Why Do We Have Weeds Anyway?

Invasive Species – Where Managed Lands and Natural Areas Get together

Roger Becker
University of Minnesota
Wild World of Weeds
FargoDome, Jan. 22, 2019

UNIVERSITY OF MINNESOTA
EXTENSION

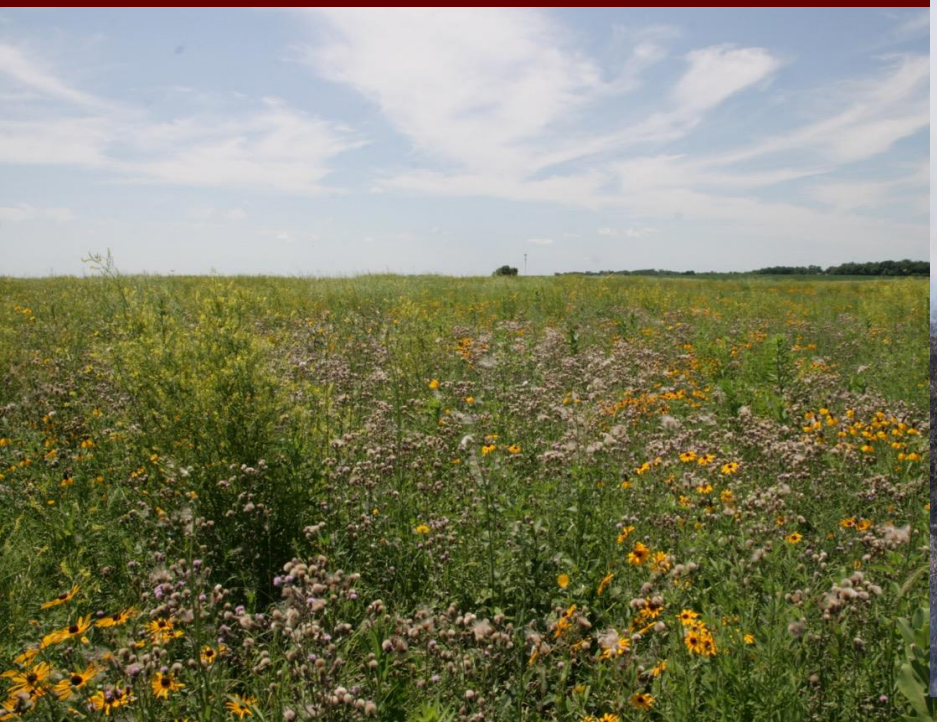
Homesteading Family 1886

http://www.usdakotawar.org/history/multimedia/homesteading-family

Historically, Species Shift

Burning

- Tall grass prairies
  - Non-woody, warm season species



USFWS https://commons.wikimedia.org/wiki/File:Bison_herd_grazing.jpg

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Amenia and Sharon Land Company

Figure 38. Amenia and Sharon Land Company, Cass County, North Dakota. *(Institute for Regional Studies, NDSU, 0005.05.01)*

Figure 39. U.S. postage stamp showing the Amenia and Sharon Land Company. *(Bureau of Engraving, #286 2c, "Farming in the West")*

https://www.ndstudies.gov/gr4/early-settlement-north-dakota/section-3-bonanza-farming*)*

Historically, Species Shift

Tilling the prairies

- Field bindweed
  - Soon followed by Canada thistle
- Annual Bdlfs.

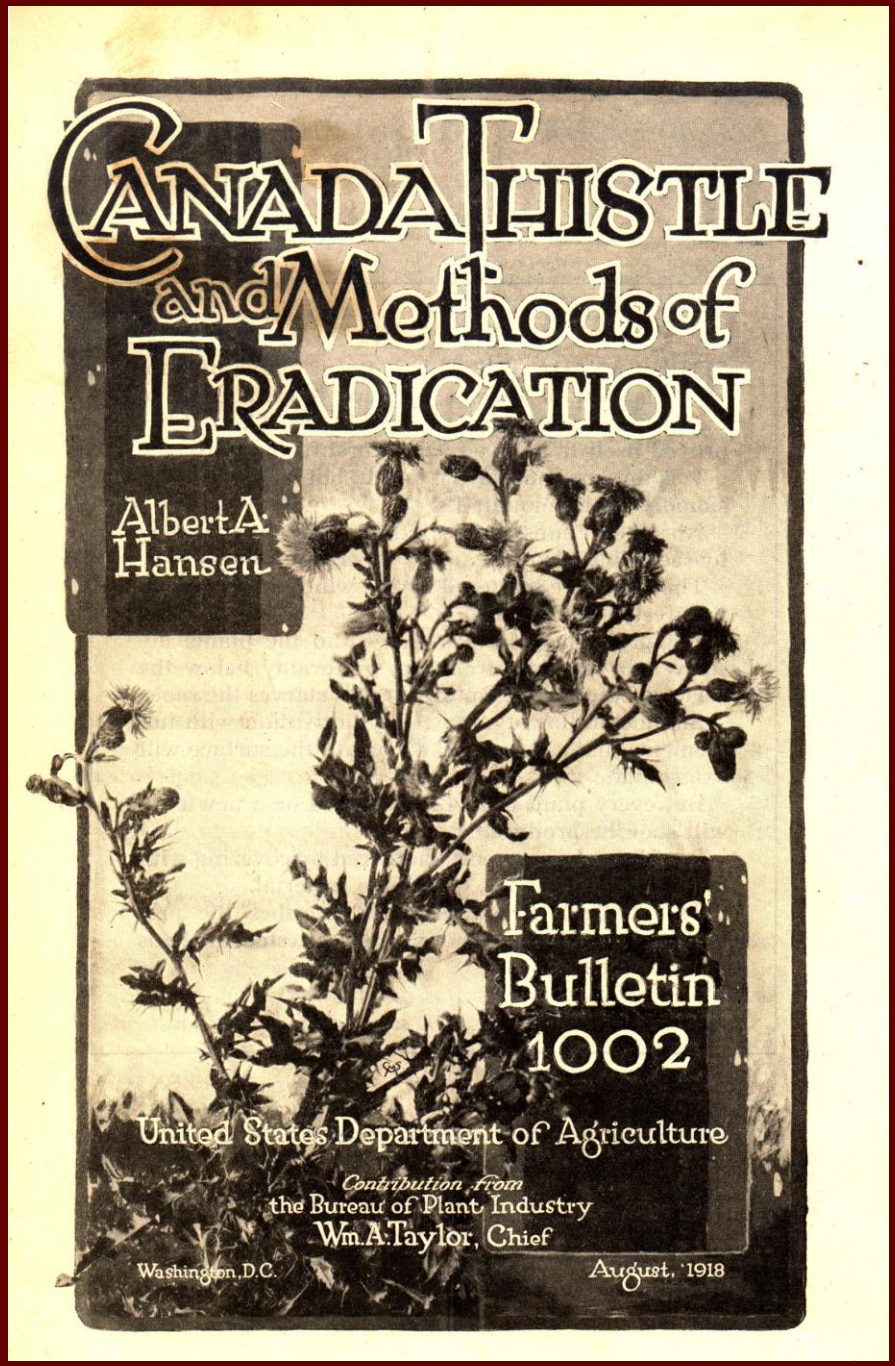
Field Bindweed

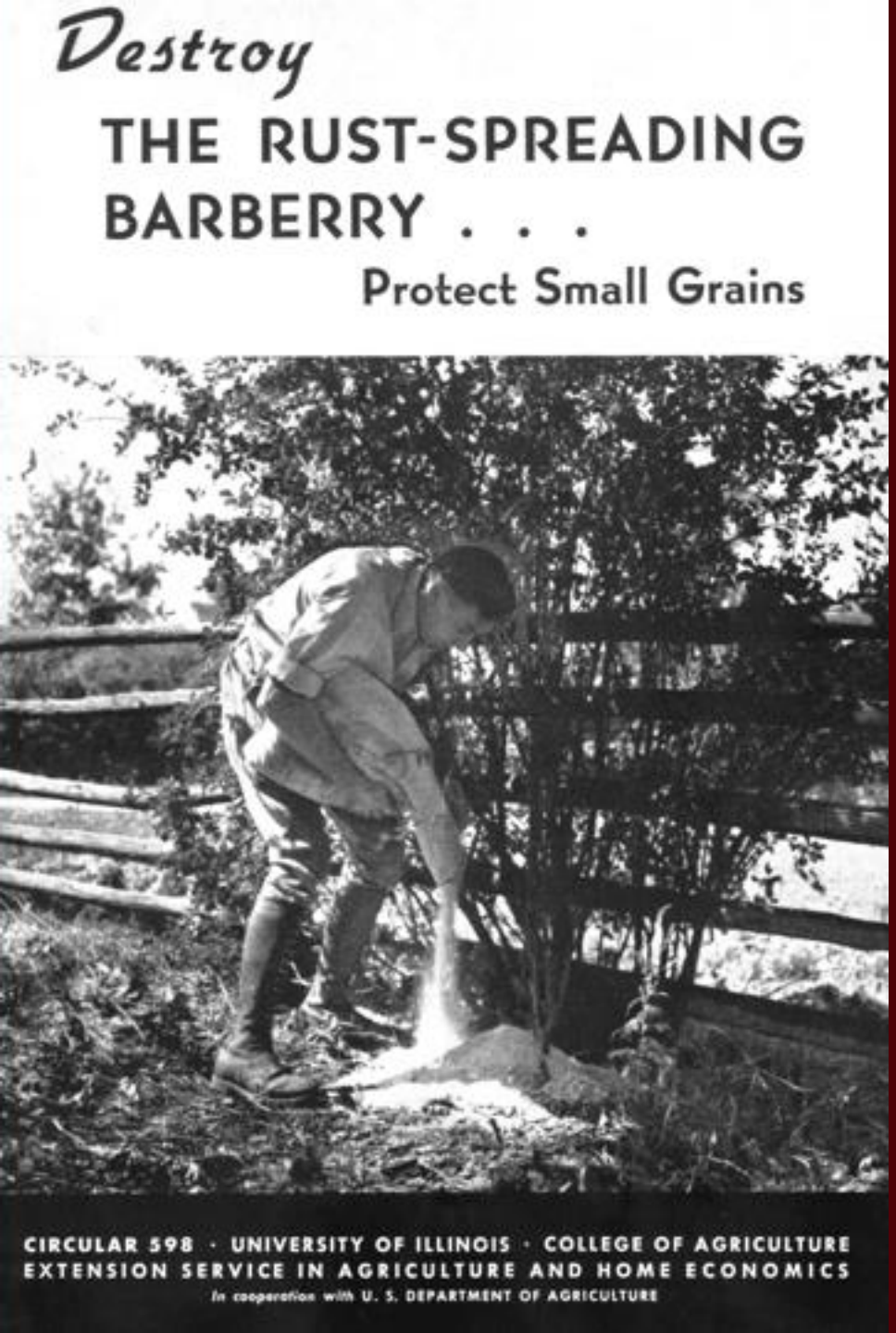
- First invasive plants in the upper Midwest
- Perennial thriving with LOTS of tillage
- Impetus for the first NCWCC (now NCWSS) Omaha, 1944

The Elusive Holy Grail of Weed Management

- **Eradication!**

Cirsium arvense





Did we really know what we were doing?

Becker, U of M

Historically, Species Shift

Herb. and fertilizer

- 2,4-D late 40s controlled Bdlfs
- Affordable N fert., Bdlfs controlled -> grasses 50's 60's
  - Triazines, acetanilides, thiocarbs, DNAs
  - controlled grasses (also bdlfs.)
    - Simazine, Atrazine / Randox, RandoxT / EPTC late 50s
    - Avedex, Fargo / Treflan / Lasso – 60s
    - Lorox, Lexone / Dual / Prowl, Cobex, Rydex, Tolban - 60s to 70s

Photo: Wolf, KState

Historically, Species Shift

- **Treflan + Sencor t.m. 70’s and 80’s**
  - **Eastern Black Nightshade**

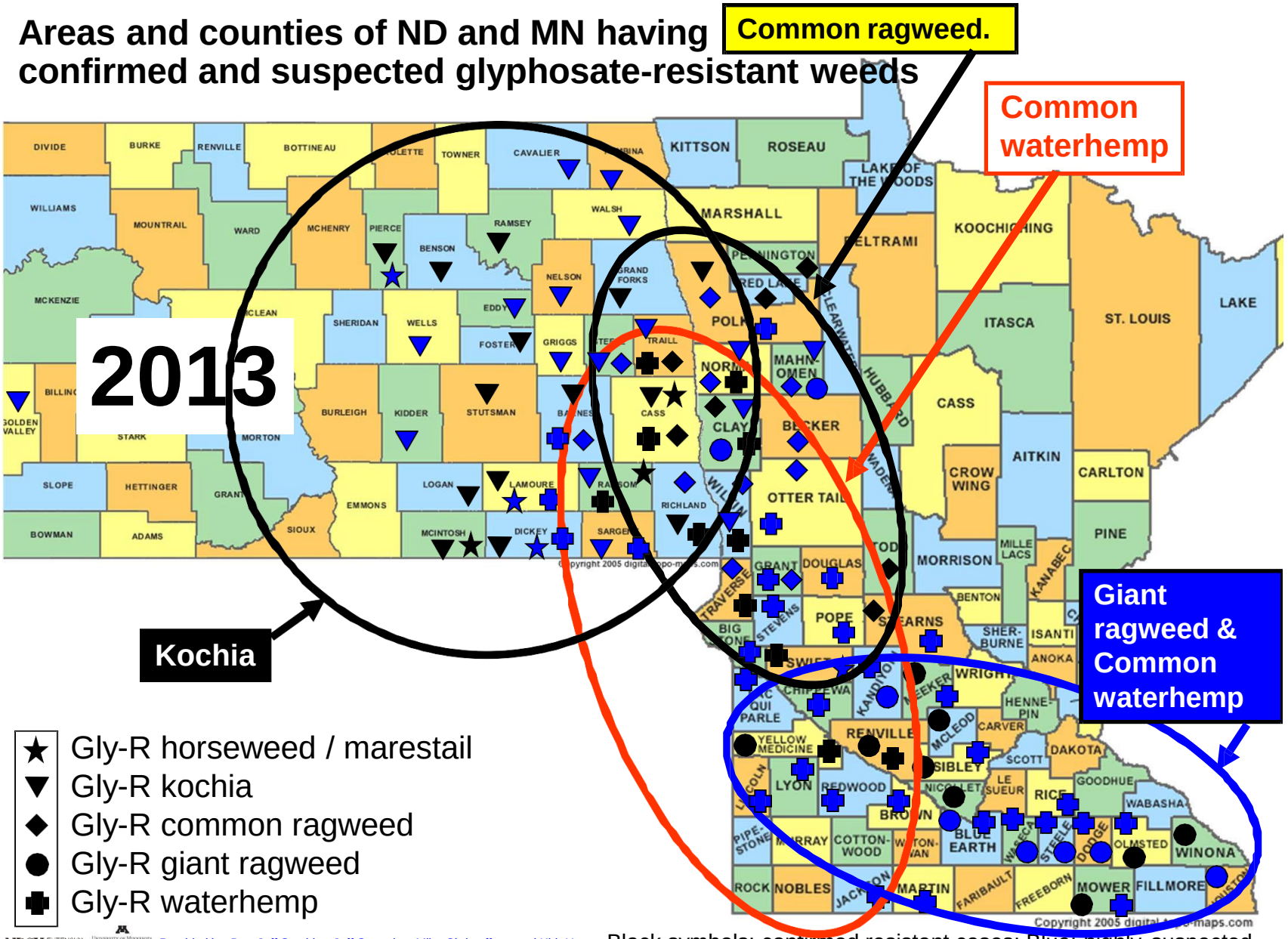
Image courtesy of MN Wildflowers
https://www.minnesotawildflowers.info/flower/black-nightshade

Historically, Species Shift

- **Imidazolinones, sulfonylureas 90's**
  - **Waterhemp**
- **Glyphosate 2000's**
  - **Waterhemp**
  - **Ragweeds**
  - **Mare's Tail**

Image courtesy of Jeff Gunsolus

Areas and counties of ND and MN having confirmed and suspected glyphosate-resistant weeds



NDSU EXTENSION SERVICE · UNIVERSITY OF MINNESOTA EXTENSION
Provided by: Drs. Jeff Stachler, Jeff Gunsolus, Mike Christoffers, and Kirk Howatt

Black symbols: confirmed resistant cases; Blue: highly suspected

Historically, Species Shift

The Post-Roundup Era

- Need for mixtures 2010's
  Rup POST
  - Numerous species resistant
  - Have shifted to warm season
    - Crabgrass
    - Lovegrass
    - Amaranth species
  - Residuals fb POST

It Takes a Village for Weeds Too!

What your neighbors do
DOES impact you

- **Roundup Ready world will shift the species you face in the non-GMO world**

Becker, U of M. 2005 MWFPA presentation.

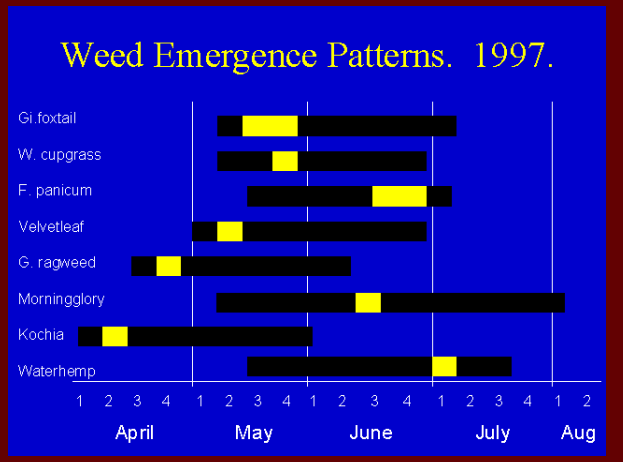
Evolution of Species Shift in Response to Continuous Practices

Adapted from Gunsolus, U Mn Weed Sci.

Historically, Species Shift

Periodicity

- **Phenology, Seed Maturation**
  - **Wild Proso Millet**
    - » matures before sweet corn



http://extension.agron.iastate.edu/weeds/mgmt/qtr97-4/weedemer.htm

- **Earlier planting dates -> cool species e.g. Giant foxtail, mustards, kochia**

- **Nonn-residual herbicides -> warm species**
  - **e.g. Crabgrass, Eragrostis, purslane, carpetweed**

Historically, Species Shift

- Rainy or droughty periods
  - Buttercups (wet)
  - Hoary alyssum (dry)
- Reduced or no tillage
  - small seeded species and perennials not adapted to tillage

Image courtesy of MN Wildflowers
https://www.minnesotawildflowers.info/flower/germander

Palmer and Waterhemp

Palmer

Native to the desert Southwest

Most competitive of the Amaranth sp.

Growth rate as fast as ~2.5”/day

http://www.extension.iastate.edu/CropNews/2013/0820hartzlerpope.htm

Waterhemp

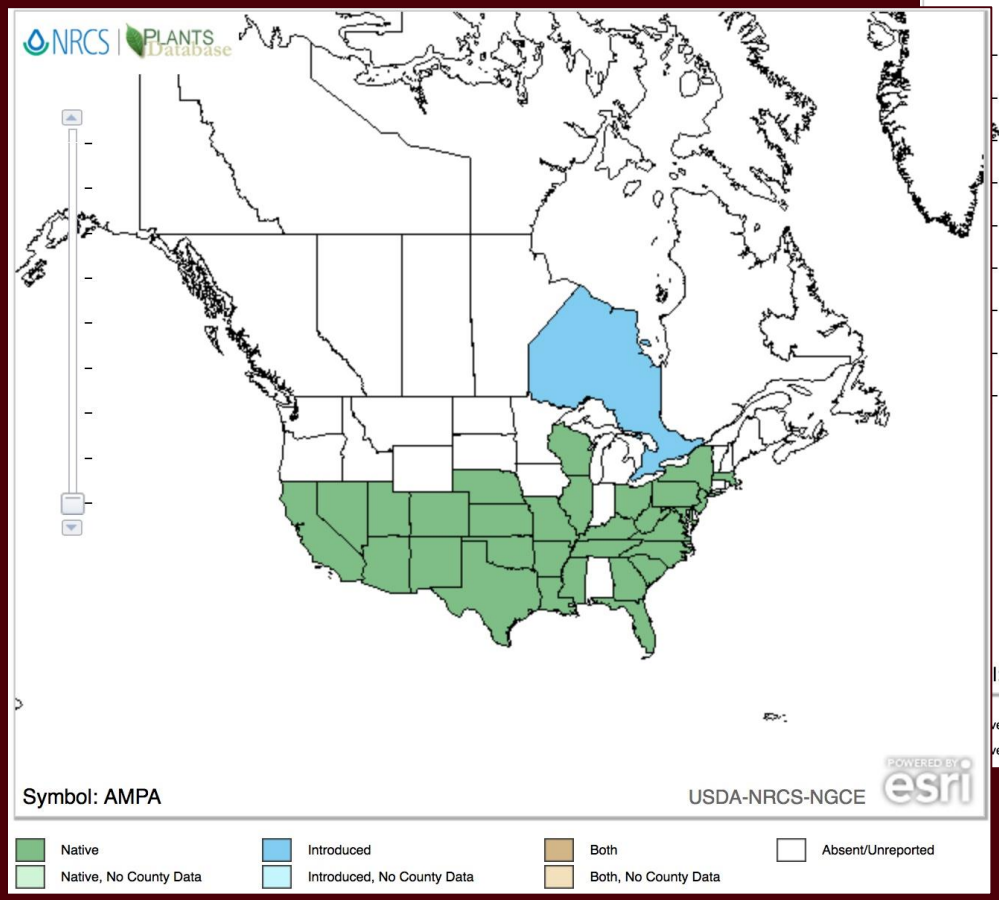
Native to the Midwest

2nd most competitive of the Amaranth sp.

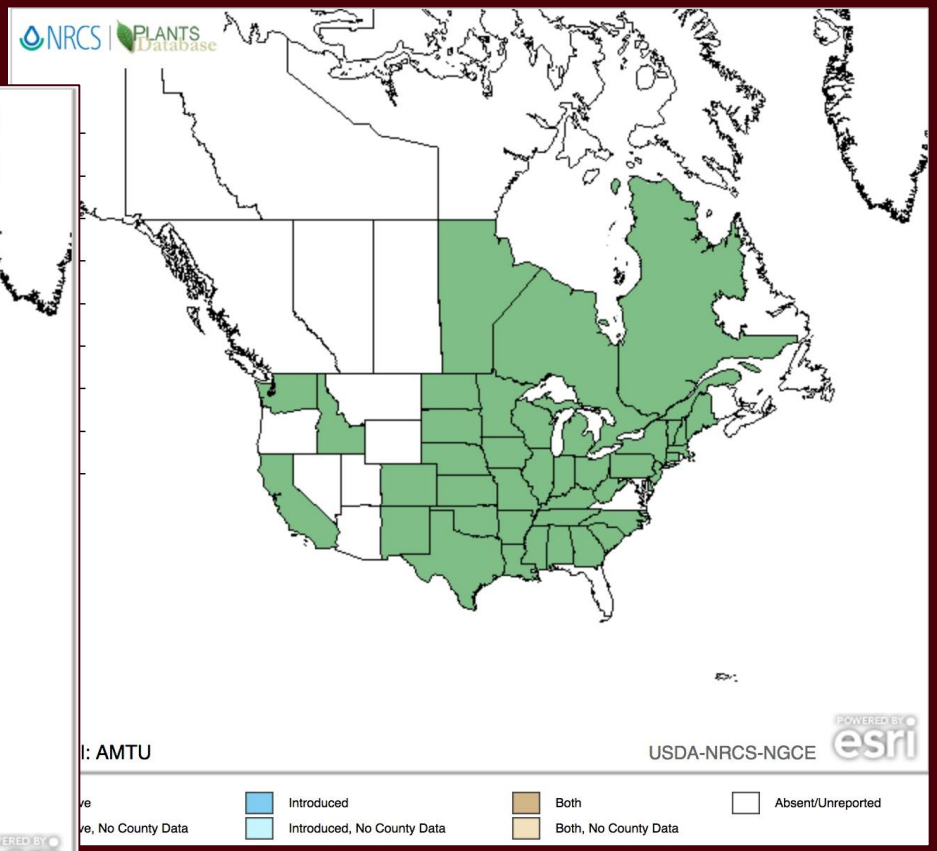
Growth rate as fast as ~1.75”/day

http://southeastfarmpress.com/management/waterhemp-showing-greater-resistance-glyphosate

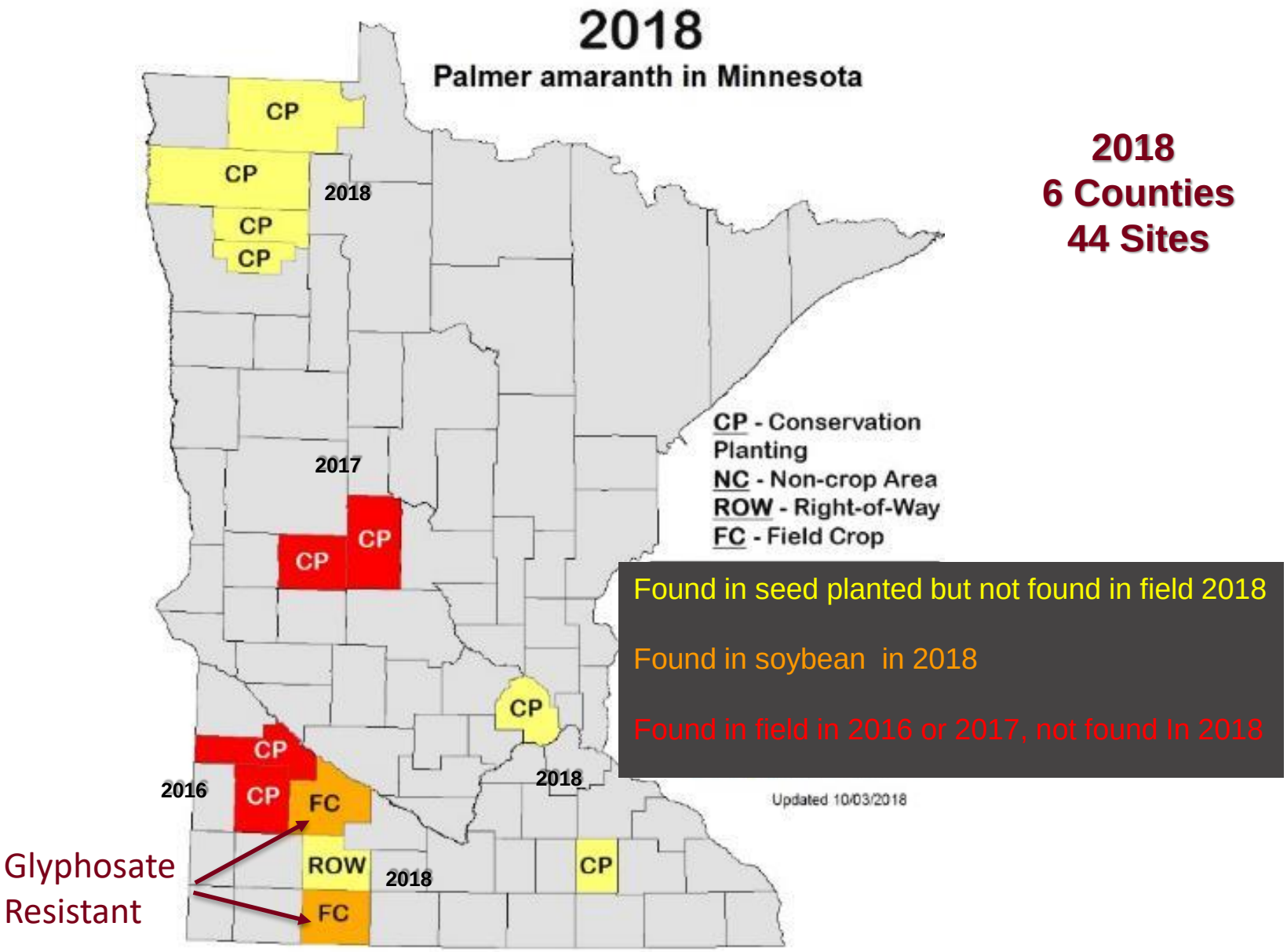
Palmer Amaranth



Tall Waterhemp



http://plants.usda.gov/



2018
6 Counties
44 Sites

Zero Tolerance Approach!

Iowa farmer has established a network of neighbors and other volunteers to help pull Palmer plants, pile and burn them

Bob Hartzler
IOWA STATE UNIVERSITY
Extension and Outreach

Weed Management- the basics

- There is a weed for every occasion
- There is a weed species that is adapted to your management, no matter what it is

Over-arching Weed Science Principles

- Weed ecology and biology basic to all systems
- Weed species cross over cropping boundaries (and land management)
- Perennial, biennial, or annual - disturbed or undisturbed - the same underlying principles apply

Weed Management- the basics

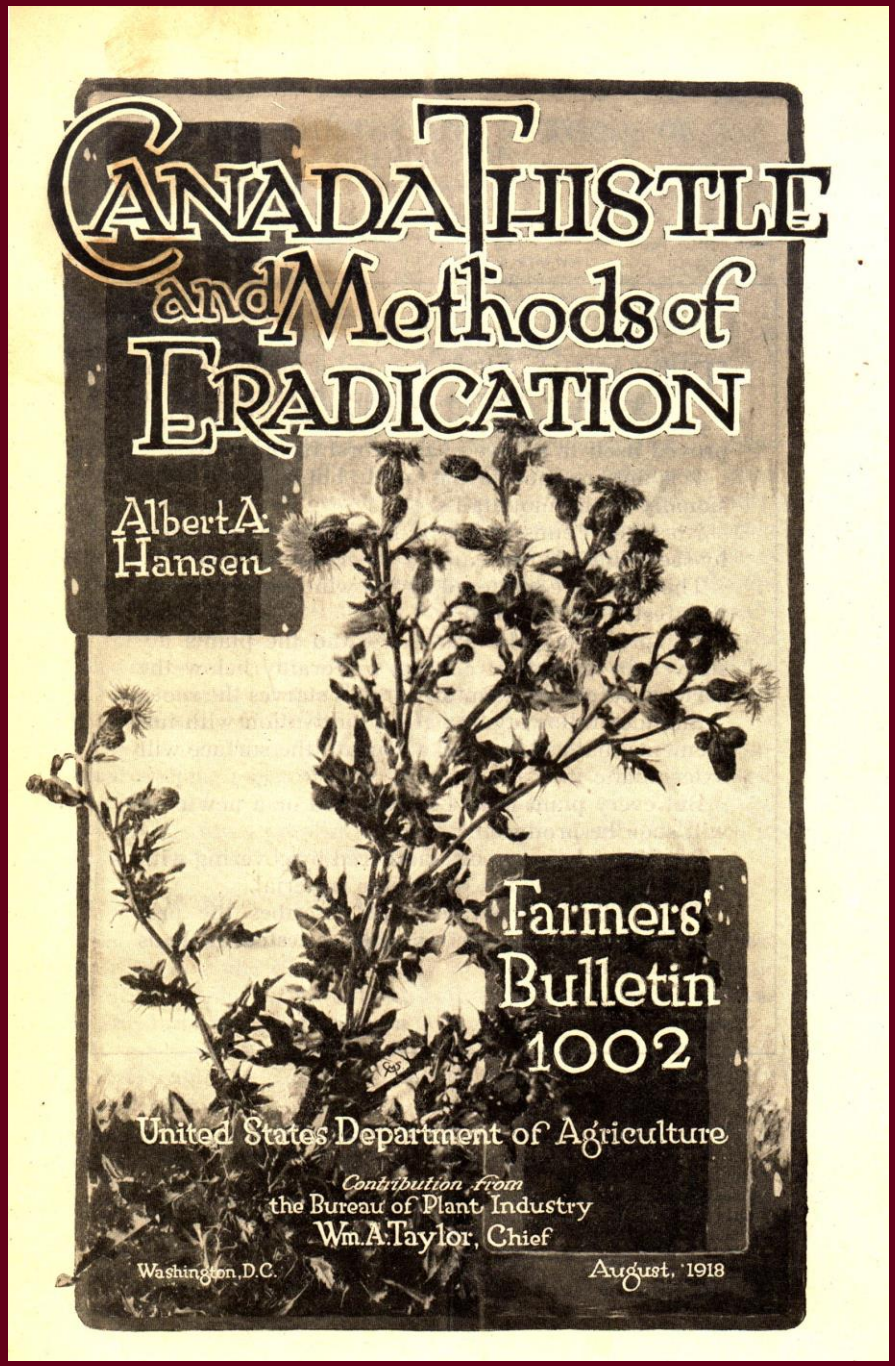
- Therefore, repeated use of the same management will result in a few species that are out of control
- Goal should be to get as many species as possible, but few of any one species
  - Means you are using diversified land management

The Elusive Holy Grail of Weed Management

It's still here…….

Focus on:

- Native forb tolerance to herbicides
- Seedings that resist invasion
- Dispersal
- Biological Control



Canada Thistle
- The Forb Tolerance Experience

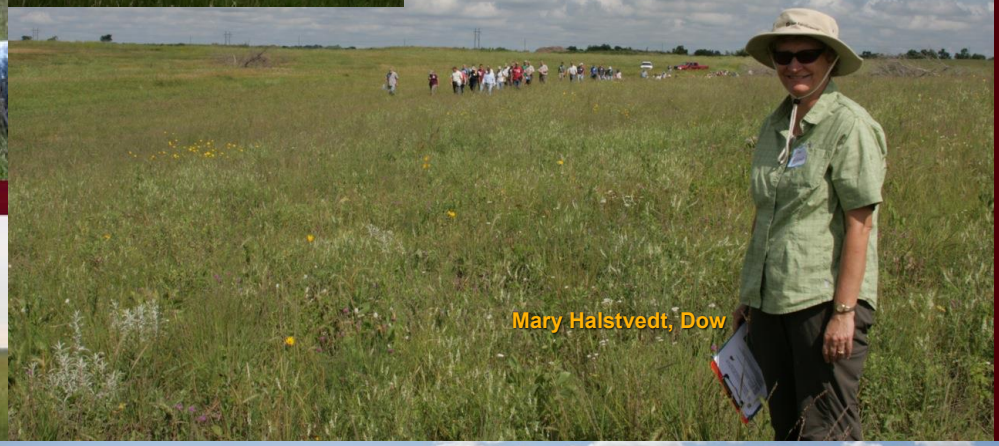
Forb plants entrench with age

- **2 Problem tracts - 7+ years old**
- **2 WMAs - 3rd year**
- **1 WMA - 2rd year juveniles**
- **6 renovation/conversions - 1st Year**

Two Rivers Forb Tolerance Site

Defining Tolerance of Native Forbs to Herbi

Kufrin WPS
2 yr. old stand



Hedquist Forb Tolerance Site

Transplanted Forb Tolerance Study

Sept 24, 2008 Trial Est. 2007

West Newton Sand Prairie
Kurt Brownell US Army Corp
Louanne Brooks, Dow AgroSciences

Cow vetch, *Vicia cracca*
Hairy vetch, *Vicia villosa*

University of Minnesota Extension

Forb Tolerance to Milestone

Species either missing or not flowering 1 year after treatment

Yellow Prairie Coneflower
Black-eyed Susan
Sunflowers

June 2, 2010 Kufrin WPA. Milestone 3 and 5 oz/A 1 YAT.

In new restorations that are likely to be prone to Canada thistle invasion, consider planting forbs that are more tolerant to Milestone®

Common Name	Family	Genus	Species	1 YAT	2 YAT
Golden Alexanders	Apiaceae	*Zizia*	*aurea*	T	T
Heart-leaved alexanders	Apiaceae	*Zizia*	*aptera*	T	NA
Nine-leaf lomatium	Apiaceae	*Lomatium*	*triternatum*	MT	T
Wyeth's biscuitroot	Apiaceae	*Lomatium*	*ambiguum*	T	T
Spreading dogbane	Apocynaceae	*Apocynum*	*androsaemifolium*	T	T
Common milkweed	Asclepiadaceae	*Asclepias*	*syriaca*	T	T
Arrowleaf balsamroot	Asteraceae	*Balsamorhiza*	*sagittata*	MS	MT
Black-eyed Susan	Asteraceae	*Rudbeckia*	*hirta*	S	NA
Blanket flower	Asteraceae	*Gaillardia*	*aristata*	MT	T
Canada goldenrod	Asteraceae	*Solidago*	*canadensis*	MS	MS
cudweed sage	Asteraceae	*Artemesia*	*ludoviciana*	T	T
Cup plant	Asteraceae	*Silphium*	*perfoliatum*	MT	NA
Daisy fleabane	Asteraceae	*Erigeron*	*strigosus*	MT	NA
Gay feather	Asteraceae	*Liatris*	*punctata*	T	T
Giant goldenrod	Asteraceae	*Solidago*	*gigantea*	MT	NA
Giant sunflower	Asteraceae	*Helianthus*	*giganteus*	S	MS
Gumweed	Asteraceae	*Grindelia*	*squarrosa*	MS	MT
Hairy golden aster	Asteraceae	*Chrysopsis*	*villosa*	MT	T
Heath aster	Asteraceae	*Aster*	*ericoides*	MT	NA
Hound's tongue hawkweed	Asteraceae	*Hieracium*	*cynoglossoides*	MT	MT
Little sunflower	Asteraceae	*Helianthus*	*pumilus*	MT	MT
Maximilian sunflower	Asteraceae	*Helianthus*	*maximiliani*	S	S
Missouri goldenrod	Asteraceae	*Solidago*	*missouriensis*	MT	T
Nuttall's pussy-toes	Asteraceae	*Antennaria*	*parviflora*	MS	MT
Orange arnica	Asteraceae	*Arnica*	*fulgens*	S	S
Panicled aster	Asteraceae	*Aster*	*lanceolatum*	MT	NA
Prairie blazingstar	Asteraceae	*Liatris*	*aspera*	MT	NA
Prairie goldenrod	Asteraceae	*Solidago*	*missouriensis*	MS	MT
Prairie sunflower	Asteraceae	*Helianthus*	*pauciflorus*	MS	NA
Rosy pussy-toes	Asteraceae	*Antennaria*	*microphylla*	MT	T
Shaggy fleabane	Asteraceae	*Erigeron*	*pumulis*	MT	T
Smooth Blue aster	Asteraceae	*Aster*	*laeve*	MT	NA
Stiff goldenrod	Asteraceae	*Solidago*	*rigida*	MT	NA

Comparison of % Cover of Each Botanical Group at Different Canada Thistle Infestation Levels

Put it in the bank

- Most native forb species survive
  - Will interrupt flowering so looks can be deceiving
- They will come back
- Canth and native forbs duke it out

Canada thistle seed flight


Becker U of Mn 2006©
University of Minnesota
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Male Flower

Female Flower

Seeds to Seedlings

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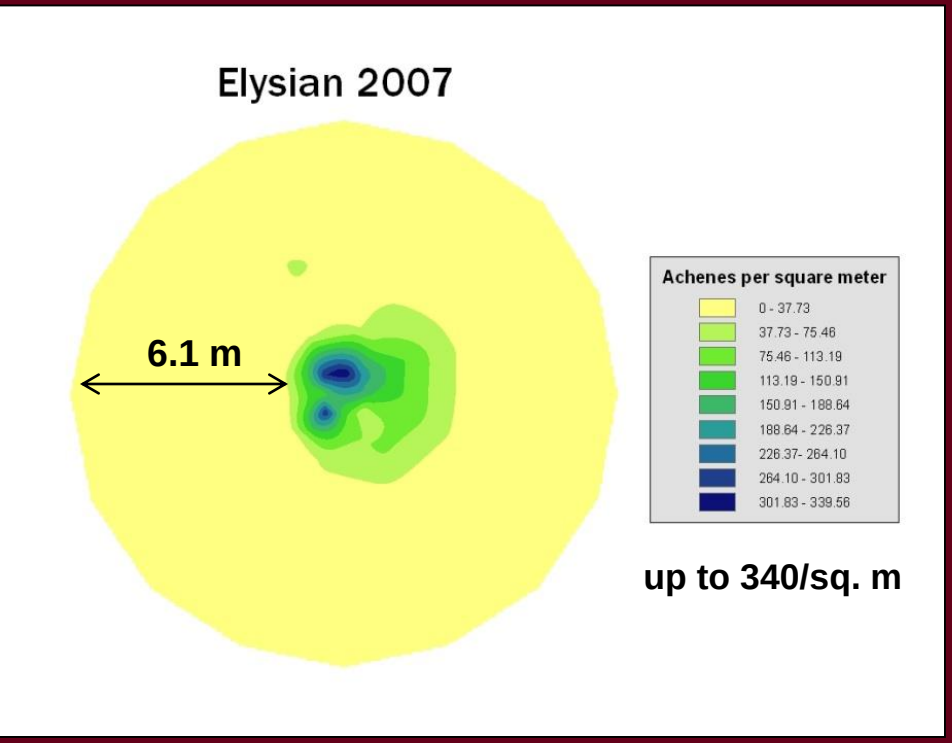
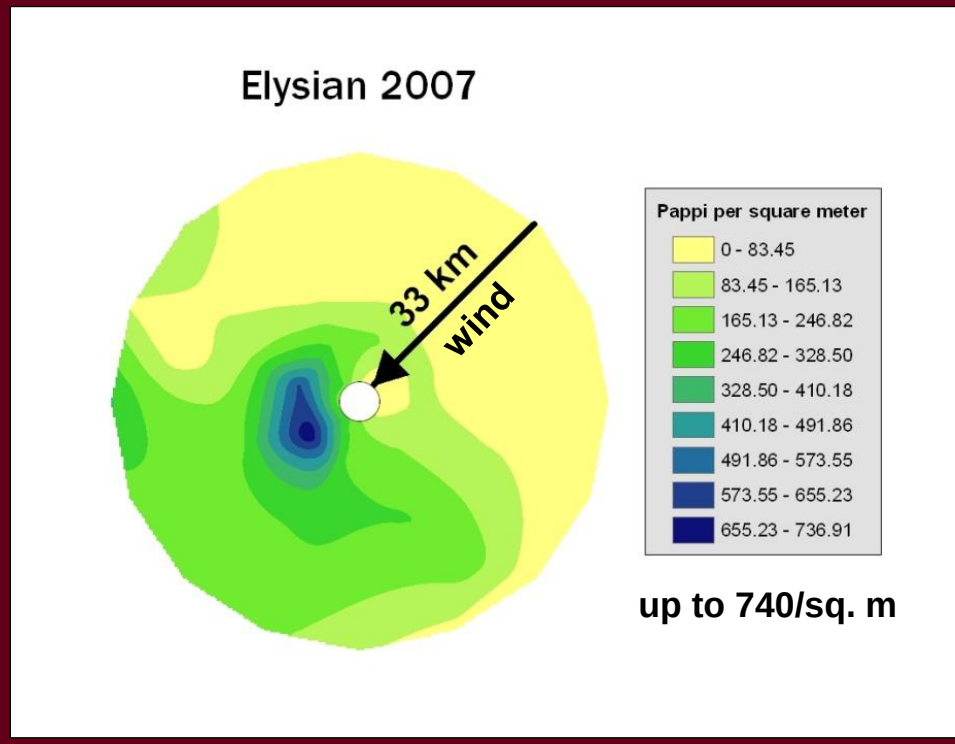
Effect of Wind of direction and distance of Canada thistle dispersal



Seeds



Pappi

Put it in the bank

- Seed dispersal local

- Where already endemic or epidemic, avoid heroic control at dispersal time

- Where rare on a landscape scale, be heroic!

Functional Groups to Resist Invasion During Prairie Establishment

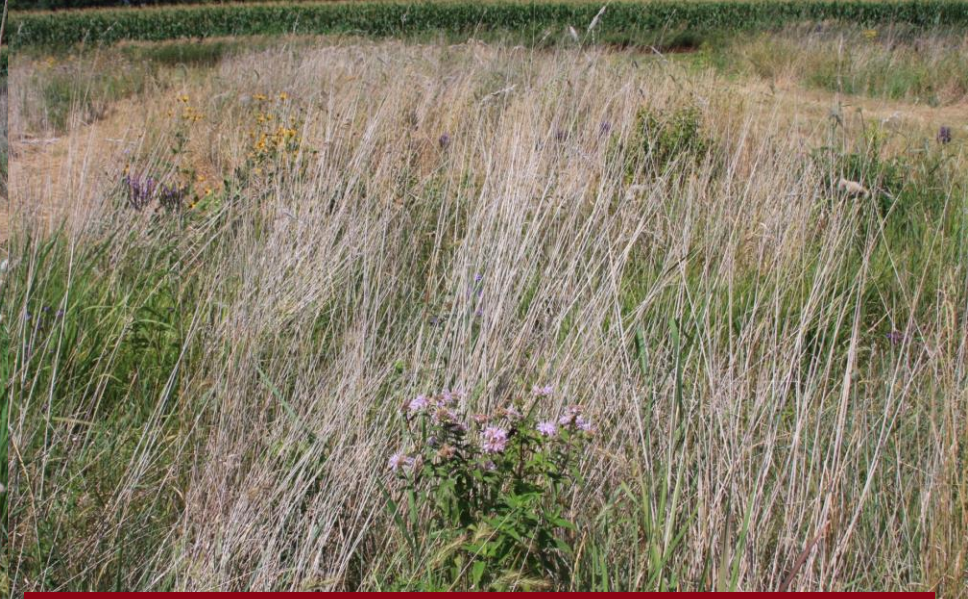
Roger Becker and Lee Klossner
University of Minnesota
Milt Haar
National Park Service

University of Minnesota Extension
Driven to Discover℠

National Park Service

Canada Thistle
Seeded in Center

Warm season only est. summer 2005



U3 Mix Clopyralid est. summer 2005

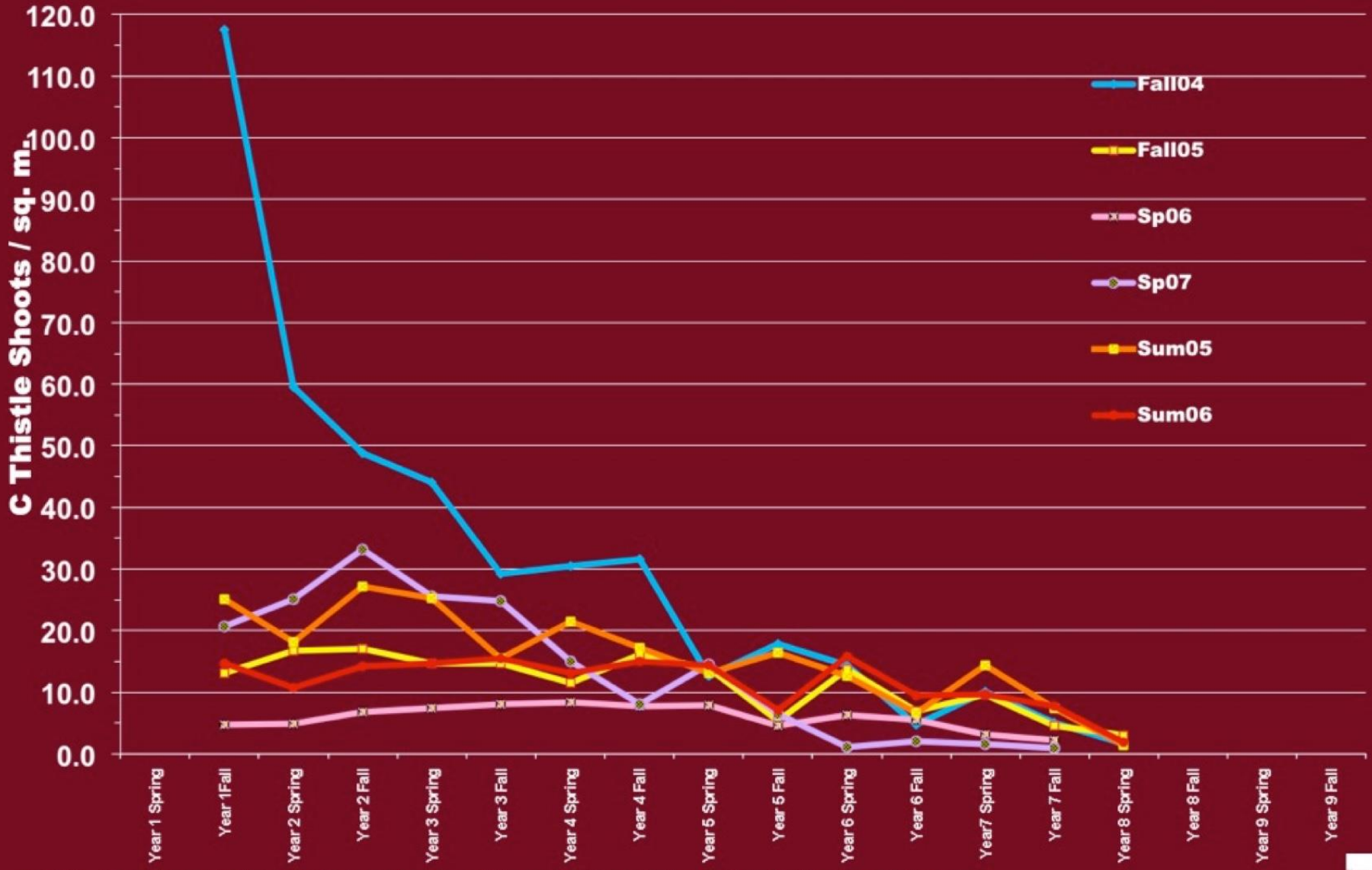
2008

Cool season only est. summer 2005

U3 Mix Control est. summer 2005

Functional Group x Canada Thistle Est.

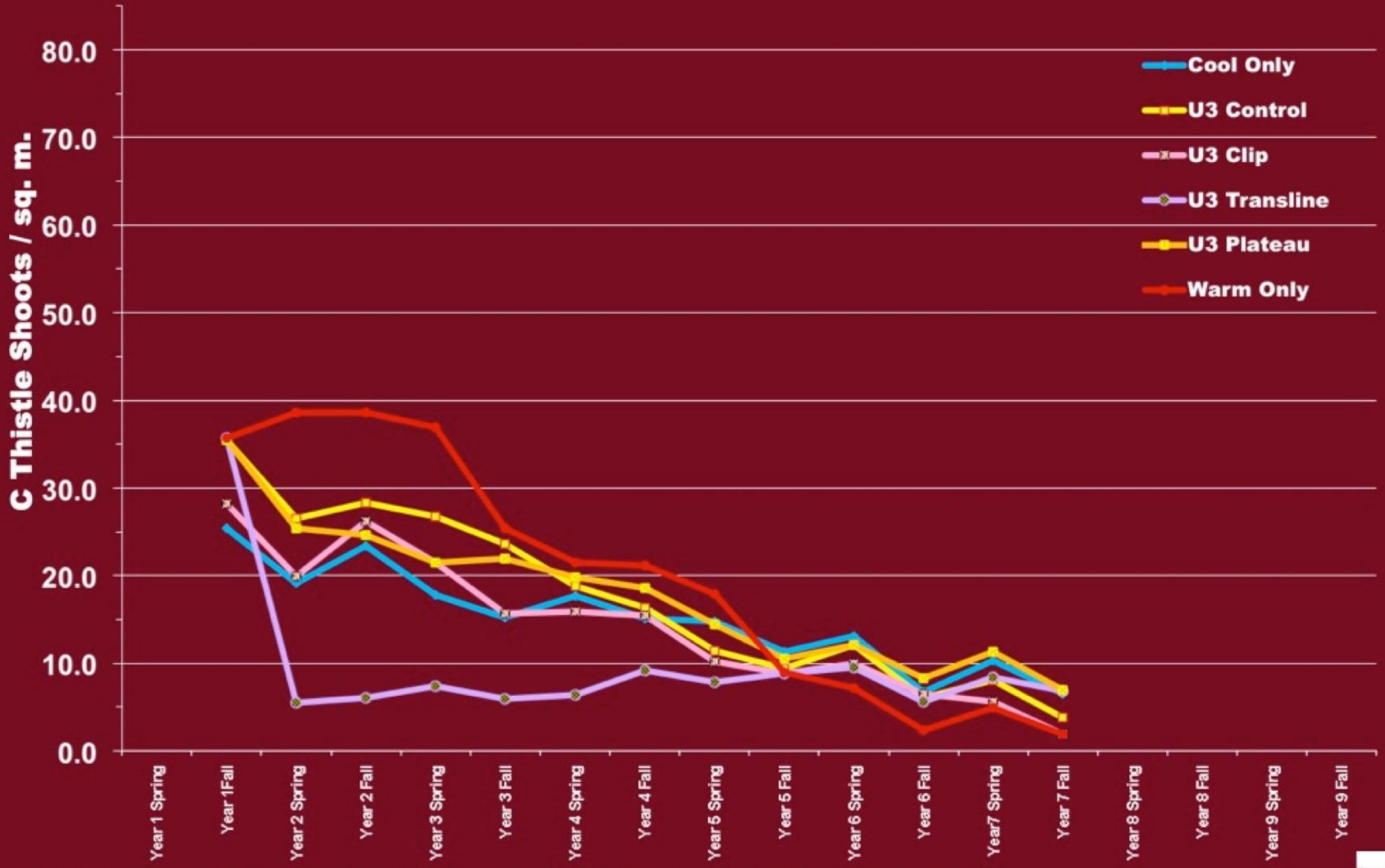
Lamberton, MN. Canth Shoot Cnts. All Funct. Groups Combined.



n = 24. Counts are in the seeded center area. May not characterize entire plot in the early years.

Functional Group x Canada Thistle Est.

Lamberton, MN. Canth Shoot Cnts. All Seedings Combined.



n = 24. Counts are in the seeded center area. May not characterize entire plot in the early years.

Functional Group x Canada Thistle Est.

Lamberton, MN 2004 – 2012 Cycle

Small, non-competitive, usually vegetative

n = 24.

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Put it in the bank

Best time to seed?

- It depends!

Best functional mix?

- It depends!

Early intervention helps?

- Maybe

Healthy prairie?

- Year 3 to 4 may look very bad!
- 5 to 7 years if politically feasible
  - – it will be OK!

Canada Thistle Biocontrol
Lake Agassiz National Wildlife Refuge

Stem-mining weevils released in fall 2007 and spring 2008

Monika Chandler, MDA

Native *Cirsium* spp. screened


Field thistle


Flodman's thistle


Hill's thistle


Tall thistle


Pitcher's thistle*


Wavy leaf thistle


Swamp thistle

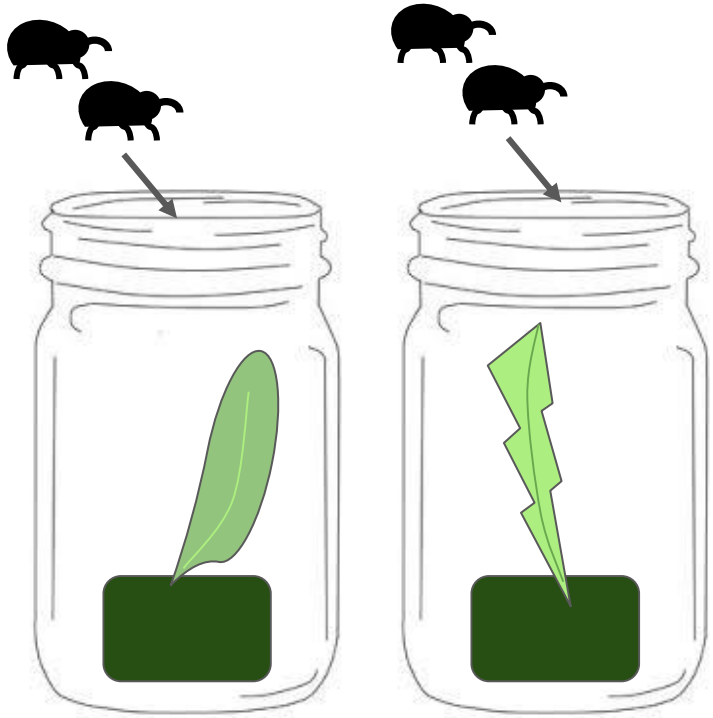
University of Minnesota Extension

All native thistles in Minnesota are *Cirsium* spp.

Cirsium Native Common Garden, established August 2015

University of Minnesota Extension

Sequential no-choice oviposition tests

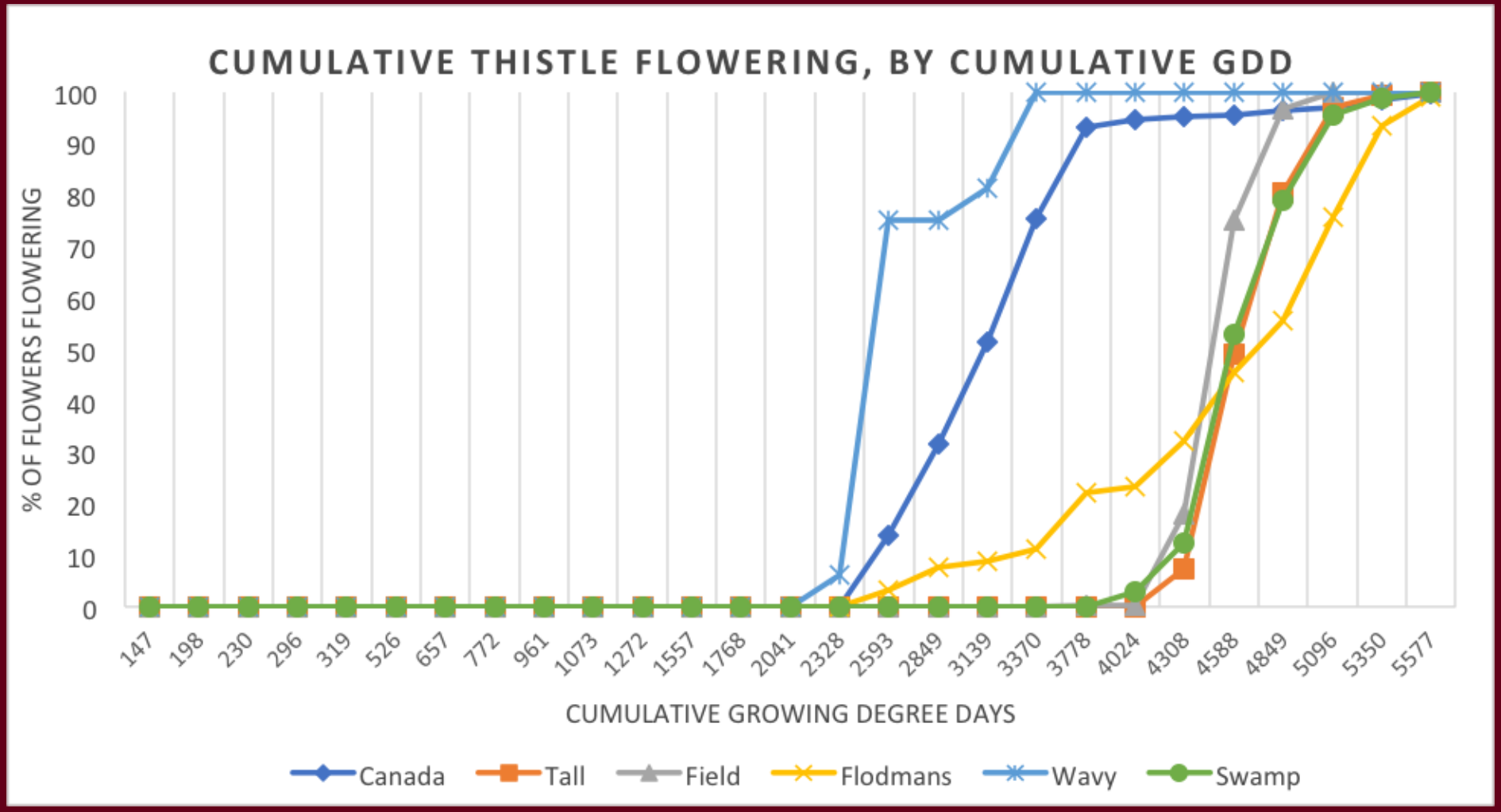


No-choice larval development test

Species	Scientific name	Number of replications		Numbers of adults emerged			Number of replications with mining
		Total	With adult emergence[1]	Total	Mean per replication	Range per replication	
Canada thistle	*Cirsium arvense*	10	8	27	2.7	0 to 7	8
field thistle	*Cirsium discolor*	8	6	112	14.0	0 to 43	7
Flodman's thistle	*Cirsium flodmanii*	5	1	9	1.8	0 to 9	4
Pitcher's thistle	*Cirsium pitcheri*	5	0	0	0.0	0	1
Hill's thistle	*Cirsium pumilum* var. *hillii*	~~5~~ 2	0	0	0.0	0	0
swamp thistle	*Cirsium muticum*	7	5	7	1.0	0 to 2	5
tall thistle	*Cirsium altissimum*	5	2	6	1.2	0 to 5	3

[1]Sum of alive and dead adults

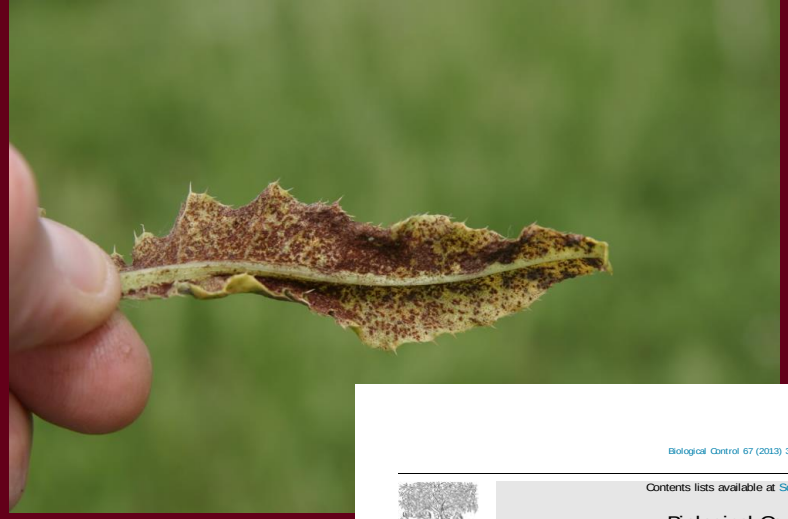
Native *Cirsium* Common Garden 2016



Canada thistle phenology compared to native *Cirsium* species to inform biological control agent synchrony.
University of Minnesota, St. Paul Campus.

University of Minnesota EXTENSION

Rusts for biocontrol?
Thistle rust
(*Puccinia punctiformis)*



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journal homepage: www.elsevier.com/locate/ybcon

Successful establishment of epiphytotics of Puccinia punctiformis for biological control of Cirsium arvense

Dana Berner [a,⇑], Emily Smallwood [a], Craig Cavin [a], Anastasia Lagopodi [b], Javid Kashefi [c], Tamara Kolomiets [d], Lyubov Pankratova [d], Zhanna Mukhina [e], Michael Cripps [f], Graeme Bourdôt [f]

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[e] All-Russia Rice Research Institute, Belozerny, 350921 Krasnodar, Russia
[f] AgResearch Ltd., Lincoln, Private Bag 4749, Christchurch, New Zealand

highlights

- Rosettes of C. arvense were inoculated in the fall with telia-bearing leaves.
- Rosettes inoculations were done in Greece, New Zealand, Russia, and the USA.
- Conditions were favorable for teliospore germination in the fall in all fields.
- Systemically diseased shoots resulted from inoculations in all 13 field sites.
- Rosettes in the fall are the infection court for basidiospore infection.

graphical abstract

article info

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Cirsium arvense
Epiphytotics
Rust fungus
Systemic disease

abstract

Canada thistle (Cirsium arvense, CT) is one of the worst weeds in temperate areas of the world. The rust fungus Puccinia punctiformis was first proposed as a biological control agent for CT in 1893. The rust causes systemic disease, is specific to CT, and is in all countries where CT is found. Despite a 120-year lapse since biological control with the rust was proposed, establishment of epiphytotics of the rust have previously been unsuccessful due to incomplete understanding of the disease cycle. In this study, newly-emerging rosettes in the fall are proposed as the physical and temporal infection courts for basidiospores, from germinating teliospores, to systemically infect CT and give rise to systemically diseased shoots the following spring. To test this hypothesis, rosettes of CT were inoculated in the fall with either telia-bearing leaves collected in mid-summer or with greenhouse-produced teliospores. Field sites were located near Kozani, Greece, Moscow, Russia, Christchurch, New Zealand, and Ft. Detrick, Maryland, USA. Telia-bearing leaves, which were used as inoculum in 12 of 13 field sites, were collected near each field site from CT shoots in close proximity to systemically diseased CT shoots producing aeciospores in the spring. Aeciospore infections of the leaves of these nearby shoots gave rise to uredinia which turned to telia in mid- to late-summer. Temperature and dew conditions at inoculation in the fall at each site were very favorable for teliospore germination. Rosettes inoculated in the fall were marked with flags, and systemically diseased shoots emerging near these flags the following spring were recorded. In 11 of the sites in these countries, individual rosettes were inoculated 2, 4, 6, or 8 times with telia-bearing leaves. Proportions of rosettes giving rise to systemically diseased shoots, out of the number of rosettes inoculated, were analyzed. Inoculations in all 13 sites produced systemically diseased shoots. A separate study on the phenology of CT showed that the maximum rate of leaf abscission occurred at the time of maximum

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University of Minnesota Extension

Bacteria for biocontrol?
Pseudomonas syringae

Check (top left) plus 4 degrees of control

Jurg Hiltbrunner

Put it in the bank

- There is no effective, specific biocontrol program
- Rust may be making a comeback
- Forget about asters yellows

Why Do We Have Weeds Anyway?

Just because……..

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EXTENSION

Special thanks to:

MnDNR: Laura Van Riper, (Luke Skinner, Mark Gulick), Judy and Randy Markl, Dennis Opdahl

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University of Minnesota Extension

Questions?

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