Why are the Swans Dying on Lake Coeur d'Alene?
Teacher Narrative

Lesson 1: Why are the swans dying?	**SEP:** Asking Questions and Defining Problems **CCC:** Cause & Effect

Materials:

- Tundra Swan background info slideshow.pdf
- Driving Question Board student handout.pdf

What students are doing:

1. Introduce the phenomenon to the students by giving some background information about tundra swans and how the lakes in Northern Idaho are a common place for them to stop on their journey north each spring. The Tundra Swan background info slideshow.pdf has some images that can be used to guide the presentation.
2. Explain that a large number of swans die each year, but only in the southern part of Lake Coeur d'Alene. You can read this article to familiarize yourself with what is happening, but do not explain why the swans die to students. Tundra swans are dying from historic mine waste in the Coeur d'Alene River Basin | Idaho Fish and Game
3. Prompt students to think about what science questions they would want answered to figure out why the swans are dying. Students work individually for 2 minutes.
4. With their lab groups, students share questions, turn closed questions into open questions, and then rank their questions. Each group should write their top 3 questions on sticky notes (one question per sticky note) and post them on the front board. These form the driving question board for the unit.
5. Keep sticky notes for the duration of the unit and revisit as students answer their questions. Can keep them on a piece of foam board or similar so questions can be kept out of the way until the class period needed.

Lesson 2: Role of swans in the ecosystem	**Standard:** HS-LS-2.5. Evaluate the claims, evidence, and reasoning that Changing the conditions of a static ecosystem may result in a new ecosystem. (Does not fully address this standard) **SEP:** Developing and Using Models **CCC:** Matter and Energy, Systems

Materials:

- Feeding Relationships on Lake Coeur d'Alene student handout.pdf
- Cda Lake food web cards.pdf

What students are doing:

1. Allow students to work through this activity using the food web cards provided. Students create models of a food chain, a food pyramid, and a food web. If students have not had a general biology class yet, the teacher should introduce the vocabulary associated with tertiary levels and the 10% rule of energy transfer.
2. As students create their food web, the teacher should monitor student progress allowing them to revise errors to improve their work. Students will need space to arrange the cards, and to draw, erase, and redraw arrows. Using butcher paper, large whiteboards, or lab tables with dry- erase markers could be options.

   If time allows, have students tour the food webs created by other groups to check for completeness. End the class with a discussion about how removing one organism from a food web affects the whole ecosystem.

Formative Assessment: Completed food web of the CdA lake ecosystem in handout.

Lesson 3: What's in the water?	**SEP:** Obtaining, Evaluating, and Communicating Information

Materials:

- Water samples from Lake Coeur d'Alene near Harrison (scoop up water from the marshy areas near the shore
- Water quality test kit for a variety of heavy metals, nitrates, and phosphates, such as these:
  - Lead Iron Copper and Mercury - Home Water Test Kit for Well Tap and Drinking Water
  - Salifert Nitrate Test Kit
  - Salifert Phosphate Test Kit

What students are doing:

1. Have students work in groups to complete the water quality tests using the samples from Lake Coeur d'Alene. I had 6 lab groups, and each group tested the water for one type of contaminant.
   a. If you have enough supplies, you could have students also test tap water to compare the results with the lake water.
2. Have students post their results on the board, or on a large piece of chart paper. Then share with students the values in healthy drinking water (figure 1), or have them research (results can be found on the EPA website). Have students determine what contaminants are in Lake Coeur d'Alene.
   a. Each time I have done this activity the water has tested positive for lead and phosphates.
3. Lead a class discussion about the dangers of the contaminants in the lake, and have the class come to a consensus about which is the most damaging for animals. Have students share their background knowledge about where each of the contaminates comes from, how it could have gotten into water, and how each affects the health of animals. If they don't know about the dangers of lead poisoning, you can share that it is a neurotoxin, or have them read this report from the USGS: USGS Fact Sheet: Lead Poisoning in Wild Birds

Students have figured out: Swans are dying from lead poisoning.

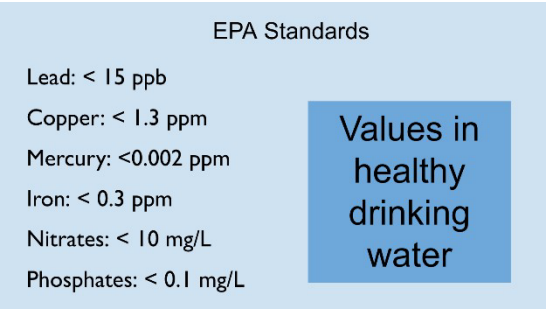

Figure 1

Lesson 4: Where is the lead coming from?	**Standard:** HS-ESS-2.5. Plan and conduct an investigation of how the Chemical and physical properties of water contribute to the mechanical and chemical mechanisms that affect Earth materials and surface processes.
	SEP: Obtaining, Evaluating, and Communicating Information

Materials:

- Video: Where we get our fresh water
- Water Supplies article .pdf

What students are doing:

1. Ask students about their ideas where the lead could be coming from using a Think-Pair-Share technique. After students have shared their ideas, guide the discussion towards the different locations of freshwater in North Idaho.
2. Show the TedEd video Where we get our fresh water (3:45 min). Explain that North Idaho has two sources of water: groundwater in the the Spokane Valley - Rathdrum Prairie Aquifer, and surface water in the lakes, rivers, and streams.
3. Students read Water Supplies article .pdf and answer the guiding questions.
4. Lead a class discussion about student's initial ideas from the beginning of the lesson, and if what they learned has changed.

Formative Assessment: Correct answers on student worksheet from Water Supplies article.

Students have figured out: The contamination in Lake Coeur d'Alene could be traveling through either freshwater or groundwater.

Teacher note: *The next lessons address groundwater first and surface water second. The order of these can be changed depending on the student's interest and questions.*

Lesson 5: Aquifer Model	**Standard:** HS-ESS-2.5. Plan and conduct an investigation of how the chemical and physical properties of water contribute to the mechanical and chemical mechanisms that affect Earth materials and surface processes. **SEP:** Planning and Carrying Out Investigations **CCC:** Stability and Change

Materials:

- Model an aquifer student handout.pdf
- Create a Model Aquifer.pdf Slideshow
- Clear plastic shoebox size containers - 1 per group
- Gravel (white aquarium gravel works best for viewing different colors of water) - each group needs enough to fill up bottom ¼ of shoebox container
- Water colored blue to make it easier to observe in the model.
- Water colored red to represent pollution
- Beakers of various sizes
- Small disposable plastic cup (4 oz), with small holes poked into bottom and around edges (such as with a dissection probe) - 1 per group
- Pipette, syringe, or turkey baster - 1 per group
- Colanders - not necessary, but makes clean up between classes much easier.

What students are doing:

1. Have students set up a model aquifer using a clear plastic container and aquarium gravel.

Teacher note: *There are many different ways to set up the model depending on the supplies you have. Some different instructions that could help:*

   a. *Instructions For Building A Three-Pump Shared Aquifer Model*
   b. *How to build a model of an aquifer*
   c. *Confined Aquifer Model*

2. Students can work at their own pace by following the directions in the Create a Model Aquifer.pdf Slideshow, or complete one step at a time following teacher directions. Students should observe the water table raising and lowering, and pollution moving from land into a lake, and should record their observations after each step on the Model an aquifer student handout.pdf.
3. Circulate around the room and prompt students to consider the speed with which pollution travels through groundwater compared to within a lake.

Students have figured out: Pollution travels slowly through groundwater. Groundwater eventually transfers pollution to nearby bodies of water.

Lesson 6: Watershed Boundaries	**Standard:** HS-ESS-2.5. Plan and conduct an investigation of how the chemical and physical properties of water contribute to the mechanical and chemical mechanisms that affect Earth materials and surface processes. **SEP:** Planning and Carrying Out Investigations **CCC:** Stability and Change

Materials:

- White paper
- Cardboard
- Brown, black, and blue water-soluble markers
- Spray bottles of water
- Graph paper

What students are doing:

1. Have students make models of watersheds following the procedures in Watershed Boundaries**.**
2. Explore maps of Idaho, and have students predict where watershed boundaries are, and where water flows. Do not give students maps of Lake Coeur d'Alene and the surrounding area yet (they will do this in a few days).

Students have figured out: In a watershed all water drains to a single point. Watersheds are defined by elevation.

Lesson 7: Stream Table Lab	**Standard:** HS-ESS-2.5. Plan and conduct an investigation of how the chemical and physical properties of water contribute to the mechanical and chemical mechanisms that affect Earth materials and surface processes. **SEP:** Planning and Carrying Out Investigations **CCC:** Stability and Change

Materials:

- Stream Tables (or make your own using rectangular roasting pans, rectangular plastic storage boxes, or plastic flats from a greenhouse. Poke a drainage hole in one end of each container so that water can drain.
- Sand
- Buckets to catch draining water (or access to sinks)
- Blocks to represent houses
- Rocks or small sticks to represent landscape features and trees
- Red food coloring
- Watering cans or water pitchers

What students are doing:

1. There are several ways to set up a stream table lab depending on the space and resources you have. Some websites that describe the set up and various activities include:
2. Stream Table - Science Friday
3. Lesson Plan: Stream Table Investigation
4. Build Your Own Stream Table
5. Students should set up a scenario in which water flows from a mountain stream into a lake, and observe erosion and deposition of sediments. When they have a scenario that models this, have students add pollution by placing drops of red food coloring near the banks of the stream at the top of the mountains.
6. Circulate around the room and prompt students to consider the speed with which pollution travels through surface waters into a lake. After cleaning up, lead a class discussion about how pollution moved through this ecosystem model, and the limitations of this model.

Teacher note: *I did not have students record observations during the lab activity because their hands were wet and sandy.*

Students have figured out: Sediments travel downstream with surface water.

Lesson 8: Pollution in Surface and Groundwater	**Standard:** HS-ESS-2.5. Plan and conduct an investigation of how the chemical and physical properties of water contribute to the mechanical and chemical mechanisms that affect Earth materials and surface processes.
	SEP: Obtaining, Evaluating, and Communicating Information **CCC:** Patterns

Materials:

- Pollution in Surface Water and Groundwater.pdf
- Watershed Maps.pdf
- Map Observations Handout.pdf

What students are doing:

1. Before class, set out Watershed Maps.pdf around the room. Number each map (write in the corner or with a sticky note) so students can reference each individually in a discussion. Larger area maps or atlases can be used to supplement these documents.
2. Students read the article Pollution in Surface Water and Groundwater.pdf, and answer the guiding questions.
3. Students make observations of the Watershed Maps.pdf by rotating around the room individually and recording their observations on the Map Observations Handout.pdf.
4. Students meet with their groups, and discuss where they think the lead pollution came from (surface water or ground water).
5. Lead a class discussion, calling on each group to share their prediction.

Formative Assessment: Student predictions area based on evidence from maps.

Lesson 9: A Dangerous Cocktail	**Standard:** HS-ESS-2.5. Plan and conduct an investigation of how the chemical and physical properties of water contribute to the mechanical and chemical mechanisms that affect Earth materials and surface processes. **SEP:** Developing and Using Models **CCC:** Stability and Change

Materials:

- A dangerous cocktail threatens the gem of North Idaho.pdf
- Butcher paper
- Colored pencils

What students are doing:

1. Students read the article A dangerous cocktail threatens the gem of North Idaho.pdf. Use guided reading techniques of your choice. Consider reading the article out loud to students, pausing to discuss important points and ask probing questions.
2. Lead the discussion to include why only the swans are affected by the lead, and how the mass of lead means it is only in the sediment, not in the water (show its position on the periodic table).
3. Have students work with their lab groups to create a diagram that explains why the lead is in the sediments of Lake Coeur d'Alene, and what will happen if an algae bloom happens. Have students use the periodic table to look up the symbols for lead and phosphorus, and use arrows to show movement.
4. If time allows, have students tour the room and give constructive feedback. Models can then be adjusted, or a class discussion can be used to determine what makes models clear, and how they can be improved in the future.

Formative Assessment: Diagram models lead in water, and what will change if there is an algae bloom.

Students have figured out: Why the swans are dying, and why other birds are not affected.

Lesson 10: Water Quality Case Study	**Standard:** HS-ESS-2.5. Plan and conduct an investigation of how the chemical and physical properties of water contribute to the mechanical and chemical mechanisms that affect Earth materials and surface processes. **SEP:** Analyzing and Interpreting Data **CCC:** Patterns

Materials:

- Water Quality Case Study.pdf

What students are doing:

1. Have students observe the data tables, and identify patterns they observe in the data in the Water Quality Case Study.pdf.
2. Lead a class discussion about how to best represent the patterns they found in a simple way. If students are having trouble coming up with ideas you can suggest averaging the data for each test site, graphing only 1-2 test sites, etc.
3. Have students choose one of the ways the class suggested to simplify the data. Then students share their graph with someone else in the room, and see if they can recognize more patterns.

Formative Assessment: Correct representation of data in a graph.

Students have figured out: The amount of nitrates and phosphates increase in a lake after a storm.

Lesson 11: Wildlife Hazards Management Plan	**Standard:** HS-LS-2.6. Design, evaluate, and/or refine practices used to manage a natural resource based on direct and indirect influences of human activities on biodiversity and ecosystem health.
	SEP: Constructing Explanations and Designing Solutions, Obtaining,
	Evaluating, and Communicating Information
	CCC: Systems

Materials:

- Swans Final Project.pdf
- Posterboard or butcher paper
- Chromebooks
- Markers and colored pencils

What students are doing:

1. Students will design a way to temporarily keep swans away from the most contaminated parts of Lake Coeur d'Alene. See page 1 of Swans Final Project.pdf.
2. Read students the scenario, then give groups time to brainstorm using pages 3-4 of Swans Final Project.pdf.
3. Have students work with partners or their lab groups to research one idea, including costs and the effects on the ecosystem. Students can create a poster or a digital (slideshow) presentation depending on your resources. This part of the lesson may take 3-4 days.
4. When presentations are complete, display them around the room, and have students read each of the solutions. Then students should choose two of the projects, and evaluate them using the form on page 5 of the Swans Final Project.pdf.
5. A grading rubric is supplied on page 6 of Swans Final Project.pdf.