

WATER QUALITY LESSON – Biological Oxygen Demand (BOD) In A Stream



www.kuaf.com/post/park-service-investigates-algae-buffalo-national-river#stream/0



www.americanrivers.org/2017/11/realities-industrial-farming/



<http://www.kuaf.com/post/hundreds-arkansas-waterways-draft-listed-ecologically-impaired#stream/0>

TOPIC: Biological Oxygen Demand (BOD) in a Stream

AUTHOR: Beaver Water District

CLASS TIME NEEDED:

- One class period (45-60 minutes) explaining the importance of oxygen in the water and how it affects stream health.
- One class period (45-60 minutes) is needed for the lab.
- Wait five days to read the results then have students finish their lab write up. One class period (45-60 minutes) is needed for their presentation.

SUBJECT/GRADE LEVEL: K-12 - Physical Science/Biology/Earth Science/ETS/Environmental Science

ARKANSAS SCIENCE STANDARDS:

Grades K-2

- Physical Science – K-PS3-1, K-PS3-2
- Biology – K-LS1-1, 1-LS3-1, 2-LS2-1, 2-LS4-1,
- Earth Science – K-ESS2-1, K-ESS2-2, K-ESS3-1, K-ESS3-3, 1-ESS1-2, 2-ESS2-1, 2-ESS2-2, 2-ESS2-3
- Engineering, Technology, & Application of Science – K-2-ETS1-1

Grades 3-4

- Physical Science – NA
- Biology – 3-LS1-1, 3-LS3-2, 3-LS4-3, 3-LS4-4, 4-LS1-2
- Earth Science – 3-ESS2-1, 3-ESS2-2, 3-ESS3-1, 4-ESS2-1, 4-ESS2-2, 4-ESS3-2
- Engineering, Technology, & Application of Science – 3-ETS1-2, 4-ETS1-2

Grades 5-8

- Physical Science – 5-PS1-1, 5-PS1-2, 5-PS1-4, MS-PS2-2, MS-PS3-1
- Biology – 5-LS1-1, 5-LS2-1, 6-LS1-5, 7-LS2-2, 7-LS2-5, 7-LS2-1, 7-LS2-4, MS-LS2-5,
- Earth Science – 5-ESS2-1, 5-ESS2-2, 5-ESS3-1, 5-ESS1-2, 6-ESS3-3, 6-ESS3-4 (NGSS: MS-ESS2-2, MS-ESS2-4, MS-ESS3-1, MS-ESS3-2, MS-ESS3-3, MS-ESS3-4, MS-ESS3-5)
- Engineering, Technology, & Application of Science – 5-ETS1-2, 6-ETS1-2, 7-ETS1-2, 8-ETS1-1, 8-ETS1-2, 8-ETS1-4

Grades 9-12

- Physical Science – PSI-LS2-7, PSI-LS4-5, PSI-ESS2-1, PSI-ESS3-1, PSI6-ETS1-1, PSI6-ETS1-2, PSI6-ETS1-3, PSI6-ETS1-4
- Biology – BI-ESS2-2, BI-ESS2-4, BI-ESS2-5, BI-ESS3-5, BI6-ETS1-2, BI6-ETS1-3, BI-ESS3-1, BI-ESS3-2,
- BI-ESS3-3, BI-ESS3-4, BI-ESS3-6, BI7-ETS1-1, BI7-ETS1-4
- Earth Science – ES-ESS2-2, ES-ESS2-5
- Environmental Science – EVS-ESS2-2, EVS-ESS2-3, EVS-ESS2-5, EVS-ESS2-6, EVS-ESS3-5, EVS1-ETS1-1, EVS-LS2-1, EVS-LS2-2, EVS-LS2-6, EVS-LS2-8, EVS3-ETS1-3

LEARNING PERFORMANCE TARGET(S): (learning expectations for this lesson combines a science practice, crosscutting concept and core idea embedded in the lesson)

Students will be able to find BOD used in determining the health of a stream, use lab equipment properly, acquire data and graph, and analyze results.

SCIENCE AND ENGINEERING PRACTICES:

Lab and field work, acquire data, graphing, planning and carrying out investigations, analyzing and interpreting data, asking questions and defining problems.

CROSSCUTTING CONCEPTS:

Structure and Function, Stability and Change

CCSS CONNECTIONS: (include mathematical concepts and reading, writing, speaking and listening opportunities in the lesson)

All exist in this lesson. ELA/Literacy, Mathematics

MATERIALS:

Water samples or creek on site.

Acorn Naturalists Science Supplies - www.acorn-naturalists.com

- Earth Force®, LaMotte GREEN (Global Rivers Environmental Education Network) Introductory Water Quality Monitoring Single 8-Parameter Test Kit for up to 10 Water Samples \$38.95 - www.acorn-naturalists.com/green-global-rivers-environmental-education-network-introductory-water-quality-monitoring-kit.html
- Earth Force®, LaMotte GREEN (Global Rivers Environmental Education Network) Introductory Water Quality Monitoring Multiple Tests Kit for 7-Parameters in 100 Water Samples and Coliform in 44 Water Samples \$258.95 - www.acorn-naturalists.com/green-global-rivers-environmental-education-network-comprehensive-water-quality-monitoring-kit.html

LaMotte – www.lamotte.com

- Earth Force® Low Cost Water Monitoring Kit \$39.95 - www.lamotte.com/en/education/water-monitoring/3-5886.html
- AM-12 (12 Individual Test Modules) TesTabs Water® Investigation Kit \$262.00 (approx. \$21.85 each)- www.lamotte.com/en/browse/5849.html

TEACHER PREPARATION:

Very little preparation is needed if you have a stream on campus. If no stream, then you will need to collect some water samples in advance. Refrigerate your samples if you are not testing BOD immediately.

Remember to time your lab to accommodate for the five-day waiting period on the BOD test results.

The BOD test takes 5 days to complete and is performed using a dissolved oxygen test kit. The BOD level is determined by comparing the DO level of a water sample taken immediately with the DO level of a water sample that has been incubated in a dark location for 5 days. The difference between the two DO levels represents the amount of oxygen required for the decomposition of any organic material in the sample and is a good approximation of the BOD level.

Take 2 samples of water and record the DO level (ppm) of one immediately using the method described in the dissolved oxygen test. Place the second water sample in an incubator in complete darkness at 20 degrees C for 5 days. If you don't have an incubator, wrap the water sample bottle in aluminum foil or black electrical tape and store in a dark place at room temperature (20 degrees C or 68 degrees F). After 5 days, take another dissolved oxygen reading (ppm) using the dissolved oxygen test kit. The BOD level is determined by subtracting the Day 5 reading from the Day 1 reading. Record your final BOD result in ppm.

Use these sites for ordering information. A Google search for dissolved oxygen test kits gives you many options for inexpensive, easy kits to high tech, expensive kits.

BACKGROUND INFORMATION/CONTENT:

Teacher: Acquire a good BOD test kit and read the directions. You can perform this lab in the field or in the classroom. If you collect some water samples and have them for an in-class lab, refrigerate your samples.

Student: Access and read the following to prepare for Biological Oxygen Demand Lab:

- **Water Quality Assessment: Overview** - ecology.wa.gov/Research-Data/Monitoring-assessment/River-stream-monitoring/Water-quality-monitoring/River-stream-monitoring-methods
- **Water Quality Assessment PowerPoints** – See Water Quality Testing PowerPoints in WQ_WATER PROPERTIES_&CHEMICAL_TESTING LESSON SUPPLEMENTS

Good sources for comprehensive understanding of watersheds and water quality:

Classroom of the Future – www.cotf.edu

- Water Quality - www.cotf.edu/ete/modules/waterq3/WQintermpuzzle.html

Beaver Water District - www.bwdh2o.org

- Drinking Water Quality Annual Reports - www.bwdh2o.org/about/regulatory-compliance/
- Lake Data/Beaver Lake Water Quality Annual Reports - www.bwdh2o.org/beaver-lake/lake-data/

United States Environmental Protection Agency (USEPA) - www.epa.gov

- Water Topics - www.epa.gov/environmental-topics/water-topics

Arkansas Game & Fish Commission - www.agfc.com

- Get Involved: On The Water/Arkansas Stream Team - www.agfc.com/en/get-involved/onthewater/streamteam/
- **Center for Innovation in Science & Engineering at Stevens Institute of Technology** - www.k12science.org
 - Global Water Sampling Project: An Investigation of Water Quality - www.k12science.org/curriculum/waterproj/

7E'S BIOLOGICAL OXYGEN DEMAND IN A STREAM

Elicit

Show images from the internet of healthy looking streams and polluted streams. Show images of a fish kill. Research articles about water quality problems where lakes have died or streams have been placed on the state impaired list. Examples provided in list:

- Watch the following video:
 - “Troubled Waters: The Documentary” - Pollution in Florida’s waterways. (www.stjohnsriverkeeper.org/issues/troubledwaters/)
- Locate local water quality articles online and in broadcast and print media (examples below).
 - Arkansas Department of Environmental Quality: Impaired Waterbodies – 303(d) List by Year - www.adeg.state.ar.us/water/planning/integrated/303d/list.aspx
 - Arkansaswater.org - <https://www.arkansaswater.org/water-quality>
 - Buffalo National River
 - Toxic Blue-Green Algae Identified In The Buffalo National River (5newsonline.com/2018/07/27/toxic-blue-green-algae-identified-in-the-buffalo-national-river/)
 - Dissolved Oxygen Monitoring in Kings River and Leatherwood Creek (scholarworks.uark.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1006&context=awrctr)
 - St. Louis Public Radio/Elli Chen: EPA’s plan to clean up Missouri’s lakes may not be strong enough to prevent pollution - www.joplinglobe.com/news/lifestyles/andy-ostmeyer-will-th-century-ways-of-protecting-ozark-rivers/article_2e06b8cc-006a-595f-9f2f-e3426e59e656.html
 - **SCIENCE REPORTS:** February 23, 2017 “Organic pollution of rivers: Combined threats of urbanization, livestock farming and global climate change” - www.ncbi.nlm.nih.gov/pmc/articles/PMC5322379/

Engage

Demonstrate the activity. Have students do the research on troubled bodies of water. What damage was done to wildlife? What were some solutions involved in the restoration?

Explore

Have the students form teams for investigation. Move the students to the lab location and collect their samples and begin the testing. Have the students record their observations and data collected.

Explain

Have the students interpret their data, graph their results, and list possible sources of the problem. Have the teams present their findings to the class.

Elaborate

Have questions for the teams during their presentation. Identify other streams or sources of depletion of oxygen. What could cause oxygen depletion in agricultural or urban settings?

Evaluate

Assess the student's lab skills, team work, presentation, and with a unit test.

Extensions

Combine this lab with full array of chemical tests and biological testing to determine total stream health.