Grassland plant invasions; progress, failures and the future

John Gaskin
Botanist
USDA ARS Sidney, MT

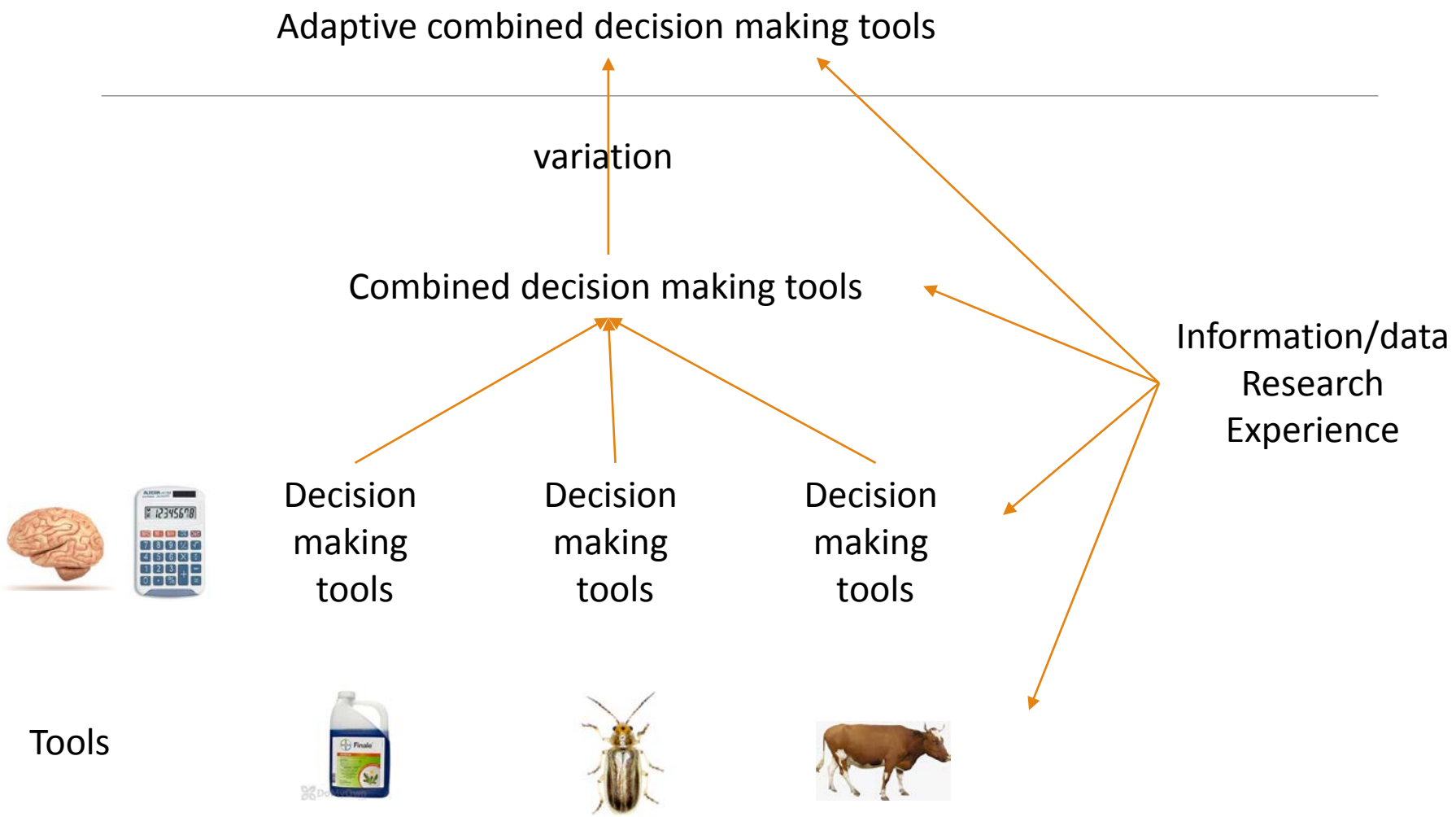
Plant Invasions

Gather experts
- Land Managers
- Researchers

Meeting attendees → Issues/solutions

Awareness
Education
Output publication

More effective tool use



Reach a higher level of working together

Resources Collaboration Communication Compromise

We are:

Land managers | Stakeholders | Agencies | Researchers

Goals and target audience of this process

This presentation is just about invasive plants on grasslands

The discussion session later is for all invasive species on grasslands

Create a paper that educates, lobbies, encourages; helps each other move forward on invasive plant management

Avoiding the mundane and well-known info; we want to discuss unique, cutting edge, controversial, or innovative concepts and methods that have helped or will help control plant invasions.

Be thinking of topics of progress or failure of invasive plant management that we can capture in this paper. If you can't make discussion, send it to Amy Symstad or me or any of the authors. john.gaskin@ars.usda.gov

Authors
Land managers and researchers

John F. Gaskin[1], Jack L. Butler[2], Erin Espeland[1], Casey D. Johnson[3], Diane L. Larson[4], Jane M. Mangold[5], Rachel A. McGee[6], Chuck Milner[7], Dean E. Pearson[8], Lora Perkins[9], Chadley W. Prosser[10], Justin B. Runyon[11], Zachary A. Sylvain[1], Amy Symstad[12], Daniel R. Tekiela[13]

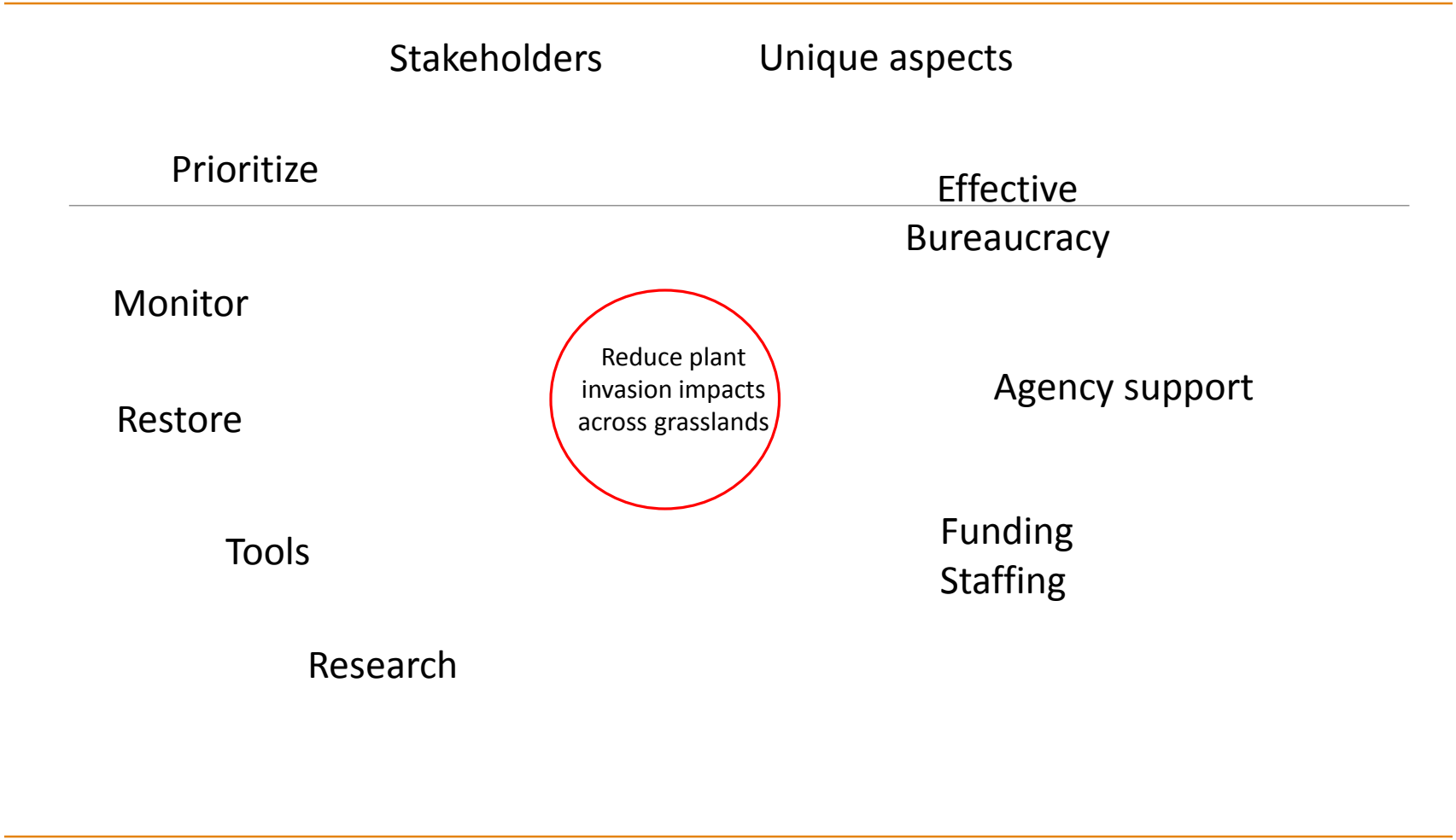
Keep in mind…

Northern bias; help us fix that.

National grasslands bias; help us fix that

What I will talk about today:

Reduce plant invasion impacts across grasslands


Stakeholders
Unique aspects
Prioritize
Effective
Bureaucracy
Monitor
Reduce plant invasion impacts across grasslands
Agency support
Restore
Funding
Staffing
Tools
Research

What I will talk about:

Stakeholders

Unique aspects

Prioritize

Effective

Bureaucracy

Monitor

Reduce plant invasion impacts across grasslands

Agency support

Restore

Funding

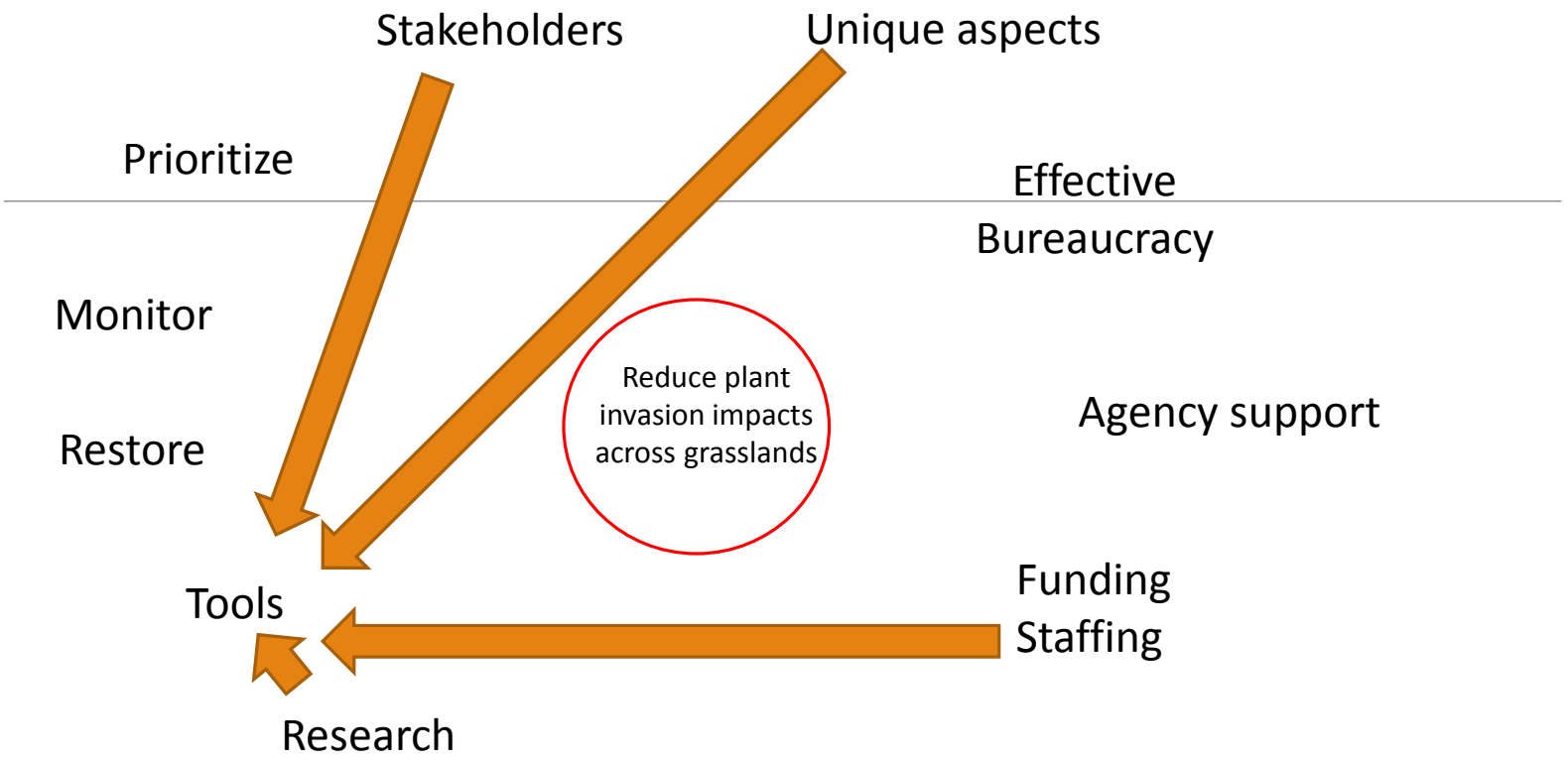
Staffing

Tools

herbicide
biocontrol
mowing
fire
grazing
adaptive
IWM
Decision making tools

Research

What I will talk about:

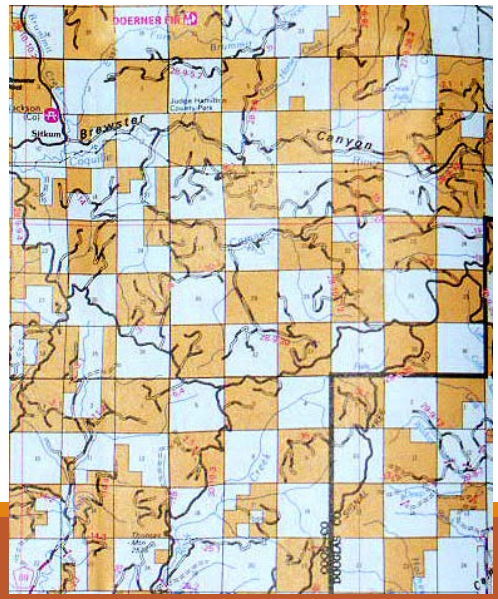


We will just touch on a few items today as examples:

Unique aspects of grasslands

National Grasslands and many neighboring lands are checkerboard ownership

- Neighboring lands have different types and levels of use and management



Information

30,000 acres

450 mi of edge vs. minimum of 30 mi

A challenge to monitor and control

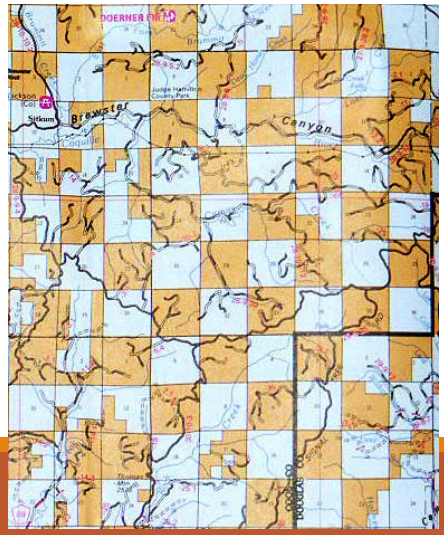
Deters a total landscape or watershed approach

Information

Fragmentation

Bonus: Increasing encroachment by woody species exacerbates fragmentation

In highly fragmented areas, stakeholder education and cooperation are key



Unique aspects of grasslands

Invasive exotics

- Kentucky bluegrass
- Crested wheatgrass
- Cheatgrass
- Japanese brome
- Smooth brome
- Jointed goatgrass
- Tree of heaven
- Houndstongue
- Scotch thistle
- medusahead

Invasive natives

- Eastern red cedar
- Rocky Mountain juniper
- Western snowberry
- Sumac, willow, aspen

Information

Unique aspects of grasslands

Invasion potential

- Federal land acquisition history
  - Sub-optimal lands more invasible?
- Tree covered vs. grass covered land

Information

Unique aspects of grasslands

Lower staffing levels compared to forests

Talk about some newer items

Prioritization

Prioritization of survey, treatment and monitoring activities

- EDRR

Prioritization of what to control

- which invaders are most important to address
- where to address them
- when to address them

Ways to prioritize species

Stakeholder input

Feasibility

Ecological input

- Apparent impacts
- Susceptibility of community

Risk of each species

Protect best communities

Noxious weed law

A common approach

target the heaviest invasions

expend the least amount of resources

remove the greatest quantity of the target species.

native plants and seed sources may be insufficient for natives to recover (e.g., Seabloom et al. 2003).

Other ways to prioritize

ecological integrity

importance to natural resources of concern

risk of invasion; invasibility

prioritize keeping invaders out of uninvaded habitat

- pushing back invaders from the edges of heavy invasion fronts
- with an emphasis on zones where there are sufficient native plants for reestablishment.

You can address feasibility

non-target impacts/unintended consequences

distribution and abundance

social-political environment

control (kill) effectiveness

ability to prevent reinvasion

ease of detection

resource availability and return on investment

(Zimmerman et. al. 2011)

Prioritization

Systematic approaches for selecting management strategies have been developed and are available for use.

http://www.ipmdat.org/

The Nature Conservancy
Protecting nature. Preserving life.™
nature.org

INVASIVE PLANT MANAGEMENT
IPMDAT
DECISION ANALYSIS TOOL

Strategies and Outcomes

Eradication

Containment

Suppression

Proceed with control (project has value and a high probability of success).

Stop – secure sustainable funding before proceeding.

Stop – control not feasible and/or not warranted.

Peer-review required – feasibility and/or return on investment are uncertain.

Peer review

Another process Quantifying weed impacts

quantifying the relationships between individual invaders and native plant abundance

within systems containing multiple invaders

allows for the ranking and prioritization of invaders according to real-time measures of their “apparent impacts” within each habitat (Pearson et al. 2016)

allows all invaders within a habitat to be ranked according to ecological impacts independent of noxious weed listing status

“apparent impacts”

based on correlational relationships between invader abundance and native plant abundance from survey data,

“true impacts” are best quantified using costly and time consuming experimental approaches which become logistically infeasible to apply to many invaders.

Decision making tool

Table 1. Components of exotic species invasiveness and impact based on surveys of n = 620 1-m^2 plots in 31 grasslands across west-central Montana, USA. ALL EXOTICS

Species	Type	Invasiveness			Impact				Other invaders		
		R	*A*	Rank (score)	*E*	*F*	*P*	Rank (score)	Slope	*F*	*P*
Bromus tectorum	AG	461	14.9	1 (6861)	−0.39	129.3	<0.001	1 (2676)	−0.50	147.9	<0.001
Centaurea stoebe [a]	PF	233	6.7	2 (1555)	−0.72	30.5	<0.001	2 (1120)	−0.43	252.1	<0.001
Euphorbia esula [a]	PF	87	12.8	3 (1111)	−0.53	37.5	<0.001	3 (589)	−0.43	229.1	<0.001
Potentilla	PF	148	6.3	4 (937)	−0.50	19.1	<0.001	4 (468)	−0.43	242.5	<0.001

Invasiveness scores are the product of range (*R*), number of plots occupied, local abundance (*A*)

Pearson et al. 2016

Quantifying weed impacts

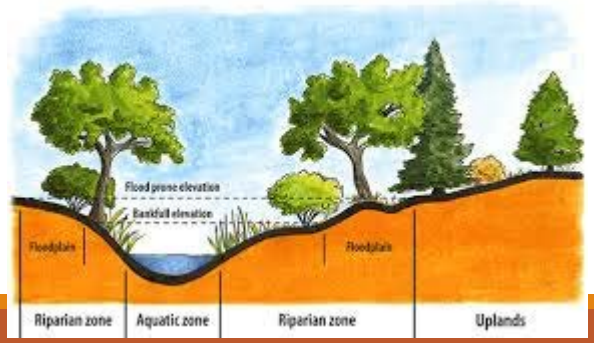
this approach identifies high-impact grasses that may not be included on noxious weed lists if they also provide livestock forage

this approach can identify “sleepers”, early-stage-invaders not yet recognized as impacting native systems

Quantifying weed impacts

For example, crested wheatgrass (*Agropyron cristatum*) was the highest impact invader in the western wheatgrass system, but it was not identified as a problem in the Intermountain grassland.

In contrast, spotted knapweed (*Centaurea stoebe*) was the second highest impact invader in the Intermountain grassland, but was not found in the western wheatgrass uplands even though this same species demonstrated significant impacts on native plants in adjacent western wheatgrass floodplain habitats (Pearson and Ortega 2017).



What I will talk about:

Stakeholders

Unique aspects

Prioritize

Effective Bureaucracy

Monitor

Reduce plant invasion impacts across grasslands

Agency support

Restore

Tools

Funding
Staffing

Research

Working with people

Tool list

Herbicides

Biocontrol

Mechanical

Fire

Grazing

IWM strategies

Decision making tools

Biological control

In the pipeline:

- Whitetop mite
- Canada thistle rust
- Russian olive fruit and flower
- Houndstongue seed feeder

In the future:

- Leafy spurge in riparian areas
  - from stakeholder input

Biological control

How can land managers access this resource more effectively?

COLORADO DEPARTMENT OF AGRICULTURE

Palisade insectary
Colorado

MONTANA BIOLOGICAL WEED CONTROL COORDINATION PROJECT

Biological control issues

Invasive grasses; fewer bc options

- Cheatgrass
- Guineagrass
- Medusahead

Stalled regulatory pipeline

Conflicts

- saltcedar agent- no interstate movement
- houndstongue agent- Canada only, but migrated to USA

Grazing

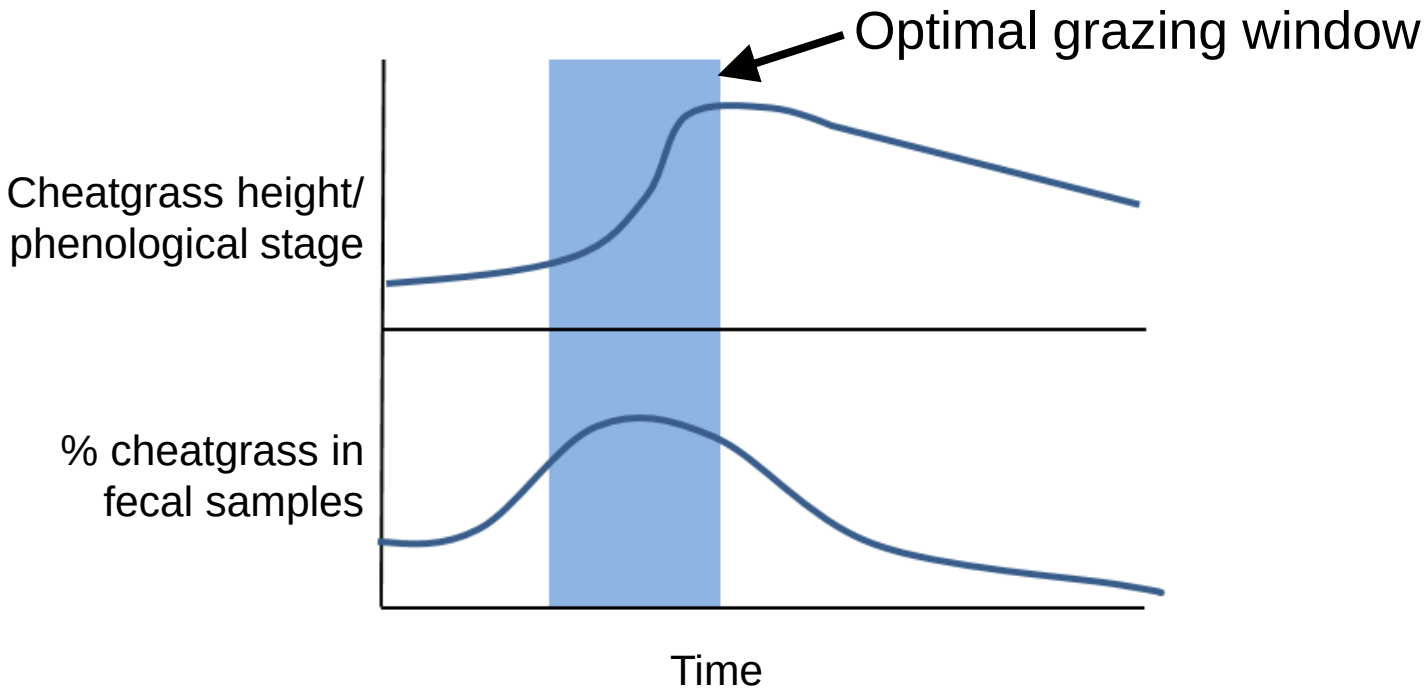
Complications and opportunities

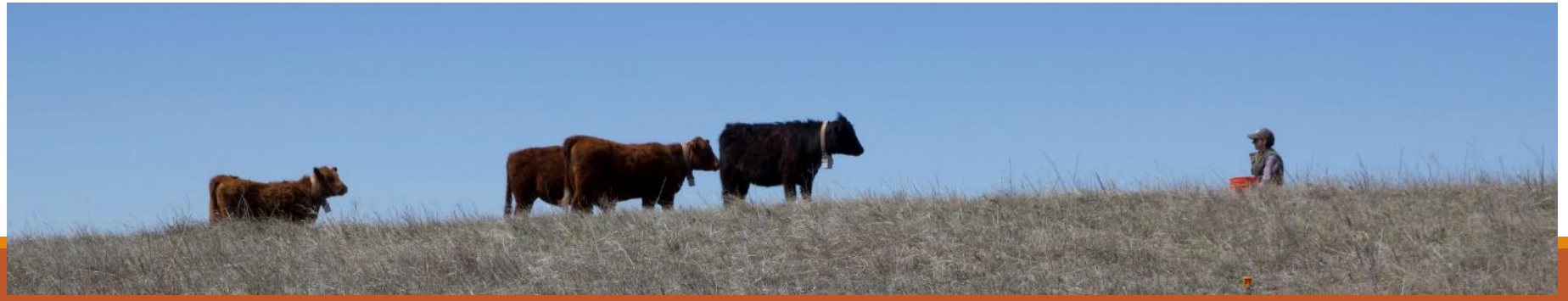
- climate change

Information

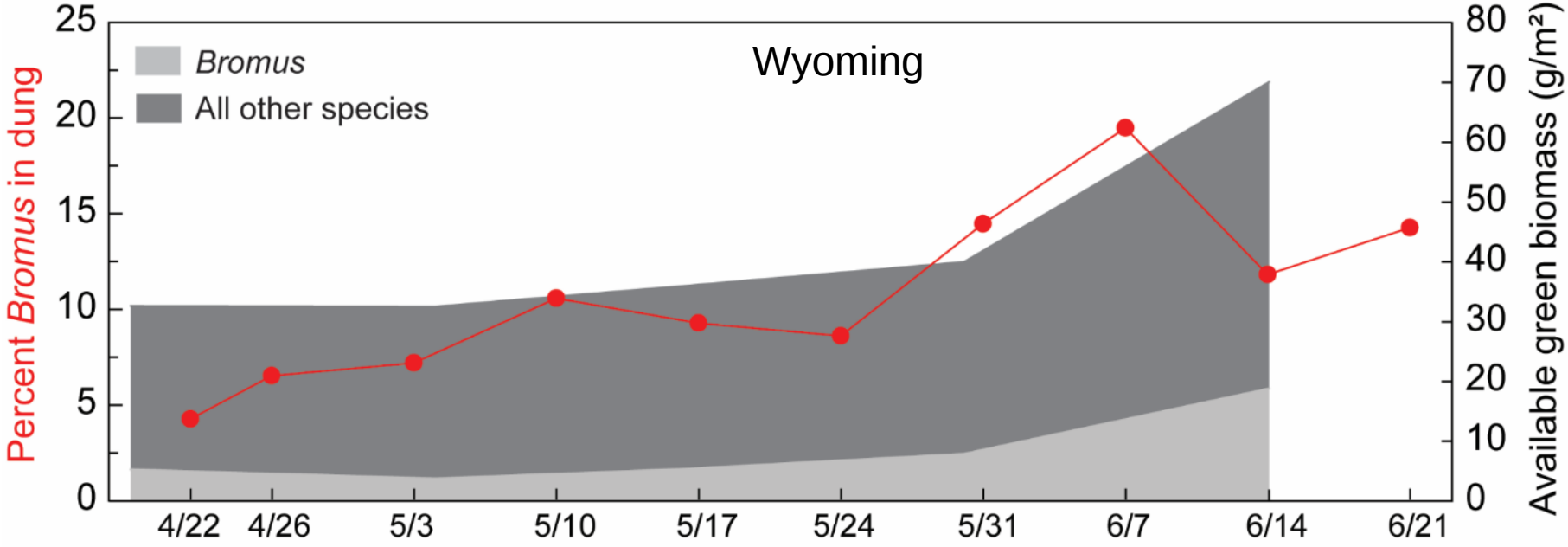
Making use of warmer springs - Targeted grazing

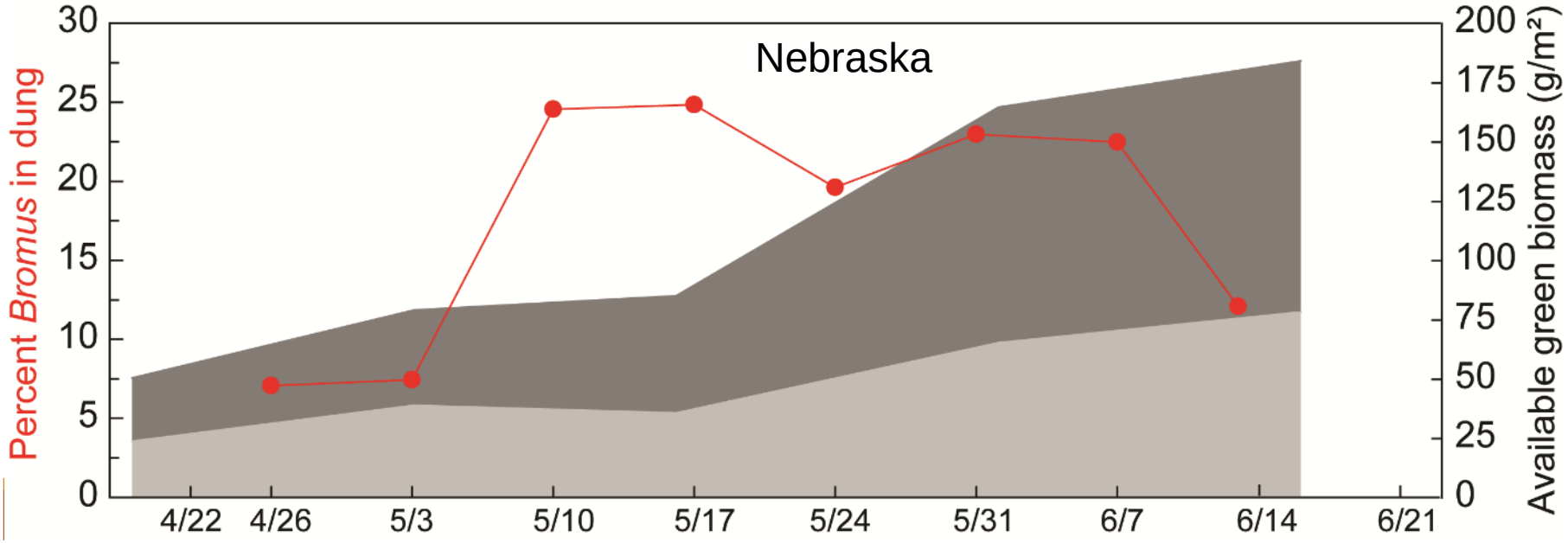
When will cows select cheatgrass?





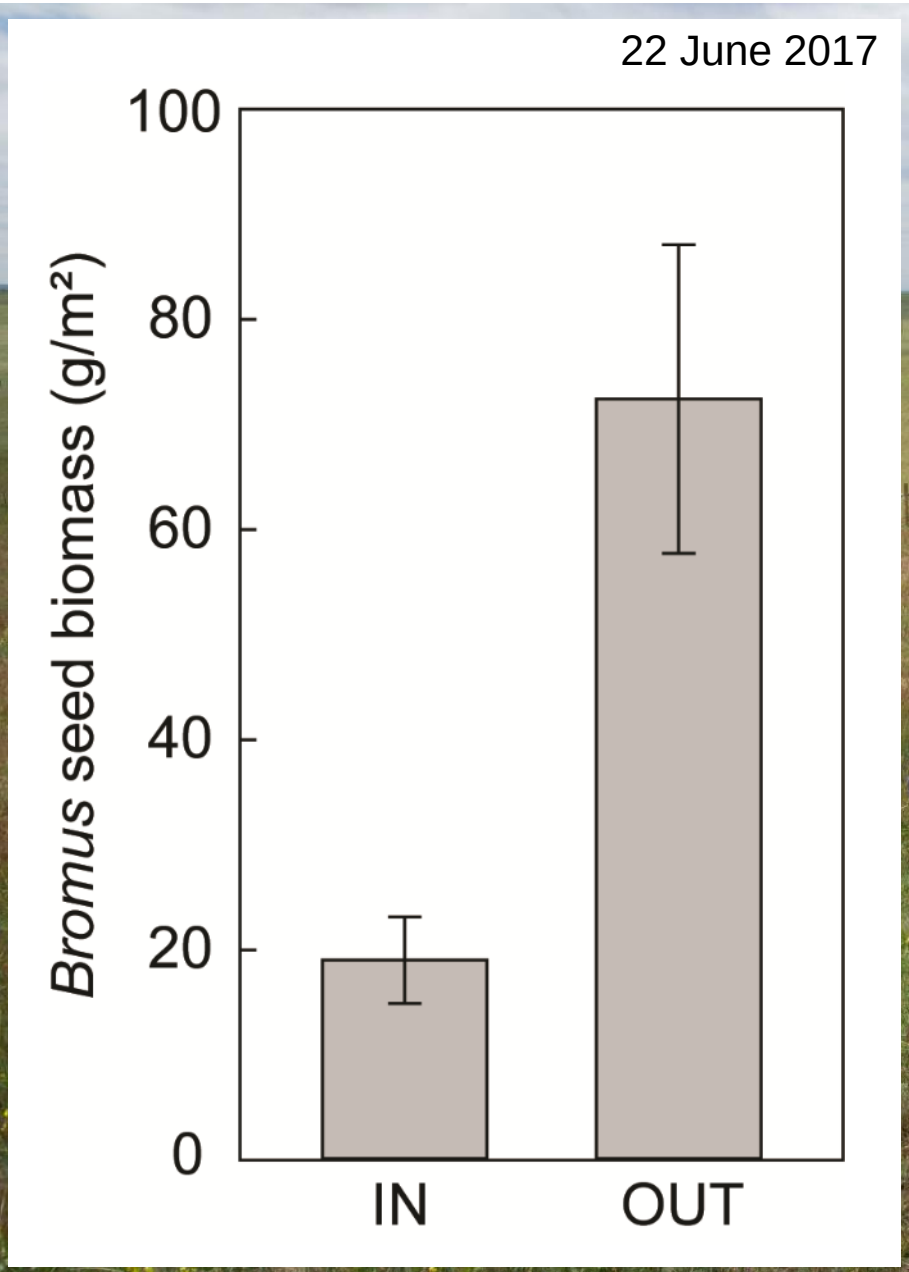
Information





Information

Information



Herbicides

Indaziflam: invasive annual grass control

Quinclorac: leafy spurge within mesic habitats

What drives herbicide decisions?

- anecdotal
- research
- sales/cost

Decision making tool

Do we need a better decision making tool specific to grasslands?

Fire

Fire suppression is leading to encroachment by juniper and other woody species and cool-season grasses in the north

Fire is dual-purpose—reduce invasives and restore natives—if applied properly

Fire + grazing can control grasshopper outbreak, and that can influence future weed control

Early (cool-season) fires often used to target cool-season invasives in warm-season-dominated tallgrass prairies

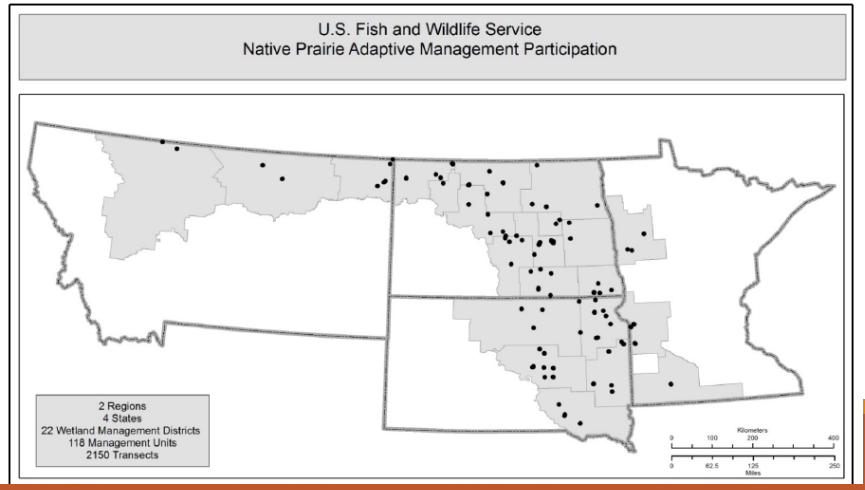
Growing-season wildfire in GP grasslands should not be vilified as invasives-generating (Porensky & Blumenthal 2016)

NPAM
Native Prairie Adaptive Management Program

Problem: High percentages of bromes and bluegrass cover in prairies

Goal: Increase native grass and forb cover at the least cost (started in 2010)

Year by year planning



Adaptive combined decision making tool

NPAM

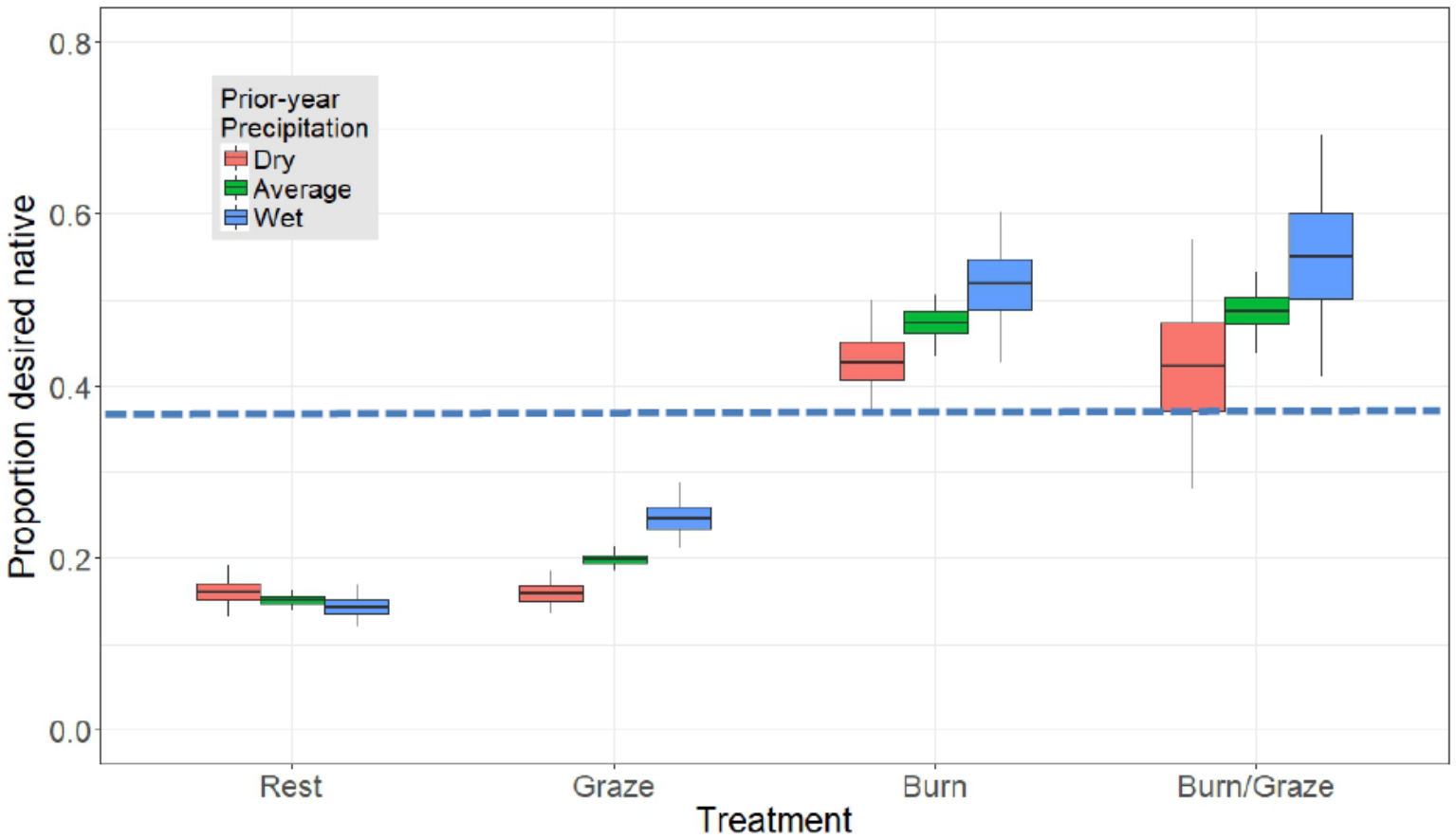


Figure 1. Predicted proportion of native cover on a mixed grass unit for four management actions at three different levels of prior-year precipitation (drier than average, average, wetter than average). All other variables included in the analysis were set to their mean values (starting proportion native cover= 0.37, long-term precipitation = 18.9 inches; long-term temperature during warmest month=70.8 degrees F).

What I will talk about:

Stakeholders

Unique aspects

Prioritize

Effective Bureaucracy

Monitor

Restore

Reduce plant invasion impacts across grasslands

Agency support

Tools

Funding
Staffing

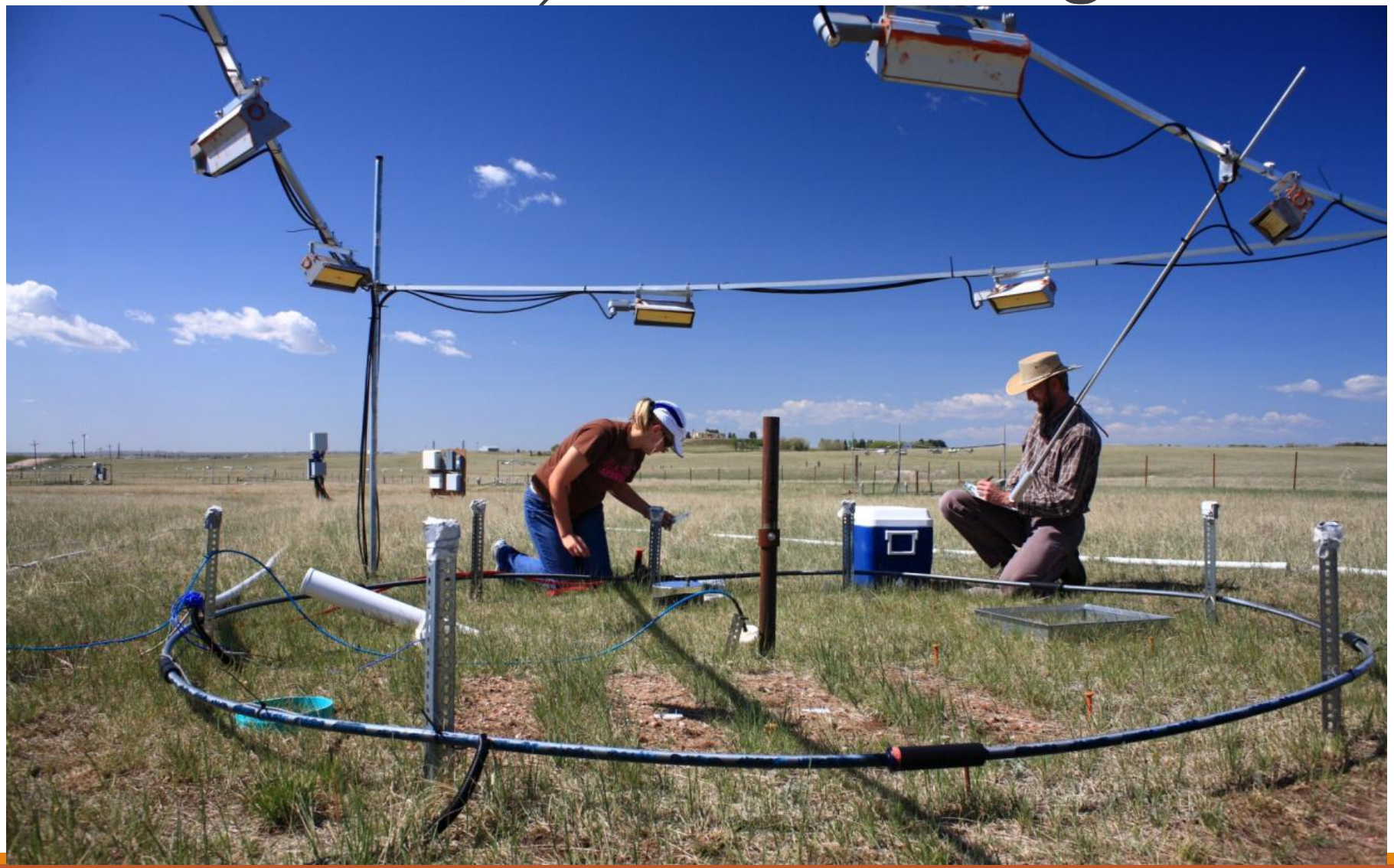
Research

Working with people

Climate change

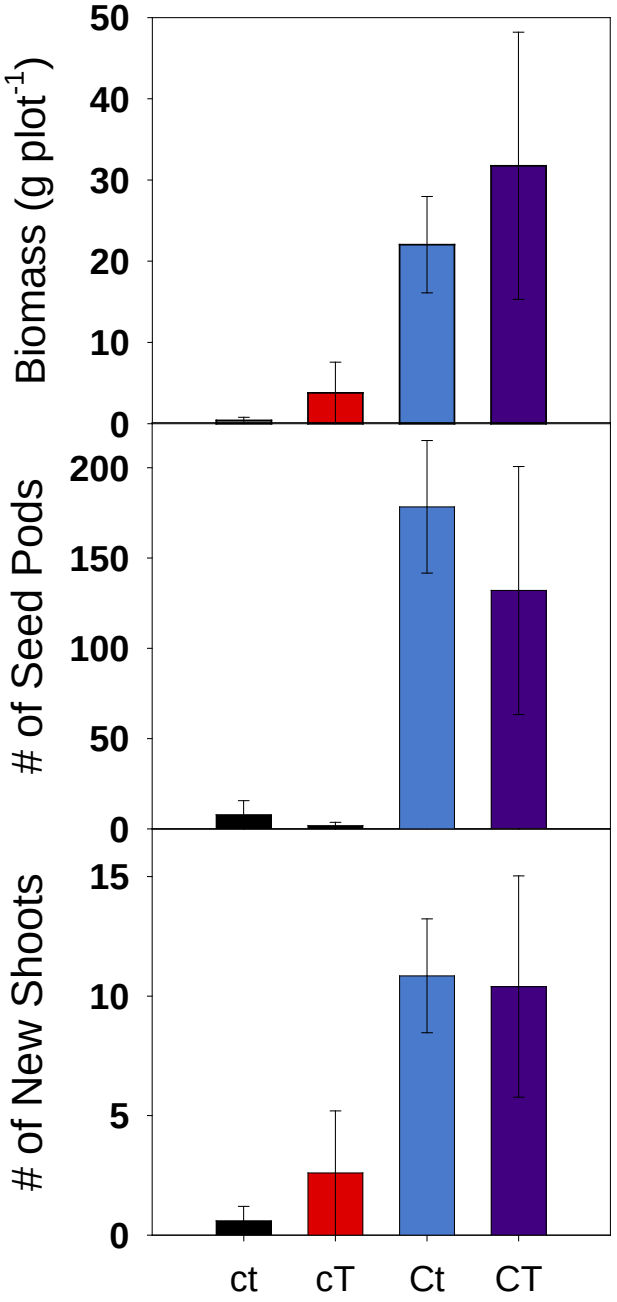
Adapting to the future

Elevated CO_2 and Warming



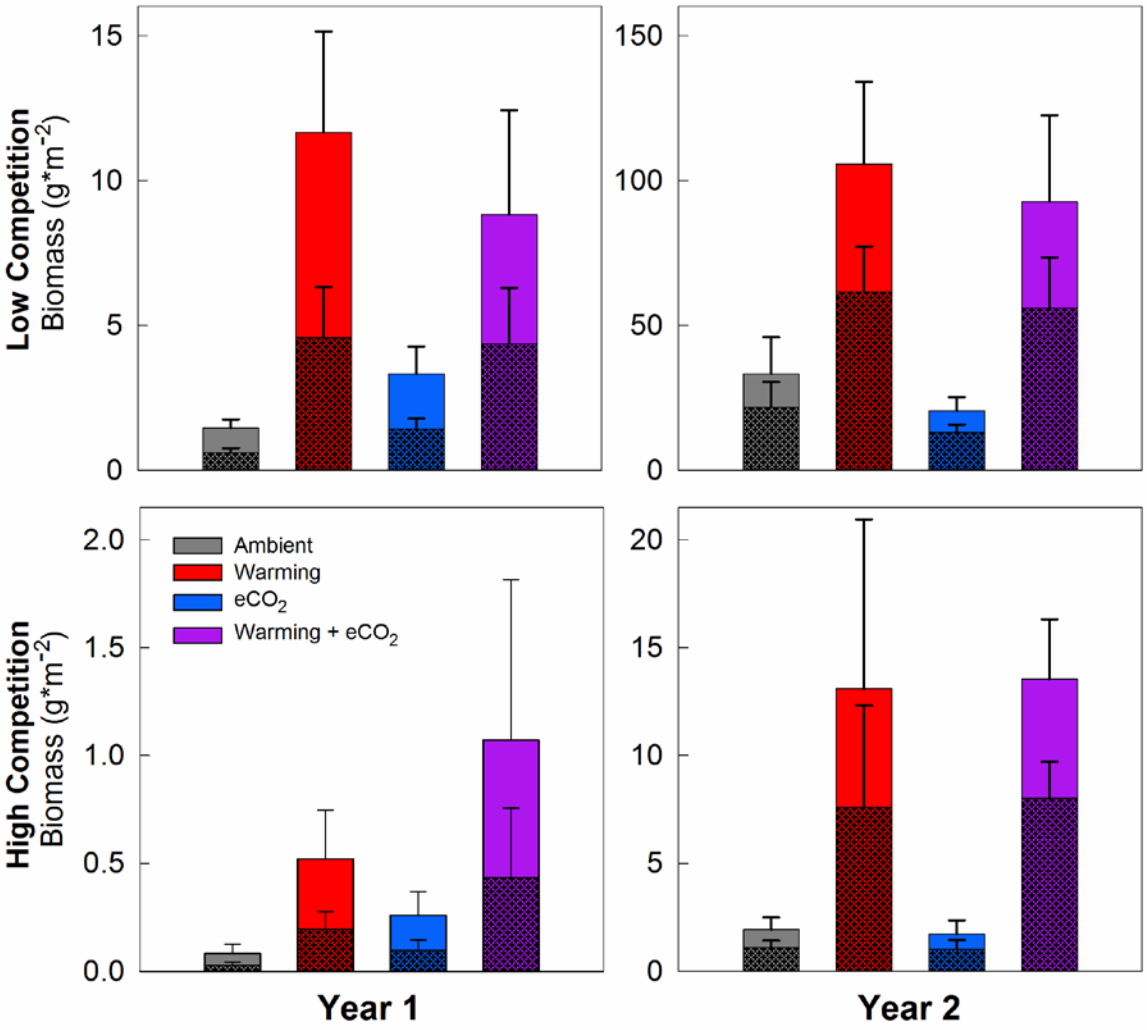
Morgan et al. 2011, Nature 476:202-205

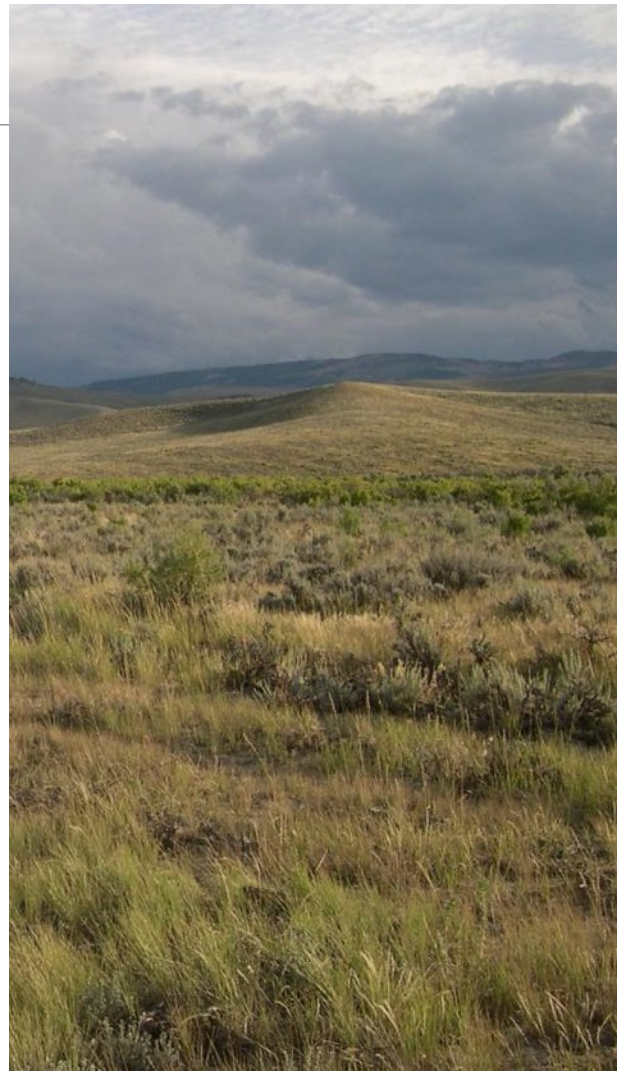
CO_2 increases lead to 13-fold increase in Dalmatian toadflax biomass



Information

Warming increases cheatgrass biomass and seed set 4-fold





Blumenthal et al. 2016, GCB 22:3026

Reach a higher level of working together

Resources Collaboration Communication Compromise

We are:

Land managers | Stakeholders | Agencies | Researchers

We need to enhance:

Effective bureaucracy

- More time spent on spraying paperwork vs. spraying

Responsive upper level management

- Stable(ish) and reasonable control objectives
- Communication between land managers and upper level management; between private land managers and regulatory agencies
- Meetings!

We need to enhance:

Stronger connections to science

- In both directions
- Meetings like this

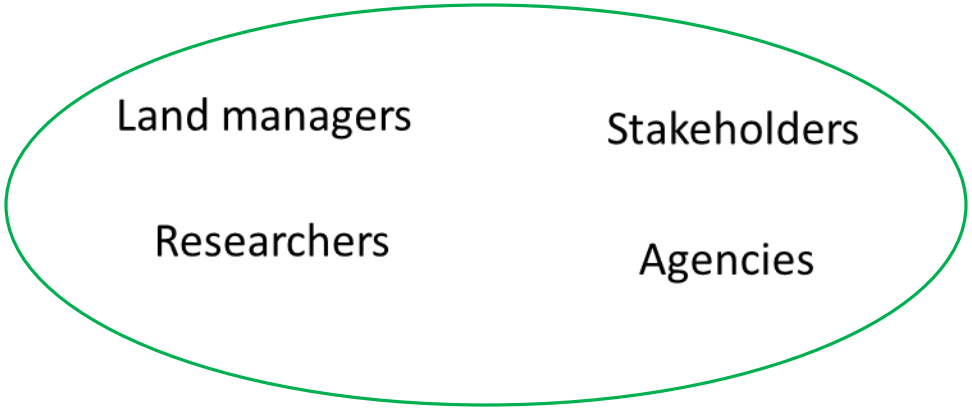
Stakeholder buy-in or compromise

- Personal connections are powerful tools to overcome conflict
- Long term outlook and staff turnover

We need to form powerful relationships

Less-than-optimal relationships decrease invasive plant management success in strong ways.

Share your communication successes with others!



Your suggestions for this paper: things we all need to know for invasive plant management on grasslands

john.gaskin@ars.usda.gov

Non-traditional tools. How to effectively engage the following:

- Management
  - meetings
- Stakeholders
- Researchers
  - Connecting to managers and stakeholders
- The Grasslands Manager

Conclusion

Hope for the future

Challenges we may never overcome

What the readers need to hear and processes that need to be fixed or improved

Major direct and indirect effects of plant invasion on National Grasslands

Revolving weed problems

Invasion trajectories over time

Required practices that enhance invasion

Prioritizing control

Funding/labor issues

Invasion diversity and effect on control

New invasions and new threats leading to invasion

Biocontrol issues

IPM success/failure

Restoration after invasion control

Restoration after energy development

Your ranked thoughts on how plant invasion control could be improved.

MT biocontrol awesome, mellissa, trust fund

Manager and stakeholder need regarding invasion?

I could talk to Watford city office botanist

Pictures of my nat grassland! Super native

Where can you get biocontrol info…look ionto this plus Mark book, bring some!

Enough tools? Enough money? Enough info?

Conflict, fragmentation and plant invasion

- Increased roads
- Fencing
- OHV
- Livestock
- trails, camping sites, visitor centers
- Any disturbance
  - Wild hogs
- Minimize effect of any conflict where possible
  - Need ideas here

Too big to handle

Despite our best efforts there are and expectedly will be future invasive plant problems that are to widespread or costly (both fiscally and ecologically) to be feasibly controlled except in specific cases

Where control is not feasible land managers should determine achievable goals and objectives.

Defined plant community structure and function goals

Managed ecosystem processes (e.g., fire)

Promoting competitive native species within invaded communities prioritizing protection of uninvaded sites

Future

network analysis methods to assess connectivity among grassland fragments

- and to assess likelihood of spread of invasive species to prioritize control efforts

Effective control of plant invasions

The Process:

- Mission: what is it? Is it changing?
  - Formal invasive plant control plans
  - Variation in invasion and control factors across grasslands
  - Surveying for invasion
  - Prioritization
  - Evaluate all tools and options
  - Implementation
  - Monitoring and readjustment
  - Repeat the process

Funding

Since 1998, fire staffing within the Forest Service has increased 114 percent, from around 5,700 employees in 1998 to over 12,000 employees in 2015.

Over the same period, staffing levels for those dedicated to managing National Forest System lands has decreased by 39 percent- from approximately 18,000 in 1998 to fewer than 11,000 in 2015

In-kind funding is key. Share sources.

Most non-target impacts of herbicides are linked to limitations in their precision associated with having a broad mode of action that affects a range of plant taxa and/or imprecise applications of the herbicide

Ecosystem reconstruction to protect against invasion

Addressing/reversing soil legacies of invasive plants (plant-soil feedbacks including altered nutrient availability, allelochemicals or changes to microbial/faunal communities)

Research suggests that invasive potential of some non-native species due to creation of and tolerance for plant-soil feedbacks, especially feedbacks causing altered microbial communities.

Studies on restored areas show soils have reduced soil organic matter, depauperate microbial communities and (for oilfield restoration in Bakken region) high salinity compared with nearby reference sites.

Legacies may also be gradually reversed by introducing tolerant native plants into restored areas, to be followed with native plants less tolerant of altered soil conditions or soil legacies of invaders.

When invasive plants are controlled, but desirable species are not present to occupy open niches, invasive plants will likely re-establish

Future work:

Greater understanding of the role of soil biota in establishment and resilience of reconstructions

Appropriate seed sources or methods for collection

Integrated Weed Management

Ideally IWM leads to synergies in management techniques

This synergy may be time and order dependent. For example, perennial pepperweed (*Lepidium latifolium*) was best controlled when mowing and herbicide were used in conjunction but, importantly, this positive result was only seen when mowing occurred before the herbicide

What is to be avoided in IWM is the potential of antagonisms where the integration in techniques results in no increased control at best, and poorer control at worst

Furthermore, because the outcomes of IWM can be site-specific (e.g. Orloff et al. 2015), managers may wish to test their own integrated treatments, monitor, and adapt as necessary