LESSON 1: HEALTHY ECOSYSTEMS

Duration: Three to four 45-minute class periods

Background information:

A healthy ecosystem consists of native plant and animal populations interacting in balance with each other and non-living things (for example, water and rocks). Healthy ecosystems have an energy source, usually the sun. The sun provides radiant energy for producer (plant) growth. Producers change radiant energy into chemical energy for use by themselves and by consumers. Consumers eat producers. Higher-level consumers also eat other consumers. Decomposers break down dead plants and animals, returning vital nutrients to the soil. Plants take up these nutrients, along with water, through their roots. Ecosystems have definite boundaries.

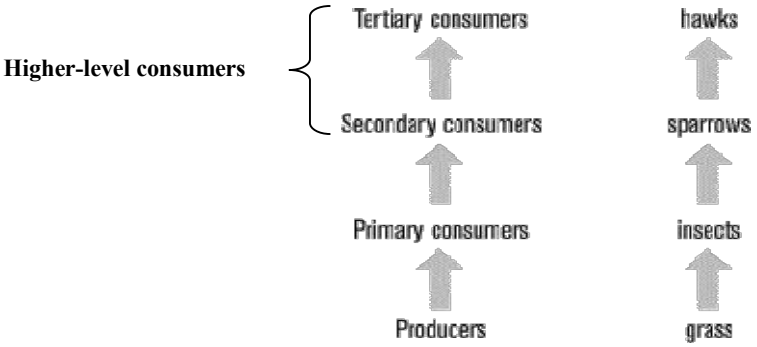
Components of a healthy ecosystem include:

- sunlight (energy source)
- living organisms (producers, consumers, decomposers; predator/prey)
- non-living things (land forms, water sources, soil, rocks)
- dead organisms
- natural boundaries (set by the living and non-living things within the area)

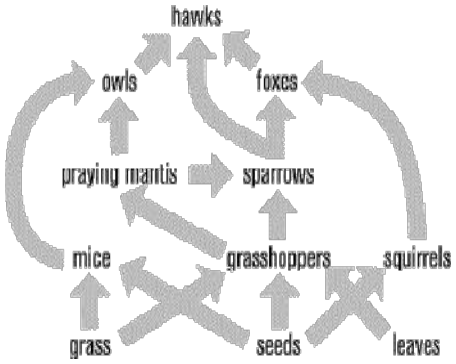
Vocabulary:

Abiotic	Not biotic; non-living components of an ecosystem (for example, water and sunlight)
Adaptations	Changes in form or behavior enabling a species to survive in a particular habitat
Biodiversity	The number of different species in a given habitat
Biome	A living community distinguished by particular plant and animal species and certain climate conditions
Biotic	Of or relating to life; components of the environment that are alive or were alive
Climate	Average yearly weather patterns of a region, including temperature, air pressure, humidity, precipitation, sunshine, cloudiness, and winds
Conservation	Preservation and management of natural resources

Dead	Formerly a living thing that can no longer react to stimuli, reproduce, move on its own, or grow and develop by cell division; returns energy to the environment by decomposing
Decomposer	An organism that breaks down dead plants and animals, returning vital nutrients to the soil
Ecosystem	All the living things plus the non-living things in an area
Exotic or non-native	Foreign; not naturally from a particular region; introduced to a place
Food Chain	A model that shows only one-to-one links between the levels of producers and consumers



Food Web	A diagram or model that shows organisms in a community hunt more than one kind of prey and are hunted by more than one predator



Habitat	A place providing the types of food, shelter, moisture and temperature needed for survival for a living organism

Living	*Actively* exchanges energy with its environment over and over again, and requires energy, moves, reacts to stimuli, grows and develops (by cell division), produces energy, adapts to changes, and respires (cellular—transforms chemical energy into a form useful to maintaining the life of the organism)
Native	Animals and plants naturally from a particular region
Non-living	Passively exists in an environment; depends on environmental forces and has no ability to move of its own will, no ability to respond to stimuli, no ability to reproduce its own kind, and no ability to grow and develop by cell division
Predator	A living animal that hunts, kills and eats other animals
Prey	A living animal that is hunted, killed and eaten by another animal
Producer	A plant that changes the sun's radiant energy into chemical energy
Web of Life	An artistic rendering of a food web (defined above)

Sources:

Some vocabulary and other definitions are adapted from "Glossary," Glencoe Science: Ecology, McGraw-Hill Companies, 2002. (See their "Online Learning Center" at < http://www.glencoe.com/sites/wisconsin/teacher/science/index.html>, under "Classroom Tools," "Student," click on "Multilingual Glossary MS," (accessed 09/05).

Spark Notes/SAT Biology, htttp://www.sparknotes.com/testprep/books/sat2/biology/chapter10section3.rhtml

***Day One*—Living, Nonliving, Dead, and Food Webs** *(one – 45-minute class period)*

Objectives:

Identify components that influence an ecosystem
Briefly describe interactions between components

Prepare in advance:

- Copy "Organisms Found in the Southern Appalachian Region" onto cardstock
- Cut out and laminate the individual cards
- Cut brightly colored yarn into 40 one-foot long pieces
- Print one "Web of Life" illustration for student preview

Materials:

- notebook paper for each student
- tape measures (at least 20 feet)
- brightly colored synthetic string and four stakes, for marking corners of plot
- mallet or hammer, for inserting stakes
- scissors for student use
- four rolls of double sided tape
- six to eight feet of butcher paper (bulletin board paper)

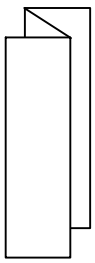
Description:

Students will learn to recognize components and healthy interactions in a healthy ecosystem through locating and identifying living, non-living, and dead things in their environment.

Instructional sequence:

(10 minutes)

- **Brainstorm** the difference between "living," "non-living," and "dead" with the class group (for example: living = grass; non-living = rock; dead = dry fallen leaf).
- **Introduce** vocabulary—biotic and abiotic—explaining how biotic things can be both living or dead and abiotic things are never alive.
- **Model** folding a sheet of notebook paper into a three-part accordion on the vertical.



- **Instruct** students to fold a sheet of notebook paper into a three-part accordion on the vertical.
- **Instruct** students to write at the top of each column, respectively: "biotic—living," "abiotic—non-living," and "biotic—dead."

(15 minutes)

- **Lead** students outside.
- **Direct** them to measure out a 15ft. x 15ft. plot in the schoolyard and mark the boundary with brightly colored string.
- **Secure** the string with stakes.
- **Direct** students to categorize things (e.g.: live grass, dead leaf, non-living rock) found in the plot as "biotic—living," "abiotic—non-living," and "biotic—dead" on their folded notebook paper.
- **Debrief** students, for example:
  - What have they listed in each column?
  - Did the type of things vary from location to location within the plot?
  - Do any patterns emerge (e.g., many ant hills in the softer soil; more rocks in the harder soil)?
  - What will happen to the dead things?
  - Did you find any decomposers?

(25 minutes—Teacher Note: The activity can be completed either outdoors or indoors from this point.)

- **Seat students** in a circle.
- **Discuss**:
  - a healthy ecosystem has:
    - living components
    - non-living components
    - dead components
    - definite boundaries
  - a habitat provides things needed for survival of a living organism:
    - food,
    - shelter,
    - moisture, and
    - temperature
- **Give** each student a card that has a living thing that might be found in a Southern Appalachian ecosystem (provided in "Organisms Found in the Southern Appalachian Region").
- **Represent** a food web using the cards:
  - Supply each student with two 12" pieces of the brightly colored yarn.
  - Place rolls of double sided tape and scissors ready for students to use.
  - Instruct students to place components on the butcher paper using double sided tape.
  - Illustrate a food web by connecting the cards using the colored yarn.
- **Guide** students to:

  - Identify their plant's or animal's connection to the previous and following organism cards
  - Model this connection by stretching a piece of yarn between the previous, current, and following cards
  - Identify their plant's or animal's purpose in the ecosystem
  - Identify predators and prey
  - Clarify predator-prey relationships
- **Discuss** the flow of energy to and through an ecosystem, including both growth and decomposition.
- **Emphasize** components and healthy interactions within a healthy ecosystem.

Source:
Lesson Plan adapted from "Unit Plan for Dynamics of an Ecosystem" Curriculum Unit Plan, available online at <http://www.michigan.gov/scope/> (accessed 09/05) and Seattle Audubon Society, "Web of Life," available online at < http://www.seattleaudubon.org/education.cfm?id=58>, accessed 09/05.

***Day Two*—Web of Life** *(one – 45-minute class period)*

Objectives:

- Identify components of a healthy ecosystem.
- Represent components in a healthy ecosystem with a two-dimensional model (collage).

Prepare in advance:

Overhead transparency of "Web of Life"

Materials:

- overhead projector
- old magazines containing nature pictures (for cutting out pictures)
- scissors (one pair for every two students)
- glue sticks
- sharpened colored pencils
- colored markers
- 9 " x 12" construction paper

Description:

Students will model interactions in a healthy ecosystem through constructing a Southern Appalachian Region ecosystem "web of life" collage.

Instructional sequence:

(10 to 15 minutes)

- **Review** the difference between "living," "non-living," and "dead" with the class.
- **Recall** the previous class activity (Healthy Ecosystems, day one).
- **Show** students the "*Web of Life*" illustration on the overhead projector. (A Web of Life is an artistic rendering of a food web.)
- **Discuss** these components of a healthy ecosystem, as you point them out on the "Web of Life" illustration:
  - characteristic living organisms
    - producers
    - consumers
    - decomposers
  - characteristic non-living things
    - land forms
    - water sources
    - soil
    - rocks
  - food chains and food webs

  - predator/prey relationships
- **Write** "predator" and "prey" on the board, with brief, simple definitions:
  - Predator: animal that hunts and eats other animals
  - Prey: animal hunted and eaten by another animal
- **Brainstorm/review** predator-prey relationships in the Southern Appalachian region with students.
- **Write** possible Appalachian ecosystems on the board for students (e.g., stream, forest, cove, grassland)

(30 – 35 minutes)

- **Instruct** students to work in groups of their choice to construct a "Web of Life" for one of the ecosystems on the board.
- **Direct** students to use pictures cut from old nature and geography magazines to illustrate a "Web of Life" for the ecosystem they choose.
- **Display** "Web of Life" illustrations in the classroom.

Source:

Lesson Plan adapted from "Unit Plan for Dynamics of an Ecosystem" Curriculum Unit Plan, available online at <http://www.michigan.gov/scope/> (accessed 09/05) and Seattle Audubon Society, "Web of Life," available online at < http://www.seattleaudubon.org/education.cfm?id=58>, accessed 09/05.

Day Three/Four—
Interactive, online grassland activity—Build a Prairie *(one to two – 45-minute class periods)*

Background information:

Grassland is a type of biome. Grasslands are typically filled with deep-rooted grasses, forbs, and other herbaceous species. Few trees or shrubs grow in grasslands. Grasslands are partly dry, receiving 10 to 30 inches rain (25 to 75 cm) per year. Most grassland has a dry season with little or no rainfall. This seasonal dry period prevents the growth of forests. Almost one-fourth of Earth's land surface is covered by grassland. Sometimes, grassland is so big that it is called a sea of grass. Grasslands are called by different names around the world including savannas, plains, steppes, prairies, pampas, and veldts. For example, in Africa, grasslands are called savannas.

Grasslands are divided into two types depending on geographic location:

- Tropical grasslands are located near to the equator. Temperatures are hot all year with wet seasons of heavy rainfall.
- Temperate grasslands are located in the middle latitudes. Temperatures are hot in the summer and cool or cold in the winter. These grasslands have rich soils. In the United States, temperate grasslands are called prairies.

Grasslands occur in two distinct areas of the Southern Appalachian region—in grassy balds and in valleys and coves.

- Grassy balds are patches of grass and shrubs that occur at high elevations (i.e., over 1,500 meters or 5,000 feet) in the Southern Appalachian Mountains. Grassy balds occur from Virginia south to Northern Georgia, but they are rare. They are rocky, cold, and windswept. Evidence suggests that some grassy balds are the result of human disturbances such as logging and fire over a century ago.
- Valley floors (such as along the Oconaluftee River) and coves (such as Cades Cove) have grassland communities. These areas may have been forested many years ago before they were cleared by humans.

Grasslands, "grassy balds," or "prairies" are important ecosystems within the Southern Appalachian region. Like other ecosystems, they are habitats for diverse populations of plants and animals. Delicate balances exist between the producers in an ecosystem and the consumers that depend upon them.

"Grassy balds are dominated by grasses, such as mountain oat grass, and sedges occasionally interrupted by small rock outcrops. The largest of these balds occur at elevations over 5,000 feet along the North Carolina-Tennessee state line on the Roan Mountain Massif, the Unaka Mountains, the Great Smoky Mountains, and in the Nantahala Mountains of southwestern North Carolina. While there are no species recognized as being unique to these communities, they harbor regionally

endemic and rare species of mammals, birds, and vascular plants associated with grasslands and high-elevation climates."

(*Source: Forest Encyclopedia Network, Grassy Balds, available online at <http://www.forestencyclopedia.net/Encyclopedia/Appalachian/the_southern_appalachian_landscape/naturalcommunities/southern_appalachian_biomes.htm/Encyclopedia_Page.2004-04-30.1845/document_view>, accessed 12/05.)*

Grassland communities occur in the open fields of Cades Cove, Cataloochee Valley, parts of the area along the Oconaluftee River, and other scattered low-elevation areas. Grasslands in the Southern Appalachian Region are susceptible to invasive species. Scientists study how exotic invasive species impact native Southern Appalachian Grassland communities.

(Source: Discover Life in America, Great Smoky Mountains ATBI, Cultivated Meadow, Nature Serve Identifier: CEGL004048, available online at <http://www.dlia.org/atbi/grsmnp_habitats/CEGL004048.shtml>, accessed 12/05.)

"Cades Cove, Great Smoky Mountains National Park, U.S.A., was historically cleared largely for pastoral purposes; it is now comprised of recently abandoned pastures dominated by non-native pasture species. To investigate the potential for reducing non-native species relative to native species, park managers initiated an experiment in 1995 that included mowing, herbicide application, planting of seed, and burning of replicate 20-50 meter plots at each of two sites within Cades Cove."

(Source: Charles A. Price and Jake F. Weltzin (2003). "Managing Non-Native Plant Populations through Intensive Community Restoration in Cades Cove, Great Smoky Mountains National Park, U.S.A.," Restoration Ecology Vol. 11 No. 3, pp. 351–358, available online at <http://eebweb.arizona.edu/Grads/Price/Price%20and%20Weltzin%202003.pdf>, accessed 12/05.)

A project carried out in greenhouses studies how young (emerging) grassland plant species compete for light and water. This study compares how plant species compete for light and water within their own populations and between species.

"Understanding the processes by which plants compete for limited resources is of critical importance to gaining a better understanding of how ecological systems will respond to environmental changes and disturbances. Competitive outcomes are driven by the availability of multiple resources; for example, the early stages of secondary succession are often driven by the availability of light and water."

(Source: Allison Fortner. "Interspecific and intraspecific competition in old-field plant communities," available online a <http://eeb.bio.utk.edu/weltzin/Home/undergraduate_students.htm>, accessed 12/05.)

Objectives:

Review and reinforce concepts of healthy ecosystems.
Apply concepts of healthy ecosystems to reclaim an ecosystem.

Prepare in advance:

- The teacher should thoroughly explore and experience the Web site (http://www.bellmuseum.org/distancelearning/prairie/build/) prior to engaging the students *(time: 20 - 45 minutes)*.
- Each student needs a copy of either Handout 1a (Tall Grasslands Guide) or Handout 1b (Short Grasslands Guide)
- Supply students with the URL for the "Build a Prairie" Web site (Handout 2).
- Bookmark the *Build a Prairie* Web site on the Web browser.

Materials:

One computer connected to the Internet for every two students

Description:

Ecosystems all have certain species that interact together to form a balanced community. When we learn more about basic changes on ecological systems and the impacts of those changes, we can apply that learning to other ecosystems that work the same way. When we learn about processes like competition for resources and environmental disturbances such as exotic invasive plant species, we can apply our learning to other ecosystems that work the same way.

In this interactive, online task, students choose either a tall-grassland or a short-grassland ecosystem to restore. Prompts imbedded in the program guide students in their selection of producers and consumers to reintroduce. They will venture into the Great Plains of North America's vanishing grasslands to learn about balanced grassland communities. This well-developed program provides gentle feedback to assure success. A field guide is available at each decision-making point. Using the guides helps students to make correct choices in restoring their ecosystem and gain greater depth of understanding.

Students can engage in interaction during this activity at various levels, depending upon the level of accountability the teacher requires. The optional "*Grasslands Guide*" is designed for students to record observations, reason, make decisions, and reflect. Students can just as easily use their lab notebooks for this same purpose. The goals of this exercise are to encourage students to read about native and exotic species and to use this knowledge to understand the structure of a healthy ecosystem.

Instructional sequence:

(5- 10 minutes)

- **Escort** students to the computer lab
- **Distribute** the URL for the "Build a Prairie" Web site. (Source: Build a Prairie," available online at <http://www.bellmuseum.org/distancelearning/prairie/build/> is part of the BellLIVE (http://www.bellmuseum.org/distancelearning/ belllive.html) 1999 "On the Prairie" program <http://www.bellmuseum.org/distancelearning/prairie/index.html> developed by Bell LIVE! and Educational Web Adventures, College of Natural Resources, © 1998 by the Regents of the University of Minnesota.)
- **Instruct** students to open the Web browser to <http://www.bellmuseum.org/distancelearning/prairie/build> and bookmark it.
- **Instruct** students to read the first Web page and decide which type of grassland they choose to restore.
- **Request** students to complete a "Tall Grassland Guide" or a "Short Grassland Guide" while building a prairie.

(25 – 35 minutes)

- **Distribute** the *Grasslands Guide* sheet appropriate for the grassland chosen.
- **Direct** students to proceed through the restoration process using the *optional Grasslands Guide* sheets provided. The teacher should be available for clarification and guidance. If the guide sheets are *not* used, it may be necessary to remind students to use the on-site *"Field Guide to the Prairie"* to assist them in the decision-making process.

(20 – 30 minutes)

- **Online Extension:** students can restore an additional ecosystem.

(10 – 15 minutes)

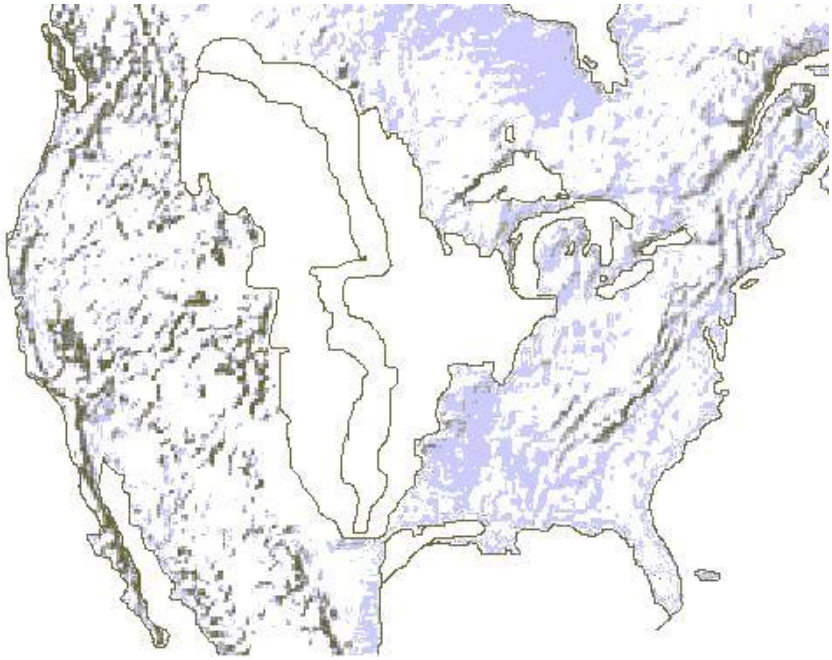
- **Generate** a discussion about the grassland ecosystem with students. On a map, **Point out** the location of grassland ecosystems within the Southern Appalachian Region (e.g., Cades Cove and various balds in the Southern Smoky Mountains). Help students recognize native plants in this region as well as animals that depend upon specific plants for survival (e.g., cover and food).

Optional Assessment Task:	Create an exhibit/diorama to demonstrate life within an ecosystem. Include a brief description of how the sun affects an ecosystem and patterns of relationships between living, non-living, and dead things found within it.

Handout 1: Tall Grasslands Guide

Build a Prairie Web Site:
<http://www.bellmuseum.org/distancelearning/prairie/build/>

Color the tall grass prairie area green



How can you tell the difference between a mesic prairie and a wet prairie?

_____

_____

Why is couch grass considered an "invader" on the mesic prairie?

_____

_____

_____

Which other grass is a "weed" on the tall grass prairie?

_____

Which of the six forbes are the exotic invasive plants?

_____

_____

Which forb is on the endangered species list?

_____

Face of an owl and body of a hawk – it must be a

_____

Which raptor of the tall grass prairie was the most surprising to you?

_____

What surprised you about that particular bird?

_____

_____

Do you think coyotes and red foxes would compete for prey in a tall grass prairie? _____

Explain your answer:

_____

_____

_____

Which reptile would go hungry in the tall grass prairie?

_____

Explain your answer:

_____

Describe why the two invasive insect species are unwanted guests in the tall grass prairie.

_____

_____

_____

How are prairie plants adapted to survive prairie fires?
Hint: see <http://www.abnc.org/stewardship/prescribed-burns.php> and <
http://www.fpdwc.org/burning.cfm> (Natural History of Fire and Why Prescribed Fire?)

_____

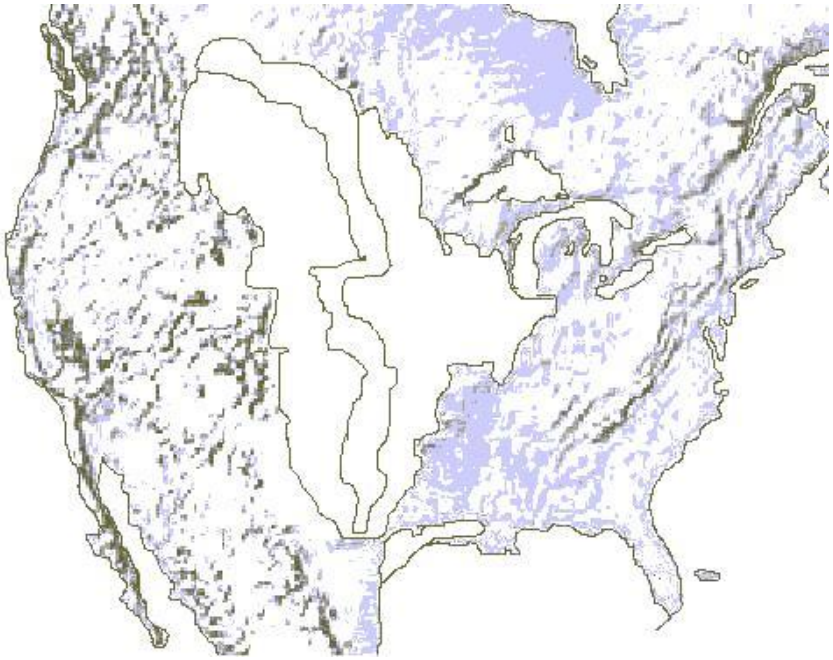
_____

_____

Handout 1: Short Grasslands Guide

Build a Prairie Web Site:
<http://www.bellmuseum.org/distancelearning/prairie/build/>

Color the short grass prairie area yellow



In the valleys of dry prairies, you would probably find another type of prairie.

Which type? _____Describe how is this type is different from a dry prairie.

_____

_____

What are the two grasses considered "invaders" on the short grass prairie?

1. _____ 2. _____

What makes them unwanted species on the short grass prairie?

_____

_____

Which of the six forbes are the exotic invasive plants?

_____

Describe how each exotic invasive plant is a danger to other short grass native plants.

_____

_____

Which of the birds you have to choose from would be much happier near a wet prairie?

_____

What do you think would happen to the number of rabbits and mice in the short grass prairie if the ferruginous hawk became extinct?

_____

Do you think anything would happen to the plant populations if the ferruginous hawk became extinct? _____

Explain your answer:

_____

_____

Which short grass prairie mammal often gives birth to twins?

_____

What is another unique fact about this species?

_____

Why do you think there is a large number of snake species in the short grass prairie?

_____

_____

Describe why the two insect species are unwanted guests in the short grass prairie.

_____

_____

How are prairie plants adapted to survive prairie fires?
Hint: see <http://www.abnc.org/stewardship/prescribed-burns.php> and <http://www.fpdwc.org/burning.cfm> (Natural History of Fire; Why Prescribed Fire?)

1. _____

2. _____

<http://www.bellmuseum.org/distancelearning/prairie/build/>

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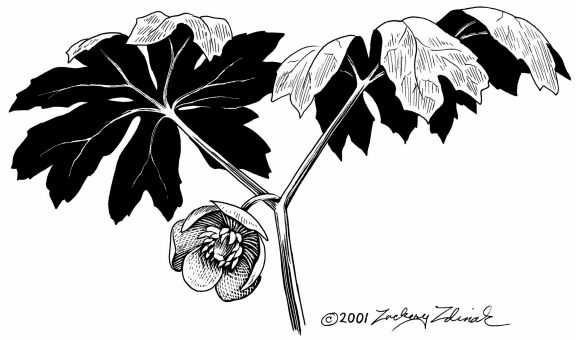
Organisms found in Southern Appalachia

Tussock Sedge

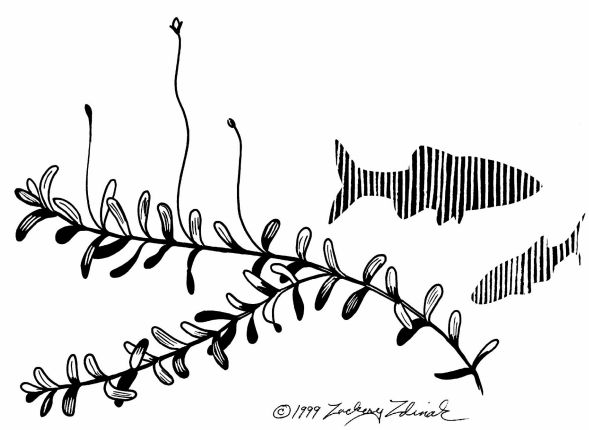
Stinging Nettle

Wild Strawberry

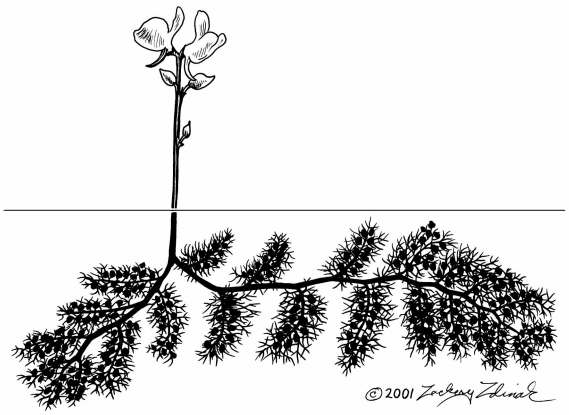


May Apple

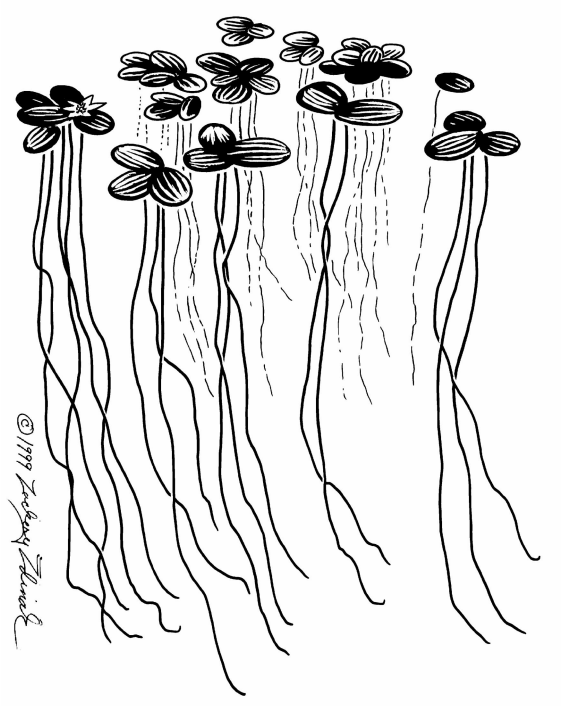
Jack-in-the-Pulpit



Elodea



Baldderwort



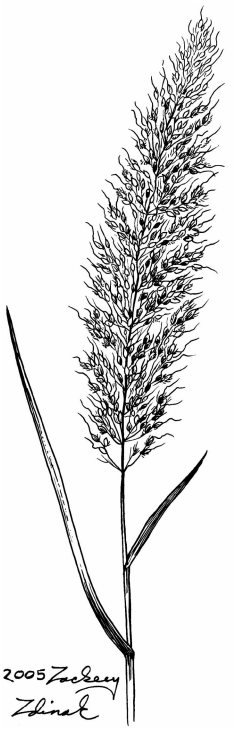
Duckweed

Black-eyed Susan

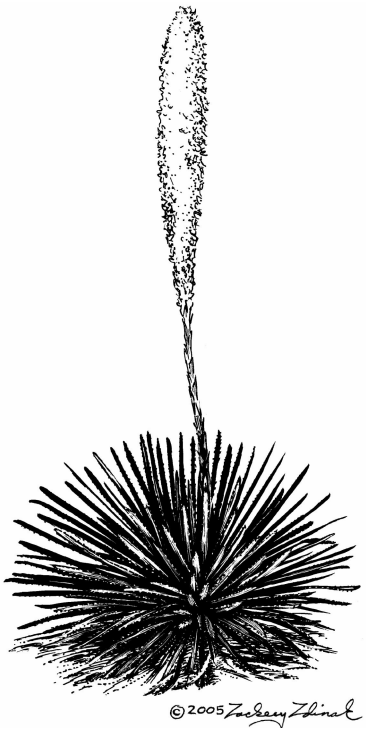
Little Bluestem

Trout Lily

Butterflyweed



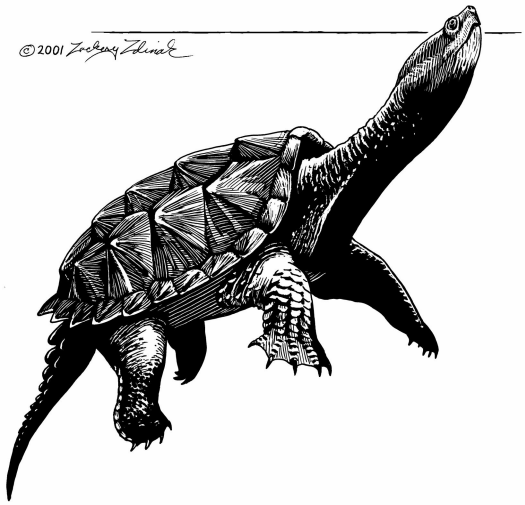
Indian Grass



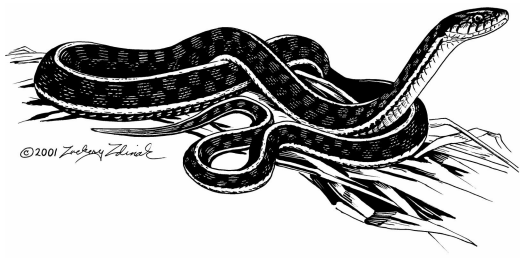
Sotol

Consumers

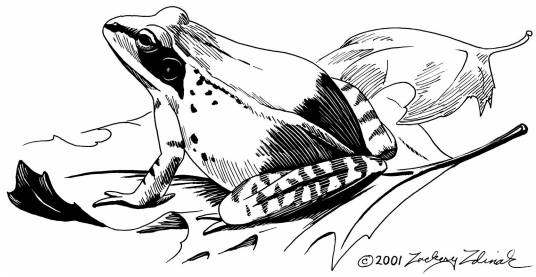
Raccoon



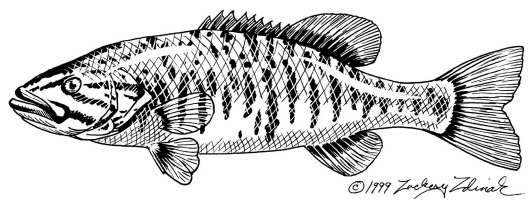
Snapping Turtle



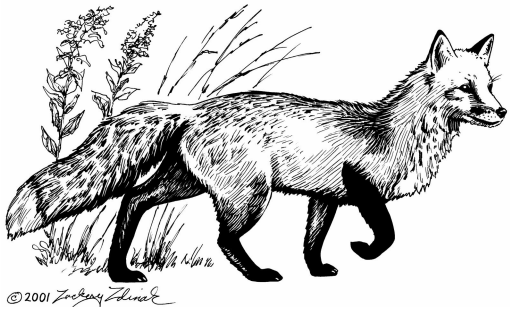
Eastern Garter Snake



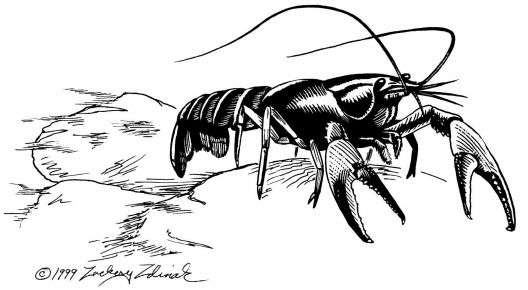
Wood Frog



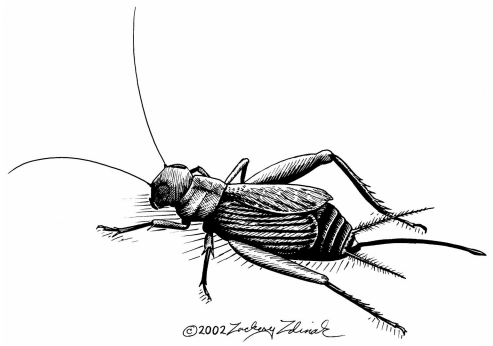
Small-mouthed Bass



Red Fox

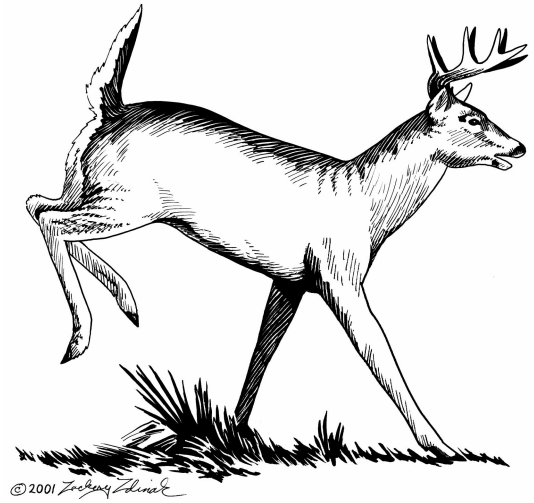


Northern Crayfish



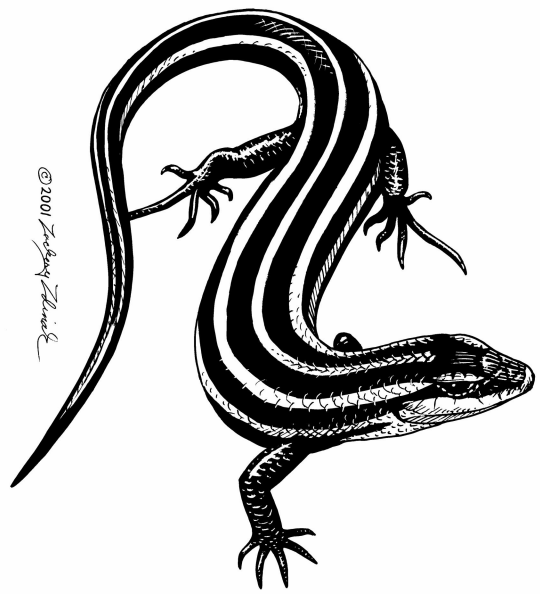
Field Cricket

Otter



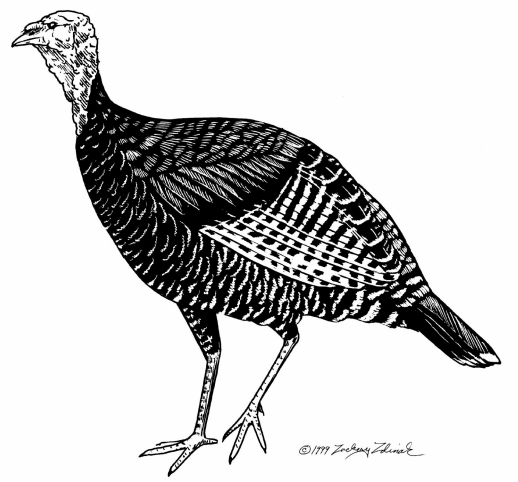
White-tailed Deer (Buck)

Great Horned Owl

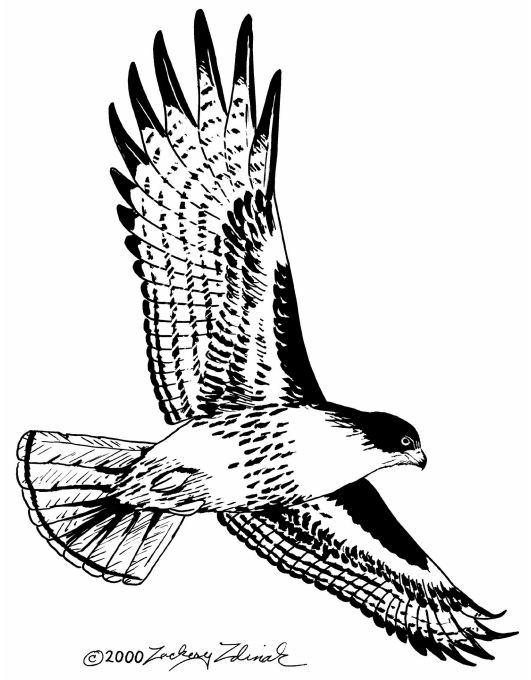


5-lined Skink

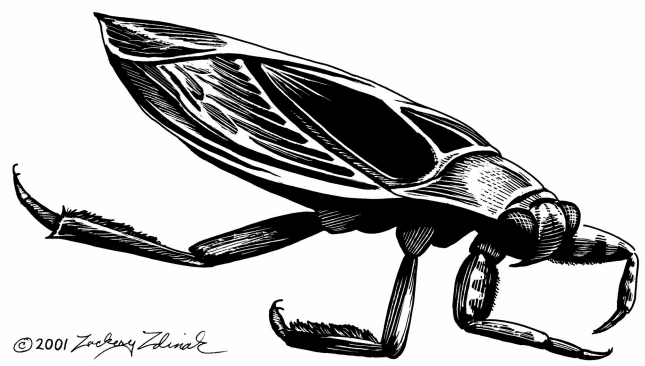
Eastern Cottontail



Wild Turkey

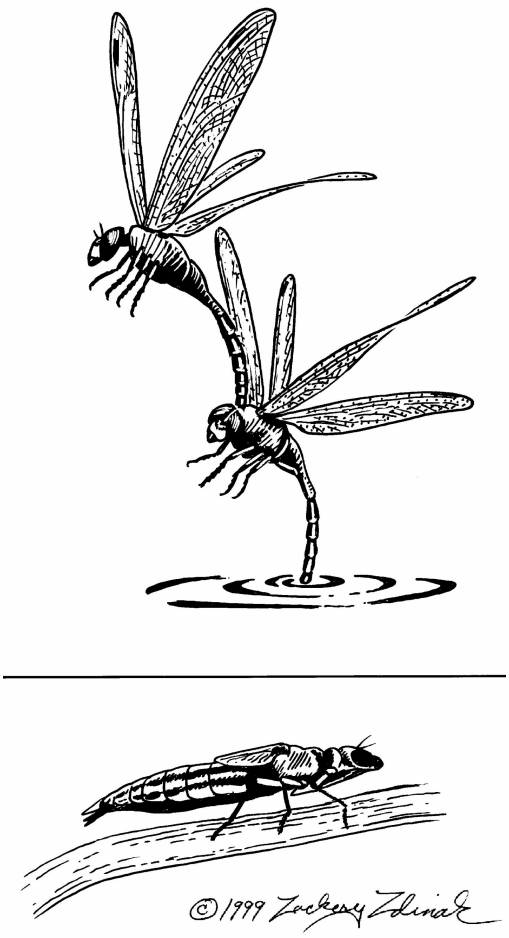


Red-tailed Hawk

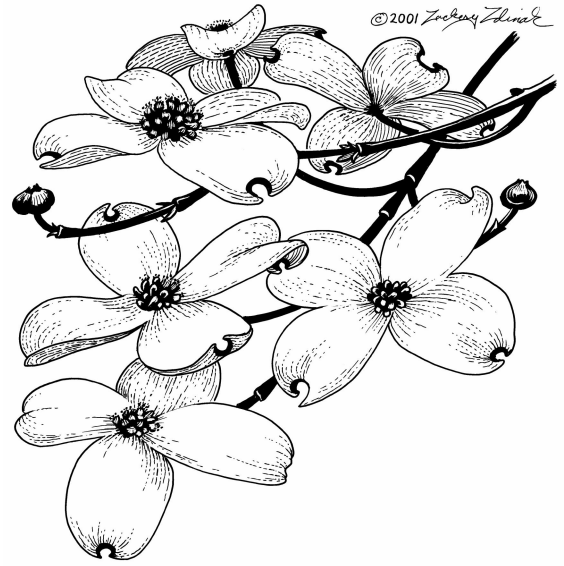


Giant Water Bug

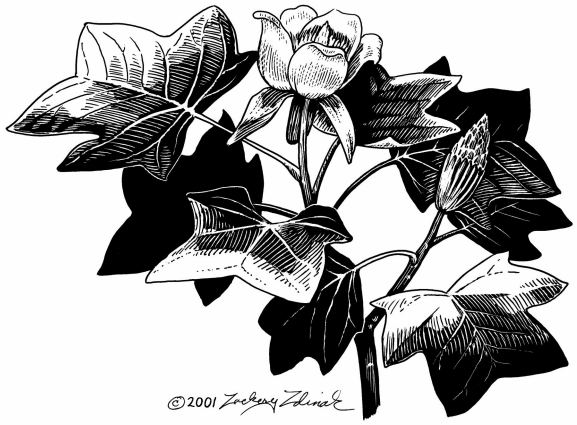
Pileated Woodpecker



Dragonfly



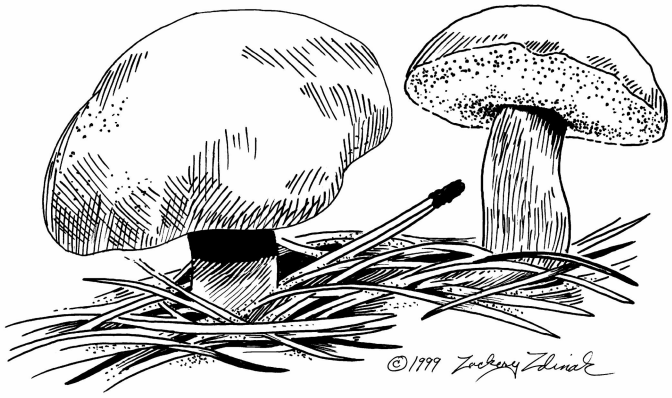
Dogwood



Tulip Tree

Red Cedar

Swamp Azalea

Decomposers	
 Amanita Caesarea	 Ink Cap Mushroom
 Boletus	


Mountain Stream