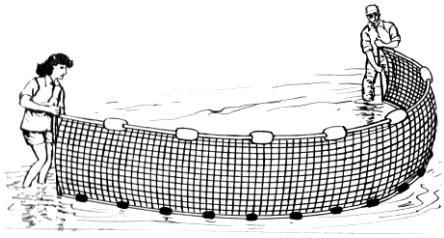
Lesson: Water's Living Things: Seining and Water Quality Testing

Arlington Echo works to continuously improve our lessons. This lesson may be modified over the course of the school year.

Environmental Literacy Question: How have humans affected the Chesapeake Bay and its watershed?



Topic/Essential Question: How does the health of our waterways affect the organisms that live in them? How can we measure the health of our waterways?

Unit/Lesson Sequence: One of two lessons in the "Water's Living Things" 4th grade module based at Arlington Echo Outdoor Education Center.

Content Standards:

- **Environmental Literacy**
  4.A.1.b. Explain and demonstrate food webs for a particular environment.
  5.A.1.Analyze the effects of human activities on earth's natural processes.
  8.F.1.b. Identify actions that can be taken as individuals and those that require the involvement of other people, organizations and government.
- **Science**
  3.F.1.a. Identify and describe the interactions of organisms present in a habitat.
  6.B.1. Recognize and describe that people in Maryland depend on, change, and are affected by the environment.
  3.A.1.b. Classify a variety of animals and plants according to their observable features and provide reasons for placing them into different groups.
- **Common Core Standards for English Language Arts Standards-**
  Speaking and Listening-4th Grade
  Comprehension and Collaboration
  CCSS.ELA-Literacy.SL.4.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

Length of Lesson:
45 minutes
*subject to change based on group size

Student Outcome: The student will evaluate Indian Creek's suitability as a wildlife habitat based on physical water quality and the abundance of wildlife present.

Knowledge of the Learner:

- Prerequisite knowledge, skills, and processes: the functions of different members of a food web. The comprehension that different organisms can tolerate different levels of water quality.
- Student needs, interests, previous learning: these will be determined during the pre-assessment.
- Conceptual difficulties: understanding how human actions on the land can affect the quality of the water.
- Differentiated: The lesson will reach different types of learners. Naturalist and kinesthetic learners

will benefit from the hands-on experience of using scientific equipment and studying living organisms. Logical/mathematical, interpersonal, and intrapersonal learners will learn by interpreting, reflecting on, and discussing the collected data.

Knowledge of Content:

- Content knowledge for activity leader: Provided in the Lesson Plan and Supplements.

- **Vocabulary:**

Fishable	Swimmable	Drinkable	Turbidity
Dissolved Oxygen	Salinity	Producer	Consumer
Seine Net	Aerator		

- **Resources:**

PFD for each child and adult	Waders
Turbidity tube	Plastic aquarium for specimens
Salinity meter	Aerator
Thermometer	Fish fact cards
Dissolved oxygen test kit	Seine net
Dip nets	Water Quality Poster
5 gallon bucket for water	Portable wifi router
iPad	

- **Supplements:**
  A: Using the Seine Net
  B: Indian Creek Assessment Guide
  C: Water Quality Information Sheet
  D: Water Quality Testing Instructions
  E: Sample Report Card Poster
  F: Vocabulary

Lesson setup:

Move the waders from the S-hooks and lay them along the wooden wall by size (written on the front) with the front of the waders facing out. Collect the teaching materials from the shed at the end of the boat pier – plastic aquarium, fish fact cards, water quality poster, dip nets, seine net, turbidity tube, thermometer, salinity meter, dissolved oxygen test kit, and two buckets.

Collect water from the creek in plastic containers with aerators to hold any organisms caught while seining. Place the thermometer in the water at the end of the pier. Before each lesson, ask a student volunteer or chaperone to fill one bucket about ¾ full with water from Indian Creek for turbidity, salinity, and dissolved oxygen tests. Pull up the oyster basket and set it in a tray on the end of the dock. Place another tray of water beside it.

Instructional Delivery

Module Introduction: All students and activity leaders will meet at the porch behind the Dining Hall. Arlington Echo staff will inform students about PFDs and hand them out to students and chaperones. Each student must keep their PFD on for the duration of the activities unless otherwise instructed. Adults must wear a PFD if they go into the water. Arlington Echo staff will discuss with students ways to behave safely down at the waterfront (no running, wearing a PFD, paying attention to instructions, leaving small rocks on the ground).

Set-up

1. Introduce yourself and ask students to take a seat on the lower ledge facing the water. Ask chaperones to help you pass out waders to students approximately based on shoe size (size 4 or 5 for the smallest students, 6 fits most students, 7 or above for larger students).
2. Explain the proper procedure for putting on a pair of waders:
    - *Sit down and take off your PFD and place it behind you.*
    - *Remove one shoe, slide that foot all the way into the boot of the waders (make sure the waders are facing the correct way); remove the other shoe and slide that foot all the way into the other boot of the waders. Keep socks off the ground the whole time; this helps keep dirt out of the waders.*
    - *Once both feet are in the boots, stand up and pull waders up and over the shoulders. Fasten straps*. (*Do NOT try to jump up and down to pull on the waders.)*
    - *Put on PFD over the waders.*

    Tip: activity leaders should put on waders before the lesson begins. Students often need assistance when putting on waders. Ask chaperones to help as well.
3. Make sure that each student securely fastens their PFD over their waders. The students must keep their PFD on for the duration of all waterfront activities.
4. Chaperones may put on waders if they wish to seine. Adults must wear a PFD when seining.

Engage:

1. Ask the students how they think human land use affects living things and their habitats in the Chesapeake Bay.
    a. ***Negative effects:*** *Polluted runoff can harm aquatic habitats; fertilizer and pet waste can cause algal blooms and dead zones in the water; stormwater runoff can carry salt from roads into waterways; removal of forested areas, wetlands, and living shorelines destroys critical habitats and intensifies erosion.*
    b. ***Positive effects:*** *The creation of living shorelines provides habitats and prevents erosion; utilizing rainscaping techniques such as rain gardens, bioretention areas, green roofs, and rain barrels controls stormwater runoff; protecting and restoring forest and wetland areas preserve habitats, control erosion and runoff, and filters out pollutants.*
2. Explain to students that we will be exploring and testing the waters of Indian Creek.
    - When a body of water is healthy enough to support life we consider it **fishable**; when a water body is clean enough for people to swim in we consider it **swimmable** *(Clean Water Act)*
    - In this activity, we will be testing to see whether or not Indian Creek is **fishable.**

Explore:

If groups are larger than 10, divide the students into two groups: one group will focus on seining while the other group will perform water quality tests. Halfway through the lesson, the groups will switch so that everybody has a chance to complete each part of the lesson.

- At least one activity leader should be in the water with the seiners while the other(s) help the water quality testing group. An adult should always be the first one into the water and the last one out of the water.
- Allow 15-20 minutes for one group to seine while the other tests water quality. Switch and allow 15-20 minutes to complete the second activity.

Seining:

1. Lead students onto the dock.
2. Discuss the conditions of the water and where the students can and cannot go while they are investigating *(this will be communicated to activity leaders from Arlington Echo staff during morning training based on water conditions that day).*
3. Before entering the water, remind students to take small steps and shuffle their feet to avoid tripping (walk like a penguin); tell them to NOT run, swim, or bend/sit down in the water.
4. Demonstrate the proper technique for using a seine net **(Supplement A)** and a dip net**.**
5. Lead students into the water. At least one adult must be in the water any time students are in the water (chaperone and/or activity leader).
6. Two students (or one adult and one student) can use the seine net while the rest use dip nets. *Remind students with dip nets that many of the organisms they are trying to catch use the grasses for shelter, so while the students may be tempted to use their dip nets in the open water, they will be more successful closer to shore.*
7. When organisms are caught, assist students in transferring them to a plastic container with an aerator (for oxygen). *If aerator stops working, please let AE staff know immediately—animals cannot be left without an aerator. Remind students to wet their hands before handling fish (dry hands can remove the scales and mucus layer that protect the fish from disease).
    - Only adults should transfer crabs and jellyfish with tentacles to the container. Always pick up crabs from the back, behind their swim fins to avoid being pinched. Always hold jellyfish by the top, being careful to avoid the tentacles.
8. If time allows, give each student the opportunity to use both seine and dip nets.
9. Allow the students to search for organisms in the oyster shells. Students can transfer the oyster shells from the basket to the empty bin. Make sure they look closely at the shells (some organisms are very small).
10. Give students time to examine what is collected, using fish cards for identification. Students should also take note of any other living things they see around them (birds, plants and animals).
11. Allow students a few minutes to change out of their waders before moving on to water quality testing or to their next activity.

    If there is a limited catch or if you find anything unusual, keep specimens in buckets with aerators for next groups just in case they don't find anything.

Explain:

Students will be testing the water quality to determine the health of the creek and to explain why we found the animals we did while seining.

Water Quality Testing

1. Instruct students to take a seat at the table for water quality testing. Students must keep their PFDs on the entire time they are at the waterfront. (If students have come from seining, they no longer need to wear waders, if they have not seined yet they should have waders on.)
2. Explain to students that they will take four different measurements of water quality to determine if Indian Creek is fishable (healthy enough to support life).
3. Before EACH test, discuss with students: **(Supplements B and C)**
    - What the test is measuring and why it is important
    - What levels of the measurement classify the water as healthy ("fishable") and how these levels vary for different species

- The different factors (human or natural) that may affect this water quality measurement

4. For the following tests, record all results both on the Indian Creek Waterfront Report Card Poster and on the iPad. **(Supplements D and E)**.
    a. Perform the dissolved oxygen test first, since it takes a while for results to show. Add 2 tablets to the vial and then use the bucket of water collected at the beginning of the lesson to fill the vial with water and cap the vial while it is still underwater (to prevent air from getting in). Ask a student to turn the vial over 10 times and then continue passing it to the next student until fully dissolved (about 5 minutes).
    b. Meanwhile, ask another student to pull the thermometer out of the water, read the temperature and report to rest of group (return thermometer to water). Compare the temperature to the average water temperature on the "Indian Creek Water Quality" temperature graph and decide if result is low, normal or high. Record on the report card poster.
    c. Perform the salinity and turbidity tests using the bucket of water collected at the beginning of the lesson, comparing the results to the "Indian Creek Water Quality" charts for salinity and turbidity.
    d. By now the dissolved oxygen test sample should be ready. Compare results to the dissolved oxygen color chart to determine dissolved oxygen range.
    e. Submit the dissolved oxygen, water temperature, turbidity, and salinity measurements through the survey form on the iPad.

Elaborate:

Water Quality Testing Assessment:

1. Using **Supplements B and C**, review the students' results and compare to the assessment guide. For example, there may be enough dissolved oxygen for the blue crab to live, but the water temperature may be too low – as in winter.
2. Have students discuss and decide whether or not they think Indian Creek is a healthy "fishable" water habitat. Students should also refer to what they found or observed during seining (i.e. if they caught a lot of organisms and saw a lot of birds, Indian Creek is probably fairly healthy). There's no right or wrong answer as long as they can come up with a justification based on what they observed.
3. Based on their findings, ask students to give Indian Creek a grade on the report card poster (A for extremely healthy, F for extremely poor).
4. Ask the students what could be done better or differently on land to help improve the quality of the water. Remind them of the ways human development impacts turbidity, salinity, temperature, and dissolved oxygen.

Evaluate:

Report Card:

What did you test during the seining activity to determine the quality of the river? (*Turbidity, salinity, temperature and dissolved oxygen levels*). Tell the students that every year, people take similar water quality tests all over the Chesapeake Bay and its tributaries in order to give the Chesapeake Bay a report card (just like they get a report card in school). What do you think the grade was 6 years ago in 2011? (Raise hands for A, B, C, etc.)

Show the groups the report card for 2011 and point out how there are more Ds than Cs, there are two Fs and no As or Bs, and the overall grade is a D.
Over time do you think the health of the Bay improved? (Thumbs up for yes, thumbs down for no it's gotten worse, thumbs in the middle for it's stayed consistent). Show them the report card for 2016.

Talking points and good news about the 2016 report:

- Now there are more Cs than Ds, there are no Fs and the overall grade is a C.
- Point out the spots that say DC and BALT and discuss why those rivers may be impaired. *(DC and Baltimore rivers are located near big cities with lots of people and pollution from transportation on roads and waterways, storm water runoff from impervious surfaces, sewage, pet waste, fertilizer, litter, and specifically in Baltimore factories and harbor traffic).*
- Good news—the amount (in acres) of underwater grasses in the Chesapeake Bay and connecting rivers and streams increased by more than 50% (58%) between 2011 and 2015 to over 91,000 acres, the most in over 30 years! Why are underwater grasses important? *(Act as food and shelter for animals, provide oxygen, absorb pollution, prevent erosion near the shore, etc.)Chesapeake Bay Barometer 2016 CBP.*
- More good news—in the past year (from 2015-2016) both the number of young blue crabs and the number of female blue crabs of spawning age (can have babies) increased. Why are blue crabs important? *(Cultural symbol of the Bay, commercial and recreational fishing, part of the healthy food web, etc.) Chesapeake Bay Barometer 2016 CBP.*

Point out the AE sticker: what does this sticker stand for? *(Arlington Echo!)* What grade did the rivers near us at Arlington Echo and Anne Arundel County get? *(D)* Ask students to share their thoughts on this—is it what you were expecting? Are you pleased with that grade? Could we improve the health of our local waterways?

How can we help improve the Bay, specifically near the AE sticker where we live? (*Ride bikes/walk instead of driving cars, carpool, canoe instead of motorboat, pick up litter, reduce reuse recycle, eat sustainably, compost and reduce food waste, pick up pet waste, enjoy the outdoors, save electricity, plant trees, use reusable water bottles, etc.)*

Lesson Conclusion:
After both activities, give the students who seined time to change out of their waders. When the entire group is ready, make sure waders are laid out on the ledge and that all students have their shoes and PFDs on.

Notes for clean up
Please clean, organize and return the lesson materials to the boat shed on the pier at the end of each day of instruction. Waders should be hung up on the hooks to dry. **The last group of students should bring their life vests up to the boathouse after the lesson.** Remember to inform the Arlington Echo Staff if you need assistance or if any materials are damaged or missing.

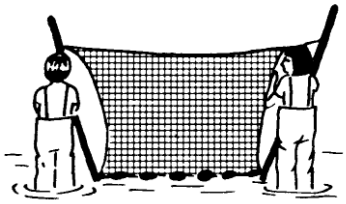
Notes for morning set up (overnight trips):
Remember to set up your materials prior to the mornings activities. If you do not spend the night, please check in with the AE staff assigned to the model and be at your teaching location by 8:45 a.m.

Notes for Inclement Weather:
Arlington Echo encourages keeping our outdoor activities outdoors—even in the rain—but in the case of severe weather (thunder, severe cold, etc.), the rain location for this activity will be in the lower Resource Lab. The alternate activity will be a watershed activity using the AR Sandbox. Students can conduct water quality tests using water that has been supplied by AE staff.

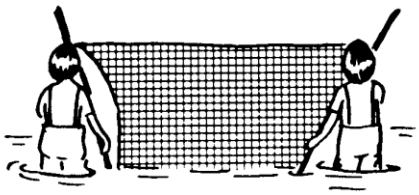
Supplement A:

Using the Seine Net

Step 1. Two students carefully unroll the seine net so the weighted side is in contact with the river bottom.



Step 2. Students walk out to hip-deep water, bumping poles along the bottom and tilting poles about 45 degrees (as pictured).



Step 3. Students stop walking and prepare to raise the net out of the water. Students should count aloud to 3 and coordinate their motions so they each flip their pole horizontally and raise the net out of the water and parallel to the surface of the water in one swift motion on "3".

Step 4. Students on the pier or a third student in the water can assist with getting the catch out of the net with their hands or a dip net. Hands should be wet when handling fish to prevent harming the fish's skin!

Supplement B:

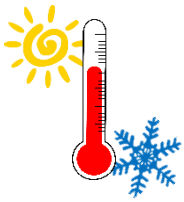
Indian Creek Assessment Guide:

At what levels is Indian Creek fishable?

Species	Dissolved Oxygen	Salinity	Water Temperature	Habitat
 Blue Crab	At least 3 ppm	3-30+ ppt	At least 59 degrees Fahrenheit for growth	Needs grassy areas to hide while molting
 Grass Shrimp	At least 2 ppm	1-2 ppt	Between 50 and 60 degrees Fahrenheit	Needs grassy areas to avoid predators
 Pumpkinseed	At least 6 ppm	0-17 ppt	39 to 75 degrees Fahrenheit	Needs shallow, clear areas to build nests
 Striped Bass	At least 6 ppm	1-11 ppt for young striped bass, up to 30 ppt for adults	40 to 70 degrees Fahrenheit for feeding	Needs grassy, fresh areas to hide when young; moves to saltier water when older
 Inland Silverside	At least 6 ppm	3-5 ppt	50-86 degrees Fahrenheit	Needs grasses for hiding
 Mummichog	At least 6 ppm	1-2 ppt up to over 30 ppt	40-100 degrees Fahrenheit	Needs grasses for hiding

Supplement C:

Water Quality Information Sheet

Measure	What is it?	Why is it important?	What impacts it?
Water Temperature 	The level of heat in the water, measured in degrees Fahrenheit (°F).	Organisms need certain temperatures to survive and reproduce. Rapid changes in temperature can harm species. Temperature also shares a direct relationship with the amount of dissolved oxygen in the water; cold water holds more dissolved oxygen than warm water.	Water temperature naturally fluctuates with changes in season. Human development can also impact temperature because stormwater runoff from surfaces like roads and parking lots enters streams and rivers at a higher temperature to create a warming effect.
Salinity 	A measure of how much salt is in the water, measured in parts per thousand (PPT).	Organisms are adapted to certain levels of salinity (freshwater fish cannot survive in the ocean and ocean species cannot survive in fresh water).	Indian Creek is a fresh body of water but at its mouth, it mixes with the brackish (partly salty) Severn River. Salinity can fluctuate with changes in season, tide, rainfall, and runoff. Humans can impact salinity by salting roads, which gets carried into the water as runoff.
Turbidity 	A measure of how cloudy or murky the water is. Turbid water is high in suspended sediment.	Waterways with high turbidity suffer because sunlight can't get through to the submerged plants below, so they cannot photosynthesize and add oxygen to the water. This harms fish and other species who need dissolved oxygen to survive.	Turbid water is high in suspended sediment like soil eroded from land, and increases after a storm or rain event carries stormwater runoff into the water. Turbidity can also increase with excess bacteria or algae in the water.
Dissolved Oxygen 	A measure of the available oxygen in the water, measured in parts per million (PPM).	Fish and aquatic species need oxygen to survive, just like humans and land animals do. Instead of breathing oxygen through the air with lungs, aquatic species obtain oxygen through the water with gills.	Just like on land, aquatic plants like underwater grasses photosynthesize and produce oxygen in the water. Dissolved oxygen can decrease when plants are blocked from the sun because of high turbidity or algae blooms (from excess nutrients in the water) and cannot photosynthesize. Temperature also affects dissolved oxygen because cold water holds more oxygen, so dissolved oxygen fluctuates depending on the season.
Biodiversity 	The variety of different species in a given environment, and a healthy population of each of those species, measured while seining and observing plants and animals around Indian Creek.	In general, a diverse environment is healthier and more resistant to environmental stresses. Biodiversity is also essential for a healthy **food web** (an inter-connected web of food chains, predator-prey-producer relationships). All organisms need a **diverse** selection of energy sources. (Osprey can eat minnows or pumpkinseed or striped bass or yellow perch or any other of countless fish species).	Overharvesting of aquatic species, habitat loss, the introduction of an invasive species that throws off the balance of the natural food web, algae blooms, litter, natural disasters and disease can all affect biodiversity and result in a lower variety of healthy species in an environment.

Supplement D:

Water Quality Testing Instructions

Dissolved Oxygen Tablets (dissolved oxygen):

Fill the small glass vial with water from Indian Creek. Place two dissolved oxygen tablets into the vial and firmly twist on the cap. Turn the vial end over end for about five minutes or until the tablets dissolve completely. Refer to the dissolved oxygen key to match the color of the water to the dissolved oxygen content in Parts Per Million (PPM).

Water thermometer (Water temperature):

Allow the water thermometer to fill with water so it sinks into the creek and only the top floats at surface level. Hold the line so you don't lose the thermometer. Allow 3 to 5 minutes to get an accurate temperature reading. Read the temperature in degrees Fahrenheit.

Hydrometer (Salinity):

Remove white cap and press the power button. Wait until the screen says 0.00, then place the tip in the water and gently move back and forth until the meter reading stabilizes. This may take a moment. Record the number. The reading is in Parts Per Thousand (PPT).

Turbidity tube (Turbidity):

Collect a sample of water in the provided bucket, being careful not to scrape up excess sediment from the bottom. Hold the turbidity tube upright in the empty bucket under the awning and fill it using the large funnel. Stand so you can stare straight down into the tube. Have someone else slowly release water (by gently pushing down on the tube) at the bottom of the tube. Continue releasing water until the black and white disc (called a Secchi disk) at the bottom of the tube **just** becomes visible (looking straight down, not from the side); and stop releasing water. Measure the water level using the markings on the side of the tube and refer to the turbidity key to determine turbidity.

Remember to submit all water quality measurements on the iPad!

Supplement E: Sample Report Card Poster

Indian Creek Waterfront Report Card

Complete each water quality test and give Indian Creek an overall grade.

Water Temperature:

_____ Degrees F

Low Normal High

Dissolved Oxygen:

_____ ppm

Bad Okay Good

Salinity

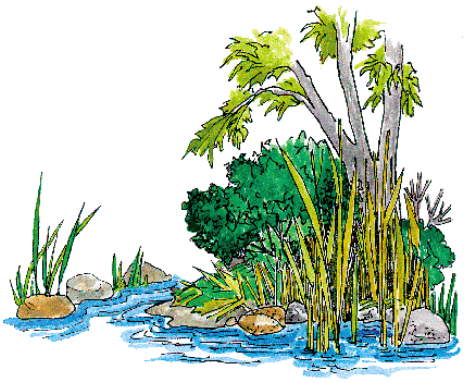
_____ ppt

Low Normal High

Turbidity:

_____ Visible Depth in cm

Bad Okay Good



Water Quality Grade:

Supplement F: Vocabulary

Fishable: a body of water that is healthy enough to support life

Swimmable: a body of water that is clean enough to swim in (little or no harmful bacteria)

Turbidity: a measure of how cloudy or murky the water is; water that is high in turbidity has a high concentration of suspended sediment

Dissolved Oxygen: a measure of the available oxygen in the water (measured in parts per million)

Salinity: a measure of how much salt is in the water (measured in parts per thousand)

Producers: organisms that make their own food using the energy in sunlight

Consumers: organisms that cannot make their own food and instead get energy from the food made by others, through eating other organisms

Seine Net: a fishing net that hangs vertically in the water with its bottom edge held down by weights and its top edge buoyed by floats

Aerator: a device that circulates water to produce oxygen