The Association of State Wetland Managers Presents:

Improving Wetland Restoration Success 2014 — 2015 Webinar Series

Prairie Pothole Restoration

Presenters:

Sue Galatowitsch, University of Minnesota and
Carter Johnson, South Dakota State University

Moderators: Jeanne Christie & Marla Stelk

Supported by EPA Wetland Program Development Grant 83541601

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AGENDA

- **Welcome and Introductions** (5 minutes)
  - **Restoration Webinar Schedule & Future Recordings** (5 minutes)
- **Prairie Pothole Restoration: C.J.** (30 minutes)
  - **Question & Answer** (5)
- **Prairie Pothole Restoration: S.G.** (25 minutes)
  - Question & Answer (5 minutes)
- **Prairie Pothole Restoration: C.J.** (10 minutes)
- **Question & Answer** (15 minutes)
- **Wrap up** (5 minutes)

WEBINAR MODERATORS

Jeanne Christie,
Executive Director

Marla Stelk,
Policy Analyst

WETLAND RESTORATION PROJECTS

- Convened interdisciplinary workgroup of 25 experts
- Developing monthly webinar series to run through September 2015
- Developing a white paper based on webinars and participant feedback
- To be continued through 2016 in an effort to pursue strategies that:
  - Maximize outcomes for watershed management
    - Ecosystem benefits
    - Climate change
  - Improve permit applications and review
  - Develop a national strategy for improving wetland restoration success

WEBINAR SCHEDULE & RECORDINGS

WEBINAR SCHEDULE & RECORDINGS

FUTURE SCHEDULE - 2015

- **Tuesday, June 9, 3:00pm eastern:**
  - **Riverine/Riparian Wetland Restoration**

    Presented by:

    Richard Weber, NRCS Wetlands Team; and

    Larry Urban, Montana Dept. of Transportation
- **Tuesday, July 14, 3:00pm eastern:**
  - **Peat Land Restoration**

    Presented by:

    Norman Famous & Marcia Spencer-Famouos, Spencer-Famous Environmental Consultants; Richard Weber, NRCS Wetland Team; and Larry Urban, Montana Department of Transportation

FOR FULL SCHEDULE, GO TO: http://aswm.org/aswm/6774-future-webinars-improving-wetland-restoration-success-project

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PRESENTERS

Sue Galatowitsch
Professor and Head of Fisheries, Wildlife, and Conservation Biology
University of Minnesota

Carter Johnson
Distinguished Professor of Ecology
South Dakota State University
& Chairman of EcoSun Prairie Farms, Inc.

A "COOKBOOK" APPROACH TO WETLAND RESTORATION WON'T WORK

There are too many variables.

- *Ingredients are always different*
- *Reason for 'cooking' varies*
- *Recipe isn't always correct*
- *Inexperienced cooks*
- *Cooking time varies*
- *Poor inspection when "cooking"*
- *Additional ingredients may be needed*
- *Is it really done?*

WE NEED TO UNDERSTAND THE PLANNING PROCESS AND VARIABLES FROM SITE TO SITE THAT MUST BE STUDIED, UNDERSTOOD AND ADDRESSED

EACH WETLAND RESTORATION PROJECT IS UNIQUE:

- *Consider both historic and current landscape setting*
- *Analyze how water moves into and out of the site*
- *Evaluate soils present and identify any onsite drainage*
- *Focus first on hydrology and soil first, last on plants*
- *Develop a plan that is achievable for the site*
- *Develop comprehensive cost estimates*
- *Ensure plan is followed*
- *Hire experienced and knowledgeable contractors*
- *Adapt plan as needed during construction*
- *Determine if monitoring criteria will measure progress*
- *Keep good records and share with others*

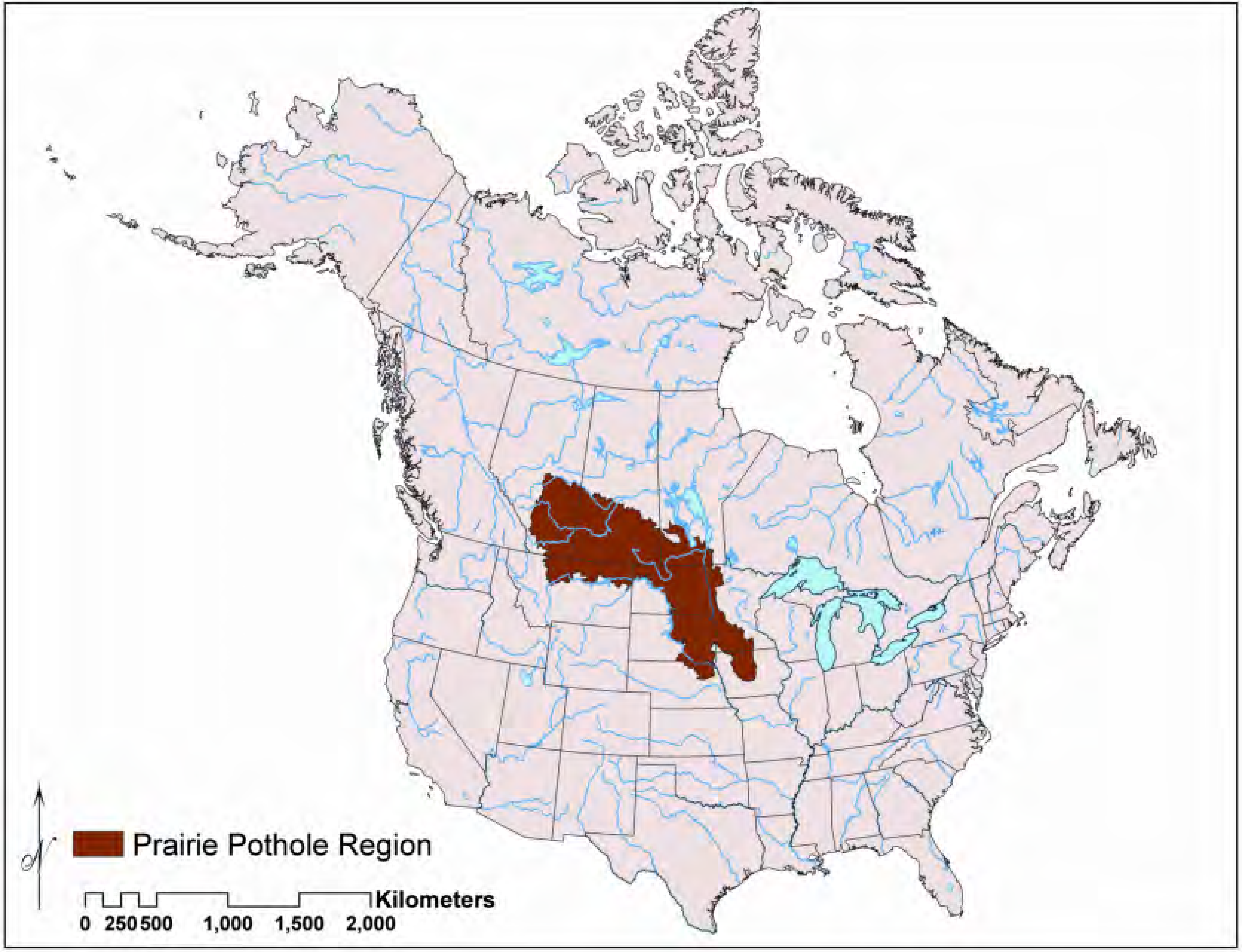
Prairie Pothole Restoration

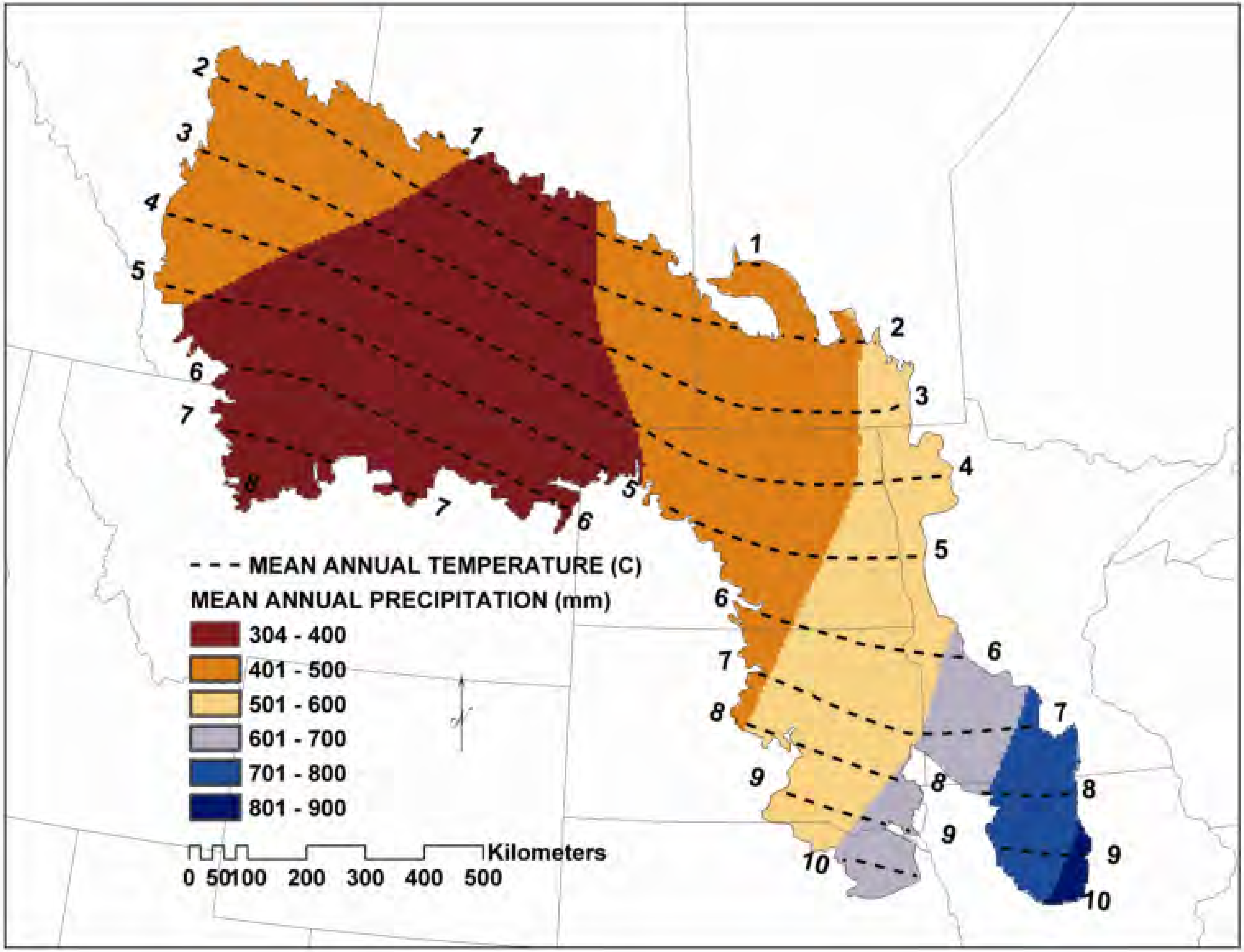
IT WILL TAKE US A FEW MOMENTS TO MAKE THE SWITCH…

Photo Credit: Laura Hubers, USFWS

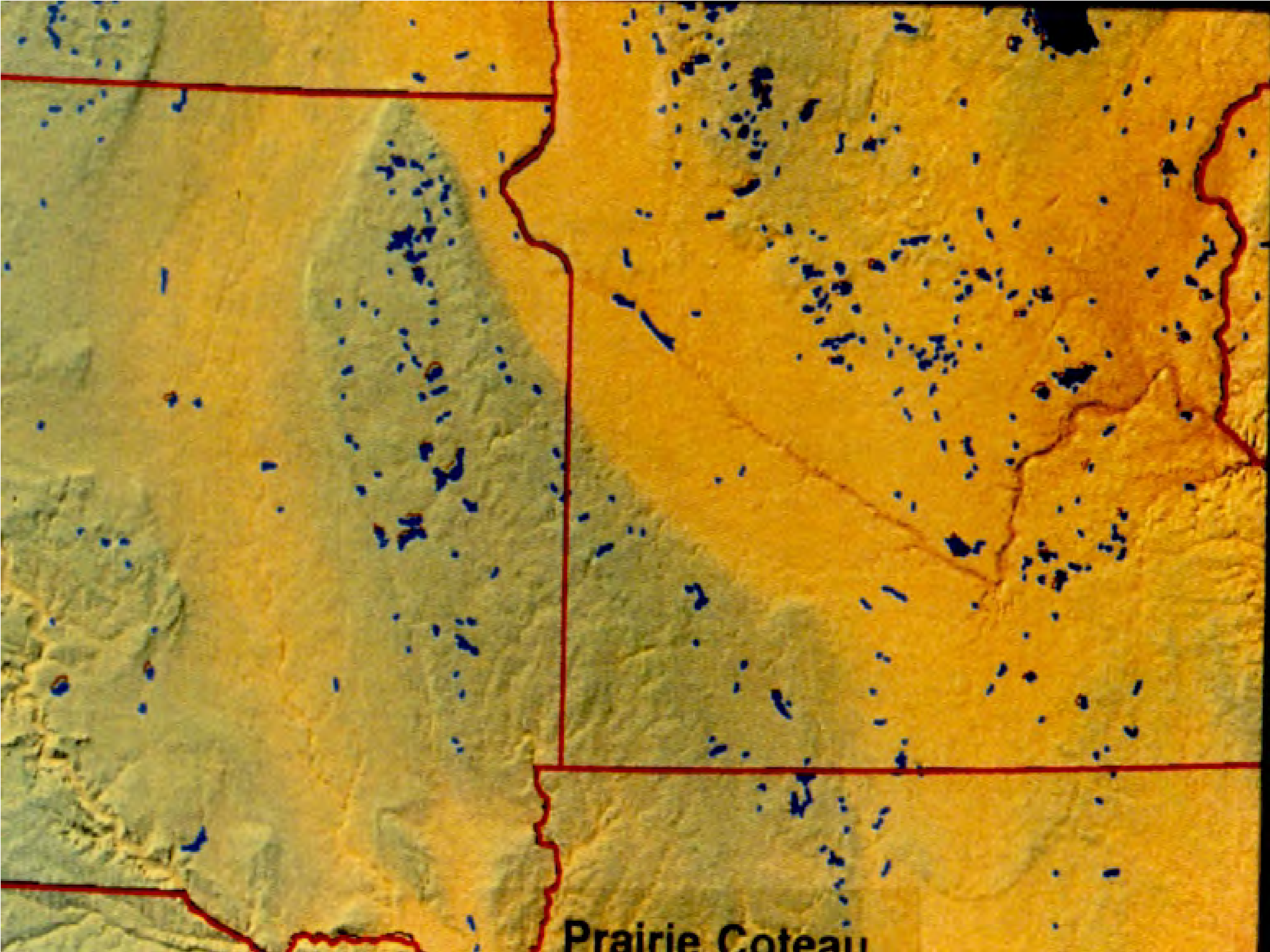
Glaciated Prairie Wetlands: Potholes 101 and Their Vulnerability to Climate Change

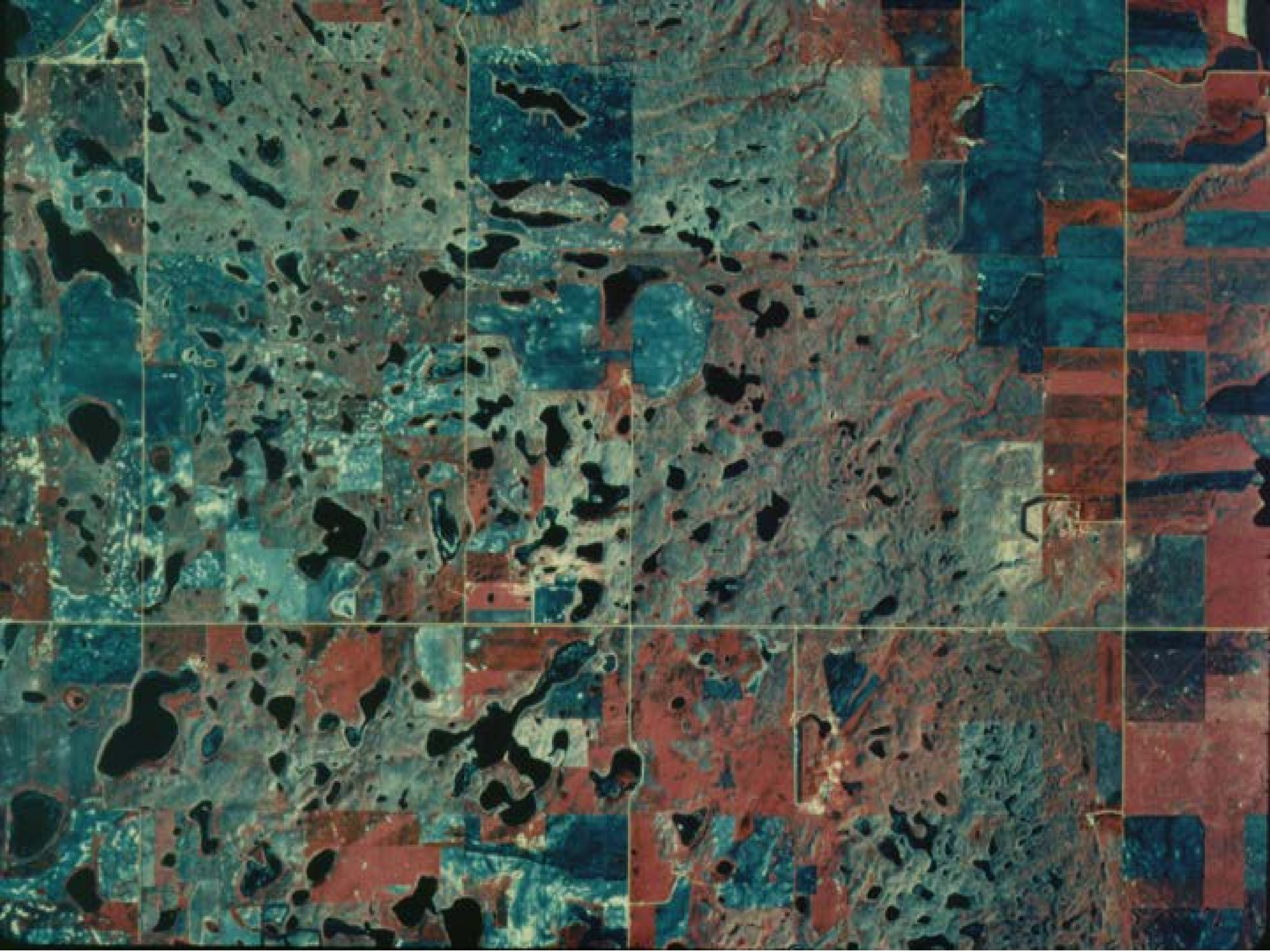
W. Carter Johnson
Department of Natural Resource Management
South Dakota State University


Prairie Pothole Region
Kilometers
0 250 500 1,000 1,500 2,000

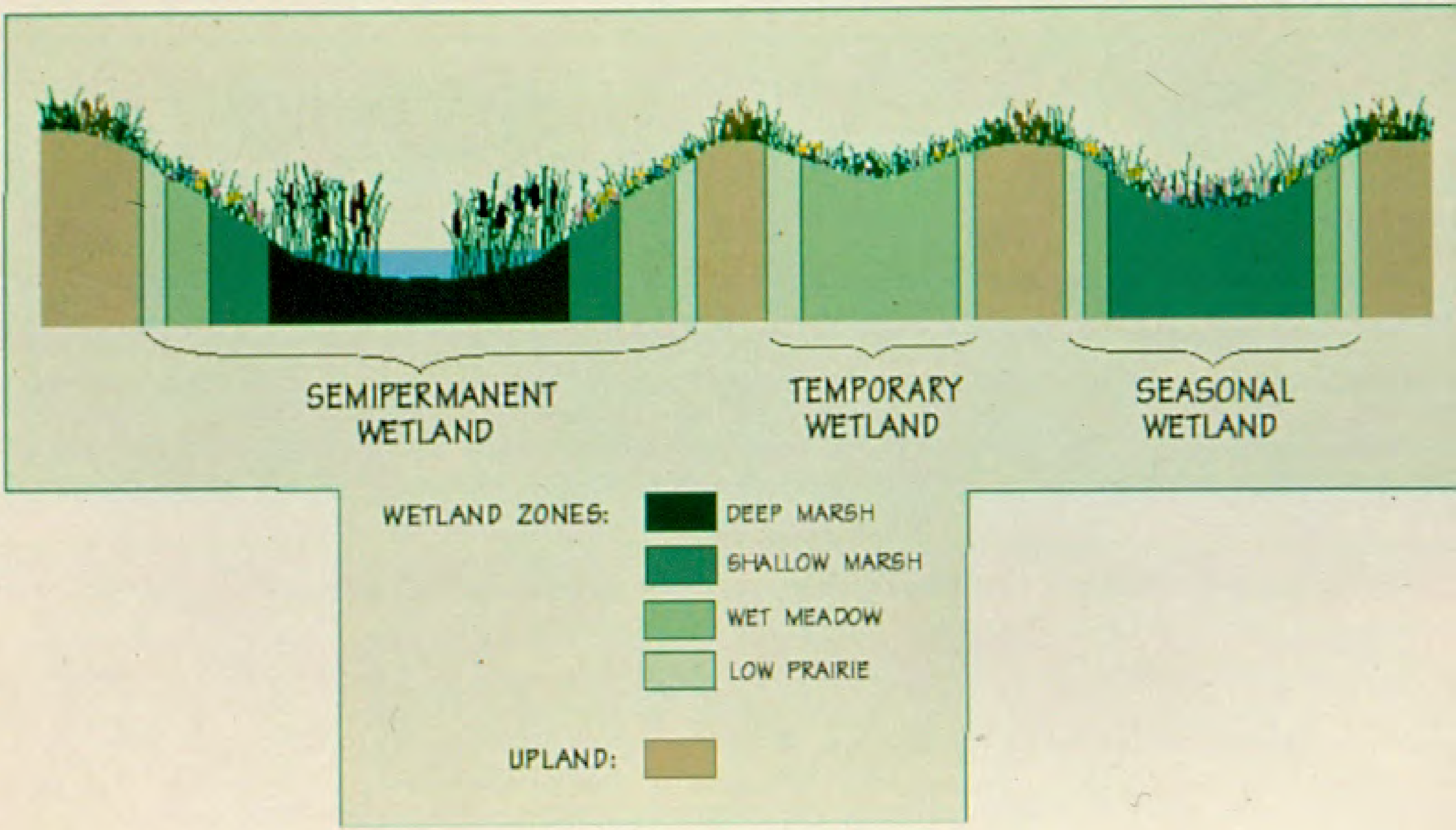


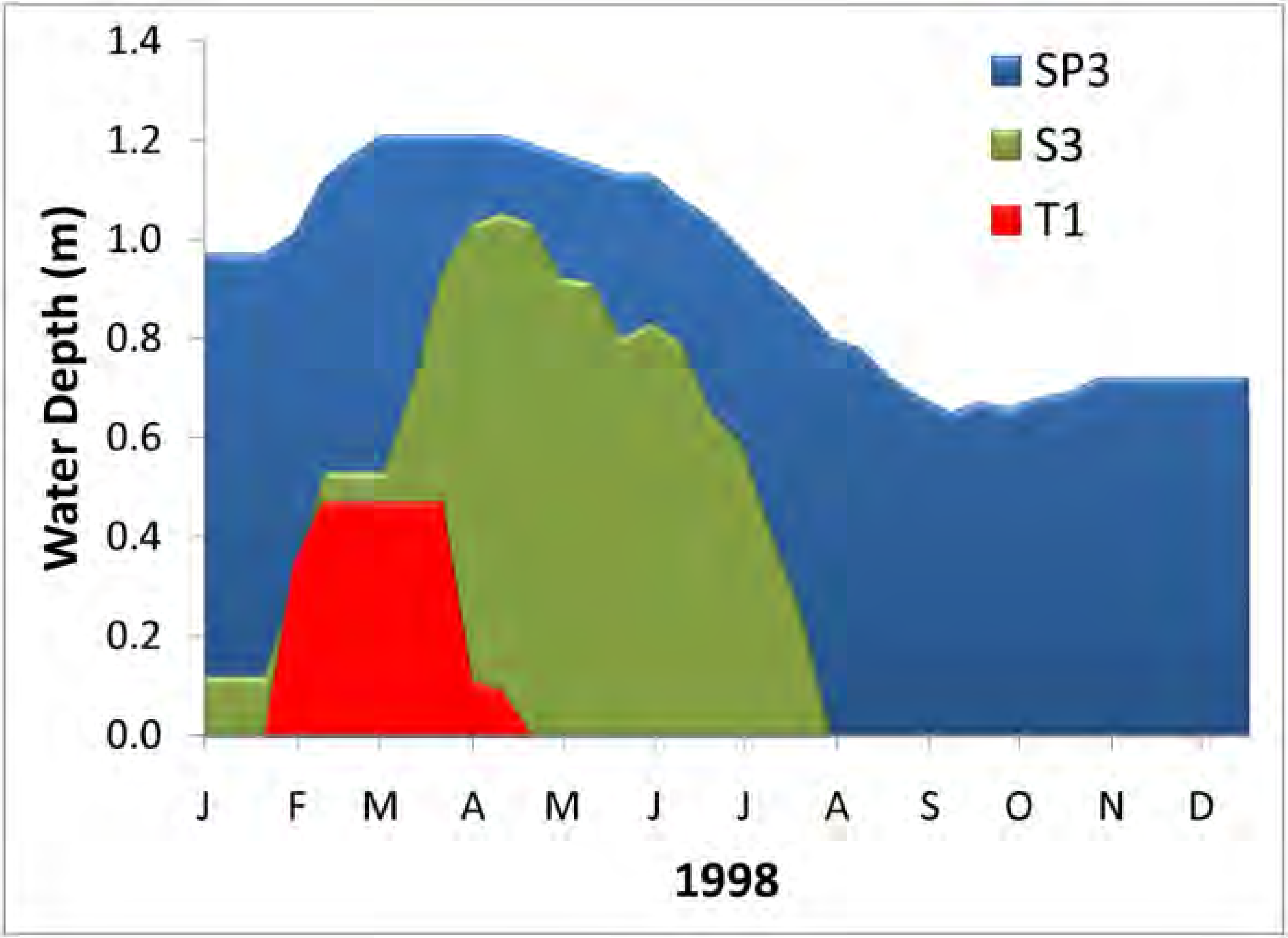
1
2
3
4
5
6
7
8
9
10
- - - MEAN ANNUAL TEMPERATURE (C)
MEAN ANNUAL PRECIPITATION (mm)
304 - 400
401 - 500
501 - 600
601 - 700
701 - 800
801 - 900
Kilometers
0 50100 200 300 400 500


Prairie Coteau



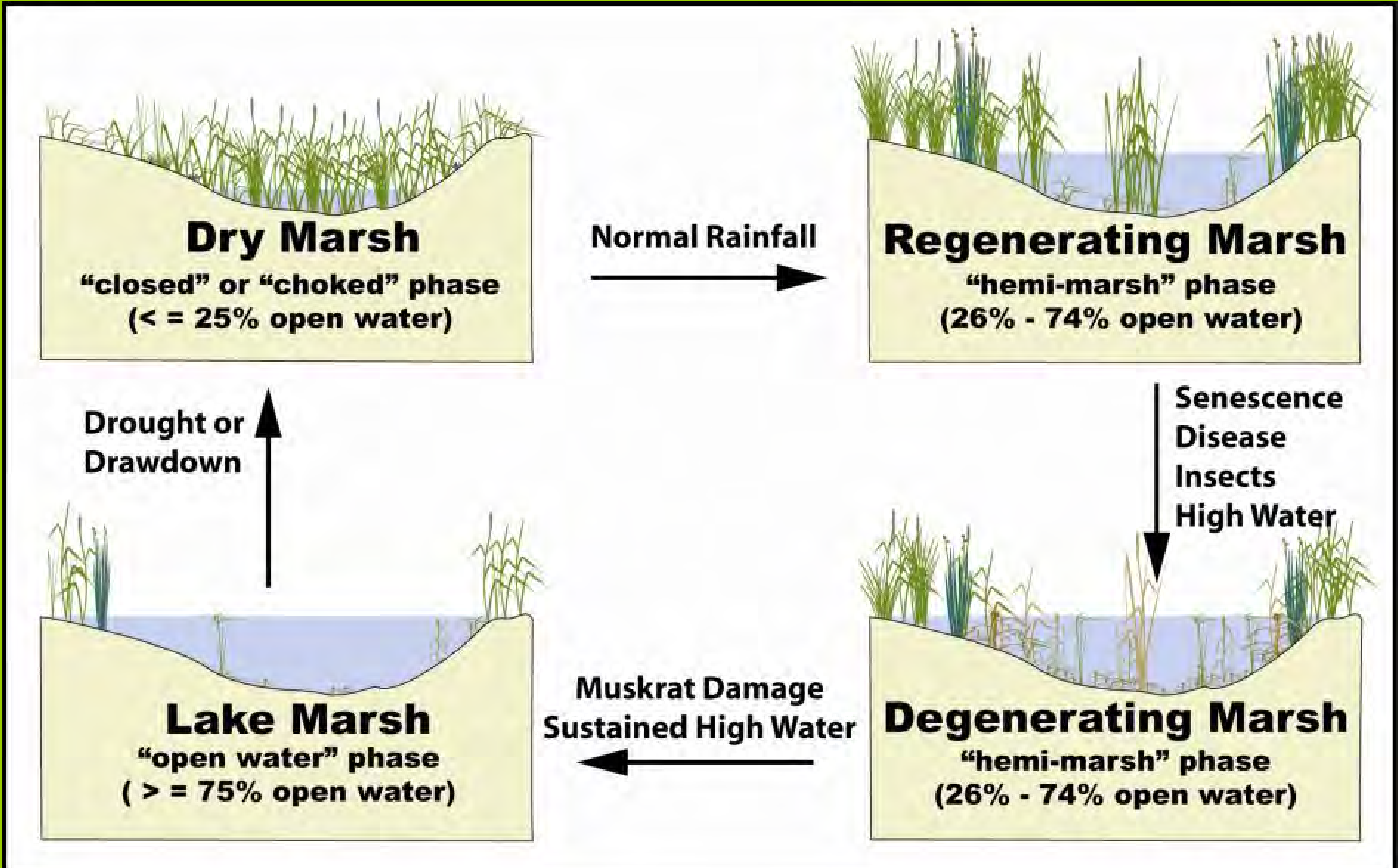
CROSS-SECTION THROUGH A WETLAND LANDSCAPE

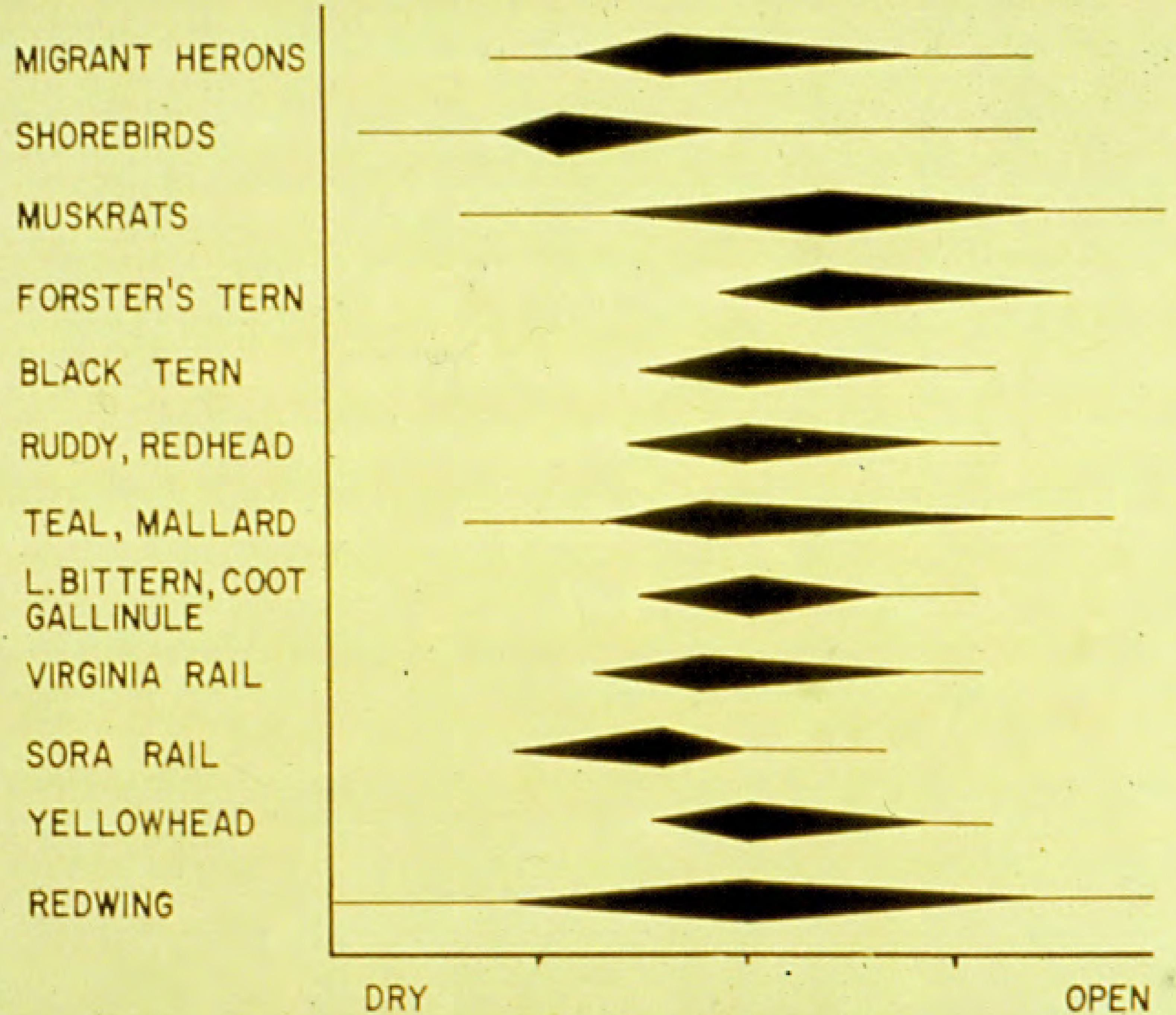




Water Depth (m)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
SP3
S3
T1
J
F
M
A
M
J
J
A
S
O
N
D
1998

Wetland Vegetation Cover Cycle




MIGRANT HERONS
SHOREBIRDS
MUSKRATS
FORSTER'S TERN
BLACK TERN
RUDDY, REDHEAD
TEAL, MALLARD
L.BITTERN, COOT
GALLINULE
VIRGINIA RAIL
SORA RAIL
YELLOWHEAD
REDWING
DRY
OPEN

Prairie Wetland Drainage by State

- Iowa…………..99%
- Minnesota…….. 70-90%
- South Dakota….35%
- North Dakota…..60%

- Source: Tiner 1984; Dahl et al. 1990, 1991

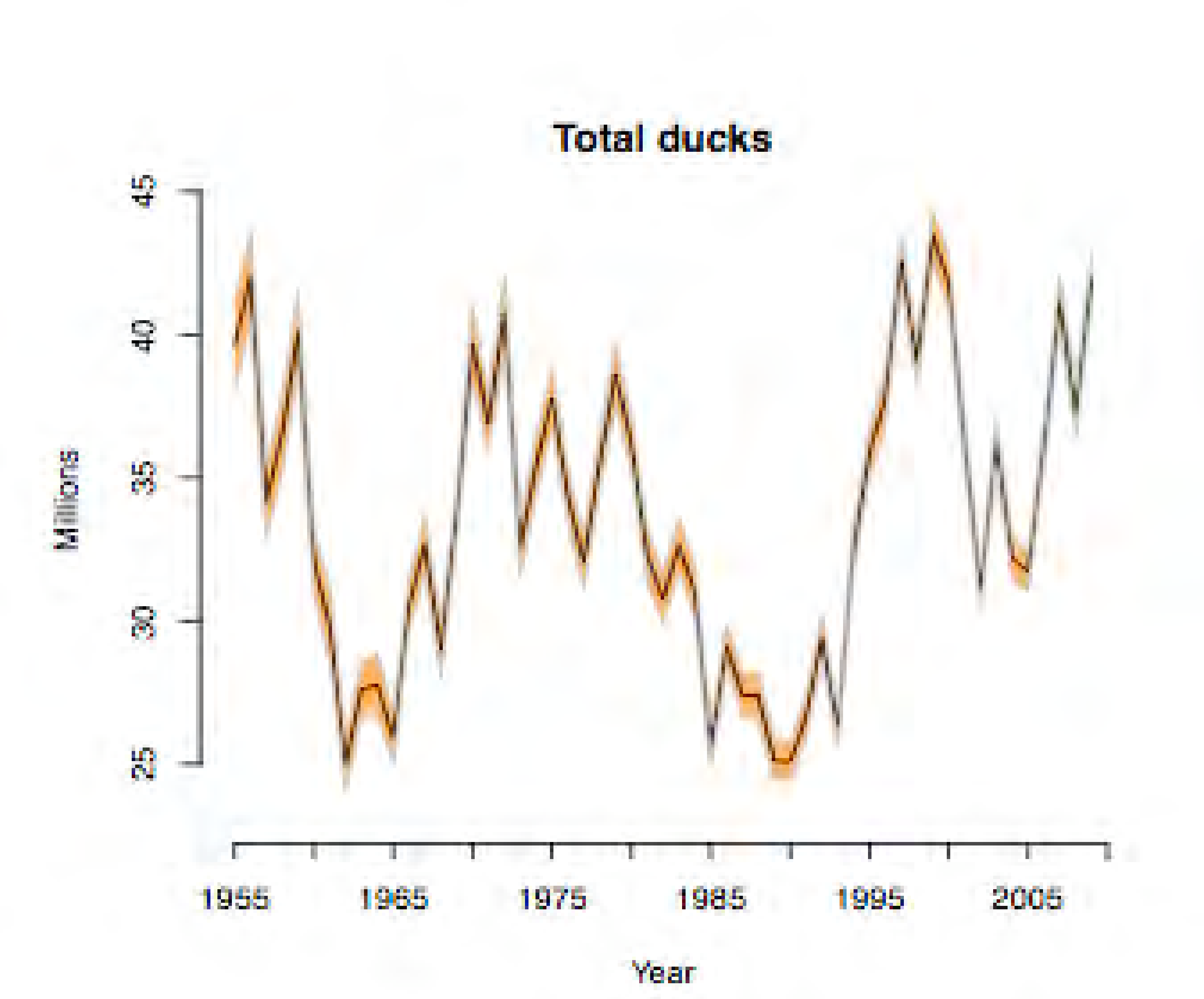
Climate Projections

- 1.4-5.8^{o}C increase globally by 2100 (Houghton et al. 2001)
- 3.6-6.1^{o}C increase for central and northern Great Plains (Ojima and Lackett 2002)
- Warming increases with increasing latitude

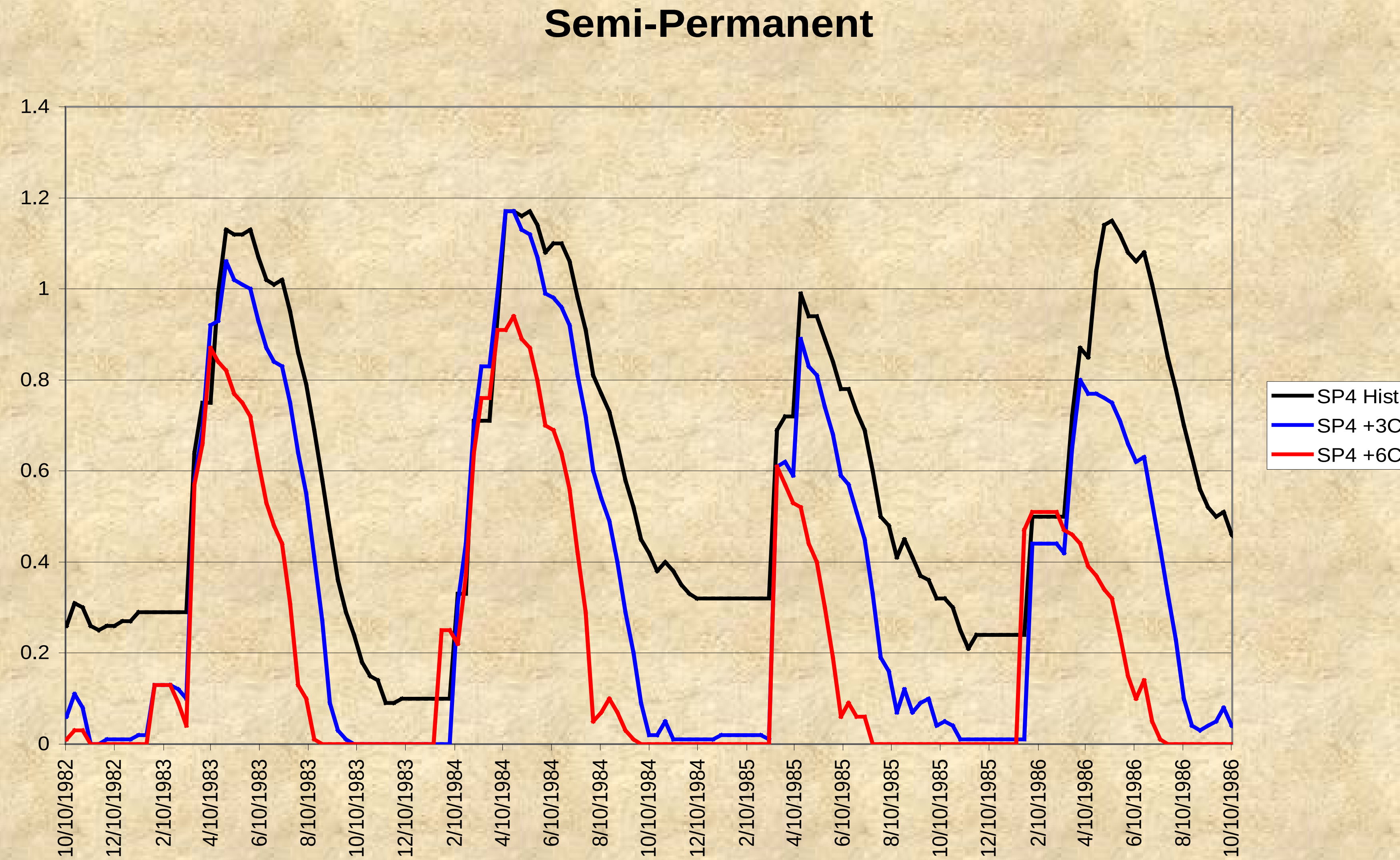
Climate Projections continued

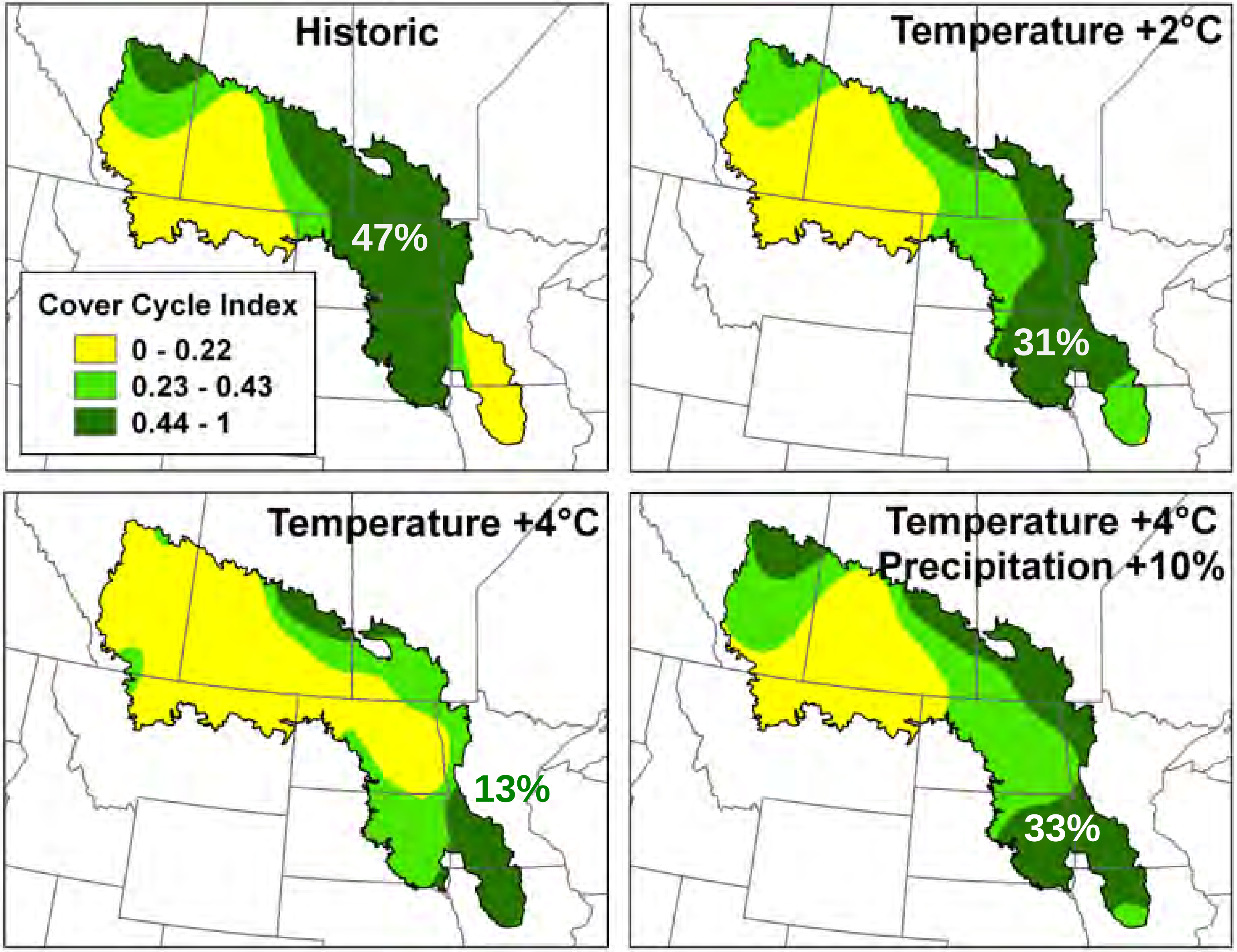
- Greater warming in winter than in summer
- Greater warming at night than in daytime
- Increased climatic variability
- Greater precipitation globally

Total Ducks (1955-2009)

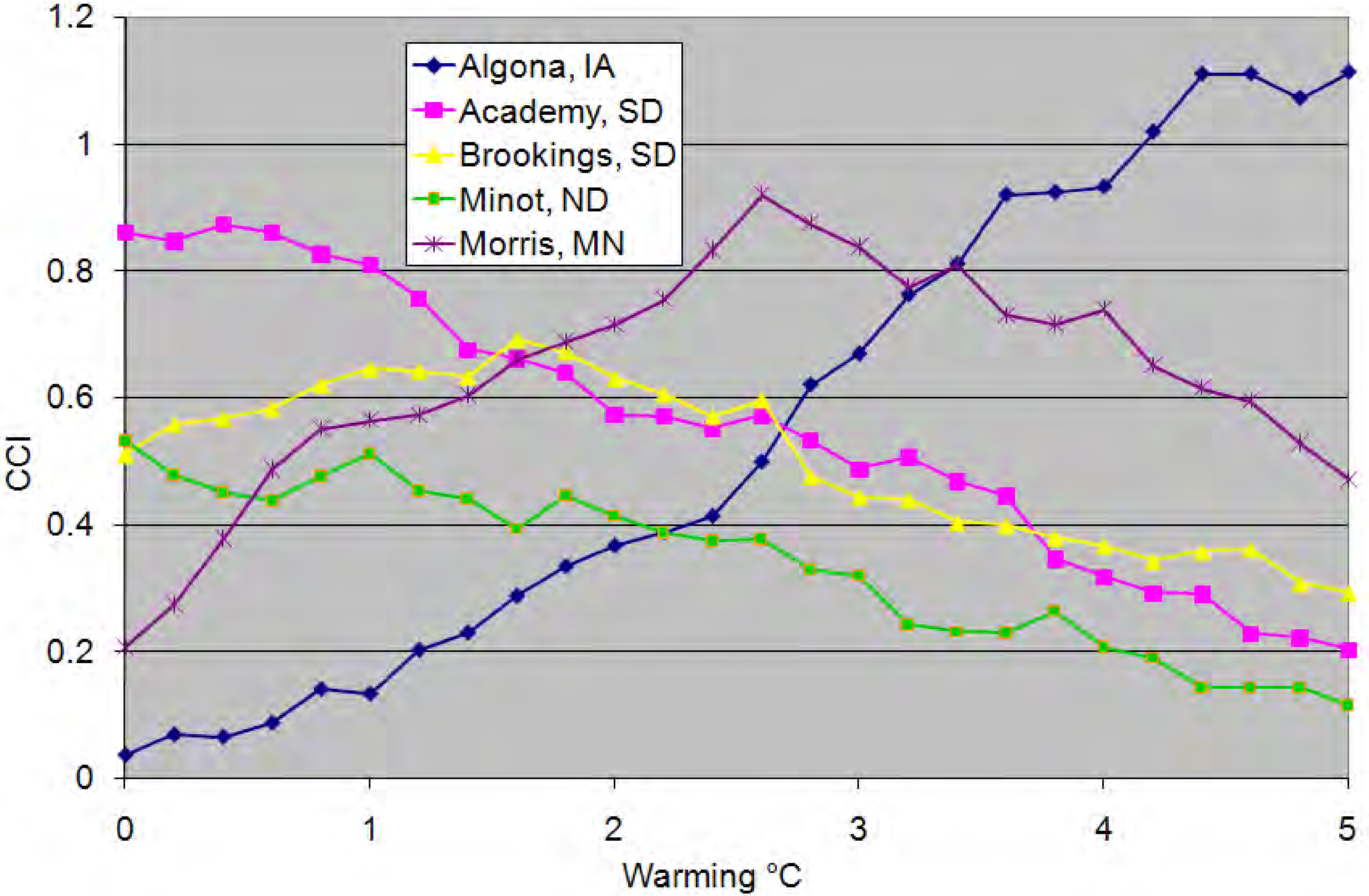


Academy, SD (1982-1986)

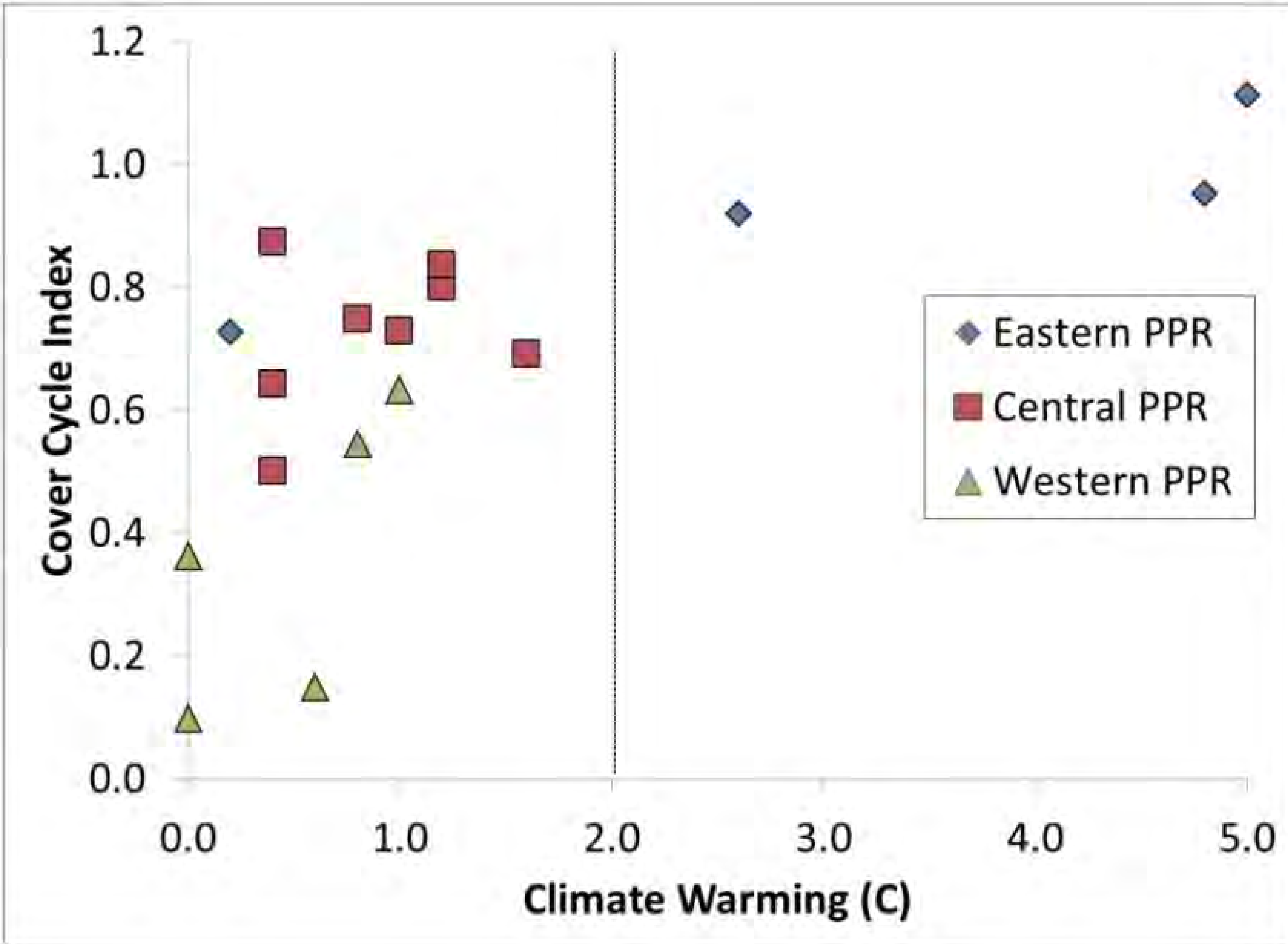




Historic
Temperature +2°C
Temperature +4°C
Temperature +4°C
Precipitation +10%
Cover Cycle Index
0 - 0.22
0.23 - 0.43
0.44 - 1
47%
31%
13%
33%

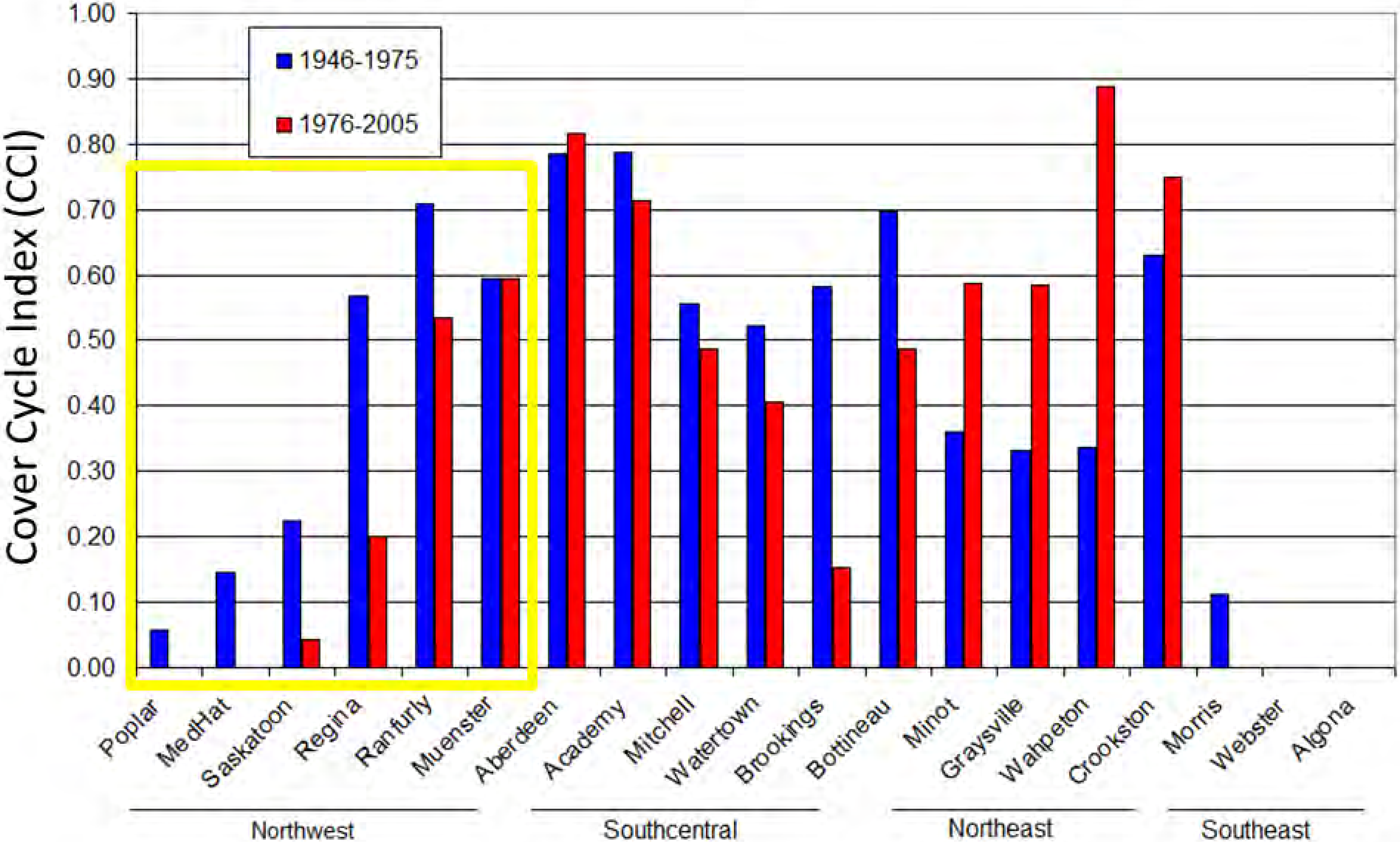


1.2
1
0.8
0.6
0.4
0.2
0
CCI
0
1
2
3
4
5
Warming °C
Algona, IA
Academy, SD
Brookings, SD
Minot, ND
Morris, MN


Cover Cycle Index
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
1.0
2.0
3.0
4.0
5.0
Climate Warming (C)
Eastern PPR
Central PPR
Western PPR

Train Has Left the Station

30-year Comparison of Cover Cycle Index



Conclusions-Science

- Air temperature really matters to wetland dynamics
- Western PPR wetlands most vulnerable to climate change
- Under a warmer and drier climate, the best climate for waterfowl production would shift eastward, but most wetlands there have been drained

Conclusions-Science (ctd.)

- Effects of climate change may already be apparent in PPR

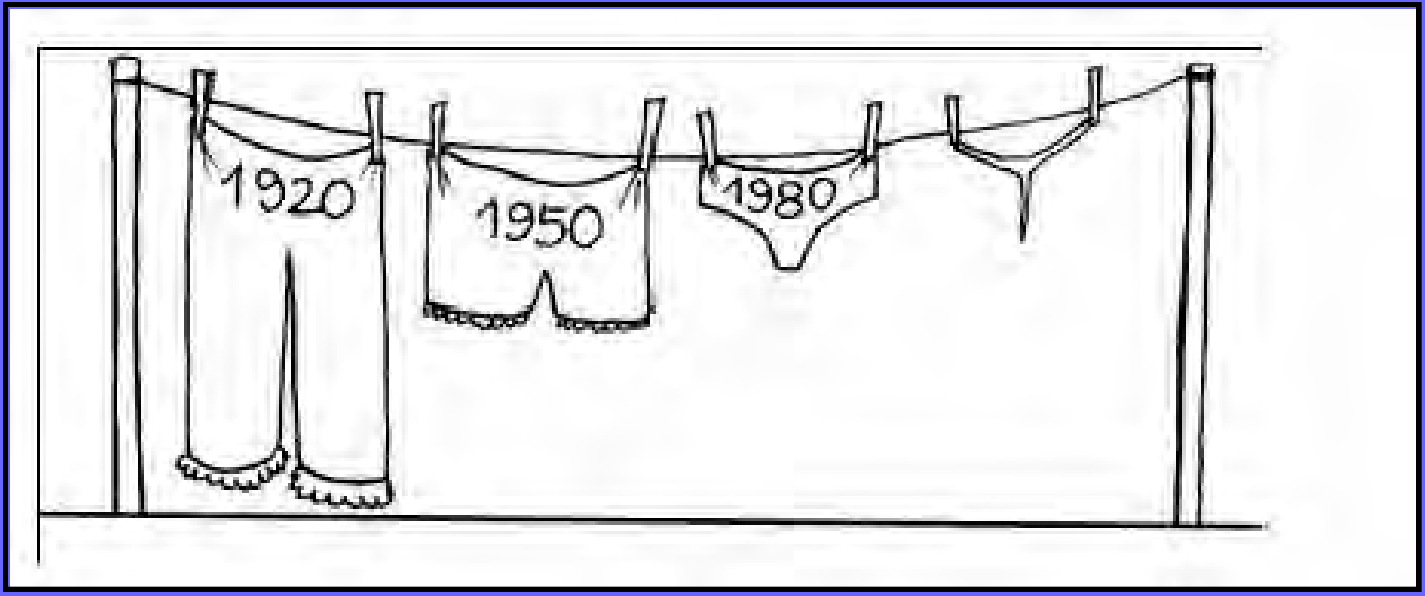
Conclusions--Management

- Expand weather monitoring and analysis needed for early detection of climate change
- Remediation: stop wetland drainage and intensify wetland restoration and management across the PPR
- Re-double wetland restoration efforts in eastern PPR (MN-Dakota border area and Iowa)


•Snowmelt Management •Watching Extinction
BioScience
Organisms from Molecules to the Environment
February 2010
American Institute of Biological Sciences
Vol. 60 No. 2
Prairie Wetland Landscape in a Changing Climate
21st Century Directions in Biology: Metagenomics and the Units of Biological Organization
$5.95 • $6.95 Canada
www.biosciencemag.org

Cause of Failure	Recommendation	Details
Climate change effects remain undetected	Initiate monitoring on long-term field sites and/or use wetland models to simulate future conditions	Because of high variability in climate and other factors that influence wetland water budgets, negative effects of climate change may go undetected for decades
Wetlands restored in high risk parts of the PP	Priority for restoration should match up geographically with areas expected to have the best wetland climate	Western, drier parts of the PPR may experience greatest loss of wetland functionality. Future climate in the east looks more productive
Wetland restoration too little too late	Massive restoration efforts will be needed to offset wetland losses due to climate warming and drying	Wetland losses continue to exceed gains. This trend needs to be reversed soon if we are to at least partially mitigate for climate change.

Evidence of Global Warming



Questions??

Barriers to Recovery of Restored Prairie Wetlands

S. Galatowitsch, University of Minnesota

Typical Restoration Strategy for Prairie Potholes

Assumption

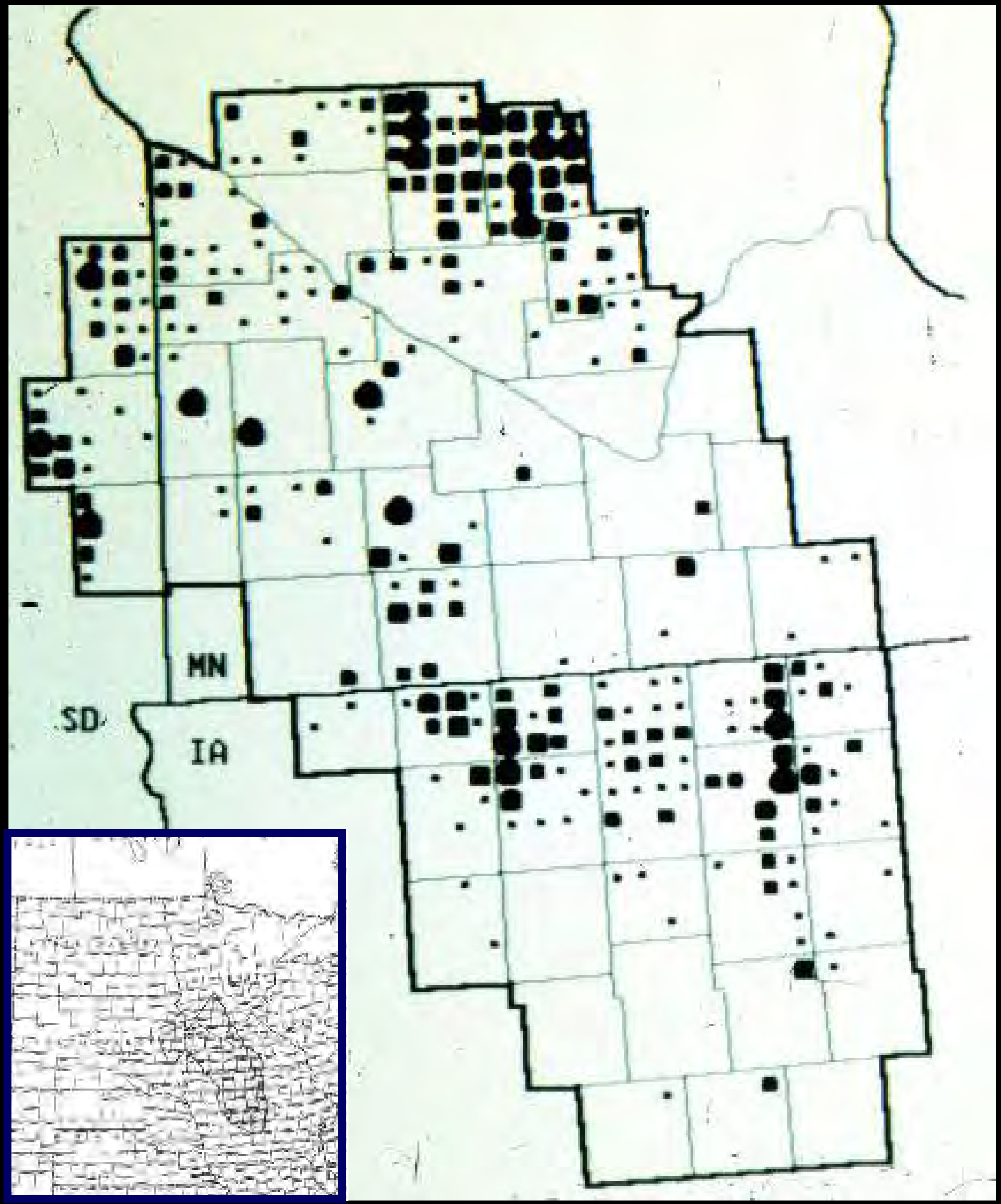
No dispersal limitation (seedbanks and rapid dispersal)

– full recolonization would occur within a few years of reflooding.

Restoration practice

Reflood wetlands, allow natural recolonization (no planting).

Restorations in the Southern Prairie Pothole Region



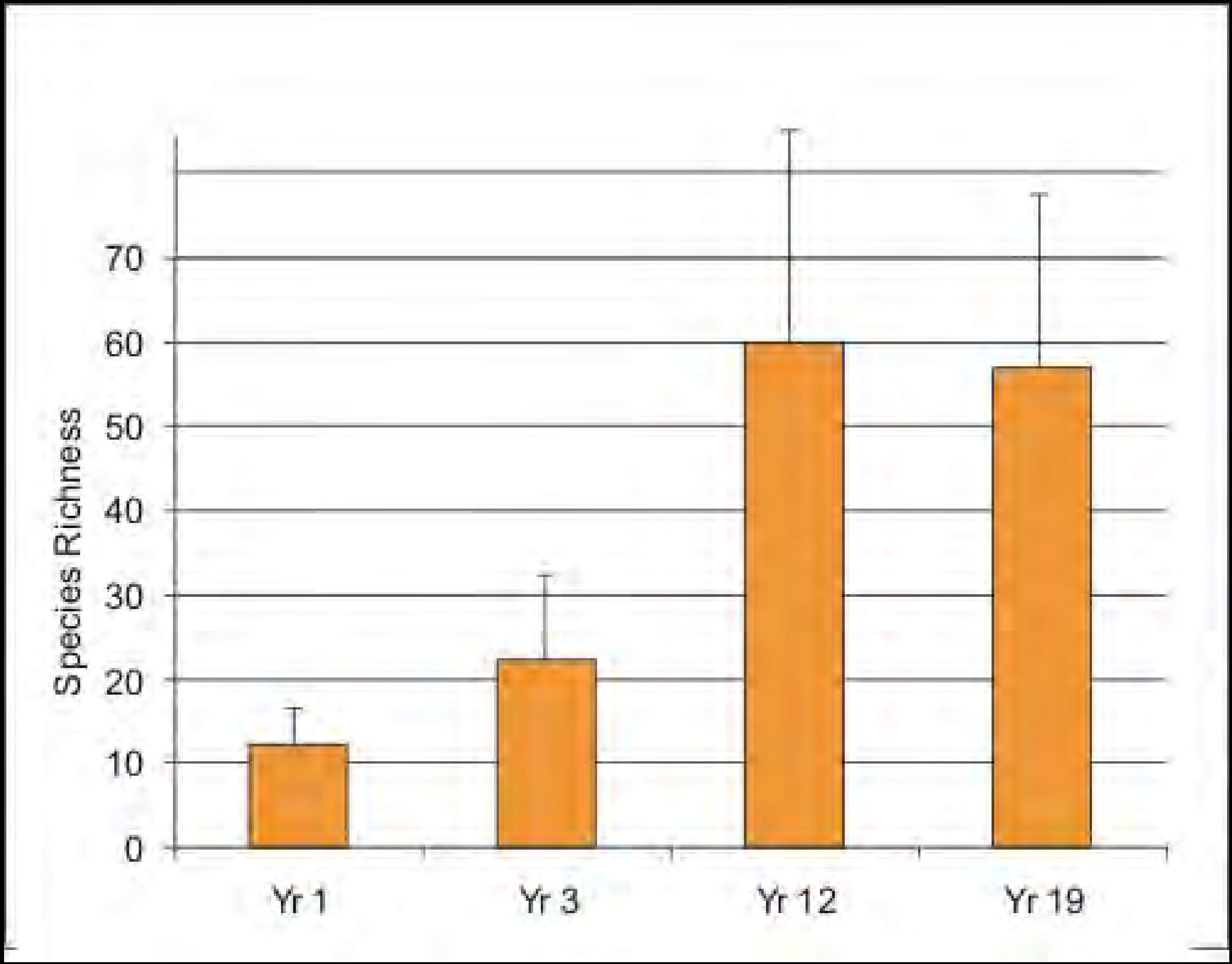
- 1892 restorations, 1987-1991
- Projects of the Conservation Reserve Program & Reinvest-In-Minnesota
- Nearly all on private land
- Most small, 0.2-2 ha
- Nearly all drained (tile or ditch) and cultivated or pastured
- Most drained > 50 yrs, seedbanks of wetland plants minimal
- Restorations only drainage modification – no site prep or planting

N=64

N=43

N=37

Change in Species Richness – Site Averages
37 Restored Wetlands



Initial Revegetation Patterns

3 years post reflooding – 64 wetlands

Ditched wetlands retained refugia for hydrophytes during agricultural use. Emergent perennials spread vegetatively and rapidly became the initial, dominant cover.

Tiled basins lacked refugia for hydrophytes. Upon reflooding, mudflat annuals and submersed aquatics were the initial colonists.

Regardless of drainage history, reflooded wetlands lacked wet meadows.

Galatowitsch and van der Valk 1996

Phalaris arundinacea, an invasive perennial, is present on every prairie pothole after 12 years of reflooding, typically with 75-100% cover in peripheral zones.

Other invasives – *Cirsium arvense* and *Typha angustifolia* – expand significantly on many sites.

Vegetation of Wet Meadow Zones

1991	Freq	Cover	2000	Freq	Cover	2007	Freq	Cover
Elytrigia repens	52.9	27.1	*Phalaris arundinacea*	100	44.6	*Phalaris arundinacea*	100	66.0
Cirsium arvense	44.1	9.0	*Cirsium arvense*	92.3	8.1	*Polygonum amphibium*	82.9	3.72
Bromus inermis	38.2	38.2	*Asclepias syriaca*	78.4	1.2	*Scirpus fluviatilis*	80.0	4.1
Ambrosia artemisiifolia	35.3	4.8	*Polygonum amphibium*	78.4	0.7	*Aster praeltus/simplex/ lancelolatus*	77.1	3.4
Phalaris arundinacea	35.3	16.1	*Aster praeltus/simplex/ lancelolatus*	75.7	2.8	*Cirsium arvense*	74.3	1.0
			Rumex crispus	73.0	0.7	*Asclepias incarnata*	71.4	0.5
						Solidago canadensis	71.4	1.7

Vegetation of Emergent Zones

1991	Freq	Cover	2000	Freq	Cover	2007	Freq	Cover
Polygonum amphibium	50.0	0.9	*Phalaris arundinacea*	83.3	13.8	*Scirpus fluviatilis*	93.5	22.3
Scirpus fluviatilis	50.0	17.4	*Scirpus fluviatilis*	75.0	22.3	*Phalaris arundinacea*	90.3	22.5
Lemna minor	46.7	32.0	*Scirpus validus*	72.2	4.7	*Polygonum amphibium*	77.4	3.3
Amaranthus rudis	43.3	3.6	*Eleocharis palustris*	69.4	10.1	*Typha angustifolia/x glauca*	77.4	56.3
Typha angustifolia/x glauca	43.3	7.9	*Typha angustifolia/x glauca*	66.7	43.4	*Scirpus validus*	74.2	4.2
Echinochloa crusgalli/muricata	40	11.2	*Polygonum amphibium*	61.1	1.0	*Lemna minor*	58.1	23.1

How long are the lag times?
How do the lags affect community composition?
What establishment constraints are most important?

Possible Explanations for Inefficient Recolonization

- Minimal on-site sources of propagules (no remnant seedbanks)
- Conditions not suitable for germination or seedling establishment
- Limited dispersal of seeds to new restorations




Seed Banks in Drained, Cultivated Fields

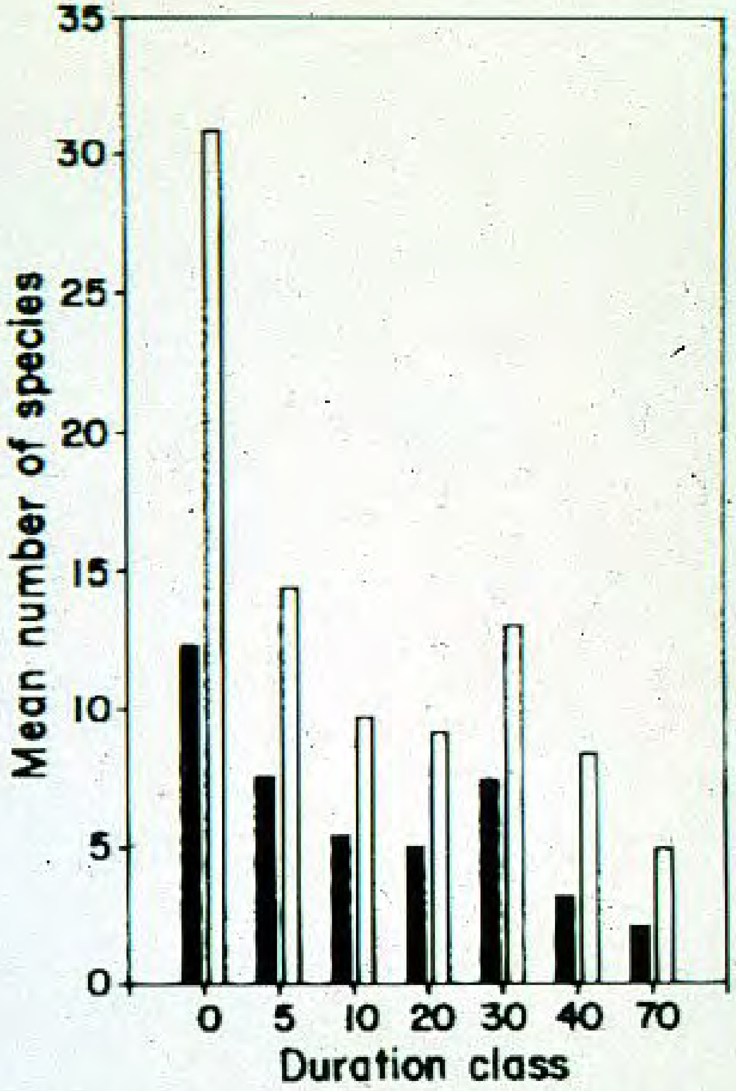
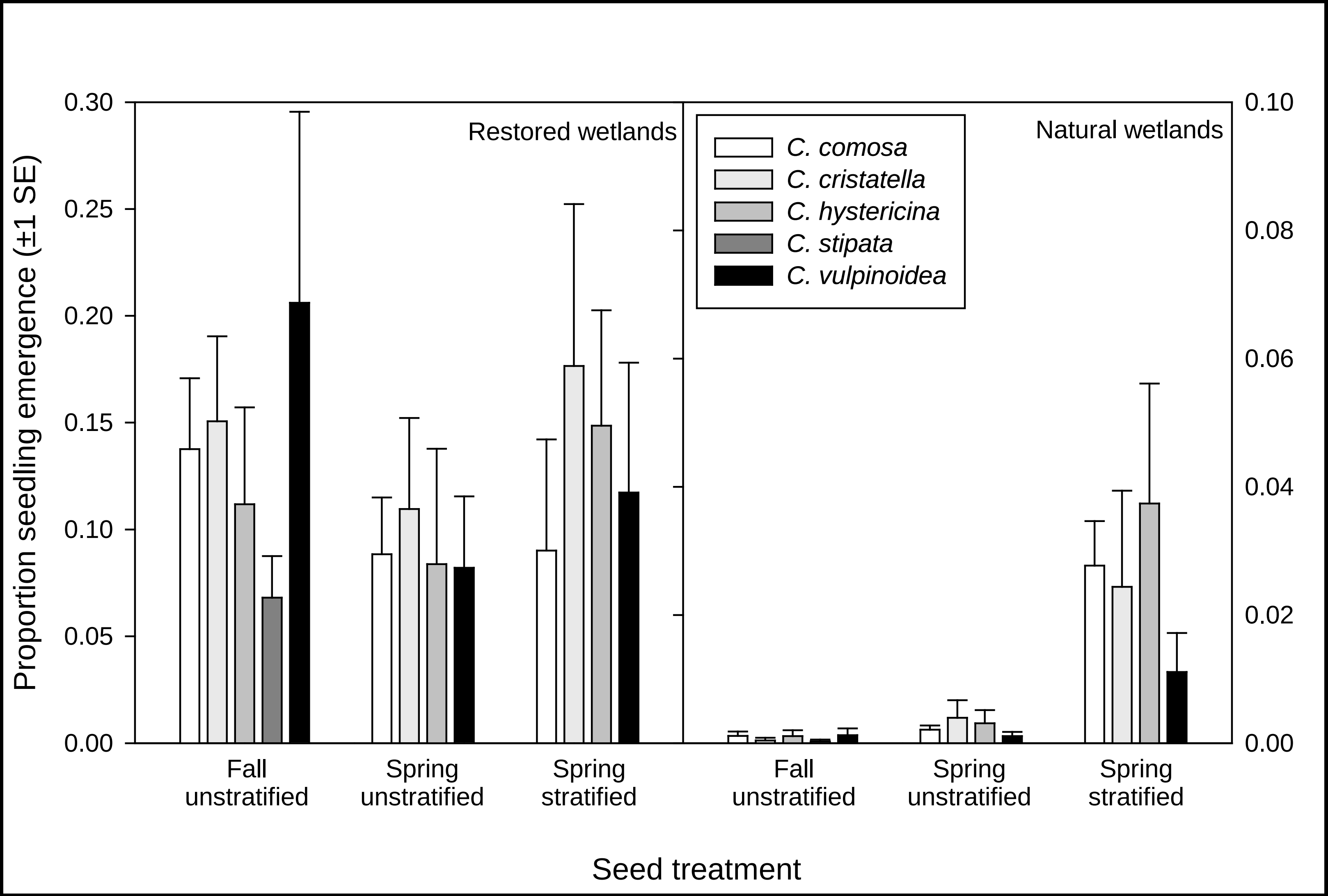


FIG. 3. Mean number of wetland species per wetland found in the seed bank (solid bars), and the seed bank plus additional species found in the vegetation (open bars) of extant wetlands (0 years) or wetlands drained for various duration classes.

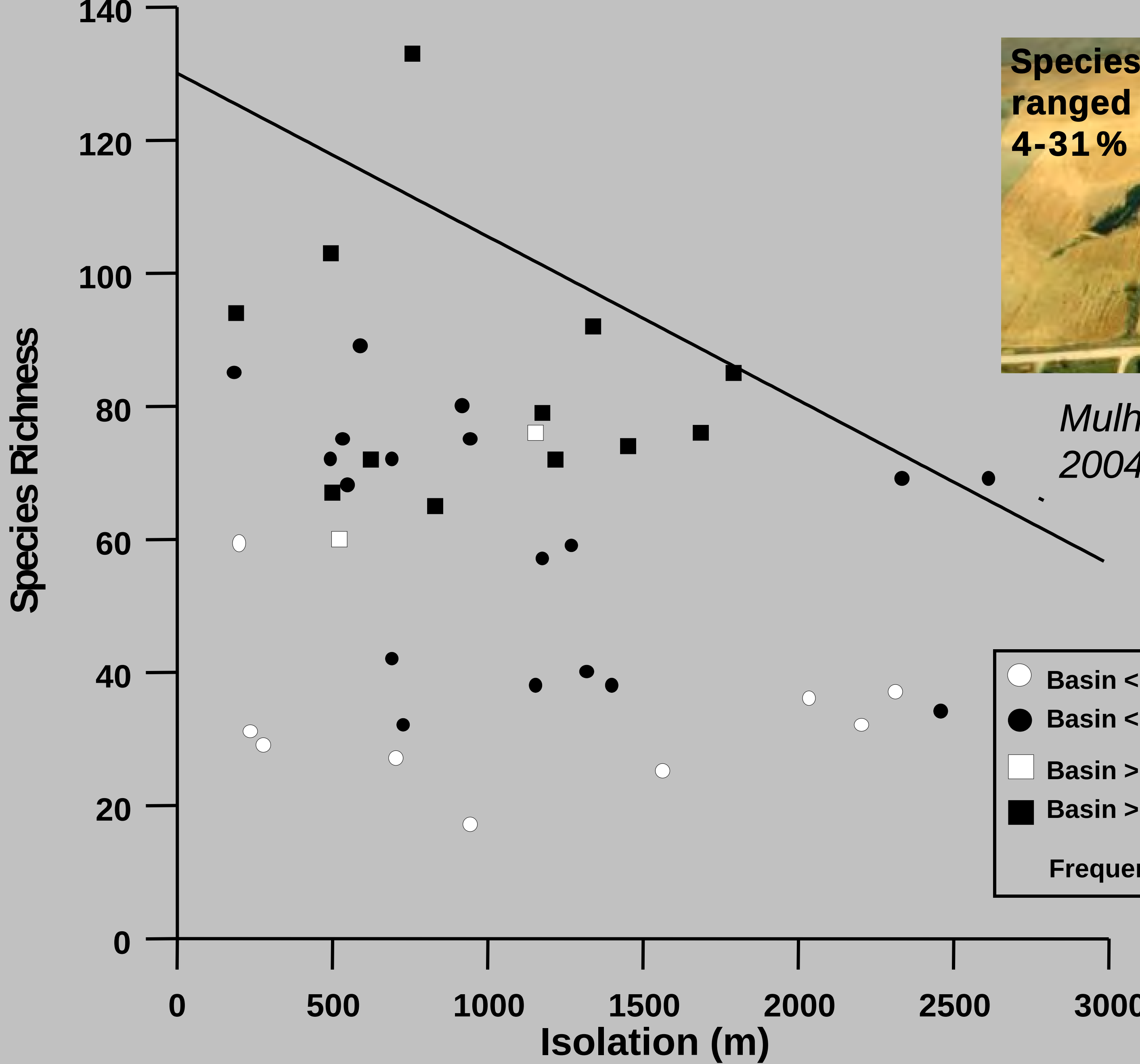
Wienhold & van der Valk 1989

Carex seedling establishment in restored & remnant meadows

(Kettenring & Galatowitsch 2007)

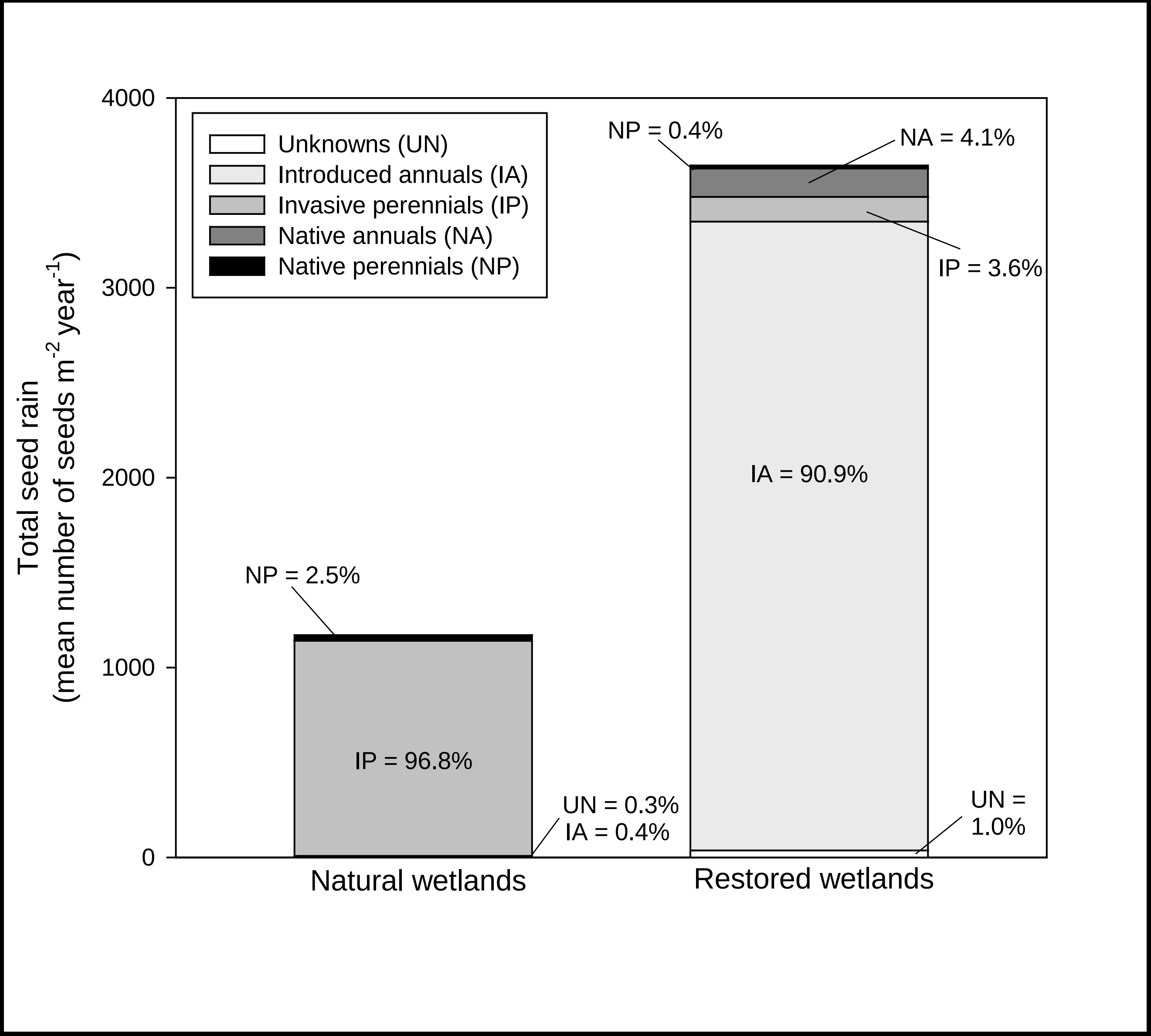


Effects of Isolation, Size & Flooding Frequency on Richness



Mulhouse & Galatowitsch 2004

Comparison of Seed Rain in Restored and Remnant Wetlands



Kettenring & Galatowitsch (in prep)

How long are the lag times?

Species reassembly primarily occurred in the first decade.
The “lag” to redevelopment of wet meadows may be indefinite.

How do the lags affect community composition?

Phalaris arundinacea dominate wet meadows.
Non-invasive wet meadow perennials are poorly represented.

Phalaris spread in Quebec (Lavoie et al. 2005)

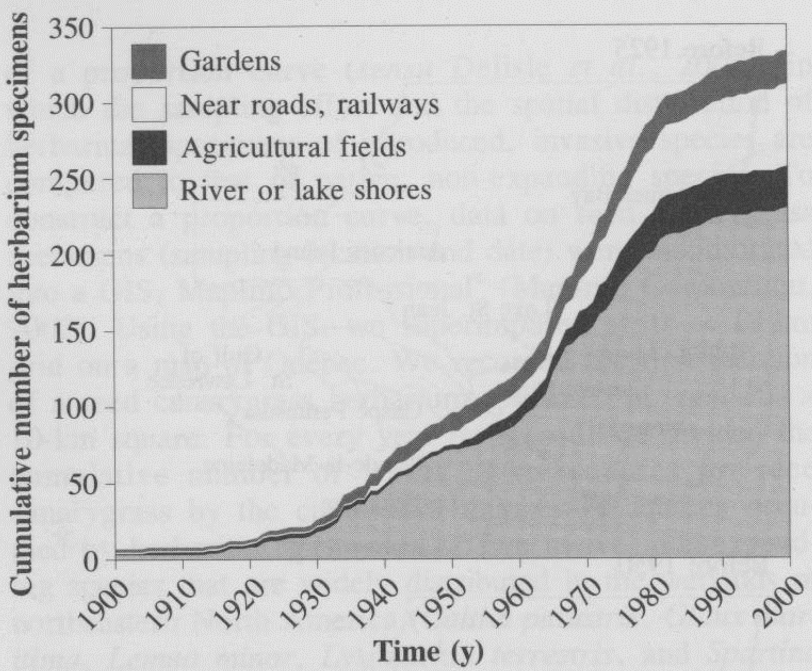


FIGURE 4. Cumulative number of reed canarygrass (*Phalaris arundinacea* and *P. arundinacea* var. *picta*) herbarium specimens found in Québec during the 20th century according to their respective collection habitat.

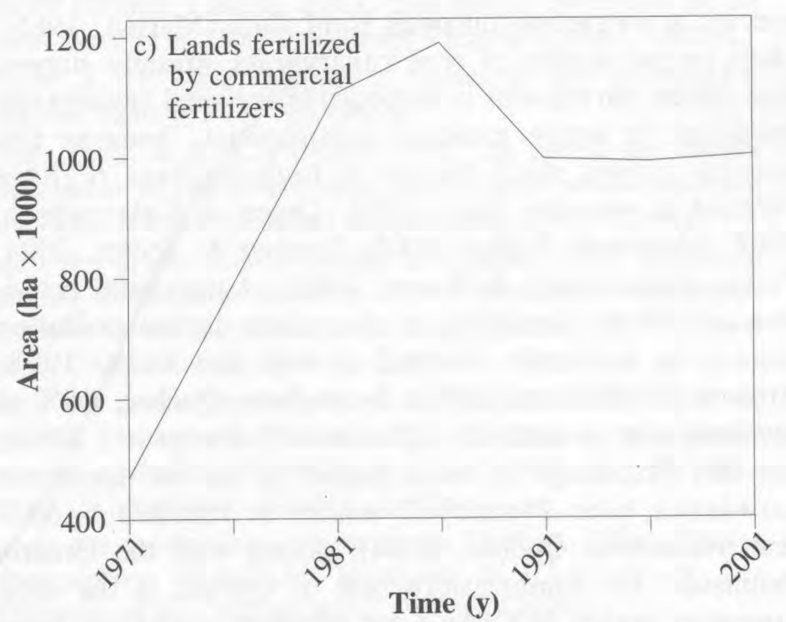
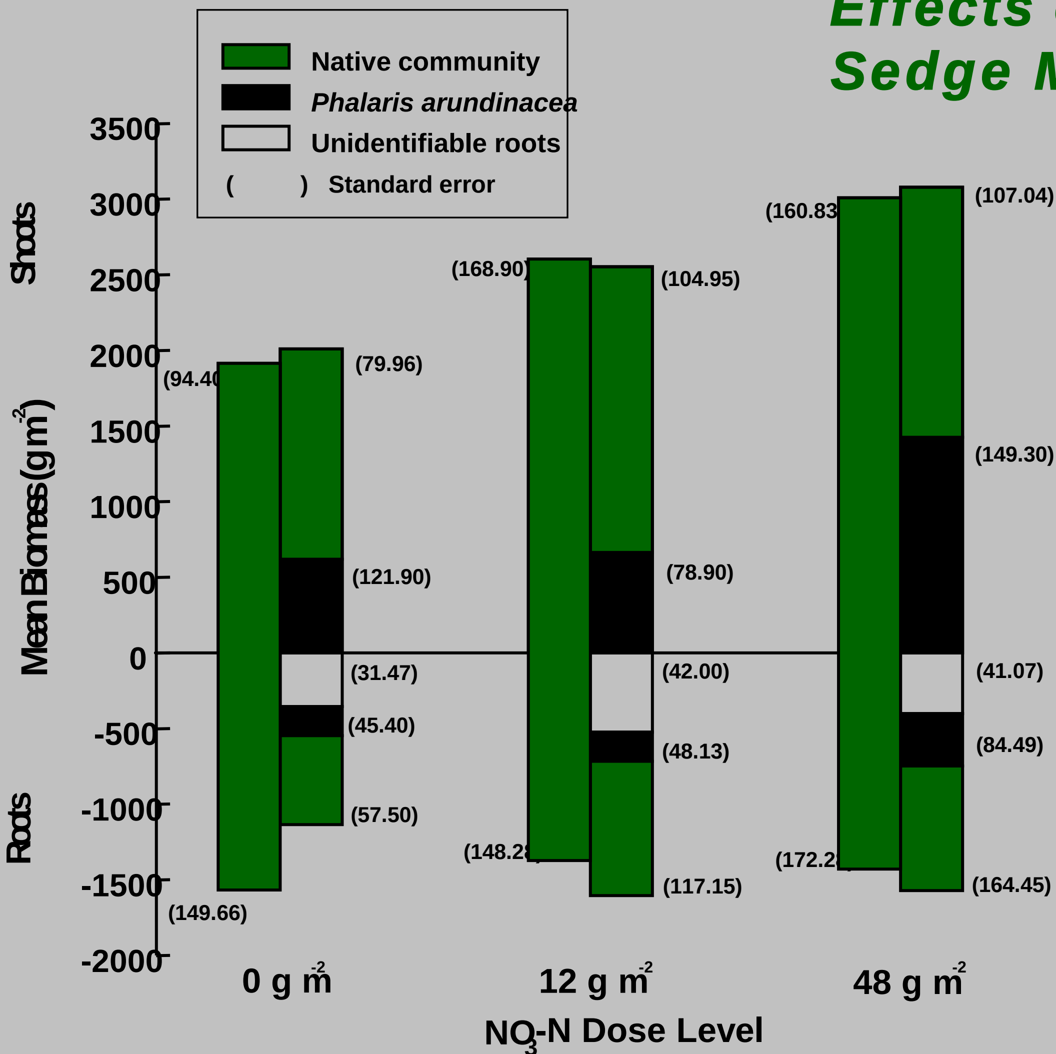


FIGURE 7. Sales of a) fertilizer materials (animal manure, ammonium nitrate, ammonium phosphate, nitrogen solution, potassium chloride, super phosphate, etc.) from 1963 to 1975 and of b) mixed fertilizers in Québec from 1951 to 1975 (April *et al.*, 1967; Bureau de la statistique du Québec, 1968; 1971; 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).

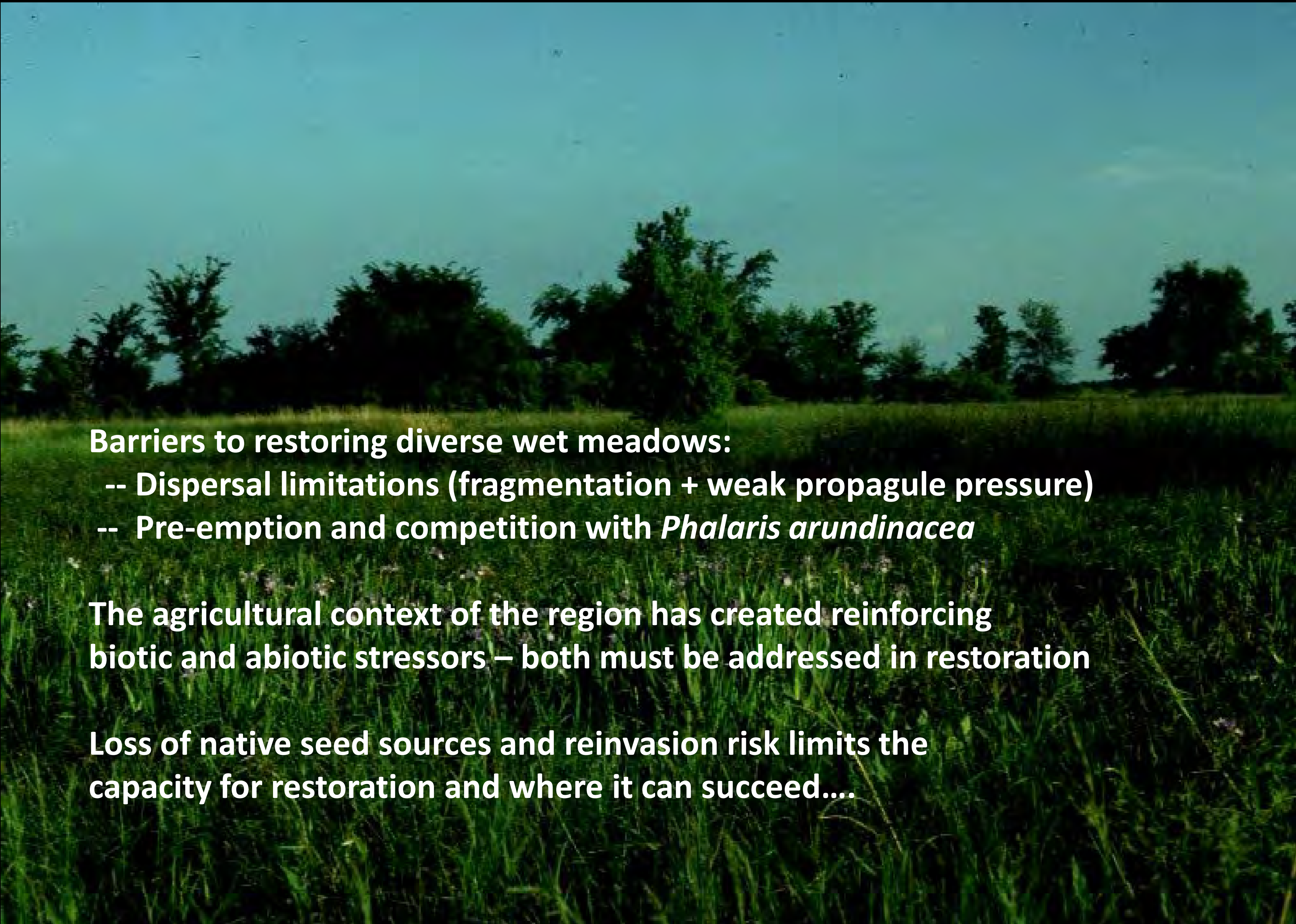
Effects of Nitrate & Phalaris on Sedge Meadow Establishment



11 species native community

***Phalaris* density 1/12 native community**

Green & Galatowitsch 2002


Barriers to restoring diverse wet meadows:
-- Dispersal limitations (fragmentation + weak propagule pressure)
-- Pre-emption and competition with *Phalaris arundinacea*
The agricultural context of the region has created reinforcing
biotic and abiotic stressors – both must be addressed in restoration
Loss of native seed sources and reinvasion risk limits the
capacity for restoration and where it can succeed….

Five Recommendations for Improving Success of Prairie Pothole Restorations

Cause of Failure	Recommendation	Details
Over-estimating ecosystem resilience	Assess likelihood that wetland plant community will recolonize after reflooding	Resilience is a function of duration of drainage and distance to natural wetlands
Spread of invasive species	Control species such as RCG, especially prior to and following reflooding	Invasive perennial plants cause arrested succession in more than 75% of PP restorations.
Conflicting project goals	Recognize tradeoffs between goals—especially biodiversity support and water quality or stormwater interception	Stormwater and nutrient interception are ecosystem stressors that greatly reduce biodiversity support.
Inadequate after care	Continue to manage vegetation during the establishment phase	For nearly a decade following reflooding, a PP restoration is still in a state of recovery and typically more invasible.
Lack of adaptive management	Link decision-making to monitoring	Ignorance is not bliss. Not detecting problems related to hydrology and biotic recovery often lead to insurmountable problems.

Why has "hit and run" restoration become the prairie pothole norm?

Questions?

Part II
Strategic Wetland Rehabilitation Can Pay for Itself

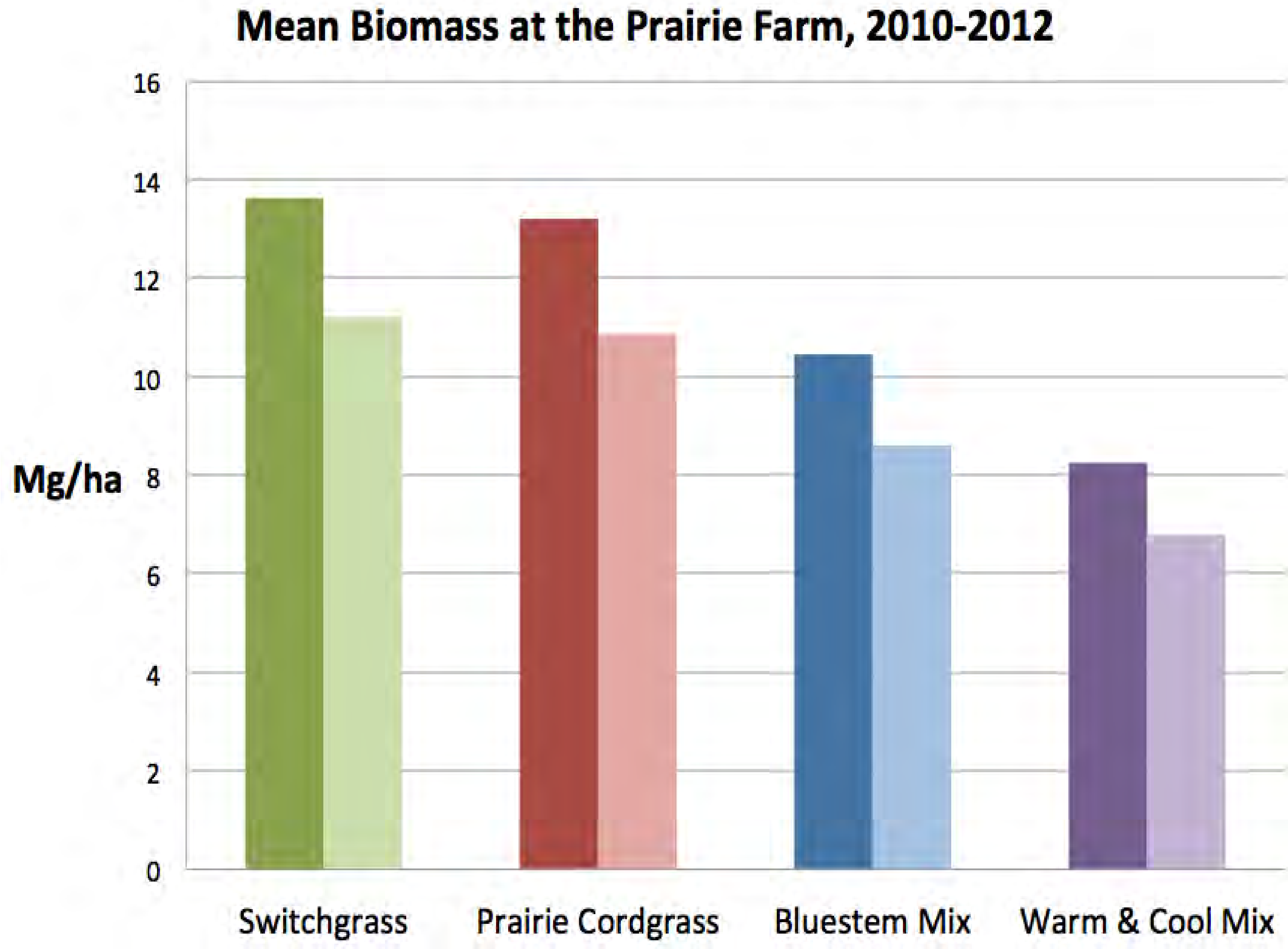
W. Carter Johnson
Chairperson, EcoSun Prairie Farms
Brookings, South Dakota

EcoSun Prairie Farms, Inc.


N

2008

2009


Mean Biomass at the Prairie Farm, 2010-2012
Mg/ha
16
14
12
10
8
6
4
2
0
Switchgrass
Prairie Cordgrass
Bluestem Mix
Warm & Cool Mix

Cordgrass Economics

Value of dormant season hay

- 4 tons/acre @ $75=$300/acre

Value of seed

- 10 lb./acre @ $ 50/pls lb. = $500/acre (min.)
- 55 lb./acre @ $ 65 pls lb. = $3575/acre (max.)

Income potential/acre

- $800/acre (min.); $3,875/acre (max.)

Cost recovery time

- 4-7 years depending on seed and hay prices

Cordgrass Economics (cont'd)

Cordgrass Reference

Zilverberg, C., W. C. Johnson and others. 2014. Growing *Spartina pectinata* in previously farmed prairie wetlands for economic and ecological benefits. *Wetlands* 34:853-864.

General Prairie Farm Reference

Zilverberg, C. W. C. Johnson and others. 2014. Profitable prairie restoration: The EcoSun Prairie Farm experiment. J. Soil and Water Conservation 69:23A-25A.

Conclusion

- Growing prairie cordgrass on sub-irrigated sites can increase biodiversity, whole farm income, and pay for establishment costs.

Cause of Failure	Recommendation	Details
Species planted not commercially viable	More study of markets and species available for planting needed	Higher diversity plantings provide more commercial options in the future
Commercially-viable species outcompeted by invasive species	Be vigilant and remove any invasive colonists before they can spread	Use multiple management methods including fire and water control to discourage invasive species
Weather and markets reduce income from planted wetlands	Establish an economic "safety net" to stabilize income	Some form of government subsidy comparable to crop insurance needed for wetland agriculture to survive drought and occasionally depressed seed, forage, and future biofuel feedstock markets

Questions?

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Photo Credit: Kulm Wetland Management District, USFWS


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