Flint Creek Nature Center Species List

	Woody Plants	
1	Sassafras	*Sassafras albidum*
2	Chinkapin Oak	*Quercus muehlenbergii*
3	Northern Red Oak	*Quercus rubra*
4	Green Ash	*Fraxinus pennsylvanica*
5	Box Elder	*Acer negundo*
6	Sycamore	*Platanus accidentalis*
7	Hickory, spp	*Carya*
8	Redbud	*Cercis canadensis*
9	Flowering Dogwood	*Cornus florida*
10	American Elm	*Ulmus americana*
11	Spicebush	*Lindera benzoin*
12	Paw Paw	*Asimina triloba*
13	Black Willow	*Salix nigra*
14	Persimmon	*Diospyros virginiana*
15	Black Walnut	*Juglans nigra*
16	Hackberry	*Celtis occidentalis*
17	Red Mulberry	*Morus rubra*
18	Black Cherry	*Prunus serotina*
19	Silver Maple	*Acer saccharinum*
	Vines & Shrubs	
1	Trumpet Creeper	*Campsis radicans*
2	Possum Grape	*Cissus trifoliata*
3	Blackberry	*Rubus*
4	Passion Vine	*Passiflora*
5	Poison Ivy	*Toxicodendron radicans*
	Wildflowers	
1	Black-eyed Susan	*Rudbeckia hirta*
2	Chicory	*Cichorium intybus*
3	Orange Day Lily	*Hemerocallis fulva*
4	Wood Sage	*Salvia karwinskii*
5	Starry Campion	*Silene stellata*
6	Water Willow	*Justicia americana*
7	Wild Garlic	*Allium canadense*
8	Deptford Pink	*Dianthus armeria*
9	Queen Anne's Lace	*Daucus carota*
10	Daisy Fleabane	*Erigeron annus*
11	Ox-eye Daisy	*Leucanthemum vulgare*
12	White Crownbeard	*Verbesina virginica*
13	Yellow Rocket	*Barbarea vulgaris*
14	Moth Mullein	*Verbascum blatteria*
15	Spotted Touch-me-not	*Impatiens capensis*

16	Blue Phlox	*Phlox divaricata*
17	Pickerel-Weed	*Pontederia cordata*
18	Asiatic Day Flower	*Commelina Coomunis*
	Pollinators	
1	Tiger Swallowtail	*Papilio glaucus*
2	Spicebush Swallowtail	*Papilio troilus*
3	Black Swallowtail	*Papilio polyxenes*
4	Variegated Fritillary	*Euptoieta claudia*
5	Great Spangled Fritillard	*Speyeria cybele*
6	Buckeye	*Junonia coenia*
7	Red Admiral	*Vanessa atalanta*
8	Painted Lady	*Vanessa cardui*
9	American Lady	*Vanessa virginiensis*
10	Hackberry Emperor	*Asterocampa celtis*
11	Tawny Emperor	*Asterocampa clyton*
12	American Snout	*Libytheana carinenta*
13	Monarch	*Danaus pleippus*
14	Silvery Checkerspot	*Chlosyne nycteis*
15	Wood Nymph	*Thalurania glaucopis*
16	Eastern-tailed Blue	*Cupido comyntas*
17	Sulphur sp	*Pyrsitia nise*
18	Hairstreak sp	*Strymon melinus*
19	Skipper sp	*Hesperiidaw hylephilaphyleus*
20	Honey Bee	*Apis mellifera*
21	Bumble Bee	*Bombus*
22	Carpenter Bee	*Xylocopoda virginica*
23	Thread-waisted Wasp	*Ammophila procera*
24	Wasp sp	*Hymenoptra*
	Birds	
1	Indigo Bunting	*Passerina cyanea*
2	Summer Tanager	*Piranga rubra*
3	Common Yellowthroat	*Geothylpis trichas*
4	Eastern Phoebe	*Sayornis phoebe*
5	Wood Pewee	*Contopus virens*
6	Eastern Kingbird	*Tyrannus tyrannus*
7	Carolina Wren	*Thryothorus ludovicianus*
8	Northern Mockingbird	*Mimus polyglottos*
9	Eastern Meadowlark	*Sturnella magna*
10	Green Heron	*Butorides virescens*
11	Great Blue Heron	*Ardea herodias*
12	Turkey Vulture	*Carthartes aura*
13	Red-tailed Hawk	*Buteo jamaicensis*
14	Red-shouldered hawk	*Buteo lineatus*
15	Cowbird	*Molothrys ater*

16	Red-winged Blackbird	*Agelaius phoeniceus*
17	Chipping Sparrow	*Spizella passerina*
18	Eastern Bluebird	*Sialia sialis*
19	Northern Cardinal	*Cardinalis cardinalis*
20	Blue Jay	*Cyanocitta cristata*
21	Brown Thrasher	*Toxostoma rufum*
22	American Goldfinch	*Cardeulis tristis*
23	American Crow	*Corvus brachyrhynschos*
24	Great Egret	*Ardea alba*
	Mammals	
1	White-tailed Deer	*Odocoileus virginianus*
2	Eastern Cottontail	*Sylvilagus floridanus*
3	Nine-banded Armadillo	*Dasypus novemcinctus*
4	Red Squirrel	*Tamiasciurus hudsonicus*
5	Gray Squirrel	*Sciurus carolinensis*
6	Groundhog	*Marmota monax*
7	Beaver	*Castor canadensis*
	Fish	
1	Smallmouth Bass	*Micropterus dolomieui*
2	Largemouth Bass	*Micropterius salmoides*
3	Spotted Bass	*Micropterius punctulates*
4	Yellow Bullhead Catfish	*Ictalurus natalis*
5	Flathead Catfish	*Plyodictus olivaris*
6	Channel Catfish	*Ictalarus punctatus*
7	Blue Catfish	*Ictalarus furcatus*

HOW TO USE AN OUTDOOR CLASSROOM TO INCORPORATE READING, WRITING AND SERVICE LEARNING.

This research was found at
http://www.jefferson.k12.ky.us/departments/environmentaled/schoolyardhabgd/section1.html

Putting Outdoor Classrooms into a Learning Context

Outdoor Classrooms and Core Content

by the JCPS Center for Environmental Education

Outdoor classrooms are powerful vehicles to achieve educational goals. They naturally motivate young people to learn, building on what Rachel Carson calls the "sense of wonder." Nature places learning in a meaningful context, helping learners to more easily integrate new knowledge and skills into a larger framework. Outdoor classrooms support curriculum objectives in all program areas, including science, mathematics, social studies, language arts, health, physical education, and other subjects. The trick is to make sure that outdoor learning is based upon the existing curriculum. It should not be an extra or add-on (Habitats for Learning, Ohio Environmental Education Fund).

Skills for Reading Assessment

Outdoor classrooms can provide the impetus and purpose for a variety of **informational and literary readings**. Whether students are reading about landscape design or different types of spiders, they can relate what they are reading to real-life applications. More specifically, building and maintaining an outdoor classroom directly relates to practical or workplace reading. This type of reading includes excerpts from warranties, receipts, forms, memoranda, consumer texts, and "how to" manuals. Students have to follow directions; explain why the correct sequence of activities is important; interpret specialized vocabulary found in practical reading passages; identify information, which provides additional clarity; and locate and apply appropriate information.

Skills for Mathematics Assessment

Outdoor classrooms fit best with three of the **core content strands within mathematics: Number and Computation, Geometry and Measurement, and Probability and Statistics**. Elementary students should be able to sort objects and compare a tribute; use standard and nonstandard units to measure length, area, liquid capacity, volume, temperature, and weight; pose questions that can be answered by collecting data; collect, organize, and describe data; construct and interpret displays of data. Middle school students should be able to estimate large and small quantities and computational results, identify characteristics of two- and three-dimensional shapes, estimate measurements in nonstandard and standard units, gather data about large populations, and use counting techniques to solve probability problems. These are all skills applicable to planning, setting up, and implementing outdoor classrooms.

Skills for Writing Assessment

As with reading, outdoor classrooms are a vehicle to motivate students to write, whether it is a personal narrative, a vignette, imaginative writings, or a persuasive piece. Writing, based on experiential learning in the outdoor classroom,

capitalizes on real-life vocabulary/language acquisition that is readily transferred to written language. The outdoor classroom provides a perfect opportunity to develop higher-level thinking skills described in Bloom's taxonomy, for example, compare and contrast; design, interpret, and analyze. These higher-level skills form the foundation of open-response questions.

Skills for Science Assessment

In many ways, science skills are obvious in an outdoor classroom. Nevertheless, to ensure that specific skills are covered, it is important that areas of concentration are identified. All of the science-process skills (observing, classifying, communication, measuring, predicting, inferring, identifying, and controlling graphs, analyzing, formulating hypothesis, and designing investigations and experiments) can be carried out in an outdoor classroom, but not at the same time. You must choose your focus. The content areas of physical science, life science, and earth and space science are all very appropriate for outdoor classrooms. For example:

Life Science—Elementary School

- The Characteristics of Organisms (similarities for classification)
- Life Cycles of Organisms (differences in life cycles)
- Organisms and Their Environments (relationships among producers, consumers, and decomposers)

Life Science—Middle School

- Regulation and Behavior (behavior and adaptation)
- Diversity and Adaptation of Organisms
- Populations and Ecosystems (individuals and physical factors) (food webs, carrying capacity)

Life Science—High School

- Biological Change (similarities for classification)
- Interdependence of Organisms (population size, environments, and resources)

Skills for Social Studies Assessment

Outdoor classrooms are easily aligned to understanding geography. Outdoor classrooms help students understand that Patterns on the Earth's surface can be identified by examining where things are, how they are arranged, and why they are in a particular location; the Earth is vastly complex with each place on its surface having human and physical characteristics to deal with these complex people-created regions; patterns emerge as humans move, settle, and interact on Earth's surface; and human actions modify the physical environment and, in turn, the physical environment limits or promotes human activities.

Reading and Outdoor Classrooms

Read Aloud

Use the outdoor classroom setting to provide context clues for reading aloud. When preparing students for a Read Aloud, choose a location that reflects the content or setting of the selected book.

Some examples are as follows:

Location	Related Read-Aloud Book
Pond or Wetland	*All Eyes on the Pond* by Michael Rosen
Forest	*The Man Who Planted Trees* by Jean Giono
Meadow	*The Other Way to Listen* by Byrd Baylor

When introducing each book, ask students to predict what the words on the list might have to do with the story. Encourage other predictions about the book.

During the reading:

- connect with prior knowledge.
- discuss unknown words.
- adjust predictions.
- After the reading:
- reflect on the message.
- discuss and identify the main idea.
- compare predictions with the outcome.
- reflect on your location. How is it similar (or different) from the book?

When in the classroom refer back to books read at the center and guide students to create a Word Wall that describes or names objects in their surroundings.

Shared Reading

Shared Reading offers a risk-free environment for uncertain readers. This component includes reading with students from big books, charts, or student reproducibles. Textbooks also can be a Shared-Reading experience, with the teacher reading and discussing concepts before students are asked to read on their own.

In your outdoor classroom, Shared-Reading opportunities may include reading and writing nature poetry. Chart paper can be used to copy poetry for the shared reading. For example, *Joyful Noise: Poems for Two Voices* by Paul Fleischman are poems that celebrate nature and can be used for choral reading or call and response by individuals or in groups.

A lesson that may include Shared Reading would start by reading a poem about nature and identifying the various sensory descriptions and images created by the words. Students would then explore and interpret their surroundings, using all of their senses, to create a strong visual image. Finally, students create a poem,

either to share individually or as a group (Shared Writing). This writing then becomes additional material for Shared Reading.

Guided Reading

Guided Reading involves students' reading materials on their instructional level with the support of their teacher. Students need to be intentionally taught reading strategies and to be given time to share how they use these strategies.

Outdoor classrooms provide opportunities for the support of Guided Reading through related experiential learning. If the book, *How the Forest Grew*, by William Jasperson is being used for Guided Reading, exploring the nature center and learning firsthand about ecological succession gives students the chance to use vocabulary from the Guided Reading and to strengthen comprehension of the science context.

Similarly, Informational Reading in the areas of science may be supported by scientific investigations in outdoor classrooms, using vocabulary and concepts being taught through Guided Reading. For example, after using *A River Ran Wild*, by Lynn Cherry, as Guided-Reading material, students perform a stream study, applying new vocabulary and connecting the experience to the Guided-Reading lessons, increasing their depth of comprehension.

Self-Selected Reading

As students build reading skills, they need the opportunity to practice with material that is of interest to them and at a level that builds fluency. Teachers monitor books being selected to make sure the text is appropriate to independent reading levels.

The literature links provided in *Wild About Reading* allow the teacher to follow up on the outdoor field study in the classroom with related reading. Students may use book buddies, story maps, conferences, or retelling as ways of connecting the Self-Selected Reading to their outdoor-classroom experience.

Word Work

Students' work in outdoor classrooms is embedded with vocabulary and concept development related to the learning experience. As students use the school grounds, have them write in a writer's notebook or journal. Through the course of the study, vocabulary words are recorded or added to a Word Wall. Through this process, the student creates an individual Word Wall that can be used in follow-up activities and writing in the classroom.

There are many other possibilities for Word Work at your site. As you plan your studies, identify vocabulary you would like for the students to learn and use as they engage in the activity. As a part of the student preparation, introduce the vocabulary. This will give students a head start on incorporating the language into their work.

These suggestions represent a few possibilities for using outdoor classrooms as an impetus for teaching reading on a variety of levels. Think about how you can best use your site to support the standards that you are currently addressing in all academic areas. The Center for Environmental Education staff will work with

you to develop plans that support content areas and literacy.

Environmental education not only represents content, but also is a process of approaching the complete curriculum. Taking the work done in an outdoor classroom back to the classroom, to produce meaningful outcomes, requires that reading and writing be an integral part of an outdoor-classroom experience.

Reading: The Wisdom of Children's Environmental Literature

The Project WILD Annotated Bibliography of Children's Environmental Literature (K-12) lends itself well, at all levels, to comprehension work. A particularly useful tool is the Wisdom Strategy (developed by Barbara Inman, a classroom teacher from Washington) and applied to children's environmental literature.

This strategy involves reading aloud a book that teaches a "wisdom." Inherent in environmental literature at all levels is a meaning or wisdom. Using this literature not only provides material to work on comprehension, but it frames the lesson as authentic learning, extending the outdoor experience to the classroom.

The teacher gives students some examples of wisdoms or lessons that books teach. Then the teacher asks students to listen for the wisdom of the book as he/she reads aloud. The first time the strategy is used with students, the wisdom needs to be obvious. The teacher posts a piece of chart paper listing the title of the book, the author, and a small illustration in the middle of the chart paper. The teacher gives the wisdom the first time, encloses it in quotes, and puts his/her name underneath. Then he/she asks students to share a wisdom and, using a different-colored marker for each child, lists each student's wisdom in quotes, with the student's name. Then, even struggling readers can easily reread their own or another wisdom that had special meaning for them. Extensions can include the following:

- Further discussion of the book and its lessons
- Locating the part of the book that caused the student to think of the wisdom
- Students writing their own wisdom stories

There are several categories of children's environmental literature (see graphic organizer) enabling the teacher to select the content that supports the students' work done on-site while developing comprehension skills.

Wild About Reading Books

Books are arranged by the Project WILD themes noted on this page. Although the books are listed by Primary, Intermediate, middle, and high school levels, educators need not feel limited by this classification. Many of the books are appropriate for various reading levels. Educators are encouraged to select books based upon the needs of their students.

Theme	Primary	Intermediate	Middle School	High School
Awareness and Appreciation This section examines the similar survival needs of people and wildlife.	• *Animal Tracks* • *Box Turtle at Long Pond* • *In the Tall, Tall Grass* • *Mother Earth* • *North Country Night* • *The Old Boot* • *Owl Moon* • *Spider Watching* • *Where Are You Going, Emma?*	• *The Little Fish in a Big Pond* • *Old Ben* • *Paddle-to-the-Sea* • *What's Smaller Than a Pygmy Shrew?* • *Who Came Down That Road?*	• *Hatchet* • *In the Language of Loons* • *John Muir: Wilderness Protector* • *The River* • *While a Tree Was Growing*	• *The Collected Poems of Wendell Berry, 1957-1982* • *Into the Wild* • *Sense of Wonder*
Diversity of Wildlife Values This section examines contributions made by wildlife to people and the environment.	• *Crinkleroot's Guide to Knowing Animal Habitats* • *Dancers in the Garden* • *The Reason for a Flower* • *Wonderful Worms*	• *My Side of the Mountain* • *Squish!: A Wetland Walk*	• *Brian's Winter* • *Old Turtle* • *Winter Danger*	• *Opposing Viewpoints: Global Resources (series)* • *Small is Beautiful: Economics As if People Mattered*
Management and Conservation This section examines how wildlife and other natural resources can be managed and conserved.	• *The Empty Lot* • *Pumpkins: A Story for a Field* • *Who Keeps the Water Clean? Ms. Schindler!*	• *Heat Wave!* • *Saving the Peregrine Falcon*	• *Brother Eagle, Sister Sky: A Message from Chief Seattle* • *Our Endangered Planet Groundwater (series)* • *Our Endangered Planet: Rivers & Lakes (series)*	• *Hie to the Hunters*

Theme	Primary	Intermediate	Middle School	High School
Trends, Issues, and Consequences This section provides opportunities to explore difficult issues and their consequences.	• *The Giving Tree* • *Gray Fox* • *Prince William* • *Where Once There Was a Wood* • *Window*	• *Backyard Rescue* • *Lostman's River* • *Our Common Ground: The Water, Earth, & Air We Share* • *There's an Owl in the Shower*	• *American Environmental Heroes* • *Our Fragile Planet: Food and Water, Threats, Shortages, & Solutions (series)* • *Our Fragile Planet: Threatened Oceans (series)* • *Vanishing Wetlands*	• *The New Springtime* • *Phoenix Rising* • *Silent Spring*

Index by Title

- *Lizard's Song,* Shannon, George
- *Looking at the Environment,* Suzuki, David
- *The Lorax,* Dr. Seuss
- *Lostman's River,* DeFelice, Cynthia
- *Making a Better World (series),* Chandler, Gary
- *The Man Who Planted Trees,* Giono, Jean
- *Milo and the Magical Stones,* Pfister, Marcus
- *Minn of the Mississippi,* Holling, Holling C.
- *Mother Earth,* Luenn, Nancy
- *My Side of the Mountain,* George, Jean Craighead
- *Nature All Year Long,* Leslie, Clare Walker
- *Nature Watch,* Manning, Mick
- *Nearer Nature,* Arnosky, Jim
- *The New Springtime,* Silverberg, Robert
- *Night Visitors,* Young, Ed
- *North Country Night,* San Souci, Daniel
- *Old Ben,* Stuart, Jesse
- *The Old Boot,* Baines, Chris
- *Old Turtle,* Woods, Douglas
- *Once There Was a Tree,* Romanova, Natalia
- *One Day in the Woods,* George, Jean Craighead
- *One Small Square: Pond (series),* Silver, Donald
- *Opposing Viewpoints: Global Resources (series),* Polesetsky, Matthew
- *The Other Way to Listen,* Baylor, Byrd
- *Otters Under Water,* Arnosky, Jim
- *Our Common Ground: The Water, Earth, & Air,* Bang, Molly
- *Our Endangered Planet: Groundwater (series),* Hoff, Mary
- *Our Fragile Planet (series),* Tesar, Jenny
- *Owl Moon,* Yolen, Jane
- *Paddle-to-the-Sea,* Holling, Holling C.
- *The People Who Hugged the Trees,* Rose, Deborah Lee
- *Phoenix Rising,* Hesse, Karen
- *Places of Power,* DeMunn, Michael

Prince William, Rand, Gloria

- *Pumpkins: A Story for a Field,* Ray, Mary Lyn
- *The Reason for a Flower,* Heller, Ruth
- *The River,* Paulsen, Gary
- *The Salamander Room,* Mazer, Anne
- *A Sand County Almanac,* Leopold, Aldo
- *Saving the Peregrine Falcon,* Arnold, Caroline
- *Sense of Wonder,* Carson, Rachel
- *Silent Spring,* Carson, Rachel
- *Small is Beautiful,* Schumacher, E.F.
- *Spider Watching,* French, Vivian
- *Squish!: A Wetland Walk,* Luenn, Nancy
- *There's an Owl in the Shower,* George, Jean Craighead
- *Thunderbird,* Sachs, Marilyn
- *Urban Roosts: Where Birds Nest in the City,* Bash, Barbara
- *Vanishing Wetlands,* McCormick, Anita
- *Walden,* Thoreau, Henry David
- *Watership Down,* Adams, Richard
- *What's Smaller Than a Pygmy Shrew?,* Wells, Robert E.

- *When Birds Could Talk and Bats Could Sing: The Adventures of Bruh Sparrow, Sis Wren and their friends,* Hamilton, Virginia
- *When the Monkeys Came Back,* Franklin, Kristine
- *When the Wind Stops,* Zolotow, Charlotte
- *Where Are You Going, Emma?,* Titherington, Jeanne
- *Where Butterflies Grow,* Ryder, Joanne
- *Where Once There Was a Wood,* Fleming, Denise
- *While a Tree Was Growing,* Bosveld, Jane
- *Whisper From the Woods,* Wirth, Victoria
- *Who Came Down That Road?,* Lyon, George Ella
- *Who Keeps the Water Clean?,* Duvall, Jill
- *Window,* Baker, Jeannie
- *Winter Danger,* Steele, William
- *Wonderful Worms,* Glaser, Linda
- *The Young Naturalist,* Mitchell, A.

Writing and Outdoor Classrooms

Outdoor classrooms offer the perfect setting to stimulate all types of writing. Many classes have spent hours on their site observing the world around them and then writing about it. Use writers' notebooks and student journals developed to encourage writing about your site. These entries can be used as the information-gathering step of the writing process or as a self-contained lesson, resulting in a finished piece.

The literacy components in writing (paired with reading in the literacy overview of this section) can be applied as strategies to approach writing at your site.

Write Aloud

As the final part of an outdoor lesson, the teacher models writing, using the vocabulary and concepts taught. Teachers share their thinking as they craft a piece of writing on chart paper, reflecting work done by the group. This is an opportunity to summarize the lesson, using the finished Write Aloud as a Read-Aloud piece. Students may be asked to identify key words and to explain how the piece connects with the work they did, making it authentic.

Shared Writing

An effective use of Shared Writing is creating charts describing, summarizing, or reflecting student work. Students can combine individual entries from their journals to create a shared piece that incorporates key words and concepts in a selected genre. A related form of Shared Writing is brainstorming lists of topics (relating to the outdoor experience) in a variety of genres to be used in the classroom as a springboard for further writing.

Independent Writing

Experiential learning is an authentic and effective approach for connecting oral language to the written word. Students may be asked to respond to their field-study work through a journal. It is important for young students to have the opportunity to explain their writing, as it may be scribbles or pictures.

Word Work

As you work to implement lessons on your site, keep charts with important words and concepts to be used as a Word Wall for independent writing. As you conduct writing workshops in your class, students may choose to use their outdoor experience and resulting Word Wall for topics.

Service Learning—A Natural Connection

Introduction

The roots of service learning can be found in the theory espoused by John Dewey that students learn best while "doing." An article in the Phi Delta Kappa magazine Fastback, "Service Learning for All Students" (Carl I. Fertman, 1994), points out that Dewey believed that youth want "to explore and gain control over their environment." Service learning is an effective technique for encouraging students to investigate their world, to identify problems, and to use their collective knowledge to solve problems.

Recent research supports Dewey's theory: Students learn best when they apply their knowledge to problems that exist in real-life context. According to Fertman, when students participate in service-learning projects, they "grow in their understanding of how their skills and knowledge may be directly applied to problem solving."

What Is Service Learning?

Service learning is not just community service.

Yes, it is service, but it also has an academic basis. Community service provides students with opportunities to serve in various settings throughout the community. Learning is incidental to the service. In contrast, service learning emphasizes learning by providing students with opportunities to apply academic skills to service activities. Service learning engages students in real-life experiences that promote academic learning and that build citizenship skills. Learning is fundamental to the service. Service learning as a form of community-based experience that blends both service and academic learning goals in such a way that both occur and are enriched by each other.

The Three Steps in a Service-Learning Project

All service-learning projects must involve students in significant, well-planned service experiences that meet a genuine community need. The projects also must contain the following three components:

Action

Action refers to the study, research, and planning related to understanding the problem to be addressed through the service.

Preparation

Preparation refers to the actual service. The service encourages dignity and growth for both the giver and receiver of service, and the service should "make a positive difference" to a person or community when completed.

Reflection

Reflection refers to thinking about and identifying learning that occurs as a result of the service (e.g., journal and/or portfolio writing, oral presentations, participating in reflection discussions).

Reflection/Assessment

The essential question to be answered by the reflection is, "How can we measure whether the activity met the stated outcomes?" The answer to this question represents the third and final step in the planning process.

Reflection helps learning by providing an opportunity for students to look inward, to try to picture themselves carrying out the service activity, and then, by using the mirror image, to analyze the service experience.

Most authorities on service learning emphasize the importance of scheduling structured reflection times as opportunities to:

- describe what has happened.
- draw inferences from these descriptions.
- revise the plan of action wherever necessary.

Some questions that might facilitate a reflection session include the following:

- What was your first impression of this project?
- What fears did you have before undertaking the project? Did your attitude change as a result of it? How?
- What was the best thing that happened during the service activity?
- What could you do better?
- What do you think the people you served thought of your efforts?
- Did anyone say anything to you that surprised you? Startled you? Concerned you?
- How would you describe the volunteer activity to a friend? To your parents?
- If you were writing a newspaper account of the project, what would you write?
- Is there more you can do to address this issue?
- How does this experience relate to _____ (other experiences)?
- Is there some skill you lack now that should be addressed through classroom instruction? Through other training?

Reflection occurs in many ways, and a variety of creative approaches can be used to identify what students have learned: journal writings, skits, videotapes, original raps, and/or other performance activities. All program participants and recipients should have an opportunity to evaluate the program in some way, and these assessments should be shared during reflection times.

Summary

Careful planning is the key to success in organizing a service-learning project. Following the three-step planning process may assist in ensuring success.

Best Practices in Service Learning

Probably the best practice in service learning is the first recommendation from the following list: Start small! Successful service-learning practitioners recommend the following:

- Start small! Don't set up your project for failure from the start by being too ambitious.
- Ask a cosponsor to help share the load or to form a Project Team.
- Try to avoid weekend or after-school projects.
- Establish student ownership of the project by involving students in the design and preparation process.
- Attend a professional-development training regarding service learning.
- Have a plan outlined, and check off each step as it is completed. Use the school calendar for planning.
- Visit and talk with the project recipients first to see if they want to be a served by the project.
- Decide early where the project will take place, but have a back-up plan.
- Advertise, market, and recognize the project.
- Secure all necessary permissions prior to the start of the project (video releases, Field Trip forms, letters of participation to parents, etc.).
- Take advantage of grant opportunities.
- Write a budget.
- Create a file or series of files to keep project information organized.
- Set up additional reward and recognition guidelines.
- Don't be afraid to ask questions or to ask for help.
- Find an existing project that can be adapted to meet the needs of your situation.
- Have students work together as a team to accomplish service-learning goals.
- Seek parent involvement.
- Remember that actual service should only represent one-third of the project time.
- Evaluate the project upon its completion.

Hands-on Outdoor ABCs
Grade Level(s): Preschool

Gather outdoor items on a walk, discuss, and make your own book!

Objectives:

Children learn about ABCs, different things about the outdoors, colors, textures, shapes.

Materials:

- construction paper
- glue
- shoe box
- string (for binding book)

Plan:

1. In the fall, go outside with the children and ask them (with your help) to gather different things that start with different letters.
2. Place these items in a shoe box then return inside.
3. Talk about what you found: colors, textures, letters, etc.
4. Then, glue them onto construction paper and make a book for looking at later.

Hints: If things are brittle, do not use them. If leaves are in color, the best way to preserve them is by ironing them with wax paper.

Comments:

Children love hands-on activities they feel more involved, more like they did it, being outside helps them develop their imagination.

Editor's Note: The Ziplock Bag Book would be very appropriate for this activity so you don't have to worry about things staying glued on.

BUG KICKING

ALL LEVELS

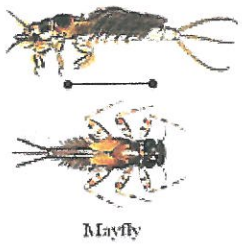
When visiting the Flint Creek portion of the Nature Center students can find macroinvertebrates byparticipating in a Bug Kicking activity.

Using a swimming pool skimmer, have one person hold the skimmer and a partner stand 2-3 feet away. The partner will kick the bottom of the creek and allow the rustled water, etc. to flow down stream into the skimmer net. Empty the contents of the net in a plastic container.

Compare what is found to the MacroInvertebrate Mania Chart. These "Critters" can tell students a lot about the quality of water in the creek depending on what "critters" live there.

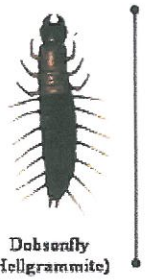
Macroinvertebrate Mania!

Design your own experiment ...



Mayfly

Stonefly



Dobsonfly (Hellgrammite)

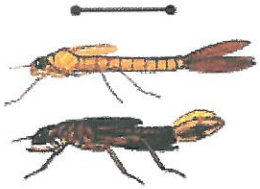
Caddisfly

Water Penny

Riffle Beetle

Gilled Snail
(Shell opens to the right)

Group 1 Taxa
These organisms are generally pollution intolerant or sensitive and their presence generally signifies good water quality.



Damselfly

Dragonfly

Beetle Larva

Fishfly Larva

Group 2 Taxa
These organisms are somewhat pollution tolerant and their presence generally signifies fair water quality.

... Here's How! Make it Happen!

1. Choose a tributary in the Illinois River watershed with a site where you have permission to access and sample.
2. Make a kick net using a broom handle and a window screen. (Visit www.irwp.org for kick net design instructions)
3. Let two people hold the net on the bottom of the stream.
4. Another person stands a few feet upstream (where the water is coming from) and does a "bug kick" by shuffling their feet and stirring up the rocks. This helps organisms wash into your net.
6. Empty the net's contents into a light-colored tub with some water to identify and count your collection. Keep track of how many you find in each category then set them free!
7. Contact the Arkansas Game and Fish Commission's Stream Team program (www.agfc.com) or the Oklahoma Conservation Commission's Blue Thumb program (www.okcc.state.ok.us) to become a registered Stream Team and report your findings!

More Macroinvertebrate Mania!

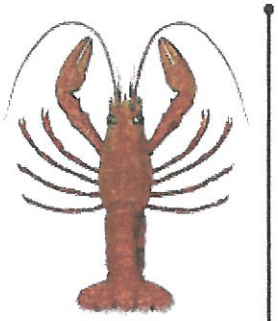
The insects and crustaceans in a stream can explain a lot about the ecosystem quality of the watershed. Sensitive organisms cannot tolerate very much pollution or disturbance. Pollution tolerant organisms can withstand much more. Can you find out what is living in a stream near you? These organisms are near the base of most food webs. Why is this important?

Group 2 Taxa
These organisms are somewhat pollution tolerant and their presence generally signifies fair water quality.

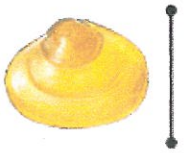
Alderfly

Crane Fly

Sowbug



Crayfish



Clam

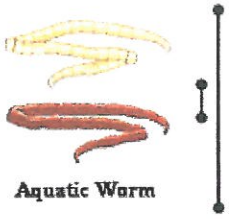
Scud

Group 3 Taxa
These organisms are generally pollution tolerant and can be found in any quality water.

Leech

Blackfly Larva

Midge Fly Larva



Aquatic Worm

Pouch Snail
(Shell opens to the left)

Other Snails

The bars indicate relative size of these invertebrates.

Illustrations by: Arwin V. Provonsha, Aquatic Entomology, 1981, Amy Bartlett Wright, A Guide to Common Freshwater Invertebrates of North America, 2002.

Educational Panels Acknowledgements:
Developed for the Illinois River Watershed Partnership
Initial content: Sarah Lewis
Final design: Mary Hightower
Editing: Michele Steele and Katie Teague
Printing funded by an EPA 319(h) grant through the Arkansas Natural Resource Commission.

Living or NonLiving?

Discuss the importance of all aspects of an ecosystems. Some things are considered BIOTIC (living) and some are considered ABIOTIC (nonliving). Discuss what is found at the Nature Center that falls in to the BIOTIC and ABIOTIC categories.

Discussion topics:

Why are abiotic factors important?

What do they do the enhance the ecosystem?

Could an ecosystem exist without biotic factors?

Could an ecosystem exist without abiotic factors?

Leaf Structure and Tree Identification

All Levels

The following illustrations have basic leaf structures utilized for identification purposes. Look at the figures and compare them to trees at the Nature Center.

Use the tree identification guide to apply your leaf structure knowledge to identify trees.

FIGURE - 1: SIMPLE LEAF

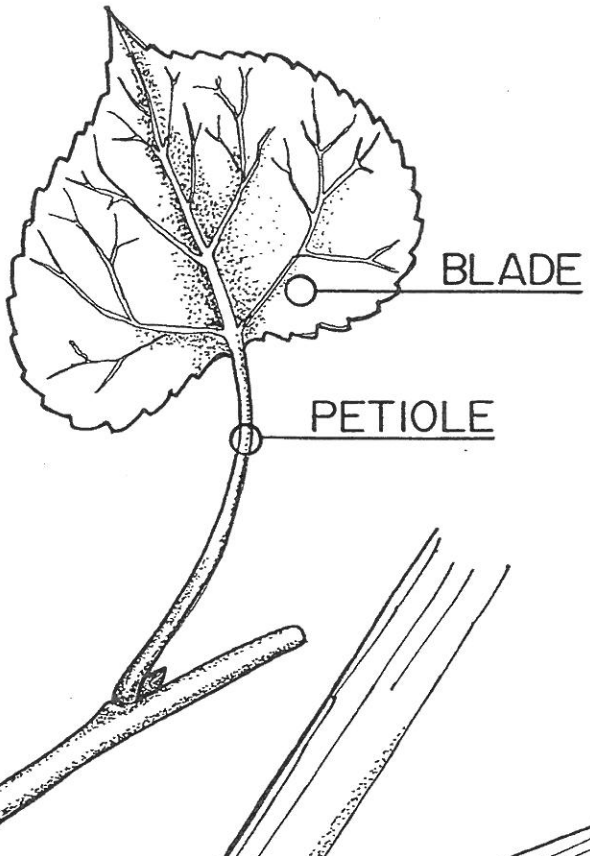
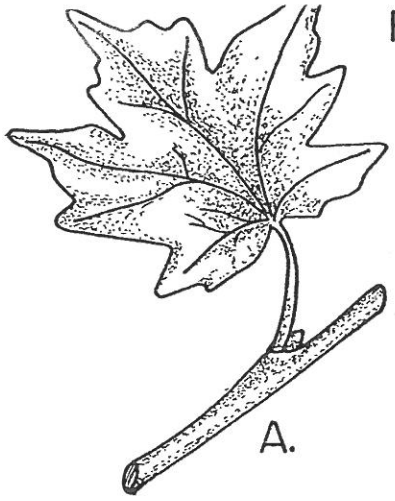


FIGURE - 2:
PARALLEL VENATION
(CHARACTEISTIC OF MONOCOTYLEDONS)



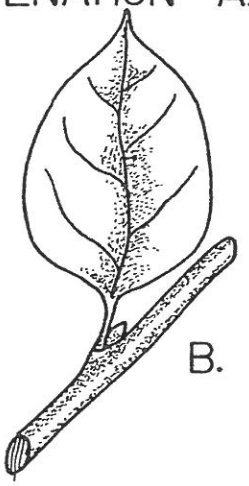
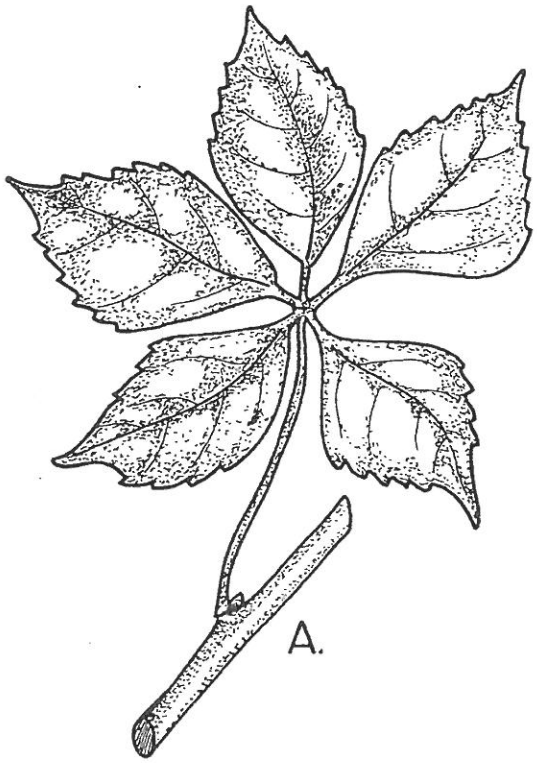


FIGURE-3: TYPES OF NETTED VENATION---A. PALMATE; B. PINNATE



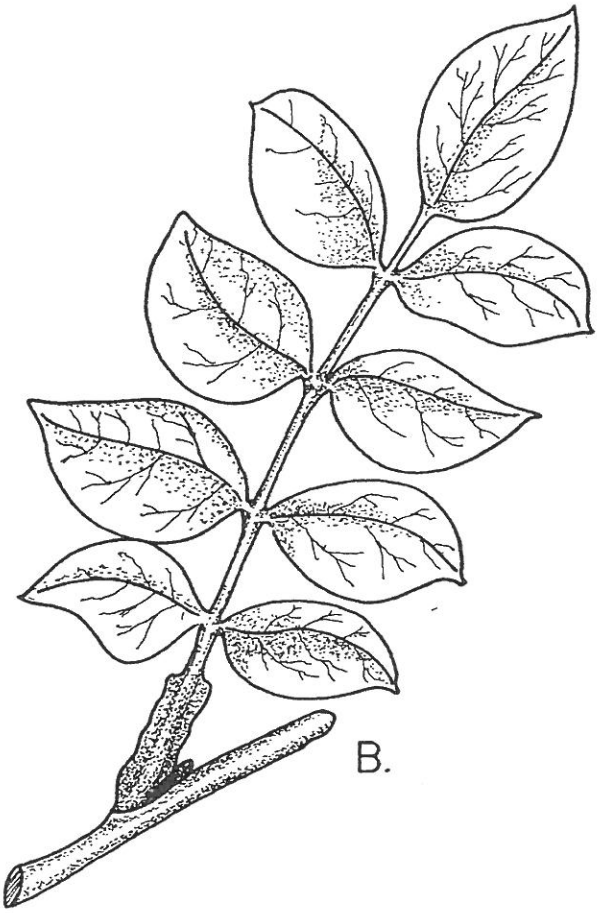
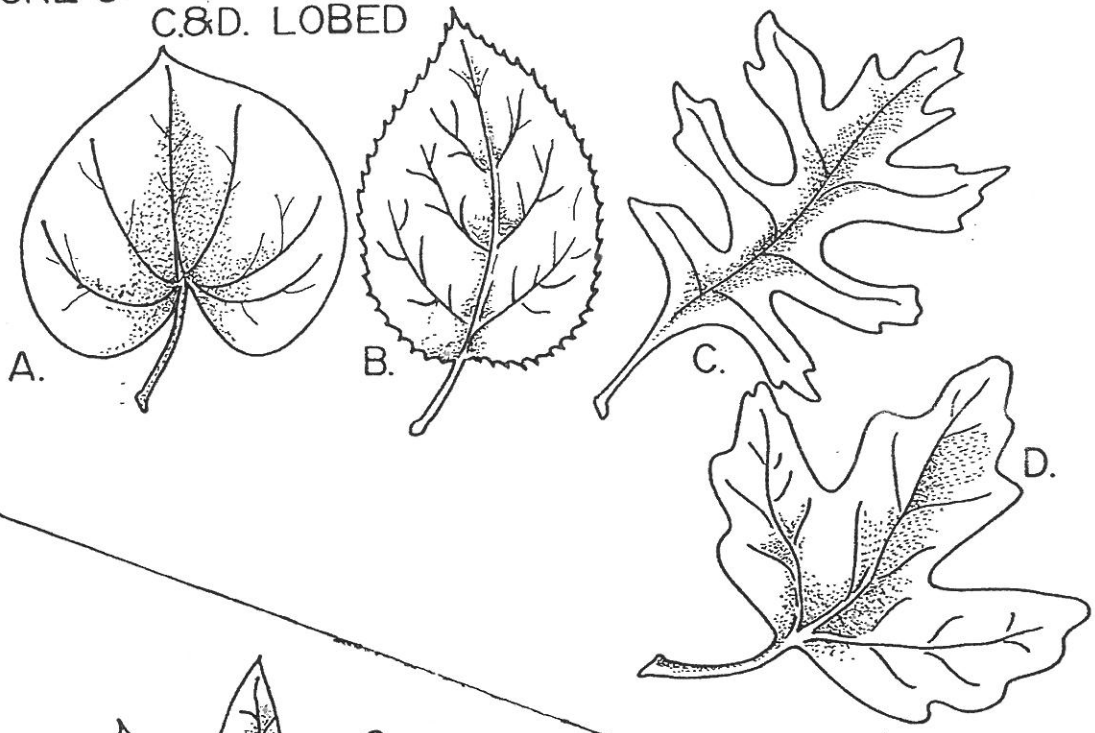


FIGURE-4: TYPES OF COMPOUND LEAVES---
A. PALMATELY COMPOUND
B. PINNATELY COMPOUND

FIGURE 5: LEAF MARGINS---A. ENTIRE; B. TOOTHED
C.&D. LOBED



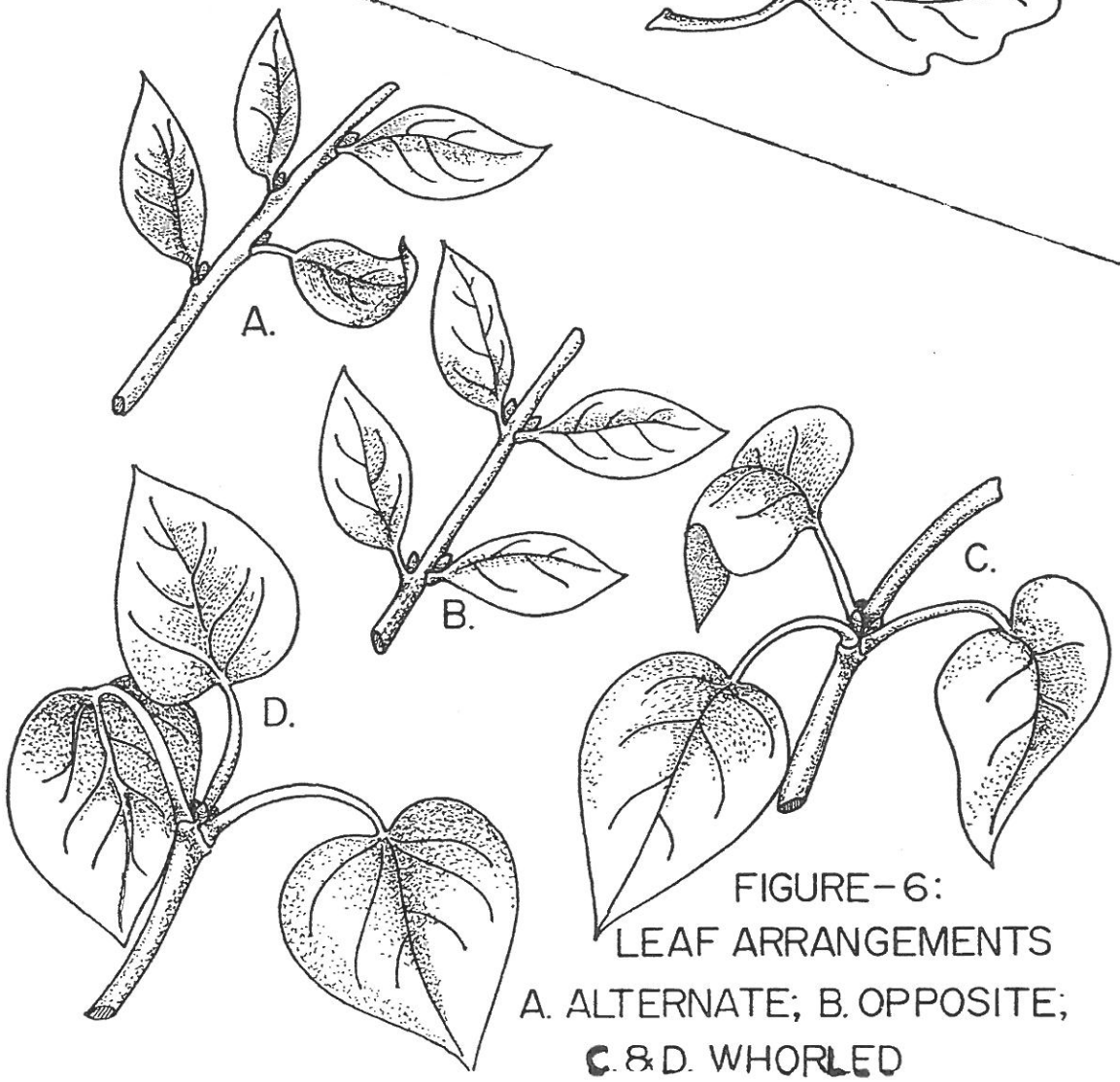


FIGURE-6:
LEAF ARRANGEMENTS
A. ALTERNATE; B. OPPOSITE;
C.&D. WHORLED

GUIDE TO IDENTIFICATION OF TREES

1. LEAVES SIMPLE.....2
   2. LEAVES OPPOSITE.....3
      3. LEAVES WITH SMOOTH MARGIN.....DOGWOOD
      3. LEAVES WITH LOBES.....MAPLE
   2. LEAVES WHORLED.....CATALPA
   2. LEAVES ALTERNATE.....4
      4. LEAVES WITH PALMATE VEINS.....5
         5. LEAVES WITH SMOOTH MARGIN.....REDBUD
         5. LEAVES WITH LOBED MARGIN.....6
            6. LEAVES WITH TEETH ON THE LOBES.....7
               7. LEAVES WHITE ON LOWER SURFACE.....WHITE POPLAR
               7. LEAVES GREEN ON LOWER SURFACE.....SWEET GUM
            6 LEAVES WITHOUT TEETH ON THE LOBES.....SYCAMORE
         5. LEAVES WITH TOOTHED MARGIN.....8
            8. LEAVES WITH IRREGULAR LOBES.....MULBERRY
            8. LEAVES WITHOUT LOBES.....9
               9. LEAVES NARROW; LONG TAPERED TIP.....HACKBERRY
               9. LEAVES BROAD, HEART SHAPED WITH ABRUPTLY POINTED TIP.....BASSWOOD
      4. LEAVES WITH PINNATE VEINS.....10.
         10. TWIGS WITH THORNS.....11
            11. LEAVES WITH SMOOTH MARGIN.....OSAGE ORANGE
            11. LEAVES WITH TOOTHED MARGIN.....HAWTHORN
         10. TWIGS LACKING THORNS.....12
            12. LEAVES WITH TEETH.....13
               13. LEAVES NARROW, MUCH LONGER THAN WIDE.....WILLOW
               13. LEAVES BROAD.....14.
                  14. LEAF SHAPED LIKE A TRIANGLE...COTTONWOOD
                  14. SIDES OF LEAF UNEVEN AT BASE..ELM
                  14. SIDES OF LEAF EVEN AT BASE....RIVER BIRCH
            12. LEAVES WITH LOBES.....OAKS

LEAVES COMPOUND.....15

15. LEAVES OPPOSITE.....16
   16. LEAFLETS WITH SMOOTH TO LOW TOOTHED MARGIN..ASH
   16. LEAFLETS WITH COURSE TOOTHED MARGIN.....BOX ELDER
15. LEAVES ALTERNATE.....17
   17. PITH WITH CROSS WALLS.....BLACK WALNUT
   17. PITH WITHOUT CROSS WALLS.....PECAN(HICKORY)

Who eats what?

All Levels

Identify as many producers and consumers as you can at the Nature Center. Develop a food chain utilizing organism that you were able to locate. The graphic organizer found in the packet (fiendishlyclever.com) will help you organize your organisms.

Vocabulary for high levels (middle/high school)

What is a producer?

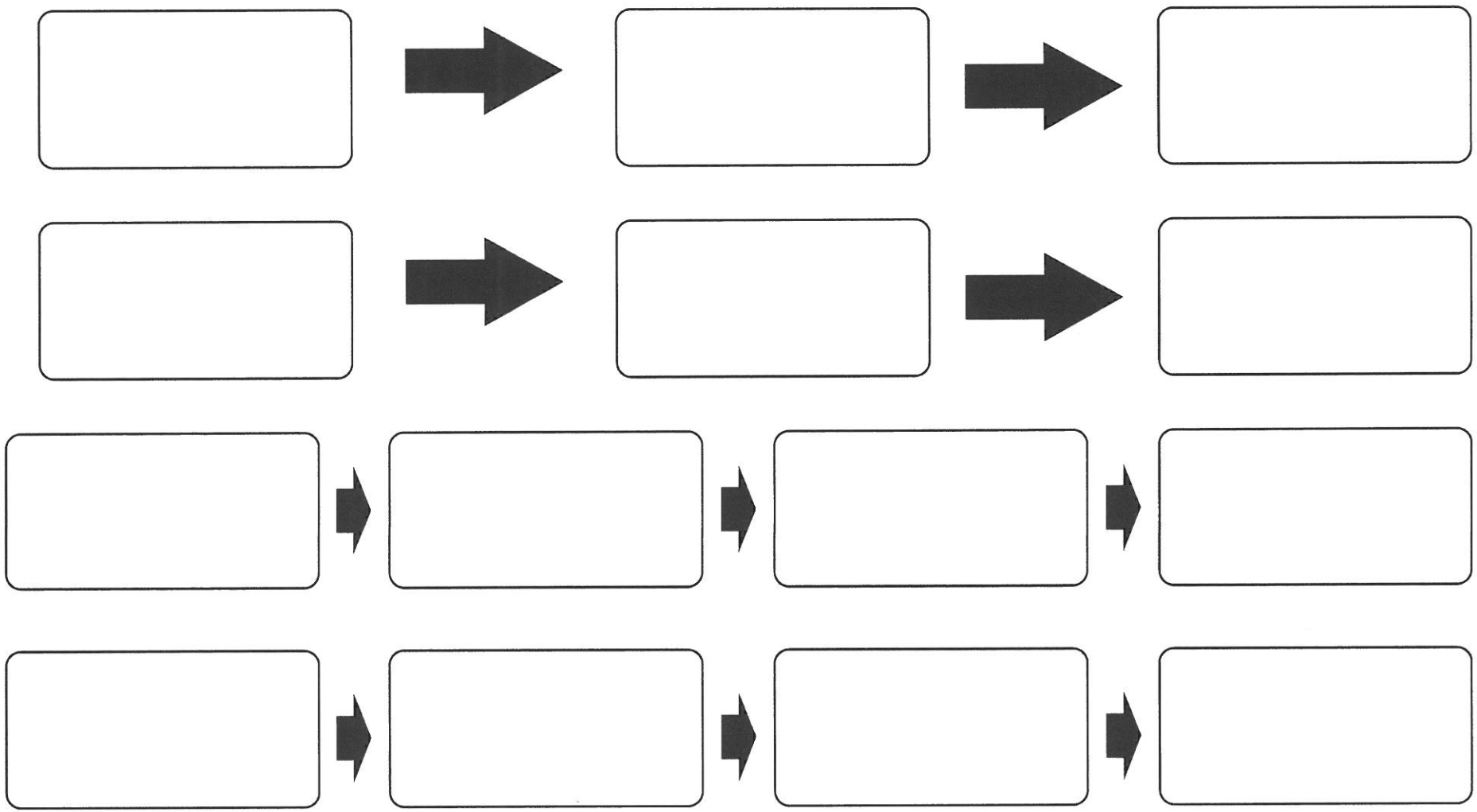
What is a consumer?

What is a autotroph?

What is a heterotroph?

Who eats what?

All consumers need to eat (well usually) to survive, but who eats what?



© fiendishlyclever.com

ORGANIZING ANIMALS

PUTTING ANIMALS INTO GROUPS

ANIMALS ARE CLASSIFIED BY DIFFERENT CHARACTERISTICS THAT THEY HAVE.

USING THE HANDOUTS PROVIDED PUT AS MANY ORGANISMS AS YOU CAN THAT YOU SEE AT THE FLINT CREEK NATURE CENTER INTO THE SELECTED GROUPS.

This can be done at different age levels. For younger students it can be a teacher guided study with more independence given as age and skill level increases.

FOUND AT WWW.FIENDISHCLEVER.COM

Putting animals into groups

Birds	Mammals	Reptiles	Amphibians
have feathers lay eggs	fur feed young milk	lay eggs have scales	lay eggs in water have moist skin

© fiendishlyclever.com

Putting animals into groups

Insects	Crustaceans	Fish	Arachnids
have 6 legs most have wings	hard shell live in water/damp	live in water have scales	have 8 legs 2 body parts

© fiendishlyclever.com

Species Interdependence

This activity allows students to graph and plot the interdependence of two species to see how one has a direct effect on another.

After visiting the site, students can look at species found in the Nature Center that are Interdependent. Have them predict how a graph with those two species might look and what factors would cause a change in population size.

This was developed for 6th through 10th grades.

Interdependence

Time (months)	Number of foxes	Number of rabbits
1	10	12
2	9	14
3	8	16
4	8	18
5	9	19
6	10	19
7	11	18
8	11	17
9	12	16
10	11	14
11	10	12
12	9	10
13	8	11
14	8	14
15	7	15
16	6	18
17	7	20
18	8	20
19	8	18
20	9	16
21	10	14
22	10	12

1. Plot **one** graph showing how the number of rabbits and the number of foxes change. Draw your curve in different color pencil.

2. Why does the number of rabbits start decreasing around month 7?

3. What effect does this have on the number of foxes? Why?

4. What would happen to the number of rabbits after day 22?

5. In this situation, what words can the rabbit and the fox be referred to as?

6. How are they both suited to surviving in this role?

7. Foxes also eat mice, as do hawks. What would the effect on the number of hawks be if the rabbit population decreased due to disease?

Explain your reasoning for this answer.

WHAT IS A HABITAT?

All levels

Introduce HABITATS to your students. Let them know that all organisms have four basic needs. In the younger levels this can be compared to a pet or themselves. What do they need to live?

Water, Food, Shelter and Space.

One activity to show the importance of space would be to place a student within the confines of a hula hoop. Keep adding students until there is no more room. Talk to the students about the importance of having enough space.

If they have enough space and they are where they can find food water and shelter, they can survive.

In the classroom each student could draw a picture of their favorite animal in their habitat including food, water, shelter and space.

Example: (They might draw a bear, by a stream with a fish near a cave)

When visiting the Nature Center, have a Habitat Hunt.

As they explore the nature center, have them look for and point out habitats. They may find a bird's nest, a beehive, an ant hill, a spider web, etc.

NATIVE AND INVASIVE SPECIES

Background Knowledge: Students will need to understand what a native species is. Are native species the same in all biomes? How are invasive species introduced?

Discussion questions:

What is a Native Species?

What is an invasive species?

Can an invasive species be problematic?

The Flint Creek Center has a list of native species found on the site.

Are there any other species there?

How would an invasive species get there?

The Invasive Species Case File will need to be done in class as a research project. There is a list of invasive species included for assistance.

Found at www. Arkive.org

CASE FILE

ATTACH PHOTO HERE

COMMON NAME:

SCIENTIFIC NAME:

NATIVE TO:

WHERE HAS THIS SPECIES BEEN INTRODUCED?

HOW WAS IT INTRODUCED?

WHICH NATIVE SPECIES/HABITATS DOES IT AFFECT?

WHAT IS THE IMPACT ON NATIVE SPECIES/HABITATS?

WHAT CHARACTERISTICS MAKE THIS SPECIES A GOOD INVADER?

WHAT MANAGEMENT OR CONTROL MEASURES ARE IN PLACE?

SUPPORTING MATERIAL:

To include additional photographic and video evidence, newspaper clippings/links to news articles, range maps and any other important information (continue on another sheet if required).

ASSESSMENT:

Based on your research and observations, discuss the extent to which this species is causing a problem for the ecosystem that it has invaded. Give the species an 'invasive rating' of 1 to 5, based on how seriously this species is impacting native species and habitats and how hard it is to control (1 = not very invasive and/or easy to remove, 5 = highly invasive and/or difficult to eradicate). Based on your research, could you suggest any management or control measures that may potentially be appropriate for this species but are not currently in place or enforced? (Continue on another sheet if required).

REFERENCES:

Invasive Species – Suggested Species List

1. Brown rat: http://www.arkive.org/brown-rat/rattus-norvegicus/
2. Black rat: http://www.arkive.org/black-rat/rattus-rattus/
3. Grey squirrel: http://www.arkive.org/grey-squirrel/sciurus-carolinensis/
4. House mouse: http://www.arkive.org/house-mouse/mus-musculus/
5. Lionfish: http://www.arkive.org/common-lionfish/pterois-volitans/
6. Harlequin ladybird: http://www.arkive.org/harlequin-ladybird/harmonia-axyridis/
7. Himalayan balsam: http://www.arkive.org/himalayan-balsam/impatiens-glandulifera/
8. American mink: http://www.arkive.org/american-mink/mustela-vison/
9. Rabbit: http://www.arkive.org/rabbit/oryctolagus-cuniculus/
10. European starling: http://www.arkive.org/european-starling/sturnus-vulgaris/
11. Giant African land snail: http://www.arkive.org/giant-african-snail/achatina-fulica/
12. Common mynah: http://www.arkive.org/common-myna/acridotheres-tristis/
13. Red deer: http://www.arkive.org/red-deer/cervus-elaphus/
14. Crab-eating macaque: http://www.arkive.org/crab-eating-macaque/macaca-fascicularis/
15. Stoat: http://www.arkive.org/stoat/mustela-erminea/
16. Wild boar: http://www.arkive.org/wild-boar/sus-scrofa/
17. Red fox: http://www.arkive.org/red-fox/vulpes-vulpes/
18. American bullfrog: http://www.arkive.org/american-bullfrog/lithobates-catesbeiana/
19. Sika deer: http://www.arkive.org/sika-deer/cervus-nippon/
20. Canada goose: http://www.arkive.org/canada-goose/branta-canadensis/
21. Racoon: http://www.arkive.org/northern-raccoon/procyon-lotor/
22. Cuban treefrog: http://www.arkive.org/cuban-treefrog/osteopilus-septentrionalis/

What's in your Biome?

This project allows students to evaluate what is seen at the Flint Creek Nature Center and apply it to different Outdoor Classrooms that would be developed in other Biomes.

This was developed for 9-12 grades.

This project would be done after the visit in the classroom utilizing research and prior knowledge.

Grade Level and Course: 9th grade ~ Pre-AP Biology

Title: What's in your Biome?

Topic: Designing and understanding the components and interactions in different biomes.

Summary of lesson: This lesson will encourage students to look at locations of biomes and the differences that are in each one. They will have to find native species and develop an nature site or outdoor classroom that will be functional in the biome given.

Concepts: Different aspects of biomes, importance of conservation and education of biome systems and interactions.

Objectives: The objective will be for students to be able to understand and demonstrate differences in a variety biome; they will be able to learn different biomes contain diverse species and they interact differently; they will understand human interaction on a biome; and how small sections (Classrooms) can be utilized and enhanced.

Background for Teachers: Many students do not have access to or do not take advantage of educational opportunities found in outdoor natural areas. If there are parks or nature centers where they live, they are often not utilized. This also enhances student awareness for other environments other than those they live in. This shows how students/humans can interact with nature and discuss different types of interactions.

Background needed for students: Students will need background information on what a biome is; the different aspects of a biome; relationships within a biome; and how and why different species are native to different biomes. Students will have to understand that there are different biomes that exist in different parts of the United States.

Procedures: Students will be placed into groups of 3-5 students. Each group will draw a city and establish what biome it is located. (I would do this by having playing cards with City and State names located on it and they would randomly draw.) They will then need to be able to locate their "site" on the United States Biome Map. (handout) Students will then need to develop a complete and accurate description of Biome including temperatures, rainfall, etc. Students will then begin to establish an outdoor classroom or nature center using the following steps.

1. Start by taking an inventory! (gather information)
    - What Native Wildlife may be present?
    - What native plant life (trees, grasses, flowers, shrubs) may be present?
    - What aquatic features may be present? (Lakes, rivers, streams, ponds, creeks) Must have at least one.
    - What native aquatic plant and animal life may be present?
    - What features or elements would you enhance?
    - What feature or elements would you look to add?

2. Develop a power point presentation with the following information:
    a. a "guide" for your outdoor classroom

i. Your guide will need to include all geographical information and location of your "classroom" as well as all aspects of the biome as well as current native species. All the information gathered in your inventory will be utilized for this section of the presentation.

b. Develop any ideas of study stations, nature or identification trails, gardens, greenhouses, or any other additions and how they can benefit the center. You need to be specific on what they will include and how they benefit or enhance the classroom.
c. Establish a year around maintenance plan for the center.
d. Address conservation practices that need to take place at the site. Address the effect on human activity on the plants and wildlife and measures taken to minimize.

3. Develop a drawing of your center including a map as well as all aspects that were native to the center as well as any additions made.

Management suggestions: This activity will include a minimum of one class period (55 minutes) with research access to be able to attain information on native species. Students will need one to two class periods for discussion and planning within their group. Students will also need to have access to computers with power point capabilities. This will be needed for two 55 minute class periods. Presentations will take one to two class periods as well.

Safety cautions: I do not think there are any safety concerns for this activity.

Decision making or critical thinking: After researching common plants and animals that are native to the biome they have, they will have to develop a plan of maintenance that will allow these species to thrive and survive as well as counteract any human interactions or enhance the current populations.

Extensions: Students can continue this activity by detailing how species are able to thrive and reproduce with existing elements of the biome. They would have to establish a food web and discuss if this would or could be altered by human activity. Another extension would be to include other biomes or other geographic locations.

Assessment methods: Students will be assessed via the attached rubric.

Source: The source of my lesson plan is the Arkansas Forestry Commission's handout of "Designing an Outdoor Classroom" written by Victor Drier when he was a Research Assistant at the University of Arkansas' College of Education. This activity shows how to build an outdoor classroom on a school site. I enhanced this to include how this would be adapted to fit different biome and ecosystem situations. I wanted students to know that this activity would be different with different native species and different biome attributes. Another source in generating this lesson plan was the book "Last Child in the Woods: Saving Our Children from Nature Deficit Disorder" by Richard Louv which discusses today's children and they "Nature Deficit Disorder" they have due partly to enhanced technology. I was hoping to open the eyes of students into seeing the importance of nature and how to develop areas that are both fun and educational and one that gives all children access.

Materials: I would place students in groups of 3-5. Students will need to have access to computers with internet access as well as access to power-point programs.

Correlation to the Arkansas Frameworks and Next Generation Standards:

Arkansas

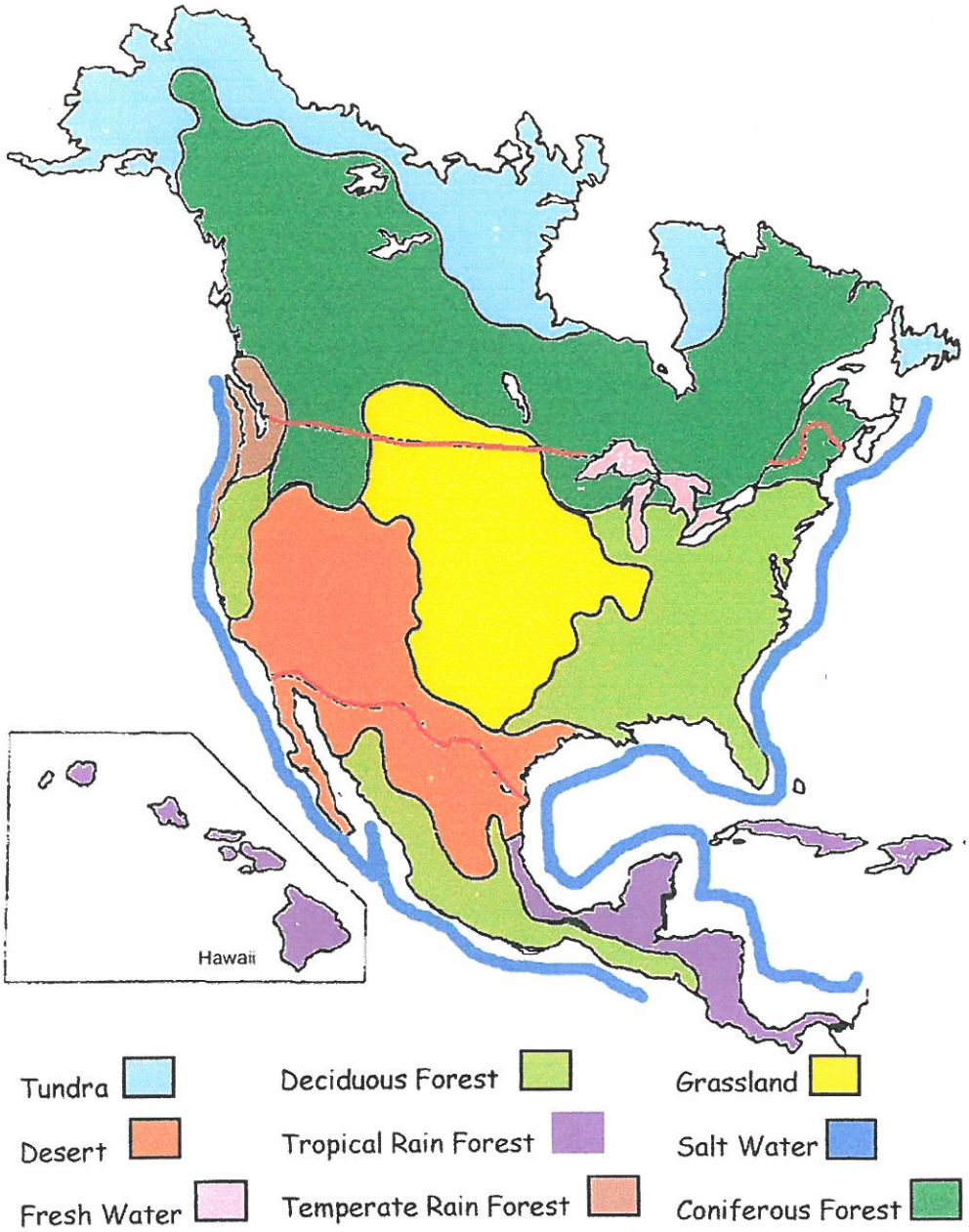
CDL.7.B.3
EBR.8.B.1
EBR.8.B.8
EBR.9.B.1
EBR.9.B.3
NS.15.B.1

Next Generation

HS-LS2-6
HS-LS2-7
HS-LS2-8

Student handout: Students will be given a handout of a map of different Biomes in the United States.

Powerpoint Grading (100 points)


Hawaii
Tundra
Deciduous Forest
Grassland
Desert
Tropical Rain Forest
Salt Water
Fresh Water
Temperate Rain Forest
Coniferous Forest

**Please note an accurate description includes name and illustration.

Cover Page

___2 points for name.

___2 points for class period.

Elements of the biomes

___2 points for accurate biome for location given.

___2 points for temperature range of biome.

___2 points for precipitation averages for biome.

Native Wildlife

___ 2 points for each accurate description of wildlife native to the biome up to 10 points.

Native Plants

___ 2 points for each accurate description of a plant native to the biome up to 10 points.

___2 points for each accurate description of trees native to the biome up to 10 points.

___2 points for each accurate description of shrubs native to the biome up to 10 points.

Aquatic features

___2 points for addition of aquatic feature with accurate representation up to 4 points.

Aquatic Species

___2 points for accurate description of aquatic species native to biome up to 10 points.

(Can be plants or animals)

Enhancements and Additions

___1 point for any descriptions of enhancements or additions added to site up to 5.

Maintenance Plan

___1 point for each maintenance activity planned. Must be season appropriate and accurate up to 10 points.

Conservation Practices

___2 points for each conservation activity planned. Must be season appropriate and accurate up to 10 points.

Human Activity

___1 point for example of how human activity will affect the site. Up to 3 points.

___1 point for methods to counteract the human affect. Up to 3 points.

Creativity

___ Creativity will be given 0-5 points.

Drawing

The drawing must be a map or key to the site. It must be scale appropriate and demonstrate all natural features as well as additions. The drawing must be illustrated in color and labeled. The drawing is is worth 25 points.

____0 to 10 points for all illustrated biotic features. (Drawn and labeled)

____0 to 10 points for all illustrated abiotic feature. (Drawn and labeled)

____0 to 5 points for color.

Flint Creek Nature Center

This project allows students to understand important aspects of the Nature Center including ecological characteristics of the pond, creek and aquatic life.

It looks at Nitrogen and Phosphorous Cycles, Cladograms, Bacteria, Protists, Fungus, Plants and Animals and there importance in the environment.

Much of this activity can be done as a pre-lab prior to visiting the site.

It includes a scavenger hunt utilizing basic Biological elements and vocabulary. It also allows students to create their own experiment based on observations.

World Water Monitoring has kits available for many tests involved.

Some of this can be done at lower levels but developed for 9-12

Flint Creek Nature Center

Important water quality factors include: dissolved oxygen, temperature, nitrates, phosphates, hardness, and pH. The pond is also home to several microscopic organisms. At the end of the field trip, you will design your own experiment testing one of these factors. Your experiment must be able to be tested using the equipment you use at the pond.

DISSOLVED OXYGEN

Oxygen is dissolved into water in 2 ways:

1) **Aeration**: atmospheric oxygen diffuses into the water at the surface
    a. *Explain what diffusion means.*

2) **Photosynthesis**: the oxygen given off during photosynthesis by plants and algae is dissolved in the water. A total of three-fourths of the earth's oxygen supply is produced by phytoplankton in the oceans.
    a. *Write the equation for photosynthesis using words. Label the reactants and the products.*

Oxygen is removed from the water in 2 ways:

1) **Animal and Plant Respiration**: organisms take in oxygen and produce carbon dioxide to breathe, and plants use oxygen at night when they are not photosynthesizing
    a. *Write the equation for respiration using words. Label the reactants and the products.*

2) **Decomposition of organic matter**: by bacteria and/or fungi increases carbon dioxide production and takes away oxygen from the water
    b. *What are some examples of organic matter that can be found in Pond Fayetteville?*

What other 2 things affect the amount of dissolved oxygen in the water?

TEMPERATURE

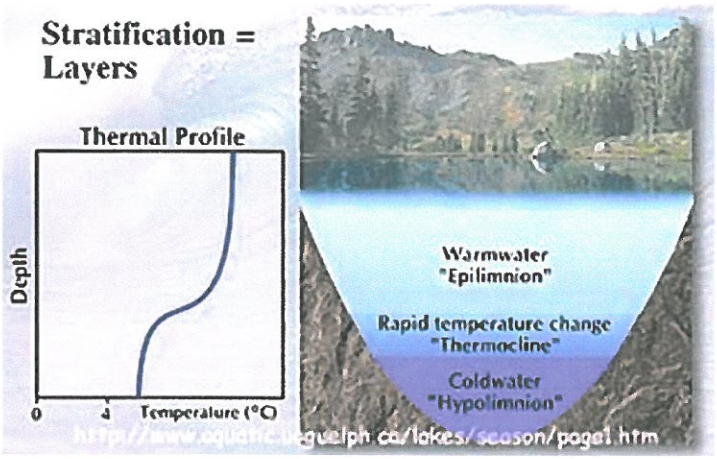
Variables that affect temperature include:

1. 4. 7.
2. 5.
3. 6.

Fish and most aquatic organisms are cold-blooded. Therefore, their metabolism increases as the water warms and decreases as it cools. Each species of aquatic organism has its own optimum (best) water temperature. Cold-blooded animals can't survive temperatures below 0 degrees Celsius, and only rough fish like carp can tolerate temperatures much warmer than about 36 degrees Celsius. Temperature affects fish spawning, growing, and even determines if adults and/or embryos live or die.

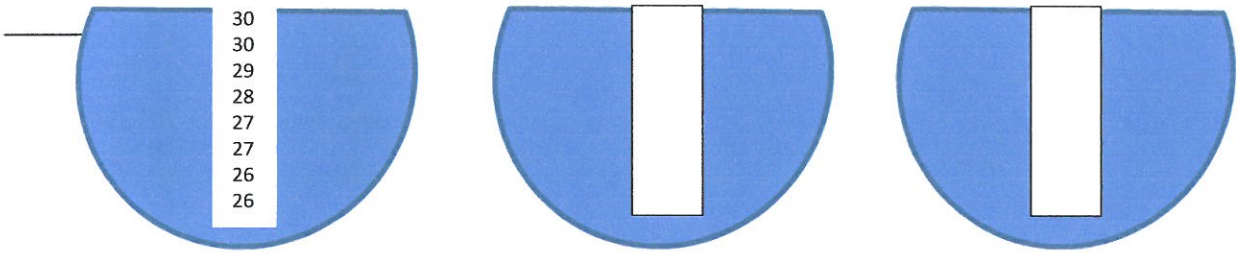
Temperature also affects the density of water. Warm water is less dense than cold water therefore it rises in the water table, while cold water will sink. Water is at its most dense state when it reaches 4 degrees Celsius, as it is cooled further it expands and becomes less dense.

Thermal Stratification: stratification is the separation of something into layers. When the pond is thermally stratified it has separated into layers of temperature. The top layer which is warmer (less dense) is called the Epilimnion, the cold bottom layer is called the Hypolimnion, and the smaller layer in the middle which is transitioning from warm to cold is called the Thermocline.



Pond Turnover: turnover occurs when the top layer of the pond is cooled to temperatures that are equal to or greater than the temperature at the bottom of the pond. When turnover occurs the anoxic water from the bottom rises up through the water column, often leaving behind a foul taste or odor in the water that does not filter out, even if our drinking water. Spring and fall turnovers are common in reasonably sized ponds.

The first picture shows a stratified pond (the numbers resemble the temperature of the layer). If the top layer cools from 30 to 21 degrees Celcius, show what would happen to the layers of the pond in the next two pictures that illustrates a pond turnover. Eventually, when the pond has all the same temperatures in all the layers, the pond is called



NUTRIENTS

Phosphates: Phosphorus is a vital nutrient for converting sunlight into usable energy, and essential to cellular growth and reproduction. Phosphorus plays an essential role in the synthesis of DNA and the development of roots, stems, flowers, and seeds in plants. In animals, phosphates make up ATP (adenine triphosphate) which is a source of chemical energy. A high presence of phosphates in the water causes "Algal Blooms". Phosphates from manure, pesticides, cleaning compounds, industry, and chemical fertilizers enter the water through run off from the surrounding watershed. An increase in algae decreases oxygen in 3 ways:

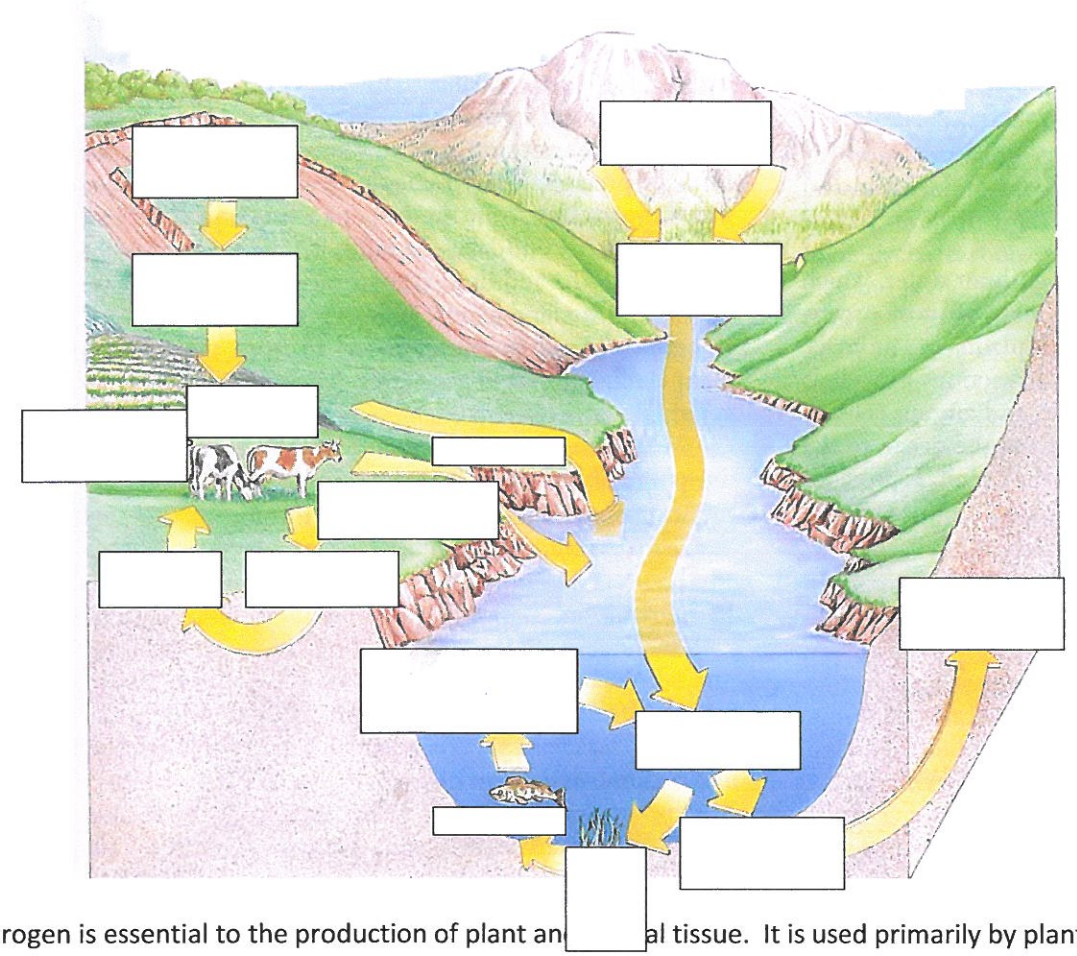
1) Algae respiration at night
2) Algae cloud water and block sunlight from reaching photosynthetic organisms such as aquatic grasses
3) Bacteria use oxygen to fuel the breakdown of dead decaying organic matter

Phosphate-phosphorus levels and effects	
Total phosphate/ phosphorus	**Effects**
0.01-0.03 mg/L	Amount of phosphate-phosphorus in most uncontaminated ponds

0.025 mg/L	Accelerates the eutrophication process in ponds
0.1 mg/L	Recommended maximum for rivers and streams

Directions: Read the description of the cycle below. Use underlined words to fill in the boxes in the illustration. If there is a 2 by the word, it will be used twice.

The Phosphorus Cycle: Phosphorus is always part of an organism, dissolved in water, or part of a rock. Phosphate enters the environment from phosphate rocks(2) (mountains, boulders, etc.) or deposits such as marine sediments. Weathering and erosion(2) releases phosphate ions that are soluble in water. The water with the dissolved phosphates soaks into the soil, or goes into a water source such as an ocean, and then is either absorbed by land plants or algae. Phosphorus that comes from phosphate mining acts as a fertilizer for crops and helps growth. Animals, such as grazers or fish eat the plants/algae, and the phosphates get incorporated into molecules essential for life such as ATP, DNA, or RNA. When animals excrete or decompose (2), phosphates will return to the soils/oceans in the form of soil phosphates / dissolved phosphates.

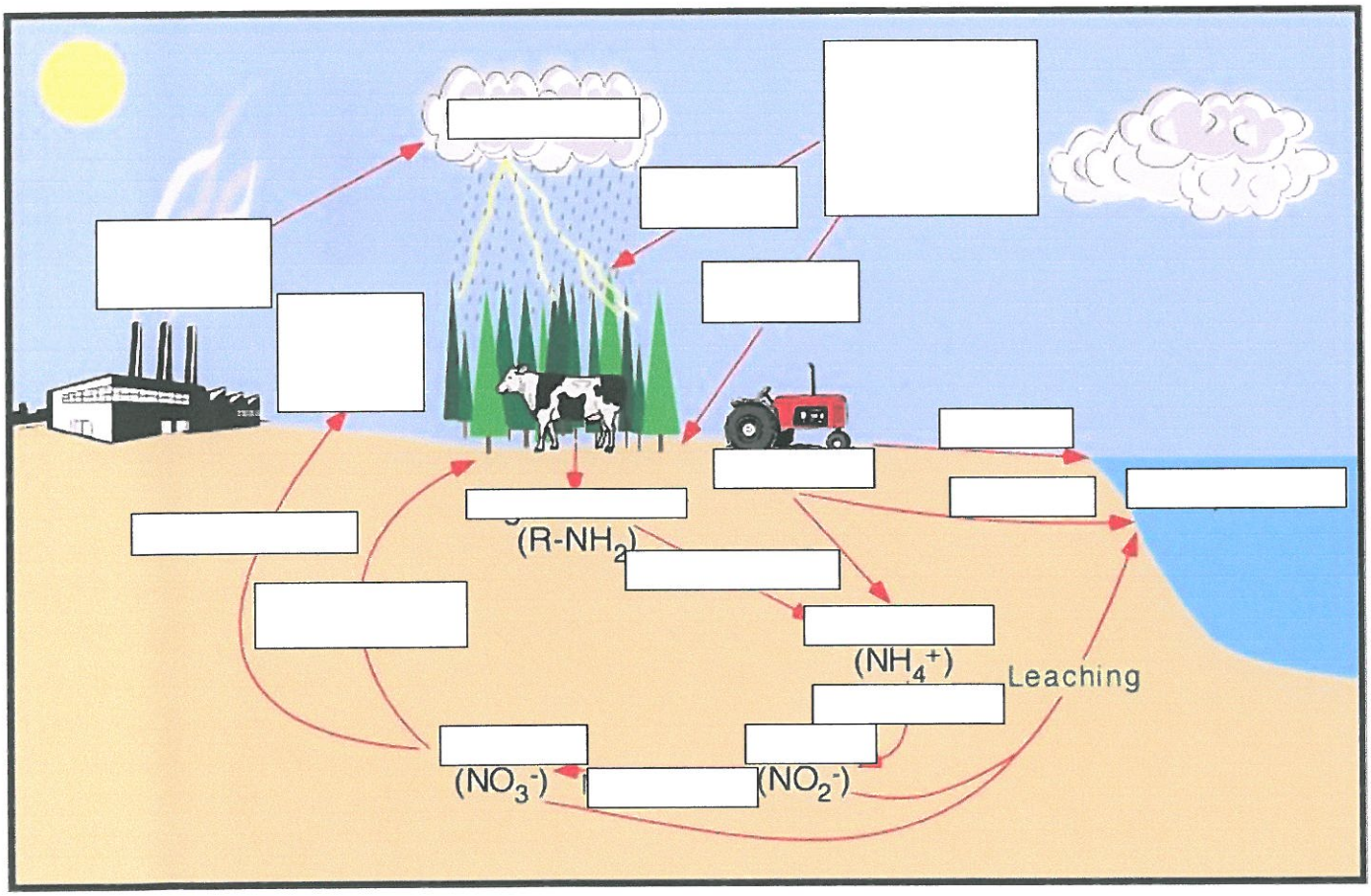


Nitrates: Nitrogen is essential to the production of plant an al tissue. It is used primarily by plants and animals to synthesize protein. Nitrogen provides proper leaf growth and color in plants, and also plays an important role in the synthesis of amino acids, proteins, nucleic acids, and chlorophyll. A high presence of nitrates is an indicator of fertilizers and sewage leaks in the water. The U.S. Public Health Service has established 10 mg/L of nitrate-nitrogen as the

maximum contamination level allowed in public drinking water. Nitrate-nitrogen levels below 90 mg/L and nitrite levels below 0.5 mg/L seem to have no effect on warm-water fish, but salmon and other cold-water fish are more sensitive.

Directions: Read the description of the cycle below. Use underlined words to fill in the boxes in the illustration. If there is a 2 by the word, it will be used twice.

The Nitrogen Cycle: The atmosphere contains about 78% nitrogen gas (N_2)(2) that cannot be used directly by plants and animals. Living organisms need nitrogen for making proteins, so nitrogen has to change forms from nitrogen gas into nitrogen compounds in the soil so plants can use it. 4 different types of bacteria play a crucial role in the nitrogen cycle. Bacteria in the soil, bacteria on the roots of legumes, (soybeans, clovers, alfalfa, peanuts) and lightning "fix" nitrogen in a process called nitrogen fixation(2) so plants can use it. After nitrogen fixation, nitrogen gas has turned into ammonium. Plants can directly use ammonia, or the ammonia undergoes the process of nitrification(2). During nitrification, nitrifying bacteria in the soil turn ammonia first into nitrites, then further nitrification turns nitrites into nitrates. Denitrifying bacteria in the soil turn nitrates back into nitrogen gas in the atmosphere in a process called denitrification. Nitrates can also be consumed by plants, which is transferred to animals that eat plants. Ammonium is also formed from decomposing bacteria in the soil break down proteins in rotting organic matter, and urea in animal waste through the process of mineralization. Nitrogen is also found in fossil fuel emissions and can get incorporated in clouds, returning back to Earth in the form of precipitation. Lastly, nitrogen is found in fertilizers on farms and can cause eutrophication in nearby ponds through runoff and leaching of the nitrogen-rich groundwater.



HARDNESS

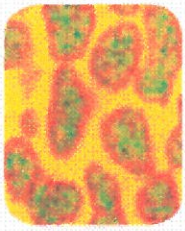
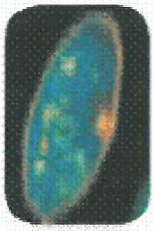
Hard water is water that has a high level of mineral content. In your house, the affect is no suds in the water. No suds = no cleaning. Water has a carrying capacity and when it's full with minerals it won't dissolve anything else, such as soap.

Hardness reduces the solubility of water, reducing the amount of things that will dissolve in water. $CaCo_3$ is the measure of hardness. Limestone rock has large amounts of Calcium and Magnesium that form $CaCo_3$ deposits.

pH

The balance of positive hydrogen ions (H+) and negative hydroxide ions (OH-) in water determines how acidic or basic the water is. On a scale from 0-14, pH is the measure of acidity (more hydrogen ions) or alkalinity (more hydroxide ions) of a substance. Pure water (H_20, composed of one hydrogen ion and one hydroxide ion) is considered neutral (7). Anything below 7 is considered acidic, and anything greater than 7 is alkaline. In a pond or pond, the water's pH is affected by its age and the chemicals discharged by communities and industries. Most ponds are alkaline when they are first form and become more acidic with time due to the build-up of organic materials. As organic substances decay, carbon dioxide forms and combines with water to produce a weak acid, called "carbonic" acid — the same stuff that's in carbonated soft drinks. Large amounts of carbonic acid lower water's pH. Most fish can tolerate pH values of about 5.0 to 9.0.

Draw and label a pH scale below. Include the following terms: acidic, alkaline, neutral, pure water, hydrogen ions (H+,) and negative hydroxide ions (OH-)

Domain	Bacteria	Archaea	Eukarya			
Kingdom	Eubacteria	Archaebacteria	Protista	Fungi	Plantae	Animalia
Example	*Pseudomonas*  SEM Magnification: 5500×	*Methanopyrus*  TEM Magnification: 25,000×	*Paramecium*  LM Magnification: 150×	Mushroom 	Moss 	Earthworm 
Cell type	Prokaryote		Eukaryote			
Cell walls	Cell walls with peptidoglycan	Cell walls without peptidoglycan	Cell walls with cellulose in some	Cell walls with chitin	Cell walls with cellulose	No cell walls
Number of cells	Unicellular		Unicellular and multicellular	Most multicellular	Multicellular	
Nutrition	Autotroph or heterotroph			Heterotroph	Autotroph	Heterotroph

BACTERIA

Bacteria are prokaryotes (lack a nucleus, lack membrane bound organelles, and are smaller than eukaryotes) that are divided into two kingdoms: Archaebacteria and Eubacteria. Eubacteria is a much larger kingdom, including common

bacteria. Archaebacteria live in extreme environments such as salty ponds, deep hydrothermal vents, and boiling hot temperatures.

1) What are 2 differences between prokaryotes and eukaryotes?

2) Using the chart, which two kingdoms are prokaryotic?

3) Which bacteria are we more likely to see at Pond Fayetteville; Eubacteria or Archaebacteria? Explain why.

4) What is one difference in <u>structure</u> between Eubacteria and Archaebacteria?

PROTISTS

The definition of a protist is any eukaryotic organism that is not a plant, animal, or fungus. We classify protists on how they obtain nutrition. Animal-like protists (also called protozoans) are heterotrophic and are further classified by how they move. Plant-like protists create their own food using photosynthesis, and fungus-like protists absorb their food from dead and decaying matter.

5) How many cells do protists have? (Use the chart)

6) List the 3 classifications of protists and explain how they each obtain nutrition.

7) What important organelle would you expect a plant-like protist to have?

ANIMALS

Zooplankton are tiny animals in the water that eat the phytoplankton (autotrophs) in a body of water. Many zooplankton have a striking resemblance to many crustaceans (like crabs and lobsters) and mollusks (like squid and snails). Both zooplankton and phytoplankton serve as the base for many oceanic and other water food chains.

8) What is a difference between zooplankton and phytoplankton?

FUNGUS

The Kingdom Fungi is composed of eukaryotic heterotrophs that have cell walls made up of chitin, which is also found in exoskeletons of lobsters and insects. Fungi do not photosynthesize, instead, fungi digest dead decaying matter outside of their bodies and nutrients diffuse into the fungus. Some fungi, such as lichen, live in symbiosis with other organisms. Lichen consists of a fungus that gives photosynthetic organism water and minerals and protects them from intense light, and a photosynthetic organism that gives fungus energy. All fungi except for yeasts are multicellular, and multicellular fungi is made of hyphae. Fungi can reproduce both sexually and asexually.

1) Name one similarity and one difference between fungi and plants.

2) Name one similarity and one difference between fungi and animals.

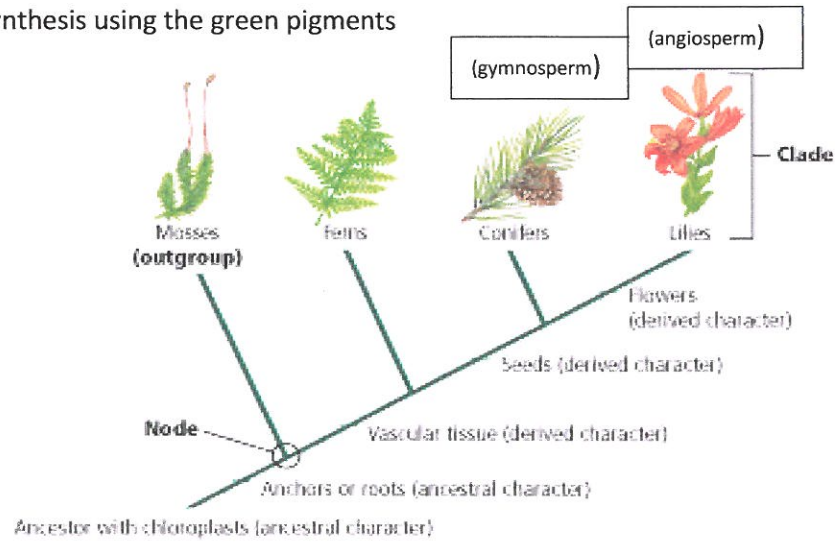
3) Name one similarity and one difference between fungi and protists.

4) How are fungi important economically?

5) How are fungi important medically?

PLANTS

Kingdom Plantae consists of "stationary animals that eat sunlight"! Plants are multicellular eukaryotes that have cell walls made of cellulose. They carry out photosynthesis using the green pigments chlorophyll *a* and *b*. Plants are autotrophs that provide the base for food chains on land. They also provide shade, shelter, and oxygen for animals. Early plants evolved from plantlike protists.



6) What is the diagram on the right called?

7) What characteristics did ferns derive?

8) Which groups of plants contain seeds?

9) Which group of plants do not have vascular tissue?

10) Which type of plant derived cones?

11) Which type of plant derived flowers?

12) A cycad has a cone-which group of plants will the cycad be in?

Plant Tissues

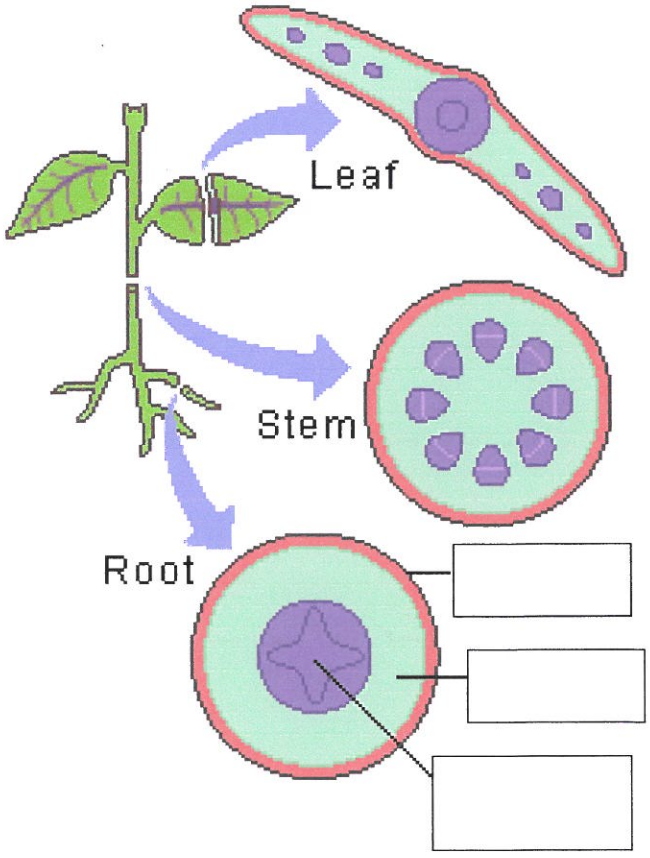
Dermal tissue
- "skin" of a plant-outermost layer of cells

Vascular tissue
- "bloodstream" of a plant-transport water and nutrients throughout the plant

Ground tissue
- "everything else"

Match the function with the appropriate tissue. Write D for dermal, V for vascular, and G for ground. Then label the picture on the left with the appropriate plant tissue.

13) _____Made of epidermal cells
14) _____most common type of tissue
15) _____contains xylem, a water-conducting tissue that allows upward flow
16) _____Often covered with a thick waxy layer (cuticle) that protects against water loss and injury
17) _____In roots, includes root hair cells that increase surface area for water absorption
18) _____On underside of leafs, contains guard cells which regulates gas exchange
19) _____contains phloem, a food-conducting tissue that allows 2-way flow
20) _____functions mainly as support, storage, and photosynthesis

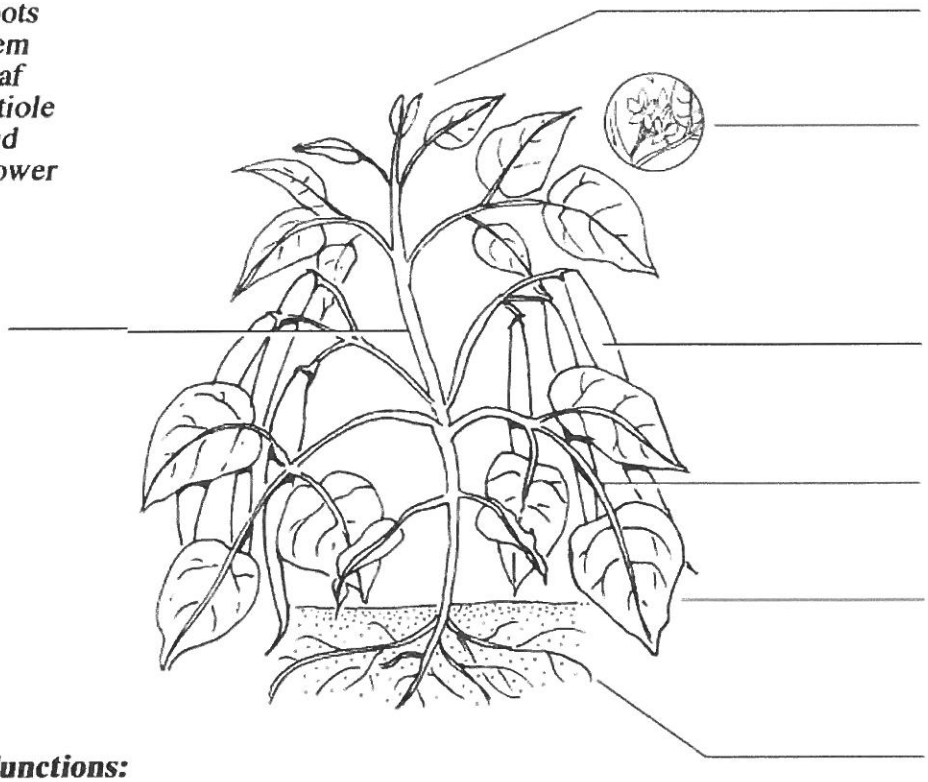


25-30 *Label the parts of the plant*

Parts of the Plant:

Write in the correct name.

Roots
Stem
Leaf
Petiole
Bud
Flower



Functions:

Flower: *The flower's job is to make seeds.*

Roots: *Holds the plant into the ground, takes in water and minerals from the soil and stores food made by photosynthesis.*

Stem: *Holds up the plant's leaves, flowers and fruits, moves water and food between the leaves and the roots and stores water and stores food made by photosynthesis.*

Leaf: *The part of the plant that collects sunlight for photosynthesis to make food that the plant needs.*

Petiole: *Connects the leaf to the stem.*

Bud: *The growing part at the tip of the plant.*

31) How are plants important medically?

32) How are plants important economically?

Scavenger Hunt at Flint Creek Nature Center

You need to find and photograph the following. When returning to class you will need to create a powerpoint with all items found.

1) Picture of a Plant-like Protist (labeled)
2) Picture of a Animal-like Protist (labeled)
3) Picture of Vascular Plant (labeled)
4) Picture of a Nonvascular Plant (labeled)
5) Picture of a Gymnosperm /Cycad(labeled)
6) Picture of a Angiosperm (labeled)
7) Picture of a Fungus (labeled)
8) Picture of an organism with radial symmetry (labeled)
9) Picture of an organism with bilateral symmetry (labeled)
10) Picture of an organism that is asymmetrical (labeled)
11) Picture of an abiotic factor (labeled)
12) Picture of a biotic factor (labeled)
13) Use a minimum of 6 pictures to create a food web with arrows pointing the direction that the energy is flowing
14) Picture of commensalism (labeled, explained, and defined)
15) Picture of mutualism (labeled, explained, and defined)
16) Picture of parasitism (labeled, explained, and defined)
17) 2 pictures showing succession (labeled and defined-also explain difference between primary and secondary succession)
18) Picture of a Population (labeled and defined)
19) Picture of a Community (labeled and defined)
20) Picture of an Ecosystem (labeled and defined)
21) Picture of an invasive species (labeled and defined)
22) Picture of 3 trees identified with leaf identification system. (labeled and defined)
23) Picture showing the effects of human population growth on the environment (explained)

DESIGN YOUR OWN EXPERIMENT

Using what you have learned today, design an experiment to test a hypothesis. Be detailed in your procedures so that a stranger could perform your experiment. Setup a table to record your data and a graph (if needed) with the axes labeled, units included, and an appropriate title.

Research Question:

Hypothesis:

Independent Variable:

Dependent Variable:

Control group (if you have one):

Equipment:

Procedures:

Data Tables and Graphs:

Testing that can be conducted at the site.

Dissolved Oxygen

pH

Phosphorous levels

Nitrogen levels

Temperature

Clarity

These should all be done at different areas at the site. Discuss why these values would be different at the creek, different areas of the pond, where water enters and leaves the pond. What do these differences indicate?

ARKANSAS STATE SCIENCE STANDARDS

THE FOLLOWING STANDARDS RELATE DIRECTLY TO FLINT CREEK NATURE CENTER EDUCATIONAL MATERIALS

K-8 AND BIOLOGY

Strand 2: Life Science

Standard 3: Life Cycles, Reproduction, and Heredity

Students shall demonstrate and apply knowledge of life cycles, reproduction, and heredity using appropriate safety procedures, equipment, and technology.

THE GOAL FOR EACH STUDENT IS PROFICIENCY IN ALL REQUIREMENTS AT CURRENT AND PREVIOUS GRADES.					
	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4
Life Cycles	LS.3.K.1 Describe plant development and growth LS.3.K.2 Illustrate *complete metamorphosis* (e.g., butterfly, frog)	LS.3.1.1 Illustrate in*complete metamorphosis* (e.g., grasshopper) LS.3.1.2 Compare and contrast *complete metamorphosis* and *incomplete metamorphosis*	LS.3.2.1 Illustrate embryonic development (e.g., chicken) LS.3.2.2 Compare and contrast embryonic development and *incomplete metamorphosis*	LS.3.3.3 Differentiate among *complete metamorphosis*, *incomplete metamorphosis*, and *embryonic development*	

Key: LS.3.K.1 = Life Science. Standard 4. Kindergarten. 1st Student Learning Expectation

Strand 2: Life Science

Standard 4: Populations and Ecosystems

Students shall demonstrate and apply knowledge of populations and ecosystems using appropriate safety procedures, equipment, and technology.

THE GOAL FOR EACH STUDENT IS PROFICIENCY IN ALL REQUIREMENTS AT CURRENT AND PREVIOUS GRADES.					
	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4
	LS.4.K.1 Recognize what it means for a *species* to be *extinct*	LS.4.1.1 Identify some endangered *species* in Arkansas	LS.4.2.1 Compare and contrast living and *extinct species* LS.4.2.2 Describe characteristics of various *habitats*		LS.4.4.1 Recognize *environmental adaptations* of plants and animals LS.4.4.2 Illustrate the interdependence of organisms in an *ecosystem*

Key: LS.4.K.1 = Life Science. Standard 4. Kindergarten. 1st Student Learning Expectation

Strand 2: Life Science

Standard 2: Living Systems: Characteristics, Structure, and Function

Students shall demonstrate and apply knowledge of living systems using appropriate safety procedures, equipment, and technology

THE GOAL FOR EACH STUDENT IS PROFICIENCY IN ALL REQUIREMENTS AT CURRENT AND PREVIOUS GRADES.					
	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4
Structure and Function	LS.2.K.5 Name and describe the five senses LS.2.K.6 Discuss the functions of the five senses LS.2.K.7 Identify the basic materials for oral hygiene LS.2.K.8 Demonstrate the proper technique for cleaning teeth	LS.2.1.3 Locate the following human body parts: • heart • lungs • brain • stomach • muscles • bones LS.2.1.4 Locate plant parts: • leaves • stems • flowers • roots	LS.2.2.5 Identify the major parts and functions of the skeletal system LS.2.2.6 Describe the function of the following plant parts: • leaves • stems • flowers • roots	LS.2.3.2 Identify major parts and functions of the following systems: • respiratory • muscular	LS.2.4.3 Identify major parts and functions of the following systems: • digestive • circulatory • nervous

Key: LS.2.K.5 = Life Science. Standard 2. Kindergarten. 5th Student Learning Expectation

Strand 2: Life Science

Standard 3: Life Cycles, Reproduction, and Heredity

Students shall demonstrate and apply knowledge of life cycles, reproduction, and heredity using appropriate safety procedures, equipment, and technology

THE GOAL FOR EACH STUDENT IS PROFICIENCY IN ALL REQUIREMENTS AT CURRENT AND PREVIOUS GRADES.				
	Grade 5	Grade 6	Grade 7	Grade 8
Regulation and Behavior		LS.3.6.5 Describe behavioral *adaptations* of *organisms* to the *environment:* • *hibernation* • *estivation* • *tropism* • *territorial behavior* • *migration* LS.3.6.6 Differentiate between *innate behaviors:* • *migration* • web spinning • defensive posture • *communication* • *imprinting* and *learned behaviors*: • speaking a language • using tools • hunting skills	LS.3.7.12 Summarize the interactions between *organ systems* in the maintenance of *homeostasis*	LS.3.8.12 Compare the theory of evolution to the characteristics of a scientific *theory* LS.3.8.13 Identify basic ideas related to biological evolution: • diversity of *species* • variations within *species* • *adaptations* • *natural selection* • *extinction* of a *species* LS.3.8.14 Explain that the *fossil* record provides *evidence* of life forms' appearance, diversification, and *extinction* LS.3.8.15 Explain the process of n*atural selection*

Key: LS.3.6.5 = Life Science. Standard 3. Grade 6. 5th Student Learning Expectation

Strand 2: Life Science

Standard 3: Life Cycles, Reproduction, and Heredity

Students shall demonstrate and apply knowledge of life cycles, reproduction, and heredity using appropriate safety procedures, equipment, and technology

THE GOAL FOR EACH STUDENT IS PROFICIENCY IN ALL REQUIREMENTS AT CURRENT AND PREVIOUS GRADES.				
	Grade 5	Grade 6	Grade 7	Grade 8
Regulation and Behavior		LS.3.6.7 Describe the following *structural adaptations* for survival in the *environment:* • coloration • *mimicry* • odor glands • beaks • feet • wings • fur • ears • spines • teeth • thorns • characteristics of seeds LS.3.6.8 Investigate careers, scientists, and historical breakthroughs related to learned and *innate behaviors*		LS.3.8.16 Identify *genetic* traits that make *organisms* more likely to survive and reproduce in a particular environment LS.3.8.17 Investigate careers, scientists, and historical breakthroughs related to *natural selection* and the *fossil* record

Key: LS.3.6.7 = Life Science. Standard 3. Grade 6. 7th Student Learning Expectation

Strand 2: Life Science

Standard 4: Populations and Ecosystems

Students shall demonstrate and apply knowledge of populations and ecosystems using appropriate safety procedures, equipment, and technology.

THE GOAL FOR EACH STUDENT IS PROFICIENCY IN ALL REQUIREMENTS AT CURRENT AND PREVIOUS GRADES.				
	Grade 5	Grade 6	Grade 7	Grade 8
Populations and Ecosystems	LS.4.5.1 Distinguish among and model • *organisms* • *populations* • *communities* • *ecosystems* • *biosphere* LS.4.5.2 Identify the transfer of *energy* using *energy* pyramids: • terrestrial • aquatic LS.4.5.3 Design food webs in specific *habitats* to show the flow of *energy* within *communities:* • terrestrial • aquatic LS.4.5.4 Evaluate food webs under conditions of stress: • overgrazing • overpopulation • natural disaster • introduction of non-native *species* • human impact/urban development	LS.4.6.1 Identify *environmental* conditions that can affect the survival of individual *organisms* and entire *species* LS.4.6.2 Conduct simulations demonstrating competition for resources within an *ecosystem* LS.4.6.3 Conduct simulations demonstrating *natural selection* LS.4.6.4 Analyze *natural selection*	LS.4.7.1 Explain the role of *reproduction* in the continuation of a *species*	LS.4.8.1 Analyze the effect of changes in environmental conditions on the survival of individual *organisms* and entire *species*

Key: LS.4.5.1 = Life Science. Standard 4. Grade 5. 1st Student Learning Expectation

Strand 2: Life Science

Standard 4: Populations and Ecosystems

Students shall demonstrate and apply knowledge of populations and ecosystems using appropriate safety procedures, equipment, and technology

THE GOAL FOR EACH STUDENT IS PROFICIENCY IN ALL REQUIREMENTS AT CURRENT AND PREVIOUS GRADES.				
	Grade 5	Grade 6	Grade 7	Grade 8
Populations and Ecosystems	LS.4.5.5 Examine the role of *limiting factors* on the *carrying capacity* of an *ecosystem:* • food • space • water • shelter LS.4.5.6 Describe and diagram the nitrogen cycle in *ecosystems* LS.4.5.7 Describe and diagram the *carbon cycle* in *ecosystems* LS.4.5.8 Describe and diagram the *carbon dioxide-oxygen cycle* in *ecosystems* LS.4.5.9 Conduct investigations demonstrating the role of the *carbon dioxide-oxygen cycle* in *ecosystems* LS.4.5.10 Analyze the concept of conservation of *mass* as related to the amount of *matter* in an *ecosystem*			

Key: LS.4.5.5 = Life Science. Standard 4. Grade 5. 5th Student Learning Expectation

Strand 2: Life Science

Standard 4: Populations and Ecosystems

Students shall demonstrate and apply knowledge of populations and ecosystems using appropriate safety procedures, equipment, and technology

THE GOAL FOR EACH STUDENT IS PROFICIENCY IN ALL REQUIREMENTS AT CURRENT AND PREVIOUS GRADES.				
	Grade 5	Grade 6	Grade 7	Grade 8
Populations and Ecosystems	LS.4.5.11 Create *ecosystems* in which plants can exist without animals LS.4.5.12 Conduct investigations in which plants are encouraged to thrive LS.4.5.13 Construct, compare, and contrast *environments* in *open* and *closed* aquaria LS.4.5.14 Categorize *organisms* by the function they serve in *ecosystems* and food webs: • *predator/prey* • *parasitism* • *producer/consumer/ decomposer* • *scavenger* • *herbivore/carnivore/ omnivore* LS.4.5.15 Conduct *field studies* identifying and categorizing *organisms* in a given area of an ecosystem			

Key: LS.4.5.16 = Life Science. Standard 4. Grade 5. 16^{h} Student Learning Expectation

Strand 2: Life Science

Standard 4: Populations and Ecosystems

Students shall demonstrate and apply knowledge of populations and ecosystems using appropriate safety procedures, equipment, and technology

THE GOAL FOR EACH STUDENT IS PROFICIENCY IN ALL REQUIREMENTS AT CURRENT AND PREVIOUS GRADES.				
	Grade 5	Grade 6	Grade 7	Grade 8
Populations and Ecosystems	LS.4.5.16 Evaluate positive and negative human effects on *ecosystems* LS.4.5.17 Describe and illustrate various symbiotic relationships: • *parasitism* • *mutualism* • *commensalism* LS.4.5.18 Investigate careers, scientists, and historical breakthroughs related to *populations* and *ecosystems*			

Key: LS.4.5.16 = Life Science. Standard 4. Grade 5. 16^{h} Student Learning Expectation

Strand: Classification and the Diversity of Life

Standard 7: Students shall demonstrate an understanding that organisms are diverse.

CDL.7.B.1	Differentiate among the different *domains:* • Bacteria • Archaea • Eukarya
CDL.7.B.2	Differentiate the characteristics of the six kingdoms: • Eubacteria • Archaea • Protista • *Fungi* • Plantae • Animalia
CDL.7.B.3	Identify the seven major taxonomic categories: • kingdom • phylum • class • order • family • *genus* • *species*
CDL.7.B.4	Classify and name organisms based on their similarities and differences applying *taxonomic nomenclature* using *dichotomous keys*
CDL.7.B.5	Investigate Arkansas' *biodiversity* using appropriate tools and *technology*
CDL.7.B.6	Compare and contrast the structures and characteristics of *viruses* (*lytic* and *lysogenic cycles*) with non-living and living things
CDL.7.B.7	Evaluate the medical and economic importance of *viruses*
CDL.7.B.8	Compare and contrast life cycles of familiar organisms ▪ sexual reproduction ▪ asexual reproduction ▪ metamorphosis ▪ *alternation of generations*
CDL.7.B.9	Classify *bacteria* according to their characteristics and adaptations
CDL.7.B.10	Evaluate the medical and economic importance of *bacteria*

Key: CDL.7.B.1 = Classification and the Diversity of Life. Standard 7. Biology. 1st Student Learning Expectation

Strand: Classification and the Diversity of Life

Standard 7: Students shall demonstrate an understanding that organisms are diverse.

CDL.7.B.11	Describe the characteristics used to classify protists: ▪ plant-like ▪ animal-like ▪ *fungal*-like
CDL.7.B.12	Evaluate the medical and economic importance of protists
CDL.7.B.13	Compare and contrast *fungi* with other eukaryotic organisms
CDL.7.B.14	Evaluate the medical and economic importance of *fungi*
CDL.7.B.15	Differentiate between *vascular* and *nonvascular plants*
CDL.7.B.16	Differentiate among cycads, gymnosperms, and angiosperms
CDL.7.B.17	Describe the structure and function of the major parts of a plant: ▪ roots ▪ stems ▪ leaves ▪ flowers
CDL.7.B.18	Relate the structure of plant tissue to its function • epidermal • ground • vascular
CDL.7.B.19	Evaluate the medical and economic importance of plants
CDL.7.B.20	Identify the symmetry of organisms: ▪ radial ▪ bilateral ▪ asymmetrical
CDL.7.B.21	Compare and contrast the major invertebrate classes according to their nervous, respiratory, excretory, circulatory, and digestive systems
CDL.7.B.22	Compare and contrast the major vertebrate classes according to their nervous, respiratory, excretory, circulatory, digestive, reproductive and integumentary systems

Key: CDL.7.B.11 = Classification and the Diversity of Life. Standard 11. Biology. 1st Student Learning Expectation

Strand: *Ecology* and Behavioral Relationships

Standard 8: Students shall demonstrate an understanding of ecological and behavioral relationships among organisms.

EBR.8.B.1	Cite examples of abiotic and *biotic factors* of *ecosystems*
EBR.8.B.2	Compare and contrast the characteristics of *biomes*
EBR.8.B.3	Diagram the carbon, nitrogen, phosphate, and water cycles in an *ecosystem*
EBR.8.B.4	Analyze an *ecosystem's* energy flow through food chains, food webs, and *energy pyramids*
EBR.8.B.5	Identify and predict the factors that control *population*, including *predation*, *competition*, crowding, water, nutrients, and shelter
EBR.8.B.6	Summarize the symbiotic ways in which individuals within a *community* interact with each other: ▪ *commensalism* ▪ *parasitism* ▪ *mutualism*
EBR.8.B.7	Compare and contrast *primary succession* with *secondary succession*
EBR.8.B.8	Identify the properties of each of the five levels of *ecology:* ▪ organism ▪ *population* ▪ *community* ▪ *ecosystem* ▪ *biosphere*

Key: EBR.8.B.1 = Ecology and Behavioral Relationships. Standard 8. Biology. 1st Student Learning Expectation

Strand: *Ecology* and Behavioral Relationships

Standard 9: Students shall demonstrate an understanding of the ecological impact of global issues.

EBR.9.B.1	Analyze the effects of human *population* growth and *technology* on the environment/*biosphere*
EBR.9.B.2	Evaluate long range plans concerning resource use and by-product disposal in terms of their environmental, economic, and political impact
EBR.9.B.3	Assess current world issues applying scientific themes (e.g., global changes in climate, *epidemics*, *pandemics*, ozone depletion, UV radiation, natural resources, use of *technology*, and public policy)

Key: EBR.9.B.1 = Ecology and Behavioral Relationships. Standard 9. Biology. 1st Student Learning Expectation

HS-LS4 Biological Evolution: Unity and Diversity

builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. ▪ Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-LS4-1) --- ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ▪ A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-LS4-1)	▪ Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5) **LS4.D: Biodiversity and Humans** ▪ Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS-LS4-6) *(Note: This Disciplinary Core Idea is also addressed by HS-LS2-7.)* **ETS1.B: Developing Possible Solutions** ▪ When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary to HS-LS4-6)* ▪ Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. *(secondary to HS-LS4-6)*	

Connections to other DCIs in this grade-band: **HS.LS2.A** (HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5); **HS.LS2.D** (HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5); **HS.LS3.A** (HS-LS4-1); **HS.LS3.B** (HS-LS4-1),(HS-LS4-2) (HS-LS4-3),(HS-LS4-5); **HS.ESS1.C** (HS-LS4-1); **HS.ESS2.D** (HS-LS4-6); **HS.ESS2.E** (HS-LS4-2),(HS-LS4-5),(HS-LS4-6); **HS.ESS3.A** (HS-LS4-2),(HS-LS4-5),(HS-LS4-6); **HS.ESS3.C** (HS-LS4-6); **HS.ESS3.D** (HS-LS4-6)

Articulation across grade-bands: **MS.LS2.A** (HS-LS4-2),(HS-LS4-3),(HS-LS4-5); **MS.LS2.C** (HS-LS4-5),(HS-LS4-6); **MS.LS3.A** (HS-LS4-1); **MS.LS3.B** (HS-LS4-1),(HS-LS4-2),(HS-LS4-3); **MS.LS4.A** (HS-LS4-1); **MS.LS4.B** (HS-LS4-2),(HS-LS4-3),(HS-LS4-4); **MS.LS4.C** (HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5); **MS.ESS1.C** (HS-LS4-1); **MS.ESS3.C** (HS-LS4-5),(HS-LS4-6)

Common Core State Standards Connections:

ELA/Literacy –

RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-LS4-1),*(HS-LS4-2),*(HS-LS4-3),*(HS-LS4-4)
RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS4-5)
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. *(HS-LS4-1),*(HS-LS4-2),*(HS-LS4-3),*(HS-LS4-4)
WHST.9-12.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. *(HS-LS4-6)*
WHST.9-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS4-6)
WHST.9-12.9	Draw evidence from informational texts to support analysis, reflection, and research. *(HS-LS4-1),*(HS-LS4-2),*(HS-LS4-3),*(HS-LS4-4),(HS-LS4-5)
SL.11-12.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. *(HS-LS4-1),(HS-LS4-2)*

Mathematics –

MP.2	Reason abstractly and quantitatively. *(HS-LS4-1),*(HS-LS4-2),(HS-LS4-3),*(HS-LS4-4),(HS-LS4-5)*
MP.4	Model with mathematics. *(HS-LS4-2)*

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

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HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

HS-LS2-1. **Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.** [Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.]

HS-LS2-2. **Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.** [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.]

HS-LS2-3. **Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.** [Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.] [Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.]

HS-LS2-4. **Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** [Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]

HS-LS2-5. **Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.** [Clarification Statement: Examples of models could include simulations and mathematical models.] [Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.]

HS-LS2-6. **Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.** [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]

HS-LS2-7. **Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*** [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]

HS-LS2-8. **Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.** [Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show how relationships among variables between systems and their components in the natural and designed worlds.

- Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5)

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)
- Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)
- Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1),(HS-LS2-2)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)
- Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)
- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6)

Crosscutting Concepts

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8)

Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)
- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5)

Energy and Matter

- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS2-4)
- Energy drives the cycling of matter within and between systems. (HS-LS2-3)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6),(HS-LS2-7)

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HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

and will continue to do so in the future. (HS-LS2-3)
- Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7)

Engaging in Argument from Evidence

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)
- Evaluate the evidence behind currently accepted explanations to determine the merits of arguments. (HS-LS2-8)

Connections to Nature of Science

Scientific Knowledge is Open to Revision in Light of New Evidence
- Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2),(HS-LS2-3)
- Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6),(HS-LS2-8)

- Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

LS2.D: Social Interactions and Group Behavior
- Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8)

LS4.D: Biodiversity and Humans
- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary to HS-LS2-7)*
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. *(secondary to HS-LS2-7) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.)*

PS3.D: Energy in Chemical Processes
- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. *(secondary to HS-LS2-5)*

ETS1.B: Developing Possible Solutions
- When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. *(secondary to HS-LS2-7)*

Connections to other DCIs in this grade-band: **HS.PS1.B** (HS-LS2-3),(HS-LS2-5); **HS.PS3.B** (HS-LS2-3),(HS-LS2-4); **HS.PS3.D** (HS-LS2-3),(HS-LS2-4); **HS.ESS2.A** (HS-LS2-3); **HS.ESS2.D** (HS-LS2-5),(HS-LS2-7); **HS.ESS2.E** (HS-LS2-2),(HS-LS2-6),(HS-LS2-7); **HS.ESS3.A** (HS-LS2-2),(HS-LS2-7); **HS.ESS3.C** (HS-LS2-2),(HS-LS2-7); **HS.ESS3.D** (HS-LS2-2)

Articulation across grade-bands: **MS.PS1.B** (HS-LS2-3); **MS.PS3.D** (HS-LS2-3),(HS-LS2-4),(HS-LS2-5); **MS.LS1.B** (HS-LS2-8); **MS.LS1.C** (HS-LS2-3),(HS-LS2-4),(HS-LS2-5); **MS.LS2.A** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6); **MS.LS2.B** (HS-LS2-3),(HS-LS2-4),(HS-LS2-5); **MS.LS2.C** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-7); **MS.ESS2.A** (HS-LS2-5); **MS.ESS2.E** (HS-LS2-6); **MS.ESS3.A** (HS-LS2-1); **MS.ESS3.C** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-7); **MS.ESS3.D** (HS-LS2-7)

Common Core State Standards Connections:

ELA/Literacy –

RST.9-10.8	Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-LS2-6),*(HS-LS2-7),(HS-LS2-8)*
RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-LS2-1),(HS-LS2-2),*(HS-LS2-3),(HS-LS2-6),(HS-LS2-8)
RST.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. *(HS-LS2-6),(HS-LS2-7),(HS-LS2-8)*
RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8)
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. *(HS-LS2-1),(HS-LS2-2),*(HS-LS2-3)
WHST.9-12.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS2-3)
WHST.9-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS2-7)

Mathematics –

MP.2	Reason abstractly and quantitatively. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-6),*(HS-LS2-7)*
MP.4	Model with mathematics. *(HS-LS2-1),(HS-LS2-2),(HS-LS2-4)*
HSN-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),*(HS-LS2-7)*
HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. *(HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-7)*
HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),*(HS-LS2-7)*
HSS-ID.A.1	Represent data with plots on the real number line. *(HS-LS2-6)*
HSS-IC.A.1	Understand statistics as a process for making inferences about population parameters based on a random sample from that population. *(HS-LS2-6)*
HSS-IC.B.6	Evaluate reports based on data. (HS-LS2-6)

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