Starting Up an Ecological Monitoring Project

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In keeping with our theme for this fall call I've prepared this synopsis document called An Introduction to Biomonitoring. As a part of the fall call I am presenting you with two biomonitoring projects to consider for your curriculum and students. The first project is Biomonitoring with Birds and the second is called the Ecological Relevé. In each case, I will discuss simple and effective ways you can immediately use to adopt a more organismal based approach to teaching science. The techniques I propose can easily be adopted in many different age groups (4? to 12) and classroom settings. The goal is to adopt a long-term view of ecology education by starting with activities to take you through an entire year. Further, there are near endless opportunities to tie these activities to subjects such as math, art, composition, or after school activities.

Environmental monitoring and assessment have been a part of ecological research for many decades now. Most people have a passing familiarity with Organizations like the US Environmental Protection Agency grew out of concerns over the need for national monitoring and regulation of environmental conditions. State, county and local agencies all have staff dedicated to the collection and analysis of ecological information.

Background and Philosophy

Unfortunately, for those of us teaching in the biological sciences the integration of activities related to ecological assessment rarely make their way into the classroom or lab. Most classes that have a ecology/environmental science component present little more than textbook based summaries and term intensive material that have little intrinsic interest to our students. This is compounded by the fact that in South Dakota we are witnessing an increase in students with a decreased interest and exposure to nature. In short, we are often our own worst enemies in fostering inquiry in ecological sciences.

Most biology/science textbooks are written by faculty who subscribe to the reductionist pedagogical method in spite of the fact that our students think and learn in a constructivist manner. Consider our science curriculum for a moment; we often spend weeks on entirely abstract and confusing topics and terms occasionally throwing in a real world example. A quick glance at almost all biology textbooks reveals that the ecology unit does not represent the centerpiece of the book. Ecology always occupies the end of the book and tends to get covered quickly at the end of the school year (if at all). How often are you taking your students outside? How often do your assignments require the student to work outside?

Developing a series of biomonitoring projects involves your students in their local ecology and creates a meaningful exposure to nature and environmental conditions. It allows your students to learn in an organismal, constructivist manner supporting internalization of the information and a life long interest in the world around them. Biomonitoring helps make "place" relevant to your students, not material simply drawn from a textbook that presents information that is unfamiliar to the place they live. Biomonitoring projects provide a solid framework to move forward into studying other habitats, biomes, ecological issues, and controversies they will encounter outside their community. Lastly, South Dakota is developing Environmental Education standards that will be implemented in the next few years. Developing and personalizing a biomonitoring project can better prepare you and your schools science faculty for future requirements.

Biomonitoring with Birds

Birds represent a charismatic group of organisms that all ages are familiar with. There are nearly 10,000 species of birds making them the most diverse group of tetrapod vertebrates. Genetic research on bird DNA is rewriting our understanding of bird systematics on a weekly basis. Poll your students, how many have a bird bath in their yard, a bird feeder, go bird hunting? Nearly everyone can identify a robin, cardinal or Canada goose. The sounds a flock of geese make as they fly overhead are unmistakable! Birds are a part of our everyday lives here in South Dakota, we see and observe them year-round. Their behavior and activities are easy to document and most are easily understood. One species, the ring necked pheasant *(Phasianus colchicu)* is responsible for much of the budget of the SD Game Fish and Parks Department.

There is an enormous amount of information available on the common birds of South Dakota—Game Fish and Parks publishes several useful guides that are available for free. Field guides for birds are inexpensive, often available at huge discounts in the bargain bins at places like Borders Books. Online there is a wealth of helpful information…start with the Cornell Lab of Ornithology at http://www.birds.cornell.edu/ for everything from bird pictures and songs to range, habitat and physiology. The site even provides links to nest cams for daily monitoring of specific birds.

Globally, there are tens of millions of bird watchers devoted to monitoring their regional bird populations. Each year in the United States two large-scale bird monitoring data collection operations take place. In December the Christmas Bird Count records the overwintering bird population and the Breeding Bird Survey done in June records bird data associated with reproduction. These programs are overseen by the United States Geographical Survey (USGS) and information can be found at: http://www.fws.gov/migratorybirds/statsurv/mntrtbl.html. There are other specialized surveys that monitor endangered birds as well as waterfowl counts.

Getting Started with Bird Biomonitoring

Getting started is as easy as posting a sheet of tagboard on the bulletin board. Either as a class or individually go outside and discuss the types of bird habitat available (prairie, forest, lake shores, rivers etc). Consult a field guide, many are arranged by habitat type based on the birds commonly found in those areas. Have the students begin recording what birds they see and what the birds are doing. Many of us are bird identification challenged….its okay. Consider it an opportunity to make use of the identification keys found in the guide books. Have the students do the leg work for you. Most communities have an extension agent who might be available to help, bird watching groups or members are everywhere. Take a picture of unknown birds and ask for help from bird experts in the SD Game Fish and Parks. As with all biomonitoring projects, you can use this as a one-time activity or establish a long-term data collection process. I recommend that you establish a long-term database for students to contribute to year after year. This creates a quantitative connection to the local ecology and gives students a sense of contribution to the local knowledge base. Find out who the birders are in your community and ask one of them to speak to your class about their experiences in the local area. Ask your local Game Fish and Parks representative to talk with your class about bird migration and banding programs in our state.

Location

Birds can be observed from just about anywhere—that's part of the benefit of starting a project on an organisms so diverse and ecologically adaptable. Keep in mind that where you go to collect data will drive the types of information you obtain. You are less likely to finds hawks in downtown Sioux Falls and waterfowl in a dry prairie. Having established those limitations, make use of the area you have adjacent to your school or in your students neighborhoods. If they have a bird feeder, it's a great opportunity for them to make observations and collect data at home.

Equipment

A pair of binoculars will help, but in many situations all you need is a pad of paper and your eyes. More sophisticated bird watchers use cameras with high powered lenses or powerful spotting scopes. Many students will have binoculars available at home, if a spotting scope is available, set it up in the window of your classroom for students to make observations from there. Used field guides for birds are available online through Amazon.com for as little as $2, most libraries will loan them out for free.

Data To Collect

- Name of person collecting the data
- date and time of day for observations
- location (latitude/longitude of observation points-or location description)
- habitat type
- weather conditions (temperature, precipitation, winds)
- bird species
- life stage (chick, sub-adult, adult)
- gender (not always easy—some birds have no sexual dimorphism)
- activity (migrating, on nest, flying to water, hunting, mating displays)
- vocalizations (see the Cornell site or others for help here)
- pictures of birds in the local habitat

What to do with the data

Have the students collect the data and record it on the tagboard using columns for each bird species. Recording changes over time permits students to understand bird activities as a function of changing seasons or environmental conditions. The idea is to begin to open their eyes to the world around them.

If you intend to start a long-term project you'll need to start entering data in a spreadsheet format. In Microsoft Excel you can create a separate worksheet for each day or each species. Using separate worksheets for permits a greater ability to manage the database. If you are lucky enough to have a cooperative IT person, have them develop a simple MS Access database with a common data entry page using the components I described in the previous paragraph. MS Access provides the best opportunity to manage your database long term by having the flexibility to generate a range of report types for each of the dataset categories. Choose the format you are most comfortable with and stick with it. Changing formats at a later date decreases the utility of the data previously collected. If you have a common use computer, make the students responsible for entering the data they have collected.

Have students summarize the data sets you are collecting. Over time you can have them compare results from year to year. When do they first/last observe the presence of a migratory robin? What trends do they see developing. How do your data compare with regional information (see your local birder or search for migratory details online).

For additional creative curriculum ideas using birds visit the website http://www.aviary.org/curric/teachers/t_hopscotch.htm

Biomonitoring using an Ecological Relevé

In scientific terms, a relevé is a very handy tool for conducting an ecological evaluation/assessment and creating a long-term bio-monitoring tool. In most cases it is the quickest way to obtain detailed, semi-quantitative community information. Technically, a relevé does not necessarily involve sampling other components of the site such as soils and site factors, although these are often collected if environmental gradient analysis is part of the research or evaluation. A relevé is a subjective sampling tool (centralized replicate) that is qualitative in the sense that species cover is estimated instead of measured. A relevé is quantitative in the sense that it gives a complete list of species for the plot and can thus provide information on diversity, species richness, frequency and density. At the most basic level, a relevé represents a simple, permanent plot you and your class can use over time to collect data on. In most cases, you can set up a research plot near your school, some of you may need to move to a nearby field. Where you place your plot is up to you and your intended use.

Ecologists have long recognized the value of vegetation as an indicator of soil type, nutrient availability and climatic conditions. This organismal approach is at least somewhat familiar to your students…..they walk, drive, ride through this environment daily. Ecologically, certain plants are considered indicators of disturbance, ecological health and biodiversity. The Environmental Protection Agency has an entire website devoted to biological monitoring. The link for this site is http://www.epa.gov/emap/index.html.

Setting up your Ecological Relevé

The first consideration is where to set up my relevé. In a heterogeneous community, many relives' must be created to capture all the attributes of the plant community. In your case, site selection will depend upon many factors such as: proximity, access, disturbance, native vs. non-native. Your site should be recognizable as a unit that is common in multiple areas of the broader landscape. You should avoid highly disturbed sites, ecotones, or breaks between community types.

How large a relevé should be is a function of the plant community diversity. The plot should be the smallest possible that is representative of the larger community in order to minimize your sampling effort. The plot should contain all (almost all) of the total plant species in the community. The actual minimum area used for a relevé is usually somewhat larger than the graphical minimum area (when using a species abundance curve). Minimal areas have been established for a wide variety of vegetation types and so there are certain guidelines that can be followed when there is not sufficient time to establish the minimal sample area.

Table 9-1 Minimal areas for various vegetation types. From *Aims and Methods of Vegetation Ecology*. Mueller-Dombois and Ellenberg. Copyright © 1974 John Wiley and Sons, Inc. Reprinted by permission.

Type	Minimal area (m^2)
Tropical rain forest	1000–50,000
Temperate forest:	
Overstory	200–500
Undergrowth	50–200
Dry temperate grassland	50–100
Heath	10–25
Wet meadow	5–10
Moss and lichen communities	0.1–4

Common Minimum Area for Relevé based on Cover Type (above)

Typical Data Sets to be collected by your students

latitude and longitude
elevation
aspect of the slope
percent slope
presence/absence of water
plot size
Species composition/diversity (floristic listing)
climate data (temp, rainfall etc)
solar radiation (light sensors)
Cover class (recommend Braun-Blanquet)
Density
Frequency
plant height
Basal area/volume/physical characteristics of woody plants
Tree height/diameter
biomass

How often to collect the data

How often you collect data is dependent upon how you choose to implement the project. Clearly data like lat/long are collected once; unless you move your plot or have multiple plots. Data on temperature, rainfall, and light conditions can be collected continuously if you have the data loggers or at predetermined times of the day if you do not. for example, a $35 weather station from the hardware store can collect and store daily high and low temperatures.

Biological data like diversity, species richness, physical attributes need to be collected at specific times. For example, diversity information ideally is collected continuously during the growing season—but for teaching purposes anytime is fine. Biomass should be done at the end of the season in the fall.

Cover "The area of ground covered by the vertical projection of the aerial parts of plants of one or more species. " Cover estimates are easily obtained index of plant biomass. Estimates of cover can be obtained by using cover-abundance scores collected during the relevé. Measures of cover can be made using point sampling methods, line transect method, or photos and planimeter or other direct measure of cover. In our demonstration we will use the point sampling method using flags to locate our points.

Cover can be very difficult to accurately estimate. The use of cover-abundance scores greatly reduces the variation in scores from observer to observer. For the relevé method, actual scores are not as important as the presence or absence of species. Cover is a secondary consideration in the Braun-Blanquet method and rarely affects the outcome of a table analysis. However, every attempt should be made to maintain consistency throughout the sampling procedure. Generally a ball-park estimate is good enough (e.g., 20% for species B above. This falls in B-B cover category 3, which is the same as the actual cover (33%) determined by measurement.)

Braun Blanquet Cover Abundance Scale

5 = >75%
4 = 50-75%
3 = 25-50%
2 = 5-25%
1 = numerous but less than 5 % cover or scattered with cover up to 5%
+ = few, with small cover
r = rare, solitary, with small cover

Density The number of plants per unit area. Expressed as number/square meter, stems/acre, etc. Most often used for trees or large plants. An easy concept to grasp, but very difficult to perform in some types of vegetation because of: (1) There is difficulty of defining an individual (e.g. certain growth forms, plants with underground rhizomes, plants in peaty landscapes often have complicated stems just beneath the surface of the moss layer) (2) Quadrat size affects density size because of problem of counting large individuals near the boundary of the quadrat (3) It is very time-consuming in grass dominated systems and low growing vegetation.

Frequency Expressed as a percentage of plots (quadrats) of equal size in which at least one individual of the species occurs in a stand. It is a measure of the degree of uniformity with which individuals of a species are distributed in an area,

and more specifically a stand. Generally frequency quadrats are much smaller than quadrats used to determine species composition in plant communities (relevés). Rule of thumb is that the frequency plot size should be at least twice the size of the largest individual sampled.

I've provided you with a starting point for developing your own ecological relevé project. Be creative and proactive. Consider adopting an organismal approach in teaching a unit on ecology, environment, or earth science. I hope you can use this material and feel free to contact me if you have any questions.

Developing Data Sets—long term projects

Counting, measuring, mapping and other related relevé activities help you develop multiple data sets for student analysis and use. Field data collection techniques are a valuable skill set and help students gain a hard won appreciation for the difficulties involved in scientific study and where all that textbook information is derived from. The easiest way to organize your data sets is to create a separate MS Excel worksheet file for each assignment element. For example, a simple species list can occupy one file for one season. Each year, a separate list should be created. The previous year can be used as a guide if desired. Once the data set is created for a year, write protect that file and back it up. Once it is write protected, students can copy the file to conduct an analysis. You can begin to use this information to have students do simple summary statistics to regression and multivariate statistical analysis for advanced math students.

Related Ecological Relevé Activities

Floristic quality index analysis

The original floristic quality assessment method developed by Floyd Swink and Gerould Wilhelm for the Chicago Region is the basis for this activity. The basis of floristic quality assessment is the concept of species conservatism, the degree to which a species can tolerate disturbance and its fidelity to undegraded conditions. Conservatism is not always equated with rarity. The method uses the aggregate conservatism of all species found on a site as a measure of the site's intactness, an indication of its ecological integrity. Why conduct a floristic quality survey of your relevé?

- Floristic quality assessment offers the ability to assess any plant community, giving us a method that can be immediately employed while comparing biological integrity indexes to other sites in South Dakota.
- Floristic quality assessment provides a standard, unbiased, repeatable method, and
  thus holds promise for monitoring trends over time.
- Compared to biological indexes requiring extensive laboratory processing, floristic quality assessment can be mainly accomplished directly in the field,
  although this depends on observer expertise.

The coefficients for South Dakota plants can be found in the publication:

Northern Great Plains Floristic Quality Assessment Panel. 2001. Floristic quality assessment for plant communities of North Dakota, South Dakota (excluding the Black Hills), and adjacent grasslands. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/plants/fqa/index.html

Abstract:
Floristic quality assessment can be used to identify natural areas, to facilitate comparisons among different sites, to provide long-term monitoring of natural area quality, and to evaluate habitat management and restoration efforts. To facilitate the use of floristic quality assessment in North Dakota, South Dakota (excluding the Black Hills), and adjacent grasslands, a species list and assigned coefficients of conservatism (C values; range = 0 to 10) are assigned to each plant species in the region's flora. The C values we assigned represent our collective knowledge of the patterns of occurrence of each plant species in the Dakotas and our confidence that a particular taxon is natural area dependent. Because state boundaries usually do not follow ecological boundaries, the C values we assigned should be equally valid in nearby areas with the same vegetation types. By applying the coefficients of conservatism supplied here and calculating $\bar{C}$ and FQI, an effective means of evaluating the quality of plant communities can be obtained. Additionally, by repeating plant surveys and calculations of $\bar{C}$ and FQI over time, temporal changes in floristic quality can be identified.

Ecological classification systems

Ecological classification systems (ECS) are a descriptive means by which ecologists categorize geographic areas. An entire scientific field of phytosociology has developed studying plant-plant and plant-ecosystem interactions. In many cases scientists will refer to plant associations—plants typically found together in certain ecological units. In some cases, the descriptions are very course or large scale (like biomes) and in others they describe small scale ($1m^2$) habitats. In most cases, your relevé will occupy a single ECS type (ie temperate short grass prairie). An excellent regional publication is:

Maybury, Kathleen P., editor. 1999. Seeing the Forest *and* the Trees: Ecological Classification for
Conservation. The Nature Conservancy, Arlington, Virginia.

Creating a student herbarium

Part of this handout is devoted to herbarium techniques. This is a wonderful opportunity for students to learn about building a plant reference library (herbarium) with multiple samples of each plant type found in your local ecosystem. Collect samples of each plant for each phase of development/season. Be sure to collect samples of each plant when they are in flower. This can help you teach students about plant identification/taxonomy and makes an excellent winter activity when you can't get outside.

Winter Plant Collection

With our prolonged winter season it is recommended that you expose your students to winter plant morphology and identification. Have your students tag known/identified plants in the fall prior to senescence and then collect them in their winter condition prior to snowfall when the plants may be buried or broken up.

Ethnology, edible plants, cultural links

Of tremendous importance in our native Indian populations. There are many good books available that discuss these subjects, but it is best to seek out a Master Gardener from the county extension office or best of all, a native Indian elder who has knowledge of the plant uses and cultural significance of plants found in your community.

Geography—cartography, GIS

A start would be mapping your relevé for GIS coordinates relative to the school or other landmarks. In a broader context have your students develop a map that shows the ecological classification system for your town, region or the state.

Ecological interactions

A whole host of activities that can include:

1. food webs
2. ecological interactions (competition, parasitism etc)
3. pollination interactions
4. coevolution

Taxonomy and systematics

As an offshoot of your outdoor relevé activity you can expose students to taxonomy and systematics through identifying the plants found growing on your site. Have your students use a field guide or the Plants book provided to initially identify your plants. Follow on with a dichotomous key for a more advanced examination of plant anatomy and taxonomic processes.

Soil nutrient analysis

A simple soil nutrient analysis kit from Carolina Biological or Wards Natural Science is available for less than $20. This simple kit provides enough sampling supplies to easily complete 10 macronutrient analysis.

Water quality analysis

Both Carolina and Wards have kits available for less than $50 for completing some simple water quality analysis like: CO_2 and O_2 content, nitrate concentration, and phosphate concentration. You may have Vernier or Pasco probes to augment this project as well as ion concentrations with conductivity analysis. Turbidity is easily obtainable by using a homemade sechi disk.

Disturbance patterns and impacts

Have students examine areas in the local community with shared ecological attributes that have undergone (continue to undergo) different levels of disturbance. Have them examine the changes in the plant community similar to those conducted in the relevé site. A wonderful way to personalize the topics of disturbance ecology and succession.

Insect collection

A natural (no pun intended) activity that helps students further understand ecological interactions. Build an insect database similar to those for you plants (diversity, species richness, changes over time). There are many great guides available in helping you get started. A quick Google turned up: http://entomology.unl.edu/tmh/ent115/labs/collecting.htm

Time series photography

A visual means to document what occurs on your relevé. Choose photo points and mark then with a post or stake and document changes that occur month to month. Develop (again, no pun intended) a photographic record for all the plants on your relevé.

Creating an organismal or ecological profile

A great assignment to personalize student interactions with their local environment. Have students take digital pictures of all the organisms in your relevé, town, region. Create your own digital library for use in related assignments, for example having the students create their own Organismal Profile of one of the organisms. See:

Krueger, J.A. and Noyd R.K. 2008. Using Profile Projects to Pull Together Concepts. The American Biology Teacher. 70 (1). Available online at www.nabt.org/sites/s1/File/pdf/090-01-0001.pdf

Wildlife watching, bird survey

Encourage students to note wildlife that occupy or interact with your relevé. Develop a log and have students make notations of what wildlife is observed, behavior, timing, or type of ecological interaction.

Small mammal survey

This activity you may need permits for or assistance with. Consult your local Game, Fish and Parks office. Small mammals are often overlooked but have one of the most significant impacts on our plant communities. Surveying provides students a close up look a these fascinating animals and their interactions with your relevé. If repeated, you can begin to document population dynamics which can parallel your plant activities.

Biomass calculations

Select some adjacent sites and conduct a series of simple, inexpensive experiments with fertilizers and impact on biomass production. Each season you can harvest a section of plant matter from your relevé to begin documenting primary production on your site. By doing this year to year you can have students develop an appreciation for the interaction of climate and plant productivity different from the highly visible row crops produced in our state.

Complete an ecological profile

Similar to an organismal profile, have your students profile your relevé or regional ecological system. Base the assignment on the reference given above in the nature photography section.

Prairie restoration (seed with native plants)

While this can be a pricey project depending upon if you purchase seeds, it is highly rewarding and provides a great context for students to examine ecological changes produced by disturbance patterns associated with building. A great alternative is to have students collect native plant seeds in the late summer/early fall as a part of the project. A local extension agent or Master Gardener can help identify native plants in the local community and help you develop a seed collection strategy. Take the seeds and store them or plant them as dictated by the physiological requirements for that seed. A great way to

discuss/teach plant reproduction and seed ecology. Select an adjoining site for a native plants restoration relevé. Plant the native seeds among the existing plants, document the success and failure over time. Students gain an appreciation for just how difficult it is to "restore" a plant community.

Reflective journaling, blogging, writing assignment

Have students journal or blog about their relevé assignments. Have them accomplish a research report relative to the information they are obtaining from their plots. Have your students create a web page that documents their relevé work. Work with your composition faculty on creating interesting or linked assignments. Have them read an environmental or conservation essay by someone like Bjorn Lomborg, Gifford Pinchot, Dian Fossey, Teddy Roosevelt, John Muir, Rachel Carson, or Aldo Leopold and relate it to their relevé work.

Line drawings, art assignment

Drawing is an integral skill for most biologists. Simple black and white line drawings occupy a prominent place in most biology field notebooks. It helps students remember key characteristics of organisms and forces people to consider elements such as attention to detail. In a more creative sense, it allows students freedom to express themselves by creating an artwork related to an ecological activity.

Ecological Relevé Technique Bibliography

Hanson, D.S. and B. Hargrave. 1996. Development of a multilevel Ecological Classification System for the state of Minnesota. Environmental Monitoring and Assessment. 39(1-3) pgs. 75-84.

Leps, J.; and V. Hadincova. 1992. How Reliable Are Our Vegetation Analyses? Journal of Vegetation Science. 3(1) pp. 119-124.

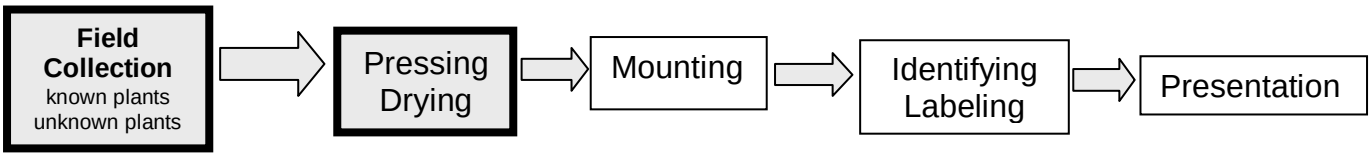
Ralph, J.C.; Geupel, G.R..; Pyle, P.; Martin, T.E.; and D.F. DeSante.1993. Handbook of field methods for monitoring landbirds. USDA Forest Service General Technical Report, PNW-GTR-144. 41 pgs.

Smart, S.M. 2004. Ecological assessment of vegetation from a nature reserve using regional reference data and indicator scores. Biodiversity and Conservation. 9(6): 811-832.

The following are examples of activities and worksheets that can help you apply some of the ecological monitoring activities related to plants.

Plant Collecting Foray:
Field Techniques

foray n. 1. A raid. 2. A first attempt or venture.



Field Collecting Techniques
Equipment List: field notebook, plastic bag, digging tool, clipping tool

Place the first plant into one your plastic collecting bags for pressing

- Use strong white or light-colored (so not to absorb heat) plastic bag. *Place about a tablespoon of water in bag. Keep plants hydrated right up until pressing.*

- Collect *all the plant* when possible including the underground part such as a taproot, bulb, or rhizome. For trees, collect a representative portion of the shoot (stem and leaves)

- Give each kind of plant a number. These numbers run in consecutive order as you collect.

- Keep accurate information about each specimen; do not rely on memory alone.
- In a notebook, record the following information when you collect the plant:

1. plant number
2. collection date
3. habitat
4. location

Pressing & Drying Specimens
Materials: plant press, ventilators, cardboard, blotters, newspaper, plant specimens, and straps

How to Set-up a Plant Press:

Top of Press

cardboard (provides rigidity/stiffness to press)
ventilator (allows air flow through press)
blotter (along with newspaper, slowly absorbs moisture from plant)
newspaper
specimen
newspaper
blotter
ventilator
****
Repeat
ventilator
cardboard

Bottom of Press

Drying Plants in the Press

If necessary, bend the plant to fit it to a standard sheet of herbarium paper, which is about the same size as that of folded newspaper.

To prevent excessive wrinkling/crinkling of the plant specimen, place your press in a hot, dry location such as the back of a car on a sunny day for at least 24-48 hours. Otherwise, allow enough time for plants to dry at room temperature. The newspaper and blotters serve to slowly absorb moisture from the plant.

The plants may be dried in two different ways. Compare the plants and determine which was pressed when collected and which was pressed after it wilted?

What is the function of the cardboard? ventilators?

How long do you leave plants in the press?

Herbarium Techniques

herbarium – a collection of dried and pressed plants

A typical herbarium specimen is attached to or mounted on a sheet of stiff card to display and present the stem, leaves, flowers, fruit, etc. for study. The specimen label is also attached to the mounting sheet.

The biological part of a herbarium specimen typically consists of a dried portion of a plant, typically a piece of a stem with attached leaves, flowers and/or fruit. The sample has been pressed and thoroughly dried and will last for hundreds of years if kept dry and secure from insect attack and physical damage.

The **stem** is securely anchored to the herbarium sheet with glue or cloth adhesive tape. The **leaves** have obvious characters for identification (structure, arrangement) and have useful identifying features (hairs, scales, glands, veins, etc.) on both surfaces; in preparation and mounting care is taken to ensure *that both leaf surfaces are exposed*.

Stem and leaf characters by themselves are usually not enough to allow a plant to be fully identified and additional characters from the flowers and fruit are needed.

Mounting Plants on to Herbarium Sheets

Materials: glue ***(No scotch/transparent tape)***, herbarium paper, labels.
Before mounting, be sure to inventory the plants you've collected. It's a waste of your time (and expensive herbarium paper) to mount more plants than you need (unless you want to have a few extras). For mounting larger plants, place 1 plant per herbarium sheet. For smaller plants, place 2 on a sheet of herbarium paper. Be sure to leave enough room for the label on the **lower right**. Use herbarium paper, do not adhere plants to blotters or cardboard. Use white glue. You do not have to glue every inch of the plant surface. Carefully spread glue at specific points along the stem. Be careful not to use too much glue. Be neat. Apply necessary pressure by putting the specimen back into its newspaper sleeve and place some weight on top.

- Note how large plants are properly mounted with the important parts on the paper.

Directions: Following the instructions above, mount one of the plants you collected on your foray onto a sheet of herbarium paper.

Plant Names --- Taxonomy

Taxonomy or Classification – ordering of organisms into groups, or taxa based on similarities and/or differences.

Nomenclature – the naming of groups of organisms and the rules governing application of these names; the system of naming organisms.

There are a multitude of reasons that plant names may be valuable or hinder communication. Use the yellow book *How to Identify Plants* (p 13). How many different common names are there for any given plant species?

A. Common Names - plant names in general use. There is no system of rules. Examples, bellflower, pineapple, spring beauty

Give 3 *advantages* to using common names in communication.
1.
2.
3.

Give 5 *disadvantages* to using common names.
1.
2.
3.
4.
5.

B. Scientific Names. A plant is given a scientific name when it is first identified and published in a journal. The initials of this person appears as the authority after the scientific name. For example L. is the abbreviation for Linnaeus. This is very different from the rule used in naming and referring to animals. Rules that deal with application of scientific names are published in the *International Code of Botanical Nomenclature.*

Give 5 *advantages* to using scientific names.
1. 4.
2. 5.
3.

Give 3 *disadvantages* to using scientific names.
1.
2.
3.

How to write a plant's scientific name.

The scientific name of a plant consist of two parts:
1. **Generic or genus name** – always written with an uppercase initial letter. ex. *Pinus*
2. **Specific epithet** – always written with a lowercase initial letter. ex. *ponderosa*

Scientific names (as well as genus alone) should always be given in *italics* when printed/word processed or <u>underlined</u> when written by hand. The space between the two parts in never underlined.

Specific epithets are often descriptive of the plant or its habitat. There are many books available to help you learn the meaning of names. The book "The Names of Plants" by D. Gledhill is an excellent guide to epithets:

flavescens - *arvensis* -

Name 3 things that are wrong with the notation to the right. <u>Pinus</u>
<u>Ponderosa</u>
1. 2. 3.

Plant Identification: Keys

Identification – assigning a name to an unknown specimen

Keys are tools used to identify plants. They consist of a series of choices between two contradictory statements called a couplet. Note that in the example of a *bracketed* key, couplets are found together and the choice leads you to a number, whereas in the *indented* key, couplets are separated and your choice leads you further indented to the name. In each case, you will need to observe the unknown specimen and use your understanding of botanical terms to arrive at the correct identification.

Directions: Use the key and clues provided at this station to identify the following specimens.
What kind of key are you using? Indented or bracketed?

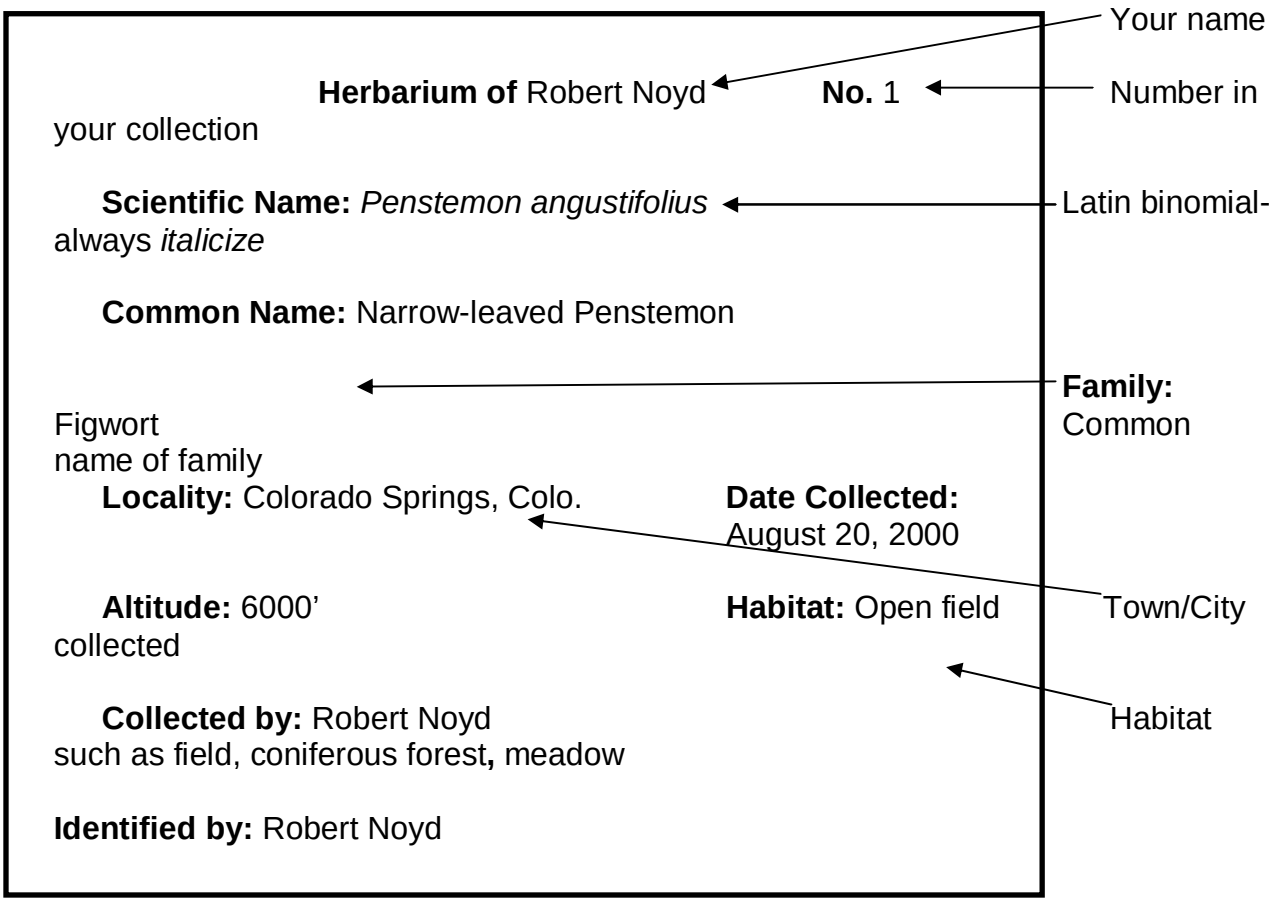
Specimen 1. _____

Specimen 2. _____

****

The Herbarium Label & Storage of Your Collection
A proper label is an important part of your herbarium specimen. A template for labels has been placed on the K drive. *Labels must be typed and always are glued in the lower right-hand corner*. Once the label is properly adhered to the herbarium sheet, you have completed the process for this specimen.

An Annotated Herbarium Label (3" x 5")



Classification

When you completed your seed profile you delved back in to the taxonomic world. Select a plant from the local ecology. This becomes your plant for the remainder of the semester. You will be responsible for researching the biology, ecology, systematics and uses for your plant.

This is the one plant I expect you to know the scientific name for.

1. Write the scientific name for your plant.

2. What family is it in? What reference did you use to look this information up?

3. Scientific names have meanings, what does the specific epithet for your plant mean?

4. In the world of Botany, the person who first scientifically described the plant gets to add his/her name to the official scientific name. Whose name is associated with your plant?

****

Literature of Taxonomic Botany

For each of the following types of botanical literature, check its contents for the following:
A technical description uses specialized terms such as *glabrous*, whereas the non-technical term is *waxy*. A glossary of terms may be in the front or the back of a book.

Type of Literature	photo/drawings	technical description	keys	glossary	taxonomy	range of plants
Manual/Flora					**X**	**state/region**
List						
Field Guide				**X**		
Monograph						
Keys						
Journal	X					

1. Which type of literature generally covers a group of plants (wildflowers, grasses, trees, ferns)?

2. Which type of literature serves the amateur botanist or the weekend hiker?

3. Is the booklet titled “Field Guide to United States Air Force Academy Flora” appropriately named?

4. From the list in your table, classify the book “Vegetation of the US Air Force Academy.”

5. Which type(s) of literature would you consult to find the following information?
A. The original description of a plant species.

B. When a tree species flowers.

C. A photograph or drawing of a plant’s flower structure.

D. Find the technical description (measurements, types of fruit, habitat) of a plant.

E. Highly specialized information such as surface features, chromosome numbers, or elevation.

F. What family a particular plant belongs.

6. **Review Exercise**. Name the type of botanical literature described by each of the following:

_____1. a book for the field identification of a particular group of plants (ferns, grasses, peat mosses, wildflowers, trees). Includes non-technical descriptions of plants based on features you can readily recognize (leaf shape, flowering time, flower structure) along with drawings or photographs.

_____ 2. a comprehensive treatise representing an analysis and synthesis of existing knowledge of a taxon, (usually family or genus)

_____3. a publication by which new plant species are introduced or the classification of a named species is revised.

_____4. a work devoted to the plants of a particular region, and is also restricted to a major segment of the plant kingdom (vascular plants, flowering plants, etc.) Plants are arranged according to one of the taxonomic systems, giving for each plant the technical description and geographic distribution.

_____ 5. a tool to identify an unknown plant based on its characteristics. Reader chooses between a pair of contradictory statements (couplets). May or may not have drawings.

_____ 6. a book of photographs and micrographs and drawings of plants and their structures. (Hint: you purchased one for this course).

Review: Be sure you can describe/define/distinguish between/give examples of the following terms introduced during Labs 1 and 2:

- herbarium
- foray
- nomenclature
- International Code of Botanical Nomenclature
- identification
- taxonomy/classification
- taxa
- manual/flora
- key – be sure you know how to use
- journal
- field guide
- monograph
- genus- be sure you know how to properly write it
- ventilator
- cardboard
- plant press
- specific epithet
- family
- phylum
- scientific name – be sure you know how to properly write it

Environmental Education Resources

North American Association for Environmental Education
Excellence in Environmental Education:
Guidelines for Learning (preK-12)

www.eelink.net

While environmental education (EE) has its roots in nature study, conservation education, and outdoor education, it is distinctly different from these earlier movements. Whereas these areas focus on nature, wise use of natural resources, and the use of the outdoors to teach, EE is fundamentally concerned with the interconnection between humans and the environments that surround them (Disinger & Monroe, 1994). In 1969 Dr. William Stapp at the University of Michigan published the first definition of EE:
Environmental education is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution (Stapp, W.B, et al. 1969. The Concept of Environmental Education. *The Journal of Environmental Education*. 1(1):30-31.).

The Stapp definition has evolved with the research findings of environmental education scholars and their understanding of environmental literacy, behavior and the complexity of environmental issues. For the most part this definitional evolution has been a refinement and clarification of the original, while the overall objectives of EE - awareness, knowledge, attitudes, participation and skills and ultimately the creation of an environmentally literate citizenry, laid out in the Tbilisi Declaration of 1977 - have remained central to the mission of environmental education (see the "Foundations of EE" page for a more detailed examination of this evolution).

The field of EE maintains a solid foundation based on the definitions and guiding principles mentioned above. Nonetheless, the field has been influenced over the past 30 years by various forces, including the education reform movement, the emergence of sustainable development, as well as changing national demographics. As with any effective educational program or field, EE is undergoing continuous improvement. Some issues, such as scientific and educational content, action and citizenship participation, and the inclusion of economic and culturally diverse perspectives in EE have emerged in both positive and negative contexts. The field has responded in various ways such as by forming innovative partnerships, developing new programs, and publishing national guidelines for materials, learners, and educators. This section of EE-Link begins to explore some of these issues.

BioScience Education Network BEN

http://www.biosciednet.com/portal/

Welcome to the BEN portal, the National Science Digital Library (NSDL) Pathway for biological sciences education. The BEN Portal provides access to education resources from BEN Collaborators and is managed by the American Association for the Advancement of Science (AAAS). Over 6,630 reviewed resources covering 77 biological sciences topics are available. BEN resources can help you engage student interest, shorten lesson preparation time, provide concept updates, and develop curricula that are in line with national standards for content, use of animals and humans, and student safety.

Registration is required in exchange for access to the wealth of information freely available through the BEN Portal. Our **privacy policy** provides detailed explanation on what information is collected, protected, and used. **Register** to join our community of 9,150 biological science educators.

Ecological Society of America—EcoEd.net--Ecology Education Network
http://www.ecoed.net

The Ecological Society of America (ESA) is pleased to announce the beta launch of the Ecology Education Network (ecoed.net). The goal of this library is to provide educators a forum to contribute and locate peer reviewed, scientifically and pedagogically sound ecology education content. EcoEdNet will strive to foster a community of ecology education users and contributors.

Ecoed.net is a partner in the Bioscience Education Network (BEN) a collaborative of more than 10 professional societies and coalitions of biology education partners, funded by the National Science Foundation and coordina ted by the American Association for the Advancement of Science (AAAS). Its purpose is to coordinate the ongoing development of digital library collections for the teaching and learning of undergraduate biology, with users at the center of the development.

The Ecological Society of America

The Ecological Society of America (ESA) is North America's leading professional society of ecologists, representing over 7,800 ecological researchers in the United States, Canada, Mexico, and more than 70 other nations. Founded in 1915, ESA seeks to promote the responsible application of ecological principles to the solution of environmental problems through scientific reports, journals, research, and expert testimony to Congress. The Society convenes a conference every summer featuring the latest finding in ecological research which attracts 3,000 scientists and students, as well as members of the media.

ESA members hail from academia, government agencies, industry, and nonprofit organizations and work to provide the ecological knowledge needed to contribute to environmental problem solving in: ecosystem management; global change; habitat alteration; biotechnology; loss of biological diversity; and ecological restoration. Many of ESA's members are also leaders in ecological education. Through its Professional Certification Program, the Society provides a national set of standards for the field of ecology.

Project WILD/Project Wet

http://www.projectwild.org/

Project WILD is one of the most widely-used conservation and environmental education programs among educators of students in kindergarten through high school. It is based on the premise that young people and educators have a vital interest in learning about our natural world. A national network of **State Wildlife Agency Sponsors** ensures that Project WILD is available nationwide --training educators in the many facets of the program. Emphasizing wildlife because of its intrinsic value, Project WILD addresses the need for human beings to develop as responsible citizens

In South Dakota you can contact Mr Chad Tussing; SD Dept of Game Fish and Parks

Chad.Tussing@STATE.SD.US

Project Learning Tree of South Dakota

www.SDPLT.org

Mission

PLT uses the forest as a "window" on the world to increase students' understanding of our environment; stimulate students' critical and creative thinking; develop students' ability to make informed decisions on environmental issues; and instill in students the commitment to take responsible action on behalf of the environment.

Goals

- To develop students' awareness, appreciation, skills, and commitment to address environmental issues.
- To provide a framework for students to apply scientific processes and higher order thinking skills to resolve environmental problems.
- To help students acquire an appreciation and tolerance of diverse viewpoints on environmental issues and develop attitudes and actions based on analysis and evaluation of the available information.
- To encourage creativity, originality, and flexibility to resolve environmental problems and issues.
- To inspire and empower students to become responsible, productive, and participatory members of society.

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