Nevada Weed Conference

October 28th, 2015

Establishing new agents, how to use them, and more agents on the horizon

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BLM

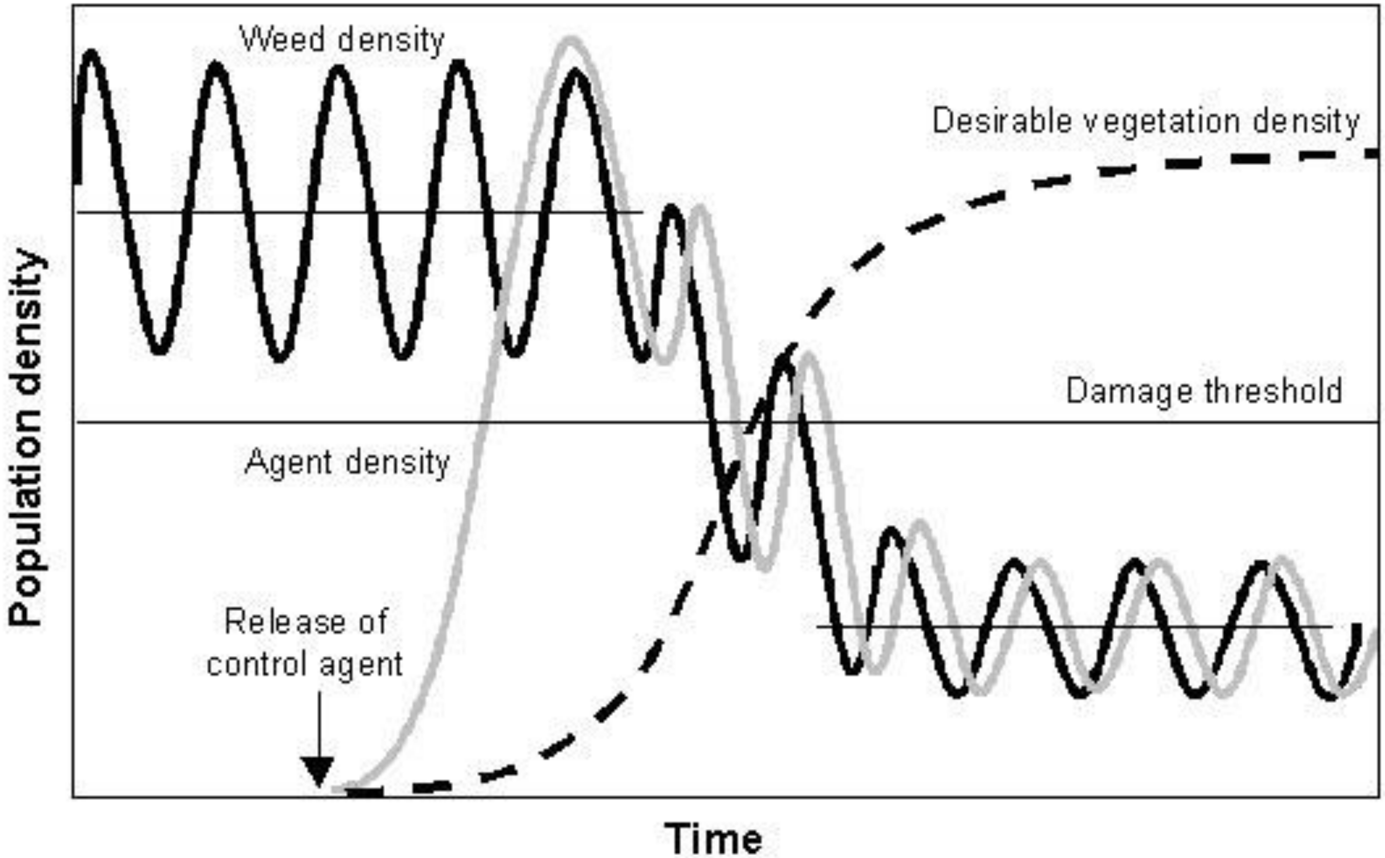
Overview

- Biological Control
  - Pros and Cons
  - Agent selection process
- New Agents for Old Problems
  - Scotch thistle (*Onopordum acanthium*)
  - Russian knapweed (*Acroptilon repens*)
  - Saltcedar (*Tamarix* spp.)
  - Spotted knapweed (*Centaurea stobe*)
  - Yellow toadflax (*Linaria vulgaris*)
  - Rush skeletonweed (*Chondrilla juncea*)
  - Russian olive (*Elaeagnus angustifolia*)
  - Oxeye daisy (*Leucanthemum vulgare)*
  - Common tansy (*Tanacetum vulgare)*
- Standard Impact Monitoring Protocol (SIMP)
- BLM/ISDA's webpage

Classical Biocontrol

- Focuses on simple plant-herbivore interactions
  - Advantages:
    - Target specificity
    - Continuous action
    - Long – term cost effective
    - Gradual in effect
    - Generally environmentally benign
    - Self dispersing, even into difficult terrain
  - Disadvantages:
    - Protracted time until impact is likely or visible
    - Uncertainty over ultimate scale of impact
    - Uncertain "non-target" effects in the ecosystem
    - Irreversible
    - Not all exotic weeds are appropriate targets
    - Will not work on every weed in every setting

Ideal Biocontrol Results



Agent Selection Process

- Foreign exploration for natural enemies
  - Establish target
  - Thorough literature survey
  - Climate matching (CLIMEX)
    - Rainfall, degree days, temp., moisture, drought
  - Field collections
  - Laboratory processing
  - Rearing
  - Petitions & paperwork

Host Specificity Testing

- How specific are biocontrol agents?
- How is specificity tested?
  - Plant lists
  - Types of tests
    - Oviposition
    - Feeding
    - No choice
    - Multiple choice
  - Examining the results

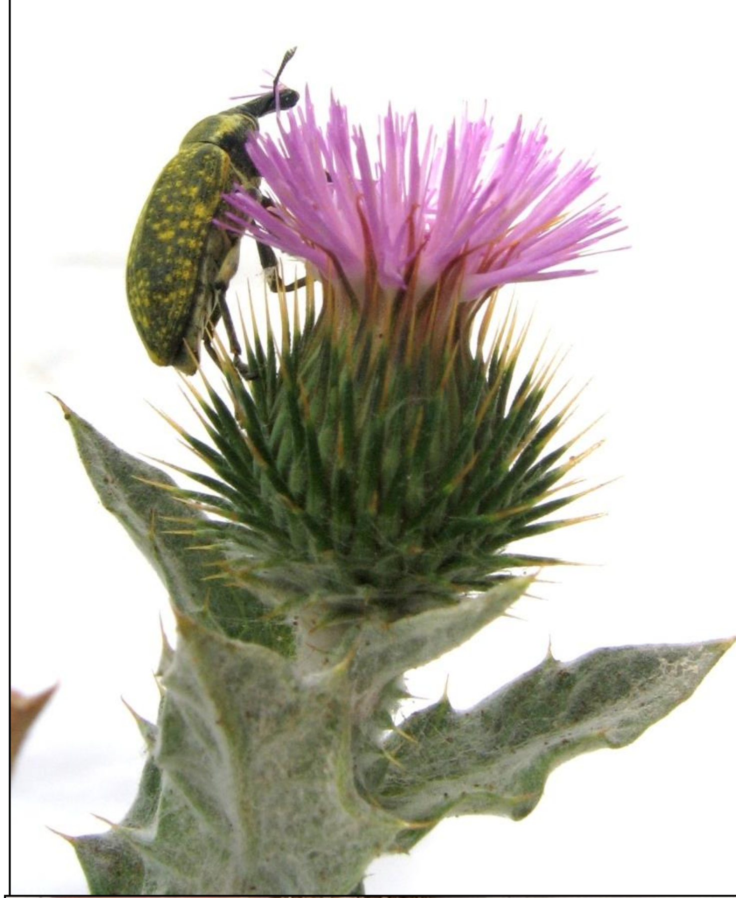
Scotch thistle
(*Onopordum acanthium*)

Larinus latus (seedhead weevil)

Tested in field gardens in Turkey in 2012 and in Bulgaria and Italy in 2013

Results look very promising

Quarantine experiments and more field testing planned for 2015

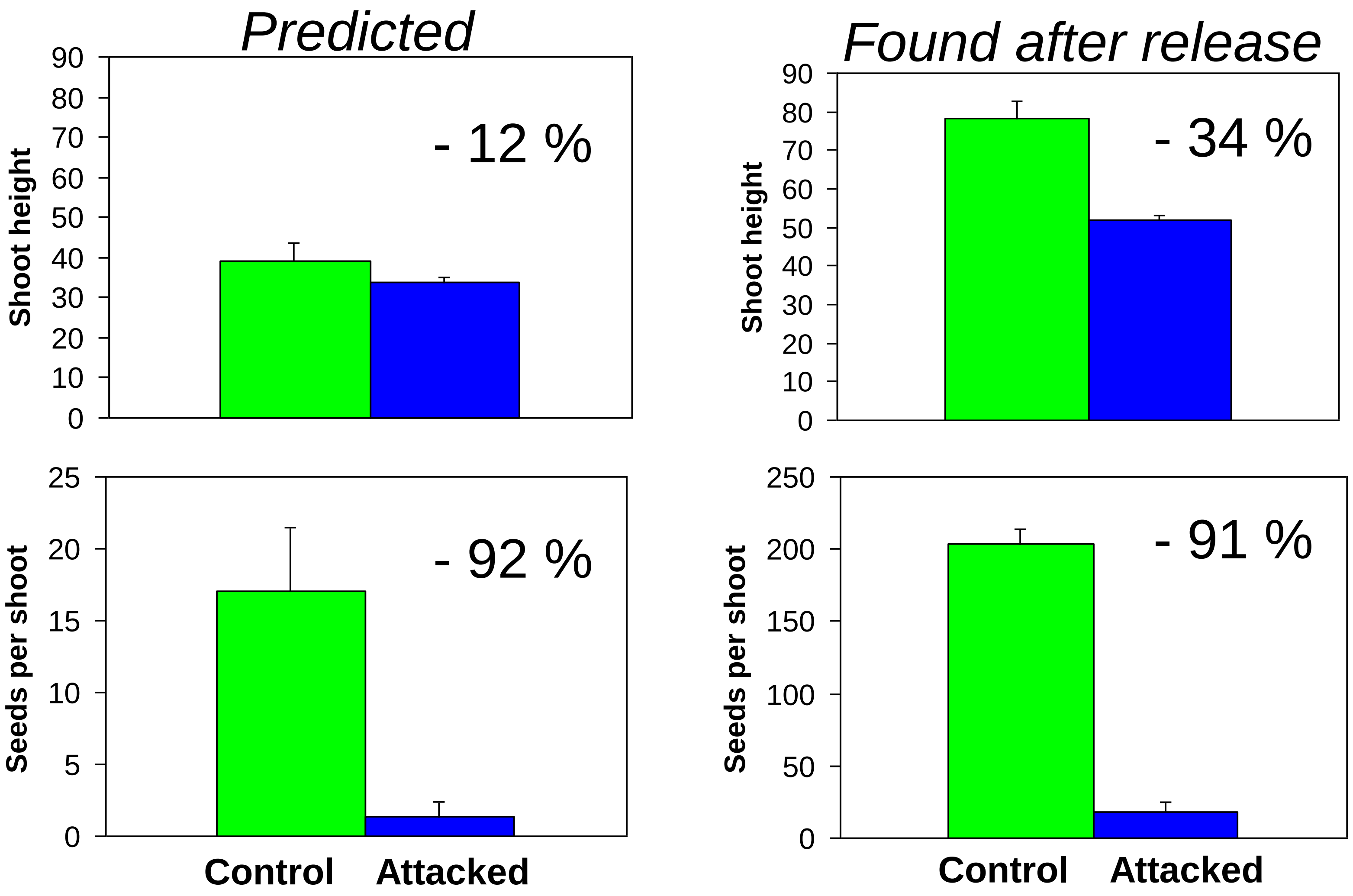


Russian Knapweed

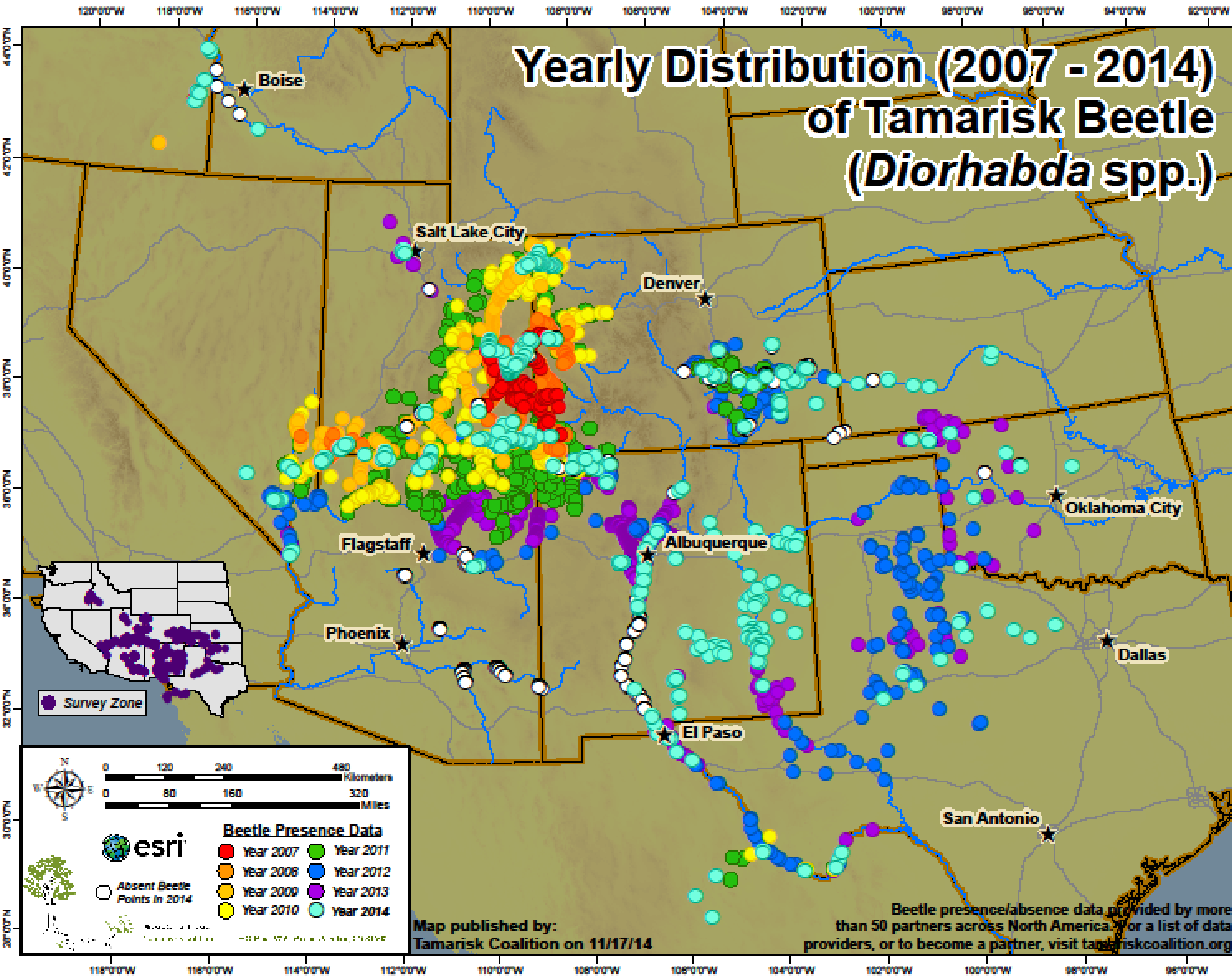
- Gall midge *Jaapiella ivannikovi* for control of Russian knapweed
- Established in Alberta, Wyoming, Oregon, Washington, and now Idaho
- Recent release of the gall wasp, *Aulacidea acroptilonica*



Impact of *Jaapiella ivannikovi* on Russian knapweed



Saltcedar (*Tamarix*)



Spotted Knapweed

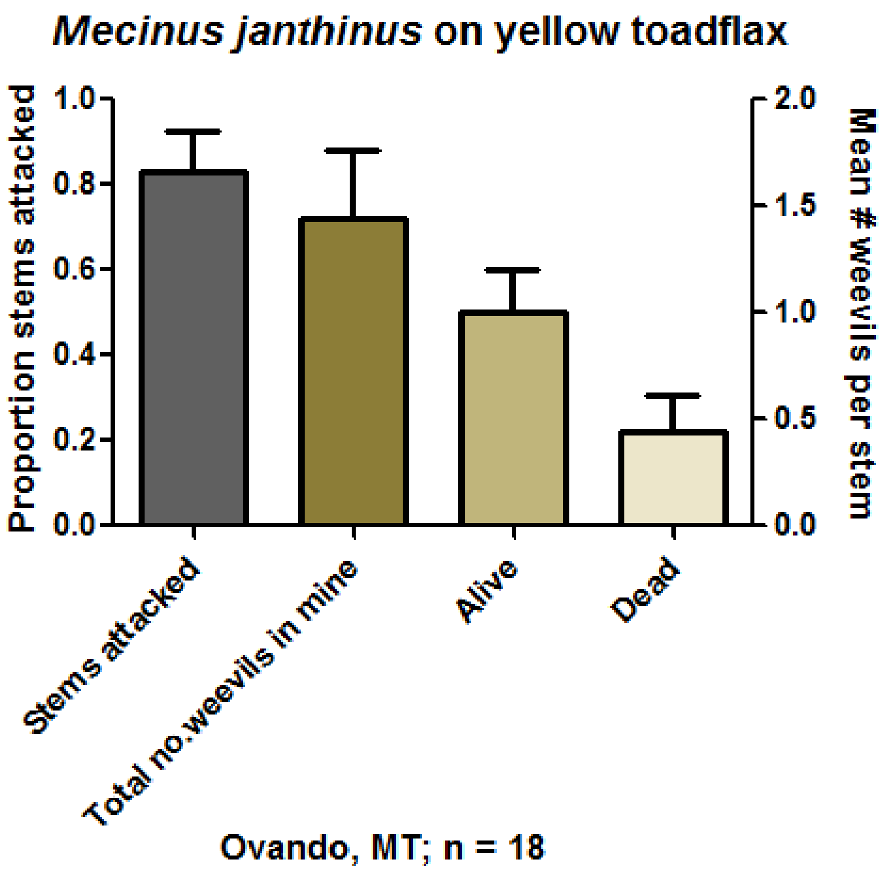
- Continue to see declines in spotted knapweed across the state
- Three "bug corral" insectaries have been developed
  - Salmon, ID
  - McCall, ID
  - Sun Valley, ID

Yellow Toadflax

- *Linaria vulgaris*
- Reproduces vegetatively and by seed
- Originally brought in as an ornamental
- Readily colonizes disturbed areas

Yellow Toadflax

- *Mecinus janthinus* on *Linaria vulgaris*
- Many biological control agents released with minimal success
- Hybrid toadflax issues
- Now have insecataries in Idaho and Montana
  - YT is receding rapidly



Attack rates for small stems suggest *Mecinus janthinus* should be as successful on yellow toadflax as it is on Dalmatian toadflax

Rush Skeletonweed

Bradyrrhoa gilveolella

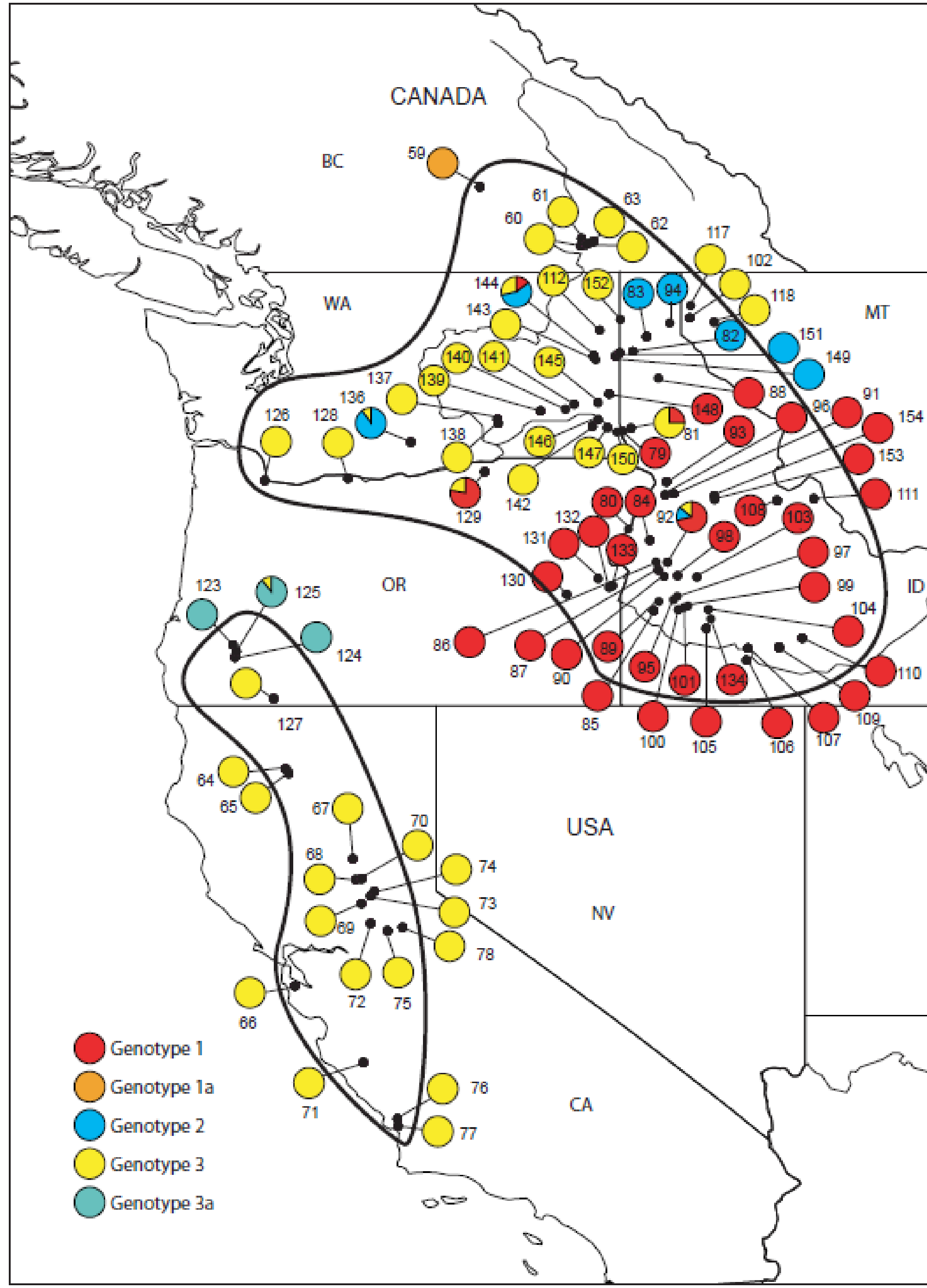
- Permit for release in 2002 (Dr. George Markin, USFS)
- Rearing moth at University of Idaho and Nez Perce Biocontrol Center since 2006
- Field releases using cages, caged plants and open releases of larvae and adults
- Established in Idaho and Oregon since 2010, 2011 respectively
- Redistribution ongoing

Rush Skeletonweed

- Biological control research 2004-2014
- Emphasis on plant resistance, impact and establishment of *Bradyrrhoa gilveolella*
- Not overly optimistic about *Bradyrrhoa gilveolella*
  - 14 larvae on a single plant
- Have *Bradyrrhoa gilveolella* established at four locations
- Difficult to collect in the field
  - Sex ratios
  - Biology of the moth

Genetic population structure of rush skeletonweed populations in the western U.S.

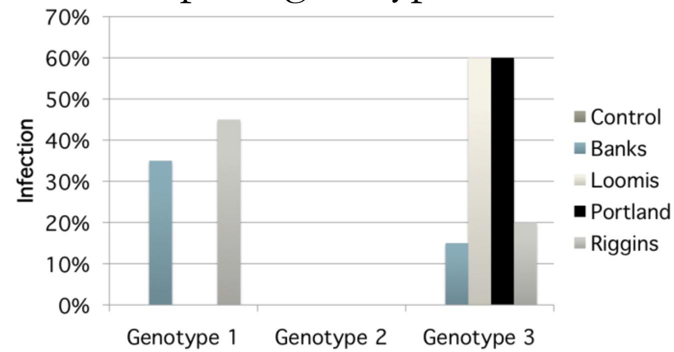
- Genotype 2 (blue) is the least widely distributed genotype
- It is also the most resistant genotype
- Gaskin et al. 2013

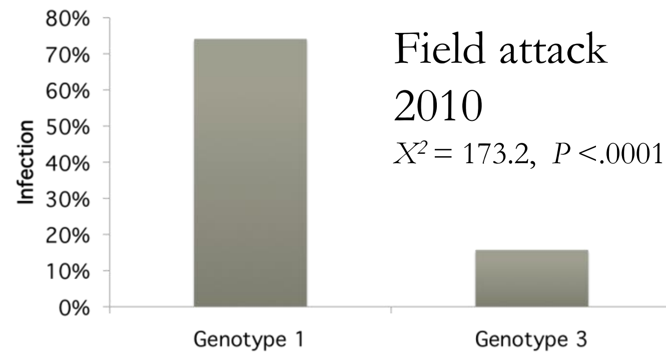


Puccinia chondrillina

- Field surveys 2008-2010 to assess attack rates in the field
- Genotype 3 suffers much more attack than genotype 1
- Resistance of skeletonweed to rust studied 2010-2012
- There is differential resistance of genotypes 1 and 3
- Genotype 2 is totally resistant

Resistance to rust by plant genotype









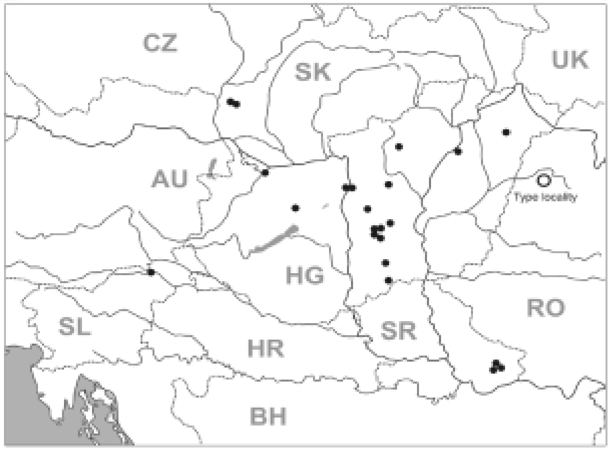
Schinia cognata: flower bud moth

- Studied by Dr. Jeff Littlefield (MSU)
- Noctuid moth
- Caterpillars feed on flower buds and flowers
- Reduces seed production of rush skeletonweed
- Host specificity studies underway at MSU
- Not biotype specific



Oporopsamma wertheimsteini: root crown moth

- Dr. Jeff Littlefield (MSU) and Dr. Justin Runyan (USFS)
- Very damaging root crown mining caterpillar
- Currently studied at Montana State University for biology, host-specificity
- Work will continue in 2015



Sphenoptera faveola: stem mining buprestid beetle

- Very rare insect
- Buprestid requires larger plants for development
- Populations identified in Kazakhstan and Russia
- University of Idaho, BLM, Collaborators in Italy and Russia will study biology and propagation techniques
- Host-specificity testing next

Implications – Rush Skeletonweed

1. Current biological control agents (mite and rust) may have some impact but do not limit the invasiveness of rush skeletonweed

   Problems with parasitism and host plant resistance

2. Rush skeletonweed management relies on biological control

3. New candidate species, given sufficiently host-specific, provide excellent outlook to successfully and sustainable manage skeletonweed

Biological control of Russian olive

NEW PROJECT

Project scientists:

Urs Schaffner (CABI),
in collaboration with
Massimo Cristofaro (BBCA)

Funded by in 2014:

- Wyoming Biological Control Steering Committee
- Montana Weed Trust Fund through MSU

Consortium chair:

Lars Baker (Wyoming)

Biological control of Oxeye daisy

NEW PROJECT

Project scientists:

Sonja Stutz (PhD student) and
Urs Schaffner

Funded by in 2014:

- Ministry of Forests, Land and Natural Resource Operations , British Columbia
- Montana Weed Trust Fund through MSc
- USDA Forest Service

Biological control of common tansy

Project scientists:
André Gassmann
Ivo Toševski

Funded by in 2014:

Common tansy Consortium of
Canadian and U.S. partners lead by:

- Alec McClay (McClay Ecoscience)
- Jeff Littlefield (Montana State University)

Idaho's Strategic Plan

- Mission statement:

  "To facilitate the meaningful incorporation of biological control into long term integrated weed management throughout the state of Idaho."

  - Goal 1 – Coordination
  - Goal 2 – Technology Development
  - Goal 3 – Education and Outreach
  - Goal 4 – Capacity Building
  - Goal 5 – Evaluation and Assessment

Standardized Impact Monitoring Protocol (SIMP)

- Is biocontrol working?
- What agents are effective?
- How long does it take?
- How much does location matter?
- What kind of vegetation moves in if the target weed moves out?

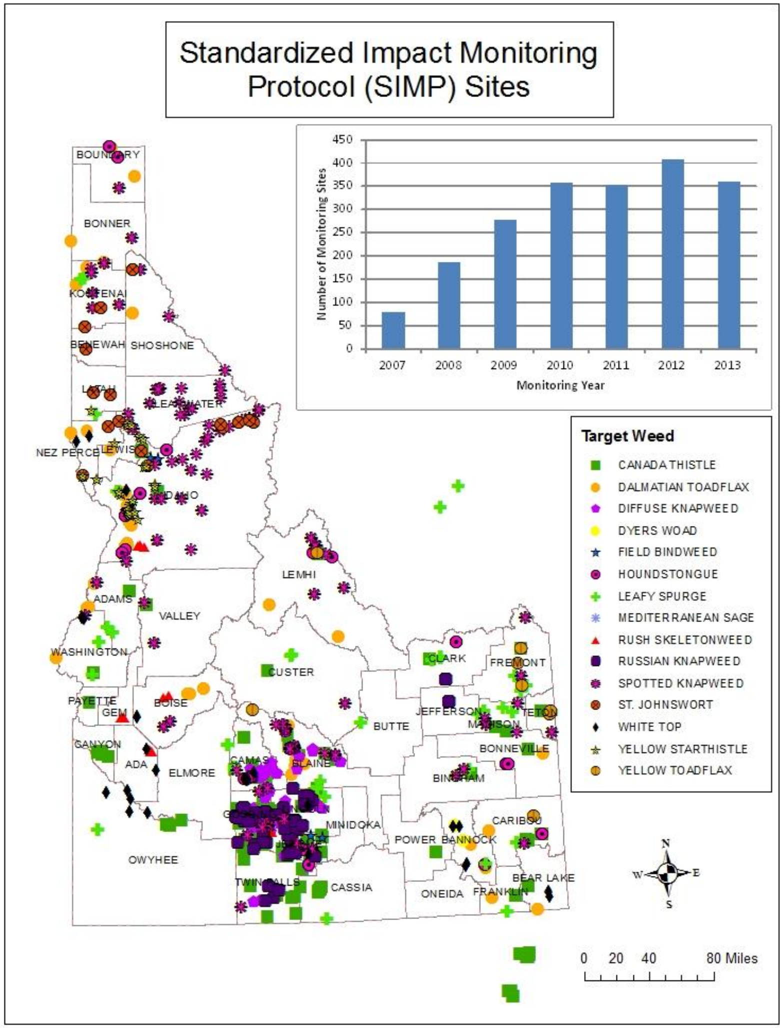
Standardized Impact Monitoring Protocol (SIMP)

- 2-pagers
  - Documents outlining the process
- Monitoring forms
  - 30-45 minutes once per year
- Many cooperators
- Minor tweaks

Idaho's Biological Control Program

- Program began in 2006
- Initiated the Standardized Impact Monitoring Protocol (SIMP)
  - 2007 – 80 sites
  - 2014 – 367 sites

    (still compiling 2015 data)
- Currently over 1,100 sites in the US
  - Other countries are using it too



Standardized **I**mpact **M**onitoring **P**rotocol (SIMP)

Objectives

1. To collect on a regional scale robust data over time documenting the efficacy (or lack thereof) of biological weed control
2. To do so using a simple and fast protocol that allows involvement of constituents and citizen scientists

Standardized Impact Monitoring Protocol (SIMP)

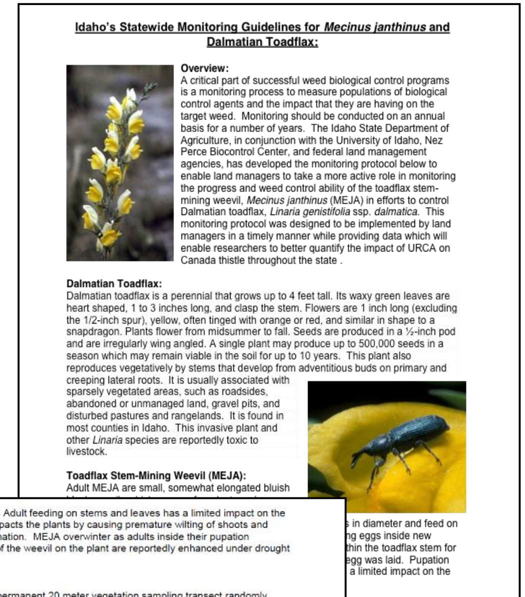
Who came up with it?

In 2006, a small group representing the BLM, USFS, Nez Perce Biocontrol Center and the University of Idaho met in Moscow, to develop the monitoring protocol.

Standardized Impact Monitoring Protocol (SIMP)

Approach

- User-friendly protocol
  - (Educational 2-page leaflets)
  - Google "BLM Biological Control"
- 45 minute time requirement
- Once per year
- Training workshops



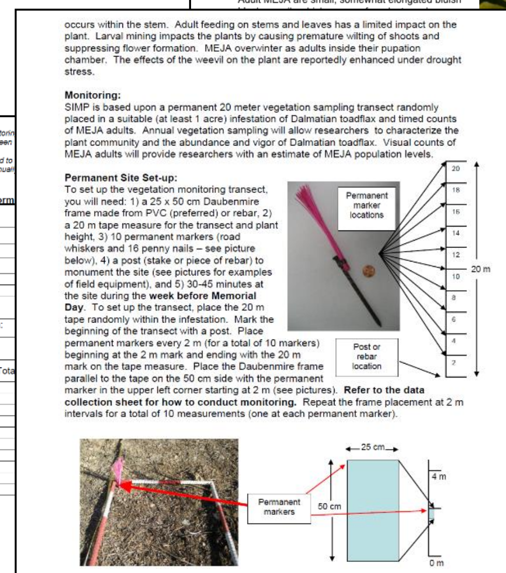
Idaho's Statewide Monitoring Guidelines for *Mecinus janthinus* and Dalmatian Toadflax:

Overview:
A critical part of successful weed biological control programs is a monitoring process to measure populations of biological control agents and the impact that they are having on the target weed. Monitoring should be conducted on an annual basis for a number of years. The Idaho State Department of Agriculture, in conjunction with the University of Idaho, Nez Perce Biocontrol Center, and federal land management agencies, has developed the monitoring protocol below to enable land managers to take a more active role in monitoring the progress and weed control ability of the toadflax stem-mining weevil, *Mecinus janthinus* (MEJA) in efforts to control Dalmatian toadflax, *Linaria genistifolia* ssp. *dalmatica*. This monitoring protocol was designed to be implemented by land managers in a timely manner while providing data which will enable researchers to better quantify the impact of URCA on Canada thistle throughout the state .

Dalmatian Toadflax:
Dalmatian toadflax is a perennial that grows up to 4 feet tall. Its waxy green leaves are heart shaped, 1 to 3 inches long, and clasp the stem. Flowers are 1 inch long (excluding the 1/2-inch spur), yellow, often tinged with orange or red, and similar in shape to a snapdragon. Plants flower from midsummer to fall. Seeds are produced in a ½-inch pod and are irregularly wing angled. A single plant may produce up to 500,000 seeds in a season which may remain viable in the soil for up to 10 years. This plant also reproduces vegetatively by stems that develop from adventitious buds on primary and creeping lateral roots. It is usually associated with sparsely vegetated areas, such as roadsides, abandoned or unmanaged land, gravel pits, and disturbed pastures and rangelands. It is found in most counties in Idaho. This invasive plant and other *Linaria* species are reportedly toxic to livestock.

Toadflax Stem-Mining Weevil (MEJA):
Adult MEJA are small, somewhat elongated bluish

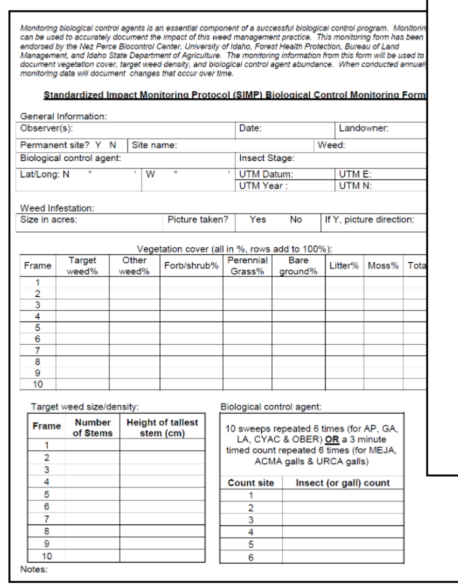
…s in diameter and feed on …ng eggs inside new …thin the toadflax stem for …egg was laid. Pupation … a limited impact on the



occurs within the stem. Adult feeding on stems and leaves has a limited impact on the plant. Larval mining impacts the plants by causing premature wilting of shoots and suppressing flower formation. MEJA overwinter as adults inside their pupation chamber. The effects of the weevil on the plant are reportedly enhanced under drought stress.

Monitoring:
SIMP is based upon a permanent 20 meter vegetation sampling transect randomly placed in a suitable (at least 1 acre) infestation of Dalmatian toadflax and timed counts of MEJA adults. Annual vegetation sampling will allow researchers to characterize the plant community and the abundance and vigor of Dalmatian toadflax. Visual counts of MEJA adults will provide researchers with an estimate of MEJA population levels.

Permanent Site Set-up:
To set up the vegetation monitoring transect, you will need: 1) a 25 x 50 cm Daubenmire frame made from PVC (preferred) or rebar, 2) a 20 m tape measure for the transect and plant height, 3) 10 permanent markers (road whiskers and 16 penny nails – see picture below), 4) a post (stake or piece of rebar) to monument the site (see pictures for examples of field equipment), and 5) 30-45 minutes at the site during the **week before Memorial Day**. To set up the transect, place the 20 m tape randomly within the infestation. Mark the beginning of the transect with a post. Place permanent markers every 2 m (for a total of 10 markers) beginning at the 2 m mark and ending with the 20 m mark on the tape measure. Place the Daubenmire frame parallel to the tape on the 50 cm side with the permanent marker in the upper left corner starting at 2 m (see pictures). **Refer to the data collection sheet for how to conduct monitoring.** Repeat the frame placement at 2 m intervals for a total of 10 measurements (one at each permanent marker).



Monitoring biological control agents is an essential component of a successful biological control program. Monitorin… can be used to accurately document the impact of this weed management practice. This monitoring form has been … endorsed by the Nez Perce Biocontrol Center, University of Idaho, Forest Health Protection, Bureau of Land Management, and Idaho State Department of Agriculture. The monitoring information from this form will be used to … document vegetation cover, target weed density, and biological control agent abundance. When conducted annuall… monitoring data will document changes that occur over time.

Standardized Impact Monitoring Protocol (SIMP) Biological Control Monitoring Form

General Information:

Observer(s):	Date:	Landowner:
Permanent site? Y N / Site name:		Weed:
Biological control agent:	Insect Stage:	
Lat/Long: N ° ' / W ° '	UTM Datum: / UTM Year :	UTM E: / UTM N:

Weed Infestation:

Size in acres:	Picture taken?	Yes No	If Y, picture direction:

Vegetation cover (all in %, rows add to 100%):

Frame	Target weed%	Other weed%	Forb/shrub%	Perennial Grass%	Bare ground%	Litter%	Moss%	Tota…
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Target weed size/density:

Frame	Number of Stems	Height of tallest stem (cm)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Biological control agent:

10 sweeps repeated 6 times (for AP, GA, LA, CYAC & OBER) **OR** a 3 minute timed count repeated 6 times (for MEJA, ACMA galls & URCA galls)

Count site	Insect (or gall) count
1	
2	
3	
4	
5	
6	

Notes:

SIMP as a post-release analysis tool

- Provides evidence of biocontrol impact
  - Long-term
  - Varying scales (local to regional)
- Evaluation of other environmental factors (e.g. plant community composition, precipitation, elevation) affecting weed
  - What other factors influence weed dynamics?
  - Is impact locally variable?
  - Are changes desirable?
- Enhance integrated weed management
  - Improve understanding of biocontrol whether or not it is working & adapt release strategies and control measures accordingly

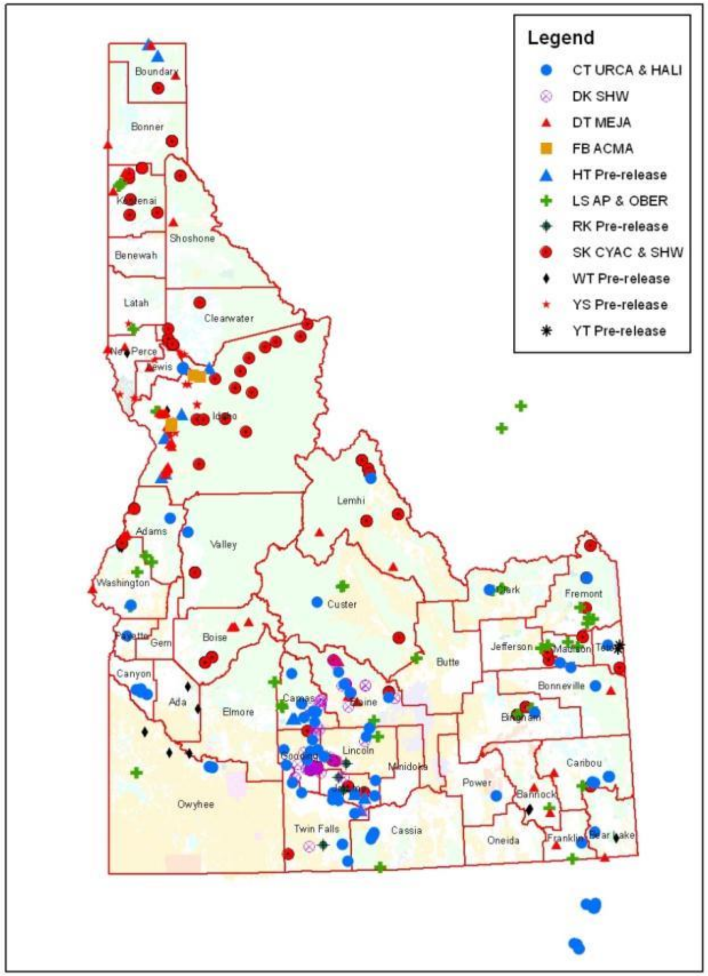
Standardized Impact Monitoring Protocol (SIMP)

Currently monitored 'biocontrol systems'

1. Canada thistle and *Hadroplantus litura /Urophora cardui*
2. Dalmatian toadflax and *Mecinus janthiniformis*
3. Diffuse knapweed and *Larinus* spp.
4. Field Bindweed and *Aceria malherbae*
5. Leafy spurge and *Aphthona* spp./*Oberea erythrocephala*
6. Russian knapweed and *Jaapiella ivannikovi/Aulacidea acroptilonica*
7. Spotted knapweed and *Cyphocleonus achates/ Larinus* spp.
8. Yellow toadflax and *Mecinus janthinus*

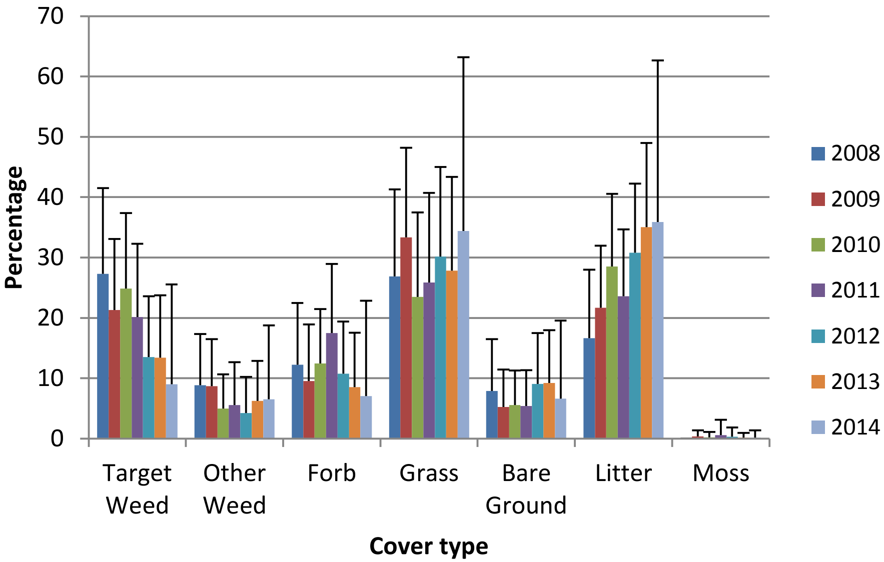
Pre-release monitoring systems:

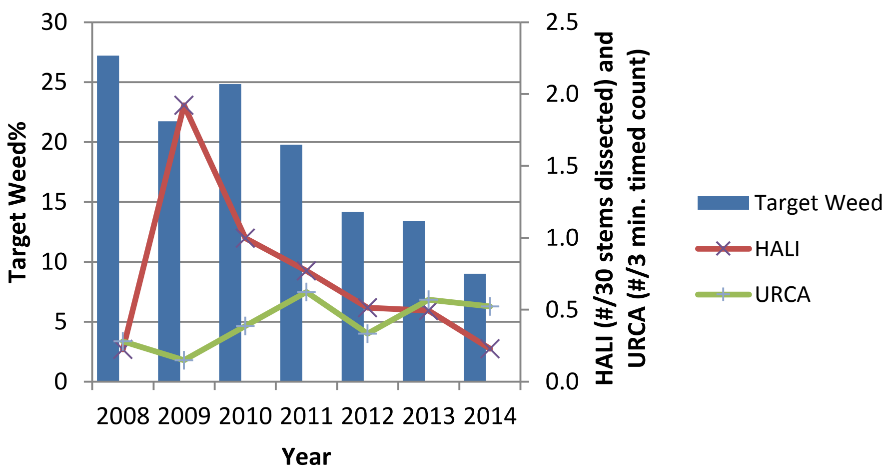
1. Dyer's Woad
2. Houndstongue
3. Hoary Cress/White top
4. Yellow starthistle



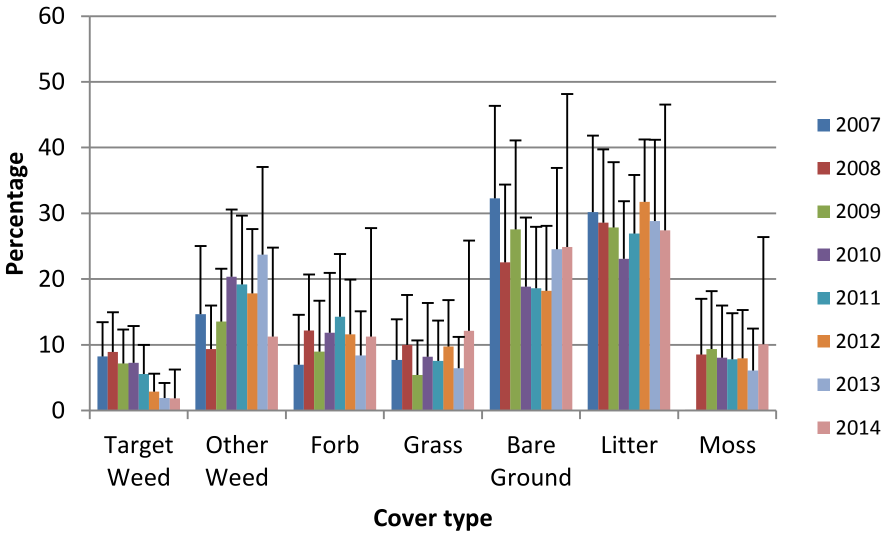
Results

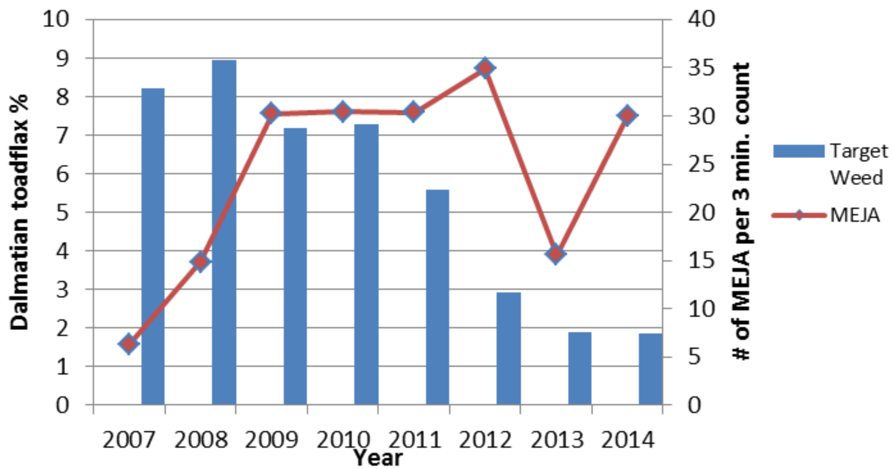
Canada Thistle





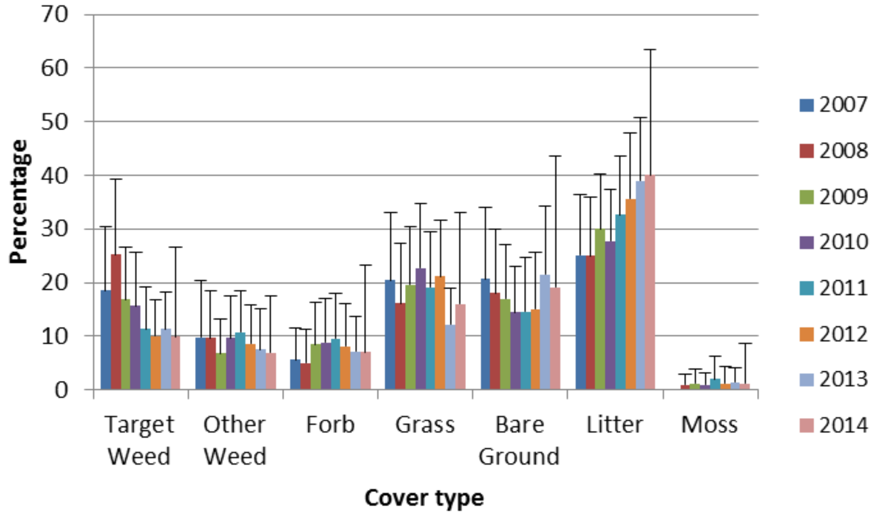
Dalmatian Toadflax

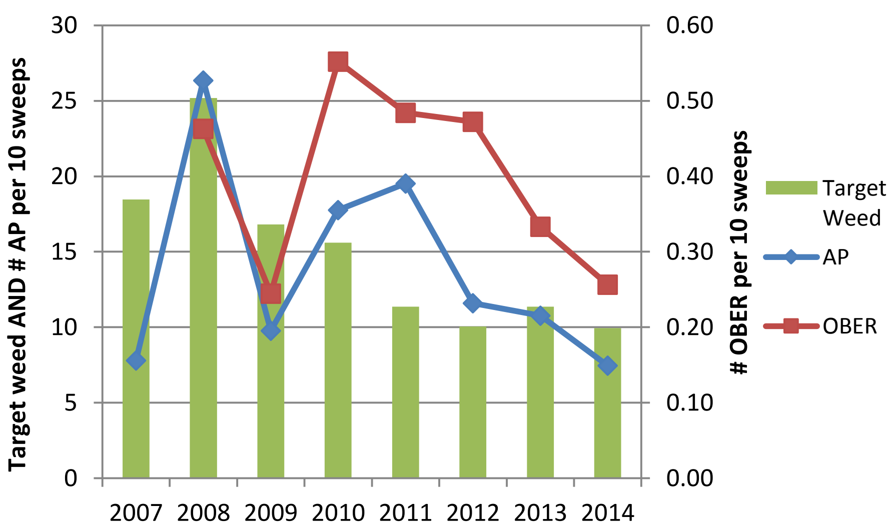




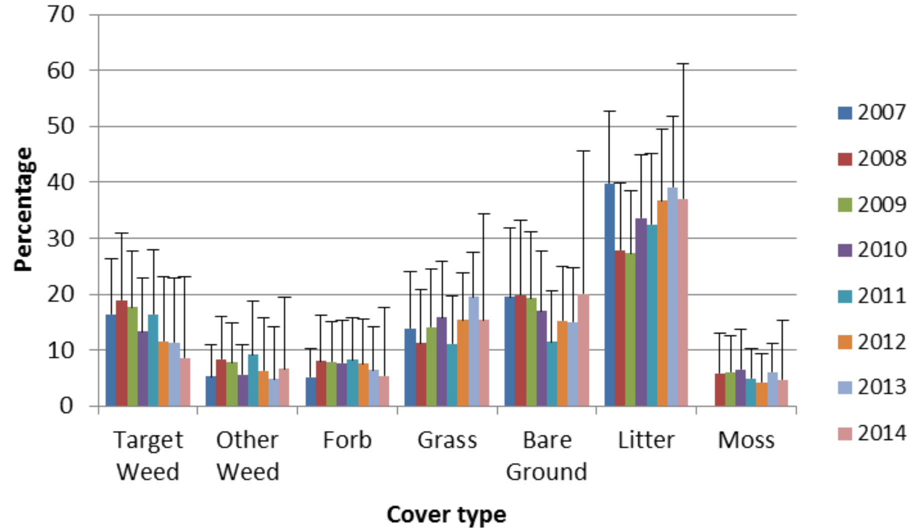
Results

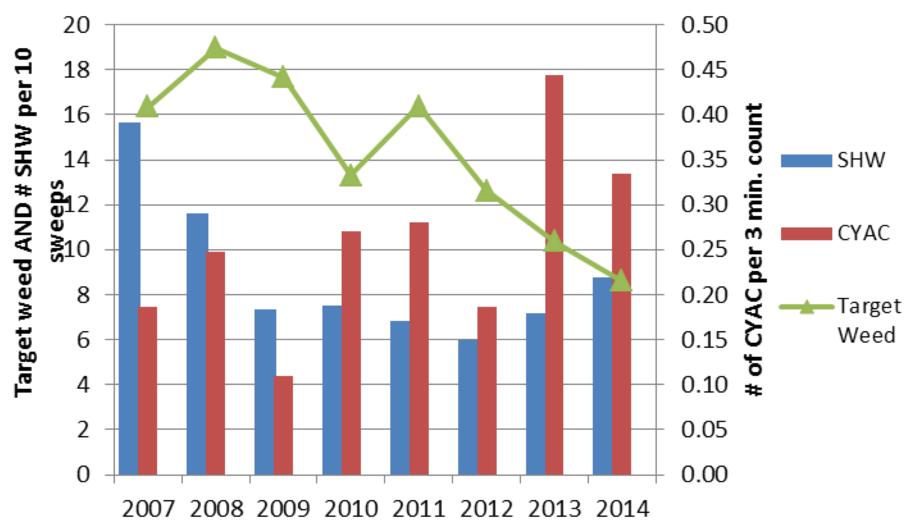
Leafy Spurge





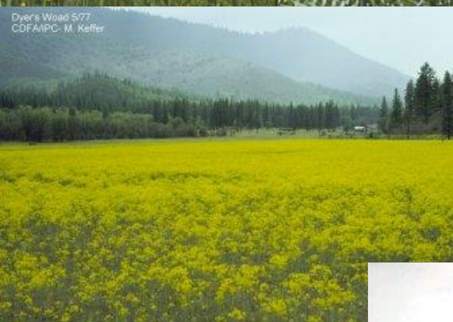
Spotted Knapweed





Monitoring New Agents

- Apply the protocol to new agents that have recently been released or are currently being petitioned for release
- Baseline data
- Insure data collection on an annual basis



Common tansy (left) and tansy ragwort (right) flowers

- *Acroptilon repens*, Russian knapweed
- *Alliaria petiolata*, Garlic mustard
- *Centaurea solstitialis*, Yellow starthistle
- *Crupina vulgaris*, Common crupina
- *Cynoglossum officinale*, Houndstongue
- *Elaeagnus angustifolia*, Russian olive
- *Hieracium* spp., Hawkweeds
- *Isatis tinctoria*, Dyer's woad
- *Leucanthemum vulgare*, Oxeye daisy
- *Lepidium draba*, Hoary cress
- *Lepidium latifolium*, Perennial pepperweed
- *Linaria* spp., Toadflaxes
- *Phragmites australis*, Common reed
- *Potentilla recta*, Sulphur Cinquefoil
- *Senecio jacobaea*, Tansy ragwort
- *Solsola tragus*, Russian thistle
- *Tanacetum vulgare*, Common Tansy

Web Page

- BLM/ISDA's website:
  - Currently being updated
  - Biocontrol do's and don'ts
  - Idaho's Strategic Plan for Biological Control of Noxious and Invasive Weeds
  - All 2-pagers, monitoring forms
  - Agent-specific information regarding collecting, impacts, and optimal release habitats
  - Google "BLM Biological control"

Questions?

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