Reed Canarygrass: research and control methods

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Learning Objective

- This webinar will introduce participants to the latest research on reed canarygrass (*Phalaris arundinacea*) invasion of wetlands and ways to address this resource concern during the conservation planning process.
- This webinar will include
  - a literature review of reed canarygrass (*Phalaris arundinacea*) research
  - highlight related resource concerns and conservation planning approaches for managing and controlling this invasive species within wetlands.
  - Native wetland graminoids that may be planted and experimented with as an alternative to reed canarygrass will also be discussed.

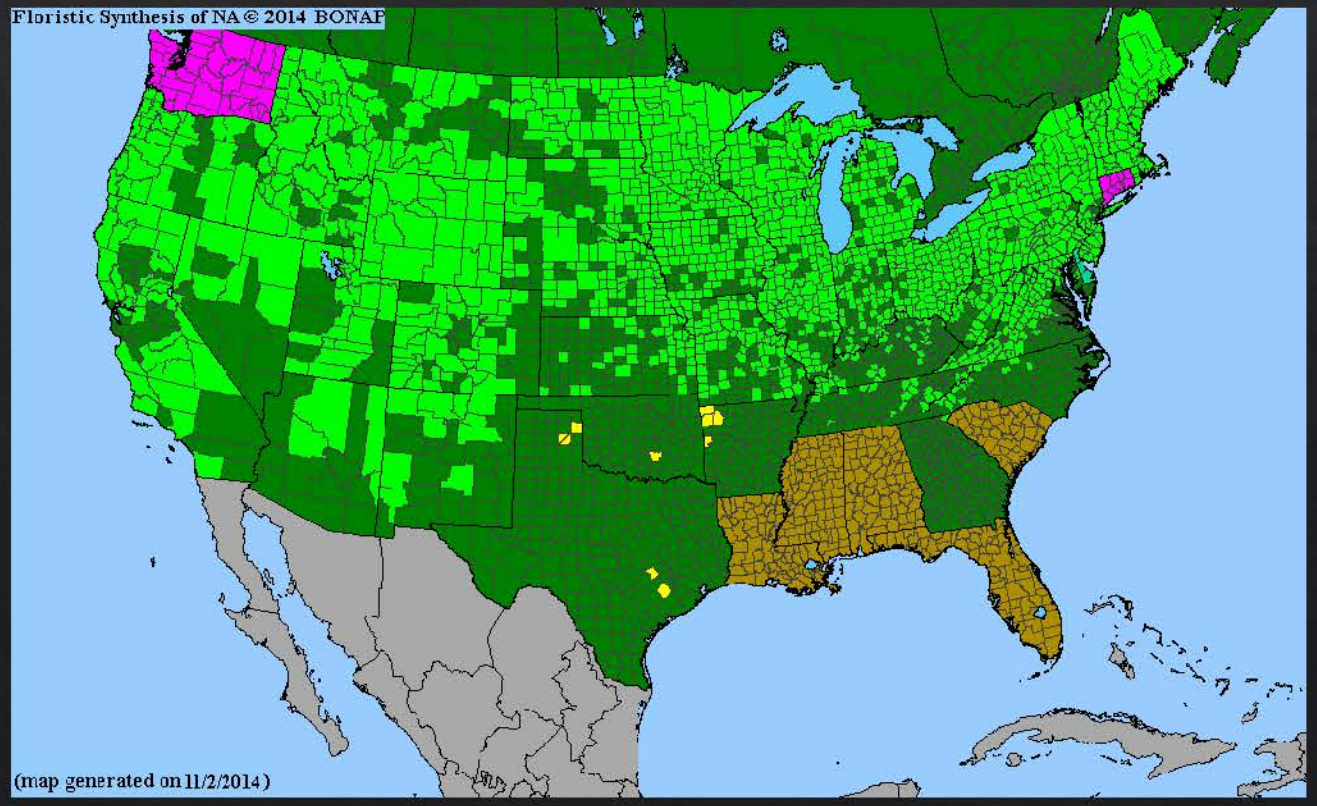
What is Reed Canarygrass

- A C3 photosynthetic pathway - Cool Season Grass
- Perennial
- Rhizomatous
- Forms root mats in the top several inches of soil
- May form monotypic stands
- 2-7 feet high
- Can grown in 3’ wide clumps
  - common in areas of frequent prolonged flooding within floodplains of major waterways (personal observation)

(Waggy 2010)

Reed Canarygrass – where it is from

- Native in temperate regions of Europe, Asia, and North America
- Is reported to be native in North America
  - Inland Northwest
  - Areas of the Southwest
  - great plains
  - Midwest
  - Great lakes region
  - Northeast
  - Manitoba and Ontario



(Waggy 2010)

Reed Canarygrass – when, how , and why

- Cultivation for human use began in Sweden in the mid 1700s
- Use of European cultivars was first reported in the US in the 1930s under the name ribbongrass.
- Cultivars developed to improve
  - Forage production
  - Soil erosion control
  - Biomass production
  - phytoremediation

(Waggy 2010)

Questions?

Reed Canarygrass: the challenge

- The invasive populations consist of non-native strains or hybrids between the non-native and native strains
  - Invasive populations of reed canarygrass in North America consist of genotypes from repeated releases of European cultivars
    - Interbreeding has resulted in high genetic diversity and novel genotypes as compared to native populations
    - Can adapt quickly to an environment and changing conditions
    - Releases of new phenotypes into the environment may keep the species competitive

(Dore and McNeil 1980, Lavergne and Molofsky 2004)

Reed Canarygrass: the challenge

- Occurs in wet meadows, prairie potholes, marshes, riparian areas, and peatlands (bogs and fens)
- Reed canarygrass is most invasive within sedge/wet meadow zones of wetlands -
  - Research in the prairie pothole region indicates that sedge dominated zones are the least likely to naturally revegetate
    - Due to
      - Poor dispersal ability of native wetland sedges and grasses
        - Resources primarily allocated to clonal spread vs. sexual reproduction (seed)

(Galatowitsch and van der Valk 1996, Waggy 2010)

Anthropogenic Disturbances

- Where natural vegetation, hydrology, soils, or fertility have been or altered
  - Directly
  - Indirectly
- Reed canarygrass typically spreads mid-late succession

Waggy 2010

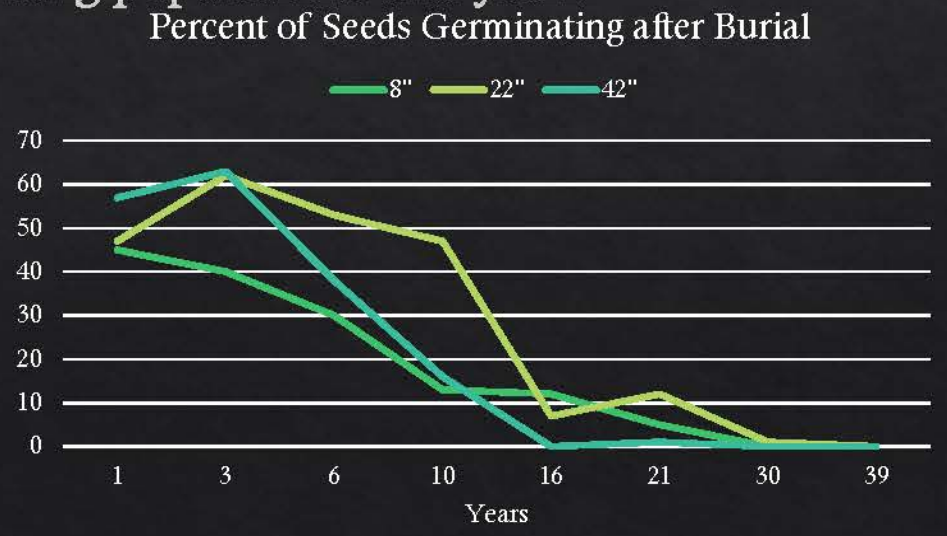
Reed Canarygrass

- Becomes invasive due to
  - Rapid growth rate
  - Tall leafy shoots
  - Extensive lateral spread of canopy and rhizomes
- Biofeedbacks
  - Can increase nutrient and carbon turnover rates in wetlands
  - Forms a thick duff layer

(Iannone and Galatowitsch 2008, Volder et al 2007)

Reed Canarygrass Propagation

- Spread by rhizomes and tillers in established populations
  - Up to 74% of new shoots may come from rhizomes
  - May root at nodes
- Colonizes new sites by seed
- Seed production and viability is highly variable among populations and years
- Invests in the seed bank
  - NJ tidal wetland = 100-5000 seeds/m^2
  - MN wet meadow = 475-862 seeds/m^2
  - WI sedge meadow and cattail stand
    - Wet soil conditions = 0-1126 seeds/m^2
    - Flooded conditions = 0-211 seeds/m^2



(Adams and Galatowitsch 2008, Evans et al 1941, Leck and Simpson 1994, Lyons 2003, USDA 1948)

Resource Concern: Soil Quality Degradation

- Subsidence
- Compaction
- Organic matter depletion
- Concentration of salts or other chemicals

Soil Nutrient Availability

- Excess nitrogen and phosphorus concentrations increase reed canarygrass biomass and tiller production.
- Significant relationship between nutrient levels and the competitive invasiveness of reed canarygrass
  - Nitrogen
  - Cation exchange capacity
  - Calcium
- Soil carbon amendments
  - Can tie up excess inorganic soil nitrogen
  - Need high C:N ratios
    - Cedar sawdust (31:1) – 9 week effect
    - Pine sawdust (187:1) reduced inorganic soil nitrogen levels allowing a native sedge to outcompete reed canarygrass
      - Recommended reducing inorganic soil N to < 30 mg kg^{-1}

(Figiel et al 1995 and Iannoe et al. 2008)

Resource Concern: Excess/Insufficient Water

- Excess water
- Insufficient water or inefficient moisture management

Resource Concern: Water Quality Degradation

- Excess nutrients in surface and ground waters
- Pesticides transported to surface and ground waters
- Excess pathogens and chemicals from manure, bio-solids, or compost
- Excessive salts in surface and ground waters
- Petroleum, heavy metals, and other pollutants transported to receiving water sources
- Excessive sediment in surface waters

Resource Concerns: Air Quality Impacts

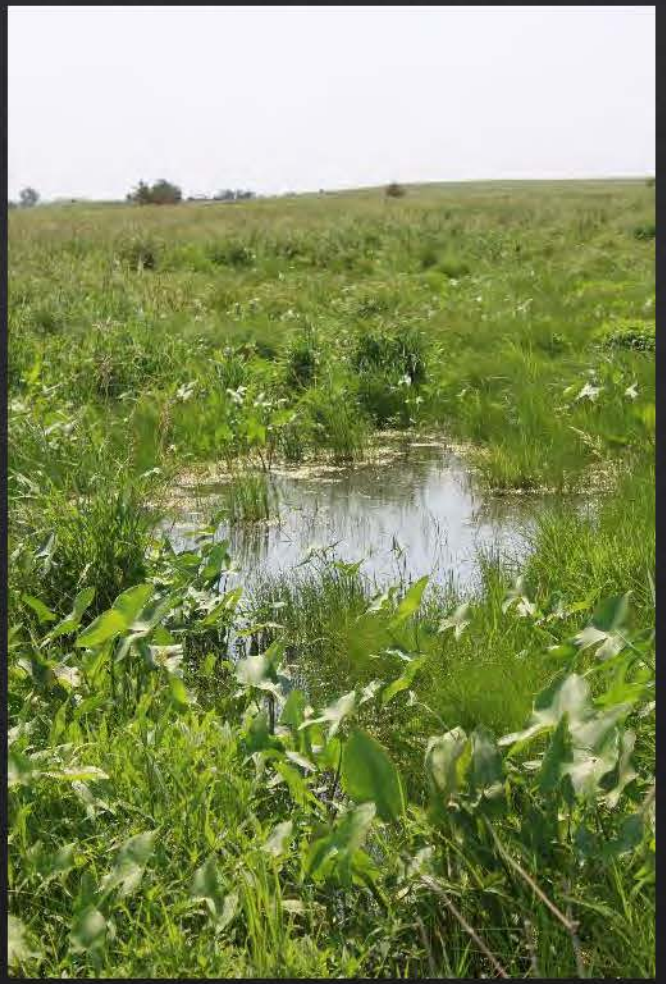
- Emissions of Particulate mater and PM precursors
- Emissions of Greenhouse Gases
- Emissions of ozone precursors

- Climate change may be impacting invasion by way of increasing carbon availability
  - Favors the spread of C3 cool season plants
  - C4 warm season plants lose their competitive edge

(Vitousek 1994)

Resource Concern: Inadequate habitat for fish and wildlife

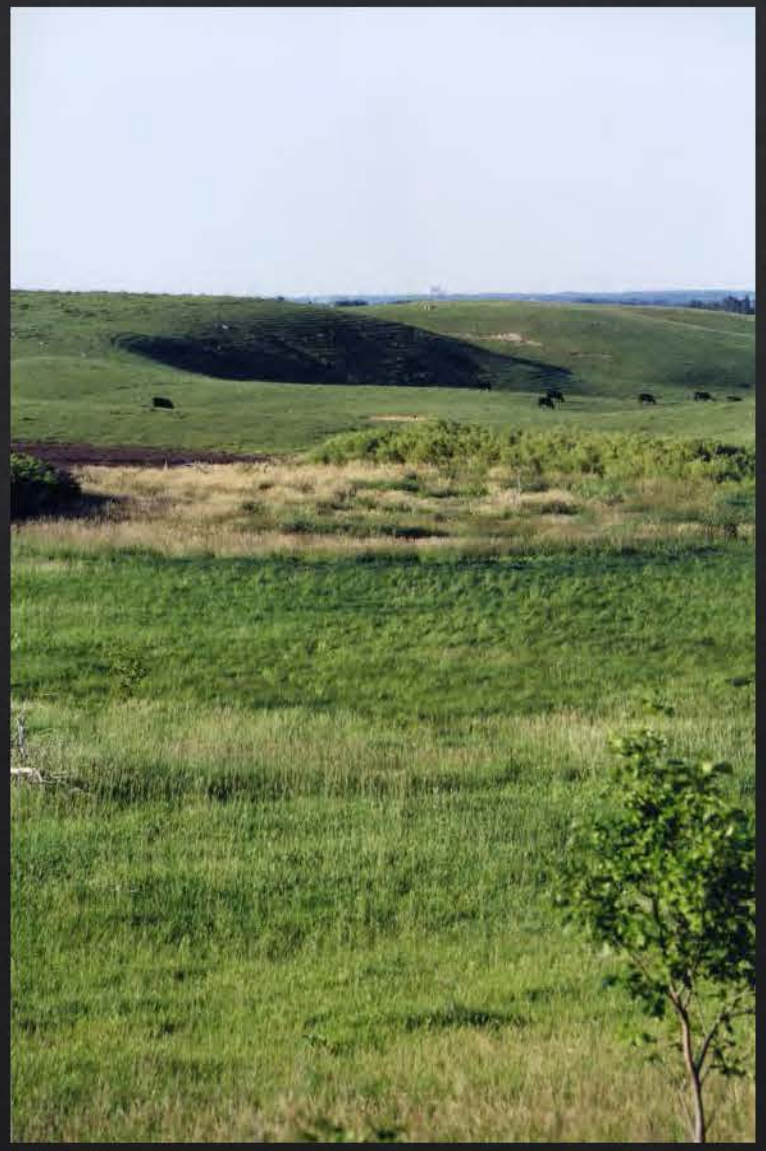
- Monotypic Reed canarygrass stands lack the vegetative structure and diversity of native sedge meadow communities.
- Pheasants preferred Canada bluejoint (*Calamagrostis canadensis*) stands over reed canarygrass stands in WI
- Greater Sandhill Cranes preferred to nest in spikerush plant communities as compared to reed canarygrass stands in OR.



(Gilbert et al 1994, Martin et al 1951Peach and Zedler 2006)

Resource Concern: Livestock production limitation

- Inadequate forage
- Inadequate shelter
- Inadequate water



Resource Concern: Degraded Plant Condition

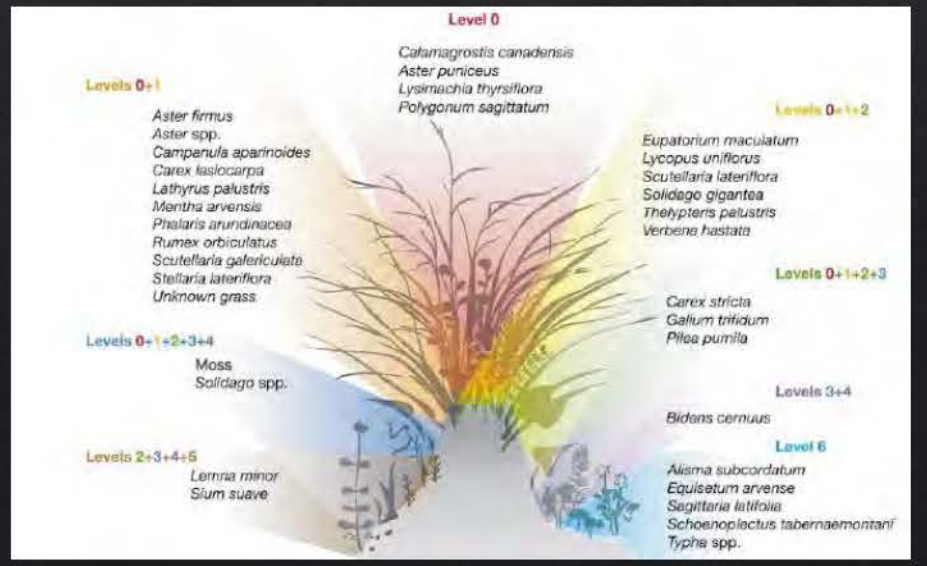
- Undesirable plant productivity and health
- Inadequate structure and composition
- Excessive plant pest pressure
- Wildfire hazard, excessive biomass accumulation

Habitat degradation

- Tussock sedge forms ~15 cm high tussocks
  - Standing water to saturated soil between tussocks
  - Drier conditions prevail as you move to the top of the tussock
  - Microtopographic variation

adds niche complexity and diversity

- Found to provide a 10-fold increase in species diversity in Wisconsin sedge meadows as compared to reed canarygrass stands



Peach and Zedler 2006

Light Requirements

- In light limited conditions, reed canarygrass
  - allocates resources to asexual reproduction and spreads by tillers
  - Tiller shoot biomass and rhizome survival reduced
- Germination rates are higher in well lit environments
  - Lab experiment
    - 0% germination buried ≥0.4”
    - Almost 100% germination when exposed on the surface

(Leck 1996, Maurer and Zedler 2002)

Light availability

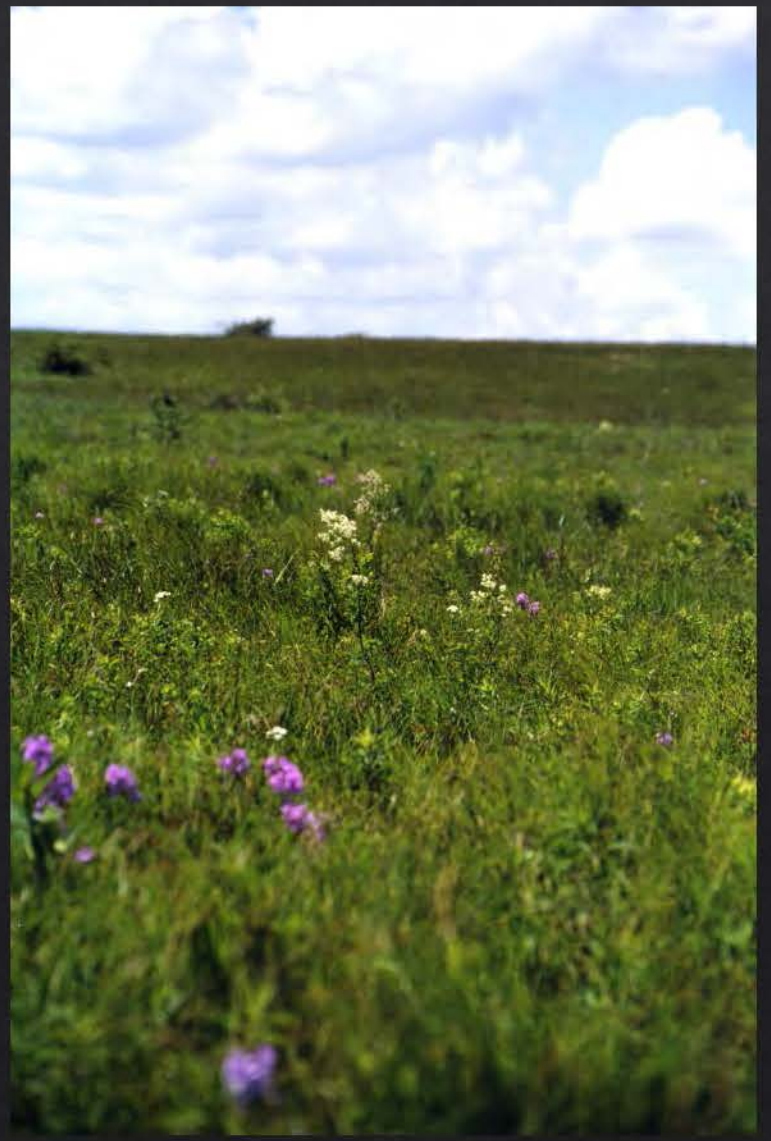
- Low red:far-red light ratios reduce reed canarygrass seed germination up to 30%
- In heavy shade, reed canarygrass
  - survival was reduced by 25%
  - Growth was reduced by 95%
  - Species rich plantings of natives reduced reed canarygrass germination
  - Reed canarygrass seed planted into species rich, native stands did not germinate
    - Unless the species rich native stand was manipulated
      - Reed canarygrass germination in openings was 43% lower in a diverse native stand as compared to a single species native monoculture

(Lindig-Cisneros and Zedler 2001)

Reed Canarygrass: a case of get in where you fit in

- Population – individuals of the same species occurring within a distinct boundary
- Community – all living species occurring within a given area
- Assemblage – all species of a certain taxonomic group (grass assemblage, forb assemblage, insect assemblage, etc.)
- Guild – species that utilize the same resource, such as cool season plants (C3), warm season plants (C4), legumes, etc. (synonymous with functional group/guild)
- Ecosystem – both the living and nonliving components in an environment
  - Regulates energy flow and nutrient cycling within a given space and time

(Morin 1999)



Questions?

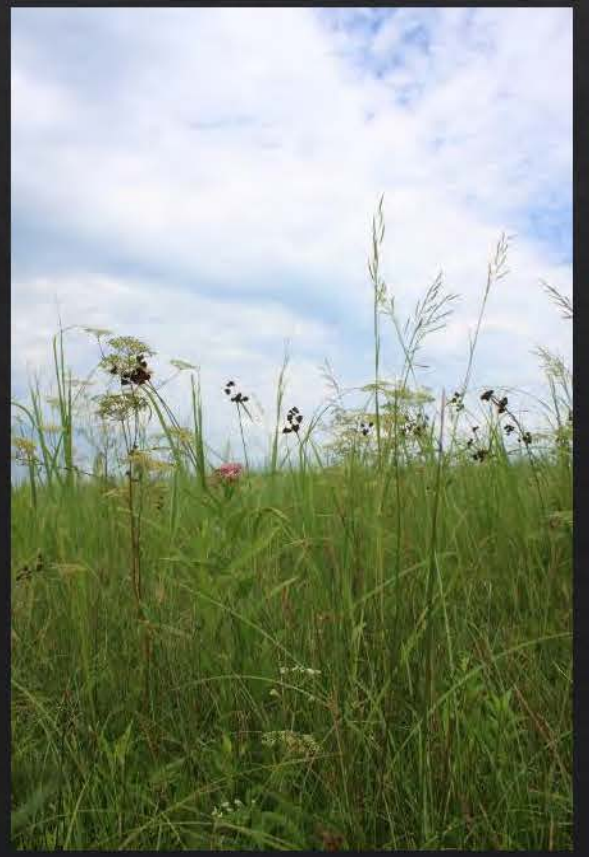
Communities

- Driven by the strength of organism interactions
  - Some interactions are strong
  - Some interactions are weak
- Interactions can occur
  - Between individuals within the same species (intra-specific)
  - Between separate species (interspecific)

(Morin 1999)

Between Species Interactions

- Direct between species interactions can be
  - Negative for both species under competition
  - Negative for prey and positive for the predator
  - Negative or neutral for plants under herbivory while positive for the herbivore
  - Negative for a species under parasitism while positive for the parasite
    - Don't forget parasitic and hemiparasitic plants
  - Positive for one species and neutral for the other under commensalism
    - brown-headed cowbirds and livestock
  - Positive for both species under mutualism
    - Mycorrhiza and host plants
- Indirect effects from all of these interactions may benefit the community, and even the species, as a whole.
- Delimits and drives ecological neighborhoods



(Morin 1999)

Competition

- When 2 or more species are utilizing a limiting resource at the same time and place
  - This has a harmful effect on both species
- May be diffuse among many species
- Can be intense between few species

(Morin 1999)

Niche

- An area occupied
- Resources used
  - Which resources
  - Timing of use
  - Location of use
- If two species within an interactive distance (i.e. neighborhood) utilize the same limiting resource at the same time and place without interruption, one will go extinct.
  - Niche exclusion

(Morin 1999)

Niche Partitioning

- Species competition (lose-lose) drives each species to reduce competition by utilizing a resource differently by capitalizing on respective strengths and weaknesses
  - Resource partitioning
    - Species uptake/utilize resources
      - at different times,
      - Places (spatial variation)
      - or in different ways
    - Disturbance
- Results in moderating the impact of competitive species and prevents competitive exclusion and loss of diversity

(Morin 1999)

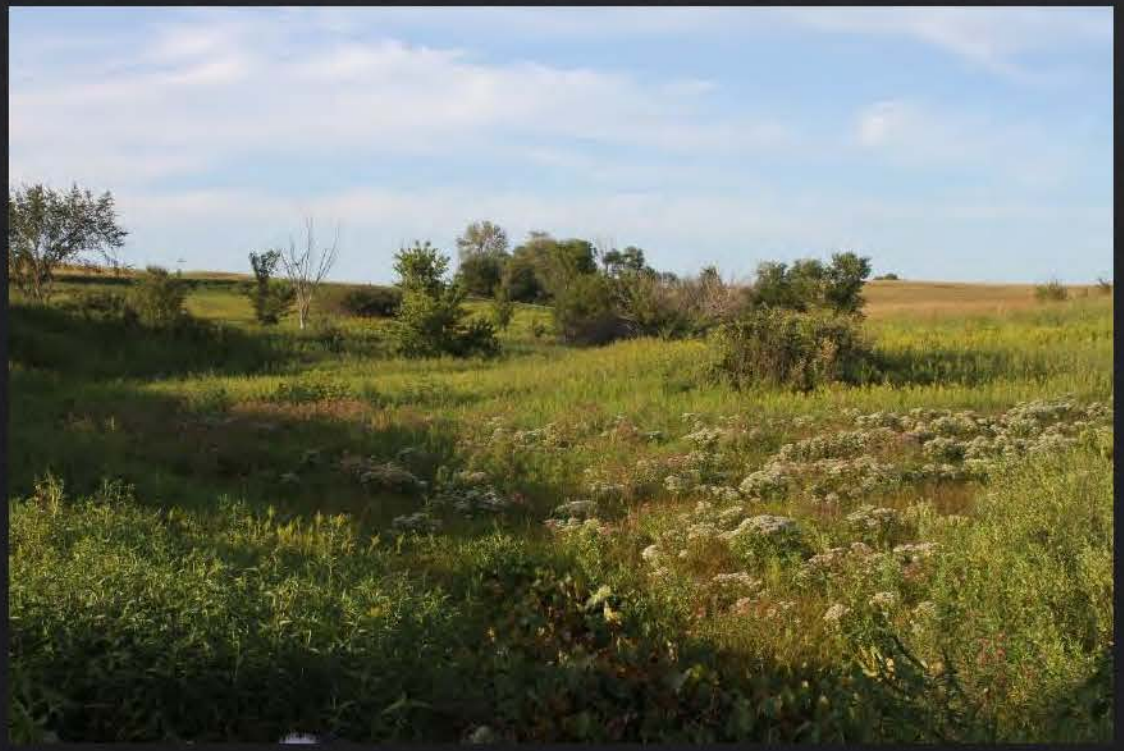
How communities form

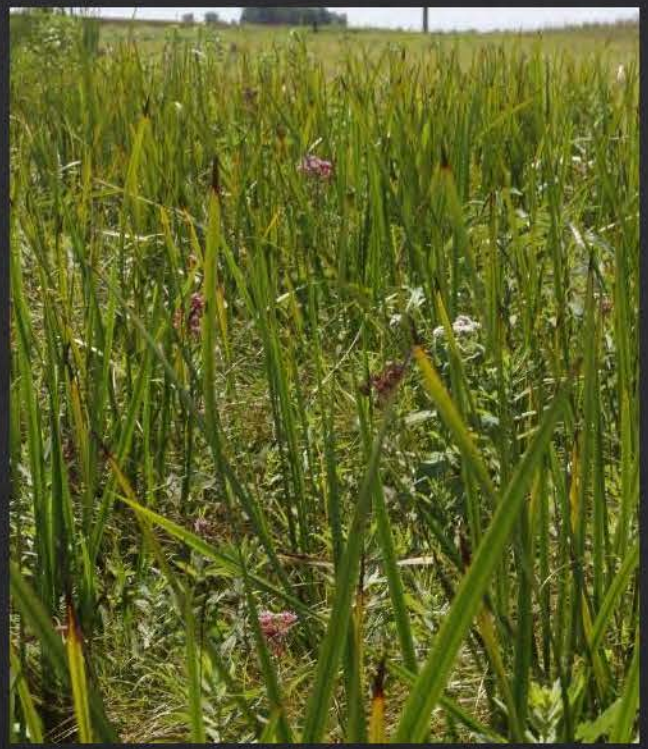
- Transitions in species and composition over time
- Occurs after a disturbance
- Transitions occur based on the composition of the community itself
  - Dispersal rates
  - Residual species and their propagules (species pool)
  - Priority affects
    - Alters resource availability
    - May inhibit, tolerate, or facilitate the establishment of new species to the community

(Morin 1999)

Community Assembly

- Occurs over time and is interrupted by disturbance
  - Typically results in non-achievement of a “climax” community
  - Multiple “stable” states are possible





(Morin 1999)

Disturbance: maintenance processes

- Community diversity, stability, and development is driven by one or more maintenance processes (fire, wind throw, flooding, grazing, browsing, etc.)
  - Induces patchiness/mosaics
  - Influenced by the disturbance's
    - Timing
    - Extent
    - Duration
    - Frequency
    - Intensity

(Morin 1999)

Reed Canarygrass Prevention Recap

- Nutrient reduction
- Reduce sedimentation
- Restoration of natural hydrology and hydrologic regimes
- Restoration of natural maintenance processes
- Reduction of canopy altering activities
- Restoration and maintenance of diverse, site adapted plant communities.

Management strategies

- Carbohydrate content of reed canarygrass rhizomes is the lowest early in the growing season
  - Increases July – November
- Mowing
- Herbicide
- Grazing
- Cultivation
- Fire
- Shading
- Flooding

Only long-term, strategic, ecosystem based approaches taking advantage of the species growth characteristics and phonological stages will be successful.

TABLE #1 – Management Practices

Treatment	Effect	Should use	Could use	Should not use	Comments
Burning 	• Removes biomass and litter; may kill seeds on soil • Reduces available nitrogen over multiple burns • Releases seed bank of desirable/undesirable species • Stimulates dormant buds of RCG, rhizomes re-sprout • Can jumpstart growing season by warming soil	• To reduce RCG in late spring after RCG is active but before natives break dormancy • To force RCG to re-sprout and use reserves from rhizomes • Use in combination with other practices	• To remove thatch prior to a planting/seeding of desirable natives • To remove thatch and prompt early spring sprouting of RCG, which can then be treated with glyphosate or sethoxydim	• In fall to control RCG in short term; RCG benefits from high light conditions after fire • In early spring in mixed vegetation sites; RCG growth is encouraged by increased light, unless you plan to combine with another treatment • On organic sites if very dry	• Jumpstart occurs if burn done in fall or spring • No research on critical density of RCG that can be controlled by burning alone • Early burns will stimulate RCG; timing and frequency critical
Excavation 	• Removes rhizomes and seed bank • Removes sediment and nutrients • Alters hydrology	• Where material can be pushed to fill drainage ditches or where it can be moved off site; where deeper water is desired • During winter, to reduce soil compaction • During summer when wet sites are dry	• To remove alluvium over native wetland soils	• If there is no soil disposal site. • If compaction is an issue • If you don't want a deep-water marsh. • If there is a high-quality remnant plant community in area	• May cause soil compaction • RCG will rapidly re-colonize disposed soil; use caution when selecting a disposal site • Additional treatments will be necessary on drier sites • Seed with natives afterwards, except in the deepest water, or if a rich native seed bank exisits • May require special permits
Tree/shrub planting 	• When woody species overtop RCG, shade slows its growth • May change plant community • Adds structure to habitat	• Where herbaceous vegetation cannot gain a competitive advantage	• Where landscape is receiving RCG seed inputs • Where inflows can't be diverted • To connect existing woody patches	• Where management goal is to maintain grassland habitat	• Apply herbicide/mulch around newly planted trees/shrubs • Conifers may be the most effective at shading RCG • Need to control RCG for 3-5 years to allow trees to establish
Grazing 	• Reduces biomass in spring • Causes disturbance • Allows seedling establishment (good/bad) • Adds nutrients to system	• In highly disturbed sites to reduce RCG biomass • In fall, after a prescribed burn (RCG regrowth more palatable)	• To reduce biomass and height before herbicide treatment • To reduce seed production • Lightly, to sustain diversity	• During wet conditions in spring where trampling and compaction can damage a site • If there is a high-quality remnant plant community in area	• Effective at suppression only • Use proper stocking rates to prevent overgrazing of desirable species
Mowing & harvesting (haying) 	• Removes biomass and nutrients • Reduces RCG height • Similar to fire (promotes seed establishment, stimulates plant growth by increasing light)	• To reduce biomass before herbicide treatment • To remove P from site • Before RCG seed heads appear • To prepare for herbicide application	• As a substitute for fire (though not quite the same) • To change fire behavior by reducing fuel height	• Where tussocks and microtopography will be damaged • When grassland bird nesting habitat will be impacted. • If site is too wet for equipment	• On high quality sites, avoid use during growing season • Mow before RCG seed heads appear (boot to late boot stage)* to prevent seed production

Wisconsin Reed Canary Grass Management Working Group. 2009. Reed Canary Grass *(Phalaris arundinacea)* Management Guide: Recommendations for Landowners and Restoration Professionals

TABLE #3a – Species recommended for reed canary grass replacement

Latin name	Common name	Species Preferred Ranking	Successional Stage			Phenology	Hydrology	Geographic Area	Comments
			Early	Mid	Late				
Grasses									
Calamagrostis canadensis	Canada blue-joint	1			x	mid	wet/wet mesic	statewide	rhizomatous
Cinna arundinacea	Wood reed	3		x	x	mid	mesic	more common south	semi shade-- may be good in tree planting areas, prefers loam soils
Cinna latifolia	Drooping wood reed	3		x	x	mid	mesic	more common north	semi shade-- may be good in tree planting areas, prefers loam soils
Echinochloa muricata	Coastal barnyardgrass	1	x			mid	wet mesic	statewide	annual; use as cover crop
Echinochloa walteri	American barnyardgrass	1	x			mid	wet mesic	statewide	annual; use as cover crop
Elymus canadensis	Canada wild rye	1	x			early-mid	mesic	more common south	semi shade-- may be good in tree planting areas
Elymus riparius	Riparian wild rye	1	x			early-mid	wet mesic	more common south	semi shade-- may be good in tree planting areas
Elymus virginicus	Virginia wild rye	1	x			early-mid	wet mesic	more common south	semi shade-- may be good in tree planting areas
Glyceria canadensis	Rattlesnake grass	2	x	x		mid	wet/wet mesic	more common north	can be difficult to establish
Glyceria grandis	Reed manna grass	2	x	x		mid	wet/wet mesic	statewide	shorelines, shallow water
Glyceria striata	Fowl manna grass	2	x	x		mid	wet/wet mesic	more common south	shorelines, shallow water
Leersia oryzoides	Rice cut-grass	1	x	x		late	wet	statewide	does well in organic soils
Muhlenbergia racemosa	Wild timothy	1	x	x		early-mid	wet mesic	statewide, less common southwest	may be resistant to grass-specific herbicide, prefers loamy soils

Wisconsin Reed Canary Grass Management Working Group. 2009. Reed Canary Grass *(Phalaris arundinacea)* Management Guide: Recommendations for Landowners and Restoration Professionals

Appropriate Strategies Depend on Site History and Characteristics

TABLE #2 – Site Assessment

Amount of RCG present[1]	Site characteristics/vegetation (recent <25 years)	Hydrology[2]	Inputs[3]	Tree Planting	Burn[4]	Excavate[4,5]	Graze	Mow[6]	Broad-Spectrum Herbicide[6]	Grass-specific Herbicide[7,8]	Tillage/ Farming	Raise water levels[9]	Seeding[9]
RCG Monotypes	< 25 years since tillage/farming, uniform topography[2]	Normally wet	High/low	E	2	2			2	2		1	1
		Seasonally dry		1	1	1	1	1	1	2	1		1
	> 25 years since tillage/farming or no ag history, uneven topography[2]	Normally wet	High/low	E	2					2		1	2
		Seasonally dry	Low		1			2		2			2
			High	2	1		2	2		2			2
	Shrub or forest edge[2]	Normally wet	High/low	E	2			1	2	2			2
		Seasonally dry		1	2			1	2	2			1
RCG Mixtures	Mixed with non-native grasses and/or weedy forbs	Normally wet	High/low	E	2	2			2	2		1	1
		Seasonally dry		1	1	1	1	1	1	2	1		1
	Mixed with native grasses	Normally wet	High/low		2				spot-spray	spot-spray			2
		Seasonally dry			1			2	spot-spray	spot-spray			2
	Mixed with native sedges, rushes and forbs	Normally wet	High		2					2			2
			Low		2					2			2
		Seasonally dry	High/low		1			1		1			2
	Mixed with shrub or forest matrix[2]	Normally wet	High/low	E						2			2
		Seasonally dry		1						1			2
	Discreet linear strips or clumps of RCG within a desirable native plant community				1			1	spot-spray	spot-spray			1

Wisconsin Reed Canary Grass Management Working Group. 2009. Reed Canary Grass *(Phalaris arundinacea)* Management Guide: Recommendations for Landowners and Restoration Professionals

Competitive Native Grasses, Sedges and Rushes

- Bouteloua curtipendula
- Bromus inermis
- Calamagrostis canadensis
- Calamovilfa longifolia
- Carex lacustris
- Chasmanthium latifolium
- Cyperus esculentus
- Dulichium arundinaceum
- Eleocharis obtusa
- Eleocharis palustris
- Eleocharis tenuis
- Elymus repens
- Eragrostis spectabilis
- Eriophorum gracile
- Festuca rubra
- Glyceria striata
- Juncus marginatus
- Juncus torreyi
- Leersia lenticularis
- Leersia oryzoides
- Leersia virginica
- Muhlenbergia glomerata
- Muhlenbergia mexicana
- Panicum virgatum
- Pascopyrum smithii
- Phragmites australis
- Schoenoplectus acutus var. acutus
- Schoenoplectus fluviatilis
- Schoenoplectus heterochaetus
- Schoenoplectus maritimus
- Schoenoplectus pungens var. pungens
- Schoenoplectus tabernaemontani
- Scirpus microcarpus
- Scirpus pallidus
- Scolochloa festucacea
- Sorghum halepense
- Spartina pectinata
- Thinopyrum intermedium

Based on comparative: Growth Form, Seed Spread Rate,Seedling Vigor, Root Depth Minimum (inches), Growth Rate, and/or Height - Mature (feet). USDA Plants Database (www.plants.usda.gov)

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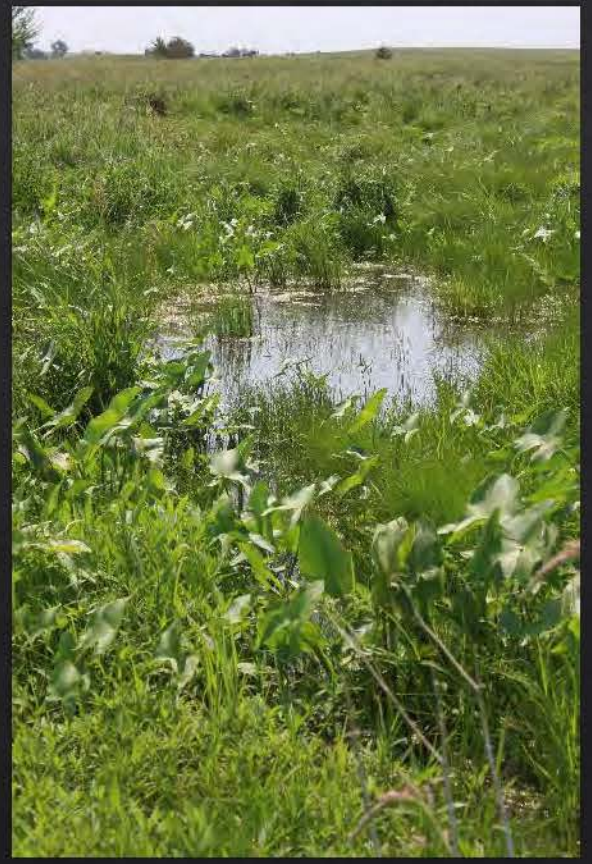
Questions?



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