Activity: Graphing the Population Explosion of Weeds

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Adapted from:
The Montana Weed Trust Fund Teacher's Handbook &
"What's Wrong With This Picture? Invasive Weeds: A Growing Pain"- BLM

Overview
This session will illustrate the exponential explosion of invasive plant populations. Students will explore the general path of the seed cycle and the potential barriers in that cycle that prevent populations from exploding. Students will reinforce these concepts by calculating the growth of a hypothetical but realistic Yellow Starthistle population.

Grade Level: 5-6

Focus: Life Science, Experimentation, Investigation, and Ecology

Objectives
1. Students will be able to outline the path of the seed cycle.
2. Students will list the natural and human barriers to the population explosion of a species.
3. Students will calculate the explosive rate of reproduction of Yellow Starthistle over a three-year period. (Note: Less experienced students could be given the data and asked to graph the corresponding points.)
4. Students will graph the growth occurring within the seed bank and plant population of the Yellow Starthistle plant over a three-year period.

Site: Classroom

Time Format: 1 session

Materials:
- The General Seed Cycle image.
- The Yellow Starthistle Seed Cycle worksheet.
- Yellow Starthistle information sheet
- Yellow Starthistle - Plant Invasion & Yellow Starthistle Seed Invasion Graphs

Advanced Preparation:

1. Make copies of: The General Seed Cycle image.
(Note: This image can be handed out for student reference or used by the teacher as a transparency.)
The Yellow Starthistle Seed Cycle worksheet.
(Note: Make enough copies to hand this cycle out. It can be used as a guide for extracting the problem solving information from the Yellow Starthistle information sheet.)

Yellow Starthistle information sheet
Yellow Starthistle graphs:
Yellow Starthistle - Plant Invasion & Yellow Starthistle Seed Invasion (Graph Activity Sheets)

Activity

1. Begin by listing and discussing with students factors which prevent populations of plants and animals from growing without limit.

List: Natural factors (examples: disease, predators, fire, insects, etc.)
List: Human barriers (examples: herbicides, collecting, habitat destruction, etc.).

Ask Students:
Which of these controls is absent in the case of weeds?
(I.e. Nothing eats them, Spread by humans) Note: This varies greatly depending on species and conditions.

2. Discuss animal populations that have not been kept in control, and reasons for this. (Teacher Help: Many populations of ground squirrels are exploding because natural predators, such as bobcats and hawks, have been eliminated and the squirrels have adapted to human presence.)

3. Explore the Seed Cycle of weeds with students by drawing in the direction and position of flow arrows through the cycle. Have students determine the direction and position of the flow arrows through the cycle.

Ask students: Is anything decreasing the growth rate of the weeds in this example?
Teacher Help: No.

What types of factors could decrease the spread of these weeds?

(Teacher Help: Point out that each step of the Seed Cycle can have a control. Example: Dispersal = Washing vehicles and equipment, Staying on trails (Disturbance increases Dispersal)

Germination = Disease, Low Water, Low Nutrients, Seedlings = Low Sunlight, Herbivores, Pulling, Herbicides, Fire, Plants and New Seeds = Seed Eaters (Insects), Pulling

4. Distribute the Yellow Starthistle information sheet , Yellow Starthistle blank graphs, and the Yellow Starthistle Seed Cycle image. Explain that we are going to calculate the growth rate of an invasive weed called Yellow Starthistle. Have students read the Yellow Starthistle information sheet or read through it with them. While reading through the Yellow Starthistle information sheet have students fill in the missing information from the Yellow Starthistle Seed Cycle image. After students have read the Yellow Starthistle information sheet discuss the following questions with students.

How long does a Yellow Starthistle plant live? 1 year

What makes Yellow Starthistle a weed? Produces large amounts of seed, No predators,
invades space, and dominates nutrients/water, harmful to horses, and prevents grazing by
all other animals.

How many seeds does one plant produce? 1,000

How long are the seeds viable? 10 years

How many of these seeds germinate? 4 % or 4 out of every 100.

What happens to the other 96% of the seeds? They survive in the seed bank for up to 10 years. The seed bank is the seeds that are dormant in the soil from previous years.

How long does a seed take to germinate? 1 year

How many seedlings survive to become mature plants? 25%

Note: The answers to some of these questions could be organized into the following table to help students organize the parameters needed for the calculation problem:

Yellow Starthistle Reproduction Information

Seeds Produced per Plant = 1000
Germination Rate = 4%
Seedling Survival Rate = 25%
Plant Live Span =1 year
Seed Viability = 10 years +

5. Using the information from the Yellow Starthistle information sheet, have students calculate the rate of reproduction (plants/seeds produced) of Yellow Starthistle over 3 years given the problem below. Note: This could be assigned as a homework problem.
One hundred Yellow Starthistle seeds are introduced in an area inadvertently (livestock feed, roadways, animals, recreation, etc.) . How many Yellow Starthistle plants and seeds will there be after 3 years?

Plant Facts about Yellow Starthistle
(from the Yellow Starthistle information sheet)

A Yellow Starthistle plant produces 1,000 seeds per plant.

Four percent of Yellow Starthistle seeds in the seedbank germinate (sprout) each year, leaving 96 percent for next year's seedbank.

Twenty-five percent of the seedlings that sprout survive to become mature plants. Yellow Starthistle seeds remain viable in the soil for up to 10 years.

It takes 1 year for Yellow Starthistle to germinate and produce seed.

Yellow Starthistle plants live for 1 year.

Clues for students: Keep your eye on the Seedbank!!

Answer:

The first part of this section explains the steps used to calculate the problem for the first
year and second year. The second part is a table showing the calculated results.

Year 1

From 100 seeds, 4 (four percent of 100 seeds) will germinate the first year.

Ninety-six will remain in the seed bank (100- 4 to germination = 96 seeds).

Twenty-five percent of the sprouts (one of the four germinated seeds) will survive.

That one surviving Yellow Starthistle plant will produce 1,000 seeds the first year. At the
end of the first year the seed bank = 1096 seeds

Year 2

In the second year, 44 (4% of 1096) seeds from the seed bank will sprout and 11 (25% of 44) of those plants will survive.

Remember that the previous year plant dies so only the 11 plants remain.

These 11 plants produce 11,000 new seeds plus the 96 percent of the second year's seeds (1096 - 44 = 1052) that did not germinate for a total of 12,052 seeds in the seedbank.

Continue for the third year, taking 4 percent of the previous year's seedbank (4% of 12,052 = 482) and take 25 percent of those seedlings (25% of 482 = 120) for the new number of plants (120) in the third year.

Multiply 120 plants times 1,000 for seeds produced in the third year and add to 9 percent of the previous year's seedbank for the new seedbank.

Note: Remember the plants only live for 1 year so don't add them to the next year.

The results can be organized into a table like the one below.

Year	Plants	Seeds Produced	Seedbank
0	0	0	100 Introduced
1	1	1000	1096
2	11	11000	12052
3	120	120122	131653

Point out to students the final (year 3)

Ask students: What could be done to stop this from happening?

Teacher Help:

- Don't allow the 100 seeds to be released. Pull the first Yellowstar seedling.
- Keep searching for new seedlings until the seed bank is gone.

Explain to students that it may be impossible to stop all the spreading of seeds everywhere. This is why it is important for everyone to do their part to look for these invaders and help protect the native plants and animals by removing the weeds.

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

6. Have students graph the results of the Yellow Starthistle invasion using the Plant and Seed Yellow Starthistle - Blank Graphs.

Note: If you feel this problem is too difficult. Give students the answers and have them fill in the Yellow Starthistle graphs, showing the rate of growth over time.

Note: Students could design or decorate their own graphs. These graphs could be placed in their journals or be turned into visuals for use in a public awareness campaign.

Wrap-Up/Evaluation

Have students discuss the following with drawing and journal writing:

1. 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).

2. Draw and label the weed seed cycle.

3. What makes Yellow Starthistle a weed?

- Produces large amounts of seed
- No predators
- Invades space quickly without sharing
- Dominates nutrients/water
- Harmful (toxic) to horses and prevents grazing by farm animals.

Yellow Starthistle Information Sheet

Instructions: Read the article below and answer the following questions.

Yellow Starthistle, Centaurea solstitialis L., is a plant of Old World origin that probably arrived in California in the late-1800's as a contaminant in alfalfa seed. It is a member of the sunflower family and belongs to the thistle group. Since its introduction, Yellow Starthistle has spread steadily and was estimated to inhabit about 14 million acres statewide in 1998. It is considered one of California's worst noxious weeds.

Yellow Starthistle is infesting parks, rangelands, pastures, hay fields, orchards, vineyards, canal banks, roadsides, and other disturbed areas. This invader results in major economic losses to agriculture by rendering grazing lands unusable and increasing the cost of removing problem weeds from their lands. Yellow Starthistle is also a growing pain because it is toxic to horses. Horses can die from eating Yellow Starthistle and this results in the closing of patureland and recreational horse trails for thier protection. When Yellow Starthistle invades neighborhoods and gardens it creates an ugly landscape. This invader can also increase the rates of erosion on hillsides that border our homes, causing landslides and muddy yards. The removal of these invaders costs homeowners neighborhoods a lot of time and money.

Yellow Starthistle is considered a weed because:

- It produces large amounts of seed
- Nothing in its new environment will eat it.
- Invades space quickly and pushes out native vegetation
- Dominates nutrients/water
- Harmful to horses and humans.

Yellow Starthistle plants are called annuals because they only live for 1 year. During their year of life Yellow Starthistle plants grow quickly and produce up to 1000 seeds. These seeds are viable, able to survive in the soil as a seedbank, for up to 10 years. Each year 4 percent of these seeds in the seed bank germinate, or sprout, to become seedlings. 25 percent of these Yellowstar seedlings mature to become adult, seed producing, plants.

Questions:

1. How long does a Yellow Starthistle plant live?

2. What makes Yellow Starthistle a weed?

3. How many seeds does one plant produce?

4. How long are the seeds viable?

5. How many of these seeds germinate?

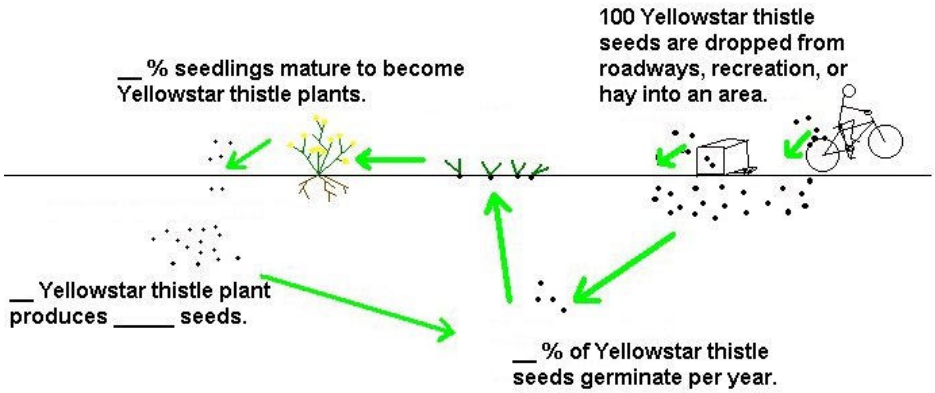
6. What happens to the other 96% of the seeds?

7. How long does a seed take to germinate?

8. How many seedlings survive to become mature plants?

Yellow Starthistle Seed Cycle Worksheet

Fill in the missing information by using the Yellow Starthistle Information Sheet. Complete the seed cycle for Yellow Starthistle and answer the following questions.



What will be the number of Yellow Starthistle plants and the number of seeds that will be in the seedbank after three years if 100 Yellow Starthistle seeds are dropped by humans into an area?

If 100 Yellow Starthistle seeds were spread accidentally by humans to form a weedy **seedbank,** 4% of them will **germinate** and 96% stay in the **seedbank**.

100 X **_4_** % = ___ This is the amount of seeds that will become **seedlings.**
100 X **96** % = ___ 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 4% of the **seedbank** and they will germinate into seedlings.

____**Seedbank total** X _**4**_% = ___ This is the amount of seeds that will become **seedlings.**

____ **Seedbank total** X **96** % = ___ 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 4% of the **seedbank** and they will germinate into seedlings.

____**Seedbank total** X _**4**_% = ___ This is the amount of seeds that will become **seedlings.**

____ **Seedbank total** X **96** % = ___ 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 3rd year.

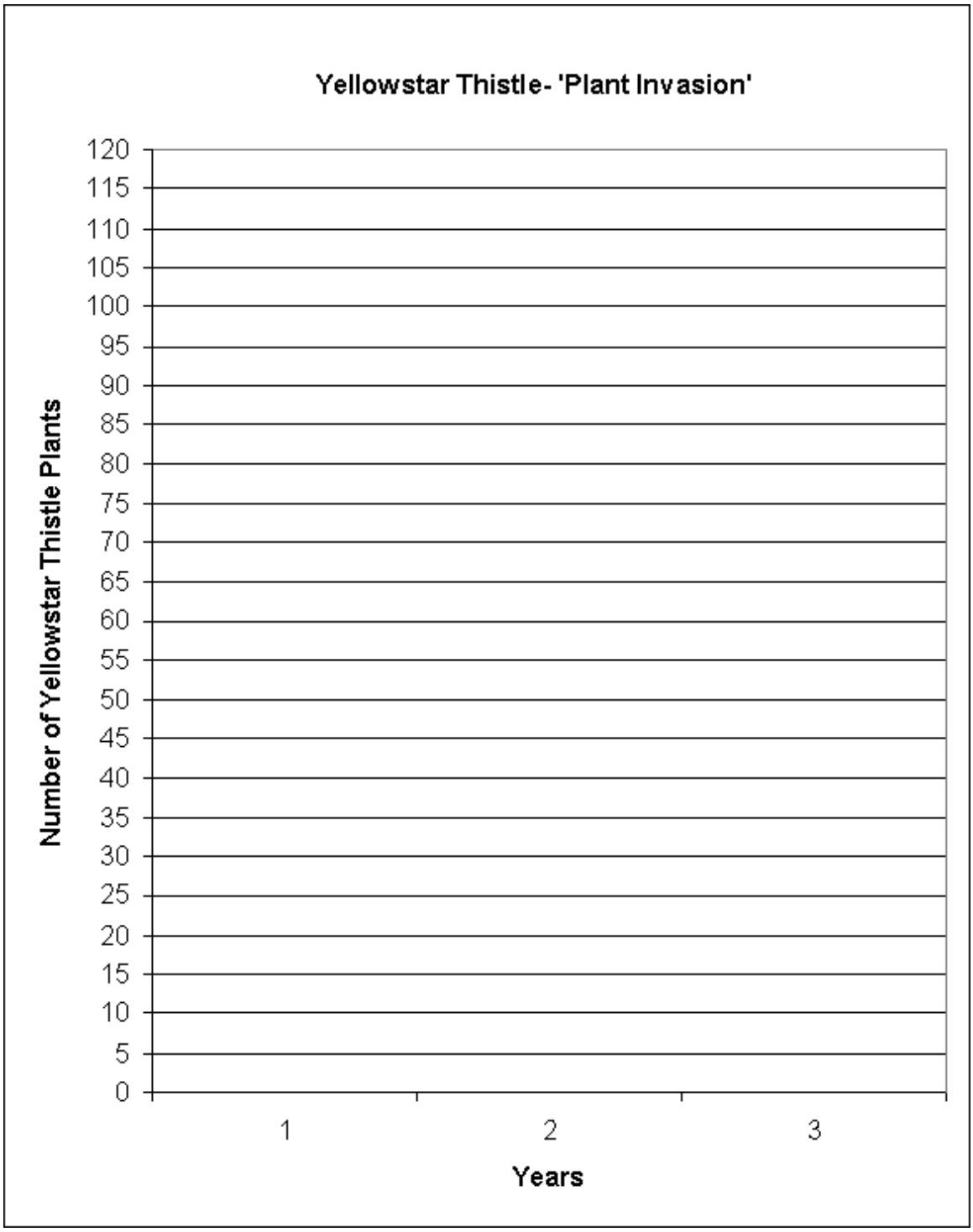
Those _____ **adult plants** will produce _____ seeds each.
These _____ seeds from the **adult plants** are added to the _____seeds already in the seedbank = _____**Next years seedbank.**

Fill in the table below and graph the population explosion of Yellow Starthistle.

Year	Plants		Seedbank
0	0		100 Introduced
1	____		_____
2	____		_____
3	_____		_____

Why is this called a population explosion?

Graph the number of Yellow Starthistle plants that are produced for each of the 3 years.



Graph the number of seeds produced and in the seedbank for the 3 years.