



Combating Plant Blindness

An Educator's Resource

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Institute For Applied Ecology (IAE)

RESTORATION, RESEARCH, EDUCATION

SW program examples:

- On-the-Ground Restoration & Resources
 - [Southwest Seed Partnership](#) (Improving supply of native seed)
 - Leonora Curtin Wetland (Invasive species control)
- Education
 - [Native Plant Society Outreach](#)
 - [Project Botany](#) (Native Plant Curriculum)
 - [Forest Bound](#)
- Research
 - NM Milkweed Establishment Studies



What to Expect ...

- About Plant Blindness
- Native Plant Curriculum NM
 - How to use it
- **Break for questions**
 - Sample lessons
- **Break for questions**
- Taking it Further
 - Educator Resources/Partnering with IAE
 - Summer program – Forest Bound
- **Questions**



Plant Blindness ... What is it?

'the inability to see or notice the plants in one's own environment, leading to the inability to recognize the importance of plants in the biosphere and in human affairs.'

What is this a picture of?



<https://news.mongabay.com/2016/09/can-plant-blindness-be-cured/>

Why do we care?



What do all of these things have in common?

People know milkweed because of the
Monarch Butterfly!



So ... how do we combat it?

Find the **CONNECTION**

Establish a **RELATIONSHIP**

Build upon that relationship through exciting and engaging **EXPERIENCES**

Address the need through applicable, accessible programming



We asked you ...

Project Botany

Currently teach:		
4 out of 10	Science	
3 out of 10	Community Educator	
3 out of 10	Other: Parent; Reggio; Cultural Institution; Educator for Public Lands	
Current program is effective:		
5 out of 10 - Yes	3 out of 10 - No	
Able to take students on field trips:		
6 out of 10 - Yes	3 out of 10 - No	
Have natural area at school or walking distance:		
4 out of 10 - Yes	6 out of 10 - No	
Topics discussed in current programming:		
4 - Plant identification	4 - Plant Biology/Physiology	
5 - Plant Names/Common Family Names	3 -Plants & Culture	
2 - Overview of Scientific Names	3 - Ethnobotany	
2 - Botanical Terms	3 - Phenology/Citizen Science	
3 - Dichotomous Key	2 - Plant Migration	
1 - Plant Collection	3 - New Mexico Ecoregions	
5 - Invasive Species	1 - Soil Science	
4 - Different b/w plant v lichen, etc.	3 - Plants for Pollinators	
5 - Biodiversity & Ecosystem Services	2 - Measuring and Monitoring	
What do you LIKE about content/application of current programs you teach?		
Civic Action	Hands-on	Naturalist
Rio Grande Teacher	Watershed activities	Vegetable garden

Where do you feel existing programs need improvement? What barriers in classroom?

Native plants information

More time outside

Teach to the test

Local plants information

Funding

Teacher involvement

Additional training

Have room to implement own lesson plans into existing programs:

8 out 10 - Yes

1 out of 10 - No

Can have outside organizations come into classroom for workshops:

8 out of 10 - Yes

2 out of 10 - No

Citizen Science programs currently implemented at my school:

3 out of 10 - Yes

5 out of 10 - No

2 out of 10 - What is this?

Anything else you would like to tell us?

More about local plants

More about invasive species

IAE'S SOLUTION

Project Botany: Curriculum based in experiential learning.

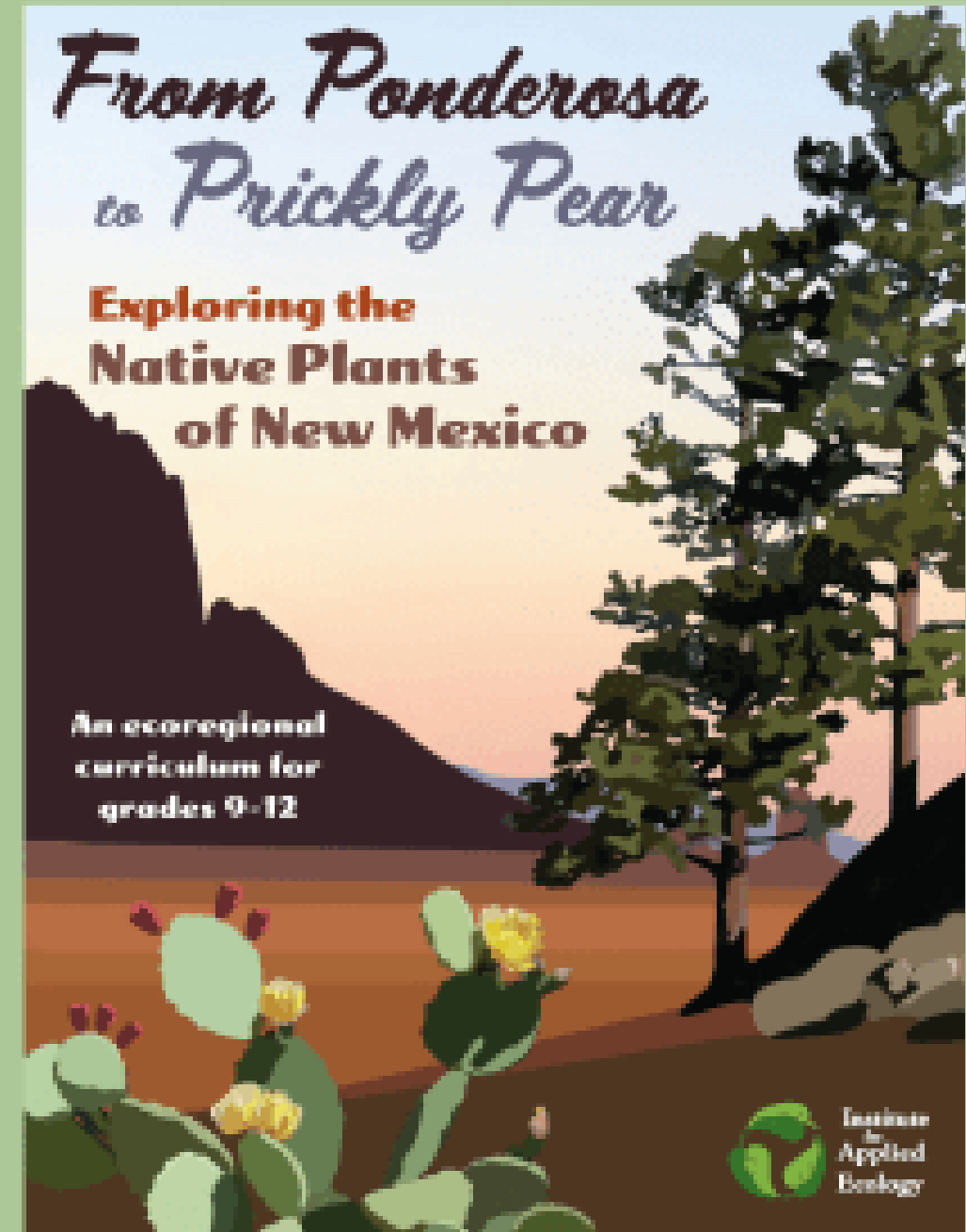
Guiding Principles:

- Place Based
- Hands-on
- Inquiry-based
- Experiential
- Service-learning
- [Education Standards](#)
- Community Partnerships
- Interdisciplinary
- Developed w/ [NAAEE Guidelines](#)



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Common Core State Standards



Strand II: The Content of Science

Standard II (Life Science): Understand the properties, structures, and processes of living things and the interdependence of living things and their environments

<http://www.ped.state.nm.us/MathScience/dlo8/Standards/G9-12ScienceStandards.pdf>

Implementing the Curriculum

GETTING OUTSIDE IN NATURE

Table of Contents

Structured by 7 major sections

Each section has references
and are numbered accordingly

Gets progressively more advanced

Ends with opportunities for
projects



Section 1: Plant Identification

- 1. Botany Bouquet..... 1-4**
Explore and become familiar with plant names, and the usefulness of a common plant language.
- 2. Botanical Terms Challenge..... 5-14**
A plant structure and function vocabulary-building exercise.
- 3. The Secret Life of Flowers 15-21**
Students dissect, observe, and record flower anatomy.
- 4. Drupes, Pomes, and Loculicidal Capsules:**
A Botanist's Lingo for Describing Fruits..... 22-26
Understand the different types of native fruits and learn to categorize them.
- 5. What's in a Name? 27-32**
A technology-based lesson on the importance of using scientific names.
- 6. Plants Have Families Too 33-41**
Learn ten common New Mexico plant families and explore the science of taxonomy.
- 7. Mechanics of a Key..... 42-47**
Learn the basics of how a dichotomous key works and how to construct one by keying out students' shoes in the classroom.
- 8. Make a Field Guide for Your School 48-52**
Construct a dichotomous key and field guide to a natural area near or around the school grounds.
- 9. Make Your Own Plant Collection 53-59**
Make a herbarium of local species. Learn proper technique for collecting, pressing, labeling, mounting, and storage of the collection.
- 10. Plant Adaptations: Create-A-Plant 60-69**
Create a fictional plant and field guide entry to demonstrate understanding.

Glossary

abiotic	the non-living elements of an ecosystem. Example: rocks, water	axillary	the leaf growing from it
accessory fruit	a succulent fruit developing from the receptacle instead of the pistil. A strawberry is an example, with the ripened ovaries' small achenes on the fruit surface	axils	a description of a location as it relates to North in degrees, minutes, and seconds
achene	a simple, dry, indehiscent fruit with a single, small seed that attaches to the ovary wall at only one point	basal	leaves growing from the base of the plant stem
adaptation	a process over multiple generations in which an organism changes to better fit the habitat. Example: Natural selection would favor the deeper-rooted plants during climate shifts that cause drought conditions	berry	a simple, fleshy, indehiscent fruit with many seeds, like a tomato or blueberry; commonly applied to any fruit that is fleshy throughout, though not botanically correct
adventitious root	a root structure developing in an unusual location, such as growing from a stem	biennial	a plant that takes two years to complete its life cycle; usually forming a rosette of leaves the first year, and producing flowers and fruit the second year
aggregate fruit	a cluster of small fleshy fruit, as in the cluster of drupelets that make up a raspberry. Arising from several pistils in a single flower, each producing a single drupe that when connected, form a cluster	binomial nomenclature	a two-part scientific system of naming organisms. Example: <i>Canavalia quaternata</i>
allelopathy	the process whereby one plant species produces biochemicals to inhibit the growth of other plant species	biochemical	a chemical process in living organisms
alternate	a leaf pattern where one leaf grows from each node on the stem, alternating sides of the stem	biodiversity	the variation of all life forms within an ecosystem; often used to measure the health of a given ecosystem
analgesic	a medicinal pain reliever	biological control	the control of a pest by the introduction of a natural enemy or predator
angiosperm	a flowering plant that produces seeds in a fruit	biome	the world's major ecological communities, defined by the predominant flora and climate, and covering large geographic areas. Examples: desert, forest, grassland, tundra
annual	a plant that completes its entire life cycle in the same year; germinate, flower, set seed, and die	biotic	the living elements that make up an ecosystem
anther	the enlarged, pollen-bearing part of the stamen, located at the tip of the filament	botany	the scientific study of plants
antibacterial	a medicinal that inhibits or destroys bacteria	bract	a small, leaf-like part at the base of a flower or along the flowering stem
antioxidant	a substance that slows oxidation. In the human body it counteracts the negative effects of oxidation on body tissues	bud	undeveloped (or baby) stem or flower, covered with scales
assisted migration	deliberately moving members of a species from their present habitat to a new location with the intent of permanent establishment. Most commonly used in response to habitat loss and climate change	bulb	a short, vertical, thickened underground stem, such as an onion; NOT a root
axil	the angle point between the stem and	burden basket	a woven basket, usually conical-shaped with pointed or flattened bottom, made in an assortment of sizes and weaves to accommodate the load to be carried
		calyx	the outermost whorl of flower parts
		candidate species	plant and animal species that are proposed for addition to the Federal Endangered Species Act (ESA)
		capsule	a dry, dehiscent fruit with more than one carpel
		carbon sink	place of carbon accumulation, such as

Appendix IV

New Mexico Ethnobotany Plant List: Food Plants

FOOD PLANTS			
Common Name	Scientific Name	Use	Native American Tribe or Pueblo
New Mexico maple	<i>Acer glaberrimum</i> <i>acer macrocarpum</i>	Sap collected and boiled to obtain syrup and sugar	Apache, Chinle, Navajo, Mesquero
Bowlder	<i>Aspen rugosus</i>	Dried food; inner bark scrapings dried and kept for winter use Sweetener: inner bark boiled until sugar crystallizes out of it	Apache, Chinle, Navajo, Mesquero
Indian hogweed	<i>Achillea millefolium</i> <i>byerneseoides</i>	Ground seeds used as a staple before the availability of corn	Navajo (maple), Apache, White Mountain
Goat thymus	<i>Achillea millefolium</i> <i>byerneseoides</i>	Used as one of the most important foods	Comanche (maple), Navajo (maple), Apache (maple), Ute (maple)
		Leaves used for flavoring	Laguna, Acoma
Agave	<i>Agave spp.</i>	Wet: baked and eaten; crowns with leaves removed eaten as greens in winter/spring Flowering stalks eaten as greens in spring before they emerge; stalks roasted, baked or eaten raw	Apache, Comanche, Mohave, Ute, Chinle, Navajo, Mesquero Staple for all
Rocky Mountain Indian garden	<i>Aletris ciliata</i>	Blue leaves eaten as a relish or cooked Leaves eaten as greens	Navajo
Indian bush	<i>Aletris ciliata</i>	Food staple: seeds harvested, winnowed, parched, ground and the meal eaten	Navajo
Onion	<i>Allium spp.</i>	Bulbs used for food	Apache, Chinle, Navajo, Mesquero, Acoma, Laguna, Navajo, Hopi, Teva, Navajo, Ute
		Onions used to flavor soups and greens	Apache, Chinle, Navajo, Mesquero, Acoma, Laguna, Pueblo
Figweed	<i>Amaranthus spp.</i>	Eaten without preparation or cooked as greens or mixed with other food	Hopi, Apache, Pueblo, Chinle, Navajo, Acoma, Mohave, Navajo, Laguna, Navajo, Navajo, Navajo
		Seeds winnowed, ground into flour and used to make bread	Apache, Chinle, Navajo, Hopi, Mesquero, Laguna, Navajo, Acoma, Navajo
		Young plants cooked and dried for winter use	Acoma, Laguna, Mohave
Utah gooseberry	<i>Ambrosia artemisiifolia</i>	Fruit used for food	Navajo, Navajo, Ute, A. artemisiifolia
		Berries dried for winter use	Navajo
Saltbush	<i>Atriplex spp.</i>	Fruit expanded calyx eaten for food	Acoma, Laguna
		Fresh young leaves eaten or boiled and eaten as greens or with plant products and meats for flavoring	Navajo, Acoma, Laguna, Chinle, Hopi, Navajo, Pueblo, Navajo
		Seeds mixed with ground corn to make a mush	Navajo
		Flowers used to make puddings	Navajo, Hopi
Indian tea	<i>Baccharis salicifolia</i>	Young shoots roasted and eaten as a famine food	Navajo
Colorado barberry	<i>Berberis fasciculata</i>	Berries used for food	Navajo

Making the most out of it

- Create a student field journal at the beginning of study (pg. 138)
- Purchase field guides specifically written for your ecoregions
- Plan ahead to take advantage of outdoor, hands-on learning opportunities
- Make Community Connections



Field Journaling: Observations from a Special Spot

"To see a wren in a bush, call it 'wren,' and go on walking is to have (self-importantly) seen nothing. To see a bird and stop, watch, feel, forget yourself for a moment, be in the bushy shadows, maybe then feel 'wren'—that is to have joined in a larger moment with the world."
- *Gary Snyder*, *Language Goes Two Ways*, (1930-present)



Overview

A field journal can be used to record observations and questions, to make drawings, and to pursue ideas. This lesson is an introduction to using a field journal for all of these things and more. Students can use their field journals to support their study of native plants and ecosystems. It can be a handy reference for places they have visited, new terms they have learned, and plants that they have identified.

Teacher hints

- Begin your unit of study on New Mexico's native plants by introducing students to writing about personal observations in nature. A field journal can be an important tool for nature study. It can foster writing skills and provide a portfolio of information, a source of questions for scientific study, an inspiration for future projects, and a place for reflection.
- Share some plant related field journal entries from Lewis and Clark's Voyage of Exploration or excerpts from other explorers with your students. Show them journal entries for them to see how drawings are used to enhance their writing (see link in the Resources section).
- Before beginning, read students a few passages from Aldo Leopold's book, *A Sand County Almanac*. If possible, have a few copies available for students to read further on their own. Consider assigning passages for students to read at home.
- For students who are reluctant to write, encourage sketching. Ask them to add a few words about their drawing, maybe notes on size or color. Ask them to record the weather and the date. Each time have them include a little bit more written detail about their drawings. Pretty soon they will be writing!
- When you take students outdoors for journal writing, be the timekeeper. Have them observe quietly for 10 minutes before they start to write. Then allow them 20 minutes to write and draw. Give them a couple minutes of warning before time is up to allow them to gradually return to the group after their time alone. Allow 15 minutes for sharing.
- Have students record journaling prompts from the directions and have students tape these to the inside cover of their journal. Encourage them to refer to this list whenever they have trouble starting.
- A field journal is an excellent way to integrate science with studies of language, history, and art.

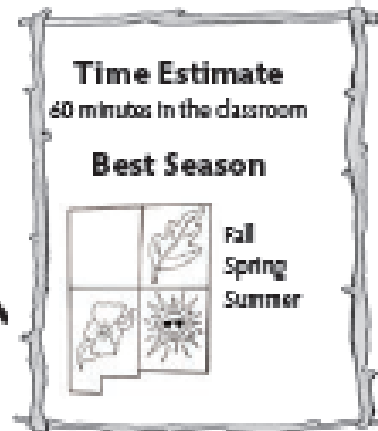
Assessments

- 1 Record one observation in detail or several small observations.
- 2 Make observations using more than one sense (e.g. smell, touch, hearing).
- 3 Focus on your project and be courteous of other students.



Anatomy of a Lesson

Planning: Time estimate and best season for the lesson



Teacher Hints: how to prepare the lesson successfully and other useful resources

Teacher hints

- This activity is a good introduction to plant studies because it highlights specialized terminology that might be useful in attempting to describe plants and that a system for identifying plants would be handy
- If possible, choose plants with unique features to help students identify differences from one plant to the next.

Vocabulary: help familiarize students with language associated with the lesson

Vocabulary

herbarium
herbaria

Overview

This activity awakens basic plant observation skills as students examine and describe plants collected by the teacher. Students have fun making up descriptive common names for their species and getting up close and personal with their species to make a great description. Students present their species to their class.

Preparation

1. Prepare bouquets of wild plant species (native or non-native) from your area. You will need one bouquet for each group of students. Each bouquet needs to be made up of the same plants and contain one plant for each person in the group. Consider choosing plants from different families (refer to the Plant Family Chart in the "Plants Have Families Too" section for examples).
2. Divide the class into groups (adapt to fit your classroom making groups of 3-5 students) and give each group one of the bouquets.
3. Hand the students a hand lens or magnifying glass and instruct them to use it to get intimate with their plant.

Learning Objectives

1. Learn and demonstrate proper techniques for collection, drying, preserving, and cataloging plant specimens
2. Contribute to a classroom herbarium with a usable system of organization
3. Use botanical terminology as well as common and Latin names to correctly describe a plant specimen (review)
4. Practice plant identification skills (review)

Complete unit of study

Overview:
General description of lesson plan

Consistent Formatting

Preparation: simple instructions on how to plan ahead

Lessons can be used individually

Learning Objectives:
students appreciate knowing expectations

Teacher hints and tools provided

For the Students

Class Discussion:
Suggestions and leading
questions for class
conversation

Reflection: exercises
prompt students to
think about, reflect on,
and apply the concepts
they have learned

Assessments: allows
students to test their
own understanding

Student Directions

1. Assemble a personal plant press. You will need 5-8 pieces of heavy cardboard, several sections of newspaper, and 4 long, heavy rubber bands. Cut the cardboard pieces to the size of a folded newspaper. Use newspaper as your blotter paper to position your plant specimens, plus use additional layers of newspaper between each specimen to help absorb moisture. Use an 8 1/2 x 11 sheet of paper as a size guide; your finished specimen will be mounted on this size paper.

2. Make a weed collection from your home, roadside or vacant lot (follow the steps below). Collect 4-5 different weed specimens. Do not collect from parks, natural areas, or personal property without the owner's consent. **BE RESPONSIBLE;** do not spread weeds. Be sure to contain any seeds that may fall off your collections and dispose of extra weedy materials that you bring back to the classroom in the trash.

CLASS DISCUSSION

How does human activity impact your ecoregion now?
How do you expect it to change in the next 10 years? The
next 50 years? Include both negative impacts and positive
impacts.

Reflection

What are your ecoregion apart from
the others around it? What makes it a
special place? Think about what you
like about the different seasons: winter, spring,
summer and fall. Are there things that you enjoy doing
outdoors that are enhanced by or only possible in your
ecoregion? Do you have a special place that you like to
visit? Describe it. If you don't have a particular special
place, think about characteristics that would make an
outdoor place special to you—describe it.



Self Assessment

- 1 Name and describe one native and one invasive plant species found in your ecoregion.
- 2 Name and locate one (or more) natural areas in your ecoregion.



In the Field

Go on a field trip or go on your own time to
a natural area in your own level III ecoregion.
Bring a hand lens and your field journal. Find
and observe several samples of different native
plant species and take careful notes about each in
your field journal. Use your knowledge of plant
adaptations to explain how
each species is adapted to
your ecoregion. Where else
might these species thrive?
What factors do you think
limit the range of each
species?



EARLY FINISHERS

Design an experiment that will test control
methods for an invasive plant species that is a
problem in your area. Start by brainstorming
possible ways to limit the further spread of
the plant. Think outside the box to create
new, more effective, environmentally friendly
methods that could be used for control.
Narrow your ideas to ones that you can test.
Write a proposal and submit it to your teacher.

Directions: written
step by step with the
students in mind

Self guided or used
as a lesson

In the Field: provides
opportunities for
students to apply
learning out in nature

Lessons can be done
In groups

Early Finishers:
enrichment or extension
activities engage
motivated students

Can be integrated into
service – learning and
community projects

BREAK FOR QUESTIONS



Examples of Lessons

Plants Have Families too

- In class opportunity
- Understand how plants relate to one another

Measure / Monitor Lesson

- Outdoor opportunity
- Skills acquired transfer to career opportunities

Ecoregions

- Understand our relationship to place



Plants Have Families Too

"I have seen trees as my friends. When they grow along my path, I reach out to them, draw their needles through my hands, and smile. I say their names, an acknowledgment of kinship." – *David Sabel* (Contemporary)

Adapted from: Earth Partnership For Schools K-12 Curriculum Guide,
University of Wisconsin-Madison Arboretum

Time Estimate

20 minutes for each plant family (includes time to investigate and discuss findings); an additional session is required for *In the Field!*

Best Season



Winter
(using photos)
Fall
Spring
Summer

Teacher hints

- Supplement the student's field journals with vocabulary words from this lesson for a handy reference on field trips and during outdoor activities.
- If completed, students can use the Self-Study Sheet from the "Botanical Terms Challenge" chapter.



Overview

Students learn about the science of taxonomy while studying plant families living in their ecoregion.

Preparation

- The day before or the day of the activity, obtain several specimens of multiple species for each family to learn. A list of potential species follows each family description. Plants appropriate for dissection are weedy or common, found along roadsides or in gardens. (Be aware that garden plants are often hybrids and may have more flower parts than plants growing in the wild). Flowers may also be available from florists (same hybrid warning applies, and florist sometimes remove stamen).
- Keep specimens cool and moist. Lay short-stalked flowers between moist sheets of paper towel in a sealed plastic bag; put long-stemmed plants in a vase.
- If plants are no longer blooming, students can investigate fruits, seeds, and seed dispersal mechanisms. As an alternative, collect photos of plants, flowers and fruits to do this activity in winter.
- Set up numbered stations with several representative species of each plant family. Have enough stations so there are 3-4 students at a station at a time.
- Divide students evenly among the stations. Act as timekeeper, have groups move at 10-15 minute intervals to next station.

Assessments

- Recall the common name and the Latin name for each plant family learned.
- List at least two characteristics from each family learned that make that family unique.
- Identify one representative of each plant family learned.

Lessons are all connected and build upon each other. Vocabulary from Botanical Terms challenge can be applied when looking at plant families. When we start to explain how plants relate, we have the vocabulary to do so.

1-38

Family Name	Characteristics				Ex. of Natives	Common Weeds	Garden or Landscape Plants
	General	Leaf	Flower	Fruit			
Agavaceae (ah-gah-VAH-see-ee) century plant family	Succulents with a network of shallow rhizomes; each rosette grows slowly and flowers only once; adapted to very dry conditions	Basal rosettes of fibrous sword-shaped leaves with sharp, spiked edges; persistent, remaining on the plant for many years; leaves coated to prevent evaporation	Short, tubular flowers in tall spikes [some species pollinated by bats]; perfect flowers forming terminal or clustered panicles; 3-fused carpel ovary; a single and slender style; 6 stamen at base of perianth (collectively, the sepals and petals) tube	Indehiscent pods	soapweed yucca (<i>Yucca glauca</i>), banana yucca (<i>Yucca baccata</i>), Parry agave (<i>Agave parryi</i>)		century plant, tequila, mesquite
Asteraceae (as-ter-AY-see-ee) daisy or sunflower family	Some heads have only disk flowers (thistles and snakeroots), others have only ray flowers (dandelions, chicory); many species have both ray and disk flowers (sunflowers, asters); bracts: flower head is subtended by involucre bracts; modified leaves that protect the growing bud	Alternate or occasionally opposite; usually toothed, lobed or divided	Small flowers in center called disk flowers attach to fleshy area (receptacle) and make up a single inflorescence. Inflorescence: although may look like single flower, is actually cluster of flowers called a head, which may contain a few hundred individual flowers	cypsela	wood sunflower (<i>Helianthus quinquevallis</i>), Mexican hat (<i>Ratibida columnifera</i>), Bailey's rabbit-brush (<i>Chrysothamnus pulchellus</i>)	ox-eye daisy (<i>Leucanthemum vulgare</i>), dandelion (<i>Taraxacum officinale</i>), bull thistle (<i>Cirsium vulgare</i>)	artichoke, lettuce, sunflower, asters, hysanthemums, chamomile, cosmos, edimacea
Brassicaceae (bras-i-KAY- see-ee) mustard family	Usually annual, biennial, or perennial herbs	Simple, alternate leaves	Always 4 petals in a cross; usually 6 stamen, 4 long, 2 short; usually 4 upright sepals; 2-chambered ovary positioned above the other flower parts.	A distinctive pod of 2 carpels; long, thin fruits (siliques) and short, rounded fruits (silicles)	Fendler's arabis (<i>Arabis fendleri</i>), western wallflower (<i>Erysimum capitatum</i>), spectade pod (<i>Dimorphocarpa wislizeni</i>)	broadleaved pepperweed (<i>Lepidium latifolium</i>), tumble mustard (<i>Sisymbrium altissimum</i>), shepherd's purse (<i>Capsella bursa-pastoris</i>)	cabbage, broccoli, kale, turnip, brussels sprouts

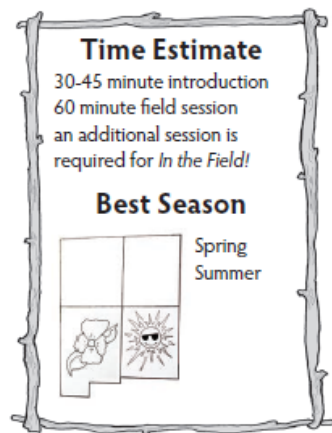




Teacher
Page

Measuring and Monitoring Plant Populations

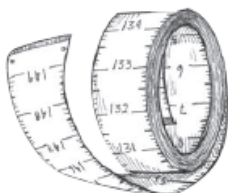
"An experiment is a question which science poses to Nature, and a measurement is the recording of Nature's answer."
- Max Planck (1858-1947)



Teacher hints

Differential education - ways to adjust the level of this lesson:

- To introduce more difficulty, add additional sampling methods for more advanced students to compare.
- To simplify the lesson, reduce the sample size or reduce the types of data collected.



Overview

When botanists and ecologists work in the field, it is not practical or possible for them to count and measure every single plant out there. If this is the case, how do they collect accurate data on plant populations? Field biologists use different methods of sampling portions of a larger population or plant community to collect data that is representative of the whole. The data can then be used to describe the overall population or habitat. This lesson will introduce you to several methods of sampling plant populations and the different types of data that can be collected.

Preparation

1. Students should complete the exercises in the How to Estimate Percent Cover worksheet before attempting the lesson.
2. Students will conduct a plant population survey to sample one common (abundant) and one uncommon (rare) plant within the survey area. Choose an area to support such a set up. A natural meadow would supply an area for several student teams to work.
3. Break the class into teams of two to four students. Each team will conduct a survey in the same general area. Students can then compare and discuss results.

Assessments

- 1 Students are able to explain what sampling is and discuss the strengths and weaknesses of using sampling as compared to a census to measure plant populations.
- 2 Students can describe two or more methods of sampling plant populations and discuss their applications.
- 3 Students can describe two or more types of data to collect and their applications.



Student
Project

Measuring and Monitoring Plant Populations

Estimating Percent Cover

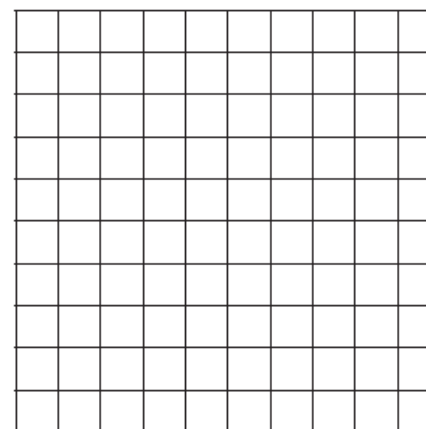
Percent cover is a measurement used by botanists and ecologists to describe and quantify plant communities and habitat. It refers to the proportion of the ground that is covered by a specific habitat component, which could be a certain plant species, or bare ground, or the canopy of a tree overhead. Because percent cover is not tied to a specific measurement unit (like inches or centimeters), it is easy to compare across different sample unit sizes and shapes.

A good starting point is to evaluate the percent cover of plant species or types of plants within a 1 meter x 1 meter quadrat frame (see diagram below). The first step is to orient yourself to the proportion of the area in the quadrat that equals 1%, 5%, or 10%. For a 1 meter x 1 meter (100 cm x 100 cm) frame, the total area is 10,000 square centimeters.

Therefore:

- 1% of 10,000 is 100 cm², or the area of a square that is 10 cm x 10 cm in size.
- 5% of 10,000 is 500 cm², or about the area of a square that is just over 22 cm x 22 cm in size.
- 10% of 10,000 is 1000 cm², or the area of a square that is 31.5 cm x 31.5 cm in size.

Example: 1 meter x 1 meter quadrat



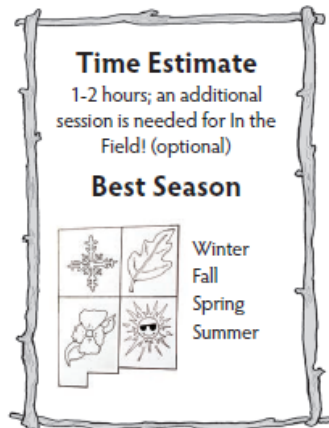
Each square is 10 cm x 10 cm, or equal to 1% cover.

Forest Bound Measuring and Monitoring Lesson



T Teacher Page The Place I Call Home

"Life is like a landscape. You live in the midst of it but can describe it only from the vantage point of distance." —Charles Lindbergh (1902-1974)



Teacher hints

- Consider setting a minimum number of resources students must use to research their ecoregion.
- This lesson works well when preceded by the *Exploring New Mexico's Ecoregions* lesson, where students are introduced to the concept of ecoregions and the ways in which abiotic factors influence the biotic elements of a region.



Overview

In this lesson, students will take an in-depth look at their home ecoregion. Students will explore what makes their ecoregion different than the rest of New Mexico. Students research climate, geology, native vegetation communities, human influences, land uses, and a few of the rare and invasive species that reside in their ecoregion.

Preparation

- You will need to look at a map of the level III ecoregions to determine which ecoregion you call home.
- Gather a list of web sites and materials to help the students glean information about their home ecoregion. An electronic handout provides information on land cover and use for level III ecoregions for New Mexico can be found <https://www.epa.gov/eco-research/ecoregion-download-files-state-region-6#pane-29>. It needs to be enlarged to 100% be able to read the details of land cover and use. This handout for New Mexico's ecoregions can be ordered by contacting staff on the EPA Ecoregions homepage (search EPA ecoregions by state if the link is broken).

Assessments

- 1 Name and describe one native and one invasive plant species found in your ecoregion.
- 2 Name and locate one (or more) natural areas or natural landscapes in your ecoregion.
- 3 Describe at least two primary land-uses in your ecoregion.

S Student Project The Place I Call Home

6. Your presentation could include discussions on the following subjects:

- Location:** Where is your ecoregion located? Use a map to show the general location of your ecoregion, and relate it to the location of major features such as mountain ranges and rivers.
- Physical Characteristics:** Describe the general topography of your ecoregion. Are there any wetlands, rivers, or lakes in your ecoregion?
- Climate:** What is the average annual temperature? What is the annual average precipitation? At what time of year does this precipitation usually fall, and in what form (e.g. rain or snow)? How do the physical characteristics of your ecoregion affect the climate? How might they affect climates of neighboring ecoregions? How might neighboring ecoregions affect the climate of your ecoregion? US Climate data: <http://www.usclimatedata.com> is a great source.
- Biological Characteristics:** What are some of the most common groups of native plant species in your ecoregion. For example, is your ecoregion dominated by desert, grassland, small shrubs, coniferous trees, or deciduous trees? Why might this group of species thrive here? Hint: Think about the physical characteristics and the climate in your ecoregion, and what adaptations plants need to survive in such a setting.
- Human Activities:** What are some of the primary land-uses in your ecoregion? What features of your ecoregion make this a profitable use of the land? What are some of the notable impacts on the landscape caused by these land-uses? Can you think of any ways to minimize or reduce these impacts?
- Diversity within Ecoregions:** Even level III ecoregions are very large, and the landscapes they encompass are very diverse. Your level III ecoregion has many different plant communities within it. Use a combination of research and your own observations to describe the variety of plant communities encompassed by your ecoregion. What abiotic factors might affect and help form these communities? A botanist is a good person to contact for more information; try reaching out to botanists from the Bureau of Land Management (BLM), US Forest Service, US Fish and Wildlife Service, or other agencies, non-profits, or watershed councils.
- Local Plants:** Include a profile of one native plant and one invasive plant that occurs in your ecoregion. Include a description of the plant's appearance, adaptations, and habitat. How is it adapted to live in your ecoregion? Appendix II provides examples of native plants and Appendix III provides examples of invasive plants for each ecoregion.
- Rare Plants:** Does your ecoregion have any rare plant species? What are some activities or land uses that may be a threat to the survival and health of populations of rare plants? Visit the New Mexico Rare Plants Website for information: <http://nmrareplants.unm.edu/>

7. Be sure to cite the sources you used for research.

8. Present your information to the class. Be sure that everyone in your group plays a part. Use your creativity to display images and information that help your classmates to picture your ecoregion.



Teacher
Page

An Ecosystem Through an Artist's Eye

"Nature is painting for us, day after day, pictures of infinite beauty."
—John Ruskin (1819-1900)



Overview

Students will use drawings to understand the different perspectives gained from making observations on different ecological scales. Students will focus on the local habitat by drawing three different views: one landscape view, one smaller scale view, and one magnified close-up view. This activity encourages aesthetic appreciation for the local landscape while exercising flexible thinking skills and hand-eye coordination. Drawing emphasizes careful observation of detail and patterns in the natural world.

Preparation

Prepare 5 x 7 rectangular viewing frames for students to use for their artwork. Or, assemble supplies and have students prepare their own before beginning the activity.

Assessments

- 1 Summarize the activity by comparing and contrasting views, and discussing the processes associated with different ecological scales.
- 2 Participate in the activity; work independently and join discussions.



Teacher hints

- Encourage doing this activity in pen for the upper grades; it discourages editing. The object is to practice observation skills and gain appreciation for their surroundings, rather than to produce a perfect drawing.
- Stress to students that this exercise is to help observe what is around them, rather than to judge their drawing abilities. If students are drawing-phobic, have them make blind contour drawings, drawing by not watching their hand on the paper. Remind students that their work does not need to be perfect (this seems to be more of a problem with older students).
- Read quotes from literature of descriptions of landscape perspectives (see Resource section). For inspiration, do an internet search on "New Mexico nature".
- Repeat this activity in different landscapes (desert, grassland, forest, wetland), or in the same place during different seasons. This activity is more challenging in a forested setting with a limited landscape or vista view.
- Between each drawing session, regroup and share what students saw, as well as their feelings about what they saw at each step. This is a good way to keep students on schedule—or some will become so involved in one drawing that they won't finish the activity.
- Have students use their 5x7 frame to draw a template on their paper for each of the three drawings before starting. Stress that their drawing should fill this frame. Also, encourage them to spend the entire 20 minutes drawing. If they finish drawing before the activity is over, they can go back and add more to it.



Student
Project

An Ecosystem Through an Artist's Eye

Student Directions

1. Discuss what things you might notice in a landscape or macro view. With your eyes closed, listen to your teacher read an inspiring quote from literature. Imagine how the scene must have looked to the writer.
2. Spread out. Look through your viewing frame at arm's length, select a spot, and draw the landscape view you see in your frame on your paper. Take your time to observe before beginning. Look for and include in your drawing patterns of color, texture and contrast. Regroup and share your drawings and feelings while looking at the landscape.
3. Discuss the process at work in a close-up view and listen to your teacher read a quote. Now select a spot to observe and draw the detail of your landscape close-up. Use your viewing frame to look at an area at your feet and draw what you see. Look for details, differences in size, color, shapes. Regroup and share your drawings and feelings while making observations at the close-up scale.
4. In the microscopic view, pick one plant to look at in greater detail. Isolate an area of the plant by looking through a hand lens and explore in close detail what you see. Fill your drawing frame with what you see in the hand lens. Pay particular attention to patterns, textures, and colors as you draw. Look at your subject, then take a minute to draw, and then look again. Repeat this process until you have sufficient detail. Fill your entire frame with what you see! Regroup and share. Did this view turn up any surprises? What processes are at work to create what you see at this scale?
5. Return to the same location and repeat this exercise during each season and look for changes throughout the year.



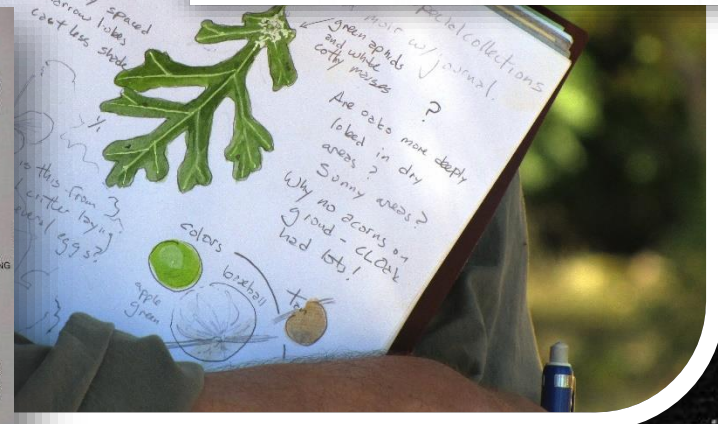
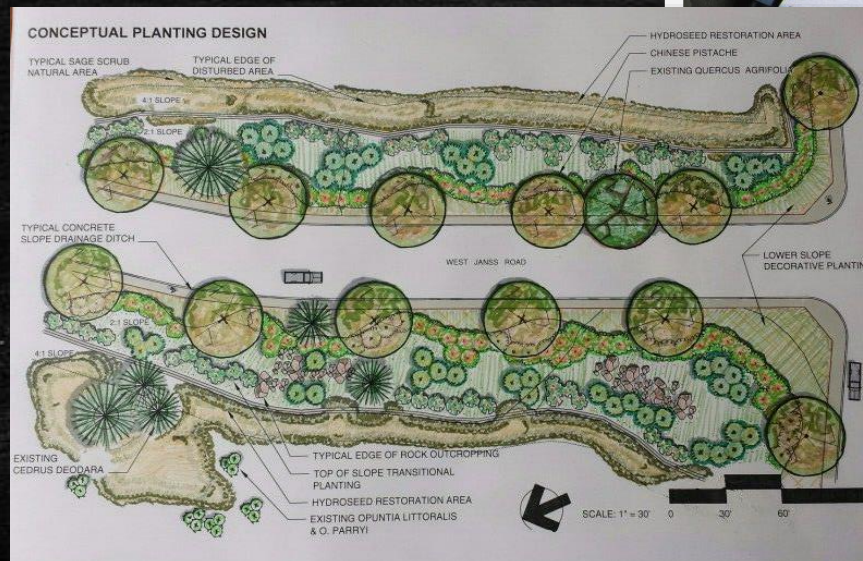


Taps into creativity and engages the senses while learning!



Homework & Projects for Students

- Field Study Journal
- Take home projects
 - Botany crossword puzzle
 - Create your own restoration plan
 - Create your own native plant garden (with a specific focus: pollinators, erosion prevention, medicine, food, etc.) (pg. 142)
 - Project Based Learning



Botanical Terms Challenge

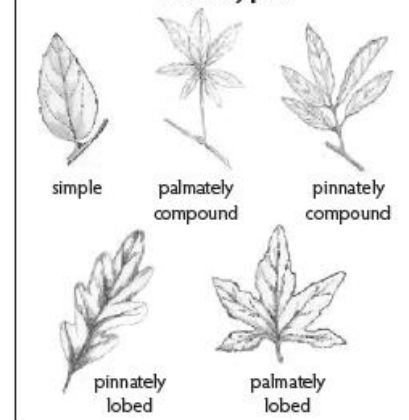
Self-Study Sheet

Name _____

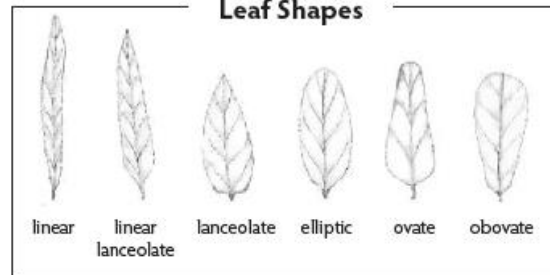
Word	Knowledge Connection	Definition

Student Project Botanical Terms Challenge

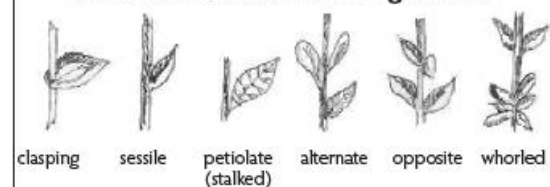
Leaf Types



Leaf Shapes

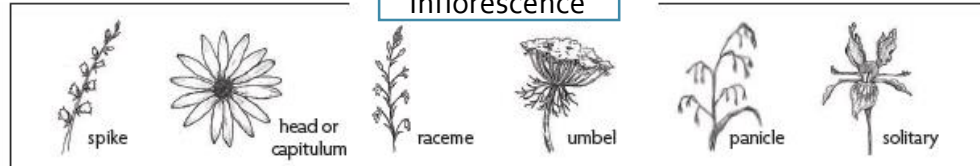


Leaf Attachments & Arrangements

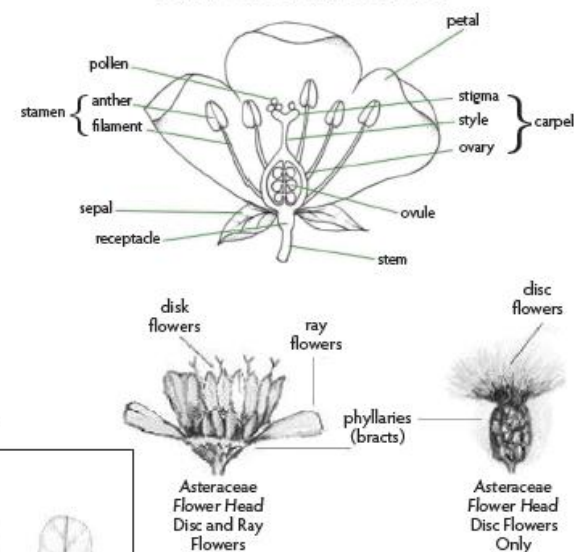


Above illustrations (not including Parts of a Perfect Flower) done by Adair Peterson taken from *Wildflowers of the Northern and Central Mountains of New Mexico* by Littleton and Burns

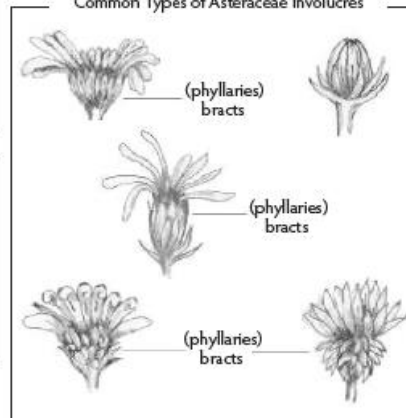
Inflorescence



Parts of a Perfect Flower



Common Types of Asteraceae Involucres





*Student
Project*

Botanical Terms Challenge

Across

1. Heart-shaped
3. Two leaves growing directly across from each other on a stem
5. Underground stem
6. Without stem, stalk, or petiole
7. Enlarged base of the pistil; contains developing seed
12. Leaflets or veins arranged on each side of a common stalk
13. Small swelling or knob where new growth originates
14. Thread-like stalk that supports the anther
16. A rounded, modified, underground stem for storage, not a root
17. Leaves with wavy, rounded margins
22. Portion of pistil receptive to pollen
24. Leaf that is divided from a central point into lobes
25. Structure atop the stem where flower parts attach
26. Division of a compound leaf
30. Cluster of flowers
34. A primary, thick root
35. The whorl of a flower comprised of the petals
38. Single flower, not in a cluster
39. Umbrella-like inflorescence with multiple small flowers
41. Ripened flower part that contains the seeds
42. Branched inflorescence; central stalk with side stalks containing multiple flowers
45. Unbranched inflorescence with single, unstalked flowers



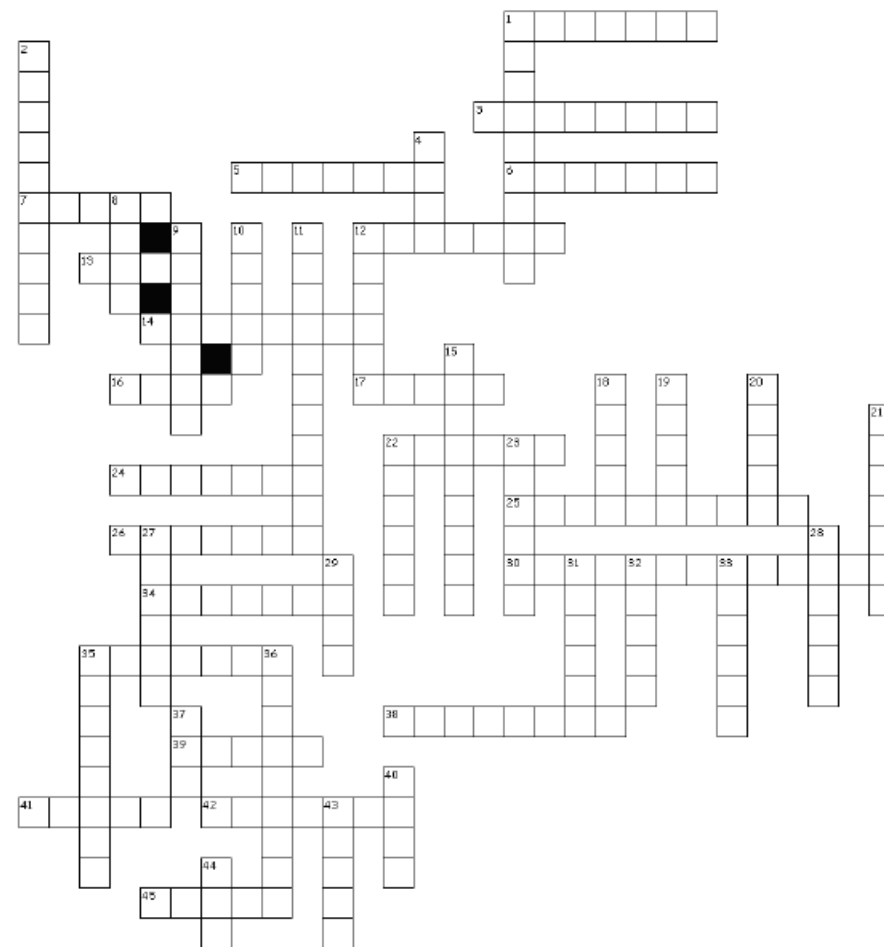
Down

1. Inflorescence with numerous small flowers on a single base
2. Lance-shaped, much longer than wide
4. Transports water, sugars, and minerals within the leaf
8. Anchors the plant and takes up nutrients and water
9. Stalk that attaches the leaf to the stem
10. A modified leaf in the whorl between the sepals and stamens, often colorful
11. Fruit not opening on maturity
12. Female reproductive structure of the flower
15. Fruit opening on maturity
18. Part that connects the stigma to the ovary
19. Small, leaf-like part at the base of a flower
20. Positioned at the base of the plant
21. Three or more leaves arising from the same node on the stem
22. Male reproductive structure of the flower
23. Edge of a leaf
27. Leaf margin that is not toothed, notched, or divided
28. Enlarged, pollen-bearing part of the stamen
29. Above-ground part of a plant that supports leaves and flowers
31. Often colorful and showy; the reproductive unit
32. Oval or egg-shaped
33. Undivided leaf
35. Leaf divided into two or more leaflets
36. Where one leaf arises from each node on alternating sides of the stem
37. Undeveloped stem or flower; covered with scales
40. Blade; primary site of the photosynthesis



*Student
Project*

Botanical Terms Challenge

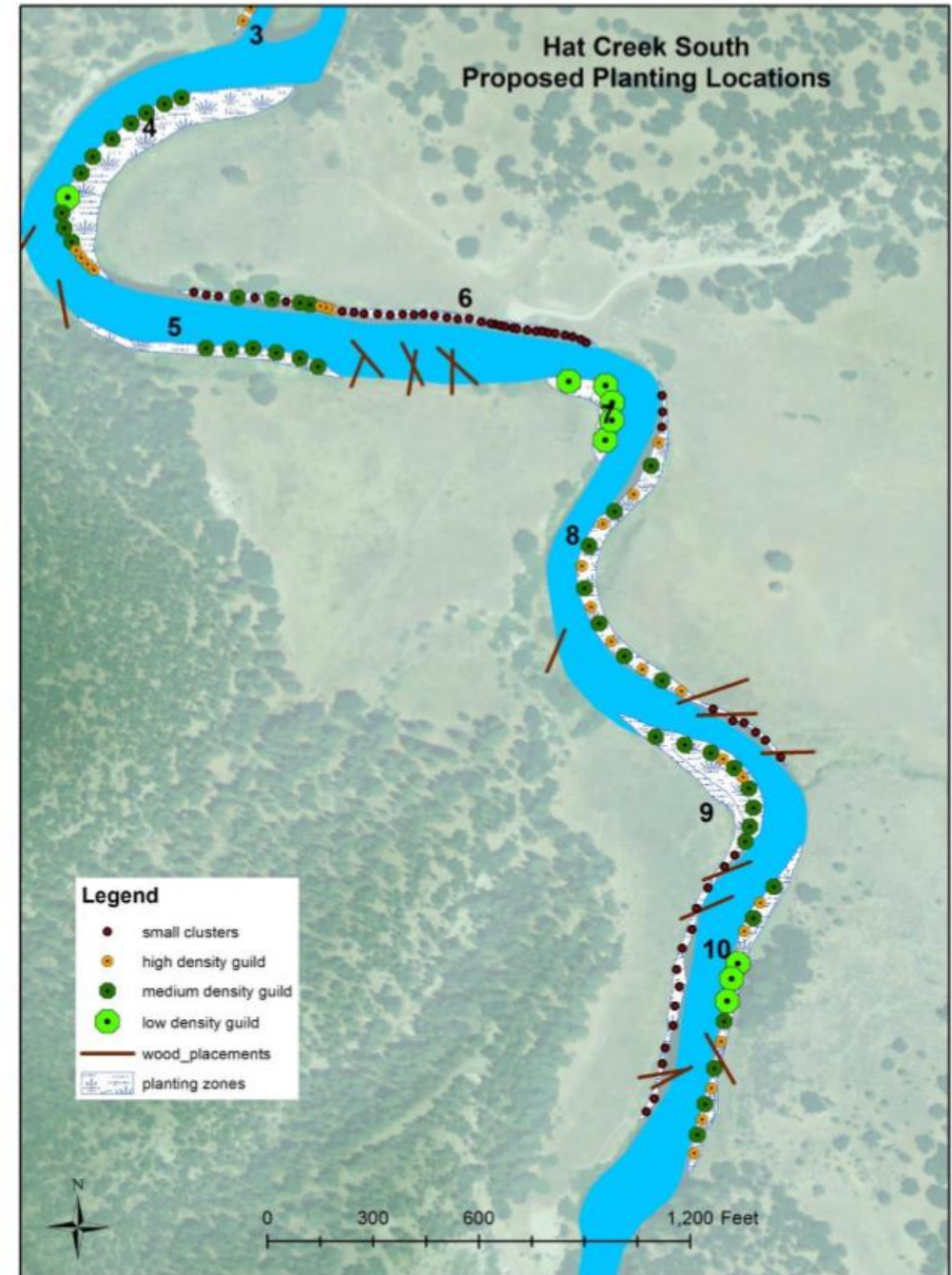


This lesson is very versatile! Can be used in the classroom or outside!

Riparian Restoration Plan

EXAMPLE

- Planting plan for native tree and shrub species
 - Species and density of planting varies along river corridor
- Strategic placement of woody structures to control water flow





Teacher
Page

Nurture a Native Garden Project

Part 1: Research and Planning

"Why try to explain miracles to your kids when you can just have them plant?"
—Robert Brault, gardener (c. 1980)



Assessments

- 1 Give the common and scientific name of 2-3 wildflowers that grow in your ecoregion.
- 2 Give one reason to conserve native plant species.
- 3 Work as part of a group to prepare a project presentation (example: oral, report, or poster).

Overview

Explore the definition of the term "wildflower" and explore people's use of the word. Research native flowering plants for your local habitat. In this lesson, students embark on a native plant garden project by working through the planning stages in the first of three lessons. This lesson offers learning opportunities to share knowledge with your community.

Teacher hints

- For your planting projects use local seed sources and native plants whenever possible. Beware of "wildflower" mixes; many contain species that are not native to your ecoregion, or even native to North America in some cases.
- For Part 1 of the activity have students write down their definition of "wildflower" before presenting the lesson.
- Continue this lesson as a multiyear project. Classes can add to the garden and do long term monitoring on the project. Gather data and survival rates to assess the long term results. Results can be repeated and from year to year, or work with a different plant species. Students can seed from the garden for future seedling projects or as a fundraiser.
- Species recommendations for your ecoregion can be found in the Appendix: Species List by Ecoregion and local field guides and on the Native Plant Society of New Mexico and on the Native Seed Network webpages. Use this feature on the Native Seed Network to locate your ecoregion and select native species that grow there. Where community data is available, use that naturally co-occur in communities.
- Refer to the glossary to define vocabulary words.

Preparation

- Collect plant species lists from natural areas and field guides for your area. Consult with natural resource agencies, native plant societies, parks and recreation areas, and extension offices for additional help with species lists.
- Assemble a variety of wildflower seed packets or labels for student use in research. Packets can be found at garden centers, plant nurseries, and online. Find mixes that state the species contained.
- Site preparation is covered in "Nurture a Native Garden Project Part 2" to start this process as early as possible, once a site has been identified.



4-142

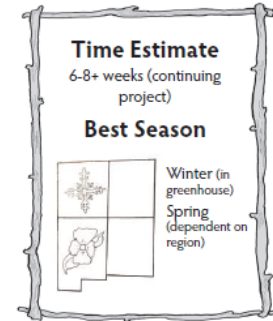


Teacher
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Nurture a Native Garden Project

Part 2: Starting Propagules and Growing Plants

"The creation of a thousand forests is in one acorn." —Ralph Waldo Emerson (1803)



Overview

Part 2 of this native garden project will focus on starting propagules by germination or rooting cuttings, and growing plants for your native garden. In the process students will learn about seed germination or rooting techniques and basic plant care.

Teacher hints

- Review appropriate background information for each section before starting (seed treatments, cutting preparation, planting, plant care, hardening off, and transplanting).
- Set up a student watering schedule for potted plants.
- Extend the science inquiry section by requiring students to write up a scientific report on their experiment. The reports can be saved or summarized for future classes to re-test or build on the experiments and contribute to the ongoing research for this activity.
- Keep potted plants in trays to minimize watering messes.

Preparation

Gather or purchase supplies needed well in advance of starting this project. Potting soil can be harder to locate in the winter months.



Assessments

- 1 Demonstrate knowledge of seeds, seed germination, preparing and planting cuttings, and adaptations as they apply to local species.
- 2 Participate in an experiment, gaining skills in science inquiry steps.
- 3 Follow through on a long term project requiring attention to detail.

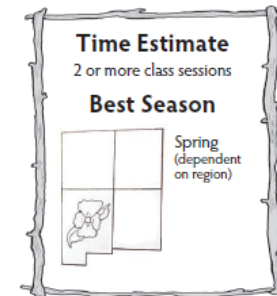


Teacher
Page

Nurture a Native Garden Project

Part 3: Planting and Celebration

"To own a bit of ground, to scratch it with a hoe, to plant seeds and watch their renewal of life - this is the commonest delight of the race, the most satisfactory thing a man can do."
—Charles Dudley Warner (1829-1900)



Overview

Plant out the fruits (or flowers) of your labor in your native plant garden! Students learn transplanting techniques, how to organize and carry out the planting day, and planning a garden celebration. The third stage of this project connects students with community through a service-learning project.

Teacher hints

- Empower your students by offering them specific leadership roles in this stage of the project.
- Facilitate leadership by guiding students into planting day committees, working with students to outline individual duties, and helping them create reasonable timelines. Act as an advisor or mentor to the project. Be sure everyone is included and has a role that feels good.
- Additional community service connections: buddy up with an elementary school class and use the student storyboards to help instruct the young students on transplanting.
- After finishing planting, walk through the planting area and do some quality control to ensure that the transplants were well planted. Check for exposed roots and for plants that are in holes that are too shallow or too deep. Make sure plants are marked so they can be easily watered while they are adjusting to their new environment in the first couple years.
- Emphasize the importance of safety first at your work site including the safe use of tools, equipment and lifting techniques.
- Continue this project from year to year; hold a garden birthday party where everyone adds gifts to the garden through art projects, new plantings, or general maintenance. Extend the project by working with other schools or natural areas to add wildflower areas at their site. Collect and use your own seed. Sell seed or transplants as a fundraiser for the garden.

Preparation

- 1 Plan far in advance for this day. You will need to (or have your students) research to determine the best time to transplant. This may vary by the species you have and the region in which you live. Contact local nurseries, extension services, or watershed councils for advice on this.
- 2 Prepare for pre-planting activity by making a copy of transplanting steps (see copy page at end of lesson). Cut this list into strips, each with one step, and put the strips of paper into an envelope for each team of students. The transplanting steps are listed in the correct order on the copy page. You may wish to refer to this list as a key when helping students.

Can be done in groups or as an individual project. Can be completed for a garden on or off campus!

Adapting to younger grades

- More hands on
- Project based
- Utilizing the school grounds
- Field Journaling



What is a Plant?

"It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change." -*Charles Darwin*

Overview

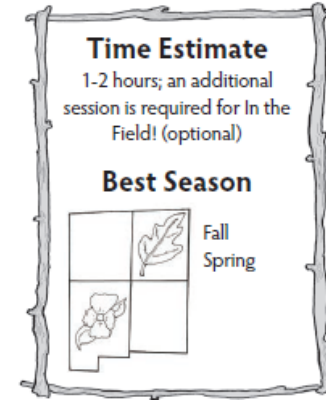
Students explore the diversity among plants and plant-like organisms, such as fungi, algae, and lichens, which may be confused for plants. This lesson will emphasize the structural and reproductive differences between the groups and the relationships between these organisms within an evolutionary context.

Preparation

1. Collect examples of the different groups of organisms represented in this lesson. Try to collect at least three species of each type. If a trip to the forest is not feasible to find mosses, ferns, and mushrooms, some of these examples can be purchased at a local nursery or grocery store.
2. Reproductive structures are easier to observe when magnified, so provide a dissecting scope or hand lens.
3. At each station except for the lichens, include a life cycle diagram. The lichen life cycle is omitted because much remains to be understood about lichen reproduction. See the Resources section or biology text books for sources.

Assessments

- 1 Compare and contrast major differences in structure and reproduction between two of the groups of organisms studied.
- 2 Write a definition of a plant.
- 3 Explain the evolutionary relationships and progression of plants and plant-like organisms.



Teacher hints

- To simplify the life cycle study, emphasize the similarities and differences in the haploid and diploid generations and modes of reproduction.
- Consider splitting students into groups for the background reading. Each group can be in charge of learning about one group of plants or plant-like organisms, and presenting a short summary of the information about that group to the class.
- Definitions for vocabulary words not defined in the text can be found in the glossary.



BREAK FOR QUESTIONS



How



Institute for Applied Ecology

Can Partner

Currently:

- Curriculum Kits for Teachers
- Facebook Support Group
- Forest Bound Summer Program

Looking to the Future:

- In person teacher & student workshops
- Educator / Agency Webinars
- Forest Bound expands to the greater New Mexico

Curriculum Kits for Teachers

- Ecoregion Map
- Flagging Tape
- Clipboard
- Microviewer
- Compass
- Measuring Tape
- Ruler
- Thermometer
- Pruner / Hand Trowel
- Copy of Curriculum
- Flagging Stakes
- Plant Press
- 1m x 1m plot square
- Whiteboard
- Wildflowers of N. & Central Mountains in NM





Facebook Support Group

FROM PONDEROSA
TO PRICKLY PEAR
An Educator's Resource



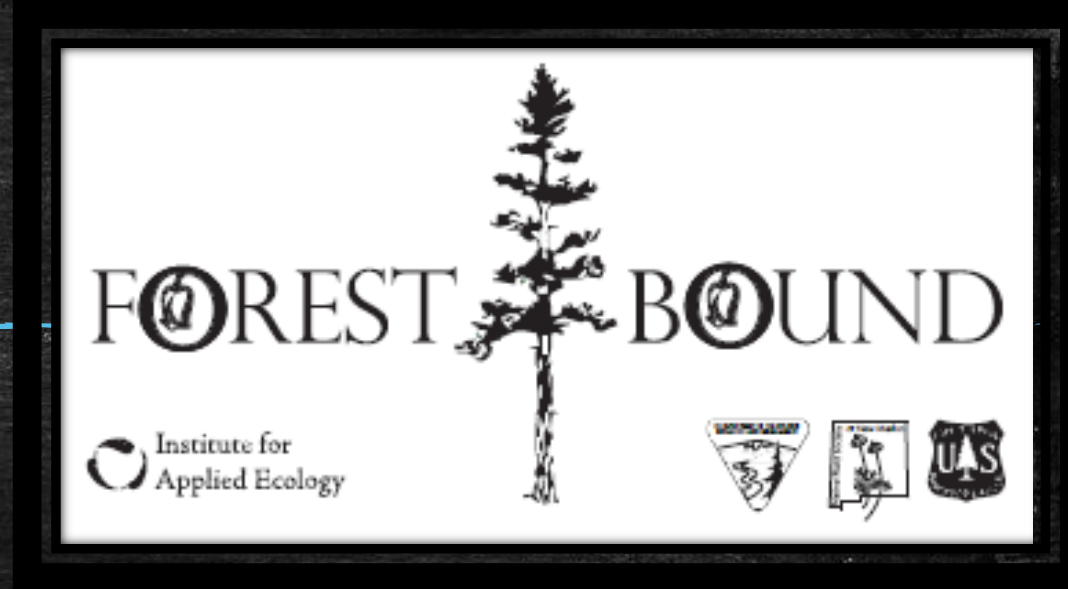
Institute for
Applied Ecology



facebook.com/groups/NMNativePlants.edu

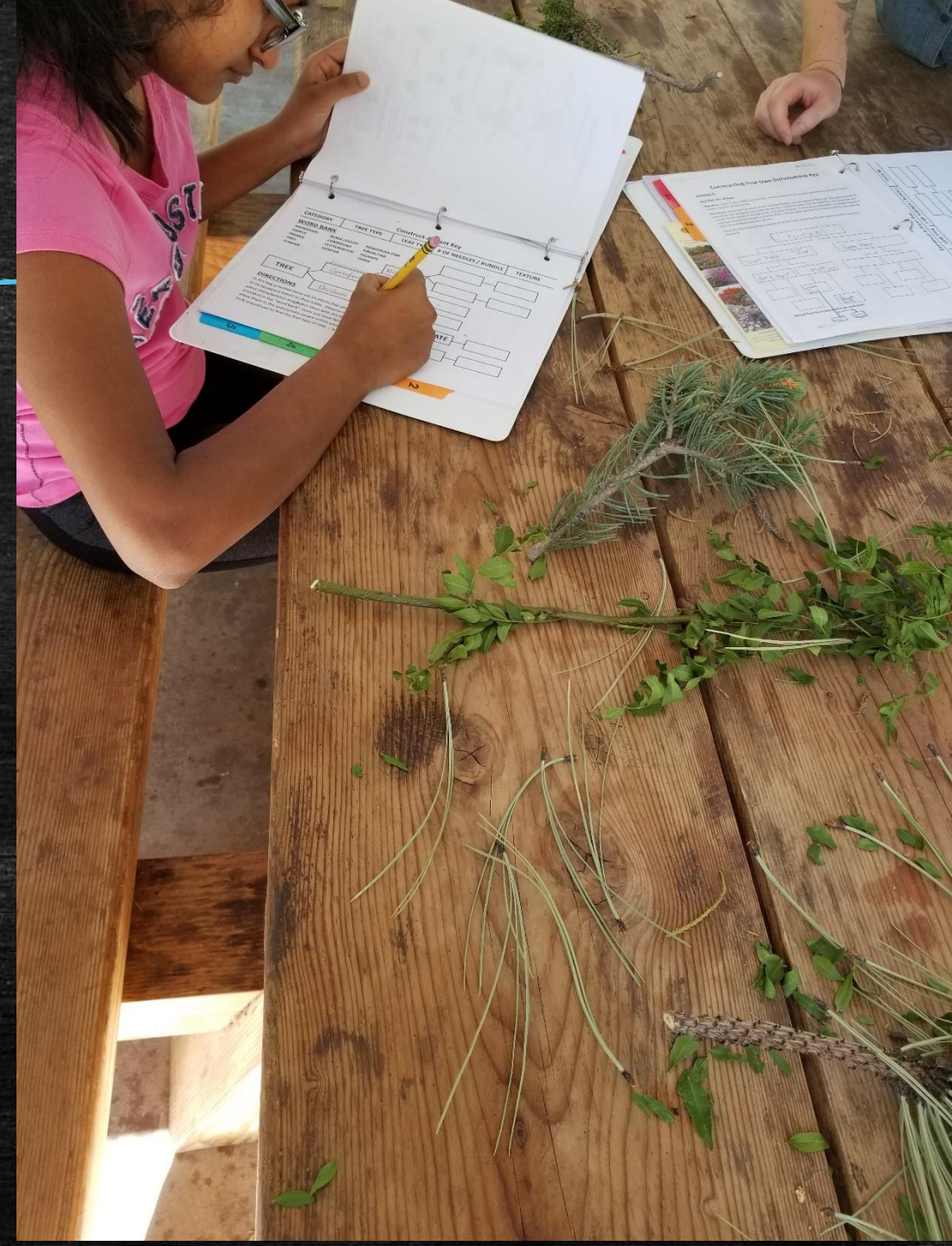
Summer Program

- Links experiential learning w/ classroom objectives
- Learn fundamentals and apply them to the forest
 - Plant biology, botany, identification, etc.
 - Hike w/ plant identification
 - Taking leaves and keying out their characteristics & creating one's own key
 - Understanding soil structure and identifying various types of plants that live in different environments (heath/dry tolerance, wetlands, mountains)
 - Understanding the ecoregion we are standing in at this moment and how it differs or is same the other 7 ecoregions of New Mexico, or on a larger scale the states or the world



Student Workshops

- In class
- After class programming
- Provided by IAE & other supporting organizations



Teacher Support

CURRENT SUPPORT

- Supplemental webinars
- Supplemental Materials

FUTURE SUPPORT

- Mentorship
- Teacher workshops



ADDITIONAL RESOURCES



Plant ID Apps & Online Resources

- [SEINET](#) – Arizona & New Mexico Specific
- [NRCS Plants Interactive ID Keys](#)
- [Colorado Wildflowers High Country Apps](#)
- [New Mexico Wildflowers App](#)
- [Flora ID](#)



Organization Resources

**Environmental Education
Association of New Mexico**

<https://eeanm.org/>

Hands on the Land

<https://handsontheland.org/>

Project Based Learning

<http://www.bie.org/>

**North American Association
for Environmental Education**

<https://naaee.org/>

Native Plant Society

www.npsnm.org

Experiential Education Association

<http://www.aee.org/>

Native Plant Society Meetings

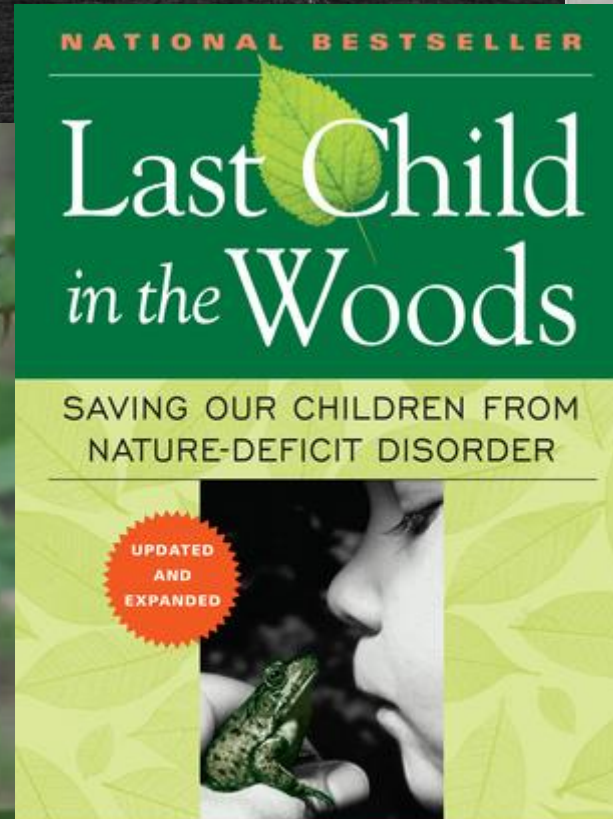
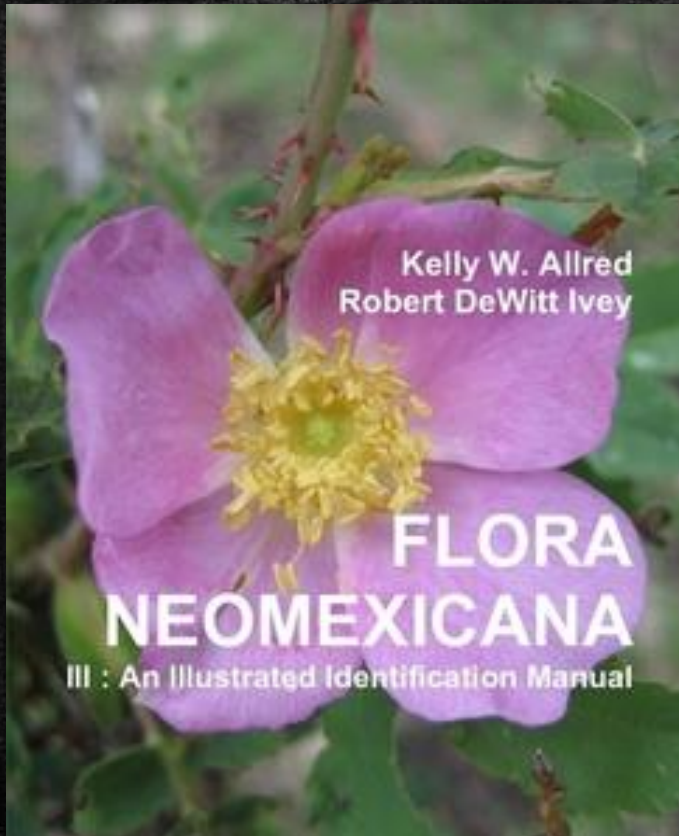
El Paso
Santa Fe
Las Cruces
Taos
Albuquerque
Otero
Gila



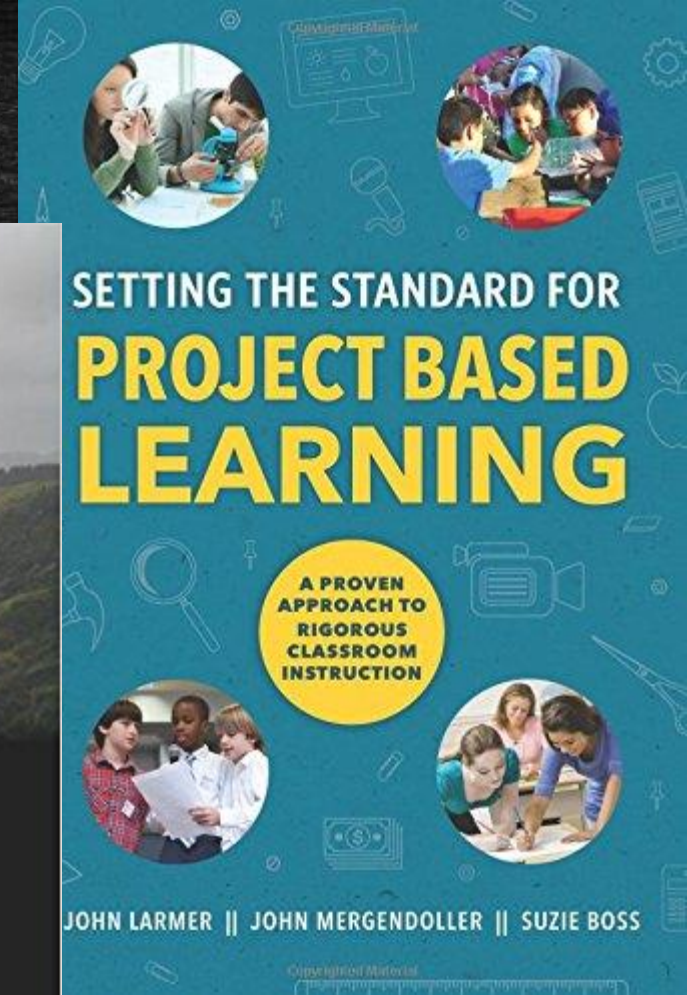
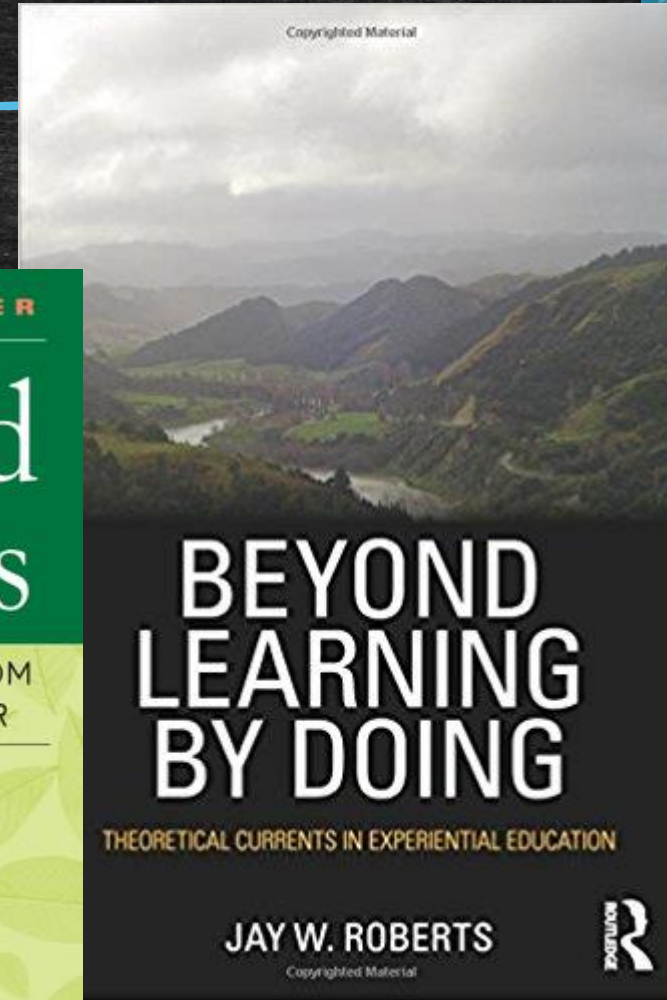
<https://www.npsnm.org/events-calendar/>

www.npsnm.org - resources

Supplemental Books



RICHARD LOUV
RECIPIENT OF THE 2008 AUDUBON MEDAL



Upcoming Events

Education Advisory Council (Friends of Valle de Oro)

November 28th, 4:30 – 6:30 |

New Mexico Museum of Natural History

North American Association for Environmental Education

December 8th, 1-4 | Valle de Oro

Society for Ecological Restoration (SER) Conference

December 6 – 8 Albuquerque NM

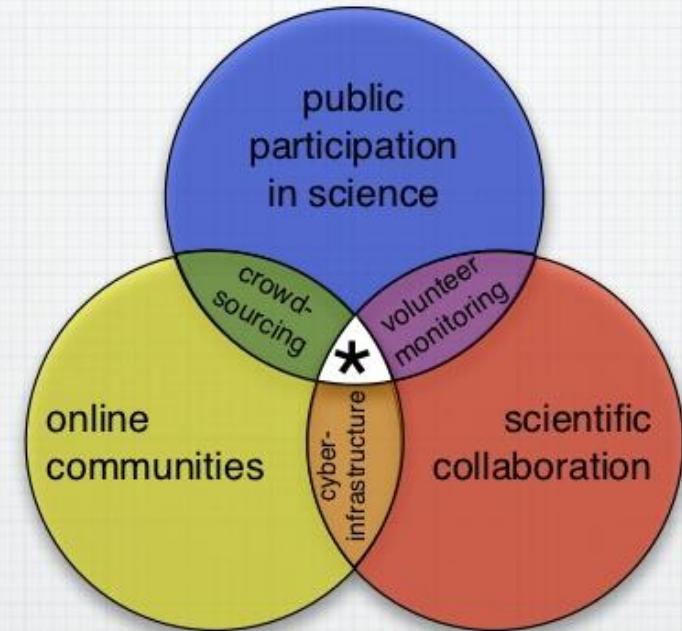
<http://sersw2017.wixsite.com/conference>

Citizen Science Opportunities

<http://citizenscience.org>

- Citizen science grant
<https://www.epa.gov/citizen-science/citizen-science-grants-and-other-funding-opportunities>
- Project Budburst
<http://budburst.org/>
- Monarch Watch
<http://www.monarchwatch.org/>
- Nestwatch (Cornell University)
<https://nestwatch.org/>

What is citizen science?



* = citizen science

Thank you to our funders & partners who made
this project and others possible

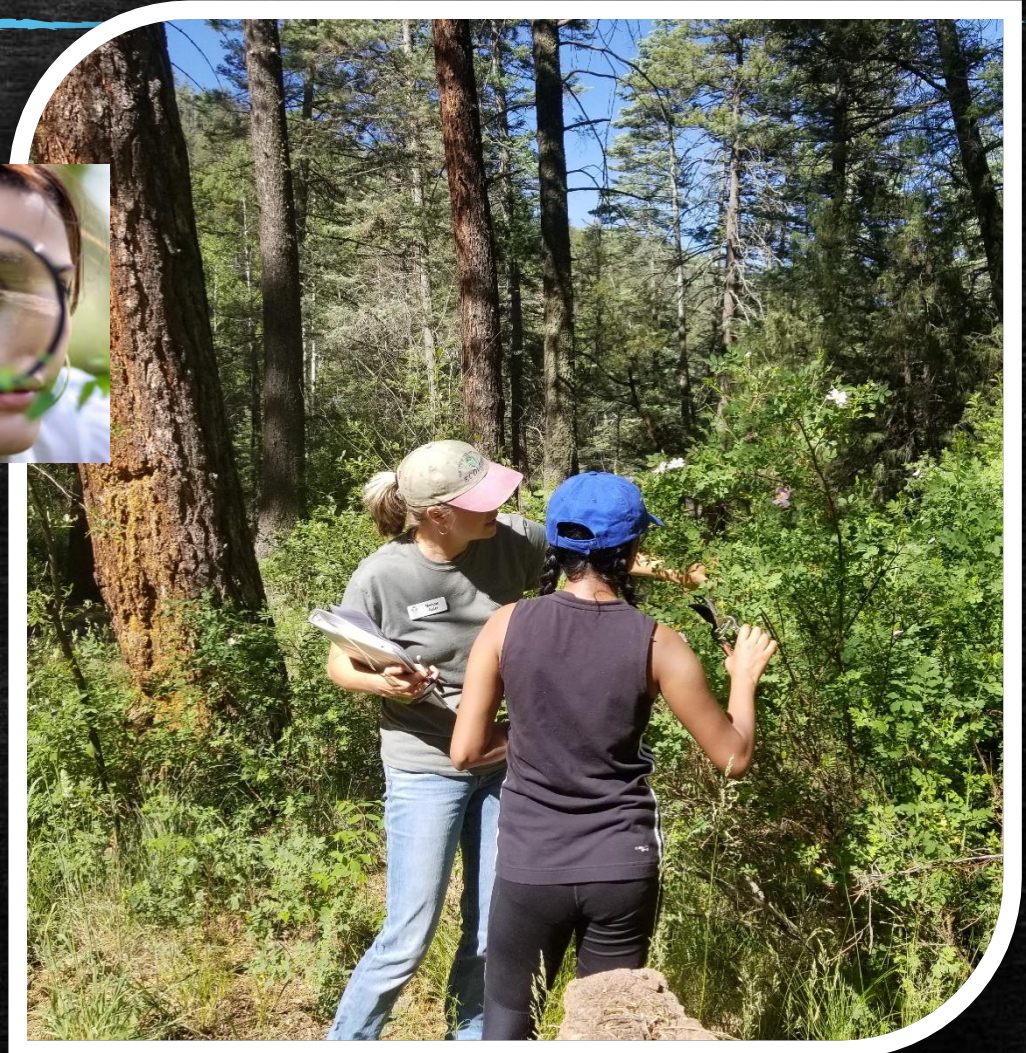
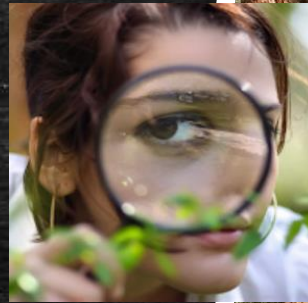


The Best Cures for Plant Blindness

Make a Connection

Establish a relationship

Build upon that relationship



QUESTIONS

