Spotted Knapweed (Centaurea maculosa)

A Study of the effects of a biological control agent by students from Fort Benton High School, MT

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http://mtwow.org/spotted-knapweed-Fort-Benton-student-study.htm

Background:

Noxious Weeds:

Weeds are plants that interfere with the management objectives of a given area. Noxious weeds are weeds that society has declared our legal responsibility to manage because of their negative impacts. Noxious weeds also spread like wildfire out of control. These weeds displace native plants, reduce biodiversity, eliminate rare plant species, and alter normal ecological processes like the nutrient and water cycle. They also decrease wild life habitat and increase soil erosion.

Noxious weeds have a big effect on wildlife. They reduce wildlife forage, alter thermal and escape cover, and some noxious weeds like cheatgrass increases the frequency of fires. These quick spreading weeds also have a huge effect on agriculture – they can displace valuable forage for livestock. They can reduce grazing capacities by 65% to 90%. Currently, weeds cost farmers over $100 million a year. (8)

In Montana there are three categories of noxious weeds. Category 1 is a well-established weed that covers many acres like spotted knapweed. Category 2 is present but there is not much of it in the state like diffuse knapweed. Category 3 is a weed that this State doesn't have yet but know is on the way like yellow starthistle. (9)

Spotted Knapweed:

Spotted knapweed (*Centaurea maculosa*) is an aggressive introduced weed species that rapidly invades pasture range and fallow land causing a decline in forage and crop production. It releases a toxin that reduces the growth of other plants in the area. (2) It often displaces native vegetation. For example spotted knapweed causes blue bunch wheat grass to decrease by 88%. (6)

Spotted knapweed infests more than 4.5 million acres in Montana, and is present in every county. (7) Is costing the state 14 million dollars a year in control cost (8) and the county alone spends $3,000 a month to control spotted knapweed. (9)

(spotted knapweed plant)

History:

Spotted knapweed's native range is central Europe and east to central Russia and western Siberia. (6) In Europe the weed is found in light fertile well drained soils in warm areas. It occupies dry meadows, stony hills, roadsides, and sandy/gravely flood plains of rivers and streams. (3) It was introduced into North America in the late 1800's as a contaminant in alfalfa. Early introductions were also thought to be in discarded soil used as ship ballast. The first record of spotted knapweed in North America was in Victoria, British Columbia in 1883. The weed was spread further in domestic alfalfa seed and hay. (6) Spotted knapweed does so well here because there are no natural enemies like back in Europe.(9) It tolerates the dry conditions in Europe but is thrives in wetter conditions like the mountains in western Montana. (3)

Description and Life Cycle:

Spotted Knapweed is a biennial or a short lived perennial. It is commonly 3-4 feet tall and has leaves that grow 1-3 inches apart. The plants have single thistle like pinkish purple flower heads that get as big as ¾ inch in diameter at the tips of their stems. (See figure 1) The flowers bloom in late June to August. Their seeds are brownish and under ¼ inch in length notched on 1 side and have a short tuft of bristles at the tip for wind dispersal. The taproot is stout and elongated. (3)

(Figure 1)

(figure 2)

The spotted knapweed flower blooms in late June to August for 2-6 days each. The bracts reopen after 20 days and scatter seeds. The seeds are viable for 7 years. They germinate through the growing season. Seedlings (see figure2) emerge in fall and develop into a rosette of leaves that resume growth in the spring. (3)

Mechanical Control:

Spotted knapweed can be controlled mechanically by removing all the pioneering plants. Small populations can be removed by digging or pulling. When removing the plant the entire root should be removed. Mowing is not successful as the weed will just re-flower at a lower height. Annual burns can reduce knapweed populations by 5-90%, reductions seem to be associated with the intensity of the burns. (3)

Chemical Control:

This is the effective way to eliminate spotted knapweed, but it also has the most adverse consequences because it involves the use of very potent chemicals. Experimental testing for effectiveness before use is recommended for the less toxic broad leaf herbicides such as Triclopyr or Glyphosate. Triclopyr in the water soluble formation with dye can be sprayed on the plant, it should be applied 3-4 times per year for 2 years and should have no effect on grasses, shrubs or trees. Other

chemicals can be applied without affecting the other plants in the area are Picloram, Dicamba, and Clopyralid. (3)

Biological Control:

There are several ways to control Spotted Knapweed biologically (see page 5 for map). 1st grazing with goats or sheep will decrease populations. These are the only animals that destroy viable seeds. Insects that control knapweed are: two types of root mining moths, a flower moth (3), the *Larinus minutus*, a beetle whose larva destroys almost 100% of the seeds in the seed head the adults also eat leaves and flowers in the late summer causing less seed production. (See figure 4)

(Figure 4)

(Figure 5)

***Larinus minutus*:**

History:

The beetle is from Europe and was introduced to the USA in 1991 and is released in many western states including Montana.

Life Cycle:

The beetle winters in the ground by the roots of the plant. They lay about 130 eggs in clusters of 5 in the flower head, the eggs hatch after 3 days and become a larva. In the four weeks it takes for the larva to develop into a pupa it feeds on the pappus hair of the flower and then moves to the achenes where it then feeds on the seeds. This creates a cell (see figure 5). As a pupil it makes a white cocoon inside the seed head. The adult comes out of the cocoon in May through August. They mate and lay eggs for 11 weeks during the June, July, and August. The adult beetles are brownish gray and have a large snout. They are 4-5mm in length.

Redistributing and Purchasing:

The beetle prefers warm, dry climates with knapweed infestations, the plants should be 1-2 feet apart. About 500 adults should be released in an area. The area should also be open and not shaded. Adults can sometimes be acquired from the county or state weed management agencies for no cost. Commercially they can be purchased at Biological Control of Weeds website, for $100 for 105 insects. (4)

Another insect, the most promising are the 2 seed head attacking flies. The flies can reduce the population of spotted knapweed by 95%. (3)

(Figure 6)

(Figure 7)

***Urphora affinis* (seed-head fly):**

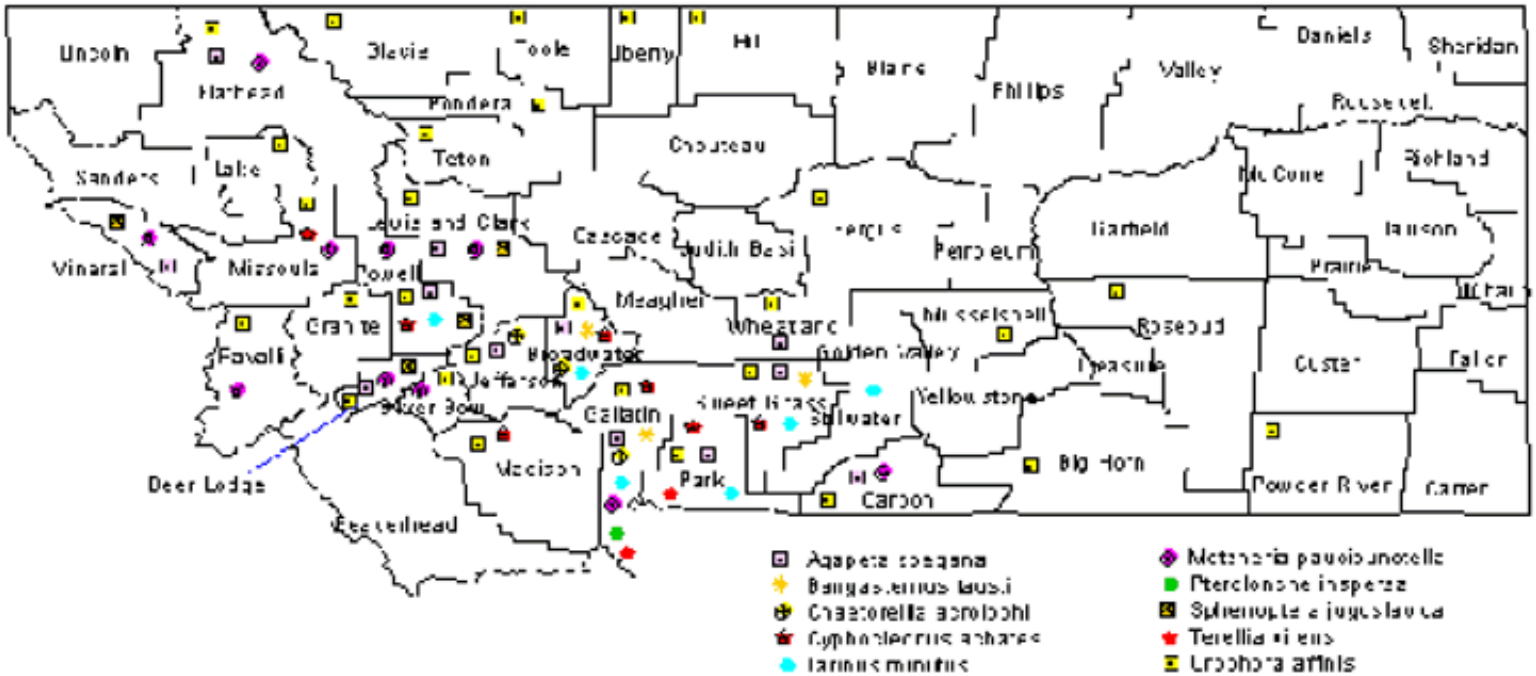
The fly (see figure 6) was first released in the USA in 1971 in many states including Montana. It can be found in the spring on unopened buds of the knapweed flower. The larva causes the plant to form a gall (see figure 5) in which the larva lives and feeds. The gall is found on the receptacle it is pointed at the tip and is made of lignified material.

It is a small fly 3-4 mm in length with a barred wing, and dark body. The fly larvae winters in the seed heads and emerges in mid to late spring as adults. After mating the eggs are laid in between bracts on the closed flower buds.

The larvae draws nutrients from the plant so new flower buds abort and do not develop due to the lack of nutrients. Unattached seed heads produce an average of 12.6 viable seeds. Each gall is estimated to reduce seed production by 2.4 seeds per seed head. (5)

Biocontrol Agents released in Montana against Spotted Knapweed (Centaurea maculosa)

2000-05-10 Data retrieved from National Agricultural Pest Information System



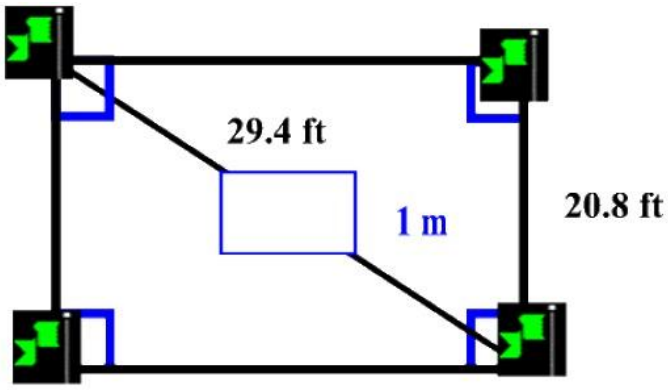
The Center for Invasive Plant Management Systems does not certify the accuracy or completeness of this map.

Purpose:

This study was done to find the affect of the *Larinus minutus* on spotted knapweed on the Teton River.

Procedure:

1. The class took a bus to the Teton River on Oct.1, 2002.
2. Each group was assigned an area. The measurement of the area was to be 20.8 on each side and 29.4 diagonally, the plot was 1/10 of an acre.
3. A flag was put in the ground at 47 degrees 50.360 north & 110 degrees 43.488 south.
4. From that flag 29.4 feet were measured diagonally, another flag was set there at 47 degrees 50.361 north &110 degrees 43.488 west.
5. From the first flag 20.8 feet were measured vertically and the 3rd flag was placed there at 47 degrees 50.359 north & 110 degrees 43.488 west
6. 20.8 feet were measured from the 1st flag in a horizontal direction and the 4th flag was set there at 47 degrees 50.359 north and 110 degrees 43.489 south.



Finished plot 10th of an acre (blue lines-mini plots)

7. 2 people put on gloves and went into the plot.
8. Cut spotted knapweed at the ground and counted the number of seed heads and the number of stems without seed heads. Those numbers were recorded.
9. The seed heads were put in a Biohazard bag being held outside the plot.
10. Mini Plots were put in each corner and one in the middle they were each 1meter squared (see blue lines). The other plant species inside the mini plots were counted and recorded.
11. Back in the classroom the number of seed heads with cells and the number with out were recorded.
12. The seed heads were put back in the bag and destroyed.

Data:

Group	Total Stems	Stems with seed heads	Stems without seed heads	Seed heads with cells	Seed heads with no cells	% Error
Ben Ian Brett R. Logan. Kyle	14	138	302	21	90	-24.3%
Mitzy, Dusty, Andy, Kayla	117	1228	133	277	1012	-5.5%
Brett S. Chris, Kaela, Nikki	233	1461	873	276	960	-18%
Carol Ann, Ashley, Alex, Julie, Kristen	193	973	226	396	450	-15%
Cory, Jesse, Jackson, Khatin	301	2313	259	919	1098	-14.7%
Laura, Bobbe, Kyle, Lindsee	174	1051	186	299	743	.86%
Casey, Trevor, Curtis, Eric	175	1340	249	263	952	-30.5%
Maggie, Melissa, Jen, Andréa	392	1841	421	666	1066	-30.6%
Dusty, Nathan, Garth, Shawn	373	2076	501	622	857	-74.2%
Averages	**315**	**2070**	**525**	**623**	**1204**	**-22.44%**

Data (Continued):

Mini Plots

Plant	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	**Averages**

Cheat grass	320	500	4		25	**169**
	36	7	3	70	4	**24**
	7	1				**1**
		1				**.2**
			4			**.8**

(Cheat grass)

(Leafy Spurge)

(Clover)

(Knapweed Rosette)

(Showy Milk Weed)

Analysis:

- % Infestation:

  Cells

$$\frac{\text{(Head w/cells) + (heads w/out cells)}}{\text{(Head w/cells) + (heads w/out cells)}} *100$$

- Seed Production:
  (Stems w/heads + stems w/o heads) *32
- Seed reduction:
  (Seed production) * (100-% infestation)= seeds remaining
- % Error

$$\frac{\text{Lab heads- field heads}}{\text{Lab Heads}} *100$$

- Uncontrolled Expansion
  Increases by 27% /year
  (Current acres)*(1.27) =34 million
- Controlled Expansion
  Increases (27%) *(1-% infestation)=Y
  (Current acres)*(1.Y) =34 million

Results:

Year	Total Plants	Stems w/heads	Stems w/o heads	Seeds Produced	Heads w/cells	Heads w/o cells	% Error	% Infestation	Seed reduction	Uncontrolled	Controlled
1998	828	6066	1231	233504	2591	2560	15%	50%	116752	8.02yr.	15.1yr.
1999	714	3778	571	139168	1342	1970	24%	40.5%	82805	8.02yr.	12.8yr.
2000	1553	6226	1282	240256	2209	3461	24%	39%	146556	8.02yr.	12.6yr.
2001	349	2865	603	110957	1258	1350	10%	48%	83756	8.02yr.	15.06yr.

2002	**315**	**2070**	**525**	**83040**	**623**	**1204**	**-22.4%**	**34%**	**54723**	**8.02yr.**	**11.7yr.**

Conclusion:

The data for this year shows that there are 2,595 total stems. 2,070 of the plants have heads and 525 do not. 623 plants have cells and 1,204 of them do not. This year there were more stems that the other years. This year has the least amount of seed heads. The seed heads that were not on the stem either fell off or were eaten by deer mice.

If spotted knapweed is not controlled in 8.02 years it could take over the entire state of Montana. In 1998 the controlled growth rate was 15.1 years. In 1999 the controlled growth rate was 12.8 years. Then in 2001 the controlled growth rate went up to 15.06 years. Then it went back down to 11.7 years. So, next year the rate should go down more.

Knapweed travels very fast so it is hard to control all at the same time. If we keep putting the seed head weevil out, spraying chemicals, pulling and mowing the knapweed, in 11 years most of it should be gone.

Many thanks to the students of Fort Benton for allowing us to publish their fine study!!

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