pollution is usually found spread out throughout a large area. It is often difficult to trace the exact origin of these pollutants because they result from a wide variety of human activities on the land as well as natural characteristics of the soil, climate, and topography.
The most common nonpoint-source pollutants are sediment, nutrients, microorganisms and toxics. Sediment can degrade water quality by contaminating drinking water supplies or silting in spawning grounds for fish and other aquatic species. Nutrients, microorganisms, and other toxic substances can be hazardous to human health and aquatic life.

Pollution Tolerance Classification (taken from ACNW's lesson plan)
Scientists group macroinvertebrates according to their tolerance of pollution in the water. The following describes their tolerance and physical adaptations that allow them to survive in those conditions.
Group I: Pollution Intolerant/Sensitive: These organisms are considered "pollution sensitive." They are intolerant of nutrient pollution (from sources such as sewage and fertilizer) and of decreased oxygen levels. If pollution increases, macroinvertebrates in Group I will die. In their ideal habitat – cold, clear streams with high oxygen levels – you would find a diverse and abundant group of stoneflies, alderflies, and dobsonflies. They feed on naturally available food sources such as decaying leaves.
Group II: Somewhat Intolerant/Sensitive: Organisms in this group have a higher tolerance for nutrient pollution, but are still mainly intolerant of decreased levels of oxygen. This group contains a diverse number of species, such as mayfly nymphs, caddisflies, riffle beetles and water penny beetles. They can be found in different areas within the stream. Cranefly larva and crayfish live in riffles; dragonfly and damselfly nymphs live in pooling water. Mussels and clams don't move – they are found on the bottom, clinging to rocks. Scavengers and omnivores like aquatic sowbugs and scuds feed on decomposing organic matter.
Group III: Pollution Tolerant: As the name of the group suggests, these macroinvertebrates can tolerate severe nutrient pollution and low levels of oxygen. They often have adaptations to get their oxygen from the surface of the water. Midge larvae feed on a variety of plant and animal food sources. Blackfly larvae thrive in the nutrient-filled water of sewage treatment plants. Aquatic worms and leeches tolerate stressed, low oxygen environments. Left-hand snails have special air-breathing adaptations and bloodworms (midge larva) have special blood that helps move oxygen through the body.

VIII. References

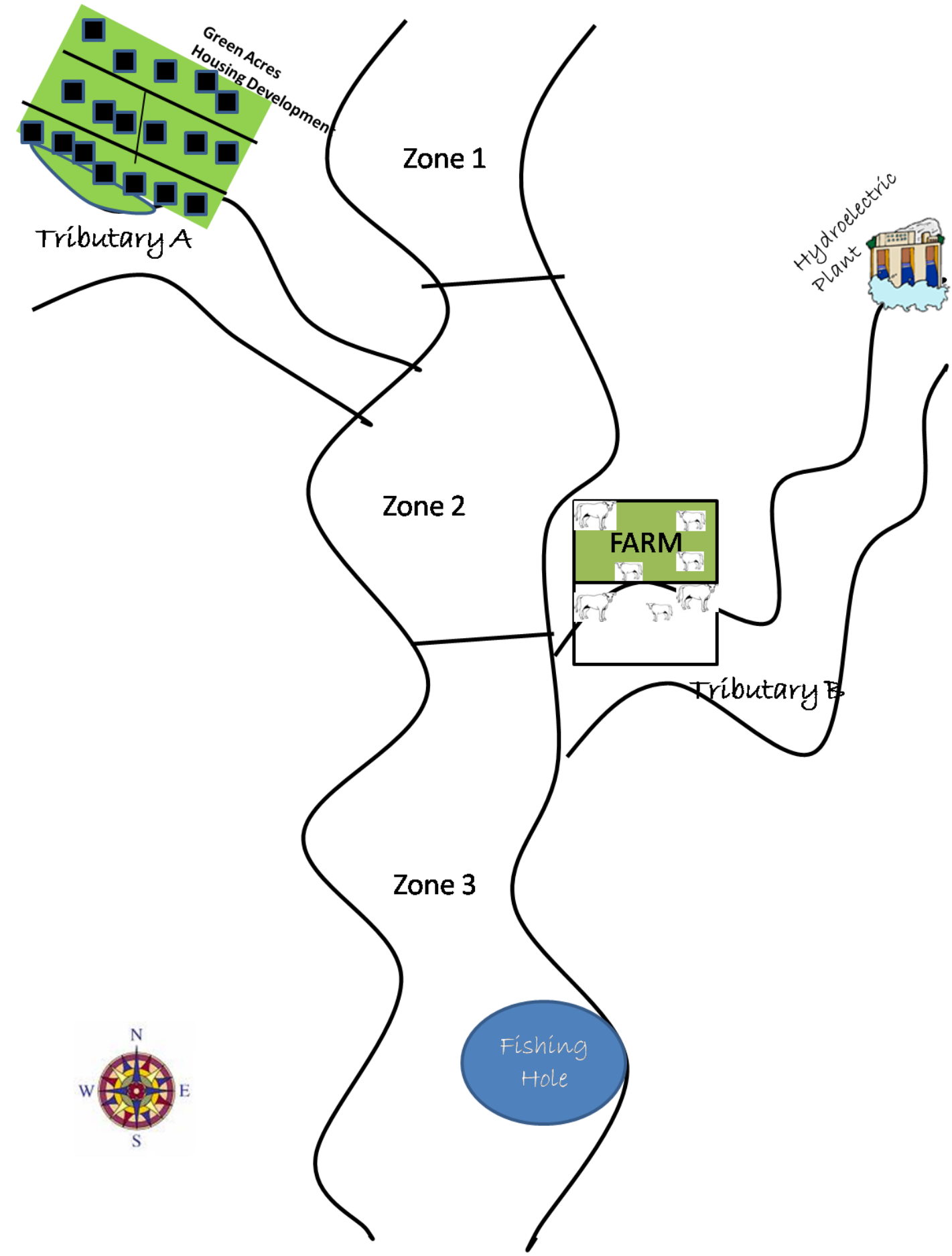
- Audubon Center of the North Woods: Stream Superheroes Lesson Plan
- http://www.waterencyclopedia.com/Po-Re/Pollution-Sources-Point-and-Nonpoint.html
- Creator of Deerfield Dilemma: Emily Lorenzen, Naturalist Intern 2009-2010
- http://www.dnr.state.mn.us/lakescaping/index.html

Deerfield Creek –worksheet NAME: _____



Use this worksheet to take notes and write down any information gathered during your investigation.

Final board design



Quality Indicators

Keep a tally for how many individual organisms of each species your group found within the sample

Group 1 – Pollution Sensitive


Stonefly Nymph


Mayfly Nymph


Caddisfly Larva


Dobsonfly Larva (Hellgrammite)


Water Penny


Gilled Snail Opening to right

Number of Species Found
_____ 3 or more
_____ 1 to 3 Species
_____ No Species Found

Group 2 – Somewhat Sensitive to Pollution


Dragonfly Nymph


Scud


Predacious Diving Beetle


Water Boatmen


Backswimmer


Daphnia


Water Scorpion


Damselfly Nymph


Whirligig Beetle

Number of Species Found
_____ 3 or more
_____ 1 to 3 Species
_____ No Species Found


Orb Snail


Fairy Shrimp


Marsh Treader


Giant Water Bug


Water Strider


Crawling Water Beetle


Cranefly Larvae


Freshwater Mussel


Seed Shrimp


Water Mite

Group 3 – Pollution Tolerant


Phantom Midge Larvae


Horsefly Larvae


Blood Midge


Leech


Mosquito Larvae


Black Fly Larvae


Water Scavenger Beetle


Flatworm (Planaria)


Pouch Snail Opening on Left

Number of Species Found
_____ 3 or more
_____ 1 to 3 Species
_____ No Species Found