BIOLOGICAL CONTROL OF SPOTTED KNAPWEED

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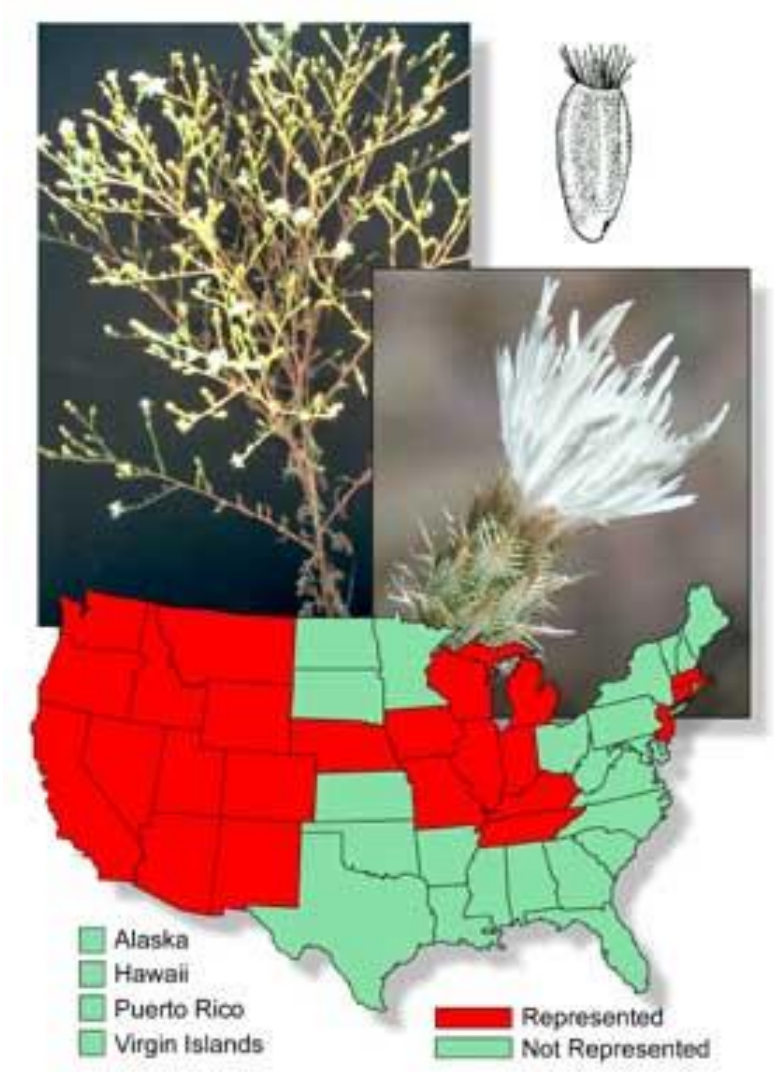
Knapweeds

- Spotted knapweed – *Centaurea maculosa*
- (= *C. stoebe ssp. micranthos*)
  - Perennial
  - Reproduces by seed
  - Stout taproot
  - Habitat includes well drained, light soils, more mesic sites

Wilson et al.

Knapweeds

- Diffuse Knapweed - *Centaurea diffusa*
  - Biennial to short lived perennial
  - Reproduces by seeds
  - Habitat – drier more disturbed soils



Wilson et al.

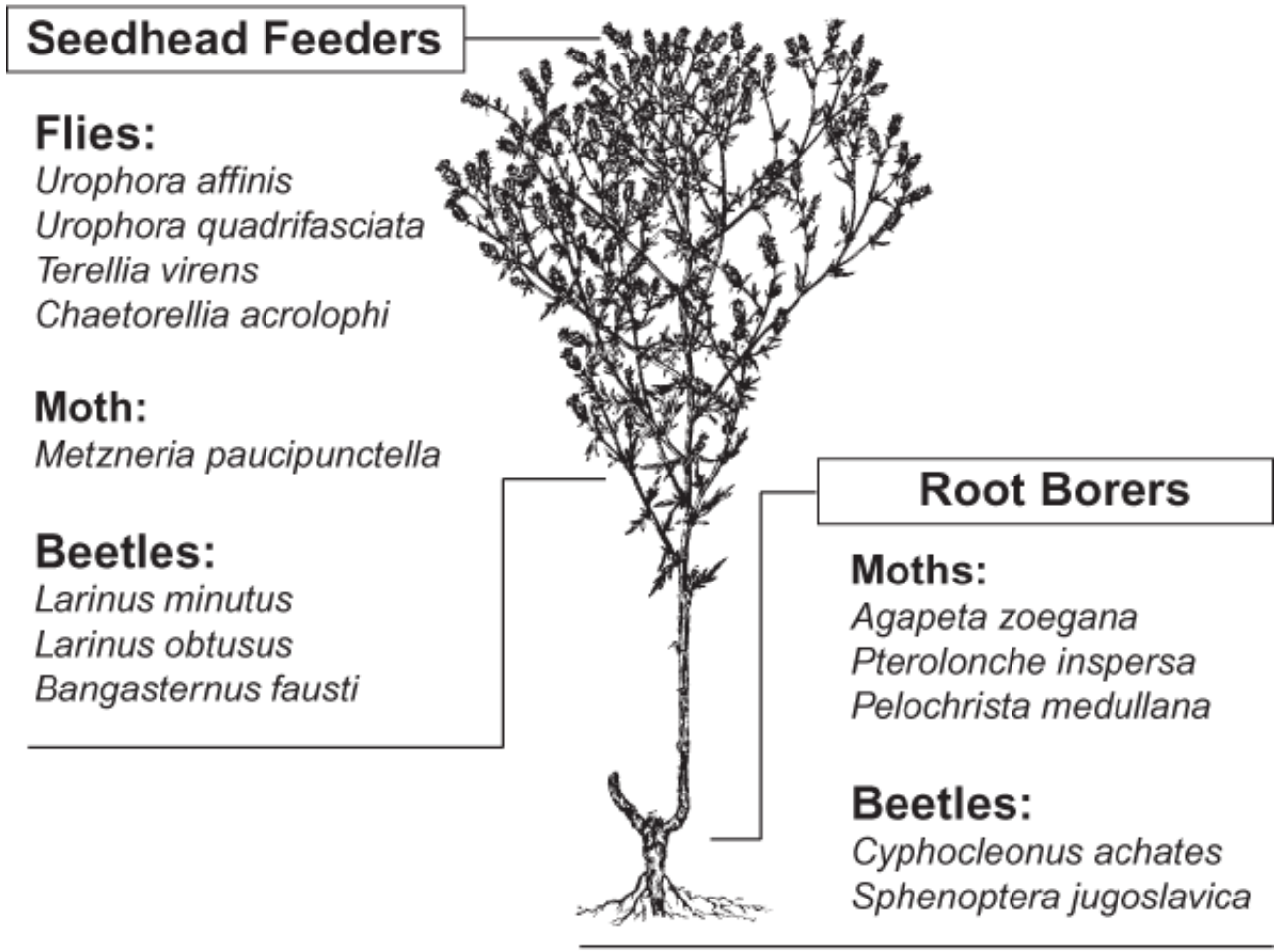
Knapweeds

- Costs Montana $42 million annually (Hirsch and Leitch 1996)
- Spotted knapweed is a noxious weed in 11 of the Western states
- Infests more than 3 million ha (7M acres) of land in 46 US states and 7 Canadian provinces.
- It continues to spread at about 20% per year (Duncan 2005).

Control Options

- Herbicide – effective, but repeated treatment
  - Environmental concerns
  - Expensive
- Livestock grazing – requires more intense management (Targeted grazing)
- Biological control
  - Specialized Agents
  - Self perpetuating

Agent Complex



Wilson et al.

Seedhead Feeders

Seedhead Feeders

Flies:
Urophora affinis
Urophora quadrifasciata
Terellia virens
Chaetorellia acrolophi

Moth:
Metzneria paucipunctella

Beetles:
Larinus minutus
Larinus obtusus
Bangasternus fausti

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Larinus minutus – Lesser knapweed flower weevil

- Life Cycle:
  - Overwinter as adults in soil near the base of plant
  - Adults-active from May through mid-September
  - Adults feed on leaves and flowers

Larinus minutus – Lesser knapweed flower weevil

- Life Cycle cont.:
  - ➢ Larvae feed within flower head and complete development in 4 weeks
  - ➢ Pupation occurs in seed head within a cocoon constructed by larvae

Larinus minutus – Lesser knapweed flower weevil

- A single larva can destroy entire contents of a knapweed seedhead

Documented Impacts – Seedhead Feeders

- Knapweed seeds in soil 4,218 seeds/m^2
- Seedhead Biological Control
  - 19-281 seeds/m^2
- Seedbank exhausted 7 years
  after arrival of bugs (Knochel et al. 2010)
- But damage dependent on bug density!

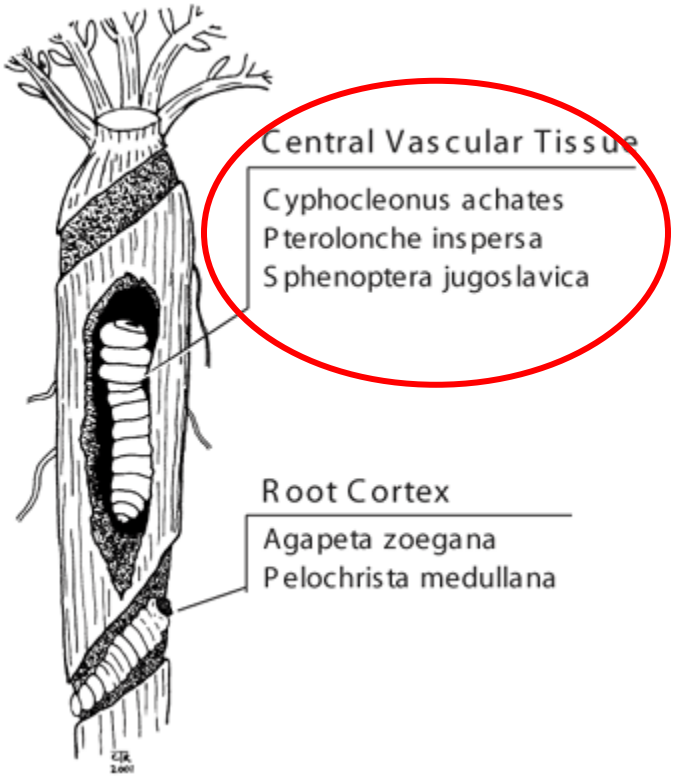
Documented Impacts – Seedhead Feeders

- Oregon – 7 years after release of *Larinus*

Root Insects

Laura Parsons, University of Idaho, PSES, Bugwood.org

Cyphocleonus beetle



Sphenoptera beetle

Cyphocleonus achates – *Root Weevil*

http://www.invasive.org/weeds/knapweed/chapter2.html

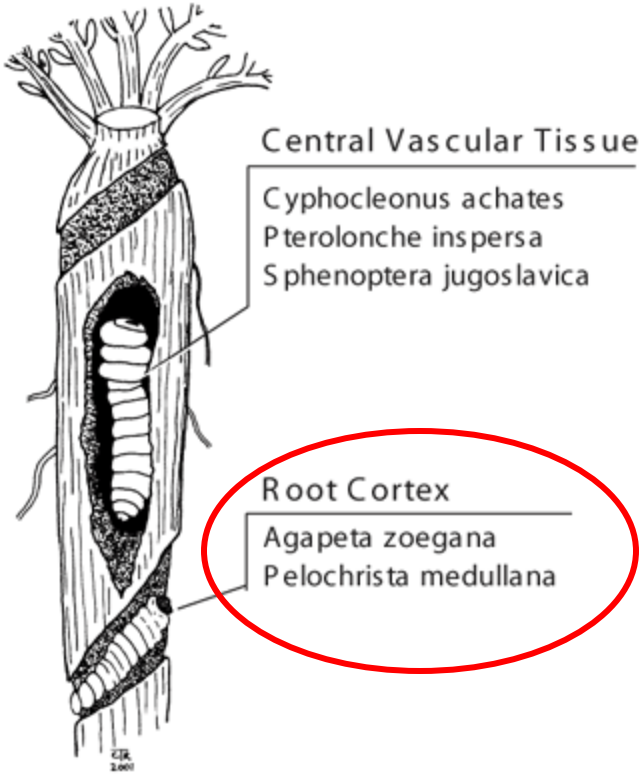
- Life Cycle:
  - Adults emerge from June to mid-September
  - Females lay individual eggs in a notch excavated by female on root crown just below soil surface

Cyphocleonus achates – *Root Weevil*

- Life Cycle:
  - Larvae mine toward the cortex of root and form a gall-like enlargement of root
  - Overwinter as larvae in the root
  - Pupation occurs within the root
- Site of Attack:
  - Larvae feeding in the roots
  - Best control achieved at >5 larva per root

Agapeta zoegana – *Root Boring Moth*

Photo by Jim Vargo



Impacts – Root Boring Weevils

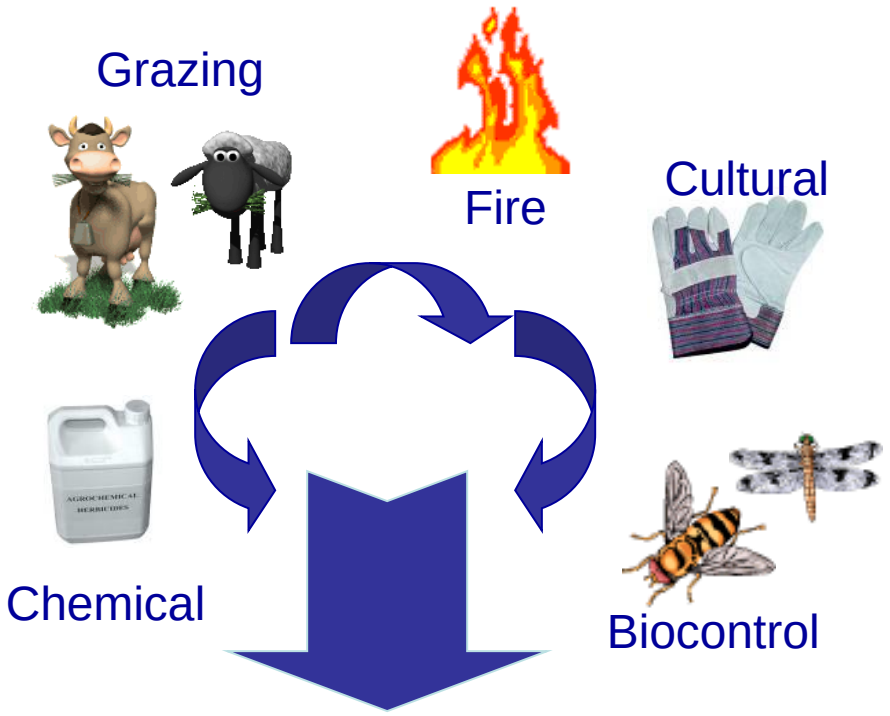
- 77-99% decline of knapweed
- Cyphos increase by 14% annually
- Density of 0.3 to 0.4 beetles/m^2

Biocontrol Success - Wisconsin

- Visible decrease in knapweed.
- Sites with a combination of root agents and seedhead agents provide best control.

IPM and Biocontrol

- Know the tool you need for your objective
  - Eradication, suppression, or containment?
- Examine all possible methods
  - Mechanical, cultural, chemical?
- Integrate biocontrol where feasible



Herbicides and Biological Control

- Current weed populations so thick may impede biological control establishment
  - *Cyphocleonus* establish best when knapweed cover 30-70% (Jacobs et al. 2000)
  - Picloram at <0.09 kg AI/ha^{-1}

- Late spring application of 2-4,D and clopyralid both compatible with root feeders, *Agapeta* and *Cyphocleonus*. (Story and Stougaard, 2006).

- Fall herbicide application NOT compatible with root feeding insects

Targeted Grazing and Insect Biological Control

Biocontrol alone effective in only 30% of cases
(McFadyen 1998)

Potential for synergistic effects:

- Cumulative stress from herbivory
- Concentration of seedhead feeding insects

Concerns:

- Livestock interfering with population growth and stability
- Biocontrols not designed for eradication

Integration of Targeted Grazing with Insect Biocontrol

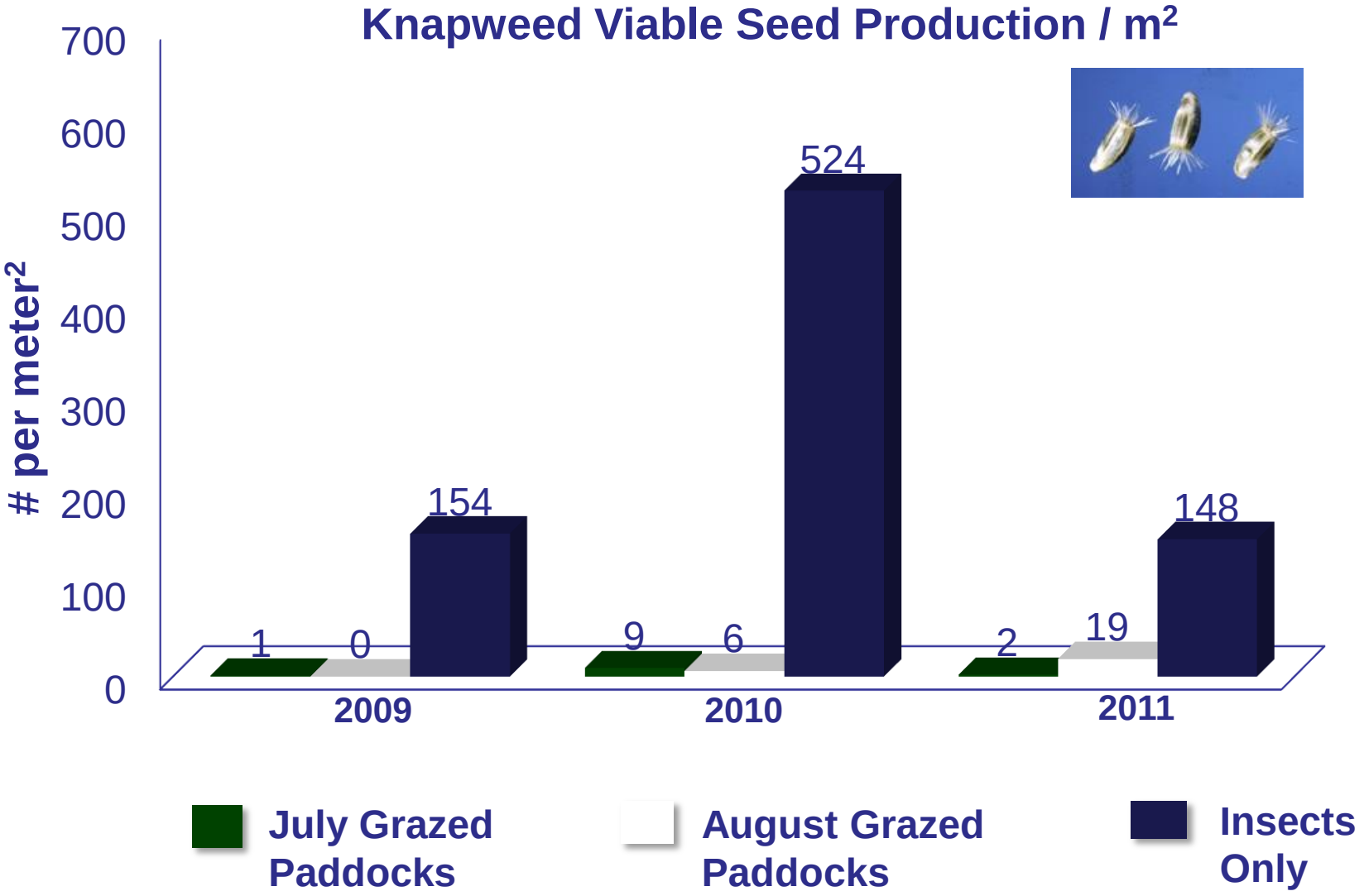
Leafy spurge:

- Increased control when targeted grazing used in conjunction with flea beetles
  (TEAM Leafy spurge)

Yellow starthistle:

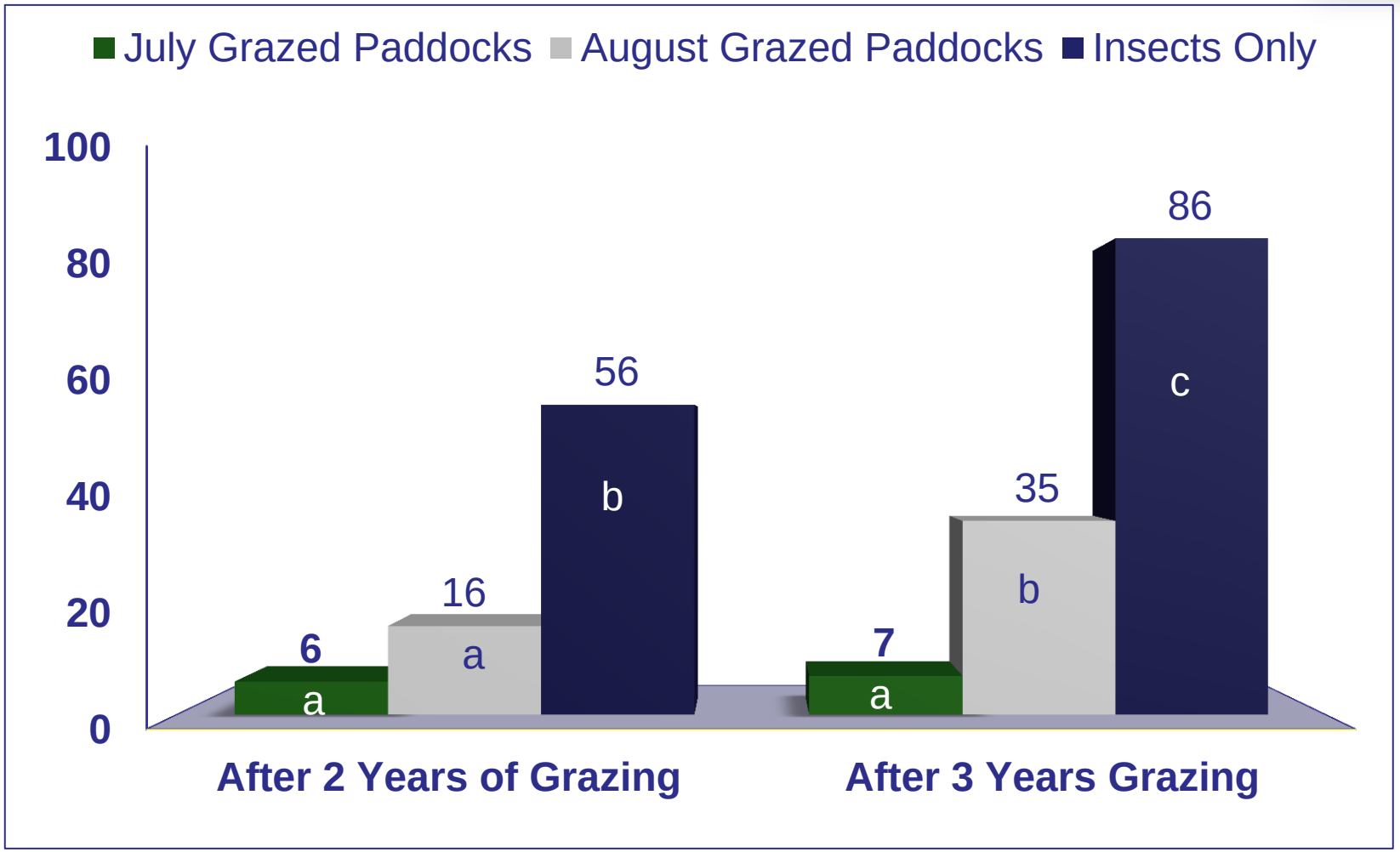
- Grazing by sheep or cattle did not impact the effect of seed head feeding insects on seeds of yellow starthistle (Wallace et al. 2008)

VIABLE SEED PRODUCTION OF SPOTTED KNAPWEED



SEEDLING NUMBERS PER METER^2

Spotted Knapweed Seedlings



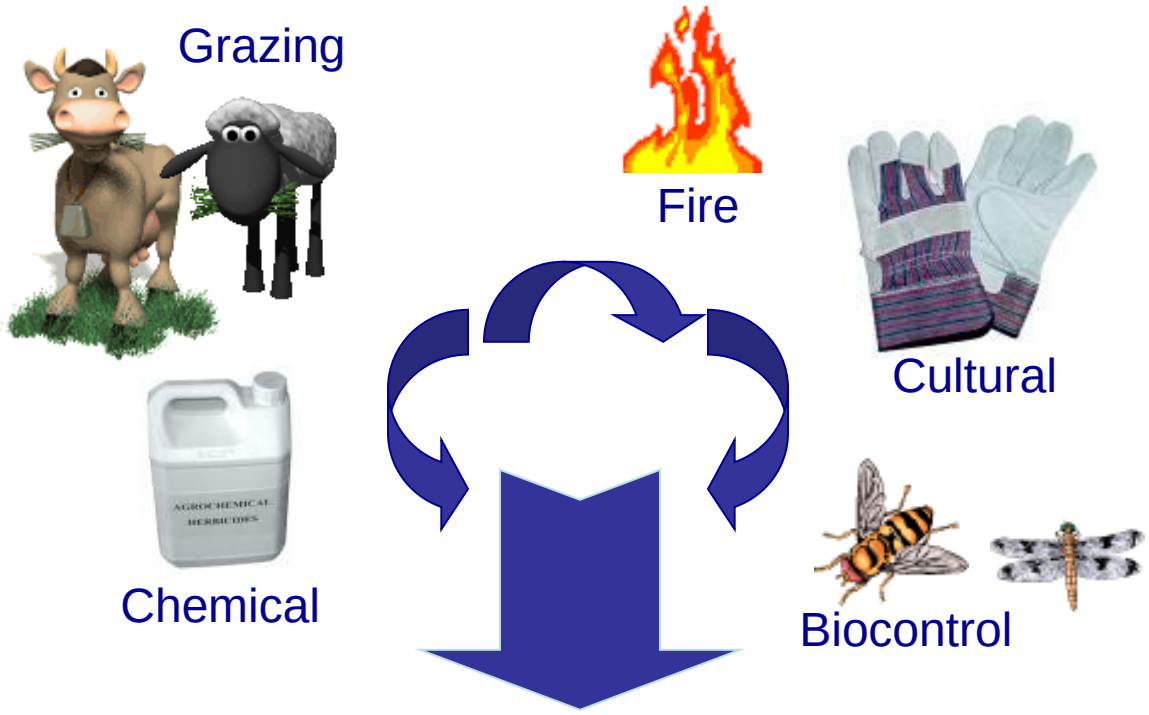
Results Summary

- Sheep grazing does not reduce *Larinus* or *Cyphocleonus* populations the following year.

- Addition of sheep grazing reduced seed production 99% more than biological control alone.

- Grazed paddocks had 5 times fewer seedlings than paddocks that were not grazed by sheep.

Power in Integration



- Integrated systems
  - More complete achievement of objectives
  - More rapid than single method
  - More economical vegetation management

Additional Information

- Biology, Ecology and Management of Montana Knapweeds
  - http://msuextension.org/publications/AgandNaturalResources/EB0204.pdf
- Diffuse and Spotted Knapweed – Colorado Extension
  - http://www.ext.colostate.edu/pubs/natres/03110.pdf
- Montana Knapweeds: Identification, Biology and Management
  - http://www.sheepinstitute.montana.edu/articles/eb311.html
- Knapweed Biocontrol
  - http://ag.montana.edu/warc/research/biocontrol/knapweedcontrol.htm