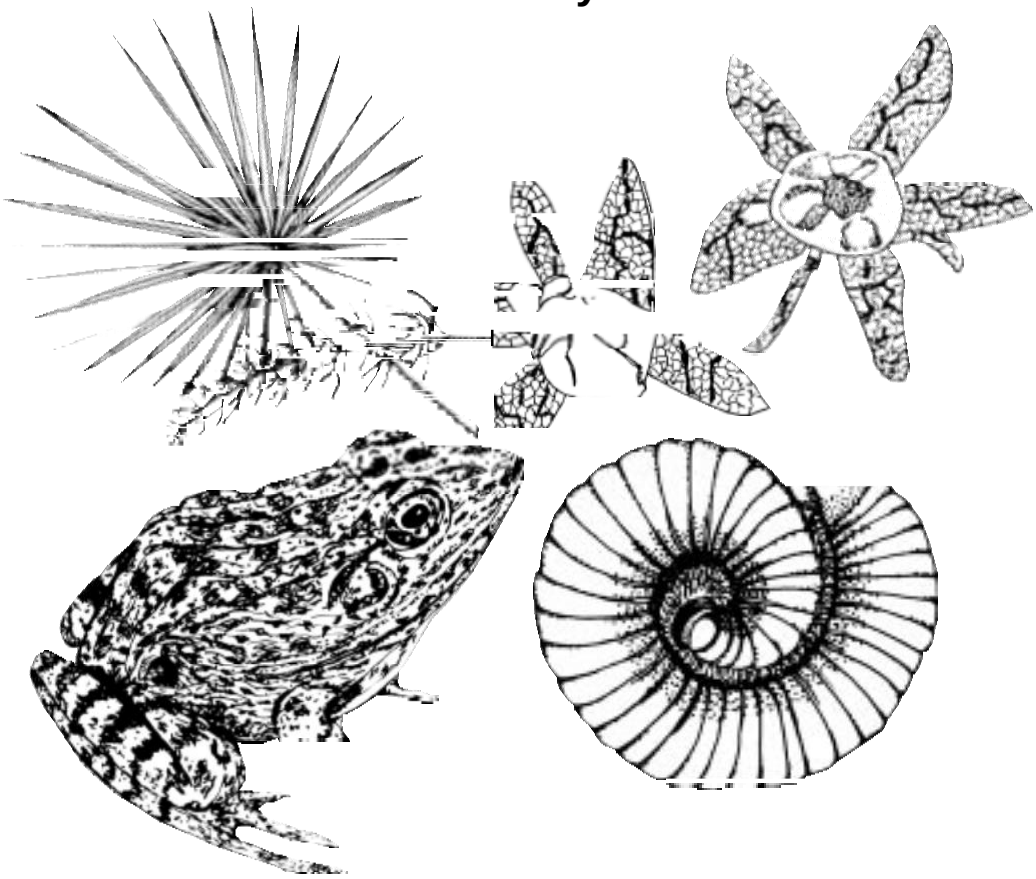
DISCOVERING FLORIDA SCRUB

a guide to exploring science in a native ecosystem



environmental education activities for 3rd, 4th and 5th grades

by Nancy D. Deyrup and Charlotte B. Wilson
Archbold Biological Station

Illustrated by Virginia Carter

DISCOVERING FLORIDA SCRUB

ACKNOWLEDGEMENTS

This project grew from our desire to provide Florida children with more opportunities to be immersed in a local, threatened habitat. Our shift of focus from teaching children to writing a curriculum for educators was a logical one and required input from many talented and knowledgeable people with a great deal of experience both in education and in science.

We were able to undertake this curriculum because of the extraordinary level of support from the staff and Trustees of Archbold Biological Station. Executive Director Hilary M. Swain, and Research Biologists Reed Bowman, Mark A. Deyrup, Eric S. Menges, and Glen E. Woolfenden, and Land Manager Kevin N. Main reviewed the material and answered a multitude of questions. Reed Bowman wrote the chapter, Research in the Florida Scrub. Mark Deyrup was especially generous with his time and expertise and took a very active interest in this project. He offered countless ideas and worked closely with the illustrator to familiarize her with many scrub organisms. Information Manager Fred E. Lohrer was a meticulous and thorough editor. Richard Lavoy helped test and retest the activities. Helen W. Obenchain and Ingrith D. Martinez provided dependable office support.

Sandi Schlichting and Cindy Benkert of the West Central Florida Environmental Education Regional Service Project, St. Petersburg, Florida, helped ensure that the Sunshine State Standards covered by curriculum activities were properly identified and helped locate teachers for field-testing the activities. Sandi was always prepared to give helpful advice and was a very dependable and necessary resource throughout the project's development.

The following advisory panel of Highlands County, Florida, teachers met with us repeatedly to provide comments and suggestions as the project progressed: Sandi Smith, Marilyn Blair, Ann Homan, Donna Tomlinson, Kim Douberly, Gail Penfield, and Sherri Hall. We are especially grateful to Marilyn Blair for all the time and energy she invested in this project and for her valuable insight and ideas.

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Brenda Wunker and Cindy Landen of Babson Park Elementary,
Amy Till, Jenny Insua, Sandy Bush, David Coleman of Bartow Academy, Marilyn Blair of Fred Wild Elementary in Sebring,
Kim Douberly of Sun 'n Lake Elementary in Sebring,
Gail Penfield of Park Elementary in Avon Park, and
Karla Patrini and Susan Moye of Wauchula Elementary.

Archbold Biological Station, a privately endowed research facility located in south-central Florida, is "devoted to long-term ecological research and conservation, part of the global effort to understand, interpret, and preserve the earth's natural diversity." Since 1941, scientists at Archbold have conducted research on the flora and fauna of the scrub habitat on the Lake Wales Ridge, a relict sand dune habitat with one of the highest concentrations of threatened and endangered species in the United States. The Station owns and manages a 5,160-acre natural preserve. Over 1,100 scientific publications document the important studies at Archbold. Some of the long-term research projects, like the internationally recognized Florida scrub-jay study, have been conducted for more than 30 years.

James E. Carrel, Professor at the University of Missouri in Columbia and visiting scientist at Archbold Biological Station, edited the section on scrub burrowing wolf spiders.

Janice Easton, currently a graduate student at the University of Florida, reviewed the curriculum and provided helpful suggestions for the evaluation methods on pages 6-7 and the evaluation questions at the end of each unit.

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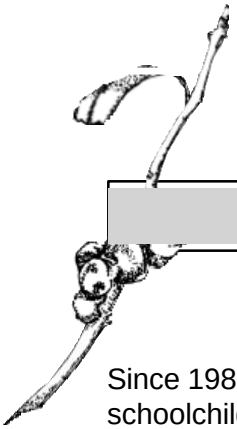


CURRICULUM GOALS AND DEVELOPMENT

Since 1989, Archbold Biological Station has included environmental instruction for elementary schoolchildren as a part of its activities. Over 10,000 students have participated in this outdoor environmental education program. Each year, virtually every 4th grade student in Highlands County completes prepared classroom material on scrub ecology and participates in a full day of outdoor activities during a field trip to Archbold. One of the program's strengths is that the Education staff has easy access to Archbold's research programs and facilities and, as a result, is able to convey recent scientific findings to students.

Although the program has been very successful, one field trip for each Highlands County 4th grade student was not enough. The Education staff who developed this curriculum (Nancy Deyrup and Charlotte Wilson) wanted to do more. We wanted to reach more students and teachers and make Archbold education products available in other regions of Florida with scrub habitat. We wanted to give teachers ideas and expanded material so they could further develop their instruction and provide students with enhanced opportunities to learn outside. We wanted students throughout the state to be more involved with hands-on science exploration and to discover, from first-hand experience, many of the organisms and interactions that make an ecosystem—especially Florida scrub—so outstanding. These were the motivating factors that led us to develop Discovering Florida Scrub; a guide to exploring science in a native ecosystem.

This curriculum is designed to serve as a bridge between the interesting and complex world of science, the needs of busy teachers, and the learning styles of curious students. The goal of the curriculum is to give teachers and students a deeper understanding of science and the practice of science, and a greater appreciation for the Florida scrub.

The specific objectives of this curriculum are to provide science activities that:

- Increase teacher and student understanding of ecological principles such as predatory/prey relationships, food webs, microhabitats, and adaptations.
- Convey the principles of the scientific method to teachers and students.
- Increase teacher and student knowledge of the scrub—a unique Florida ecosystem.
- Provide teachers with scientific tools and techniques appropriate for 3rd, 4th, and 5th grades that will enhance student understanding of how science is conducted.
- Show how science can be integrated with other subjects, such as language arts and math.
- Increase the use of inquiry-based, action-oriented learning by students in the classroom and on field trips.
- Encourage teachers to take their classes out in the field more often by providing the structure needed for outdoor learning.
- Increase the use of collaborative learning, including teamwork and discussion, among students.
- Enable teachers to use this curriculum to meet their needs for science, math, and language arts education by providing cross-references between this curriculum and the Sunshine State Standards.
- Increase student interest in, and attitudes towards, ecology and science.
- Increase positive attitudes among teachers and students about the need to conserve and protect the Florida scrub and other native ecosystems.

Science Education Resources

Office of Environmental Education
1311 Paul Russell Road
Suite #201A
Tallahassee, FL 32301
1-800-542-3733
www.polaris.net/~oee/oeeinfo.htm

This office coordinates the state's five Environmental Education Regional Service Projects. (Phone numbers listed below.)

Region I: 850-638-6131
Region II: 904-329-3800
Region III: 407-823-3807
Region IV: 813-553-3165
Region V: 954-986-8050

League of Environmental Educators in Florida, Inc
P.O. Box 6061
Live Oak, FL 32069
www.flmnh.ufl.edu/fnps/education.htm

Florida Center for Environmental Studies
Florida Atlantic University
N. Palm Beach Campus
3970 RCA Blvd.
Palm Beach Gardens, FL 33410
561-691-8554
http:// www.ces.fau.edu/

Florida Department of Education
325 West Gaines Street
Tallahassee, FL 32399
http://www.firn.edu/doe/

Florida scrub was chosen as a model habitat for this curriculum development for three reasons:

- The Florida scrub is a unique ecosystem with extraordinary species and features that make it a dynamic and interesting system in which to explore science. The major factors that affect scrub organisms, such as sand and fire, are both fascinating and relatively easy to understand.
- We could capitalize on the extensive knowledge collected by Archbold on the scrub ecosystem—making it one of the best understood systems in the state.
- Third, increasing community-wide understanding that protecting endangered habitats such as Florida scrub is important and perhaps critical to their preservation.

However, it is important to realize that many of the ideas behind these projects, such as the significance of soil types and drainage or the relationships between producers, consumers, and decomposers, apply to other Florida ecosystems. Furthermore, this curriculum is not a comprehensive overview of scrub ecology. We chose to focus on plant and animals that would most likely be present regardless of how big or intact a scrub site might be. Almost all of the activities focus on plants and invertebrates. Vertebrates are not highlighted for several reasons. Most scrub mammals are nocturnal. Because they spend the day in their burrows or nests, scrub mammals can be very difficult to observe directly. In addition, there are no activities involving fire. Although fire is an important feature of Florida scrub and working with fire is an outstanding educational experience, it is not recommended for schoolchildren!

One of the main goals of this curriculum is simply to get students out in the scrub with their eyes wide open. Who knows what they will see? Perhaps something that no scientist has ever noticed. They will certainly see many organisms and phenomena not mentioned in this curriculum. Each time your students see something new, they have the opportunity to ask their own questions and, with your guidance, to find interesting ways to answer these questions.

On page 169 of this curriculum is an evaluation form. Any curriculum is a work in progress and is in constant need of refinement and refreshment. We are very interested in your views of how well this curriculum works. Please let us know. We will post educator feedback along with curriculum updates and changes on our web site www.archbold-station.org.

HOW TO USE THIS BOOK

Children are better learners when they are encouraged to ask questions, and then allowed to explore and discover the answers to these questions through hands-on activities. With Florida scrub as its focus, this curriculum provides you, the educator, with some of the tools you need to teach ecology principles and concepts in ways children learn best. By using the activities in this book, you and your students will learn about the scientific method, investigate a very rare and distinctive ecosystem, and become better acquainted with the "real" Florida.

Discovering Florida Scrub is divided into four units, each with one or more sections. Because the concepts presented in this curriculum become more complex with each unit, we highly recommend that you begin with the first unit.

Each unit consists of the following components:

- **Objectives** will list ecological concepts included in the unit and the skills students will develop as a result of completing the unit activities.

- The **Introduction** and **Background Information** portions will help you present the units to your class.

- **Outdoor activities** are indicated by a symbol of the sun () and require that you take your students to appropriate schoolyard sites or to other accessible scrub sites. All outdoor activities have an indoor component that involves analyzing data collected by your students.

- **Indoor activities** are designed for the classroom and are indicated by a light bulb symbol (). We suggest that you try these activities before you attempt them with your class.

  At the beginning of each activity, the following information is provided:
  a. Concepts will list the ecological principles addressed in each activity.
  b. Skills will list the thinking strategies and manipulative skills used during the process of that activity.
  c. Time needed will state the approximate time required for your class to complete the activity. It does not include prep and set-up time.
  d. Best time of year. While many of the activities can be done throughout the year, some may require a particular season.
  e. Sunshine State Standards.

  Each activity will also include:
  f. Materials you will need to complete the activity. Whenever possible, supplies that can be found around your home or school are used. Some materials may need to be ordered.

  g. Instructions for the teacher can be found on bordered pages and includes all the information you will need to complete the activity. If you have not yet taken your students outside for this type of exploration, see Tips on Exploring the Outdoors with Your Students on page 152.

h. Student Data Sheets are designed especially for students and are indicated by a watermark and a pencil symbol (✎) on the upper left corner of the page. The distinct type-face and format will be easily recognized. Some activities also include Class Data Worksheets to help you compile student data.

i. Notes may suggest other ways of doing the activity. For example, you may choose to do some activities several times throughout the year and compare the results.

j. Results will summarize important scientific concepts and skills covered by the activity.

k. Further Questions and Activities for Motivated Students, included with some activities, offers challenges for eager students who want more.

At the end of each unit you will find:

- A **Glossary** to help you and your students understand terms found within the unit. Words that are bolded will appear in unit glossaries.

- **Questions for Student Evaluation** that can be used after completing unit activities to test student knowledge of ecological concepts and science methodology as well as scrub examples included in the unit.

  The questions provided range from easy to difficult. We encourage you to select questions that are appropriate for your students and, if necessary, make changes in the questions so they are more useful in your situation.

On page 169 of this curriculum is an evaluation form. Any curriculum is a work in progress and is in constant need of refinement and refreshment. We are very interested in your views of how well this curriculum works. Please let us know. We will post teacher feedback along with curriculum updates and changes on our web site www.archbold-station.org.

Ongoing Assessments can help you evaluate your students' advances and should be completed during or after each activity. Consider using some of the following ideas:

1. Stand back and watch individual team members interact. Listen to their comments and observe their behavior. Make a checklist to help you keep track of the desired goals. For example, if you want students to improve skills in teamwork and in the scientific method, your checklist might look like this:

   Name Date

Score	Objective
	Curious and interested in activity
	Works well with others
	Listens to other team members
	Keeps a positive attitude during activity
	Observes carefully
	Asks questions and looks for answers
	Is able to state hypothesis
	Keeps careful records
	Takes careful measurements

2. Ask students to evaluate their own team using questions such as:
    a. On a scale of 1-5 with 5 being the best, how well did your team members share ideas?
    b. On a scale of 1-5 with 5 being the best, how well did your team members respect different opinions and help each other learn?
    c. What did you learn from this activity?

3. Have students make a collection of their papers, drawings, and data sheets. Can you see an improvement over a period of time in their record keeping and involvement?

4. You can also measure your students' knowledge and attitude skills with a pre and post-test instrument. The following questions can be used before and after you use this curriculum to look for attitude changes:

    Circle the phrase that best describes how you feel about the following statements.

    a. I feel very much at home in the scrub.

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree

    b. I do not want to spend any more time learning about scrub.

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree

    c. I enjoy learning about Florida scrub best when I am outdoors.

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree

    d. We don't need to protect the scrub because we do not really use it for anything.

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree

    e. I like activities that take place in nature.

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree

Other references for good ideas on assessment techniques include:

- Ballas, Jacqua and Kathy Abrams. 1998. Teaching Naturally. Using Environment to Improve Teaching and Learning. An Interdisciplinary Guide to Sunshine State Standards. Florida Department of Education.
- Hogan, Kathleen. 1994. Eco-Inquiry. Institute of Ecosystem Studies. Kendall/Hunt Publishing Co., Dubuque, Iowa.
- Wolfe, Christopher. 1999. Reaching All Students: Assessing Student Learning. Dragonfly Teacher's Companion May/June 1999, 5-6.

Field guides are extremely helpful to have in your classroom for student reference. Children seem to especially like the inexpensive, easy-to-use Golden Guides, published by Golden Press, New York Western Publishing Company, Inc. and available in most bookstores. Some of the Golden Guide titles include:

Birds	Pond Life
Butterflies and Moths	Reptiles and Amphibians
Insects	Spiders and Their Kin
Mammals	

An additional paperback series with good color pictures is Florida's Fabulous, published by World Publications, Tampa, Florida. Titles include:

Butterflies: Their Stories, by Thomas Emmel
Insects: Their Stories, by Mark Deyrup will be published by the end of 1999.
Land Birds: Their Stories, by Winston Williams
Mammals: Their Stories, by Jerry Lee Gingerich
Reptiles and Amphibians: Their Stories, by Peter Carmichael and Winston Williams
Waterbirds: Their Stories, by Winston Williams

A **bibliography** at the end of the book provides more information sources for curious educators.

The Florida Scrub Coloring Book (1996) is a good learning tool and is an informative and attractive accompaniment to this curriculum. The coloring book is available to teachers at no expense from St. John's River Water Management District (P.O. Box 1429, Palatka, Florida 32178-1429) or for the cost of shipping from Archbold Biological Station (P.O. Box 2057, Lake Placid, Florida 33862).

Although this curriculum has a copyright, educators are permitted to photocopy pages for their students. This curriculum is also available on the Internet by visiting the Archbold Biological Station web site at **www.archbold-station.org.** Any revisions made to this curriculum after publication can be found on the Internet version.

If you have questions or comments, call the Education Office at Archbold Biological Station in Lake Placid, Florida at 863-465-2571, send us a fax at 863-699-1927, or e-mail a message to us at educationoffice@archbold-station.org.

AN INTRODUCTION TO FLORIDA SCRUB

Welcome to Discovering Florida Scrub curriculum. Sorry the habitat name is not more inspiring. If Florida habitats could be named all over again, maybe scrub could be the Florida Dwarf Forest, or the Florida Elfin Woods, or the Florida Pygmy Oak Woodlands. Alas, it is too late now to choose a pretty name. Florida scrub is the original name, the tough name, the name that makes no promises. Maybe it's an appropriate and meaningful name after all.

In spite of its unattractive name, Florida scrub is famous, recognized nationally as an unusual place with strange plants and animals. Biologists come from all over the country to study scrub. What is scrub and what makes it so special?

What is scrub?

Florida scrub is frequently considered to be Florida's most distinctive ecosystem. With so many interesting ecosystems that exist in Florida, such as mangrove swamps, hardwood hammocks, dry prairies, and freshwater marshes, the title is an honorable one. Florida scrub has some very striking differences.

Age

Florida scrub is a very old ecosystem found on coastal and ancient inland dunes throughout the state. Some of the inland ridges of scrub have been around since the early Pleistocene (approximately one million years ago), while other parts of Florida, such as the Keys, have been above sea level for only a few thousand years.

Moisture

While much of Florida is very flat, low, and wet, Florida scrub is relatively high (sometimes more than 200 feet above sea level), dry, and desert-like. Although seventy-six percent of the annual rainfall (or approximately 40 inches) is produced during six months of summer, winters are very dry. Rain drains through scrub soil very quickly. Even within an hour of a heavy rain, very little water will remain on top of the sand. (During the wet season, seasonal ponds may form in some depressions found among the ridges.)

Soil fertility

Most of Florida is sandy. But while many habitats have rich organic matter mixed with sand, scrub soils have lost almost all of their organic components to the action of wind, waves, and water and are chronically low in nutrients. Because water soluble compounds leach out quickly, only plants adapted to the dry, sandy soil and low nutrient levels can survive.

Ecosystem, Habitat, or Community

What's the difference?

A **community** includes all the organisms—or all the populations of different species—that live and interact in a particular area.

A **habitat** typically has a characteristic community of organisms and is generally defined by the plant community that occurs.

An **ecosystem** may be comprised of several habitat types. An ecosystem includes all the life forms that exist in an area and all the nonliving factors such as temperature, moisture, and nutrients.

Florida scrub is often discussed as both a habitat and an ecosystem. Scrub is a shrub community with a variation of organisms from site to site and is part of a larger xeric (dry) upland ecosystem that includes high pine.

Location of Florida Ridges (peninsular)

1. Brooksville Ridge
2. Mount Dora Ridge
3. Lake Wales Ridge
4. Crescent City Ridge
5. Deland Ridge
6. Atlantic Coastal Ridge
7. Lakeland Ridge
8. Bombing Range Ridge

Modified by Deyrup (1989) from White (1970)

Fire-frequency

Fire affects almost all plant communities in Florida, but the frequency of fire in scrub is higher than for other habitats. Fires usually occur at intervals of about 5-25 years in scrub. Lightning strikes central Florida more frequently than anywhere else in the United States. Historically, lightning-ignited wild fires periodically scorched, yet regenerated, patches of the scrub landscape. These regularly occurring fires swept across the landscape in erratic patterns, keeping scrub relatively low and open and ensuring a mosaic of scrub that varied in stages of growth.

Plant community

More than anything else, plants define Florida scrub. (Biologists typically define habitats by the community of plants that are found in an area. Sixty-nine different plant community types occur in Florida.) Florida scrub has a very distinct plant community. Instead of the trees or grasses found in many other Florida habitats, scrub is dominated by shrubs and dwarf oak trees, with an occasional pine mixed in. Other plants typically found in scrub include low palmettos, hickories, and Florida rosemary. Scattered throughout the scrub are bright, open patches of bare sand dotted with small herbaceous plants and lichens.

The combination of plants that occur in scrub varies from site to site. Sand pine scrub is sometimes open and airy or forest-like with a dense overstory of mature sand pines and a shrub layer underneath. On more excessively drained scrub sites you may find nearly pure stands of Florida rosemary. Oak scrub can be dense or open. Coastal scrub can be treeless. Some of the shrubs, small plants, and trees that live in Florida scrub occur nowhere else in the world.

Living among the plants are many animals—mammals, birds, reptiles, amphibians, insects, and spiders. Among these organisms are forty species of plants, four species of vertebrates, and at least forty-six species of arthropods that are found in Florida scrub and nowhere else. These species are well adapted to life in the dry, sandy, nutrient-poor scrub soil.

Where can scrub be found?

Florida scrub is found on coastal and inland ridges throughout Florida. These ridges also support other dry, but very different habitats, such as sandhill and scrubby flatwoods.

As seen on the map, three major groupings of scrub exist: coastal panhandle, coastal peninsula, and inland peninsula. The biggest areas of scrub are found inland with the largest block occurring in and around Ocala National Forest.

Millions of years ago, these ridges were formed by rising and falling sea levels. During the periods when the sea level was high and flooded most of peninsular Florida, these ancient islands became refuges for plants and animals. Populations were isolated from the mainland for thousands of years and evolved within these small, sandy habitats. The central inland ridges are older, having remained islands while coastal ridges were flooded, and have a greater concentration of endemic species.

The Lake Wales Ridge, an inland ridge, is the highest and oldest ridge in Florida. Extending about 100 miles north to south from Clermont to Venus and 4 to 10 miles wide, the Lake Wales Ridge holds a large portion of the remaining scrub habitat. Several scrub species—17 species of plants, 1 species of vertebrates, and at least 10 species of arthropods—are found on the Lake Wales Ridge and on no other ridges. (For a list of species endemic to Florida, contact the Florida Fish and Wildlife Conservation Commission. See page 156 for contact information.)

Before the ridges were formed when the southeastern United States was very dry, many western species were also found in Florida. When the climate became much wetter, some of these desert species were able to survive on the dry sandy ridges. When the oceans receded, these species remained on the ridges. Today, these species, such as the gopher tortoise, the Florida mouse, and the Florida scrub-jay, have obvious western relatives, but are really quite different.

For more information about scrub sites in your area that are accessible to the public, contact the Florida Fish and Wildlife Conservation Commission, the U.S. Fish and Wildlife Service, The Nature Conservancy, or your water management district office. See page 156-157 for contact information.

Location of Florida Scrub (peninsular)

Redrawn by Deyrup (1989) from Davis (1967)

Why do so many plant and animal species live only in Florida scrub?

The reason: this habitat has an unusual blend of challenges and opportunities, and some plants and animals are specialized to meet these challenges and take advantage of these opportunities. Life in Florida scrub is complicated, as it is everywhere else. However, the combination of scrub's distinctive features and history make it exceptional.

First, sand is ideal for animals that dig. Many of these animals require deep, well-drained soil or are dependent on hosts that, in turn, depend on the characteristics of scrub soil. While sand provides opportunities for digging animals, their natural enemies also move easily through sand and are a constant threat.

Endangered and Threatened Species

Both the state of Florida and the United States government maintain a list of endangered and threatened species. The two lists are not identical because the state list considers the status of a species only within Florida. Therefore some widespread species common outside the state, such as the marsh wren, burrowing owl, alligator snapping turtle, or eastern chipmunk, are rare in Florida and appear on the Florida list but not on the federal list.

The Florida Fish and Wildlife Conservation Commission (formerly the Florida Game and Freshwater Fish Commission) maintains the state lists of animals, which are categorized as endangered, threatened, and species of special concern. The Florida Department of Agriculture maintains the lists of plants, which are categorized as endangered, threatened, and commercially exploited.

The federal list of plants and animals is maintained by the U.S. Fish and Wildlife Service and categorized into endangered species, threatened species, and candidates for designations.

To obtain a list of endangered species in Florida see the U.S. Fish and Wildlife Service and Florida Fish and Wildlife Commission listings in Sources of Scrub Information on page 156.

Second, while fires are a hazard for scrub plants and animals, they also provide opportunities for a new start in less crowded conditions. Most scrub plants are adapted to fire and can resprout or reseed. The sand can act as a bank, storing viable seeds, sometimes for decades, until the conditions are right for germination. Sometimes seeds only need an open area where sun can warm the sand.

Third, as mentioned above, some of the species found in Florida scrub are related to western species that were also found here. Florida scrub is a lingering example of a series of dry habitats that extended from southwest North America across southern North America to Florida hundreds of thousands of years ago. Since Florida is often very hot and dry and has very porous soil, some plants and animals from the old dry habitat have remained in scrub—even though the climate is now much wetter.

What plants and animals are found in scrub?

Because of scrub's unusual blend of features, Florida scrub has unique and fascinating species, including the Florida scrub-jay, the Florida mouse, the sand skink, the blue-tailed mole skink, the various species of scrub mints, the Highlands scrub St. John's-wort, the scrub golden aster, and the scrub wedge-leaf button snakeroot. All of these species are considered either threatened or endangered. They are rare because they have a limited distribution within Florida scrub and may occur at some scrub sites but not others. They are also rare because much of their habitat has recently been destroyed for agriculture, commerce, and housing. Many other scrub species, such as the Florida scrub lizard and the scrub pawpaw, are not in trouble yet, but the areas where they live and grow are also diminishing.

The Florida scrub-jay is probably the best-known scrub endemic. Scrub-jays require a low shrub layer with no canopy. When fires are suppressed, scrub becomes overgrown and scrub-jays abandon the site. Eighty-five to ninety percent of the Lake Wales Ridge xeric uplands, which include scrub, have been lost to development or agriculture. Much of the remaining ten percent is degraded or has been subdivided for residential use. Proper management of the remaining scrub can be difficult or sometimes impossible.

Mourning over the losses with your students, most likely, will not help them foster a positive attitude toward threatened habitats. Students need opportunities to discover and celebrate what remains and to find the personal value of wild places as well as the biological necessity of them. These students could grow up to be guardians of our Florida scrub heritage.

I. UNIT ONE

SAND: FLORIDA SCRUB'S FOUNDATION

Objective: To better understand some adaptations of scrub plants and burrowing scrub animals by investigating the characteristics of sand.

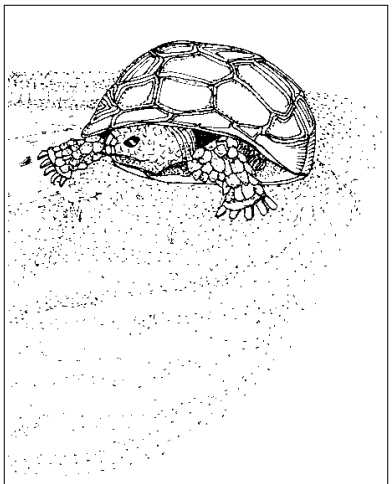
A. Physical Properties of Sand

- **I.A.1 Why Doesn't a Small Animal Burrow in Sand Cave-in?**
  - Part One: How does sand take the shock?
  - Part Two: How does sand take the pressure?
- **I.A.2 What Happens to Sand When You Build and Dig in It?**
  - Part One: Piles of Sand
  - Part Two: Pits in the Sand
- **I.A.3 What Happens When Water Invades Sand?**
  - Part One: Sand Under Water
  - Part Two: Water Moving Through Sand

B. Animal Tracks in the Sand

- **I.B.1 Animal Tracks**
  - Part One: Making Tracks
  - Part Two: Finding Tracks
  - Part Three: Using Tracks to Create a Story

A. PHYSICAL PROPERTIES OF SAND



Gopher tortoises are turtles that live in dry habitats in the coastal plain of the southeastern United States. They have close relatives; the desert tortoise in southwest Nevada. Gopher tortoises eat mostly grasses and burrow in sandy soils to help them regulate their body temperature. The width of the gopher tortoise burrow is about the same as the tortoise's length, which means it can turn around anywhere in its burrow. Generally, the larger the burrow, the older the tortoise. Gopher tortoises can live at least 40 years and possibly much longer, but no one has studied them long enough to know just how long they live.

Introduction

Sand is the soil of Florida scrub. Sometimes it's sugary white, sometimes yellow. Living in sand can be tough. Compared to particles in other soil types, sand grains are large and hold virtually no nutrients or water. Rain drains through sand rapidly and the upper layers of sand dry out quickly. The surface can also become dangerously hot and dry. Sand is also very abrasive. Yet many species of plants and animals have adapted to these conditions and some species can live nowhere else. How do they do it?

The Advantages of Burrowing

When you walk along a sandy path in scrub, you may see a rich diversity of plants and animals. However, many animals may be in burrows and tunnels beneath your feet. Some excavations are just under the surface while others are deep (up to 10-12 ft.). Why do so many scrub animals burrow?

- Because it's cool. Many scrub animals are **nocturnal** and come out only after the hot sun goes down. The surface quickly loses heat at dusk, making it less threatening for animals to walk on. But **diurnal** animals need a way to cool off too, especially in summer when surface soil temperatures can reach 125 degrees Farenheit. Even tough old gopher tortoises can get overheated and die on a hot afternoon if they can't retreat to their burrows. Their 12-foot deep homes can be a cool 80 degrees during the steamiest part of the day—which is one reason why so many other animals like hanging out at a gopher tortoise's place.

Because the soil cools down more slowly than the air, animals also burrow during extremely cold temperatures to stay warm.

As the temperature and humidity of the sand changes, many burrowing scrub animals travel up, down, or even sideways in the sand to find the conditions they like best. In loose sands, some animals, like the bluetail mole skink, move freely between the sand surface and subsurface.

- Because (frequently) it's more humid. Not only can the sun be hot, but it can broil you to a crisp if you're an insect without protective armor. Like many forest or wetland arthropods, many scrub **arthropods** have a thin layer of protective wax covering their bodies to keep them from drying out. But because sand can scratch up the waxy coating, many burrowing scrub arthropods are also hairy. The hairs protect the wax by holding sand up off the surfaces of their bodies.

- Because (sometimes) it's safer down there. The scrub is full of predators. A burrow is one of the best ways to protect yourself from red-tailed hawks, bobcats, or raccoons if you happen to be an eastern indigo snake, a Florida mouse, or a camel cricket. However, if you are a termite, grub (beetle larvae), ant, or grasshopper egg, the sand may not be the same safe haven. It's another world down there and most creatures are in constant danger of being eaten—even underground.

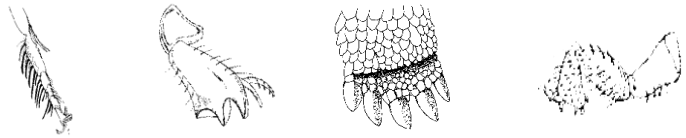
- Because there's food down there. Many predators are well equipped to hunt beneath the surface of the sand. Moles and shrews tunnel for grubs, caterpillars, and other insect larvae that graze on the fine hair-like roots of some scrub plants. Sand skinks live in the sand and search for termites that munch on buried leaves and twigs. Scrub pygmy mole crickets prefer to eat microscopic algae that grow between the grains of sand just under the surface in sunny locations. Ant lions make pits to trap ants and other insects, or they hunt in "doodlebug" fashion. Almost all of these predators leave trails that can be seen on the surface!

- Because it's a good place to raise young. Babies can be easier to protect in an enclosed space underground. Mice do it, ants do it, digger wasps do it, and so do scrub burrowing wolf spiders. Some animals, like the rosemary grasshopper and scrub firefly, lay eggs in the sand but don't make a burrow for them. Most likely, animals dig their home burrows deeper than the tunnels they make while looking for food.

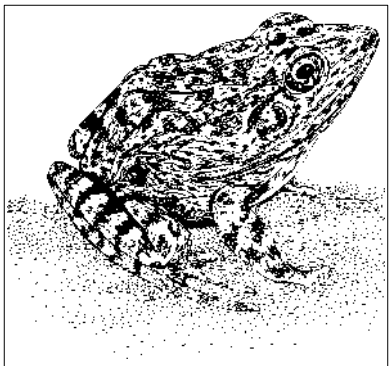
- To escape fire. Fires occur naturally and frequently in scrub. Although intense, the heat from these fires only penetrates several inches below the surface of the sand. Animals can survive fire by finding refuge in a nearby gopher tortoise burrow, a rodent burrow, or in their own burrows.

- Because they can! Scrub animals that live and hunt underground are especially adapted for life in sand. Most have body parts specialized for digging. Most likely, animals adapted for life in sand would not survive in habitats with other soil types.

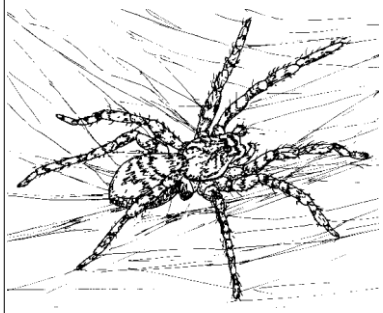
digger wasp scarab beetle gopher tortoise pygmy mole cricket



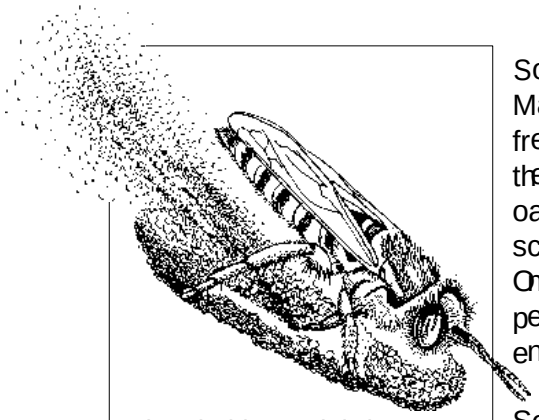
Digging feet of some sand-dwelling animals



A gopher tortoise burrow can provide year-round shelter for over two dozen **vertebrate** species including the **threatened** eastern indigo snake, the **gopher frog**, and the Florida mouse. The gopher frog spends most of its life in the burrow, coming out only to feed and to find water in which to breed in late summer.



Most spider babies leave home as soon as they emerge from the egg, but the **Lake Placid funnel wolf spider** mother keeps her young at home in her burrow until they are half adult size. She lines the upper part of the burrow with silk to prevent cave-ins and builds a sheet web at the burrow entrance. The young spiders emerge from the safety of the burrow to eat prey caught in the web.



The Florida scrub is home to many different species of **digger wasps** that build nests in the sand by raking, pulling, pushing, or carrying grains of sand. Some digger wasps can throw sand six inches or more, which keeps the sand from accumulating at the burrow entrance and helps conceal it from potential predators. Some species even make several shallow false burrows to confuse enemies such as velvet ants.

Digger wasps beware! **Velvet ants**, which are actually wingless parasitic wasps, will slip into the undefended burrow of a digger wasp and lay their eggs on the mature larvae. When the eggs hatch, the velvet ant larvae eat the wasp larvae. Brightly colored velvet ants can be seen racing around boldly in open areas where digger wasps (and digger bees) are likely to have burrows.

Some Scrub Plants Are Like Icebergs

Many scrub plants have adapted to the dry, sandy conditions and the frequent fires that occur in scrub habitat by exposing only parts of themselves. Rather than stretching big limbs out above the ground, oaks that occur in scrub, such as chapman's, myrtle, sand live oak, and scrub oak, have underground branches that often look a lot like roots. Only 25 percent of a typical scrub oak is above ground. The other 75 percent is underground, giving it lots of roots to take up water and enabling it to sprout back after a fire.

Some scrub plants, such as the scrub wedge-leaf button snakeroot, pigeon-wing, and scrub buckwheat, have adapted to dry soil conditions by having very long taproots. Other scrub plants like palmettos, prickly pear cactus, and Florida rosemary have a network of fine, shallow roots that can quickly absorb rainfall before it drains through the sand.

See pages 122 and 124 for more information on adaptations that help scrub plants conserve water.

The Background Scoop on Sand

The sand of Florida scrub was formed millions of years ago as the southern Appalachian mountains were eroded by frost and gravity. Rivers carried the sand to the sea. Coastal currents transported the sand south to the region of Florida. As the sand accumulated, dune islands were created. When the ocean receded, these islands became connected together and formed ridges. Today, Florida scrub is found on these ridges.

The Mississippi River delta and the floodplain of Louisiana were deposited in a similar way yet do not appear as hills, like the uplands of Florida. That's because sand and mud behave very differently. One of the strange, fluid-like features of sand is that it can be formed into waves, called dunes. Mud does not do this. Mud can be ground to dust and blown away to form an even layer, but it almost never forms dunes of dust. When dust does form little dunes, they quickly erode under the force of rain, but sand does not.

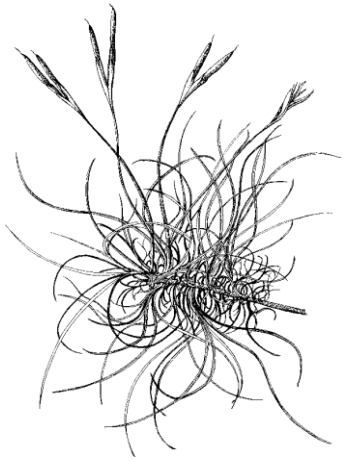
Sand is a bizarre and sometimes confusing material. When dry, sand pours like a liquid, but under a sudden shock, dry sand acts like a solid and can support a great amount of weight. When wet, sand acts like a solid and can be easily shaped. Water creates surface tension that holds the sand grains together.

Small burrowing animals that live in scrub benefit greatly from these simple facts of physics. Sand grains spread the force from shock or pressure away from the point of contact and help prevent a burrow from caving in. Surface tension keeps the sides of a small burrow from collapsing. Surface tension also allows small burrowing animals, such as ants, to bring up sand in little clumps rather than grain by grain.

Clay is probably a better soil for building burrows than sand is, but excavating sand is much easier for most small animals than digging a burrow in clay. And although sand is more easily displaced than clay, an animal can build and rebuild its underground chambers and runways in sand with a minimum of effort. Some of the special animals and plants we see in the scrub such as gopher tortoises, sand skinks, and wedge-leaf button snakeroot are probably there because of sand.

The activities in the unit are designed to help students understand the characteristics of sand and adaptations of scrub plants and scrub animals that burrow in sand.

The federally **endangered scrub wedge-leaf button snakeroot** has a long taproot that can absorb water. Snakeroot seedlings grow under a layer of sand grains, which keeps them from drying out.



Some plants that live in scrub don't depend on soil moisture or nutrients at all. **Ball moss** is an air plant commonly seen in scrub. It absorbs the moisture it needs from the air and gets its nutrients from rainwater, dust, and perhaps from insects and spiders that live in the base of the plants

I.A.1. Why Doesn't a Small Animal Burrow in Sand Cave-In?

Concepts: Simple physics of sand—how sand pours like a liquid when dry but will act like a solid when dealt a sudden shock, and the effect of surface tension on a granular material.
Skills: Cooperative learning, observation, scientific method, measurement, and discussion.
Time needed: Approximately 20 minutes for each part.
Best time of year: Anytime
Sunshine State Standards: LA.B.2.2.1, MA.A.1.2.3, MA.B.1.2.2, MA.B.4.2.2, SC.A.1.2.1, SC.C.1.2.1, SC.C.2.2.2, SC.C.2.2.3, SC.C.2.2.4, SC.H.1.2.1, SC.H.1.2.2, SC.H.1.2.3, SC.H.1.2.4, SC.H.1.2.5, SC.H.2.2.1, SC.H.3.2.2, SC.H.3.2.4.

This investigation shows two features that make sand burrows work for small animals. During Part One, your students will explore how effectively sand grains spread the force from a shock or pressure and keep a small burrow from collapsing. In Part Two, your class will see how surface tension prevents the sides of a small burrow from caving in.

I.A.1 Part One—How Does Sand Take the Shock?

If you have an outdoor classroom, you may prefer to do this activity outside.

Materials:

Each team of 2 students needs:

- Dry sand free of debris-approximately 225ml (1cup) Commercially available "play" sand, usually found in garden sections of large department stores, can be used.
- Cardboard paper towel roll
- Dowel that will fit into the roll (¾" diameter is good). All dowels must be the same length and diameter. A cut up broom handle also works well.
- 1 facial tissue (Avoid the tissues with added lotion.)
- Rubber band
- Student data sheet
- Centimeter ruler
- Meter stick
- Pencil and small piece of paper

Instructions for the Teacher:

1. This experiment is important because it shows that dry sand, which flows like a liquid, acts like a solid under a sudden shock. Small burrows in dry sand of scrub are somewhat protected from a larger animal stepping on or near its burrow.

   Please stress to your students that while small burrows are surprisingly stable, large ones are not. Trying to dig a child-size burrow would be incredibly dangerous!

   Tell your students that the activity that they are about to do will demonstrate that sand can cushion a blow or force so well that even a thin facial tissue is not ripped or penetrated by this force. Next, ask your class the following question. Give them a short period of time to discuss this question and to make predictions:

   How much sand do you think is needed to prevent a thin tissue from breaking when force is applied?

2. Divide your class into teams of two. One member of the team will be the recorder and record data from the experiment on the student data sheet and measure the amounts of sand. The other will be the investigator who sets up the experiment and drops the dowel. They should change jobs after 2 drops of the dowel.

3. Supply each team with the necessary equipment.

4. Guide the teams through the following steps:

   a. First, discuss how much sand the students think will be needed to prevent the tissue from breaking when a force is applied. Have students record their prediction on the data sheet.

   b. Anchor a tissue to one end of the cardboard roll with the rubberband. Make sure that the tissue is completely under the rubber band all the way around the roll so sand can't leak out.

   c. Measure the length of the paper towel roll and record the information on the data sheet. (A)

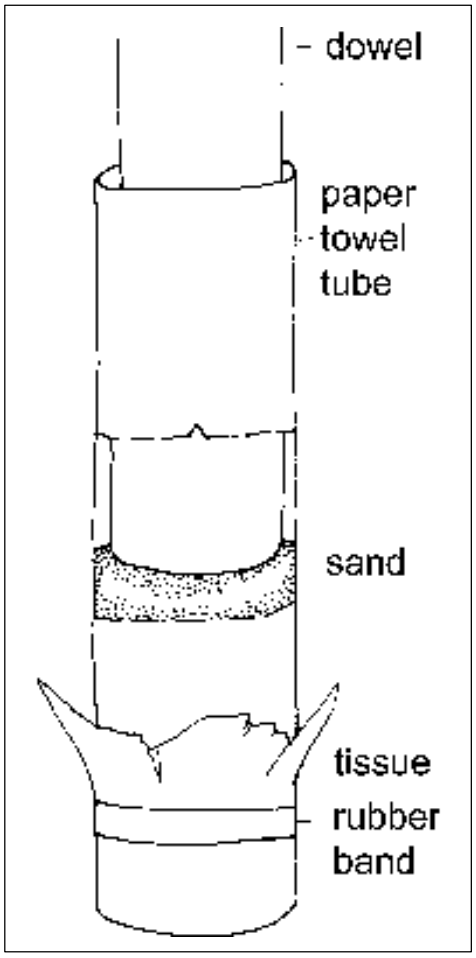
   d. Have one student hold the roll while the other carefully pours sand into the roll until it is half full (approx. 1 cup). Level the sand in the roll by giving a gentle shake. Record the measurement (B) and calculate the depth of sand (C). (A-B=C)

   e. Hold the dowel so the bottom edge is lined up with the top of the roll. Next, release the dowel into the roll and let it fall on the sand. Record whether or not the tissue broke.

   f. Pour out some of the sand (try ¼ cup increments) and measure, record, and calculate the depth again. Hold the bottom of the dowel at the top of the roll again and release the dowel.

   g. Continue the process until the tissue breaks. Always make sure to measure and record the level of the sand before releasing the dowel.

   h. Each team should record on the data sheet the level of sand present in the roll when the tissue breaks.



5. Teams should do the entire activity at least three times. On a chalkboard or overhead projector, record each team's final sand levels for the entire class to see.

6. To find the average depth of sand needed to withstand a downward force, first add all the teams' sand depths* together then divide the total by the total number of trials. (*Use the last sand depths recorded before the tissues broke.)

Notes

1. This part of the activity can be completed as a class or with teams.
2. Instead of teams of two, try teams of four. One student holds the tube, one drops the dowel, one measures, and one records the data and does the math. Students can take turns doing each job.
3. You can further reveal the special strength of sand by substituting other materials in the tube and comparing the results. For example, how does cotton handle the force? Or Styrofoam? Or raisins? How would these other substances hold up to rain? Heat and cold?

Results

After completing Part One of this activity, your students should:

- Understand that force is spread out from the point of contact by the irregular shapes of individual sand grains.
- Understand that only a small amount of sand is needed to prevent cave-ins.
- Understand that these features of sand make it a good material for building small burrows.

I.A.1 Part Two—How Does Sand Take the Pressure?

This part of the activity can be completed as a demonstration.

Materials:

Each team of 4 students needs:

- Plastic storage container with clear sides (approximately the size of a shoe box)
- Dry sand (enough to fill the box ¾ full) Commercially available "play" sand, usually found in garden sections of large department stores, works well.
- Water (approximately 1 cup)
- Pencil
- Small block —approximately 2" long x 2" wide and ¼ " deep
- Unopened soda cans (3-4) or other stackable cans
- Marker

Instructions for the teacher:

1. This experiment shows the effect of surface tension on a granular material. Dry sand flows like a liquid, but when you add a true liquid to it, the sand acts like a weak solid and can form a stable and predictable shape. Once sand is wet, you can slice it with a knife or make a hole in it with vertical sides. The wet sand acts like a solid because of surface tension that holds the grains together.

   This surface tension is important to small burrowing animals (see page 16, The Background Scoop on Sand)

2. (Optional) Copy the following table on the chalkboard or overhead projector:

# of soda cans	Vertical burrow	30 degree angle	45 degree angle	60 degree angle
1				
2				
3				
4				

3. Guide your students through the following steps:
    a. Put enough dry sand in the box so it is about half full. Slowly add some water and carefully shake the box until the sand is evenly moist. Add more sand and water to the box and shake again. Keep doing this until you have a box approximately ¾ full of moist sand.

    b. Pack down the sand to create a flat surface.

    c. Using a pencil, create a series of burrows in the center area of the box. One burrow should be vertical to the bottom of the box. Make several other burrows that are angled toward the side of the box. (angles of approx. 30, 45 and 60 degrees) Make sure you extend the burrows to the bottom or sides of the box so light will pass through and you can see inside. Do not make a burrow all along the side of the box because weight cannot be evenly distributed over the burrow.

4. Have the students predict which burrows will collapse, if any and how much weight can be piled on the burrow without collapse.

    If you plan for students to calculate the weight per square inch, have teams first place the small block over a burrow. (A square piece of cardboard will also help distribute the weight evenly.) Next, teams should start stacking soda cans on top of the block, one at a time, How much weight can the burrows take? (One full 12 fl. oz soda can weighs 13.5 oz. or 382.7 g.)

5. Have each team copy down the table from the chalkboard or overhead projector. This table should show their results. Students can use the following descriptions:
    - no change
    - slight change
    - partial collapse
    - complete collapse

Results

After completing Part Two of this activity, students should:

- Understand that dry sand flows like a liquid, but moist sand acts like a weak solid.
- Understand that moist sand can hold a stable and predictable shape due to the surface tension of the water.

I.A.1. Why Doesn't a Small Animal Burrow in Sand Cave-in?

Part One: How Does Sand Take the Shock?

Team members _____

Team Prediction: (How much sand is needed to prevent the facial tissue from breaking when force is applied?) _____

Trial #	1	2	3	4
Length of paper towel roll (A)				
Length from top of roll to sand surface (B)				
Depth of sand (C) (A-B=C)				
Did the tissue Break? Yes or no				
Trial #	**1**	**2**	**3**	**4**
Length of paper towel roll (A)				
Length from top of roll to sand surface (B)				
Depth of sand (C) (A-B=C)				
Did the tissue Break? Yes or no				
Trial #	**1**	**2**	**3**	**4**
Length of paper towel roll (A)				
Length from top of roll to sand surface (B)				
Depth of sand (C) (A-B=C)				
Did the tissue Break? Yes or no				

Compare your prediction with your results:

a. How much sand did your class predict would be needed to prevent the tissue from breaking? _____
b. How much sand was in the tube before the tissue finally broke?

1.A.2. What Happens to Sand When You Build Or Dig in It?

Concepts: Simple physics of sand—the holding properties of sand, how circumference of a pit is dependent on the depth of sand, and animal adaptations for digging.
Skills: Cooperative learning, observation, scientific method, measurement, and discussion.
Time needed: Approximately 20 minutes for each part.
Best time of year: Anytime.
Sunshine State Standards: LA.B.2.2.1, LA.C.1.2.1, LA.C.1.2.5, LA.C.3.2.2, MA.A.1.2.3, MA.B.1.2.1, MA.B.1.2.2, MA.B.2.2.1, MA.B.2.2.2, MA.B.3.2.1, MA.E.1.2.1, MA.E.1.2.3, MA.E.2.2.2, MA.E.3.2.1, MA.E.3.2.2, SC.A.1.2.1, SC.B.1.2.1, SC.G.2.2.3, SC.H.1.2.1, SC.H.1.2.2, SC.H.1.2.3, SC.H.1.2.4, SC.H.1.2.5, SC.H.2.2.1, SC.H.3.2.2, SC.H.3.2.4, VA.A.1.2.1, VA.B.1.2.1

This activity has two parts that explore the shape-holding properties of sand on two very different scales. During Part One, students will make small dunes and see whether they are affected by the amount of sand. During Part Two, students will discover that the circumference of a pit at the surface of the sand is dependent on the depth of the pit.

1.A.2 Part One—Piles of Sand

This activity can be presented as a demonstration or you can divide your class into teams and guide them through.

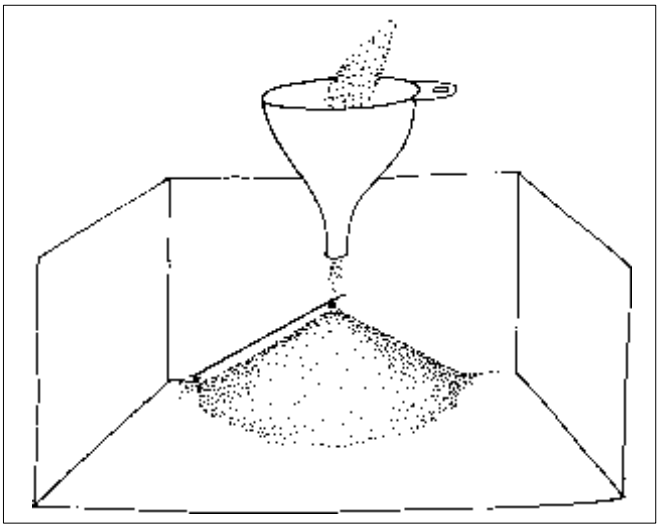
Materials:

- A cardboard box (any size) with the front panel cut out. (Note: When front of box is cut out, it can be placed in the bottom of the box to create a flat surface to pour sand on.)
- 1 quart of sand, free of debris
- Felt-tip pen
- Protractor
- Funnel
- Ruler

Instructions for the teacher:

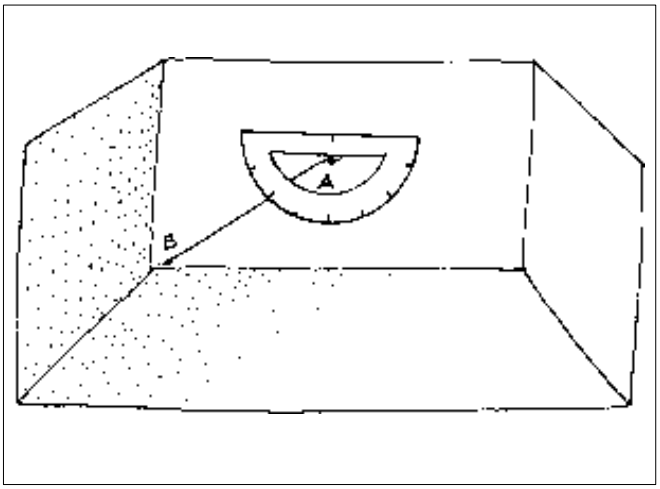
1. Read The Background Scoop on Sand on page 16 and initiate a discussion with your class.

2. Hold the funnel just below the edge of the top of the back of the box and slowly pour all of the sand into the funnel so the sand makes a cone shape along the back panel of the box. (Be careful not to hit the box and ruin your formation.) One student can hold the funnel while the other pours the sand evenly. Try to keep the sand flowing evenly through the funnel. It is better if the funnel is kept ½ full or full while pouring. A third student can record the data while a fourth can measure the angle.



3. Make a mark carefully on the back panel of the box that is even with the top of the cone. (Point A)

4. Make a mark carefully on the back panel of the box even with the base of the cone. (Point B) Remove the sand and draw a diagonal line on the back of the box from point A to point B. Measure the distance from the bottom of the box to point A, then make 2 more points one on either side of point A. Connect the points with a straight line. This is the reference line.



5. Measure the angle of the cone by placing the flat edge of a protractor on the reference line drawn on the back wall lining it up with the center of the protractor at point A as seen in the diagram. Or lay the flat edge of the protractor on the bottom of the box and measure the angle.

6. Have a quick discussion with your class. Do the students think that a dune made with 4 times as much sand would make a dune with the same angle? Do they have any idea why or why not?

7. Now make a second dune using four times as much sand. Is the angle the same? How about a sand dune 100 feet tall. Would it fall down?

8. Copy the following table on the chalkboard or overhead projector and fill it out.

Dune (Pile) #	Amount of sand	Angle of dune
1	125 ml	
2	250 ml	
3	500 ml	
4	750 ml	
5	1000	

9. Ask the students using the funnels and sand: How would you make a sand ridge on a large piece of paper?

10. Have another short discussion with your students. The sand ridges of Florida were not made with giant funnels. How were they made? Here is a little riddle for the students:

    I push without a hand,
    Without a hoe I move the sand,
    Without a voice I still can sigh,
    Unseen, I still can touch your eye.
    Who am I?

Notes

You can carry this activity a bit further by setting up a ridge of fine, dry sand or salt on a large, flat piece of paper positioned at the edge of a table. A student can then carefully blow at table level to cause ‘blow-outs”, and shape ridges in the sand—and even move the whole dune “inland”!

Results

After Part One of this activity, your students should:

- Understand that flowing sand forms a standard angle of incline regardless of the amount of sand.
- Understand how sand dunes are formed.

I.A.2 Part Two—Pits in the Sand

This activity is designed to show that the circumference of a pit that can be dug depends on the depth of dry sand available. It will also show the effectiveness of various kinds of digging tools and introduces a tricky, but very important concept: sometimes we can get useful answers even when we ask misdirected questions.

Materials:

Each team of four students needs:

- Shoe box
- Dry sand (enough to make 11/2 inches in the box)
- Plastic spoon
- Plastic fork
- Pencil (for digging)
- Popsicle stick
- 6" Ruler
- Small piece of paper
- Pencil

Instructions for the teacher:

1. Divide students into teams of four. Each member of the team should have a different digging tool.

2. Write the following question on the board or overhead projector: Which digging tool can make the largest pit? Have teams decide amongst themselves and write their answer down on a piece of paper.

3. Tell students that, one at a time, they will each dig a pit in the sand with their digging tool. Once they reach the bottom of the box, they will stop and measure the diameter of the pit. Show students how to measure the diameter of a pit. Once the pit is measured and the diameter is recorded, students will level the sand in the box.

4. Have students begin digging with their tools, one at a time. Remind them to measure the pit once they reach the bottom, and write the answer on a piece of paper. Continue until all team members have had the opportunity to dig and measure their pits.

5. Copy the table below on the chalkboard or overhead projector. Collect data from all the teams and put the results on the table.

Pit Diameters:

Team	Spoons	Forks	Pencils	Popsicle sticks

6. Find the average diameter for each column. The average diameter for all columns should be similar—which, most likely, is not what most students expected.

7. Ask your students: If the type of digging tool is not important, then what is? (The time it takes to dig the burrow and how deep the burrow needs to be.)

Notes

The additional activity below is intended to get students to use what they now know about sand and think about animal adaptations:

Ask your class the following question: Ant lions make pits in sand that other insects fall into. Why don't any big animals make pits in sand?

Assign each team of four students an animal that must catch its prey in a sand trap: a pit-fox, a pit-turtle, a pit-snake, a pit-bobcat, etc.

- What special problems might a large animal have as a pit-maker?
- What special features would they give their animal to make it easier to live and dig in the sand?
- Draw the animal.

Results

After completing this activity, students should:

- Understand that sand is easy to dig in.
- Understand that sand is an unusual but predictable material.
- Understand that the circumference of a pit enlarges as the depth of the pit increases.
- Understand that the adaptations scrub animals have for digging can assume a variety of shapes and sizes.

I.A.3 What Happens When Water Invades Sand?

Concepts: How water is absorbed by sand, how it moves through soil and why scrub is a good water storage, recharge, and purification area.
Skills: Cooperative learning, observation, scientific method, and discussion.
Time needed: Part One: approximately 15 minutes. Part Two: approximately 15 minutes.
Best time of year: Anytime
Sunshine State Standards: LA.A.1.2.4, LA.A.2.2.5, LA.B.2.2.1, MA.A.1.2.1, MA.B.1.2.1, MA.B.1.2.2, MA.B.2.2.1, MA.B.2.2.2, MA.B.3.2.1, SC.A.1.2.1, SC.A.1.2.4, SC.C.1.2.1, SC.C.1.2.2, SC.C.2.2.3, SC.C.2.2.4, SC.D.1.2.3, SC.H.1.2.1, SC.H.1.2.2, SC.H.1.2.3, SC.H.1.2.4, SC.H.1.2.5, SC.H.2.2.1, SC.H.3.2.2, SC.H.3.2.4, SS.B.2.2.2, VA.A.1.2.2.

This two-part activity explores the strange relationship between sand and water and demonstrates the importance of drainage. During Part One, students will explore how water moves sand. During Part Two students will compare how quickly water drains through different soil types.

I.A.3 Part One—Sand Under Water

Materials:

Each team of 4 students needs:

- Clear plastic storage container with approximately 2-3 inches (5-7 cm) of damp sand (Boxes from Part Two of the first activity can be used.)
- Container of water (approximately 1 cup)
- Funnel
- Moist sponge
- Pencil (for making burrows)
- Waterproof marker or crayon
- 12 dried navy beans or other small bean

Instructions for the teacher:

1. Read The Background Scoop on Sand on page 16.
   Additional background information:
   When water occurs as a surface film on sand grains, it binds them together as seen in Part Two of I.A.1 on pages 20-21. When more water is added, however, the relationship changes dramatically. Once water fills all the spaces between the sand grains, the sand no longer holds together like a solid. At this point—when sand grains are in a liquid instead of having liquid sticking to them—the very wet sand begins to move like a liquid again. The sand grains actually displace some of the surrounding water, which means the sand grains are partially supported by the water (just like a person is partially supported by the water while swimming). This not only makes it tough for the sand grains to stick together, but also keeps the force of gravity that collapses burrows from being quite so strong. This is important for the animals that make burrows in the sand—as you will see.

2. Distribute all the materials. Have each student use a pencil to make 3 vertical burrows next to one side of the box so they can see inside. Each side of the box will have three burrows. (Several replications are important in the scientific method.)

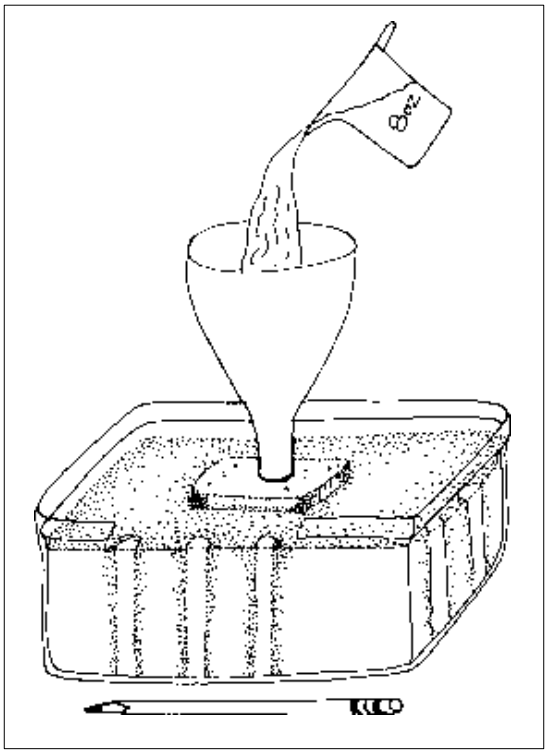
3. Using a waterproof marker or crayon, students should initial or personalize 3 dried beans and drop one in each burrow.

4. After students make their burrows, go around to each team's box and gently, slowly move the

box back and forth on the table two or three times to see what happens to the burrows in moist sand.

5. Tell the students that enough water will be added to each box to cover the sand. The water will be added to the middle of the box, away from the burrows. Give the teams five minutes to discuss what they think will happen to the burrows when the box is flooded.

6. Write each team's hypothesis on the board or overhead projector. Explain that a hypothesis is a statement about what you think might happen. A hypothesis is used to work on an experiment and is not to show how much a person knows.



7. Instruct students to put the moist sponge on top of the sand in the middle of the box. (The sponge prevents the water from creating a large hole in the sand when pouring out the funnel spout.) Students should then place the funnel over the sponge and slowly add water until the box is flooded. What happens to the burrows?

8. Have a team member gently and slowly move the box back and forth on the table so students can see how water moves sand.

9. For added discussion, consider the fate of the "animals" in their burrows. Have your students suggest all the ways animals might be able to survive the flood and write their answers on the chalkboard or overhead projector. For example, some animals might leave right away. Some might wait, then dig out. Some might be able to withstand flooding (many insects have this ability). Most species of insects, reptiles, and mammals can swim if they have to. Students may think of more creative solutions. Whatever they come up with, some animal probably does it!

In many scrub areas of Florida, there are seasonal wetlands adjacent to scrub habitat, so it is not unusual for species at the edge of scrub to have water invade their burrows.

Results

After completing Part One of this activity, students should:

- Understand how sand behaves in water.
- Understand the importance of drainage.
- Understand that flooding can occur in Florida scrub during the wet season and how burrowing animals might respond.

I.A.3 Part Two—Water Moving Through Sand

Materials:

- 4 cups of sand (Sand that is free of dust and silt works best.)
- 4 cups of commercially available topsoil
- 4 cups of heavy, muck-type soil or commercially available cow manure
- plastic container for moistening soil before putting it in the soda bottles
- 3 clear, 2-liter soda bottles with tops cut off and three holes punched in the bottom (use thumb tacks)
- 3 4x4 gauze pads (from first aid kit) to put over holes in the bottom of the soda bottles
- 3 containers to catch the flow of water as it leaves the soda bottle
- 3 quart-size milk jugs with 5-6 holes punched in each lid
- 6 cups of water (1 cup for each quart container and 1 cup to moisten each soil type before beginning activity)
- 3 digital watches or watches with second hands
- 3 measuring cups

Instructions for the Teacher:

1. Read The Background Scoop on Sand on page 16.
   Additional background information:
   When sand is in a container such as a glass, or the basin of a pond with an **impermeable** clay layer, the sand grains are partially supported by water. If sand is not in a container, the water drains right through until all that remains is the hard-to-remove layer of water covering the damp sand grains. The water is pulled away by gravity and compared to soils with smaller particles, water moves through sand very quickly.

   For plants and animals that live in the sand, this means that life can be greatly influenced by how well a site drains. Sandy sites that are poorly drained, such as a small depression with an impermeable layer, are actually aquatic environments during a wet season and support aquatic plants and animals. Well-drained, sandy sites, such as a small ridge or knoll of sand, are as dry as deserts during Florida's dry season.

2. Keeping the soils separate, moisten each soil type with 1 cup of water.

3. Place 1 gauze pad (flat) over the holes in the bottom of each soda bottle.

4. Put 4 cups of each soil type in a different soda bottle and firmly compact the surface.

5. Copy the following table on the chalkboard or overhead projector and have each student make a copy on a piece of notebook paper.

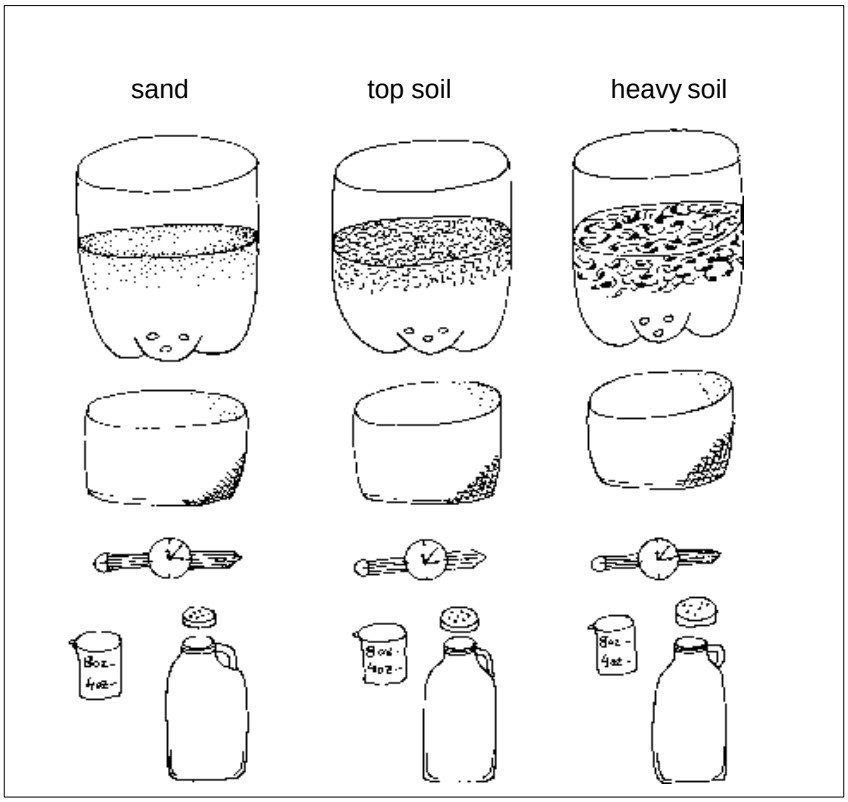
Soil type	Prediction	Time for water	Water measured	Color of water

6. Have each student predict which soil type will allow water to flow through most rapidly.

7. Assign two students to each soil type. One student will be the time-keeper and will observe at eye level with the bottom of the soda bottle. The other student will make “rain” over the soil.

8. The three teams should start at the same time so the class can make visual comparisons. The student who pours merely turns the quart of water over so the water “rains” from the holes on the lid.

9. Have all students write down how long it takes for the water to start dripping from the bottom of each soda bottle.



10. Measure the water that drained through the soils to determine which soil type holds the most water. Have students fill in their tables.

11. Ask your class to think about how plants might survive in soil where rain drains through rapidly.

12. Look at the color of the water that drained from each soil type. Which water is the clearest? (Water draining through sand should be much clearer than water draining through other soils.) Use this opportunity to begin a discussion of scrub habitat as a **water purification** and **water recharge** habitat. This role of sandy uplands, recognized by water management districts, is an important one. Sand acts as a filter, taking out small particles. Sand also provides a place for bacteria to grow. These bacteria help remove impurities, such as the high levels of nutrients that seep from septic tanks. However, some chemicals, such as pesticides, pass through easily and move into the ground water.

    Scrub is not only a good habitat for filtering and cleaning water, but it also stores water. The water that sinks deep into the sand does not evaporate and, if the sand is deep, the water goes beyond the reach of roots. Even when the water is within a couple of feet of the surface, it may be low in oxygen and plant roots may not be able to grow in this oxygen-free zone.

Water that lies in the sand beneath the Florida scrub moves slowly and follows the contours of impermeable zones underground. Eventually this water flows out into lakes or in seeps and creeks along the edge of a ridge. Because this happens very slowly and the water does not evaporate, scrub is an ideal water storage and recharge area—even though water cannot be seen for most of the year!

The next time you and your students go out to a scrub site, remind them of these experiments on sand and water. In most parts of Florida, scrub areas are adjacent to wet areas, or have little wet areas within them. As shown in the activities, sand can make an aquatic habitat, or an extraordinarily dry habitat depending on the drainage of the site. Often, dramatic changes in the vegetation can be seen that seem to have no good explanation. Usually the reason is differences in drainage. With a little practice, you and your students can begin to pick out plants associated with a higher water table, such as shiny lyonia (fetterbush) and Highlands scrub St. John's wort. Florida rosemary indicates a deep water table. Some drought-adapted plants, such as cactus, can live where the water table is shallow, as long as the site never floods.

Notes

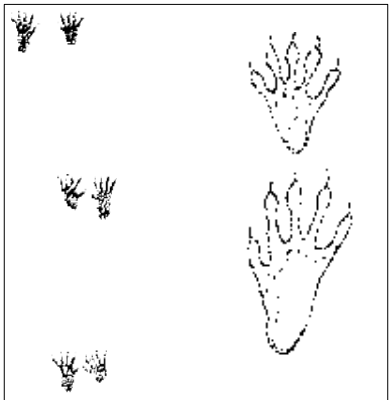
1. This experiment can be completed using several teams that test all three soil types. Results can be compared and discussed as a class.
2. Ideally, several trials of this experiment should be performed. Several teams using each type soil can serve as multiple trials.

Results

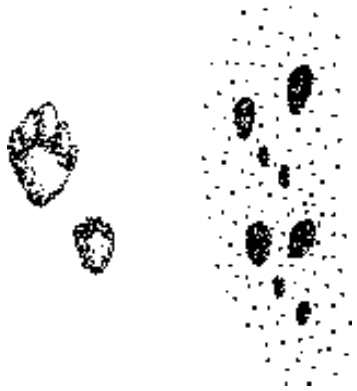
After completing Part Two of this activity, students should:

- Understand that a relationship exists between the depth of water in sand and some special plants and animals that grow in scrub.
- Know that the sand of Florida scrub is a good water storage, purification, and recharge area.

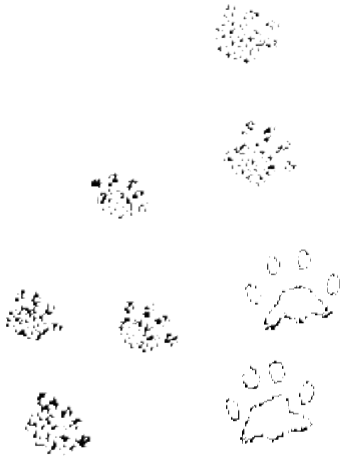
B. ANIMAL TRACKS IN THE SAND



Raccoon
(Pacer)



Rabbit
(Galloper)



Bobcat
(Diagonal walker)

Introduction

By searching the surface of the sand for tracks, you can not only find evidence of animals that live in scrub, but you can also become more aware of how animals move and behave. In addition, tracking can help students feel more connected with wildlife—which often makes them better trackers! To be a good tracker, you must be able to mix the animal evidence you find with a little imagination. Tracks help bring the elusive animal a bit closer, but also make it more mysterious. Students are often so intrigued by the pattern of the track, the weight of the animal pressing into the earth, and the way it pushes its individual toes and pads or nails into the sand, that they naturally rise to the next level and begin asking questions. Where did the animal go? What was it looking for? How long ago did the animal pass by? What was it running from?

Tracking is one of the oldest human skills. We have an inborn capacity to learn to interpret tracks. Throughout history, our ability to envision an animal's life and anticipate how that animal may respond to drought, heavy wind and rain, threats from other animals, or being followed have made humans good hunters. The best modern trackers, such as the native people of the Kalahari Desert in southwest Africa, make a conscious effort to empathize with the animal they are tracking. They know what resources are important to the animal, who its natural enemies are, and how it interacts with other animal species. In a sense, they try to become the animal. For example, to try to think like a raccoon, you might look at its tracks and imagine the following scenario: "I am a raccoon. I cross the campground tonight to see if I can find chicken bones or fish heads in the trash can. One of the campers has a big dog that barks and lunges at me. Although it's tied up, the dog scares me and I run as fast as I can to the nearest clump of palmettos to hide." Of course, raccoons don't think in words, but they do follow adaptive sequences like the one above. Students can often learn more about how an animal lives by following its tracks than by watching a documentary on the species. Tracking makes the learning experience a personal one and, most likely, one that students are more likely to remember.

The best time to look for tracks is after a heavy rain, once animals have had time to move around on the damp sand. After a rain, tracks often keep their shape for two to three days—or even longer. You will find tracks more easily during mornings or afternoons when the angle of sunlight creates shadows in the tracks. Finding tracks can be difficult when the sun is directly overhead at mid-day. Tracks are almost impossible to find or identify during windy days when sand quickly covers them up.

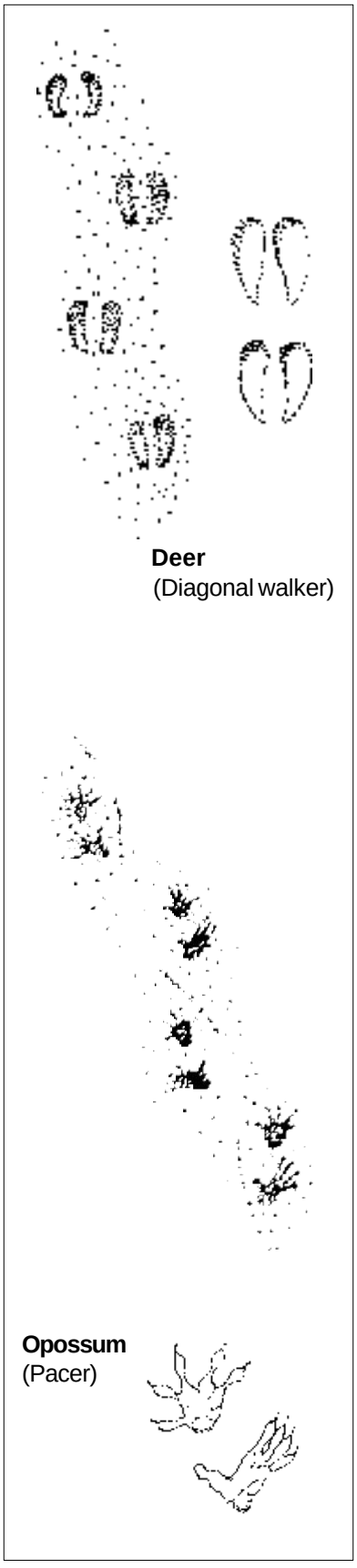
You can often identify an animal by examining a single track, but if you investigate several of the animal's tracks, you can more positively identify the kind of animal that made them. Search for other clues animals may leave behind such as **scat**, nests, burrows and dens, evidence of digging or chewing, or even clumps of fur or feathers.

Make a habit of regularly checking sandy areas around your school for tracks. Animal activity changes throughout the year, and, sometimes, even week to week! Raccoon and deer tracks are usually fairly abundant in scrub any time of year, while tracks of reptiles, such as snakes, sand skinks, and gopher tortoises are more frequently seen during hot weather.

Part of the fun of tracking is getting to know an individual animal's habits and finding out how predictable that animal can be. Some animals, such as foxes, bobcats and rabbits have territories, or home ranges where they live and which they patrol regularly. Their fresh tracks can be found in the same areas almost everyday.

Tracks can also be very mysterious and unpredictable. When you visit scrub sites with your students, you will almost always find a puzzling track. Was that track made by a very large beetle or a very small lizard? What bird track is that, and why did it land in the sand, hop three paces, then fly away? Was that furrow made by a caterpillar? These unpredictable encounters and questions can lead to the best kind of learning. Encourage your students to consider how they can turn their questions into a research project—then carry through with the research! Although you may not know the outcome of such a project, you will be giving your students the opportunity to see the scientific process in action and deal with their own spontaneous interests.

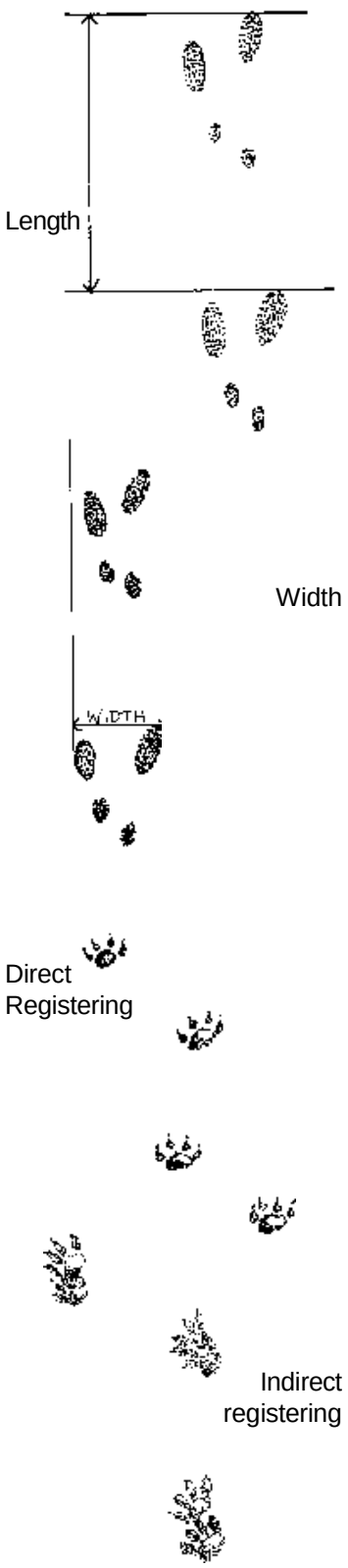
Animal tracks are fun to find, but they can also be an important part of biological research. A **mammalogist** can use animal tracks to help estimate mammal populations within a defined area. Several times throughout the year, a scientist counts how many mammal crossings he sees within designated areas of his study site. This helps show what species of animals are present and gives a very general idea about how abundant they are. Scientists also use tracks to show the boundaries of an animal's territory. Knowing the size of an animal's territory helps biologists figure out how much habitat must be preserved to protect a species of animal. Some animals, such as bobcats, make tracks that are different (to the expert eye!) in tiny ways from one individual to another. A dedicated biologist can then study the individual lives of these animals.



Deer
(Diagonal walker)

Opossum
(Pacer)

Measuring the Stride



Background Information

While wet sand holds the shape of a track particularly well, dry sand can also provide clues about the animal that left the track. Be aware of the following characteristics when identifying tracks in both wet and dry sand:

Size and shape

• Was the track made by an animal with big feet or small feet?
• Does the animal have hooves? Five long toes? Four round toes?
• Do you see claw marks?

Track pattern

What is the length of the animal's **stride** (distance between two set of tracks or steps)

• Are tracks of the front and back feet the same size and shape?

• Does the animal **register** when it walks (step on their own footprint)? If an animal direct registers, one track is directly over another and the two appear as one track. (Bobcats often direct register.) When an animal indirect registers, a track either overlaps another one or is very close. (Foxes and coyotes indirect register.)

Track trail

What is the animal's **gait**? (how an animal moves its legs and the pattern left by a series of tracks)

• Gallopers push off with their back feet, place their forefeet down one before the other, and then swing their back feet up in front of the forefeet tracks. Rabbits are gallopers.

• Pacers move the front and back foot on one side of the body at the same time and then move the feet of the other side. Bears, opossums, and raccoons are pacers.

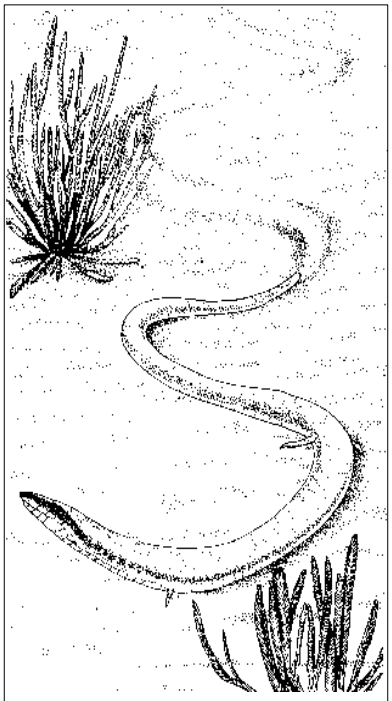
• Diagonal walkers leave a straight line of tracks and move feet on opposite sides of its body at the same time (for example: left front foot and right back foot) Bobcats, deer, and foxes are diagonal walkers.

• Hopping birds leave pairs of tracks. Walking birds leave a line of single tracks. Florida scrub-jays usually hop, but will run if they need to move very fast on the ground. Quail and doves walk.

Be aware of other outstanding features such as a tail drag. Don't be fooled by patterns made by sticks and pine needles being tossed around by the wind or by marks created by dew or rain dripping off leaves and power lines. Be alert to those enterprising students who make mystery marks in the sand with knuckles, fingers, and sticks!

The following books are good sources of information on tracking:

- Brown, Tom. 1983. Tom Brown's Field Guide to Nature Observation
- Headstrom, Richard. 1971. Identifying Animal Tracks, Mammals, Birds and Other Animals of the Eastern United States.
- Murie, Olaus J. 1974. A Field Guide to Animal Tracks (Peterson Field Guide series).
- Stokes, Donald and Lillian Stokes. 1984. A Guide to Animal Tracking and Behavior.



The **sand skink** is the only sand-swimming lizard in North America. As far as anybody knows, the sand skink lives only in central Florida, on the Lake Wales Ridge and north into the Ocala National Forest. All scrub biologists look for the track of the sand skink—a smooth and regular series of curves caused by the skink swimming just underneath the surface. Because it moves so close to the surface, the skink displaces sand on both sides of its body. The sand then collapses behind the skink, leaving a curved groove. Wandering ant lions also move just under the surface of the sand. Ant lions can make very wavy tracks sometimes, but do not make the constant, curving tracks made by a swimming sand skink. (See page 45 for more information about sand skinks.)

I.B.1 Animal Tracks in the Sand

Concepts: Animal behavior, animal locomotion.
Skills: Cooperative learning, observation, measurement, track identification.
Time needed: Part One: approximately 30 minutes. Part Two: approximately 30 minutes. Part Three: approximately 15 minutes.
Best time of year: Anytime.
Sunshine State Standards: LA.B.1.2.1, LA.B.1.2.2, LA.B.1.2.3, LA.B.2.2.3, LA.B.2.2.6, MA.B.2.2.1, MA.B.2.2.2, MA.E.3.2.2, SC.F.1.2.3, SC.G.2.2.1, SC.H.1.2.1, SC.H.1.2.2, SC.H.1.2.3, SC.H.1.2.4, SC.H.1.2.5, SC.H.3.2.4, SS.B.2.2.2, SS.B.2.2.3, VA.B.1.2.1.

This activity has three parts. During Part One, students will mimic animal movements on a sandy area of your schoolyard to help them develop track identification skills. During Part Two, students will use the knowledge gained in Part One to identify animal tracks and make educated guesses about the animals' behavior. In Part Three, students will use animal tracks to create a story.

I.B.1 Part One-–Making Tracks

Materials:
Each team of four students will need:

- Animal Tracks Data Sheet #1 and #2
- Clipboard
- Pencil
- 12-inch (30 cm) ruler
- Meter stick or broom for smoothing sandy area (optional)

Teacher will need:

- Garden rake (optional)
- 10-ft. tape measure (3 meters)
- Stakes and/or flagging (optional)
- Extra pencils (optional)
- Whistle (optional)
- Animal tracks guide book for easy reference for Part Two (optional)

Instructions for the Teacher:

1. Several days before the activity locate 2 sandy areas. In one area, student teams will mimic animal walking. Each team will need a space about 10 ft. long by 6 ft. wide. It may be helpful to mark the starting line and the finish line.

   The second area should be a sandy patch where animals are likely to cross and where students can easily search for their tracks. You may need to protect the second area from human activity for a short while by marking it off with stakes and/or flagging. A sign that reads "Please do not disturb this area" may be necessary. You may want to rake the areas if they are lumpy and scattered with leaves or other debris. You can also smooth the area by scraping the surface with a meter stick or broom handle held horizontally on the ground.
   If two sandy areas are not available, complete Part One, smooth over and protect the area, then wait several days before doing Part Two.

2. Begin the activity by reading the following scenarios and asking your class the questions that follow. These should stimulate thoughts and questions. The point of these questions is to

remind the students that, when it comes to tracks, people are animals, too. The same things that affect the appearance of human tracks may affect the appearance of animal tracks. (These questions are also visualization exercises.)

a. There is a sandy area just outside the school kitchen. Near the door to the kitchen is a large garbage can. A week goes by before the garbage can is emptied.
   - Who makes the smallest tracks around the can? (Many funny answers are possible. Rats? Baby rats? Cockroaches? Ants?)
   - Who makes the biggest tracks? (Only one answer: Humans!)

b. On a sandy trail near your house, you find a strange track. It looks like a person has been hopping along on only one foot, but there are no skid marks like those normally made by a hopping person. About a foot or two on either side of the footprint are round holes in the sand. Who was walking by? (A person on crutches.)

c. A girl and a boy are walking up a sandy road. The girl is 20 feet ahead of the boy. They are tossing a baseball back and forth. What is unusual about the girls' footprints? (She turns around and walks backward when she tosses or catches the ball.)

3. Review track characteristics (size and shape, track pattern, track trail) with your class. (See Background Information on page 34.)

4. Divide your class into teams of four students. One pair of students will be track-makers. The other pair will include a measurer (who measures features of the tracks) and a recorder (who fills in the data sheet). The track makers will also smooth the track area after the data have been recorded. Each pair will change roles after each exercise.

5. Distribute materials and review the Making Tracks data sheets.

6. Take students to the first sandy area and have students form their teams. The track maker pairs should take their positions near the starting line. The measurers and recorders should stand a small distance away, with their backs turned.

7. Have all track makers walk normally from the starting line to the finish line (about 10 feet). The tracks will be much more interesting if students take off their shoes and socks before making tracks—assuming that there are no sharp objects in the sand. (Do not tell the measurers and recorders that track makers will be barefooted.)

8. Measurers and recorders should return to observe tracks and complete section one of Making Tracks on their data sheets. Track makers should smooth out the sand.

9. Now roles should switch. Original track makers are now the measurer and recorder and should turn their backs to the track area. Have the original measurer and recorder run 10 ft.

10. The new measurer and recorder should try and figure out why the tracks look different. Team members should then compare the running track to the walking track and complete section two of Making Tracks on their data sheets. (If they have forgotten what a walking track looks like, they can walk a few steps.) Track makers should smooth out the sand.

11. Have original track makers walk backwards while the original recorder and measurer are turned away. The recorder and measurer should then try and figure out why these tracks look different. Teams should then compare these tracks to the walking and running tracks and complete section three of Making Tracks. Track makers should smooth out the sand.

12. Students will now attempt to walk like different animals. Each team member should take turns walking on their hands and knees like the following animals:
    a. Deer (diagonal walker). Place the left hand and right knee forward then put the right hand and left knee forward
    b. Raccoon (pacer). Move the right hand and right knee forward and then move the left hand and left knee forward.
    c. Rabbit, squirrel, or mouse (galloper). Push off with the knees, land on the hands and swing the knees in front of the hands. (Good luck!)

    This exercise may be a bit chaotic. The point is to show that not all animals move in same way and many move very differently than humans. By the end of the exercise, the phrases diagonal walker, pacer, and galloper should actually mean something!

13. Students should complete section four of Making Tracks on their data sheets.

I.B.1 Part Two—Finding Tracks

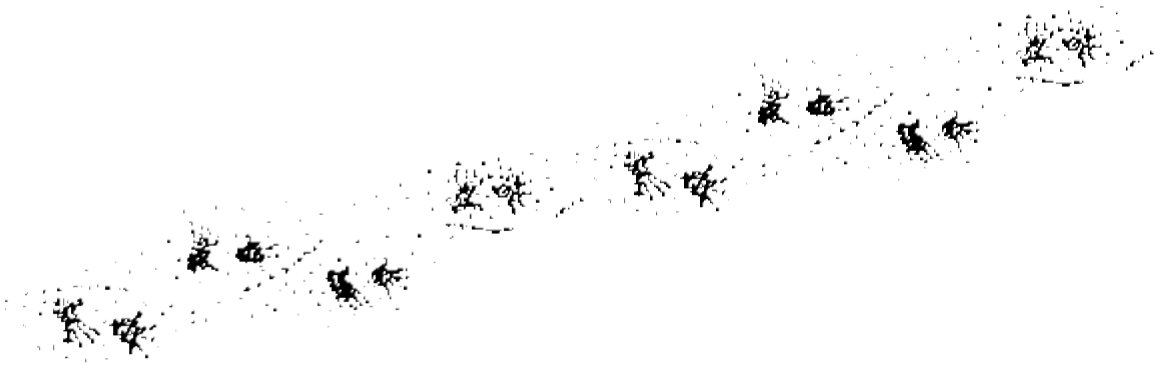
Materials needed:
Same as Part One with the addition of a poster or guide to tracks.
(See page 35 for a list of good tracking books.)

Instructions for the teacher:

1. Take students to the second sandy area and have them get together with their teams. Remind them to be very observant and avoid stepping on animal tracks, if possible. Encourage students to step in each other's tracks to limit the damage to animal tracks.

2. Instruct students to try and find four different kinds of animal tracks to measure. If tracks are scarce, teams may need to measure the same tracks. Encourage them to look for insect and bird tracks as well as mammal tracks. They may find some mystery tracks. Can they think of a way to discover the origins of these tracks?

3. Have students complete all three sections of Finding Tracks on their data sheets.

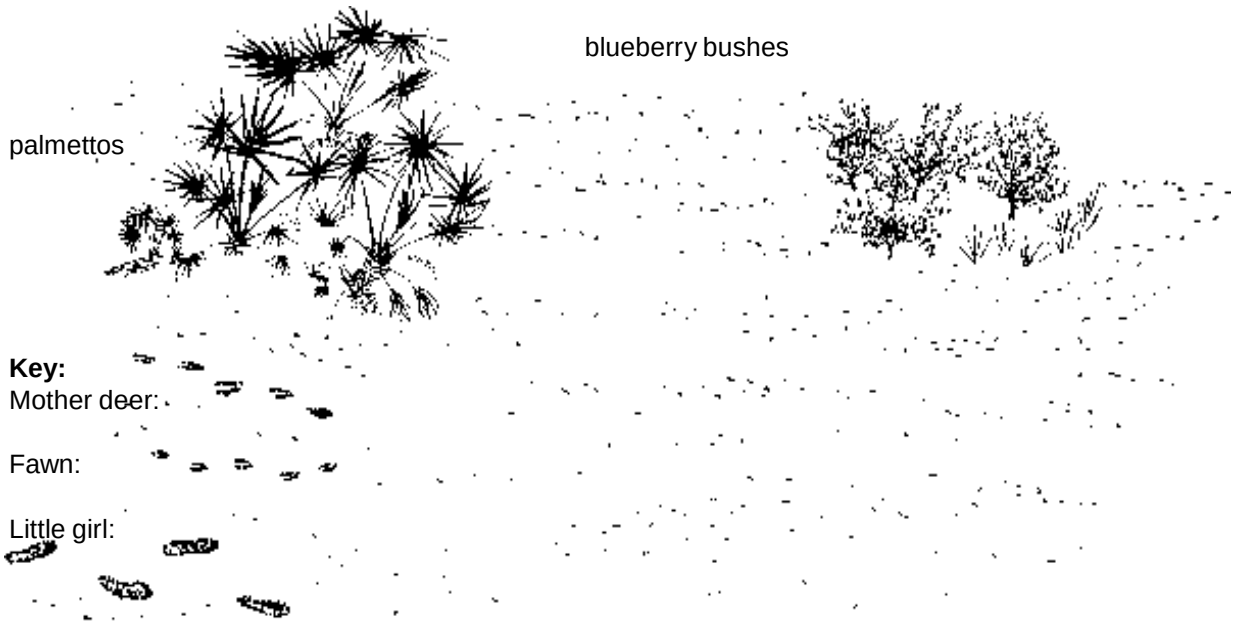


I.B.1 Part Three—Creating a Story (inside the classroom)

1. On the chalkboard, list the different kinds of tracks the class found and draw simple illustrations of the tracks. (Students can help you do this.)

2. Put the following story and map example on the board. (You can also include the raccoon example from page 32 of the Introduction.):

   Early one morning, a mother deer and her young fawn went to the bushes to eat but found a little girl picking the berries and ran away.



   Read the example to your class and explain how to use animal tracks and other map features to write a story. Stories should be short and simple and include the following:
   - Map of tracks (students should be aware of track sizes and stride lengths)
   - Any plants and buildings that are part of the story
   - A key to the tracks

3. Have the students fill in the tracks that tell the story on the map example.

Results

After completing this activity, your students should:
- Understand that animals have different ways of moving.
- Be able to examine features of a track and make an educated guess about the animal that made it or the animal's behavior.

Further Questions and Activities for Motivated Students

1. Make plaster casts of a variety of animal tracks for a reference collection.
2. Investigate other kinds of signs animals leave behind, such as chewing marks, nests and dens, scat, and digging evidence. Keep a journal of your discoveries and include a description and a sketch of what you see. Be sure to date each journal entry.

I.B.1 ANIMAL TRACKS IN THE SAND Student Data Sheet # 1

Team member s:_____

MAKING TRACKS

Section One

a. Compare the walking tracks of track maker # 1 with the tracks made by track maker # 2:

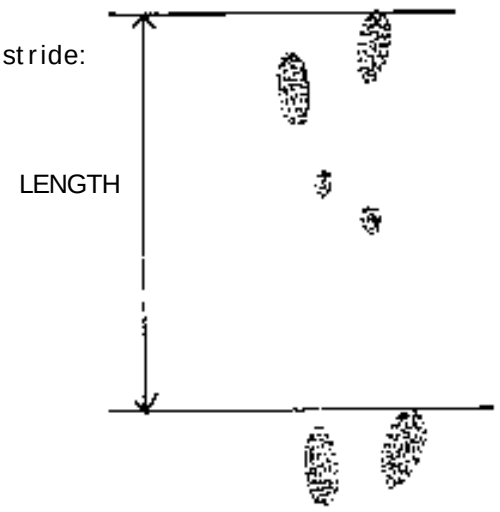
- In what way do they look alike? (check all that apply)
  ___ shapes are similar
  ___ size is the same
  ___ gait is the same
  ___ stride is the same
  ___other _____

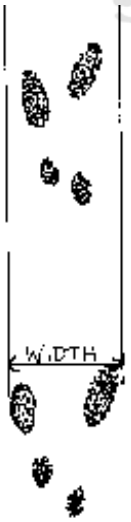
- In what ways do they look different? (check all that apply)
  ___size is different
  ___gait is different
  ___stride is different
  ___other _____

b. Measure the tracks and space between tracks of both the track maker and your other team member. Record your data on the table below:

Name of Student	Length	Width	Stride

How to measure stride:





Section 2

After track maker # 3 & # 4 has finished making a new set of tracks, compare them to the walking tracks. How do you think the track maker was moving?

- How is the shape different from the walking track?
- How is the depth different from the walking track?
- How is the stride different from the walking track?

Section 3

After track makers # 1 & # 2 have finished making a new set of tracks, compare them to the running tracks. How do you think the track maker was moving?

- How is the shape of the new tracks different from the running tracks?
- How is the depth of the new tracks different from the running tracks?
- How is the stride of the new tracks different from the running tracks?

Section 4

Examples of animal gaits:

After your team tries to walk like different animals, compare the tracks you made.

We tried walking like a: (circle four)

bear deer raccoon rabbit bobcat opossum squirrel

I.B.1 ANIMAL TRACKS IN THE SAND Student Data Sheet #2

Team members_____

FINDING TRACKS

Section 1

Use the table below to record your track observations:

Animal	Sand condition (stiff or soft)	Length (cm)	Width (cm)	Stride (cm)
Example: Raccoon	soft	5cm	4cm	22cm

Section 2

If you can see enough tracks, try and determine what kind of gait the animal used. (check one)

___ Diagonal walker
___ Galloper
___ Pacer

Section 3

Did you find tracks made by animals such as birds, snakes, turtles, or insects? If yes, draw pictures of what the tracks look like:

GLOSSARY

1. **arthropod**—an invertebrate of the phylum Arthropoda with a segmented body, jointed limbs, and usually with a hard exoskeleton and undergoes moltings.
2. **diurnal**—active during the day.
3. **endangered**—species in danger of extinction or extirpation if the deleterious factors affecting their populations continue to operate.
4. **gait**—a manner of walking, stepping, or running.
5. **impermeable**—impassable.
6. **larva** (plural: larvae)—the immature, wingless, eating stage of an insect that undergoes complete metamorphosis.
7. **mammalogist**—a scientist who studies mammals.
8. **nocturnal**—active at night.
9. **register**—a precise superimposition of one track on another.
10. **scat**—animal excrement.
11. **silica**—a form of silicon that occurs as quartz sand in Florida scrub.
12. **stride**—the act of progressive movement completed when all feet are returned to the same position as at the beginning.
13. **threatened**—a species likely, in the near future, to become an endangered species within all or much of its range.

QUESTIONS FOR STUDENT EVALUATION

The questions presented below range from easy to difficult. Select questions most appropriate for your students and, if necessary, modify the questions so they will be more useful in your situation. Answers are in italics.

1. What helps sand hold its shape after an animal has dug a burrow?
   Water, or the surface tension of water.
   Sand grains spread the force of shock away from the point of contact.

2. List two things besides animals and humans that move and shape sand.
   Wind and water

3. Imagine you had to build a pit to catch food the way ant lions do. How big would you need to build your pit? What kind of problems would you have when building your pit? (A thought question. A quantitative answer is not necessary.)
   The pit would need to be huge. Sand is very slippery when it dries. Because the sand is so slippery, the pit would have to be very wide to hold a good angle. The sides would collapse very easily. Finding an open, sandy area large enough would be difficult.

4. Why is sand good for digging tunnels and pits?
   Sand is easy to dig in. If a burrow or pit is destroyed, another one can be easily made.

5. List two qualities of sand that make it a good water storage and recharge area.
   Water will drain more quickly through sand because sand grains are large compared to other soil types.
   Sand acts as a filter by providing a place for the growth of bacteria colonies that help remove impurities from the water.
   Water that sinks deep into the sand does not evaporate. In deep sand, water even moves beyond the reach of roots.

6. List three reasons why so many scrub animals burrow.
   To stay cool and moist.
   To keep warm (in winter.)
   To hide from predators.
   To keep their young safe.
   To survive a fire (the heat only penetrates a few inches).
   To hunt for insects.

7. What animal evidence can you find in the sand of Florida scrub? Put a check beside any answers below that are true:
   __footprints or animal tracks
   __burrows
   __scat
   __dens scooped out of the sand under branches

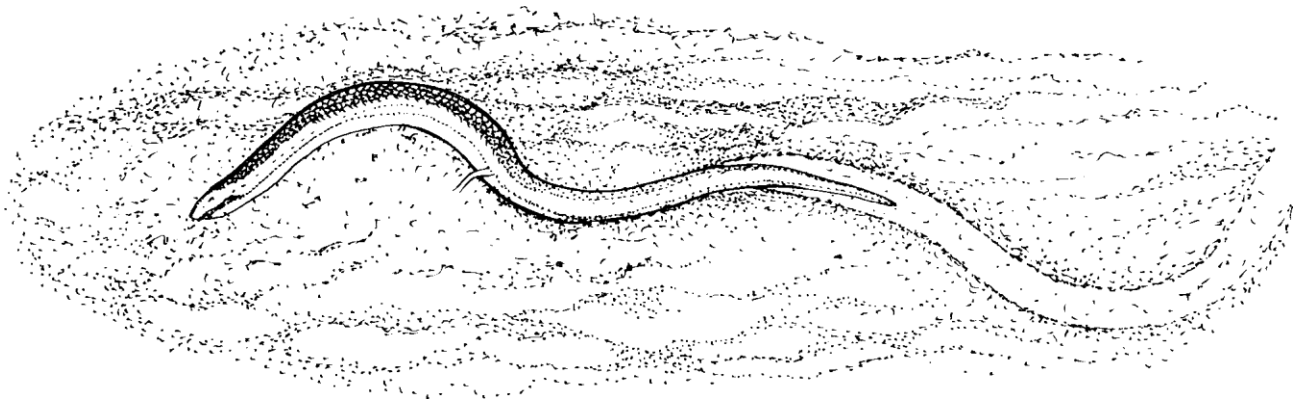
8. Put a check beside any of the following things you can discover about animals by looking at their tracks:
   __what animals think about
   __if an animal was walking or running
   __how animals “talk” to each other
   __how animals move their legs and feet when they walk
   __if an animal was big or small

9. Sand can hold water because of:
   a. suction
   b. surface tension
   c. magnetism
   d. muscles
   e. none of the above

10. True or False (T or F)
    All animals have the same stride. F
    Direct register means that none of the animal’s tracks are touching each other. F
    Gait means how an animal moves it legs seen in the pattern of the tracks. T
    Birds only hop, they cannot walk. F

II. UNIT TWO
SAND-DWELLING ANIMALS

Objective: To help students understand adaptations of sand-dwelling animals in Florida scrub and to explore predator/prey relationships.

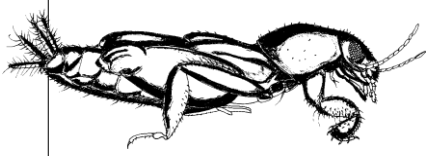


The **sand skink** literally swims through loose sand as it hunts for termites and beetle larvae. Its lower eyelid has a transparent “window” so the sand skink can see even when it closes its eyes to protect them from abrasive sand grains. As the sand skink wriggles along, its tiny, **vestigial** legs fold into little grooves on the sides of its body. Its wedge-shaped head helps the skink slice through the sand more easily. With no external ear opening, the skink doesn’t worry about getting sand in its ears! Because the habitat of this uncommon animal is disappearing, the sand skink is a federally endangered species. (See page 35 for more information about sand skinks.)

- **A. Ant Lions**: **The Hairy Predator From Down Under**
- **B. Scrub Burrowing Wolf Spiders**: **The Stay-at-Home Predator**
- **C. Ants**: **Strength in Teamwork and Safety in Numbers**

II. SAND-DWELLING ANIMALS

The **Florida mouse** escapes its predators and the hot, dry conditions by being **nocturnal** and by burrowing. It frequently uses gopher tortoise burrows and will construct its own burrows and nest chambers off the main gopher tortoise burrow.



While feeding, the ¼-inch long, flightless **scrub pygmy mole cricket** excavates extensive burrows that branch and curve about 3mm under the sand's surface. It eats microscopic algae, which grow in a layer underneath the translucent grains of sand in open, sunny locations of scrub. Burrows are best seen a couple of hours after a rain because the sand over the burrow dries quickly and appears white while the surrounding sand is still damp and gray.

Introduction

For sand-dwelling organisms, the Florida scrub is a vast sea of sand with very different rules for living. These rules are not so obvious to humans. Our experience with sand is limited. We may notice that sand is more difficult to walk on than dry clay soil, but a bit easier than walking in mud. We dig easily in sand—except when we encounter tree roots—and watch how the sides of a hole tend to collapse. We don't need special sand shoes. We don't need special sand shovels. Most scrub animals, however, live immersed in sand. For them, sand is a whole environment. For them, sand offers special opportunities and challenges. This means that animals that live in sand often need different adaptations from animals that live in other kinds of soil. Therefore, the animals found in sand are often different species from animals that live in other places. Some of the animals that live in the sand of Florida scrub live nowhere else on Earth.

The activities in this chapter focus on the remarkable adaptations of animals that live in sand. In a larger sense, these activities are designed to help students understand that while the features of these animals may seem like bizarre and meaningless distortions, there are actually important adaptations to sandy conditions. This is a challenge! An ant lion larva really does look strange! And students see weird things in our culture that do not have functional meaning or purpose—like ties worn by businessmen and very baggy pants worn by students.

To help students understand adaptations, you can present them as tools and skills. (This approach is a little flawed because adaptation actually implies a long, slow process of change without any preset goal. This means that animal adaptations are often less perfect than you'd expect if these skills and tools had been designed by an engineer.) Students need to understand that an animal's structure (tools) and behavior (skills) have functional meaning. For example, the teeth on the inner side of the ant lion's jaw have a function: they hold the prey in place while the hollow tips of the mandibles inject digestive fluid. They are the tools of the ambushing predator. The burrows that a pygmy mole cricket makes on the surface of the sand after a rain demonstrate how the cricket is looking for and eating algae that live under the surface. Making these burrows is an instinctive skill of the pygmy mole cricket.

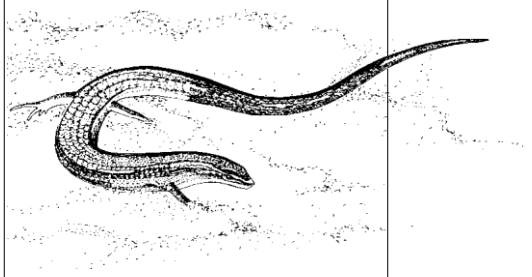
The activities in this chapter focus on insects and spiders because their tools and skills are easy to see. Their tools are built into their exoskeletons. Their skills are mostly instinctive. Both the ant lion and the scrub burrowing wolf spider exhibit one of the most interesting features of animal adaptations—they are both ambushing predators that eat small scrub insects. The tools and skills of these two animals, however, are completely different.

Background Information

Because the Florida scrub is a very old type of sandy habitat, it has many of its own animals with their special adaptations. Two particular characteristics of sand have shaped the adaptations of these sand-dwelling animals.

One characteristic of the scrub environment that is very important to small scrub animals is sand's permeability, its "digability," its "burrowaceousness." (The right word for this doesn't exist!) Permeability means that animals can swim and burrow through the sand with remarkable ease. They can excavate tunnels and underground chambers. Larvae of root-eating beetles can move around a plant, grazing on its rootlets. Larvae of predatory beetles and flies can hunt for the beetle larvae or for underground caterpillars. Snakes can move along the subways left by fast-moving moles. Ants and termites build subterranean corridors and chambers throughout. Some species such as the sand skink, the blue-tailed mole skink, and the short-tailed snake spend almost their entire lives underground. A wingless, blind scarab beetle species probably never emerges from the sand. Several species of tiny yellow ants never appear on the surface, only the males and queens emerge for their mating flight. Several species of beetles have males that emerge from the sand and fly to disperse. However, the females are flightless and remain buried just under the surface of the sand. Since the sand is so permeable, animals can easily move up or down to find warmer or cooler, damper or drier regions.

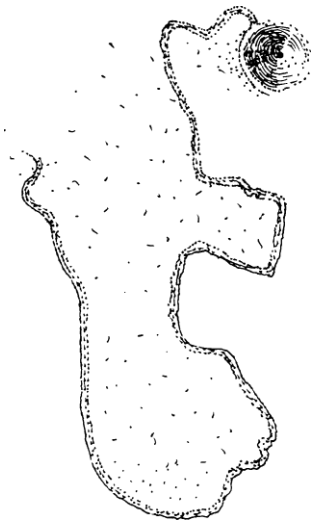
A second major feature of sand, though less important than its permeability, is its abrasiveness. This is particularly significant to insects. Many sand-dwelling insects, especially those that swim through the sand, are heavily armored. They may also be covered with backward-pointing hairs that hold sand away from the body, and keep the insect from slipping backward as it moves through the sand. (See pages 14-15 for more information about sand and why animals burrow.)



The **blue-tailed mole skink**, occurs only on the Lake Wales Ridge, and is most frequently found at a depth of 1-2 inches under the sand's surface. The young of the southeastern racerunner lizards also have a blue tail, but these lizards spend their time above ground and do not burrow in the sand. When threatened, the blue-tailed mole skink wriggles and burrows, while the racerunner scurries away rapidly. Like the sand skink, blue-tailed mole skinks lay relatively few eggs—which makes it more difficult for populations to recover from disasters.

The small, blind, and flightless **scrub scarab beetle** spends its entire life in sand located in sunny, open areas of scrub. This beetle is commonly found in sand around harvester ant hills and clumps of grass where it can find small bits of dead plant material to eat.

A. ANT LIONS: THE HAIRY PREDATOR FROM DOWN UNDER



Ant lion trail and pit

Introduction

If ant lions were the size of humans, we'd live in almost constant fear of falling into their traps, being drained of blood by their large, hypodermic-like jaws, and discarded like fast food trash. Sound like a horror movie? Life as an insect can read like science fiction. The drama of the voracious, bizarre-bodied, **predatory** ant lion and its death pit will surely captivate your students.

Lucky for educators, where there is sand there are ant lions! These hairy, backward-moving creatures—known to many as doodlebugs—are fascinating insects to watch, easy to find every month of the year, simple to catch, and can be kept indoors for several weeks with minimal effort. A combination of indoor and outdoor observation is recommended.

Getting students involved with ant lions at this point in the curriculum should help solidify concepts that were introduced in the previous chapter on sand. The ant lion also makes a good contrast to the wolf spider, another digging and ambushing predator. Ant lions are very accessible to your students. They are very common all over Florida and are often found near buildings. A project with these insects will give your students a little area of specialized knowledge about a very interesting animal that they can share with friends, parents, and relatives.

Background Information

Ant lions are the **larvae** of a group of insects called Neuroptera, which includes lacewings and dobsonflies. Active day and night, larval ant lions are usually light gray or brown, have fat, hairy, segmented bodies, short legs, and long curved jaws on tiny heads. Some species are very small and others can be as big as your fingernail! They move backward most of the time and tickle when they "doodle" in your hand. Their stiff hairs point forward, which helps to anchor the ant lion in the sand, even when struggling with prey. Ant lions are not harmful to people and will not pinch you with their jaws. Typically, they "play dead" when held.

The adult ant lion resembles a damselfly, but is a weak flyer. Usually **nocturnal**, adult ant lions are rarely seen. You might encounter one resting on a vertical twig or grass stem or see one near a light at night.

The Drama of the Pit

After mating, the female ant lion lays many eggs in soft dry sand. After the eggs hatch, the larvae will build pits in the sand under undisturbed cover, such as palmetto leaves, dead leaves, roof eaves, and even in tree hollows. Because most prey are too fast for the ant lions to catch, building pits is a very energy efficient way for it to get food. Although the meal is usually an ant, ant lions will eat other small insects that fall into their pits. Because beetles are slick and hard, ant lions often have trouble capturing them.

Ant lions build their traps by spiraling around and around from the top of the pit at the surface of the sand to the deep point in the funnel. The ant lion then sits at the bottom with its body covered by a thin layer of sand and waits, with open jaws, for its prey to slip in. To be effective, the trap must be kept neat. If small objects, such as pebbles or bits of plant material fall into the pit, the ant lion will try to clear them away. After a rainy or windy day, the ant lion often needs to reshape its pit. If it doesn't catch enough prey in its trap, the ant lion often abandons it and moves to another location.

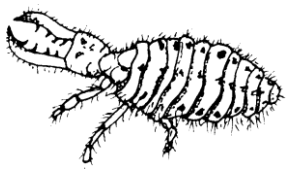
The ant lion's pit is steep and slippery. The ant lion uses fine grains of sand, which hold together to form a steep slope and are likely to slide when touched. When an insect falls into the pit and struggles to escape, the ant lion quickly responds by flicking sand grains. These bombard the prey and cause more sand to slide to the bottom of the pit, sweeping the prey down with it. The open, ready jaws snap shut and the ant lion slowly pulls the struggling prey underground to secure its capture. Digestive juices and a toxin are then injected into the prey's body, liquifying everything but the **exoskeleton**. After sucking the liquid meal up through its jaws, the ant lion tosses the exoskeleton from the pit.

Ant lions have predators, too. Their pits alert birds to a potential snack! **Parasitic** wasps and flies often lay eggs on ant lions. Once the eggs of the parasitic wasp hatch, their larvae consume the ant lion.

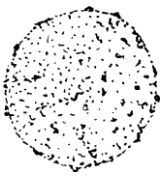
When the ant lion larva reaches full size, it **pupates** within a small ball of sand and silk just under the surface at the bottom of its pit. The pupa is very well camouflaged and difficult to find. When ant lions die or pupate, their pits become messy or disappear.

Hunting is not the pits…

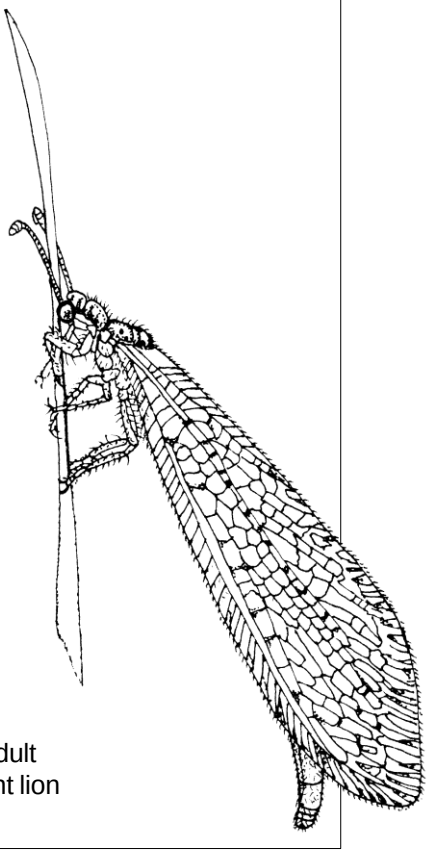
Some ant lion species do not build pits, but are easily recognized by the unique doodle-like trail they leave in the sand as they actively hunt for prey. The hunting ant lion can usually be found at one end of the trail. Pit making ant lions also doodle briefly just before making their pits or moving to another location. Just how do they find ants if they're hunting backwards in the sand?



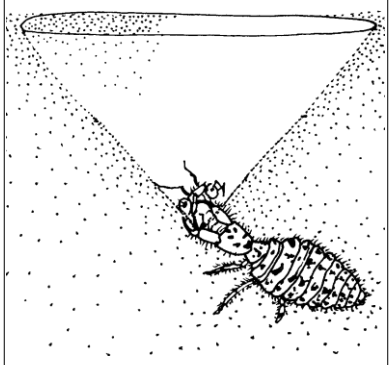
Ant lion larva



Ant lion pupa



Adult
ant lion



Ant lion in its pit

How to Catch and Care for Ant Lions

Search dry, undisturbed sand for funnel-like pits. Your students will be very good at this! Particularly good sites will often have many pits clustered together. An active pit will be neat and well formed. If you look carefully, you may even be able to see the ant lion's jaws at the bottom of the pit, open in anticipation. With a cup or spoon, carefully scoop out a thin layer of sand at the base of pit or at the end of trail. Search the sand carefully for the ant lion. They are usually very well camouflaged and are especially difficult to see if they "play dead."

Once you have a captive ant lion, make sure to provide it daily with ants or other insects and a drop of water about every three days. A hunter ant lion will need room to make its trail, but a pitmaker will be content in a cup. You may want to line the top of your container with petroleum jelly to keep the ants from getting out. Make sure to put your containers of ant lions in a low traffic area so they are less likely to get bumped.

II.A.1 Ant Lions: The Hairy Predator From Down Under

Concepts: Predator/Prey relationship, ecological niches, food chains, adaptations, and locomotion.
Skills: Observation, cooperative learning, measurement, and scientific method.
Time needed: Part One: approximately 30 minutes. Part Two: approximately 20 minutes.
Best time of year: Anytime.
Sunshine State Standards: LA.B.2.2.1, MA.B.1.2.1, MA.B.1.2.2, MA.B.2.2.1, MA.E.1.2.1, MA.E.1.2.3, SC.G.1.2.2, SC.G.1.2.5, SC.G.1.2.7, SC.G.2.2.2, SC.H.1.2.1, SC.H.1.2.2, SC.H.1.2.3, SC.H.1.2.4, SC.H.2.2.1, SC.H.3.2.1, SC.H.3.2.2.

This activity has two parts. During Part One, your students will observe ant lions and their behavior and record data. During Part Two, your class will compose and graph the data and use the results to answer a question about ant lions.

II.A.1 Part One—Collecting the Data

Materials:

Each team of 2 students will need:

- Ant Lion Data Sheet
- Clipboard
- Plastic spoon
- Small mm ruler
- Hand lens
- Pencils

Teacher will need:

- Soil or pocket thermometer (available from any science education catalog.)

Instructions for the teacher:

1. Before taking your class out, locate an area with enough pits for each team to have at least one to examine. (You can mark off the area(s) with stakes and flags.)

2. Use the question below and the information in this section's introduction to initiate an ant lion discussion with your class. Remember, the more students are allowed to discover on their own, the more involved they will be in the activity.

   If you were sitting in the bottom of a pit, trying to catch ants, what would you do?

3. Review student data sheet with your class. Stress the importance of observing carefully before doing anything that might disturb the pit. Ant lions are very sensitive to any movement around their pits, so students need to watch calmly and quietly.

   When measuring pits and ant lion larvae, it is very important that students measure the ant lion and the pit made by that particular ant lion. If students measure a pit and then find no ant lion, they should measure a second pit and then catch and measure the ant lion. If they cannot catch the ant lion, or lose it, then students must find a third pit and ant lion to measure. The accuracy of this ant lion data is important for Part Two of this activity.

4. Divide the class into teams of two. One student will be the recorder that records the information on the data sheets and reports to the class and the other will be the explorer that looks for the ant lions, their pits and measures them.

5. Provide each team with necessary equipment and head on out!

II.A.1 Part Two—Composing and Graphing the Data

During this portion of the activity, you and your class will compile all the ant lion data and plot the results on a graph.

Each student will need:

- Pencil
- Ant Lion Class Data Worksheet
- One piece of graph paper

Instructions for the teacher:

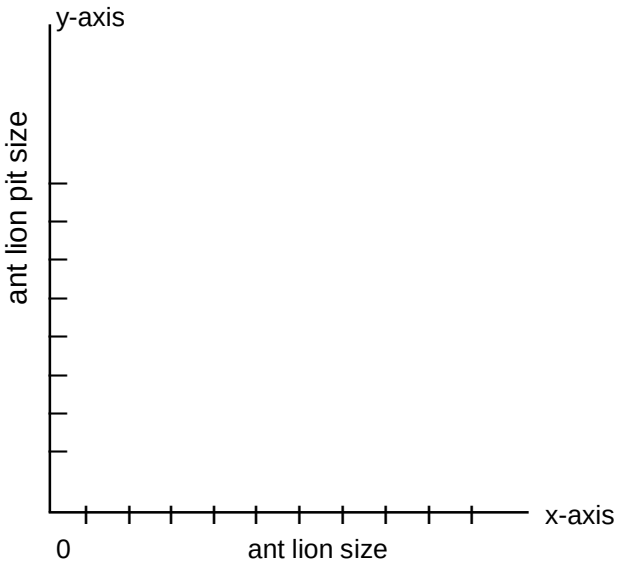
1. Copy the Class Data Worksheet on the chalkboard or overhead projector.

2. Collect data from your student teams column by column as they appear on the Class Data Worksheet. Record these on the board or overhead projector. (You may need a team spokesperson.) Not all teams will have information for each column. Students should fill in their Class Data Worksheets along with you as each team calls out its information.

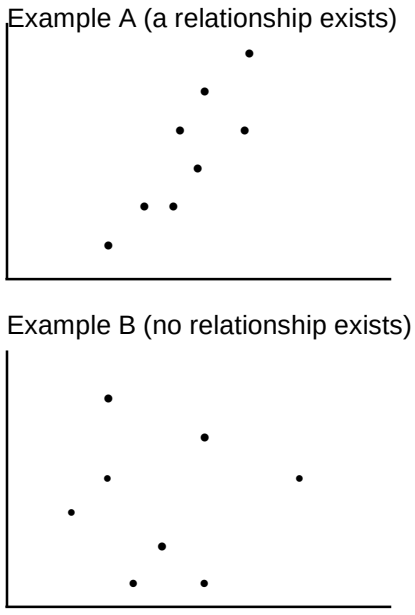
3. Once all the data have been recorded on the Data Worksheets, guide students through the steps below to make a graph of the data. The graph you make will address the question: Is there a relationship between ant lion size and pit size?
    a. Draw an outline of the graph. (The x-axis, or bottom, horizontal line, should be approximately 16 squares long. The y-axis, or vertical line, should be approximately 16 squares long.)
    b. Label the x-axis “ant lion size.”
    c. Label the y-axis “ant lion pit size.”
    d. Put a zero at the point where the y-axis and x-axis come together.
    e. On the y-axis, make a mark every 5mm, starting at the zero. Label these marks .5cm, 1cm, 1.5cm, 2cm, 2.5cm, 3cm, 3.5cm, 4cm, 4.5cm and so on until the largest ant lion pit is accounted for.
    f. On the x-axis, make a mark every 2mm, starting with the zero. Label these 2mm, 4mm, 6mm, 8mm, and so on until the largest ant lion is accounted for.
    g. Now plot the data from the Data Worksheet onto your graph. Start with information collected by team #1. Find team #1’s ant lion pit size on the y-axis. Lightly draw a horizontal line to the right.
    h. Next find team #1’s ant lion size on the x-axis. Draw a vertical line up from that point until it intersects with your first line. Make an easy to see dot where the lines intersect. Continue doing this until the data from each team are included in your graph.

4. To interpret your graph, use the examples below.

   - If the dots on the graph form an almost straight line or are scattered in an almost straight line as seen in Example A, there is in fact a direct relationship between ant lion size and ant lion pit size. This means that pit size is fairly predictable. From looking at an ant lion, you would know approximately how large a pit it would make. Or, by looking at the pit alone, you could make a good guess about how large the ant lion was that made it.
   - If the dots are unorganized as in Example B, then no relationship exists between ant lion size and ant lion pit size. This would mean that a big ant lion could make a small pit or a small ant lion could make a big pit, etc.



Ant Lion and Pit Size Relationship



Results

After completing this activity, students should:

- Understand predator/prey relationships.
- Be able to give examples of adaptations sand-dwelling animals have for digging.
- Understand the concept of an **ecological niche**.
- Be able to carefully observe and measure.
- Be able to participate in discussion and learn cooperatively.

Further Questions and Activities for Motivated Students

1. Collect as many different kinds of small insects as you can find to feed your captive ant lion. Keep a data sheet to record the time and date, how many and what kind of insects you fed your ant lion, and what was captured and eaten. Continue this for at least one week. Try to answer the following questions:
    - What is the average number of insects that the ant lion eats in one day?
    - What kind of insect does the ant lion prefer?
    - What is the average distance the ant lion can throw the discarded body of its prey?

    Be sure to properly care for your captive ant lion. (See How to Catch and Care for Ant Lions on page 50.)

2. Design an experiment to test whether ant lions prefer wet or dry sand.

II.A.1 ANT LIONS: The Hairy Predator From Down Under
Student Data Sheet
Team members: _____

1. Find an ant lion pit. Describe its location and surroundings.

Is it under cover or out in the open?	Under cover	open
Do you see any anthills close by?	yes	no
Do you see any bird tracks around the pit?	yes	no

2. Do you see any other ant lion pits close by? Measure the distance to the closest one _____.

3. How many pits do you see within 20 centimeters of your ant lion pit? (Use your ruler to measure.) _____

4. Carefully measure the diameter (width) of your ant lion pit. _____ centimeters (cm)

5. Catch an ant or some other small insect and drop it carefully into your ant lion pit.

Did the ant lion catch it?	yes	no
Or was it able to escape?	yes	no

6. How did the ant lion catch the insect?

7. What happened after the ant lion caught the insect?

8. What happens if you drop a tiny piece of debris into the pit?

9. Try to catch your ant lion with a spoon. Watch it move in your hand. Does it move forward or backwards?

10. Measure the ant lion: _____cm (Make sure you measure the ant lion that came from the pit that you measured in question # 3. If you have problems catching the ant lion, you may need to measure a second pit and try to catch and measure that ant lion.)

11. Do you see any hairs on its body? yes no W

hich direction are they pointing? _____ W

hy do you think ant lions have hairy bodies?

Why do you think the hairs are pointing in the direction you see?

12. Do you see any doodle trails? yes no

If yes, measure the width of the trail. _____ centimeters (cm)

Can you see a small pit at one end of the trail? ____

13. What is the temperature of the sand? _____

14. Is the sand wet or dry? _____

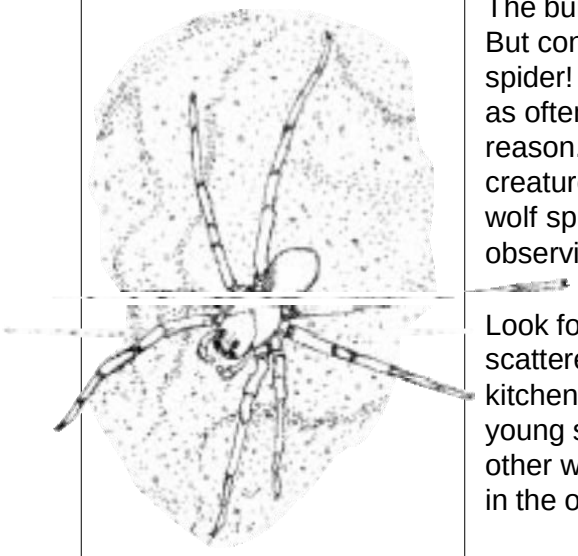
II.A.1 Ant Lions: The Hairy Predator from Down Under

Class Data Worksheet

Name_____

Team #	Pit maker ant lion length (cm)	Diameter of ant lion pit (cm)	Hunter ant lion length (cm)	Hunter ant lion trail width (cm)	Insects the ant lion caught & ate	Insects ant lion tried to catch & missed	Was the sand near the pit wet or dry?	Total # of pits seen within 20 cm
Example: # 1	.6 cm	3.5 cm	1 cm	5 cm	ant	Beetle	dry	4

B. SCRUB BURROWING WOLF SPIDERS: The Stay-at-Home Predators



Scrub burrowing wolf spider

Introduction

Have you ever noticed a perfectly round hole in the ground that looks like someone stuck a pencil straight down into the sand? Most likely, the hole was the burrow of a scrub burrowing wolf spider. If you kept looking, you probably saw a cluster of these small holes.

The burrows of this spider can be found fairly easily throughout the year. But consider yourself lucky if you actually see a scrub burrowing wolf spider! They're very reclusive and leave their excavated homes about as often as a couch potato leaves the sofa—and usually for the same reason. Food! Because the burrows are much easier to find than the creatures that make them, we can learn a lot about scrub burrowing wolf spiders—including their size, age, and species—by carefully observing their burrow entrances.

Look for burrow holes in open sandy patches and in nearby areas scattered with leaf litter. (The sandy patches can be as small as a kitchen table.) In the fall, look even more carefully for tiny holes made by young spiders that no longer live in their mother's burrow. You may find other wolf spiders on your school grounds, but they do not dig burrows in the open sand like the scrub burrowing wolf spider.

You can sometimes catch a quick look at a scrub burrowing wolf spider by gently wiggling a grass stem or pine needle at the edge of its burrow or dropping a few grains of sand over the hole. The spider will often scurry up to the burrow entrance to investigate. These **nocturnal invertebrates**, whose eyes reflect light, can also be seen at night with the help of a flashlight. Hold the light at your eye level and direct the beam onto the path in front of you. Once you locate a pair of shining eyes, hold the flashlight steady on the spider as you walk up for a closer look. Sometimes the light attracts insects and the spider will hunt in your spotlight!

After completing the activity in this section, your students will, hopefully, understand spiders better and be less susceptible to **arachnophobia**. The wolf spider is just another interesting and harmless creature preoccupied with making a living in a world filled with natural enemies.

What's the Word on Wolf Spiders?

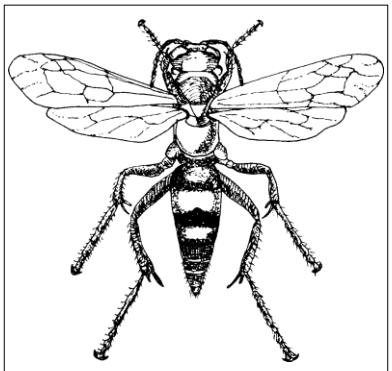
Wolf spiders hunt rather than build a sticky web to catch prey. They use their silk to line the top of their burrows and prevent cave-ins. Because they are hunters, wolf spiders have excellent vision (they have eight eyes, after all), large jaws, a well-developed sense of touch, and long, strong legs. Scrub burrowing wolf spiders have a slow **metabolism** and can survive for days without eating. Because scrub burrowing wolf spiders don't venture far from their burrows and prey can be very scarce, this slow metabolism is important! Scrub burrowing wolf spiders conserve energy year round by spending most of their life in the insulated burrow.

Newly hatched male and female spiders stay in their mother's burrow and live on the reserves from their yolk sacks. Once a spider's **exoskeleton** hardens and it can walk and hunt for itself, the young spider leaves its mother's burrow to build its own tiny home—which the spider will enlarge as its body grows. When ready for a meal, adult females will rush out to pounce on passing prey. Young males venture out at reproductive age in search of females, but die after mating. Scrub burrowing wolf spiders can live for two years, which is longer than the one-year life span of most spiders.

When building a home, scrub burrowing wolf spiders, unlike ants, do not pile sand up at their burrow entrances. Instead, they carry sand out with their mouth parts and distribute the grains evenly nearby. The burrow is simply a vertical tube about 20 cm deep with a small enlargement at the bottom. The enlargement not only gives the spider a place to turn around, but also provides room for the spider to eat prey and, in the case of a female, form her egg sack. The burrow is very narrow, which helps keep predators out. The spider stays in the tube part of the burrow, blocking the tunnel with her head and big jaws, which protect her from predators such as the spider wasp.

Several thousand species of wolf spiders have been discovered worldwide by biologists. The Florida scrub is home to six of these species that are especially well adapted to hot, dry sandy conditions. As the soil temperature changes, scrub burrowing wolf spiders adjust their temperature by moving up or down in the burrow. On a cool morning or during the night, wolf spiders will most likely stay close to the warm surface. In the middle of a hot day, the spider will move deeper in the burrow to stay cool. The humidity in the burrow keeps the spider from drying out.

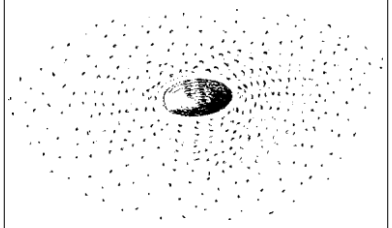
The six species of scrub burrowing wolf spider that occur in scrub habitat are never found all together on a single ridge (See pages 10-11 for more information about the location of Florida's ridges). Instead, each of the several high ridge systems in Florida is home to only two



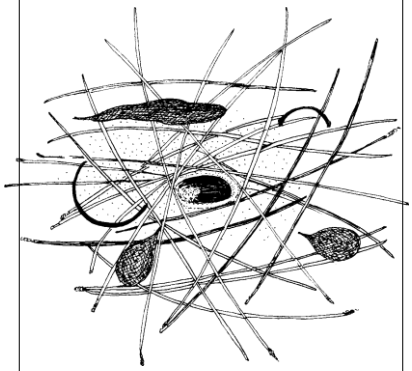
A **spider wasp**, after stinging and immobilizing a spider, lays a single egg on the spider's body. When the egg hatches, the larva consumes the spider's soft body parts. Some types of spider wasps attack spiders that spin webs. Other kinds of spider wasps target non-burrowing wolf spiders and can be seen searching along the ground for their prey. Yet another type of spider wasp will dive bomb a scrub burrowing wolf spider tunnel. And although the spider is almost always home, the wasp is not always successful!

With practice, you can easily recognize spider wasps at a glance. These long-legged, very active, black insects often have a red band on the abdomen. They spend much of their time running around on the ground, flicking their black wings open and shut.

Spider wasps are very active and agile. The female spider wasp provides each of her many young with a single paralyzed spider—which is all the food the larva will get. To make sure the larva grow to be at least her own size, the female spider wasp must battle spiders as big as she is—or even bigger!



Bare-sand-loving burrowing wolf spider burrow



Leaf-litter-loving burrowing wolf spider burrow

species. And although both species of scrub burrowing wolf spiders live in scrub, they occupy different **microhabitats**. One of the species lives in open, bare patches of sand with no overhanging shrubs, while the other species lives in areas covered with leaf litter, closer to shrubs and trees. You rarely find bare-sand-loving burrowing wolf spiders and leaf-litter-loving burrowing wolf spiders in the same place! Both species are extremely sensitive to an obvious difference in microhabitat: the presence or absence of leaf litter on the sand.

The well-camouflaged, bare-sand-loving burrowing wolf spider mixes sand with silk to reinforce its burrow entrance. If conditions have been windy, the silk and sand will sometimes form a slight raised edge, giving the burrow an ant hill appearance. Bare-sand-loving burrowing wolf spiders are picky about their space! If leaf litter suddenly covers an area where a bare-sand-loving spider lives, the spider will abandon its burrow!

The leaf-litter-loving burrowing wolf spider, which tends to be darker in color than the bare-sand-loving burrowing wolf spider, uses its silk to weave a turret (raised collar) of leaves and pine needles around the mouth of its burrow. The turret helps camouflage the burrow entrance and also helps to reinforce it. Leaf-litter-loving burrowing wolf spiders can be found in open lawns as well as in scrub.

Burrows of both scrub burrowing wolf spiders are usually found near their own kind in an **aggregation**, or cluster. The bare-sand-loving wolf spiders are very particular and have a tough time finding suitable sites. So when a site is good, lots of spiders will live there. Also, breeding is easier for both species if they don't have to travel far to find a mate! What a relief for spiders who like to stay home!

II.B.1 Scrub Burrowing Wolf Spiders: The Stay-at Home-Predators

Concepts: Food chain, adaptation, and microhabitat.
Skills: Observation, cooperative learning, measurement, and discussion.
Time needed: Part One: approximately 20 minutes. Part Two: approximately 20 minutes.
Best time of year: fall, winter, and spring
Sunshine State Standards: LA.B.2.2.1, MA.B.2.2.1, MA.B.2.2.2, SC.F.2.2.1, SC.G.1.2.1, SC.G.1.2.2, SC.G.1.2.5, SC.G.1.2.7, SC.G.2.2.1, SC.H.1.2.2, SC.H.1.2.4, VA.B.1.2.2.

This activity has two parts. During Part One, students will locate and observe scrub burrowing wolf spider holes and collect data. During Part Two, your class will analyze the data they collected and use the results to answer several questions about this spider.

II.B.1 Part One—Collecting the Data

Materials:

Each team of two students will need:

- Student data sheet #1
- Clipboard
- Pencil
- 10 colored toothpicks or other material to mark burrows
- Ruler (mm)
- Hand lens or magnifying glass (optional)

Teacher will need:

- Flagging and sticks
- Meter stick (to be shared by teams)
- Watch
- Small flashlight (optional)
- Class data sheet #1

Instructions for the Teacher:

1. Before taking your class outside, locate an open area of scrub that has an aggregation, or grouping, of burrowing wolf spider holes. (Check any sandy area of the school grounds that is relatively undisturbed.) Mark the area with flagging. If possible, flag a leaf litter area, too. Be sure to remove the flagging when the activity is completed.

2. One of the main goals of this activity is to get students thinking about microhabitats (small-scale habitats, such as patches of bare sand, within larger habitats, such as the Florida scrub). Humans are usually more aware of larger habitats, but insects and spiders live at the level of microhabitats. (See more about microhabitats on pages 86 and 102-104.) Use the information from this section's introduction to initiate a spider discussion with your class. (Spiders use silk for making webs, trap doors, safety lines, as balloons for dispersing young, for lining burrows to prevent cave-ins, and for use as a throw net to trap a variety of insects.) Attempt to lessen students' spider fears. Spiders will not bite unless picked up and roughly handled. What many people call spider bites are actually bites from other invertebrates, such as mites and flies.

3. Briefly explain to your students that they will observe a spider burrow and, if they are lucky, will catch a glimpse of the spider. Review the student data sheet and stress the importance of careful observation. Wolf spiders are very sensitive to vibrations and movement so your students will have a greater chance of seeing spiders if they move slowly and step lightly.

4. Divide the class into teams of two. One student will be the recorder and the other will be the main observer. Roles can be switched halfway through the activity.

5. Allow approximately 10 minutes for step one of the student data sheet. Students will move more carefully if they are not aware of being timed. Encourage them to move slowly and quietly as possible as they complete their data sheet. (Once you find a burrow, try shining a flashlight down into it to see the spider or get an idea of the burrow depth.)

II.B.1 Part Two—Composing and Analyzing the Data

Each student will need:

- Class Data Worksheet
- Pencil

Instructions for the teacher:

1. After the data have been collected, return to the classroom to analyze it. Distribute a copy of the Class Data Worksheet to each student.

2. Answer the questions on the Class Data Worksheet as a class. When this information has been collected, try answering the questions below:

    - Did you find one or two different species of wolf spiders?
    - What kind of habitat does the scrub burrowing wolf spider prefer?
    - Do the spiders live near each other? If so, why do you think they do?
    - Did you find both small and large burrows within the flagged area? (Adult spider burrows are approximately 10mm wide. Young spider burrows are approximately 5mm wide.)

Results

After participating in this activity, your students should:

- Understand the concept of **ecological niche**.
- Understand the concept of a microhabitat and give examples.
- Give examples of spider adaptations.
- Be able to carefully observe and measure.
- Participate in discussions and learn cooperatively.

Further Questions and Activities for Motivated Students

1. Observe marked spider burrows over a period of time (several months to a year). Do the number of burrows increase or decrease with time, season or weather conditions?
2. How do sand-loving scrub burrowing wolf spiders deal with a heavy rainfall? How long does it take for the spider to repair the damage to its burrow?
3. How does the ratio of small burrows to large burrows change from one day to the next? From one week to another? From one month to another?

II.B.1 SCRUB BURROWING WOLF SPIDERS: The Stay-at-Home Predators
Student Data Sheet

1. Carefully search the flagged area for burrows made by a scrub burrowing wolf spider. If you find one, stick a toothpick into the sand about 2 cm from the hole to mark the burrow. Look for more burrows nearby and mark them, too.

   How many burrows did you mark? _____

2. Being as gentle as possible, measure how wide the burrow hole is.

   Burrow # 1_____mm

   If you found other burrows within 5 meters, measure them, too.

   Burrow # 2_____mm Burrow # 3_____mm

3. Observe the area right around the burrow hole. What does it look like? (Circle the right answer.)

   Does the area have:

   a. open sand yes no
   b. lots of leaf litter (dead leaves)? yes no
   c. many small plants and grasses? yes no
   d. a tall tree less than a meter away? yes no

4. What does the burrow entrance look like?

   a. Does the hole have any sand piled up around it? yes no
   b. Do you see a turret (raised collar) of leaves around it? yes no

   What do you think spiders do with the sand they dig from the burrow? Why?

5. With a pine needle or long grass stem, carefully tickle the edges of the burrow opening. Watch closely for the spider, who might come up to the surface to see the "bug"!

   Did you see the spider? yes no

II.B.1 SCRUB BURROWING WOLF SPIDERS: The Stay-at-Home Predators
Class Data Worksheet

Name _____

Team #	Column A # in open sand	Column B # in leaf litter	Column C # near grass, plants, or trees	# closest to ½ cm wide	# closest to 1 cm wide
Example #1	3	1	0	1	3

1. How many spider burrows did the class find? Add the totals from columns A, B, and C to find out how many spider burrows your class found.

2. How many students got a glimpse of a spider? _____

3. How many were able to fool a spider into thinking a bug was close by? _____

4. Did you find any small spider burrows (1/2 cm or less) within 5 meters of burrows that were approximately 1 cm? _____

C. ANTS: Strength in Teamwork and Safety in Numbers

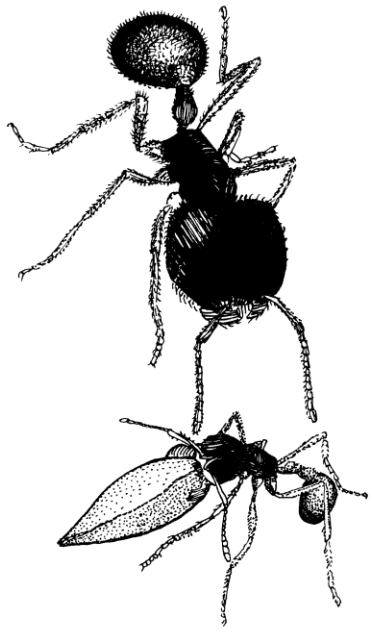
Introduction

As you saw in Unit One, sand is an ideal construction material for small burrowing animals. This section builds on that theme by focusing on ants—which are among the most abundant insects of Florida scrub and other sandy habitats of Florida. During the ant activities included, students will have the opportunity to use observation skills developed in the tracks section on page 32. Instead of identifying animal tracks, students will try to identify species of ants by observing characteristics of their anthills. The ant section will also be important for understanding the next section, Life in the Leaf Litter Layer.

The specific goals of this section are to introduce students to the concepts of animal sociality and animal communication. Ants beautifully demonstrate these two subjects because they are simultaneously very complex insects and incredibly limited in their behavior. While ants are dominant insects of Florida scrub habitat, they are just as dominant in most other **terrestrial** habitats in Florida. Therefore, students can apply ideas from this section to the ant behaviors they see in their own backyards.

Because humans and ants are both social animals with advanced communication systems, the problems and benefits of being social are usually easy for students to understand. You can take advantage of this intuitive understanding when helping students formulate their own hypotheses. At the same time, our culture presents very misleading views of insect social systems. Ants offer a good opportunity to discuss how different the media presentation of insects can be from the scientific facts.

This section also deals with observing and measuring, with consideration of experimental method in designing projects. Other less prominent themes are complete metamorphosis, animal defense, and the importance of genetic relatedness in the structuring of social systems.

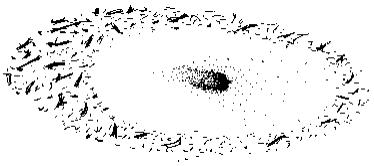


Harvester ants

Background Information

Ants are everywhere! Their nests can be found in the ground, in trees, in grass stems, at the beach, on mountaintops, in wet areas, and in the desert. Some ants are most active when it’s hot, others prefer chilly weather. Ants have some impressive abilities. Some ants grow their own food underground and others have big muscular heads for grinding seeds and blocking nest entrances. Some ants have snap-trap jaws that can cut the head off most any insect! And some ants can find that one little crumb on the kitchen counter!

Anthills
By carefully observing the size and shape of an ant nest hole and its surrounding area, you can often identify the species of ant that lives there.



The **harvester ant** clears a large area near its nest hole. Bits of vegetation, seed hulls, and other debris will be scattered beyond the cleared area. Look closely near the nest for two distinctive Harvester ant body types—one with large muscular heads (for chewing up seeds) and one with more normal-sized heads. Harvester ants often run about with the abdomen tucked under the body, so it looks like half an ant.

Florida could claim to be the "Ant State" of the eastern United States because our state has the largest number of species (around 220). Ants are also major players in Florida's ecology. The imported fire ant is the best-known species, but other ants are equally influential. Many of our **native** ants are important predators that help control populations of other insects. Because of their abundance, ants are readily available food for a large number of animals, including tree frogs, lizards, and many birds, especially woodpeckers.

Florida scrub is home to over 50 species of ants (approximately 9,500 species have been discovered in the world so far). Two species of ants are **endemic** to scrub—and can be found nowhere else. Some ant species live in hollow twigs and grass stems, but a great majority live in the ground. The sandy soil is crisscrossed with a seemingly unlimited number of underground ant tunnels. Some species dig nests as deep as 3 meters (or about 9-10 ft.) while others have tunnels and chambers just under the surface.

In some ways, a colony of ants appears to be organized like a human community with workers doing different tasks, but uniting for big construction projects and to defend the nest. The advantages of this social system are sort of like those in our own communities. Ants, like humans, benefit from both group efforts and individual specialization. The disadvantages are also similar:

1) The colony requires large amounts of resources, which must be imported, just as food must be imported into a city. **Foraging** outside the nest is often dangerous for the workers.

2) Since the colony requires large quantities of food, ants are not able to be as specialized and efficient as a species that requires a smaller supply of food. For example, there is no ant in the scrub that lives on acorns, while there are several species of acorn weevils (beetles) that are specialized for eating acorns and are able to deal with the defensive chemicals found in acorns.

3) The concentration of ants in their colonies makes them vulnerable to specialized insects, birds, and mammals that feed on ants.

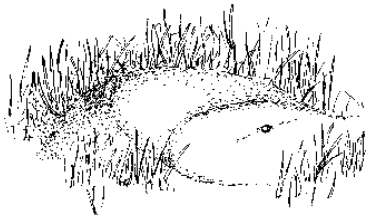
In one way an ant colony is not at all like a human community. An ant colony is a family. The queen is the mother of all the workers, who are therefore sisters. The workers don't produce their own young, but instead raise their own siblings. When ant colonies become large, they can produce males and new queens. Males and queens have wings and eventually leave the colony—usually in a mass emergence that is synchronized with the flights of males and queens from other colonies.

Mating normally occurs between males and queens from different colonies. A winged, reproductive female, or queen, is fertilized by a short-lived winged male during or after a brief flight. Ant flights often occur after a rain, when the big, soft-bodied queens are less likely to dry out. After mating, the male dies. The queen lands, sheds her wings, and digs a tunnel into the sand to establish her nest. Using the energy gained from breaking down nutrients from her now useless wing muscles, the queen begins to lay eggs.

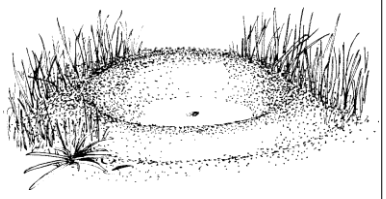
Living from 5 to 15 years, the queen can lay fertilized eggs throughout her life. (The queen mates only once, but can store sperm.) Within 2 ½ to 3 months, the eggs develop into **larvae** and the larvae into infertile, wingless females called workers. Depending on the species, the queen will break down wing muscle and use the nutrients to feed her larvae or she will come to the surface to forage. Once the larvae develop into workers, they take over the job of digging a larger underground nest and caring for the queen. As the colony grows and the nest becomes larger, more workers are produced. Although the queen produces an enormous number of workers for the colony, some ant species will capture eggs and larvae from neighboring nests and raise them as slaves. If the queen dies, the entire colony would eventually die, too.

Life in the ant colony isn't easy. First, the home must be clean. Bits and pieces of dead workers must be removed. The nest must be kept free of molds, mildews, and fungus that can kill both the ants and their larvae. An acid in ant saliva keeps dangerous **microorganisms** from spreading and multiplying. Second, food must be found and prepared for the "family." Ants have a crop (a pouch-like organ where food is softened and stored) and can save partially digested food that can be fed to other ants. Third, the home boundaries need to be constantly defended from other territorial ants and nest **parasites**. Fourth, the eggs and helpless larvae must be cared for in the nursery. The larvae are fed solid food such as pieces of dead insects and food **regurgitated** from the crop. They are also licked clean by the workers. And, finally, the queen must be fed and cleaned.

Digging and maintaining the nest is tough work. Ants do not have specialized digging feet, but carry the sand in their mouths or under their chins with the help of a loose basket of hairs. If the nest gets too hot, workers dig more horizontal side tunnels to increase the airflow. If the nest gets too dry, workers dig deeper tunnels to find moisture. Some ant species can be identified by their nest entrances.



Fungus-growing ants can be identified by their crescent-shaped pile of loose, usually yellow sand that forms a "c" around the nest entrance. The ants pile the sand on the downhill side where it won't wash back into the burrow during a rainstorm.



The **cone ant** forms a volcano-shaped nest entrance. Two species of cone ants are found in Florida scrub and nowhere else.

Commonly found in scrub, the nests of the **fungus-growing ant** can be identified by the pile of loose, sometimes yellow sand it distributes in crescent-shape around the burrow entrance. Inside the nest is a “fungus garden” that the ants create by chewing up plant matter, spitting it out, and embedding it with spores of certain fungi. Sometimes caterpillar droppings are collected and used as fertilizer. Ants must weed out any alien fungi and bacteria (which could wipe out their crop), and must ventilate the growing chamber to maintain correct moisture and temperature. When new queens fly away to mate and start a new colony, they carry a supply of delicious fungus with them!

Because ants have so much work to accomplish, they need effective ways to communicate with each other. Ants use special communication chemicals, called **pheromones** to send alarm signals, create scent trails to a food source, recruit help from colony members, recognize each other, identify the young that need to be fed, and determine who their enemies are. Ants also communicate in physical ways. Some kinds of ants beg for regurgitated food by tapping antennae with a fellow worker. Other kinds of ants can make a squeaking noise by rubbing parts of their abdomen together.

Different species of ants have different food preferences. Some ants are **carnivorous**, while others are **herbivores** and eat only plant material. Some ants are specialists and eat only insect eggs, others feed on fungus they grow themselves, while other species will eat just about anything, including dead insects and plant nectar.

Sometimes other **invertebrates**, such as beetles, cockroaches, flies, and other ant species, will disguise themselves by using a colony’s chemical language and invade an ant nest. These social parasites, which often look nothing like an ant, can live in a thriving ant nest without being recognized as an imposter! Once inside the nest, these predators prey on the ant eggs and larvae while being cared for by the workers! What a life!

Ants defend themselves by tasting bad (formic acid), by biting and stinging, and by fighting. One species of carpenter ants defends its nest entrance by blocking the opening with its big, cork-shaped, hard head. The imported fire ant is especially well known for defending itself with its double-whammy sting and bite!

The Nasty Non-Native

First seen in Alabama in the 1940s, fire ants are an exotic (non-native) species accidentally introduced to the U.S. from the flood plains of Brazil. They are adapted to seasonally flooded, grassy areas, so do not thrive in dry scrub as well as in other habitats. However, they can be found in lower, slightly wetter areas adjacent to scrub and in lawns. If a nest area floods, fire ants can form a clump by grasping onto each other and floating until they hit safety—a clump of grass stems, high ground, etc. When waters recede, the ants rebuild their shallow nest.

While shallow nests are important to fire ant survival, the location means the nest is easily disturbed. If you quickly swipe your foot over the top of the mound, you can expose the nest, workers, nursery area, and queen. Because their nests are so vulnerable, fire ants are very aggressive. In response to a disturbance, some of the frenzied workers will boil out of the tunnels in an attempt to find the invader. A chemical

signal tells workers when to sting and bite (in unison). Meanwhile, other workers attempt to carry the eggs and larvae to safety.

The **fire ant** creates a nest with loose sand piled high and scattered with holes.

Not all animals feel fire ant bites and stings as we do. **Armadillos**, also an exotic species, can be seen digging in fire ant nests, covered head to toe with angry insects, yet rarely seem to notice!

II.C.1 Ants: Strength in Teamwork and Safety in Numbers

Concepts: Social insects, adaptations, ecological niches, chemical signals and metamorphosis.
Skills: Cooperative behavior, scientific method, measurements, observation, discussion, and creative thinking.
Time needed: Part One: approximately 30 minutes. Part Two: approximately 25 minutes. Part Three: approximately 15 minutes.
Best time of year: A warm, dry day anytime of the year
Sunshine State Standards: LA.B.2.2.1, LA.C.1.2.1, LA.C.3.2.3, MA.B.1.2.1, MA.B.1.2.2, MA.B.3.2.1, MA.E.1.2.1, MA.E.1.2.3, MA.E.2.2.1, MA.E.2.2.2, MA.E.3.2.1, SC.F.2.2.1, SC.G.1.2.1, SC.G.1.2.2, SC.G.1.2.7, SC.G.2.2.2, SC.G.2.2.3, SC.H.1.2.2, SC.H.1.2.3, SC.H.1.2.4, SC.H.3.2.2, VA.A.1.2.2.

This activity has four parts that can be split into several days. During Part One, the students will share their ant experiences with the class. In Part Two, students will try to match up anthills with the kinds of ants that made them. During Part Three, students will offer various kinds of bait and observe how ants recruit help in transporting food. During Part Four, you and your class will analyze the data and answer some specific questions about ants.

II.C.1 Part One—Ant Stories

This activity is designed to get students thinking about ants and their own ant observations.

Materials needed:
No special supplies necessary

Instructions for the teacher:

1. Have a brief ant discussion with your class.

2. Summon ant stories from your students. This should be relatively easy since most children in Florida have probably inspected ants. On the chalkboard or overhead projector write the following headings:
    - Ant attacks
    - Smart ants
    - Amazing ants
    - Strange ants
    - Hardworking ants

    Have students use the categories to trigger memories and focus on specific ant behaviors. For each observation, have a class discussion about the “how and why.” How did the ant do that? Why did the ant do that?

    Another way to get students to share and discuss ant observations is to divide the class into teams of three and give each student a task. Using the same headings, have members of each group select an experience one of them has had that would fit into one of the categories. The student who had the experience is the “hero.” Of the remaining two, one is designated as the “narrator,” the other the interpreter. The narrator tells the class the little story (no more than a minute or two). The interpreter tries to answer questions, beginning “why” or “how” posed by the instructor.

Example:
Narrator: “One day Jill’s mother plugged in her electric tea kettle, and hundreds of little ants came running out the spout.”
Teacher: (one possible “why” question): “Why do you think the ants went in the tea kettle?”
Interpreter (possible answer): ”Because they were thirsty?”
Teacher (possible “how” question to class): ”Has anyone here seen ants drinking water? How do they drink? Do they have tongues?”

With a class of 25 or more, this activity could take at least a half-hour. It is a good way, however, to help students realize that someone else will most likely be fascinated with interesting **natural history** objects and events they notice. After making a discovery, many scientists immediately begin to imagine telling someone else about it or they start writing about it. Similar to the way testimonies in court help a jury, retelling the natural history story helps a scientist observe the important details that will make the story complete and compelling. When you encourage your students to wonder about the missing details of a story out loud, you are promoting a helpful trick of scientific narrative. “I wonder how long Jill’s mother’s tea kettle was left unplugged?” “I wonder what kind of ants they were?” “I wonder how much water an ant needs?”

At certain points, you can probably insert scientific information. Only a small number of stories may give you this opportunity. Although this may seem to be an inefficient way to convey scientific information, students seem to retain more when the information is in some way relevant to their personal life.

II.C.1 Part Two—Ant Hill Identification

In this project, students will try to identify an ant species by observing only the burrrow entrance. Students must describe both the anthill and the ant that lives in it.

Materials needed:
Each team of 2 students will need:

- 2 copies of Student Data Sheet #1
- Clipboard
- Pencil
- Hand lens or magnifying glass
- Centimeter ruler
- Digital watch or watch with second hand

Teacher will need:

- Stakes and flagging
- Various kinds of bait (small seeds, tuna fish, honey or jelly, bread crumbs) to distribute to teams.
- Small paper cups and popsicle sticks (for distributing bait)
- Small bag (for collecting empty bait cups and popsicle sticks)

Instructions for the Teacher:

1. You will need a warm, dry day—70 degrees or warmer—and approximately 20-30 minutes to complete this activity. (Ants are not active in cold or wet weather.)

2. Before going outdoors with the class, locate a study area where ants are abundant and there seems to be several different kinds of ants. The edge of a sandy trail is often a good place for ants.

3. Using strings, stakes and flags, mark off two long, narrow areas (one for Part Two and one for Part Three) so students can look at the anthills without stepping over the string and disturbing the anthills. Each section should be long enough for all the students to stand along the edge. Each section should also have a number of different anthills.

4. On the day of the activity, divide students into teams of two. Distribute and review Student Data sheets #1 and #2.

5. Once you are outside, have students line up outside the first roped-off area. Locate the anthills and demonstrate how to put down ant bait. Using pieces of bait no larger than a pea, carefully place three different kinds of bait approximately 3-4 cm away from the burrow entrances. This should increase the activity of the ants so that the students can get a good look at them.

6. Distribute the three different kinds of bait to your teams. Each team should watch one or more active ant mounds (with ants going in and out) and complete the questions on the Student Data Sheet #1. As students fill out the data sheet, it is important to move among them and get an idea of how they are naming their ants. Some consistency is important because the class data sheet that you will complete in Part Four will need pooled data. (Unfortunately, it may not be possible to provide the official names for the ants your students observe, mainly because a guide to Florida ants does not currently exist. However, this makes a good point—much remains to be done even in the most basic areas of insect study.)

7. Leave up the second marked-off section to use during Part Three.

II.C.1 Part Three—Ant Communication

During this project, students will observe how ants recruit other ants to resources, such as a dead grasshopper, or, in this case, tuna fish. Because your students may need a lot of experience observing, you may want to give them two opportunities to do this part of the activity. The first time, have students just observe and follow it with an informal class discussion. The second time, students can do a more formal investigation.

Materials needed:
Each team of 2 students needs:

- Student Data Sheet #2
- Pencil
- Clipboard
- Hand lens or magnifying glass
- Small cup with bait (Tuna fish works best. A 1cm chunk, about the size of a pea, will be plenty.)
- Ruler (metric)
- Digital watch or stopwatch

Teacher will need:

- A small bag to collect the empty bait cups
- Soda straws for ant experiments (to distribute to teams who may need them)

Instructions for the teacher:

1. You will need a dry, warm day (70EF or above) and approximately 20-30 minutes to complete this activity.

2. Divide the class into teams of two.

3. Distribute and review Student Data Sheet #2.

4. Give each team a cup of bait.

5. Students will work within the area established for Part Two, #3 of this activity (see page 72). Instruct the teams to set up their bait a short distance (0.5-1.0 meter) from an ant nest. Students should watch how the ants aggregate around a food source and transport it back to the nest. (Ants lay down scent trails between the food and the nest entrance to help other ants find the food. Scent trails are deposited by a gland at the tip of the abdomen, so an ant returning from a bait can often be seen "dragging its tail." The scent trails are picked up by the antennae.)

6. The students will observe what happens and complete Student Data Sheet #2, questions #1-7.

7. Teams should then plan their own experiments as instructed on the data sheet. Students should not kill ants during the procedure. The experiments can be very simple, such as drawing a finger across the trail in the sand. All experiments should:
    a. Have a **hypothesis**
    b. Record the experimental procedure
    c. Report on the experiment

    Some simple experiments with ant trails include:
    - interrupting the trail in a variety of ways
    - removing the bait
    - changing the bait
    - moving the bait to another place
    - altering the scent trail by getting the ants to walk across a piece of paper or a bit of leaf, then turning it around, etc.

8. When all teams have completed the data sheets, return to the classroom for a quick review. The principle themes that should come out of this discussion are:
    a. The ants that return to the nest while laying down the trail return more or less directly, they do not wander around like an ant that is out looking for food.
    b. The scent trail is a simple and versatile communication system.
    c. Working as a team, the ants are much more efficient.

    The experimental method approach utilized by students in #8 on the data sheet, is still widely used in science, especially in the early stages of a research program. To be considered scientifically valid, however, the method must be repeated over and over again. Even if the

experiment is only completed a few times, it can be useful as an indicator. The important point for the students to learn (aside from interesting ant behavior) is that it is necessary to carefully describe what was done, so the experiment could easily be repeated.

II.C.1 Part Four—Compiling and Analyzing the Data

Materials needed:

- Class Data Worksheet
- Data from Student Data Sheets #1
- Data from Student Data Sheets #2

Instructions for the teacher:

1. The Class Data Worksheet can either be photocopied for each student or copied on the chalkboard or overhead projector.

2. Use data sheets from Part Two to complete the tables in question #1 and #2 of the class data sheet.

3. Vote on names for the different kinds of ants. The students will have fun with this. Remind them that all the ants they saw were female workers, so for example, naming a fast ant after a popular quarterback may not be the best idea! Watch for names that might accidentally offend some person or group.

4. Reconstruct the placement of the teams along your study site by completing "Ant Main Street, Scrubville, USA." Have students come to the chalkboard, beginning with the teams who were at one end or the other of the string, and draw a little house with the name of the ant or ants that they looked at. The students will almost certainly remember who they were next to. When they are finished it will be possible to see who lives next to whom. If you find just one species of ant, then, most likely, it outcompetes other ants. If you find several species living close together, a variety of foods are most likely available or the species have different food preferences.

5. Use Student Data Sheet #2 from Part Three to fill in the table in question #4 on the Class Data Worksheet.

Results

After completing this activity, students should:

- Be able to give examples of some advantages of social living and working as a team.
- Know that chemical signals and scent trails are a form of insect communication.
- Know that the use of chemicals by insects to communicate, locate food, recognize other insects, and as defense is an adaptation.
- Be familiar with the experimental method.
- Be able to observe carefully and share observations with other students.
- Be able ask creative questions about what they observe.

Further Questions and Activities for Motivated Students

Compare sand-dwelling animals of the Florida scrub with animals that live in some of the great deserts of the earth, such as the Sahara and Kalahari deserts of Africa, the Gobi Desert in Asia, etc. Make a list of some of the similarities and differences between the animals of these great deserts and the animals of the scrub.

II.C.1 ANTS: Strength in Teamwork and Safety in Numbers

Student Data Sheet #1

Team members _____

Directions: Fill out one data sheet for each active anthill you observe.

1. Describe the shape of the anthill (Check one answer below):
   - ___Volcano-like
   - ___Half-circle (hill only on one side)
   - ___Hard to see hill with several holes
   - ___No noticeable hill, one entrance hole
   - ___Wide bumpy hill with many entrance holes
   - ___Other (describe here):

2. Record the size of the anthill in cm:

Length: Width:

3. Describe the type of ants seen going in and out of the anthill:
   - What color are they?
   - Are they shiny or dull?
   - How does the ant move? (give example)
   - Do all the ants look alike? Or are some bigger with much bigger heads?

4. Make up a name for your kind of ant.

5. Which bait does this ant take?

6. Is there more than one kind of ant at a bait?

II.C.1 ANTS: Strength in Teamwork and Safety in Numbers

Student Data Sheet #2

Team members_____

Directions: Set out the bait at least 0.5 meters from your anthill.

1. Watch the bait. How long does it take an ant to find the bait? _____minutes

2. How long does it take the ant to gather a bit of bait to take back to the nest? _____ minutes

3. Watch the returning ant. Does it do anything unusual? Does it go directly back to the nest, or does it move back and forth and in circles?

4. How long does it take for more ants to emerge from the nest? _____minutes

5. Do the ants coming to the bait follow the trail of the returning ant exactly? Or do they wander a bit, as if following directions?

6. Some pieces of bait may attract more than one species of ant. Report on any interactions between the species.

7. Trail experiment. Plan an experiment dealing with the ant trails between the bait and the nest. The experiment can be as simple as drawing a line across the trail with your finger, or blowing away the sand with a soda straw, or removing the bait.

   EXPERIMENT-the experiment has _____parts

   a. What I intend to do. (Make sure to measure, and keep track of time. If you interrupt the trail, how wide is the gap, how close is it to the nest and how close is it to the bait?)

   b. What I think the ants will do.

   c. How the ants reacted. (Use the back of this sheet for more room)

II.C.1 ANTS: Strength in Teamwork and Safety in Numbers

Class Data Worksheet

Instructions for the teacher:
This sheet can be can be copied on the chalkboard or overhead projector. See Part Four on page 74 for additional instructions.

1. **Anthills:** Use all Student Data Sheets #1 that your students completed. List the team #s in the box of the appropriate anthill type.

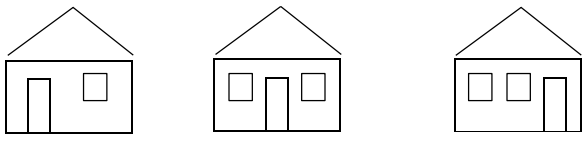
Volcano	½ circle	1 hole, no hill	Several holes, no hill	Wide bumpy hill, many holes	Other

2. **Anthill identification:** Use Student Data Sheet #1 to fill in the information for each team. This will help associate ants with the appropriate anthill and ensure students are using the same names for the same ants.

Team	Length	Width	Ant description	Bait used	Name of Ant
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

3. **Ant Main Street, Scrubville, USA**: Have student teams draw a small house on the chalkboard to represent each anthill they studied. Each house should be labeled with the name of the ant that lives there. Teams should try to record the houses in the order the anthills were arranged at the study site. (See page 73, # 4.)

Example:



fast ant yellow ant crazy ant

4. **Recruitment:** Use Student Data Sheet #2

Team	Bait distance	Time to find bait Column A	Time to return to nest Column B	Time to recruit help Column C	Number of kinds of ants at bait

- Add numbers in column A and divide by the number of teams to get the average time it took for ants to find the bait.
- Add the numbers in column B and divide by the number of teams to find the average time it took for the ants to return to the nest.
- Add the numbers in column C and divide by the number of teams to find the average time it took for ants to recruit help.

GLOSSARY

1. **arachnophobia-** a fear of spiders.
2. **carnivorous-** meat-eating.
3. **ecological niche-** the interactive role of a species in its community including activities, relationships and environmental factors.
4. **endemic-** confined to a particular place and occurring nowhere else.
5. **exoskeleton-** a hard external covering that protects an animal and provides points of attachment for muscles.
6. **exotic-** not native, introduced from another habitat or place.
7. **forage**- to search for food.
8. **generalist**- an animal that uses a broad array of resources.
9. **herbivore-** an organism that eats only plants.
10. **hypothesis-** an educated guess that serves as a temporary explanation of an observed phenomena.
11. **invertebrate-** an animal that lacks a backbone.
12. **larva (plural, larvae)-** the immature, wingless feeding stage of an insect that is structurally different than the adult and undergoes complete metamorphosis.
13. **metabolism-** all the chemical reactions that take place in a living organism.
14. **microhabitat-** an extremely localized, small-scale environment.
15. **microorganism-** any organism too small to be seen by the unaided eye.
16. **native-** originating in a particular habitat.
17. **natural history**- the study of all objects in nature.
18. **nocturnal-** active at night.
19. **parasites-** organisms that live on or in an organism of a different species and gets nutrients from its body.
20. **pheromones-** a chemical released by an animal that influences the behavior of other members of the same species.
21. **predatory-** preying on other organisms for food.
22. **pupate-** to become an insect in the non-feeding stage of metamorphosis.
23. **regurgitate-** to vomit.
24. **social insects-** insects of the same species that live together including non-reproductive adults.
25. **specialist-** an animal that requires a very specific resource.
26. **terrestrial-** growing or living on land.
27. **territorial-** defending an area against intruders, especially those of the same species.
28. **vestigial-** a structure , function, or behavior pattern which has diminished during the course of evolution, leaving only a trace.

QUESTIONS FOR STUDENT EVALUATION

The questions presented below range from easy to difficult. Select questions that are most appropriate for your students and, if necessary, modify the questions so they will be more useful in your situation. Answers are in italics.

1. Where do ant lions build their pits for catching prey?
    a. a dry sandy area
    b. a moist, leafy area with lots of insects
    c. at the edge of a pond or lake
    d. all of the above

2. Explain why you would not find ant lions in muddy soil.
    Ant lions would not be able to move backward easily through muddy soil or build pits to catch their prey. The pit wouldn't work in muddy soil because the slope would not be slippery and the trapped insect could get out.

3. What are the benefits of using a pit to capture prey? What are the disadvantages?
    Ant lions can stay hidden in the pit, safe from predators, and don't waste a lot of energy trying to hunt down and capture prey. However, they might have to wait a very long time for an insect to fall into their pit and may have to relocate their pit. Ant lions must also rebuild their pits if rain or wind destroy them.

4. Some of the animals that live in the sand of Florida scrub live no where else on Earth. One of these animals is:
    a. raccoon
    b. opossom
    c. deer
    d. sand skink
    e. all of the above

5. True or False (T or F)
    a. Some kinds of young ant lions build pits to capture other insects to eat. T
    b. Adult ant lions have wings and only come out during the day. F
    c. Ant lions have forward pointing hairs that help keep them anchored in the sand. T
    d. Ant lions build their pits using their strong back digging feet. F
    e. The ant lion must keep its pit clean in order to catch prey. T
    f. Ant lions protect themselves from predators by being camouflaged and "playing dead." T

6. Ant lions and scrub burrowing wolf spiders are called ambush predators. Describe how they catch their prey.
    Ant lion: digs a pit and waits for an insect to fall in then grabs the prey and sucks out its body fluid.
    Burrowing wolf spider: stays in its burrow until the prey walks by then jumps out, grabs the prey, and sucks out its body fluid.

7. Match the scrub animal on the left with its adaptation for living in the sand on the right.

a. ant lion larva	___is nocturnal and often lives in a gopher tortoise burrow (d)
b. pygmy mole cricket	___is nocturnal and mixes sand with silk to support its burrow entrance (e)
c. sand skink	___has a tiny, hairy head with long, curved jaws that help it catch its prey (a)
d. Florida mouse	___has see-through lower eyelids and “swims” under the sand (c)
e. scrub burrowing wolf spider	___has specialized digging feet and wings, but cannot fly (b)
f. ant	___lives in colonies and uses chemical signals to communicate (f)

8. Some kinds of scrub burrowing wolf spiders live in open sand and some live in leaf litter. Draw a line from the phrases on the left to the kind of spider or burrow it describes.

a. silk is used to support the burrow entrance	
b. silk and leaves are woven together to make a collar around the entrance	sand spider & burrow
c. spider can hide in the leaves to hunt	
d. spider can see prey at a distance	leaf litter spider & burrow
e. spider is white and blends in	
f. spider is brown and blends in	
g. found close to trees shrubs or in the grass	
h. found in open, sunny areas	

9. Circle the correct underlined word. An ant colony is like a big family. The queen/king rules all the workers. All the workers are sisters/brothers. When the ant colony gets too big, they produce males and new queens/females and new kings.

10. Ants use chemicals to communicate with each other. Put a “T” beside all the statements below that describe ways ants use chemicals to communicate.

___a. alarm calls (T)
___b. scent trails (T)
___c. recruit helpers (T)
___d. dig tunnels

11. Ants can defend themselves in many ways. List 3 ways in which some ants protect themselves and their colony.

By tasting bad, biting, stinging, fighting other animals, blocking their colony entrance, and by using alarm calls.

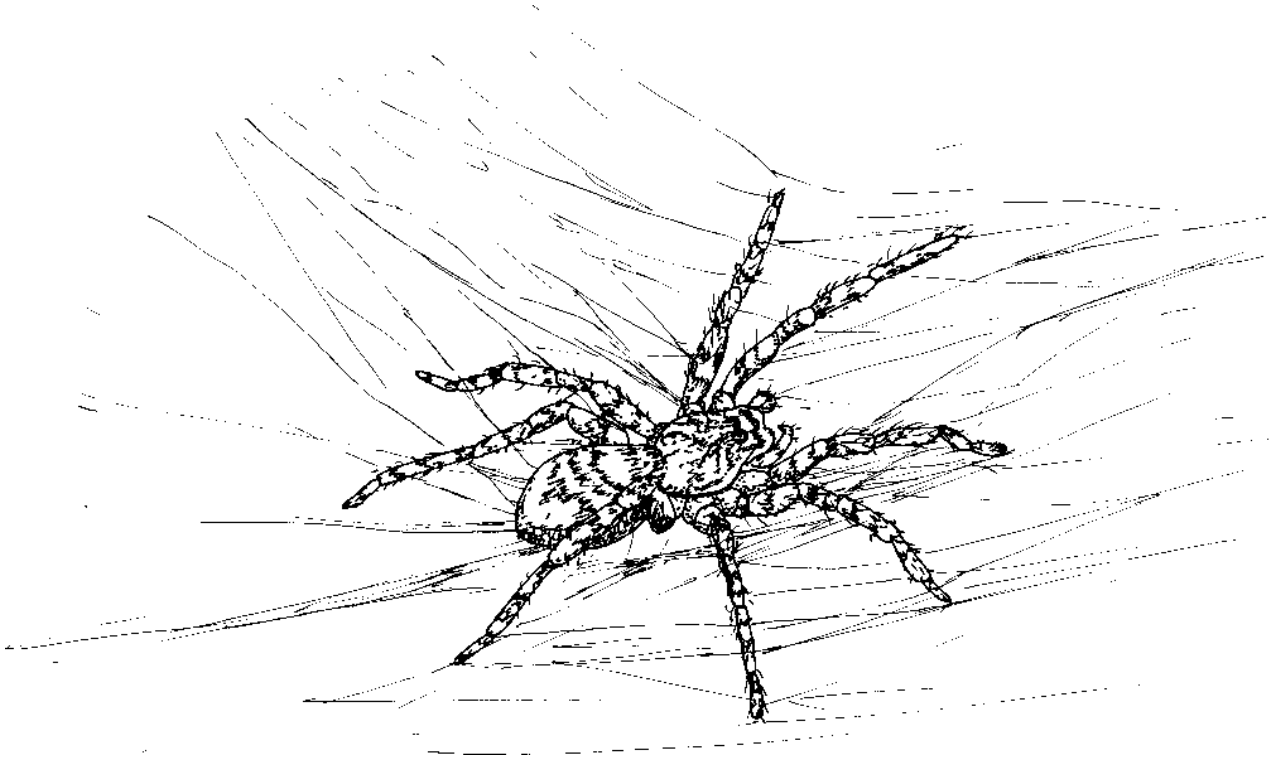
12. List at least 4 adaptations that an animal would need to live in Florida scrub.
    a. specialized digging feet or legs
    b. heavy armor to protect against abrasive sand
    c. see-through lower lid to protect eyes while moving through sand
    d. hairs to protect skin or exoskeleton from coarse sand grains
    e. wingless (wings would be damaged while moving in sand)
    f. hard covering to protect wings from sand?
    g. specialized baskets of hairs to carry excavated (too hard) sand
    h. no ears openings that could fill up with sand
    i. any other, reasonable, even imaginary adaptation

13. Design an imaginary animal well adapted to live and burrow in the Florida scrub. What would this animal need to make its home? Find food? Protect itself from predators?

III. UNIT THREE

LIFE IN THE LEAF LITTER LAYER

Objectives: To learn about adaptations of plants and animals found in the leaf litter of scrub and explore ecological relationships such as symbiosis and producers, consumers, and decomposers.



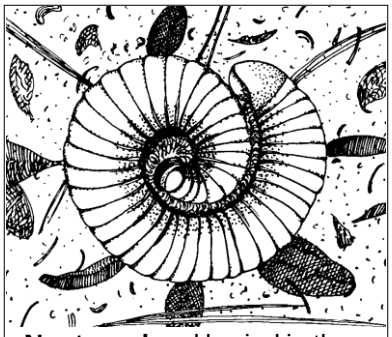
A. Mushrooms: Partners and Recyclers

- **III.A.1** Mushrooms—What Are They Good For?
- **III.A.2** Decomposing Decomposers—Mushrooms and Their Associates
- **III.A.3** What Are Spores and How Can You Find Them?

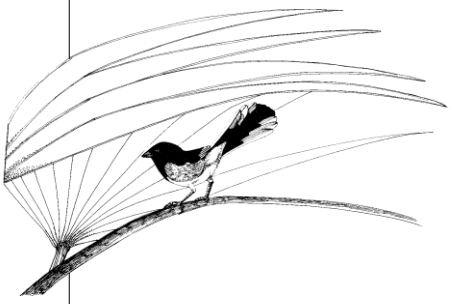
B. Life in a Microhabitat

- **III.B.1 Life in a Microhabitat**
  - **III.B.1** Part One: Make a Pitfall Trap
  - **III.B.1** Part Two: Make a Berlese Funnel
  - **III.B.1** Part Three: Investigating Microhabitats
  - **III.B.1** Part Four: What Did You Find? (Analyzing the Data)

III. Life in the Leaf Litter Layer



Nocturnal and buried in the sand during the day, the **Florida scrub millipede** feeds mostly on dead scrub oak leaves. When threatened, it defends itself by curling up and exuding a golden toxin that turns brown once it hits the air. While the toxin protects the millipede from some predators, it might attract some of its special enemies such as the glowworm and a millipede-eating fly.



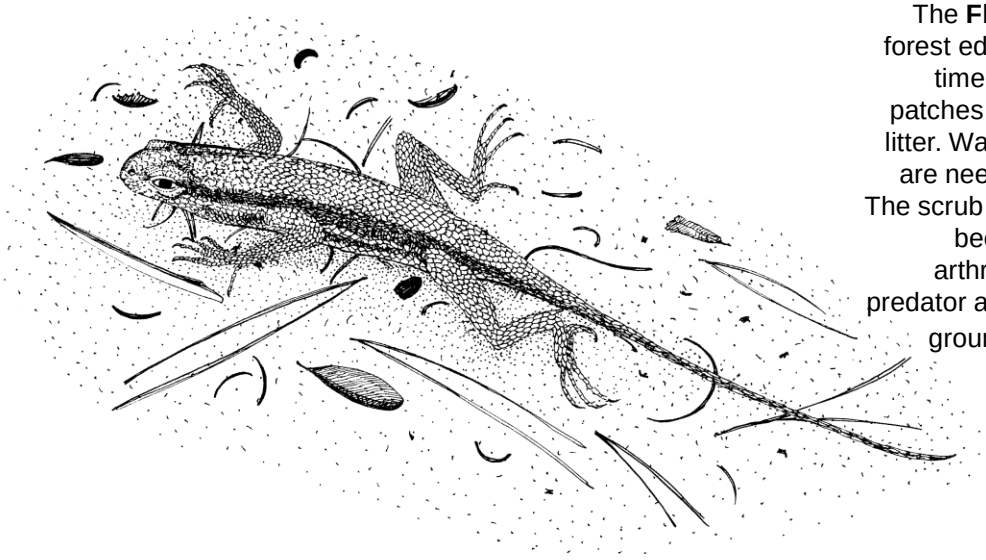
The **eastern towhee** is a ground nesting bird, common to the Florida scrub year-round. Towhees scratch in the dead leaves on the ground for insects and seeds. "Drink your tea," it seems to say as the towhee sings out over the scrub.

Introduction

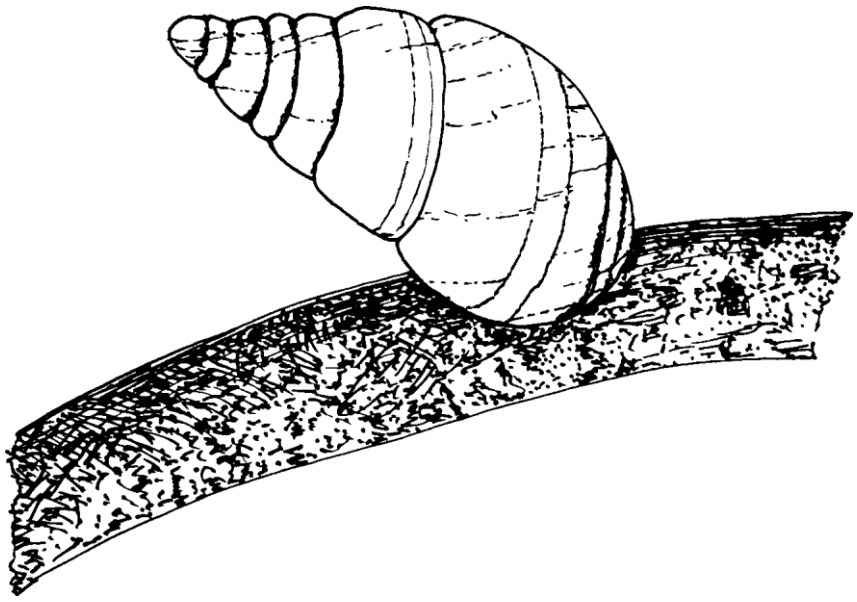
The entire scrub ecosystem has a foundation of sand. But what's on the sand's surface can vary from site to site. While some scrub areas have lots of open, sandy patches, other scrub sites support larger shrubs, pine trees, hickory trees, and low-growing oaks. And where there are trees, there is leaf litter. And where there is leaf litter, the moisture often lingers a little longer. Layers of decaying leaves on the ground create an inviting habitat for many decomposers, such as fungi, insects, and the occasional slug.

While open areas of scrub are hot and dry, the leaf litter layer is relatively dark and more protected. Shade prevents rapid drying of the ground and keeps the sand a bit cooler. Plants and animals that can't survive in the bare sandy patches of scrub can often thrive in this **microhabitat** within the Florida scrub.

Leaf litter is just one example of the many microhabitats within the scrub. Much of the diversity of life depends on the existence of a large variety of microhabitats within larger scale habitats such as the Florida scrub. These microhabitats are like little reservoirs of life and can play a very important role in the distribution of plants and animals. To protect endangered species, preserve management often includes the creation of microhabitats. For example, after a prescribed burn, you will often see patches of bare sand, patches of rapidly reemerging plants, and patches of shrubs and trees that did not burn. With a wide selection of conditions to choose from, there is a greater possibility that the large-scale habitat will appeal to a great number of different kinds of plants and animals.

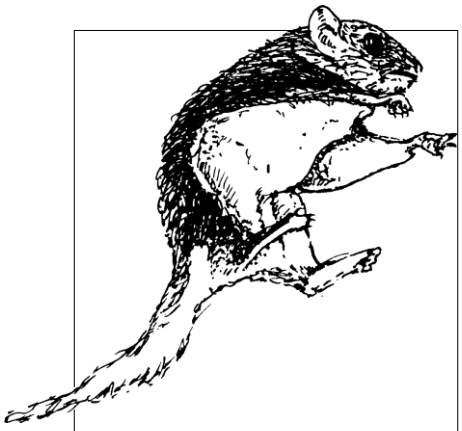


The **Florida scrub lizard** is a forest edge species and spends time in both the open sandy patches of scrub and in the leaf litter. Warm, sunny, sandy spots are needed for egg incubation. The scrub lizard, which eats ants, beetles, spiders and other arthropods, is a sit-and-wait predator and can be found on the ground or low on tree trunks

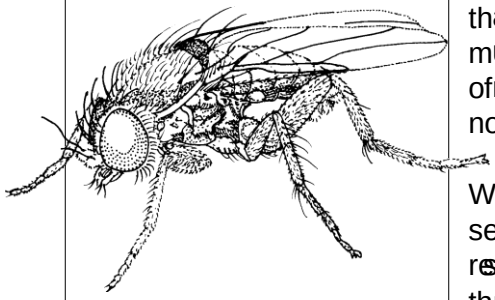


While **snails** can be found in wooded areas in most parts of the country, they rarely live in scrub. No doubt, dry periods make snail survival difficult. When the weather is hot and dry, some kinds of snails are able to close themselves up in their shell to seal in moisture. But snails need calcium to build their protective hard shells. Snails normally get calcium from the soil. In scrub, the closest calcium is about 100 feet down—and unavailable to the snail—which may be why snails are rarely seen in scrub.

MUSHROOMS: PARTNERS AND RECYCLERS



Mushrooms are a main food of the nocturnal **southern flying squirrel.** Squirrels often dig up and eat the fruiting bodies of a subterranean mushroom. Common in scrub, flying squirrels typically convert holes made by woodpeckers in dead or dying trees into nest cavities.



When it comes to mushrooms, it pays to be fast. **Flies**, attracted to a mushroom's odor, can usually locate a mushroom faster than a wingless insect. Fly eggs also hatch quickly, which means the young are more likely to grow and prosper than the eggs of an insect that moves or develops more slowly.

Introduction

Mushrooms do more than make a good pizza topping! Some glow in the dark; some are deadly poisonous. Some turn blue when you cut them; some smell like dead animals. Some are star-shaped; some are flat. Some provide nutrients for plants while other mushrooms are parasitic and take nutrients from plants. Not all mushrooms are decomposers, but almost all mushrooms are habitat for other organisms.

The best time to find mushrooms is just after a rainy spell during warm weather. In Florida, you're guaranteed to see mushrooms almost anytime!

Some mushrooms can be deadly if eaten. However, this is not a good reason to avoid studying them. Make sure your students wash their hands after handling mushrooms and keep all wild mushrooms away from their mouths!

Background Information

Mushrooms aren't plants or animals, but have their own classification—the Kingdom Fungi. Because they lack **chlorophyll** (the green pigment that absorbs energy from sunlight and uses it to make food), mushrooms get the food energy they need in other ways. Some kinds ofmushrooms break down dead animal and plant matter for nourishment while other mushrooms absorb nutrients from living plants.

We usually see only a small fraction of a mushroom's body. The part we see is the reproductive part, like a seed-containing fruit on a tree. The rest of the mushroom's body is made up of hundreds of tiny, branching threads. The individual threads, or **hyphae** (pronounced HI-fee), grow at an incredible rate. As the hyphae branch, the threads form a network called the **mycelium** (pronounced my-SEEL-ee-um). The densely branched mycelium spreads out through the sand or dead matter and the hyphae absorb needed nutrients. If the hyphae cross each other and fuse together, small buttons are created that can become fruiting bodies almost overnight. For most of the year, a mushroom remains completely underground. After a good rain, the mycelium enlarges rapidly and will send up fruiting bodies with spores.

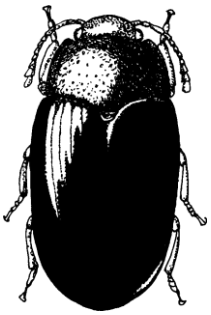
Spores are almost weightless and can float long distances on a light breeze. But not all spores travel with the wind. Flies, attracted to mushrooms that smell like rotten meat, carry spores to a variety of

locations. Animals such as flying squirrels and the Florida mouse will eat mushrooms and the spores will pass, unharmed, through their digestive tracts. Spores can also travel in water.

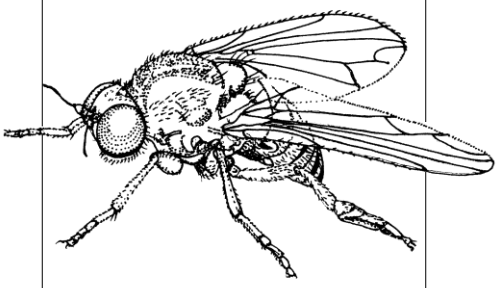
Some mushrooms have a cooperative, mutually beneficial relationship with tree roots. This relationship is called **mycorrhizal symbiosis** (pronounced MY-ko-RY-zal SIM-by-O-sis). The hyphae attach themselves to the roots and absorb sugars and amino acids stored by the tree. The tree roots, with the help of the attached hyphae, are able to absorb more water and minerals, such as phosphorus and nitrogen. Approximately 2/3 of plant species in the world have a fungus association. This cooperative relationship is essential for plants in the Florida scrub. Without it, many plants could not survive in the nutrient poor sand.

Mushrooms that are mycorrhizal are not decomposers. Mycorrhizal mushrooms seem to pop up out of the ground. If a mushroom is a decomposer, you will normally see it attached to a dead tree or on rotting leaves. The decomposer mushroom stretches thin filaments throughout the decaying material and sends out a chemical that helps break the soft wood into nutrients. The decomposing mushroom plays an important role in any habitat by helping to keep dead matter from accumulating. Without decomposers, the world would be overwhelmed by a sea of waste!

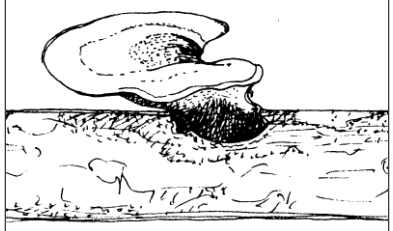
Mushrooms are food for many kinds of animals and insects. Over time, some species of mushroom have developed poisons that protect them from being eaten. Their poisons are mostly effective against eager vertebrates, such as mice, gray squirrels, and flying squirrels, but some poisons may also protect a mushroom from snacking insects. If the mushroom is mycorrhizal, the poisons do not affect the associated tree.



This **pleasing fungus beetle**, commonly found munching and laying eggs on mushrooms, was named by an entomologist because its brightly colored body was pleasing to the eye.



Named for its unusual feet, the **flat-footed fly** is a frequent mushroom visitor. The reason for its strange adaptation is not yet understood. (So many questions about nature have yet to be answered!)



Orange bracket fungi is typically found on decaying logs in the scrub and is an important decomposer.

III.A.1 Mushrooms—What Are They Good For?

Concepts: Decomposition, mutualism, dispersal, consumers, plant/animal interaction, food webs, niche, microhabitat, plant nutrition, and chemical defense.
Skills: Observation, using a search image, cooperative learning, discussion, measurement, description, and interpretation of data.
Time needed: Part One: approximately 20 minutes. Part Two: approximately 15 minutes.
Best time of year: Anytime during warm, wet weather.
Sunshine State Standards: LA.B.2.2.1, MA.B.1.2.2, MA.B.2.2.1, SC.F.1.2.3, SC.F.1.2.4, SC.F.2.2.1, SC.G.1.2.4, SC.G.1.2.5, SC.H.1.2.2, SS.B.2.2.2.

This activity has two parts. During Part One your class will collect data. In Part Two, your class will use the data to answer the following questions:

- What kind of mushrooms are found in scrub?
- Are all mushrooms decomposers?
- What kind of relationship do mushrooms have with other plants?
- How do mushrooms help plants survive in the sandy, nutrient-poor sand of scrub? Can trees be helpful to mushrooms?

III.A.1 Part One—Collecting the Data

Materials:

Each team of 2-3 students will need:

- Student data sheets (one sheet for each kind of mushroom they find)
- Clipboard
- Pencil
- Centimeter ruler
- Meter stick
- Small paper or resealable plastic bags

Teacher will need:

- Class data sheet
- Stakes and flagging
- Spoon or trowel for carefully digging up mushrooms
- Small paper or resealable plastic bags (one for each mushroom collected)
- Mushroom labels photocopied and cut from mushroom label sheet on page 93 (one label for each mushroom)

Instructions for the teacher:

1. Locate and flag an area of scrub where a variety of mushrooms can be found. (You will be more successful at this after a rainy spell.)

2. Use the question, “What happens to all the materials from plants and animals when they die?” and the information in the section introduction to have a decomposition discussion with your class. Encourage the students to think of examples of decomposers and decomposing matter. Write your list on the board. (A decomposer, or scavenger, is any organism who cannot make its own food and eats things that are already dead. Examples include: bacteria, fungi such as molds, mildews, and mushrooms, worms, vultures, termites, millipedes, and some insect larvae.) Be aware that a decomposer can sometimes be a consumer. Try posing the following questions to your class: When a vulture eats roadkill, is it a consumer or decomposer? Are humans decomposers when they eat a hot dog or veggie burger?

3. Briefly introduce the concept of mutually beneficial relationships (**mutualism**). In our culture, grocery stores benefit both the owner and the people who shop for food. With mycorrhizal associations, mushrooms get the food it needs from the root of a tree and the tree is able to absorb more minerals and water. (See Background Information on page 88-89 for more information.)

4. Distribute and review data sheets.

5. Divide class into teams of two or three. Each team needs a recorder and observer. Teams of three may also have a data collector. The recorder and observer work together to answer questions on the data sheet. The data collector or observer should be equipped with a meter stick so they can collect data when the team finds a new mushroom to describe.

6. Supply the teams with necessary equipment. Inform students of the risks of poisonous mushrooms. Students should never put any mushroom in their mouths during this activity and students who handle mushrooms should wash their hands after the activity is completed.

7. Encourage the students to carefully observe the designated areas and find as many kinds of mushrooms as possible. Be sure they look under logs and throughout the leaf litter in addition to surveying the surface areas. Use a hand lens or magnifying glass to search for hyphae (which will look like white threads) in the leaf litter or in rotten wood. Have students fill out data sheets for each kind of mushroom that they find.

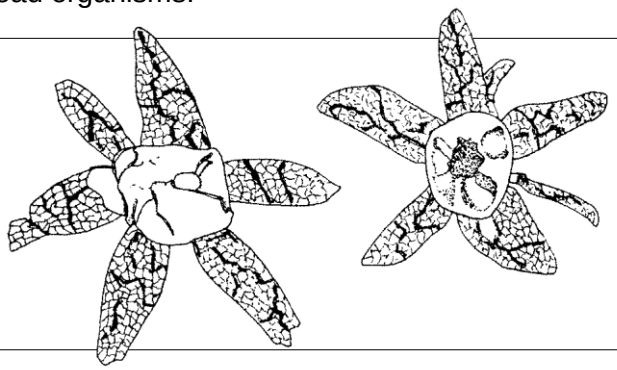
8. Collect 4-6 different kinds of mushrooms found by your students. (Students should not collect the mushrooms themselves.) Each mushroom sample should include a label. (See page 92.) Students should use a pencil to complete the labels because moisture will not affect pencil marks. The activity will be just as effective if the mushroom breaks into several pieces. If the mushroom breaks, make sure to include all of the broken parts in your container.

III.A.1 Part Two—Compiling and Analyzing the Data

Materials:
Each student needs:
- Part One Student Data Sheet
- Part Two Class Data Worksheet

Instructions for the teacher:
1. Instruct students to review their Student Data Sheets from Part One.

   Ask the students to divide their data sheets into two piles. Pile 1 will be mushrooms found on dead logs or other dead matter. Pile 2 will be mushrooms found near live trees and green plants and not on dead organisms.



Often found on dead leaves, the **earthstar** is a puffball mushroom and fruiting body of a decomposer fungi. Carefully tap the mushroom center to release its smoky-looking spores

2. On the chalkboard, list the total number of different kinds of mushrooms the class found (see format below). Write down the number of mushrooms the class thought were decomposers.

How many?	Name	Description	Decomposer?	Plant Association
3	White mushroom	Simple, white-capped	no	Grows near oaks
2	Red-brown mushroom	Reddish-brown cap, milky sap	no	Grows near oaks and pines
1	Ringed mushroom	White, rounded cap with ring around stem	no	Grows near oaks
4	White bracket fungi	White, on dead log, woody	yes	

Total # of decomposers: 4 Total # of plant associated mushrooms: 6

3. Explain that the mushroom and tree or plant association might signal a mycorrhizal symbiosis, or a relationship that benefits both the mushroom and the tree or plant. (See page for more information.) Ask students the following questions:

    - What kind of help can a mushroom give a tree?
    - Can a tree help a mushroom to grow?
    - How did the mushroom find the tree?
      (Spores were blown there and conditions were right.)

Results

After this activity, your students should:

- Understand the role of decomposers and give examples.
- Understand the meaning of mychorrizal symbiosis.
- Understand the concept of a food web.
- Know that some kinds of mushrooms use chemicals to defend themselves.
- Be able to observe carefully and record data.
- Be able to share and discuss observations with other students.
- Be able to measure using a meter stick.
- Be able to record data.

Name: Mrs. Amanita's Class (or student's names) Date: 26 August 1999 Location: Toadstool Scrub Preserve, Turkeytail, FL Description of area: grassy, bordered by oak trees Weather conditions: sunny and dry	Name: Date: Location: Description of area: Weather conditions:
Name: Date: Location: Description of area: Weather conditions:	Name: Date: Location: Description of area: Weather conditions:
Name: Date: Location: Description of area: Weather conditions:	Name: Date: Location: Description of area: Weather conditions:

III.A.1 Mushrooms—What Are They Good For? Part One

STUDENT DATA SHEET

Instructions: Complete a data sheet for each type of mushroom you find.

- Team members: _____
- Mushroom # _____

Mushroom description:

Color: _____

Cap shape (circle one):

Flat Rounded Bell-shaped Puff ball Star-shaped
Funnel-shaped Edge curved under

Does the mushroom have a stem?	yes	no
Does the mushroom have gills or pores?	yes	no
Is the mushroom hard to the touch?	yes	no
Does the mushroom change color if broken?	yes	no
Does the mushroom have a milky white sap?	yes	no

- Height from the ground (use centimeter ruler) _____cm
- Are there any similar mushrooms nearby? (circle one) yes no
  If yes, how many? _____
- How far away is the mushroom from trees or other plants? (use a meter stick to measure to the closest plant or tree) _____
- Is the mushroom on dead leaves or dead wood? yes no
- Do you think this mushroom is a decomposer? yes no
- Is this mushroom popping up right out of the sand or grass? yes no
- Do you see any insects on the mushroom? yes no
  If yes, how many different kinds? _____

III.A.2 DECOMPOSING THE DECOMPOSERS: Mushrooms and their Associates

Concepts: Insect/fungal associations, decomposition, food web, and classification.
Skills: Observation, cooperative learning, data recording and interpretation, and description.
Time needed: Part One: approximately 10 minutes each day. Part Two: approximately 15 minutes.
Best time of year: Anytime of year that mushrooms are present (wet periods).
Sunshine State Standards: LA.B.2.2.1, LA.B.2.2.6, MA.E.1.2.1, MA.E1.2.3, MA.E.3.2.2, SC.G.1.2.1, SC.G.1.2.2, SC.G.1.2.4, SC.G.2.2.1, SC.G.2.2.2, SC.G.2.2.3.

This classroom activity has 2 parts. During Part One, students will observe how a mushroom changes over a two to three week period and will record their observations. In Part Two, students will analyze data the class collected.

III.A.2 Part One—Collecting the Data

Materials:

Each team of 2 students needs:

- One mushroom with collection label
- Plastic wrap to fit over jars
- Rubberbands (one for each jar)
- Cotton
- Black construction paper (one sheet per jar)
- Scissors
- Tape
- Decomposing the Decomposers data sheet
- Pencil
- Clipboard
- Hand lens or magnifying glass
- Small vials or jars

Teacher needs:

- Clean, clear glass or plastic bottles (mayonnaise, peanut butter, or pickle jar). One jar for each team.
- Dry, sifted sand (enough for 2-3 inches in each jar)
- Funnel (can be easily made with paper)

Instructions for the teacher:

1. Each team of 2 students needs a mushroom to observe. Use mushrooms collected from the previous activity, Mushrooms—What Are They Good For, and/or mushrooms you bring from home. Make sure a collection label is included with each mushroom (see page 92).

2. Prep the jars with the 2-3 inches of sand. (You may choose to go ahead and put the mushrooms in the jars and tape the collection label to the outside of the jar.)

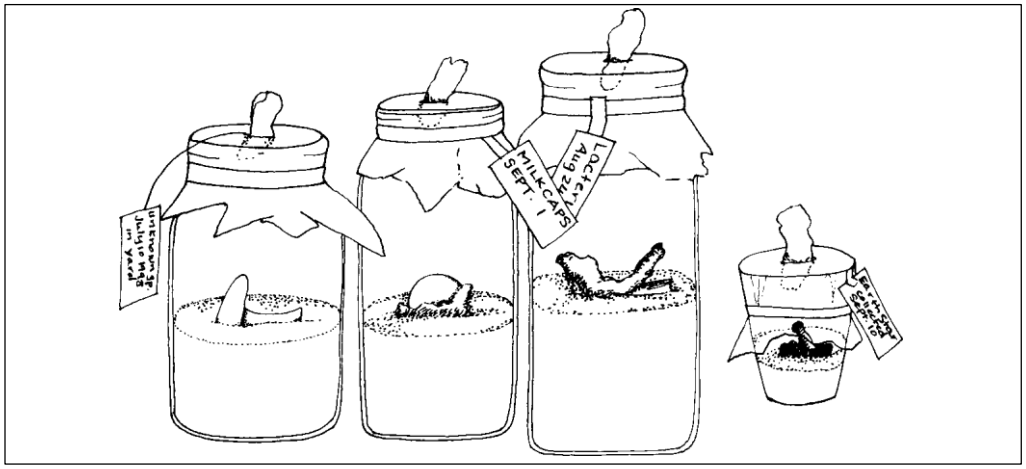
3. Distribute materials to your teams of students. Instruct students to cover the jar with clear plastic wrap once the mushroom is inside and secure the plastic with a rubberband.

4. Instruct students to make a small hole in the plastic wrap with the sharpened end of a pencil and plug the hole with a wad of cotton. Be sure the cotton is secure and won't fall into the jar.

5. Have students tape a piece of black construction paper around the jar so that the sand is covered, but the mushroom is still visible. (This mimics the darkness underground.)

6. Write a number on each jar and make sure each team knows the number of its jar.

7. Place the jars in a low traffic area of the classroom, but where students can still easily observe the mushrooms. Each day, the students should carefully observe the jars and record information on their data sheets. Water droplets may collect in the beginning, but the sand will absorb most of it. After a day or so, mold may begin to grow.



8. Once mold begins to form, have a brief mold discussion with your class. Explain that mold is also a fungus and the white threads of the mold are hyphae, similar to mushroom hyphae. (See introduction for more information.)

9. Keep a sharp lookout for insect larvae tunnels that may be visible close to the edge of the glass (You may lift the black paper for viewing.) If students look carefully, they might see the tiny larvae or pupae of insects that were most likely in the egg stage when the mushroom was collected.

10. Watch the jar for several weeks and record data. Be careful to look in all parts of the bottle—but without disturbing the sand. The young insects will mature into adults and can be seen flying under the plastic wrap. To more closely view the insects, remove the cotton wad and place a small vial over the hole. The natural tendency of most insects is to fly up to higher, brighter areas, so they will fly into a well-placed vial. Replace the cotton and examine the insect(s) with a magnifying glass—or with a dissection scope if you have access to one. (See page 99 for illustrations of insects commonly found in and around mushrooms.)

11. When recording the insects your students find, it is not important that they correctly identify them. However, the students should be able to describe what the insects look like and be consistent with their description when recording data. Encourage your students to create look-alike categories. For example, if a student identifies an insect as a spotted wing fly one day, the same description must be used each time the student sees that kind of insect.

12. On the last day of the activity, discuss how conditions may differ between the mushroom in the jar and an outdoor mushroom that has fallen on the ground.
    - More moisture will be visible indoors because sunlight and wind would dry out the mushroom on the ground.

- Because air does not circulate freely around the mushroom in the jar, it stays very moist and the mold can grow more rapidly for a longer period of time.
- The mushroom in the jar is protected from predators such as mice and squirrels.

III.A.2 Part Two—Analyzing the Data

Instructions for the teacher:

1. After the class has collected data (for as many days as you wish), use the table below to compile all the information. Copy the table on the chalkboard or overhead projector. Have a team spokesperson report their data. (You will need to enlarge the spaces for the data.)

Team #	Mushroom Jar # Observed	# of days observed	Changes in the mushroom	Changes in the sand?	How many insects appeared? (total)	How many different kinds of insects appeared?

2. After the data have been compiled on the table, encourage your class to answer the following questions:
    a. If you didn't see any insects on your mushroom when it was collected and some appeared, where do you think the insects came from?
    b. If you did see insects on your mushroom when it you collected it, what kind of insects were they? How many did you see? Were the insects you saw at the end of the observation a different kind than the insects you saw in the beginning?
    c. What do you think would happen to the mushroom if you kept it in the jar for a month or even two months?
    d. What was the total number of mushrooms observed by your class?
    e. What was the total number of different kinds of insects observed in your mushroom containers?

Results

After this activity, students should:

- Understand that associations exist between mushrooms and insects and be able to give examples.
- Understand the role of insects as decomposers.
- Understand the concept of a food web.
- Understand the need for a classification system.
- Be able to work cooperatively and share observations.
- Be able to observe carefully and record data.

Further Questions and Activities for Motivated Students

Keep a sketchbook and draw how your mushroom changes. Use a magnifying glass to carefully examine the insects that emerge and sketch them, too.

III.A.2 DECOMPOSING THE DECOMPOSERS Student Data Sheet

Team Members _____

Mushroom number_____

HYPOTHESIS (What do you think will happen to the mushrooms?)

_____

_____

Day one: Carefully inspect your mushroom (in case it changes overnight) and describe how your mushroom and the sand around it looks.

_____

_____

Day	Changes in Mushroom?	In the sand?	Any insects? How many? Describe.	Other changes?
2				
3				
4				
5				

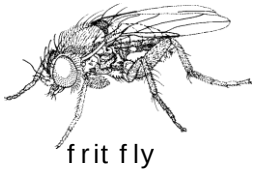
6				
7				
8				
9				
10				

Insects commonly seen in and around fungi:

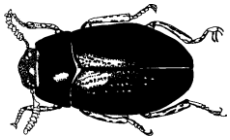
humpbacked fly

fungus gnat

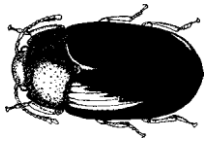
flat-footed fly



frit fly



darkling beetle



pleasing fungus beetle

III.A.3 What Are Spores and How Can You Find Them?

Concepts: Spore dispersal, fungal reproduction, and microscopic size of spores.
Skills: Observation, description, discussion, and appreciation of natural design.
Time needed: First day: approximately 10 minutes. Second Day: approximately 10 minutes.
Best time of year: Anytime mushrooms can be found (usually warm, wet periods).
Sunshine State Standards: SC.F.2.2.1, VA.A.1.2.1, VA.A.1.2.2, VA.A.1.2.3, VA.A.1.2.4, VA.B.1.2.1, VA.B.1.2.4

During this two-day activity, your students will make prints using spores from mushroom caps.

Materials:
Each student or team of students needs:

- 1-2 mushroom caps (with pores or with intact gills)
- A light or dark piece of paper (or both)
- 1-2 plastic cups or bowls

Teacher needs:

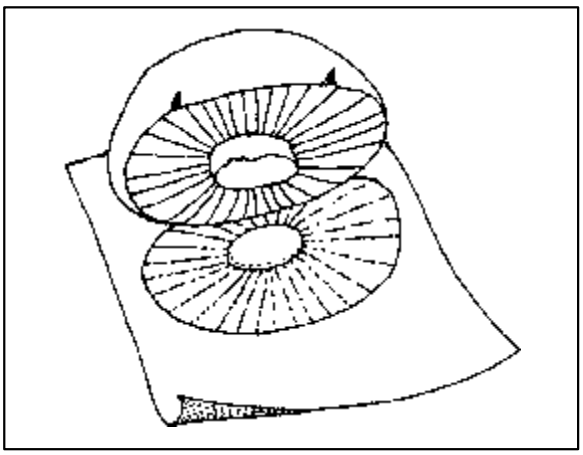
- Spray fixative or hair spray

Instructions for the teacher:

1. Use the question "Where do spores come from?" to start a spore discussion with your class. (Spores are a mushroom's way of reproducing. Each mushroom cap has millions of spores, which are difficult to see without magnification. Some species of mushrooms can be identified from other species only by their spore color! For more information about spores, see page 88.)

2. Distribute materials to your students. Have each student label the piece of paper with their name, the date, and place the mushroom was collected.

3. If the mushroom cap still has its stem attached, have students gently break it off. The caps should then be very carefully placed gill or pore side down on a piece of dark paper. (Spores show up best on dark paper.) If you have enough mushroom caps, place another cap (preferably same type of mushroom) on a light piece of paper.



4. Cover the cap with a bowl or cup and leave it undisturbed for 24 hours or overnight.

5. Carefully remove the cup and mushroom cap and examine the design left by the spores. What color are the spores? (Most spores will look white on a dark piece of paper and pale yellow or pink on white paper.)

6. Use hair spray or a spray lacquer to fix the spores to the paper and preserve the print.

Notes

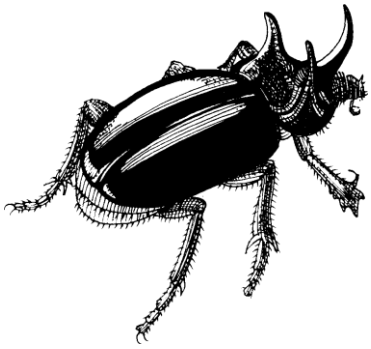
Spore prints cannot be made with puffball mushrooms. If you have a fresh puffball mushroom, you can observe the spores by carefully squeezing the “ball” to release the smoke-like spores. These spores will be kept afloat by even a light breeze for hours or days and will travel great distances.

Results

After completing this activity, you students should:

- Understand that mushrooms reproduce by spreading spores.
- Be aware that not all kinds of mushrooms hold or release their spores in the same way.
- Be able to observe carefully.

B. LIFE IN MICROHABITAT



The magnificent **ox beetle** uses leaf litter in an unusual way. After digging a deep burrow (about 20 cm) in the sand, the beetle fills the bottom with dead oak leaves and lays an egg. After the egg hatches, the larva feeds on the dead leaf compost.

Introduction

If you look at the Florida scrub landscape through a camera lens, you will see areas of bare sand and patches of ground covered with brown, decaying plant parts. If you zoom in for a closer view of the brown leaf cover, you will see lots of plant parts such as dead leaves, pine needles, acorns and parts of acorns, grass stems, twigs, branches, chewed pine cones, and bark. This dark mix of dead plant material is home to an amazing number of organisms. You won't see many of these animals, even if you pick up or kick the debris around with your foot. But by using traps especially designed by entomologists to find small creatures in leaf litter, your class will discover a very populated, diverse world of animals that they have probably never seen before.

In this section, your class will make several simple traps to investigate leaf litter and catch a variety of insects and non-insect arthropods. The results will confirm—life among the dead leaves is more complex and fascinating than you'd ever imagine!

Background Information

Scientists have identified well over a million kinds of plants and animals—and more than half of these are insects! This vast variety and abundance of all kinds of living organisms is referred to as **biodiversity**. Some habitats have a greater biodiversity than others. For example, a forest has more biodiversity than your yard and your yard probably has more biodiversity than an orange grove! The biodiverstiy of a habitat frequently reveals how healthy it is. A lower biodiversity often indicates that a habitat no longer has the space, food, or shelter needed to support a variety and abundance of organisms or it may signify other environmental problems.

Even in healthy Florida scrub, the biodiversity is not as great as you might expect. The harsh conditions of scrub are impossible for many organisms to endure. Only plants and animals specially adapted to dry, hot sandy conditions can survive. However, the more protective conditions of the leaf litter make this **microhabitat** within the scrub appealing to a variety of organisms. Therefore, the diversity of organisms in scrub leaf litter will often be greater than the diversity in the dry, open sandy patches of scrub.

Biologists also use the term **species richness** to describe the variety of organisms found in an **ecosystem**, habitat, or microhabitat. The species richness of scrub leaf litter is impressive. The decomposition of

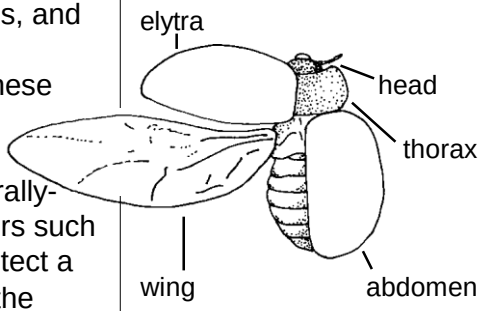
dead plant material is tough work and it takes many creatures with different “skills” to get the job done. Although the final breakdown of decaying plant material is completed by bacteria and chemicals, the dead material is broken down much faster if it gets chewed up first. Many different species of **arthropods** such as millipedes, pillbugs, and caterpillars consume dead leaves while eating a bacterial film or threads of fungi that invade leaf litter. You will capture some of these leaf-eating organisms during this activity.

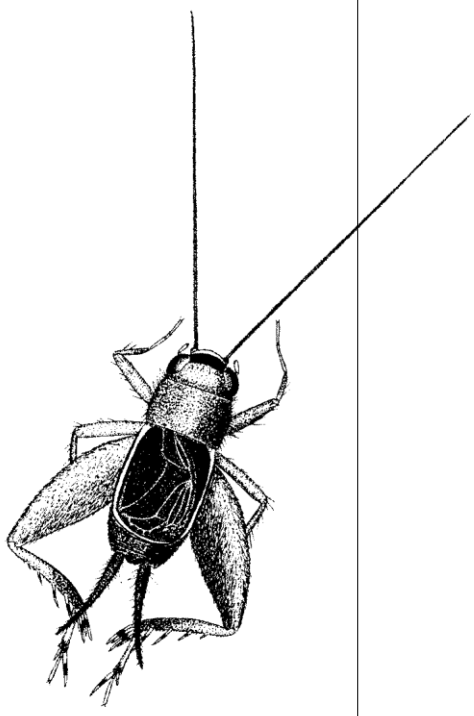
Many of the arthropods found in leaf litter have dark and/or neutrally-colored exoskeletons that allow them to easily hide from predators such as the eastern towhee. Hard, outer wing covers called **elytra** protect a beetle’s hindwings and abdomen and are a useful adaptation in the close quarters of the leaf litter. Other insects in the leaf litter, such as the pillbug, protect themselves from predators by rolling up or “playing dead.”

When you collect your leaf litter and examine your catch, you will probably discover that the organisms found in one batch of leaf litter may be quite different from those found in other samples collected just a few feet away. Leaf litter and the surrounding **environs** create separate microhabitats. And because conditions vary from one microhabitat to another, the animals that live in them will vary, too. For example, leaf litter found under a scrub oak will provide different physical and biological conditions to organisms than leaf litter dug out of a tree stump or grass clump. You may find more pill bugs in leaf litter and more termites in a dead log.

When you go out with your students to examine leaf litter, the multitudes of species you encounter may be a bit overwhelming. The names of the species are not important, but the biodiversity is. It is important to know that there are great numbers of species, and their combined activities keep our world in balance. They purify air and water, they recycle the nutrients that would otherwise be lost from the system, they keep pest species in check, so, for example, we almost never need to use pesticides when growing pine trees in Florida. The services performed by natural systems do not depend on a few key species. They depend on thousands of species. In a similar way, we may think of our bodies requiring a few key chemical compounds to function well: carbohydrates, vitamin C, certain amino acids, etc. In actuality, we depend on thousands of chemicals, most of them produced inside our own system, in order to function well. Ecological systems are more flexible and less easily disrupted than our own physiological systems, but both kinds of systems depend on diversity. Many students today spend almost all their time in habitats with hardly more biodiversity than their classroom. They have no idea of the biodiversity of the systems that sustain humanity. These students might know a lot of technology, but the ecological world that they depend on might as well be run by magic. This might not matter, except that we

Parts of a Beetle





Several kinds of crickets live in leaf litter. In Florida scrub, the most common cricket is the **painted ground cricket**, which is dark brown with bright, cream-colored trim on the head and wings. The males sing day and night during much of the year. Their quiet songs blend into the background, like the ticking of a clock, and are a part of Florida scrub’s atmosphere that few people notice.

Not all species of Florida **cockroaches** like kitchens and garages. The leaf litter of Florida scrub is home to several species. Because they scurry away quickly at the slightest disturbance, they can be difficult to find. Biologist know that these scrub cockroaches, when observed in the lab, will eat almost anything from dry oatmeal to peanut butter sandwiches. However, the natural diet of these roaches out in the scrub is not known. Scrub cockroaches are eaten by lizards, spiders, and several species of wasps.

already have the power to change the world so that its ecology is disastrously simplified. By the time these students are adults, the power of our species will be even greater, and require even more judgement and responsibility.

III.B.1 Life in a Microhabitat

Concepts: Microhabitat, biodiversity, adaptations, and research techniques.
Skills: Observation, cooperative learning, data recording and interpretation.
Time needed: Part One: approximately 10-15 minutes. Part Two: approximately 20 minutes.
Best Time Of Year: Anytime.
Sunshine State Standards: LA.B.2.2.1,LA.C.1.2.1, MA.A.3.2.2, MA.E.1.2.1, MA.E.1.2.3, SC.G.1.2.1, SC.G.1.2.2, SC.H.1.2.1, VA.A.1.2.1.

This activity has four parts that should be split into at least two days. During Parts One and Two, your class will construct pitfall traps and Berlese funnels. During Part Three, your class will go outside to observe microhabitats, set pitfall traps, collect leaf litter, and will set up Berlese funnels inside the classroom. (Time must also be allowed for students to check pitfall traps the next day.) In Part Four, your class will answer questions using data collected from their observations.

III.B.1 Part One—Make a Pitfall Trap

Pitfall traps will catch small animals such as beetles, spiders, small lizards, and even frogs or toads that move around in the leaf litter. These simple traps should take approximately 10-15 minutes to make. Each team of 2-3 students should have one.

Materials needed (for one trap):

- One clear, 2-liter plastic soda bottle, large cottage cheese or yogurt container (or other non-breakable container with slick sides).
- One "roof" made with a disposable plastic plate (or the top of the container) to keep out rain and intense sunlight.
- Supports to keep the roof up off the container and allow space for animals to drop in. (Rocks, sticks, bamboo skewers).
- A weight to keep the roof from blowing away (a small piece of wood works well). If bamboo skewers are used, they will sufficiently anchor the roof.
- Big metal spoon or trowel for digging a hole in the sand for your trap.

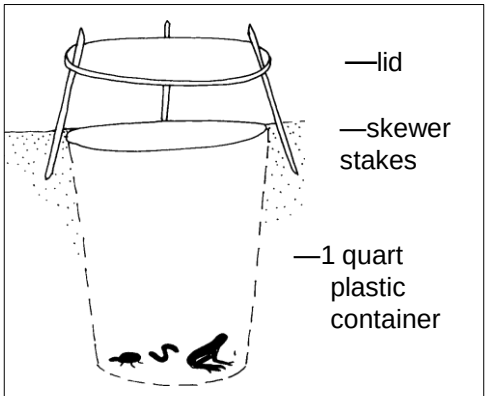
Directions:

1. If using a plastic soda bottle, cut the neck off the soda bottle off where it begins to curve.

   Prep your roof with bamboo column supports, if desired, by punching approximately 4 small holes in a plastic plate and sticking the skewers through the holes.

2. To set your trap, dig a hole big enough so that the trap's top edge is even with the surface of the sand. (If the edge of the trap sticks up above the sand, the leaf litter organisms will run into the edge and will not fall inside.) Place your container in the hole and carefully mound the sand to the edge.

3. Position roof supports around the container and put the roof on. (If you use bamboo skewers, simply push one end of each skewer into the sand.) Make sure to leave a gap approximately 2 inches between the trap and roof so organisms have room to fall in.



Pitfall trap

5. Put a weight on your roof to keep it from blowing away (unless you used bamboo skewers).

After you set your traps, be sure to check them the next day—or within a 24-hr. period. When you are finished with your trap, dig it up and bring it inside. If animals get trapped and aren't collected or released, they can get overheated and die or become easy targets for predators.

Don't be surprised if you don't capture animals in all the traps. Scientists at Archbold Biological Station in Lake Placid, Florida, put out bucket–sized pitfall traps and will sometimes capture only one or two organisms in a trap each time the traps are set.

III.B.1 Part Two—Make a Berlese Funnel

The Berlese funnel trap (pronounced ber-lace-ee) is named after an Italian entomologist who invented the trap more than100 years ago. Berlese funnel traps are essential to scientists who study very small organisms that live in leaf litter. These animals prefer moist, cool conditions and rarely leave the cover of dead leaves. A Berlese funnel works by changing the preferred conditions of leaf litter organisms and forcing them out. As a light bulb in the trap warms up the plant material, the animals seek a cooler, wetter place to hide, and they fall into your trap!

A Berlese funnel should take approximately 20-25 minutes to make. Each team of 2-3 students should have one.

Materials needed (for one trap):

- One 2 liter plastic soda bottle
- Knife or scissors for cutting the bottle
- One moistened, white paper towel
- Paper clips, tape, or bamboo skewers for attaching the funnel
- Circular piece of stiff wire screen approximately 3 inches in diameter with holes big enough for insects and animals to pass through. (Window screen will not work because it is too flexible and the holes are too small.)
- One incandescent light bulb (Gooseneck lamps work well. Do not use florescent lights!!)
- Small container such as a film canister of rubbing alcohol for preserving insects (optional)
- Magnifying glass for observing trapped animals

Directions:

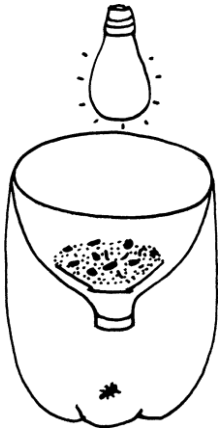
1. Cut the neck of the soda bottle off where it begins to curve into the bottle. Save the top.

2. Place a white piece of moistened paper towel into the bottom of the bottle. This will give your creatures some moisture and make them easier to see.

3. Take the top and turn it upside down to make a funnel. Put the funnel into the soda bottle so that the top edges are flush. Secure the funnel with tape or paper clips.

4. Take the piece of wire screen and fit it into the funnel about 2 inches from the top edge.

5. Put in a small handful of leaf litter.



Berlese funnel

6. Place the incandescent light bulb a few inches over your trap. Allow it to warm and dry the leaves overnight.

7. To observe your live animals more closely, remove the funnel and leaf litter carefully and quickly cover the bottle with a plastic bag. Gently turn the bottle over and shake the contents into the bag. Secure the bag opening and examine your specimens!

8. If you prefer to preserve your collection and examine nonliving animals, tape a small container, such as a film canister, under the spout of the funnel. The animals will tumble into the rubbing alcohol and stay preserved until you are ready to look at them under magnification.

III.B.1 Part Three—Investigating Microhabitats

Materials needed:

Each team of 2-3 students will need:

- Life in a Microhabitat data sheet #1
- Clipboard
- Pencil
- 1 plastic grocery bag
- 1 label for leaf litter bag (see page 115)
- Pitfall trap (including roof and weight)
- Trowel or big spoon for digging a hole for the trap

Instructions for the teacher:

1. Locate an area of your schoolyard study site with a variety of different microhabitats. If helpful to you, mark boundaries for your students.

2. Use the question “What’s the difference between a habitat and a microhabitat?” and information from the Introduction on page 102-104 to initiate a microhabitat discussion with your class.

3. Distribute and review the data sheet #1.

4. Take your class out to search for microhabitats. Encourage each team to find at least three different types of microhabitats and complete the data sheet. Examples of types of microhabitats include: under an oak tree, inside a dead log, at the base of a pine tree, inside a clump of grass, on a palmetto frond or stem, on the side of the road, etc.

5. As teams finish their data sheets, give them plastic bags to collect leaf litter. Students should push aside large, dry leaves and pine needles and collect one handful of well-composted leaf litter from one microhabitat. Students should avoid pine cones or wood chunks. Also instruct students to avoid taking handfuls of sand or soil. These will fall through the wire in the Berlese funnels and make it difficult to see the animals on the bottom of the trap. In each bag of leaf litter, teams should place a label that states the date, team members, location (school or study site), and description of microhabitat. This label will later be taped to the outside of the Berlese funnel trap.

6. Have each team choose one of their microhabitats for the pitfall trap. Make sure they put the trap in an undisturbed area where it is unlikely to get stepped on or moved. The area they choose should be one easy to dig—preferably sand with a leaf litter cover. (See pitfall trap instructions for how to set the traps.)

7. When you return to class, carefully set up the Berlese funnels. (Funnels can be set up prior to going out.) Make sure the label from the leaf litter bag is taped to the outside of the trap. If you want live animals from the trap, line the bottom of the trap with a moistened paper. If you prefer to observe dead animals, tape a small container of rubbing alcohol to the bottom of the funnel (see illustration). See Berlese funnel instructions for more information about how to use them. Leave the Berlese funnel lights on overnight.

8. The next day, each team of students should check their pitfall trap and Berlese funnel and fill out data sheet #2 and data sheet #3. When recording information on data sheet #3, it is not important that your students correctly identify what they catch. However, descriptions should be consistent. Encourage students to develop look-alike categories such as brown walking stick, small gray toad, black beetle with fancy antennae, etc.

III.B.1 Part Four—Composing and Analyzing the Data

Materials needed:

- Student teams should be prepared to report information from data sheets #1, #2, and #3.

Instructions for the teacher:

1. Copy the following table on the board of overhead projector. Use the table to compile data collected by your students.

		Total # of animals			**Total # of animal types**		
Microhabitat types	Total # of this type	# of animals in Pitfall trap	# of animals in Funnel trap	Total	# of types in Pitfall trap	# of types in Funnel trap	Total
Example: leaf litter under oak tree	5	3	17	20	2	6	8

2. Encourage your students to answer the following questions:
   a. How many different types of microhabitats did the class find?
   b. How many animals were trapped in each of the microhabitats?
   c. Which habitat had the greatest total number of animals? Why do you think so? Is this what you predicted?
   d. Which microhabitat had the greatest number of different animal types (or greatest species richness)? Why do you think so? Is this the answer you predicted?

Notes

This is a good activity to do several times throughout the year. Results will vary from wet season to dry season; between cool weather and warm weather. You can then compare your data to see how species richness and abundance varies as the conditions change. (See page 102 for definitions of species richness and abundance.)

Further Questions and Activities for Motivated Students

Using the same trap location, continue this project once a month throughout the school year. Try to determine how weather conditions or the time your trap is open might affect trap results. What happens to the animals during periods when you don't trap them?

III.B.1. LIFE IN A MICROHABITAT Student Data Sheet #1

Team members_____

Describe microhabitat #1:
Give it a name:

Describe its location (for example, in the shade or under a low branch):

Explain how it is different from other areas (for example: cooler, drier, hotter):

Describe microhabitat #2:
Give it a name:

Describe its location (for example, in the shade or under a low branch):

Explain how it is different from other areas (for example: cooler, drier, hotter):

III.B.1 LIFE IN A MICROHABITAT Student Data Sheet #1 (pg. 2)

Describe microhabitat #3:
Give it a name:

Describe its location (for example: in the shade or under a low branch):

Explain how it is different from other areas (for example: cooler, drier, hotter):

WHAT'S YOUR PREDICTION?

1. Which microhabitat do you think will have the largest total number of animals (or the greatest abundance)? Why do you think so?

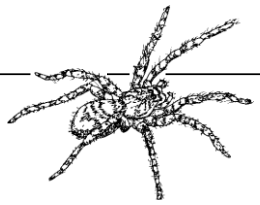
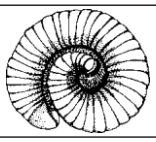
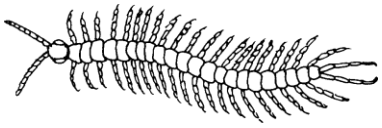
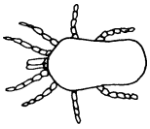
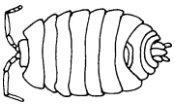
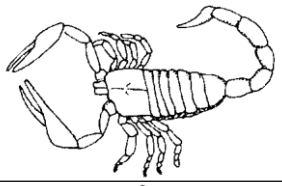
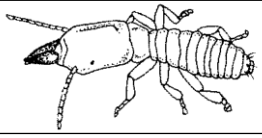
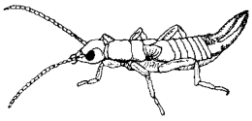
2. Which microhabitat do you think will have the greatest number of different kinds of animals—or the greatest species richness? Why do you think so?

III.B.1 LIFE IN A MICROHABITAT Student Data Sheet #2

BERLESE FUNNEL

Team members:_____

Microhabitat type: _____

Description of animal		How many?
Spider		
Millipedes		
Centipedes		
Mites		
Isopods (Pillbugs)		
Ants		
Springtails		
Scorpion-like arthropods		
Termites		
Other (describe)		

III.B.1. LIFE IN A MICROHABITAT

Student Data Sheet #3
PITFALL TRAPS

Team member s:_____

SETTING PITFALL TRAPS

Trap #: _____ Date trap was set: _____
Time trap was set: _____

Location of trap: _____

Description of microhabitat:

_____

_____

Weather conditions when trap was set (circle one from each list):

List A	List B	List C	List D
hot	sunny	dry soil	light breeze
warm	partly cloudy	damp soil	windy
cool/cold	clouds, no sun	rain today	calm or still

CHECKING PITFALL TRAPS

Trap #: _____ Date trap was checked: _____
Time trap was checked: _____

Weather conditions when the trap was checked (circle one from each list):

List A	List B	List C	List D
hot	sunny	dry soil	light breeze
warm	partly cloudy	damp soil	windy
cool/cold	clouds, no sun	rain today	calm or still

Number of organisms found: _____

III.B.1. LIFE IN A MICROHABITAT Student Data Sheet #3 (pg. 2)

Directions: List the different types of organisms you found in your trap (use look-alike categories) and how many of each that you caught:

	Type of organism (Give it a name and describe what it looks like)	# caught
	Example: white hairy spider-small as a quarter with long, skinny legs	5
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

III.B.1. LIFE IN A MICROHABITAT LEAF LITTER LABELS

Leaf Litter Label Team members: Date: Collection site (school name or study area): Type of microhabitat:
Leaf Litter Label Team members: Date: Collection site (school name or study area): Type of microhabitat:
Leaf Litter Label Team members: Date: Collection site (school name or study area): Type of microhabitat:
Leaf Litter Label Team members: Date: Collection site (school name or study area): Type of microhabitat:

GLOSSARY

1. **biodiversity-** the variety of species that make up a community; refers to the species richness (the total number of different species) and relative abundance of the different species.
2. **ecosystem-** a system formed by the interaction of a community of organisms, plants, and animals with their environment.
3. **environs-** the surrounding area.
4. **hyphae** (singular: hypha)- filaments that make up the body of a fungus.
5. **microhabitat-** a small area where an organism lives that has different conditions from other small areas that might be right next door!
6. **mutualism-** a relationship between organisms in which both partners benefit.
7. **mycelium** (plural: mycelia)- the densely branched network of hyphae in a fungus.
8. **mycorrhizal-** a symbiotic association of the mycelium of a fungus with the roots of certain plants.
9. **nocturnal-** active at night.
10. **parasitic-** living on or in the organism of another species, known as the host, and obtaining nutrients from its body.
11. **species richness-** the total number of different species at a site or in an area.
12. **spores-** reproductive bodies, usually microscopic, that are produced by mushrooms, plants, bacteria, and Protozoa and that are widely dispersed.
13. **symbiosis-** an interdependent or mutually beneficial relationship between two dissimilar organisms.

QUESTIONS FOR STUDENT EVALUATION

The questions presented below range from easy to difficult. Select questions most appropriate for your students and, if necessary, modify the questions so they will be more useful in your situation. Answers are in italics.

1. The following statements are descriptions of microhabitats:
   A hot, dry, open patch of sand.
   A shady area under a bush, full of leaves.

   Can you describe another microhabitat?

2. Mushrooms are not plants or animals but are called fungi. Put a “T” beside the following statements about mushrooms that are true.

   ___Some mushrooms are decomposers. (T)
   ___Some mushrooms can be helpful to trees. (T)
   ___The part of the mushroom we see holds the spores. (T)
   ___Mushrooms get their food energy from sunlight. (F)
   ___A mushroom can be a microhabitat. (T)

3. A decomposer is an organism that cannot make its own food and eats things that are dead. Put a "D" beside any of the following organisms that are decomposers:

   ___bacteria (D)
   ___mold (D)
   ___worms (D)
   ___millipedes (D)

4. Construct a food chain that includes at least one producer, one consumer, and one decomposer.
   examples: Grass—grasshopper—
   bacteria Grass—grasshopper—
   bird—hawk Old log—mushroom—fly
   larva—bird

5. Fill in the blanks of the following statements:
   _____is a consumer that would eat a decomposer: _____.
   (example: flying squirrel—mushroom)
   _____is a consumer that would eat another consumer: _____.
   (example: woodpecker—beetle larva)
   _____is a producer that would be eaten by a consumer:_____.
   (example: dead leaves—millipede)
   _____is a producer that would be eaten by a decomposer: _____.
   (example: log—mushroom)
   _____is a decomposer that would be eaten by another decomposer:_____.
   (example: mushroom—insect larva)

6. Put "T" beside the statements below that are true and an "F" beside those that are false:
   ____The variety and abundance of all kinds of organisms is referred to as biodiversity. (T)
   ____Species richness means how much food is available to all the organisms. (F)
   ____Biodiversity can be an important indicator of how healthy a habitat is. (T)

7. What kinds of animals do you expect to catch in a pitfall trap?
   Animals that walk or run across the ground.

8. What kind of animals do you expect to catch in a Berlese funnel?
   Small animals that can be found in leaf litter and like cool, dark places.

9. List three things that might help leaves decompose once they fall to the ground:
   Insects and other invertebrates
   Water
   Mold and bacteria
   Air

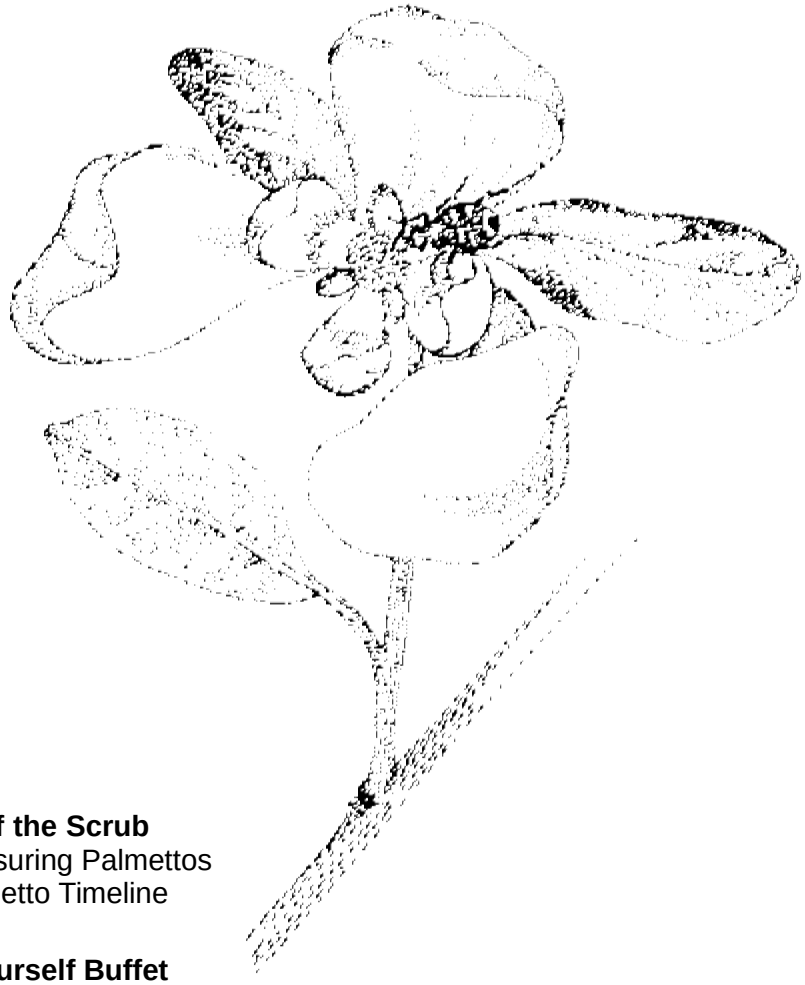
10. Describe the life cycle of a mushroom. Be sure to include spores, mycelium and hyphae, and the fruiting body.

    Spores are dispersed in the air. If they land on a good spot to grow, the spores send out fast-growing hyphae. The hyphae form a network called the mycelium. As the hyphae cross and fuse, a mushroom fruiting body forms and pushes up out of the ground. New spores are held in the cap of the new mushroom.

IV. UNIT FOUR

PLANT-ANIMAL INTERACTIONS

Objectives: To introduce scrub plants and their adaptations for life in the scrub. To emphasize the importance of plants as producers and their place at the beginning of the food chain. Plant-animal interactions discussed include **herbivory**, **mutualism**, plants as providers of shelter, and plant-human interactions.



IV.A.1 Palmettos: Old-Timers of the Scrub
Part One: Observing and Measuring Palmettos
Part Two: Constructing a Palmetto Timeline

IV.B.1 Oak Trees: The Serve Yourself Buffet
Part One: Collecting the Data
Part Two: Making a Collection of Leaf-eating Evidence

IV. Plant-Animal Interactions

wasp pollinating palmetto flowers

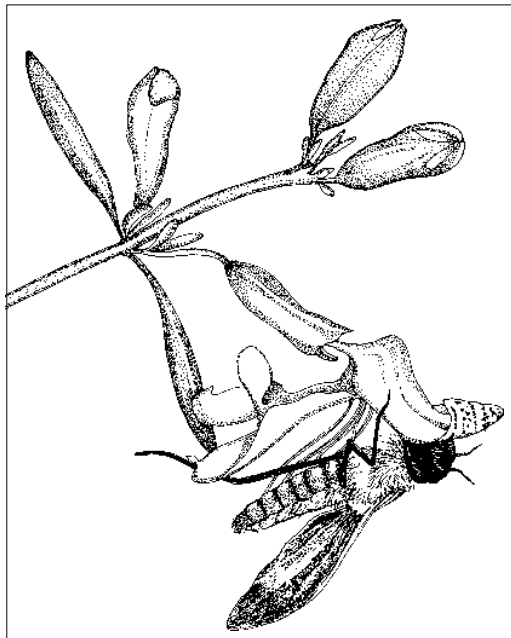
Introduction

Placing the plant unit last in a curriculum may seem unusual since plants are so basic to all life in the scrub, just as they are everywhere on our planet. But to consider plants requires moving to new levels of complexity. The earlier activities in this curriculum were stepping-stones to this unit.

The simplest aspects of biology deal with physics, as in the physics of sand. **Predation,** as in ant lions and ants, is still a relatively simple topic, as long as the focus is on the mechanisms of predation and not the **population dynamics** of predator and prey. Decomposition introduces the idea that there are whole systems revolving around plant by-products. Now it is possible to consider the much larger systems of plant-animal interactions. This curriculum has been slowly building increasing levels of complexity.

Plants also express the theme of adaptations for life in the scrub in the most definitive and complex ways. Plants cannot move around freely, and must take life as it comes. Plants cannot flee fire in the scrub, so they must have specific adaptations for it. Plants cannot hide from the sun in the heat of the day. They cannot roam around like animals and search for concentrations of nutrients. Although the adaptations of plants for life in the scrub are clearly displayed in leaf and growth forms, some adaptations are difficult for students, or anyone else, to imagine. Therefore, it makes sense to introduce plant adaptations after you and your students have thoroughly explored the concept of adaptation.

This section concentrates on two groups of plants that are very important in the Florida scrub habitat—the palmettos and the oaks. Unfortunately, dozens of other groups of plants and their interactions with animals are not mentioned. By developing the stories of palmettos and oaks in depth, we hope to more clearly convey the number of complex relationships in the scrub than if we quickly presented many plants. Observant students will probably notice additional plant-animal relationships. These students can be encouraged to design little research projects to explore these relationships. Since many of the relationships between plants and animals in the scrub have not been studied by scientists, a research project undertaken by a student could easily grow into an exciting original project for a science fair or a school research project. These could even become part of a new curriculum! The examples of pollination ecology mentioned below should give you an idea of all the things that could be studied.



The **Lake Placid scrub mint** is an endangered plant, which lives only in a small area near the town of Lake Placid. Other kinds of endangered scrub mints occur in other areas of Florida. In order to protect an endangered plant species it can be useful to know some details of its biology.

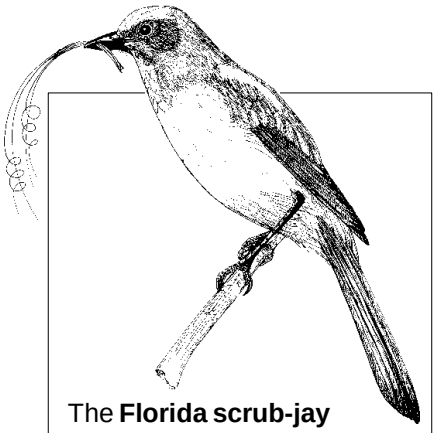
Scientists began looking at the insects pollinating the Lake Placid scrub mint and discovered that one kind of bee-fly usually pollinates its flowers. The pollen of this plant is kept under pressure inside the pollen-bearing structures, called anthers. When the fly collects nectar from the flower, the fly's furry belly presses down on the top of these anthers. This pressure causes a little slit to open in the anther so that the pollen comes popping out onto the fly's belly.

To save the Lake Placid scrub mint we need this fly. Fortunately, the fly is quite common. Nobody knows, however, what the fly larvae eat. Most likely, they are predators that attack other insects underground, but nobody really knows if these fly larvae require something special.

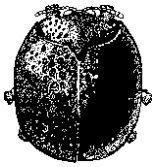
At least three species of **pawpaws** occur in Florida Scrub, including the endangered Four-petal pawpaw, found in scrubs along the East Coast of Florida. Pawpaws bloom in the spring and have big white flowers that are not attractive to bees and butterflies. The flowers produce a peculiar fruity or musky smell that attracts beetles, especially flower scarabs and longhorn beetles.

These beetles feed on part of the center of the flower and carry pollen from one plant to another. Although these beetles fly away quickly when disturbed, you can easily catch one in a clear plastic food storage bag and examine it for a moment before releasing it. (A plastic bag should be in every naturalist's field kit!) Students can identify the pollen producing flowers by sniffing at each flower (without touching it) for the characteristic fragrance. To catch beetles that may be feeding in the flower, place a bag gently over the flower, then tap the flower or move its inner petals. If beetles are feeding in the flower, they will tumble out and buzz around the bag like bees or wasps. Because these beetles fly and buzz like stinging insects but do not sting, they provide a good example of **behavioral mimicry**.

A. PALMETTOS: OLD-TIMERS OF THE SCRUB



The **Florida scrub-jay** collects tan-colored threads from scrub palmetto fronds at the beginning of nesting season and weaves them together to make a soft lining for its oak-twig nest.



The **blue tortoise beetle** spends its entire life on the leaves of either a scrub and saw palmetto. With its tiny jaws, it scrapes away at the palmetto leaf, leaving a thin yellowish line behind it as it moves along the leaf. When alarmed, the blue tortoise beetle clamps itself down on the leaf holding on with its yellow feet. Each foot is covered with hundreds of oily hairs, which stick to the wax that covers the palmetto leaf. The larva of the blue tortoise beetle also feeds on palmetto leaves. It covers itself with curved bits of waste material so that it looks like a tiny, upside down bird's nest. This beetle is never common enough to damage a palmetto plant.

Introduction

Plants that thrive in the Florida scrub are tougher than Indiana Jones in Raiders of the Lost Ark. And like Indiana Jones, it is amazing that plants can survive at all. They must prevent their leaves from drying out in the intense summer heat or from baking under the broiling sunlight. They must be able to survive weeks without water, yet be strong enough to survive a deluge during summer storms. They must grow and thrive with almost no nutrients. When fire approaches, they cannot run away, but must either sprout back after being burned to the ground or recolonize from seeds that were protected from the flames. Scrub plants must defend themselves against an abundance of insect and animal predators and from being overwhelmed by molds and fungus during the wet season. Yet despite all the conditions that seem to work against them, some scrub plants seem to grow with great ease.

Palmettos demonstrate some of the water conserving features found in many scrub plants:

- The leaves are covered with a coating of wax that prevents water from escaping from the surface of the leaf. One reason why Florida scrub burns so fiercely is that the heavy wax coating on palmetto leaves ignites once the leaves are heated sufficiently.
- The leaves are tough and thick, and not easily damaged in ways that could expose the moist inner tissue.
- The leaves are held upright when the plant is growing in open areas, so the rays of the sun hit the flat surfaces of the leaves directly during morning and afternoon, but not in the middle of the day when the sun is hottest.

There are other water-saving adaptations in scrub plants. Some of these are discussed later in the section on oaks. How is a cactus adapted for drought?

Background Information

The saw and scrub palmetto are two rugged species found throughout the Florida scrub in peninsular Florida. (Scrub palmetto is not found growing in the Panhandle.) These tough, slow-growing plants are well adapted to scrub and live very long lives—sometimes as long as 600-700 years! Palmettos play an important role in scrub habitat by providing food and cover for animals and material for nest building. Because your students are probably very familiar with palmettos, they will have lots of fun discovering so many new things about these plants. Both species of palmettos bloom during a predictable period, so your

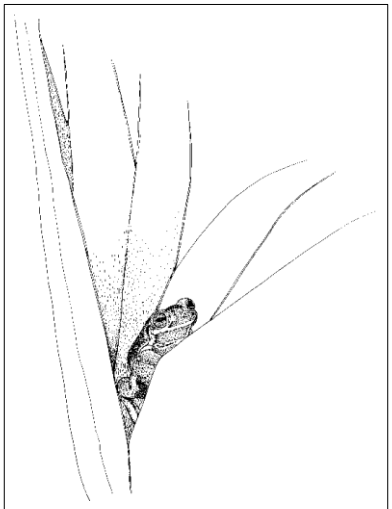
class can plan on visiting a few flowering plants to see what kind of insects drop by for nectar! Your students can easily locate and estimate the age of saw palmettos by measuring the length of the stem (or trunk) during Part One of the activity.

Both types of palmetto grow slowly out from the bud end and produce between 3 to 7 leaves a year—depending on the type of palmetto. Each leaf can live for 1 to 2 years. When a leaf dies, it loses its color and stays attached to the stem for about a year. Palmetto leaves are covered with a waxy coating which make them highly flammable. Palmetto leaves burn easily, but the growing bud of the saw palmetto is well protected by fiber that covers the stem and thick palm boots (the bases of old fronds). Because the stem is so well protected, it never burns down to the ground. After a palmetto burns, the charred stem can produce a new leaf within a week of the fire. Palmettos are one of the quickest scrub plants to respond after a fire. The stem and growing point of the scrub palmetto are usually under the sand and stay protected from fire.

Although palmettos respond quickly after a fire and are difficult to kill, young palmetto seedlings take a long time to get established and mature enough to produce flowers. Saw palmettos are **clonal**, so are more likely to spread underground than to produce new seedlings from fruits. Most populations of saw palmettos are made up of very old, well-established individuals. Saw palmettos grow in dense impenetrable thickets and can reach heights of 6 to10 feet or more. As the stem grows along the ground, it sends out roots to collect moisture from the soil. In moist, shady areas, the stem grows toward the light and is more erect. Scrub palmettos, on the other hand, are not clonal, so do not grow in thickets as saw palmettos do.

Both kinds of palmettos produce a cluster of white flowers in the spring. Saw palmettos typically bloom during March-April and scrub palmettos during April-May. Some plants will bloom at other times during the year—usually as a result of a recent fire. During a warm, sunny day, you can find many insect species as well as a great number of individual insects visiting the sweet-smelling palmetto flowers. Palmetto berries develop soon after the flowers drop. Initially, the fruit is green. As the fruit slowly ripens, it changes to yellow, then orange, and, finally, turns black by October.

The interactions between palmettos and animals are almost endless! Many animals are dependent on palmettos for survival. More than 100 birds, 25 amphibians, 61 reptiles, 27 mammals, and hundreds of insect species use palmettos as food, cover, or for nest material. Black bears, white-tailed deer, raccoons, opossums, gray fox, wild turkeys, bobwhite quail, and gopher tortoises eat palmetto berries. Feral pigs and bear dig out the growing tip from the stem (which kills the plant) and eat the newest leaves and “heart of palm.” Gopher tortoises and cattle eat parts



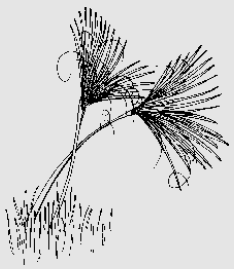
Although Florida scrub might seem too dry for frogs, **squirrel tree frogs** are quite common. They can find shady places that are cooler and more humid among the leaves of plants. This is another example of a microhabitat, like the ones in the leaf litter discussed in Unit Three. Palmettos are often a good place for tree frogs, because the frog can tuck itself down in a folded palmetto leaf out of sight during the day. Tree frogs eat spiders, crickets, and katydids also found on the palmettos. Some areas near scrub habitat are often marshes during the rainy season (summer, fall) and dry during the dry season (winter, spring). Because these seasonal wetlands do not have fish that eat tadpoles, these marshes are good places for tree frogs to lay their eggs.

Estimating the Age of a Saw Palmetto

Dr. Warren Abrahamson of Bucknell University has been conducting research at Archbold Biological Station in Lake Placid, Florida, for more than 20 years. He discovered that the age of a saw palmetto could be estimated by examining the relationship between the growth rate of the palmetto stem and the stem length. For four years, he measured the growth of more than 400 palmettos in two different habitats. The averaged growth rates for all palmettos in both habitats was 1.2 cm per year.

By measuring the length of a saw palmetto stem and dividing the length by 1.2, the approximate age of any saw palmetto can be determined. Intermediate-sized saw palmettos in his study typically had a stem length of 100-150 cm with an estimated average age between 75 to 200 years. However, longer palmetto stems were not uncommon and Dr. Abrahamson judged that some saw palmettos he measured could be well over 700 years old!

Scrub palmettos have a subterranean, curved stem so their age cannot be estimated using this method.



of the leaves. Florida scrub-jays, grasshopper sparrows, and wild turkeys collect parts of the plant to use as nesting material. Panther, black bear, and white-tailed deer use the protected cover provided by palmettos as a birthing den. Spiders and wasps commonly build nests and webs in the fronds and blue tortoise beetles “glue” themselves to the leaves (see page 122). Vines often use palmetto for support and mosses and lichen grow along the stem if it has not recently burned.

Humans are known to have eaten the palmetto berries in the past, but the berries are said to have a “rancid tobacco juice” flavor. Today, saw palmetto berries are used by pharmaceutical companies to manufacture certain drugs and medications. In one season, well over 7,000 tons of palmetto berries are harvested. Wildlife researchers worry that if demand for palmetto berries increases, the loss of available berries will be harmful to wildlife that eats the berries.

Saw Palmetto Adaptation Review

- Tough leaves provide protection from drought and damage.
- Waxy leaves keep the plant from drying out.
- Vertically-held leaves in open areas mean less exposure to the noon sun.
- Less vertically-held leaves in shaded sites allow a plant to capture more light.
- Fibrous layer in the trunk insulates the plant from fire.
- Clonal growth from root system allows the plant to colonize quickly in open patches after a fire.
- Blooming after fire means plants can take advantage of nutrients from ash, and produce more seeds when open areas are available.
- Flowers produce large amounts of nectar which attract many species of insects for pollination
- Edible fruits attract raccoons and other animals that disperse fruit
- Extremely hard, indigestible seeds are excreted unharmed from an animal that may eat them.

Saw Palmetto Plant-Animal Interaction Review

- Leaves as food: example-blue tortoise beetle
- Nectar as food: examples-bees, wasps, flies, butterflies
- Palm hearts as food: example-black bear
- Berries as food: example-raccoons, deer, black bear, gray fox, wild turkey
- Seeds as food: example- palm seed weevil
- Fibers for nesting: example-grasshopper sparrow
- Shelter in leaves: Examples-frogs, lizards, spiders, insects
- Shelter in thickets: examples-panther, black bear, deer, raccoon, gray fox, opossum, wild turkey, eastern towhee, snakes
- Habitat maintenance for wildlife: since palmettos burn easily they can help carry fire through the scrub habitat
- Medicine: example-humans

IV.A.1 Palmettos: Old-Timers of the Scrub

Concepts: Adaptations, plant-animal interactions, food webs, predator/prey relationships, microhabitats, diversity of life, and mutualism.
Skills: Observation, cooperative learning, measurement, scientific method, and discussion.
Time needed: Part One: approximately 20 minutes. Part Two: approximately 30 minutes.
Best time of year: anytime
Sunshine State Standards: LA.A.1.2.1, LA.A.1.2.2, LA.A.1.2.4, LA.A.2.2.1, LA.A.2.2.5, LA.A.2.2.8, LA.B.1.2.3, LA.B.2.2.1, LA.B.2.2.2, LA.B.2.2.3, LA.B.2.2.6, LA.C.1.2.1, LA.C.1.2.3, LA.C.1.2.4, LA.C.1.2.5, LA.C.3.2.2, LA.C.3.2.5, MA.A.1.2.3, MA.A.3.2.3, SC.F.1.2.2, SC.G.1.2.1, SC.G.1.2.2, SC.G.1.2.5, SC.G.1.2.6, SC.G.2.2.1, SC.G.2.2.2, SC.H.1.2.1, SC.H.1.2.2, SC.H.1.2.3, SC.H.1.2.4, SC.H.3.2.2, SC.H.3.2.4.

During Part One of this activity, your class will observe palmettos and animals found on the fronds and stem. Your students will also measure the length of the palmetto stem to help calculate the approximate age of the plant. During Part Two, your class will use data collected to construct a palmetto time line.

IV.A.1 Part One—Collecting Palmetto Data

Materials needed:
Each team of 2-3 students needs:

- Data sheet
- Clipboard
- Pencil
- String (not too thin) approximately 5 meters long
- Scissors (or teacher can have)
- Meter sticks or metric rulers

Teacher needs:

- Extra pencils or pencil sharpener
- Flagging to mark palmettos and boundaries (optional)
- Whistle (optional)
- Calculator
- Garden clippers (optional)

Instructions for the teacher:

1. Locate an area with enough saw palmettos for each team of 2-3 students to have a plant to investigate. Use flagging to mark palmettos or the boundaries, if necessary.

2. Use the information from the introduction to initiate a palmetto discussion with your class. Talk with students about the two different types of palmettos and how important they are for animals and humans. (Humans have used palmetto fronds, including those from cabbage palms, to thatch roofs, make hats, and to spread on sandy roads to prevent cars from getting stuck. Other parts of the palmetto plant have been used as food and medicine.)

3. Distribute and review student data sheet: Palmettos: Old-Timers of the Scrub.

4. Remind your students to observe carefully. Many insects and small animals (tree frogs, lizards, spiders) can be seen on palmettos if the student approaches the plant very slowly

and quietly and observes the palmetto before touching the fronds. Wasps will sometimes build nests on palmetto fronds, too, so it is important that they look before charging in.

5. Divide the class into teams. One student should be the recorder. Take the class outside to look for palmettos.

6. Instruct students to observe their palmetto and begin answering questions on their data sheets. Spend at least 5-6 minutes looking over the palmetto carefully. Examine the leaf **petiole**, palmetto stem (trunk), and palm boots that line the stem. Students may want to cut away some of the dead leaves or leaves that prevent them from getting a clear view of the palmetto stem.

   If the students see an animal, they should try to watch it without disturbing it and try to decide what the animal is doing. Remember, knowing the correct name of the organism (plant or animal) is not important. Instead, students should give the animal a descriptive name like yellow and black spider, green lizard, or green velvety moss.

7. When observations are completed, instruct the teams to carefully stretch their piece of string along the palmetto stem from the front growing tip to the very base of the stem. (The growing tip is the point from which the live leaves are growing—not the tip of the leaf.) If the creeping stem is buried under leaf litter, you might want to excavate some of the litter or dirt from around the stem to see where it goes. Instruct students to cut the string at the spot where it touches the base of the palmetto stem.

8. Instruct students to measure the length of the string and record this information on their data sheets. (This part can be done inside the classroom to keep you from having to take meter sticks out or if you need teams to share meter sticks.)

9. When you return to the classroom, find the age of each palmetto by dividing the length by 1.2. Students should record the age of their palmettos on their data sheets.

10. Create a table on the chalkboard or overhead projector using the example below as a guide. Compile student data on the table.

Saw Palmetto Data

Team #	Age of palmetto	Blooming? Fruit?	Plants living on stem	Evidence of Animals

11. Have a wrap up discussion with your class. Do animals prefer older or younger palmettos? Do older or younger palmettos have more plants growing on them? Why do you think so? Does the stem show evidence of fire? Did you see roots growing out of the stem? Where on the stem? Did you see any evidence of animals feeding on the fruits or leaves?

Palm weevil 

IV.A.1 Part Two—Constructing a Palmetto Time Line

This activity will be easier for your students if they have an example of a completed Palmetto Time Line to look at.

Materials needed:

Each team of students needs:

- Completed student data sheet from Part One—Collecting Palmetto Data
- Palmetto Time Line Worksheet
- History book, encyclopedias, or almanacs
- Pieces of posterboard (approximately 5" x 28") that can be taped together as needed (one posterboard (22"x28") can be divided into 4 pieces lengthwise). Each team may need up to 6 pieces. (Adding machine tape or rolls of paper used for bulletin board backgrounds also works well.)
- Tape
- Marker

Teacher needs:

- Calculator

Instructions for the teacher:

1. Brainstorm with your class and make a list of important historical dates. These dates can include locally significant ones as well as those relating to Florida and American history and world events. Some examples are listed below:

1497-1512	Florida first explored by Spanish
1763	Florida changed from Spanish rule to English rule.
1821	Florida becomes part of the U.S.
1845	Florida becomes a state
1861	Civil War begins
1917	U.S. enters World War I
1941	U.S. enters World War II
1950	First rocket launched from Cape Canaveral
1966	Kennedy Space Center opened
1971	Disney World opened

   You might also include the year your school was built or when your town was established.

   Encourage students to also consider important dates in their own lives such as when they were born, when they moved to Florida, when a brother or sister was born, when they learned to ride a bike, etc.

2. Have students get together with their teams. Each team will need their data sheet, a Palmetto Time Line Worksheet, a piece of posterboard or adding machine tape, some adhesive tape, and a marker.

3. Teams should complete Part One of the Palmetto Time Line Worksheet.

4. Guide your students through the following steps**:**

   a. Stretch your string out as straight as you can from the top to the bottom of a piece of posterboard and tape it down. You may need to tape several pieces of posterboard together if you have a very long string.

   b. Make a mark on the posterboard beside the top of your string. Beside the mark, write the current year. The top of your string represents the growing tip of the palmetto.

   c. The other end of the string represents the year the palmetto started to grow. Make a mark on the posterboard beside the end of the string. Beside the mark, write the year the palmetto started to grow. (Refer to Part One of your Timeline Worksheet.)

   d. Next, figure out where the ten events listed on your Timeline Worksheet belong on your string. This requires several steps:
      - First, subtract the year the event happened from the current year. For example, the Declaration of Independence was signed in 1776. When you subtract 1776 from 2000, the answer is 224 years.
      - Now multiply the answer (224) by 1.2 and round off the number. (We multiply by 1.2 because, on average, palmettos grow 1.2 cm. per year.) 224 years x 1.2 cm = 268.8 or 269 cm.

      Other examples:

      1971-Disney World opened.

      2000-1971 = 29 years

      29 x 1.2 = 34.8 rounded off to 35 cm.

      1845-Florida becomes a state.

      2000-1845 = 155 years

      155 x 1.2 = 186 cm.

   e. From the top of your string, measure down the same number of cm. as your answer above (269 cm.) and make a mark. Beside the mark, write the year (1776) and the event that happened that year (The signing of the Declaration of Independence).

   f. Repeat this process for every event listed on your Timeline Worksheet.

5. Find a spot in the classroom where the time lines can be displayed. Have fun!

Results

After completing this activity, students should:

- Be able to give examples of plant-animal interactions.
- Be able to give examples of plant adaptations.
- Understand the concept of mutualism and give an example.
- Be able to observe carefully.

Further Questions and Activities for Motivated Students

When palmettos bloom, many insects visit the flowers in search of nectar and pollen. Watch a flower stalk for 15 minutes. How many insects come to the flowers? How many different kinds of insects can you see? Check the same palmetto flowers at different times of the day. When do you see the most insect activity around the flower? When do you see the least?

IV.A.1 Palmettos, Old-Timers of the Scrub
Student Data Sheet #1

Team member s:_____

PART ONE

Stand and observe your chosen saw palmetto from a distance of about 60 cm (or about 2 feet):

- How does it protect itself from heat and sun?

- How does it protect itself from predators?

- Is your palmetto growing in a clump with other palmettos?
  yes no

- Are there any plants growing on the palmetto?
  yes no

  If yes, describe or draw them:

- Is the palmetto blooming? yes no

- Does it have fruit? yes no

PART TWO

Look closely at the palmetto leaves:

- Are palmetto leaves bigger than the leaves of nearby plants?
  yes no

- What does a palmetto leaf feel like?

- Draw a picture to show the shape of a palmetto leaf:

- Do you see any insects or other animals sitting on the leaves?

Animal	What is it doing? (Hiding, hunting, eating, sleeping)
example: green lizard	hiding

PART THREE

Look closely at the stem of the palmetto and the ground around it:

Carefully stretch a string along the stem. Cut the string so it is the length of the stem. Measure the string to discover the length of the stem (trunk).

The stem is _____cm long.

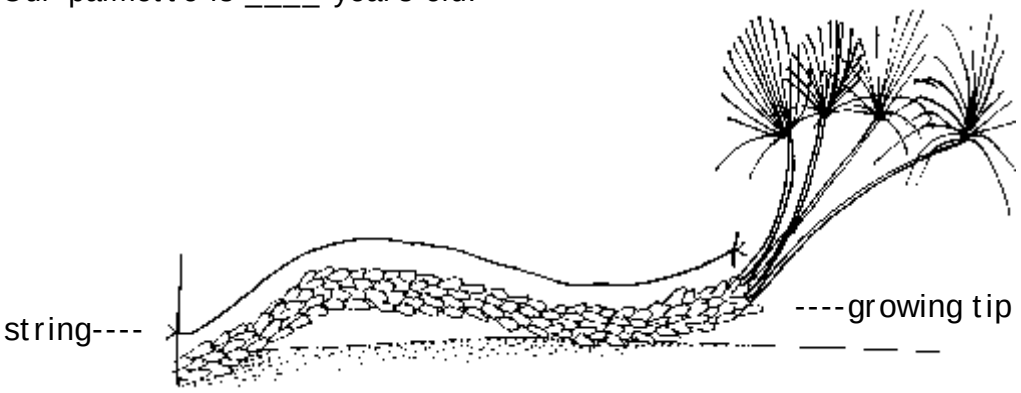
Are there any holes or burrows under the stem (trunk)? How many? ____

yes no

PART FOUR (inside the classroom)

With your teacher's help, find the age of your palmetto by dividing the length of your palmetto stem by 1.2.

Our palmetto is ____ years old.



IV.A.1 Palmetto Time Line Worksheet

Team members_____

How old is the palmetto your team observed? _____

To find out when your palmetto started growing, solve the problem below:

_____(fill in the current year)

- _____(fill in the age of your palmetto)

_____

_____ The year your palmetto started growing

PART ONE

Using dates from the class brainstorming session, history books, World Almanac, encyclopedias, the Internet, and dates from your own life, list 10 important historical dates that occurred after your palmetto started growing. (Be sure to write down the event and the year it happened.)

Example: 1845 Florida becomes a state

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

PART TWO

a. Stretch your string out as straight as you can from the top to the bottom of a piece of posterboard and tape it down. You may need to tape several pieces of posterboard together if you have a very long string.

b. Make a mark on the posterboard beside the top of your string. Beside the mark, write the current year. The top of your string represents the growing tip of the palmetto.

c. The other end of the string represents the year the palmetto started to grow. Make a mark on the posterboard beside the end of the string. Beside the mark, write the year the palmetto started to grow. (Refer to Part One of your Timeline Worksheet.)

d. Next, figure out where the ten events listed on your Timeline Worksheet belong on your string. This requires several steps:

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- Now multiply the answer (224) by 1.2 and round off the number. (We multiply by 1.2 because, on average, palmettos grow 1.2 cm. per year.) 224 years x 1.2 cm = 268.8 or 269 cm.

Other examples:

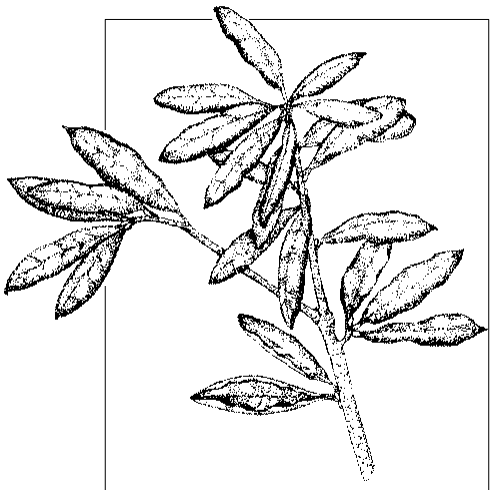
1971-Disney World opened.
2000-1971 = 29 years
29 x 1.2 = 34.8 rounded off to 35 cm.

1845-Florida becomes a state.
2000-1845 = 155 years
155 x 1.2 = 186 cm.

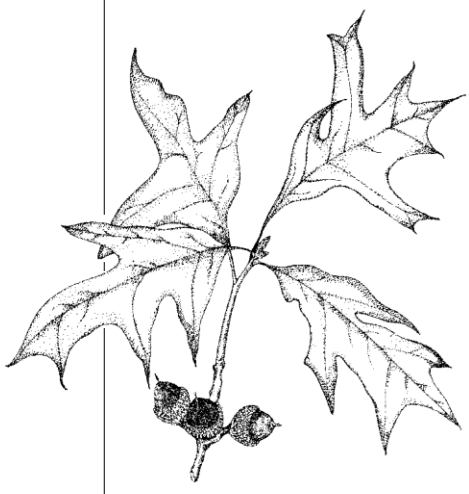
e. From the top of your string, measure down the same number of centimeters as your answer (example: 269 cm.) and make a mark. Beside the mark, write the year (1776) and the event that happened that year (The signing of the Declaration of Independence).

f. Repeat this process for every event listed on your Timeline Worksheet.

B. OAK TREES: THE SERVE YOURSELF BUFFET



Sand live oak



Turkey oak

Introduction

A few generations ago a large percentage of children grew up on farms. From an early age these children were responsible for tending gardens. They observed and, unconsciously, began to understand the complexity of the biological systems. These children would have fought specific pests on a variety of different plants. Tomatoes had hornworms, potatoes had several kinds of leaf beetles, squash vines had borers, apples had fruit maggots and fruitworms, and so on. These children not only understood that different plants had their own enemies, but they would have known that different parts of a plant may be eaten by particular insects. They would have known to look for cabbage worms on the underside of the leaf, and that cutworms hide in the soil during the day and emerge at night to fell and consume bean plants under cover of darkness. They would have known that some insects attack young plants, other insects attack older plants. They would have understood that a plant does not need to be pest-free in order to thrive and produce a crop.

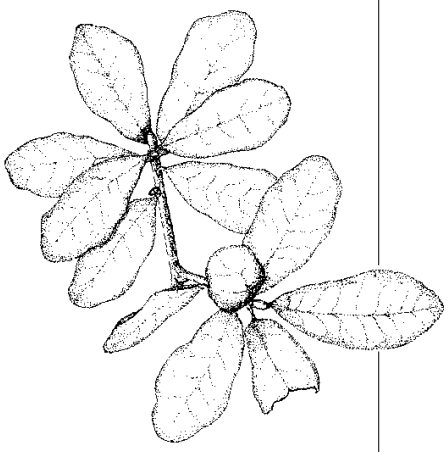
Old farm circulars and rural school leaflets from 50 or 70 years ago included sections on beneficial insects called, “the farmer’s friends.” Children would also have been familiar with these “friends.” When children got bored with pulling weeds and squashing caterpillars all day, their sharp eyes and curious minds were quick to appreciate the dramas of predation. A wasp pounces on a furiously writhing caterpillar, a lady beetle cuts a swath through a patch of aphids, a team of ants find a grasshopper changing its skin, and attack it in its weakened condition. A spider wraps a big June beetle in silk, an assassin bug on a flower subdues a bee, a praying mantis carefully eats the head of a fly that is still buzzing. As crops matured, insects visited the flowers, one kind of bee for the squash, another for the alfalfa. Bumblebees pollinated blueberries; honey bees and solitary bees visited apples and plums.

When work was finished in the garden, children possibly postponed the next round of chores by exploring adjacent pastures where dung beetles rolled their trophies home from the cow pat. Or they made little discovery trips to the woods, where caterpillars dropped from the beech trees on invisible silken threads when chased from their rolled leaves by quick-probing warblers.

Life of the average child today is much different. They are expected to know and understand very little about the complexity of ecological systems. Does this lack of understanding matter? Yes! Most of the photosynthesis that provides food energy for humans and other animals

still takes place in very complex systems. The forests that give us wood and paper need thousands of species in order to function properly. The decontamination of water in lakes and rivers requires a whole web of interacting organisms. Humans have the ability to disastrously simplify these systems so that they no longer work well. Talking about the nitrogen cycle or the hydrologic cycle as if they were mere chemical and physical processes is not enough! If we want our students to become a generation of responsible citizens, we need to introduce them to the complexity of ecological systems. The oak tree project will, for many students, be their first direct observation of the complexity of familiar ecological systems.

This one project cannot completely change the way students view the world. However, it can be an important step toward a more mature and realistic view of the planet they will inherit. Or, to look at it another way, this section may help students enjoy natural diversity and drama in a way that all children might have just a few hundred years ago.



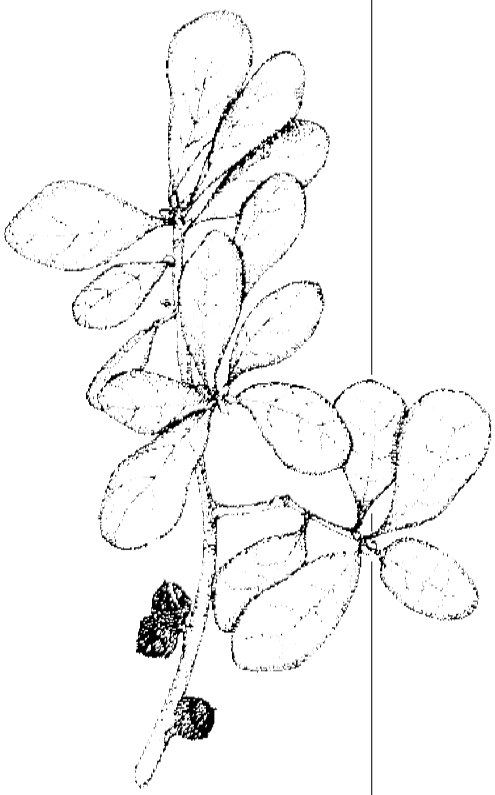
Chapman Oak

Background Information

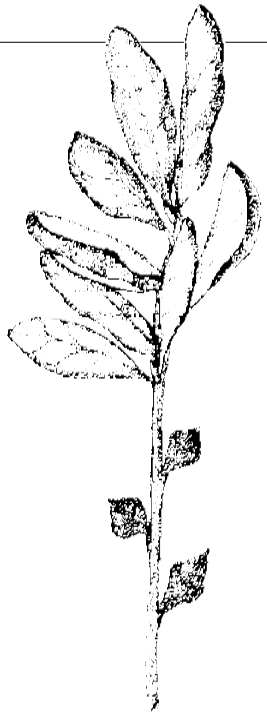
During this activity, students will approach ecological complexity by investigating how plant-eating insects divide up the resources provided by oak trees. A big plant, such as a tree, offers as many different places to live as a good-sized city does to a human, and the choice of different kinds of restaurants is equally large. A single tree has leaves, flowers, buds, twigs, bark, and roots. A single leaf may be old or newly developed, it may be exposed to the sun, or it may be shaded. These distinctions are important to insects. The leaf itself has veins that can be tapped for sap, it has several layers of tissue that can be eaten, and it can even be induced to grow special structures called galls (see page 137).

The insects that feed on trees are fussy about where and how they feed. They are picky because these insects are specialized to feed in particular ways. They have no choice in what they do: their mouthparts and digestive systems are adapted for a particular way of eating and processing some special part of the tree. Part of the specialization seen in tree-eating insects is the result of plant defenses.

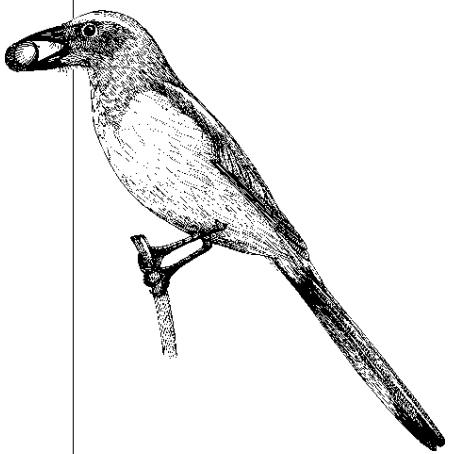
Plants do not tamely submit to being gobbled up by insects. Different parts of a tree have different kinds of tough, inedible protective coverings. Tender tissues, such as young leaves, may have a protective coat of barbed or hook-shaped hairs. Most tissues have chemical defenses, usually several kinds. In movies, a special agent who is trying to retrieve a stolen document or invention is equipped with all kinds of fancy gadgets to bypass the elaborate security measures of the enemy stronghold and storage vault. Insects that feed on plants are like those secret agents with their fancy gadgets. Like real secret agents, insects are not always successful in penetrating the defenses and gaining the prize.



Myrtle oak



Scrub oak



Some species of oaks produce **acorns** with higher tannins than other oaks. When the Florida scrub-jay caches acorns, it buries ones heavy in tannins so they are less likely to rot or be eaten by animals.

A question often comes up as students begin to explore the diversity of insects that may feed on a single species of tree. “With all these bugs, why does the tree still have leaves on it?” This topic is considered at the end of the project, when the students list the habits of the animals they see on the tree, including predators. The plant-eating insects all have many predators. The predators, the “farmer’s friends” of the old days, keep the tree-eating species under control.

A question that almost never comes up, but which is still interesting is, “What is the value of the plant-eating insects?” The value of these insects is that they are, to a large extent, responsible for the diversity that we see in plants as well as the number of interesting and useful features found in each species of plant. Beyond this, the more general value of all biological diversity is that it makes ecological systems more versatile and efficient. Most people, including students, understand and value diversity at some level. For example, we all understand that each person is different, and while life would be simpler if we were all the same, in the long run, humans are very dependent on this diversity. We need people with a variety of different skills and abilities to keep mankind versatile and efficient. (Imagine a town full of dentists!) Extending this principle to the scale of ecological systems is not easy, but it is a step that all biologists and students must eventually take.

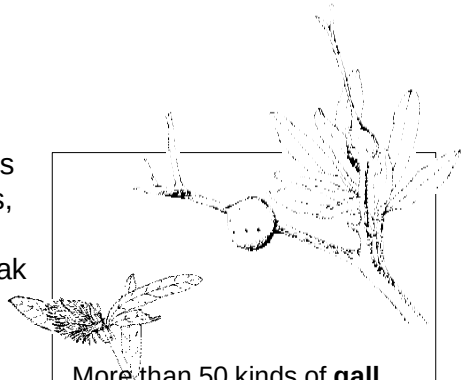
About Oaks

This activity focuses on oaks because the Florida is full of them! The six species that occur in scrub include: scrub oak, sand live oak, myrtle oak, chapman’s oak, runner oak, and the less frequent turkey oak. Except for the turkey oak, all of the oaks are **evergreen**, which means leaves stay on the trees all year and drop off only as they die. Turkey oaks lose their leaves in winter and tender new leaves emerge in early spring. (Scrub oaks drop almost all their old leaves before new ones emerge, but stay leafless for a very short time.) Most of the leaf eating occurs in March and April when new growth is easy to eat, or after a fire, when the new oak sprouts emerge.

While many species of plants have flowers with male and female parts to ensure pollination by insects, oak trees have separate male and female flowers that occur on the same tree. Rather than relying on insects for pollination, oak trees need wind to blow pollen from male flowers, or **catkins**, to petal-less female flowers. Several species of native bees, gall-making wasps, and caterpillars eat pollen produced by male flowers and can be found on the catkins when oak trees bloom in early spring.

Oak trees provide essential food for many animals in the scrub. Leaves are eaten by a wide variety of insects, such as grasshoppers, katydids, caterpillars, leafminers, gall-making wasps, and beetles. Tree- and leafhoppers suck sap from twigs and leaves. Acorns, the fruit of the oak tree, are favored by weevils and other insect larvae, squirrels, deer, bear, and birds, including the Florida scrub-jay

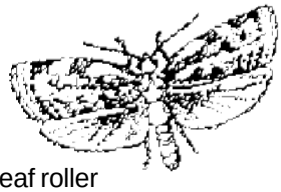
Oaks and acorns contain chemicals called **tannins** that help protect them from being eaten. However, some insects and animals have adaptations that help them deal with these tannins so they can eat oak leaves anyway!



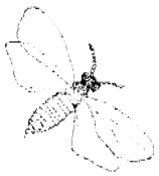
More than 50 kinds of **gall wasps** live on scrub oaks. These wasps are so tiny that they couldn't sting a person, even if they wanted to. Different kinds of gall wasps usually cause the tree to produce different-looking galls. These **oak galls** are formed by the oak in response to chemicals produced by both the gall wasps as they insert their eggs into leaves, stems, flowers, and fruits, and by the larvae that develop inside the gall. The wasp larvae feed on the soft and nutritious flesh of the plant available to them from inside the gall. Larvae remain in the protective and edible gall until they mature into adults, and then gnaw their way out, leaving tiny neat holes.

Just how the different gall wasps stimulate oaks to form a specific kind of gall is not completely understood. Because galls are often complicated structures with several layers, it appears the wasp gives the plant a set of instructions (in the form of growth-stimulating chemicals) that result in the special residence and restaurant the wasp larva needs.

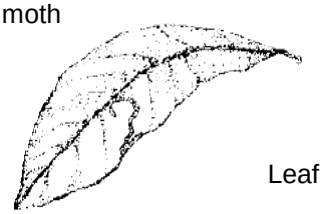
Many kinds of moth **caterpillars**, and a few butterfly caterpillars, feed on scrub oak leaves. Some caterpillars eat entire oak leaves. Others make irregular holes or notches in the leaves. Others eat the green parts of the leaves and do not eat the leaf veins, leaving a brown network of veins. Some very flat moth caterpillars feed inside the leaf, between the upper and lower surfaces, and leave behind a brownish or whitish blotch or twisting line. Some kinds of caterpillars use silk to sew together overlapping scrub oak leaves and then feed within this shelter.

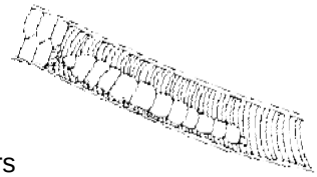


Leaf roller moth



Leaf miner moth





Leaf miners

With so many caterpillars eating scrub oak leaves, it is amazing that oaks have any leaves left at the end of summer! However, so many birds and insects feed on caterpillars, their numbers are usually kept down to a reasonable level. Florida scrub-jays eat lots of caterpillars, and so do digger wasps and twig-nesting wasps. Dozens of kinds of little parasitic wasps and flies prey on caterpillars. When biologists try to raise oak caterpillars to see what kind of moths will develop, frequently wasps or flies emerge instead.

IV.B.1 OAK TREES: THE SERVE-YOURSELF BUFFET

Concepts: Predator/prey relationships, chemical defenses, species diversity, and ecological niches.
Skills: Observation, cooperative learning, and data collection.
Time needed: Approximately 30 minutes. More time is needed if making a leaf-eating evidence collection (step #8).
Best time of year: Spring, when new leaves begin to emerge.
Sunshine State Standards: LA.A.1.2.1, LA.A.1.2.2, LA.A.1.2.4, LA.A.2.2.1, LA.A.2.2.5, LA.A.2.2.8, LA.B.1.2.3, LA.B.2.2.1, LA.B.2.2.2, LA.B.2.2.3, LA.B.2.2.6, LA.C.1.2.1, LA.C.1.2.3, LA.C.1.2.4, LA.C.1.2.5, LA.C.3.2.2, LA.C.3.2.5, MA.A.1.2.3, MA.A.3.2.3, SC.F.1.2.2, SC.G.1.2.1, SC.G.1.2.2, SC.G.1.2.5, SC.G.1.2.6, SC.G.2.2.1, SC.G.2.2.2, SC.H.1.2.1, SC.H.1.2.2, SC.H.1.2.3, SC.H.1.2.4, SC.H.3.2.2, SC.H.3.2.4.

During this activity, your class will examine oak trees for evidence of the variety of ways insects and small animals consume and use leaves, acorns, and other parts of the tree.

IV.B.1 Part One—Collecting the Data

Materials needed:
Each team of 2 students needs:

- Data sheet
- Clipboard
- Pencils
- Clippers
- Small envelope for leaf collection

Teacher needs:

- Flagging to mark boundaries (optional)

Instructions for the teacher:

1. Locate an area with enough short scrubby oaks (about the height of your students) so each team of two students can have their own oak tree to explore. This height will allow students to compare exposed leaves from the top of the tree to more protected ones. Identifying the species of scrub oak is not necessary for this activity. Mark the boundaries for your students.

2. Use the question, “Do trees have flowers?” and the information in the introduction to initiate a class discussion about oaks. Be sure your students understand that acorns are the seeds of oak trees. Trees have flowers although they are usually very small and not easily seen. Trees are more likely to be wind pollinated and do not need large, showy flowers. Other plants use large, aromatic, colorful flowers to attract bees and other pollinators.

3. Divide the class into teams of 2 students. (One student will be the recorder and the other will hunt for evidence of leaf eating.)

4. Distribute and review the student data sheets #1 and #2.

5. Take the class outside to explore scrub oaks.

6. Instruct your teams to select a tree to investigate. Have one team member choose a small branch of the tree and begin examining each leaf for evidence that it has been eaten while

the other student records information. Students should look for chewed edges, holes, tunnels, or blotches (leaf miners) and for protrusions growing out from the leaf (galls).

Encourage your students to look carefully for the small animal that ate part of the leaf. Like many diners who sit in dark corners, many insects prefer to remain inconspicuous and will hide under leaves, in leaf curls, or between leaves that overlap.

7. Students should collect examples of each type of leaf-eating they find and put them in the envelope. Continue until the first student has finished looking at one branch. Students should then switch roles.

IV.B.1 Part Two—Making a Collection of Leaf-eating Evidence

Materials needed:

- Leaf-eating evidence from Part One
- Sheets of 81/2 x 11 posterboard or heavy paper
- Tape and/or glue
- Ring binder or rings

Instructions for the teacher:

1. Have students tape or glue the leaves to posterboard or heavy paper.

2. Label the collection with the date and location of your study site, and underneath each leaf, identify the “name” of the type of chewing.

   For a more permanent leaf collection, press the leaves between sheets of newspaper under several books for a week. Then arrange on heavy paper and either cover the pages with clear adhesive paper or laminate them. Put the pages in a binder or hold together with rings.

   These booklets can be used as references and/or as a comparison for future leaf-eating explorations.

Notes

Although evidence of leaf-eating can be found any time of the year, the best time for this activity bright is in the spring when the green new growth emerges and the eating insects are present. Check the oaks regularly, beginning in late February.

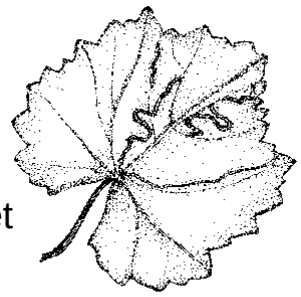
Results

After completing this activity, students should:

- Understand the concept of predator/prey relationships and give examples.
- Be aware that many plants and animals use chemicals to defend themselves.
- Understand the concept of ecological niche (which refers to one animal or one population of a species) and how it is different than microhabitat (which refers to a variety of species).
- Be able to observe carefully and record data.
- Be able to learn cooperatively

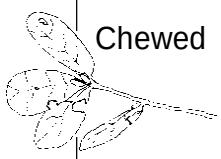
Further Questions and Activities for Motivated Students

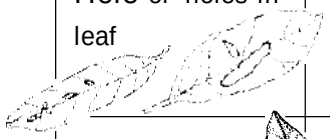
1. Examine fallen acorns for signs of life. Collect 20 acorns off the ground. How many of those acorns have holes in them? Carefully open the acorns. Do you see any animals in them? If you can see acorns still on the tree, examine them closely to see if they have holes in them, too.
2. In the spring, carefully collect caterpillars from oak leaves and put them in a jar. Give the caterpillar plenty of oak leaves to eat and punch holes in the jar lid so the caterpillars will have fresh air. Draw a picture of each kind of caterpillar you collected. Keep watching your caterpillars to see what kind of moths or butterflies they turn into. Identify and draw a picture of the adults before you release them.
3. During the winter, collect several oak galls without holes in them and put them in a resealable plastic bag. Watch to see what kind of gall-making wasp emerges from the gall. Use a strong magnifying glass to get a good look.

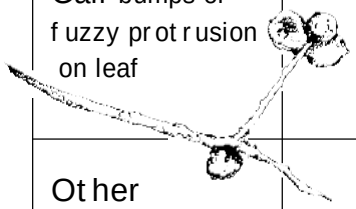


IV.B.1 Oak Trees; The Serve Yourself Buffet
Student Data Sheet # 1
Team members:_____
Use tally marks to help you count the number of leaves in each category. Then record the total.
For example:

Chewed edge	𝍸 5	𝍸 𝍸 𝍸 15	II 2	𝍸 III 8
Type of eating	Branch # 1	Branch # 2	Branch # 3	Branch # 4
Chewed edge				
Hole or holes in leaf				
Leaf mine- tunnels or blotches inside the leaf layers				
Gall-bumps or fuzzy protrusion on leaf				
Other evidence- describe				
Total number of leaves found with evidence of insect eating				
Location of branch on tree (top, middle, low, inside or outside)				







IV.B.1 Oak Trees; The Serve Yourself Buffet
Student Data Sheet #2

Team members:_____

Instructions: While you look for chewed leaves, use the table below to record any animals you see in the leaves, on the tree, or in the acorns you pick up.

Do you think the animal you found is eating the plant?
Or is the animal a predator and hiding so it can catch another animal to eat?

Animal found	How many?	"L" = leaf eater "P" = predator	Where the animal was found?
Caterpillar	𝍸 5	L	Between 2 leaves
Caterpillar			
Beetle			
Spider			
Evidence of gall insect 			
Evidence of leaf miner 			
Grasshopper			
Leaf hopper 			
Frog			
Lizard			
Weevil			
Other:			
Other:			

GLOSSARY

1. **behavioral mimicry-** one species of animal acting like another, usually to defend itself.
2. **evergreen-** having green leaves throughout the year, the leaves of the past season not being shed until new leaves have been completely formed.
3. **catkins**- a spike of unisexual flowers with no petals.
4. **clonal**- genetically identical plants that are, in the case of many scrub oaks, connected underground by a common stem.
5. **herbivory**- the act of plant-eating
6. **mutualism**- a symbiotic relationship where both partners benefit.
7. **petiole**- the slender stalk where a leaf attaches to the stem of a plant.
8. **population dynamics**- changes in population size that result from various forces (such as disease, habitat destruction, predation, etc.) that control and regulate populations over time.
9. **predation**- an interaction between species in which one species, the predator, eats the other species, the prey.
10. **tannins-** astringent compounds found in oaks and some other plants.

QUESTIONS FOR STUDENT EVALUATION

The questions presented below range from easy to difficult. Select questions most appropriate for your students and, if necessary, modify the questions so they will be more useful in your situation. Answers are in italics.

1. Several kinds of rare plants live in the Florida scrub. In order to preserve them, we need to understand what these plants need. Put a "T" beside the statements below that are true:
   ___To keep a rare plant from becoming extinct, we need to preserve some of the habitat that the plant lives in. (True)
   ___We need to know what insects pollinate the flowers of rare plants and know the life cycles of these insects. (True)
   ___We need to understand the life cycles of rare plants. (True)
   ___We need to make sure all the rare plants get watered every week. (False)

2. Plants that live in scrub are tough! List 3 adaptations that help plants conserve water.

   Waxy coating on leaves
   Tough, thick leaves
   Leaves held upright to minimize sun exposure during the hottest part of the day
   Fuzzy leaves
   Tiny leaves

3. Place a "T" beside the following statements that are true.
   ___Plants that live in Florida scrub must be able to grow in soil with almost no nutrients. (True)
   ___Plants that live in Florida scrub have special adaptations to fire. (True)
   ___Plants cannot protect themselves from insects and animals that eat them. (False)

4. Saw palmetto and scrub palmetto are two plants that are well adapted to Florida scrub and live a long time. Put a “T” beside the following statements that are true:
   ___Palmettos play an important role in scrub by providing food and shelter for animals. (True)
   ___Palmettos burn easily and usually die after a fire. (False)
   ___Saw palmettos can live a very long time and often grow in large thickets. (True)
   ___Both saw and scrub palmettos produce flowers in the spring. (True)

5. List two ways scrub plants come back after fire.
   Resprout, reseed (by seeds stored in the sand, from sand pine cones, or dispersed by animals)

6. Palmettos and animals interact in many ways.
   a. List two animals that eat palmetto berries:
      Black bears, raccoons, gray foxes, wild turkeys, gopher tortoises
   b. List two animals that use palmetto thickets or clumps to hide and rest:
      Florida panthers, deer, raccoons, bobcats, black bear, eastern towhee, insects, frogs, etc.
   c. List one animal that uses parts of the palmetto when it build its nest:
      Florida scrub-jays, wild turkeys, grasshopper sparrow

7. Write a food chain that starts with a palmetto as the producer:
   Possible examples:
      Palmettos leaves—blue tortoise beetle—Florida scrub-jay—bacteria
      Palmetto flower nectar—beetle—eastern towhee
      Palmetto berries—raccoon—Florida panther—bacteria

8. Oak trees are very common in the scrub. Insects and other animals use oak trees as shelter. Circle the letter beside the correct answer:
   a. Scrub oaks are evergreen and their leaves stay green all year.
   b. Scrub oaks are wind pollinated.
   c. Scrub oaks contain a chemical that protects them.
   d. All of the above.

9. List two animals that eat oak leaves:
   beetles, caterpillars, leaf miners, leaf hoppers, gall insects

10. Give two examples of how animals use oak trees:
   Birds use branches and twigs for nests
   Spiders use branches and leaves to support webs
   Insects use the trunk and underside of leaves to hide from predators

11. Use the animals below to create a food web, using the oak tree as the producer.

oak tree	mold	gall insect
beetle	weevils	spider
bird	hawk	

   Many different relationships within the food webs are possible.

12. Why do you think an oak tree produces so many seeds (acorns)? What happens to the acorns?
    Only a small percentage of acorns actually germinate so an oak tree needs to produce lots and lots of seeds. Many acorns get consumed by Florida mice, Florida scrub-jays, squirrels, deer, weevils, etc.

13. Write a short essay about what you observed while looking for leaves that were eaten by insects. What kind of leaf damage did you find? What kind of insects? What else did you notice?

FIRE IN THE FLORIDA SCRUB

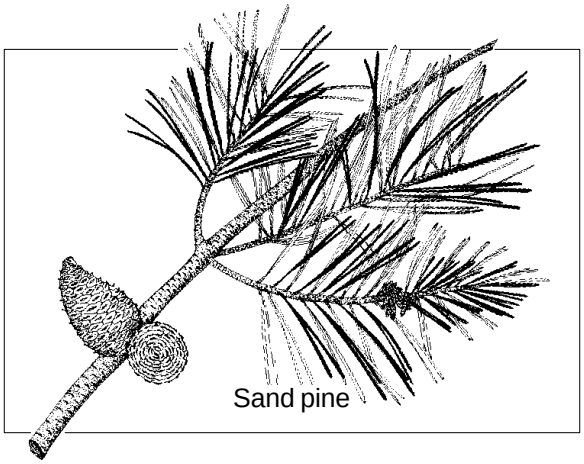
Central Florida receives more lightning strikes than any other region in the United States. Lightning-ignited fires have always been a part of life in the scrub. Plants and animals that live in this habitat are dependent on fire to maintain their world. Before Florida became so carved up by cities, roads, and housing developments, fires easily burned through scrub habitat at intervals of 6-20 years. These fires did not burn the landscape completely, but left small unburned patches that served as little refuges from which insects and other small animals could move back into the burned area. Seeds could blow over onto sand left bare by the fire. Other plants resprouted from underground stems. A mosaic of scrub that varied in stages of growth was created by fire.

As more and more people moved into Florida, these wildfires became more threatening. People were afraid of fire and interpreted the dramatic changes as destructive. Instead of being allowed to burn, fires were suppressed for decades. Florida scrub and other fire-maintained habitats such as flatwoods, prairies, and sandhill suffered as a result.

Without fire, the scrub habitat changes. In overgrown scrub, plants create so much shade and leaf litter that the open, sandy patches disappear and so do the species that prefer them. Canopy closure reduces or eliminates habitat for Florida mice, pygmy mole crickets, scrub lizards, and sand skinks. Overgrown oaks produce fewer acorns for animals such as Florida scrub-jays, Florida mice, black bear and acorn weevils. Other fire-dependent animals include gopher tortoises and gopher frogs.

Emerald moth caterpillar on Florida rosemary

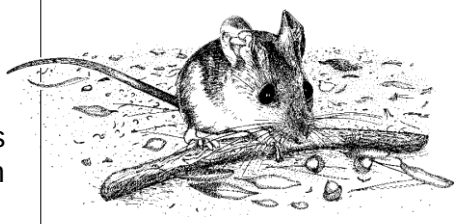
Many scrub plants are also fire-dependent. Florida rosemary needs fire to reproduce. Rosemary releases a chemical into the soil that inhibits the germination of its own seeds. When the fire kills the parent plant, the seeds are able to sprout. And if Florida rosemary disappeared, so would the emerald moth. The caterpillar of this moth lives exclusively on Florida rosemary and has two different larval forms. If developing in spring, it mimics a rosemary needle, while its winter form resembles a gray, knobby, dead rosemary twig.



Sand pine

Grasses in the scrub bloom better after a fire, and the seeds of many plants such as scrub lupines and other legumes and scrub buckwheat germinate better with fire. Heat may be a requirement for germination of many types of seeds. Sand pines invite fire into the tree by growing low, close to the ground branches. Many sand pine cones will open and drop seeds only after being scorched. Scrub oaks, lyonias, and other shrubs grow clonally with much of the plant underground. New

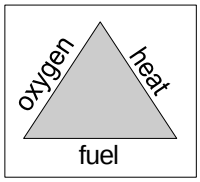
sprouts will spring up after a fire from the protected underground stems.



Florida Mouse

Many species of small animals that inhabit the scrub, such as ants, Florida mice, gopher frogs, mole crickets, and ox beetles, have ways to flee from fire, or find refuge in an existing burrow beyond the reach of the heat. Nevertheless, some kinds of little animals, such as the little caterpillars living in a cluster of blueberry leaves, or the gall wasps in their galls on oak twigs, are burned up and their populations are temporarily reduced. But fire is similar to winter in northern states—where many little plants and animals are killed by hard freezes. These species, however, have winter built into their long-term survival strategies. Both the insects and the plants are dependent on winter. If the season were eliminated, many species would disappear.

Now that we realize that many of Florida's native species will disappear unless fire is introduced back into the habitats, people in charge of preserving and maintaining natural areas are including prescribed burns as part of their management. Prescribed burns, also called controlled burns, are intended to do three things: 1) mimic natural conditions, 2) maintain a variety of plant communities, and 3) decrease the amount of accumulated plant material, and thereby reduce the chance of devastating wildfires. A prescribed burn is not a one-time event, but a process that must be continually applied to the landscape.



The fire triangle can help students remember the three essential elements of fire: 1) **fuel** (living and non-living vegetation), 2) heat, and 3) oxygen. How hot or fast a fire burns can depend on the kind of fuel, if the fuel is wet or dry, the quantity of fuel, and weather conditions.

Prescribed burns require a lot of planning and are only conducted under the appropriate conditions. **Drought index**, relative humidity, wind speed and wind direction must be considered. If conditions have been very dry, a prescribed burn can be very risky. Humidity affects a fire by changing how dry the fuel is. As the relative humidity decreases, fuel moisture decreases and the fire intensity increases. Wind speed will affect how fast a fire burns. Prescribed burns are not conducted on days with strong winds due to the increased risk of escape. Wind direction is important to consider especially if the prescribed burn occurs near homes and roads. Special permits, fire equipment, and individuals trained to work with fire are necessary elements of a prescribed burn.

When a prescribed burn is planned for a specific **burn unit**, information about relative humidity, fuel conditions, wind speed, wind direction, weather conditions, hazards, smoke sensitive, etc., must be included in the prescription.

A Prescribed Burn on School Property

Donna Tomlinson, a teacher at Cracker Trail Elementary School in Sebring, Florida, regularly took her 4th grade class out to explore a trail on school property. She knew what healthy scrub habitat was supposed to look like and knew their scrub and flatwoods was overgrown. She was also concerned about the accumulated fuels. Donna called the Florida Division of Forestry (DOF) and discovered that the area had not burned in 20 years. In 1997, DOF agreed to do a prescribed burn and wrote a prescription. Then they waited for the small window of opportunity to open. The 15-20 acres they planned to burn was close to school buildings so students could not be present when the burn took place. Finally, when conditions were right, DOF, with the help of many trained volunteers, burned the area in sections. Donna was able to participate by creating **black lines** with a **drip torch**.

Initially, students were upset by the “destruction.” With Donna’s guidance, however, they eventually saw the value of the burn for themselves. With the principal’s permission, Donna took her students out three days after the fire. Although stumps were still smoldering, plants were already emerging from the charred ground. Her class explored the burn area twice a week for several weeks and watched as plants, spiders, animal tracks, and insects returned.

Glossary

1. **burn unit**- designated area to burn during a prescribed burn.
2. **black line**- a line created by flames from a drip torch to preburn fuels on the edge of a burn unit and help secure a prescribed burn.
3. **drip torch**- hand held apparatus used to ignite a fire by dripping flaming liquid fuel on vegetation to be burned.
4. **drought index**- a rating system that uses the high temperature and precipitation to calculate the amount of moisture in the surface layers of the soil.
5. **fuel**-accumulated living and non-living flammable vegetation.

RESEARCH THE FLORIDA SCRUB

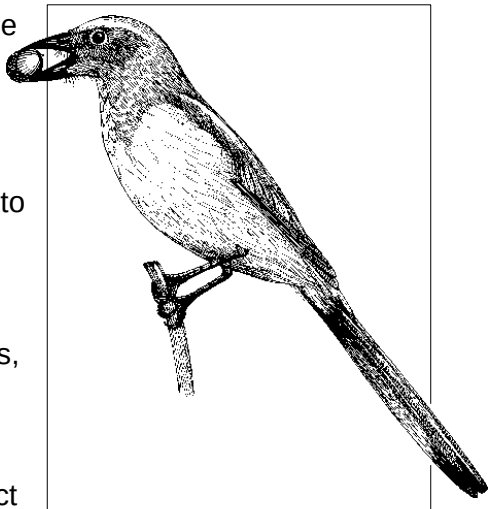
How do scientists study scrub? With a notebook and pencil, a broad-brimmed hat and sunscreen, long pants and stout boots. But to really answer this question, we must first ask another question - what is science? Science is a method of study, a way of asking and answering questions about the world around us. The first and most important step in the scientific method does not require years of training and schooling, although it helps.

Step One: Be Observant

The scientific method requires that we open our senses to the world around us. First we must observe what is happening in the natural world. We might observe that Florida scrub-jays appear to live in groups of more than two birds or that some scrub plants bear lots of flowers after a fire or that gopher tortoises share their burrows with other scrub animals. Then a well-trained scientist or even an eager school child will ask questions about these observations. This is the next step in the scientific method.

Step Two: Ask Questions

What questions should we ask? We might ask questions that would explain what we observed, if only we knew the answer. For example, are the Florida scrub-jays that live in these groups related to each other? Do birds in large groups have more young than birds in small groups? We might also ask how often fires occur in scrub and how well do plants grow one, two, or three years after a fire. Which animals share the gopher tortoise's burrow? Which burrows do they prefer and how do they benefit from using those burrows? These are just a few of the many questions we can ask, but to all these questions we might add another...why?



Florida scrub-jay

Step Three: Find the Answers

Once we've made our observations and asked our important questions, how do scientists actually study scrub? Well, it all depends on the questions we have asked. The third step in the scientific method is to make a list of different observations we need to make to answer our questions. Or we might think of an experiment we would like to conduct that would help us answer our questions. Let's use scrub-jays as one example:

Example #1:

Question: How can we tell if the scrub-jays in a group are related to one another?

Research Design: To answer this question we would first need to be able to tell one jay from another. We can recognize different people and jays can recognize different jays, but we have a hard time telling one jay from another. So first, we must mark the jays so that we know

individuals.
Devising methods to capture and mark birds without putting them at risk is very important. Scientists can capture scrub-jays alive in box traps baited with their favorite foods. Scientists then place a numbered aluminum band and different patterns of colored plastic bands on the scrub-jays' legs before releasing them. Each jay has a different pattern of bands. Later, when we see a scrub-jay, we can observe its bands and look in our records to see where we trapped and banded that bird. Once many birds are banded, we can determine if these groups are always the same birds. (Three permits are needed to band scrub-jays; one from the U.S. Fish and Wildlife Service Endangered Species Office, one from the U.S. Fish and Wildlife Bird Banding Laboratory, and one from The Florida Fish and Wildlife Conservation Commission.)

If we find their nests, we can find out how many young they have and if their young stay with the family or if the group is formed by other birds that move in from other parts of the scrub. We can find out if different group sizes produce different numbers of young.

By trying to find all our banded birds each month we can determine how long they live, where they go, and if jays in large groups live longer than jays in small groups. You can see that the answers to our questions are starting to help us understand why scrub-jays live in groups. But a good scientist always studies the results of his observations or experiments to see if they suggest a better answer to the questions. That is the final step in the scientific method.

Example #2:

Question: What kind of relationship exists between scrub plants and fire?

Research Design: First, we need to know where and when fires have occurred. This means we might map every fire that occurs in our study site, enter the boundaries and dates of that fire into our computer. Then we have to find plants that are living in areas that burned at different times. When we have several different sites, each with a different fire history, then we examine the plants that live in each site. This is a type of experiment.

But, like the scrub-jays, scientists need to be able to follow the lives of individual plants. Often botanists, scientists that study plants, tie numbered markers to individual plants. They can count the number of flowers, the number of seeds per flower, the height of the plant, and how many leaves it has. They can mark all the new seedlings each year and see how many are still alive the next year. Then they compare plants from the different sites. Which ones did the best? The answers to these questions might tell us a little about how frequently scrubs burned before man began to put the fires out.

Example #3

Question: What animals live underground in a gopher tortoise burrow?

Research Design: We might look into a burrow with a miniature video camera and see who is in there. Or we might carefully examine the different tracks leading into the burrow. We can measure the depth of the burrows with our video camera, find out if it is currently being used by a gopher tortoise and then census all the different animals that are using that burrow. Are some burrows better than other burrows? Why?

Step Four: Evaluation

We evaluate the answers to our questions. Often the results don't match our expectations so we have to re-think our questions. Did we ask the appropriate question? Did we measure the right variable or conduct the right experiment? In the process of getting our answer, we usually generate more questions.

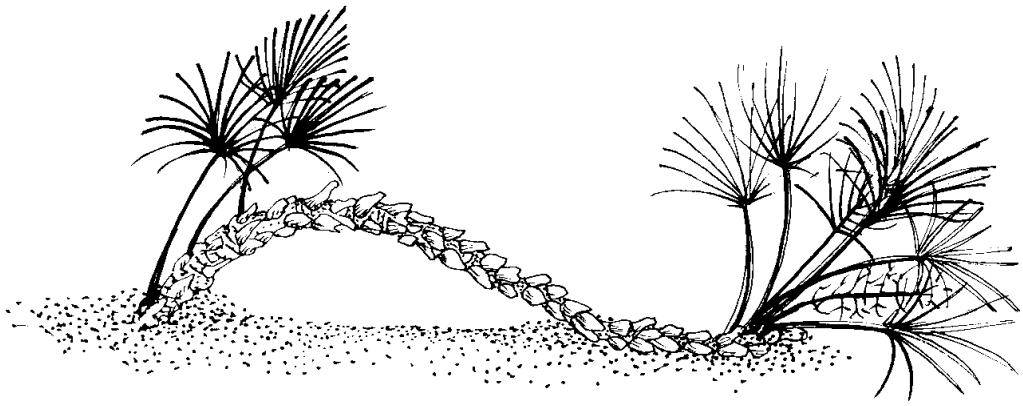
Many scientists have been observing and asking questions since they were children. We go to college to learn to ask better questions and to learn the different methods we can use to answer these questions. Since many of the questions are difficult to answer, scientists have to use many methods, some very complex. We use sophisticated radio transmitters to track the movement of animals through scrub. We use powerful computers to store and analyze data, and programs to map fires and different habitats. We use these computers to predict how animal or plant populations might respond to different fire patterns.

But often, scientists rely on a little old-fashioned common sense. To apply our common sense we have to know the lives and natural history of the plants and animals we study. Science begins with observations and kids that watch birds or butterflies or are interested in plants are really just young scientists.

TIPS ON EXPLORING THE OUTDOORS WITH YOUR STUDENTS

Expect to work out a few rough spots during your initial outings. Generally, as you continue to take your class outside, you will have a better idea about what to expect and your students will become more relaxed and easier to manage.

1. Be enthusiastic, eager, and interested (most important!).
2. Let your principal know when and where you will be taking your class.
3. Role play with your students before going out. (If "x" happens, what will you do?)
4. Ask your students questions, questions, and more questions to stimulate their curiosity. Encourage them to ask questions, too.
5. Make the boundaries for each activity very clear (flagging is helpful!).
6. Give every student a job description.
7. Divide students into small teams.
8. Make sure they know the rules.
9. Send students to the restroom before going out.
10. Encourage parents to be chaperones. You can distribute a letter at the beginning of the school year to let parents know you plan on taking several field trips to explore native habitats.
11. Enlist volunteers and give them specific duties on the day of the field trip. (Student nametags are very useful to helpers.)
12. Have all your materials organized and ready to use.
13. Have extras of everything!
14. Explain the activity, review worksheets, and demonstrate techniques before you go out. Wait to hand out supplies and equipment once you get to the site, if possible. Use student helpers to carry supplies.
15. Save your voice and use a whistle to round everyone up at the end of the activity (or at the end of a timed section).
16. DON'T plan an activity right before lunch!
17. Have students dress appropriately—hats, long pants if in thick scrub, no sandals.
18. Know which students are allergic to insect stings and plan what you will do if a student gets stung.
19. Avoid hot afternoons.
20. Encourage scrub etiquette. (For example: When walking in a line through scrub, hold any branches that overhang the trail so the person behind you doesn't get slapped in the face, warn the person behind you of cactus, holes in the ground, or thorny vines, etc.)
21. Don't expect perfection. Consider your first attempt a trial. Usually, the more you go out, the better it gets.



If you visit a scrub site away from school grounds:

1. Make sure you reserve the bus well in advance and send permission slips out to parents with plenty of time to spare. Fully explain to parents what students will be doing during the field trip.
2. Have a structured activity to keep students focused and involved while travelling to your site. Discuss your observations during the ride or walk back.
3. Make sure you take water.
4. Carry a cell phone or radio.
5. Know where the bathrooms are (or go before you leave!)
6. Take a well-stocked first aid kit.

SCRUB HAZARDS: ANSWERS FOR THE ANXIOUS

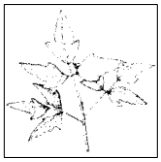
Most likely, your trips out into the scrub will be free from accidents or injury. Use common sense, be observant, show respect for living things and you will probably never face the potential hazards below. Hazards include, but are not limited to the following:

Lightning can strike well ahead of a storm and up to 30 minutes after a storm has passed. Always be cautious if the weather looks threatening.

Heat/dehydration can be a serious problem, especially if your class is outside for hours. Always take water with you and encourage your students to wear hats.

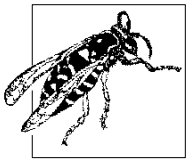
Sunburn can be a threat any time of year. The reflective sand in scrub can intensify the sun's rays. Use sunscreen and wear hats!

Cactus spines hurt!! Stay on the trails when possible and always watch to see where your next step will be.



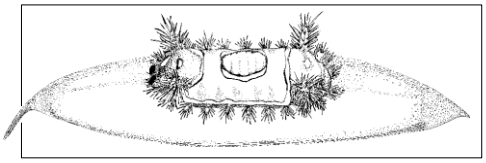
Poison ivy is not adapted to scrub, but can be found in disturbed areas adjacent to scrub. Keep your eyes open for both the leaves and the "hairy" vines that grow up tree trunks.

Paper wasps often build small nests on palmetto fronds and can be difficult to see. Identify those students who are allergic to insect stings and be prepared to take action if someone gets stung.



Yellow jackets are ground nesters. Be alert to large numbers of yellow jackets you see moving in and out of a small hole. They may try and protect their nest if you get too close. There are solitary, ground-nesting wasps that are banded like yellow jackets, but do not live in large colonies. These solitary wasps never attack.

Saddleback caterpillars can be found chewing on oak and hickory leaves in spring, summer, and early fall. Their poisonous spines can deliver a painful sting. Scotch tape helps lift bristles off tender skin.



Diamondback rattlesnakes are very rare in scrub and instead prefer pine flatwoods. Except on cool winter mornings, rattlesnakes would probably flee in response to the chatter and vibrations of excited students.

Coral snakes are usually hidden under the sand and have sometimes been mistaken for scarlet king snakes. Although coral snakes are the most poisonous snake in Florida, they are extremely docile and rarely bite. To be safe, be sure to watch from a distance!

Velvet ants are solitary wasps. They are easy to spot by their bright red markings and the way they race around on the sand. Velvet ants aren't aggressive, but will sting if handled. Watch them, but don't pick them up!

Ticks and chiggers aren't easy to spot but they can be easy to pick up! Sprinkle powdered sulfur (available at drugstores) or spray insect repellent on your socks, shoes, and calves. Try stuffing long pants into your socks to help keep these critters from crawling up your legs.

Dead animals are often very interesting to observe, but can harbor bacteria and disease. Use plastic gloves if you plan on handling one and wash your hands well afterwards.

Some **mushrooms** can be deadly poisonous if you eat them. Students should never put wild mushrooms in their mouths and should wash their hands after handling them.

Holes made by animals (concealed gopher tortoise holes, armadillo digging) can be hazardous if students aren't watching where their next step will be.

When exploring scrub, students should wear long pants, sturdy shoes, and a hat. White or light-colored shirts reflect the sunlight and are more comfortable on sunny days than dark ones, which absorb light.

SOURCES OF SCRUB INFORMATION

State and Federal Agencies

Division of Forestry (Department of Agriculture)
865 Geddie Road
Tallahassee, Florida 32304
phone 850-488-1871
web site: www.fl-dof.com/

Florida Fish and Wildlife Conservation Commission
620 South Meridian Street
Tallahassee, Florida 32399-1600
phone 850-488-4676
web site: www.state.fl.us/fwc/
For a state or federal list of endangered species see
http://sun6.dms.state.fl.us/gfc/pubs/endanger.html

Southwest Florida Water Management District (SWFWMD)
2379 Broad Street (U.S. 41 South)
Brooksville, Florida 34609-6899
phone 904-796-7211 or 1-800-423-1476
web site: www.swfwmd.state.fl.us/

St. John's River Water Management District (SJRWMD)
P.O. Box 1429
Palatka, Florida 32178-1429
phone: 904-329-4500
web site: www.sjr.state.fl.us/

U.S. Fish and Wildlife Service
Southeast Region (Division 4)
1875 Century NE Blvd.
Atlanta, Georgia
phone; 404-679-4000
web site: www.fws.gov/
To find a list of endangered species select "Endangered Species" from the bottom of their welcome page. You will be transferred to their "Endangered Species Home Page" (http://www.fws.gov/r9endspp/endspp.html). Under "Species Information" you can choose one of two paths:
-Select "State Lists" to find an alphabetical list of Florida's 99 endangered species.
or
-Select "Species List" and then "Index-Southeast Region #4 Listed Species" to find endangered species by taxonomic category.

Citizen Groups and Non-Profit Organizations

Archbold Biological Station
P.O. Box 2057
Lake Placid, Florida 33862 phone:863-465-2571
web site: www.archbold-station.org
For good links to other scrub information sites start on the ABS Home page, go to "Regional Ecology and Biota" and select "The Lake Wales Ridge." Scroll to the end and select "Lake Wales Ridge Bibliography."

Bok Tower Gardens
1151 Tower Blvd.
Lake Wales, Florida 33853
phone: 863-676-1408
web site: www.boktower.org/

Florida Audubon Society
State Headquarters
1331 Palmetto Avenue Suite 110
Winter Park, FL 32789
phone: 401-539-5700
web site www.ficus.usf.edu

Florida Native Plant Society
P.O. Box 6116
Spring Hill, Florida 34611-6116
web site: www.flmnh.ufl.edu/fnps/fnps

The Nature Conservancy (Regional Office)
222 S. Westmonte Drive, Suite 300
Altamonte Springs, Florida 32714
phone: 407-682-3664
web site: www.tnc.org
To find web pages of Florida Chapters begin on TNC's Home page, select "Where We Work" and then "State and Regional Programs". You will find a clickable map that leads to the Florida Chapter's web pages.

The Nature Conservancy Lake Wales Office
225 E. Stuart Ave.
Lake Wales, Florida 33853
phone 941-678-1551

Sierra Club (Florida Office)
475 Central Ave., suite M1
St. Petersburg, Florida 33701
web site: www.sierraclub.org/

Other Web Sites

FLORIDATA-an electronic publication that includes information on Florida scrub and other native plants.
web site: www.floridata.com/

Other Sources

Lake Wales Ridge National Wildlife Refuge (LWRNWR)
Headquarters: Merritt Island NWR
P.O. Box 6504, Titusville, FL 32782
phone: 407-861-0667.
North Brevard business directory web site: www.nbbd.com. From their Home page select “Ecotourism” from the menus on the left side of the screen. Next select “Merritt Island National Wildlife Refuge”, scroll down to the green box, and click on “Lake Wales Ridge National Wildlife Refuge”.

Lake Wales Ridge State Forest
426 School Bus Road
Frostproof, FL 33843
phone: 941-635-7801
web site: www.fl-dof.com

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Ripple, J. 1994. All in the family; the social life of the Florida scrub jay. Birder's World 8(2):23-27.

Stap, D. 1994. Along a ridge in Florida, an ecological house built on sand. Smithsonian 25(6):36-45. (This article has been printed in a recent book: Ripple, J., and S. Cerulean. 1999. The wild heart of Florida. University Press of Florida.)

SCIENTIFIC NAMES OF ORGANISMS

Ants:
- Cone ant, Dorymyrmex sp.
- Fire ant, Solanopsis invicta
- Fungus ant, Trachymyrmex septentrionalis
- Harvester ant, Pogonomyrmex badius

Ant lions, (Family) Myrmeleontidae
Armadillo, Dasypus novemcinctus
Ball moss, Tillansia recurvata
Beetles:
- Blue tortoise beetle, Hemisphaerota cyanea
- Darkling beetle, (Family) Tenebrionidae
- Ox beetle, Strategus sp.
- Pleasing fungus beetle, (Family) Erotylidae
- Scrub scarab beetle, Geopsammodius relictillus

Caterpillars:
- Rosemary caterpillar, Nemouria outina
- Saddleback caterpillar, Sibine stimulea

Centipedes (Class) Chilopoda
Cockroach, (Family) Blattidae
Crickets:
Camel cricket, Ceuthophilus sp.
Painted ground cricket, Pictonemobius arenicola
- Pygmy mole cricket, Neotridactylus archboldi

Flies:
- Flat-footed fly, (Family) Platypezidae
- Humpback fly, (Family) Phoridae
- Fruit fly, (Family) Drosophilidae
- Fungus gnat, (Family names) Myletophilidae, Sciaridae

Frogs:
- Gopher frog, Rana areolata
- Squirrel tree frog, Hyla squirella

Blue-tailed mole skink, Eumeces egregius lividus
Bobcat, Lynx rufus
Common bobwhite, Colinus virginianus
Digger wasp, (Family) Larridae
Eastern cottontail, Sylvilagus floridanus
Eastern gray squirrel, Sciurus carolinensis
Eastern indigo snake, Drymarchon corais couperi
Earthstar (mushroom), Geoaster sp.
Eastern towhee, Pipilo erythrophthalmus
Emerald moth, Nemouria outina
Florida black bear, Ursus americanus floridanus
Florida scrub-jay, Aphelocoma coerulescens
Florida scrub lizard, Sceloporus woodi
Florida scrub millipede, Floridobolus penneri
Florida mouse, Podomys floridanus
Florida panther, Felis concolor coryi

Florida rosemary, Ceratiola ericoides
Highlands scrub St. John's wort, Hypericum cumulicola
Gall wasp, (Superfamily) Cynipoidea
Gopher frog, Rana areolata
Gopher tortoise, Gopherus polyphemus
Gray fox, Urocyon cinereoargenteus
Lake Placid funnel wolf spider, Sosippus placidus
Lake Placid scrub mint, Dicerandra frutescens
Leafhopper, (Family) Cicadellidae
Leaf miner, (Family) Gracilariidae (one of several families)
Leaf roller weevil, Attelabos analis
Millipedes, (Class) Diplopoda
Oaks:
- Chapman's oak, Quercus chapmanii
- Myrtle oak, Quercus myrtifolia
- Sand Live oak, Quercus geminata
- Scrub oak, Quercus inopina
- Turkey oak, Quercus laevis

Opossum, Didelphis marsupialis
Orange bracket fungi, Pycnoporus cinnabarinus
Palm weevil, Rhyncophora cruentata
Paper wasp, Polistes sp.
Pigeon-wings, Clitoria fragrans
Pillbug, (Order) Isopoda
Prickly pear cactus, Opuntia humifusa
Pygmy mole cricket, Neotridactylus archboldi
Raccoon, Procyon lotor
Sand pine, Pinus clausa
Saw palmetto, Serenoa repens
Scrub buckwheat, Eriogonum longifolium
Scrub firefly, Lucidota luteicollis
Scrub golden aster, Chrysopsis floridana
Scrub palmetto, Sabal etonia
Scrub pawpaw, Asimina obovata, Four-petalled pawpaw, Asimina tetrapetalum
Skinks:
- Blue-tailed mole skink, Eumeces egregius lividus
- Sand skink, Neoseps reynoldsi

Snakes:
- Diamondback rattlesnake, Crotalus adamanteus
- Eastern indigo, Drymarchon corais couperi Short-tailed snake, Stilosoma extenuatum

Southern flying squirrel, Glaucomys volans
Spider wasp, (Family) Pompilidae
Wedge-leaved button snakeroot, Eryngium cuneifolium
White-tailed deer, Odocoileus virginianus
Velvet ant, (Family) Mutillidae

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Summary of Sunshine State Standards (Grade 3-5)

Activity	Language Arts	Mathematics	Science	Social Studies	The Arts
Why Doesn't A Small Animal's Burrow Cave-in? Part 1&2	LA.B.2.2.1	MA.A.1.2.3 MA.B.1.2.2 MA.B.4.2.2	SC.A.1.2.1 SC.C.1.2.1 SC.C.2.2.2 SC.C.2.2.3 SC.C.2.2.4 SC.H.1.2.1 SC.H.1.2.2 SC.H.1.2.3 SC.H.1.2.4 SC.H.1.2.5 SC.H.2.2.1 SC.H.3.2.2 SC.H.3.2.4		
What Happens to Sand When You Build and Dig in it? Part 1&2	LA.B.2.2.1 LA.C.1.2.1 LA.C.1.2.5 LA.C.3.2.2	MA.A.1.2.3 MA.B.1.2.1 MA.B.1.2.2 MA.B.2.2.1 MA.B.2.2.2 MA.B.3.2.1 MA.E.1.2.1 MA.E.1.2.3 MA.E.2.2.2 MA.E.3.2.1 MA.E.3.2.2	SC.A.1.2.1 SC.B.1.2.1 SC.G.2.2.3 SC.H.1.2.1 SC.H.1.2.2 SC.H.1.2.3 SC.H.1.2.4 SC.H.1.2.5 SC.H.2.2.1 SC.H.3.2.2 SC.H.3.2.4		VA.A.1.2.1 VA.B.1.2.1
What Happens When Water Invades Sand? Part 1&2	LA.A.1.2.4 LA.A.2.2.5 LA.B.2.2.1	MA.A.1.2.1 MA.B.1.2.1 MA.B.1.2.2 MA.B.2.2.1 MA.B.2.2.2 MA.B.3.2.1	SC.A.1.2.1 SC.A.1.2.4 SC.C.1.2.1 SC.C.1.2.2 SC.C.2.2.3 SC.C.2.2.4 SC.D.1.2.3 SC.H.1.2.1 SC.H.1.2.2 SC.H.1.2.3 SC.H.1.2.4 SC.H.1.2.5 SC.H.2.2.1 SC.H.3.2.2 SC.H.3.2.4	SS.B.2.2.2	VA.A.1.2.2
Animal Tracks in the Sand Part 1,2, &3	LA.B.1.2.1 LA.B.1.2.2 LA.B.1.2.3 LA.B.2.2.3 LA.B.2.2.6	MA.B.2.2.1 MA.B.2.2.2 MA.E.3.2.2	SC.F.1.2.3 SC.G.2.2.1 SC.H.1.2.1 SC.H.1.2.2 SC.H.1.2.3 SC.H.1.2.4 SC.H.1.2.5 SC.H.3.2.4	SS.B.2.2.2 SS.B.2.2.3	VA.B.1.2.1

Ant Lions: The Hairy Predator from Down Under Parts 1&2	LA.B.2.2.1	MA.B.1.2.1 MA.B.1.2.2 MA.B.2.2.1 MA.E.1.2.1 MA.E.1.2.3	SC.G.1.2.2 SC.G.1.2.5 SC.G.1.2.7 SC.G.2.2.2 SC.H.1.2.1 SC.H.1.2.2 SC.H.1.2.3 SC.H.1.2.4 SC.H.2.2.1 SC.H.3.2.1 SC.H.3.2.2		
Scrub Burrowing Wolf Spiders: The Stay-at-Home Predators Parts 1&2	LA.B.2.2.1	MA.B.2.2.1 MA.B.2.2.2	SC.F.2.2.1 SC.G.1.2.1 SC.G.1.2.2 SC.G.1.2.5 SC.G.1.2.7 SC.G.2.2.1 SC.H.1.2.2 SC.H.1.2.4		VA.B.1.2.2
Ants: Strength in Teamwork and Safety in Numbers Parts 1,2,3,4	LA.B.2.2.1 LA.C.1.2.1 LA.C.3.2.3	MA.B.1.2.1 MA.B.1.2.2 MA.B.3.2.1 MA.E.1.2.1 MA.E.1.2.3 MA.E.2.2.1 MA.E.2.2.2 MA.E.3.2.1	SC.F.2.2.1 SC.G.1.2.1 SC.G.1.2.2 SC.G.1.2.7 SC.G.2.2.2 SC.G.2.2.3 SC.H.1.2.2 SC.H.1.2.3 SC.H.1.2.4 SC.H.3.2.2		VA.A.1.2.2
Mushrooms- What are they good for? Part 1&2	LA.B.2.2.1	MA.B.1.2.2 MA.B.2.2.1	SC.F.1.2.3 SC.F.1.2.4 SC.F.2.2.1 SC.G.1.2.4 SC.G.1.2.5 SC.H.1.2.2	SS.B.2.2.2	
Decomposing Decomposers: Mushrooms and Their Associates	LA.B.2.2.1 LA.B.2.2.6	MA.E.1.2.1 MA.E.1.2.3 MA.E.3.2.2	SC.G.1.2.1 SC.G.1.2.2 SC.G.1.2.4 SC.G.2.2.1 SC.G.2.2.2 SC.G.2.2.3		
Decomposing Decomposers: What Are Spores and How Can You Find Them?			SC.F.2.2.1		VA.A.1.2.1 VA.A.1.2.2 VA.A.1.2.3 VA.A.1.2.4 VA.B.1.2.1 VA.B.1.2.4
Life in a Microhabitat Parts 1, 2, 3, & 4	LA.B.2.2.1 LA.C.1.2.1	MA.A.3.2.2 MA.E.1.2.1 MA.E.1.2.3	SC.G.1.2.1 SC.G.1.2.2 SC.H.1.2.1		VA.A.1.2.1

Plant-Animal Interactions: Palmettos-Old timers of the Scrub	LA.A.1.2.1 LA.A.1.2.2 LA.A.1.2.4 LA.A.2.2.1 LA.A.2.2.5 LA.A.2.2.8 LA.B.1.2.3 LA.B.2.2.1 LA.B.2.2.2 LA.B.2.2.3 LA.B.2.2.6 LA.C.1.2.1 LA.C.1.2.3 LA.C.1.2.4 LA.C.1.2.5 LA.C.3.2.2 LA.C.3.2.5	MA.A.1.2.3 MA.A.3.2.3 MA.B.1.2.1 MA.B.1.2.2 MA.E.1.2.1	SC.F.1.2.2 SC.G.1.2.1 SC.G.1.2.2 SC.G.1.2.5 SC.G.1.2.7 SC.G.2.2.1 SC.H.1.2.1 SC.H.1.2.2 SC.H.1.2.3 SC.H.1.2.4 SC.H.2.2.1 SC.H.3.2.2 SC.H.3.2.4	SS.A.1.2.3	
Plant-Animal Interactions: Oak Trees-The Serve Yourself Buffet	LA.A.1.2.1 LA.A.1.2.2 LA.A.1.2.4 LA.A.2.2.1 LA.A.2.2.5 LA.A.2.2.8 LA.B.1.2.3 LA.B.2.2.1 LA.B.2.2.2 LA.B.2.2.3 LA.B.2.2.6 LA.C.1.2.1 LA.C.1.2.3 LA.C.1.2.4 LA.C.1.2.5 LA.C.3.2.2 LA.C.3.2.5	MA.A.1.2.3 MA.A.3.2.3	SC.F.1.2.2 SC.G.1.2.1 SC.G.1.2.2 SC.G.1.2.5 SC.G.1.2.6 SC.G.2.2.1 SC.G.2.2.2 SC.H.1.2.1 SC.H.1.2.2 SC.H.1.2.3 SC.H.1.2.4 SC.H.3.2.2 SC.H.3.2.4		

Discovering Florida Scrub Curriculum Evaluation Form

We are very interested in your comments about this curriculum. Please complete both sides of this evaluation form and return it to:

Education Office
Archbold Biological Station
P.O. Box 2057
Lake Placid, FL 33862

Instructions: Circle one letter in each of the following questions below and fill in the blank where appropriate:

1. I received this curriculum:
   a. at a workshop
   b. on the web
   c. from a teacher
   d. other _____

2. I am a:
   a. teacher grade level _____
   b. informal educator at _____ (nature center, museum)
   c. homeschooler: # children and grade levels _____
   d. other _____

3. The audience I will use the curriculum with are:
   a. school children
   b. scouts and youth groups
   c. general public
   d. other _____

Please rate the following statements by circling the number that best describes how you feel. Choosing a **1** indicates that you **strongly disagree** with the statement and circling a **5** indicates you **strongly agree**.

	Disagree			Agree	
I learned a lot about Florida scrub by reading the curriculum.	1	2	3	4	5
I plan to use activities from the curriculum with my students.	1	2	3	4	5
I feel my students will be better acquainted with the scientific method after using the curriculum.	1	2	3	4	5
I feel more comfortable taking my students outside using this curriculum as a guide.	1	2	3	4	5

I believe my students will understand ecological principles better after doing some of these activities.	1	2	3	4	5
I feel that my students will learn to work well collaboratively after using activities from this curriculum.	1	2	3	4	5
After using the curriculum, my students will have a better understanding of Florida scrub.	1	2	3	4	5
Overall, I found the curriculum well-organized and easy to use.	1	2	3	4	5

I found the following sections to be most useful to me:

Why?

The following sections were least useful to me:

Why?

I would recommend the following changes, additions or deletions to the curriculum:

Other comments:

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