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| **Water Dawgs Lesson Plan**  **Topic: Bacterial Monitoring**  **Learning Module #12** | | | |
| **Lesson Objectives(s):** | | * SWBAT define: coliform, fecal coliform*, E. coli.* * SWBAT describe how bacteria and *E. coli* enters stream ecosystems. * SWBAT conduct Adopt-A-Stream bacterial monitoring protocols. | |
| **Associated NGSS Standard(s):** | | N/A | |
| **Associated A.P. Environmental Science Standard(s):** | | N/A | |
| **Materials:** | | * PowerPoint * Printed materials:   + Lesson worksheets (WS) – 1 copy per student   + Bacterial Data Form – p. 34 of Handout 1 (H1) ­– 1 copy per student   + Bacterial Monitoring Directions pp. 23-29 of Handout 1 (H1) – 1 copy per student * Materials for bacterial sampling collection and plating:   + Whirl-pak bags (~4 bags)   + Cooler with Ice   + Cup(s) to hold Whirl-pak bags   + 3M Petrifilm E. coli plates (~4 plates)   + 1mL pipette and sterile tips (1 per every 2 students)   + Incubator   + Sharpie   + Safety glasses   + Lysol spray   + DI water   + Gloves * Access to computers for EXPLORE activity | |
| **Instructor to do before lesson:** | | * Print:   + Lesson worksheets (WS) – 1 copy per student   + Bacterial Data Form – p. 34 of Handout 1 (H1) ­– 1 copy per student   + Bacterial Monitoring Directions pp. 23-29 of Handout 1 (H1) – 1 copy per student * Review PPT/Lesson plan * Test videos to ensure both are still available and that visual/audio works. * *NOTE: If the E.coli in the Chattahoochee video has been taken down or no longer works, there is a written version of the news story within the folder for this lesson (H2)* * Go to Chattahoochee River Keeper and BacteriALERT websites and ensure websites are still it the same format (so that students will be able to answer all questions in the activity). * Secure computer lab or computers for student use during EXPLORE activity * Collect control sample and stream sample from the study stream for the Bacteria Monitoring. This should be done within 24 hours of the activity, but ideally <6 hours before incubation begins. * Turn on incubator before class – see Petrifilm directions to know what temperature to set incubator to. * Collect supplies for bacterial monitoring. | |
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| **Part of Lesson** | **Time** | **Duration** | **Lesson** |
| **ENGAGE** | 1:00 | 20 min | Opening Activity  \*\*Pass out lesson worksheets (WS)  \*\*Tell students that today, we will be learning more about *E. coli* and how to sample for *E. coli* in our waterways.  \*Students will answer the following questions as a think, pair, share:  Question 1: What do you already know about E. coli? (For example, why is it a problem? How do humans contract E. coli? Have you ever heard about it in the news?)  Feel free to write down information that you learned this in the previous lesson, or things you already knew.  ^^Allow students 5-10 minutes to write their response on their lesson worksheets, 3 minutes to share their responses with a partner, and ~7 minutes to discuss the question with the class. |
| **EXPLORE** | 1:20 | 1 hour | *E. coli* in the Chattahoochee  \*\*Tell students that in the next activity, we will be exploring E. coli concentrations in the Chattahoochee river. Ask students if they know they location of the Chattahoochee River.  \*\*Show location of the Chattahoochee River on PowerPoint.  \*\*Next, play the following news video clip from WSB-TV Atlanta (Air date: October 7, 2021).  <https://www.wsbtv.com/news/local/atlanta/rain-raises-e-coli-levels-chattahoochee-dangerously-high-levels/3PYOXDOHYJFBHKSYS4QK7VXE6I/>   * *NOTE – if the video has been taken off the website, there is a written version of the news story within the folder for this lesson (H2)*   \*\*After the video plays, discuss the following questions as a class:   1. How high were the *E. coli* concentrations in the Chattahoochee in October 2021? 2. How is *E. coli* and other bacteria entering the Chattahoochee? (hint: there are two ways) 3. Why do swimmers need to avoid the Chattahoochee when *E. coli* levels are above the designated standard?   ^^Allow 10 min for video and discussion  \*Next, students will visit the Chattahoochee Riverkeeper’s BacteriALERT page (mentioned at the end of the video) to explore realtime *E. coli* data.  *🡪 NOTE: We suggest guiding students to the website on a main screen, and then letting them answer the guided questions on their own.*  Directions for accessing the Chattahoochee BacteriALERT page:   1. Go to Google 2. Type in “Chattahoochee RiverKeeper” 3. Click on website (Chattahoochee.org) 4. Along the top panel on the main page, scroll over “Our Work” 5. Under “Our Work”, click “Water Quality Monitoring” 6. Scroll to the bottom of the page. Click on “View BacteriALERT Data”   \* Once students access the website, they will have 40 min to follow the guiding directions/questions on their lesson worksheets (WS).  ^^Allow students 40 min to access website, explore website, and answer the guided questions.  \*\*Discuss guided questions from the lesson worksheet with the students  ^^Allow 10 min for activity discussion |
| BREAK | 2:20 | 15 min | BREAK |
| **EXPLAIN** | 2:35 | 20 min | All about bacteria!  \*\*Lead students through informational slides on bacteria/coliforms/E. coli. Encourage students to ask questions and take notes as you talk.  **Slide 1** (the slide builds)  What are bacteria?   * Microscopic-single celled organisms. * They can survive and adapt to almost all conditions present on earth * Most bacteria are beneficial and responsible for important environmental processes like decomposition, nutrient cycling, and the breakdown of environmental toxins. * However, some bacteria are pathogenic (or disease causing).   **Slide 2** (the slide builds)  What are coliform bacteria?   * Coliform bacteria are members of the Enterobacteriaceae family. * Some are found naturally in soil, some types live in the intestinal tract of warm-blooded animals. * The types that are found in human and animal wastes are called fecal coliform bacteria.   **Slide 3** (the slide builds)  What is *E. coli*?   * *Escherichia coli* (*E. coli*) is one subgroup of fecal coliform bacteria. * Even within this species, there are many strains. Some are harmless and some are pathogenic. * *E. coli* is a useful indicator bacteria. It is an indicator of fecal contamination – but their presence does not necessarily mean pathogens are present! (That is because many strains of *E. coli* are non-pathogenic!!) * However, if *E. coli* bacteria are present at high concentrations, there may be risk to human health   **Slide 4** (the slide builds)  How does *E. coli* get into waterways?   * Non-point source pollution   + Animal fecal matter is on land (dog parks, dairy farms, land application of animal waste, poultry operations, geese in parks, etc.). When it rains, runoff can carry this fecal matter into streams and rivers. * Point source pollution   + Failing septic tanks   + Leaking sewer lines   + Wastewater treatment plants   **Slide 5** (the slide builds)  How does *E. coli* affect human health?   * Higher the bacterial levels = higher risk of gastroenteritis   + Vomiting, diarrhea, fever, nausea, stomachache; skin infections; and respiratory, eye, ears, nose, throat infections * Excessive levels of *E. coli* may indicate presence of harmful pathogens such as:   + *E. coli* 0157   + Salmonella   + Shigella   + *Cryptosporidium*   + Giardia   + Hepatitis A   **Slide 6**  Recommended *E. coli* standards for recreational waters (see chart)  ^^Allow 20 min for PPT/notes. |
| **ELABORATE** | 2:55 | 1 hour | Bacterial Monitoring Protocols  \*\*Pass out:   * Bacterial Data Form – p. 34 of Handout 1 (H1) ­– 1 copy per student * Bacterial Monitoring Directions pp. 23-29 of Handout 1 (H1) – 1 copy per student   \*\*Tell students that there are 5 steps to the bacterial monitoring process:   1. Prepping the blank/control sample 2. Collecting site samples in the field 3. Plating your samples 4. Incubating 5. Reading the results   The instructor has already completed steps 1 and 2. Today in class, we will be completing steps 3 and 4. We will complete step 5 tomorrow afternoon.  Materials needed  To collect:   * Bacterial data form (p. 34 of H1) * Boots * Whirl-pak bags * Gloves * Sharpie * Cooler with Ice   To plate/incubate:   * Cup to hold Whirl-pak bags * 3M Petrifilm E. coli plates * 1mL pipette and sterile tips * Incubator * Sharpie * Safety glasses * Lysol spray   \*\*Next, go over steps 1-2 with the students, explaining how you (or someone else) collected the blanks and the samples.  Step 1: prepping the blank/control sample  **\*\*First, make sure to review:**  --What is a blank/control sample?  *\*\*Wait for student response.*  For bacterial monitoring, it’s when the scientist fills a sample bag with distilled water instead of sample water.  --Why might we need a blank/control sample?  *\*\*Wait for student response*  A control sample will ensure that you are practicing sterile (clean) techniques and that your samples are not contaminated.  Lab analysis of the blank should result in zero reading for bacteria. If it is contaminated, you will need to discard all of the samples!  \*\*Go over steps for collecting a blank/control in the field (see PPT or handout for exact directions)  Step 2: Collecting site samples in the field  \*\*Go over the steps of how to collect a sample in the field (see PPT or handout for exact directions)  **\*\*Then, make sure to review:**  --Why do you want to sample upstream from where you are standing?  *\*\*Wait for student response*  To make sure you are not collecting water after sediment has been disturbed.  Pipette Review  \*\*Next, explain that in order to complete step 3 (plating your samples), students will need to know how to use a pipette.  \*\*Ask students if anyone has used a pipette before.  \*\*Review what pipettes are and why we use them.  \*\*Then, play the following YouTube video that reviews how to use pipettes:  <https://www.youtube.com/watch?v=8Afh_0IAfrQ>  \*\*Have students practice using pipettes with distilled water following these steps:   1. Set/check the volume 2. Put a tip on your pipette 3. Depress the plunger (1st stop) 4. Withdraw the solution 5. Expulsion of the solution (1st stop then 2nd stop) 6. Discard the tip     Step 3: Plating your samples  **\*\*First, make sure to review:**  --What is petrifilm?  Petrifilm is a plate that is covered with a certain agar. The agar turns the E. coli colonies blue and the coliform colonies red. The top film captures gas produced by the colonies.  \*\*Split students into 3 groups. Each group will plate one sample (for a total of 3 reps).  Each plate label should include:   * Stream name * Rep number * Incubation start date * Incubation start time   \*\*Go over steps for how to plate samples.  (See PPT or handout for exact directions)  Step 4: Incubating your samples  **\*\*First, make sure to review**  --What is an incubator? Why do we use them?  *\*\*Wait for student response*  An incubator is a heated, insulated box used to grow and maintain microbiological or cell cultures. The incubator maintains optimal temperature, humidity and gaseous content of the atmosphere inside.  \*\*Go over steps for incubating the samples (see PPT or handout for exact directions)  \*\*Take students to incubator to show them. Let them place samples in the incubator.  \*\*Clean up lab space with 10% bleach solution  ^^Allow 1 hour for entire activity. |
| --BREAK | 3:55 | 15 min | BREAK |
| **EVALUATE** | 4:10 | 20 min | Closing Activity  \*\*Have students answer questions on their lesson worksheets (WS):  **Scenario**: Imagine that you are volunteering for the Upper Oconee Watershed Network (a citizen science group). You are measuring *E. coli* levels in rivers and streams around Athens during early Fall months. You go to sample a popular swimming hole, which is at the intersection of Barber and McNutt creeks. The swimming hole is located near a park where many people walk their dogs. You find *E. coli* concentrations in the swimming hole to be 450 cfu/100 mL. You look back and past UOWN data and realize this site has a history of having high (above EPA standard) *E. coli* concentrations.  Answer the following questions:   1. How would you plan to communicate your findings with local citizens? 2. You are asked to give advice to the park managers about what they could do to help decrease E. coli concentrations to the creeks and swimming hole. What would you suggest?   ^^Allow students 10 min to write responses on their lesson worksheets. If time remains, student can share their answers. |