Aliens In Your Neighborhood

A Teacher's Guide to the National Park Service

Invasive Weed Curriculum

2003

by

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Table of Contents

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It goes without saying that a great number of people have generously provided their expertise and shared their resources in order for this curriculum to become a reality:

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- Ellen Petrick-Underwood, John VanGundy and Don Wolf have been a click away via email for nearly two years as they thoughtfully and critically assisted with editing grammar and content.

There are countless others who have provided feedback and shared resources during the development of this curriculum. Where possible I have tried to remain faithful to the documents and web resources that in many ways provided the backbone of my research. Citations and web

sites for these resources are found throughout Aliens and should I have neglected to include a proper citation I hope that I would be contacted to rectify any oversights.

And finally, a smile to my former students at Sunriver Preparatory School, who indulged me with a typical middle school roll of the eyes when I told them we were going to study weeds, then went on to develop their own creative research projects and fanciful make-believe aliens. It was the students who taught me how to integrate invasive weed studies into the regular science curriculum.

Alien, but biologically correct!

Information Section for Teachers

Introduction
Getting Started
Invasive Weeds as the Integrating Context
Building Partners
Citizen Scientists

Introduction

Alien plant species affect us all. Whether you live in an urban area or rural farm lands, whether you live near one of our National Parks, alien plant species (also referred to as exotics, non-native, weeds, introduced, and non-indigenous) affect the biodiversity of all our lands. Alien plants can damage or replace native animal and plant populations, as well as the health of our ecosystems by replacing land and water quality. Each year alien plants cause billions of dollars in damage to public and private lands and the ecosystems upon which we all depend. A National Park Service (NPS) Fact Sheet stated that 196 of 368 National Parks have serious problems posed by invasive plant species. The costs of managing weeds were estimated at $80 million during 1996 — 2000.

You might wonder how a curriculum on weeds can become a part of your school's curriculum. *Aliens In Your Neighborhood* is not a curriculum about weeds, but instead provides a model for integrating a theme within a school's curriculum at the middle school level, as well as expanding it to multiple grade levels and subjects (math, language arts, social studies, art, etc.). The National Park Service, in cooperation with a wide variety of local, state, and other federal agencies, is working to control invasive species through cooperative partnerships with communities and unifying management plans. Invasive species know no boundaries; the aliens are in your neighborhood, and your students can help!

The National Park Service has developed a series of strategies and associated benchmarks to direct efforts toward managing invasive plant species. Invasive exotic weeds infest 7 million acres of our national parks, or the equivalent of 31% of park land outside of Alaska. To control these alien invaders, the NPS has identified over 450 Integrated Weed Management projects to control these exotics. The *Strategic Plan for Managing Invasive Nonnative Plants on National*

Park System Lands lists several areas where students can be directly involved (*Preserving Our Natural Heritage*, 1996):

Students can help by:

- Preventing Invasion
- Increasing Public Awareness
- Assisting with Inventory & Monitoring
- Conducting Research
- Managing Invasive Plants

The *Aliens In Your Neighborhood* curriculum addresses all these key national strategies, enabling your students to become working partners with their National Parks System as Citizen Scientists.

Throughout this curriculum guide, links are provided to give you and your students additional background information and resources for in-depth studies. The textbook edition includes websites within each section, as well as a full Resources section in the back of the book. The online edition includes embedded links to pages within the curriculum guide and to relevant sites on the Internet.

Meeting the National Science Education Standards

Recent movements in teaching science calls for teaching practices that closely follow the manner in which science is practiced. The *Aliens* curriculum follows the guidelines of environmental inquiry, where students develop research projects with design focused on topics relevant to their local community and provides students with an understanding of scientific content and process while participating with local scientists and resource specialists. According to the *National Science Education Standards* (National Resource Council [NRC], 1996), the central strategy for teaching science should be to engage students in authentic inquiry or research:

> "Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with the processes of inquiry, including asking questions, planning and conducting an investigation, using appropriate tools and techniques, thinking critically and logically about the relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments."
>
> (NRC, 1996, p. 105)

Each lesson in the *Aliens* curriculum includes the appropriate, grade-level national standards addressed within the lesson. For your convenience, a checklist of content standards is organized by grade level in **Appendix A**, along with the web address for accessing the National Science Education Standards.

Getting Started

Online and Textbook Editions

The online edition of *Aliens In Your Neighborhood* is available under the Quicklinks option on the homepage of the National Parks nearest you. All information available in the textbook edition can be accessed online (online lesson plans and other information may be available as downloadable .pdf files requiring Acrobat™ Reader® 5.0). Links are provided to resources within the NPS database and Internet sites outside the NPS pages.

The textbook edition of *Aliens In Your Neighborhood* is designed primarily for use in conjunction with field studies and projects you might design for your nearby National Park. The curriculum is equally adapted to studies in the schoolyard, your community, or any other resource base to which you may have access. Lessons within both the online and upcoming textbook are designed for the classroom (concept development, planning, and prediction) and for fieldwork at the park (investigations and contributions). The range of lessons, however, is also designed to work within the framework of your school's science curriculum, with activities conducted on school grounds or nearby areas within the community.

Invasive Weeds as the Integrating Context

Whether you use the textbook or online edition, it is important for you, the teacher, to understand the thread of inquiry learning that runs throughout. For those not familiar with the nuance of inquiry, process science, and content, an inquiry mind map is provided (Fig.1). The four stages of inquiry used with *Aliens In Your Neighborhood* include:

- Concept development
- Planning & Prediction
- Investigation
- Summary - Contributions as Citizen Scientists

Concept development is considered the standardized science curriculum in your school that provides students with the basic earth and life sciences needed as background information when conducting research and field investigations. *Aliens In Your Neighborhood* is not intended to replace your curriculum or cause unnecessary modification to an existing curriculum. It is designed to serve as an integrating theme that takes advantage of the curriculum you've already developed. ***Concept development provides your students with the foundation knowledge needed prior to application of that knowledge in the field investigations at your National Park site***.

The Planning and prediction stage of inquiry learning allows the students to develop their own questions and follow their own interests as revealed during concept development. The students determine the area of interest, skills needed, and a plan of action. >With a written plan, information provided by the NPS websites, CD-ROM, or resource manager, and sharing of that information in context with their fellow scientists (classmates!) they predict the possible results of their investigation ***Planning and prediction provide your students with the roadmap needed to discover the answers to questions that are relevant and meaningful to them***.

The investigation stage is the scientific journey your students take at their National Park. It is where they use a range of process skills (Fig. 1) to gather data that can support or refute their predictions. ***Investigation provides your students with real-time field explorations and direct application of prior concepts and skills they have learned in the classroom***.

Contributions as "Citizen Scientists" are the most important and often the most rewarding aspects of inquiry learning. At this stage the tiring and ageless question, "Why do I have to learn this?" becomes clear when the students discover that the questions they posed, their investigation, and their findings can provide valuable data to the resource specialist and managers of our National Parks. Species type, population levels, GIS mapping, and answers to authentic questions meet three of the five strategies established by the NPS (Public Awareness, Inventory & Monitoring, and Conducting Research). ***Contributions as citizen scientists provide your students with an opportunity to make their education contextual and locally relevant, i.e., kids can make a difference!***

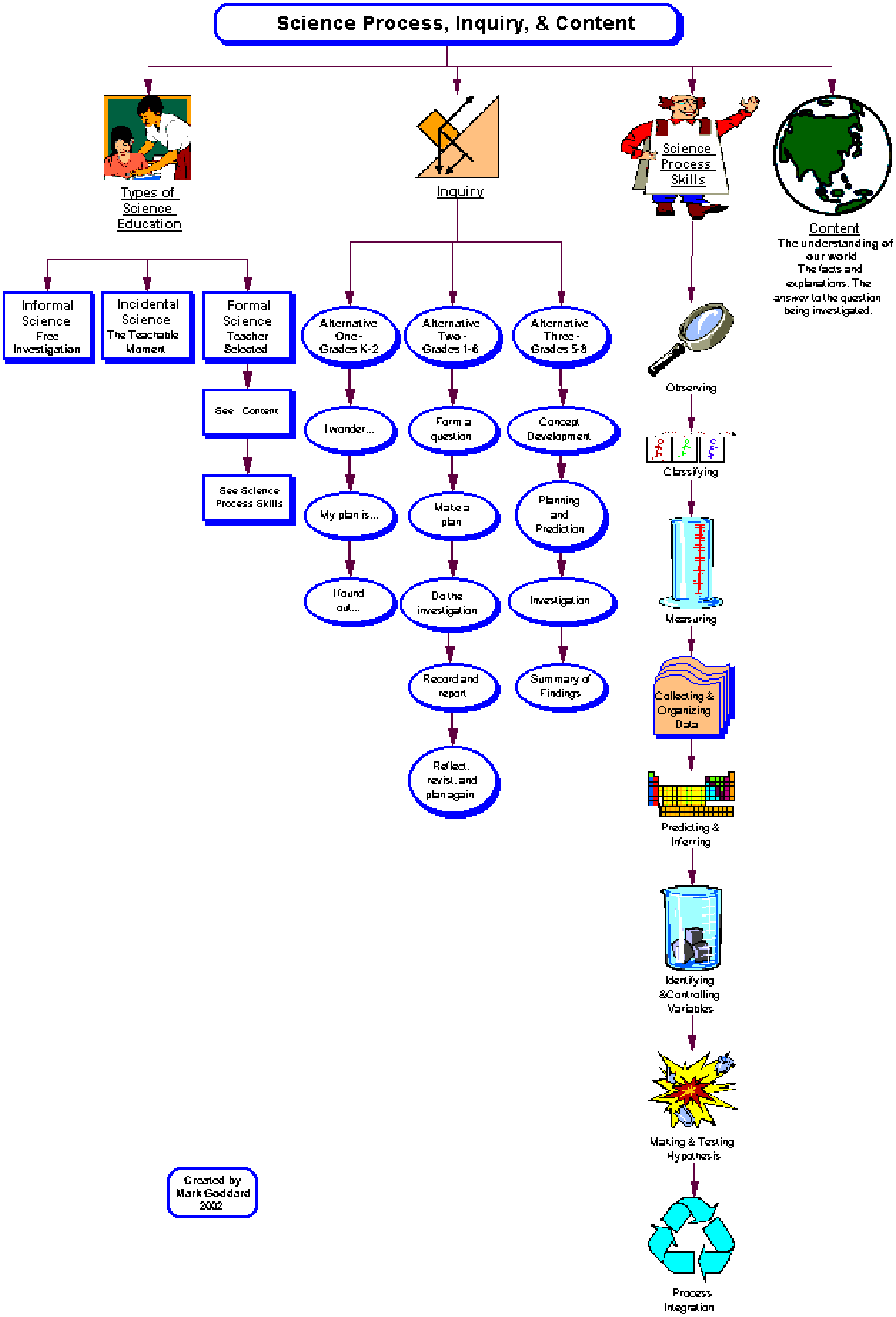

Science Process, Inquiry, & Content
Types of Science Education
Informal Science Free Investigation
Incidental Science The Teachable Moment
Formal Science Teacher Selected
See Content
See Science Process Skills
Inquiry
Alternative One - Grades K-2
Alternative Two - Grades 1-6
Alternative Three - Grades 5-8
I wonder...
My plan is...
I found out...
Form a question
Make a plan
Do the investigation
Record and report
Reflect, revisit, and plan again
Concept Development
Planning and Prediction
Investigation
Summary of Findings
Science Process Skills
Observing
Classifying
Measuring
Collecting & Organizing Data
Predicting & Inferring
Identifying &Controlling Variables
Making & Testing Hypothesis
Process Integration
Content
The understanding of our world
The facts and explanations. The answer to the question being investigated.
Created by Mark Goddard 2002

Fig. 1

Building Partners with Your National Parks: Establishing A Network of Community Resources and Professionals

The Curriculum Overview speaks to methods of inquiry whereby students can contribute scientific data as Citizen Scientists. For students to truly benefit from their experience there must be a way to see how the data is used, and ultimately, for the students themselves to be involved with the social change that may arise from use of that data. The approach to solving invasive weed problems has often utilized students and communities in the role of social service rather than in the larger role of social change. Getting kids out to pull noxious weeds is an example of social service; it may temper an alien invasion during one season in one locale, but it does not address the larger issues of how humans may have initially altered the ecosystem to cause the invasion or how we, as a community, will perceive our relationship with the land in concert with a diverse and healthy ecosystem. Addressing the latter relationship involves social change. Involving students in social change begins with building healthy partnerships.

The National Park Service believes that its employees are not only technical stewards of the land, but are also leaders in our communities. A Discovery 2000 session report, *Leadership Beyond Park Boundaries*, speaks directly to the role that Park personnel might have in assisting teachers to help students understand how student contributions (data, public awareness, etc.) can affect social change. The key focus of the NPS report is building connections with communities outside of the Park boundaries.

Building partnerships, however, is not a one-sided endeavor, it is the coming together of many groups and individuals who share common goals. Teachers who use the *Aliens* curriculum can involve themselves and their students with partnerships that address the common goals of a healthy ecosystem in their own community. Given the burden of the normal classroom, building partnerships may sound like a daunting addition to a teacher's life, but it need not be, because in the course of studying the science of invasive weeds in the *Aliens* curriculum, the students will naturally be involved with local, state and federal resource people who can also become members of this partnership.

Using the guidelines below, teachers should be able to draw out the partnerships within their own community when students investigate invasive weeds through the collected lessons of *Aliens*. Your local NPS resource or education specialist may also be available to help your students with the process of building partnerships. In some cases this process begins at the start of the school year, and then the *Alien* lessons would be geared towards understanding the particular invasive weed problems and addressing the goals of the partnership.

Work Together - Consult with your NPS resource specialist to identify invasive weed problems that may serve as the focal point for using the *Aliens* curriculum. Wherever possible, you may also involve other local groups (conservation groups, Native Plant Societies, environmental centers), agencies such as the Bureau of Land Management, U.S. Forest Service, Fish & Wildlife or county offices such as local weed boards or extension services. Emphasize that you wish to have your students conduct investigations as part of their regular science curriculum and contribute valid data and information about the invasive weed problem(s).

Assess Needs - Develop a checklist of questions about what the children might do to contribute as Citizen Scientists. The Aliens curriculum provides an outline of lesson plans that can serve as a guide to areas the students will be investigating and what needs might be addressed by their studies.

Survey Resources - Poll the contact people from the organizations above to find out what other resources might be available in the community. Some of the resources might include experts who can come to the school and give presentations, groups that have access to GPS and other field data collection equipment, community college or university resources, or supplies for the *Aliens* lessons.

Share Information - Find out about available activities and events that the students might participate in such as Weed Awareness Week, local festivals where the students might put up a public awareness display, or speaking opportunities for the students. Let the community know that your students are researching a problem that affects the entire community!

Set Goals - Set clear goals about what the individual partners will do, what the students will be contributing, and what might be the long-term goal or benefit of a weed education program might be.

Decide on Measures of Success - Based on your goals, how do you know you were successful? More importantly, how will the students know that their investigations provided useful information to resource managers and scientists, and how will that information be used to affect the problems caused by invasive weed species? One of the key goals of this curriculum is that the student's education be meaningful within their own community... how will students know that the community values their contributions?

Ellen Petrick-Underwood provides some specific suggestions on how to make sure students know their work is being used and that their efforts are valued by the community:

- Actively solicit project follow-up from your professional partners. The students might do this themselves, along with a thank-you note for the partner's assistance.
- Ask if it might be possible for students to attend meetings or presentations at which their work is shared. It might even be desirable for students to present a portion of such a presentation.
- Invite members of the local media to come see what you are doing.

- If the project involves a national park, be sure and notify the public affairs office of media involvement in advance.

Sources of additional information:

The Montana Heritage Project (MHP) [http://www.edheritage.org/] is dedicated to teaching young people to think clearly and deeply about the world they face. Students are asked to explore their community... the following two resources from MHP provide teachers with ways to involve students and ask important questions:

ALERT: Learning as Narrative Process [http://www.edheritage.org/tools/alert.htm]

Everything Else Follows [http://www.edheritage.org/teachlore/5_steps.html]: 5 Steps from Community-Centered Schools to Education-Centered Communities by Michael L. Umphrey

Connect For Kids [http://www.connectforkids.org/] - a website of building communities for kids and families. Two case studies that illustrate the important role students can provide are:

The Sierra Holds a "Regional Vision" for Children by Melia Franklin [http://www.connectforkids.org/resources3139/resources_show.htm?attrib_id=374&doc_id=115152]

Working to Rescue a Neglected River [http://www.connectforkids.org/resources3139/resources_show.htm?attrib_id=259&doc_id=143568&parent=82322] by **What Kids Can Do** [http://www.whatkidscando.com/home.asp]

Citizen Scientists

Contributing Data and Affecting Change - The nationwide database

One of the key pedagogical goals of *Aliens In Your Neighborhood* is to provide students with the opportunities to make contributions to their community, their National Parks, and to science. When learning is contextual, i.e., when learning takes place within the realm of issues which affect the students themselves, then learning takes on meaning that is relevant to their lives. It was stated in the introduction that *Aliens In Your Neighborhood* would provide a model for integrating a theme within a school's curriculum at multiple grade levels and subjects. That "theme" is invasive weed species, but the curriculum is still about life science, in particular, botany and ecology. By integrating the theme of invasive species students are not only involved with the curriculum currently established and aligned with state and national standards but have the opportunity to learn to those subjects in their own community with real life issues.

Studies have shown that when students' learning is contextual and relevant the level of interest is increased because the subjects being taught have real meaning, and answer that dreaded question, "Why do I have to learn this?" With students who are engaged in their own meaningful learning, negative classroom management issues are minimized, parental and community involvement is easier to solicit and academic performance is enhanced (i.e., grades go up).

After reviewing the selection of *Alien* lessons and activities intended to be integrated with you regular curriculum, you will find various suggestions on how to have your students become citizen scientists - contributing their new found knowledge to the scientific community and their own. These contributions may range from establishing education awareness programs in their own school or on a community wide basis to the ultimate expression of being a citizen scientist by contributing solid scientific data to resource and land managers or scientific mapping projects and even working hand in hand with field managers in the control of invasive weed species.

One of the most popular methods for students to contribute real data is through programs like NatureMapping, where students upload specific field site data so that scientists can use the data in the study of ecosystems or specific species. NatureMapping is evolving to be a state by state database. The *Aliens* website currently links students in Washington, Idaho and Montana to the Washington NatureMapping database, and at this printing there are plans for an Oregon NatureMapping site, hosted by the Oregon Natural Heritage Program which has created many of the species and land use maps for Oregon. In addition to the NatureMapping database, there are other state and national databases to which students might contribute:

(the following sites open new windows, press your back button to return)

- One of the primary goals of the *National Park Service Inventory and Monitoring Program* is to make existing and new natural resource information more available and useful to park managers, scientists, and educators for planning, management, research and education. The I&M Program is coordinating the development of an integrated set of modern GIS and database tools and an overall framework for organizing, storing, displaying, and analyzing natural resource information. The Product Specifications document being developed presents an overview of these tools and technical specifications for products developed by NPS staff, cooperators and contractors for work funded by the I&M Program. The specifications presented here are a "work in progress", and the most recent version of this document and updates on the development of the information management tools being developed by the NPS can be found at this website.
- The *National Gap Analysis Program* is a scientific method for identifying the degree to which native animal species and natural communities are represented in our present-day

mix of conservation lands. Those species and communities not adequately represented in the existing network of conservation lands constitute conservation "gaps." The purpose of the Gap Analysis Program (GAP) is to provide broad geographic information on the status of ordinary species (those not threatened with extinction or naturally rare) and their habitats in order to provide land managers, planners, scientists, and policy makers with the information they need to make better-informed decisions.

- The *USGS-NPS Vegetation Mapping Program* is a cooperative effort by the U.S. Geological Survey (USGS) and the National Park Service (NPS) to classify, describe, and map vegetation communities in more than 270 national park units across the United States. This landmark program is both the first to provide national-scale descriptions of vegetation for a federal agency and the first to create national vegetation standards for its data products. Its goal is to meet specific information needs identified by the National Park Service.
- The *Alien Plants Ranking System* (APRS) is a computer-implemented system to help land managers make difficult decisions concerning invasive nonnative plants. The management of invasive plants is difficult, expensive, and requires a long-term commitment. Therefore, land managers must focus their limited resources, targeting the species that cause major impacts or threats to resources within their management, or the species that impede attainment of management goals. APRS provides an analytical tool to separate the innocuous species from the invasive ones (typically around 10% of the nonnative species). APRS not only helps identify those species that currently impact a site, but also those that have a high potential do so in the future. Finally, the system addresses the feasibility of control of each species, enabling the manager to weigh the costs of control against the level of impact.

- The *U.S.D.A. National PLANTS Database* provides standardized information about the vascular plants, mosses, liverworts, hornworts, and lichens of the U.S. and its territories. It includes names, plant symbols, checklists, distributional data, species abstracts, characteristics, images, plant links, references, crop information, and automated tools. PLANTS reduces costs by minimizing duplication and making information exchange possible across agencies and disciplines. **Note**: Although students may not be able to directly upload data to this site, it nonetheless is an extremely valuable source of information and used as a resource in several of the lessons available with *Aliens In Your Neighborhood*.
- **In Oregon** - *WeedMapper* from the Rangeland Resources Dept. at Oregon State University is a web-based spatially referenced database of noxious weeds that anyone may query. The database includes locations of noxious weeds throughout Oregon as collected by responsible federal, state, and local agencies. Electronic maps are viewable at the state, county, township, or section (square mile) level
- **In Montana** - Statewide weed distribution data collected through the Section-based weed mapping project are now available for viewing as part of the *Montana Natural Resource Information System (NRIS) Thematic Mapper*.

Weed Collection Standards

BLM Noxious Weeds GIS Layer Standard - http://www.blm.gov/nhp/efoia/or/fy2000/im/m2000-060.htm

Mapping and GIS for Weed Management, Northern Territories, Australia - http://www.nt.gov.au/dbird/dpif/plants/weeds/gis_techniques.shtml

Mapping Noxious Weeds in Montana - http://agri.state.nv.us/nwac/montanaweeds.pdf

The Nevada Invasive Plant GIS (based on Montana's weed mapping system) - http://agri.state.nv.us/nwac/GIS_1.htm

Other Related Links

Montana Noxious Weed Survey and Mapping System - http://www.montana.edu/places/mtweeds/

Weed Gallery - http://www.ipm.ucdavis.edu/PMG/weeds_common.html

The Center for Invasive Plant Management (includes some images) - http://www.weedcenter.org

The North American Weed Management Association (NAWMA) (scroll down on the left side and click on Position Papers for an excellent collection of reports (in .pdf format) on rapid response, biological control and invasive weed programs) - http://www.nawma.org/

California Regional Invasive Species Information System - http://cain.nbii.gov/crisisindex

Aliens In Your Neighborhood

A Teacher's Guide to the National Park Service

Invasive Weed Curriculum

Curriculum for the National Parks Invasive Weeds Curriculum

The following lessons correlate to most middle school science curricula and many are easily adapted to elementary or high school grades. Lessons are currently being created to expand *Aliens In Your Neighborhood* to a K-12 curriculum!!

Ecosystems
Introduction to Ecosystems
Your Curriculum
Exploring Ecosystems in the Classroom
Exploring Your Ecosystem
Writing Through the Ecosystem

Plants
Introduction to Plants
Your Curriculum
When Is A Rose Not A Rose? (defining plants
as weeds) - Research & Activities
Tracking Aliens In The School Yard - Mapping
Alien Wanted Posters - Photography
Pressing Aliens - Collection
Raising Aliens - Growing Plants in a Solar-Powered Cold Frame
Make-Believe Alien - Assessment through Art

Spreading the Invasion
Introduction to the Invasion
Your Curriculum
Alien Species Research Discussion
Alien Seed Bank
Alien Shopping Spree
Aliens In Your Socks
Alien Invasion - Math

Alien Impacts
Introduction to the Impacts of Alien Plants
Your Curriculum
Alien Populations EXPLODE!
Aliens In The Web - Upsetting the Balance

Alien Controls
Introduction to Controlling the Spread
Your Curriculum
And Just How DO You Kill A Weed?
Create A Spotted Knapweed Insectory

Alien Issues
Introduction to Issues & Human Needs
Your Curriculum
Student-Designed Research/Experiments
Debate & problem-solving
Public Awareness

Activities to Introduce the XID System and Classification

Classification Pre-test - testing prior knowledge
Classification Pre-test Key
Introduction to Classification - how do your students organize things?
Classification Worksheet - practice grouping different sets of animals and plants
Mythical Classification - develops an understanding on how science organizes by *like characteristics*
Using the Dichotomous Key - practice with a simplified frog key and developing their own flower key
Handouts/Transparencies for lesson above:
- Frogs
- Frog Anatomy
- Frog Key

Classification of Triangulum species - practice session for the XID System

Citizen Scientists - Contributing Data and Affecting Change: The National Database systems

Introduction to NatureMapping

Introduction to NatureMapping with specifics for Washington, Idaho and Montana
Introduction to Oregon NatureMapping
- Where Am I?
- Data Collection
- Mapping and Contributing Data
- Appendix

Teacher's Outline for Student-Based Inquiry

This .pdf document contains:
Teacher's Outline for a Student-Based Inquiry
Student *Design An Experiment* form
Student Experiment Notebook check-off List
Science Experiment Assessment Rubric
Student Science Experiment Assessment Detail (feedback form)

Glossary & Plant Facts

Resources

Online lesson plans are available as downloadable .pdf files requiring Acrobat™ Reader® 5.0

Teacher's Timeline & Checklist
for
Integrating Aliens with Your Curriculum

Summer

- ❑ Attend National Park Service teacher training workshop for *Aliens In Your Neighborhood*
- ❑ Contact your local weed control board, Extension office, or state/federal agencies to gather information, about local weed problems
- ❑ Contact your local National Park education specialist to identify inventory and monitoring projects for the following spring (or identify local projects)

Fall

- ❑ Compare timeline of life science curriculum with lessons listed on *Aliens* Curriculum – Integration begins when you utilize *Aliens* in place of conventional lessons (ex. when teaching about plant parts, use the context of weeds instead of "textbook" example). Remember that the *Aliens* curriculum is a theme that you are integrating with the regular curriculum. Typical middle school curricula may follow this general pattern and the *Aliens* curriculum overlaps most of these topics (the order can be switched depending on your own schedule):

- **Life Science – 7th Grade** - Items in ***italics*** indicate *Aliens* connections
  - General Life Science – Recap connection to phy. science, esp. measurement and the Nature of Science (NOS)
  - *Living Things – Characteristics & Needs*
  - Cells
    - Single Cell Organism
    - Multi Cell Organism

  - Cell Growth
  - Cell Reproduction
- *Classification Systems*
- Living Things
  - Complexity – single cell to higher orders (enhanced in 8th grade)
  - *Plants (Aliens Plant Unit)*
  - *Classification of Plants (Aliens XID Classification Unit)*
  - *Life Cycles of Plants (Aliens Plant & Invasion Units)*
  - *Obtain and Use Energy-Plants*
  - *Structure-Function Plants (Aliens Plant, Invasion & Impact Units)*
  - Animals
  - Classification of Animals *(Aliens XID Classification System)*
  - Invertebrates
  - Vertebrates
- *Mapping/GIS (Aliens NatureMapping sections)*
- *Ecosystems (Aliens Ecology Unit)*
  - *General Ecosystems*
  - *Food Chain-Food Web*
  - *Energy Distribution*
  - *Biomes*
  - Land Dwellers
  - Water Dwellers
  - Flying Animals
  - *Ecology*

        - *Humans vs. Environment- Issues (Aliens Impact, Control, Issues Units)*
    - Evolution
        - *Adaptations to the Environment*

- ❑ Locate weeds in and around your schoolyard or community. By late summer most weeds have gone to seed… a good time to collect seed and plants for future lessons during the winter months. Several *Aliens* lessons involve long-term projects growing weeds in the classroom
- ❑ Connect with other teachers in your school and suggest ways that they may integrate *Aliens* (via math, art, social studies and language arts) to support the future project. Other core subjects are identified on each *Alien* lesson plan.

Winter

- ❑ Student research projects, writing, long-term experiments being planned and implemented

Spring

- ❑ Begin unit on Mapping/GPS. This may be done in partnership with the Social Studies teacher where students are often introduced to mapping. Practice using GPS technology on the school grounds.
- ❑ Invite National Park personnel (or other partners) to speak to the students about their invasive weeds research on upcoming field trips
- ❑ Field trip planning
- ❑ Contribute data to science. Ask hosting agency to provide feedback to the students on how their data was utilized.

Introduction to Ecosystems

The Semi-Arid Network of the National Park System contains some of the last remnants of unique ecosystems that have shaped our lives here in the western United States. The abundance and fertility of these ecosystems opened the door to settlement, yet that settlement has altered, and in many places threatens, those ecosystems. Development of farm, industry, and construction, and over use of our land, contribute to the fragmentation of the land and open the door to new settlers: alien plant species. The National Park System seeks to protect these unique ecosystems, and now faces the challenge of halting the destruction of invasive aliens. Alien species rank second only to habitat destruction in causing disruption to our ecosystems, and currently about 42% of federally endangered or threatened species are listed because of the influence of alien species (Brooks & Pyke, 2001).

To understand the effect of alien plant species it is important to first understand what makes an ecosystem unique. This unit is designed to give students an understanding of ecosystems and how different ecosystems interact to form the inter-connected fabric of our planet's biosphere. Students will understand that each ecosystem is a unique system, composed of biotic and abiotic factors, dependant upon each other in an intricate web of life. And students will begin to understand, through this and successive units, how and why non-native plants persist and take hold to disrupt our biosphere's intricate web... for the impacts of alien plant invasions do not stop at the boundaries of the plant kingdom.

Your Curriculum - Many earth and life science curricula follow a pattern of exploration through the geosphere, biosphere, and atmosphere. The following lessons can be incorporated with your regular curriculum in Life Science, the biosphere, and the characteristics of living things. When you combine these lessons with your own curriculum you take the first step to integrating invasive plants species as a unifying theme.

- Exploring Ecosystems in the Classroom
- Exploring Your Ecosystem
- Writing Through the Ecosystem

Exploring Ecosystems in the Classroom

Subject: Life science | Grade: 6-8

Lesson Topic: Ecosystems | Length: 1+

Learner Objective:

Students will gain an understanding of the components of ecosystems.
Students will understand the vocabulary used to describe and define ecosystems.
Students will be able to differentiate between abiotic and biotic components of an ecosystem.

Introduction:

This collection of activity ideas is intended to supplement the regular life science ecosystem units normally taught. It provides the classroom teacher with the necessary vocabulary and concepts common to the study of ecosystems, provides a variety of activities that may stand alone or be added to the regular curriculum and can be used to transition from a broad approach of ecosystem study to one that incorporates alien weed species as the integrating context by which students study the dynamics of ecosystems in their own community.

Content:

The earth's living layer, or biosphere, is the largest ecosystem. Ecosystems may also be as small as a tiny weedy patch in the corner of a parking lot, or a puddle. Wherever you find a select group of living and non-living things interacting with each other can be considered an ecosystem.
Within each ecosystem, no matter the size, there are populations of living things (biotic), with their own particular habitat that best supports their lives. The habitat may support several populations of organisms that interact with one another and form a particular community or association. The habitat must supply the needs of the community from the non-living things (abiotic) in the form of food, water, nutrients, sunlight, and temperature. Plants are unable to move from a habitat where their needs are not met, but many have evolved mechanisms of adaptation. The plants are best adapted to particular niches within the community where the greatest number of their needs is met. Animals, on the other hand, are able to move to more suitable niches if their needs are not met. Since two or more species of plants or animals cannot occupy the same niche at the same time, it follows that competition, predation, cooperation, and symbiosis may occur, and consequentially, the plants and animals evolve strategies to deal with these processes. Therefore, each biotic population has it's own specific niche, sharing a general habitat with other populations to different degrees of cooperation and competition, and all utilizing the available abiotic resources.

The earth is also one very large biome, a place defined by particular, overlapping habitats. The most dominant biomes are deserts, tundra, grasslands, and large forested groups such as the rainforest and northern temperate forests. Many of our National Parks of the Pacific Northwest Region are within the Great Basin Ecosystem, which encompasses a range of biomes.

Although we are often focused upon the biotic components of the world around us, it is the cycle of energy and abiotic factors that defines and determines the success of any biome, habitat, or ecosystem. The sun is the driving force behind the flow of energy in our biosphere, and all living things require energy in one form or another. The transfer of energy occurs because all living things have particular functions within the ecosystem: producers, consumers, decomposers, and scavengers. Energy within the ecosystem is transferred by these functions within the food chain.

Just as energy is cycled through the system in the give and take of nutrients, so also are other abiotic factors such as water (the water cycle), gases, and minerals. For each living thing to survive within a particular habitat there must be a system of conservation, where through a recycling of all abiotic substances maintains a supply of resources available a different moments to the living things best adapted to utilize those resources. When a resource becomes limited or disappears, living things may become endangered or extinct.

It must not be forgotten that humans too, are an abiotic partner in the earth's ecosystem, with all the same needs and functions of other living things. Since we are mobile and adaptable to a wide variety of habitats, our footprint upon the earth carries greater weight. As we shall see in later units, sometimes we alter the available resources and create an imbalance to the system of conservation that affects the ability of other living things to survive. And in some cases, by altering habitats we cause the demise of native species and invite *Aliens In Our Neighborhood*.

Materials and Supplies:

Materials required are dependent upon the activities, chosen from the list below.

Anticipatory Set:

Show the students a potted plant, an aquarium (or fish bowl), a glass of water, a moldy sandwich, and a clear glass of soda or tonic water. Ask them to point out which items are ecosystems and for them to explain/defend their assertions.

Activity Outline:

The above background information is intended to provide a guide to a variety of activities that may be done in the classroom to introduce students to ecosystems. There are many activities, and variations of them, of ecosystem studies that are found in a great number of life science textbooks, the Internet, and other sources. A few of the most common are listed here:

- Build a classroom aquarium, or have each student design their own using the popular *Bottle Biology* (Bottle Biology Project. 1993. Department of Plant Pathology, College of Agriculture and Life Sciences, University of Wisconsin-Madison. Published by Kendall-Hunt Publishing Company. ISBN 0-8403-8601-X).
- Build/design a terrarium, an ant farm, a butterfly habitat

- Create a collage of pictures depicting a particular ecosystem from pictures cut out of old magazines.
- See also the matrix which cross-references this activity with similar activities by [Project Learning Tree] and [Project Wild]

Students can keep a journal of their daily observations. A great project is for the students to make their own Ecosystem Journal, and a good source for book binding is *Written and Illustrated By: A Revolutionary Two-Brain Approach for Teaching Students How to Write and Illustrate Amazing Books* by David Melton, 1985, published by Landmark Editions. ISBN: 0933849001

Closure and Assessment:

Student journals can used to assess understanding of key concepts. Their observations and reflections should utilize the above vocabulary. Journals kept over a period of time should demonstrate a movement from inference to true observation. Students may also exhibit understanding through oral presentation of the ecosystems they created.

Independent Practice and Related Activities:

Students may wish to expand their studies of classroom ecosystems by recording specific data (temperature, moisture, plant growth, mortality, pH, etc.) over time, by manipulating variables, and by developing and testing hypothesis through experimental design and process.

(These aspects of research may be used to adapt this lesson plan to upper middle school and high school classes)

Resources:

Bottle Biology. Bottle Biology Project. 1993. Department of Plant Pathology, College of Agriculture and Life Sciences, University of Wisconsin-Madison. Published by Kendall-Hunt Publishing Company. ISBN 0-8403-8601-X

Written and Illustrated By: A Revolutionary Two-Brain Approach for Teaching Students How to Write and Illustrate Amazing Books by David Melton, 1985, published by Landmark Editions. ISBN: 0933849001

Vocabulary:

Abiotic, Adaptation, Biosphere, Biotic, Community, Competition, Consumer, Cooperation, Decomposers, Endangered, Extinct, Food Chain, Habitat, Niche, Population, Predation, Producers, Recycling, Scavengers, Symbiosis

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- ❑ Abilities necessary to do scientific inquiry
- ❑ Understandings about scientific inquiry

Physical Science - CONTENT STANDARD B:
As a result of their activities in grades 5-8, all students should develop an understanding of

- ❑ Transfer of energy

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- ❑ Structure and function in living systems
- ❑ Regulation and behavior
- ❑ Populations and ecosystems
- ❑ Diversity and adaptations of organisms

Exploring Your Ecosystem

Subject: Life science, writing | Grade: 6-8

Lesson Topic: Ecosystems | Length: 1+

Learner Objective:

Students will apply concepts and vocabulary learned from the previous lesson (*Exploring Ecosystems in Your Classroom*) to an area on their school grounds, their community, or in they're nearby National Park.

Introduction:

This activity is intended to supplement the regular life science ecosystem units normally taught. It provides the classroom teacher with the necessary vocabulary and concepts common to the study of ecosystems, provides an activity that may stand alone or be added to the regular curriculum and can be used to transition from a broad approach of ecosystem study to one that incorporates alien weed species as the integrating context by which students study the dynamics of ecosystems in their own community.

Content:

Ecosystems include all the biotic (living) and abiotic (non-living) things in a particular area that interact with each other. Within each ecosystem these thing are intimately entwined in a variety of interrelated cycles: the water cycle, energy cycle, nutrient cycle, chemical cycles, and are affected by the cycles of the seasons. All living things exist connected to each other in an intricate web of life and have specific roles as producers, consumers, or decomposers.

Materials and Supplies:

Ecosystem Journal (see *Exploring Ecosystems in Your Classroom*)
String or hula-hoops to designate study area
A range of supplies may be required depending on the depth of their investigations (hand trowels, sifters, thermometer, scales, ID books, etc.)

Anticipatory Set:

Standing outside with a hand trowel, look around and ask the students, "Now, where can I find an ecosystem?" Lead a discussion that concludes with the fact that an ecosystem may exist anywhere that living things interact with each other; from a hand trowel full of soil to the earth's biosphere.

Activity Outline:

Have the students define an area as their own ecosystem for study. Use surveyor's stakes and string to delineate an area. For younger children (or a quick version of this activity) use hula-hoops to designate the areas of study. The study site should be measured to calculate the area (math skills). If you are ready to start a larger study, or are working in conjunction with the education specialist at a national park, you may want to break the area into a grid and randomly assign each section to a student.

- Make observations about the site in their journal. They may also draw a map or sketch of the area, or use digital photographs (make sure the point where the photograph is taken is measured in distance and cardinal direction from the site).
- Inventory all biotic and abiotic aspects. Where possible, and depending on grade level, the total population of each species should be counted, and in the case of plants, the percent coverage should be determined.
- Soil samples can yield a variety of information depending upon the resources available for testing. Living creatures can be screened from the soil (be sure to return them unharmed!) and other procedures exist for extracting nematodes and microscopic organisms from the soil. The soil can be tested for percent of organic material, percolation rates, pH, composition, and type.
- Students should explore how survival needs are met by each species within their plot (Hint: have them think in terms of air, water, food, and sunlight).
- Observe and/or infer influences by humans. If humans shaped or altered the ecosystem, *when* did it occur and *how* might it have occurred.
- Are there plants or animals in their plot that could not live in the plots being examined by their peers? Investigate the differences and similarities between student plots and determine if they are the same, if they influence one or another, if they are uniquely different. For small plots in a small area, try having the students create a web of connections by tying a string to a plant chosen at random and then connect all abiotic and biotic things in all the plots. Can they all be connected? (this activity can also serve as an assessment).

Closure and Assessment:

Student journals can used to assess understanding of key concepts. Their observations and reflections should utilize the above vocabulary. Journals kept over a period of time should demonstrate a movement from inference to true observation. Students may also exhibit understanding through oral presentation of the ecosystems they created.

Independent Practice and Related Activities:

Students may wish to expand their studies of classroom ecosystems by recording specific data (temperature, moisture, plant growth, mortality, pH, etc.) over time, by manipulating variables, and by developing and testing hypothesis through experimental design and process.

(These aspects of research may be used to adapt this lesson plan to upper middle school and high school classes)

Resources:

Written and Illustrated By: A Revolutionary Two-Brain Approach for Teaching Students How to Write and Illustrate Amazing Books by David Melton, 1985, published by Landmark Editions. ISBN: 0933849001

Vocabulary:

Abiotic, Biotic, Ecosystem

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science - CONTENT STANDARD B:
As a result of their activities in grades 5-8, all students should develop an understanding of

- Transfer of energy

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- Structure and function in living systems
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

Writing Through The Ecosystem

Subject: Life science, writing

Grade: 6-8

Lesson Topic: Ecosystems

Length: Variable

Learner Objective:

Students will express their knowledge of ecosystem interactions through creative writing.

Introduction:

The interwoven concepts and interactions of ecosystem components are often described as a web of interactions, but unfortunately students often get caught in a web of confusion when trying to understand the subtleties of those interactions. Creative writing provides an opportunity for students to express their understanding of the concepts through the web of imaginative connections.

Content:

Having introduced the various concepts and interactions of ecosystems to the students, allow them to take their own imaginative journey through an ecosystem of their choosing, using as many of the keywords listed in the Vocabulary section below.

Materials and Supplies:

None required.

See Vocabulary section below for keywords used in the writing exercise.

Anticipatory Set:

Read stories out loud, which have ecosystems as the theme (see Resources). Older students may be assigned particular titles to read on their own. Since this ecosystem lesson, and others within *Aliens In Your Neighborhood*, is meant to be blended with your own Life Science curriculum, the integration of literature can occur at any time.

Activity Outline:

The students' stories may encompass any genre they wish such as an adventure story, a love story, a mystery, or science fiction.

As a basic format it should have an introduction, a rising tension or climax, and some sort of resolution. If the students are cued to think in terms of an adventure or journey they will most likely think in terms of moving through the ecosystem and thus, be more successful with incorporating a wider range of the keywords listed in the Vocabulary section below.

Length should not be a requirement, though 2-5 pages are not unreasonable. Where possible, papers should be double spaced to allow for corrections. At least one draft should be presented, and if time permits, peer reviews should be part of the first draft assessment. If possible, this activity can be in conjunction with the Literature instructor as part of his/her curriculum. Encourage final drafts to be submitted with a cover page and/or illustrations.

Closure and Assessment:

Assessment should be based upon:

- Effort in creating a rough draft
- Ability to fairly consider and critique other students' works in peer review
- Timeliness of work
- A final story that incorporates a full range of the keyword *in appropriate fashion*.

A story that successfully weaves a greater number of keywords in an imaginative and accurate manner will be scored higher than students who are not yet able to express understanding of ecosystem terminology.

Independent Practice and Related Activities:

Request a second peer review, lengthen the story with use of additional keywords, and prepare a manuscript for publishing - type *"children's stories" + publish* in your Internet browser to search for publishing sources and contests.

Resources:

The following reading list was assembled by using various vocabulary words (listed below) in the *Database of Award Winning Children's Literature*, found at:

http://www.dawcl.com/introduction.html

Author: Savage, Deborah
Title: Summer Hawk (1999)
BBYA 2000;

When her rescue of a baby hawk takes fifteen-year-old Taylor to a raptor rehabilitation center in rural Pennsylvania, their offer of a summer public relations job seems a step toward her dream of becoming a journalist. (Chapter)

Author: Gilmore, Kate
Title: Exchange Student (1999)
BBYA 2000;

When her mother arranges to host one of the young people coming to Earth from Chela, Daria is both pleased and intrigued by the keen interest shown by the Chelan in her work breeding endangered species. (Chapter)

Author: Larson, Gary Illus. by: Larson, Gary
Title: There's A Hair in My Dirt ! : A Worm's Story (1998)
BBYA 1999;

When a worm becomes tired of being a worm, Father worm tells him an environment fable, of the beauty, power, and fragility of nature, and the importance of all players -- including the worms. (P) (Picture)

Author: Lauber, Patricia
Title: Summer of Fire : Yellowstone 1988 (1991)
ALAN 1992;

Describes the season of fire that struck Yellowstone in 1988, and examines the complex ecology that returns plant and animal life to a seemingly barren, ash-covered expanse. (Chapter)

Author: Bond, Nancy
Title: Voyage Begun (1981)
BGHBH 1982;

Living in the not-so-distant future when the energy supply has been almost depleted, a teenage boy begins to understand the long-term effects of recent climate and weather changes and environmental pollution on the land and the people. (Chapter)

Author: Kevles, Betty Ann
Title: Watching the Wild Apes : The primate studies of Goodall, Fossey, and Galdikas (1976)
BGHBH 1977;

Describes the field work of three female primatologists and what their studies have revealed about the behavioral patterns of chimpanzees, gorillas, and orangutans in their natural habitat. (Chapter)

Author: Hobbs, Will
Title: Maze (1998)
BBYA 1999;

Rick, a fourteen-year-old foster child, escapes from a juvenile detention facility near Las Vegas and travels to Canyonlands National Park in Utah where he meets a bird biologist working on a project to reintroduce condors to the wild. (C) (Chapter)

Author: Bodker, Cecil Translated by: Poulsen, Gunnar
Title: Leopard (1975)
MLBA 1977;

An Ethiopian boy finds his life endangered when he discovers that a disguised blacksmith, not a leopard, is responsible for a great many missing cattle in the area. (Chapter)

Vocabulary:

Abiotic, Adaptation, Biosphere, Biotic, Community, Competition, Consumer, Cooperation, Decomposers, Endangered, Extinct, Food Chain, Habitat, Niche, Population, Predation, Producers, Recycling, Scavengers, Symbiosis

National Science Education Standards:

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- ❑ Structure and function in living systems
- ❑ Regulation and behavior
- ❑ Populations and ecosystems
- ❑ Diversity and adaptations of organisms

Science in Personal and Social Perspectives - CONTENT STANDARD F:
As a result of activities in grades 5-8, all students should develop understanding of

- ❑ Populations, resources, and environments
- ❑ Risks and benefits
- ❑ Science and technology in society

History and Nature of Science -CONTENT STANDARD G:

As a result of activities in grades 5-8, all students should develop understanding of

- ❑ Science as a human endeavor
- ❑ Nature of science

Introduction to Plants

An understanding of plant growth and development is essential in understanding how and why alien plant species adversely affect the land and water quality of our environment. In the previous Ecosystems Unit, students learned how biological diversity exists as an intricate web of populations uniquely adapted to the environmental conditions within particular communities.

Plants deal with their environment in different ways than animals do. Although we are surrounded by plants all our lives, most of us never realize just how alien they are. From the way they manufacture their food to the ways in which they respond to the environment, plants are quite different from animals.

An important reason for this difference is the sedentary lifestyle of plants. While some animals are sedentary, such as barnacles and sponges, most are quite able to move around. Thus, when conditions become uncomfortable, they may simply move away to another location. By contrast, plants are generally unable to move to a new location, but must rather cope with the circumstances in which they find themselves. For example, if a lion began to nibble on your leg, you would probably try to run away, however when a grasshopper begins to nibble on the leaf of a plant, the plant cannot simply run away. Instead plants must deal with the situation where they stand, by such means as producing noxious chemicals, growing spines, and generating sticky saps to deal with this problem. Plants cannot move when they are too hot or too cold, or when they are thirsty, or when their environment dramatically changes.

Alien plant species become invasive because of a range of adaptations that allow them to survive a wide range of environmental changes. When an environment is altered and disturbed, usually at the hand of humankind, the delicate web of environmental connections are broken, thus changing the conditions to which native plants and animals are adapted. Alien plant species can often cope with these changes by mechanisms that allow them to establish themselves before the native species can recover. By producing seed heads with thousands of seeds in each pod, by producing seeds that may germinate within a wider range of temperature and moisture conditions, by having rapid growth patterns that utilize soil nutrients before the native plants can use them, and by developing extensive root systems that rob native plants of precious water reserves, alien plants establish themselves in disturbed environments and crowd out the more finely adapted native species.

The following activities provide students with an introduction to these alien plants, provides them with skills to begin a basic inventory and research into alien plant species, presents opportunities to collect and preserve field specimens through plant pressing and photography, and to express their understanding of plants through both research and art.

Your Curriculum - Many life science curricula follow a pattern of exploration in the study of plants; from simple plant species to the complex flowering plants. The following lessons can be incorporated with your regular curriculum in Life Science, the biosphere, plant development units, and the characteristics of plants within their environment. When you combine these lessons with your own curriculum you take the first step to integrating invasive plants species as a unifying theme.

- When Is A Rose Not A Rose? - Defining Plants As Weeds - Research & Activities
- Tracking Aliens In The School Yard - Mapping
- Alien Wanted Posters - Photography Sample WANTED poster
- Pressing Aliens - Collection
- Raising Aliens - Growing
- Make-Believe Alien - Assessment through Art

When Is A Rose Not A Rose?

Subject: Life science, botany, writing

Grade: 6-8

Lesson Topic: Defining plants as weeds

Length: Long-term

Learner Objective:

Having been introduced to the basics of plant biology, students will use that knowledge to research the diversity of invasive plant characteristics and adaptations.

Students will understand why some plants are considered weeds.

Students will understand the adaptations and conditions that enable weeds to spread and become established.

Introduction:

Plants have evolved over millions of years and have developed a wide range of adaptations for the ecosystems where we find them today. Because plants cannot move, they have developed means to best take advantage of available resources, to fend off insects, disease, and animals, and to compete with other plants for nutrients, water and sunlight. Therefore, each plant occupies a particular niche within the environment.

Content:

Weeds are any plant that is unwanted, one that grows in an area to which it was not adapted (thus, a rose could be a weed!). Besides growing in plant communities where it is unwanted, in order for a plant to become an invasive species it must be able to grow and reproduce quickly, out-competing the native plants for nutrients, water and sunlight. Besides disrupting the biodiversity of the native plant community, weeds also become a nuisance to humans (degrading the land, altering crop or range yields, become poisonous forage to livestock, altering water tables, etc.)

As in all healthy ecosystems, there is a balance between the species that form that ecosystem. Plants that are introduced to new ecosystems often arrive without the diseases, insects, and animals that would normal keep the population of that plant in check… in other words, invasive weed species are native plants that have been introduced into the wrong ecosystem!

Using the list of invasive plant species for your area, students will research and report the characteristics and adaptations of a particular alien. The research they do will be shared with the rest of the class and serve as foundation knowledge for the other activities within this plant unit of *Aliens In Your Neighborhood*.

Materials and Supplies:

Invasive Plants list for your area (see Resources section for sources)
Student worksheets (at end of this lesson)
Roses, ornamental plants, invasive weed species (see Resources section for models of invasive weeds)

Anticipatory Set:

Have a bouquet of roses at the front of the room and at the beginning of class ask the students if a rose is a weed. Offer examples of other plants (ex. Native plants, ornamental plants (from a nursery) and invasive weeds) and pose the same question. Allow an open discussion about what a weed is, and let the students create their own definition of a weed.

Activity Outline:

Using the list of invasive species in your area, assign a different plant to each student (this is usually easiest with a random "draw from the hat"). Depending on the number of Aliens in your area and number of students you may want to create "scientific research teams."

Remind the students of the basic outline found in most reports:
Title: catches the reader's eye.
Attention getter: gets the reader's attention.
Introduction: tells the reader what you (the writer) are going to say.
Body: lists all the facts that support the writer's topic statements.
Conclusion: tells the reader what you just said and allows for the writer's opinion.
Bibliography: lists the sources so that the reader can easily find them if they are still skeptical.

A strategy that has proven effective is to have the students attach copies of their resources to their rough draft. Rough drafts can then be "peer reviewed" in class and the attached resources enable students to look for plagiarized statements and provide the writer with an opportunity to practice paraphrasing.

A suggested sequence might include these elements:

1. Introduction to invasive weeds following plant biology unit
2. Description of format for research and reporting (including mini-unit on paraphrasing)
3. Students are assigned plants, begin research, and fill out report outline (see below)
4. Students prepare rough draft
5. Peer review of rough draft (with references attached to draft)
6. Prepare Final Report

Closure and Assessment:

Presentation of Final Report to class (oral).

Provide outline for notes to be taken while listening to the presentation (note outline should be based upon the Four Main Points of the Report Outline (see below).

Assessment may be a test based upon notes taken by students during presentations.

Independent Practice and Related Activities:

Create a poster or display.
Make a taxonomic key.
Contribute the information in a community outreach program.

Resources:

County weed boards or extension offices, state and federal offices and the internet all provide amble information on individual weed species.

The National Plant Database is a great place to start gathering information about individual plants and contains links to your local state: http://plants.usda.gov/

Vocabulary:

Adaptation, biodiversity, community, ecosystem, forage, niche, range, weed

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- ❑ Abilities necessary to do scientific inquiry
- ❑ Understandings about scientific inquiry

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- ❑ Structure and function in living systems
- ❑ Reproduction and heredity
- ❑ Regulation and behavior
- ❑ Populations and ecosystems
- ❑ Diversity and adaptations of organisms

Science in Personal and Social Perspectives - CONTENT STANDARD F:
As a result of activities in grades 5-8, all students should develop understanding of

- ❑ Personal health
- ❑ Populations, resources, and environments
- ❑ Natural hazards
- ❑ Risks and benefits
- ❑ Science and technology in society

History and Nature of Science -CONTENT STANDARD G:
As a result of activities in grades 5-8, all students should develop understanding of

- ❑ Science as a human endeavor
- ❑ Nature of science

Tracking Aliens In The Schoolyard

Subject: Life science, mapping

Grade: 6-8

Lesson Topic: Habitats, plant structure

Length: 1-2

Learner Objective:

Students will understand that weeds are everywhere.

Students will become familiar with the structures, plants, and signs of habitats around their schoolyard.

Students will use a drawing of their schoolyard to organize and understand spatial distances and relate that information to the occurrence of alien weed species.

Introduction:

This lesson is intended as an introductory lesson to the mapping lessons found elsewhere in the *Aliens In Your Neighborhood* curriculum. One of the skills to be learned, especially with younger students, is awareness for spatial distances. Alien weed species can take advantage of a wide range of habitats, and can cause problems on the small scale of school property as well as within the larger environment. Mapping the location and number of alien weed species is one way that scientists track the spread of invasive plants.

Content:

All of the map views used in the anticipatory set are a “bird’s eye” view of the places we live. This view of our world allows us to imagine large areas and the spatial relationships (where things are in relation to each other) between objects. Relating the area being mapped to the larger world is done by indicating both scale (distances represented on the map) and heading (normally the cardinal direction North). Younger students need to understand that a North arrow pointing up doesn’t mean in the air, but in the direction you would be heading if you walked towards the Earth’s north pole.

Materials and Supplies:

Clipboards, paper, pencils/markers, rulers

Compass

100’ measuring tape (surveyor’s tape)

Student Map View sheet (at end of lesson)

Anticipatory Set:

Depending on age group, begin with a series of maps – the globe, the United States, a state map, a county map, a city map, and if available, the school property map. Older students will conceptualize this “zooming in” view and you may want to start with USGS topographic maps or local surveyor's maps of the property. This "map view" of their world can be done outside if the weather permits (tape the maps in series to the side of a building).

Activity Outline:

The student's first maps may be as simple as a sketch of the buildings and trees from the perspective of a bird. Students can be given a sheet of paper, draw a 7" square, and draw what they believe this bird's eye view would be like (or use the student map view sheet at end of this lesson). Have the students use the compasses to make sure their maps are oriented to north. It will not take long for the students to discover that things "don't fit" and that objects need to appear not only in terms of their relative distance from each other, but also in terms of scale.

If you have access to the surveyor's map of the school property you can make copies for the students (enlarge or reduce to fit your needs, or copy sections of the map into convenient 8"x10" sheets so that each student may only do a portion of the entire area). These maps have a specific scale, and the surveyor's tape can help the students visualize how the map scale translates to objects on the ground. Students may add as much detail as they feel is important, but at the least they should indicate major structures, major planting areas, sidewalks and parking areas, and if possible, basic features of terrain like creeks or hills. The initial sketches should be done lightly in pencil. Once the students are satisfied with their maps they can color code their map using markers in the classroom. Talk to the class about creating a map key and the importance of using a key that is easy to use and, more importantly, easy for others to read. Let the students design a uniform key for the entire class to use.

Using knowledge gained from their alien plant research, flash cards of weed plants, or other sources of identification, have the students mark the locations of weed species. Younger students might just use a colored marker to put a dot "where the weed is next to the office," or similar simple representations of weed locations. Older students may want to identify specific survey points and measure the distance from that point to each weed to find the location on their scaled maps. At the highest level, this activity may be adapted to give practice using GPS waypoints before going into the field and doing the large scale projects discussed in the NatureMapping section of this curriculum.

Students may wish to color code the different weed species. This should be a requirement at most grade levels. Once the maps are completed the students should examine the color-coded plants and look for patterns and groups of plants. Where are they growing? Where are they growing in relation to other features? Have the students draw a line around groups of common species. What relationships are found now? Can you tell if a species is growing in particular direction (in terms of numbers of plants)? Encourage a full class discussion and allow the students to list all possible patterns and relationships?

Closure and Assessment:

If the area was sectioned into small parcels for individuals or teams to map, reassemble the maps on the wall of the classroom. If a scale was used accurately, the maps should all "go back together" in a coherent manner, and similarly, the color-coding will be consistent and the key will be understood by all.

If time, have students orally present their maps, and encourage them to discuss their method, problems encountered, things they have learned after taking a bird's eye view of their school, and if they notice any particular patterns of where the weed species are growing.

Assessment may be in the form of a rubric which scores 1) map components (scale, features, distance, color codes, and key), 2) behavior and attention (including involvement while outside, use of equipment, and teamwork), and 3) oral presentation of findings.

Independent Practice and Related Activities:

Students with high levels of spatial relationships, distance, perspective can be encouraged toward higher levels of complexity in their mapping, to map other or larger areas, to include topography and other advanced mapping techniques, and to serve as mentors for their peers. Regardless of grade level, mapping activities consistently have higher levels of complexity for students who require additional challenges.

Examine the list of patterns and relationships created during the classroom discussion. Each one of these patterns or relationships provide an opportunity to ask further questions and/or design an experiment to test whether or not the patterns and relationships are perceived or authentic. These experiments may be conducted by an individual student, or as an extension for the entire class to pursue.

Interview administrative and custodial staff to see how invasive plants might be a problem and what evaluate the associated costs of control (labor & materials) and damage.

Use this activity as an introduction to NatureMapping.

Resources:

NatureMapping Unit
TerraServer Imagery (for maps of your area) http://terraserver.microsoft.com
USGS Map Wizard http://interactive2.usgs.gov/learningweb/fun/map.asp

Vocabulary:

GPS, habitat, map view, scale, topographic

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- Structure and function in living systems
- Populations and ecosystems
- Diversity and adaptations of organisms

Science and Technology - CONTENT STANDARD E:
As a result of activities in grades 5-8, all students should develop

- Abilities of technological design
- Understandings about science and technology

History and Nature of Science -CONTENT STANDARD G:
As a result of activities in grades 5-8, all students should develop understanding of

- Science as a human endeavor
- Nature of science
- History of science

Map View

Name ________________________________ Date ________

Location ______________________________

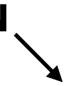
Place an arrow that points to North **N**

(see example below)

Key:

SCALE: __________ = __________ (You must designate unit of measurement, ex. 1 cm = 5 m)

North symbol example: **N**



Alien Wanted Poster

Subject: Life science, Art

Grade: 6-8

Lesson Topic: Photography, technology, art

Length: 1-3

Learner Objective:

Students will become familiar with digital photography, scanners, and photo manipulation software.

Students will be able to express knowledge about invasive plants learned in previous lessons through art.

Students will gain knowledge of light, shadow, background, and other aspects of photography.

Students will have the opportunity to educate others, including peers and through community outreach.

Introduction:

When scientists such as ecologists, wildlife biologists, geologists, archaeologists and others are working in the field a photographic record of their findings often becomes an important part of the data they collect. Precise record of the time and place a photograph was taken enables them to return to the same spot and record changes over time. Sometimes the photographic record is the only record before something is lost or destroyed (can the students think of some examples?).

Content:

Photography involves an understanding of light and shadow, and an ability to "see" the background in relation to the subject just as clearly as the subject itself, i.e., it is not just the subject that make the photograph but the total of all images and light within the frame of the camera.

This particular activity can be done with a wide range of grade levels, using a wide range of cameras, and so the details of camera use and image composition will not be expanded upon. Younger students should be free to explore and evaluate their own images and older students may already have had training in image composition. This is a wonderful activity to involve the art and/or technology instructors at your school.

The Alien Wanted Posters can be used to teach others about invasive plants, including, the school population and in community outreach programs.

Materials and Supplies:

Digital camera(s) (disposable 35mm cameras may be used if prints can be scanned)

Access to computers with photo manipulation and word processing software

Photo print paper (optional)

Student Photo Data Sheet (see below)

Anticipatory Set:

Have the cameras in class and let the students know that they will all get to be photographers. Lead a short discussion on how a photographic record is one way that scientists collect data… can they think of examples where that is true? Alternatively, have a local wildlife photographer come speak to the class and show his/her own work.

Activity Outline:

Having identified and mapped the locations of invasive weed species at their school or in their community, the students will now return to those sites and make a photographic record of the aliens. Photographs may be of two types, 1) wide angle shots of a broad area, and 2) close-up photos of individual plants. In either case, or where possible, the time and location of the photograph should be record on a data sheet (see sample sheet below).

Try taking close-up pictures with various backgrounds by having a partner hold a large sheet of either black or white paper behind the plant. In most cases they will have sharper images if the light source (sun) is behind the photographer. Older students may want to have a scale (in centimeters) along one edge of the background paper so the relative size of the plant can be recorded. Photos should be taken at a level with the plant, rather than down at the plant.

Photos will be uploaded to a computer (or prints scanned into the computer). Advanced students may want to experiment with print size, resolution, file size, brightness and contrast, and other effects. Using a word processor, students will create a wanted poster with:

1. A large, bold font heading that says, "WANTED!"
2. The photo imbedded in the document below the heading
3. A brief description of the plant and where it's found
4. A description of it's crime(s) against the local environment
5. A reward

These are only suggested items to include, as the students may want to design their own layouts. Younger students, or those who are not yet familiar with word processing, can print the photo and paste it to a sheet of paper (8.5" x 11") and include the information by hand. All information for the poster should be taken from the invasive weed reports done previously in this unit. Alternatively, the instructor may want to provide a pre-made template of the wanted poster for the students to fill in with the appropriate information and photo.

Closure and Assessment:

Assessment may be in the form of a rubric which scores 1) photo features (scale, lighting, and detail), 2) behavior and attention (including involvement while outside, use of equipment, and teamwork), 3) completeness of information, and 4) oral presentation of findings.

Independent Practice and Related Activities:

Create a website of invasive weeds in your area.

Create a set of flashcards by printing a smaller version of the wanted poster (approx. 5" x 7"). The layout of the poster should have the space between the bottom of the picture and the text is in the middle of the card so it can be folded in half with the backsides glued to each other. This creates a flashcard with the photo on one side and the information on the other. They can be laminated for use in the field.

Use the flashcards for an Alien Scavenger Hunt.

Resources:

Local photographers

USDA Plant database for plant photos http://plants.usda.gov/

Vocabulary:

Dependent upon depth of subject and photographic terms that may or may not be introduced.

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:

As a result of activities in grades 5-8, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Life Science - CONTENT STANDARD C:

As a result of their activities in grades 5-8, all students should develop understanding of

- Structure and function in living systems
- Populations and ecosystems
- Diversity and adaptations of organisms

Science and Technology - CONTENT STANDARD E:

As a result of activities in grades 5-8, all students should develop

- Abilities of technological design
- Understandings about science and technology

Science in Personal and Social Perspectives - CONTENT STANDARD F:
As a result of activities in grades 5-8, all students should develop understanding of

- ❑ Populations, resources, and environments
- ❑ Science and technology in society

History and Nature of Science -CONTENT STANDARD G:
As a result of activities in grades 5-8, all students should develop understanding of

- ❑ Science as a human endeavor

Alien Wanted Poster

Photo Data Record

Date	**Photo #**	**Subject** (plant name)	**Location**	**Time**	**Background** (white or black)	**Other**

Photographer's Name: ______________________________

Camera used: ____________________

Notes:

WANTED!

Photo by Peggy Greb, USDA ARS

yellow star-thistle
Centaurea solstitialis L.

This plant is listed as a Class B invasive weed by the State of Oregon, Oregon Revised Statute Section 561.510, State Department of Agriculture, General Quarantine Powers. This plant may be known by one or more common names in different places, and is known to have crossed state lines.

If you, or anyone you know, has seen this weed contact:
Oregon Department of Agriculture

Pressing Aliens

Subject: Life science

Grade: 6-8

Lesson Topic: Plant characteristics, collecting

Length: 1-2

Learner Objective:

Students will acquire the skills for collecting and preserving plants, and the basic reasons why plants are collected.

Students will be aware of the rules of collecting to protect a species that may be low in numbers or to protect themselves against harmful plants.

Introduction:

Scientists often make collections from the field; plants that are collected and preserved as mounted specimens (pressed) are one form of a herbarium. Herbariums, or plant collections, allow scientists to examine details about plants without continually having to return to the field, or provide scientists who cannot do field studies with examples of the actual specimen. Collecting plants when they are in flower often allows for identification at a later date when the plant may no longer be flowering.

In conjunction with photographs (see *Alien Wanted Poster* activity), mounted alien weed species can be used to educate others about the problem of invasive plants.

Care should be taken when collecting plant specimens from the field… *know what you are collecting*! The collection of rare **and** endangered **species is a crime and can potentially damage the reproductive success of sensitive species.**

Content:

Students will be applying prior knowledge in plant characteristics, classification and invasive weed research in this activity.

Materials and Supplies:

- Plant presses
- Digging tools
- Plant pruners
- Mounting paper, labels, glue, scissors
- Plant Source Data sheet (see below)

Anticipatory Set:

A few days in advance, warm enough clean dry sand (approx. 150° F) to fill a 1 gal. wide-mouth jar. Holding an invasive weed species upside down in the jar, pour the sand into the jar so that the plant is buried and hidden in warm sand. It's important that the plant be no taller than the jar and does not touch the sides. The warm sand process will dry the plant in its natural state (if the sand is too hot you can burn fragile plant parts or lose too much of the natural color… this process works great for fungi such as conks and mushrooms).

At the beginning of class, tell the students you have trapped an alien in the sand. Reach into the sand and, holding the stem so that the plant stays centered in the jar, pour the sand into a tray and withdraw the plant. Explain the hot sand process by which you preserved the plant, and let the students know that they will learn another method for collecting and preserving plants.

Activity Outline:

This activity can be done in concert with the alien plant research paper. Have students collect and mount the species they had previously researched.

- Building a Plant Press – there are a great many designs for plant presses, and many are available commercially. The students in the classroom using the standard "sandwich" method common to all plant presses can make simple plant presses. Each plant press will be made from two pieces of ¼" – 12"x18" plywood or pegboard, newspapers, 12"x18" pieces of rag or butcher paper, and two adjustable tie-down straps. The sequence of layers would be:

board → 2-3 sheets newspaper → rag → specimen → rag → newspaper → board

Repeat the newspaper-to-newspaper sequence for not more than ten specimens. Plants that are moist may have to have the paper changed each day, and drying normally takes about 3-5 days.

- Collecting and Pressing Plants – when collecting plants the following rules should be observed:
    1. Do not collect plants if you are unsure whether or not they are rare or endangered
    2. Don't take plants you're not going to press
    3. Don't take plants if you do not see at least 10 of the same kind in the area (this may not apply to invasive weed species

  Think about the size of your press when you select a plant for collection. In some cases having the root is also advantageous, although some invasive species may have root systems longer than 20'! Dig up the plant and prune unnecessary branches or roots. Place the plant between the sheets of rag paper and arrange the leaves and flowers to best be shown. Some flower heads may need to be bent at 90° to best show the petals. Put a numbered tag in with each plant that corresponds to the plant data sheet (see below).

- Labeling and Mounting - the students will design labels for their plants that contain the following information:

1. Name of collector
2. Location (name of school, Nat. Park, etc.)
3. Map location
4. Name of plant (common and scientific)
5. Special notes

After the plant has dried it can be mounted on a fresh sheet of clean paper. Mounting can be done with glue or tape, depending on the plant. It is also possible to use clear contact paper or to laminate the plant, but it is important that the plant be thoroughly dry (to prevent mold). Plants may be dried in a low heat (100°F) oven, but care must be taken to not burn the plant. Excessive drying or baking may diminish plant color. After the plant is mounted, affix the label to the page. The mounted plants can be bound into a herbarium book or displayed in a variety of ways.

Closure and Assessment:

Create a rubric to assess effort, behavior and the three main areas of the activity:

- Building a Plant Press –
- Collecting and Pressing Plants –
- Labeling and Mounting –

Include the mounted plant as part of the oral presentation and assessment of the weed research report (see previous activity, *When Is A Rose Not A Rose*)

Independent Practice and Related Activities:

Use collection of pressed plants for community outreach programs.
Use collection in the field to identify plants.
Have students investigate other preservation methods such as the hot sand method.

Resources:

Utilize resources from previous lessons and the findings of student research of invasive weed species.

Vocabulary:

Endangered, Herbarium, Rare

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- ❑ Abilities necessary to do scientific inquiry
- ❑ Understandings about scientific inquiry

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- Structure and function in living systems
- Reproduction and heredity
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

Pressing Aliens

Plant Source Data Sheet

Date	Plant #	Plant Name (common)	Plant Name (scientific)	Map Location	Notes

Location ________________________________ Collector:______________________________

Notes:

Raising Aliens

Subject: Life science

Grade: 6-8

Lesson Topic: Plant Growth & Development

Length: Variable*

* Projects may take several weeks to a year, but after they are in process, sometimes only a half period per week is needed to maintain the project. The plants may be used in conjunction with future activities.

Learner Objective:

The students will:

- -draw and describe a seed.
- -describe how seeds and fruits help with seed dispersal.
- -sprout seeds and grow a plant.
- -record data over a long period of time and use these data to make a graph.
- -draw and describe the structure and function of a flower and its parts.
- -use a microscope to observe pollen.
- -simulate a weed control method.
- -understand and explain why noxious weeds are an ecological and economic problem.
- -be able to explain chemical, cultural and biological weed control methods.
- -identify at least one weed species in the field.
- -understand various ways to prevent weed dispersal.
- -understand the idea of Integrated Pest Management (IPM.)

Introduction:

This activity may be used prior to all other *Alien* plant activities as part of your plant biology unit since it involves plant growth and development. Modifications (regarding information about invasive species) will have to be made, but because this activity involves growing plants and is of long duration, the "killing" portion of the activity may take place by the time you are utilizing all of the *Aliens* curriculum.

Content:

This can be a full year or a half year lab. Select and gather weed seeds from noxious weeds in your area before school starts (some species such as spotted knapweed can be gathered after school starts as the seeds stay in the seed heads). Be careful to prevent weed spread!! You may want the whole class to try all one species, or try several. Try small groups or individual students (fit this to the needs of your students!). Contact your County Weed Coordinator and/or Extension Agent for more information, or check the Resources section of *Aliens*. The students may also use the wealth of information from the weed report they created in the *When Is A Rose Not A*

Rose activity. Try growing the species of your choice at least once (or with a small group of students) so you know what to expect when you do the lab with a whole class.

Materials and Supplies:

Student Guide to Raising Aliens (included at end of lesson)

This activity will require a space to grow plants in your room, a greenhouse, or you can have your students build a solar powered cold frame outdoors (see link to building a cold frame on *Aliens* plant curriculum page or in Resources).

Other materials:

weed seeds (you must collect these), safe seed container, grow lights or greenhouse, growing area, pots (many weeds are tap rooted and need deep pots), potting soil or soil, water, rulers, student data notebooks, graph paper, flower and noxious weed literature, Internet access, microscopes, slides, cover slips, lens paper, forceps, stereo scopes and/or hand lenses, various materials to "kill the weed."

Anticipatory Set:

Have a closed box sitting up at the front of the class that is clearly labeled, "Alien Babies: DO NOT DISTURB". Even if you have already been studying invasive weed species the students will still be curious, until you open the box and show them the weed seeds, at which point you'll get a few of the groaners you deserve. But then, let them know they will be growing alien weed species, and that you will trust them to make sure that no aliens escape, in fact, it will be necessary to kill the experiment when they are done.

Activity Outline:

Building a solar powered cold frame plant tender: This cold frame will allow you to start plants and continue growing them after winter begins. The cold frame is made from recycled and found materials…another good way to take care of the Earth while learning about plants! Return to the plant curriculum page of *Aliens* or go to the Resources page for a link to fun project.

Sprouting Seeds: Each weed seed has different needs, and the students can research those needs. To keep costs down, use local soil (free-dug up from the waste areas of the school grounds) for the bottom 3/4 of the pot and sterile potting soil (purchase large bags from a local greenhouse) for the top 1/4th. This potting soil suppresses the unwanted seeds that may sprout from the local soil (see seed bank activity) because they can not push up that high, and thus, and helps sprouting success for the plants you do want. Many weed seeds need to be planted quite shallow, misted and the pot covered with a clear plastic wrap cover until the new sprout is well established. The students can also sprout them in smaller pots (such as plastic cups or yogurt cups) and transplant the best plant at a later date. Better yet, use that new solar powered cold frame!!

Growing the Weed: Make sure the plants have a normal growing environment with constant warmth, grow lights and/or sunlight, water and room to grow (some weeds get quite large!). Unless soil is reused, fertilizer is not usually needed.

Flower Observation: Teach about the structure and function of flowers before this so the students know what to look for. Have drawings or models of flowers for them to refer to and print off some pictures of their actual weed species flowers to help explain the evolutionary modifications that have occurred with each particular species.

Pollen Observation: Make sure the students have used microscopes, slides and cover slips and have observed samples on all powers before you attempt this part. They can either cut off the anthers or just rub the whole flower in the drop of water on the slide. You may want to get other flowers (from your local floral shop, greenhouse or outside in season) to show the variety of pollen.

Kill the Weed: Make sure you have CONTROL of this part of student activity!! Herbicides (plant growth hormones), burning, chopping, etc. are dangerous and must be treated accordingly!! Keep weeds from spreading!! Have the students simulate many of the ways that weeds are controlled.

Disposal and Clean Up: These are noxious weeds and *must not be spread*. Double bag the soil and transport it directly to the land fill for burial. Wash the pots in indoor sinks and sterilize them. Wash and sterilize your growing area. Monitor the area for potential weed sprouts for 10 years!

Raising Aliens Journal – Have the students keep a journal of the activities. You may want to have the students make their own journals. Use the Student Guide to Raising Aliens worksheet (see below) as a guideline for student entries.

Closure and Assessment:

The journals become the assessment for this activity because it includes research, drawings, answering specific questions and reflection. You might schedule specific "journal check dates" according to the sequence of teaching.

Independent Practice and Related Activities:

The "killing" methods investigated provide a perfect platform for older students to create their own programs for eradication of invasive weed species. Many people object to kids being brought in to "pull weeds" when some of the research in this activity will show that pulling weeds is not always effective. Some people object to the use of chemical herbicides. Others object to introducing a non-native pest (insect) to eradicate a weed when there is a chance that the insect may become an invasive species too. Have students investigate these issues and see if they can develop an effective eradication program for a specific weed species.

Resources:

Aliens In Your Neighborhood Resources

Vocabulary:

None

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- ❑ Abilities necessary to do scientific inquiry
- ❑ Understandings about scientific inquiry

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- ❑ Structure and function in living systems
- ❑ Reproduction and heredity
- ❑ Regulation and behavior
- ❑ Populations and ecosystems
- ❑ Diversity and adaptations of organisms

Science in Personal and Social Perspectives - CONTENT STANDARD F:
As a result of activities in grades 5-8, all students should develop understanding of

- ❑ Personal health
- ❑ Populations, resources, and environments
- ❑ Risks and benefits
- ❑ Science and technology in society

History and Nature of Science -CONTENT STANDARD G:
As a result of activities in grades 5-8, all students should develop understanding of

- ❑ Science as a human endeavor
- ❑ Nature of science
- ❑ History of science

Student Guide to Raising Aliens

Use these instructions as a guide to your journal entries.

1. After having planted the weed seed(s) as instructed and read the information about your weed, you must care for the weed every class day (water if needed, check health, and turn the pot if the light comes from the side). Record the date of each observation in your notebook!
2. When the weed sprouts, record the date and then sketch and describe its growth once each day.
3. After the first week of growth you will only take data on your weed once a week. You will: 1) Sketch the plant, 2) measure the height of the longest stem, 3) count the number of stems, and 4) note big changes.
4. Water, fertilize (if needed) and repot the plant as instructed. Be sure and keep the soil moist but not soggy
5. When the plant flowers, draw the flower and label the following parts: stem, sepals (these may fall off on some flowers when they bloom), pistil, anthers, and petals. If your plant does not flower by the end of the lab, draw another students flower. Refer to the standard flower drawing in your text.
6. When several flowers of the group have matured, observe and draw the pollen. To do this, rub the anthers in a drop or two of water on a microscope slide, place a cover slip on the slide and observe on at the available powers. Draw the various views.

WARNING: do not let seeds from your noxious weed escape! Prevent their spread!!

7. At the end of this lab you will attempt to kill your weed (they may be harder to kill than you think!). Each person will try a different weed control method. List each classmates name and method in your data. Some suggested methods are: 1) apply a herbicide, 2) simulate a wildfire - burn the stems and leaves, 3) defoliate the plant the way a leaf feeding biological control agent might, 4) let a goat or sheep eat the stems and leaves - a cultural control method, 5) dig up the plant, chop it up and rebury the parts - to simulate plowing/tilling, 6) Bury whole and chopped plants in a compost pile to see if they actually turn to compost or if they start growing. Do these carefully with teacher supervision! Now water the remains of your plant for 2 more weeks and see if your method really works to kill the plant.

IMPORTANT WARNING: Dispose of the plant parts and soil as instructed in a manner that prevents the spread of these noxious weeds.

8. Complete the results, discussion and conclusion.

Results: In a few sentences, sum your data.

Discussion: Answer these Discussion Items on your own paper.
1. Explain why plants have seeds and fruits with several examples of each.
2. What is a weed? Why are many plants weeds?
3. Why are specific noxious weeds in Montana classed as category 1, 2 & 3?
4. a. Describe how your weed grew (its life stages). b. Make a line graph of the growth of your weed.
5. Describe the function of each part of your flower (stem, sepals, pistil, anthers, petals and pollen).
6. Explain: 1) chemical, 2) biological, and 3) cultural weed control.
7. What is the idea of Integrated Pest (Weed) Management [IPM]?
8. How can you (yourself!) help: 1) prevent weed spread, and 2) help control weeds already established in your area? Explain several examples of each!

Conclusion: a minimum of 3 sentences of summary and 3 sentences of your opinion about the lab.

This lab was adapted from curriculum developed by:

Montana Weed Project
Missoula County Conservation District
3550 Mullan Road, Ste. 106
Missoula, Montana 59808-5125
Phone: (406) 829-3395 http://mtwow.org

Make-Believe Aliens

Subject: Life science, Art

Grade: 4-12

Lesson Topic: Plant Characteristics

Length: 1-2 days

Learner Objective:

1. Students will create imaginative "new" invasive weed alien, based upon adaptations and characteristics to be explained and demonstrated,
2. Students will be able to classify the alien according to plant parts, habitat, and defense mechanism,
3. Students will be able to:
    a. orally describe adaptations alien plants use in their particular niches
    b. orally describe how adaptations help plants use survive within their environment
    c. orally describe the relationship between habitat and the presence of certain alien weed species

Introduction:

This activity is designed to fit within the larger context of plant biology and invasive weed studies. Easily adapted in 4-12, *Make-Believe Aliens* combine science and art to help students learn about concepts such as adaptations, defense, habitats, and other plant characteristics. The students should rely on their experiences and knowledge gained in the previous lessons, and in particular the plant research papers they developed.

Content:

While this activity satisfies several *National Science Education Standards* (NSES) outlined below, it also helps students gain understanding of invasive plant issues within their own community. An awareness of the environment's level of health, and the factors that influence its health, helps our students become informed citizens. There will come a day when they will be involved with the decisions (development, pollution, land management, etc.) that affect the quality of our life and our environment.

Besides learning how plants adapt to specialized habitats (the niches within a particular habitat), students will learn that some of these plants are indicators of poor environmental health. Plant not only have specialized physical characteristics, but also adaptive characteristics that enable them to be successful within their unique habitats. When habitats are altered, either due to catastrophic events or by the action of humans, specialized plants such as many invasive weed species are often the first to indicate an imbalance.

Materials and Supplies:

- A variety of construction paper, crepe or colored tissue paper
- Scissors
- Materials to decorate a very creative make-believe alien plant such as markers, sequins, ribbon, rick-rack, cotton, paper scraps, raffia, foil, beads, glitter, etc.
- Coat hanger wire or other stiff wire for stem
- Stapler
- Long pipe cleaners, green or brown
- Liquid glue (diluted ½ with water) and paint brush
- Modeling clay (to form stand)
- Student Instructions and worksheet (below)

Anticipatory Set:

Normally when starting activities like this an instructor may show examples of the type of "creation" the students will make. However, it is recommended that sample make-believe aliens not be shown to students prior to the activity in order that the students might freely express themselves without preconceived notions cued by the work of others, and because this activity is intended to be an assessment of their understanding of invasive plants.

Activity Outline:

Provide each student with the Make-Believe Alien Worksheet (see below).

The make-believe alien students create; along with the randomly chosen plant parts, will be based upon the adaptations and characteristics the students choose from the list on the worksheet. Students will put an **X** by *each* of their choices in *each* category, and the choices are entirely up to the individual student.

Once they have made their selections, students will be given three envelopes labeled with various plant parts. The envelopes contain plant parts from a variety of different weed species found in picture books, field guides, etc. (see Resources). Without looking, each student will reach in and choose one "plant part" from each envelope. Using these as a guide, along with the choice of adaptations and behaviors below, the students will create a "new" alien weed species!!

Providing a wide range of art materials will allow the students free expression in creating their alien. The most difficult step is creating the stem, and you may want to modify this procedure for younger students. Depending on the branching of their particular alien, the main stem is generally made from a length of coat hanger wire, with pipe cleaner wires wrapped around to form the secondary stems (either opposite or alternate stems). Colored tissue paper is dipped in a thin solution of wallpaper paste and wrapped around the wires, spiral fashion, to hold the pipe cleaners in place (this can be done "sloppily" to give the stem texture). The plant stems can then be bent into various shapes. Attaching leaves can be done in a similar manner by creating a leaf stem on each leaf, and using a small wrap of tissue to hold it in place. The students will continue in this general manner to build the alien stem, leaf structure, and flowers.

It goes without saying that the variations of this project are numerous, and depending on the supplies gathered, the age group, and available time, the alien plant creations could become an amazing project. This would be a wonderful activity to invite parents to come and assist. Remember that the children are using real scientific terms and concepts to create a totally imaginary plant – <u>the science is provided in a structured and defined manner, but expressing that knowledge, and the assessment through art, should be as free and open as possible</u>.

Be sure they also give an appropriate name for their creation! Advanced students should also create a scientific name (at least *Genus species*) and the Latin roots of the scientific name should reflect specific characteristics of their Make-Believe Alien.

Closure and Assessment:

When the plants are completed and dried they should be placed on display throughout the room or in your school. The final portion of the assessment is an oral presentation where the student report describes their Make-Believe Alien in scientific terms (see criteria of plant reports in the lesson *When Is A Rose Not A Rose*).

Independent Practice and Related Activities:

Use the Make-Believe Aliens as part of a community outreach program.
Create a Field-Of-Aliens Float for an Earth Day parade.

Resources:

Plant drawings adapted to this activity from:
A Peterson Field Guide to the Wildflowers of North America

Vocabulary:

National Science Education Standards:

<u>Science Teaching Standard B</u>: Teachers of science guide and facilitate learning
<u>Science Teaching Standard C</u>: Teachers of science engage in ongoing assessment

<u>The National Standards for Arts Education</u>:

<u>Content Standard #3</u>: Choosing and evaluating a range of subject matter, symbols, and ideas
<u>Content Standard #5</u>: Reflecting upon and assessing the characteristics and merits

Make-Believe Aliens Worksheet

Student Name ________________________________ Date _______

Your make-believe alien that you create; along with the randomly chosen plant parts your teacher will provide, will be based upon the adaptations and characteristics chosen from the following list. Put an **X** by *each* of your choices in *each* category.

- **Habitat**
  forest___ wetland___ desert___ meadow___ pond or stream edge___

- **# of seeds**
  1-10___ 11-100___ 101-1000___ 1001-10,000___ 10,000+____

- **Seed Dispersal**
  Wind blown___
  Wind blown "parachutes"___
  Burrs that catch on fur___
  Falls to ground___
  Is "shot" from the seed pod___
  Consumed then dispersed by birds or other animals ___

- **Color of Flower ______________**

- **Number of Flower Petals _____**

- **Defense**
  Armed ___
  Sticky ___
  Bad Taste ___
  Hairy ___

- **Tolerance to fire**
  Intolerant (is killed by wildfire)___
  Somewhat tolerant (might survive wildfire)___
  Tolerant (survived and is enhanced by wildfire)___

Common Name of your Make-Believe Alien

____

Scientific Name of your Make-Believe Alien

____

Teacher initials here when this is completed and you are ready for the next step!!! _____

Make-Believe Aliens Worksheet cont.

To begin the activity, you will be given several envelopes labeled:

- ❑ ***Flower arrangements***
- ❑ ***Regular/irregular petals***
- ❑ ***Pistal parts***
- ❑ ***Ovary position***
- ❑ ***Special flower parts***
- ❑ ***Plant surface traits***
- ❑ ***Fruit types***
- ❑ ***Leaf Shapes***
- ❑ ***Leaf arrangements***
- ❑ ***Leaf base***
- ❑ ***Compound leaves***

The envelopes contain plant parts from a many different species of invasive weeds. Without looking, your teacher will let you reach in and choose one "plant part" from each envelope. The circled plant characteristic is the one you will be assigned. Using these as a guide, along with the choices you made on the first page, you will create a "new" alien plant species!!

List the plant part names and make a drawing of the parts you picked from the envelopes and return your selections to the appropriate envelope (you may use the back of this sheet to design your alien plant):

Make-Believe Aliens Worksheet cont.

Steps to help you make your Make-Believe Alien:

- Use wires to build the main stem and branches
- Cover the wires with crinkled tissue paper or other kind of paper
- Bend the wires to shape your plant
- Attach leaves
- Build a flower with the correct number and shape of petals
- Build and attach a seed pod (remember: a real plant may not have both seeds and flowers on the same plant, but hey, *this is an alien*!!!)
- Be as creative as you want with color, texture, and *special* features!

Additional Notes:
Record extra facts about your plant that you might imagine… these will become part of the story you tell when you describe you Make-Believe Alien to others! You may also want to include interesting facts about some of the alien weed species you have all ready learned about. (*some of the plant names and facts are on the slips of paper you selected from the envelopes… use these words to properly describe your alien plant when you present it to the class*)

Plant drawings adapted to this activity from:
A Peterson Field Guide to the Wildflowers of North America

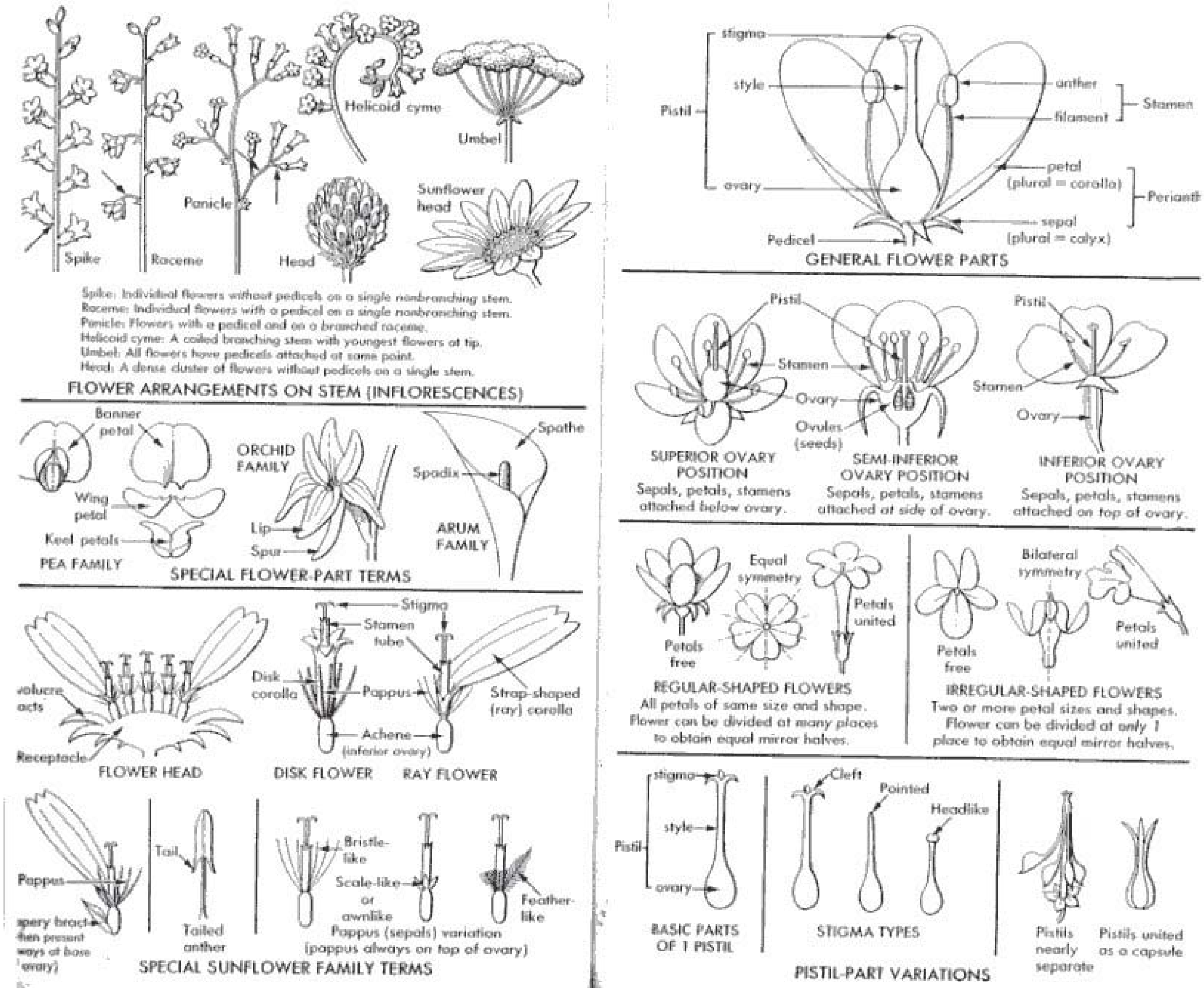
Make-Believe Aliens Plant Parts

Instructions for Envelopes:
Label enough envelopes according to the following list:

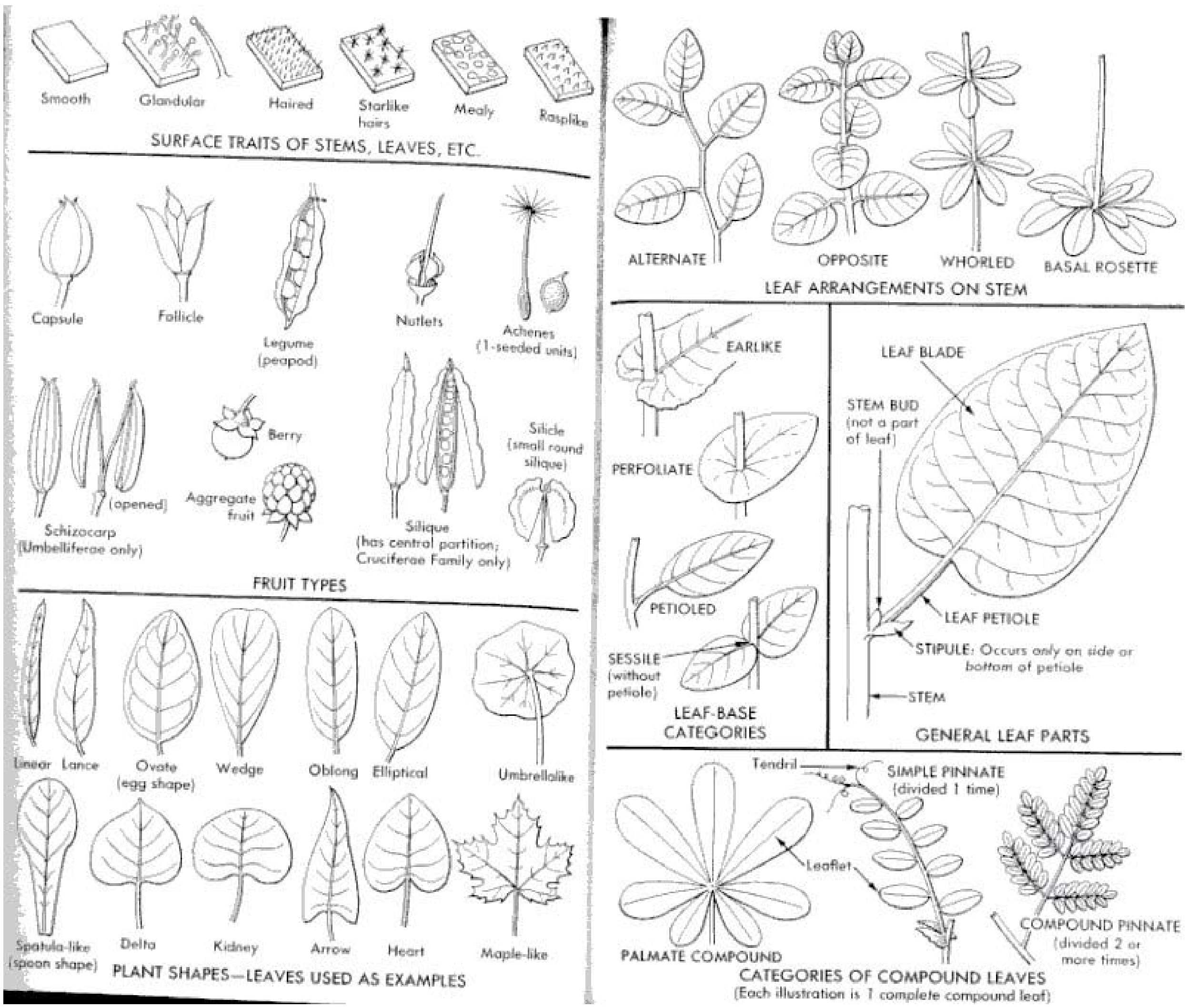
- ❑ ***Flower arrangements***
- ❑ ***Regular/irregular petals***
- ❑ ***Pistal parts***
- ❑ ***Ovary position***
- ❑ ***Special flower parts***
- ❑ ***Plant surface traits***
- ❑ ***Fruit types***
- ❑ ***Leaf Shapes***
- ❑ ***Leaf arrangements***
- ❑ ***Leaf base***
- ❑ ***Compound leaves***

Make at least four copies of the plant characteristics below (the actual number will be dependent on class size). Cut out the different sections, and use a colored felt pen to circle one different characteristic on each section. For example, for the section titled *Flower Arrangements*, there are seven types of inflorescence. Circle one different type of inflorescence on each Xeroxed copy (if you made four copies you would have circled four different types). Place these in the corresponding envelope. Repeat this for all plant sections. When students draw from the "flower arrangement" envelope, they will draw one slip of paper only, and the circled item will be part of their alien plant.

Make-Believe Alien
Plant Parts A



Make-Believe Alien
Plant Parts B



Spreading the Invasion

Since plants are a sedentary life form (not mobile like animals) they have evolved a number of means to disperse throughout the environment and to persist under conditions not always favorable to native species. In addition, human activities often facilitate the dispersal of invasive plants in a number of ways. In this unit the students will learn some of the mechanisms by which invasive plants spread throughout the ecosystem. From windblown seed, to a hike across muddy fields, to the innocent purchase of wildflower seed in an effort to establish native plants, invasive weed species are spreading through our environment at alarming rates.

As seen in the Ecosystem Unit, native plants occupy particular ecological niches, within communities that occupy specific habits. In a balanced ecosystem, natural systems of competition, predation, herbivory, disease and natural forces (such as fire) have evolved together (the Impacts Unit describes how these forces disrupt biodiversity).

Most alien weed species, like our native species, are also a part of a balanced ecosystem *within their natural range*. The majority of alien weed species are native to other countries, predominantly Europe, the Mediterranean, and Asia. Within those areas, plants function in the same manner as our own native species: in balance with nature. Alien species become invasive if they are able to become established where natural forces that keep them in balance no longer exist. If the animals or insects that feed on a plant, if the diseases that normally affect the plant, and if the competition that normally restricts their spread are removed, there is every likelihood that an alien plant will be successful in it's new habitat. These events, combined with some general traits shared by most invasive plant species (high seed production, extensive root systems, and an ability to survive a wide range of environmental conditions), further enhance the ability for these plants to become invasive.

In general terms, of every 100 species introduced to our country, 10 will likely become established, and one will become invasive. Although 1% doesn't seem significant, when students calculate the exponential growth of alien plant species in a landscape devoid of natural limiting factors, the potential invasion of that 1% becomes a wildfire of biological pollution. In 1998 the estimated acreage in California invaded by yellow starthistle was 41 million acres. Eastern Oregon, Washington and parts of Idaho are inundated with starthistle from a single seeding project intended to restore burned over land during wildfires of the 1980s. Starthistle seed was unknowingly a major contaminant of the grass seed used in the restoration project, and now affects ranch animals, agriculture, recreation, and the general economy of the area to this day.

In this unit students will discover how weeds can spread so quickly, and in the process completely disrupt the balance of natural ecosystems. They will explore the sources of weed species and how human activities have encouraged both the establishment and eventual invasion of Aliens In Your Neighborhood.

Your Curriculum - Many life science curricula follow a pattern of exploration in the study of plants. Plant reproduction and seed development are essential topics of study and are the foundation to an understanding of how invasive plant spread. The following lessons can be incorporated with your regular curriculum in Life Science, ecology, the biosphere, plant reproduction, and the mechanism of plant dispersal in the environment. When you combine these lessons with your own curriculum you take the first step to integrating invasive plants species as a unifying theme.

Lessons in this unit:

- Alien Species Research Discussion
- Alien Seed Bank
- Alien Shopping Spree
- Aliens In Your Socks
- Alien Invasion - Math

Alien Species Research Discussion

Subject: Life science, writing

Grade: 6-8

Lesson Topic: Invasive species comparisons **Length**: One class session

Learner Objective:

Students will recognize similarities between alien weed species with regards to both habitat characteristics and plant growth characteristics.

Students will learn to contribute their own research to the "scientific community" within the classroom through written and oral means.

Introduction:

Before doing the lessons within the Invasion Unit, the introductory comments to the unit may be combined with the student research previously done in the activity *When Is A Rose Not A Rose?* (Ecosystems Unit). If the research activity has not been done, this would be a good time to introduce the students to that activity.

Content:

Species produce more offspring than will survive

Plants have adapted to extreme environments by the development of extensive root systems, resins and waxy cuticles that prevent moisture loss, long seed survival, fast growth, early germination, the ability to sprout new plants from roots or stem pieces, and/or having resistance to fire.

Materials and Supplies:

Student research papers from *When Is A Rose Not A Rose?*

A 6-column grid chart (can be drawn on the chalkboard, or on a 4'x6' sheet of butcher paper

Colored markers

Anticipatory Set:

Show the students a jar of seeds, representing a thousand or a million seeds. Ask them to estimate the number of seeds in the jar and the number of plants they think it would take to produce all the seeds. After entertaining their comments, let them know that a single plant produced all the seeds.

Making your seed jar – Your seed jar will not contain the exact number, but you can estimate the number of seeds to put in the jar in the following manner: Choose an inexpensive (non-invasive!) seed (grass seed, or possibly seeds available in bulk at a natural food store), weigh 1 gram of seed and count the number of seeds. If 100 seeds weigh 1 gram, you would need 10 grams to represent a thousand seeds, or 10 kilograms to represent a million seeds! Poppy seeds work well because they are both small and dense… you actually might find a jar to hold a million. If you use grass seed, you may end up buying a 25# bag!

Activity Outline:

Create a table on a 4'x6' sheet of butcher paper or on the chalkboard in the following manner:

Plant Name	**Place of Origin**	**Characteristics**	**Habitat**	**Problem**	**Control**

The number of species will determine the number of rows. In small classes, each student will have researched a different alien weed species found in your area. For larger classes, students who research the same plant will pool their findings.
Plant Name – May be common and/or scientific names
Place of Origin – The country or continent where the plant is native. If known, also include year of introduction to North America
Characteristics – May include special features of plant; number of seeds produced, length of root system, or other interesting facts
Habitat – A description of the ecosystem where the plant is commonly found (ex. Dry/rocky, wetlands, etc.)
Problem – Why the weed is a problem in your area
Control – The recommended method of control

Allow the students to discuss similarities and patterns they may find by comparing the alien weed species in each category. The following questions may be useful in leading the discussion:

- Where do most of the plants originate?
- How and when did they get here?
- What are some common characteristics shared by alien weed species?
- What general habitats do most invasive weeds utilize?
- What are some of the common problems caused by the weeds in the list?
- What are the most often recommended methods of control? Do they work? (you may want to save this chart to reference in other alien lesson units (e.g. the Control Unit)

Closure and Assessment:

Bring the discussion to a close and let the students know that in following lessons they will investigate some of the common characteristics that make alien weed species such a problem in their own community. Assessment for this activity includes:

- the completeness with which students are able to fill out the chart from their research
- their ability to find patterns of similarity (create a simple rubric based upon the chart above and place the students' names down the left column, then place a tic mark under each category for students who are able to make connections, who join the discussion, and to record whether or not each student contributed to each category).

Independent Practice and Related Activities:

- Students may want to calculate the volume of seeds that would represent a million (or thousand) seeds of their plant
- Students may extend the depth of their own research papers by including patterns they learned about, characteristics of their species they want to learn more about, or improve their research if it was lacking in any of the categories
- Students may design their own experiments to explore particular characteristics of their plants (ex. Investigating seed dispersal, attempting to dig up an entire root system, etc.)

Resources:

Seed sources: Check with local seed companies or co-ops for seed to be used in the Anticipatory Set.

Your local county weed board, Extension office, or local government agencies will have more information about the weeds particular to your area. Provide guidelines to your students and allow them to contact professionals in your community!

Vocabulary:

Habitat, native, niche, seedbank, viable

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:

As a result of activities in grades 5-8, all students should develop

- ❑ Abilities necessary to do scientific inquiry
- ❑ Understandings about scientific inquiry

Life Science - CONTENT STANDARD C:

As a result of their activities in grades 5-8, all students should develop understanding of

- ❑ Structure and function in living systems

- ❑ Reproduction and heredity
- ❑ Regulation and behavior
- ❑ Populations and ecosystems
- ❑ Diversity and adaptations of organisms

Alien Seed Bank

Subject: Life science, math

Grade: 6-8

Lesson Topic: seeds, plant growth

Length: 1-2 periods +

Learner Objective:

Students will learn that from the abundance of seeds produced by invasive plants, not all germinate the first season and most of the seeds persist for several years.

Students will be able to describe plant growth and life cycles of plants.

Introduction:

Many flowering plants (angiosperms) produce many more seeds that will germinate in a given season. Canada thistle may produce up to 5000 seeds per plant, while purple loosestrife can produce upwards of 2.7 million seeds per plant. Some of these seeds will sprout, some will become food for birds and rodents, some will die, but most will remain viable in the soil. This collection of viable seeds in the soil is the plant's seedbank, it's investment for future survival. Not only are the seeds viable, but the will remain so until environmental conditions for germination are just right…for some plants like English ivy, seeds may persist in the soil for up to 50 years.

Content:

In this exercise students will discover which plants are represented in the seedbank. The seeds may have been dropped by the plant or dispersed by wind, animals (clinging to fur), birds (defecation), or by humans. When the soil temperature and moisture is optimal, seeds will absorb moisture, cell division takes place, and the seed sprouts (germination). Some of these seedlings will survive and grow to become mature plants. The pattern of survival with seedlings is much the same as with seed; a certain percentage will survive, and a *larger* number of them will die due to environmental conditions or by becoming food. Once the seedling grows to a mature plant it produces flowers, the flowers are pollinated, the flower dies back and new seeds mature within the ovary, finally to be dispersed when they are "ripe," or mature.

Materials and Supplies:

Milk cartons (qt. size, cut in ½ lengthwise) or 4" flower pots
Hand trowels
Potting soil
Gro-lux light on adjustable stand
Weed Journals (hand-made, spiral notebooks or small journal books)

Anticipatory Set:

Prior to this lesson, fill two cartons or flowerpots with potting soil in which a 250 ml beaker of alfalfa seeds (or some other seed commonly used for "sprouts" found at health food stores as long as the seed *matches the color of the soil*) has been thoroughly blended with the soil. One carton should be watered at least a week prior and allowed to sprout. Show the students the soil sample that has not been watered and ask them to estimate the number of seeds that might be in the sample. You might award a prize to the student who guesses the closest, but the fact remains that it will be nearly impossible for them to determine the number of seeds. Ask them to brainstorm some ideas for determining the number of seeds and list their ideas on the chalkboard or large sheet of paper. The point to this inquiry is that we often cannot see the "problem" that may exist within the soil until after the plants have germinated, at which point it may be too late to stop an invasion. At this point show them the carton with the hundreds of sprouts you had previously germinated.

Note: If the students are curious about how many seeds were really used they can count the number of seeds in one gram, determine the weight of the 250 ml beaker of seeds, and multiply the number of seeds per gram times the weight of the total seeds used.

Activity Outline:

Select an area for the students to collect soil samples. Advanced classes may establish a plot and do random sampling (in this way they can estimate the total seedbank and evaluate potential problems after growing and identifying the seedlings in their samples). The students may also collect soil from different habitats. Wherever the samples are collected, the students should record a complete description of the location and habitat type. They should also note existing plant species, and if possible, photograph the area. The students will collect enough soil from the first 20 cm of soil to fill their cartons within 2-3 cm of the top. The planters should be watered, and then arranged beneath a Gro-lux light which is mounted on an adjustable stand. The light should be positioned approx. 20 cm from the top of the cartons and left on 24 hr. per day. Be sure to check the moisture content daily.

When the first seedlings have sprouted (some plant species may germinate in a couple days, others may take upwards to a month) students should describe the seedlings and rate of growth in their weed journals. Identification of plant species in the seedling stage is difficult at first, but this is a good point to discuss the differences between dicots (broad leaf plants and monocots (grass-like). Advanced classes will want to grow the plants long enough to distinguish plant characteristics and use the XID System or other plant keys to identify the plants. Journal records should also include date of germination, other observations and/or sketches of the plants.

Closure and Assessment:

Have the students list seed dispersal methods. Include a separate list of ways humans may disperse seed (some of their ideas will be discusses in greater depth in other lessons within *Aliens*).

Have the students draw the life cycle of plants in their journals.

If an invasive plant species is identified from the seedbank, have the students conduct the Alien Invasion lesson for that species to calculate the extent of it's potential spread.

Have the students create a classification system for their seed bank plants.

Design a rubric to evaluate completeness of their journals.

Independent Practice and Related Activities:

Students may investigate a particular species, design procedures for estimating the seed bank in a given area, investigate how the seeds got there, and suggest a program for control in that area.

IMPORTANT! If you identify or suspect that invasive weeds have been grown in the course of this activity, take proper precautions to dispose of the weeds so they are not reintroduced to local habitats! In the classroom, seedlings can be harvested and put in a 1-gal. glass jar. Put the lid on the jar and set in the sun to "cook." Once the plants are decomposing they can be added to a compost pile and mulched into the garden. Many people recommend double bagging plants in plastic bags and dumping them in the landfill… what message does this give our students about wise recycling?

Resources:

XID Identification System

Weed Identification Guides available from local extension offices or weed control departments of state and federal agencies.

Vocabulary:

angiosperms, dicots, monocots, seedbank, viable

National Science Education Standards:

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- ❑ Abilities necessary to do scientific inquiry
- ❑ Understandings about scientific inquiry

Life Science - CONTENT STANDARD C:

As a result of their activities in grades 5-8, all students should develop understanding of

- ❑ Structure and function in living systems
- ❑ Reproduction and heredity
- ❑ Regulation and behavior
- ❑ Populations and ecosystems
- ❑ Diversity and adaptations of organisms

Alien Shopping Spree

Subject: Life science, Human Influence, Math

Grade: 6-9

Lesson Topic: Human weed sources

Length: variable

Learner Objective:

Students will determine origins of seed sources other than natural dispersal

Students will explore their State Laws governing agricultural seed impurities in the products we buy

Introduction:

When we buy grass seed or farmers buy crop seed there are state laws that govern the percentage of allowable weed seed that can be present in the products we buy (the seed is then "certified"). For example, wild oat seed is a noxious weed and there may be no more than 45 seeds per pound of grain seed that a farmer may buy (in Oregon). The same type of laws apply to grass seed for our lawns or in the wildflower mixes we buy. It is important that the labeling of these products indicate the percentage of weed seed (contamination levels) and the potential type of seed so we can prevent possible invasion of those noxious species.

Content:

State and Federal laws determine the allowable level of contaminants in agricultural and commercial seed products sold, "certifying" the seed products as not containing more than a certain percentage of noxious weed seed. Labeling laws are somewhat more confusing and often the consumer is unaware of certifying or labeling laws that may or may not affect the choices made at the check-out counter. A result of an uninformed public may be the accelerated establishment of non-native and noxious plant species.

Materials and Supplies:

Samples of seed products from various sources (see below)
Magnifying glasses
Weed journals for recording information about seed products

Anticipatory Set:

Display a container of commercial wildflower mix and engage a discussion of what it is, why people desire the product, how many of the students have used it (or seen their parents use it) and if they think it might be a source of invasive weed species. For advanced classes you may discuss the issue of introducing "native" wildflowers that are not indigenous to the local habitat, and by extension, have a discussion about what is truly native (geographical vs. genetic relatedness).

Activity Outline:

Either you or the students will need to collect an assortment of seed sources that may contain noxious weeds. Possible sources include:

- Farm and garden stores (grass, wildflowers, feed)
- Nurseries (grass, wildflowers, vegetable and flower seed)
- Large 'box" stores (grass, wildflowers, vegetable and flower seed)
- County seed growers associations and co-ops (grass, crop seed, feed)

Depending on the number and variety of products, students may work individually or in teams. The students will examine the package labels to determine pertinent information (source, seed types, percentages of species, allowable weed seed amount, etc.). Allow the students to fully examine the labeling and discuss whether or not it provides all the information needed if a person was concerned about invasive weed species or issues of being truly "native." A suggested outline for a data table in their weed journals is displayed below.

Product Name

Seed Type	Seed Source	% Weed Seed	Weed Species Present	Quantity	Price	State Laws Yes/no

Distributor:
Other Labeling Information:

Students should examine a 10 g sample of seed, separating any impurities different than the intended seed. If they find seeds that are different than the intended seed (potential weed seed) they should calculate the percentage of weed seed and compare their figure to the allowable contamination rate. Students should describe the variety of contaminants in their sample (in some cases companies use inert fillers or allow other contaminants such as dirt and twigs).

How would they determine the percentage of contaminants in a mixed species product such as in "wildflower meadows"? Have them design a procedure for making this determination and, if time allows (or as an extension) have them carry out their procedure.

Students should also contact their county agents to research the state laws, kinds of seeds sold in their community and to determine any correlation between existing county weed problems and allowable contamination rates of weed species in the products sold locally. Consider the implications and ramifications if your students discovered a direct correlation! Students can affect change and make a difference in their community through their in-school investigations!

Have students collect invasive weed seed from the dominant weed plants in their area and design and Invasive Weed Seed Identification pamphlet. Use this guide to identify contaminants in the seed products sold in their area.

Closure and Assessment:

Collate and review the records of all possible weed contamination sources the students have found in their community. Discuss why it is important for people to know the types of weed seeds they may be purchasing. Would they buy a product that did not advertise the percentage and type of contaminant seed? Why or why not? Discuss the impact that might occur in their community if a product's marketing program was highly successful and the potential for invasive weeds existed with that product.

Examine their weed journals for completeness of records kept on all aspects of the products they examined.

Independent Practice and Related Activities:

Students interested in a long-term study can extend any of the suggested activities above. Because germination and knowledge of plant identification may be the only way to determine the presence of potential invasive seed, students will need to be aware of the time involved to conduct these studies, as well as, the correct disposal methods for any noxious weeds grown in the course of their investigations.

Resources:

Grain growers, seed co-ops, county extension, county agricultural agents, feed stores, nurseries and plant stores.

Laws governing contamination rates can be found on the Internet by searching state and federal agricultural department web sites. By typing the phrases, *"weed content" + "state law"* or *"certified seed"* into a favorite search engine, students can gain additional information about these laws.*****

***Tech Tip** – When entering a phrase such as "certified seed" into a search engine the quotation marks are needed in order to restrict the search to certified seed, rather then returning all web sources on anything related to *certified* or *seed*.

Vocabulary:

Certified, contaminants, native

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- ❑ Abilities necessary to do scientific inquiry
- ❑ Understandings about scientific inquiry

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- ❑ Structure and function in living systems
- ❑ Regulation and behavior
- ❑ Populations and ecosystems
- ❑ Diversity and adaptations of organisms

Science in Personal and Social Perspectives - CONTENT STANDARD F:
As a result of activities in grades 5-8, all students should develop understanding of

- ❑ Populations, resources, and environments
- ❑ Risks and benefits

Aliens In Your Socks

Subject: Life science

Grade: 6-8

Lesson Topic: seed dispersal (Fall activity)

Length: 1-2 periods +time to grow plants

Learner Objective:

Students will understand the mechanism of seed dispersal including wind, wildlife and human causes.

Students will investigate why alien weed species tend to have multiple means for dispersal than most plants and tend to germinate easier.

Introduction:

This popular activity has many versions and most of them are used to address the topic of plant seed dispersal within the environment. Since invasive weed species tend to produce large numbers of seed, are suited to a variety of habitat and may benefit from several methods of dispersal, *Aliens In Your Socks* is particularly well suited to adapt this activity to the study of invasive weeds.

Content:

Invasive weed species produce amazing numbers of seed, from thousands to millions per plant (see the lesson, *Alien Invasion* in this unit for statistics of particular species). Along with impressive numbers of seed, invasive weed species tend to have seed that germinate and grow faster in a wider range of environmental conditions than do most native species that are finely adapted to specific niches. Invasive species, by germinating early and growing fast, are also able to utilize soil nutrients and water resources before the native species. Additionally, the invasive species typically have evolved a variety of means of defense against predation. All of these factors contribute the aggressive establishment of invasive weed species. Seeds of any one species may be dispersed via the wind, carried by animals (seeds can "stick" or "cling" to animal fur), and many seeds are consumed by birds and animals and then dispersed when the animal defecates. One way for preventing the spread of weed species is for students to understand that human activities are a leading cause of weed dispersal… as one example, the seeds that normally may stick to an animal's fur can also cling to our clothes, our vehicle tires and many other articles we take through the brush on our excursions. By understanding the human role in seed dispersal, students will be in a position to help control the invasion by watching their own actions in the field and by educating others.

Materials and Supplies:

Old socks (preferably large "rag" or woolly type)
Mild carton planters or flower pots
Commercial potting soil
Gro-lux light on adjustable stand
Magnifying glasses
Tweezers
Spray bottle
Zip-lock bags
Butcher paper to cover tables
Weed journals

Anticipatory Set:

You will need to tell the students in advance of this activity to bring in some woolly socks (even better if they ask their folks for large socks, but make sure the parents understand that the socks will not be coming home!). Don't tell the students why the socks are needed. As the socks come in, keep them in a tub or basket on "display," partly as a reminder to those have forgotten to bring in socks, but also to build curiosity and anticipation.

Activity Outline:

Review with the students the definition and characteristics of alien weed species. Have them create a list of all the ways they think seeds might be dispersed and diagram their ideas on the board or large sheet of paper. Don't forget to discuss the ways that plants might move from country to country, or continent to continent across the sea. Create sub-categories under each of their ideas, i.e., if they mention "animals,' lead them to the various ideas on how animals might specifically disperse seeds. Another example might be:

Humans ⟶ Recreation ⟶ Horse camping ⟶ Hay
(seeds are transported to our forests in the horse feed)

In the outdoor portion of this activity, students will form a line at the edge of field or forest and you will produce the basket of old socks. Students will pull the socks over their shoes Depending on the number of students and/or sock, they may put socks on one or both shoes). The socks go *over* their shoes for the purpose of preventing puncture wounds or other injuries from, essentially, going barefoot in the field. Have the students walk a designated distance and return. They should then carefully remove their socks, turning them inside out as they do so in order to contain any seeds that may have stuck to the socks (alternatively, they can carefully remove their socks and place them in a zip-lock bag).

Once back in the classroom, the students should work over a large sheet of white paper or butcher paper (or cookie trays if you have enough for everyone), turn their socks right side out, and examine the sock for seeds that may be stuck to or embedded in the sock. Some seeds may be too small to see, or blend in perfectly with the color of the fabric, so caution the students not assume "there isn't anything there!" or "I found them all!" If there are too many seeds to count, have them cut the sock lengthwise, count the number of seed in several measured squares (2x2 cm), measure the total area, and calculate the estimated total. If there are multiple types of seeds represented they should describe and record the information in their weed journals. All of the students should cut a weedy section of their socks, approximately 10x30 cm. If they removed a number of seeds they can "re-apply" the seeds to their sock strip. The weedy sock strips can be planted in moist, sterile (seed free) soil and then arranged beneath a Gro-lux light positioned approximately 20 cm above the planters. Be sure to keep the soil moist with the spray bottle, but do not over water (or this becomes a moldy experiment!). In their weed journals, the students should record where they walked (describing the habitat), the date, a description of what they found on their on their socks (particularly using the magnifying glasses to examine the surface of the seeds), the number and kind of seed, and their predictions about what might grow out of their socks. The students should make regular observations and record their findings in their weed journals. Germination time will vary with species, from a couple of days to several weeks. You can best determine when to end this activity as it fits with other scheduled activities, but because the germination phase works "in the background," you may go on with other activities in this unit. Remember to properly dispose of any weed species that are grown (as outlined in this unit's previous activities).

Closure and Assessment:

How many seeds germinated? Were the students able to determine which species were present? Were their predictions correct? Have students share observations about the surfaces of seeds and relate that to how the seeds hitchhike to new areas. How many different kinds of seeds were found? How many native species were dispersed by this method? Was the mechanism for adhering to clothing the same in all seeds? What can they do to minimize the spread of seeds?

Independent Practice and Related Activities:

Design an experiment to discover how many types of surface to which a particular seed might "stick."

Continue growing the plants to a mature state in order to truly identify the plants and differentiate between invasive and native species that may have been found.

Resources:

XID Identification System

Photographs and weed identification guides available from county, state or federal agencies.

Vocabulary:

Dispersal, herbivory, niche, predation

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- ❑ Abilities necessary to do scientific inquiry
- ❑ Understandings about scientific inquiry

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- ❑ Structure and function in living systems
- ❑ Reproduction and heredity
- ❑ Regulation and behavior
- ❑ Populations and ecosystems
- ❑ Diversity and adaptations of organisms

Alien Invasion

Subject: Life science, writing, story problems (math)

Grade: 6-8

Lesson Topic: seed dispersal

Length: 1-2 Period

Learner Objective:

Students will investigate the means and rate of invasive weed spread.

Students will calculate the extent of an invasion after seeds have dispersed to understand exponential growth.

Students will create their own story problems that illustrate how humans contribute to the spread of invasive weed species.

Introduction:

In this lesson, students will encounter a scenario that may indeed be quite familiar to them, one in which it is possible that they have instigated the spread of invasive weed species through their own actions. Invasive weed species are often carried unintentionally by humans to new areas (cars, trucks, bikes, clothes or our pets). With increasing access to field and forest as our population grows, more and more opportunities exist for seeds and plant parts to be carried to new areas. With the ease of air and ship travel, non-native species are often just a few hours away from being transported thousands of miles to habitat that may be favorable to setting the stage for an invasion. More often then not, our rather innocent recreational activities can become significant sources of redistributing plant species (second to development).

Content:

The leading cause of loss of biodiversity is development because native flora and fauna are removed to make way for our needs and because the disturbed environment is primed to receive alien species. Alien weed species are particularly suited to these disturbed lands through adaptations that enable them to survive in a wide range of environmental conditions. Because of this, invasive weeds are the second leading cause of our loss of biodiversity. With an ever-increasing range of all invasive weed species and our increase access to wildlands, the wildfire of noxious weeds runs unabated. Invasive weed species also produce large numbers of seed that, if not immediately germinated, remain viable in the soil over many years in a wide range of conditions. Therefore, when alien seeds are carried by humans to new areas (particularly back to areas of disturbance like roadsides), factors such as temperature, moisture, soil types and time may *not* significantly limit the chances for a plant to become invasive.

Materials and Supplies:

Magnifying glasses
Weed Journals
Calculators
Alien Invasion Worksheet

Anticipatory Set:

Begin a discussion by asking how many of them have started an alien invasion (imply that some of them have). Ask about their recreational activities and if they can imagine ways by which those activities may have started an invasion.

Take a walk out to the parking lot to examine the tires, bumpers, doors and undercarriage of the vehicles (as always, a reminder to be respectful of other people's property… they are just *looking*). Vegetation may be caught in doors or in the undercarriage; seeds may be found in the tire tread (use magnifying glasses) or behind the bumper or other places where dirt is thrown and accumulates. Did they find any vehicles that are spreading the invasion?

Activity Outline:

List the various ways that the students have discussed as possible scenarios whereby they may have started an invasion.

Hand out the Alien Invasion Worksheet, then provide them with the following scenario and have them calculate the extent of the invasion (they should listen carefully and record important numbers):

> *A tract of land that had once been cleared was now overgrown with weeds and brush, including spotted knapweed (a Class A noxious weed). This land separated an urban neighborhood from the nearby national forested lands, and a few miles beyond that was a National Park. Although this tract of land was private property, it had several trails across it, used by people living nearby to access the forests beyond. A local mountain bike club requested permission from the owner to cross the land and join the forest trail system rather than drive their vehicles from town to the trail system. Securing permission, the club organized a 50 mile "City To The Park" benefit ride to advertise their new club and help vitalize their town and the nearby National Park with this popular recreational activity.*
>
> *The event went off as planned, but 150 bicyclists cutting across the weeded tract of land also carried broken bits of seed-bearing knapweed branches caught in the gears of their bikes and knapweed seed caught in the deep lugs of their tires. After a few miles of jarring along the forest trails, 300 seeds were dislodged. Assuming 50% will germinate and grow to maturity, and a mature plant may develop 1000 seeds, how many plants grew after the event, how many seeds would be produced for the seedbank, and how many plants would appear in the forest the following year?*

Calculation

300 seeds x 50% germination = 150 mature plants
150 mature plants x 1000 seeds per plant = 150000 seeds
150000 seeds x 50% germination = 75000 new knapweed plants in the forest the second year.
75000 new knapweed plants + 150 plants after the race = 75150 of plants one year after the benefit race!

The students could calculate the second year:
75150 plants x 1000 seeds per plant x 50% germination = 37,575,000 plants, *plus* the 75150 plants from the year prior because spotted knapweed is a perennial, **37,650,150 plants!!**

Carried out and graphed over five years, the rapidly rising plot line exhibits exponential growth. Refer to the chart below for germination and survival rates of various weed species (to be used in the activity below). The germination rate was placed at a high level for dramatic effect, though in under some conditions a 50% germination rate may be possible. The story also does not include a factor for seedling success. Like germination rates, seedlings have their own survival rates based upon local environmental conditions.

Return to the list of recreational activities the students developed at the opening discussion. Working in teams of two, have them invent similar story problems based upon:

- activities they actually do
- weed seed production numbers of actual weeds in their community(refer to chart above or have the students research local species)

The stories may be as complex as they can imagine, but they must have a sense of reality… in other words, they are creating story problems that might explain how their own recreational activities could lead to aliens in their neighborhood.

Closure and Assessment:

Have the students exchange and solve each other's story problems. Assessment may be in the form of a rubric to evaluate how realistic the stories problems are, the degree of complexity in math skills, and their ability to work in partnerships to create the story. Evaluate the completeness of their notes on the Alien Invasion Worksheet, in particular, notice how they interpreted the instruction to "record important numbers," not all numbers given in the story was important to the calculation of a knapweed invasion.

It is important to have a discussion on "limiting factors" in nature which would realistically prohibit the actual establishment of the "37 million plants" offered in the example on the Alien Invasion Worksheet. Limiting factors may include land area, competition, grazing, etc. What limiting factors can the students think of?

Independent Practice and Related Activities:

List of plants and seed viability data, available from local weed districts or by searching web sites such as http://plants.usda.gov

Advanced students may want to pursue their storylines over a five year period and graph the exponential growth. These "real life" scenarios can be used to educate others in their community.

Expand the discussion of limiting factors to the spread of invasive plants.

Vocabulary:

Adaptations, biodiversity, exponential growth, perennial, seedbank

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- Structure and function in living systems
- Reproduction and heredity
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

Science in Personal and Social Perspectives - CONTENT STANDARD F:
As a result of activities in grades 5-8, all students should develop understanding of

- Populations, resources, and environments
- Natural hazards
- Risks and benefits
- Science and technology in society

History and Nature of Science -CONTENT STANDARD G:
As a result of activities in grades 5-8, all students should develop understanding of

- Science as a human endeavor

Alien Invasion Worksheet

Name___________________________ Date_________

In the space below, write important information from the story, and record important numbers to be used in the activity below:

Using information from the story, answer the following questions and *show your calculations*.

How many plants grew after the event?

How many seeds would be produced for the seedbank?

How many plants would appear in the forest the following year?

I bet there would be over ***37 million plants*** in the forest by the end of the second year! How is that possible?!?! Show your work

Alien Impacts

Before discussing the impacts of alien plant species, it is important to mention the egocentric view that exists around the word "impact." Too often the word tends to be directed at ourselves with regard to how invasive weeds impact our lives. There is no question that the spread of invasive plants affects both aesthetic and practical aspects of our lives. The question of impact though, can be viewed from another direction, "What role do humans play in the distribution of non-native plant species, and how does the establishment of those invasive species impact biodiversity?" It can be argued that our actions have affected the quality of biodiversity, and therefore, *by our own hand* we suffer the consequences of unhealthy ecosystems in both personal and economic loss.

This unit examines the dramatic impact of alien invasions upon biodiversity, and then looks upon the consequences of our actions that brought these invasions to our lands. Why is Biodiversity important? The renowned biologist, E. O. Wilson, coined the term "biophilia" to describe the feeling that most people have for the value of great numbers of species. Species richness, or variety, is key to healthy environments, and healthy environments provide people with many values. Aesthetic values (the value of beauty and wonder) also extend to include spiritual value (where the environment plays a role in our cultural and religious traditions) and our ethical values (our value of life and the fact that it simply exists). Biodiversity is also valued by humans for more practical reasons. The greater the number of species, the greater the diversity, and so by extension, the more opportunities for humans to obtain food, medicines and materials that sustain our lives. Richness of species also improve the quality of abiotic resources. The energy flow within ecosystems, including nutrient cycles, carbon and nitrogen cycles, and the hydrologic cycle, are fueled by biodiversity. The air we breath, the water we drink, and the soil for our crops are directly affected by a healthy ecosystem, this web of richness, this diversity of life.

Invasive plant species affect biodiversity by altering habitats through competition for light, water, nutrients and space. As we saw in the previous Invasive Unit, non-native plants introduced to a new habitat frequently arrive without limiting factors of competition, herbivores, or disease that kept their numbers in check within their native habitat. Without these natural limiting factors, invasive weed species are able to quickly monopolize the landscape. The pressure of this competition is often too much for the native plant species, and so, the health and biodiversity of the habitat declines. The impact does not end with the weakened native plants, for in a healthy ecosystem, all life is connected. Herbivory refers to the animals and insects that feed on plants. Those herbivores may find fewer and unhealthy plants, leading them to move from an area or find their own health affected. Diseases that are naturally occurring may benefit from the weakened plant community in the short run, quickly moving through their weakened host, decimating the population and making way for the spread of invasive plants. The ripple affect of an invasive plant can quickly diminish biodiversity; approx. 400 of the 950 species listed as threatened or endangered are at risk specifically because of the introduction of non-native plants and animals, leading to the second major cause of lost biodiversity in North America.

In the opening paragraph, it was suggested that the impacts of invasive weeds to our lives is by our own hand. Indeed, the leading cause of biodiversity loss is from human actions which reduce and destroy habitat through development. Since we have seen the majority of invasive weeds are best able to benefit from these disturbed soils around our developments, it is not surprising to see that alien species, by our own hand, have become the second leading cause of habitat destruction and the diminishment of biodiversity around the world.

Your Curriculum - The following lesson fit naturally within your regular classroom ecosystems curriculum. They extend the Invasion Unit, allowing students to see firsthand how exponential growth patterns diminish biodiversity, upsetting the balance of life, and hence, impacting our lives economically and spiritually.

Lessons in this unit:

- Alien Populations EXPLODE!
- Aliens In The Web - Upsetting the Balance

Alien Populations EXPLODE!

Subject: Life science, Math

Grade: 6-8

Lesson Topic: Impact of seed production

Length: 1+

Learner Objective:

Students will learn that the impact of weeds begins with large seed production.

Students will be able to calculate and graph the exponential growth of seed production over time.

Students will be able to discuss the variety of environmental factors affecting germination.

Introduction:

In this session students will explore the seed production capabilities of various invasive weed species and the potential barriers that can inhibit population explosions. With a background in math (percentages and graphing) the activity will illustrate the *exponential* explosion of invasive plant populations.

Content:

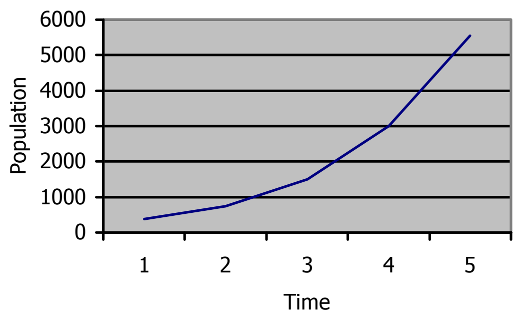
In previous activities the students have learned about some of the adaptations of invasive weed species that enable the plants to be so successful in habitats outside of their native range. One of those adaptations is a prolific number of seeds, but what is really meant by that? We know that a common evolutionary precept is that nearly all species produce offspring in greater numbers than can survive. When it comes to alien plants, how many seeds are we really talking about and how many of those seeds actually will germinate and survive to become mature plants? Without barriers to the survival of great numbers of offspring, the numbers of a population will exhibit *exponential growth*, in other words, the numbers will increase at a steady and unusually rapid pace. Many of us have heard of the examples used with the number of cats or rabbits that one pair can produce in a year, but these "statistics" are frequently touted as problematic without a discussion of the natural or human barriers that prevent such occurrences of explosive population growth. In this lesson the students will utilize current research on certain invasive plants which seek to address the various barriers and environmental factors which determine population growth. The students will see that invasive plants, unlike cats or rabbits, exhibit phenomenal growth potential even when factoring in germination rates, seedling survival rates and other barriers such as temperature, moisture, and competition. The lesson leads naturally to other barriers that may inhibit population explosions, especially those barriers that humans may impose to prevent *Aliens In Your Neighborhood*.

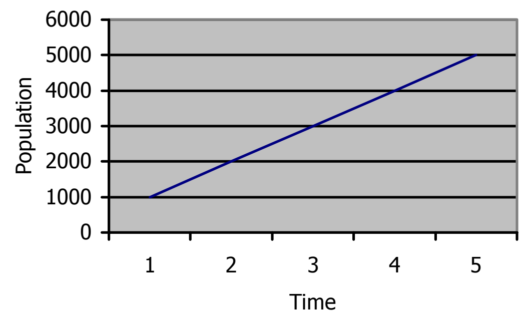
Materials and Supplies:

Chart of Seed Production and Germination – Teacher's Version
Chart of Seed Production and Germination – Student Version (chart only with space to take notes)
Seed Production Calculation Sheet
Graph paper
Calculators

Anticipatory Set:

Show students the two following graphs and ask them to explain their understanding of the two curves. The first graph is typical of populations growth without barriers (though they will soon learn that even with some barriers at play certain species like invasive weeds can still exhibit this exponential growth pattern).





Activity Outline:

Display an overhead transparency of the Chart of Seed Production and Germination and provide the students with their own copies so that they make take notes as needed. Ask the students if they can make any sense of the numbers represented for each species. The numbers are a reflection of some of the natural barriers to population growth and other factors. For example, the Canada thistle relies heavily on pollination from bees in addition to season temperature and humidity factors. There must also be good numbers of male and female plants in close proximity. If all conditions are not met it is possible to have no seeds produced. A plant like cheatgrass, with high germination and seedling survival rates, shows high adaptability in a wide range of environmental conditions. Notes are provided below the Teacher's Version of the chart to aid in this discussion

Provide the students with the Seed Production Calculation Sheet. From the Chart of Seed Production they should choose a plant species and record the data for that plant on their worksheet. Where a range of numbers or percentages is given, students may use the higher number, and average, or any number within the range… the important thing for them to understand is that seed production, germination rates and survival will fluctuate widely depending upon the state where the plants are found, the habitats it has invaded, seasonal weather patterns, soil and nutrient conditions, temperature and humidity, depth of seed in the soil, competition, and many other localized factors.

Have them fill in the appropriate blanks with the data they have chosen, and using their calculators, determine the numbers of seeds, seedlings and mature plants for a three year time period. They should transfer the data to the chart provided. The data chart is a good "stopping point" if you run out of time or need to help slower students. The questions following the data collection can be answered by the students in class, as homework, or in class discussions. Once the data is calculated and charted the students should proceed to the graphing portion of the activity. Students may create their own graphs (with colors!) rather than the one provided in this lesson. Advanced students could go on and pick another species to run the population calculations, and then graph that plant as a different color, overlaying their first set of data.

Closure and Assessment:

Collect and evaluate student worksheets.

Create a rubric to score class involvement, discussion, ability to complete task, and reliance or mentoring of peers.

Independent Practice and Related Activities: (I combined mine with Ag's because they are different but important extensions)

Resources:

U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2003, June). Fire Effects Information System (FEIS), [Online]. Available: http://www.fs.fed.us/database/feis/ [July 7, 2003]

U.S. Department of Agriculture, National Plant Data Center [Online] http://plants.usda.gov/ [July 8, 2003]

Credits:

Lesson adapted from Return of the Natives (RON), a Curriculum and Online Toolbox For The Restoration Of Native Plants & Eradication Of Invasive Weeds [Online], http://watershed.csumb.edu/ron/roncor/cor/index.htm [July 8, 2003] which adapted a similar lesson from:

The Montana Weed Trust Fund Teacher's Handbook and "What's Wrong With This Picture? Invasive Weeds: A Growing Pain", BLM, from the Montana War On weeds [Online] http://mtwow.org/ [July 8, 2003]

Vocabulary:

Allelopathic, annual, exponential growth, perennial

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- Structure and function in living systems
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

History and Nature of Science -CONTENT STANDARD G:
As a result of activities in grades 5-8, all students should develop understanding of

- Science as a human endeavor
- Nature of science

Alien Seed Cycle Worksheet

Name ___________________ **Date______**

Fill in the missing information by using the Chart of Seed Production and Germination and choose an alien species to use for your calculations.

Alien Species _______________________

# of seeds _____________ (choose a single number)

Germination Rate __________

Seedling Survival __________

Complete the seed cycle for your alien and answer the following questions. What will be the number of plants and the number of seeds that will be in the seedbank after three years if 100 seeds were dropped by humans into an area?

If 100 were spread accidentally by humans to form a weedy seedbank, ___% of them will germinate and ___% stay in the seedbank.

100 X ____% germination = ______ This is the amount of seeds that will become seedlings.
100 X ___ % not germinated = ___ the Seedbank for the 1st year.
If ___% of those new seedlings will survive and mature into adult plants, then ____number of seedlings X ___% survival = ____ amount of adult plants for the 1st year.
Those ______ adult plants will produce ______ seeds each.
These ______ seeds from the adult plants are added to the _______seeds already in the seedbank = ______, Next years seedbank.

To determine the second year:
Take ____% of the seedbank and they will germinate into seedlings.
____Seedbank total X ___% = ______ This is the amount of seeds that will become seedlings.
____ Seedbank total X ___ % = _____ the percentage of the Seedbank that does not germinate.
If ___% of those seedlings will survive and mature into adult plants, then ____Number of seedlings X ___% survival = _____ amount of adult plants for the 2nd year.
Those ______ adult plants will produce ______ seeds each.
These ______ seeds from the adult plants are added to the _______seeds already in the seedbank = ______, Next years seedbank.

To see how the population will grow in the third year:
Take ____% of the seedbank and they will germinate into seedlings.
____Seedbank total X ___% = ______ This is the amount of seeds that will become seedlings.
____ Seedbank total X ___ % = _____ the percentage of the Seedbank that does not germinate.
If ___% of those seedlings will survive and mature into adult plants, then
____Number of seedlings X ___% survival = _____ amount of adult plants for the 2nd year.
Those ______ adult plants will produce ______ seeds each.
These ______ seeds from the adult plants are added to the _______seeds already in the seedbank = ______, Next years seedbank.

If you finish early and the teacher allows you the time, calculate the fourth year!

Fill in the table below and graph the population explosion of your alien.

Year	**Plants**	**Seed Produced**	**Seedbank**
0	0	0	100
1			
2			
3			
4			

Why is this called a population explosion?

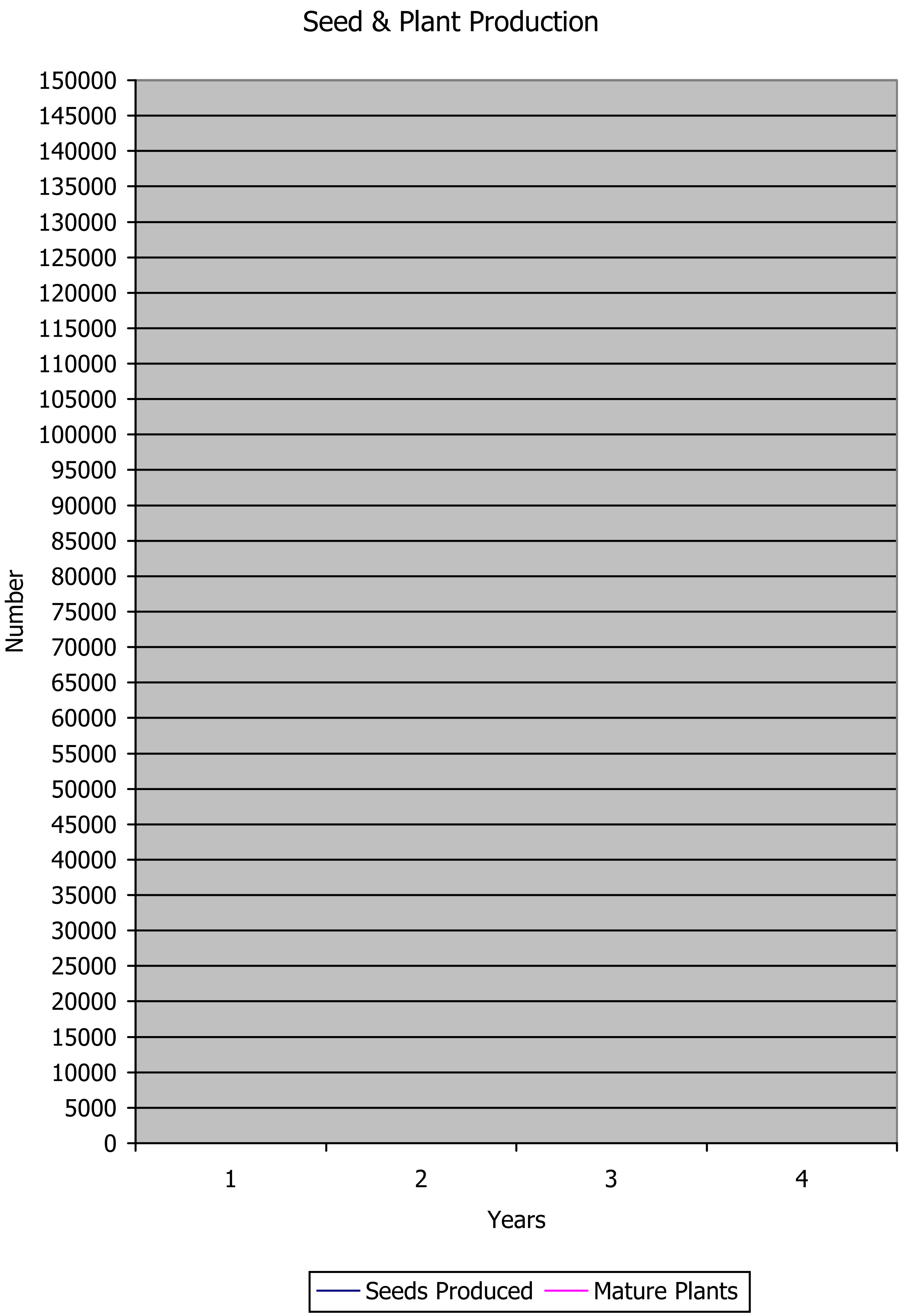
What do you think will happen to the native plants if this weed population explosion continues?

What natural and human barriers prevent populations of plants and animals from growing without limit?

Natural Barriers:

Human Barriers:

Graph the number of seeds and plants that are produced for each of the 3 years on the following page or create your own graph. Use different colors for the two graph lines you create.


Seed & Plant Production
Number
150000
145000
140000
135000
130000
125000
120000
115000
110000
105000
100000
95000
90000
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1
2
3
4
Years
Seeds Produced
Mature Plants

Teacher Information sheet

Seed Production & Survival*

Alien Species	# of Seeds	Survival (yrs)	Germination Rate (%)	Seedling Survival (%)
Canada thistle [a] ***Cirsium arvense***	0-40,000	1-22	90	5
Field bindweed [b] ***Convolvulus arvensis***	2-4 (per flowerhead)	30-50	90	90
Purple loosestrife [c] ***Lythrum salicaria***	100,000-2.5mill	2-3	98	10-20
Spotted knapweed [d] ***Centaurea maculosa***	65-25,000	5	90	45-88
Yellow starthistle [e] ***Centaurea solstitialis***	30-150,000	10	90-100	50
Cheatgrass [f] ***Bromus tectorum***	25-5,000	2-3	95	95

*The numbers used in the chart above are not intended to be representative of all plants in all conditions, though unlike some invasive weed education activities, they do reflect accurate ranges. It may be appropriate to tell your students that purple loosestrife produces 2.5 million seeds, but they should understand that in some situations a plant might only produce a few hundred (in two separate weed education curricula both knapweed and starthistle are represented as *each* producing 1000 seeds/plant and *both* species having a 4% survival rate, without any discussion of more realistic ranges based upon environmental conditions and patterns). Seed production, germination rates and survival will fluctuate widely depending upon the state where the plants are found, the habitats it has invaded, seasonal weather patterns, soil and nutrient conditions, temperature and humidity, depth of seed in the soil, competition, and many other localized factors. Numbers were drawn from the available research on the botanical and ecological characteristics for the species, synthesized in the reports available at the website listed below. For the purpose of the *Aliens In Your Neighborhood* activities, and to illustrate the power of exponential growth, it is suggested that students use a range of numbers for each species when doing the

Population Explosion activity. Advanced students may want to investigate localized conditions affecting seed production and germination rates.

Additional plant facts and notes:
a – highly dependent on pollination between male and female plants (primarily by bees) and on very specific local environmental conditions.

b – plants produce long stems (20-200 cm) with several flowers per stem, and can successfully reproduce from it's extensive rhizomes (roots may penetrate the soil to a depth of 20'). Seeds can remain viable after passing through animal digestive tracts.

c – Seeds can germinate even when saturated or in soil that is under water. Seeds can be transported in fur of mammals, plumage of waterfowl, mud attached to footgear, vehicle treads or cooling systems of outboard motors, dispersed by birds after ingestion, and by wind and water. The low seedling survival rate should not be taken lightly considering the extremely high number of seedlings that would be present after a 98% germination rate… they would in effect, be their own competitor.
d – Individual plants can live for nine years. Because of the sheer number of seeds, about 0.1% of the seed produced under certain conditions would be needed to maintain the size of the stands (the same figure can hold true for purple loosestrife). Allelopathy and colonization of spotted knapweed roots by arbuscular mycorrhizal fungi, may contribute to its competitive dominance over native grasses.

e – An interesting adaptation is to have hairs and waxy coating on mature yellow starthistle leaves reflect light, thus reducing the heat load and transpiration demand, while winged stems also dissipate heat. Tap roots up to a meter deep also help conserve and find water in direct sun habitat. Long-distance dispersal of yellow starthistle seed is often directly related to human activities and occurs by movement of livestock, vehicles, equipment, and contaminated hay and crop seed [32,35]. Birds such as ring-necked pheasants, California quail, house finches, and American goldfinches feed heavily on yellow starthistle seeds.

f – Cheatgrass reproduces only by seed and, unlike the other species in this list, is an annual. Have students explore the relationship between an annual plant and seed production and why this particular plant is often referred to as a "living wildfire." See http://www.fs.fed.us/database/feis/plants/graminoid/brotec/botanical_and_ecological_characteristics.html for a lengthy description of the range of adaptations and dispersal modes.

Information from various research papers cited for each individual plant at:
U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2003, June). Fire Effects Information System (FEIS), [Online]. Available: http://www.fs.fed.us/database/feis/ [June 9, 2003].

Students interested in additional information can access this site, click on the Invasive Weeds Plants List, and scroll through an extensive list of alien plant species for specific botanical information.

Questions on Student Alien Seed Cycle Worksheet:

Why is this called a population explosion?

The plant population is increasing at a rate faster then it would under normal circumstances of competition and other natural barriers that were most likely in place in the plant's native habitat/

What do you think will happen to the native plants if this weed population explosion continues?

Native plants will most likely be suppressed due to loss of water and nutrient resources, shading, allelopathic effects, herbivory and other impacts of severe competition from the large numbers of invasive plants.

What natural and human barriers prevent populations of plants and animals from growing without limit?

Natural barriers (disease, predators, fire, insects)
Human barriers (herbicides, collecting, habitat destruction… see Alien Control Unit).

Chart of Seed Production and Germination

Alien Species	# of Seeds	Survival (yrs)	Germination Rate (%)	Seedling Survival (%)
Canada thistle ***Cirsium arvensis***	0-40,000	1-22	90	5
Field bindweed ***Convolvulus arvensis***	2-4 (per flowerhead)	30-50	90	90
Purple loosestrife ***Lythrum salicaria***	100,000-2.5mill	2-3	98	10-20
Spotted knapweed ***Centaurea maculosa***	65-25,000	5	90	45-88
Yellow starthistle ***Centaurea solstitialis***	30-150,000	10	90-100	50
Cheatgrass ***Bromus tectorum***	25-5,000	2-3	95	95

Notes:

Aliens in the Web

Subject: Life science | Grade: 6-8

Lesson Topic: Food Chain & Food Web | Length: 1+

Learner Objective:

Students will exhibit the interrelationships between consumers and producers by creating a food web.

Students will be able to illustrate how alien weed species can interrupt a native food chain.

Students will gain an understanding of how an invasive weed species can disrupt biodiversity and the entire food web.

Introduction:

Humans too often view particular plants or animals as separate entities, most often in the guise of resources (things we can use to our own benefit). Resource extraction is the utilization of a single resource from nature. Timber, mining, and grazing are examples of resource extraction. Too often our quest to utilize one resource has unintended and adverse effects on the surrounding resources. The adverse effects to these other resources of forest and field have led to laws controlling extraction, laws to protect species (Endangered species Act), tremendous costs of restoration, and the domino effect of continued disruption to the environment (the introduction of invasive species being but one example of the disruptive chain reaction).

In this activity students will examine the intricate web that ties all life together and learn how the entire web of life is affected by the disruption or removal of a single strand. Students will not only investigate the eating relationships between species but the kinds of relationships involved with water, shelter, and reproduction.

The single beat of a butterfly wing is felt around the world.
(Unknown)

Content:

Natural ecosystems function in an ever-dynamic exchange of energy, producing and distributing this energy through a web of relationships between all biotic and abiotic resources. This web of interconnected relationships intimately ties the biodiversity of any particular ecosystem. All of life depends upon the sun for energy. Through photosynthesis, plants convert the energy of the sun into food (producers) and this food is then used by herbivores and omnivores (consumers). Other consumers include the carnivores, which obtain their energy from eating herbivores and omnivores.

This cycling of energy is complete when plants and animals die and the decomposer species return vital nutrients (abiotic resources) to the soil where the producers once again use them.

A food chain is a simple way to illustrate this transfer of energy:

Sun → pine tree → pine seed → squirrel → great horned owl

A food web describes the more intricate interconnections between various food chains and gives a clearer portrayal of the complexity that actually exists in a healthy ecosystem (see Alien Food Web below).

Materials and Supplies:

3 x 5" index cards (assorted colors are helpful but not required) for game labels
Optional: Yarn to tie to labels so they can be worn around the neck
Large ball of twine (yarn works well but can break when the "web" is drawn taut during the activity)
Alien Food Web transparency
List of "members" of the game (see list of Abiotic & Biotic Resources). You may want to have your students come up with their own list.

Anticipatory Set:

Make a transparency from the Alien Food Web (below) and display on the overhead. Use a thin strip of paper to cover the consumer/producer labels on the left side of the illustration. Initiate a discussion about what the illustration depicts, and introduce the various terms about consumers and producers.

As a preliminary activity you might have the students draw their own food webs using the flora and fauna of their local areas and incorporating the particular invasive weed species they have researched in previous units.

Activity Outline:

This activity has many variations, and can be done indoors or outdoors. It is recommended that when the students form a circle you have them sit because it is too hard to stand through this activity and not wiggle!

On 3 x 5" cards, write the name of each resource from the Abiotic & Biotic Resources list below with a bold black marker (or use the guide to assist you in having the students create their own list). It is helpful to use colored cards for the different groupings, i.e., yellow cards for the abiotic resources, blue for… etc. – in this manner students who are more visually oriented can cue in the various groups, and the color-coding helps to facilitate dividing the cards among however many students you have for the game.

In some manner depending upon the dynamics of your classroom, distribute one card to each student – an easy method is to simply shuffle the deck, fan them with the names facing you, and have the students randomly choose a card (naturally you will not have told them the significance of the colored cards beforehand). Arrange the students in a circle and have them display their cards to their peers (it may be easier to punch two holes in the cards and tie on a length of yarn so they can wear their labels around their necks). You may want to have younger students or large groups be seated rather than stand.

Tell them they are going to create a food web, and begin the discussion by asking, "What one thing is all life dependent upon?" Discussion will lead to the answer, "Sun," at which point you can hand or toss the ball of twine to the student wearing the "sun" label. Ask for a show of hands and ask, "Who needs the sun?" Many, if not all hands will shoot up (this is a good point for an initial mental assessment as you observe which students *did not* raise their hand, the point being, all hands should have been raised). Choose someone from those who raised their hands and have "the sun" toss the ball of twine to the chosen person while hanging on to the loose end of the twine. If the sun threw the twine to the "apple tree," ask who needs the apple tree, chose a person who has a good connection to the apple tree and have the ball of twine tossed to that individual. Continue in this manner until all students are connected to the web. Your own knowledge of the relationships between the resources will be important in guiding the students to connections between resources that may not be readily apparent to them. Abiotic resources, particularly the sun, water and soil, may be used more than once to help make connections (don't suggest this possibility right away – it becomes important near the end of the game when the only resources remaining are an aspen and the cheatgrass; the aspen needs sun, to the twine can go back to the sun, and then to the cheatgrass that needs the sun's energy – it may take some creativity to connect the last few resources). When all the connections have been made, have the students hang on tightly to their string with one hand and have everyone take a half step backwards to make the web as taut as possible. If you tug or pluck one strand several students will feel it. Have the ones who feel it raise their hands. The web is a visual representation of ecosystem relationships, the tug is a sensory representation of a disturbance in another part of the ecosystem.

How do invasive weed species fit into the activity? There are a couple different versions of the game that could illustrate the objectives of the activity. In one, the invasive species of plants and animals are mixed in with the rest of the cards and the game played in the "normal" fashion. In this version it will appear that the invasive species fit in perfectly with the web of relationships between native species. Can an ecosystem be in relative balance with the presence of invasive species? Possibly. But what is really happening to the ecosystem? Tug on one of the invasive species. Who or what is affected? If an invasive plant uses resources intended for a native species, what will happen to the native species? And what will happen to the species connected to it? If woodpeckers start feeding on long-horned beetles, what happens to the population of insects normally consumed by the woodpecker? Use the "tug and hand raising" approach to lead a discussion of other disruptions to the ecosystem.

In a second version of the game, the first web formed is created entirely from native species, along with the appropriate conversation about the relationships producers, consumers, decomposers and abiotic factors that exist to keep the whole system healthy. Then, introduce invasive species and discuss the effect on the student's "healthy" web. Introduce the invasive species by hanging the labels around different students, for example, the "snag" may be connected to a "woodpecker," so you can introduce a starling by hanging it's label around the "snag," announcing that the starling laid it's eggs with the woodpecker's eggs, and the starling babies threw their "native" nest mates out. Hang the "cheatgrass" sign around the "fescue" and announce that the fescue has been forced out by the highly competitive cheatgrass. What other connections can you come up with? Let the students introduce other invasive species to the game and discuss the effects of that introduction to the web.

Note on Management from the Author: The throwing of the ball of twine, students dropping their end of the string, having the ball only go part way and then drop through the web, the string breaking, and someone needing to go to the bathroom are examples of potential group management challenges. Of all the things I have seen go "wrong" with this activity, in reality they have added to the overall fun. If you approach these little challenges with a fun and creative attitude it makes the activity more joyful, and they do not detract from the point of the activity, which the students will see very clearly. And major Bonus Points to whichever student gets the whole mess of string wound back in to a ball!!! (I have some suggestions to make this easier, but I don't want to rob you of all discovery!)

Closure and Assessment:

If the students created their own food web drawings, initiate a discussion of how the activity relates to their own food webs and the overall impacts to the biodiversity of their own community.

Create a rubric to score class involvement, discussion, out-of-the-box thinking, ability to complete tasks, and reliance or mentoring of peers.

Independent Practice and Related Activities:

Students may draw/color their own food chains and food webs. If you have a collection of wildlife magazines they can cut out all the plants and animals from a magazine and arrange them into a food web.

Modify the activity and discussion to include primary and secondary producers and consumers.

Have the students inventory the habitat of their schoolyard, local areas or National Park to create a food web of the ecosystem.

Resources:

Krasny, Marianne, et al. (2003) *Invasion Ecology*. Cornell Scientific Inquiry Series, National Science Teachers Association: Arlington, VA.

Vocabulary:

Abiotic, biodiversity, biotic, carnivore, consumer, decomposer, food chain, food web, herbivore, omnivore, producer

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science - CONTENT STANDARD B:
As a result of their activities in grades 5-8, all students should develop an understanding of

- Transfer of energy

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- Structure and function in living systems
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

Science in Personal and Social Perspectives - CONTENT STANDARD F:
As a result of activities in grades 5-8, all students should develop understanding of

- Personal health
- Populations, resources, and environments

History and Nature of Science -CONTENT STANDARD G:
As a result of activities in grades 5-8, all students should develop understanding of

- Science as a human endeavor
- Nature of science

Alien Food Web

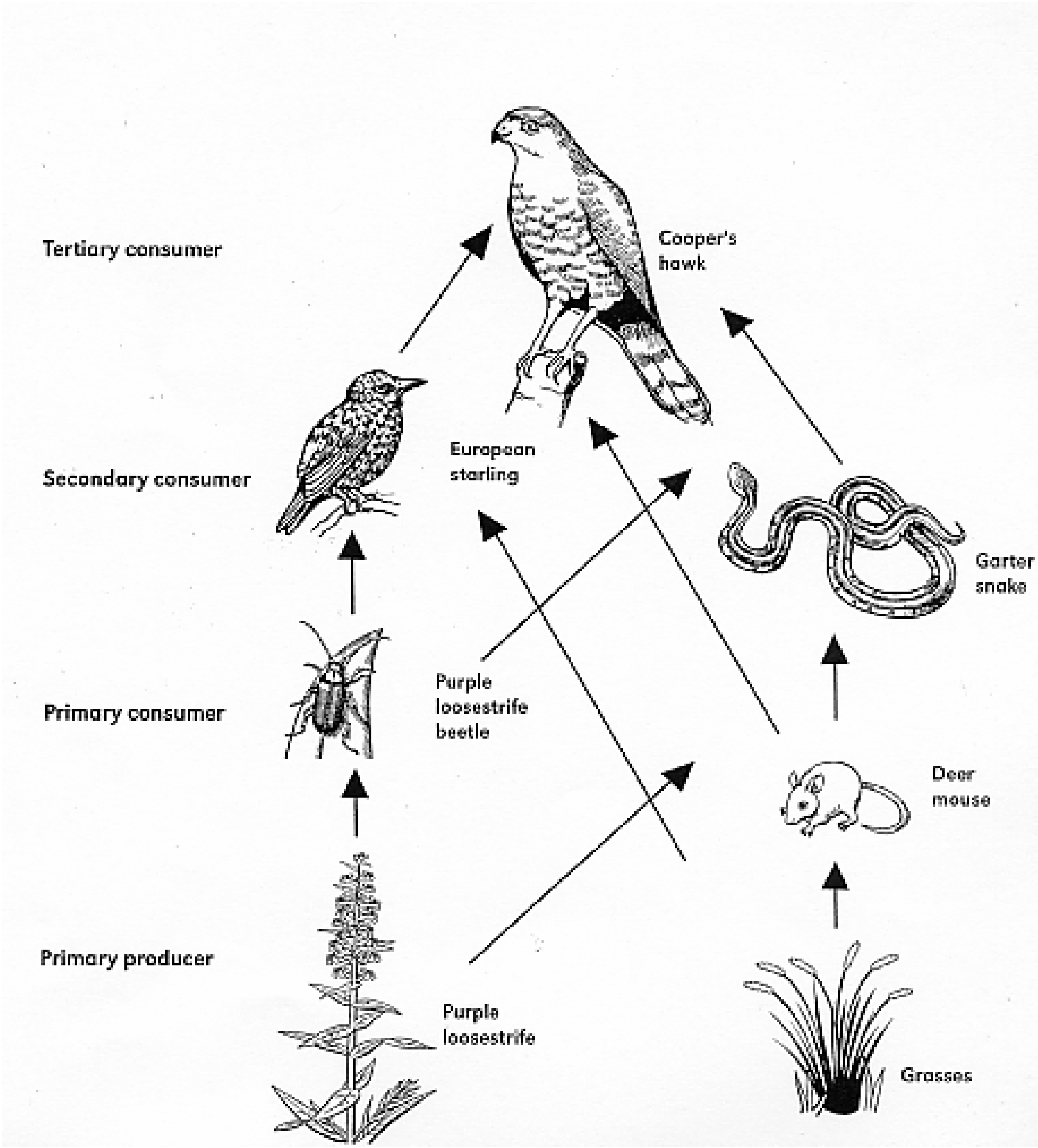


Illustration Credit:
Krasny, Marianne, et al. (2003) *Invasion Ecology*. Cornell Scientific Inquiry Series, National Science Teachers Association: Arlington, VA, p. 30.

Abiotic & Biotic Resources

Abiotic

Sun
Water
Soil
Wind
Snag

Biotic

Producers

Bitterbrush
Sagebrush
Aspen
Fir tree
Pine tree
Wheat
Apple tree
Fescue

Consumers

Human
Woodpecker
Deer
Frog
Grasshopper
Robin
Mosquito
Red-tailed hawk
Gopher snake
Deer mouse
Bull trout
Osprey
Coyote
Housefly
Butterfly
Macroinvertebrate
Ant

Decomposers

Mushroom (fungi)
Bacteria
Earthworm
Ground beetle
Turkey vulture

Introduced Resources

Producers

Tansy ragwort
Purple loosestrife
Spotted knapweed
Cheatgrass

Consumers

Purple loosestrife beetle
Root boring weevil (*Cyphocleonus achates*)
Root boring moth (*Agapeta zoegana*)
Asian long-horned beetle
Starling

Note: For more advanced students and larger class sizes you might add more species and create sub-groups of primary and secondary producers and consumers.

Alien Controls

In previous units students saw how alien weed species came to be in The Invasion, and the manner in which the exponential growth of weeds allow them to spread when natural limiting factors are not present. Once weeds are established, students investigated The Impact upon biodiversity and the aesthetic and practical consequences to humans. In this final unit before students embark on inventory and monitoring of weeds in their community, students will investigate the human response to this biological pollution through chemical, mechanical (including fire), and biological control.

It is important to remember that controlling alien plant species is a response to biological pollution, to a problem that will persist unless restoration of a healthy environment also becomes part of the solution. Pulling weeds may slow the *spread* of weeds, but it does not alter the conditions that first favored the invasion. Students who participate in NatureMapping, the capstone unit of *Aliens In Your Neighborhood*, contribute valuable information about the entire ecosystem affected by alien weeds. By understanding the complex web of interactions, land managers may better prescribe a combination of control methods that eliminate the alien species, as well as, obtain from the students valuable information for the restoration of the land.

Alien weed species have the advantage of few natural enemies and an ability to persist in a wide range of habitat and environmental conditions. For these reasons, it is rare that a single method of control is effective... as any child will tell you, after being told to weed the garden, it is a job that never seems to go away! Besides hand pulling, land managers have a variety of other means for controlling invasive weeds.

Chemical control includes a wide range of methods to apply herbicides (or for non-plant alien species, insecticides, fungicides and pesticides). Concerns about chemical control include pollution of the land and water, the killing of non-selected plants and animals, and the ability for chemicals to persist and accumulate in the environment. The potential to persist and accumulate in both abiotic and biotic, non-target areas is particularly disturbing when it may take many years, if ever, to discover the effects.

Mechanical control may include that dreadful call to pull weeds by hand, or remove them with weedeaters, chain saws, and mowing (both rotary and flailing). Like chemical controls, many of these methods are not specific to the alien weed, e.g. machinery typically cut, chip and grind everything in their path (not to mention the insects, small mammals and reptiles along the way). For some alien species, and with the proper timing during the plant's growth cycle, mechanical control methods can be effective. Fire is included in this category as one other method for controlling weeds. Of important consideration in the use of fire is the timing and understanding of fire's effect on the plant. Many plants are rated with regard to their resistance to fire; a plant with low resistance to fire (flammable) may respond to control by fire. Fire is not necessarily the best control for all plants with low resistance though, for example, cheatgrass is highly flammable (low resistance) but it's prolific seeds are resistant to fast, low temperature fires, and may also benefit from the nutrients released to the soil by the fire. Mechanical control and fire may have significant costs due to the labor intensiveness of the work, may accelerate the invasion rather than eliminate it, and requires specific knowledge of the target plants and the timing of the work.

A third approach used to control invasive plants is biological control. Biological control involves some change in the environment that prevents the opportunity for alien species to dominate an ecosystem. The most common form of biological control is the introduction of a host specific herbivore. Host specificity is the ideal, for if an insect only feeds upon a particular plant, the plant is eradicated as the insect attacks, and the insect is eradicated as the food source disappears. Unfortunately nature doesn't always work so smoothly. Because alien weed species arrive without their natural herbivores, the insect must be imported as well, which introduces yet another alien to the ecosystem. More than once an imported predator has found native species tastier than the target, and suddenly the new alien is eliminating the competition for the alien plant it was intended to destroy. Biological control also includes changing the environment (ex. through flooding or drying) in an effort to create extreme conditions where the alien cannot survive (and unfortunately where some native species also suffer). In the past few years gene manipulation has become another potential method for controlling invasive species. Regardless of the methods used, whether introducing aliens to fight aliens, altering an ecosystem that once was in balance, or manipulating the genetic code, biological control has complex ethical issues, and short or long term consequences to the natural world.

More often we find land managers using a combination of several methods, especially when the combination can narrow the range of impact to other species, i.e., when the control is host-specific. This unit allows students to investigate various methods of control and evaluate the effectiveness of that control on various species. Because of the complexity involved with controlling alien species, the intent is not to teach students *how* to control invasive weeds, but rather, to evaluate methods that might be most effective, and more importantly, to understand why some methods are inappropriate. The final NatureMapping Unit provides students with the opportunity to inventory and map infested areas in order to understand the complexity of the target area, secondly to apply their knowledge of various control methods, and ultimately to participate in the restoration of the land, to contribute to healing.

Your Curriculum - Students should have a background in ecology as provided in previous units and through your regular life science and ecosystems curricula. As your students work with resource managers of the National Parks or other agencies and communities dealing with the problem of invasive weeds, they will need to understand how the methods of control are used, how the methods can be combined, and how to measure the success of control. Most importantly, they need to understand that the ultimate answer to eradicating alien weed species is a functioning native ecosystem. They need to understand the principles behind a functioning native ecosystem where the web of interactions between abiotic and biotic components is at balance. Because of the complexity of control issues, and the time it takes to eradicate alien weeds, this unit will focus on student's awareness of the methods and difficulty in removing alien species in order to restore an ecosystem to health.

Lessons in this unit:

And Just How DO You Kill A Weed? - Explorations in eradication! Includes experiment design and implementation while interwoven with traditional life science curriculum

Create A Spotted Knapweed Insectory - This is an outside link to the Montana War On Weeds website. This is at least a full year to multiple year project for those teachers who want to create a worthwhile biological control project for their students, and have the students assist local weed control boards or National Park resources managers with knapweed control. It is offered here as an example of projects that can have a significant effect on both education and weed control. It also underscores the true nature of the methods and difficulty in removing alien species in order to restore an ecosystem to health.

(For an article that you can share with your students in a "current events" discussion format on using insects to control invasive weed species, see *In War On Weed, Beetles Winning*, an article from the Portland Press Herald (.pdf file).)

And Just How DO You Kill A Weed?

Subject: Life science, Research & Experimental Design

Grade: 6-8

Lesson Topic: Plant growth and Regeneration

Length: ~6 weeks

Learner Objective:

The students will be able to describe how both seeds *and fruits* help with seed dispersal.
Students will investigate other means for plants to regenerate besides seeds
The students will be able to explain chemical, cultural and biological weed control methods.
The students will design and conduct an experiment to simulate a weed control method.
Through their experiments students will understand various ways to prevent weed dispersal and the problems of applying "one solution."
The students will be introduced to the idea of Integrated Pest Management (IPM)

Introduction:

It is important to remember that controlling alien plant species is a response to biological pollution, to a problem that will persist unless restoration of a healthy environment also becomes part of the solution. Pulling weeds may slow the *spread* of weeds, but it does not alter the conditions that first favored the invasion. Students who participate in NatureMapping, the capstone unit of *Aliens In Your Neighborhood*, contribute valuable information about the entire ecosystem affected by alien weeds. By understanding the complex web of interactions, land managers may better prescribe a combination of control methods that eliminate the alien species, as well as, obtain from the students valuable information for the restoration of the land.

Content:

Alien weed species have the advantage of few natural enemies and an ability to persist in a wide range of habitat and environmental conditions. For these reasons, it is rare that a single method of control is effective... as any child will tell you, after being told to weed the garden, it is a job that never seems to go away! Besides hand pulling, land managers have a variety of other means for controlling invasive weeds – chemical, biological, mechanical and fire (refer to the Control Unit introduction for a detailed explanation of these methods).

In this activity, students will become familiar with the process of experimental design as they create innovative solutions to controlling invasive weed species. Land managers often use a combination of several methods, especially when the combination can narrow the range of impact to other species, i.e., when the control method is host-specific. But many unanswered questions remain about how best to control invasive species, and, it can be assumed, there are probably as many solutions as invasive plants have adaptations to thwart our efforts. Your students will have the opportunity to explore and invent some possible solutions… who knows, maybe some of them will create solutions which will be adopted by land managers, and thus, turn their education into a meaningful contribution as citizen scientists.

Many students interested in science are anxious to "do science in the field" because the media typically reports the more exciting aspects of field work in exotic places, often under difficult conditions. What they fail to report is all the research, often years of it, which must form the foundation of the fieldwork. In this activity students will perform basic research on what is currently known about the invasive weed of their choice, and then design an experiment and hypothesis to investigate their own ideas. The activity begins, as with all investigations, with an "I Wonder…" statement, for example, "If cheatgrass isn't killed by a forest fire, I wonder if freezing it would work?" Short of detonating nuclear devices, I would allow ideas as broad and as wild as a young mind could create (actually, I've had this discussion with students and we hypothesized that some invasive plants would even survive a nuclear blast, but we lacked the resources (and security clearance!) to carry out an experiment).

After the "I Wonder" statement the students should be guided through the Experiment Design Form. The most difficult aspect of experimental design is refining the question. When we wonder, we tend to do so broadly and hence we inadvertently include a great number of variables that make it difficult to answer our question. Doing research on our question is often helpful in refining the question. For example, we may ask the question, "Why is the sky blue?" Seemingly a simple question, but upon examination we find a need to define what we mean by "sky" and what exactly is "blue?" After research we may have a better understanding of the layers of atmosphere, particulate matter (dust) suspended in different quantities at different altitudes, the reflective properties of those particles, the physics of light waves, the wavelengths emanating from the sun, the angle of light to our perspective on the surface of the earth, and the splitting of wavelengths by angles of entry and particles struck. Having done all that research we would be in much better position to design an experiment that could simulate a blue sky, and so answer the original question of wonder.

The second most difficult aspect of designing an experiment is defining the variables; the independent variable (the thing being manipulated, ex. temperature), the dependent variable (the thing you believe will respond to the independent variable, ex. germination rate), the controlled variables (those things you hold constant, ex. humidity) and the control (the "normal" situation without manipulating variables so you have something to compare your results against). Students must have done a certain amount of research before they can start imaging the variables. The more time you can assist them in refining their question, the easier it will be to determine, and limit the variables (the fewer the variables in an experiment, the less chance for error, and by extension, the more reliable the data).

Materials and Supplies:

Living invasive plants and/or seed from a variety of aliens in your neighborhood.
A set-up with Gro-lux lights to grow plants, small greenhouse, or solar frame
Weed Journals (or have the students make an Experiment Notebook)
The following forms are included in this lesson:
Teacher's Outline for a Student-Based Inquiry, *with suggested time frames*
Design An Experiment Form
Student Experiment Notebook Check-off List
Assessment Rubrics

Students will be designing their own experiments, so the materials will vary. Complete materials and procedures outlines are essential elements of experimental design and students should gain approval for their materials list and procedures before being allowed to continue.

Anticipatory Set:

Obtain a plant like bindweed (Morning Glory), ivy or some other plant that naturally regenerates from rhizomes, stem sections and tap roots (although an alien weed makes a better point to the activity, it is possible to use more common plants). Make sure the plant is alive and planted in a garden pot, displayed prominently at the beginning of class. Hidden from view, have a tray of moist potting soil that has been "spiked" with a small amount of fertilizer and root hormone (B-1 Root Stimulator® would be great). Ask your students for suggestions on how you might kill the plant and list their (appropriate) suggestions on the board. After making the list, jerk the plant out of the pot and ask how many of the students think you just killed the plant (you'll need to be doing a bit of the violent gardener act here). Break a few limbs off and tear up some leaves. Do any students think it is dead yet? Pull out some scissors and snip the limbs and roots into 2-3" sections and ask the students if they think the plant is dead. At this point pull out the tray of soil, bury all the plant parts about ½" deep, mist the surface thoroughly with water, and as you walk it over to the growing station remark, "Well, it might look dead, but *I sure don't think it's dead*." (In a couple days, after maintaining moisture and a 24 hr. light, you should have new sprouts from the segments of the original plant).

Activity Outline:

The students will design an experiment to "kill" an invasive weed species based upon the list of methods they created during the anticipatory set (or any other appropriate means they may come up with).

Some suggested ways to kill a weed might be (excluding nuclear explosions):

- ❑ Applying chemical treatment (herbicides, fungicides or pesticides)
- ❑ Simulate a wildfire
- ❑ Mechanical destruction (chopping, grinding, etc.)
- ❑ Defoliation
- ❑ Biological control (introducing herbivores or parasites/Integrated Pest Management - IPM)
- ❑ Grazing (have a pet goat at school!)
- ❑ Bury them in a compost pile
- ❑ Other?

Live plants may be transplanted from the field or started from seed, depending upon availability and time constraints. Students should record important information concerning their plant in their Weed Journals or Experiment Notebook, including:

- ❑ Species name
- ❑ Date collected or planted
- ❑ Drawings of their plant
- ❑ Identification of plant parts
- ❑ Measurement of plant
- ❑ Other observations taken daily while caring for them until they are ready to begin their experiments.

While caring for their plants the students should be conducting research about their plant and the control methods they are planning to investigate. Follow the guidelines from the Student Experiment Notebook Check-off List to assist students in their research and report writing.

Assist them with filling out the Experiment Design Form. Once they have most of the elements decided, they should begin writing a detailed procedure for their experiment. It is difficult for them to do this because they need to visualize an entire process that *they have not yet done and are only just inventing*. Stay with them here, and let them know that all scientists are continually changing or modifying their procedures.

Approve their materials list and procedural outline before allowing them to begin. The first few days will be spent gathering materials and building their experiment set-ups. Once their experiments are up and running the time spent to monitor them is reduced and there will be time each day for integrating other lessons. Students should be encouraged to come immediately to class, collect data and care for their plants, 10-15 minutes is usually enough. They are 100% responsible for all aspects of their experiment – caring for the plants, collecting and recording data, updating their Experiment Notebooks, modifying procedures, adding to their research paper, designing data collection forms, and thinking ahead to the presentation of their findings to the "scientific community" (their peers).

Closure and Assessment:

Use or modify the Experiment Assessment Rubrics included with this activity. You might create a simpler version of them so that students can assess their peers during the oral presentation.

This is an on-going activity, taking about a week to get started and a minimal amount of time each day thereafter. During the course of this activity there will be a great many life science/botanical topics touched upon by the students during their research – focusing on the concepts they discover is the way to integrate this activity with the regular life science curriculum. Some of the subjects they will naturally "stumble" upon include the following life science topics:

- ❑ Plant life cycles (annual, perennial, biannual)
- ❑ Botanical terms for stems, leaves, flowers and reproductive parts
- ❑ Adaptations to particular niches
- ❑ Plant defense
- ❑ Population dynamics
- ❑ Structure and cellular topics
- ❑ Germination

Because the students are continually refining their question and procedures, and are collecting and organizing data, all leading to supporting or refuting their hypothesis, like real science the activity is continually evolving. Collect their Experiment Notebooks each Friday and use the *Science Experiment Assessment* form to give them weekly reports of their progress and the areas that need to be improved. These assessment forms have been field tested in middle school. Another advantage of the forms is that over time the students start to shift from focusing on "getting an A" to improving particular skills. This shift is critical, for they learn that when they work on improving their skills, an "A" is often the logical consequence, in addition to acquiring a skill that will last a lifetime. The *Science Experiment Assessment Detail* form has been used by students to periodically evaluate themselves and their progress.

Independent Practice and Related Activities:

Many of the students will end up developing highly innovative approaches to the issues of controlling invasive weed species. They should be encouraged to refine, extend, publish and take their innovations into the community through the education of others or with on-the-ground application of their ideas.

Resources:

For getting started on the background information students will need (in addition to their own Internet and library research), try:

U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2003, June). Fire Effects Information System (FEIS), [Online]. Available: http://www.fs.fed.us/database/feis/ [July 7, 2003]

U.S. Department of Agriculture, National Plant Data Center [Online] http://plants.usda.gov/ [July 8, 2003]

Vocabulary:

During the course of their research and experiments students should maintain a list of new words and create their own vocabulary list to be included in their Experiment Notebooks

National Science Education Standards:

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- ❑ Abilities necessary to do scientific inquiry
- ❑ Understandings about scientific inquiry

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- ❑ Structure and function in living systems
- ❑ Reproduction and heredity
- ❑ Regulation and behavior
- ❑ Populations and ecosystems
- ❑ Diversity and adaptations of organisms

Science and Technology - CONTENT STANDARD E:
As a result of activities in grades 5-8, all students should develop

- ❑ Abilities of technological design
- ❑ Understandings about science and technology

Science in Personal and Social Perspectives - CONTENT STANDARD F:
As a result of activities in grades 5-8, all students should develop understanding of

- ❑ Personal health

- Populations, resources, and environments
- Natural hazards
- Risks and benefits
- Science and technology in society

History and Nature of Science -CONTENT STANDARD G:
As a result of activities in grades 5-8, all students should develop understanding of

- Science as a human endeavor
- Nature of science
- History of science

Teacher's Outline for a Student-Based Inquiry

I Wonder… (One day)

Have the students write an "I wonder…" statement of some control method that would be effective for the invasive weed species they have selected.

Group the "I Wonder…" questions into similar themes based upon control methods (chemical, biological, mechanical, fire or other).

Create scientific teams based upon the various themes and provide each team with an experiment that addresses each theme (or alternatively, students may work individually).

Instruction on experimental design…

(One day)

Provide information on elements of experimentation, including:

- Independent and dependent variables
- Controls
- Hypothesis
- Data Collection

Have the scientific teams identify the above elements for the experiment that they have designed, using the *Design An Experiment Form*

Review of the Literature

(3-5 periods + homework)

From their experiment idea, have the students conduct a review of the literature to research what is known about their particular topic and prepare a report.

Students will include copies of the sources of their information (not a reference list, but the actual articles… this will assist you with assessing their reports to help them with the difference between plagiarism and paraphrasing).

Conduct the Experiment

(6-8 weeks, after a week or two it only takes 10-15/day to record data)

Students will assemble the materials and supplies for their experiment, provide a detail procedure for the experiment, conduct the experiment, and design a data collection process.

Reporting

(Ongoing – research details, procedures refinements, etc. should be upgraded regularly)

Students will write a "scientific paper" to report the results of their experiment to the "scientific community" (the class) and give an oral presentation based upon the following criteria:

- A report of the research and review of the literature behind your experiment, including:
  1. A title page with the name of the project, your name, and date
  2. paraphrasing the science you learned from the research
  3. copies of the resources you used
- A description of the experiment you conducted, including:
  1. the independent and dependent variables
  2. the control
  3. problems with the experiment (sources of error)
  4. the hypothesis you were testing
- An interpretation of the data collected from your experiment, including:
  1. how you collected the data
  2. a display of the data (charts, transparencies, etc.)
  3. what the data tells you
  4. whether or not your hypothesis was supported
- Implications of the experiment (what new questions arise and how would you use the information gained from the experiment to learn more)
- Any photos or drawings that help illustrate what you did

Design an Experiment

Name: ______________________________ Date:_________

Research Topic (describe in as much detail as possible):

1. Identify the *independent* (manipulated) variable. ______________________________

2. Identify the *dependent* (responding) variable. ________________________________

3. Come up with a *research question*. ______________________________________

____

4. State you *hypothesis*. ____

____

5. Describe the *materials* you will need to do the experiment. ____________________

____

6. On the back of this form, or a separate sheet of paper, write a *procedure* to test your hypothesis. Remember to include safety considerations and a detailed set-up.

7. Identify your *control*. ____

8. Describe the variables that you will hold *constant*. ___________________________

9. On a separate sheet of paper, design a *data table* to collect and display your results.

10. What kind of *graph* or *chart* would you use to present your data? **line/bar/circle**

11. Be ready to graph your data on graph paper. Include a title, labels, and units for the vertical and horizontal axis.

12. Describe the results of your experiment. Did it answer your question? Did it support or disprove your hypothesis? Do you need to re-design the experiment and try again?

Student Experiment Notebook Check-off List

Name: ________________ Area of Research ______________________________

Below is a checklist of the different components that I would like you to assemble in a "My Experiment" notebook. Check off each item as you complete it!

______Your original "I Wonder" question.

______A report of the research and review of the literature behind your experiment, including:

- A title page with the name of the project, your name, and date
- paraphrasing the science you learned from the research
- copies of the resources you used
- and the following subjects should be addressed:
    - Botanical description
    - Life Cycle of the alien weed species
    - Classification
    - Adaptations
    - Known control methods

You may have already written an initial report about your alien plant. However, as you become involved with your experiment you will find you must learn new skills or details that will necessitate further research. *Those additional aspects should be added to the original research paper*.

______A description of the experiment you conduct, including:

- the independent and dependent variables
- the control
- problems with the experiment (sources of error)
- the hypothesis you were testing
- Detailed procedures
- Examples of the data collection sheet (preferably done in table form in either Word or Excel)

The procedures should be *very detailed* – a step-by-step outline of everything you have done or will be doing, including a materials list. This is another part of the project that will change and need to be *updated regularly* as you encounter problems or changes to your experiment/research.

______An interpretation of the data collected from your experiment, including:

- how you collected the data
- a display of the data (charts, transparencies, etc.)
- what the data tells you
- whether or not your hypothesis was supported
- Implications of the experiment (what new questions arise and how would you use the information gained from the experiment to learn more)
- Any photos or drawings that help illustrate what you did

______ A daily journal that details what you did each day, things you've learned, problems encountered, how you resolved those problems and/or altered the design and procedures, your feelings about the process (frustrations, confusing moments, feelings of success or breakthrough, Ah Ha! Moments, etc.) You should do daily 10-15 minute writings in class, but this should also be followed up at home and on weekends.

______ All of these components will be bound and organized in a 3-ring notebook with a front cover of your own design, table of contents, etc. The final version will be typewritten but your preliminary rough drafts, hand-written notes, copies or printouts of resources will also be included.

______ The original rubrics that were scored each time you turned in a draft copy.

______ Include this check-off sheet with your notebook.

The next check of the Notebook will be ___________. The score will be based on this updated check-off list, so everyone knows in advance what is needed!

Date of check-off: ___________

Instructor initials here that it was done on time: ______

Science Experiment Assessment			
Name:	Experiment Topic:	Date:	
SKILLS			
Basic Process - each skill below would score a "5" if all applicable criteria are observed in the student's project			**Score**
Observation	Uses five senses to observe; observes using tools (lens, etc.); identifies properties of an object; uses numbers to describe observations; notes changes in objects; realizes that observation enhances understanding.	Rate 1-5	
Classification	Identifies similarities and differences in properties; identifies properties for sorting; classifies objects or attributes into groups; forms subgroups; has logical rationale for sorting; understands characteristics define sorting systems	Rate 1-5	
Communication	Describes accurately using appropriate vocabulary; asks relevant questions; verbalizes thinking; shares views with others; constructs other means to communicate (reports, media, graphs, etc.)	Rate 1-5	
Measurement	Uses non-standard ways as well as traditional ways to measure; selects appropriate measuring tools; uses tools with precision (i.e., to 10ths in metric); compares and orders objects by weight, length, volume and/or time	Rate 1-5	
Prediction	Performs simple predictions based on inferences; recognizes and extends patterns; shows reasoning in defending predictions; able to blend events, patterns, and data to form ideas of what may happen in the future	Rate 1-5	
Integrated Processes			
Interpreting Data	Able to find meaning or patterns with accuracy between sets of information and use that meaning to construct inferences, predictions, and hypothesis; able to identify a single pattern among objects within an experiment	Rate 1-5	
Controlling Variables	Able to identify variables within an experiment that are to be held constant and those that are to be manipulated; understand the difference between single and multiple variable manipulation	Rate 1-5	
Designing Experiments	Able to visualize the procedures that may be necessary to answer question and plan the appropriate data collection operation; includes a plan to organize data; uses organized, sequential plans to test a hypothesis	Rate 1-5	
Inferring	Uses all appropriate information to form inferences and is able to distinguish non-essential information; develops inferences (ideas) based on observations; able to defend inferences reasonably and logically	Rate 1-5	
Defining Operationally	Able to explain relationships between observed actions to explain phenomena; uses events to describe how something works or doesn't work; is able to find alternative actions from evaluating what doesn't work	Rate 1-5	
Notes:			

RESEARCH	0	1	2	3	4	5	6	Score
Evaluate research paper on the following criteria and provide a single score	No work Completed	Incomplete, poor organization, many misspellings, poor punctuation and plagiarism. Some references	Many details organized, few spelling or punctuation errors, attempts paraphrasing 1-3 references	Good writing skills and use of own interpretation 3 or more references	Progressing - expressing an understanding of concepts with good writing style. References, and some are attached	Proficient - solid expression of concepts, a broad range of information written very well References attached	Exemplary - thorough understanding and expression of concepts, information complete, incorporates prior knowledge, and written creatively and technically. Fully cited as appropriate for scientific papers.	
							Sub-total Score	
JOURNAL	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**Score**
Journal is scored according to ONE of the six categories	No journal	Little response and/or the writing is inaccurate or unrelated	The writing shows partial knowledge; lacks detail	The writing is mostly accurate	Shows detail, use of vocab., and a positive attitude	Shows great detail and reflects personal feelings	A coherent whole, personal feelings motivate creative solutions and extensions	
ATTITUDE	(scored as -1 to -5)	1 to 5	1 to 5	1 to 5	1 to 5	1 to 5		**Score**
Score EACH a value of 0-5 and total	Poor Attitude	Curious	Cooperates	Persists	Open-Minded	Handling Equip.Works Safely		(max. 25)
GENERAL	Poor (0)	Inadequate (1)	Fair (2)	Good (3)	Outstanding (4)			**Score**
Score general completion in ONE of the five areas	The student did not do the task, did not complete the assignment, or did not show comprehension	The experiment does not accomplish what was asked, contains errors, and/or is of poor quality	The experiment meets most of the criteria and does not contain gross errors or significant omissions	The experiment completely meets the expectations described by the criteria	the experiment meets all criteria, exceeds expectations and shows additional effort	Notes: Criteria for this assessment were provided to the students via the: **Science Experiment Check-off List**		
Score to Grade Conversion: A maximum score of 100 points is possible (including bonus points for early turn-in, exemplary presentation of material, or at the discretion of the instructor) A = 90-100 B = 80-89 C = 70 - 79 Scores below 70 - Project returned, parents contacted. Project to be re-done by:							Total This Page Total Previous Page Bonus (max. 9) **TOTAL SCORE**	

Science Experiment Assessment Detail

Name:	Experiment Topic:	Date:	
SKILLS			
Basic Process - Describe **specifically** how your experiment allows you to use each skill in the spaces below			**Score**
Observation	Uses five senses to observe; observes using tools (lens, etc.); identifies properties of an object; uses numbers to describe observations; notes changes in objects; realizes that observation enhances understanding.	Rate 1-5	
Classification	Identifies similarities and differences in properties; identifies properties for sorting; classifies objects or attributes into groups; forms subgroups; has logical rationale for sorting; understands characteristics define sorting systems	Rate 1-5	
Communication	Describes accurately using appropriate vocabulary; asks relevant questions; verbalizes thinking; shares views with others; constructs other means to communicate (reports, media, graphs, etc.)	Rate 1-5	
Measurement	Uses non-standard ways as well as traditional ways to measure; selects appropriate measuring tools; uses tools with precision (i.e., to 10ths in metric); compares and orders objects by weight, length, volume and/or time	Rate 1-5	
Prediction	Performs simple predictions based on inferences; recognizes and extends patterns; shows reasoning in defending predictions; able to blend events, patterns, and data to form ideas of what may happen in the future	Rate 1-5	

Other Notes			
Integrated Processes			
Interpreting Data	Able to find meaning or patterns with accuracy between sets of information and use that meaning to construct inferences, predictions, and hypothesis; able to identify a single pattern among objects within an experiment	Rate 1-5	
Controlling Variables	Able to identify variables within an experiment that are to be held constant and those that are to be manipulated; understand the difference between single and multiple variable manipulation	Rate 1-5	
Designing Experiments	Able to visualize the procedures that may be necessary to answer question and plan the appropriate data collection operation; includes a plan to organize data; uses organized, sequential plans to test a hypothesis	Rate 1-5	
Inferring	Uses all appropriate information to form inferences and is able to distinguish non-essential information; develops inferences (ideas) based on observations; able to defend inferences reasonably and logically	Rate 1-5	
Defining Operationally	Able to explain relationships between observed actions to explain phenomena; uses events to describe how something works or doesn't work; is able to find alternative actions from evaluating what doesn't work	Rate 1-5	

Alien Issues

The damage to biodiversity and the economic costs of living with and controlling alien weed species are issues often far removed from our student's awareness or concern. A deep understanding of ecosystem ecology is often needed to understand the damage invasive weed species can cause. Many of the problems occur so slowly that the consequences may not have been realized with the short lives of our students. The economic costs are often hidden in slight increases to the prices of products we buy, in slight dips of crop yields, and in the distribution of tax dollars. But cumulatively, the costs are enormous. It is little wonder that our students are both unaware and unconcerned with the issues of invasive plants.

Our students are also unaware of the legacy of damaged ecosystems they will inherit. For this reason, our students need to acquire the skills for confronting and engaging with issues that affect us today, and in their tomorrow. *Aliens In Your Neighborhood* has been designed to provide students with the scientific background necessary to understand the issues brought by the invasion of alien weed species. Collaborations with the National Parks, local weed boards, citizen weed control groups and other agencies allow students to see models of how we currently manage weed control issues. The inventory and mapping in NatureMapping provides students with the skills to evaluate the extent of an invasion, and more importantly, contribute valuable data to those who currently make decisions of how our land is managed.

In the course of their studies throughout the Aliens curriculum, student have acquired the skills and foundation knowledge for application to weed problems in their community. In this unit, students will conduct research and experimentation, debate solutions, and develop their own strategies to increase public awareness. The lessons and activities will not take the conventional form of previous lesson plan outlines used throughout this guide. Instead, teachers are encouraged to collaborate with their students on issues that are relevant within their own community. The collaboration to investigate local issues prepares students with the following series of activities - **Student-Designed Research**, **Debate & Problem Solving**, and **Public Awareness**.

The student-designed research project may include extensions of plant profile research the students conducted in the Plant Unit and combined with other lessons (ex. control methods). The research may be done individually or in teams, or as a class project with students assigned to various elements of the research and experimentation. The main focus of any research should be on alien plant species within your own community. Students can generate their own areas of research by first posing an "I Wonder" question and then using discussion groups to focus the question towards a specific area of research or experimentation. To get you started, some suggested topics are listed below:

- Investigate the spread of weeds in their own schoolyard
- Observe species composition change after control methods have been implemented by local agencies
- Compare a treated vs. untreated area to examine control effectiveness
- Comparison of decomposition rates in a natural and infested area
- Follow an invasion along a transect and make predictions about distribution and abundance
- Design an experiment to discover the relationship between native plants and animals and what happens to that relationship when alien plants are introduced.

Students can also engage in classroom debates and problem-solving discussions surrounding invasive weed issues. In addition to practice in public speaking, students learn to exchange ideas, defend positions, and understand alternative perspectives. Debate topics might include:

- Releasing a non-native insect for biological control
- Use of chemical sprays along roadside ditches in neighborhoods
- Can native plants become invasive?
- Should plant nurseries sell non-native species?
- Should land disturbed by natural disasters be allowed to "heal" naturally?
- Since nature is always in a state of flux, how do we know when we have "restored" the land?
- Should livestock be removed from stream sides (and how does this relate to invasive weed species)?
- Should genetic manipulation be a method of control?

Finally, the students should be able to interact with their community on local weed issues, especially if their research, experiments and debates have provided the background needed so they become the educators of their community. Some public awareness ideas the students may consider are:

- The Wanted Posters in the Plant Unit can be extended has a class project to distribute notices of local weed problems.
- Scientists often use poster displays to help explain their research findings. Students can design tri-fold displays that include concise bits of information, photographs, drawings or data, and a simple layout that is organized, attractive, readable, and understandable.
- Provide weekly weed reports to news media
- Create a website for their local area
- Use their research to suggest alternative control methods to local agencies
- Support preservation movements when those lands are threatened by aliens

Since any of these projects listed above can take considerable time and, in some cases, involve seasonal factors, it is suggested that they be done in conjunction with the NatureMapping activities since much of NatureMapping data will be relevant to their experiments and debates. The suggested time frame for these extended projects would be in March - June, after previous units of Aliens In Your Neighborhood had been integrated with your regular life science curriculum.

The glossary at the end of each lesson provides additional keywords that can assist you with background information for the integration of concepts similar to your own curriculum.

Student-Designed Research/Experiments

Debate & problem-solving

Public Awareness

Activities to Introduce the XID System and Classification

One of the goals for including a unit on classification is for students to understand the principles of classification as used by the scientific community. The benefit in creating a system, where large amounts of information about living things are organized by similarities, is to have a system that facilitates study of those organisms.

Since early times, scientists have attempted to classify organisms to better understand the relationship and similarities between them. Swedish botanist Carolas Linnaeus (1707-1778) used structural similarity as the basis of his system. Binomial nomenclature, the naming of all living things according to a hierarchy of shared characteristics, and the associated dichotomous keys used for identifying species, stem from his original work and is the worldwide language used by scientists today.

Traditional classification systems are a part of all school's science curricula, explicitly described as an essential skill in the *National Science Education Standards* (NSES) and most state education standards. The first few activities of *Aliens In Your Neighborhood* include introductory and practice activities to familiarize students with the standard classification system. These activities may be used to replace or supplement a school's unit on classification. Once the foundation of typical classification systems has been introduced, the students will have the necessary vocabulary and understanding of how scientists group organisms by similar characteristics. With this foundation, students are ready to be introduced to the XID Identification System.

The XID authoring system allows students to create their own system for the identification of any group of species or objects. Similar to the file trees that manage computer files (ex. Windows Explorer®), students create their own multi-layered menus of *attributes* that can be described and identified.

A dichotomous key, which contains rigid steps and requires the user to have an in-depth knowledge of physical characteristics at all levels, limits our ability to think of plants and animals as anything more than scientific binomial names. The XID System allows students to determine the initial physical attributes by which they will classify the species under study. Additionally, one of the most powerful features of the system allows students to consider attributes that normally would be outside the boundaries of dichotomous keys. Attributes such as location (GIS mapping), plant zones, soil types, aspect, associations with other living things, or *any relevant environmental factors*, can be used as part of the student's classification system. The XID System feature that allows students to use relevant environmental factors, and associations with species that share the same environment, is especially important in helping them search for a deeper understanding of the complexity of their world. This deeper understanding comes from knowledge of the interconnectedness of all living things.

> *"Once we begin exploring below the species level, the really exciting botanical explorations will begin. When you get involved in ecotype study and ecological restoration, you get a deep look at life and its relationship to its environment. You get an opportunity to read the fascinating and ancient stories that the environment has written into the genes and structures of the native plants and animals. You begin to discover how the plants and animals function with and have evolved with their environment."*
>
> Craig Dremann, 1996

These lessons are designed to provide students with an introduction to conventional classification systems of binomial nomenclature and dichotomous keys used by scientists. With a background in the conventional system, which is based upon like characteristics, students will be able to apply that knowledge to learn the XID System. The XID System includes a range of attributes;

like characteristics *and* ecological factors. Learning to view plants and animals within their ecological context will provide valuable tools necessary for future NatureMapping activities.

Lessons in this unit:

- Classification Pre-test - testing prior knowledge
- Classification Pre-test Key
- Introduction to Classification - how do your students organize things?
- Classification Worksheet - practice grouping different sets of animals and plants
- Mythical Classification - develops an understanding on how science organizes by *like characteristics*
- Using the Dichotomous Key - practice with a simplified frog key and developing their own flower key

  Handouts/Transparencies
- Frogs
- Frog Anatomy
- Frog Key
- Classification of Triangulum species - practice session for the XID System

Classification Pre-Test

Name______________________ Grade: ___

Match the letter of the word in the column on the right with the phrase. Not all letters will be used.

_____ A word that means "different kinds"

_____ The procedure for grouping organisms

_____ Who made the system of classification of grouping organisms?

_____ Classification is based upon _________.

_____ The smallest grouping that can interbreed.

_____ The term for a scientific name made up of two Latin names.

_____ An organisms name always begins with a ___.

_____ The largest grouping in classification.

A. Species
B. Small letter
C. Linnaeus
D. Kingdom
E. Diversity
F. Darwin
G. Capital letter
H. Classification
I. Structure
J. Binomial nomenclature
K. Phylum

Number the following classification groups from the largest to the smallest (the largest group will be Number 1)

_____ Class

_____ Genus

_____ Kingdom

_____ Species

_____ Phylum

_____ Order

_____ Family

Classification Pre-Test
KEY

Name________________________

Match the letter of the word in the column on the right with the phrase. Not all letters will be used.

__E___ A word that means "different kinds"

__H___ The procedure for grouping organisms

__C___ Who made the system of classification of grouping organisms?

__I___ Classification is based upon _________.

__A___ The smallest grouping that can interbreed.

__J___ The term for a scientific name made up of two Latin names.

__G__ An organisms name always begins with a ___.

__D__ The largest grouping in classification.

Number the following classification groups from the largest to the smallest (the largest group will be Number 1)

___3__ Class

___6__ Genus

___1__ Kingdom

___7__ Species

___2__ Phylum

___4__ Order

___5__ Family

L. Species
M. Small letter
N. Linnaeus
O. Kingdom
P. Diversity
Q. Darwin
R. Capital letter
S. Classification
T. Structure
U. Binomial nomenclature
V. Phylum

Introduction to Biological Classification

Subject: Life science, classification

Grade: 6-8

Lesson Topic: Kingdoms

Length: 1

Learner Objective:

After instruction and group discussion, the students will be able to:

1) list the five kingdoms, their characteristics and examples from each with !00% accuracy,
2) list the classification groups in order with 100% accuracy, and explain how an organism's name is assigned.

Introduction:

This lesson introduces the basic five Kingdom method of classification. Depending upon the age and sophistication of your students you may want to introduce the more widely accepted six Kingdom method, especially if your intention is to visit all the Kingdoms later in the year.

Content:

The **Five-Kingdom** system is a fairly recent system that divides all living things into five groups. Just as we can group the potato chips into piles of like characteristics, so we also divide living things into the Animal Kingdom, the Plant Kingdom, The Fungi Kingdom, the Protista Kingdom, and the Monera Kingdom. Each kingdom is made up of smaller groups called **Phyla**. Phyla are composed of **classes** and classes of **orders**. Each order is made up of smaller groups called **families**. A family is composed of genera and a **genus** is composed of **species**. Each organism has a scientific name made up of two names, the genus and species names. The genus is always capitalized and the two-part name is underlined.

Display the overhead showing the classification of humans (also on worksheet below).

Materials and Supplies:

Biological Classification Worksheet
Overhead showing the classification of humans (also on worksheet below)
10 Bags of mixed chips (different varieties/brands)

Anticipatory Set:

Give each pair of students a bag of chips and ask them to sort them into piles (a chip key) according to the characteristics each chip exhibits, *before they eat them!* Explain how we often have common names (chips, humans) for large groups of things when in fact there are lots of differences that make each thing unique.

Activity Outline:

The biological classification handout should be given to each student. Through a combination of direct instruction and questioning, assist the students in filling out the worksheet.

Working in pairs or small groups is acceptable. Move around the room and observe progress while reviewing the key points.

Closure and Assessment:

While working on the in-class portion of the worksheet, give a rubber stamp or initial each student's paper if they have completed the in-class portion. Having it initialed will be part of the total score (-5 pt. for not completing in class). Fill-in answers are worth 2 pt. and the take home portion is worth 20 pt.

Independent Practice and Related Activities:

The last activity on the worksheet will be homework. Instruct them on what they are to do and remind them the paper will be expected at the *beginning* of class the following day.

Provide students with old copies of nature/animal magazines, one per student. Have them cut out every animal (or every plant) from the magazine and organize the pictures in to some sort of classification system. Asking students to do this prior to instruction is a good assessment of prior knowledge. They should create a collage or poster of their "grouping" and make an oral presentation to the class to explain the reasoning behind their system.

Resources:

None noted for this intro lesson.

Vocabulary:

Kingdom, Phyla, Class, Order, Genus, Species

National Science Education Standards:

Life Science - CONTENT STANDARD C:

As a result of their activities in grades 5-8, all students should develop understanding of

- ❑ Structure and function in living systems
- ❑ Reproduction and heredity
- ❑ Regulation and behavior
- ❑ Populations and ecosystems
- ❑ Diversity and adaptations of organisms

Name ________________________

Biological Classification Worksheet

Five-Kingdom System:

Animal Kingdom – Invertebrates (without backbones) and vertebrates (with backbones), multicellular, no cell walls, obtain energy through respiration
Plant Kingdom – multicellular, have cell walls, obtain energy through photosynthesis. Ex. mosses, ferns, flowering and seed plants
Fungi Kingdom – cells with cell walls but not green and do not carry out photosynthesis, break down other organic materials to obtain food. Ex. mushrooms and molds and yeasts
Protist Kingdom – come in a wide variety of forms, some are animal-like, such as amoeba, paramecium and protozoan. Some are plant-like such as algae and others are fungi-like. Many are single-celled and others are multicellular.
Monera Kingdom – some photosynthesize while others respire. The nucleus of moneran cells are not bounded by nuclear membranes like cells in the other kingdoms. Ex. bacteria and blue-green algae

The classification of humans – Homo sapiens
The two part naming system is called Binomial nomenclature
Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Primata
Family: Hominadae
Genus: Homo
Species: sapiens (note: species is **not** capitalized)

Answer the following questions in class:

1) What is the next smallest classification group after Order? _______________
2) What is the smallest classification group? _______________
3) Every living organism has what classification groups as its name? __________ and ________
4) The first letter of every genus name is _______________.
5) The first letter of every species name is ________________.
6) What is binomial nomenclature? ____.

Homework:

1) Give one example of how you classification is used in your home.

2) Why is the understanding of classification an important life skill?

3) List the five kingdoms and give as many examples for each one that you can find in and around your home.

Kingdom	**Examples**
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________

Classification Practice - Animals

Subject: Life science, classification

Grade: 5-8

Lesson Topic: Classifying animals

Length: 1-2

Learner Objective:

With minimal instruction, the students will demonstrate their ability to group a given list of animals into specific, related groupings by creating a minimum of two subgroups from the given group with 90% accuracy.

Introduction:

Grouping, or classification, facilitates study by allowing focus on like species, and is simply an extension of a practice we all use to organize our world and the non-living objects we use regularly. Since early times, biologists have attempted to classify organisms in order to understand them and their relationships to other forms of life.

Content:

To classify things means to arrange them into groups based upon some similarity. Much of what we do in our daily lives can be considered classification. For example, when we put our clothes away, we tend to group them according to types, i.e. shirts, pants, socks, etc. Some things can be classified in more than one way, and there is no wrong or right way to do it.

Materials and Supplies:

Student Worksheet (below)

Anticipatory Set:

Show them some animal pelts and prompt them to describe the animal with as much information as they can deduce. There are no wrong answers. Write the list on the board. Encourage them to realize the importance of their powers of observation, to pay attention to details and how to really look at things. Just like sometimes when we read we skip over words we don't know, sometimes we look at things and forget to go back and ask what it really was we saw.

Activity Outline:

Provide the students with the worksheet on animal groups. Have them group the animals in any way they choose. They should work independently. When they are finished (approx. 10 min.) have them share with the class the different ways the animals were grouped. Ask them to think about other characteristics, which could have been used to group the same animals.

Closure and Assessment:

This activity is meant to be a warm-up to other lessons in classification. Have them turn in their worksheets to evaluate their progress on this activity.

Independent Practice and Related Activities:

Have the students create their own classification system of things at home, either within the entire home or a classification system of things in their bedroom. Their systems of classification should be shared in class, with special attention to how different students may classify the same objects in different ways.

Resources:

None noted for this intro lesson.

Vocabulary:

Classification

National Science Education Standards:

Life Science - CONTENT STANDARD C:

As a result of their activities in grades 5-8, all students should develop understanding of

- Structure and function in living systems
- Reproduction and heredity
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

Name______________________________

Animal Grouping Worksheet

Part A

In the exercises that follow, arrange the items listed into different groups. Give each group a title indicating what the members of that group have in common.

1) German Shepherd, Great Dane, parrot, Irish setter, canary, husky, robin, pigeon

Title ______________________ Title ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

2) apples, peas, orange, banana, carrot, lettuce, turnip, pear, grape, potato

Title ______________________ Title______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

3) steak, football, sausage, chair, table, bacon, sofa, baseball bat, cleats, ham, bookcase

Title __________________ Title__________________ Title__________________

__________________ __________________ __________________

__________________ __________________ __________________

__________________ __________________ __________________

__________________ __________________ __________________

__________________ __________________ __________________

Name ________________________________

Part B Study the following list of living things:

mare, trout, parrot, quarterhorse, woodpecker, spaniel, goldfish, Great Dane, eagle, bass, beagle, hawk, stallion, Dalmatian, shark

Classify them into two groups.

Group 1 ____________________ Group 2 ___________________

1) Using the same list of living things show how they could be classified into three groups.

   Group 1 _____________ Group 2 ______________ Group 3 _____________

2) Using the same list, show how they could be classified into four groups.

Group 1 ______________

Group 2 ______________

Group 3 ______________

Group 4 ______________

How Are Animals Classified?

Subject: Life science, classification

Grade: 6-8

Lesson Topic: Taxonomy

Length: 2

Learner Objective:

After completing the investigation the students will be able to"

1) *Identify* common characteristics of some imaginary animals
2) *Compare and contrast* characteristics of groups
3) *Classify* the imaginary animals according to their similarities, all three with 100% accuracy.

Introduction:

To make order out of a collection of different things, it is helpful to put these things into groups. In this activity students will use a set of imaginary animals to practice classification based on taxonomy. The importance of this lesson becomes evident in latter weed identification activities and in using the XID Expert Classification System where students may rely on observed attributes rather than having a deep knowledge of botanical physiology.

Content:

Taxonomy is the science of grouping living things on the basis of like characteristics. The ones most often used are *external structure, internal structure, and behavior.* This method sometimes leads to grouping together animals that seem very different. The whale and the bat are examples. Though very different in size and habitat, they are both classified as mammals. How are they different? Why are they alike?

Materials and Supplies:

Animal Classification worksheet
Overhead of imaginary animals
Colored pencils

Anticipatory Set:

Place the overhead of imaginary animals on the projector to gain their attention! Ask them to come up with some names for the animals based on the observed characteristics.

Activity Outline:

In this investigation, students will identify the common characteristics of some imaginary animals. They will then put them into groups based on such features of external structure as means of locomotion, type of body covering, and type of appendages.

Provide the animal classification handout and colored pencils. Assist students in completing the worksheet in cooperative groupings.

Closure and Assessment:

Relate this activity to previous classification lessons. Stamp and collect the completed worksheets at the end of class for scoring assessment.

Independent Practice and Related Activities:

Allow the students to construct their own "divisions of taxonomy" from a collection of animal flashcards or from a random collection of animals cut from magazines.

Resources:

None noted for this intro lesson.

Vocabulary:

Taxonomy

National Science Education Standards:

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- ❑ Structure and function in living systems
- ❑ Reproduction and heredity
- ❑ Regulation and behavior
- ❑ Populations and ecosystems
- ❑ Diversity and adaptations of organisms

Name ______________________________

Animal Classification Worksheet

To make order out of a collection of different things, it is helpful to put these things into groups. **Taxonomy** is the science of grouping living things on the basis of like characteristics. The ones most often used are *external structure, internal structure, and behavior.* This method sometimes leads to grouping together animals that seem very different. The whale and the bat are examples. Though very different in size and habitat, they are both classified as mammals. How are they different? Why are they alike?

In this investigation, you will identify the common characteristics of some imaginary animals. You will then put them into groups based on such features of external structure as means of locomotion, type of body covering, and type of appendages.

A. Study the six imaginary animals.

1. In which animal(s) is the principal form of locomotion flying? _______________

   Walking?_____________ Swimming?______________ Rolling?_______________

2. In which animal(s) is the principal body covering feathers? _________________

   Bare skin? ____________ Scales? _____________ Armored plates? ____________

3. Which animals have legs and feet? ____________

   Fins? ___________ no limbs? ____________

B. Using a different colored pencil for each animal, write the number that corresponds to each animal in the appropriate space under "Principal Form of Locomotion," "Principal Type of Body Covering," and " Limbs/Appendages" on Chart B. Then fill out the rest of the chart.

C. Use the information in Chart B to fill out Table C. Animal #1 has been done for you.

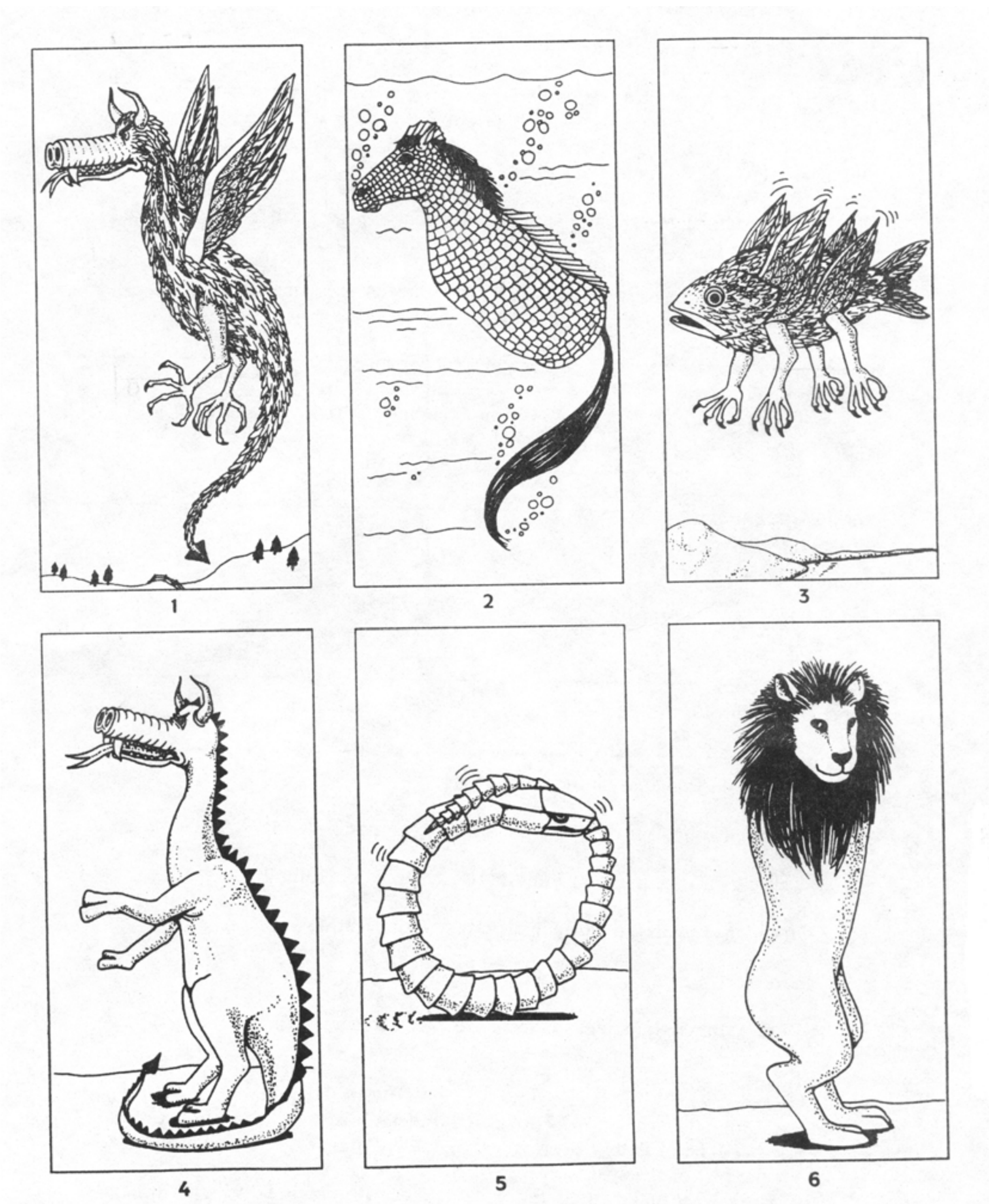
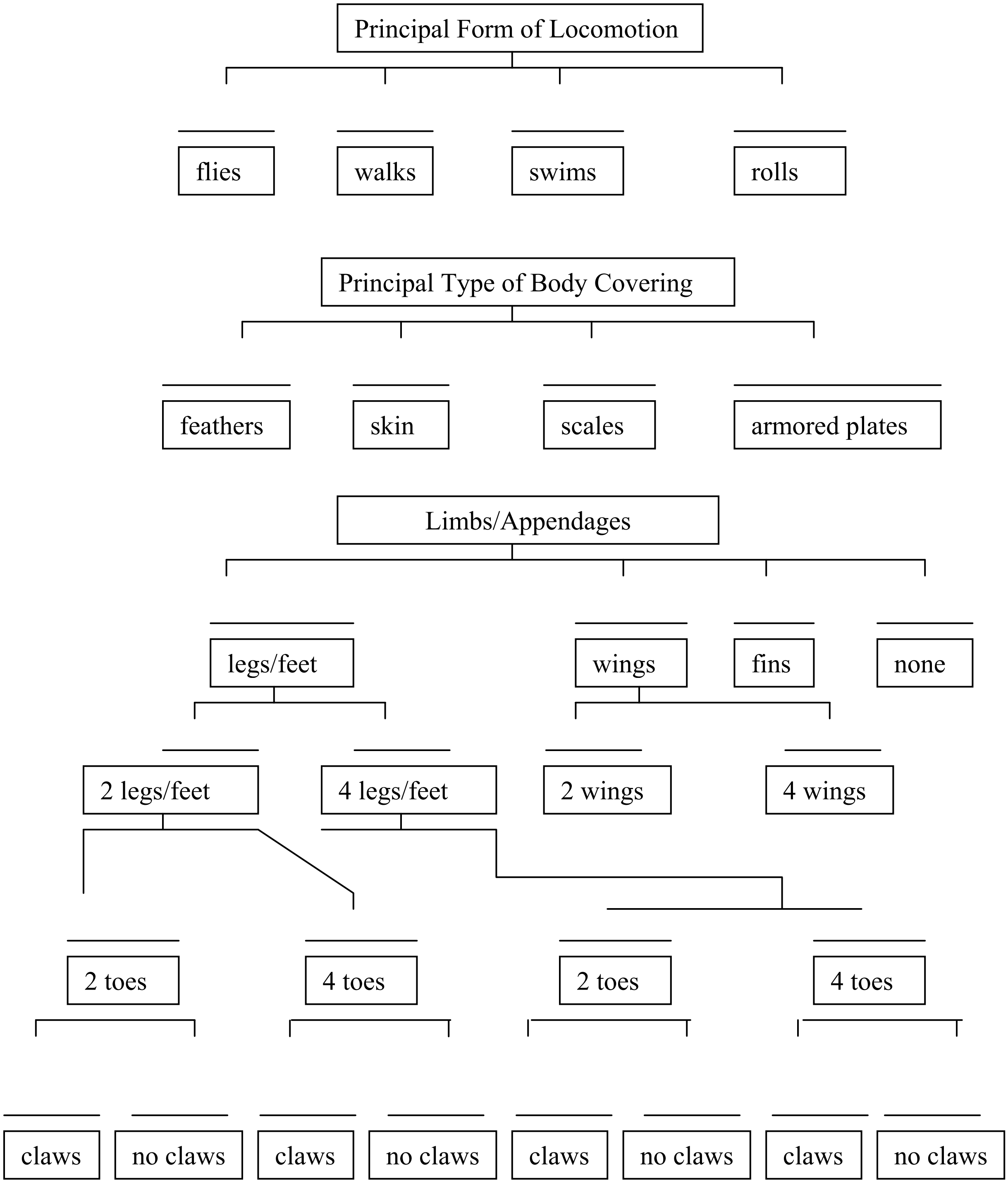


Chart B



Which animals with similar characteristics can be paired?

____

Table C

1	2	3	4	5	6
Flies					
Feathers					
Legs (2)					
Feet (2)					
Wings (2)					
Toes clawed 4					

Table D

In this table the animals have been classified into four groups on the basis I of their similarities. List the characteristics that an animal must have to be placed in each of the groups. The numbers of the members in each group have been indicated.

Groups	**Members**	**Characteristics**
A	**1,3**	
B	**2**	
C	**4,6**	
D	**5**	

Conclusions

1. Which of the four groups in Table D would the following imaginary animal belong to: frog that flies, is covered with smooth bare skin, has four wings and has four legs and feet and two clawed toes? Explain your answer.

2. In some of the groups, certain differences are ignored. Why do you think this is necessary?

3. On which one of the following characteristics would an animal's classification most likely be based: type of appendages, number of legs, presence or absence of claws? Explain your answer.

How Can A Classification Key Be Used To Identify Organisms?

Subject: Life science, classification

Grade: 6-8

Lesson Topic: Classification, Dichotomous Keys

Length: 1

Learner Objective:

After completing this investigation students will be able to;

1) *Identify* a set of pictured organisms by using a classification key with 100% accuracy
2) *Write* a dichotomous key for the identification of a set of pictured organisms, with 90% accuracy of content.

Introduction:

Future studies of invasive weed species will involve the need to understand dichotomous keys. These practice lessons, although not specific to alien weed species, provide students with a means to gain understanding of keys using plants and animals that are more familiar to them. Once the skill has been learned, it is easily transferable to the study of other plants and animals that may not be as familiar to students.

Content:

Suppose while walking through the woods you find a large colorful wildflower. Chances are the flower has already been named and classified, but how can you learn its identity? As an aid to help others identify unknown organisms, biologists have developed classification keys.

Many kinds of classification keys have been developed to identify wildflowers and many kinds of plants and animals. Though some of these keys may vary in purpose and complexity, they share certain features in common. These classification keys are often called *dichotomous keys*. The word dichotomous comes form the word dichotomy meaning "two opposing parts." A dichotomous key presents the user with two opposite statements about some trait of an organism. By choosing the statement that best describes the unknown organism, the user is led to further pairs of statements. By going from one set of statements to another, the name of the organism or its classification group is finally discovered.

Materials and Supplies:

Overhead of wildflowers
Overhead of frog anatomy
Overhead of frog species
Classification packet for each student (includes pictured organisms and worksheets)

Anticipatory Set:

Set out a collection of preserved frogs for the students to examine. Lead a discussion and list on the chalkboard on the descriptive characteristics they notice.

Activity Outline:

In this investigation students will use a simple classification key to identify several pictured organisms. Assist with the identification of frogs by using an overhead of the frogs while they examine their pictures (some features may be difficult to discern without giving assistance). They will then write a classification key for another group of pictured organisms. Provide the students with their classification packet and work as a group, with some direct instruction, through the worksheet.

Closure and Assessment:

Go over terms they have learned through this and previous classification labs. Make sure adequate time is allowed for completion of this worksheet so that it can be turned in for scoring at the end of class.

Independent Practice and Related Activities:

Extra credit "Questions for Thought" are provided at the end of the lesson.

Resources:

No other resources needed for this introductory lesson.

Vocabulary:

Dichotomous

National Science Education Standards:

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- ❑ Structure and function in living systems
- ❑ Reproduction and heredity
- ❑ Regulation and behavior
- ❑ Populations and ecosystems
- ❑ Diversity and adaptations of organisms

Name________________________________

Answer Sheet – Frog Classification

1. In what ways are the forelimbs and hindlimbs of a frog different?

2. Describe the dorsolateral ridges that are present in some frogs.

3. describe two ways in which the feet of frogs may be different.

Investigation

Part A

1. Write the name of each frog on the line that corresponds to its letter.

a) ______________________	h) ______________________
b) ______________________	i) ______________________
c) ______________________	j) ______________________
d) ______________________	k) ______________________
e) ______________________	l) ______________________
f) ______________________	m) ______________________
g) ______________________	n) ______________________

2. What are the advantages of using a classification key when identifying organisms?

3. What characteristics of frogs were most useful for keying them?

4. Do you think it would be easier to identify real frogs, rather than pictured frogs, by using a dichotomous key? Explain your answer.

Name ____________________________

Part B

Wildflower Classification Key

1. Study the drawing of wildflowers, which show some common Northern wildflowers. As you study the pictured flowers, notice different characteristics such as flower shape, number of petals, and leaf number or shape. In the space provided below develop a classification key to identify each of the wildflowers.

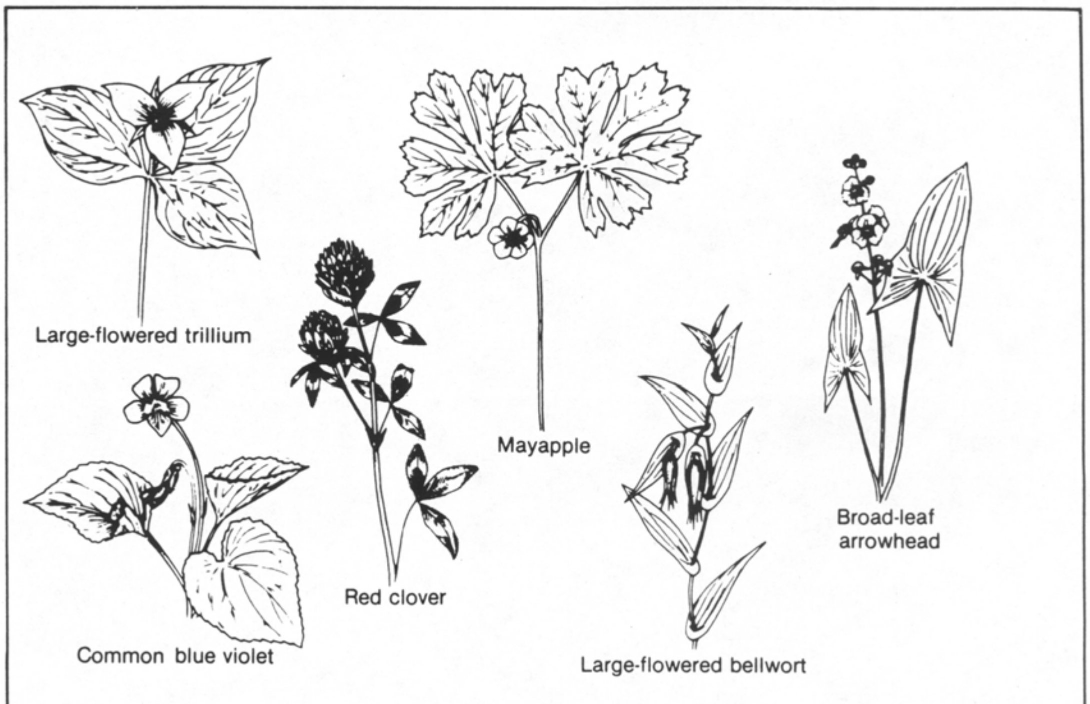


Fig. 21-3

Write your key here:

Name ________________________________

Part B cont.

1. Was your key exactly like that of other students? Why or why not?

2. If you were using actual wildflowers, what other characteristics could you use to identify them?

Extra Credit (5 pts. Each)

1. Do you think that there may be some closely related species of organisms that cannot be identified with a classification key? Explain your answer.

2. Why do you think biological classification keys always present two, rather than some other number of choices, at each step?

Frog species Worksheet

Frog Anatomy Worksheet

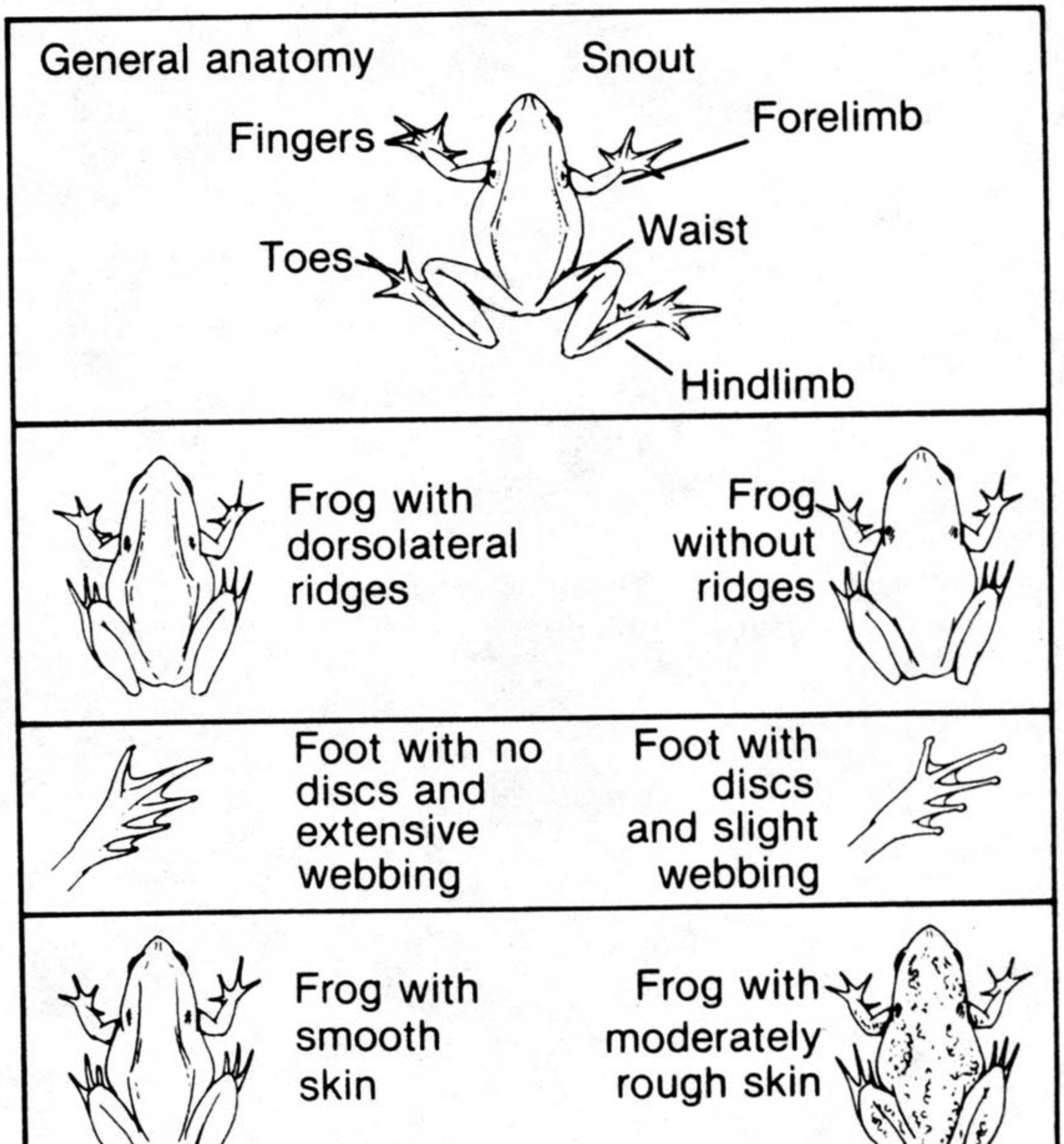


Fig. 21-1

Frog Species Key

Classification Key

1a	Discs on the tips of fingers and toes	Go to 2
1b	No discs on fingers or toes	Go to 7
2a	Slight webbing between toes	Go to 3
2b	Extensive webbing between toes	Go to 4
3a	Masklike stripe from snout to forelimb, dark spot below eye	Strecker's chorus frog *(Pseudacris streckeri)*
3b	Masklike stripe from snout to forelimb, bold spots near hindlimb	Ornate chorus frog *(Pseudacris ornata)*
4a	Skin smooth	Go to 5
4b	Skin moderately rough	Go to 6
5a	Light stripes on side of body	Green tree frog *(Hyla cinerea)*
5b	X-shaped marking on back	Spring peeper *(Hyla crucifer)*
6a	Warty markings on back, dark bar below eye	Canyon tree frog *(Hyla arenicolor)*
6b	Irregular dark pattern on back, light spot below eye	Gray tree frog *(Hyla versicolor)*
7a	Dorsolateral ridges present	Go to 8
7b	Doroslateral ridges absent	Go to 10
8a	No dark spots on back, dark patch extending back from eye	Wood frog *(Rana sylvatica)*
8b	Dark spots on back	Go to 9
9a	Square spots in two rows down the back	Pickerel frog *(Rana palustris)*
9b	Rounded dark spots on back and sides	Leopard frog *(Rana pipiens)*
10a	Fold of skin across back of head	Go to 11
10b	No fold of skin across back of head	Go to 13
11a	Single light stripe extending down back	Sheep frog *(Hypopachus variolosus)*
11b	Back without single light stripe	Go to 12
12a	Dark-colored patch on head and back	Eastern narrow-mouthed toad *(Gastrophryne carolinensis)*
12b	Small spots in irregular pattern on back	Great Plains narrow-mouthed toad *(Gastrophryne olivacea)*
13a	Fourth toe extends slightly beyond webbing	Pig frog *(Rana grylio)*
13b	Fourth toe extends well beyond webbing	Bullfrog *(Rana catesbeiana)*

Classification of Triangulum© Species

Subject: Life science, classification

Grade: 6-8

Lesson Topic: Classifying Attributes

Length:

Learner Objective:

Students will become familiar with the XID Expert Identification System

Introduction:

You have been exploring the Badlands Wilderness Study Area in early spring and have found a **vernal pool**. Curious as to what life forms might be living in the water, you use a fine mesh screen and draw it through the water to collect whatever microscopic organisms might be there, and rinse the screen into a collection vial. After returning to the lab, you place the water sample in a petri dish, and under the dissecting scope's low power objective lens you are surprised to see a number of different organisms swimming in the water. Although you suspect that they are similar to various Triangulum[1] species found in high elevation vernal pools, a review of the existing literature does not provide any information about species found in the ephemeral, snowmelt pools of the Badlands. Perhaps there are some new species. Your task is to create a database that groups the various organisms in your database according to their field data. This will allow you to create the **taxonomy** for the members of the group.

Content:

The XID authoring system allows students to create their own system for the identification of any group of species or objects. Similar to the file trees that manage computer files (ex. Windows Explorer®), students create their own multi-layered menus of *attributes* that can be described and identified.

A dichotomous key, which contains rigid steps and requires the user to have an in-depth knowledge of physical characteristics at all levels, limits our ability to think of plants and animals as anything more than scientific binomial names. The XID System allows students to determine the initial physical attributes by which they will classify the species under study. Additionally, one of the most powerful features of the system allows students to consider attributes that normally would be outside the boundaries of dichotomous keys. Attributes such as location (GIS mapping), plant zones, soil types, aspect, associations with other living things, or *any relevant environmental factors*, can be used as part of the student's classification system.

The XID System feature that allows students to use relevant environmental factors, and associations with species that share the same environment, is especially important in helping them search for a deeper understanding of the complexity of their world. This deeper understanding comes from knowledge of the interconnectedness of all living things.

In this lesson the students will use the imaginary Triangulum© species found in vernal pools (bodies of water remaining from winter snowmelt that persist long enough for a small ecosystem of plants and animals to exist until the pond dries) to create their own XID database. Instead of creating a conventional dichotomous key, students will use all data concerning Triangulum© and it's environment to create their own key to the species.

Materials and Supplies:

XID Expert Classification System software (see Resources)
Student Handout

Anticipatory Set:

Initiate a discussion with students concerning the dichotomous keys created in previous classification lessons by asking how much they can discern about the species natural ecosystem, life habits such as feeding, defense or breeding, and the environmental conditions most favorable to the species. Without making inferences, and discounting prior knowledge of the species, student may not find the keys very helpful in pinpointing aspects about the species life and environment. Emphasize that the XID Classification System allows them to create their own keys with a full range of information about the species they wish to study.

Activity Outline:

The students do the first portion of the activity sheet below in the classroom, either individually or in groups of scientific teams.

The second portion requires a computer lab and the XID software. The teacher, as administrator, will need to enter students' names into the database and provide them with login names. The administrator function of the software enables the teacher to assess the movements and decisions of each student as they build their database.

Closure and Assessment:

Refer the students back to the anticipatory set discussion and have the students compare the amount of information they included in their database to the information that would be available in a conventional dichotomous key.

Evaluation of student worksheets and evaluation of the XID Teacher Administration reports will provide the basis for assessment.

Independent Practice and Related Activities:

Students who are particularly adept with the XID System may wish to create their own database… the XID System is flexible enough to be used for any subject from plants and animals to all the characters in all the Star Wars movies to all the dead insects found in the windowsills throughout the school!

Resources:

XID Expert Identification System was created by, and is available from:

Dr. Richard Old
XID Services, Inc.
Pullman, Washington 99163

www.xidservices.com

Vocabulary:

Attributes, Taxonomy, Vernal

National Science Education Standards:

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of

- Structure and function in living systems
- Reproduction and heredity
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

Science and Technology - CONTENT STANDARD E:
As a result of activities in grades 5-8, all students should develop

- Abilities of technological design
- Understandings about science and technology

[1] The Triangulum name, the Triangulum species names, and the Triangulum .gif images are copyright protected under United States and Foreign law, and are made available for educational purposes only (non-commercial) by **© 2000 SRI International 333 Ravenswood Avenue, Menlo Park, CA 94025-3493** https://www.sri.com
The original use of triangulum can be found in a lesson plan titled "Dichotomous Key" located at http://pals.sri.com/tasks/5-8/DichotomousKey/rubric.html or PALS (http://pals.sri.com)
PALS (Performance Assessment Links in Science) is an on-line, standards-based, continually updated resource bank of science performance assessment tasks indexed via the National Science Education Standards (NSES), provided by **©1997-2002 SRI International, Center for Technology in Learning. All rights reserved.**

[2] The XID Expert Identification System was generously provided by Dr. Richard Old of XID Services, Inc. Information regarding purchase of the system is located in the **Technology** section under **Resources**

Classification of Triangulum© Species

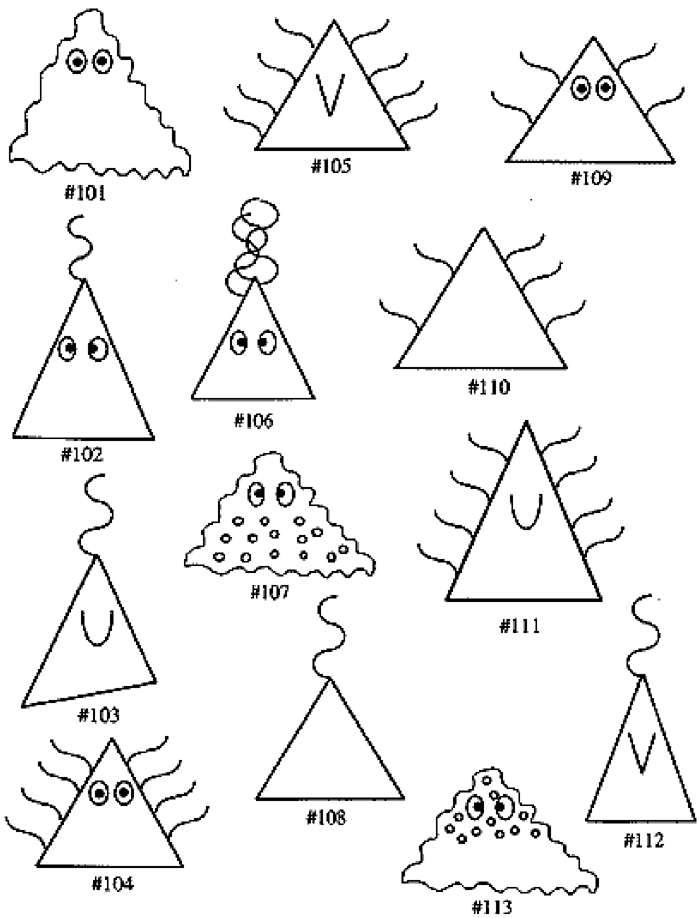
NAME ______________________ DATE _______

You have been exploring the Badlands Wilderness Study Area in early spring and have found a **vernal pool**. Curious as to what life forms might be living in the water, you use a fine mesh screen and draw it through the water to collect whatever microscopic organisms might be there, and rinse the screen into a collection vial. After returning to the lab, you place the water sample in a petri dish, and under the dissecting scope's low power objective lens you are surprised to see a number of different organisms swimming in the water. Although you suspect that they are similar to various Triangulum species found in high elevation vernal pools, a review of the existing literature does not provide any information about species found in the ephemeral, snowmelt pools of the Badlands. Perhaps there are some new species. Your task is to create a database that groups the various organisms in your database according to their field data. This will allow you to create the **taxonomy** for the members of the group.

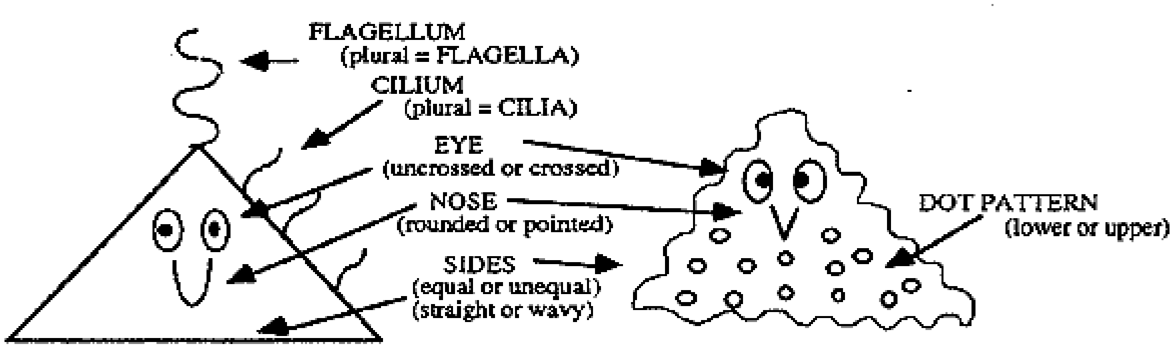
Define **vernal pool**: ____

Define **taxonomy**: ____

After hours in the lab you have created the following sketches of the microscopic organisms found in the vernal pool water samples from the Badlands:



From further research into the existing literature on known species of Triangulum, you construct the following drawings with regards to the taxonomy:



From your field notes and observations in the laboratory, you have recorded the following data:

Species ID #	Free Swimming	Bottom Dweller	Pool Size (M^2)	Temp (C)	Responds to Photo stimulus (neg. or pos.)	Color	Substrate Of Pool
101	N	Y	<1	15	N	CLEAR	BASALT
102	Y	N	1-10	10+	N	TAN	BASALT
103	Y	Y	<1	10+	N	CLEAR	BASALT
104	Y	N	>10	1-5	N	CLEAR	BASALT
105	Y	N	>10	1-5	N	CLEAR	BASALT
106	N	Y	1-10	5-10	N	TAN	SILICA
107	N	Y	1-10	15	P	TAN	SILICA
108	Y	Y	<1	10+	N	CLEAR	BASALT
109	Y	N	1-10	10+	N	CLEAR	SILICA
110	Y	N	>10	1-5	N	CLEAR	BASALT
111	Y	N	>10	1-5	N	CLEAR	BASALT
112	Y	N	<1	10+	N	CLEAR	BASALT
113	N	Y	>10	1-5	P	TAN	SILICA

Because the scientific community still utilizes a standard biological classification system that relies on **binomial nomenclature**, you create the following names for the species you have found:

Species ID #	**Genus species** (***proposed Spring 2003***)
101	T. waveum
102	T. monoflagelleum
103	T. rotundoflagelleum
104	T. polyciliatum
105	T. pointiatum
106	T. polyflagelleum
107	T. ventridotteum
108	T. equalium
109	T. biciliatium
110	T. oddcilitum
111	T. rotundum
112	T. pointiflagelleum
113	T. dorsalidotteus

Define **binomial nomenclature**: ____

The literature contains no information about the classification of Triangulum species, and it becomes necessary to create a new database that describes the characteristics, behaviors, and ecological niche of the species you have found. Rather than trying to construct a standard **dichotomous key**, you decide to use the new **XID Expert Identification System** developed by Dr. Richard Old of XIS Service, Inc. With this system you can create a database for your Triangulum species that allows you to organize the valuable field data you've collected and create taxonomy for the species.

Define **dichotomous key**: ____

Creating a New Database

To Login, open the XID program and enter your Login name and Password, *click* **OK**

My Login name is _____________ My Password is _____________

To create a new database, select **New** from the **File Menu** or press the **New** button on the toolbar. The XID application sets up an empty database and displays the **Database Description Editor**. You must give a title to the new database. If you are building a database of plant or animal species with their scientific names, enable scientific names in this form by checking the box for that option. Pressing the **OK** button creates the top-level menu, with the menu type assigned according to the menu structure type specified in the form.

Name of your new database: ________________________________

The next step is to create a menu structure. The context menu is found with a *right-click* on the Menu structure box. Selecting **Edit** from the context menu for the Menu Structure tree brings up the **Individual Menu Editor** for the top-level menu. Selecting

Add submenu and **Add menu attribute** from the same context menu allows you to add menus of submenus and attribute menus to the Menu Structure tree. Activating the context menu for an attribute menu and selecting **Insert** from it allows you to insert and define attributes. Continuing this process creates the entire menu structure (*see steps outlined below!*).

Define attribute: ____

Creating your menu structure:

1) *right-click* the Menu Structure Box
2) *click* Add Submenu. Give it any name you choose (example: movement)
3) *right-click* the new Submenu called Movement
4) *click* Add Attribute Menu. Give the attribute any name you choose (example: Flagella)
5) *right-click* submenu Movement again
6) *click* Add Attribute Menu. Give the attribute another movement name (example: Cilia)
7) *right-click* the attribute menu title Flagella
8) *click* Insert Attribute. Define an attribute (ex. No Flagella)
9) *right-click* the attribute menu title Flagella again
10) *click* Insert Attribute again. Define another attribute (ex. Single Flagella)

Repeat the steps above to add all the submenus, attribute menus, and specific attributes you feel will adequately describe your collection of Triangulum species and the associated field data. As another example, “Habitat” might be a Submenu, “Pool Size” might be the name of an Attribute Menu, and the range of pool depths would be the various attributes you insert.

If you want to include literature references for the items or species, *right-click* **References** in the tree and select **Insert** from the context menu. Each item or species can be given the desired page number(s), for each reference title. Since these appear to be new species you can skip this for now and enter information later. If it turns out that you have indeed found some new species, *your* published findings would be in the References section!!

Once you have defined menus and some attributes, you can add items or species: *right-click* somewhere within the **Item/Species List** box and select **Insert** from the context menu. This will call the **Item Description Editor**. Enter the Family, Genus, and species names, and a description of the species (you can come back later and fill in the description, general purpose data, comments, and illustrations), then *click* **OK**.

Have you entered all the species names from the chart above? _____ (yes or no)

Your teacher should initial here that this is done ______

Now, here are the steps to see your classification system at work!!!

1) *right-click* on any species name you have entered
2) *click* **Edit Item Attributes**

3) from the list provided, check the boxes that apply to your species
4) *click* **NEXT** (if you are editing attributes for many species) or **OK** if you just edit one
5) Repeat the process for each species

Items that are eliminated by the XID logic are moved to the end of the Item List. This permits you to edit a subset of the items in the database. This technique can be very useful for entering data for several items at once (via the Mark All and Clear All features in the Item/Species Attribute Data Editor. It can also be used to create a subset database.

Once a database is created, you should save it as an XID Database File by selecting **File | Save**, with the .xid file extension. You can freely edit the database description, menu structure, reference titles and item data.

[1] The Triangulum name, the Triangulum species names, and the Triangulum .gif images are copyright protected under United States and Foreign law, and are made available for educational purposes only (non-commercial) by
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https://www.sri.com
The original use of triangulum can be found in a lesson plan titled "Dichotomous Key" located at http://pals.sri.com/tasks/5-8/DichotomousKey/rubric.html or PALS (http://pals.sri.com)
PALS (Performance Assessment Links in Science) is an on-line, standards-based, continually updated resource bank of science performance assessment tasks indexed via the National Science Education Standards (NSES), provided by **©1997-2002 SRI International, Center for Technology in Learning. All rights reserved.**

[2] The XID Expert Identification System was generously provided by Dr. Richard Old of XID Services, Inc. Information regarding purchase of the system is located in the **Technology** section under **Resources**

Introduction to NatureMapping

NatureMapping is a wildlife data collection activity in which you observe wildlife and plant life, gather environmental information in the field, and record your observations on a standard form. This data is contributed to the scientific community, allowing your students to become citizen scientists!

- connects you with the natural world by giving you real-world, outdoor experiences;
- helps you learn more about the environment through access to "hands-on" field observation experiences and easy-to-use materials;
- gives you useful and practical skills like map reading and species identification;
- enables you to create and maintain your own environmental database; and
- sharpens your observation and identification skills, which will be a valuable asset to organized inventory and monitoring efforts, while becoming a citizen scientist.

Although the focus of this unit is to help resource managers inventory and monitor alien plant species in the National Parks, you can participate in NatureMapping practically anywhere. You can participate with your own students, or organize a group of observers from your community.

The NatureMapping activities provide step-by-step instructions on how to participate. It includes the forms you'll need for recording and mapping your field observations. The Washington NatureMapping program includes various wildlife and community modules which lists species you may encounter and the codes used to indicate which species you found. There is not currently an Invasive Weeds Module, but individual plant species can be coded using the plant code assigned in the USDA Plant National Database. At that website, click on the Invasive Weeds link, and then the state link for one of the states listed below to access a complete list of the invasive species, along with their plant codes. As an example, you might refer to the Oregon Weeds list provided under the Oregon NatureMapping unit in this curriculum.

Washington NatureMapping -

NatureMapping began in Washington, and their program has served as the preeminent model for NatureMapping programs in several other states. There are many conservation projects involving NatureMapping throughout the state, and teacher-training workshops are provided to assist the classroom teacher in implementing school wide NatureMapping programs. See the Resources page for a list of National Parks in this area.

Idaho NatureMapping -

Idaho's NatureMapping program is an outreach component of the USGS National GAP Analysis program, headquartered at the University of Idaho. GAP is a proactive approach to protecting biodiversity. It seeks to identify gaps between land areas that are rich in biodiversity and areas that are managed for conservation. Idaho NatureMapping's goal is to involve local communities in the Gap program, by training individuals to monitor and map the species around them, and by providing tools to inventory and report their observations. Idaho has relied on a partnership with Washington NatureMapping for teaching resources and support but is now actively seeking to build their own Idaho NatureMapping Program. The Sawtooth Science Institute (SSI) is working to build this new program. SSI is located in the heart of Central Idaho as an outreach field study center of the College of Education at Idaho State University, and the Idaho Museum of Natural History, dedicated to the study of the natural history of the northern Rockies. NatureMapping with the Sawtooth Science Institute is a partner program with the:

Natural Heritage Project of the Idaho Museum of Natural History;

Dr. Charles Peterson's NatureMapping Idaho Amphibians & Reptiles Course at Idaho State University; the Digital Atlas of Idaho 2000; and the National Gap Analysis.

See the Resources page for a list of National Parks in this area.

Montana NatureMapping -

Montana does not currently have an in-state NatureMapping program but is included here because the Big Hole National Battlefield, located in Montana along the border with Idaho, was one of the original parks involved with this project. There exists ongoing problems with invasive weed species within the park, and teachers from schools in Idaho and Montana who utilize the park for field excursions are encouraged to use the Idaho NatureMapping links to NatureMapping, in conjunction with *Aliens In Your Neighborhood*.

Oregon NatureMapping -

Several people are beginning to implement NatureMapping in Oregon, and *Aliens In Your Neighborhood* includes a special section combining aspects of Washington NatureMapping and work done by the Oregon Biodiversity Project and Defenders of Wildlife. See the following section.

Introduction to Oregon NatureMapping

Oregon NatureMapping is a wildlife data collection activity in which you observe wildlife and plant life, gather environmental information in the field, and record your observations on a standard form. This data is contributed to the scientific community, allowing your students to become citizen scientists!

- connects you with the natural world by giving you real-world, outdoor experiences;
- helps you learn more about the environment through access to "hands-on" field observation experiences and easy-to-use materials;
- gives you useful and practical skills like map reading and species identification;
- enables you to create and maintain your own environmental database; and
- sharpens your observation and identification skills, which will be a valuable asset to organized inventory and monitoring efforts, while becoming a citizen scientist.

Although the focus of this unit is to help resource managers inventory and monitor alien plant species at the John Day Fossil Beds National National Monument, you can participate in NatureMapping practically anywhere. You can participate with your own students, or organize a group of observers from your community.

The NatureMapping activities provide step-by-step instructions on how to participate. It includes the forms you'll need for recording your field observations. You can maintain a database of your observations by using the unit's simple data entry/data management software, custom designed for *Aliens In Your Neighborhood* and the Oregon NatureMapping project.

Where Am I?

At last, you've arrived! But where exactly are you? Determining your physical location is critical to Oregon Nature-Mapping. It gives important information about the location of the species you see. Should your data eventually be included in a statewide database, it is important that you record your location by coordinates and not by name only. Below is a discussion of the tools and methods to help you determine your site location.

Location Tools. NatureMappers can use any of three tools to determine site location:

Maps. Maps are the least expensive means for determining your location. For approximately $4.00, you can purchase maps at your local bookstore, outdoor store, or local Forest Service or Bureau of Land Management office. You can also order them directly from the U.S. Geological Survey (USGS).

We recommend you use maps at a scale of 1:24,000 (these are also known as "7.5- minute quadrangle maps"). This means that every one inch on the map represents 24,000 inches (or 2,000 feet) in nature.

If you use the mapping option, you'll need to know how to read its coordinates accurately to report your location correctly. This is discussed in greater detail on the following pages.

Maps are also available from a number of websites where you can print out landform or topographic maps for your area of interest. For an example of these websites see TerraServer USA.

Global Positioning System Receiver. One of the most accurate methods for determining site location is a Global Positioning System (GPS) receiver. This handy device picks up signals from satellites orbiting the Earth and instantly displays the latitude and longitude (and altitude, if desired) of your location. To work properly, GPS receivers must be able to "see" the sky in order to locate the satellites. A cliff, canyon, or even a dense forest can all interfere with your ability to get a good read-out. A read-out from a GPS receiver looks like this:

N 4° 36' 18.6"
W 122° 39' 15.8"

GPS units can also provide locations in UTM coordinates (explained below) and would appear as:

454,250m E.
4,661,500m N.

Hand-held models are available through the links provided in the NatureMapping Appendix, along with hand-held computers for downloading coordinates and recording field observations.

Location Methods Oregon NatureMapping uses three methods for determining site location: Town-ship, range and section (TRS), latitude and longitude (lat/long), or the UTM System (Universal Transverse Mercator). The former can best be determined by using maps; the latter by all three location tools (maps, GPS receivers, or web-based map servers). The following pages discuss how to use TRS and the UTM system.

Refer to the **Badlands Coordinates Map** below to go along with the following discussion!

Township, Range, and Section. In 1879, Congress established the U.S. Geological Survey to topographically map public lands. The agency's emphasis was on mapping western public lands, which at the time, were largely unsettled and relatively unknown.

Armies of surveyors fanned out across the West, risking life and limb and to survey the often hostile landscape. By modern standards, their methods were not terribly sophisticated or accurate, but they nevertheless provided important information. For mapping purposes, western lands were carved into blocks, or townships, of 36 square miles each. Each township was further divided into 36 sections, each a square mile in area.

The system is far from perfect. Nevertheless, it is a system that is very much in use today. If you own a home, you'll notice that your deed describes the location of your house by township, range, and section. The system is equally adequate for NatureMapping purposes.

Below, we show you how to determine location by this method.

In the upper right hand corner of the Badlands Coordinates Map you can see the designation "T18S" for Township 18 South. Each township has 36 sections, each section is one mile square. The **red lines** on the map indicate the borders between the mile wide sections, and the horizontal line in this example is the line separating T18S and T19S below it. The range is not shown on this small example but the margin of the map would show it is R14E. The section numbers are always in red.

Determining Township: A township is 36 square miles. Township numbers are printed in the margins on the extreme right and left sides of maps (in the example, only a portion of the map is shown). Townships are centered between two horizontal lines, which on real maps, are always red and thick. In this example, only one light red horizontal line is seen, separating sections .

The Badlands are located partially in Township 18 South, written as T 18 S.

Determining Range: Range numbers are printed in the margins at the top and bottom of maps. Ranges are centered between two vertical lines, which on real maps, are always red and thick. In this example, the two vertical lines are not as dark and thick as the lines that would separate ranges.

The Badlands are located partially in Range 14 East, written as R 14 E.

Determining Section: A section is one square mile. There are 36 sections in each township. On most maps, only the four corner section numbers (1, 6, 31, 36) are printed within each township. Sections are delineated by red lines not quite as thick as those used for township and range, and their identifying numbers are always printed in red.

The first row of section numbers (1-6) reads from right to left, the second row (7-12) reads from left to right, and so forth to section 36. Look at the red sections numbers in this sample of the Badlands and refer to the Township Template below to help you imagine the sections in the unseen portions.

6	5	4	3	2	**1**
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	**36**

For Oregon NatureMapping purposes, accuracy to within *a quarter of a quarter mile* is optimal (although accuracy to within just a quarter of a mile is sufficient). What do we mean by "a quarter of a quarter mile"? Since a section is one square mile, divide the section into four equal quadrants (NE, SE, NW, SW) to get your location down to a quarter of a mile. Then, to get it even smaller to a quarter of a quarter mile, divide the quadrant containing your site into four again. Thus, where the highway crosses the bottom left portion of Sec. 33, your first siting of invasive plants might be in the SE quarter of the SE quarter of Section 33.

Putting It All Together. Standard recording procedure requires that the final location recording begin with the smallest area and work backwards: Thus, your final site identification for a cheatgrass invasion in the Badlands parking area should read:

SE 1/4, SE 1/4, S33, T18S, R14E

This is the order you write the information in the section "Information About Your Location" on your Oregon NatureMapping data collection form.

Understanding the Universal Transverse Mercator (UTM) System -

1. UTM stands for Universal Transverse Mercator. It is one way to pinpoint a location on a map.

2. UTM numbers are in Kilometers. Add three zeros and you have converted them to Meters.

Example 1: 400 kilometers is equal in distance to 400,000 meters.

Example 2: 200,000 meters is equal in distance to 200 kilometers.

3. The UTM numbers coincide with a light blue tick mark along the edges of the 7.5' USGS Quadrangle. Some 7.5' Quadrangles don't have the blue ticks, but instead have a fine black UTM grid laid out over the entire map, similar to the grid shown in the graphic. In the Badlands Coordinates Map the UTM lines are indicated as **blue** lines.

4. What about UTM numbers? Why do they look funny? UTM numbers are numbers that are printed along the left, right, top, and bottom of the 7.5' Quadrangle Map. The individual digits are printed in two different sizes. This DOES NOT indicate where a comma or decimal goes. Apparently, the different sized digits help the reader distinguish the UTM numbers from the myriad of other numbers printed along the sides. Some of the other numbers represent Latitude and Longitude coordinates and Township and Range numbers.

5. The UTM system is laid out in a grid pattern. Think of finding a UTM coordinate like finding an (x) and (y) point in Algebra. In Algebra, it is called the Cartesian coordinate system.

6. There are two numbers to be found in a UTM coordinate. The first number coincides with an

East direction (or "Easting"). This is (x). These numbers can be found along the top and bottom of the Quadrangle. The second number coincides with a North direction (or "Northing"). This is (y). These numbers can be found along the left and right sides of the Quadrangle.

7. Always "read RIGHT, UP" - find the distance to the EAST, then the distance to the NORTH.

8. 1 Kilometer = 1000 Meters. Each UTM grid square is 1-kilometer in length on each side, or 1000 meters on each side.

9. UTM coordinates can be found accurately to the nearest 25 meters using a 7.5' Quadrangle Map and an appropriate scale bar. For NatureMapping, finding the UTM coordinates to the nearest 100 meters is accurate enough.

10. Each set of UTM coordinates correspond to a given zone. Remember, most of the Pacific Northwest is located in Zones 10 and 11. On the bottom left corner of the Badlands map, the UTM coordinate is read as 646,400.0 m E x 4,864,000.0m N., Zone 10, or in other words, the point on the ground is 646,400 meters east of the Zone 10 line (which lies off the coast of Oregon) and 4,864,000 meters north of the equator. Remember to always include the Zone in your UTM reading. The UTM numbers are exclusive to just one spot in each zone, however, the same set of coordinates are used over again in every other zone.

11. To find out which Zone you are in, look in the lower left corner of a 7.5' Quadrangle map.

12. This UTM coordinate will coincide with one 100-meter x 100-meter area, or plot (usually the coordinate represents a point in the center of the area). This 1-hectare area is large enough for you to determine the dominant habitat type for the area you are monitoring. You may have a monitoring site larger than 1 hectare. In that case, you have two options: (1) locate and use different sets of UTM coordinates for any additional 100m x 100m areas, or plots, or (2) determine a unique area larger than 1-hectare for each UTM coordinate. In the first option, you may want to do this if you are monitoring consecutive 1-hectare areas, along a hiking trail for

example. This would be considered a type of point count, where you monitor at regular time intervals at each site, and perhaps return regularly to those points. In the case of the second option, the UTM coordinate may coincide with an area larger than 1-hectare, such as a large forest or other contiguous habitat that varies little in vegetation cover. This is considered a more casual observation technique, such as when we go on a bird hike and record every bird species we see, without placing each individual species at a particular coordinate. When recording what you see using the second option, it is important for the UTM coordinate be in the dominant habitat type you describe for the larger area.

13. An advantage to using UTM coordinates is that they are increasingly becoming the convention in other monitoring programs. The UTM is also one of many coordinate systems included on hand GPS (Global Positioning Satellite) units.

14. The advantage of using UTMs is that they are precise points based entirely on actual distance. If you do not have a GPS device for determining the UTM points you can still do it "by hand with a map." On a map, distance and area are important. When laying out your monitoring site for NatureMapping, you can use a UTM grid scale on a 7.5' Quadrangle (or whatever scaled map you are using) to measure out the area. Lay a transparency sheet over your map and trace the outline of the blue UTM grid lines in the area of your survey. The grids are 1 kilometer sq., or 1000 meters across. Using a ruler, divide the squares into units of 10, creating a 10 x 10 grid with 100 meter square plots.

15. The data collection forms include a space for the UTM coordinates of the species you find.

Whew, that was a lot, but mapping an invasion is a critical component to understanding whether or not an invasive species is spreading, and providing this information to scientists enables them to monitor that species, and hence, make decisions about the management of invasive species.

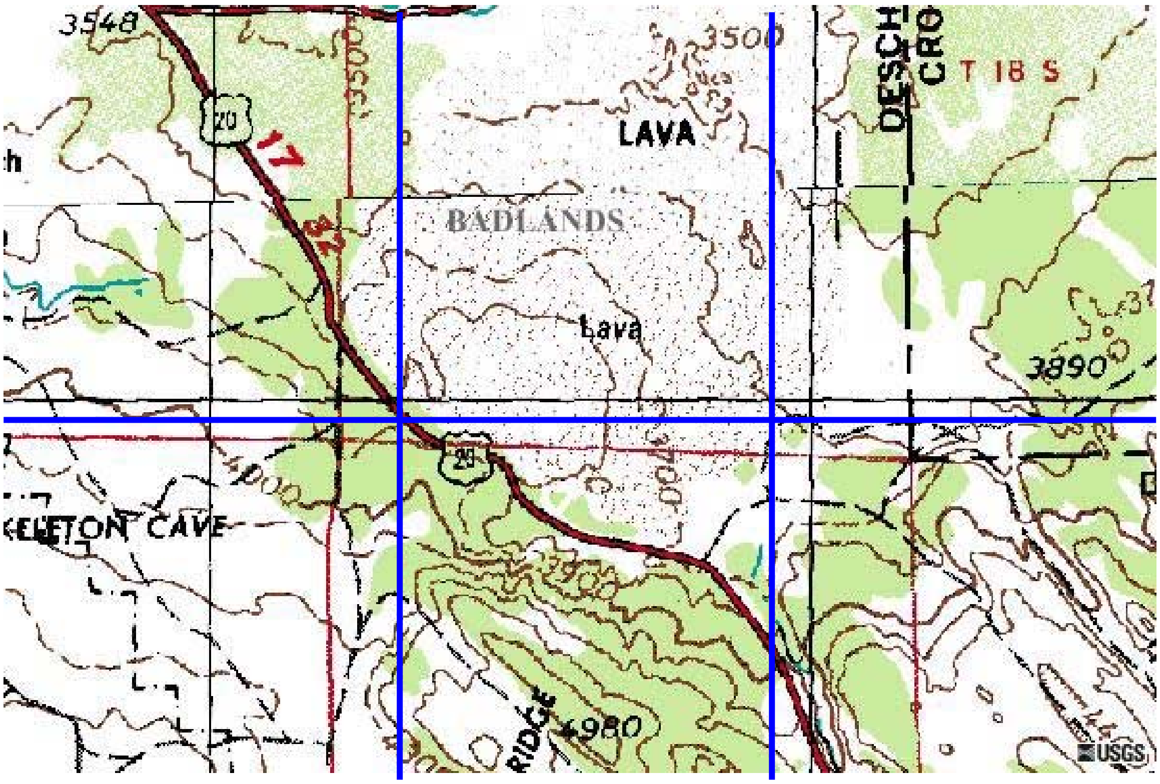
Badlands Wilderness Study Area

~25 Km E. of Bend, Oregon

121W10’23” 646,400.0 | 121W 05’36” 652,800.0 | 121W 00’48” 659,200.0 | 120W56’01” 665,600.0

44N 01’47” 4,876,800.0 | 44N 01’32” 4,876,800.0

43N 58’20” 4,870,400.0 | 43N 58’05” 4,870,400.0



43N 54’52” 4,864,000.0 | 43N 54’38” 4,864,000.0

121W 10’36” 646,400.0 | 121W 05’49” 652,800.0 | 121W 01’02” 659,200.0 | 121W 56’15” 665,600.0

Township, Range, Section –

In the upper right hand corner of the map you can see the designation “T18S” for Township 18 South. Each township has 36 sections, each section is one mile square. The **red lines** on the map indicate the mile square sections.

Latitude & Longtitude –

The map above is divided into six squares by the **blue lines**. At each point along the border of the map, where a blue line touches the edge, are two sets of numbers. The first set is the latitude and longitude designations, for example, the bottom left corner of the map would be designated as 43N 54’52” 121W 10’36”, or in other words, nearly 44 degees of latitude north of the equator and just over 121 degrees of longitude west of the Prime Meridian.

Universal Transverse Mercator (UTM) –

The blue lines also indicate the UTM lines, and the second set of numbers along the map edge is the UTM coordinates. For the same bottom left corner of the map, the UTM coordinate is read as 646,400.0 m E x 4,864,000.0m N., Zone 10, or in other words, the point on the ground is 646,400 meters east of the Zone 10 line (which lies off the coast of Oregon) and 4,864,000 meters north of the equator.

Data Collection

Using the Data Collection Forms

The data collection forms are good for one plot location only. In other words, if you NatureMap at two different plots (i.e., two different quarter/quarter sections), you must use new forms for the second plot, even if that plot is only a quarter of a mile away and within the same natural area.

In general, field work should be conducted for about hour at the same plot location. (Teachers: this may be too long for your students; use your judgment about their abilities.) The observation plot size should be about 1/40 of an acre, or approximately a circle with you at the center and a 37-foot radius around you. Sightings beyond and above this imaginary plot may be included on your data form, but you should not *actively* NatureMap beyond this imaginary plot (i.e., walk beyond it). Even smaller plot sizes are encouraged when *NatureMapping* strictly for amphibians, reptiles, small mammals or plants. Use the open box on page 1 of the data collection form to describe or depict the plot habitat—its dominant vegetation and any other details of interest (e.g., weather conditions, habitat surrounding the plot, etc.).

Be sure you read and understand the instructions below before going into the field and using the *NatureMapping* data collection forms. You must use *NatureMapping* data collection forms and no others when *NatureMapping*. Refer to the sample form in the manual.

Information About You

Record personal information and your affiliation. If you're a student, record your school and your teacher's name. Enter your complete address, including zip code. Enter all phone, fax and e-mail information, as applicable.

Information About This Field Work

Enter the date you conduct field work (mm/dd/yy). Enter start and stop time. Indicate whether you were accompanied by a naturalist or resource specialist during your field work. Provide their name and contact information in case data needs additional verification.

Information About Your Location

For State Code, write "OR." For County Code, determine the county in which your site is located; refer to the list of counties below for the correct three-letter code.

Baker	BAK	Lake	LAK
Benton	BEN	Lane	LAN
Clackamas	CLK	Lincoln	LCN
Clatsop	CLT	Linn	LIN
Columbia	COL	Malheur	MAL
Coos	COS	Marion	MAR
Crook	CRK	Morrow	MOR
Curry	CUR	Multnomah	MUL
Deschutes	DES	Polk	PLK
Douglas	DGS	Sherman	SHM
Gilliam	GLM	Tillamook	TIL
Grant	GRT	Umatilla	UMA
Harney	HRN	Union	UNI
Hood River	HDR	Wallowa	WAL
Jackson	JAK	Wasco	WSC
Jefferson	JEF	Washington	WAS
Josephine	JOS	Wheeler	WHE
Klamath	KLM	Yamhill	YAM

Record the nearest town to your site, and the approximate distance and direction of the town from the site. Enter either the TRS or lat/long location. With TRS, try to narrow your location down to the quarter/quarter section.

Species Complete Common Name

Try to identify the species as best as possible. Refer to your field guide. Use the complete common name. Some species within the same family are almost impossible to distinguish by sight.

Species Code

Refer to the Weeds of Oregon in the Appendix for the plant species code.

CPQ Indicate the degree to which you're certain of each observation. If you're absolutely certain, your observation is confirmed (C); if you're fairly certain, but not entirely, your observation is probable (P); if you're not comfortable saying you're fairly certain, but you still want to make an educated guess, your observation is question-able (Q). Remember, all observations are important. Don't fail to record an observation simply because you're uncertain. Your uncertainty may prove to be a valuable observation.

How Observed? How did you "observe" this animal? Write in the space provided how you "observed" the animal (saw alive, saw dead, saw signs, heard, etc.). To the right, place the appropriate code (see below). You might, for example, have a combination like "saw/heard," in which case the code you would enter next to "saw/heard" would be "L/H."

(L) Saw it alive

(D) Saw it dead

(H) Heard it

(S) Saw signs (tracks, droppings, fur, feathers)

You don't have to record the codes while in the field; these can be entered later as long as you were careful to write how you "observed" each species. Codes must be entered for each observation before transferring your data.

How Many? How many of this animal did you "observe"? Record individual observations up to 25; thereafter, record the following best guesses: 26-50, 51-100, or >100. For plant species, try to estimate the percent coverage of your plot area, for example, 50% would indicate the invasive weed occupies half of the area observed.

Habitat Code Use the form Building Your Habitat Code, available in the Appendix, to determine the code for the particular habitat you are observing. The code sheet includes specific instructions for identifying habitat. There is also a list of Commonly Used Codes. Both of these are available on the *Aliens* website as printable .pdf files.

Oregon *NatureMapping* **Data Collection Form**

The Data Collection Form is available on the *Aliens* website as a printable .pdf file and on the following page.

Oregon *NatureMapping* Data Collection Form

Information About You

Last Name: ____________________________ First Name:_______________________________

Affiliation/School: ______________________ Teacher's Name:___________________________

Address:___________________________ City: ________________ State:___ Zip:___________

Phone:__________________ Fax:_____________________ E-Mail:______________________

Information About This Field Work

Today's Date:__________________________ Start Time:__________End Time:____________

Were you accompanied today by a naturalist or resource specialist?: Yes_______ No_______

Name and contact information of guide: ____

Phone _____________ E-mail: ____________________________________

Information About Your Location

State Code:__________ County Code: ___________ Township/Range:

____

Location name, if any (e.g., national park or refuge name):_______________________________

Nearest town or city:____________________ Approx. distance/direction from site: _________

Location Description

(habitats, dominant vegetation, geography, geology, weather, unusual features, etc.)
Sketch of plot area, plant drawings, additional notes:

Field Data

Location (TRS, Lat/Long or UTM)	**Species Common Name**	**Species Code**	**CPQ**	**How Observed?***	**How Many?**	**Habitat Code**

Species Code – See State List of Oregon Weeds in Appendix
CPQ - C = confirmed; P = probable; Q = questionable
How observed - L = Live; D = Dead; S = signs of; L/H = Live/heard; H = Heard
How Many? – Record number seen at that location if bird or animal, estimate % coverage if invasive weed
Habitat Code – See Habitat Code sheet in Appendix

How to Build Your Habitat Code

• The habitat descriptions are a set of three (3) numbers.
• The major habitats begin with numbers 1-9.

1) Unvegetated
2) Developed
3) Agriculture
4) Open Water
5) Wetlands
6) Non-forest
7) Deciduous/Hardwood forest
8) Deciduous/Conifer forest mix
9) Conifer forest

• The second number is found indented below the major habitat. For example, agriculture (3) that has irrigated fields would be assigned a (1).
• The third number is the next indention. An irrigated agricultural field that has vineyards on it would be labeled (3) agriculture (1) irrigated (3) orchards/vineyards.

Some more examples:
231= Developed (2) light development (3) and residential (1).
A stream surrounded by deciduous trees would be coded 533: wetland (5) riparian (3) and deciduous trees (3).
There are many different possible combinations to identify a habitat using this system.
TIPS:
If you are not sure what code to pick, go backwards and decide what codes you wouldn't select.
Do your best. Many people will look at the same habitat and decide to use different codes. Select the code and stick with it.
Habitats change over time.
Forest codes are difficult for beginners. You may want to just use 700, 800, or 900 for your forest codes.
Habitats (1) unvegetated and (4) Open water have the 2nd and 3rd numbers combined already.

1) Unvegetated

Less than 10 vegetation cover. Excludes agricultural and developed areas, and open water. Refers mostly to large areas of bare rock, saline flats, and permanent snow and ice fields.

10 - Rock/Talus
11-Cliff's
20 - Ice/Snow (permanent)
30 - Sand (beaches, dunes)
40 - Bare Soil (found after floods or forest fires)

2) Developed: Significant human influence

Surface development includes buildings, pavement, mining operations, etc. Excludes agricultural land and clear cuts.

0 - All levels of development from 10-100
1 - Heavy: >60 surface development / < 40 of vegetation
2 - Moderate: 30-60 surface development / - 50 vegetation
3 - Light: 10-30 surface development / > 50 vegetation
    0 - All types of development
    1 - Residential
    2 - Industrial/Business
    3 - Mining operations (i.e. gravel pits or quarries)
    4 - Roads
    5 - Grass/Shrub (i.e. cemeteries, golf courses, mowed parks)

6 - Wooded Forests (i.e. forests/parks with mostly natural vegetation surrounded by development)

3) Agricultural

Intensively managed fields. Does not include unmaintained range used as pasture. Hedgerows are important and should be included in the comments.

- 0 - Irrigated and Non-irrigated fields
- 1 - Irrigated fields
- 2 - Non-irrigated fields
  - 0 - All crop species
  - 1 - Developed/maintained pasture: seeded and regularly mown pasture.
  - 2 - Herbaceous row crops
  - 3 - Orchards/Vineyards
  - 4 - Conservation Reserves

4) Open Water

- 00 - All open water
- 10 - Fresh water
- 11 - Fresh water lakes
- 12 - Municipal ponds
- 13 - Channeled scabland ponds (Eastern Washington)
- 14 - Sewage ponds
- 15 - Fresh moving water
- 17 - Man-made canals
- 18 - Irrigation ponds
- 20 - Salt water
- 30 - Brackish water (partially salty)

5) Wetlands

Vegetated areas where plants are rooted in water or water saturated soil, or that regularly tolerate flooding for extensive time periods.

- 0 - All wetland types
- 1 - Estuarine marsh (saltwater)
- 2 - Freshwater marsh
- 3 - Riparian (rivers and streams)
- 4 - Vernal pools (pools which dry up pan of the year)
- 5 - Ocean beaches (vegetated)
- 6 - Intermittent streams
  - 0 - All wetland vegetation types
  - 1 - Submerged/floating aquatic plants
  - 2 - Emergent herbs/shrubs
  - 3 - Trees - deciduous
  - 4 - Trees – conifer

6) Non-Forested Classes

Grasslands, mountain meadows, unmaintained range, clear cuts, as well as young replanted forests with trees less than 15' tall and have less than 26% canopy cover.

Certain plants are colonizers and are later eliminated as the slower growing climax vegetation become large enough to outgrow the colonizers. The colonizers and young climax vegetation are considered successional. Colonizers appear when there has been a disturbance, such as a. fire, grazing or mowing.

Recently disturbed can mean disturbed yesterday, or 10 years ago. Most of undisturbed/climax vegetation is on preserves or hard to access parcels of land.

- 0 - Successional and climax vegetation
- 1 - Recently disturbed/successional
- 2 - Undisturbed/climax

0 - All structure classes
1 - Sparsely vegetated; 60-90 bare ground
2 - Grassland, forbs; 0-10 shrub or tree cover
3 - Shrub savannah; 11-25 shrub cover
4 - Shrubland; >26 shrub cover
5 - Tree savannah; 11-25 tree cover

7) Deciduous (including hardwoods, such as Madrona that are evergreen)

Forest classes: dbh (diameter at breast height) measured 4.5' from the ground with a special tape measure. The circumference can be measured using a standard measuring tape. Take the measurement at the same height (4.5' from the ground) as you would a dbh.
The following codes are used for the Deciduous, Deciduous/Conifer mix and Conifer classes:

0 - All structure classes
0 - All age/size classes
1 - Saplings (1-4" dbh (3-14" circumference), 15-30' tall)
2 - Pole (5-15" dbh (15-47" circumference), >30' tall)
3*- Small saw (15-20" dbh (48-63" circumference)
4*- Large saw (20-30" dbh (64-94" circumference)
5*- Old Growth: defined primarily by structure 2 or more layers, dominant trees generally >30" dbh on the westside.
6 - Young forests; mostly sapling or pole, possibly including seedlings
7 - Intermediate aged forests; mostly pole or small saw, may include variable aged forests.
8 - Mature to 'over-mature' forests; mostly saw timber to old-growth, may include mature forests of smaller stunted trees, such as some subalpine forests.

To estimate canopy closure, look at the ground and estimate shaded percentage. Walk or look into the forest to estimate canopy closure. The best time to test is when the sun is overhead, about midday.

0 - Open and closed canopy
1 - Open; 26-60% canopy closure
2 - Closed; 60-100% canopy closure
* - These would be homogenous stands. The trees would be about the same size and height.

8) Deciduous/Conifer mix

Forest classes: dbh (diameter at breast height) measured 4.5' from the ground with a special tape measure. The circumference can be measured using a standard measuring tape. Take the measurement at the same height (4.5' from the ground) as you would a dbh.
The following codes are used for the Deciduous, Deciduous/Conifer mix and Conifer classes:

0 - All structure classes
0 - All age/size classes
1 - Saplings (1-4" dbh (3-14" circumference), 15-30' tall)
2 - Pole (5-15" dbh (15-47" circumference). >30' tall)
3*- Small saw (15-20" dbh (48-63" circumference)
4*- Large saw (20-30" dbh (64-94" circumference)
5*- Old Growth: defined primarily by structure 2 or more layers, dominant trees generally >30" dbh on the westside.
6 - Young forests; mostly sapling or pole, possibly including seedlings
7 - Intermediate aged forests: mostly pole or small saw. may include variable aged forests.
8 - Mature to over-mature forests; mostly saw umber to old-growth, may include mature forests of smaller stunted trees, such as some subalpine forests.

To estimate canopy closure, look at the ground and estimate shaded percentage. Walk or look into the forest to estimate canopy closure. The best time to test is when the sun is overhead, about midday.

0 - Open and closed canopy
1 - Open; 26-60 canopy closure
2 - Closed; 60-100 canopy closure

- - These would be homogenous stands. The trees would be about the same size and height.

9) Conifer

Forest classes: dbh (diameter at breast height) measured 4.5' from the ground with a special tape measure. The circumference can be measured using a standard measuring tape. Take the measurement at the same height (4.5' from die ground) as you would a dbh.
The following codes are used for the Deciduous, Deciduous/Conifer mix and Conifer classes:

0 - All structure classes
0 - All age/size classes
1 - Saplings (1-4" dbh (3-14" circumference), 15-30' tall)
2 - Pole (5-15" dbh (15-47" circumference), >30' tall)
3*- Small saw (15-20" dbh (48-63" circumference)
4*- Large saw (20-30" dbh (64-94" circumference)
5*- Old Growth: defined primarily by structure 2 or more layers, dominant trees generally >30" dbh on the westside.
6 - Young forests; mostly sapling or pole, possibly including seedlings
7 - Intermediate aged forests; mostly pole or small saw, may include variable aged forests.
8 - Mature to 'over-mature' forests; mostly saw timber to old-growth, may include mature forests of smaller stunted trees, such as some subalpine forests.

To estimate canopy closure, look at the ground and estimate shaded percentage. Walk or look into the forest to estimate canopy closure. The best time to test is when the sun is overhead, about midday.

0 - Open and closed canopy
1 - Open; 26-60 canopy closure
2 - Closed; 60-100 canopy closure

* - These would be homogenous stands. The trees would be about the same size and height.

Note: The Non-forest and Forest classes may be the most difficult to label. Many professionals can go to the same site and disagree on the classification. Do your best and be consistent using the classes. Label the habitat based on a good sample (i.e. away from the path or edge of a forest) that best describes the habitat. Remember, vegetation is constantly growing, so classes may change within a couple of years.
Urban areas with a lot of large trees are not forests.

Adapted with permission from Washington NatureMapping

Mapping and Contributing Data

Contact Mark Goddard for additional information on contributing GPS field data for mapping purposes in Oregon.

Data Collection Forms, Resources for Activities, GPS and Software Resources used in Oregon NatureMapping

Information needed to assist with filling out the Data Collection Form (it is suggested that the following six files be printed and used in conjunction with the instructions on the Data Collection page. All files are available as printable .pdf files on the *Aliens* website):

Data Collection Form (Oregon) – provided above and can be adapted to other states/needs

Badlands Coordinates Map - to assist with understanding location coordinates methods. Create a colored transparency from the printed form to use in classroom discussion.

State List of Oregon Weeds

List of Oregon County Codes

Building Your Own Habitat Codes – provided above and on the *Aliens* website

Commonly Used Habitat Codes

The Oregon NatureMapping Flora & Fauna CyberTracker Module:

When you download the CyberTracker software (see below) you will need a database of Oregon flora and fauna. Mark Goddard, the developer of the *Aliens* curriculum, has created the Oregon Flora & Fauna Module for CyberTracker software. When loaded into your handheld computer (that is connected to a GPS receiver) you will be ready for making your first inventories of invasive weeds and related species. Contact Mark for more information on obtaining and using the Oregon Flora & Fauna Module (please put Oregon Module in the subject line).

Sources for Oregon Maps:

Oregon Digital Orthoquads - Every USGS 7.5 Topographic Quad map has its own distinct identifying number, know as the Ohio Code. This website is a list of all Oregon quads and includes place names, Ohio Codes, and lat/long information. *Use this list to determine which map for your area to download from the following website* (which only lists quads by Ohio Codes and not place names).

Oregon Geospatial Data Clearinghouse: Complete Alphabetical Listing - This is a complete list of maps available from the Oregon State Dept. of Administrative Services, Information Resources Management Division. Scroll through the alphabetical list until you find Digital Raster Graphics (DRG) - 1:24,000 and click on the word " varies" in the third column. Scroll through the list to find the Ohio Code number for the place name you found in the Oregon Digital Orthoquads list above. The DRGs are in .tif image format, downloadable as .zip files and recognized by most GIS mapping software, including the Cybertracker software recommended for this curriculum.

GIS Software:

CyberTracker - "CyberTracker Conservation aims to make a fundamental contribution to our understanding of complex ecosystems by providing innovative solutions to monitor the environment and manage the utilisation of natural resources. We seek to enable and further the protection of biodiversity, forestry, agriculture, sea fisheries and environmental security. The CyberTracker is the most efficient way to gather large quantities of geo-referenced data for field observations. Involving local communities in key areas of biodiversity, the CyberTracker combines indigenous knowledge with state-of-the-art computer and satellite technology." (from CyberTracker Mission Statement)

Combine the free CyberTracker software with the Oregon Flora & Fauna Module in your handheld computer, add a USGS 7.5 Quad map for your area in to the module, connect it to a GPS receiver and you are ready to begin inventory and mapping.

ArcGIS -

Purchasing GPS and Palm equipment:

CDW Government, Inc. www.cdwg.com

44084 Riverside Parkway

Suite 350

Landsdowne, VA 20176-5102

Ph#: 800-808-4239

Fax: 847-419-6200

for cables to link GPS and Palm computers:

Blue Hills Innovations www.bluehillsinnovations.com

2749 20 3/4 Ave.

Rice Lake, WI 54868

Ph#: 715-234-3303

Fax: 715-234-3350

To assist with weed identification and classification:

XID Pacific Northwest Weed ID - the XID CD-ROM has an interactive key, illustrated glossary and color images for 600 weeds of the Pacific Northwest (available through their website). This is one of the key tools used in *Aliens* for both weed identification and can be used in the Classification Unit.

Glossary & Plant Facts

Abiotic - not from or relating to life, not biotic; inert materials such as soil, water, minerals, gases

Adaptation - any change in an organism through natural selection that enables it to survive and multiply in its environment

Alien - plant species referred to as exotics, non-native, weeds, introduced, and non-indigenous that effect the biodiversity of all our lands to the detriment of native species

Allelopathic - a plant is considered allelopathic if it produces natural toxins that inhibit the growth of nearby plants

Angiosperm - any vascular plant having seeds enclosed in a fruit, grain, pod or capsule; all flowering plants

Annual - a plant that completes its life cycle within one year, then dies, its seeds being retained in the seedbank

Attribute - a quality, characteristic, or property relating to a specific plant, usually outside of the typically described botanical characteristics: *this yellow plant prefers dry, sandy soils; "yellow" and the soil type being attributes of this species*

Biodiversity - the total variety of different kinds of living things in an area

Biome - a major regional ecological community of plants and animals, ex. desert biome

Biosphere - the living layer of the earth where the biotic components interact with and utilize the abiotic components, with the atmosphere above and geosphere below

Biotic - the living components of environment

Carnivore - an animal that eats meat (other animals)

Community - a group of interacting plants and animals within a given area

Competition - the efforts by multiple species to utilize the same resource

Conservation - the efforts to preserve a single or multiple species and the optimum environmental conditions in which they are most successful

Consumer - an animal that obtains food by eating

Contaminant - an agent, either abiotic or biotic, that upsets the normal functioning of a system

Cooperation - mutually beneficial interactions between species living in a limited area

Decomposer - organism that uses dead material as energy source; bacteria and fungi

Detrivore - organism, other than bacteria and fungi, that feeds on dead organic matter; turkey vulture

Dicot - any flowering plant having two embryonic seed leaves, flower parts in fours or fives, and net-veined leaves: includes most broad-leaved flowering plants and trees

Dispersal - the act of spreading seed via some physical action; wind, water, forcible ejection, barbs that catch on fur, etc.

Ecosystem - an area where living things interact with each other and their physical environment

Endangered - at risk of becoming extinct from both ultimate and proximate pressures

Exponential growth - where the numbers of a species increase by some factor over time; a logarithmic growth

Extinct - a species with no living representative

Food Chain - the linear links from producers (plants) to primary consumers (herbivores) to secondary consumers (carnivores)

Food web - an intertwining and overlapping of several food chains, where all species are represented as being connected to, and thus dependent, on the other species

Forage - the plant species consumed by herbivores

GIS - Global Information System; mapping software and hardware to utilize coordinate data from global position satellites (GPS)

GPS - Global Position Satellites; a series of satellites orbiting the earth used for locating specific points on the Earth's surface; the information is picked up by GPS Receivers and downloaded to GIS mapping software

Habitat - the place where an organism lives

Herbivory - feeding on plants by any animal

Invasive - the act by any plant or animal that establishes itself in an area other than its native habitat and succeeds in supplanting the native species of its new locale

Map View - an aerial, or bird's-eye, view of any geographic area

Monocot - a plant characterized by having an embryo containing a single seed leaf and floral parts in multiples of three; grasses, orchids and lilies

Native - a plant or anima's geographic area in which it originally evolved

Niche - functional role of a species in the community, including activities and relationships

Omnivore - an animal that consumes both plants and animals

Perennial - plants that have a life cycle lasting more than two years

Population - the total number of one species within a given area; the abundance of a species

Predation - the act of by one species to seek and consume another species

Producer - any plant within a food chain or food web that makes sugar (via photosynthesis)

Range - the geographic extent of any species

Recycling - the return of abiotic resources to the environment through decomposition

Scale - the numerical representation of geographic area in mapping

Scavenger - any animal (detrivore) that actively searches for and consumes dead animals

Seedbank - a plants investment in future generations, expressed as the total number of seeds that remain viable in soil until conditions are right for germination

Symbiosis - the living together of two dissimilar organisms; as in mutualism, commensalism or parasitism

Topographic - a representation of geographic land forms as a function of contours and elevations

Viable - a seed "at rest" in the soil, sometimes for many years, but alive and able to germinate when environmental conditions are optimal

Weed - any plant unwanted and deemed a nuisance by humans; may include native or non-native plants

An Annotated Bibliography:

Invasive Weed Resources and Internet Sites

Sources are organized alphabetically under the following headings: Classification, Databases, Education, Fire, Impacts, Inventory & Monitoring, Mapping (including GPS), and Weed Information. When applicable, secondary keywords are listed with each source.

Classification

1. Old, Richard. (2003) XID Expert Identification System, [Web Page]. URL http://www.xidservices.com/ [2003, August].
   Keywords: Classification, Software
   Abstract: XID keys can be as simple or sophisticated as the author wishes, making this program as useful to junior high school teachers as it is to scientific specialists. Such programs offer many advantages over traditional dichotomous keys. While originally produced to increase speed and ease of use, they also provide the ability to easily update the data and images, and are much cheaper to produce and more compact than hard copy guides. In general, much more data is included on each item/species than is necessary to identify it. With this abundance of data, the user can identify any of the items/species using the characteristics most obvious and easy to describe. With each characteristic entered by the user, the program eliminates all species that do not have the combination of features entered.

Database

1. Butterfield, C. J. S. a. J. S. (1999) Species Abstracts of Highly Disruptive Exotic Plants [Web Page]. URL http://www.npwrc.usgs.gov/resource/othrdata/exoticab/exoticab.htm [2003, August].
   Keywords: Database
   Abstract: The pages that follow include the ranking system, developed by Ronald Hiebert and James Stubbendiek, and comprehensive abstracts for each species that was ranked as highly disruptive in the areas that have been surveyed. The abstracts contain information on the taxonomy, ecology, distribution within the park, control options, and a literature review for each plant.

2. Rice, P. (Director). (INVADERS Database System [Web Page]. URL http://invader.dbs.umt.edu/ [2003, August].
   Keywords: Database
   Abstract: The INVADERS Database is a comprehensive database of exotic plant names and weed distribution records for five states in the northwestern United States. The spatial and temporal spread of weeds can be displayed using the historic distribution records in INVADERS. The INVADERS web site contains

actual examples of how land management and weed regulatory agencies are using these data to improve their weed management programs. Noxious weed listings are provided for all US states and six southern tier Canadian provinces.

3. U.S. Department of Agriculture, (2003) Fire Effects Information System [Web Page]. URL http://www.fs.fed.us/database/feis/ [2003, August].
Keywords: Database
Abstract: The FEIS database contains synoptic descriptions, taken from current English-language literature of almost 900 plant species, about 100 animal species, and 16 Kuchler plant communities found on the North American continent. The emphasis of each synopsis is fire and how it affects each species. Background information on taxonomy, distribution, basic biology and ecology of each species is also included. Synopses are thoroughly documented, and each contains a complete bibliography. Personnel from several land management agencies (USDA Forest Service, USDI-BIA, NPS, BLM, F&WS) identified the species to be included in the database. Those agencies funded the original work and continue to support maintenance and updating of the database.

4. USDA. (PLANTS - Invasive & Noxious [Web Page]. URL http://plants.usda.gov/cgi_bin/topics.cgi?earl=noxious.cgi [2003, August].
Keywords: Database, Plants
Abstract: A searchable database of all plants, with links to State noxious weed lists and botanical information

5. USDA, (2003) Germplasm Resources Information Network - (GRIN), Taxonomic Database [Web Page]. URL http://www.ars-grin.gov/cgi-bin/npgs/html/tax_search.pl [2003, August].
Keywords: Database, Plants
Abstract: GRIN taxonomic data provide the structure and nomenclature for the accessions of the National Plant Germplasm System (NPGS). Many plants (37,000 taxa, 14,000 genera) are included in GRIN taxonomy, especially economic plants. A recent paper on GRIN taxonomy provides a thorough discussion of data standards and taxonomic philosophy.

Education

1. American Institute of Biological Sciences. (2004). ActionBioScience [Web Page]. URL http://www.actionbioscience.org [2004, February]
Keywords: Biodiversity, Environment, Invasives
Abstract: ActionBioScience.org is an education resource of the American Institute of Biological Sciences that is a non-commercial, ad-free, educational site promoting literacy in the biosciences by featuring peer-reviewed articles and class lessons in the areas of biodiversity, environment, genomics, biotechnology, evolution, new frontiers, and bioscience education. (Spanish translations of select articles are also available.)
The Actionbioscience.org site was recently honored with a “2003 Sci/Tech Web Award for best biology web sites” by *Scientific American*. We invite you to visit

our web site and see for yourself why it has received numerous recognitions for its articles and educator resources.

2. Bottle Biology Project. (1993). Bottle Biology. Department of Plant Pathology, College of Agriculture and Life Sciences, University of Wisconsin-Madison, WI:Kendall-Hunt Publishing Company.

3. Carla Hoopes (Project Coordinator). (2003) Pulling Together Against Noxious Weeds [Web Page]. URL http://www.weedawareness.org/ [2003, August].
Keywords: Education, Land Use
Abstract: This weed awareness site provides references and resources for education and awareness of the serious impacts of noxious weeds on the economy and environment of Montana. This site represents the work of a committee of land managers from federal and state agencies, local organizations, industry, and concerned individuals across Montana who care about our future.

4. Bartell, Lisa. (2003). Database of Award Winning Children's Literature. [Web Page]. URL http://www.dawcl.com/introduction.html. [2003, August].
Keywords: Education, Literature

5. David Melton, (1985). Written and Illustrated By: A Revolutionary Two-Brain Approach for Teaching Students How to Write and Illustrate Amazing Books. Landmark Editions.
Keywords: Education, Art

6. Detka, Jon. (2000). Return of the Natives: A curriculum and Online Toolbox for the Restoration of Native Plants & eradication of Invasive Weeds. [Web Page] URL http://watershed.csumb.edu/ron/roncor/cor/index.htm [2003, August].
Keywords: Education, Activities
Abstract: Return of the Natives (RON) - Cycle of Restoration is designed with the flexibility to be integrated into existing ecology-based curricula to increase awareness about the imposing spread of invasive non-native weeds and the importance of maintaining healthy native plant communities in California.

7. Krasny, Marianne, et al. (2003). Invasion Ecology. Cornell Scientific Inquiry Series, National Science Teachers Association (NSTA): Arlington, VA.
Keywords: Education, Activities
Abstract: A middle school to high school curriculum

8. Montana Heritage Program. (2004) The Montana Heritage Program [Web page] URL http://www.edheritage.org/ [2004]
Keywords: Education
Abstract: Dedicated to teaching young people to think clearly and deeply about the world they face. Students are asked to explore their community. The following two resources from MHP provide teachers with ways to involve students and ask important questions:
ALERT: Learning as Narrative Process

Everything Else Follows: 5 Steps from Community-Centered Schools to Education-Centered Communities by Michael L. Umphrey

9. National Research Council. (1995). Inquiry and the national science education standards: A guide for teaching and learning. (ed.). National Research Council.

10. National Research Council. (1996). National science education standards. (ed.). Washington, D.C.: National Research Council.
Keywords: nature of science, history of science.

11. Oregon Field Guide. (OFG - Noxious Weeds - Curriculum [Web Page]. URL http://www.opb.org/programs/ofg/908/weeds/index.html [2003, August].
Keywords: Education
Abstract: This resource is not an exhaustive guide to noxious weeds, but it is a good introduction to a current environmental problem. This resource is also a starting point for further discussion and research. The Oregon Field Guide segment touches on a few scientific principles you can explore more fully with your classrooms after or before viewing the video.

12. Rieben, Elizabeth. How to Prevent the Spread of Noxious Weeds [Web Page]. URL http://www.blm.gov/education/weed/weed.html [2003, August].
Keywords: Education, Activities
Abstract: What's Wrong With This Picture?
Invasive Weeds: A Growing Pain
Many weeds have pretty flowers but they are a growing pain. They crowd out native plants, harm animal habitats and increase erosion.

13. Simon, B. (Education Specialist). A Teachers Curriculum for Noxious Weed Educational Projects [Web Page]. URL http://www.nwcb.wa.gov/education/curriculum.html [2003, August].
Keywords: Education, Activities
Abstract: In plant communities across the west - from shrub steppe habitats, to waterways, to Puget Sound prairies - noxious weeds are invading the landscape like an explosion in slow motion. All citizens of the state, young and old included, need to learn and work together to preserve and protect our native ecosystems from further invasion by invasive plant species.

14. Washington State Noxious Weed Control Board. Weed Education [Web Page]. URL http://www.nwcb.wa.gov/education/educationhome.html [2003, August].
Keywords: Education
Abstract: The mission of the Washington State Weed Board is to serve as responsible stewards of Washington by protecting and preserving the land and resources from the degrading impact of noxious weeds. The State Weed Board serves as the state's noxious weed coordination center. Through its actions and policy decisions, the Board coordinates and supports the activities of 48 county noxious weed control boards and weed districts of Washington.
This link directs you to their Education Page.

Fire

1. Brooks, M. (2001) Invasive Plants and Fire in the Deserts of North America [Web Page]. URL http://www.werc.usgs.gov/pubbriefs/brookspbmar2002.html [2003, August].
Keywords: Fire

Impact

1. Andrascik, R., et al. (1996) A Strategic Plan for Managing Invasive Nonnative Plants on National Park System Lands [Web Page]. URL http://www.nature.nps.gov/wv/strat_pl.htm [2003, August].
Keywords: Impact
Abstract: The National Park Service prepared this document to describe the impacts of invasive nonnative plants on the National Park System's natural resources and to outline strategies and tactics to help prevent and manage their spread on National Park System lands. This plan describes for National Park Service managers and partners the management challenges facing the agency and outlines ways to better coordinate all National Park Service programs in the fight against invasive nonnative plants.

2. National Park Service. (2000) Discovery 2000: The NPS General Conference [Web Page]. URL http://www.nps.gov/discovery2000/home.htm [2004, February].
Keywords: Impact, Resources
Abstract: This conversation is not about the technical side of how we do work, but the leadership side that the National Park Service has or should and can have within communities and how the NPS can contribute and be an effective advocate for NPS values and ideas at the same time serving in the role of contributor and supporter of community goals and needs.

Inventory & Monitoring

1. APRS Implementation Team. (2002) Alien plants ranking system version 5.1 [Web Page]. URL http://www.npwrc.usgs.gov/resource/2000/aprs/aprs.htm [2003, August].
Keywords: Inventory & Monitoring
Abstract: The Alien Plants Ranking System (APRS) is a computer-implemented system to help land managers make difficult decisions concerning invasive nonnative plants. The management of invasive plants is difficult, expensive, and requires a long-term commitment. Therefore, land managers must focus their limited resources, targeting the species that cause major impacts or threats to resources within their management, or the species that impede attainment of management goals. APRS provides an analytical tool to separate the innocuous species from the invasive ones (typically around 10% of the nonnative species). APRS not only helps identify those species that currently impact a site, but also those that have a high potential do so in the future. Finally, the system addresses the feasibility of control of each species, enabling the manager to weigh the costs of control against the level of impact.

3. National Park Service. (2001) Inventory and Monitoring [Web Page]. URL http://www.nature.nps.gov/im/ [2003, August].
Keywords: Inventory & Monitoring
Abstract: The goal of the National Park Service's Natural Resource Inventory and Monitoring Program is to acquire the information and expertise needed by park managers in their efforts to maintain ecosystem integrity in the approximately 270 National park System units that contain significant natural resources.

Mapping, GPS, GIS and Related Software

1. Bureau of Land Management. (2004) BLM Noxious Weeds GIS Layer Standard [Web Page] URL http://www.blm.gov/nhp/efoia/or/fy2000/im/m2000-060.htm [2004]

2. Environmental Systems Research Institute, Inc. (2003) ArcExplorer Mapping Software. [Web Page] URL http://www.esri.com/software/arcexplorer/ [2003, August]
Keywords: Mapping, software
Abstract: ESRI creates innovative mapping software for use with GPS equipment in your invasive weed mapping projects. "ESRI is about improving our world and the use of our resources through better information management (Jack Dangermond President, ESRI)" ESRI and the ESRI Logo are licensed trademarks of Environmental Systems Research Institute, Inc.

3. Johnson, Dr. D. E. (Project Leader). (2003) WeedMapper [Web Page]. URL http://www.weedmapper.org/ [2003, August].
Keywords: Mapping
Abstract: WeedMapper is a web-based spatially referenced database of noxious weeds that anyone may query. The database includes locations of noxious weeds throughout Oregon as collected by responsible federal, state, and local agencies. Our electronic maps are viewable at the state, county, township, or section (square mile) level.
WeedMapper is designed to facilitate identification, reporting, and verification of noxious weeds in the state of Oregon. It provides maps of known infestations of the most serious weed pests, as well as photographs, taxonomic and diagnostic characteristics to assist in their identification.

4. *Oregon Geospatial Data Clearinghouse. (2003). Spatial Data Library, [Web Page] URL http://www.gis.state.or.us/data/ [2003, August].*
Keywords: Mapping, Software
Abstract: Part of the Oregon Resources Management Division of the Dept. of Administrative Service, the library contains a vast number of maps available for download in use with GIS software. A valuable source of Oregon maps.

5. University of Washington. (2003). NatureMapping of Washington [Web Page] URL http://www.fish.washington.edu/naturemapping/index.html [2003, August].
Keywords: Mapping, Education

Abstract: The NatureMapping Program's vision is to create a national network that links natural resource agencies, academia and land planners with local communities primarily through schools. Our goal is to keep common animals common and to maintain our quality of life. Our approach is to train individuals to become aware of their natural resources and to provide the tools to inventory and monitor their resources.

6. USGS Biological Services. (2003) National GAP Analysis Program [Web Page]. URL http://www.gap.uidaho.edu/default.htm [2003, August].
Keywords: Mapping
Abstract: GAP is the acronym used to refer to the Gap Analysis Program of USGS. It could also refer to the fact that GAP is a geographic approach to planning.
Gap Analysis is a proactive approach to protecting biodiversity. It seeks to identify gaps between land areas that are rich in biodiversity and areas that are managed for conservation.
The gap approach is based on three main assumptions:
* The best time to save species is while they are still common;
* it is cheaper to maintain natural populations, than it is to intensely manage endangered populations; and,
* while we cannot perfectly model biodiversity, we can use what we know about the distributions of vertebrate species and vegetation types to assess biodiversity at local, state, regional and national levels.

7. USGS-NPS. (2003) Applications of USGS-NPS Vegetation Mapping Program Data [Web Page]. URL http://biology.usgs.gov/npsveg/apps/ [2003, August].
Keywords: Mapping
Abstract: The applications described below are provided here to illustrate the wide variety of uses currently being made of the USGS-NPS Vegetation Mapping Program products. They are also provided in the hope that an application described for one park may promote a similar or modified application at a different location. These applications are not funded by the USGS-NPS Vegetation Mapping Program, but make use of the products created by the program.
8. State Sites:
Mapping Noxious Weeds in Montana - http://agri.state.nv.us/nwac/montanaweeds.pdf
Montana Noxious Weed Survey and Mapping System - http://www.montana.edu/places/mtweeds/
The Nevada Invasive Plant GIS (based on Montana's weed mapping system) - http://agri.state.nv.us/nwac/GIS_1.htm
California Regional Invasive Species Information System - http://cain.nbii.gov/crisisindex

Weed Information

1. BLM (Office of Environmental Education and Volunteers). (The Weed Hall of Shame [Web Page]. URL http://www.blm.gov/education/weeds/hall_of_shame.html .
Abstract: Many weeds have pretty flowers but they are a growing pain. They crowd out native plants, harm animal habitats and increase erosion. Click on the pictures below to learn more about America's Most Wanted Weeds.

2. Booth, B. (Weeds: BLM Education [Web Page]. URL http://www.blm.gov/education/weed/pain/ [2002, February 26].
Keywords: Weed Info

3. Breitenfeldt, T. (Site Supervisor). (Mt. Wow [Web Page]. URL http://mtwow.org/ [2003, August].
Keywords: Weed Info
Abstract: This web site will educate you about Montana State Noxious Weeds in a user friendly, how-to, information, link and picture-packed series of pages. We are dedicated to Integrated Pest (Weed) Management, which means we will inform you of any and all reasonable methods possible to help you fight your 'War On Weeds.

4. Cocannoue, J. A. (1950) Weeds - Guardians of the Soil [Web Page]. URL http://www.journeytoforever.org/farm_library/weeds/WeedsToC.html [2003, August].
Keywords: Weed Info
Abstract: So far as we are able to determine this is the first book to be written *in praise of weeds*. Many are the books which treat weeds as pests, and each season sees an advance in anti-weed campaigns and techniques; a host of chemicals, mechanical eradicators and even flame throwers are making life increasingly hard for nature's greatest and most widely dispersed group of plants -- the plants which stand condemned because they are deemed "out-of-place."

5. Hoopes, C. (Project Coordinator). (Pulling Together Against Noxious Weeds [Web Page]. URL http://weedawareness.org/ [2003, August].
Keywords: Weed Info
Abstract: This site represents the work of a committee of land managers from federal and state agencies, local organizations, industry, and concerned individuals across Montana who care about our future.

6. Malone, M. (Montana Weed Control Association Noxious Weed Information [Web Page]. URL http://mtweed.org/ [2003, August].
Keywords: Weed Info
Abstract: This site includes a wealth of noxious weed information. One of the projects that MWCA is promoting is The Montana Weed Education and Awareness Campaign. The mission of the campaign is to inform all Montanan's about noxious weeds and their impact on our environment. Over the past 100

years, noxious weeds have been spreading at an alarming rate. For example, spotted knapweed arrived on the west coast in 1893 on the San Juan Islands Washington. By 1920, this weed had established itself in over 24 counties in three Northwestern states, with several large infestations near Missoula, Montana. Now, spotted knapweed is established in every county in the western United States and has invaded five million acres in Montana alone. Large infestations continue to expand, especially along waterways and major transportation routes. Many other knapweeds, such as yellow starthistle, diffuse knapweed, Russian knapweed, and square rose knapweed have similar invasion rates throughout the western United States. Leafy spurge and many other noxious weeds are invading from the east, rather than the west. In our opinion, if these weeds continue to spread at their current rate for the next 100 years, they will dominate most western rangelands. The Montana Weed Control Association is dedicated to educate the landowners, recreationists, and visitors why the control of noxious weeds is so important to the well being of Montana. This web site's purpose is to provide the visitor with identification information, the dangers of noxious weeds, and control recommendations. If you have further questions check out the information page. We hope the site will answer your questions. If you have additional questions e-mail us with your questions. A weed control expert will provide information on your question.

7. McFall, W. (Project contact). (Idaho's OnePlan [Web Page]. URL http://www.oneplan.org/Crop/1cPestM.htm [2003, August].
Keywords: Weed Info
Abstract: A consortium of agencies with many links to information about invasive weeds in Idaho

8. Murphy, A. (Center for Invasive Plant Management [Web Page]. URL http://weedcenter.org/ [2003, August].
Keywords: Weed Info
Abstract: The Center for Invasive Plant Management represents a coalition of agencies, organizations, and individuals interested in managing invasive plants and maintaining healthy ecosystems in western North America. Enhancing land manager and public education, coordinating regional research, facilitating partnerships, increasing multidisciplinary communication, and implementing practical management programs are the Center's goals.

9. National Invasive Species Council. (2003) A Gateway to Federal and State Invasive Species Activities and Programs [Web Page]. URL http://www.invasivespecies.gov/index.shtml [2003, August].
Keywords: Weed Info
Abstract: Invasivespecies.gov is the gateway to Federal efforts concerning invasive species. On this site you can learn about the impacts of invasive species and the Federal government's response, as well as read select species profiles and find links to agencies and organizations dealing with invasive species issues. Invasivespecies.gov is also the website for the National Invasive Species Council, which coordinates Federal responses to the problem.

10. Plant Conservation Alliance's Alien Plant Working Group. (2003) Weeds Gone Wild: Alien Plant Invaders of Natural Areas [Web Page]. URL http://www.nps.gov/plants/alien/index.htm [2003, August].
Keywords: Weed Info
Abstract: A web-based project of the Plant Conservation Alliance's Alien Plant Working Group, that provides information for the general public, land managers, researchers, and others on the serious threat and impacts of invasive alien (exotic, non-native) plants to the native flora, fauna, and natural ecosystems of the United States.
This site provides a compiled national list of invasive plants infesting natural areas throughout the U.S., background information on the problem of invasive species, illustrated fact sheets that include plant descriptions, native range, distribution and habitat in the U.S., management options, suggested alternative native plants, and other information, and selected links to relevant people and organizations.

11. The Nature Conservancy, W. I. S. T. (2003) Invasives on the Web [Web Page]. URL http://tncweeds.ucdavis.edu/ [2003, August].
Keywords: Weed Info,
Abstract: TNC statement: "It might seem strange that an organization like The Nature Conservancy, which is dedicated to protecting biodiversity, practices weed management. Does this conflict with our goal of preserving biodiversity? Not at all! On our preserves we strive to protect the native plants, animals, and communities that live there. Weeds are those plants that interfere with this objective. If a non-native plant is decreasing the native biodiversity, we consider it a weed and decide whether we must take action to protect the native plants, animals, and communities on our lands."

12. Westbrooks, R. G. (1998) Invasive Plants: Changing the Landscape of America: Fact Book [Web Page]. URL https://www.denix.osd.mil/denix/Public/ES-Programs/Conservation/Invasive/intro.html [2003, August].
Keywords: Weed Info
Abstract: "Developed by Dr. Randy Westbrooks and the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW), this fact book is intended to raise awareness of the destruction and economic losses caused by invasive plants in the United States. We hope this compilation of facts will encourage individual and collaborative efforts to respond to this threat to the integrity of the nation's ecosystems."
Mark Schaefer, Ph.D.
Deputy Assistant Secretary for Water and Science U.S. Department of the Interior

Weed Information, Control

1. Dremann, C. (2002) Craig's Juicy Native Grass Gossip & Research: Weeds and persistent Exotics on Public Lands, Vol 6 [Web Page]. URL http://www.batnet.com/rwc-

seed/juicy.gossip.six.html [2003, August].
Keywords: Weed Info, Control
Abstract: EXOTIC INVASIVE PLANTS. Public land agencies, for the past fifteen years, have been moving toward a concept called "ecosystem management", which includes a concern about exotic plants that interfere with ecosystem function. The spread of exotic invasive plants is the principle focus of this concern, with plans developing for control and eradication. Exotic plants impact natural ecosystems, and have the possibility of spreading off the public land onto private property. Billions of dollars will be needed to get the exotic invasive plants on public lands (including highway right-of-ways) under control within the next few decades. However, there is another class of plants, other than exotic invasives, which disrupt ecosystem function and need to be looked at: the persistent exotics.

Appendix

Appendix A - National Science Education Standards

Appendix B - Cross-reference of Aliens with Project Learning Tree and Project Wild

Appendix A

Checklist for Content Standards Grades K-4

For a complete description of each Content Standard, see:
http://books.nap.edu/html/nses/html/overview.html#content

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades K-4, all students should develop
- ❑ Abilities necessary to do scientific inquiry
- ❑ Understandings about scientific inquiry

Physical Science - CONTENT STANDARD B:
As a result of their activities in grades K-4, all students should develop an understanding of
- ❑ Properties of objects and materials
- ❑ Position and motion of objects
- ❑ Light, heat, electricity, and magnetism

Life Science - CONTENT STANDARD C:
As a result of their activities in grades K-4, all students should develop understanding of
- ❑ The characteristics of organisms
- ❑ Life cycles of organisms
- ❑ Organisms and environments

Earth and Space Science - CONTENT STANDARD D:
As a result of their activities in grades K-4, all students should develop an understanding of
- ❑ Properties of earth materials
- ❑ Objects in the sky
- ❑ Changes in earth and sky

Science and Technology - CONTENT STANDARD E:
As a result of activities in grades K-4, all students should develop
- ❑ Abilities of technological design
- ❑ Understanding about science and technology
- ❑ Abilities to distinguish between natural objects and objects made by humans

Science in Personal and Social Perspectives - CONTENT STANDARD F:
As a result of activities in grades K-4, all students should develop understanding of
- ❑ Personal health
- ❑ Characteristics and changes in populations
- ❑ Types of resources
- ❑ Changes in environments
- ❑ Science and technology in local challenges

History and Nature of Science -CONTENT STANDARD G:
As a result of activities in grades K-4, all students should develop understanding of
- ❑ Science as a human endeavor

Checklist for Content Standards Grades 5-8

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop
- ❑ Abilities necessary to do scientific inquiry
- ❑ Understandings about scientific inquiry

Physical Science - CONTENT STANDARD B:
As a result of their activities in grades 5-8, all students should develop an understanding of
- ❑ Properties and changes of properties in matter
- ❑ Motions and forces
- ❑ Transfer of energy

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 5-8, all students should develop understanding of
- ❑ Structure and function in living systems
- ❑ Reproduction and heredity
- ❑ Regulation and behavior
- ❑ Populations and ecosystems
- ❑ Diversity and adaptations of organisms

Earth and Space Science - CONTENT STANDARD D:
As a result of their activities in grades 5-8, all students should develop an understanding of
- ❑ Structure of the earth system
- ❑ Earth's history
- ❑ Earth in the solar system

Science and Technology - CONTENT STANDARD E:
As a result of activities in grades 5-8, all students should develop
- ❑ Abilities of technological design
- ❑ Understandings about science and technology

Science in Personal and Social Perspectives - CONTENT STANDARD F:
As a result of activities in grades 5-8, all students should develop understanding of
- ❑ Personal health
- ❑ Populations, resources, and environments
- ❑ Natural hazards
- ❑ Risks and benefits
- ❑ Science and technology in society

History and Nature of Science -CONTENT STANDARD G:
As a result of activities in grades 5-8, all students should develop understanding of
- ❑ Science as a human endeavor

- ❑ Nature of science
- ❑ History of science

Checklist for Content Standards Grades 9-12

Science as Inquiry - CONTENT STANDARD A:
As a result of activities in grades 9-12, all students should develop

- ❑ Abilities necessary to do scientific inquiry
- ❑ Understandings about scientific inquiry

Physical Science - CONTENT STANDARD B:
As a result of their activities in grades 9-12, all students should develop an understanding of

- ❑ Structure of atoms
- ❑ Structure and properties of matter
- ❑ Chemical reactions
- ❑ Motions and forces
- ❑ Conservation of energy and increase in disorder
- ❑ Interactions of energy and matter

Life Science - CONTENT STANDARD C:
As a result of their activities in grades 9-12, all students should develop understanding of

- ❑ The cell
- ❑ Molecular basis of heredity
- ❑ Biological evolution
- ❑ Interdependence of organisms
- ❑ Matter, energy, and organization in living systems
- ❑ Behavior of organisms

Earth and Space Science - CONTENT STANDARD D:
As a result of their activities in grades 9-12, all students should develop an understanding of

- ❑ Energy in the earth system
- ❑ Geochemical cycles
- ❑ Origin and evolution of the earth system
- ❑ Origin and evolution of the universe

Science and Technology - CONTENT STANDARD E:
As a result of activities in grades 9-12, all students should develop

- ❑ Abilities of technological design
- ❑ Understandings about science and technology

Science in Personal and Social Perspectives - CONTENT STANDARD F:
As a result of activities in grades 9-12, all students should develop understanding of

- ❑ Personal and community health
- ❑ Population growth
- ❑ Natural resources
- ❑ Environmental quality
- ❑ Natural and human-induced hazards

- ❑ Science and technology in local, national, and global challenges

History and Nature of Science -CONTENT STANDARD G:
As a result of activities in grades 9-12, all students should develop understanding of
- ❑ Science as a human endeavor
- ❑ Nature of scientific knowledge
- ❑ Historical perspectives

Appendix B

Cross-reference of Aliens with Project Learning Tree and Project Wild

Aliens Relate to Project Learning Tree and Project Wild!!

The *Aliens In Your Neighborhood* lesson plans are cross-linked to Project Learning Tree (PLT), Project Wild (PW) and Project Wild Aquatic (PWA). Each *Aliens* Unit is listed in bold, followed by suggested activities which are listed by activity title, the manual where it is found, how it relates to the *Aliens* unit and to NatureMapping, and a brief description of the activity. The activities listed are not restricted to the *Aliens* unit in which they are found.

***Aliens* Unit Key** – Classification (**C**), Ecosystems (**E**), Issues (**I**), Invasion (**In**), NatureMapping (**NM**), Plants (**P**)

Aliens	Activity	Manual	Relationship to Aliens Units & NatureMapping	Activity Description
C NM	Animal Charades	PW	Reinforce characteristics of animals students will be mapping, helps learn ID characteristics	Students use "charades" to distinguish between wild & domestic animals
E	Blue Ribbon Niche	PW	If site includes a riparian area, familiarize students with critters in riparian areas	Students create a variety of representations of animals & plants that live in riparian areas
E	Can it be Real?	PLT	Help students better understand the concept of adaptation; help students relate relationship of animals to their habitats	Students study characteristics of unusual plants and animals and describe how they are adapted to a particular set of environmental conditions
E	Carrying Capacity	PW	Develop better understanding of natural processes; carrying capacity: basic habitat requirements	Students become herds of animals seeking food in a physically involving game
E	Classroom Carrying Capacity	PW	Develop better understanding of natural processes; discussion of habitat: densities of critters at different times of the year	Students sit unusually close to each other & describe the results
E	(The) Forest of S.T. Shrew	PLT	If map a forest area; important to learn about where different animals live	Students identify microhabitats in the forest by drawing pictures or writing stories and describe plants or animals that characterize microhabitats in a forest
E	Habitat Lap Sit	PW	Understanding of what needs to be present for animals to survive; habitat	Students physically form an interconnected circle to demonstrate components of habitat
E	Habitat Rummy	PW	Understanding of what needs to be present for animals to survive; habitat	Students make cards with habitat components & play a card game

E	Habitracks	PW	Understanding of what needs to be present for animals to survive; habitat	Students identify the components of habitat by using a map & exploring their school grounds
E	Marsh Munchers	PWA	If site includes a wetland, learn about marsh critters	Students use body movement & pantomime to simulate the feeding motions of marsh animals & identify their interconnectedness in a food web
E	Puddle Wonders!	PWA	Larger puddles – students can survey wildlife, perhaps even as part of the Frog & Toad Survey	Students observe water that accumulates in puddles on or near the school grounds as well as any associated wildlife
E	Riparian Retreat	PWA	If site is along a stream, learn about habitat components & critters along streams	Awareness of a riparian zone is created through the use of a simulated field trip
E	What's That, Habitat?	PW	Understanding of what needs to be present for animals to survive; habitat	Students draw pictures of people's & animal's homes, comparing basic needs
E I	Riparian Zone	PW	Introduce students to civic processes; extensive discussion of land use/ wildlife impacts, WQ impacts	Students simulate a Board of Commissioners meeting
E I	Who Lives Here?	PW Extension	Students learn about native/introduced animals, impacts on an ecosystem	Students research & write reports about native & introduced animal species & conduct a class quiz & discussion
E In	How Many Bears (Coyotes) Can Live in this Forest?	PW	Develop better understanding of natural processes; discussion of habitat; densities of critters at different times of the year	Students become bears & look for one or more components of habitat during this physically involving game
E NM	Who Fits Here?	PW	Learn about different animals will map their habitats	Students play an identification game using posters & cards – match the animal to the environment where it lives
E, NM	Wildlife Is Everywhere!	PW	Hone observation skills	Students search their environment for evidence of wildlife
E P	(The) Beautiful Basics	PW	Understanding of what needs to be present for animals to survive: habitat	Students list & organize needs of people, pets, & wildlife
E P	Designing a Habitat	PWA	Students learn about habitat requirements of animals	Students design a habitat suitable for aquatic wildlife to survive in a zoo or aquarium
E P	Everybody Needs a Home	PW	Understanding of what needs to be present for animals to survive; habitat	Students draw pictures of homes & compare their needs with those of other animals
I	Changing Attitudes	PW Extension	People's roles in wildlife management	Students design & conduct community interviews, compiling & summarizing findings
I	EthiThinking	PW Extension	What impacts wildlife; also quality of life	Students list activities that might be harmful to wild plants & animals & use photos or drawings to picture, discuss, interpret, or evaluate these activities

I	Facts & Falsehoods	PWA	Learn to assess quality of information; also crucial when working with diverse groups	Students analyze & evaluate print material according to criteria they establish for quality, balance, & fairness; then develop their own presentations using such criteria
I	Fire Ecologies	PW	Students can NatureMap areas with prescribed burns	Students conduct a field investigation
I	Flip the Switch for Wildlife!	PW Extension	Look at indirect impacts of our actions, how they impact natural resources & wildlife in particular	Students illustrate the route of energy from its sources to human use, including environmental impacts along its path; & then invent & try ways to make beneficial impacts on wildlife through their personal energy use practices
I	Keeping Score	PW	Recommend actions to improve/ maintain habitat in community; can do comparative studies before and after using NatureMapping	Students investigate their neighborhoods for cause & effect relationships affecting wildlife; recommend actions to improve/maintain quality of wildlife habitat in the community
I	Know Your Legislation: What's in it for Wildlife?	PW	Acquaint students with legislative process/impact	Students actively participate in the legislative process
I	Philosophical Differences	PW Extension	People's roles in wildlife management	Students select an environmental issue of concern & find out philosophical positions of interest groups
I	Planning For People & Wildlife	PW Extension	What impacts wildlife; also quality of life	Students imagine & research what the area in which they live was like before development; design planned communities, & build & evaluate models of their designs
I	Shrinking Habitat	PW	Relate effects of development on habitat	Students simulate a process of land development in a physically involving activity
I	To Zone or Not to Zone To Dam or Not to Dam	PW PWA Extension	Land use planning; students learn about impacts of land use on natural resources & importance of responsible planning	Students role play a meeting of a county commission pertaining to a land use issue
I	Watch on Wetlands	PLT	Help students gain important background information if the adopted site is a wetland; do survey of vertebrates	Students study a wetland ecosystem and analyze issues and opinions relating to the management and protection of wetlands
I	Wildlife Issues: Community Attitude Survey	PW Extension	People's roles in wildlife management	Students develop a questionnaire & conduct a community survey
I	Wild Bill's Fate	PW	Acquaint students with legislative process/impact	Students investigate pending legislation affecting wildlife

I NM	Something's Fishy Here!	PWA Extension	Allows students to explore possible avenues of action; students can look at an area they have NatureMapping data for; they can look for any noticeable changes & try to come up with possible explanations for those changes; they could contact local resource people for more information	Students read & discuss a story, inventing their own endings that lead to environmental action in their community: ext #1
I R	Who Pays for What?	PW	Helps students gain a better understanding of funding sources for wildlife research, habitat, etc.	Students identify principal sources of wildlife related funds; correspond with agencies & organizations to investigate sources, amounts, uses, trends & problems concerning such funding, & summarize their findings
In	Here Today, Gone Tomorrow	PW	Endangered species: how relates to keeping "common animals common"	Students become familiar with classification of animals, conduct research, & make a master list of threatened & endangered animals & factors affecting conditions
In	Migration Headache	PWA Extension	Impact of habitat loss on migrating waterfowl	Students role play migrating waterfowl traveling between nesting & wintering habitats
In	Oh Deer!	PW	Develop better understanding of natural processes; discussion of habitat: densities of critters at different times of the year	Students become deer & look for habitat components in a highly involving physical activity
In I	Planting Animals	PW Extension	Students learn about reintroductions, impacts on an ecosystem	Students write a letter to a wildlife agency for information & make dioramas of animals transplanted into new habitats (information supplements & listed references)
In I	What Did Your Lunch Cost Wildlife?	PW Extension	Look at indirect impacts of our actions	Students trace food sources, diagram environmental impacts, & apply the knowledge they gain by making changes in some of their consumer choices
NM	Bird Song Survey	PW	Learn to ID birds by song, can use NatureMapping &/or national survey protocols	Students investigate an area & use bird counting techniques
NM	Earth Manners	PLT	Good activity to introduce appropriate behaviors in natural areas; older students skip the story and just discuss appropriate behaviors in natural areas	Students express appropriate ways to treat living things and to act in forests, parks, and other natural areas
NM	Graph An Animal	PW	Research habitats that will be observed, learn to identify animals there, graph observations	Students create picture collections of animals in two different habitats; then tally the number of animals they see
NM	Microtrek Treasure Hunt	PW	Hone observation skills	Students go outside on a "treasure hunt" for wildlife
NM	Planet of Plenty	PLT	Build observation and recording skills; helps illustrate relationship of diverse habitat (soils, plants) to diversity of animals (can relate to cultural context with human populations)	Students investigate the diversity of plants and animals on a small plot of land and explain the value of diversity of life forms in a particular ecosystem

NM	School Yard Safari	PLT	Good way to inventory animals before and after initiating projects to improve habitat	Students find signs of animals living in the school yard and describe ways environment provides what they need to survive
NM	Sounds Around Part A	PLT	Hone listening skills if map birds; also can better locate source of sounds to find other animals	Students identify sounds and map location
NM	Time Lapse	PW	Photographic records & narratives of study areas	Students prepare & present a visual interpretation of a concept
NM	Tracks!	PW	Help identify presence of animals in an area	Students make plaster casts of animal tracks
NM	Wild Words... a Journal Making Activity	PW	Journals for additional observations, students record role in project, impact on them	Students go into an outdoor setting to make & write in journals they design
NM	Wildlife Research	PW	Use criteria to look at NatureMapping protocols, how fit with what students want to learn	Students evaluate types of research involving wildlife; apply their results to develop individual proposals that meet criteria for appropriateness & conduct research
NMP	Improving Wildlife Habitat in the Community	PW	Can use NatureMapping to survey wildlife before & after a project	Students design & accomplish a project to improve wildlife habitat in their community
NMP	Learning to Look, Looking to See	PW	Hone observation skills	Students list what they remember seeing in a familiar environment, check for accuracy & discuss the results, & then practice their skills in a new environment
NMP	Photos Keep it Happening	PW	Additional records of site, wildlife	Students create photo or other visual studies of wild or domesticated animals
NMP	Urban Nature Search	PW	Use as an introduction if do NatureMapping in an urban area	Students go outside to observe an environment & use a questionnaire to assist in gathering data

NOTES: