Lesson Plan: Aquatic Macroinvertebrates of Obed Wild and Scenic River

Grades: 5-8

Stage 1: Desired Results:

Understandings:

Students will understand that…

- National parks are special places for everyone to enjoy. They protect the environment including plants and animals.
- The Obed is home to many different species of aquatic macroinvertebrates.

Essential Questions:

- What is the life cycle of an aquatic macroinvertebrate?
- What can studying the aquatic macroinvertebrates of the Obed River tell us about the environment surrounding the river?

Students will know…

- There is a link between land use activities within a watershed and water quality.
- There is a link between aquatic macroinvertebrates and water quality.
- National parks, such as the Obed Wild and Scenic River play an important role in preserving many of our country's important natural areas.

Students will be able to…

- Identify several aquatic macroinvertebrates that live at Obed Wild and Scenic River.
- List the stages of an aquatic macroinvertebrate's life cycle.
- Identify ways in which a watershed can become polluted.
- Understand the role of macroinvertebrates in a stream ecosystem.

Stage 2 – Assessment Evidence:

Performance tasks:

Pre-Assessment:

Teachers may want to use their own pre-assessment based on their students' abilities and needs. One fill-in sheet as a pre-assessment has been provided that may need to be modified for students (may also be used as a post-assessment.)

Stage 3—Learning Plan:

Learning Activities:

Preparation:

Materials: Obed WSR brochure, lesson plan, aquatic macroinvertebrate key, aquatic macroinvertebrate lifecycle chart, KWL (Know now, Want to know, Learned) chart, website for Obed/NPS.

Key Vocabulary:

Aquatic Macroinvertebrate small animals that live in water, are big enough to see with the naked eye, and have no backbone.

Lifecycle the series of changes that a living thing goes through from the beginning of its life until death

Adaptation a change, or the process of change an organism makes in order to better survive in their environment.

Watershed an area of land from which all water drains to the same location, such as a stream, pond, lake, river, wetland, or estuary.

Pollution bringing unsafe or toxic substances into the environment

Intolerant Species	organisms easily killed, impaired, or driven off by bad water quality; includes many stonefly, dobsonfly, and mayfly nymphs, caddisfly larvae, and water pennies.
Tolerant Species	Organisms capable of withstanding poor water quality, includes most leeches, aquatic worms, midge larvae, and sow bugs.
Somewhat Tolerant	Organisms with the ability to live under varying conditions may be found in good or poor water quality; includes amphipods, scuds, beetle and crane fly larvae, crayfish and dragonfly nymphs

Procedures:

Teaching/Learning Sequence: This lesson plan is designed to be a stand alone lesson in the classroom, or to be used to help prepare your students for their field trip to Obed Wild and Scenic River. It can be used to teach about adaptations, feeding habits, life history strategies, and body parts of aquatic macroinvertebrates (mostly aquatic insects), as well as how aquatic macroinvertebrates are linked to water quality. This lesson plan can take more than one day to complete, depending on the depth you chose to cover with your students, their abilities, and the number of activities you use .

1. Using a Know now-Want to know-Learned (KWL) Chart, as a class, drawn on your whiteboard/ technology board, ask the question(s): What is an aquatic macroinvertebrate? How might aquatic macroinvertebrates tell us more about the current condition of the environment? Why is protecting our watershed important? Record answers under the letter *K*. This is what the students know now.
2. **The Obed-** Next, pull up on your computer and/or technology board (Promethean or Smart) the following link https://www.nps.gov/obed/learn/photosmultimedia/multimedia.htm and play the short 2 minute video about the Obed.
3. Ask the students again the previous three questions and see if answers are different, if so, record answers alongside previous answers.
4. Moving on to the *W* section of your KWL Chart, asks students what they would like to learn/know about the National Parks and/or the Obed WSR. Record those answers under the letter *W*.
5. If you are using technological objects to record the chart be sure to save it for after the lesson plan or field trip to complete the *L* section, or what did you learn, with students at a later time.

6. **What is an aquatic macroinvertebrate?** Write the words on the board. Have the students break down each word and try to define them. *Aquatic*— means it lives in the water; *Macro*– means large, in this case it is large enough to be seen with the naked eye; *invertebrate*—an animal without a back bone.

7. **Their bodies—**have your students get into small groups. Provide each group with the photos of the aquatic macroinvertebrates identification key. Have them answer the following questions:

    - What is unusual about the bodies of these animals?
    - How many legs do they have?
    - What about their bodies helps them survive in a river environment?
    - What do these animals have instead of a backbone?

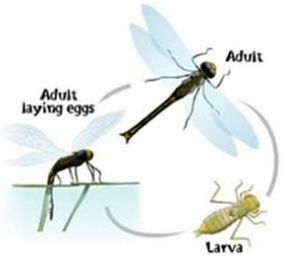
8. **Their adaptations**—using the answers to the above questions, create a discussion with your students on how these animals are very well adapted for their environment. What did they notice about the aquatic macroinvertebrates bodies, that would help them? Some examples may be:

    - Many have claws for capturing prey and holding on tight to rocky substrates.
    - They have special tails, that help them maneuver or swim in the water
    - Antennae to help them sense prey or changes around them
    - Gills to help them breathe oxygen under water

9. **Their life cycle—**Discuss with your students the lifecycle of an aquatic macroinvertebrate. Explain that each aquatic macroinvertebrate goes through a process of metamorphosis. This can be *complete metamorphosis*: egg, larvae, pupae, and adult or *incomplete metamorphosis*: egg, nymph, adult. It is very similar to other, more familiar animals like butterflies or ladybugs—the only difference is that with aquatic macroinvertebrates it happens in the water.

10. **Their environment**—All of these macroinvertebrates can be found in the waters of the Obed Wild and Scenic River. What do you think would happen to these animals if the water became polluted? What are some examples of pollution that could affect them? Remember, pollution doesn't always have to be "chemical", it can often be things like soil runoff, or algal growth. All animals handle pollution in different ways. Their ability to survive environmental changes such as pollution can be classified as: tolerant, intolerant, or somewhat tolerant. Therefore, by studying which aquatic macroinvertebrates are found in a water source, we can determine whether that source is polluted or not; simply by which species are living there. Most aquatic macroinvertebrates are fairly sensitive to environmental changes.

11. **The watershed**—all of us live in a watershed (drainage basin or catchment) It is up to us to do our part to protect it. Have students list ways in which water from the watershed can become polluted and eventually end up on a river like the Obed. What can we do to decrease the amount of pollution and in turn, help protect animals like the aquatic macroinvertebrates.

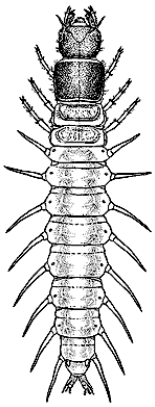


Closure:

After completing the chart for what was predicted and what actually occurred, discuss with students what they learned and complete the previous *KWL* chart that was began with students at beginning of this lesson.

Optional Activities: Teacher may choose to add some of these to the above lesson or use as assessment activities.

- Have your students create their own aquatic macroinvertebrate. This can be done as an art project, group activity, or individually.
- Introduce students to the 3 main body parts of a bug. Use posters or pictures that show the adult macroinvertebrate and each body segment (head, thorax, and abdomen).
- Research with your students your own watershed. What are some ways that your community protects it?
- Place three to six photo cards of macroinvertebrates in a container. Have student(s) blindly choose two to four of the photos out of container. Allow them to write a sentence using the photos/words of photo in a sentence, paragraph, or story to share with class. A modification would be to have someone scribe for student(s) who have a sentence/paragraph/story to share, but needs assistance in recording. Student may also hold up their chosen cards and do a verbal story.
- Many aquatic macroinvertebrates have very unusual feeding habits and can be classified into four groups, called functional feeding groups, depending on their feeding habits. They are shredders, collectors, scrapers (or grazers), and predators. Have your students research what these categories are, and which aquatic macroinvertebrates belong to each category.



Enrichment Activities:

- Invite a park ranger to visit your classroom . The ranger can bring educational materials to help build on your student's knowledge of watersheds and aquatic macroinvertebrates.
- Plan an outdoor learning experience, such as a field trip to the Obed and see first hand what lives in the river.
- Share other national parks such as: Big South Fork National River and Recreation Area and Great Smoky Mountains National Park with students by viewing on-line links and encouraging them to visit with family and/or friends. **www.nps.gov**

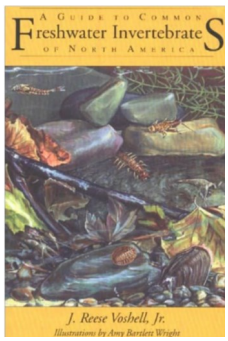
Post-Assessment:

- Use previous fill-in KWL sheet to see what students answer now after the lesson and field trip.
- Use of teacher chosen pre-assessment as a post-assessment.
- Completion of Junior Ranger booklet activities.

Additional Resources:

- Obed Wild and Scenic River brochure
- Junior Ranger booklets with activities
- Video is available for viewing at the Obed WSR Visitor Center in Wartburg for free to any visitors. It is also available for purchase.

Field Guides- (Your own classroom or school library may have some similar and wonderful examples too!)



- Voshell, J.Resse, Jr., 2002. A Guide to Common Freshwater Invertebrates of North America. The McDonald & Woodward Publishing Company. Blacksburg, Virginia, ISBN 0-939923-87-4

Online Resources:

http://www.stroudcenter.org/education/MacroKeyPage1.shtm—Macroinvertebrate Identification Key

https://water.usgs.gov/edu/watershed.html—What is a watershed?

https://cfpub.epa.gov/surf/state.cfm?statepostal=TN—What is your watershed?

https://www.nps.gov/obed/index.htm National Park Service website for Obed WSR. This link may be shared with parents to give answers to questions they may have about the park. Also, this site has more information about the history of the park, events, and includes photos.

https://www.nps.gov/webrangers/teachers.cfm has many activities to learn about the parks and is aligned to standards.

http://www.nationalparks.org/ook/every-kid-in-a-park information about the president's initiative

https://www.nps.gov/obed/learn/kidsyouth/upload/Obed-Junior-Ranger.pdf online version of Junior Ranger Booklet

www.natureworkseverywhere.org maintained by the Nature Conservancy, provides educators with lessons and information on all things natural.

https://www.teacherspayteachers.com/ is a free membership that provides activities and other classroom useable items. Some are free to download; others have a small fee attached. This is a useful tool to supplement, and search for ideas to assist students in learning.

https://www.pinterest.com/ this site has many lesson plan ideas, activities, and is a place you may save or "Pin" ideas to assist in your teaching.

Online Videos:

https://www.youtube.com/watch?v=-qSNXRxJWTc- Aquatic Insects: Voracious predators, architects, and environmental indicators

https://www.youtube.com/watch?v=lSWzx5M-fP0—Aquatic Macroinvertebrates as Bio indicators

http://www.edutoolbox.org/tntools "These resources are provided by the Tennessee Department of Education and include the materials formerly hosted at www.TNCore.org. The resources were created to align with the Tennessee academic standards and provide support regarding the academic content areas, college and career ready standards, and other department initiatives. Please note that this is a compilation of resources created over the past several years. In some instances, specific resources may reference standards or assessments that are no longer applicable in Tennessee; in that case, educators should use their best judgment to determine whether the materials still align with their content area and could benefit their students."

Additional Discussion Questions:

1. **Why are aquatic macroinvertebrates important in a stream, river, or lake?** Aquatic macroinvertebrates are important for several reasons. First, they are an important part of the food chain. Many other organisms, such as fish, birds, and other invertebrates depend on them as a food source. Also, some macroinvertebrates play a role in breaking down plant matter that falls into and/or grows in the stream. These insects either rip apart and eat plants, or they graze on the algae that grows on the streambed. Invertebrates are also used as an indicator of water quality. Because some invertebrates are sensitive to pollution, their absence in a stream system may indicate a pollution problem. This is not always the case because other factors can influence the absence of certain invertebrates. For example, stoneflies, an indicator of good water quality, can only survive in cold, clear, running water. We may not find stoneflies in large, slow rivers low in the watershed because the water temperature is naturally too warm for stoneflies. This does not mean the water quality is poor, only the natural system cannot support stoneflies.

2. **Why do some types of organisms seem to be more sensitive to pollutants than others?** This question doesn't have one simple answer, but it's an interesting opportunity to discuss the differences in these organisms. More tolerant organisms may be those that evolved under more diverse conditions, and therefore are now able to handle a wider range of conditions. Animals that evolved under very unique or non-varying conditions may have very narrow ranges of tolerance to change.

3. **What organisms depend on aquatic macroinvertebrates?** Aquatic macroinvertebrates are an important part of the food chain. Other organisms such as fish, birds, some mammals and other invertebrates depend on them for their food supply. Some organisms, such as birds, bats and fish depend directly on invertebrates because they eat them. However, other organisms such as large mammals depend on them indirectly because they eat the birds and fish that feed on invertebrates.

4. **Do aquatic macroinvertebrates spend their whole life in the water?** Some macroinvertebrates complete their life cycle in a few weeks; others may live for several years. Usually, just the larvae stage of an insect's life is spent in the water. These insects include mayflies, stoneflies, caddisflies, crane flies, and some water beetles. Most of them spend 1-2 years in the water as larvae and then only 1-14 days on land as adults. Some insects, such as the water boatmen and backswimmers, spend their whole lives in the water and do not undergo metamorphosis. Most non-insect macroinvertebrates, such as amphipods (scuds), gastropods (snails), and bivalves (clams and mussels) spend their entire life in the water.

5. **What is metamorphosis?** Metamorphosis is a process in which an animal physically develops and changes in two or more distinct stages during its life cycle. Complete metamorphosis consists of 4 stages - egg, larva, pupa and adult. Examples of complete metamorphosis include a butterfly, a caddisfly, or blackfly. For insects that go through complete metamorphosis the larva and adult stages look very different. The larva stage is often worm or caterpillar like. An incomplete metamorphosis consists of only three stages – egg, larva, and adult. Examples, of an incomplete metamorphosis include a grasshopper, a stonefly or a mayfly. The larva often looks similar to the adult and may be called a nymph.

6. **How do macroinvertebrates breathe in the water?** Different macroinvertebrates have developed several different adaptations for breathing. Invertebrates such as mayflies, stoneflies, and caddisflies have gills for obtaining dissolved oxygen directly from the water. Mosquito larva and some fly larva have slender breathing tubes that can extend past the water surface to obtain oxygen from the air. Other insects, like the water boatmen, swim to the surface and trap an air bubble on the underside of their abdomen and obtain oxygen from this bubble. They must live in still or slow moving water in order to easily resurface for more air.

7. **Why is it important for macroinvertebrates to have different feeding habits?** It is important to have different feeding habits so that one river system can support a wide variety of organisms. If all invertebrates were scrapers, a river could not support a large community. Also, some feeding groups benefit from the action of other feeding groups. As stoneflies shred large leaves, some leaf particles float downstream and may be caught in a caddisfly's net. Invertebrates help break down and process plant and animal matter that fall into or grow in a stream. If there were no scrapers to eat algae, the streambed would become covered with algae and other water plants.

8. **What are natural and human influences that cause changes in macroinvertebrate populations?** Macroinvertebrate populations can change naturally with the seasons. Human influences that can cause changes include any type of development or land use in the watershed that impacts water quality. These activities can be logging, construction, agriculture, recreation, housing developments, or road building. It is important to remember that these activities are not always bad, however, when they are poorly managed they can have a negative impact the water quality.

9. **Where do aquatic macroinvertebrates make their home in the water?** Streams, rivers, and ponds are made up of different microhabitats. In a stream, these microhabitats include the substrate, the sediments below the substrate, the river channel, the top of large rocks in the river, the edge waters, and the emergent vegetation near the edge. Ponds have similar microhabitats. Different macroinvertebrates make their home in different microhabitats and have specific adaptations to live successfully in these microhabitats. Their specific habitats must have food available and offer places of refuge from predators. Mayflies are scrapers/grazers; they scrape algae off the top of rocks for their food source. They spend their time clinging to the tops of rocks to find food and crawling between rocks on the substrate for refuge. Caddisflies are filter feeders; they build nets or use long hairs on their legs to filter food from the current. They also spend their time on top of and between rocks where they have access to flowing water. Dragonflies are predators and typically lie in wait to ambush their prey. They cling to the emergent vegetation and wait for smaller insects.

10. **What is the difference between point source and non-point source pollution?** Point source pollution is from a single source that can easily be identified or pinpointed as the source of pollution. Examples include an industrial factory, a feed lot, or a wastewater treatment plant. Non-point source pollution comes from a large area of land where there are many contributors to the same pollution. Examples include urban runoff, agricultural fields, and housing developments. Point source pollution is easy to regulate because it is easy to identify where the pollution is coming from and where it is entering the rivers or streams. It is also easy to measure the amount of pollution entering a waterbody from a point source. Non-point source, on the other hand, is very difficult to regulate.

11. **What are functional feeding groups?** Functional feeding groups refer to a characterization based on how an invertebrate obtains food.

The functional feeding groups are:

- Shredders: These organisms eat large pieces of leaves and other vegetation by shredding them apart.
- Filter Feeders: These organisms filter small particles out of the current using nets or hairs on their legs.
- Grazers/scrapers: These organisms feed by scraping algae off of rocks.
- Collectors/gatherers: These organisms crawl around picking up small pieces of debris on the bottom of the stream.
- Piercers: These organisms pierce their food source (often large plant stems).
- Predators: These organisms eat other insects and /or animals.

K-W-L Chart

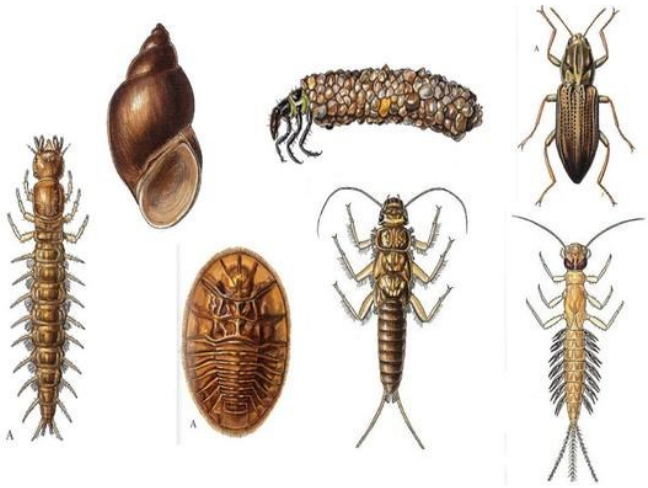
Name _____

K= know now **W=want to know** **L=learned**

1.	1.	1.
2.	2.	2.
3.	3.	3.
4.	4.	4.
5.	5.	5.
Comments	Comments	Comments

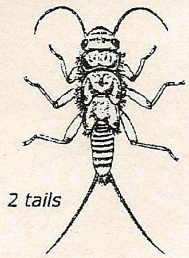
Examples of macroinvertebrate adaptations

Adaptations	Use
Legs, claws, hooked feet, suction cups, hairs on legs	Holding on to rocks and hard substrate, scraping algae off rocks, attacking prey
Tails	Swimming and maneuvering
Compound Eyes	Help insect detect motion
Hairs on head or body	Help detect movement or chemical changes in water
Antennae	Sensing food, water, surroundings
Gills	Breathing dissolved oxygen in the water
Specialized mouth parts	For scraping, piercing, shredding, etc. The mouth parts reflect food choices of the insect

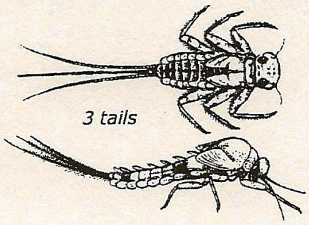


Macroinvertebrate Identification Key

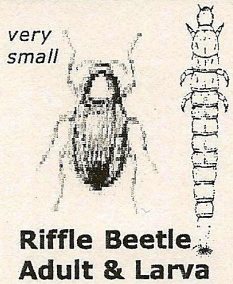
GROUP 1 – Very Intolerant of Pollution



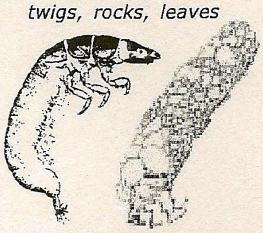
Stonefly Nymph



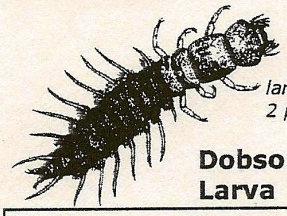
Mayfly Nymph



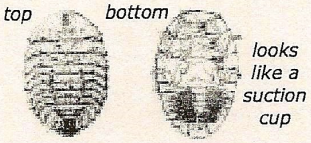
Riffle Beetle Adult & Larva



Caddisfly Larva



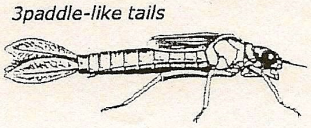
Dobsonfly Larva



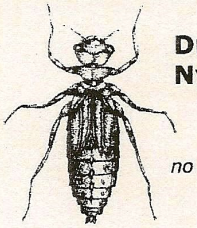
Water Penny Larva

Right-Handed Snail

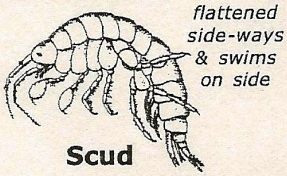
GROUP 2 – Moderately Intolerant of Pollution



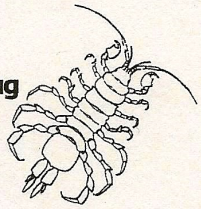
Damselfly Nymph



Dragonfly Nymph

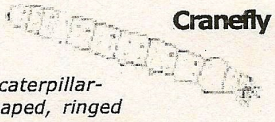


Scud

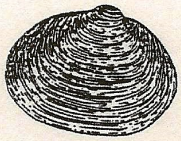


Sowbug

flattened top to bottom (looks like a pill bug)

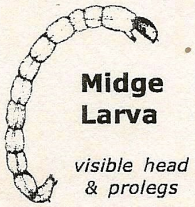


Cranefly



Clam/Mussel

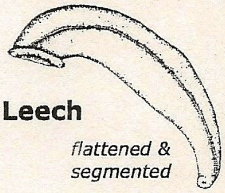
GROUP 3 – Fairly Tolerant of Pollution



Midge Larva

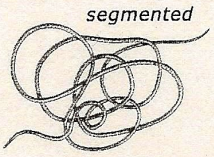
Planaria

Black Fly Larva



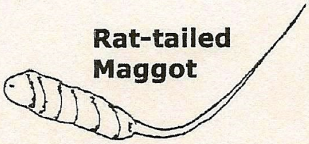
Leech

GROUP 4 – Very Tolerant of Pollution

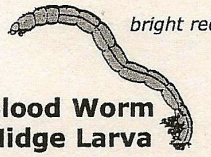


Aquatic Worms

Left-Handed Snail



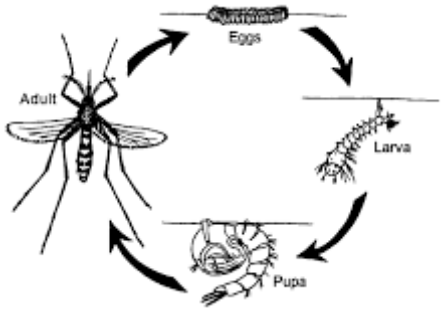
Rat-tailed Maggot



Blood Worm Midge Larva

Complete Metamorphosis Lifecycle

Complete metamorphosis consists of four stages. The organism begins as an egg, then is hatched a larvae, (often resembles little of mature adult), which gradually matures into a pupa, which then enwraps itself into a cocoon, where it finally transforms into the adult land-dwelling insect. Larvae usually do not look anything like the adult form of the insect. Many larvae are shaped like worms and have soft bodies. Some don't even have their 3 pair of legs. But all will eventually become different looking adults with wings that fly away, reproduce and lay eggs to start the life cycle all over again.

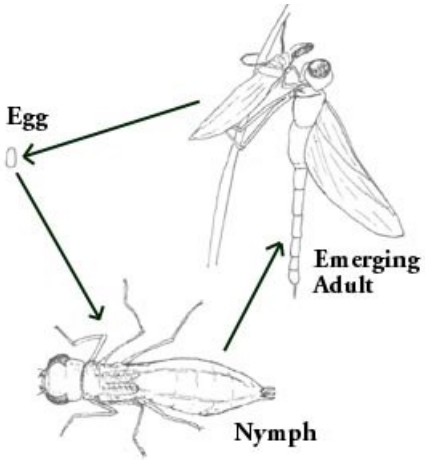


Examples of aquatic insects that undergo complete metamorphosis include a caddisfly, dobsonfly, crane fly, mosquito, midge, and many beetles.

Incomplete metamorphosis Lifecycle

Incomplete metamorphosis has only three main stages of development. The insect again begins as an egg, which is hatched producing a nymph. Nymphs are a miniature version of the adult form, often looking somewhat similar to the adult. You can even see wing pads or the beginning of wings on their backs usually. They are sexually immature, and grow larger through a series of molts until they reach full size and develop wings from their wing pads. With full size and wings, they emerge from the waterways as adults.

Examples of aquatic insects that undergo incomplete metamorphosis include a mayfly, stonefly, dragonfly, and damselfly.



Objectives/Standards: These are just some of the standards that may be used for this lesson. Please add to, or delete, as you the teacher need for your students with this lesson. These are chosen for use with *upper elementary* students with emphasis on *6h grade standards* in Science. Most of the activity choices with this lesson make it a STREAM lesson for which other standards may/will apply. (STREAM=Science, Technology, Reading, Art, Math)

Vocabulary acquisition and use ENGLA

6. Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal precise actions, emotions, or states of being (e.g., quizzed, whined, stammered) and that are basic to a particular topic (e.g., wildlife, conservation, and endangered when discussing animal preservation).

Conventions of Standard English 1. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing: a. Use correct capitalization. b. Use commas and quotation marks to mark direct speech and quotations from a text.

Speaking and listening /Presentation of Knowledge and ideas 1. Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

Comprehension and collaboration 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. a. Come to discussions prepared having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks or others. d. Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.

Science

Grade 6 : Standard 2 - Interdependence Conceptual Strand 2: All life is interdependent and interacts with the environment.

GLE 0607.2.1 Examine the roles of consumers, producers, and decomposers in a biological community.

GLE 0607.2.3 Draw conclusions from data about interactions between the biotic and abiotic elements of a particular environment.

GLE 0607.2.4 Analyze the environments and the interdependence among organisms found in the world's major biomes.

SPI 0607.2.1 Classify organisms as producers, consumers, scavengers, or decomposers according to their role in a food chain or food web.

SPI 0607.2.3 Identify the biotic and abiotic elements of the major biomes.

SPI 0607.2.4 Identify the environmental conditions and interdependencies among organisms found in the major biomes.

Alternative Assessment Indicators

Content Standard: Governance and Civics: Governance establishes structures of power and authority in order to provide order and stability. Civil efficacy requires understanding rights and responsibilities, ethical behavior, and the role of citizens within their community, nation, and world. Alternate Learning Expectation (ALE): GC. 2. Identify purposes for having rules Alternate Performance Indicators (API) Alternate Performance Indicators (API) Gr. 3-5 Alternate Performance Indicators (API) 1. Demonstrate understanding of the reason for rules

Content Standard: Governance and Civics: Governance establishes structures of power and authority in order to provide order and stability. Civil efficacy requires understanding rights and responsibilities, ethical behavior, and the role of citizens within their community, nation, and world. Alternate Learning Expectation (ALE): GC. 4. Be aware that every community has some form of governance. Alternate Performance Indicators (API) Gr. 3-5 . 1. Know rules of safety including signs and signals

Content Standard: Life Science: The student will investigate the structure and function of plant and animal cells. Cell Structure and Function Alternate Learning Expectation (ALE): LS. 1A. Recognize that living things are made up of smaller parts that contribute to the operation and well-being of entire organisms. Alternate Performance Indicators (API) Gr. 3-5. 1. Responds to living organisms (e.g., animals, plants, and people) 2. Identify plants and animals