Alien Invasion: Plants on the Move

(an Invasive Weeds Curriculum)

A K-12 curriculum introducing students to the problem of invasive weeds in their community

Sponsored by OR/WA BLM
(With Participation from many Interested Entities)

Lesson Plan Authors:

Mark Goddard
Ellen Petrick-Underwood
Michael Winston

Organization of the Curriculum

This Invasive Weeds Curriculum organizes activities under the five broad categories (Units) discussed in the introduction: Weed Facts, Weed Identification, Prevention, Weed Inventory and Mapping, and Controlling Weeds. There is also a section on Community Involvement wherein lessons learned in each Unit are applied to action-oriented problem-solving opportunities in home communities. Under each Unit, the Lessons are grouped by age levels and each age grouping is color-coded so age appropriate lessons can be quickly located.

The intent of this curriculum is to bring awareness to a problem that affects all communities, while understanding that a teacher is often constrained by time, the need to introduce other curricular topics, and a limitation of available resources. All of the lessons fit naturally within existing mandated national science curriculum standards and many of the activities integrate social studies, art, language arts and math components. For example, if the topic of classification is being taught, it might be done in the context of invasive plant species, thereby satisfying the regularly scheduled curriculum while at the same time introducing the problem of invasive weeds that may exist in your community.

Following the activities is an extensive resources guide that includes sources for information about invasive plant species, local agencies that might help, and a bibliography of publications and websites used with these lessons.

The lessons are all aligned with the National Science Education Standards (NSES) and each lesson lists the particular standards addressed through that activity. A complete list of K-12 NSES is provided at the end of the book in a "checklist" format for those teachers who wish to track the standards addressed over the course of the year or to assist with correlating these lessons with individual state standards.

Table of Contents

9-12 Activities
From Seed to Shining Seed
Classified Information (AP Biology)
Pressing Matters

Weed Prevention

K-2 Activities
3-5 Activities
Dilemma Decisions
6-8 Activities
Aliens in Your Socks
Alien Shopping Spree
9-12 Activities
An Ounce of Prevention

Weed Inventory & Mapping

K-2 Activities
Drawing Sequence Maps
3-5 Activities
Invent an Inventory
Map Journeys
6-8 Activities
The Right Inventory for the Job
Practicing Protocols
Tracking Aliens In The Schoolyard
The Marks On This Map Are Alien!!
9-12 Activities
Dollars and Sense
Sample Inventory Protocol
(The Marks On This Map Are Alien!!) (See 6-8 section)
Introduction to GIS/GPS
Intermediate GPS (AP Biology)
Intermediate GIS (AP Biology)
Macro Art
Weed Mapping

Controlling Weeds

K-2 Activities
Once Upon a Town
3-5 Activities
Weeds vs Bugs
6-8 Activities
And Just How Do You Kill a Weed?
9-12 Activities
Under/Out of Control

Community Involvement

How Can We Help (K-12)
Fundraising
Alien Wanted Poster (6-8)
How Can I Help? Level 2 (9-12)
How Can I Help? Level 3 (9-12)
Discovering the Artist Within (9-12)

Introduction

Weed Facts

The United States is a huge country, abundant in natural resources. Early immigrants to America from Europe and elsewhere were drawn by its abundant wildlife, fertile lands and the promise these held. The richness of American 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: invasive plant species. Literally thousands of invasive plant species have been introduced to the US, both intentionally and unintentionally. Land owners and land managers seeking to protect these unique ecosystems, now face the challenge of halting the destruction caused by invasive plants. Invasive plant species rank second only to habitat destruction in causing disruption to our ecosystems.

To understand the effect of invasive plant species it is important to first understand what makes an ecosystem unique. This unit is designed to extend student **understanding of ecosystems** as affected by invasive plant species and how different ecosystems interact to form the inter-connected fabric of our planet's biosphere. Students should 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 should 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 and that the impacts of invasive plants do not stop at the boundaries of the plant kingdom. Many of the lessons emphasize the importance of biological diversity to create 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 porcupine began to nibble on your leg, you would probably try to run away, however when that porcupine begins to nibble on 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.

Invasive 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 plants and animals are adapted. For example, invasive plant species can often cope with these changes by mechanisms that allow them to establish themselves before 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, invasive plants establish themselves in disturbed environments and crowd out the more finely adapted native species.

The lessons found in the Weed Facts unit provide students with a comprehensive introduction to invasive plants: **how we define them, where they are found**, their **areas of origin** and **how they got here,** their **adaptive characteristics, why they keep spreading,** their **impact on desirable plants** and the broader **consequences for the environment.**

Weed Identification

How do we distinguish between weeds and non-weeds? Can't native plants become weeds? An understanding of **plant growth and development** is essential in understanding **adaptations** that allow invasive plant species to adversely affect the land and water quality of our environment.

Introducing weed identification into your curriculum is a good way of introducing basic plant biology, for to understand how to **identify plants** one must be able to identify the **parts of a plant**. An understanding of plant parts leads naturally to the topic of **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. 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 as an aid to identifying them in the field.

Prevention

Once students are aware of the myriad problems associated with invasive plants after they become established, they are usually eager to act in ways that minimize their own negative impacts. As is often the case, the problem is not one of not caring enough – rather, it is a problem of not knowing enough. Most people simply lack sufficient knowledge to act responsibly. This unit provides important information for students and families on simple ways they can help prevent further infestation by invasive plants.

An ounce of prevention is worth a pound of cure. This old adage certainly applies to weeds – yet we often direct limited resources into fighting firmly established infestations. By that stage management is expensive, and eradication probably impossible. A more pro-active mind set might include keeping existing infestations from spreading further, while also focusing on prevention and early detection.

This unit teaches students how to **minimize risk situations** for infestation – especially those which they and their families are likely to have some control over. These include the following:

- **Preventing or minimizing the introduction of weed seeds into an area**. Lessons addressing these include Aliens in Your Socks, Alien Shopping Spree and Dilemma Decisions. These offer concrete examples of how we can keep from being unwitting vectors for weed seeds – through our socks, our pets, bicycles, boots and seed sources.
- **Minimizing disturbance of desirable vegetation and revegetating disturbed sites** with desirable plants – around our homes and in our communities. When we actively **manage for healthy communities** of native and desirable plants weeds are not as likely to establish themselves.
- Careful **monitoring** along high use/high risk corridors, such as roads, trails, and campgrounds – something we all need to feel responsible for.
- **Early detection and eradication** to prevent small infestations from becoming major problems.

There are many ways we all can participate in preventing the spread of noxious weeds. Be Proactive! Get Involved!

Weed Inventory and Mapping

Once we have an understanding of how to identify invasive plant species and why or how they've come to be a problem in a given landscape, land managers seek to find out how far the invasion has spread. Understanding the plant biology, the ecosystem dynamics, and the extent of the problem, managers may then devise strategies to quantify and then control the invasion.

Weed inventories are an important tool for weed managers. Inventories are performed for a wide range of goals, including initial **base-line data** acquisition, periodic follow-ups to determine **historic vs. current trends** (how the overall weed picture is changing), planning for specific **control**

actions, checking on effectiveness of past control actions, and investigation of **abatement** issues (such as the unintentional introduction of an invasive specie through a contaminated seed source).

Inventories come in many shapes and sizes. Areas targeted for inventory can be very small (such as a single campground), or very large (such as a 10,000 acre wildfire). Inventories can be targeted at a single **species** (i.e. Yellow Star thistle), or may need to be more generally focused (i.e. the 20 or more species on a **state noxious weed list**).

For accurate inventory timing is critical, and will vary with the species targeted and the plant ID skills of the field staff. Inventories are usually timed for when the target species are in bloom, as this is when they are most obvious to observers. Aerial surveys should only be attempted when weeds are readily identifiable from the air.

Because the goals of inventories vary widely, the process is likewise variable. Effective problem solving to meet project goals is an essential aspect of any inventory. One must carefully consider the purpose of the inventory, the species in question, the time available, the size of the area, and the size and skill of the field staff. In some instances it might be necessary and possible to canvas every inch of ground for weeds, however, in most instances, a plan will have to be devised to walk a **transect**, or move out from points of known **infestation** or high **risk potential**.

Field work involves long hours of driving or walking in remote locations. It is essential that the **data** collected be usable. This means there must be strict adherence to data collection **standards**. Towards this end, states have devised elaborate **protocols** for data collection to ensure usability/sharability of data. These include protocols for recording site locations, location accuracies, species identification, information on change over time (current vs. historic), the date infestation was originally discovered, and dates of site re-visitation. Locations can be inventoried using three types of tools: **GPS** (global positioning system), **manuscripting** onto a map or photo, and legal descriptions using **Township, Range and Section**. The accuracy of the data should be noted. This will depend on the capability of the equipment used or the confidence you have in the ability of whoever is reporting the data to locate the site(s). Species may be recorded using an abbreviation or **code**. It is helpful to use a code or naming system that follows some recognized standard. One example is the naming system and species codes used by the USDA **National Resource Conservation Service** (NRCS). Recording methods vary from location to location. Sometimes field staff will enter data by hand onto a paper form, which might later be entered into a computer database for eventual **GIS** application (mapping). Increasingly, data is entered directly into a **GPS data dictionary** in the field, which can be directly downloaded into a GIS or database.

In this unit students will learn **how to inventory** the extent of invasive plant species within a particular ecosystem, and then **map the invasion**. The range of activities introduce **basic schoolyard mapping** to more sophisticated **GPS mapping techniques,** including an introduction to **Geographic Information Systems (GIS)** and the role GIS plays in data management. Links are provided for those teachers who desire more extensive activities on contributing scientific field data to scientists and statewide or national mapping projects. These contributions may also include 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 and working hand in hand with field resource managers in the control of invasive weed species (see Community Involvement section).

Controlling Weeds

In previous units students saw how invasive weed species came to be, and the manner in which the 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 unit students will investigate the human response to the problem of invasive weed species through chemical, mechanical (including fire), cultural, and biological control, sometimes referred to as **Integrated Weed Management (IWM)**.

It is important to remember that controlling invasive plant species is a response 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. By understanding the complex web of interactions, land managers may better prescribe a combination of **control methods** that eliminate the alien species.

Invasive 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. Concerns about chemical control include pollution of the land and water, the killing of non-target plants and animals, and the ability for chemicals to persist and accumulate in the environment. However, when situations are thoroughly evaluated and herbicide use is determined to be necessary, the benefits of chemical control will outweigh the potential adverse environmental impacts. Herbicides must always be properly applied and always read and follow the label.

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 invasive 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 invasive 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.

Cultural control involves such practices as tilling, discing, planting competitive vegetation, fertilizing, and implementing crop rotations. Managed livestock grazing also falls into this category.

A fourth approach used to control invasive plants is **biological control**. The most common forms of biological control are the introduction of a host-specific agent. Host specificity is very important. If an agent only impacts a particular plant, the plant is reduced to more acceptable levels as the agent increases and conversely the agent is kept in check as its host decreases. Biological control programs are dynamic and populations of weed and control agents will continue to fluctuate. Implied within biological control is an understanding that populations of undesirable weeds will not be eliminated, but rather reduced to some acceptable level. Because invasive weed species arrive without their natural herbivores, these agents must be imported as well, which introduces yet another alien to the ecosystem. Extensive research and testing is required before biological control introductions can occur.

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 invasive species, the intent is not to teach students *how* to control invasive weeds, but rather, to let them evaluate methods that might be most effective, and more importantly, to understand why some methods may be inappropriate for a given situation.

Finally, students should understand that the ultimate answers to managing alien weed species involve promoting functioning native ecosystems, well managed agricultural landscapes, parks and gardens. They need to understand the complexities inherent in the interactions between abiotic and biotic components in any system. Because of the complexity of control issues, and the time it takes to manage alien weeds, this unit will focus on student's awareness of the methods and difficulty in removing alien species in order to restore healthy, functioning landscapes.