

Knapweed in the Web

Target Grade Level: 2nd-5th

Created and Adapted by:
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UNIVERSITY OF MONTANA GK-12 PROGRAM

1. CONTRIBUTOR'S NAME: **WENDY M. RIDENOUR**

2. NAME OF INQUIRY: **Knapweed in the Web!**

3. GOALS AND OBJECTIVES:

a. Inquiry Questions: What are food webs? Can you provide examples of local food webs? Can food webs be altered by the introduction of non-native species?

b. Ecological Theme(s): Students learn about a local Missoula, Montana example of a food web altered dramatically by the introduction of exotic species.

c. General Goal: Students will become familiar with the concept of food webs and some of the ecological problems associated with invasive species and their control.

d. Specific Objectives: After completing this module, students will be able to:

1) Discuss food webs.

2) Identify the exotic weed species spotted knapweed.

3) Explain the possible effects of exotic species on native species distributions, including indirect effects such as food web subsidies.

e. Grade Level: 2nd – 5th

f. Duration/Time Required:

→ Prep time: 15 – 30 minutes

→ Implementing Exercise During Class: 30 minutes to 1 hour

→ Assessment: 5 – 10 minute discussion/ question an answer session

4. ECOLOGICAL AND SCIENCE CONTEXT:

a. Background (for Teachers):

1) Food Webs: Food webs are representations of the feeding relationships that exist within a community. Briefly, food webs involve both species interactions and the transfer of energy and nutrients through an ecosystem. Food webs can also be simplistically represented as “food chains” or “food pyramids” (see below, Handout: Knapweed Food Pyramid).

Handout: Knapweed Food Pyramid



2) Spotted Knapweed: Spotted knapweed, *Centaurea maculosa*, was introduced into western North America from Eurasia early this century, and has since invaded millions of hectares of intermountain prairie, decreasing the abundance and productivity of native species and reducing local plant diversity. It is an **exotic** plant species because it did not evolve in the region where it has been introduced. *C. maculosa* invasion is often characterized by the almost complete competitive exclusion of native plants and the development of dense single species patches. Since its introduction into North America, *C. maculosa* has also had a significant economic impact due to its negative effects on rangeland forage quality. *C. maculosa* occurs across most of Europe, but almost never at the densities achieved in North America and is never found as a landscape dominant.

3) Indirect Effects of Biocontrols: Exotic species removal is very expensive; it conservatively costs this country over \$8 billion annually to control exotic species. Removal of exotics is also a difficult practical problem. Hand-pulling weeds simply doesn't work in areas where many species of exotics occupy huge areas. A common approach is to kill these plants with herbicides. Yet while effective, this can also negatively influence native plant species as well as wildlife. It can also be prohibitively expensive. An alternative approach to remove weeds is **biological control**. Biological control involves introducing a **specialist** herbivore (or pathogen) from an exotic plant's native range to control the plant where it is introduced. A specialist biocontrol agent is an herbivore that only attacks the target weed. Screening biocontrol agents for host specificity prior to introduction is extremely important. There have been a few cases in which biocontrol agents, many years after introduction, have switched host plants and fed on native plants that were closely related to the target weed.

Biological control agents that are introduced into new regions are also exotic species, and they often establish high population sizes. Biocontrol agents can also maintain high population sizes because, at least initially, they have a super abundant food source (the weed!). At least in theory, large populations of biocontrol insects can severely reduce the population size of their host plants.

Thirteen species of insect herbivores have been introduced to control *C. maculosa* since the 1970's; however, the consensus is that these biocontrols have not yet been successful. Pearson and Callaway (2003) discovered that host-specific biocontrol agents can exhibit substantial nontarget effects through indirect interactions and food-web subsidies. Host-specific biocontrol agents can exhibit nontarget effects on native species and ecosystems.

b. Background (to present to Students):

Knapweed food pyramid game:

Begin by engaging the students in a brief (5-10 minute) discussion of food webs. Ask them if they can tell you what a food web is and provide examples.

Next have the class build a food pyramid. Without providing any background information, tell the students that they need to arrange themselves into a pyramid that will represent a generalized food pyramid. Have each student decide whether they want to role-play knapweed, gall fly larvae, deer mice, or red-tail hawks during the food pyramid game. At this time, have them write their species name on a slip of paper. Once they've decided on their roles, let them know that the knapweed plants will provide the base of the pyramid upon which all the other players are supported. Ask them why this is the case. Ask whether enough students are playing knapweed plants to support the weight of the rest of the class. If not, they can change roles, preferably with the bigger students assigned to the base of the pyramid. Have them guess the position of the rest of the species in this local food pyramid example and show them the food pyramid handout (from the bottom up: knapweed, gall flies, deer mice, and red-tail hawks). Give them a few minutes to build their pyramid and take a photo! Then lead a discussion/question and answer session on the exotic plant spotted knapweed and the indirect effects of the gall fly introduced for the biocontrol of knapweed.

5. MOTIVATION AND INCENTIVE FOR LEARNING: It's a fun game!

6. VOCABULARY:

Food Webs: Food webs are representations of the feeding relationships that exist within a community.

Spotted Knapweed: Spotted knapweed, *Centaurea maculosa*, is a non-native, or exotic weed that was introduced into western North America from Eurasia early this century.

Exotic plant species: A plant that did not evolve in the region where it has been introduced.

Biological control: Biological control involves introducing a **specialist** herbivore (or pathogen) from an exotic plant's native range to control the plant where it is introduced.

Specialist: A specialist biocontrol agent is an herbivore that only attacks the target weed.

7. SAFETY INFORMATION: N/A

8. MATERIALS LIST (including any handouts or transparency masters):

- 1) Several color copies of the knapweed food pyramid handout

- 2) Several slips of paper and pencils or pens for each student

9. METHODS/PROCEDURE FOR STUDENTS:

- a. Pre-investigation work:
- b. Investigation work:
 - 1) What evidence (data, samples) do students collect?
 - 2) How do students present the evidence (data)?
 - 3) What conclusions are drawn from the evidence students collect?
 - 4) Include examples of data sheets.

10. ASSESSMENT:

Assess students' grasp of this lesson through a brief discussion/question and answer session following the game.

11. EXTENSION IDEAS:

Have students draw expanded prairie ecosystem food webs that include the exotic species they covered in this exercise. Ask students to hypothesize about how the exotic species spotted knapweed and the gall fly may affect the expanded prairie food web.

12. SCALABILITY

This exercise may be scaled down accordingly to be used with K/1st students.

13. REFERENCES:

Pearson, D.E. and R.M. Callaway. 2003. Indirect effects of host-specific biocontrol agents. *Trends in Ecology and Evolution* 18:456-461.

14. LIST OF EXPERTS AND CONSULTANTS

Dean E. Pearson
Wendy M. Ridenour

15. EVALUATION/REFLECTION BY FELLOWS AND TEACHERS OF HOW IT WENT:

Students and teachers had fun with this exercise, and students learned a lot. Good "sense of place" exercise as well.