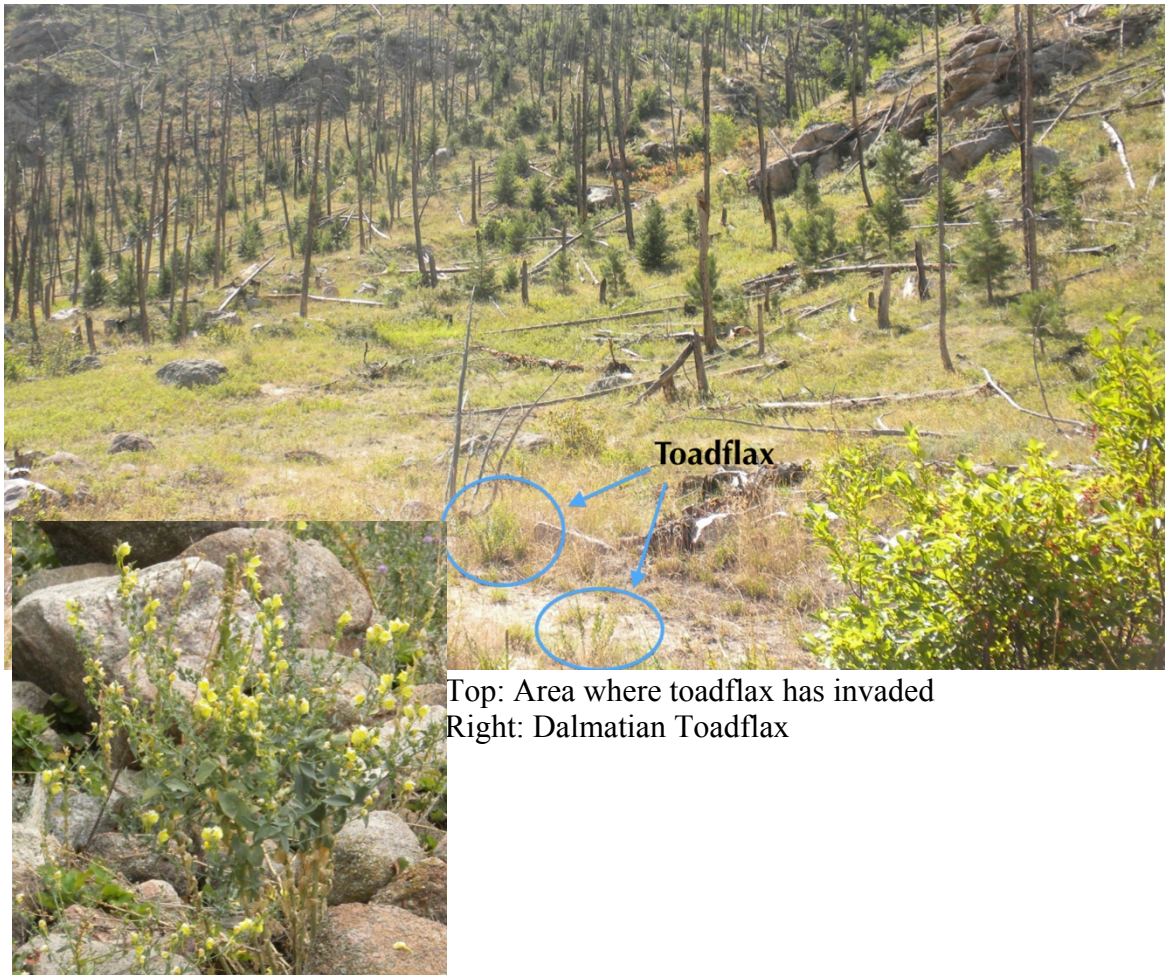


Middle School Unit:

Ecosystem Management for Regionally Abundant Invasive Plants in an Era of Global Environmental Change

Weeds and Weevils: Dalmatian Toadflax



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Ecosystem Management for Regionally Abundant Invasive Plants in an Era of Global
Environmental Change

Weeds and Weevils: Dalmatian Toadflax

**Developed by INSTAAR (Timothy Seastedt, David Knochel, Anastasia Maines) in
collaboration with BVSD teachers Kim Greene and Dan Tomlin at Manhattan Middle
School**

Dalmatian Toadflax Lessons Outline

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1.4b Dalmatian Toadflax & <i>Mencinus janthinus</i> weevil life cycle cards Correct order of photos: F, E, D, C, A, B	Attached
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Inquiry 1.6. Scientist in Action	Attached

Colorado Academic Standards:

Standard 2: Life Science

Prepared Graduates: Explain and illustrate with examples how living systems interact with the biotic and abiotic environment

Grade 6—concept 1: Changes in environmental conditions can affect the survival of individual organisms, populations, and entire species

Grade 6 – concept 2: Organisms interact with each other and their environment in various ways that create a flow of energy and cycling of matter in an ecosystem

Grade 8 – concept 1: Human activities can deliberately or inadvertently alter ecosystems and their resiliency

Standard 3: Data Analysis, Statistics, and Probability

Prepared Graduates: Solve problems and make decisions that depend on understanding, explaining, and quantifying the variability in data

Grade 6—concept 1. Visual displays and summary statistics of one-variable data condense the information in data sets into usable knowledge

Grade 7—concept 1: Statistics can be used to gain information about populations by examining samples

Teaching Notes: The Weeds and Weevils unit has two stand-alone sets of lessons each focusing on an invasive plant and its biological control insects. The toadflax lessons can be completed year-round since toadflax stems are generally available for dissection. The goal of this part of the unit is to teach students what an invasive plant is, why they are a problem, and how biological control agents (in this case insects) can be used to reduce plant populations. Students explore lifecycles and interactions between organisms and apply their knowledge to a real-world situation in the management game. Development of these lessons was supported by funding from the United States Department of Agriculture (USDA). Any opinions expressed are the opinions of the author(s) and do not necessarily reflect the views of the USDA.

Inquiry 1.1

Objectives For This Lesson:

Review the life cycles of plants and insects.

Develop an understanding of the interactions between the lifecycles of plants and some insects.

Getting Started

Materials: butcher paper

1. Draw a large Venn diagram on your piece of butcher paper. Label one circle “**Insect life cycle**” and the other circle “**Plant life cycle**”.
2. Work with your group in the **Insect** circle of your Venn diagram to draw what you think the life cycle of an insect looks like. Label any stages you know.
3. In the **Plant** circle of the Venn diagram, draw the life cycle of a flowering plant. Label any stages you know.
4. In the overlapping space of the two circles, list any ways you think the life cycles of the insect and plant could interact or depend upon each other.

Inquiry 1.2: What is an Invasive Plant?

Introduction

Plants come in all shapes and sizes just like humans. They also come from all over the world. Although plants can be so different, all of them take light energy from the sun and convert it into energy that they use to reproduce, grow, and obtain water. Some plants are not native to the ecosystem they inhabit. They have been introduced from another location. The Dandelion, for example, is native to Europe/Asia and has been introduced to the United States.

In this lesson you will develop a definition for an invasive plant. And brainstorm affects of non-native and invasive plants.

Objective for This Lesson

Build a definition for the word invasive plant.

Getting Started

1. Discuss with your group the difference between an invasive plant and a native plant. Write these differences in your science notebook.
2. In your science notebook: Write any connections between plants and insects or animals that you may have witnessed.

Answer 3 and 4 in your science notebook.

3. Why is a dandelion thought to be an invasive plant?
4. What do you think makes a plant invasive?

Dissecting /Drawing a dandelion

Materials for Lesson

Copy of dissection/drawing sheet

Newspaper to place dandelion on

Hand trowel or weed digger

Dandelion Dissection/Drawing Sheet

Procedure

1. Get a dandelion from the school yard. Try to get one that is flowering and one that already has its seeds. Use the hand trowel or weed digger to dig up a dandelion. Make sure you get the whole plant: not just the stem and flower, but the roots and leaves as well.
2. Place Dandelion on newspaper.
3. Draw and label the following parts of the dandelion: tap root, stem, leaves, and flower.

Answer the following questions with your work group, lab partner or tablemates.

4. What do you think the taproot does to help the dandelion survive?
5. Why does the dandelion have so many seeds?

And how do you think it spreads?

6. Why do you think the dandelion has such tall stems?
7. What does the term invasive mean?
8. Do you think that dandelions have an impact on native plant populations or animals?

Explain why or why not.

9. Do you think dandelions are invasive weeds?

Explain...

Inquiry 1.3: Invasion of the Soil Grabbers

Introduction: Invasive plants take over the necessities that other plants may need to survive. They may take water, sunlight, or minerals away from native plants, displacing them. This in turn may make the area less valuable for native wildlife, grazing animals, and recreation. Most of the invasive species we have today arrived in the mid to late 1800's and were brought intentionally to remind settlers of their homes or accidentally in seed and grains.

Objective of this Lesson:

Document plant communities in data sets provided to build an understanding of invasive plants.

Getting Started

1. In our last lesson your group developed a working definition for an invasive plant. Talk about the definition with your group. Anything you would like to change?
2. In your notebook write down a prediction of what you might see in a data set that shows a plant invasion.
- 3 Discuss with you work group: When do you think the plant has taken over an area?

Procedure

Look at the data set.

Develop a graph illustrating the differences in plant populations over time.

Data Set -The data set documents the non-native increase of annual (plants that only grow for one year) grasses and forbs (an herb other than grass) in Boulder County Open Space near Superior, Colorado by David Buckner of the ESCO and Timothy Seastedt from the University of Colorado from 1997-2008. Examples of species not native to Colorado are Cheat grass, Yellow Alyssum, and Stork's Bill.

Non-native Annual Invasive Grasses Percent Coverage from 1997-2007

Non-native annual invasive grasses and flowers	
Year	percent ground coverage
1997	1.9
1998	2.3
1999	1.8
2000	0.4
2001	1.9
2002	0.3
2003	4.0
2004	1.4
2005	13.6
2006	0.2
2007	11.0
2008	12.3

Reflecting on what you have done...

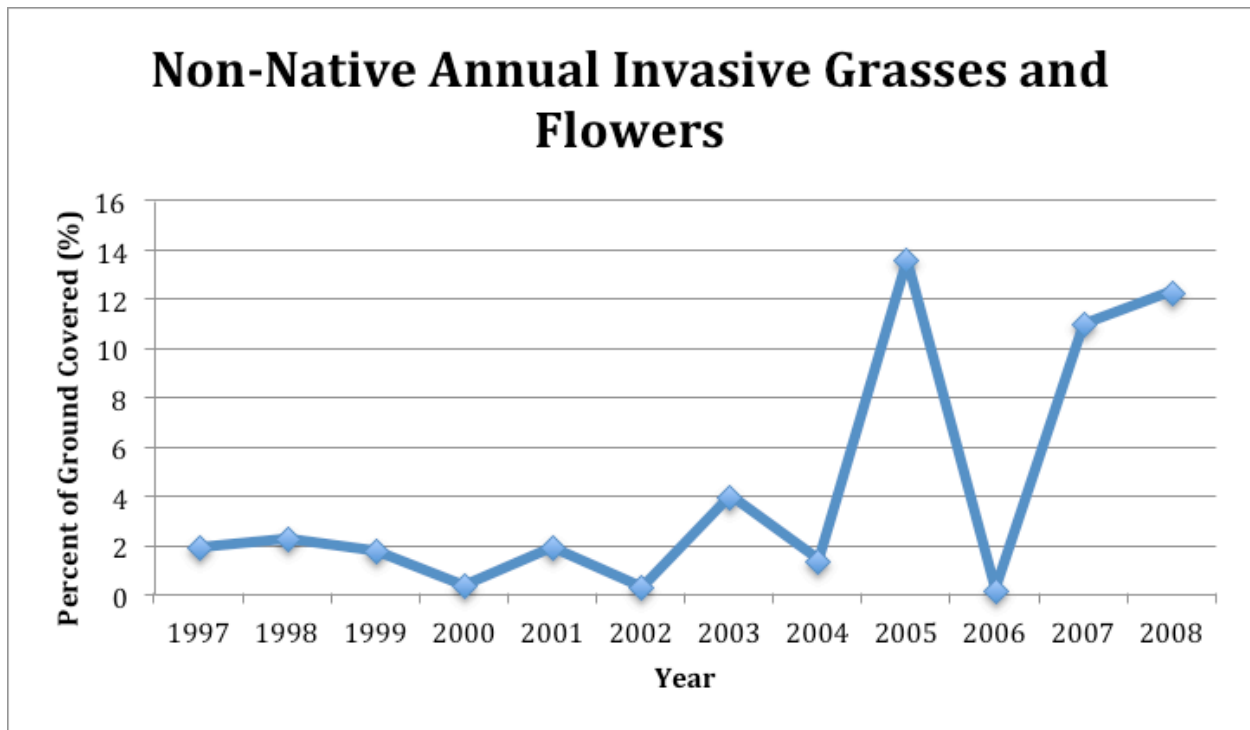
1. Did your graph look similar to the teacher key?
2. If not, what did you do differently?
3. What did the data show?
4. Try to draw a “best fit line.” (A best fit line runs through all of the data and the line’s slope would show a trend) Are there any trends?

5. Do you think the non-native plants have taken over?

At what percent of non-native ground coverage do you think there will be negative impacts on the ecosystem?

6. Propose an inquiry to find out if the invasion has an affect on animal species connected to the area.

Teacher Key



Extensions

1. Compare a non-native invasive weed to a wildfire or a military invasion.
2. Go to the website Medicinal Plants in Your Backyard: Exploring Biodiversity Through Ethnobotany

<http://www.woodrow.org/teachers/bi/2000/Ethnobotany/dandelion.html>

Research some uses for the dandelion. Then develop an advertisement that sells dandelions as a healthy product.

Inquiry 1.4: Plant and insect life cycles cards and dissections

Introduction

Plants and insects each have unique cycles of life, but are often closely intertwined with one other and with the changing of the seasons. Some plants may complete an entire life cycle in a single spring, while other plants may live for tens or even thousands of years. Likewise, many insects live for only a few weeks, while others may live a full year. How do some insects survive the cold winter months? Why do you think insects do this?

In this laboratory lesson, you will work in groups to dissect an **invasive** plant found in Boulder County: Dalmatian Toadflax. In the process, you will be able to learn more about insect and plant life cycles. You will also review the basic parts of a plant, including the roots, stems, and flowers. Pay close attention! Inside the plant tissues you can find insects in various stages of life.

Objective for This Lesson

To learn the basic parts of flowering plants and insects, and to learn their life cycles.

Getting Started

1. Take out your science notebook, and working with the person closest to you, review and draw the stages of life for a plant, and the stages of life for an insect. Use the two sets of cards on the table to help you, and put the cards in order.
2. Do you think the two sets of cards (plant and insect) are related?
3. Where do you think insects go in the winter?

Plant and insect dissections:

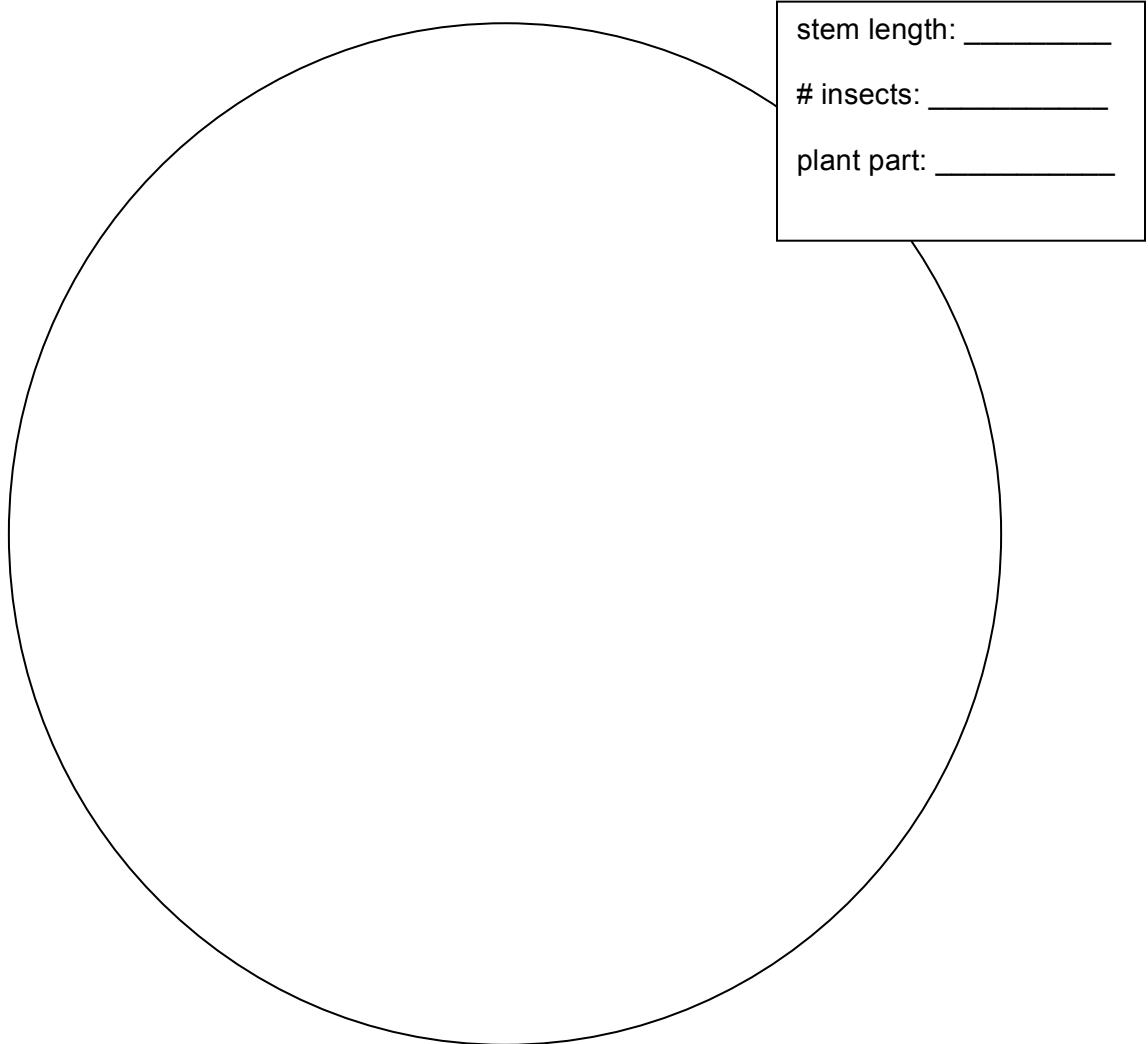
Materials for lesson

Plant and insect life cycle cards	Scissors, newspaper to place plants upon
Plant samples from a natural area (Dalmatian toadflax)	
Drawing sheet for plant dissection	Dissecting microscopes or hand lenses

Dalmatian toadflax

Procedure: Toadflax

1. Place a toadflax stem on newspaper.
2. Measure your stem, and record length in centimeters on your drawing sheet.
3. Slowly break open the stem lengthwise. Count how many insects you find, and record on your drawing sheet. What stage of development do you think they are in (hint: larva, pupa, adult?)
4. Take insect or plant specimens to dissecting scope or look at it with magnifying glass. Make a scientific drawing of a magnified view of insect in the plant part.
5. Try to find someone who found a toadflax insect in a different life stage. Use the circle below to draw their insect also.



REFLECTING ON WHAT YOU'VE DONE

A. Look at your ideas that you wrote in your notebook for a plant or insect life cycle. Using the your experience from the lab dissection, put the flash cards in order according to the insect's life cycle. Re-draw, correct, or improve on the life cycles. **Label your drawings with the terms: larva, pupa, adult; root, seed, stem, leaf, flower**

B. Does the invasive toadflax plant have seeds? Draw a picture of a toadflax seed.

C. What characteristics of the life cycle or plant parts do you think could make this plant more invasive than, say, a common yard dandelion?

D. Now think again about your hypothesis before the lab. How do you think insects rely on plants to survive over the winter?

E. What are the impacts of these biocontrol insects on their target non-native plant?

Extension Activities:

1. Design a skit that reflects what you have learned about Invasive Plants in these Lessons.
2. Write a poem or song that teaches what Invasive Plants are and how to control them.
3. Draw a cartoon that shows what happens when invasive weeds are introduced to an area.
4. Write and perform a skit that shows how invasive weeds are like an oil spill, a wildfire, a military invasion or another comparison or simile you can think of.
5. Go to the website Medicinal Plants in Your Backyard: Exploring Biodiversity Through Ethnobotany. <http://www.woodrow.org/teachers/bi/2000/Ethnobotany/dandelion.html> Research some uses for the dandelion then develop an advertisement that promotes dandelions as a cash or garden crop.
6. Look up the definition of Co-evolution. Explain how plants and insects or animals may have co-evolved to depend on each other. Write about two examples of coevolution.

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Inquiry 1.5: Management Game

Time required: two classes

Materials:

- Character Cards
- View some invasive weeds in Boulder County at:
http://www.bouldercolorado.gov/index.php?option=com_content&view=article&id=2829&Itemid=1016 Once on this site click on “plants and wildlife” then in the next screen, on “invasive weeds” on the menu on the left.

Introduction: Invasive plants are not seen the same way by all people. This role-play will be used to gain insights into the complexities in management of our resources. Remember to be true to the viewpoint assigned to you and have fun. Your “character” is allowed to change their perspective depending upon the arguments presented by other characters in the role-play.

The issue: “How should the City of Boulder manage the invasive weeds on the Shanahan Ranch property of 179 acres which was acquired in 2008?”

Objectives:

Introduce the conflicts and the various perspectives of invasive plant management.

Understand that the management of invasive species involves a mix of solutions that change over time.

Procedures

1. Get in a group with your teacher’s help.
2. Assign group jobs: speakers/argument deciders, poster maker (power point maker), organizer (keeps group on task, watches time).
3. Read your character card.
4. Create a name for your character.
5. Answer the Pre-game questions on your answer sheet.
6. Write an action plan for the South Shanahan Ranch property based on your character’s interests.
7. Attend the Land Use Council Action Plan meeting to hear the viewpoints of other characters.
8. With all the information, make a decision on weed mitigation that you think is best for the interests of all involved.
9. Answer the reflection questions.

Background

The Shanahan family have ranched the property for more than a century. It is one of Boulder County's largest remaining family ranches. The Shanahan family patriarch homesteaded the original ranch in 1863, and it has been in the family's ownership continuously since that time. Originally, the ranch covered substantially more acreage than the current holdings. Over the years, the family sold parts of the ranch, with some of the sold lands becoming the South Table Mesa and Shanahan Ridge residential neighborhoods that are now within the city. Some of the land's development rights were sold to the city of Boulder for open space purposes.

The city and county have designated the land in the ranch's northeast corner as well as the South Boulder and Bear Creek Ditch corridor, as being "significant agricultural lands of local importance".

The wetland areas provide food and shelter for many animals and are the basis for complex natural food chains. Agricultural lands of local importance are the county's most valued agricultural lands. The small ponds and irrigation ditches provide wildlife breeding and foraging habitats.

Community Sustainability Assessments and Impacts:

Environmental: The Open Space and Mountain Parks (OSMP) program is a significant community-shared program that is recognized worldwide as a leader in preservation of open space lands contributing to the environmental sustainability goal of the City Council. The acquisition of the remainder of this property meets several charter goals and purposes for open space acquisition. This property is unique in that it further preserves the agricultural heritage of the community and further protects the scenic entryway into the city.

Economic: This purchase is a component of the OSMP Acquisition and Management Plan, which contributes to council's economic vitality goals, because it provides the physical context for the diverse and vibrant economic system that sustains services for residents. This acquisition will support diversity in economics by supporting local agriculture. The land system and the quality of life it represents attract visitors and help businesses to recruit and retain quality employees.

Social: Because the Open Space land system is equally accessible to members of all economic classes, it helps support council's community sustainability goal because all residents "who live in Boulder can feel a part of and thrive in" this aspect of their community. Historical agriculture will be sustained as part of this acquisition in an area that has been designated in the Boulder Valley Comprehensive Plan (BVCP) as a Significant Agricultural Lands of Statewide Importance.

Character Cards (6)

Homeowner – Gardener

She is 37 years old she is an unemployed information technology person and lives with her 64 year old mother who is a retired customer service agent for the local University of Colorado Credit Union. She is adamant about edging, watering and using Roundup on her lawn to maintain a fresh green weed free lawn. At times her watering runs off into the street for hours. She and her mother also enjoy keeping their gardens up to date and enjoy watching birds at their bird feeders. They abhor the neighbor's dogs and cats frequently drive them from their yard and threaten owners with calls to animal control.

What does she do about invasive plants? Roundup-glyphosphate is sprayed on broadleaf weeds to control their invasion of the blue grass lawn. Glyphosphate inhibits the plants ability to produce an enzyme that allows the plant to produce proteins that enable it to grow. Hence it will kill almost any plant and attention should be given to spray drift of the chemical.

Urban Loft Owner — Avid Birder

He is 42 years old married with two children Sasha and Devon. He lives in a 2,800 foot loft in downtown Boulder and he works at the Federal Center in Lakewood, Colorado as an Environmental Protection Agency Lawyer. On his weekends and free time he manages the local chapter of the Sierra Club Inner City Outings (ICO). He spends about 10 hours a week developing activities and field trips for kids of Boulder County who are under-represented in the recreational use of surrounding state and national forest and park land. In his tenure he is responsible for over 200 middle and high school students visiting Yellowstone, Arches, Rocky Mountain and Canyonlands National Park. In his free time he likes to identify and watch local birds.

What does he do about invasive plants? He uses no chemicals and pulls out weeds from his loft vegetable and flower pots. He also takes part in Boulder Mountain Park invasive weed mitigation volunteer efforts.

Soccer and Ball Field's Manager

This character is in charge of making sure the Pleasant Street, Manhattan, and Stazio soccer and ball fields are in great shape. They have a very tight budget. The fields are used most of the year for recreational games organized by the city leagues of Boulder.

What is the Soccer and Ball Field's Manager doing about invasive weeds? They use broad leaf weed killer on the playing fields. In areas adjacent to the fields, they just ignore the weeds because they don't have the time or budget to do something about them. They really aren't sure what plants are invasive weeds anyway. They just want the grass to be healthy.

Organic Farmer

He is 36 years old and co-owns two 29 acre organic specialty farms in northeast Boulder along with Valmont farms with his girlfriend. He holds a degree in business from the University of Colorado. He always has a backup crop in mind if one fails or doesn't come up to expectation. Yearly plantings include: in the spring: five kinds of beets, peppers and tomatoes and 30 kinds of winter squash and melons. In the summer he plants spinach, carrots, parsnips, rutabagas and leeks. In October garlic, bok choy, arugula and leeks are planted. Over the last two years the farm has brought in 320,000 and 400,000 dollars and is up to 20 employees. He and his girlfriend say that to be a successful farmer in Boulder County includes adequate water and good soil. He enjoys planning for the future of his farms and keeping them sustainable.

What do they do about invasive plants? They use methods that give the crop advantages over the weeds such as: using a vigorous cash crop, drip irrigation along crop lines and covering adjacent soil in plastic. Physical removal may also be used: examples include weeding, flame weeding, cutting and grazing of animals after vegetable removal. The remaining methods include: cover crops, both synthetic and natural mulches.

Corporate Farmer

His land is irrigated and has been farmed for over 100 years. He is tired of the pressure the increased population of the county puts on farming. He is a large scale corporate farmer. He owns and manages a 1,000 acre farm which is mostly planted with wheat/alfalfa for hay or corn for cattle. He typically plants two crops a year. The harvest is sent to the Biggie Farm Corporation for sale. Biggie Farm Corporation then pays him. Weeds reduce both the quality of the crop and the amount of food an acre can produce.

The time he spends dealing with weeds is time he cannot spend doing other important tasks on the farm like improving the soil, irrigating, repairing equipment and harvesting.

He is already on a very tight cost versus profit margin which means he does not make much money from each acre of land.

What is he doing about invasive weeds? He just plows under the weeds or sprays them with an herbicide like Round-up. He plants genetically modified crops that are herbicide resistant so products like Round-up don't kill his crops. He does not want anything other than his crops growing on his fields. He tries to get the cheapest and most effective herbicides. He does not worry about waterways, other plants, or animal life. He is trying to survive as a farmer and make a little bit of income. If weeds grow on the land that cannot be farmed like the edges of fences or ditches, he really does not care. He also burns the edges of the ditches and fence lines each spring to clean up the ditches of plants. This does help reduce weeds.

Open Space Manager

She manages open space for the county of Boulder, Colorado. The county's largest city is the city of Boulder with 100,000 people. There are also several other towns within the county.

She oversees 45,000* acres of open space land which is visited by 5.3 million humans per year. The open space land is scattered throughout the 480,000 acre county (750mi²). The county population is about 305,000 people. (*All numbers have been rounded.)

The County of Boulder Open Space and Mountain Parks preserves and protects the natural environment and land resources which characterize the area. Her job is to help foster appreciation and use that sustain the natural values of the land for current future generations.

Boulder residents have recognized the value of preserving open space lands since the 1898 purchase of Chautauqua Park. In 1967, Boulder became the first city in the country to pass a sales tax for the acquisition and management of open space lands. People from around the world look at the Boulder's open space land acquisition and management policies as a model for their community. Over 45,000 acres have been preserved which include wildlife habitats, unique geologic features and greenways. OSMP provides maintenance of 130 miles of trails which are open to a variety of passive recreation uses for visitors, including hikers, bicyclists, equestrians and dog walkers.

The Visitor Master Plan has four overall goals. These goals are the product of citizen advisory committees appointed by the Open Space Board of Trustees in 1999 and 2003 to advise the Open Space and Mountain Parks Program on the preparation of this Visitor Master Plan.

Goal 1: Enhance the experience: Maintain or enhance the quality of the visitor experience when engaged in passive recreational activities such as hiking, climbing, and bicycling.

Goal 2: Improve access: Provide and maintain highly functional and sustainable visitor facilities that support visitor access to appropriate destinations and add to the quality of their experience.

Goal 3: Enjoy and protect: Ensure that passive recreational activities and facilities are compatible with long-term protection of natural, agricultural, and cultural resources.

Goal 4: Partner with the community: Partner with the community in passive recreation decision-making and stewardship efforts.

What does she have her department doing about invasive weeds? The Department has an Integrated Pest Management Program which uses many different control techniques on different weed species. Grazing, burning, mowing, hand-pulling, flooding, insect introduction, reclamation and prevention are a few control techniques that are used on Open Space. Herbicides, applied at the lowest rates possible, are used as a last resort.

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Name: _____

Management Game: answer sheet

Pre-game: Before you start the simulation: Answer the following three questions after you have read your character card.

1. What do you think is your character's position?

2. On a scale of 1-10 how committed do you think your character is? (1 is not too much and a 10 is totally) Why?

3. Who do you think your character is most likely to form an alliance with and why?

4. List three invasive weed control strategies that your character will advocate for at the town meeting.
 - A.
 - B.
 - C.

Post-game: Reflecting On What You've Done

1. Write two conclusions or discoveries you have realized about the difficulty of managing invasive weeds.
 - A.
 - B.

On your own papers or typed:

1. After listening to the town meeting, write a paragraph about what you think would be the best solution for the management of the Shanahan Ranch property keeping all the perspectives presented in mind.

2. Did you agree with your character's stance on invasive weeds? Yes/no. Explain.