A 4-H Model for Scientific Inquiry

What Can We Learn at the Pond?

4–H Wildlife Stewards Master Science Leader Guide

Contents

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Introduction: What can we learn at the pond?

Science education for kindergarten through elementary school students can be improved by immersing learners in the process of "doing" science. Informal outdoor learning environments, such as school ponds and outdoor learning centers, are ideal settings for learners to practice the skills used in scientific inquiry. This kind of learning is called **experiential learning**. Personal experience and direct observation are the basis of experiential learning and are key to the scientific inquiry process. The leader should choose the best balance between direct teaching and inquiry to help learners be successful.

The lessons in this guide are designed for use with K-6 learners. Some lessons include information as to how they might be modified for "younger" or "older" learners. The leader is the best judge of their group's learning capabilities.

Science as inquiry

The *National Science Education Standards* (National Academy Press, 1996) are organized into seven content areas. These are:

1. Science as Inquiry
2. Physical Science
3. Life Science
4. Earth and Space Science
5. Science and Technology
6. Science in Personal and Social Perspectives
7. History and Nature of Science

Science as Inquiry is used as a skill in each of these content areas. According to the national standards, "Full inquiry involves asking a simple question, completing an investigation, answering the question, and presenting the results to others." Learners work toward the ability to do full inquiry by "doing" science that is within their developmental capabilities at each grade level.

Content standard for science as inquiry: fundamental abilities necessary to do scientific inquiry

Grades K–4

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Use simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

Grades 5–8

- Identify questions that can be answered through scientific investigation.
- Design and conduct a scientific investigation.
  Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Introducing Oregon's Scientific Inquiry Scoring Guides to assess skills

Beginning in the 2003–2004 school year, inquiry will become the focus of learner assessment in science. Scientific Inquiry work samples assessed with a Scientific Inquiry Scoring Guide (as adopted April 26, 2001) will be required by the Oregon Department of Education (ODE).

Scoring guides, or rubrics, contain the criteria for assessment of activities, events, conceptual development, or goals for learners. In addition to its use as an assessment tool, a scoring guide should communicate goals and desired outcomes to the learners.

The ODE Scientific Inquiry Scoring Guides are composed of four dimensions:

- Forming a question or hypothesis
- Designing an investigation
- Collecting and presenting data
- Analyzing and interpreting results

The ODE Scientific Inquiry Scoring Guide (4/26/01) for Benchmark 2 (Grade 5) is provided in Appendix I.

Each of the four dimensions of the scoring guide are rated on a 6-point scale, with 6 being the highest score and 1 the lowest. A rating of 4 or higher is considered satisfactory. Teachers are expected to provide instruction and classroom assessment in all four dimensions of the scoring guide. "Forming a question or hypothesis" is not added to the work sample assessment until Benchmark 3 (Grade 8).

Scientific Inquiry work samples are assessed beginning at Benchmark 2 (Grade 5). They are reported for school district work sample management on the following implementation schedule.

2003–2004	***2004–2005***	***2005–2006***
Collecting	Designing	Designing
	Collecting	Collecting
		Analyzing

Let the inquiry begin!

A class of fifth graders plans to visit the pond. The theme for the lesson is, “A pond community is made up of many unique and interesting plants and animals.”

What might a scientific inquiry program at the habitat area pond look like? See the 4-H Science Inquiry Model (Figure 1, page 6).

Choosing questions

Begin in the classroom. Ask learners what they know about life in and around ponds. This helps determine the skills and understanding the learners already have. Record the learners’ answers on the board. Now you can identify any gaps in the learners’ knowledge or any misconceptions they may have about ponds (Figure 1, box 1). How should these gaps be filled?

Ask learners what they would like to know about the plants and animals in the pond community. What questions do they have (Figure 1, box 2)? You can guide their thinking by asking questions, too. Do we know which plants and animals are there? How does water get into the pond? Does the pond’s water level ever get low? Why? Record the learners’ questions on the board. Their responses will help you plan how to unfold the lesson.

Now, divide the group of learners into several small work teams of three to five learners. Ask each team to choose one of the questions on the board to investigate at the pond. The leader takes on the role of facilitator and coach, directing the selection of investigative topics and helping each team to refine its question. Help the teams focus by framing questions using cognitive terminology such as *classify, analyze, predict,* and *create.* Through this interactive process, the learners are engaged in planning and directing their own learning experience.

Once each team has chosen a question (Figure 1, box 3), members of the team design a simple investigation determining what information and data they must collect to answer their question (Figure 1, box 4). They make a list of the equipment they need to collect the data and design a data sheet to record the data (Figure 1, box 5).

The class is now ready to go out to the pond, taking along the equipment—nets, pans, thermometers, water-quality test kits, binoculars, and field guides—that they will need to complete their proposed investigation (Figure 1, box 6).

Explaining findings

Will all the questions selected by the teams be answered on their first trip to the pond? Probably not. When they return to the classroom, learners can use their data to formulate an explanation of their findings. They also may generate new questions. Teams may collaborate and share data. For instance, one team may realize that they should have taken the water temperature at the pond; but, another team has done so and can share their results.

With the assistance of the teacher, learners may do library research or design further investigations at the pond to continue the learning. They also may create models to test new explanations.

If the team is not satisfied with the findings, they may refine the question (Figure 1, box 11B to box 12) and design a new investigation (Figure 1, box 4). If they are satisfied with the findings, they may begin an inquiry on a different topic (Figure 1, box 11A to box 1).

To complete the scientific inquiry process, learners describe their investigations and communicate their analysis of the results through written reports, posters, displays, or presentations (Figure 1, boxes 7 and 8).

Learner–centered and inquiry–based

Is it easier and faster to hand learners data sheets or checklists and ask them to fill in the blanks? Of course. Guiding learner-centered, inquiry-based investigations requires the leader to have tolerance for a certain level of chaos. It also is a challenge to learners who are used to leader-directed lessons. But, with **repeated** application of the inquiry-learning model, learners will become familiar with the steps and take more initiative. Education theory tells us students learn best when we capture their attention and arouse their interest. Learners will be more engaged in collecting the data if they help design the question for their own inquiry.

Lessons for practicing leading and learning skills

The lessons in this Guide provide learners with opportunities to practice inquiry skills. Each lesson targets a different theme for inquiry at the pond. The “Extend the learning” section in each lesson references selected activities from *Project WILD Aquatic Education Activity Guide* (available from your local OSU Extension office after you’ve participated in a Leader Training Workshop) and art enrichment activities from *A Palette of Fun* (4-H 713L) (available from OSU Extension and Experiment Station Communications). In some lesson units, this section also lists additional activities for older learners.

Oregon leaders should order copies of this publication from their local office of the OSU Extension Service.

From outside Oregon, please query Extension and Experiment Station Communications for current sales price and ordering information: fax (541-737-0817), e-mail (puborders@oregonstate.edu), or phone (541-737-2513). Some 4-H youth publications are available online (**extension.oregonstate.edu**, then Publications, then 4-H youth).

The 4-H Experiential Learning Model

The habitat area pond can provide the context for a real-world application of science as inquiry **at any grade level**. The lessons in this book provide content themes. It is up to the leader to present them in such a way that learners can practice the skills they need to do scientific inquiry and become more scientifically literate. To accomplish this goal, take the learning that begins at the pond to the next step. Remember to ask learners, "How does what we learned today **apply** to your world beyond the school?" (Figure 1, box 9). To complete each application of the 4-H Experiential Learning Model, learners must have the opportunity to apply what they learn in this inquiry to a similar or different applicable situation.

In *Assessing Student Understanding in Science* (2001), Enger and Yager state, "Although there is no consensus regarding what kinds of science content are necessary for scientific literacy, a scientifically literate person is believed to be one who appreciates the strengths and limitations of science and who knows how to use scientific knowledge and scientific ways of thinking for living a better life and for making rational social decisions." Learners have the opportunity to build their scientific knowledge and to think scientifically as they investigate the question, "What can we learn at the pond?"

References

Assessing Student Understanding in Science, A Standards-Based K–12 Handbook. 2001. Enger, S.K. and R.E. Yager. Thousand Oaks, CA: Corwin Press, Inc.

Inquiry and the National Science Education Standards. 2000. National Research Council. Washington, D.C.: National Academy Press.

National Science Education Standards. 1996. National Research Council. Washington, D.C.: National Academy Press.

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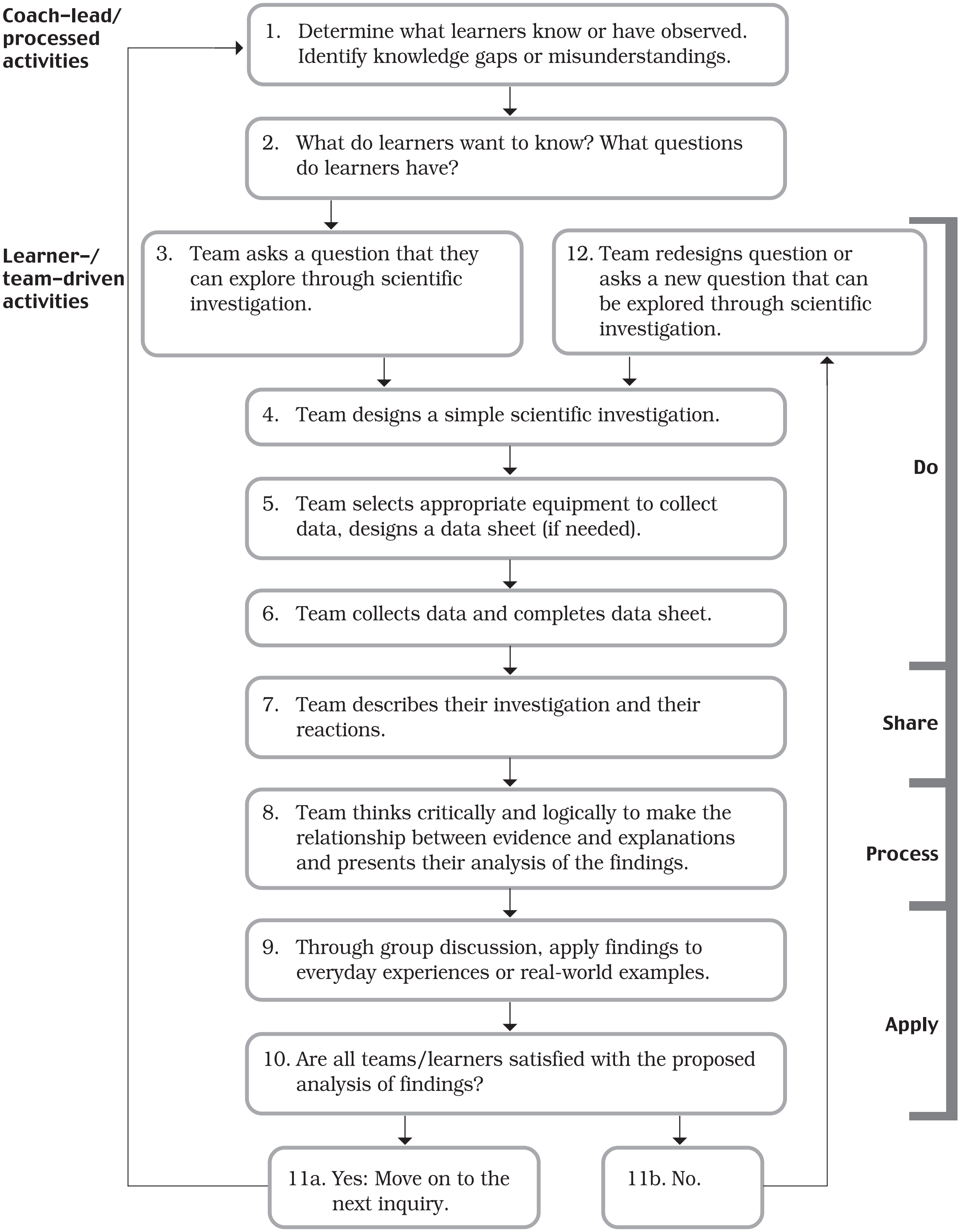
Oregon 4-H Education Center, 2003

Figure 1. 4-H Science Inquiry Model



Unit 1: Coaching for inquiry—a Sun Power lesson revisited

The Sun Power lesson in the *4-H Wildlife Stewards Project Handbook* K–3 Curriculum can provide an improved educational experience by adding content for grades 4–6 as rewritten below. Energy transfer in the atmosphere is an important concept for youth and adults to understand.

Background

The sun is the source of almost all energy in our atmosphere. This energy reaches the planet in the form of radiation. (Is all radiation bad? From sci-fi movies and cartoons, learners may have the misconception that people never should be exposed to radiation.)

Radiation is the transfer of energy by electromagnetic waves. On Earth, we experience the sun's radiation as light and heat. Heat is the transfer of energy from an object with a higher temperature to an object with a lower temperature.

What happens to the energy that enters Earth's atmosphere? Clouds and the atmosphere absorb about 20 percent of the energy and reflect another 25 percent back into space. The Earth's surface absorbs about 50 percent of the energy and reflects 5 percent back into space. One reason life on Earth is possible is the delicate balance our unique atmosphere produces between the energy Earth receives and the energy it loses. The atmosphere on Venus is composed of thick gasses and clouds that trap radiation, similar to a closed car on a sunny day. The atmosphere on Mars is so thin that radiation escapes. The atmospheres of Venus and Mars cannot support life as we know it.

Water is one of the requirements of most life found on Earth. Water moves between the atmosphere and Earth in the water (hydrologic) cycle. The sun provides the energy that "powers" the water cycle. Radiation from the sun causes evaporation of water from lakes, rivers, and oceans and transpiration from plants. When radiation is absorbed by water, this energy heats the water. As the water warms, its molecules move farther apart from each other. In the process of evaporation, the warmed water changes from a liquid to a gas, called water vapor.

Water vapor rises in the atmosphere, eventually forming clouds. Clouds are made up of many tiny water droplets. The water droplets collide with each other in the cloud and form larger drops. The water molecules move closer to each other as they cool. When the drops grow so large that they can no longer stay suspended in the cloud, they fall back to Earth as precipitation (rain, snow, or hail). Once back on Earth, the water drops may take a variety of paths to the ocean and then return to the clouds in this endless process that

Oregon Benchmarks

Benchmark 1

- Describe objects according to their physical properties.
- Identify common types and uses of energy.

Benchmark 2

- Identify substances as they exist in different states of matter.
- Describe the ability of matter to change state by heating and cooling.
- Describe examples of energy transfer.

National Science Education Content Standards

Grades K–4

- Evidence, models, and explanation
- Change, constancy, and measurement
- Abilities necessary to do scientific inquiry
- Properties of objects and materials
- Light, heat (electricity and magnetism)
- Science as a human endeavor

Grades 5–8

- Evidence, models, and explanation
- Change, constancy, and measurement
- Abilities necessary to do scientific inquiry
- Structure of the earth system
- Properties and changes of properties in matter
- Transfer of energy
- Science as a human endeavor

Content objectives

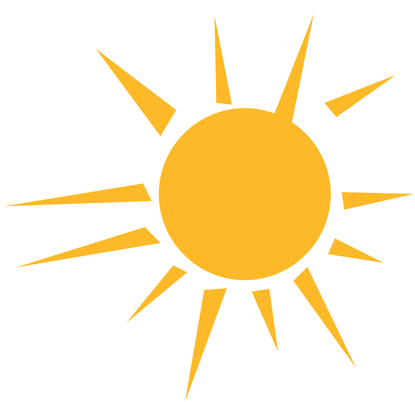
Learners will be able to do the following:

- Explain some effects that energy from the sun causes to objects on Earth.
- Understand that heat is the transfer of energy from an object with a higher temperature to an object with a lower temperature.
- Understand that energy from the sun causes evaporation, a part of the water cycle.

Process objectives

Learners will be able to do the following:

- Make observations.
- Ask questions that can be answered through a scientific investigation.
- Design an investigation to answer a question.
- Collect, organize, and summarize data from an investigation.
- Analyze and interpret data from an investigation.



is the water cycle. (We explore the water cycle in more detail in Unit 2.)

Light energy from the sun is captured by green plants (plants that contain chlorophyll). **Photosynthesis** is the name of the process plants use to change light to chemical energy, which is used to create food (**carbohydrates**) from carbon dioxide and water. Plants use the carbon dioxide found in air and release oxygen as a waste product. Thus, plants provide two essential components of much life on Earth: oxygen and food for humans and other animals.

Materials

- ○ One copy of the Sun Power Activity Sheet (page 10) for each team of learners
  or
  Have learners design their own data sheet to support the experiment they design.
- ○ Thermometers
- ○ Clear plastic cups
- ○ Water source
- ○ Supply of construction paper in both light and dark colors
- ○ Supply of plastic wrap and aluminum foil

Preparation

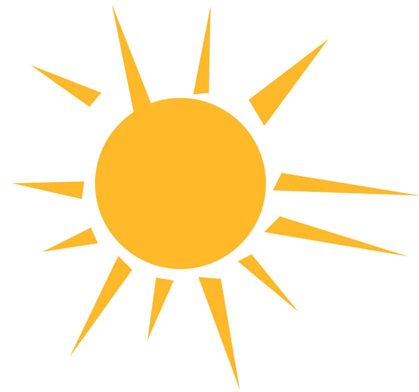
Leaders should review the following:

- Background section
- 4-H Science Inquiry Model (page 6)
- Learner evaluation criteria in the ODE Scientific Inquiry Scoring Guide (4/26/01) for Benchmark 2 (Grade 5) (Appendix I). Keep the evaluation criteria from each of the four dimensions of the scoring guide in mind as you coach learners.

Procedure

It is easier to use curriculum guides with scripted lessons that have standardized sets of data to collect and expected results or "right" answers. But, this type of lesson format does not always encourage learner curiosity. Leaders can conduct activities based on the lesson's information and allow learners more flexibility in the questions they ask and the methods they use to collect data. This method has the advantage of engaging the learners in designing their own learning experience.

Begin by asking the learners some questions to determine what they know about how the Earth receives energy from the sun. Have any of them ever had a sunburn? How is a sunburn (**radiation**) different from a burn you might get from a hot object such as a stove top or candle flame (**conduction**)? A sunburn can be a "bad"



result of radiation the Earth receives from the sun. What are some good results? Have any of the learners ever made sun tea? Lead a discussion based on the information provided in the "Background" section. Adapt the information to the age of the learners.

After the introductory discussion with learners, organize them in teams of three to five persons each. Follow the steps outlined in the 4-H Science Inquiry Model. Ask learners how they might measure the changes to different objects on Earth when they receive energy from the sun.

What questions do learners have about solar energy?

- Do objects of different colors absorb energy differently?
- How warm does water have to become for evaporation to start?
- Does the water in the pond at our habitat area get warm when the sun shines?
- Does the temperature of the pond change throughout the day?
- Does water evaporate from the pond?

Have each team select a question. Coach the teams to select questions that can be answered by a simple experiment.

Encourage older learners to use an "If....., then...." hypothesis format for their question. The question "Does water become warmer in the sun?" becomes the hypothesis, "**If** we leave water in the sun, **then** it will become warmer."

Have the suggested materials available for learners to use for collecting data. If needed, explain to learners how to use the materials. They may think of additional items they wish to use for their experiments.

Now they are ready to design an experiment. Take the materials into the schoolyard and have learners collect the data they believe they need to answer their selected question. They may use the Sun Power Activity Sheet or a data sheet they create themselves.

After they have collected the data, ask each team to analyze and interpret their results and provide a summary report to the rest of the group. Ask learners, "How does what we learned today apply to your world beyond the school?"

What else might learners want to know about the water at the pond? Unit 2 provides an opportunity for more discoveries about water.

Extend the learning

A Palette of Fun (4-H 713L): Books tell a story; Scissors snipping.

For older learners

We have learned that some radiation from the sun is absorbed by the atmosphere and the Earth. The heat can be transferred by radiation, conduction, or convection. Ask learners to look up how each of these processes transfers energy. What effect do these processes have on the atmosphere and weather conditions?

The Sun Power lesson is adapted from *Mud, Muck and other Wonderful Things*, National 4-H Council.

Sun Power Activity Sheet

Water temperature experiment

	Glass of water in the sun	Glass of water without sun
From the tap—beginning temperature of the water		
10 minutes later—temperature of the water		

My own experiment

I am going to do: ____

____

What I think will happen (my hypothesis): ____

____

____

What happened: ____

____

____

____

Why I think that happened: ____

____

____

____

Unit 2: What can we learn about water at the pond?

Background

The chemical formula of a water molecule is **H_2O**. This means there are two atoms of hydrogen attached to one atom of oxygen. The hydrogen and oxygen in the molecule are attached to each other by very strong bonds called **covalent bonds**. There are also weaker bonds between the oxygen and hydrogen of adjacent water molecules. This loose arrangement of molecules gives water its fluid nature and other remarkable properties.

When water freezes at 32° Fahrenheit (F) or 0° Celsius (C), it changes from a liquid to a solid. Water boils at 212°F or 100°C.

Learners probably know that when water boils, it produces steam. If they participated in the Sun Power lesson in Unit 1, they know that water can evaporate from a cup of water with a temperature below 100°C. In the process of evaporation, the warmed water is changed from a liquid to an invisible gas called **water vapor**. As the water warms, its molecules move further apart from each other. Another way to say this is the water becomes less dense. When water vapor condenses to liquid water, it is becoming more dense. The **water cycle** includes the process of liquid water changing to a gas and then back to liquid water.

2A—Rosa Raindrop's Water Cycle

FYI

The water—or **hydrologic**—cycle is an endless process in which water is circulated around the surface of the earth through soil, plants, animals, and the atmosphere. The amount of water moving through the cycle has been approximately the same throughout 3.5 billion years. On average, a single water molecule is evaporated once every 5,000 years and has moved through the cycle about 700,000 times.

Oregon benchmarks

Benchmark 1

- Describe changes that occur in matter.

Benchmark 2

- Identify substances as they exist in different states of matter.
- Describe the ability of matter to change state by heating and cooling.

National Science Education Content Standards

Grades K–4

- Properties of objects and materials
- Evidence, models, and explanation

Grades 5–8

- Properties of objects and materials
- Evidence, models, and explanation

Content objectives

Learners will be able to do the following:

- Name the three forms of water found on earth (solid, liquid, gas).
- Demonstrate the water cycle.

Materials

Part 1

- One set of Water Cycle Activity cards (Appendix II). There are 21 main-heading cards. If you are working with more than 21 learners, you may assign up to 7 additional cards as follows:
  - "Water vapor evaporating from the ocean" (cards 2b, 2c, 2d, 2e), for one to four additional participants
  - "Rain" (card 4b), for one additional participant
  - "Soil infiltration" (card 8b), for one additional participant
  - "Slushy melting snow" (card 13b), for one additional participant
- Overhead transparency: A Basic Water Cycle (Appendix III)
- Overhead transparency: Rosa Raindrop's World Water Tally (Appendix III)
- Overhead transparency pen, nonpermanent ink
- Blackboard and chalk or flip-chart with pens

Part 2 (optional)

- *4-H Rosa Raindrop Water Cycle Board Game* (4-H 3804), one per four learners
- Dice, one per game board
- Playing pieces. Corks work well; four per game board

Preparation

Order copies of the *4-H Rosa Raindrop Water Cycle Board Game* (4-H 3804) from the *Oregon 4-H Clover* (4-H 0230), or locate online at (**www.4hcorroboree.org**) in the Kid's Section.

Photocopy the Water Cycle Activity Cards from the masters in Appendix II onto card stock. Make the overhead transparencies listed above from the masters in Appendix III.

Procedure

Part 1

Place the overhead transparency "A Basic Water Cycle" on the projector. Pass out the first seven Water Cycle cards. These are cards 1, 2a, 3, 4a, 5, 6, and 7. As you hand a card to each learner, have him or her read the FACT on the card to the class, then take his or her place in the Basic Water Cycle circle. When the first seven learners are in place, ask them to read the title of their card to the group again. Ask the remaining learners if there are any ways not mentioned that water exists or moves on earth. Record the answers on the board or flip-chart paper.

From the remaining Water Cycle cards (8 through 21), pass out the ones from the answer list learners made first. Add all the remaining cards from the set, and, if needed, cards 2b, 2c, 2d, 2e, 4b, 8b, and 13b. As you hand each card to a learner, have him or her read the FACT on the card to the group, then take his or her place in the

Water Cycle circle. The learner with card 21 (Rosa Raindrop) joins the demonstration after all the other learners have taken their places in the Water Cycle circle.

Put the "Rosa Raindrop's World Water Tally" overhead transparency on the overhead projector. Ask Rosa Raindrop to travel around the water cycle, pausing as each learner again reads his or her card's title. At each location with a world water supply percentage listed, Rosa "collects" this water. Use an erasable overhead pen to record the water supply percentage in each blank on the World Water Tally.

Rosa Raindrop's World Water Tally

Lakes	0.017%	Rivers/streams	0.0001%
Oceans	97.54 %	Ice caps/glaciers	1.81%
Soil moisture	0.005%	Atmospheric water	0.001%
Groundwater	0.62%		

When Rosa has completed one cycle through the Water Cycle, ask learners to raise their hand if they represent a part of the water cycle in which water:

- Is a gas
- Is a liquid
- Is a solid
- Moves
- Is fresh
- Is salty. In this activity, only one learner, the ocean, represents salt water. However, the majority of the water on earth is found in the oceans. Learners should not be confused by the greater number of learners who represent the many forms of fresh water. Remind learners of this using the percent volume in Rosa Raindrop's World Water Tally.
- Which parts of the water cycle take place at the habitat area pond? (Water is lost from the pond by evaporation, transpiration, and absorption by plants. Water is added to the pond by snow, rain, hail, runoff.)
- Because the habitat area pond is an artificial pond, parts of the water cycle probably do not take place there. Ask learners, "Which parts of the water cycle do not take place at the habitat area pond?" (Infiltration of water into soil or percolation from soil, due to the pond liner.)

Part 2 (optional)

Pass out one *4-H Rosa Raindrop Water Cycle Board Game* to each group of four learners. They also will need one playing piece each and a die for each game. Ask learners to play two or three rounds of the game. Did they travel a different path through the water cycle each time they played?

Extend the learning

Project WILD Aquatic Education Activity Guide: How Wet is Our Planet?
A Palette of Fun (4-H 713L): Mural Madness; Scissors Snipping

Oregon benchmarks

Benchmark 1
- Describe the basic needs of living things.
- Describe a habitat and the organisms that live there.

Benchmark 2
- Describe the relationship between characteristics of specific habitats and the organisms that live there.

National Science Education Content Standards

Grades K–4
- Properties of objects and materials
- Organisms and environments
- Changes in environments
- Understanding about scientific inquiry

Grades 5–8
- Properties of objects and materials
- Populations and ecosystems
- Populations, resources, and environments
- Understanding about scientific inquiry

Content objectives

Learners will be able to do the following:
- Name two to four water quality factors that can be tested.
- Demonstrate how to test for water quality.
- Explain why water quality factors can affect aquatic animals, invertebrates, and plants.
- Understand that each water quality measurement must be within a tolerable range for aquatic life to thrive.

Process objectives

Learners will be able to do the following:
- Ask questions that can be answered through a scientific investigation.
- Design an investigation to answer a question.
- Collect, organize, and summarize data from an investigation.
- Analyze and interpret data from an investigation.

2B—Water Quality Tests: pH, Dissolved Oxygen, Temperature, Sediments

FYI

The pH, temperature, dissolved oxygen, and sediment in water have a direct effect on the aquatic animals, invertebrates, and plants that can live there. In an artificial pond, these factors may be altered by changing how the pond is managed. For instance, fountains and waterfalls mix (**aerate**) water, which might increase the dissolved oxygen content; they also can cause the water to become warmer, which can decrease water's ability to hold dissolved oxygen. The relationships among the factors and their effects on aquatic life are complicated. It is not necessary for adult leaders and learners to understand all these interrelationships. What is important is to understand that they each must be within a tolerable range for aquatic life to thrive.

pH

In the chart "pH Ranges that Support Aquatic Animal and Plant Life" (page 19), you can see that animals we might consider "desirable"—such as trout and the aquatic insects they feed upon—have a narrow acceptable pH range between pH 6 to 8. The pH scale ranges from 0 to 14. Both very high (or **basic**) and very low (or **acid**) pH readings are detrimental to aquatic life. A pH of 7 is called **neutral**. Rain in the western United States averages pH 6.5. In the eastern United States, rain can have a lower pH reading (thus, it is called "acid rain").

Dissolved oxygen (DO)

All aquatic animals need oxygen to survive. The amount of oxygen dissolved in water can be affected by altitude, temperature, plants, light exposure, aeration, and sediments suspended in the water. Temperature has a direct effect on the amount of oxygen in water. Colder water can hold more oxygen.

There is a chart for determining the percent saturation of oxygen on the LaMotte Water Monitoring Kit (see Appendix IV). The test is based on the combined temperature and DO reading. DO is measured in parts per million, written "ppm" (milligrams per liter of water = mg/l). A DO range of 5 to 6 ppm is acceptable for most aquatic life.

Temperature

Temperature is very important to water quality. As we learned above, temperature has a direct effect on dissolved oxygen in water. In addition, temperature can affect the rate of photosynthesis by aquatic plants and the sensitivity of organisms to parasites and disease. Salmon and trout generally prefer water temperatures between 40 and 65°F.

Sediments

The measurement of sediments in water is called **turbidity**. Turbidity is an indication of the clarity of the water. Sediments are suspended in water; they are not dissolved in the water. Sediments occur naturally as products of weathering. Like the other factors we have learned about, they can be both beneficial and harmful to aquatic life.

In a properly constructed artificial pond, sediments are of minimal importance. It may not be informative to measure turbidity there. However, if there is a natural water system nearby, learners might measure its turbidity over a period of time and record their results. If these measurements change, can learners suggest what is causing the change?

Materials

Part 1 and Part 2

- Quick Reference Guide to Aquatic Invertebrates cards (Appendix II), one set per team
- Looseleaf binder rings, one for each set of Aquatic Invertebrates cards
- Chart: pH Ranges that Support Aquatic Animal and Plant Life (page 19), one per team
- Water Quality Test Kit (see Appendix IV)
  This kit contains tests for pH, DO, temperature, and turbidity. In addition, it contains tests for coliform bacteria, biochemical oxygen demand (BOD), nitrate, phosphate, and a chart for interpreting the test results.
  If you do not wish to buy the complete kit, you can buy the following individual tests (see Appendix IV):
  - pH (pH test paper)
  - DO
  - Temperature (standard thermometers)
  - Sediments/turbidity (Secci disk)

Part 1 only

- Gathering Water Quality Data sheet (page 18), one for each learner or team of learners
- Lemon juice
- Baking soda
- Pond or stream water

Part 2 only

- 4-H Water Data Sheet (pages 20–21), one for each learner or team of learners (from the *4-H Natural Science Project Record*, 4-H 303LR)
- Aquatic invertebrate collection materials: aquarium nets, plastic collection bowls, hand lenses
- Quick Reference Guide to Aquatic Invertebrates cards (Appendix II), one set per team

Preparation

Leaders should review the following:

- Background section
- FYI section
- 4-H Science Inquiry Model
- Learner evaluation criteria in the ODE Scientific Inquiry Scoring Guide for Benchmark 2 (Appendix I). Keep the evaluation criteria from each of the four dimensions of the scoring guide in mind as you coach learners.

Order the water quality testing materials of your choice. Practice using them before demonstrating them to learners.

Make photocopies of the Gathering Water Quality Data sheet, 4-H Water Data Sheet, and the pH Ranges that Support Aquatic Plant and Animal Life chart.

Make photocopies of the Quick Reference Guide to Aquatic Invertebrates cards onto card stock, one set per team. Punch a hole in one corner of each card and insert a looseleaf binder ring through each set to keep them together. (These also are used in Lessons 4A and 6A.)

The day before the lesson, ask learners to bring in water samples from neighborhood streams or ponds in clean plastic bottles. Collect a water sample from the habitat area pond.

Procedure

Part 1

Lead a discussion with learners to determine what they know about water pollution and water quality. Share information with learners based on the "Background" and "FYI" sections. Adapt the information to the age and interests of the learners. If learners have questions that are not answered by the information provided, have them do some library research to find an answer.

One objective of this lesson is for learners to know how to use water quality test kits. Demonstrate how to take the pH test. For older learners, pass out the Gathering Water Quality Data sheet and ask them to work numbers 1 through 3. Demonstrate the test for DO and ask the older learners to complete number 4. For younger learners, the leader may do the tests outlined on the

Gathering Water Quality Data sheet and ask the learners to observe and explain the results.

Ask the group to pause before beginning number 5. Ask them to list some methods they might use to change the level of DO in the sample. If there are several methods suggested, assign a different method to each team of learners. Ask the teams to complete number 5.

When all the teams have completed number 5, ask them to report their method and results to the whole group.

Lead a discussion to answer question 6 with the group.

- How are the tests we have learned today applicable to the pond in our habitat area?
- How does what we learned today apply to your world beyond the school?
- Where in the neighborhood was the water for the tests collected?
- Is there more we could learn about the habitat area pond or the neighborhood by doing more tests? or by doing the tests over a longer period of time (several months)? or at different seasons of the year?

Part 2

For younger learners

Simply go to the habitat area pond to demonstrate the use of the water quality tests they learned in Part 1.

For older learners

Lead a discussion about water quality monitoring programs. Pass out the 4-H Water Data Sheet. (Note: The 4-H Water Data Sheet calls aquatic invertebrates "macro-invertebrates.") Using the knowledge they now have about water quality tests, ask learners to design a plan for monitoring the quality of the water and numbers and types of invertebrates in the habitat area pond. Ask, "If we do not monitor the quality of our pond's water, how would we know if the pond water was becoming polluted?" "Should a water quality program also be conducted on a local pond or stream?"

Coach learners to ask a question or form a hypothesis that they can investigate and test over time using the water quality monitoring tests they have learned. Follow the steps outlined in the 4-H Science Inquiry Model. Create a timeline for the project. This could be a week, a month, or the entire year.

At the end of the investigation phase, learners should organize and summarize their data. They then should provide some analysis or interpretation of the data. They can use the Quick Reference Guide to Aquatic Invertebrates cards and the pH Ranges That Support Aquatic Life chart to interpret the data.

Extend the learning

A Palette of Fun (4-H 713L): Mural Madness

Project WILD Aquatic Education Activity Guide: Designing A Habitat; Where Does Water Run?; Water Canaries; Aqua Words

Gathering Water Quality Data

Testing for pH

Test the pH of each item listed below. Then, use the pH Ranges that Support Aquatic Animal and Plant Life chart to see which plants and animals might live in this pH. Use the Quick Reference Guide to Aquatic Invertebrates cards to see how tolerant specific animals are to pollution.

1. The pH of lemon juice is:___________________________________

Which aquatic animals, invertebrates, and plants can live in this pH?

____

How tolerant of pollution are the aquatic invertebrates you listed?

☐ Tolerant ☐ Somewhat tolerant ☐ Not tolerant

2. The pH of baking soda is: __________________________________

Which aquatic animals, invertebrates, and plants can live in this pH?

____

How tolerant of pollution are the aquatic invertebrates you listed?

☐ Tolerant ☐ Somewhat tolerant ☐ Not tolerant

3. The pH of the water sample is: ______________________________

Which aquatic animals, invertebrates, and plants can live in this pH?

____

How tolerant of pollution are the aquatic invertebrates you listed?

☐ Tolerant ☐ Somewhat tolerant ☐ Not tolerant

Testing for dissolved oxygen

4. Test the dissolved oxygen (DO) level of the water sample. The DO is ____________ppm. On the Quick Reference Guide to Aquatic Invertebrates cards, look at “Why I’m Special” to see which animals might be found in water with this level of oxygen.
5. How might you change the DO level of the sample? Discuss some methods with your leader. Try some of the methods. Record your method and the results on a sheet of notebook paper.
6. You are a scientist studying a pond. The water samples you collected have tested 9 for pH and 4 ppm for DO. There are many midge larvae in the invertebrate sample. How healthy is this pond? How do you know? Refer to the information provided in the test kit and the pH Ranges that Support Aquatic Animal and Plant Life chart (next page). How might these water quality results be changed? Record your results on a sheet of notebook paper.

pH Ranges That Support Aquatic Animal and Plant Life

<table>
<tr><th>Most acid</th><th>1 Battery acid</th><th>2 Lemon juice</th><th>3 Vinegar</th><th>4 Coke</th><th>5 5.6 = normal</th><th>6 Rain water</th><th>7 Pure water</th><th>8 Sea water</th><th>9</th><th>10</th><th>11 Ammonia</th><th>12 Bleach</th><th>13</th><th>14</th><th>Most basic</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Snails, clams, mussels</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Largest variety of animals—
trout, mayfly nymphs, stonefly nymphs, caddisfly larvae</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Bass, bluegill</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Carp, suckers, catfish, aquatic worms, some insects such as midge larvae and black fly larvae</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="6">Plants (floating, rooted) and algae</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="12">Bacteria</td><td></td><td></td></tr>
</table>

4-H Water Data Sheet

A record is part of your 4-H project. Keep your record neat, clean, and up-to-date. It's best to use a pencil. Write clearly. If you need help, ask your parents or leaders. If you need more space, add notebook paper to your record.

Date__________________ Crew members ____

Location ____________________________ Plot no.______ Elevation _______ Percent of slope ______

Season____________________ Temperature ______ Annual precipitation _____ Soil type ____________

Type of water study area ***(check one)***

- ❑ Temperate forest
- ❑ Temperate grassland/meadow
- ❑ Marsh/wetlands
- ❑ High desert forest
- ❑ High desert grassland/meadow
- ❑ High desert shrub land
- ❑ Coastal grassland/meadow
- ❑ Coastal mountain grassland/meadow
- ❑ Other:

Record the amount of stream vegetative cover (all species), dissolved oxygen (DO), pH, width, depth, velocity, and temperature. These relate to the overall ability of the system to maintain aquatic life, slow stream flow, and decrease excessive stream bank erosion and incising. You will need a camera, 100-foot measuring tape, water quality kit, clipboard, data logger or thermometer, pencil, and this check sheet.

Stream type — Perennial (year-round) _____ Intermittent (seasonal) _____

Photo station — Perpendicular ______ Oblique to stream ______

Current precipitation year — Wet _____ Normal _____ Dry _____

Channel type — Entrenched: Slightly ______ Moderately ______ Deeply ______
Confined: Poor_______ Moderately ______ Well ______

Channel pattern — Straight ____ Slightly sinuous ____ Meandering____ Braided ____

Stream gradient — Steep (>10%) _____ Moderate (4–10%) _____ Gentle (<4%) ______

Vegetation
___ Typical riparian, perennial, water-loving species dominate
___ Typical riparian, perennial, water-loving species infrequent
___ Typical riparian, perennial, water-loving species absent
___ Typical riparian, perennial, water-loving species replaced by upland species

List the three most abundant macro-invertebrates found.

____

____

List other species found (such as fish, snails, crayfish).

____

____

Water turbidity (sediment/muddy) Clear _______ Moderate _______ Extreme________

Oregon State University Extension Service

4-H 303LR-j
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Stream flow data record

To determine stream flow (cubic feet per second = ft^3/sec), observers should take measurements at three different sites along the section of stream they are studying. The measurements will include width, depth, velocity, and streambed roughness. Use the following table to help with your calculation.

Site #	Width (w)	Depth (d) *(average of 5 locations across stream)* 1	2	3	4	5	Avg.	Velocity (v)	*Streambed roughness (a)
Site 1									
Site 2									
Site 3									
Average									

*Streambed roughness—rubble, gravel, or plant: a = 0.8; smooth mud, silt, or bedrock: a = 0.9

To calculate stream flow rate (r), use the information on the above data chart. Use the **average** value of each measurement at the three sites in the formula: r = w x d x v x a

Stream flow = _________ x ________ x ________ x ________ = ___________ ft^3/sec
r w d v a

Temperature data record

	Air temperature °C	°F	Time	Water temperature °C	°F	Time
Site 1						
Site 2						
Site 3						

Note:

$$\frac{9 \times (°C + 32)}{5} = °F$$

$$\frac{5 \times (°F - 32)}{9} = °C$$

pH data record

	Sample 1	Sample 2	Sample 3	Average
Site 1				
Site 2				
Site 3				

Dissolved oxygen (DO) data record

	Sample 1	Sample 2	Sample 3	Average	Time
Site 1					
Site 2					
Site 3					

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Unit 3: What can we learn about plants at the pond?

Background

The earliest scientific classification (**taxonomic**) system was a two-kingdom system: one kingdom was plants, the second kingdom was animals. Today, the most commonly used scientific taxonomic system includes not just two but six kingdoms. These are animal, plant (Plantae), fungi, protists (Protista), eubacteria, and archaebacteria.

A **kingdom** is the first taxonomic category. It contains the largest number of members. Organisms are classified into a particular kingdom based on shared characteristics including cell type, ability to make food, and whether they are single-celled or many-celled.

Plants are many-celled organisms. Their cell walls are composed primarily of cellulose. The cells contain green chlorophyll and yellow-red carotenoid pigments. Most plants have recognizable root and/or leaf structures, and they store starch as food. However, within the Kingdom Plantae there are many diverse species that have interesting adaptations to various habitats on Earth.

Algae may seem like the most obvious plant to study in a pond or other aquatic environment. However, algae are not really plants! They are members of a plantlike group called **protists**. They belong to the Kingdom Protista, which was added to the classification system in the 1970s. Protists are organisms that live in moist or wet habitats. They may be single- or many-celled. Some contain chlorophyll and make their own food, others do not.

3A—Seed Sense

FYI

There are nine divisions (called phyla in other kingdoms) in the plant kingdom. These are mosses and liverworts (Bryophyta); club mosses (Lycophyta); ferns (Pterophyta); horsetails (Sphenophyta); gnetums (Gnetophyta); ginkgo (Ginkgophyta); cycads (Cycadophyta); conifers (Coniferophyta); and angiosperms, sometimes called "flowering plants" (Anthophyta).

When a flowering plant or angiosperm is done flowering, it forms a seed that generally is protected by a fruit. The **cotyledon** is the part of the seed that stores food. This food supply supports a young plant's growth until its leaves can produce its own food. This cycle of plant to flower to seed to new plant sometimes is called the **seed cycle**.

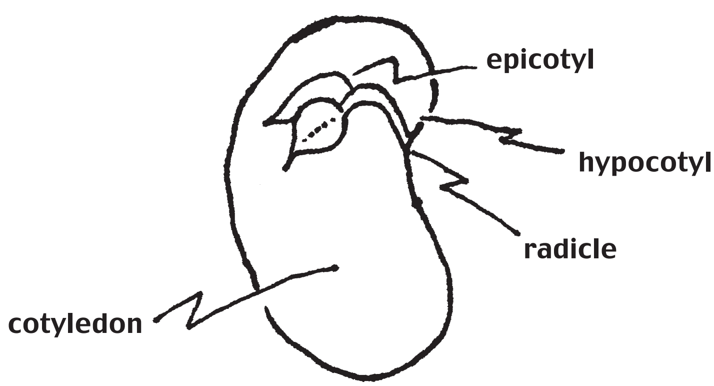
There are two types of seed structures: the monocotyledons ("monocots") and the dicotyledons ("dicots"). Monocots have one cotyledon. Rice and corn are monocots. Dicots have two cotyledons. Lentils, lima beans, and green beans are dicots.

The **epicotyl** is the structure inside the seed from which the first true leaves will form. You may wish to get some peanuts, open them, and show the parts on the inside of a seed. Young children sometimes learn to call this structure in the peanut the "gnome" or "Santa Claus." ***Caution:*** Before you use peanuts in an activity, be sure that no one in the group is allergic to them.

The **hypocotyl** is the area of the seed that forms the lower stem and roots. The epicotyl is above the hypocotyl; the radicle is below it.

The **radicle** is on the lower tip of the hypocotyl. It is the area that develops into the main root system.

Parts of a Bean



Materials

Part 1 and Part 3

- Dry corn, monocots, seeds sold for gardening, one for each team
- Dry green bean, dicots, seeds sold for gardening, one for each team
- Dry brown rice, lentil and lima bean seeds, one of each for each team
- Hand magnifying lens
- Paper and pencil

Part 2

- Corn and green bean seeds soaked in shallow water or wet paper towels for 4 days, one of each for each team

Oregon benchmarks

Benchmark 1
- Recognize characteristics that are similar and different between organisms.
- Describe how related plants have similar characteristics.

Benchmark 2
- Group or classify organisms based on a variety of characteristics.
- Describe basic plant structures and their functions.
- Describe the life cycle of an organism.

National Science Education Content Standards

Grades K–4
- Systems, order, and organization
- Form and function
- Characteristics of organisms
- Life cycles of organisms
- Understanding about scientific inquiry

Grades 5–8
- Systems, order, and organization
- Form and function
- Structure and function of living systems
- Understanding about scientific inquiry

Content objectives

Learners will be able to do the following:
- Observe seeds and notice their distinctive features.
- Design a classification system for seeds to distinguish between monocots and dicots.
- Identify similarities and differences between monocots and dicots.

Process objectives

Learners will be able to do the following:
- Make observations.

Part 4

For older learners only (or use as a demonstration with younger learners)

- Corn and green bean seeds soaked in water 48 hours, one of each for each team
- Cornstarch
- Iodine
- Eye dropper
- Protective gloves for persons who may come in contact with iodine
- Petri dishes or plates

Preparation

Buy seeds that have not been treated with fungicide or other chemicals. Sprout the seeds as described above for parts 2 and 4.

There should be three sets of seeds for each team:

- Set 1—corn, green bean, brown rice, lentil, lima bean
- Set 2—corn and green bean (Part 2)
- Set 3—corn and green bean (Part 4)

Procedure

Part 1

Pass out the dry brown rice, lentil, corn, lima bean, and green bean seeds (Set 1) to each team. Caution learners not to eat any of the seeds they will be working with today. Tell the teams that they will work together to classify the seeds into groups. Ask the learners to list some physical characteristics of the seeds they think might help them classify the seeds.

Now ask each team to design their own set of criteria to classify the seeds into separate groups. A set of criteria for classification is sometimes called a **dichotomous key**. There are two choices listed at each step in the key. In the simplest keys, the first statement choice describes a specific criteria the sample must match (e.g., the seed has a kidney shape). The second statement of the pair is selected when the sample does *not* match the first choice (e.g., the seed does *not* have a kidney shape).

See the example, A Key to Seeds, on page 25. Scientists use dichotomous keys to classify organisms. The example is one way to design a key to the seeds in this study. Remember, this is only one example; there is more than one "right" design.

A Key to Seeds

1A: Seeds are kidney shape = go to 2A
1B: Seeds are not kidney shape = go to 3A
  2A: Seeds are ¾ inch or larger in size = lima beans
  2B: Seeds are smaller than ¾ inch = green beans
3A: Seeds are round = lentils
3B: Seeds are not round = go to 4A
  4A: Seeds are long and skinny = brown rice
  4B: Seeds are triangle shape = corn

Ask each team to write down their key clearly on a piece of paper. After all the teams have finished developing their key, have them trade keys. Now ask the teams to use this other team's key to try to classify the seeds successfully.

Part 2

Ask learners to set the dry seeds aside. They will use them again later. Pass out the seeds that have been soaking for 4 days (Set 2). If the conditions have been right for growth, these seeds have germinated. The corn and bean seeds should have visible roots and leaves beginning to grow out of them. Ask learners to observe and compare the new leaves and roots of the bean and the corn. How are they similar and different? What do they see in these growing seeds that might add to the information in the key they developed in Part 1?

Ask learners to use a fingernail carefully to separate the two halves of the bean seed. Have them use the hand lens and note how the tiny plant parts are attached to the cotyledon. Ask older learners to draw a picture of the bean and label its parts. How are the bean leaf and root starts different from the corn leaf and root starts? How many cotyledons does the corn seed have? Ask older learners to draw a picture of the corn seed and label its parts.

Lead a discussion based on the information in the "FYI" section about monocot and dicot plants and the names of the parts of the seeds. Adapt the information to the age and interests of the learners.

Part 3

Ask learners to look again at the dry seeds in Set 1. What are the characteristics of monocots and dicots we identified in the Set 2 seeds? Which of the dry seeds are monocots and which are dicots? Ask the teams to separate the seeds into two groups and share their reasons.

Now learners are prepared to make a trip to the pond to look at plants and collect seeds (if available). Older learners should develop a data sheet to record their observations. Which plants in and around the pond are monocots or dicots? It is not necessary for learners to know the common names of the plants in order to separate them into the two groups.

Part 4—For older learners only!

(This also may be done as a demonstration for younger learners. Because iodine is toxic, young learners should not use it. For more information, consult the proper Material Safety Data Sheet.)

Lead a discussion about the things plants need to survive. All plants need water, nutrients, and air. So far our seeds have had air and water. Where are they getting the energy or nutrients to fuel their growth? Record the answers provided by the learners. Older learners may record their ideas on the paper where they drew pictures of their corn and bean seeds.

Learners might know that plants make their food through photosynthesis. In Unit 1, we learned that photosynthesis is the process plants use to change light to chemical energy, which the plants use to create food (carbohydrate) from carbon dioxide and water. Many plants store the carbohydrate starch in their seeds.

Iodine can be used as an indicator for starch. When the red-brown iodine contacts starch, it becomes blue-black. Demonstrate this using some cornstarch mixed with a little water. Ask learners, "From which plant do we get cornstarch?"

Pass out the corn and green bean seeds that have soaked in water 48 hours (Set 3). Each seed should be on a separate Petri dish or plate to protect the table surface. Ask learners to mush or split open each seed, exposing the contents of the cotyledon. Explain that you will be putting a drop of iodine on each seed's cotyledon. Caution learners not to touch the iodine with bare hands.

What do learners expect will happen? Do they expect the corn and bean to be different? Have older learners write down their predictions and then record the actual results after the iodine has been placed on the cotyledons. If learners have access to a microscope, have them look at the iodine reaction for starch in the cotyledon under the microscope.

Extend the learning

A Palette of Fun (4-H 713L): Painting with paper and milk (add seeds to the design)

If learners can plant a vegetable garden, they might try growing "the three sisters": corn, beans, and squash. These companion plants grow well together because they offer one another mutual benefits. The corn provides living stakes for the beans. The beans are legumes, which supply nitrogen to the soil. The squash grows in the open spaces between the corn hills and provides ground cover to reduce moisture loss. Learners can study all these factors in their Three Sisters Garden.

Kidney beans or black beans and corn are significant food sources in many cultures. Learners can do research to study why these plants have been important to people living in Central and North America in the past and today. If seeds for kidney or black beans cannot be found at the garden store, those sold dry from the grocery store often will germinate.

3B—Seedless Plant Survivors

FYI

In lesson 3A, we looked at the seeds of angiosperms, one of the nine divisions in the Plant Kingdom. Four other divisions, the conifers, cycads, ginkos, and gnetums, also produce seeds. However, the seeds of these plants are not produced by a flower and they are not protected by a fruit.

The four remaining divisions in the Plant Kingdom do not use seeds to reproduce. Instead, they reproduce by **spores**. They belong to four phyla: (1) mosses and liverworts, (2) club mosses, (3) ferns, and (4) horsetails. These phyla are divided further by the presence or absence of vascular tissue. Three of the phyla (club mosses, ferns, and horsetails) contain vascular tissue. Vascular tissue is made of long, tube-shape cells. Their function is to carry water, minerals, and nutrients to cells throughout the plant. The mosses and liverworts are nonvascular plants that are just a few cells thick. Because of their small size, they do not need vascular tissue.

Materials

- Collect fresh samples of moss, horsetail, and fern to bring into the classroom, one of each for each team. The samples will keep fresh in a plastic bag in the refrigerator until you are ready to use them.

Procedure

Pass out samples of the moss, horsetail, and fern to each team. Tell the teams that they will work together to classify the plants into groups. Ask learners to list some physical characteristics of the plants they think might help them classify the plants.

Lead a discussion on the similarities and differences learners see in the plant samples. Coach them to notice the types of leaf or leaflike structures, the root or rootlike structures, the type of growth, and the color of each plant.

Ask learners to construct a key to these plant samples. After the teams have created the keys, ask them to trade keys and see if another team can use their key to classify the plants successfully.

Lead a discussion on the similarities or differences between the angiosperms and seedless plants. What surprised learners the most about these groups of plants?

Older learners may do library research to determine the reasons for different growth forms in the nonvascular and vascular plants.

Oregon benchmarks

Benchmark 1
- Recognize characteristics that are similar and different between organisms.
- Describe how related plants have similar characteristics.

Benchmark 2
- Group or classify organisms based on a variety of characteristics.
- Describe basic plant structures and their functions.

National Science Education Content Standards

Grades K–4
- Systems, order, and organization
- Form and function
- Characteristics of organisms

Grades 5–8
- Systems, order, and organization
- Form and function
- Structure and function of living systems
- Understanding about scientific inquiry

Content objectives

Learners will be able to do the following:
- List some distinguishing characteristics of seedless plants.
- Explain the primary differences and similarities between angiosperms and seedless plants.
- Design a classification system for seedless plants.
- Identify similarities and differences between seedless plants.

Process objectives

Learners will be able to do the following:
- Make observations.

3C—Amazing Aquatic Plants?

Oregon benchmarks

Benchmark 1
- Recognize characteristics that are similar and different between organisms.
- Describe the basic needs of living things.

Benchmark 2
- Group or classify organisms based on a variety of characteristics.

National Science Education Content Standards

Grades K–4
- Systems, order, and organization
- Form and function
- Characteristics of organisms

Grades 5–8
- Systems, order, and organization
- Form and function
- Structure and function of living systems
- Understanding about scientific inquiry

Content objectives

Learners will be able to do the following:
- List one or more varieties (species) of aquatic plants.
- Explain the effects of water quality on aquatic plants.

Process objectives

Learners will be able to do the following:
- Make observations.
- Ask questions that can be answered through a scientific investigation.
- Design an investigation to answer a question.
- Collect, organize, and summarize data from an investigation.
- Analyze and interpret data from an investigation.

FYI

Algae are members of the Protist Kingdom. In the Protist Kingdom, there are three groups: the plantlike, animal-like, and funguslike protists. The plantlike protists include euglenas, diatoms, dinoflagellates, green algae, red algae, and brown algae.

Green algae is likely to be found in the school pond or other aquatic environment. Green algae also can live in other types of environments and on other organisms, such as lichens.

Because of their many interesting shapes, looking at green algae under the microscope would be a nice addition to this Unit. If you have access to a microscope, consider buying prepared microscope slide study sets of various green algae. These may include *Spirogyra, Chlamydomonas,* and *Volvox.* They are available from scientific supply houses (see Appendix IV).

Materials

- ○ Two clear plastic jars for each team of learners, plus one additional set for a control group
- ○ Algae
- ○ Elodea (aquatic plants that are available from pet or aquarium supply stores)
- ○ Pond water or distilled water
- ○ Thermometers
- ○ pH paper
- ○ Salt, vinegar, lemon juice, baking soda, food coloring, soil
- ○ Home plant fertilizer (diluted for learners' use, if needed)

Preparation

Review the 4-H Science Inquiry Model and the learner evaluation criteria in the Scientific Inquiry Scoring Guide to assist in coaching learners as they complete this lesson.

If there is algae in the school pond, learners may collect it along with some water for this lesson. Otherwise, get algae from a local natural watercourse or order it from a biological supply company (see Appendix IV).

Procedure

Pass out to learner teams the samples of algae and elodea in clear plastic jars with pond or distilled water. Keep one control set of jars with algae and elodea separate for comparison later.

Have the teams of learners use a microscope or hand lens to look at the algae and elodea. Ask learners to record the similarities and differences they see. Lead a discussion of what the teams observed.

Remind learners of lesson 2B—Water Quality Tests. Which water quality factors have they learned affect aquatic plants' growth? Record the responses on the board. Ask learners if they think the two green organisms have the same requirements for survival, or if they might be different based on what they can observe.

Ask each team to select one water quality factor to change to see how it affects each of the two green organisms. Ask them to state the change they propose to make in the form of a question. For example, "Will adding fertilizer to the water make the algae and elodea grow larger?" Encourage older learners to use an "If….., then….." hypothesis format.

When all the teams have formulated a question, ask them to share it aloud with the group. If two teams ask the same question, work with the teams to ensure that each team will be testing a different variable. Assist teams to follow the steps outlined in the 4-H Science Inquiry Model.

Possible changes learners can make to the water include raising or lowering the temperature, adding salt, lowering the pH with vinegar or lemon juice, raising the pH with baking soda, or adding other "contaminants" such as food coloring or soil for turbidity. Learners also may propose taking the plants out of the water altogether. Accept any experiment design that is not dangerous and that will produce an observable result.

Now, ask the teams to create an experiment design including a materials list and a data sheet. Remind them to determine how long their experiment will continue. If you have a set time frame, state this to learners. Avoid open-ended time frames such as, "Until the plant dies."

Continue to facilitate the experiment design. Will they add a tablespoon of vinegar today, observe the two organisms daily, then add additional vinegar in a week? How will they test to see what is happening to the pH of the water? When all teams have completed their experiment design, ask them to share it aloud with the group. Allow learners to ask the teams questions about their design.

Pass out the materials requested by each team and facilitate as needed while they prepare their two samples. Set the samples aside. Allow time each day of the experiment period for learners to view the samples and record what they observe. Ask learners to compare what they observe in their jars with the organisms in the control jars.

At the end of the experiment period, ask the teams to analyze and interpret the data they collect and give a summary report to the group. Ask learners, "How does what we learned from these experiments apply to how we manage our school pond?" and then, "How does what we learned from these experiments apply to how other ponds or natural bodies of water are managed?"

Extend the learning

Project WILD Aquatic Education Activity Guide: Kelp Help

Unit 4: What can we learn about invertebrates at the pond?

Oregon benchmarks

Benchmark 1

- Recognize characteristics that are similar and different between organisms.
- Describe how related animals have similar characteristics.

Benchmark 2

- Group or classify organisms based on a variety of characteristics.

National Science Education Content Standards

Grades K–4

- Form and function
- Characteristics of organisms

Grades 5–8

- Form and function
- Diversity and adaptations of organisms

Content objectives

Learners will be able to do the following:

- Explain that some aquatic insects have a different body form when they are immature (babies, children) and when they are a mature adult.
- Explain the difference between insect larvae and nymphs.
- Diagram a sample life cycle of an aquatic insect.

Process objectives

Learners will be able to do the following:

- Make observations.
- Ask questions that can be answered through a scientific investigation.
- Design an investigation to answer a question.
- Collect, organize, and summarize data from an investigation.
- Analyze and interpret data from an investigation.

Background

Invertebrates are animals that do not have a backbone. About 97 percent of all animals on Earth are invertebrates.

The lessons in this Unit focus on aquatic larvae and nymphs of insects and spiders in the Phylum Arthropod, and snails and slugs in the Phylum Mollusk. In addition to these, there are many other kinds of invertebrates you can study in the classroom. You can get butterflies (larvae to adult), composting red worms, beetles, crickets, and snails in kits that include information, equipment, food, and the live invertebrates. You can buy these kits from biological supply companies (see Appendix IV). They offer almost endless opportunities for learners to design inquiry investigations.

The *Oregon 4-H Entomology Manual* (4-H 3221) has additional information on insect growth and metamorphosis to assist in the discussions in lesson 4A.

4A—Presto, Change-o

FYI

All insects (class Insecta) begin life as eggs. The eggs hatch and become immature insects. Many aquatic invertebrates that are collected for study are immature insects—either **larvae** or **nymphs**. They live in ponds and streams until they are old enough to develop a full set of wings, fly off, and lay eggs of their own.

Most insects go through a change in body type to become adults from the immature form. The change that larvae or nymphs go through is called **metamorphosis**. Metamorphosis takes place in different ways in different types of insects. In this lesson, learners compare two types of immature insects, larvae and nymphs, with the adult forms they become.

Most aquatic insect larvae are shaped like worms and have soft bodies; they look very different from the adult form of the insect. An insect larvae goes through complete metamorphosis to become an adult. An example that learners may recognize is the butterfly. Most learners probably know that the caterpillar, a wormlike larva, forms a chrysalis. While in the chrysalis, the caterpillar undergoes metamorphosis to become an adult butterfly. Then, the butterfly emerges from the chrysalis.

Examples of insects that live in water as larvae are mosquitoes, crane flies, dobsonflies, caddisflies, and midges. One interesting aquatic larva that doesn't look like a worm is the water penny. Water pennies grow up to be beetles that live along the banks of streams.

Aquatic nymphs are different from larvae in one very obvious way. Instead of looking like worms, nymphs more closely resemble the adult insects. Their bodies are firmer than larvae and they have three obvious pairs of legs, just like the adult. Nymphs also are usually stronger swimmers. If learners look closely at a nymph, they will see wing pads (the beginnings of wings) on its back. As nymphs get bigger, the wing pads grow, and after metamorphosis, the adult has fully-developed wings.

Materials

Part 1

- Ask learners to bring in photographs of their parents today and when they were children, and of themselves today and when they were babies.

Part 2 and Part 3

- Immature and Adult Aquatic Organisms cards (Appendix II), one set
- Quick Reference Guide to Aquatic Invertebrates cards (Appendix II), two sets

Preparation

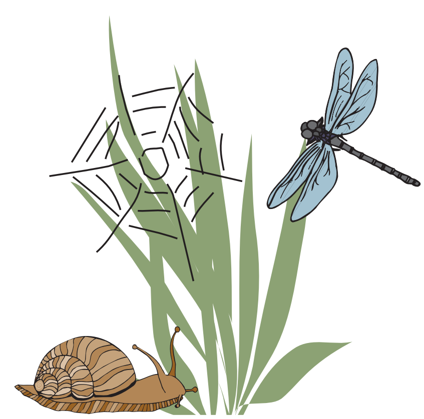
Leaders should review the following:

- Background section
- FYI section
- 4-H Science Inquiry Model
- Learner evaluation criteria in the ODE Scientific Inquiry Scoring Guide to assist in coaching learners

Part 2

Photocopy the Immature and Adult Aquatic Organisms cards masters onto card stock. Cut out each card. Divide the cards into two piles, one for adult forms and one for immature forms of aquatic organisms, and shuffle each pile.

Photocopy the Quick Reference Guide to Aquatic Invertebrates card masters onto card stock (if they were not copied for lesson 2B).



Procedure

Part 1

Look at the picture pairs of the adults/children and children/babies. Lead a discussion of how and why living things change in shape and appearance as they get older and more mature.

Part 2

Lead a discussion based on the information provided in the "Background" and "FYI" sections about the body types of immature and adult insects. Learners should understand clearly the difference between a larvae and a nymph. Adapt the information to the age of the learners.

Hand out one of the Immature and Adult Aquatic Organisms cards to each learner in your group. Make sure that for every adult card you distribute, you also hand out the corresponding card for the immature form.

Ask learners to look for the card that matches the one they have, so that each pair of learners ends up with a card illustrating the adult and a card illustrating the immature form of an organism. To help learners match up forms with which they are unfamiliar, the shapes at the right edge (immature) and left edge (adult) of matching cards fit together to form a design.

When all the cards have been matched, have each learner pair describe to the group the immature and adult forms of their organism. For insects, identify the immature form as a nymph or a larva. Ask the following questions.

- Does any pair of learners have an organism that is not an insect? (Yes, the tadpole/frog cards.)
- Are any insects ever both a larva and a nymph? (No.)
- Which immature forms go through complete metamorphosis to become an adult? (The immature insects that are larvae go through complete metamorphosis.)
- Which immature forms go through incomplete or gradual metamorphosis to become an adult? (The immature insects that are nymphs go through incomplete or gradual metamorphosis.)

Now, ask the pairs of learners to divide into two groups. Learner pairs who have immature insects that are larva form one group. Learner pairs who have immature insects that are nymphs form the second group. In these two groups, ask learners to consult their cards and look for other similarities among the insects pictured.

Pass out a set of the Quick Reference Guide to Aquatic Invertebrates cards to each group. Ask them to use the cards to learn more about the insects they have. (Note: There are no information cards for the water scorpion, tadpole/frog, giant water bug, water scavenger beetle, water penny, mayfly, or deer fly.) Can the learners discover which form of immature aquatic insect—nymph or larva—is more likely to be found in ponds rather than in streams?

The cards could be grouped as follows.

Insects with complete metamorphosis; immature forms are larvae

Beetles	Belong to the order Coleoptera. Water penny, predaceous diving beetle, water scavenger beetle, whirligig beetle
Flies	Belong to the order Diptera. Deer fly, black fly, midge, rat-tailed maggot, mosquito, crane fly
Caddisfly	Belongs to the order Tricopera. Stone case caddis
Dobson fly	Belongs to the order Neuroptera.

Insects with incomplete or gradual metamorphosis; immature forms are nymphs

Dragonfly and Damsel fly	Belong to the order Odonata.
Stonefly	Belongs to the order Plecoptera.
Mayfly	Belongs to the order Ephemoeroptera.
Bugs	Belong to the order Hemiptera. Water boatman, water strider, water scorpion, giant water bug

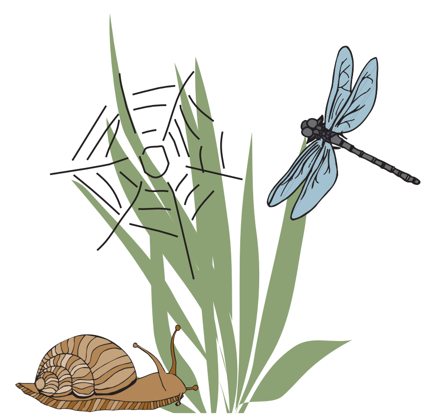
Lead a discussion about the similarities learners identified in the insects. Ask the learners to list some physical characteristics of the insects they think might help in classifying them. Ask older learners to design their own dichotomous key to classify the insects. (Remind them of the key to seeds they created in lesson 3A. There are two criteria listed at each step in the key.)

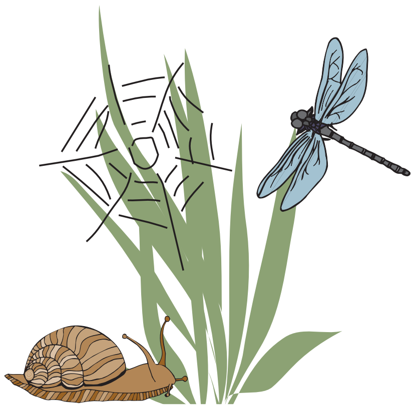
Ask each team to write down its key clearly on a piece of paper. When each group has finished its key, have the groups trade keys and insect cards.

Older learners can do some research to identify the characteristics of the insect orders listed above and then to determine whether any other members of these orders also have aquatic larvae.

Part 3

Ask learners if they think that the number or type of immature aquatic insects found in the pond is the same in all seasons of the year. (If learners began a long-term pond monitoring project after completing lesson 2B—Water Quality Tests, they already will have some data available to answer this question.) How do conditions in the pond change with the seasons? Can learners make a connection between the results of any of the specific water quality tests and the number or variety of insects? Coach learners to determine how they may answer these questions using the 4-H Science Inquiry Model.





Create a timeline for the investigation. Learners will need to take samples in at least two different seasons of the year to provide a comparison.

Extend the learning

Project WILD Aquatic Education Activity Guide: Micro Odyssey
A Palette of Fun (4-H 713L): Pop-up Pizzazz

Reference

This lesson was adapted from *Pond & Stream Safari—A Guide to the Ecology of Aquatic Invertebrates*, Cornell Cooperative Extension Publications. Used with permission.

Oregon benchmarks

Benchmark 1
- Describe the basic needs of living things.
- Describe a habitat and the organisms that live there.
- Identify how some animals gather food, defend themselves, and find shelter.

Benchmark 2
- Describe the relationship between characteristics of specific habitats and the organisms that live there.
- Describe how adaptations help a species survive.

National Science Education Content Standards

Grades K–4
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry
- Characteristics of organisms
- Organisms and environments

Grades 5–8
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry
- Structure and function of living systems
- Regulation and behavior

4B—Glorious Gastropods

FYI

Gastropod means "stomach-foot." Snails and slugs are gastropods. They belong to the Phylum Mollusk.

Two body parts that are characteristic of mollusks are the **mantle** and the large, muscular **foot**. The mantle of snails and conches secretes material for making their shells. The shell provides camouflage and protection and helps conserve water. The mantle of slugs is vestigial, appearing as a raised "cap" or "saddle" behind the optical tentacles.

A gastropod uses its foot to attach to objects or to move. Muscle fibers in the foot alternately relax and contract, creating **pedal waves** that cause forward movement. The pedal gland on the sole of the foot secretes a trail of mucus, which allows gastropods to glide across surfaces. Most of the body surface of slugs also produces mucus. It helps prevent dehydration and is used for self-defense.

Other characteristics of interest in snails and slugs are:

- The mouth is on the bottom surface of the foot and contains a tongue-like **radula**. The radula is covered with rows of teeth that work like a file to break up food and scrape algae off surfaces.
- Slugs and snails do not have antennae. They have two pairs of **tentacles** which they can move independently in or out, up or down, to gather information. The large tentacles on the top of the head end in light-sensing organs. These are called optic tentacles. The smaller pair of stalks below the optic tentacles are sensory tentacles. They are used like whiskers on a mammal to feel the way ahead.
- Slugs live only on land. Snails may live on land or in the water. Slugs and land snails have lungs. Most water-dwelling snails use gills to breathe.
- Slugs and snails are hermaphrodites. That means that each animal has both male and female sex organs.

For the lesson below, leaders either may buy snails or collect snails or slugs from “the wild.” There almost certainly will be slugs in the schoolyard habitat most months of the year. If you begin the classroom lessons studying slugs, it allows learning and experimentation to extend to the habitat more easily.

Materials

Parts 1 , 2, and 3

- Live slugs or snails (buy from a biological supply company or gather from the “wild”)
- Large (at least 10-gallon) aquarium with a solid lid
- Oatmeal, wheatgerm, and/or grass or lettuce grown in the aquarium, to feed the slugs or snails
- Journals, data sheets, or record pages; one for each learner

Part 2

- Hand lenses, one for each team
- Petri dishes, one for each team
- A variety of materials to create texture test surfaces.
  Rough: broken clay pot shards, sandpaper. Soft: fabric, dry or wet moss

Part 3

- Mini-aquaria, one for each team
- A variety of plant seeds to test for food preferences
- Apples, lettuce, or other foods to test for food preferences
- A variety of materials to create texture test surfaces.
  Rough: broken clay pot shards, sandpaper. Soft: fabric, dry or wet moss
- Other reasonable materials requested by learners, such as colored and white paper, scissors, a spray bottle, a ruler

Preparation

Leaders should review the following:

- Background section
- FYI section
- 4-H Science Inquiry Model
- Learner evaluation criteria in the ODE Scientific Inquiry Scoring Guide to assist in coaching learners

Buy land snails and/or collect slugs several weeks before the activity is scheduled: they need some time to begin to behave normally in their new home.

Set up an aquarium with materials that simulate the gastropods’ natural environment. The surroundings should be moist, but not wet. Keep a solid lid on the aquarium to help provide the proper humidity.

Content objectives

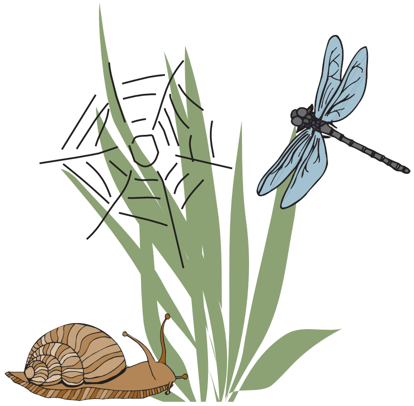
Learners will be able to do the following:

- List two organisms found in the Phylum Mollusk.
- Name some similarities and differences between snails and slugs.
- Explain how gastropods react to various changes in their habitat.

Process objectives

Learners will be able to do the following:

- Make observations.
- Ask questions that can be answered through a scientific investigation.
- Design an investigation to answer a question.
- Collect, organize, and summarize data from an investigation.
- Analyze and interpret data from an investigation.



If you bought snails, feed them the material that came with them. Additional foods include oatmeal and wheat germ, and grass or lettuce that you can grow in the aquarium by sprinkling seeds on the soil's surface.

You can involve learners in collecting the gastropods and setting up the aquarium to practice using observational skills. You may wish to reserve feeding live plants for learners to test as part of their inquiries.

Procedure

Part 1

Using the information in the "Background" and "FYI" sections, lead a discussion about snails and slugs (gastropods). Adapt the information to the age of the learners. The first thing learners generally comment on is the **slime**. Ask: Did anyone ever handle a slug and then try to wash the slime off their hands? What happened? It probably didn't work very well. Slug slime absorbs water to prevent the slug from drying out! Rub off slime with a dry towel or by rubbing dry hands together.

If the aquarium has not been where learners could see it, have them spend a few days observing the gastropods periodically in the aquarium. You may need to wipe the slime trails off the glass walls daily. Ask learners to record their observations in their journals, data sheets, or record pages. Also, ask them to record any questions they have about the gastropods and their behavior. At the end of this observation period, ask learners to share their questions and observations.

Part 2

Place the gastropods in slightly moist Petri dishes, one for each team of learners. It is important to use a Petri dish or other clear-surfaced container so learners can observe the sole of the gastropod's foot. Pass out the hand lenses and ask learners to use their journals, data sheets, or record pages to record their observations. They need to sit quietly for the gastropod to begin moving around normally. Coach learners to lift the Petri dish and look under the gastropod to locate the mouth and observe the motion of the foot. They should be able to see the pedal waves moving along the sole of the foot.

Ask learners to draw a picture of their gastropod and identify its parts on the picture.

Ask the teams to include in their observations how the gastropods respond to different simple stimuli. Do they react to movement? Light? Food? The type of surface they are on? How fast do they move? At the end of this observation period, ask learners to share new questions and observations. Put the gastropods back in the aquarium until the next activity period.

Snail	Slug
• A shell. (The snail has a mantle inside the shell, which secretes material to produce the shell.) • Tentacles—short sensory stalks and long optic stalks • Mouth • Foot • Snails may live on land or in water. Land snails breathe with lungs. Most water-dwelling snails use gills to breathe.	• A mantle—the raised "saddle" or "cap" behind the optical tentacles • Tentacles—short sensory stalks and long optic stalks • Mouth • Foot • Pneumostome—a small hole or slit on the slug's right side, leading to the slug's single lung

Part 3

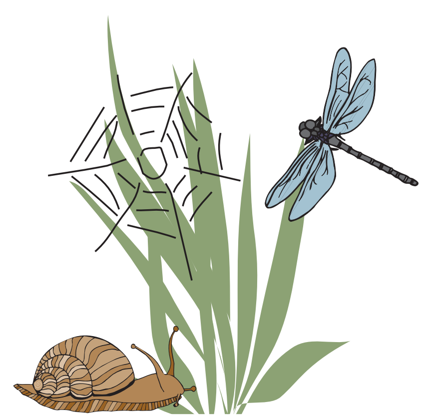
Explain to learners that each team will be given a mini-aquarium and a gastropod. They are to follow the steps outlined in the 4-H Science Inquiry Model to create an experiment design, including a materials list and data sheet. Set a time frame for the experiments to be completed. Experiments could test food preferences, like apples or lettuce; or, learners may grow plants to test preferences. Some gardeners believe that slugs will not cross a barrier of marigolds in a garden. Is this true?

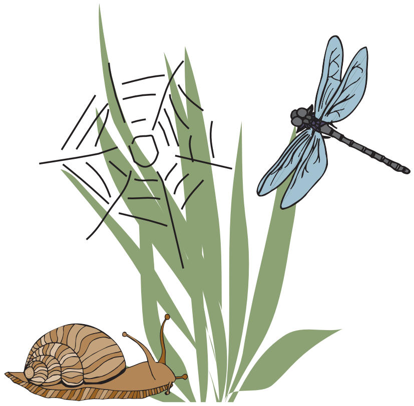
Additional differences that may be tested include various surfaces, damp or dry areas, or preferred types of hiding places. Avoid experiments that could harm the gastropod, such as applying salt.

When all the teams have completed their experiment design, ask them to share them aloud with the group. Allow learners to ask the teams questions about their designs.

Pass out the materials requested by each team and facilitate, as needed, while they set up their experiments. Be sure each team records their set-up procedure. Allow time each day of the experiment period to view the mini-aquaria and record what is observed.

At the end of the experiment period, ask the teams to analyze and interpret the data they collect and give a summary report to the group. Ask each team to explain how they could apply what they have learned to the habitat area. What additional inquiries would the learners like to make in the habitat area?





Extend the learning

A Palette of Fun (4-H 713L): Batik; Scissors Snipping

- Buy or collect pond snails and land snails. Compare their form, their movement, and their responses to various stimuli and food sources. Are there pond snails in the habitat area pond? Why or why not? If there are no snails there, should they be introduced? Why or why not? Which of the experiments that were made on the land gastropods could be tried also on the pond snails?
- Learners can do library research to study other members of the Phylum Mollusk. Characteristic body parts of a mollusk are a mantle; a thin, fleshy layer of tissue covering the mollusk's soft body; and the large, muscular foot. Bivalves and cephalopods are mollusks. Bivalves are animals such as clams, scallops, and mussels. Examples of cephalopods are octopus, squid, and chambered nautilus.
- Many fossils that originate in marine environments have bivalve shells. Learners can find marine fossils at Beverly Beach on the Oregon coast north of Newport. Take a field trip to collect some fossils, and then identify them.

References

Field Guide to the Slug. 1994. The Western Society of Malacologists. David George Gordon. Seattle, WA: Sasquatch Books.

"Snail Trails." May 2002. Pamela Galus. *Science Scope.* Volume 25, Number 8.

4C—Spider Survey

FYI

The Legend of Arachne

Arachne was a girl who was the best weaver in all the Greek Isles. She could weave such beautiful things on her loom that she challenged the goddess Athena to a weaving contest. This made Athena angry! Athena unraveled all of Arachne's work and changed her into a spider. Arachne and her descendants were doomed to weave all their lives.

Spiders are arachnids

Scientists place spiders in a group called Arachnids (class Arachnida), named after the legendary girl Arachne.

Spider anatomy

All spiders have eight legs, two body parts, simple eyes (most have eight eyes!), no wings, no antennae, and a body covered by an exoskeleton. (Insects [class Insecta] also have a body covered by an exoskeleton; however, they have six legs, three body parts, and antennae. Insects also may have wings and compound eyes.)

The two body parts of the spider are the **cephalothorax** and the **abdomen**. The cephalothorax is a combination head and thorax; this is where the legs, eyes, and mouthparts are. Spinnerets are located on the underside of the abdomen. Spinnerets produce silk, which is a protein material called fibroin. The spider's body also has sensory hairs that allow the spider to detect vibrations.

Nearly all spiders are venomous, but this should not cause people to fear them. Most cannot bite through human skin and would not cause damage if they did. The venom of most spiders is a digestive enzyme. The venom is delivered through poison ducts that come from a gland at the base of the chelicerae on each side of the spider's mouth. The pedipalps located on each side of the chelicerae may be used for feeling. They also may have tiny sharp teeth along the edge to help the spider grasp prey.

Early life

A spider typically begins life wrapped in a waterproof egg sac. The sac may contain from 1 to 3,000 eggs. When spiderlings hatch, they may cling to the back of their mother for several days. Other spiders, like those described in the children's book *Charlotte's Web,* climb to a high spot, raise their abdomens, and squirt out a silk "balloon" that catches the wind and carries the spiderling to a new home.

Spider silk

Spider silk is the strongest natural fiber found. For its size, it is stronger than steel. It can stretch to five times its original length without breaking. There are at least seven different types of silk. No spider makes all seven kinds.

Oregon benchmarks

Benchmark 1
- Describe a habitat and the organisms that live there.
- Identify how some animals gather food, defend themselves, and find shelter.

Benchmark 2
- Describe how adaptation helps a species survive.

National Science Education Content Standards

Grades K–4
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry
- Characteristics of organisms
- Organisms and environments

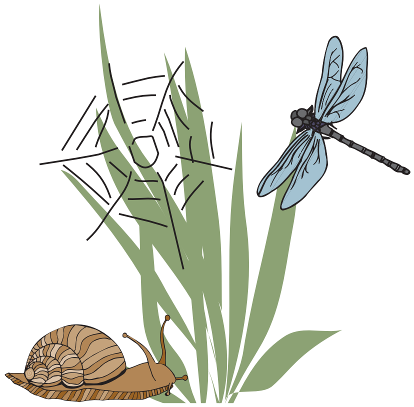
Grades 5–8
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry
- Structure and function of living systems
- Regulation and behavior

Content objectives

Learners will be able to do the following:
- Describe the parts of a spider.
- Name some similarities and differences between insects and spiders.
- Name some of the unique characteristics of a spider's habitat.

Process objectives

Learners will be able to do the following:
- Make observations.
- Ask questions that can be answered through a scientific investigation.
- Design an investigation to answer a question.
- Collect, organize, and summarize data from an investigation.
- Analyze and interpret data from an investigation.



Orb weavers make five or six of the seven types of silk, more than any other spider. They make webs with a scribbly pattern in white in the center. The silk is a liquid as it leaves the spinnerets; it hardens as it is drawn out. One kind of silk goes into the framework of a web. A second type gets coated with stickum as it passes through the spinnerets. The third type of silk is for tying up prey. The fourth is used for making egg sacs. The fifth is strung out behind and tacked down as the spider walks, like a safety rope.

How spiders get food

Web-tending spiders build webs and wait for a meal to arrive. Because they are inactive, web-tending spiders can go for a month or more without food. Once something does hit the web, the spider must decide if it is food or something that will harm it. Because most web-building spiders have poor eyesight, they use the vibrations in the web to determine if the item in the web is food or an enemy. If it is food, the spider wraps it in silk. A pinch from the chelicerae immobilizes the prey and injects enzymes that begin to liquefy the prey's internal structures. When the spider is ready to eat, it sucks out this predigested liquid.

More active hunters, such as the wolf spider, use more energy and require more food than web-dwelling spiders. Crab spiders hide in flower petals to capture bees. The fishing spider can walk on a thin film of water and carries a bubble of air underwater in its search for prey.

Materials

Part 1

- Supply of age-appropriate books depicting insects and spiders
- Compass
- Measuring tape

Part 2

- Feathers, small sticks, spray bottle of water (to wiggle a spider web)
- Refrigerated flies and other insects, to test food preferences

Preparation

Leaders should review the following:

- Background section
- FYI section
- 4-H Science Inquiry Model
- Learner evaluation criteria in the ODE Scientific Inquiry Scoring Guide to assist in coaching learners

Leaders should make their own preliminary inventory of spider activity in the habitat area before taking learners there. Spiders, like their insect prey, are more active during warmer weather.

Fall and Spring are the best seasons for this lesson. If the lesson is offered in the Fall, learners could monitor spider activity over the school year to discover for themselves when spiders are most active.

Procedure

Part 1

Using the information in the “Background” and “FYI” sections, lead a discussion about spiders. Adapt the information to the age of the learners. Using pictures from illustrated children’s books, compare and contrast the body parts of spiders and insects. Ask older learners to draw pictures to show these differences.

Ask learners if they have seen spiders in the habitat area. Where have they seen them? What were the spiders doing?

With the whole group, create an observation sheet to record information about spider webs. Coach learners to write questions for the sheet that document information such as web size; types of plants or other objects webs attach to; location of spiders; presence and location of wrapped prey; location of the web in regard to sun, shade, or other factors important to spiders.

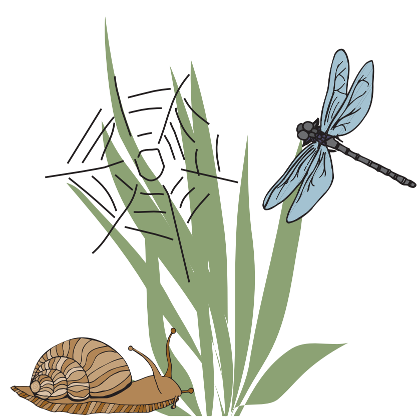
Make a photocopy of the group’s observation sheet for each learner. Take the learners to the pond to get a more focused idea of the spider activity at this time of year. Ask learners not to handle the spiders or disturb the webs. What questions do learners have about spiders? Have learners do some library research to learn more about spiders.

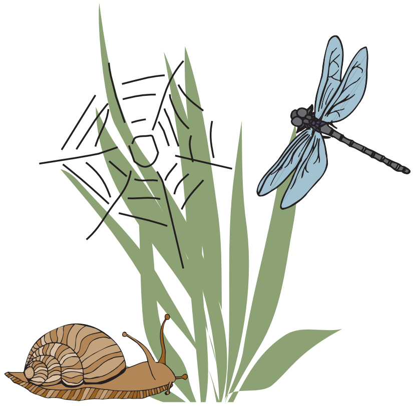
Older learners could use a compass and measuring tape or GPS units to create a map of spider web locations in the habitat.

Part 2

Before beginning this section of the lesson, decide how much time you will give learners to observe the habitat area spiders. Learners will get the most from this activity if they spend time observing a spider and its web before designing an investigation. They might do just one exercise, observe the webs each week for a month, or observe the webs over the whole school year. Be sure to explain these guidelines to learners before they begin their investigation design.

After learners have had time to observe the behavior of spiders in the pond habitat, group them in their teams and ask them to follow the steps outlined in the 4-H Science Inquiry Model to create an experiment design, including a materials list. Avoid experiments that could harm the spiders. Experiments could test food preferences, web location preferences, and spiders’ reactions to various stimuli; or monitor activity at different temperatures.





When all the teams have completed their experiment design, ask them to share them aloud with the group. Allow learners to ask the teams questions about their designs.

Pass out the materials requested by each team. Facilitate data collection in the habitat as needed over the predetermined time period.

At the end of the experiment period, ask the teams to analyze and interpret their observations and the data they collect from any experiments, and give a summary report to the group. Ask each team to explain how they could apply what they learned to spiders that do not live at the school. The next time they find a spider in their bedroom, how will they respond?

Extend the learning

A Palette of Fun (4-H 713L): Warp and Weft of Life; What a Twilling Weave!

Unit 5: What can we learn about fish at the pond?

Background

Fish are vertebrates that live in water without breathing air from the atmosphere. Vertebrates are animals with a backbone. Fish are the oldest of all animals with a backbone.

Most fish are covered with **scales** or plates. The scales are covered with a slimy mucus that lubricates the fish's body and protects it from infection. A fish's scales get longer as it grows. This creates annual growth rings on the scales that can be used to estimate the fish's age.

Fins are thin membranes supported by bonelike rays. All fins are used for balance, and some have additional functions. The **pectoral fins** help a fish stay in one place or allow for lateral and vertical movements. The **caudal fin** provides the primary power that moves a fish through the water.

Fish absorb oxygen from the water through membranes on the **gills**. Water enters the fish's mouth, passes over the gills, and exits the body at the gill opening. The delicate gill filaments are covered by a bony protective flap called the **operculum**.

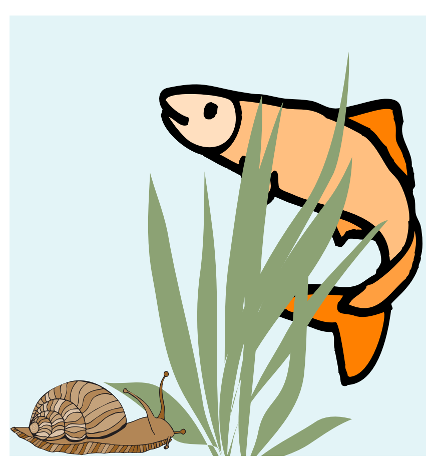
The **lateral line** runs lengthwise down each side of a fish. It's a system of openings or pores connected to sensory canals that are extremely sensitive to water currents and vibrations.

Fish who live in fresh water and fish who live in salt water face different challenges in maintaining a proper balance of salts and water in their bodies. Ocean water has a higher concentration of salts than the blood of marine bony fishes. Ocean fish need mechanisms to remove excess salt from their bodies while maintaining their internal fluid levels. Marine fish move large quantities of water through their bodies. The excess salts are removed by the kidneys and by special cells in the gills.

A freshwater fish's blood has a higher concentration of salts than the surrounding water. In fresh water, the process of osmosis draws water into the fish and removes salts from the body. To maintain balance, the specialized kidneys of freshwater fish pump out excess water as a dilute urine. Their gills contain salt-absorbing cells that move salt into the fish's blood.

Salmon live in both salt water and fresh water at different times in their life cycles. Pacific salmon move between freshwater and saltwater environments as juveniles migrating to the ocean and as adults returning to their natal stream. On these migrations, salmon pause in the estuaries of their parent watershed to allow time for their bodies to make the necessary physiological changes.

Fish species have developed different body, fin, and tail shapes; mouth types; colors; and methods of reproduction that allow them



to survive in different aquatic environments. A fish's habitat includes the food it eats, where it finds shelter from predators, and the quality of the water it lives in. Some of the factors that affect water quality are temperature, level (amount) of dissolved oxygen and pH, and turbidity caused by sediment load (silt) and other particulates.

You also might refer to the *4-H Wildlife Stewards Project Handbook* for information on "Landscaping for Salmon."

5A—Fish Fundamentals

Oregon benchmarks

Benchmark 1
- Recognize characteristics that are similar and different between organisms.
- Describe a habitat and the organisms that live there.

Benchmark 2
- Describe the relationship between characteristics of specific habitats and the organisms that live there.
- Describe the function of organ systems.
- Describe how adaptation helps a species survive.

National Science Education Content Standards

Grades K–4
- Form and function
- Characteristics of organisms

Grades 5–8
- Form and function
- Diversity and adaptations of organisms

Content objectives

Learners will be able to do the following:
- List general characteristics of fish.
- Relate structure to function in external fish anatomy.

Materials

- Fish Function activity page (page 48), one copy for each learner

Procedure

Using the information presented in the "Background" section, work with learners to label the parts of the fish on the Fish Function activity page. Explain the function of each part as it is labeled. Once all the parts are labeled, ask learners to match the parts to the list at the bottom of the activity page.

Answers—Fish Function activity page

Adipose fin—E	Lateral line—H
Anal fin—G	Operculum—A
Caudal fin—I	Gill opening—F
Dorsal fin—J	Pectoral fin—D
Pelvic fin—B	Scales—C

Extend the learning

A Palette of Fun (4-H 713L): Plants from the Garden; order rubber fish models for printing from Nasco Arts and Crafts/Nasco Science.

Of People and Fish, Oregon 4-H Natural Science and Cultural Discovery Program (4-H 3811L).

Oregon leaders should order copies of this publication from their local office of the OSU Extension Service.

From outside Oregon, this curriculum is available from OSU Extension and Experiment Station Communications. For current sales price and ordering information, query by fax (541-737-0817), e-mail (puborders@oregonstate.edu), or phone (541-737-2513). Some 4-H youth publications are available online (**extension.oregonstate.edu**, then Publications, then 4-H youth).

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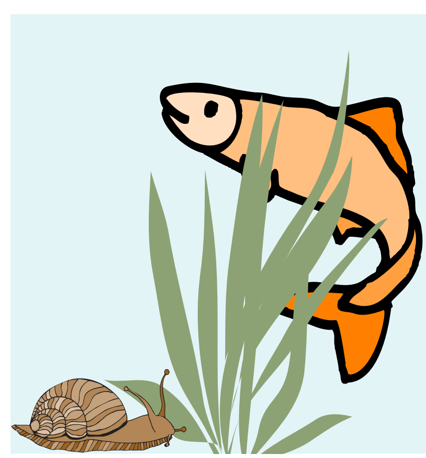
This is a combined science and social science curriculum that covers the following chapters: Fish Fundamentals, Pacific Salmon Life Cycles, Native American Salmon Life Ways and Legends, The Corps of Discovery, A History of People and Fish, Fishing Tools and Techniques, and Salmon for the Future.

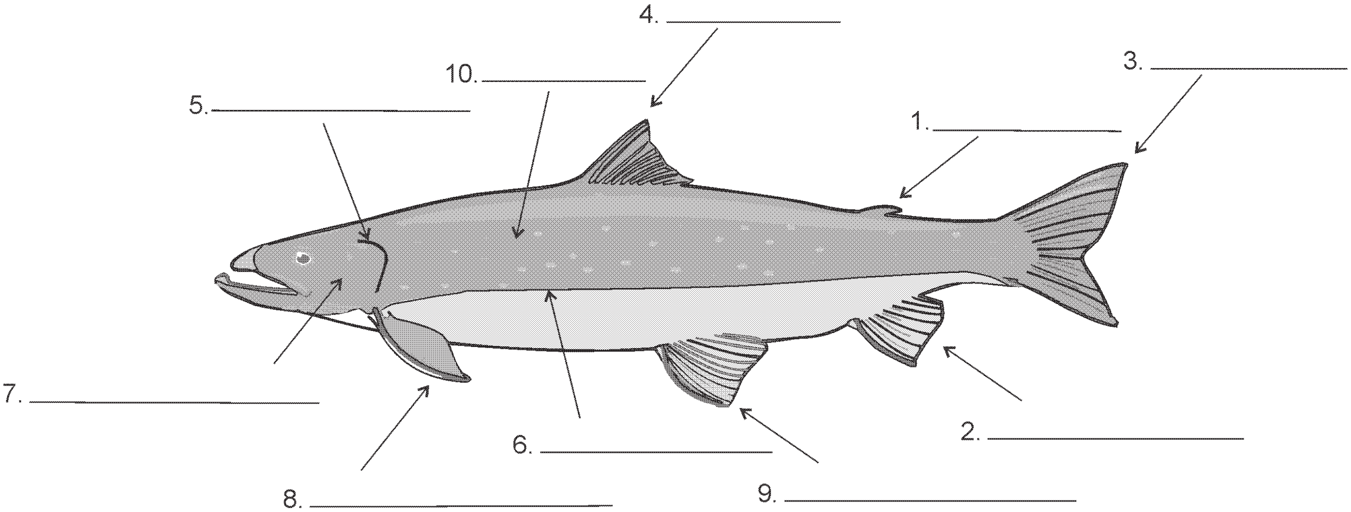
Project WILD Aquatic Education Activity Guide: Fashion a Fish; Pond Succession

Reference

This lesson was adapted from *Of People and Fish, Oregon 4-H Natural Science and Cultural Discovery Program* (4-H 3811L), “Activity 1A—Fish Function.” Oregon State University Extension Service, July 2003.



Fish Function



Identify each of the fish parts listed below. Match the parts to their function listed at the bottom of the page.

Adipose fin ____________	Lateral line ____________
Anal fin ____________	Operculum ____________
Caudal fin ____________	Pectoral fin ____________
Dorsal fin ____________	Pelvic fin ____________
Gill opening ____________	Scales ____________

A A covering of the gills

B A pair of fins used for balance; located below and behind the pectoral fins

C A special covering on the fish that protects the body from injury

D A pair of fins used to stay in one place, dive, or rise to the surface; located in front of the pelvic fins

E A single fatty fin found on some types of fish including salmon and trout; the fin that is removed on hatchery-raised fish before they are released

F The opening where water exits the fish after passing over the gills; oxygen is absorbed from the water by the gills

G A single fin used for balance; located near the tail, on the lower surface of the fish

H A line of scales on each side of the fish

I This fin moves the fish forward in the water; located on the tail

J A single fin used for balance; located on the upper surface of the fish

5B—What's in a Stream?

FYI

In addition to fish, many living things make up a pond or stream habitat. As a way to understand their relationship, the interactions among the organisms that populate a stream can be arranged in a **food chain**. A food chain is a model to depict energy flow through an ecosystem. Any ecosystem is much more complicated than a single food chain or even a group of food chains—called a food web—can demonstrate. However, a food chain is a useful model for learners to begin to understand the interrelationships in ecosystems. (In lesson 6A, learners study the different ways aquatic invertebrates obtain food. Both the way they obtain food and the type of food they eat define their role in the habitat.)

A food chain in an aquatic habitat might seem to begin with **phytoplankton** or **algae**, which create energy through photosynthesis. However, phytoplankton and algae need nutrients too. A food web has many interconnections and does not "start" or "end" in any one place. Decomposers—bacteria and other microbes—break down dead plants and animals so they are recycled back into the aquatic system as nutrients. In salmon streams, the decomposing bodies of spawned-out salmon are crucial for returning nutrients to the ecosystem. These nutrients are important not only to the stream, but to the surrounding uplands as well.

In an aquatic food chain, small animals called **zooplankton**, which feed on phytoplankton, might come next. **Salmon fry,** which have absorbed their yolk sacs, feed on the zooplankton. The salmon fry may be eaten by a variety of predators including trout, raccoons, and belted kingfishers.

Salmon are an example of how complicated ecosystem study can become. Pacific salmon do not spend their lives in the home stream of their birth. They live in the whole watershed, traveling down to the Pacific Ocean and then returning home to spawn. All the ecosystems within the watershed and the ocean affect salmon on their journey.

Materials

Part 1

- What's in a Stream? activity page (page 51), one copy for each learner

Part 2

- Stream Web of Life cards (Appendix II), one set
- Two lengths of poly-rope

Oregon benchmarks

Benchmark 1

- Describe a habitat and the organisms that live there.

Benchmark 2

- Describe the relationship between characteristics of specific habitats and the organisms that live there.

National Science Education Content Standards

Grades K–4

- Organisms and environments

Grades 5–8

- Populations and ecosystems
- Diversity and adaptations of organisms

Content objectives

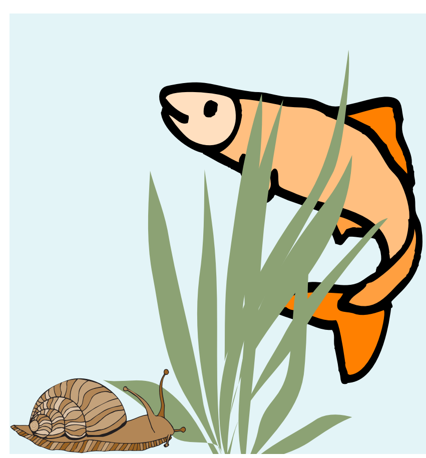
Learners will be able to do the following:

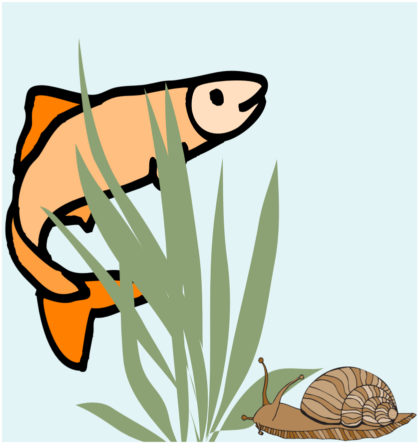
- Diagram and explain the interrelationships of a food chain and a food web.

Process objectives

Learners will be able to do the following:

- Make observations.





Preparation

Copy the Stream Web of Life cards masters onto card stock. You may wish to attach a loop of string to each card so learners can wear them around their necks.

Procedure

Part 1

Pass out a copy of the What's in a Stream? activity page 51 to each learner (the answer key is on page 52). Using the information in the "Background" and "FYI" sections and from earlier lessons, lead the learners to define a stream habitat. What are some of the nonliving things that are part of an aquatic habitat? Ask learners to list these on the four lines provided around the outside of the oval on the page. Learners might list water quality characteristics such as the temperature or amount of oxygen, the amount of water, the types of stream bottom coverings such as boulders and gravel, and the logs and sticks that would make up other components of stream structure and provide pools and places for fish to hide.

In the center of the oval, ask learners to write down three to four components of two simple aquatic food chains. A food chain typically begins with a plant and then moves to an animal that eats that plant, followed by an animal that eats the first animal, and so on.

Two examples of food chains follow:

(1) phytoplankton, (2) zooplankton, (3) juvenile salmon, (4) belted kingfisher

(1) algae, (2) snails, (3) crayfish, (4) raccoon

When learners have completed the activity page, discuss their answers. What other organisms might be added to create a stream food web?

Part 2

For this activity, you will need a large area where learners can spread out. There are 30 cards in the Stream Web of Life set. If you have fewer learners, remove some of the cards from the set. Be sure you use all six of the habitat component cards each time you demonstrate the activity. (Habitat component cards are the Sun, Salmon carcass, Riffles/runs/gravel, Woody debris, Silt, and Water quality.)

Young learners may have trouble with the vocabulary used on the cards. The leader may need to read the cards for the learners as the activity proceeds.

Ask learners to stand in a circle. Pass out one Stream Web of Life card to each learner. Ask the six learners with habitat component cards to take two steps back from the main circle of learners.

Position the six learners so they will be able to hold one of the lengths of poly-rope in a circle around the outside of the remaining circle of learners. Ask each learner with a habitat component card to read his or her card aloud in turn as you pass the rope around the group. It is helpful to begin and end this outside circle with the Sun, as it is the logical starting point for the next part of the activity.

Hand one end of the second length of rope to the learner with the Sun card. This learner now holds the beginning and ending sections of the first rope and the beginning of the second length of rope. Now, ask the Sun to pass the second coil of rope to a learner with a plant card. For example, Sun might pass the rope to Phytoplankton.

The Phytoplankton reads its card to the group, then passes the rope on to one of the components listed on the card. Learners may pass the rope to any other learner who is not yet in the web. They may pass the rope to something they eat or use or to something that eats or uses them. As each learner receives the rope, he or she reads the card aloud to the group.

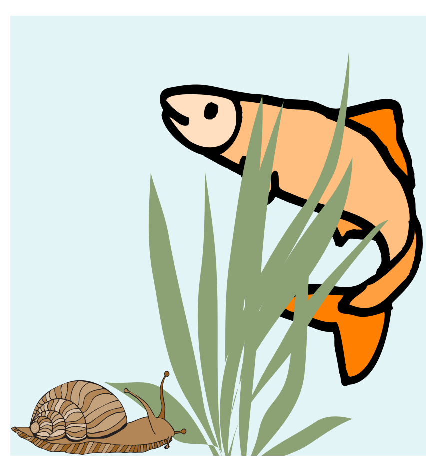
Each learner continues to hold his or her section of rope until all learners are holding a piece of rope and a web design has been created in the middle of the circle. Be sure the rope is passed across the circle to form a web, not just around the edge. (It is easiest for the leader to facilitate this activity from the center of the circle.)

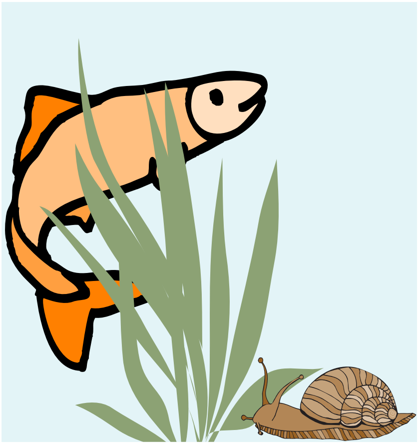
Ask learners where people fit in the web. (People eat crayfish, frogs, and salmon.) What would happen to the web if there were no more insects? Ask learners who have insect cards to drop their section of the rope. What happens to the web?

Lead a discussion with learners about how they might design a web of life for the habitat area pond. From what they have learned in previous lessons, which animals and insects live in the pond? Where might learners find other habitat webs? Do forests or meadows have webs of life? Older learners may do research and report on webs found in other habitats. Use arts activities from *A Palette of Fun* to illustrate the selected webs.

Part 3

Inventory the school habitat and another local pond or stream. What are the impacts of human activities that learners can observe? How might human activities be changed at the school and/or local pond or stream to improve the habitat for wildlife?





Extend the learning

A Palette of Fun (4-H 713L), Pop-Up Pizzazz; Mural Madness; Batik

Of People and Fish, Oregon 4-H Natural Science and Cultural Discovery Program (4-H 3811L).
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Reference

This lesson was adapted from *Of People and Fish, Oregon 4-H Natural Science and Cultural Discovery Program* (4-H 3811L), "Activity 1B—What's in a Stream." Oregon State University Extension Service, July 2003.

What's in a Stream?

_______________ Habitat component

_______________ Habitat component

(1) ______________ (2) ______________ (3) ______________ (4) ______________

(1) ______________ (2) ______________ (3) ______________ (4) ______________

_______________ Habitat component

_______________ Habitat component

What's in a Stream? Answer Key

Sun
Habitat component

Riffles/runs/gravel
Habitat component

(1) Phytoplankton (2) Zooplankton (3) Juvenile salmon (4) Belted kingfisher

(1) Algae (2) Snails (3) Crayfish (4) Raccoon

Woody debris
Habitat component

Silt
Habitat component

Unit 6: What can we learn about interdependence at the pond?

6A—Should we Introduce Mosquitofish into the Habitat Area Pond?

Background

In this lesson, learners attempt to answer a predetermined Natural Resource Management Question: "Should we introduce mosquitofish (*Gambusia)* into the habitat area pond?" To design scientific inquiries to answer the Management Question, it will be helpful for learners to know more about interdependence. This lesson will be best used when aquatic insect larva and nymphs are present.

Learner teams create models involving the biotic and abiotic parts of a stream environment and depict energy flow in a food chain and then a web pattern. (Remind learners of the food chain and food web they created in lesson 5B—What's in a Stream?.) Then, teams design experiments that they can conduct in mini-aquaria to determine whether mosquitofish would be beneficial to the habitat area pond.

Learners should not let the predetermined Management Question restrict their creativity. There are many different scientific inquiries that learners can perform to help answer this question.

Resources for lesson support

See the "Background" section of Unit 5 for an introduction to fish function. The *4-H Wildlife Stewards Project Handbook* Section 3 covers Wildlife Habitat Requirements and principles of Wildlife Ecology.

FYI

Each of the biotic members of the habitat area pond community has a role to play in that habitat. This role is called a **niche**. How a species interacts with other organisms, what it eats, and the methods it uses to obtain food all help define its niche.

This lesson focuses on the methods used by pond organisms to obtain food or nutrients. In a healthy pond community, we expect to find organisms filling the roles of producers (plants), primary consumers (**herbivores**), secondary consumers (**predators**), and decomposers (**scavengers**). **Omnivores** are animals that eat both plants and animals. (Most humans are omnivores.)

Oregon benchmarks

Unifying concepts and processes

- Understand that any collection of things that have an influence on one another can be thought of as a system.

Benchmark 1

- Describe the basic needs of living things.
- Describe a habitat and the organisms that live there.
- Identify how some animals gather and store food, defend themselves, and find shelter.

Benchmark 2

- Describe the relationship between characteristics of specific habitats and the organisms that live there.

National Science Education Content Standards

Grades K–4

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry
- Organisms and environments

Grades 5–8

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry
- Populations and ecosystems
- Systems, order, and organizations

Content objectives

Learners will be able to do the following:

- Explain the role of plants, scavengers, omnivores, herbivores, and predators in an ecosystem.
- List some scavengers, herbivores, and predators found in a specific habitat.

Process objectives

Learners will be able to do the following:

- Make observations.
- Ask questions that can be answered through a scientific investigation.
- Design an investigation to answer a question.
- Collect, organize, and summarize data from an investigation.
- Analyze and interpret data from an investigation.

Mosquitofish are predators; their primary food is mosquito larvae. Other animals or aquatic invertebrates in the aquatic habitat also may eat mosquito larvae. Mosquitofish are introduced into ponds or areas of standing water by local vector control agencies to reduce mosquito populations. So far, Oregon has been relatively free of mosquito-borne illness that causes serious harm to humans. But, mosquitos have become more of a threat to human health in other parts of the U.S., and that trend could spread to Oregon, too.

In order to answer the Natural Resource Management Question "Should we introduce mosquitofish into the habitat area pond?," learners must determine which organisms are filling the roles of producers, primary consumers, secondary consumers, and scavengers. They then must decide whether there is room (biotic energy) within this community for an additional predator, or whether they are willing to accept the loss of other organisms to attain the perceived benefits of limiting the mosquito population.

Do not introduce live mosquitofish into a habitat area pond that has any connection to a natural body of water.

Materials

Part 1

- ○ Quick Reference Guide to Aquatic Invertebrates cards (Appendix II), one set per team
- ○ Worksheet 6A—Who's on the Menu? (page 58), one copy per team

Part 2

- ○ Mini-aquaria, one (or more, if a control is needed) per team for each experiment
- ○ A large aquarium (or two, if you keep the mosquitofish separate)
- ○ Elodea purchased from a pet store, and/or natural pond weeds and algae
- ○ Sticks, rotting plant materials, or detritus collected off the pond bottom
- ○ Dead leaves with some algae on them (they feel slimy)
- ○ Mosquitofish (*Gambusia*) purchased from a biological supply company
- ○ Aquatic macro-invertebrates collected from the pond

Preparation

Leaders should review the following:

- Background section
- FYI section
- 4-H Science Inquiry Model
- Learner evaluation criteria in the ODE Scientific Inquiry Scoring Guide to assist in coaching learners

Photocopy sets of Quick Reference Guide to Aquatic Invertebrates cards onto card stock (if you don't already have enough sets from lessons 2B and 4A).

Procedure

Part 1

Pass out a set of Quick Reference Guide to Aquatic Invertebrates cards and a copy of worksheet 6A—Who's on the Menu? to each team. Ask learners to look at the "How I Get Food" section of the cards. Sort them into the categories Herbivores, Predators, Scavengers, and Omnivores.

Fill in the names of the aquatic invertebrates in each category on the worksheet. Ask learners to put an asterisk or star by invertebrates that appear in more than one category.

Remind learners of the role of plants as primary producers. Refer to Units 1 and 3 for information on how plants produce biotic energy in an ecosystem.

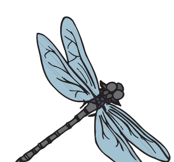
Answers for worksheet 6A—Who's on the Menu?

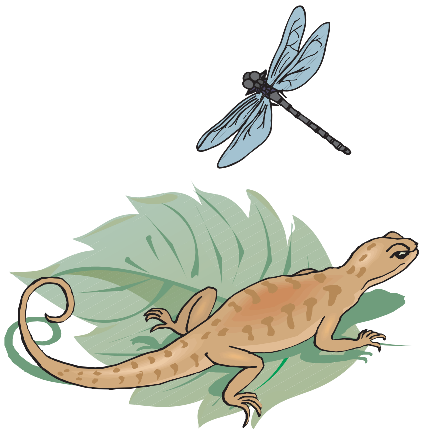
(Asterisks indicate invertebrates that appear in more than one category.)

Scavengers:	Mayfly nymph*, crayfish*, scud*, whirligig beetle, mosquito larva, aquatic sow bug, snails, rat-tailed maggot, tubifex worm
Omnivores:	Caddisfly larva*, crane fly larva*, crayfish*, scud*, midge larva*, water boatman*, blackfly larva
Herbivores:	Caddisfly larva*, mayfly nymph*, stonefly nymph*, crane fly larva*, midge larva*, water boatman*
Predators:	Add mosquitofish here. Caddisfly larva*, stonefly nymph*, whirligig beetle*, midge larva*, water boatman*, predaceous diving beetle larva, water tiger

How many animals are both Scavengers and Omnivores? Ask learners how these two roles may be associated in the habitat. Which of the aquatic invertebrates eat the same food as mosquitofish?

(If learners have not done lesson 5B—What's in a Stream? yet, this is a good time in the lesson sequence to do it.) Have learners draw a web of life depicting their habitat pond community. Which aquatic invertebrates have they found in the habitat area pond in other lessons? What role does each play? Add mosquitofish to the web (they are predators). Add mosquito larvae, if they are not included already (they are scavengers that eat bacteria and plankton). Add algae (it contains chlorophyll and is a producer).





Part 2

Lead a discussion with learners on the roles of scavengers, omnivores, herbivores, and predators in the pond community. Ask them what else they would like to know about the habitat-area pond community to decide whether mosquitofish should be introduced.

Provide a large aquarium with a variety of organisms collected from the habitat area pond. Ask the learners to spend a few days observing them periodically. You may choose to have mosquitofish in the aquarium or in a separate aquarium. Ask learners to record any questions they have about the organisms and their behavior. At the end of this observation period, ask learners to share their questions and observations.

Working in teams, ask learners what roles and interrelationships they can test using mini-aquaria. More than one aquarium may be needed by each team. For example, a team might need two aquaria to test a question such as, "Does the presence of aquatic plants provide shelter which helps invertebrates avoid predators?" This requires two aquaria with only one different variable between them: the aquatic plants.

Possible questions learners may investigate include the following:

- Do large predatory aquatic insects, such as dragonfly larvae, eat small fish?
- Do prey (scavengers, herbivores, and omnivores) hide in plant material to avoid predators?
- How long does it take for X number of scavengers to clean up Y?
- How many mosquitofish are needed to control mosquito larva in a given space?
- Which invertebrates eat mosquito larvae?
- Do mosquitofish eat anything else besides mosquito larvae?

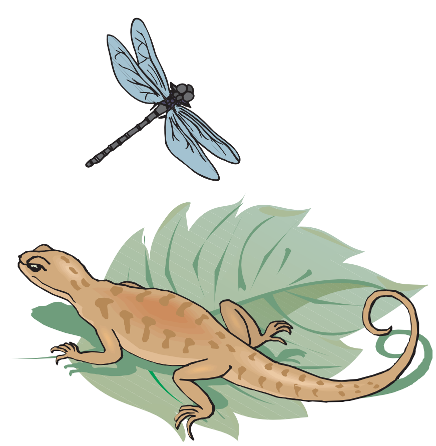
Ask the teams to select a question and agree on their experiment design, including a materials list and a data sheet. Follow the steps outlined in the 4-H Science Inquiry Model. Ask learners to set a time frame for the experiment; or, set one for them. Avoid open-ended time frames. When all the teams have completed their experiment design, ask them to share them aloud with the group. Allow learners to ask the teams questions about their design.

Pass out the materials requested by each team and facilitate, as needed, while they set up their experiments. Set the experiments aside. Allow time each day of the experiment period for learners to view the aquaria and record what they observe.

At the end of the experiment period, ask the teams to analyze and interpret the data they collect and give a summary report to the group. Working together, with all the information gathered to date, are learners ready to answer the Natural Resource Management Question? Why or why not? What else do they want or need to know? Ask learners, "How does what we learned apply to adding mosquitofish to a natural pond?" "How does this apply to introducing any animal into an ecosystem where it has not recently been found naturally?"

Extend the learning

A Palette of Fun (4-H 713L): Books tell a story
Project WILD Aquatic Education Activity Guide: Water we eating?



Worksheet 6A—Who's on the Menu?

Producers

Algae on rocks and decaying plant and animal materials

Scavengers

We eat dead and decaying things. Some bacteria that live on decaying material provide food for other scavengers.

Omnivores

We are animals that eat both plants and other animals. Some of us are filter feeders.

Herbivores

We are animals that eat plants.

Predators

We are animals that eat other animals.

6B—Reptiles and Amphibians

Background

To assist you with this lesson, you can get copies of the following publications:

Amphibians of Oregon, Washington and British Columbia. 1996. Charlotte C. Corkran, Chris Thoms. Renton, Washington: Lone Pine Publishing.

Atlas of Oregon Wildlife. 1997. Blair Csuti, A. Jon Kimerling, Thomas A. O'Neil, Margaret M. Shaughnessy, Eleanor P. Gaines, Manuela M.P. Huso. Corvallis, Oregon: Oregon State University Press.

Reptiles of the Northwest. 2002. Alan St. John. Renton, Washington: Lone Pine Publishing.

FYI

Habitat for reptiles and amphibians, like that for other species, is shrinking in Oregon. Species such as the western pond turtle (*Clemmys marmorata*) need large areas to roam along waterways and do not become sexually mature until they are 8 or more years old. The western pond turtle and the red-legged frog (*Rana aurora*) both are listed by the U.S. Fish and Wildlife Service as species of concern and by the Oregon Department of Fish and Wildlife (ODFW) as sensitive.

In contrast, the bullfrog (*Rana catesbeiana*) is an introduced species that is thriving. It is native to North America east of the Rocky Mountains. Both the tadpoles and adults are aggressive predators that are blamed for the decline of many aquatic species including western pond turtle, spotted frogs (*Rana pretiosa*), and native fish. It is a game species in Oregon.

Created habitat areas with ponds have the potential to attract and provide homes to reptiles and/or amphibians. The long-toed salamander (*Ambystoma macrodactylum*), northwestern salamander (*A. gracile*), Pacific giant salamander (*Dicamptodon tenebrosus*), and rough-skinned newt (*Taricha granulosa)* are aquatic amphibians that lay their eggs in water where the young hatch as aquatic larvae. Of these four, only the long-toed salamander is found east of the Cascades.

If the habitat area is completely enclosed by buildings, leaders may want to consider using the space as a vivarium. Reptiles and amphibians available in pet shops can be kept successfully in the classroom, where learners can observe them over time and share duties for their care. You also could do this on a larger scale with an enclosed natural area. ***Do not introduce non-native species, including bullfrogs, into the outdoor habitat.*** Contact your local ODFW office and the U.S. Fish and Wildlife Service at **www.fws.gov** for information and regulations on native species.

Oregon benchmarks

Benchmark 1
- Recognize characteristics that are similar and different between organisms.
- Describe how related animals have similar characteristics.
- Describe a habitat and the organisms that live there.

Benchmark 2
- Group or classify organisms based on a variety of characteristics.
- Describe the relationship between characteristics of specific habitats and the organisms that live there.

National Science Education Content Standards

Grades K–4
- Characteristics of organisms
- Organisms and environments

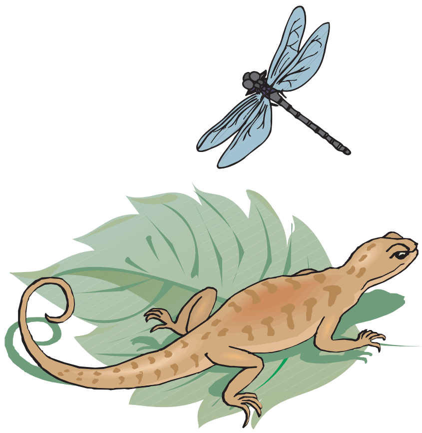
Grades 5–8
- Structure and functions of living things
- Populations and ecosystems
- Diversity and adaptations of organisms

Content objectives

Learners will be able to do the following:
- Explain the characteristics of reptiles and amphibians.
- List some animals that belong to the groups "reptiles" and "amphibians."
- List some reptiles and amphibians that live in Oregon and some of their habitat requirements.

Process objectives

Learners will be able to do the following:
- Make observations.



Materials

Part 1

- ⬭ Oregon Herptiles Poster Key (Appendix II)
- ⬭ Herp Species Cards (Appendix II)
- ⬭ If possible, buy plastic models of reptiles and amphibians. (Science museum gift shops are a good source.) The models do not have to be of Oregon species. Look for land- and sea-turtle varieties for comparison; lizard; snake; salamander or newt; toad; frog (if possible, a frog life cycle model set including tadpole, “tailed” frog, and adult frog); crocodile.
  If plastic models are not available, find color pictures to illustrate these animals.
- ⬭ Black stuff-sack to hold the plastic models used in the lesson

Part 2

- ⬭ Reptiles *OR* Amphibians Facts Game (page 63)

Part 3 (older learners)

- ⬭ Reptiles and Amphibians of Oregon (pages 64 and 65), one copy for each learner. There is one page for “West of the Cascades” and one for “East of the Cascades.”

Part 4 (younger learners)

- ⬭ Herptile Habitat page (page 66), one copy for each learner or pair of learners

Preparation

Create an Oregon Herptiles Poster Key (follow instructions in Appendix II). You will need a sheet of 22- by 28-inch (approximately) poster board, Velcro squares, scissors, glue, and access to a laminator.

Prepare the Herp Species Cards (see Appendix II). Photocopy the boxes and cut them out. Laminate the boxes to strips of poster board. Glue Velcro to the back of the cards. Then, glue Velcro to the poster where indicated by the X boxes.

Review the information on the Oregon Herptiles Poster Key before leading the introductory discussion with learners.

Photocopy the Reptiles and Amphibians of Oregon page that applies to your area.

Procedure

Part 1

Lead a discussion about reptiles and amphibians. How are they alike and how are they different? Be sure learners can list the major characteristics of reptiles and amphibians before continuing on to construct the poster.

Show learners the Oregon Herptiles Poster Key. They have had some experience with keys in other lessons, so this should look somewhat familiar. Hand one of the laminated Herp Species cards to a learner, and ask him or her to work through the key and place it on the board in the right place. Guide learners to match the characteristics on the key with the Herp Species card rather than simply placing the card by its number.

Continue handing out the Herp Species cards until the key is completed.

Now introduce the black stuff-sack. Explain that herpetologists often use sacks like this to transport reptiles. Ask one learner to reach into the black sack, without telling him or her what is inside, and remove one item.

Ask learners to work together to identify the plastic model using the key. This will reinforce the characteristics of the different groups of herps. Ask learners, "Which herps are **not** represented in the wild in Oregon?" (Crocodilians and Tuatara)

Part 2

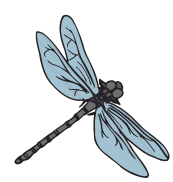
Play the "Reptiles ***OR*** Amphibians Facts Game" to review the new information from Part 1. You'll need a fairly large playing area for this game.

Divide the group into two equal teams. One team is the Reptiles; the second team is the Amphibians. Line up the two teams facing each other on two start lines. The start lines should be about 4 feet apart. About 10 feet ***behind*** each team's start line, mark off a home base line.

Explain that for each round of the game, you will be reading a fact statement. The statement will be either a fact about (1) reptiles or (2) amphibians. Learners will have a short time to think about the fact, then you will say "GO." Learners are not to move until the leader says GO.

If the fact is about reptiles, then the Reptile team is to chase the Amphibian team toward the Amphibian home base. If the fact is about amphibians, then the Amphibian team is to chase the Reptile team toward the Reptile home base. If a runner is tagged before crossing the home base line, the runner must join the other team.

Not all answers are obvious. Some members of each team may run towards each other while others run back to their home base. The leader should remain silent and neutral as long as the pandemonium is not too great. After each round, return the teams to their start lines and check to see that they all know the correct answer to the statement.



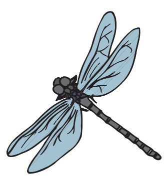
Part 3—for older learners

Pass out a copy of "Reptiles and Amphibians of Oregon" for each learner. (Use the sheet that pertains to your area: "West of the Cascades" or "East of the Cascades.")

Ask learners to brainstorm a list of plants or physical features that might be added to the habitat area to attract or support reptiles or amphibians. Work with learners to diagram a herptile habitat web on the board or flip-chart paper. Remind learners of the stream web they created with the cards and rope in lesson 5B Part 2.

Divide the group into teams. Ask each team to choose a particular species to research. Their reports should include information on the animal's life cycle, feeding requirements, shelter, and other details of interest to the learners. At the end of this research project, the team should be able to answer the question, "Can our species of reptile (or amphibian) live in the habitat area as it is now?" If the team determines that their animal could not live in the habitat as it is now, they should make recommendations for changes.

Plan a day for teams to report on their research so that the whole group can benefit from the information gathered.



Part 4—for younger learners

Pass out a copy of the Herptile Habitat page to each learner or pair of learners. Take the group to the school habitat area or any nearby pond to complete this activity. Ask the learners or pairs of learners to find a place in the habitat where their chosen animal might live.

Extend the learning

A Palette of Fun (4-H 713L): Papier Mache. Create a reptile or amphibian and write about where it lives, what it eats, how it has young, and other things of interest to learners.

Reptiles *or* Amphibians Facts Game

The answers are given below each statement. A is for Amphibian. R is for Reptile.

1. I have a moist, smooth body that is long and slender. I am active at night to avoid the drying effects of the sun.
   A—Salamander
2. I have a hard shell and can live for more than 100 years.
   R—Box turtle
3. I am a legless creature that many people believe to be slimy. Actually, my scales are dry and smooth.
   R—Snake
4. I have strong powerful legs that allow me to make huge leaps. I have small teeth on my upper jaw.
   A—Frog
5. The poison sacs in my skin do not give people warts. But I don't mind if you think they do, because I do not like to be picked up.
   A—Toad
6. I use the Jacobson's organs at the back of my mouth to help me smell my environment. That is why my tongue flicks in and out so often.
   R—Snake
7. I am not found in Oregon. I am the largest of my kind living in subtropical wetlands. People respect my powerful jaws and sharp teeth.
   R—Alligator (member of the Crocodilian group)
8. I eat worms, snails, and insects. I never need a drink because I take in water through my skin.
   A—Frog, toad, many salamanders
9. In the spring, I advertise for a beautiful mate with a loud call.
   A—Frog and toad
10. In Oregon, there are several of my kind who give birth to live young, including the short-horned lizard, the Northern alligator lizard, the rubber boa, and the rattlesnake.
    R—True of the species listed
11. My very flexible spine is made of between 100 to 400 vertebrae, each of which is attached to a pair of separate thin ribs. I move in S-shape curves, pushing along using plants, rocks, sticks, and other irregularities as shove-off points.
    R—Snake
12. I lay dozens or even thousands of eggs at a time in big clumps covered with a clear or translucent jellylike material that protects the developing embryos inside the eggs.
    A—All kinds
13. Many people mistake me for a lizard, but I do not have claws on my toes or scaly skin, and I am always careful to stay in cool, moist places.
    A—Salamander
14. In order to grow, I shed my skin in a long tube. I just begin at my head, loosen my old skin, and crawl out the mouth opening.
    R—Snake
15. Some of my kind have special skin glands that produce a more powerful poison than some snakes. Some South American native peoples coat their darts and arrows with this poison.
    A—Poison dart frogs

Reptiles and Amphibians of Oregon
West of the Cascades

Reptiles

Reptiles have a body covered with dry skin and heavy scales. They are cold-blooded. This means that their body temperature adjusts to the air or water around them. Reptiles breathe with lungs. The young of most reptiles hatch from eggs covered with a firm shell. The eggs are laid on land. The young look like small adults at birth.

Turtles

Painted turtle
Western pond turtle

Lizards

Northern alligator lizard
Western fence lizard
Western skink

Snakes

Rubber boa
Racer
Gopher (bull) snake
Common garter snake (many color phases)
Northwestern garter snake
Western (Northern Pacific) rattlesnake

Amphibians

Amphibians have a body covered with smooth, moist skin without scales. They are cold-blooded. This means that their body temperature adjusts to the air or water around them. Amphibians lay their eggs in water or in damp locations. The eggs have a moist covering rather than a shell. The young of most amphibians do not look like the adult at birth. Many young amphibians, such as tadpoles, breathe with gills. Simple lungs develop before the young grow into the adult form.

Salamanders

Northwest salamander
Long-toed salamander
Pacific giant salamander
Ensatina
Rough-skinned newt

Frogs and toads

Western toad (except mid-Willamette Valley)
Pacific tree (or Pacific chorus) frog
Red-legged frog
Bullfrog

Reptiles and Amphibians of Oregon
East of the Cascades

Reptiles

Reptiles have a body covered with dry skin and heavy scales. They are cold-blooded. This means that their body temperature adjusts to the air or water around them. Reptiles breathe with lungs. The young of most reptiles hatch from eggs covered with a firm shell. The eggs are laid on land. The young look like small adults at birth.

Lizards
Short-horned lizard
Sagebrush lizard
Western fence lizard
Western skink

Snakes
Rubber boa
Racer
Gopher (bull) snake
Common garter snake (many color phases)
Western (Northern Pacific) rattlesnake

Amphibians

Amphibians have a body covered with smooth, moist skin without scales. They are cold-blooded. This means that their body temperature adjusts to the air or water around them. Amphibians lay their eggs in water or in damp locations. The eggs have a moist covering rather than a shell. The young of most amphibians do not look like the adult at birth. Many young amphibians, such as tadpoles, breathe with gills. Simple lungs develop before the young grow into the adult form.

Salamanders
Northwest salamander
Long-toed salamander
Great Basin spade foot

Frogs and toads
Western toad (except Basin and Range Province)
Pacific tree (or Pacific chorus) frog
Bullfrog

Herptile Habitat

Every herptile has a habitat that it calls home, with just the right kinds of food, water, shelter, and space to make it healthy.

If you were a herptile, would you choose to be a reptile or an amphibian?

What kind would you be?

Why would you choose to be this kind?

Where would you live? What type of shelter would you use?

What would you eat? What would try to eat you?

Appendix I

Scientific Inquiry Scoring Guide: Benchmark 2 (Grade 5)

Forming a Question or Hypothesis

Make observations. Ask questions or form hypotheses based on those observations which can be explored through scientific investigation.

6. a. Explains the origin of the question or hypothesis based on background which is relevant to the investigation.
   b. Forms a question or hypothesis which can be answered or tested using data and provides focus for a simple scientific investigation.
   c. Communicates (a) and (b) clearly.

5. d. Links background to the question or hypothesis.
   e. Forms a question or hypothesis which can be answered or tested using data gathered in a simple scientific investigation.
   f. Communicates (d) and (e) clearly.

4. g. Provides some support or background (prior knowledge, preliminary observations, or personal interest and experience) which is relevant to the investigation.
   h. Forms a question or hypothesis which can be explored using data in a simple scientific investigation.
   i. Communicates (g) and (h) clearly.

3. j. Background is either irrelevant or missing.
   k. Forms a question or hypothesis which provides limited opportunity for data collection.
   l. Expresses a question or hypothesis which provides limited opportunity for data collection.

2. m. Not applicable.
   n. Forms a question or hypothesis which cannot be explored through a simple scientific investigation.
   o. Communicates a question or hypothesis which is not understandable.

1. p. Not applicable.
   q. Not applicable (see r).
   r. Does not express the purpose of the investigation as either a question or a hypothesis.

Designing an Investigation

Design a *simple scientific* investigation to *answer questions* or *test hypotheses*.

6. a. Records logical procedures with an obvious connection to the student's scientific knowledge. (Teacher guidance in safety and ethics is applicable.)
   b. Presents a practical design appropriate for answering the question or testing the hypothesis with evidence of recognition of some important variables.
   c. Communicates an organized design and detailed procedures.

5. d. Records logical procedures which imply a connection to student's scientific knowledge. (Teacher guidance in safety and ethics is applicable.)
   e. Presents a practical design for an investigation which addresses the question or hypothesis and attempts to provide a fair test.
   f. Communicates a general plan including some detailed procedures.

4. g. Records logical procedures with only minor flaws. (Teacher guidance in safety and ethics is applicable.)
   h. Presents a practical plan for an investigation which addresses the question or hypothesis.
   i. Communicates a summary of a plan and some procedures, but may generally lack detail.

3. j. Records generally logical procedures having flaws. (Teacher guidance in safety and ethics is applicable.)
   k. Presents a practical plan related to the topic which minimally addresses the question or hypothesis.
   l. Communicates an incomplete summary of a plan, with few procedures.

2. m. Records procedures which are significantly flawed. (Teacher guidance in safety and ethics is applicable.)
   n. Presents a plan somewhat related to the topic which may not address the question or hypothesis.
   o. Communicates an incomplete summary of a plan which is difficult to follow.

1. p. Records procedures which are wholly inappropriate.
   q. Presents a plan which is impractical or unrelated to the topic.
   r. Communicates a plan or procedures which cannot be followed.

Collecting and Presenting Data

Collect, organize, and summarize data from investigations.

6. a. Records accurate data and/or observations with complex procedures.
   b. Designs a data table (or other format) for observations and/or measurements which is efficient, organized, and uses appropriate units.
   c. Transforms data into a student-selected format which is most appropriate to clarify results.

5. d. Records accurate data and/or observations completely consistent with the planned procedure.
   e. Designs a data table (or other format) for observations and/or measurements which is organized and uses appropriate units.
   f. Transforms data into a student-selected format which is complete and useful.

4. g. Records reasonable data or observations generally consistent with the planned procedure.
   h. Designs a data table for collection and organization of data using teacher suggestions.
   i. Transforms original data into a useful format (e.g., graphs, averages, percentages, diagrams, tables) with teacher support and with minimal errors.

3. j. Records reasonable data or observations consistent with the planned procedure, with some obvious errors.
   k. Uses teacher-supplied data tables for data collection with minor errors.
   l. Does not transform data into a teacher-recommended format.

2. m. Records insufficient data and/or observations inconsistent with the planned procedure.
   n. Uses a teacher-supplied data table with minimal errors.
   o. Not applicable.

1. p. Records data and/or observations unrelated to the planned procedure.
   q. Does not correctly use a teacher-supplied data table.
   r. Not applicable.

Analyzing and Interpreting Results

Summarize, analyze, and interpret data from investigations.

6. a. Explicitly uses results to address the question or hypothesis and illustrate simple relationships.
   b. Reports results and identifies simple relationships (e.g., connecting one variable to another).
   c. Not applicable.

5. d. Explicitly uses results to address the question or hypothesis.
   e. Reports accurately and identifies obvious patterns (e.g., noting a pattern of change for one variable).
   f. Not applicable.

4. g. Responds to the question or hypothesis with some support from results.
   h. Summarizes results accurately.
   i. Not applicable.

3. j. Responds to the question or hypothesis without support from the results.
   k. Summarizes results incompletely or in a misleading way.
   l. Not applicable.

2. m. Provides a response(s) to the question or hypothesis which is unrelated to the investigation.
   n. Summarizes results inaccurately.
   o. Not applicable.

1. p. Does not respond to the question or hypothesis.
   q. Omits results in summary.
   r. Not applicable.

Appendix II

Activity Card Masters

Water Cycle Activity Cards

1.
Ocean

FACT: 97.54% of the world's water is salt water.

2a.
Water Vapor Evaporating from the Ocean

FACT: The water in the air above the earth is called **atmospheric water**. It is 0.001% of the world's water supply. Water is evaporated into the air by the sun.

2b.
Water Vapor Evaporating from the Ocean

FACT: When water is a gas, it's called vapor. Water vapor is water in its most pure form.

2c.
Water Vapor Evaporating from the Ocean

FACT: Pure water has no smell, taste, or color.

Water Cycle Activity Cards

2d. Water Vapor Evaporating from the Ocean

FACT: Water always becomes vapor (steam) when it reaches its boiling point.

2e. Water Vapor Evaporating from the Ocean

FACT: Water is a chemical combination of two atoms of hydrogen (H) and one atom of oxygen (O). This chemical combination is written as the formula H_2O.

3. Cloud of Condensed Water Vapor

FACT: The water vapor evaporating from the ocean cools as it gets higher in the air. When the vapor cools, it condenses into a group of tiny water droplets that we see as a cloud.

4a. Rain

FACT: Tiny water droplets join together with other tiny water droplets. When the water droplets join, they form bigger raindrops that are too heavy to stay in a cloud. They fall out as rain.

Water Cycle Activity Cards

4b. Rain

FACT: There are approximately 2 quarts of water in the air above every square foot of land on an average day.

5. Runoff

FACT: As rainwater runs off a parking lot, it carries oil spilled by leaky cars. Where is the oil going?

6. Stream

FACT: Only about 0.0001% of the world's water supply is found in streams or rivers.

7. Sun

FACT: The energy needed to move water "up" in the water cycle is provided by the sun. The sun's energy is needed to power **evaporation** and **transpiration**. **Gravity** causes rain to fall and water to flow downhill. Together the sun and gravity are the natural forces that power the water cycle.

Water Cycle Activity Cards

8a. Infiltration of Soil

FACT: The water in soil accounts for about 0.005% of the world's water supply.

8b. Infiltration of Soil

FACT: When water soaks into and through soil, this is **infiltration**. Water infiltrates soil slowly. When rain or garden sprinklers put water on the soil too fast, it does not soak into the soil. Water that does not infiltrate the soil becomes runoff water.

9. Plant

FACT: Minerals that plants need to grow and pollutants that are bad for plants enter the plants through the water they absorb with their roots. When water leaves the plant, the minerals and the pollutants stay in the plant's stems and leaves.

10. Transpiration

FACT: During the process of photosynthesis, a plant is making food and releasing both oxygen and water vapor. Water vapor is evaporated from the surface of leaves in a process called transpiration. What powers the transpiration process?

Water Cycle Activity Cards

11. Snowflake

FACT: Water must be at or below 32° Fahrenheit (F) [0° Celsius (C)] to be in a solid form. The freezing point is the temperature at which liquid water changes to the solid form called **ice**. A snowflake is a crystal of ice.

12. Snow Pack

FACT: When water freezes, it expands, but the weight remains the same. This is why ice cubes float in a glass of water. Snow falling in the Cascade Mountains may become part of the **snow pack**. The snow pack may melt each spring, or it may become part of a **glacier**. A glacier is formed when individual snowflakes freeze together to make a large block of ice. Just like ice cubes, glaciers can float on water.

13a. Slushy Melting Snow

FACT: Polar ice caps and mountain glaciers contain 1.81% of the world's water. This water is stored for long periods of time and is released only by melting.

13b. Slushy Melting Snow

FACT: The North Santiam River flows west toward Salem from the Cascade Mountains. The City of Salem takes a large percentage of its public water supply from this river. The river is supplied by the snow pack in 650 square miles of forest land within the North Santiam Watershed.

Water Cycle Activity Cards

14. Percolation Through Soil

FACT: As water moves through the soil toward the water table, it picks up contaminants from the soil. Spilling a single quart of motor oil onto soil is enough to pollute 250,000 gallons of water.

15. Water Table

FACT: The water table is the upper surface of groundwater. If you were to dig a hole straight into the earth, you eventually would reach water. This water would be the water table. Where the water table is exposed by the slope of a hill, a spring might be found.

16. Spring Flow

FACT: An average person drinks 1,500 pounds of water every year. This is equal to nearly eight 8-ounce glasses each day. Some people use natural springs for their drinking water supply.

17. Wetland

FACT: Inland freshwater wetlands occur along the shores of lakes, ponds, rivers, and streams. There are few trees, but there is a great variety of other plants and animals.

Water Cycle Activity Cards

18. Estuary

FACT: The type of wetland richest in plants and wildlife is the coastal salt marsh. This is the place where the fresh water of rivers meets the salt water of the oceans.

19. Groundwater

FACT: Water stored in pockets in the earth is called groundwater. Groundwater makes up 0.62% of the world's water supply. People who use wells to provide water to their homes are using groundwater.

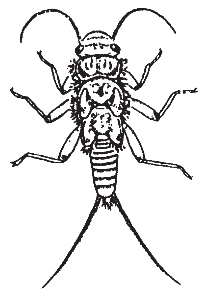
20. Lake

FACT: Freshwater lakes and inland seas and salt lakes make up 0.017% of the world's water.

21. Rosa Raindrop

Quick Reference Guide to Aquatic Invertebrates

Stonefly Nymph — Sensitive to pollution



My distinguishing characteristics

2 tails; 2 sets wing pads

How I get oxygen

- Through body surface; some small gills; does "pushups" to increase oxygen flow over body

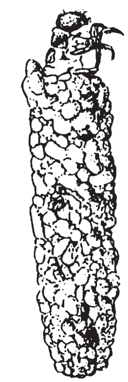
How I get food

- Predator or herbivore

Why I'm special

- Streamlined body for crawling on rocks; only tolerates high oxygen levels

Caddisfly Larva — Sensitive to pollution



My distinguishing characteristics

- Most species build cases or nets; soft body

How I get oxygen

- Through body surface

How I get food

- Filter feeder, herbivore, or predator

Why I'm special

- Builds cases of heavy materials (rocks) to avoid being swept away by fast-flowing streams; in ponds, uses grass and plants to make cases

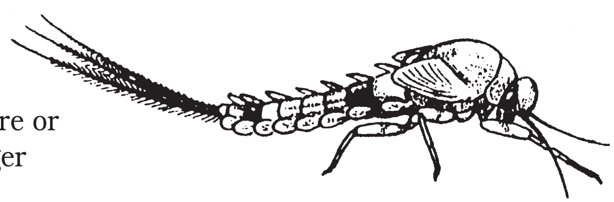
Mayfly Nymph — Sensitive to pollution

My distinguishing characteristics

- 3 tails, sometimes 2; 1 set wing pads

How I get oxygen

- Through gills along abdomen



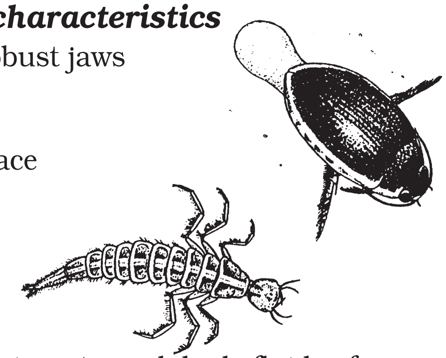
How I get food

- Herbivore or scavenger

Why I'm special

- Only tolerates high to medium oxygen levels

Predaceous Diving Beetle Larva (Water Tiger) — Somewhat tolerant of pollution



My distinguishing characteristics

- Up to 6 cm long; robust jaws

How I get oxygen

- Through body surface

How I get food

- Voracious predator

Why I'm special

- Special channels in jaws to suck body fluids of prey

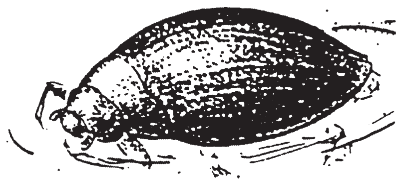
Quick Reference Guide to Aquatic Invertebrates

Whirligig Beetle (adult)

Somewhat tolerant of pollution

My distinguishing characteristics

- Black; congregates in schools



How I get oxygen

- From atmosphere

How I get food

- Predator or scavenger

Why I'm special

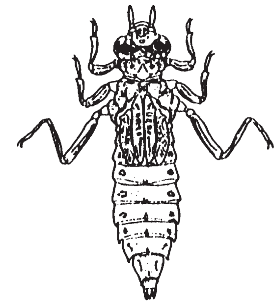
- Has two pairs of eyes to see above and below the water's surface; has a type of "radar" to locate objects in the water; secretes a white odorous substance to deter predators

Dragonfly Nymph

Somewhat tolerant of pollution

My distinguishing characteristics

- Stout body; grasping jaw



How I get oxygen

- Dissolved oxygen, through gills in internal body chamber

How I get food

- Active predator

Why I'm special

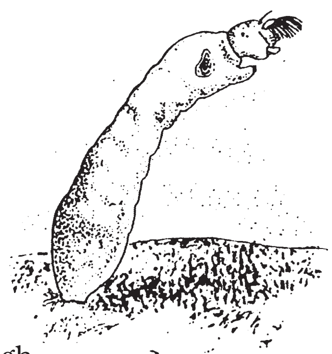
- Clings to vegetation or hides in clumps of dead leaves or sediment

Black Fly Larva

Somewhat tolerant of pollution

My distinguishing characteristics

- Small body; small hooks at end of abdomen attach to rocks



How I get oxygen

- Through body surface

How I get food

- Filter feeder

Why I'm special

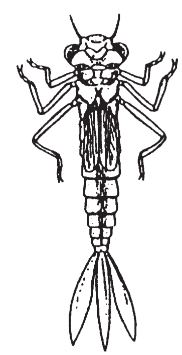
- Anchors to rocks with silk; only tolerates medium to high oxygen levels

Damselfly Nymph

Somewhat tolerant of pollution

My distinguishing characteristics

- 3 leaflike gills at end of abdomen



How I get oxygen

- Through gills at end of abdomen

How I get food

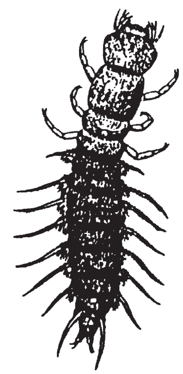
- Active predator

Why I'm special

- Clings to vegetation or hides in clumps of dead leaves or sediment

Quick Reference Guide to Aquatic Invertebrates

Hellgram-mite (Dobson-fly), Alderfly, or Fishfly larva
Somewhat tolerant of pollution



My distinguishing characteristics
- Up to 9 cm long

How I get oxygen
- Through gills along side of abdomen; some fishflies have breathing tubes

How I get food
- Active predator

Why I'm special
- Can swallow prey without chewing

Water Boatman (adult)
Somewhat tolerant of pollution

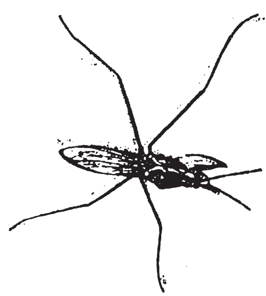
My distinguishing characteristics
- Long swimming hairs on legs

How I get oxygen
- From atmosphere, by carrying air bubble from water's surface on body

How I get food
- Omnivore, herbivore, or scavenger

Why I'm special
- Has swimming hairs on legs that act as oars

Water Strider (adult)
Somewhat tolerant of pollution



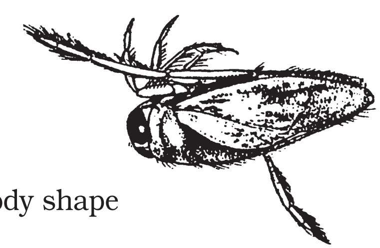
My distinguishing characteristics
- Skates on water's surface

How I get oxygen
- From atmosphere

How I get food
- Active predator

Why I'm special
- Can stay on the water's surface because my feet have a small surface area and are water repellent

Backswimmer (adult)
Somewhat tolerant of pollution



My distinguishing characteristics
- Light-colored underside; swims on back

How I get oxygen
- From atmosphere, by carrying air bubble from water's surface on body

How I get food
- Predator

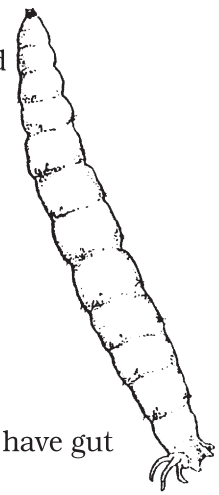
Why I'm special
- Swims on back; sleek body shape

Quick Reference Guide to Aquatic Invertebrates

Crane Fly Larva

Somewhat tolerant of pollution

My distinguishing characteristics
- Cylindrical body; often has lobes at hind end



How I get oxygen
- From atmosphere through spiracles (openings) at hind end

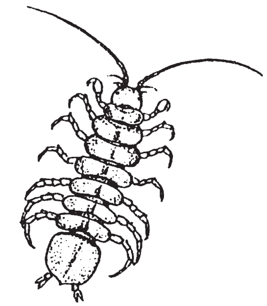
How I get food
- Active predator, herbivore, or omnivore

Why I'm special
- Species that eat woody decaying matter have gut bacteria to digest cellulose.

Aquatic Sowbug

Somewhat tolerant of pollution

My distinguishing characteristics
- Flattened body, top to bottom; 7 pairs of legs



How I get oxygen
- Through body surface on legs

How I get food
- Scavenger (eats decaying matter) or omnivore

Why I'm special
- Male clasps female under it during mating; female sheds half of exoskeleton, which becomes a case into which fertilized eggs are placed for development

Mosquito Larva

Somewhat tolerant of pollution

My distinguishing characteristics
- Small body; floats on surface

How I get oxygen
- From atmosphere through breathing tube

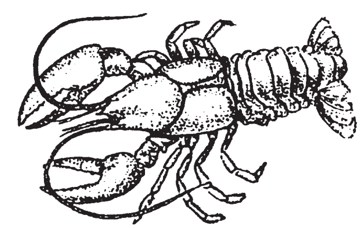
How I get food
- Scavenger—feeds on micro-organisms

Why I'm special
- Swims or dives when disturbed

Crayfish

Somewhat tolerant of pollution

My distinguishing characteristics
- 5 pairs of legs, first pair often robust; looks like a small lobster



How I get oxygen
- Through gills under body

How I get food
- Scavenger or omnivore

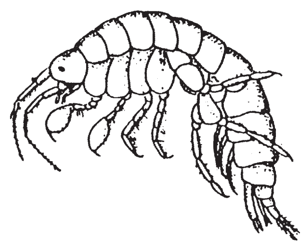
Why I'm special
- Crawls backwards when disturbed; males display some courtship behavior to reduce female aggressiveness

Quick Reference Guide to Aquatic Invertebrates

Scud — Somewhat tolerant of pollution

My distinguishing characteristics
- Flattened body, side to side; swims on side

How I get oxygen
- Through gills under body



How I get food
- Scavenger or omnivore

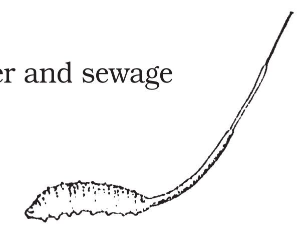
Why I'm special
- Male carries female on its back during mating; female then sheds half of exoskeleton, which becomes a case into which fertilized eggs are placed for development

Rat-Tailed Maggot (larva) — Tolerant of pollution

My distinguishing characteristics
- Cylindrical body; tail-like breathing tube

How I get oxygen
- From atmosphere through breathing tube

How I get food
- Scavenger—eat decaying matter and sewage

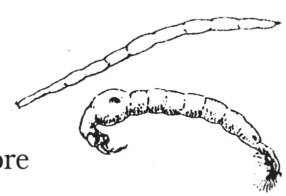


Why I'm special
- Can survive low oxygen levels fatal to most invertebrates

Midge Larva — Tolerant of pollution

My distinguishing characteristics
- Small, cylindrical body; sometimes blood red

How I get oxygen
- Through body surface

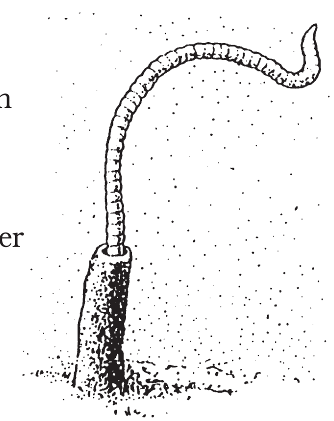


How I get food
- Predator, herbivore, or omnivore

Why I'm special
- Some have a substance in blood to hold more oxygen in oxygen-poor environments.

Tubifex Worm — Tolerant of pollution

My distinguishing characteristics
- Segmented body; builds a vertical tube from which one end protrudes

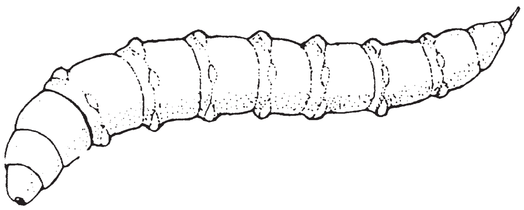


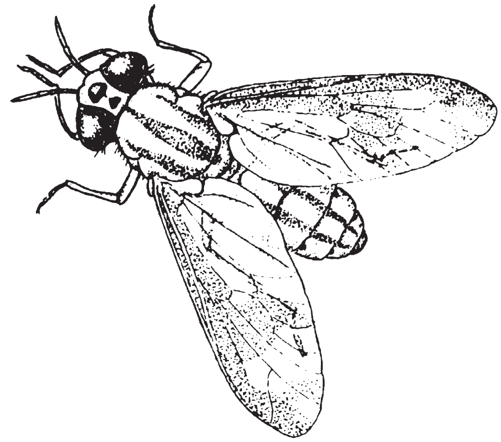
How I get oxygen
- Through body surface; but can tolerate water with no oxygen

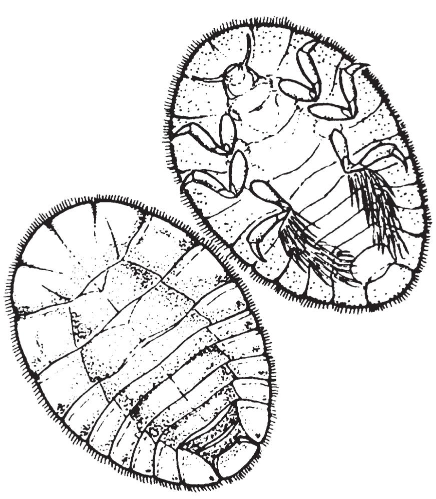
How I get food
- Scavenger—eat decaying matter and sewage

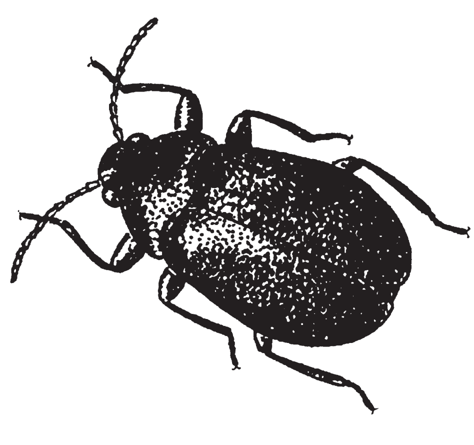
Why I'm special
- Can survive low oxygen levels fatal to most invertebrates

Immature and Adult Aquatic Organisms

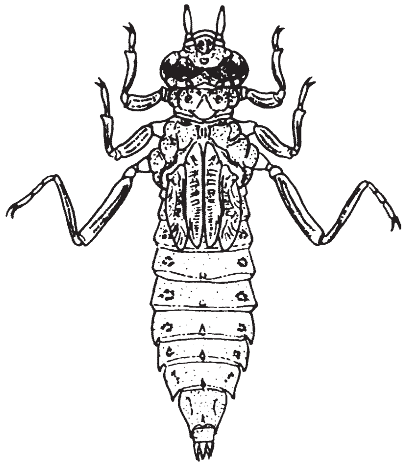


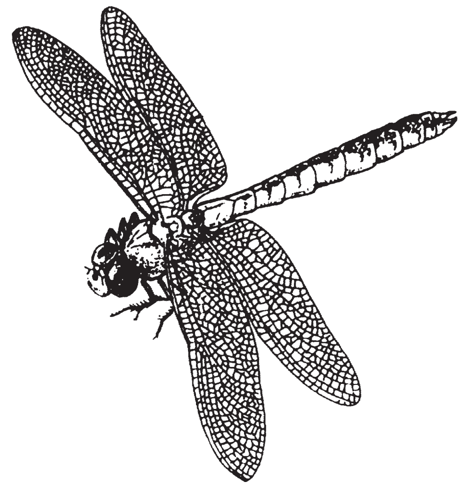


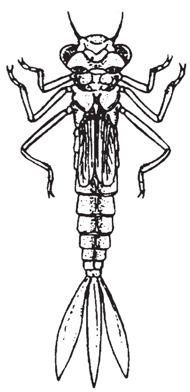


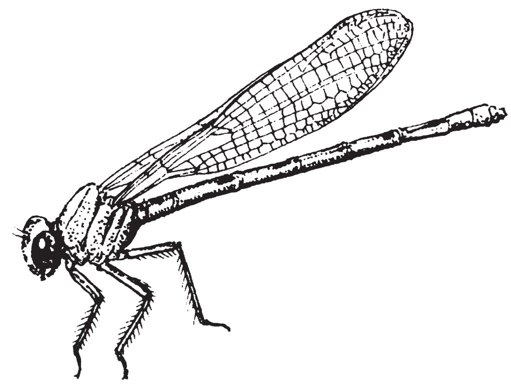


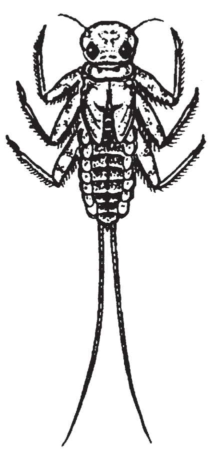
Immature and Adult Aquatic Organisms

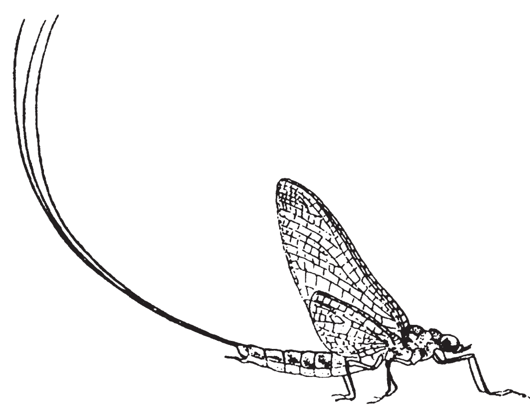




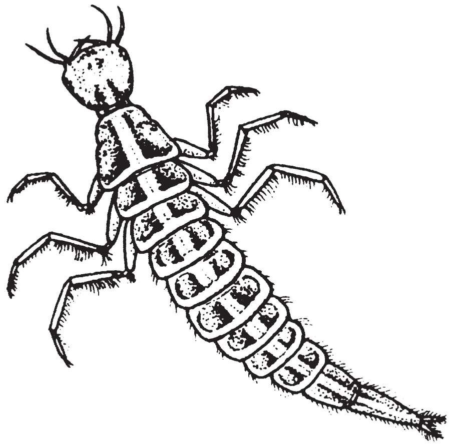


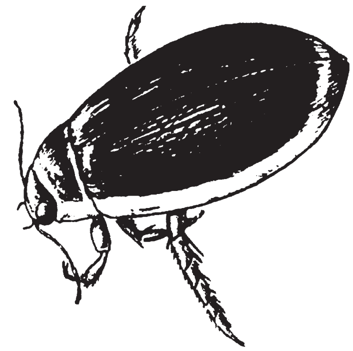


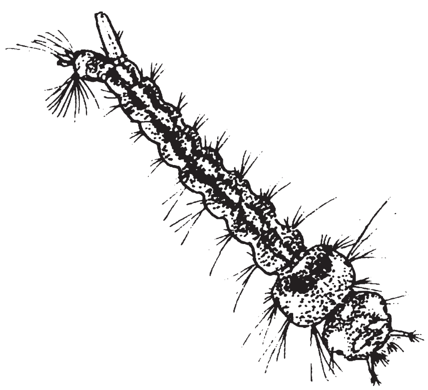


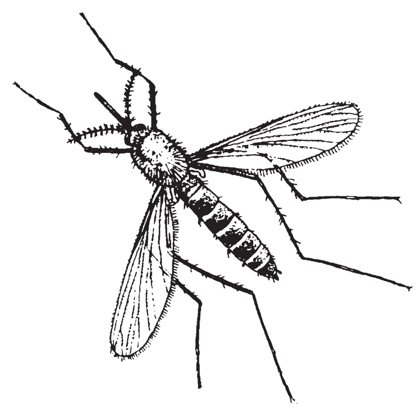


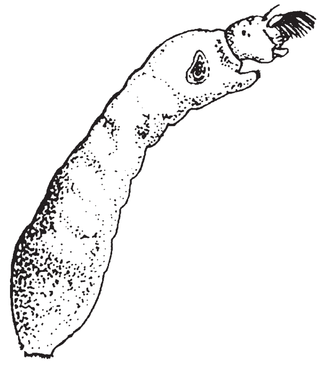
Immature and Adult Aquatic Organisms

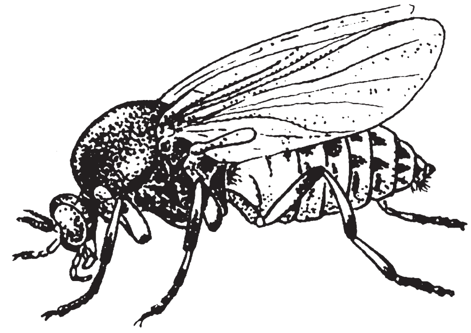




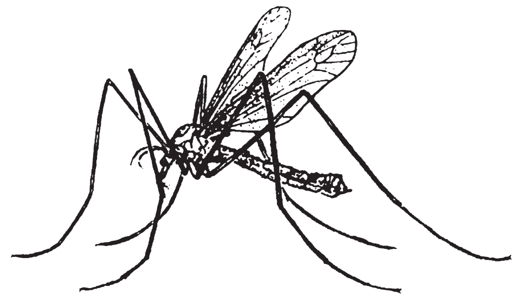


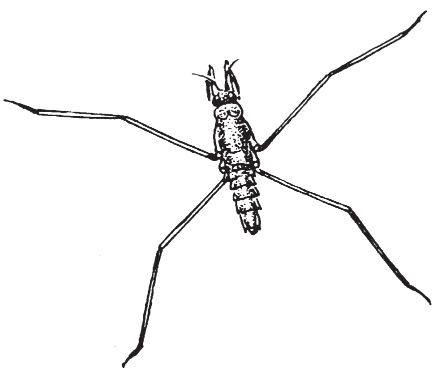


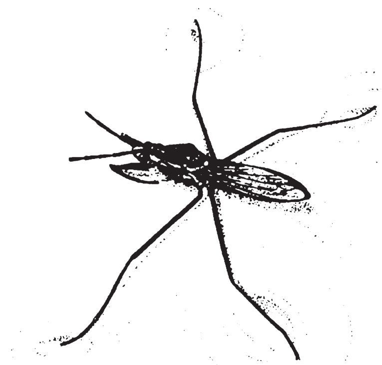


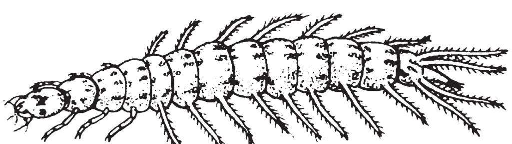


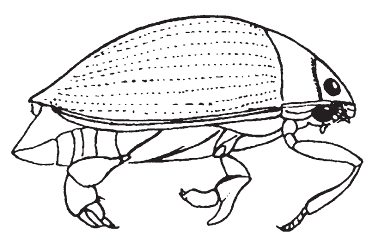
Immature and Adult Aquatic Organisms



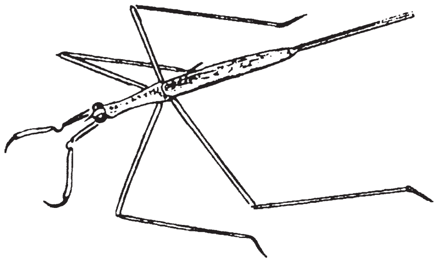


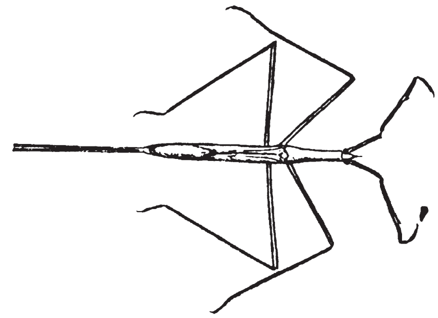


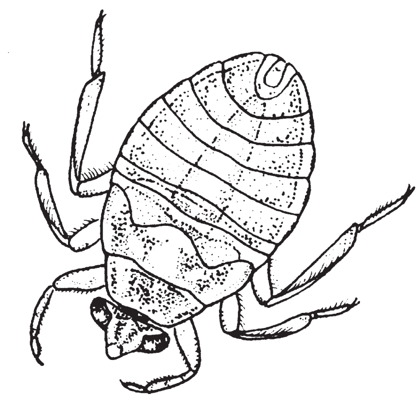


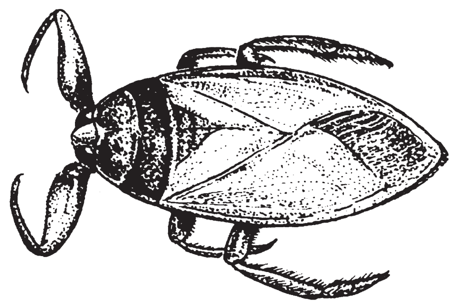


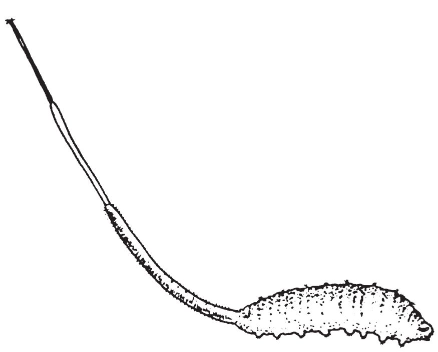
Immature and Adult Aquatic Organisms

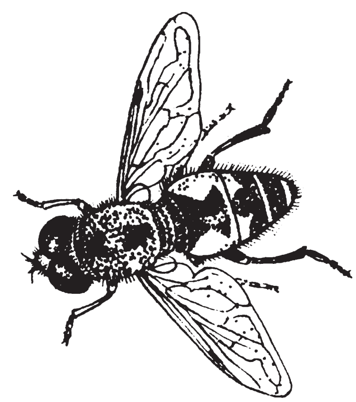












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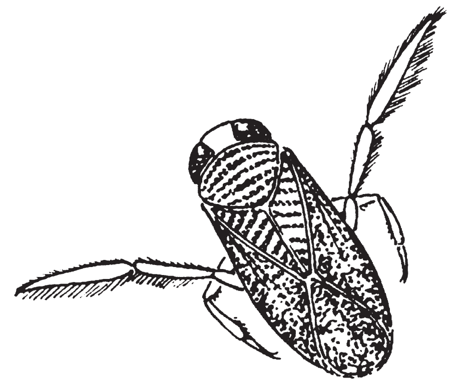
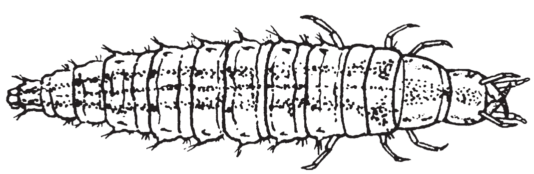
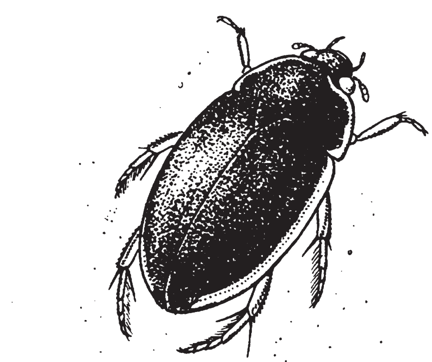
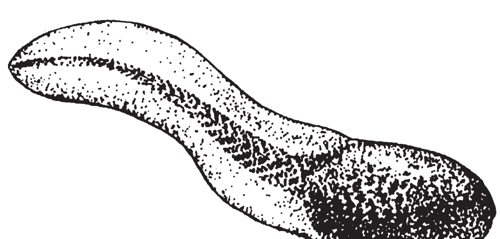
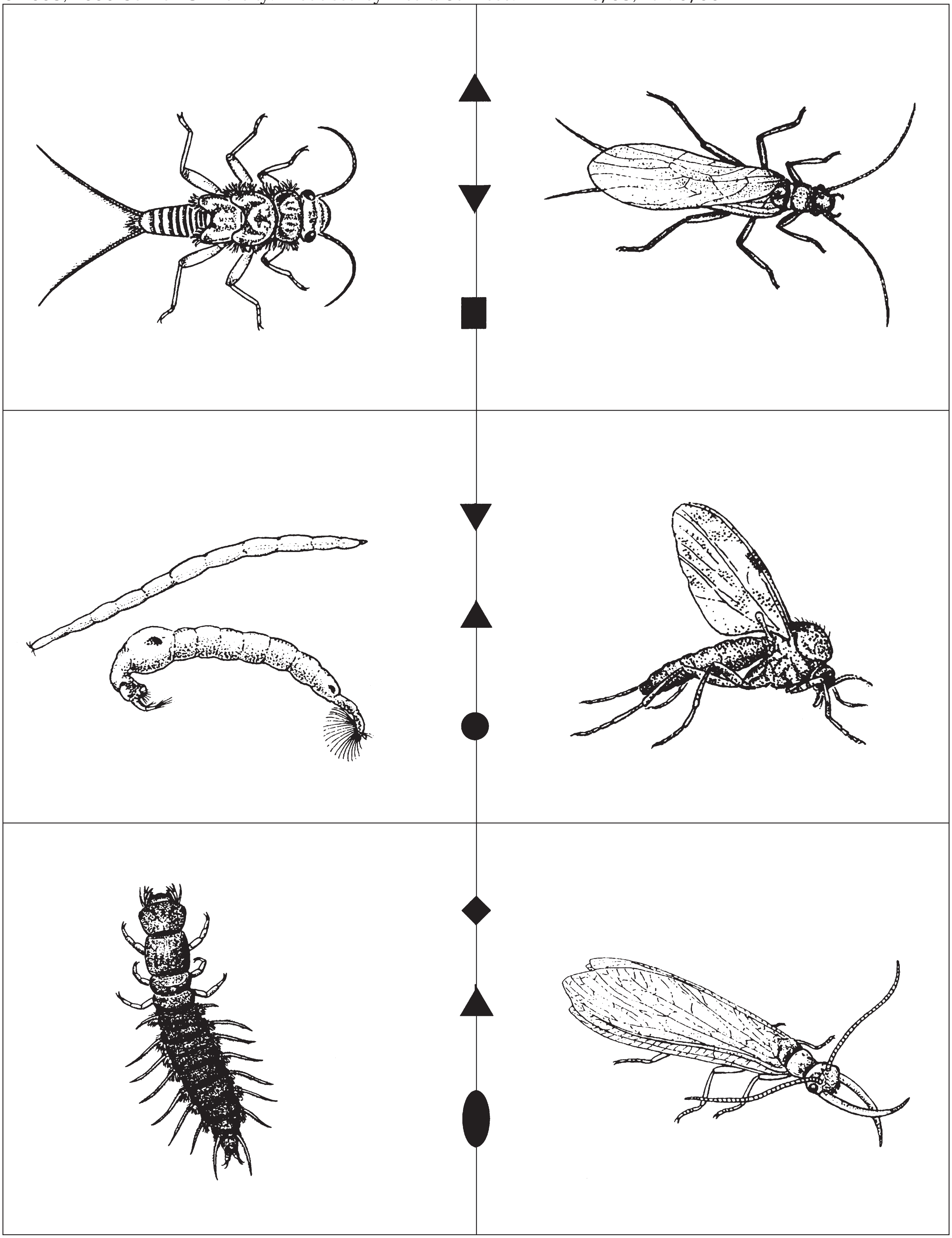








"Immature and Adult Aquatic Organisms"



Stream Web of Life Cards

Duckweed

We are small, multicelled plants. We grow very fast in quiet pools along the stream edge. Here we may provide shade and cover for tadpoles or juvenile salmon. We provide food for aquatic insects, mallard ducks, and raccoons.

Phytoplankton

We are small, single-celled plants. We cannot run away when zooplankton, salmon, aquatic insects, and snails come to eat us.

Sedges

We are a plant that grows in wet areas along the edge of the stream. Beetles eat our roots. Ruffed grouse and mallard ducks eat our seeds.

Algae

We are small, multicelled, plantlike organisms. We must grow and multiply very fast because so many animals eat us. Some of these animals are aquatic insects, crayfish, tadpoles, and mallard ducks.

Stream Web of Life Cards

Alder

We are trees and shrubs that grow near streams. When we drop branches, they may fall into the stream, adding to the woody debris. We shade the stream in summer. When we drop our leaves into the stream, algae may grow on them or aquatic insects and crayfish may eat them. Ruffed grouse feed on our catkins. Raccoons use us for shelter.

Oak

We are big trees. We may grow in forests and open prairie areas. Mallard ducks, ruffed grouse, raccoons, and humans use our acorns. Land insects such as grasshoppers and beetles may be found on our leaves. The osprey may rest on our branches while eating a salmon. The leftover salmon parts fall to the ground and become fertilizer for us.

Stonefly larvae

We live on or under rocks or stones in the stream. That is where our name comes from. Some of us eat plants. Others of us eat small insects and zooplankton. Fish like to eat us. We also are eaten by raccoons and mallard ducks.

Zooplankton

We are tiny animals that are eaten by many aquatic insect larvae, juvenile salmon, and other small swimmers. We need nutrients from phytoplankton, rotting leaves, and animals.

Stream Web of Life Cards

Snails

When we spot a water strider, beetle, salmon, or raccoon, we just pull our foot into our shells. Then we hope we don't get eaten. Our eyes and mouth are on our foot. Pretty odd? Nope! The phytoplankton and algae we eat grow where we crawl.

Caddisfly larvae

We build little homes around our soft bodies from tiny pieces of gravel or pieces of leaves and twigs. We eat plants and leaves that drop into the stream. We try to hide from mallard ducks, crayfish, and raccoons.

Beetle

I hide under leaves or swim fast to keep from being eaten by frogs or salmon. I just want to eat my mayfly larvae and greens.

Mayfly larvae

We eat zooplankton and plants. Many animals eat us, including stoneflies, beetle larvae, salmon, and mallard ducks.

Stream Web of Life Cards

Juvenile salmon

Once we come out of our gravel nest we are very hungry. We need to eat a lot of food to grow. As we get bigger, we eat bigger food. We eat both plants and animals, including phytoplankton and everything from zooplankton to beetles. There are many of us, because we are eaten by mallard ducks, raccoons, osprey, belted kingfishers, great blue herons, and otters.

Grasshoppers

Sometimes we come to the stream in search of water, but mostly we get water from the tree and grass leaves we eat. Ruffed grouse, raccoons, and frogs will eat us if we don't hop fast enough!

Crayfish

We are the stream sanitation department. We clean up anything dead, often using the body of a dead animal for a temporary home. We also eat algae, caddisfly larvae, and worms. Raccoons, otters, and some people consider us a delicacy.

Tadpoles

We are vegetarians, eating only plants and producers such as phytoplankton and algae. When I grow up, I will be carnivorous, eating other animals just like my parents do, who are frogs. Very few of my hundreds of brothers and sisters will survive to have their own eggs, because so many animals like to eat us. We must watch out for raccoons, otters, great blue herons, and belted kingfishers.

Stream Web of Life Cards

Mallard duck

We live near the stream and on the water. We eat sedge, acorns, and duckweed. We also eat aquatic insects, fish eggs, tadpoles, small frogs, and fish. We even will scavenge on dead salmon. We have many ducklings each Spring, because so many are eaten by great blue herons and otters.

Frog

We are mainly carnivorous animals. As you see in cartoons, we love to eat insects. We also enjoy snails and small crayfish. When feeding along the edge of the stream, we have to watch out for mallard ducks, otters, raccoons, and great blue herons.

Ruffed grouse

We are forest-loving birds. We like to eat grasshoppers, beetles, berries, sedge seeds, acorns, alder leaves and catkins, wild grape, and woody plants. Very few animals eat us once we are adults. Our chicks may be eaten by raccoons.

Osprey

We are called “fish hawks” because our main diet is fish. We also may eat snakes, frogs, and ducklings. We need large trees to roost in and to build safe nests for our young.

Stream Web of Life Cards

Great blue heron

I can see a frog hiding in the cattails, and I sneak up on him with my big, wide feet. If the frog gets away, I'll poke in the mud with my long bill to find crayfish or snap at a young salmon. I also enjoy snakes and grasshoppers.

Raccoon

I just love water! Clean, clear water where I can catch my food and wash it, too! I am not afraid of any other stream animals. I like to eat duckweed, acorns, grasshoppers, caddisfly larvae, stonefly larvae, snails, frogs, fish, crayfish, and small creatures found in the water and mud along the shore.

Belted kingfisher

Our loud cry can sound like a crazy laugh as we swoop over the stream. We eat any small swimmers we can catch: crayfish, frogs, small snakes, beetles, and even young birds. We nest in a burrow that is 3 to 7 feet deep in soft soil on banks or cliffs.

Otter

I would rather play than eat. I play every chance I get—even with my food! I like to eat crayfish, fish, beetles, and frogs.

Stream Web of Life Cards

Habitat component

Sun

Habitat component

Woody debris

Large branches, logs, and logjams provide shade and create deep pools of cool water.

Habitat component

Water quality

Consistent water temperatures and high oxygen levels are important to the stream. Plants growing on the stream banks shade the water. This helps to keep it cool. Woody debris and boulders help mix oxygen into the water.

Habitat component

Riffles, runs, gravel

Boulders and cobbles create riffles where aquatic insects live. Each type of salmon likes different types and sizes of gravel in a streambed.

Stream Web of Life Cards

Habitat component **Silt**	
Habitat component **Salmon carcass**	

Oregon Herptiles Poster Key

Oregon Herps

1a

2a

x

2b

3a

3b

4a x

4b x

5a x

5b

6a x

6b x

1b

7a

7b

8a xx

8b xx

9a

x

9b

10a x

10b x

Text for Oregon Herptiles Poster Key

Photocopy the box called “Oregon Herps” and boxes 1a, 1b, 2a, 2b, 3a, 3b, 5b, 7a, 7b, 9a, and 9b and cut them out. Laminate them to the poster. (See page 99 for the poster layout.)

1 a
Reptiles

Reptiles are one of the two major groups of herps.

- Skin: scaly and waterproof
- Feet: most have claws on their feet
- Eggs: have tough shells, are laid on land
  [In Oregon, reptiles who do not lay eggs but bear live young include the short-horned lizard, northern alligator lizard, rubber boa, and rattlesnake.]
- Young: look like miniature version of adults at birth
- Some lie in the sun to raise their body temperature.

Two of the four groups of reptiles are found in Oregon. One group includes snakes and lizards; the other group is turtles. The two groups not found in Oregon are the Crocodilians and Tuatara. (Tuatara are lizardlike reptiles found on about 30 small islands off the coast of New Zealand.) **Go to 2**

1 b
Amphibians

Reptiles are one of the two major groups of herps.

- Skin: moist with no scales
- Feet: without claws
- Eggs: soft, without shells, laid in water or a moist area
- Young: do not look like adults at birth. They go through a series of changes, called metamorphosis, to reach adult form. Young amphibian larvae breathe through gills.

Two of the three groups of amphibians are found in Oregon. One is frogs (which includes toads); the other is salamanders. The obscure, wormlike Ceacilians (see-SIL-ee-ans) do not live in Oregon. **Go to 7**

Oregon Herps

The word **herps** comes from the word **herpetology**. This is the branch of zoology that studies reptiles and amphibians. Reptiles evolved from early amphibians.

What, in general, do reptiles and amphibians have in common?

- Cold blooded
- Most lay eggs.
- Most shed their skins when they grow.
- Most have an excellent sense of smell.
- Some use chromatophores [pigment-containing skin cells] to change color in response to conditions in their environment.

2a

Body scaly and waterproof, encased in a shell. **Turtles**

2b

Body scaly and waterproof, not encased in a shell, with or without legs.
Lizards and Snakes—Go to 3

3a

Body scaly and waterproof, not encased in a shell, with legs present.
Lizards—Go to 4

3b

Body scaly and waterproof, not encased in a shell, without legs present.

Snakes—Go to 5

Most snakes have a pair of sensory pockets, called the Jacobson's organ, at the back of the mouth. When snakes flick their tongues in and out, they are smelling the environment. The tongue collects molecules from the air and ground and deposits them in the pockets of the Jacobson's organ.

5b

Body scaly and waterproof, without legs. Tail without rattles. **Go to 6**

7a

Body long and slender, moist and smooth, with no scales. Four legs of generally equal length, with 4 toes on each front foot and 5 toes on each hind foot.

Salamanders—Go to 8

7b

Body moist and skin smooth, with no scales, or have a dry, warty appearance. The hind legs are modified for hopping or leaping. Four toes on each foot; the back foot generally is webbed. In the mating season, males advertise their presence with loud calls. **Frogs and Toads—Go to 9**

9a

Skin appears dry and rough but not scaly. Some with lumps, called tubercles or warts, on skin. Legs modified for short hops or running on all four legs. No teeth.

Toads

9b

Moist, smooth skin. Long, powerful back legs allow huge leaps. Small teeth on the upper jaw.

Frogs—Go to 10

Text for Herp Species Cards

I have a scaly, waterproof body, encased in a shell. The top of my shell is drab brown to black, the underside is cream to yellow with large, dark brown markings.
Western pond turtle

Note: The above Species Card goes below the text for box 2a

4a

I have a scaly, waterproof body with legs. Sometimes I am called a "blue-belly." I can be seen sunning myself on fence rails. My scales have a slightly rough appearance.
Western fence lizard

4b

I have a scaly, waterproof body with legs. My young often have a blue tail. But be careful! That tail breaks off easily. My scales have rounded edges that overlap smoothly, giving me a shiny appearance.
Western skink

5a

I have a scaly, waterproof body without legs. My head is broad, almost triangular in shape, to hold my poison glands. I am venomous. I have a heat-sensing pit between my eyes and my nose. If you disturb me, I will shake my tail rattles at you in warning.
Rattlesnake

6a

I may have a beautiful yellow or orange stripe down my back, a red-orange head, and side-spot markings as well. There are many different groups of coloring used by my kind. I can eat the poisonous rough-skinned newt without ill effect.
Common garter snake

6b

I am a large snake, sometimes growing to 40 inches long. I am tan or yellowish with brown markings on top and white or cream below. Sometimes I am confused with the Rattlesnake, but I have no rattles and am not venomous.
Gopher (or Bull) snake

8a

I have a moist, smooth body with no scales. I have four legs of generally equal length. I have a dark-colored body with yellow, tan, or light green stripes and blotches down my back. **Long-toed salamander**

8b

I have a grainy skin surface that gives me my name. I am brown above and bright orange on my underside. I live in forested areas and return to a pond or stream in breeding season. I have the most toxic poison of any amphibian in Oregon, but I rarely release my poison. **Rough-skinned newt**

I have a body that is covered with warts. My hind legs are modified for short hops or running on all fours. I am large, growing to 4½ inches. I am the only one of my kind common in Oregon. **Western toad**

Note: The above Species Card goes below the text for box 9a

10a

I have a moist, smooth skin that is usually grass green but may be tan or brown. My long, powerful back legs are for taking huge leaps. I am about 1½ inches long and have a black stripe through my eye.

Pacific tree (or Chorus) frog

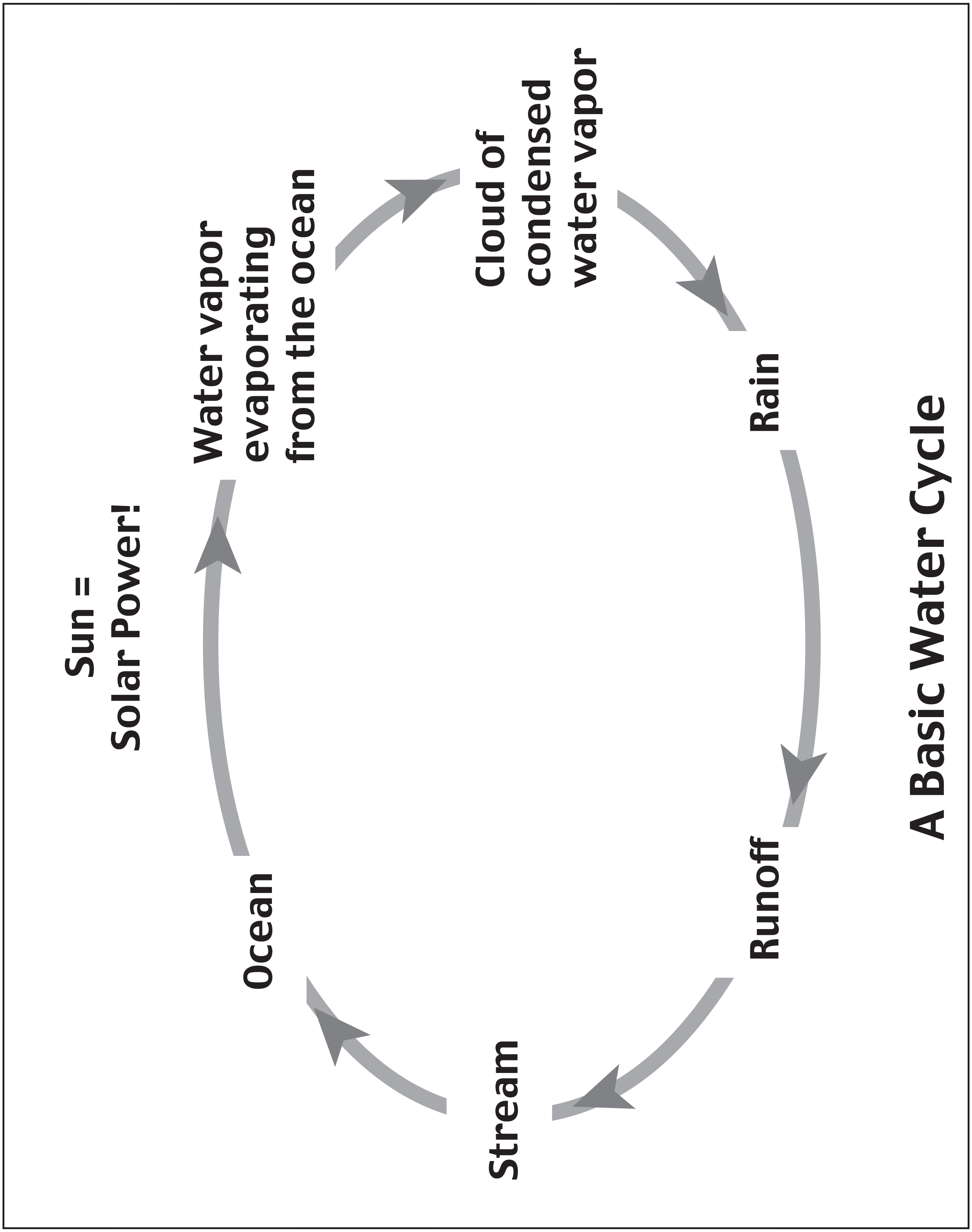
10b

I am the largest frog in Oregon—sometimes I am over 7 inches long. I have moist, smooth skin and long, powerful back legs. I am not a native, and my predatory habits have caused the decline of many native fish and amphibians.

Bullfrog

Appendix III

Overhead Transparency Masters


A Basic Water Cycle
Sun =
Solar Power!
Water vapor
evaporating
from the ocean
Cloud of
condensed
water vapor
Rain
Runoff
Stream
Ocean

Rosa Raindrop's World Water Tally

Source	***Percent of total water (approximate)***
Lakes	__________
Oceans	__________
Soil moisture	__________
Groundwater	__________
Rivers/Streams	__________
Ice caps/Glaciers	__________
Atmospheric water	__________
Total +/-	100.00%

Appendix IV

Sources for Equipment and Materials

Water Quality Monitoring Kit

GREEN (Global Rivers Environmental Education Network) Kit from LaMotte includes tests for coliform bacteria, dissolved oxygen, BOD, nitrate, pH, phosphate, temperature, and turbidity.

Acorn Naturalists
155 El Camino Real
Tustin, CA 92780
800-422-8886
www.acornnaturalists.com

Dissolved oxygen (DO) test kits

Easy to use; not as messy as Hach

CHEMetrics, Inc.
4295 Catlett Rd.
Calverton, VA 20138
800-356-3072
www.chemetrics.com

Science kits and living materials

Snails, mosquitofish, butterfly larvae

Carolina Biological Supply
Elementary Science and Math
800-334-5551
www.carolina.com

General Science supplies; chemicals; equipment; pond study equipment; pH paper

NASCO Science
4825 Stoddard Rd.
Modesto, CA 95356
800-558-9595
www.eNASCO.com/prod/Home

Carolina Biological Supply
Elementary Science and Math
800-334-5551
www.carolina.com

Forestry education products; measuring equipment; compasses; binoculars

Forestry Suppliers Inc.
PO Box 8397
Jackson, MS 39284
800-647-5368
www.forestry-suppliers.com

Books; activity guides; field guides

Acorn Naturalists
155 El Camino Real
Tustin, CA 92780
800-422-8886
www.acornnaturalists.com

Rubber fish for fish prints; rice paper; paint

NASCO Arts and Crafts
4825 Stoddard Rd.
Modesto, CA 95356
800-558-9595
www.eNASCO.com/prod/Home

Furs, hides, skulls; premade kits

Stroudsburg Fur Corp.
PO Box 729
Stroudsburg, PA 18360
570-421-6704
www.furskins.com

Rubber tracks of mammals, birds; also scat

Acorn Naturalists
155 El Camino Real
Tustin, CA 92780
800-422-8886
www.acornnaturalists.com

Earth science; geology toys and education materials

Hubbard Scott Scientific Resouorces
401 West Hickory St.
PO Box 2121
Ft. Collins, CO 80522
800-289-9299
www.hubbardscientific.com

Owl pellets; preserved specimens; dissecting equipment

Blue Spruce Biological Supply
701 Park Street
Castle Rock, CO 80109
800-825-8522
bluebio.com

Mountain Home Biological
PO Box 277
White Salmon, WA 98672
800-958-9629
www.pelletlab.com

Appendix V

Glossary

Abdomen

On the spider, the second body part which has the spinnerets on underside.

Algae

Formerly in the Plant Kingdom, algae are now classified as members of the Protist Kingdom. They belong to the plant-like Protist group and include euglenas, diatoms, dinoflagellates, green algae, red algae, and brown algae.

Carbohydrates

The food product created from carbon dioxide and water in plants through photosynthesis.

Cephalothorax

In the spider, the first body part. It serves the combined functions of the head and thorax in insects. The cephalothorax is where the legs, eyes and mouth parts are located.

Conduction

Transmission of heat or electricity through a medium.

Exoskeleton

The hard cuticle-like covering of insects, spiders and their relatives, which provides a structure and gives protection to the soft inner parts of these organisms.

Epicotyl

The structure inside the seed from which the first true leaves will form.

Food chain

A model to depict energy flow through an ecosystem. Energy continues to change form. It never truly “begins” of “ends” as a simple food chain implies.

Gastropod

Snails and slugs are gastropods. The word means, “stomach-foot”.

Hydrologic Cycle

Also called the Water Cycle. The model for the endless process in which water is circulated around the surface of the earth through soil, plants, animals, and the atmosphere.

Hypocotyl

The area of a seed that forms the lower stem and roots.

Larvae

An immature form of an insect which goes through complete metamorphosis to become an adult insect. Generally does not resemble the adult form (e.g., caterpillars go through complete metamorphosis to become butterflies).

Macro–invertebrates

Invertebrates visible with the un-aided human eye.

Metamorphosis

The changes which take place in the body type of insect larvae (complete metamorphosis) or nymphs (incomplete metamorphosis) when becoming adults.

Nymph

An immature form of an insect which go through gradual or incomplete metamorphosis to become an adult insect. May look similar to the adult form.

Photosynthesis

The process plants use to produce food from carbon dioxide and water.

Radiation

The transfer of energy by electromagnetic waves.

Radicle

The lower tip of the hypocotyl where the main root system develops in the germinating seed.

Turbidity

Sediments or material suspended in water that reduce the quality of the water habitat for living organisms.

Water cycle

The model for the endless process in which water is circulated around the surface of the earth through soil, plants, animals, and the atmosphere.