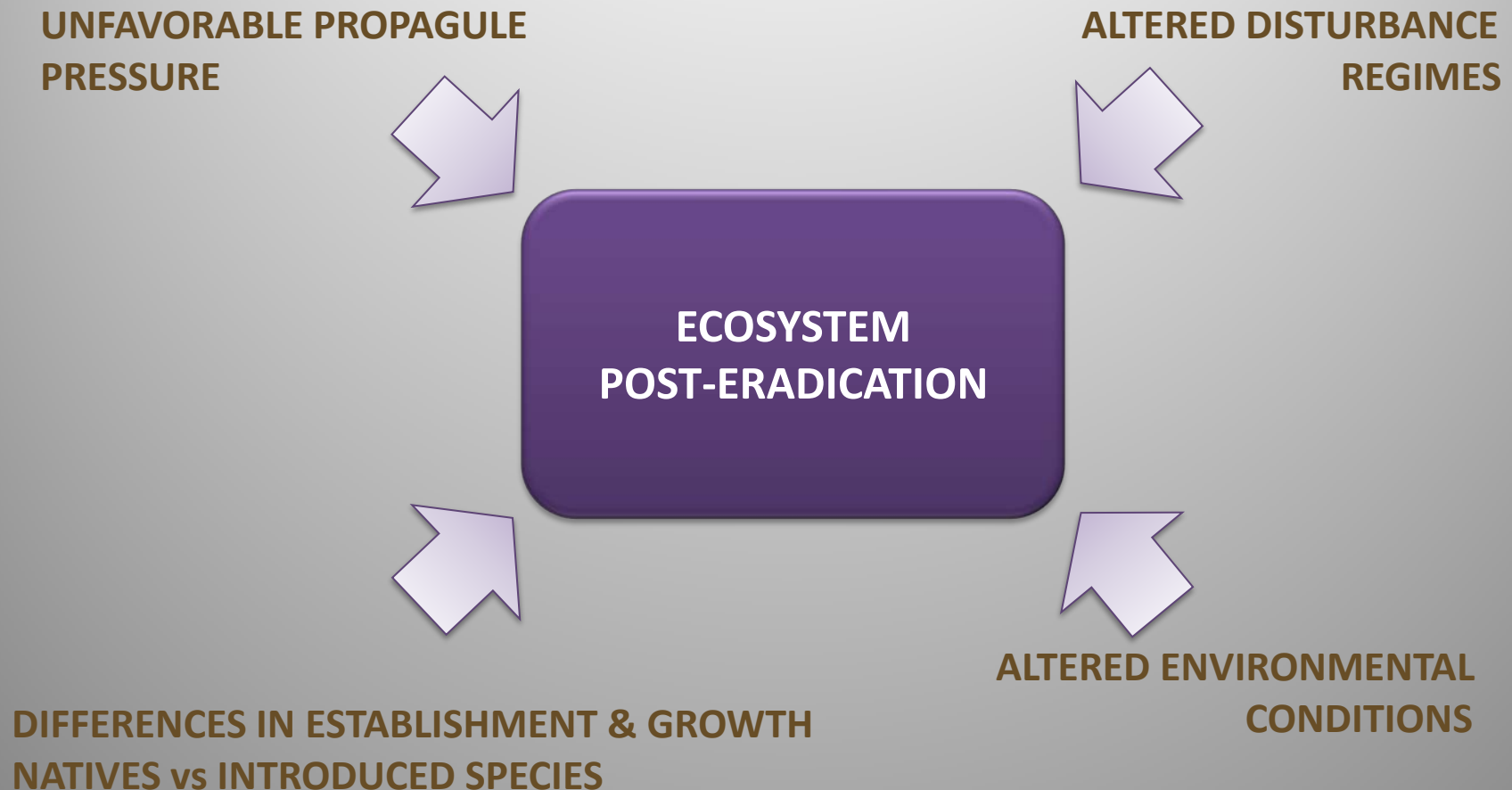


Avoiding Plant Reinvasion: Theory Practice, and Policy

Susan Galatowitsch, University of Minnesota



Ecological Mechanisms Responsible for Reinvasion



Landscape Fragmentation States

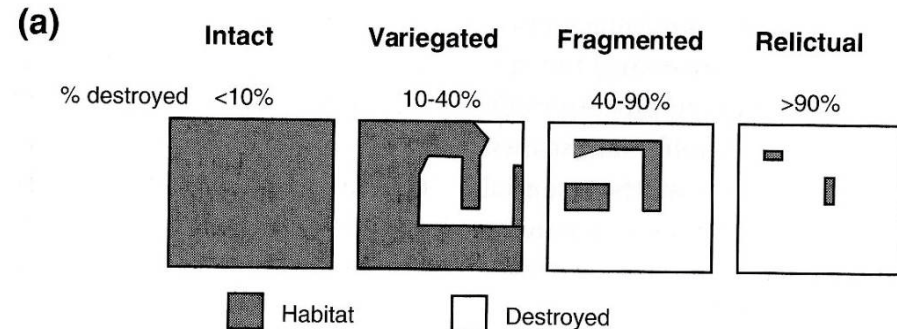
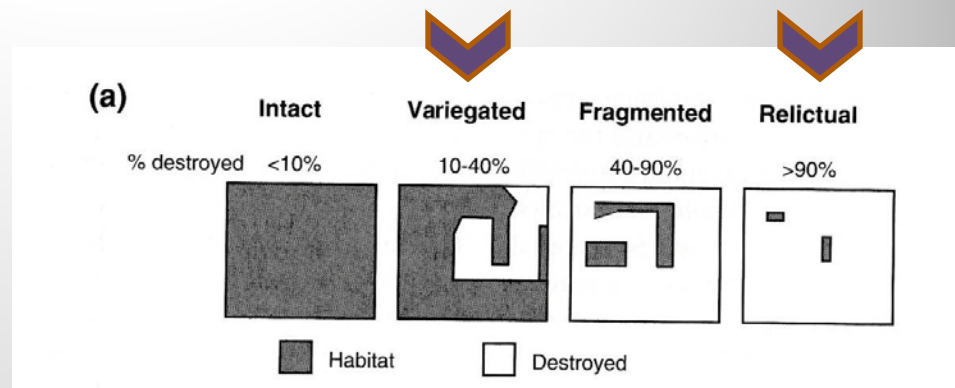


Table 3.1. Four landscape states defined by the degree of habitat destruction

Landscape type	Degree of destruction of habitat (% remaining)	Connectivity ^a of remaining habitat	Degree of modification ^b of remaining habitat	Pattern of modification ^b of remaining habitat
Intact	Little or none (>90%)	High	Generally low	Mosaic with gradients
Variegated	Moderate (60–90%)	Generally high but lower for species sensitive to habitat modification	Low to high	Mosaic which may have both gradients and abrupt boundaries
Fragmented	High (10–60%)	Generally low but varies with mobility of species and arrangement on landscape	Low to high	Gradients within fragments less evident
Relictual	Extreme (<10%)	None	Generally highly modified	Generally uniform

Landscape Fragmentation & Re-Invasion Risk in Post-eradication Sites



	Variegated	Relictual
Propagule pressure	Mix of N and I	Strongly favors I
Disturbance regimes	Variable level of alteration, depending on land use	Highly altered, site restoration potential variable
Environmental conditions	Alteration depends on level of site degradation	Affected by both site and landscape degradation
Differential establishment & growth of N vs I	Depends on site biotic & abiotic factors	Depends on site biotic & abiotic factors

Wet Meadow Reinvasion in Relictual Landscapes

Propagule pressure:
VH RCG, VL Natives

**BARE GROUND
FOLLOWING
RCG REMOVAL**

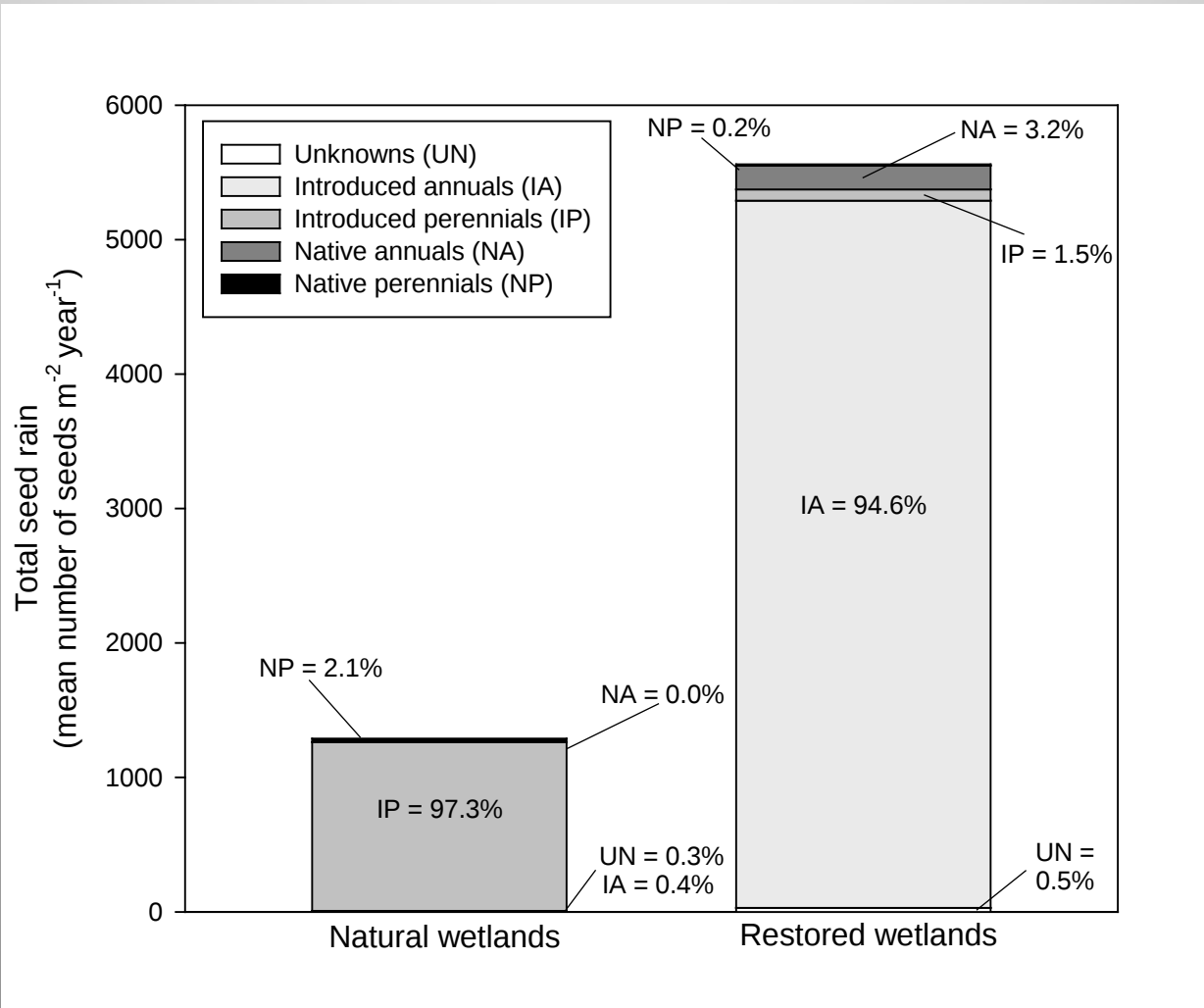
Disturbance Regimes:
Hydrology restored

	Weed	Seed	Seed & Weed	No Action
Fertile Soils	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?
Infertile Soils	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?

Wet Meadow Reinvasion in Relictual Landscapes

Propagule pressure:
VH RCG, VL Natives

BARE GROUND
FOLLOWING
RCG REMOVAL



Kettenring &
Galatowitsch
submitted

Wet Meadow Reinvasion in Relictual Landscapes

**BARE GROUND
FOLLOWING
RCG REMOVAL**

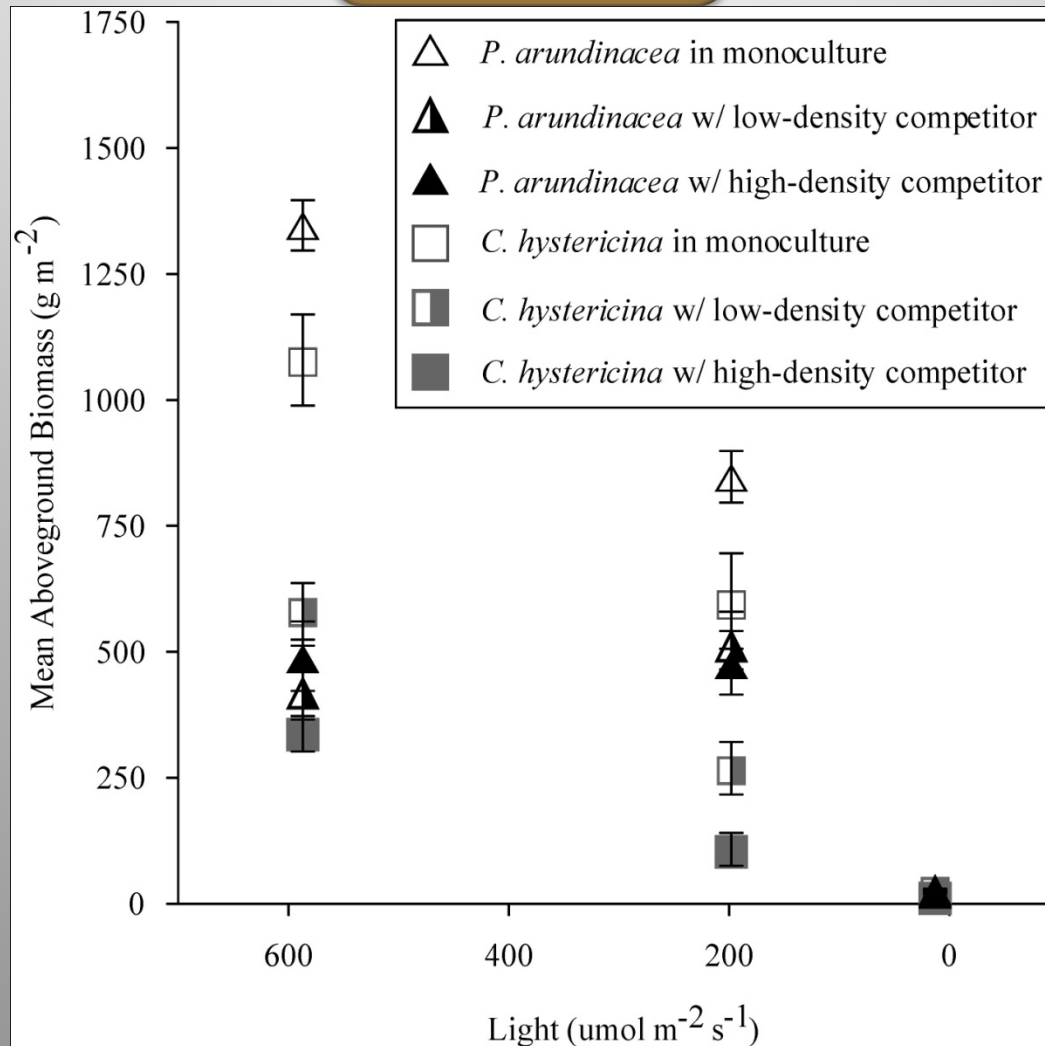
**Disturbance Regimes:
Depends on
Hydrologic Restoration**



Wet Meadow Reinvasion in Relictual Landscapes

**BARE GROUND
FOLLOWING
RCG REMOVAL**

**Disturbance Regimes:
Fire can't shift the competitive
Outcome**



Perry & Galatowitsch
2004

Wet Meadow Reinvasion in Relictual Landscapes

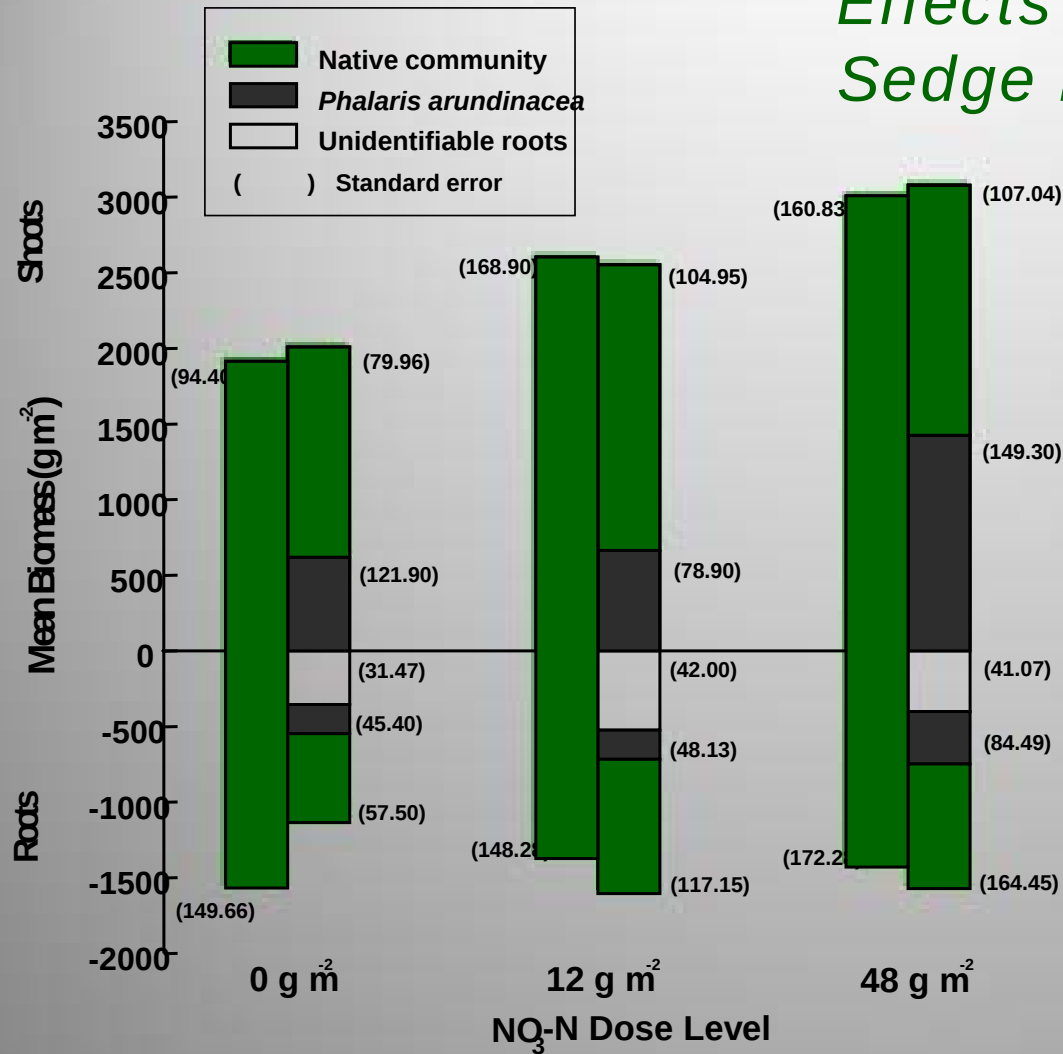
Propagule pressure:
VH RCG, VL Natives

**BARE GROUND
FOLLOWING
RCG REMOVAL**

Disturbance Regimes:
Hydrology restored

	Weed	Seed	Seed & Weed	No Action
Fertile Soils	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?
Infertile Soils	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?

Effects of Nitrate & *Phalaris* on Sedge Meadow Establishment

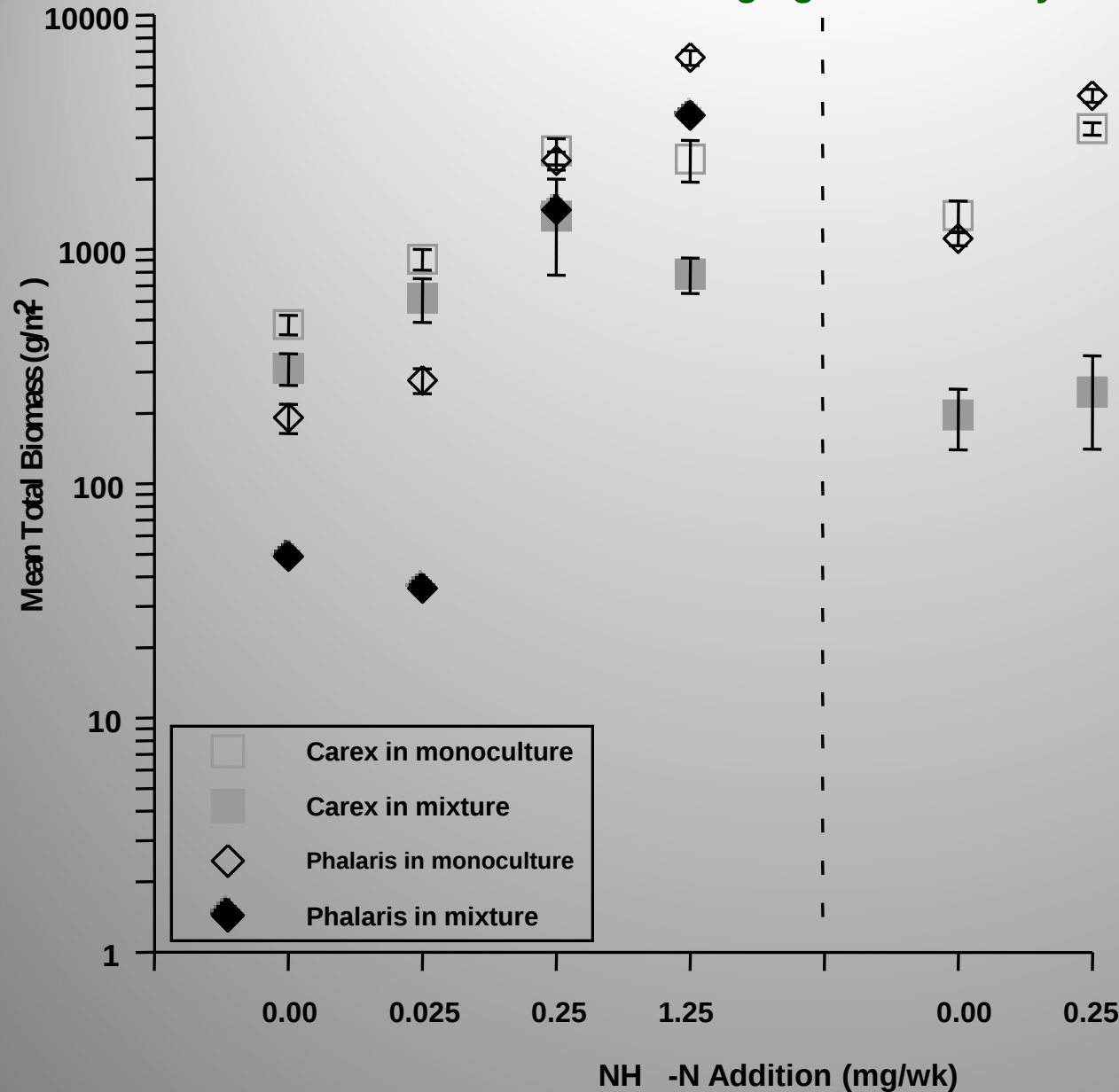


11 species native community
Phalaris density 1/12 native community



Green & Galatowitsch 2002

Altering competitive outcome between *Carex hystericina* and *Phalaris arundinacea* by changing N availability



-25 weeks of growth

-Error bars = 1 SE

-N=8 monocultures

-N=4 mixtures

Perry 2001

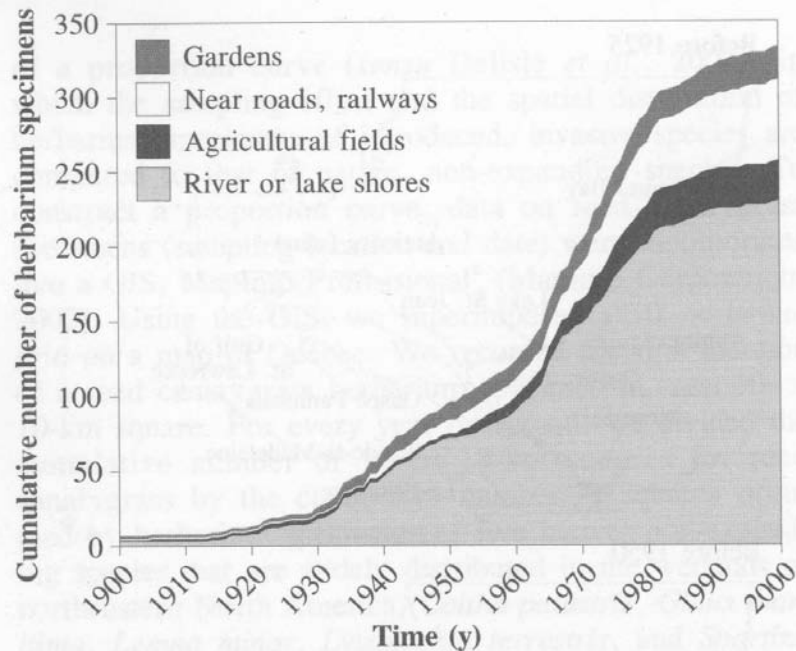


FIGURE 4. Cumulative number of reed canarygrass (*Phalaris arundinacea* and *P. arundinacea* var. *picta*) herbarium specimens found in Québec during the 20th century according to their respective collection habitat.

Long term changes in *Phalaris* distribution & N use: Quebec

LaVoie et al. 2006

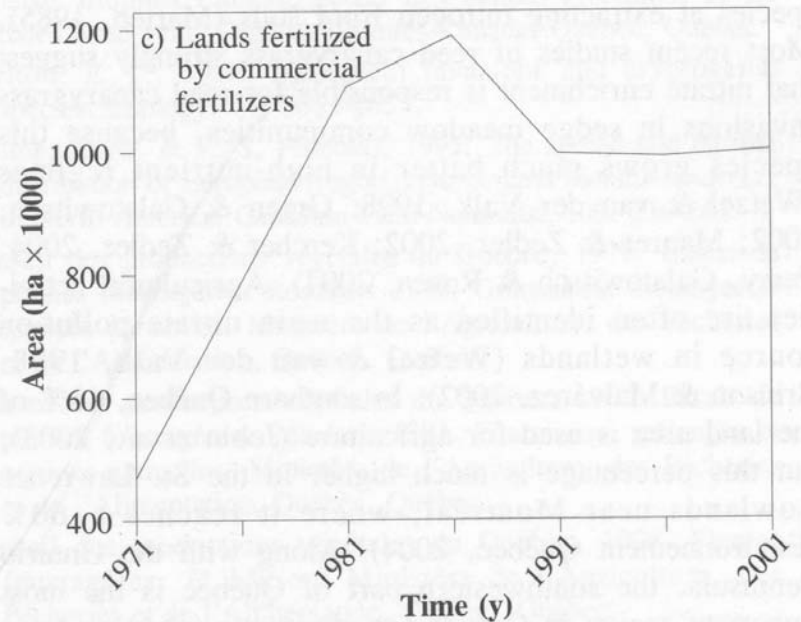


FIGURE 7. Sales of a) fertilizer materials (animal manure, ammonium nitrate, ammonium phosphate, nitrogen solution, potassium chloride, super phosphate, etc.) from 1963 to 1975 and of b) mixed fertilizers in Québec from 1951 to 1975 (April *et al.*, 1967; Bureau de la statistique du Québec, 1968; 1971; 1977; Ministère de l'Environnement du Québec, 2003). No data are available after 1975 and before 1963 for fertilizer materials, and before 1951 for mixed fertilizer. Total area of lands fertilized by commercial fertilizers in Québec from 1971 to 2001 (c) (Statistique Canada, 1992; 1996a; 2001).

Wet Meadow Reinvasion in Relictual Landscapes

Propagule pressure:
VH RCG, VL Natives

**BARE GROUND
FOLLOWING
RCG REMOVAL**

Disturbance Regimes:
Depends on
Hydrologic Restoration

Weed

Seed

Seed & Weed

No Action

Fertile
Soils

**BARE
GROUND,
ANNUALS**

RCG

**WET
MEADOW**

RCG

Infertile
Soils

**BARE
GROUND,
ANNUALS**

**RCG
WM**

**WET
MEADOW**

RCG



Can cover crops reduce reinvasion risk?

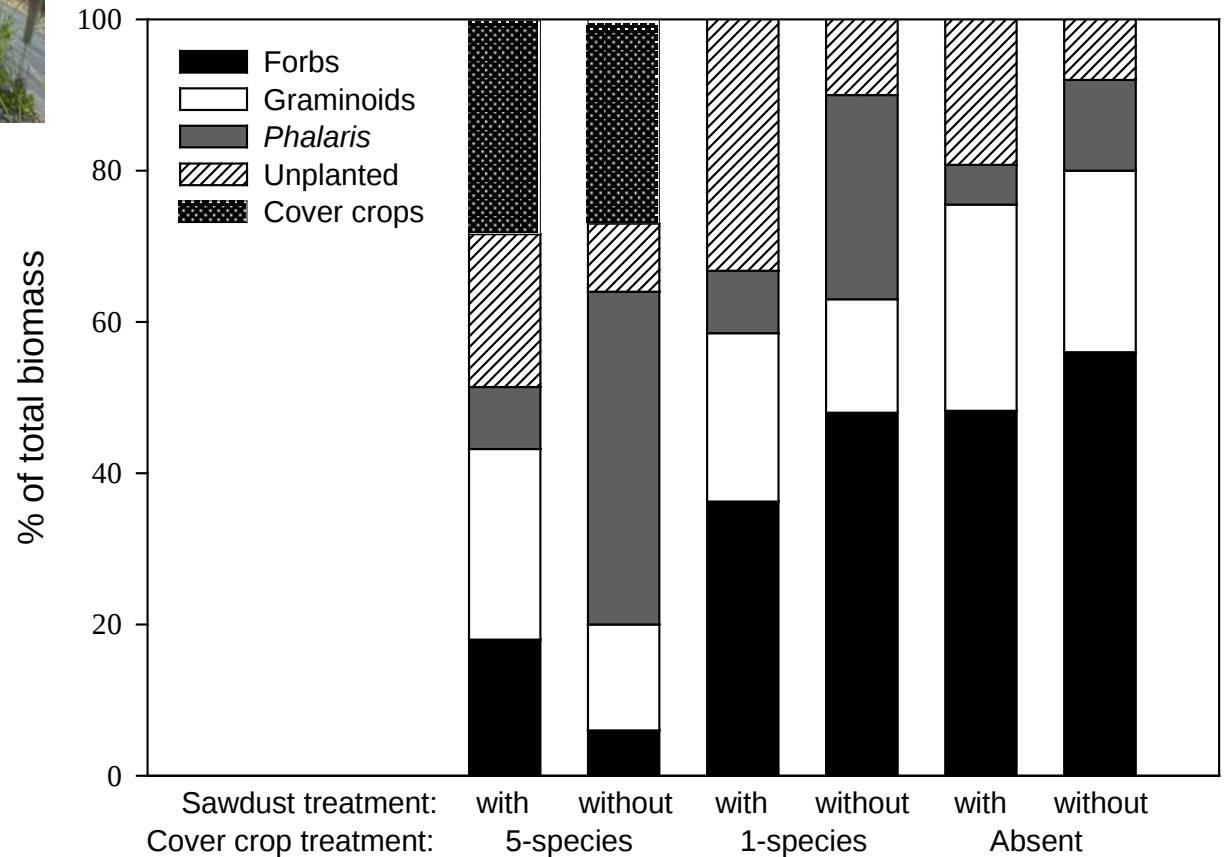


Fig. 2. Final community composition in plots with both the target community and *Phalaris* growing under different sawdust and cover crop treatment combinations.

No, they increase the risk.

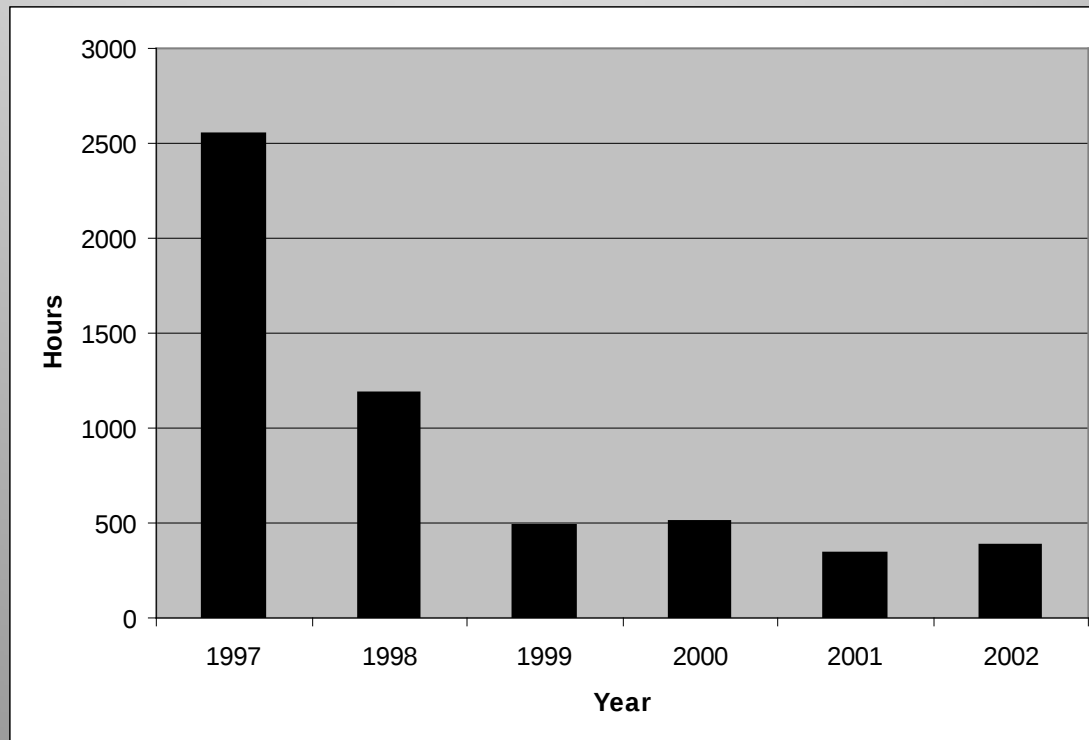
Iannone & Galatowitsch 2008



Spring Peeper Meadow Post-Eradication Management



Dense RCG seedbank
Seedbank eradication – 7 yrs



Wet Meadow Reinvasion in Variegated Landscapes

Propagule pressure:
RCG=N Perennial

**BARE GROUND
FOLLOWING
RCG REMOVAL**

Disturbance Regimes:
Hydrology restored

	Weed	Seed	Seed & Weed	No Action
Fertile Soils	FUTURE COMMUNITY ?	Seeding FUTURE COMMUNITY ?	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?
Infertile Soils	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?	FUTURE COMMUNITY ?

Wet Meadow Reinvasion in Variegated Landscapes

Propagule pressure:
RCG=N Perennial

**BARE GROUND
FOLLOWING
RCG REMOVAL**

Disturbance Regimes:
Hydrology restored

	Weed	Seed	Seed & Weed	No Action
Fertile Soils	 RCG-WM	 RCG	 WET MEADOW	 RCG
Infertile Soils	 WET MEADOW	 RCG-WM	 WET MEADOW	 RCG-WM

Policy & Management Implications

	Policy	Management
Propagule pressure	Spraying w/o seeding = RCG, don't permit in relictual landscapes & on fertile sites.	Revegetation must be coupled to eradication (relictual, fertile).
Disturbance Regimes	Wet meadows aren't restorable where stormwater fluxes are high	Don't seed if hydrology hasn't been restored; Unlike prairie, fire doesn't favor natives vs. invasives.
Environmental Conditions	Restoration of fertile sites is a 10 yr job, not 1-3 yrs	WM is not prairie-seed mixes need correct species. High fertility sites require labor-intensive mgmt until canopy closes.
Differential Establishment & Growth	Greater accountability needed for herbicide applicators—high liability to poor results.	Cover crops can't shift competitive outcome; High native seed density & priming can.

Thanks...
to research sponsors (esp. MnDOT)
and to graduate students listed in talk

