Current state of knowledge regarding cattail (*Typha* spp.) genetics and hybridization

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Wetlands

Wetlands are threatened by invasive plant species

- Aggressive growth results in monocultures that are hard to eradicate
- Decrease native plant biodiversity
- Effects reverberate through the food web
- Effects on ecosystem properties?


www.wnps.org/invasive_species.htm


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Courtesy of Elizabeth J. Czarapata


http://www.nativetreesociety.org/invasives/index_invasive.ht

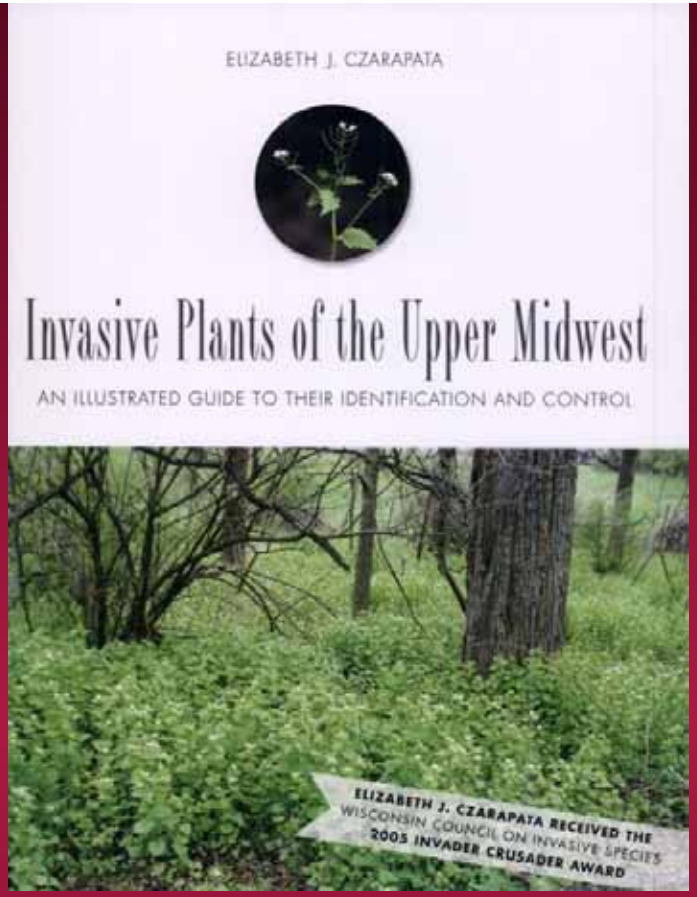

Cattails
(*Typha* spp.)

North American *Typha* spp.

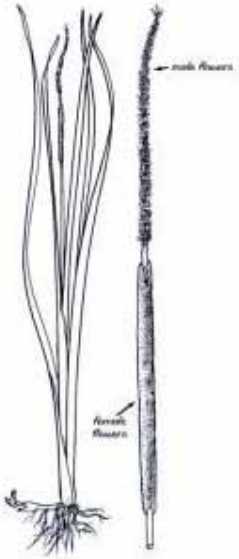
- *Typha latifolia* (L)
- *Typha angustifolia* (A)
- *Typha x glauca* (A x L)

Midwest

- *Typha domingensis* (D)
  - A x D
  - D x L



"*T. angustifolia* is probably native to Eurasia but is now established throughout much of the US. It is abundant in the Midwest, where it hybridizes with common cattail to produce the mostly sterile "hybrid cattail" (*Typha x glauca*)."



Cattails flower heads have both female and male flowers. The female flower section is brown-colored at maturity and located below the male flower section, which reaches to the tip of the flower head.

Note: Common cattail, a plant native to the upper Midwest and very similar to the two species, is discussed here rather than in chapter 6, "Native Plants That Sometimes Need Control," for the reader's convenience.

Habitat: Wetlands, lakeshores, river backwaters, roadside ditches, disturbed wet areas, consistently damp patches of rural and suburban yards; areas with wet soil or emergent in 3–4' of water; in nutrient rich or slightly saline soils. Narrow-leaved cattail and hybrid cattail are more abundant than common cattail in places with more siltation and higher levels of nutrients or salt.

Height: 4–12'.

Leaves: Long; graceful; swordlike; spongy; veins are parallel; can be 3' tall; originate at the base of stems and spread outward as they rise into the air; contain hollow chambers in cross-section.

Narrow-leaved cattail: 0.25–0. 5" wide; dark green; rounded on the back; top of the leaf sheath has thin, ear-shaped lobes at the junction

Narrow-leaved cattail has a 0.4–0.5" gap between the male and female flowers (note where male flowers were attached) and dark green leaves with rounded backs.

(*T. angustifolia*) is probably native only to Eurasia but is now established throughout much of the United States. It is abundant in the Midwest, where it hybridizes with common cattail to produce the mostly sterile "hybrid cattail" (*Typha* x *glauca*). Southern cattail (*T. domingensis*) is native in the southern Midwest, where it forms fertile hybrids with narrow-leaved cattail. Although the narrow-leaved and hybrid cattails are considered ecologically invasive, common cattail sometimes needs control as well to promote diversity in disturbed areas.

The amount of acreage in the Midwest dominated by cattails has increased dramatically since the early twentieth century due to wetland habitat modification by humans and the spread of narrow-leaved cattail westward from the Atlantic Coast. Cattails can outcompete other wetland vegetation to form dense monocultures in which dense rhizomes, leaves, and stalks, reduce overall habitat value. Many wetland areas, which were once havens for waterfowl and wading birds with a mix of cattails, open water, and diverse plant life, are now solid stands of cattails in which few species can live.

Hybrid cattail has a 0.2–2" gap between the male and female flowers, a longer and thicker female flower section, and longer leaves.

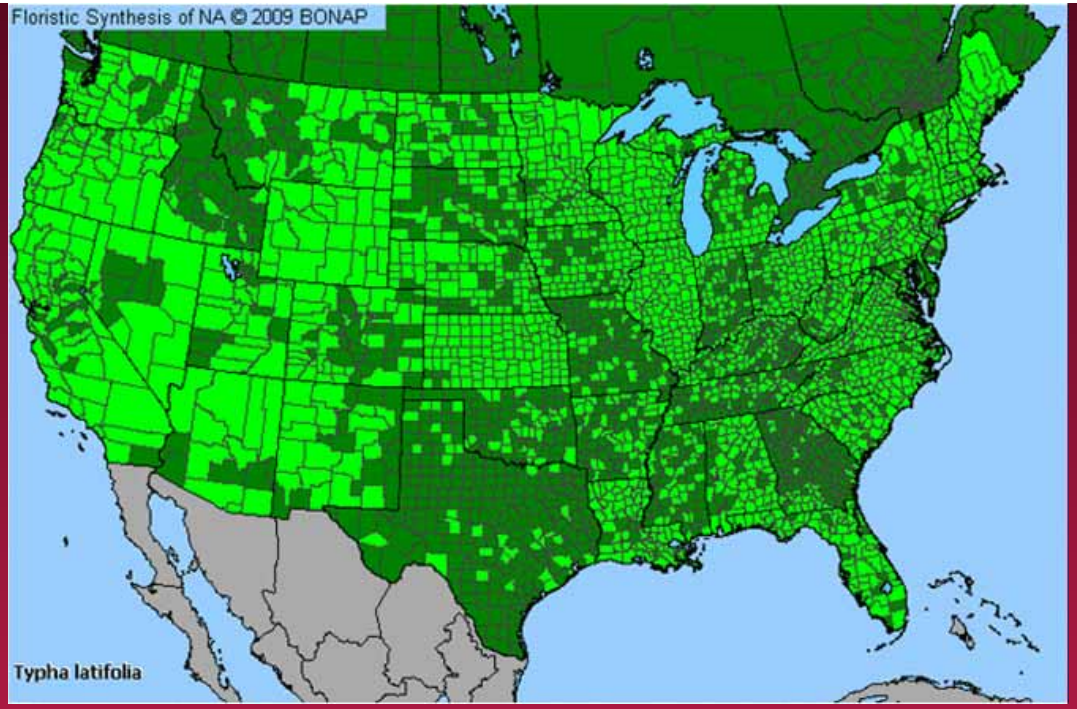
There are 3 problems with important consequences

1) Are *Typha* spp. native or invasive?
2) How do we identify *Typha* spp.?
3) Given that *Typha* spp. hybridize, are the hybrids sterile?

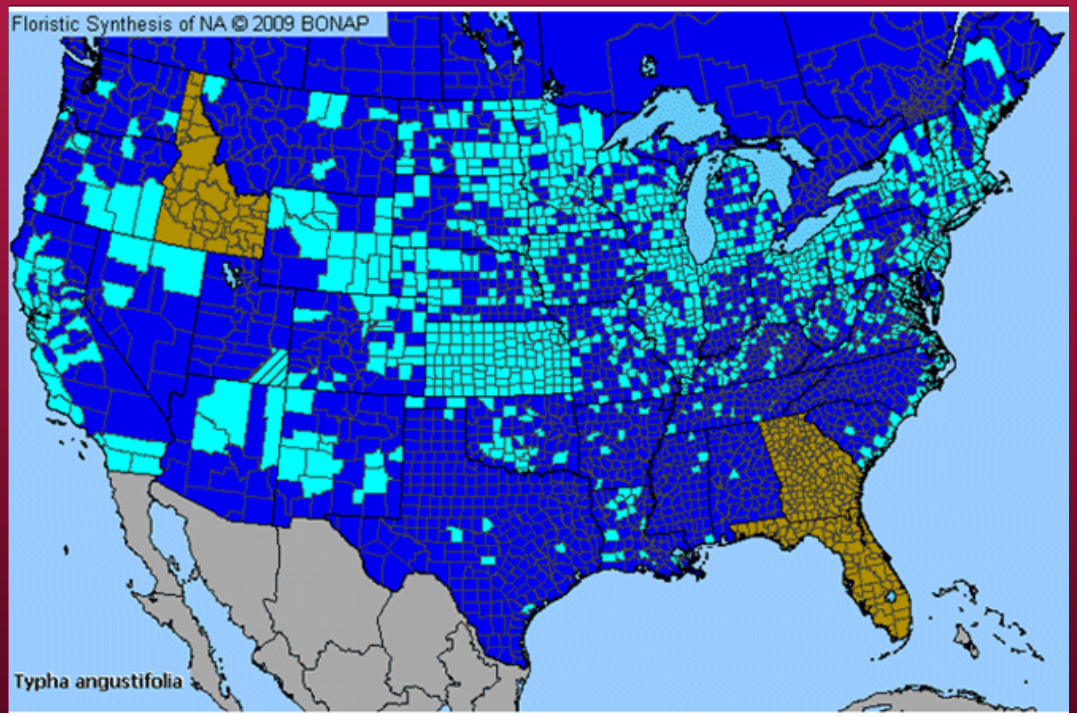
- Concept of species gets blurred…
- Consequences for restoration

PROBLEM 1: Are *Typha* spp. native or invasive?

- ***Typha latifolia*** = native
- ***Typha angustifolia*** = believed to be invasive from Eurasia… debatable
- ***Typha x glauca*** = native or invasive?



Typha latifolia



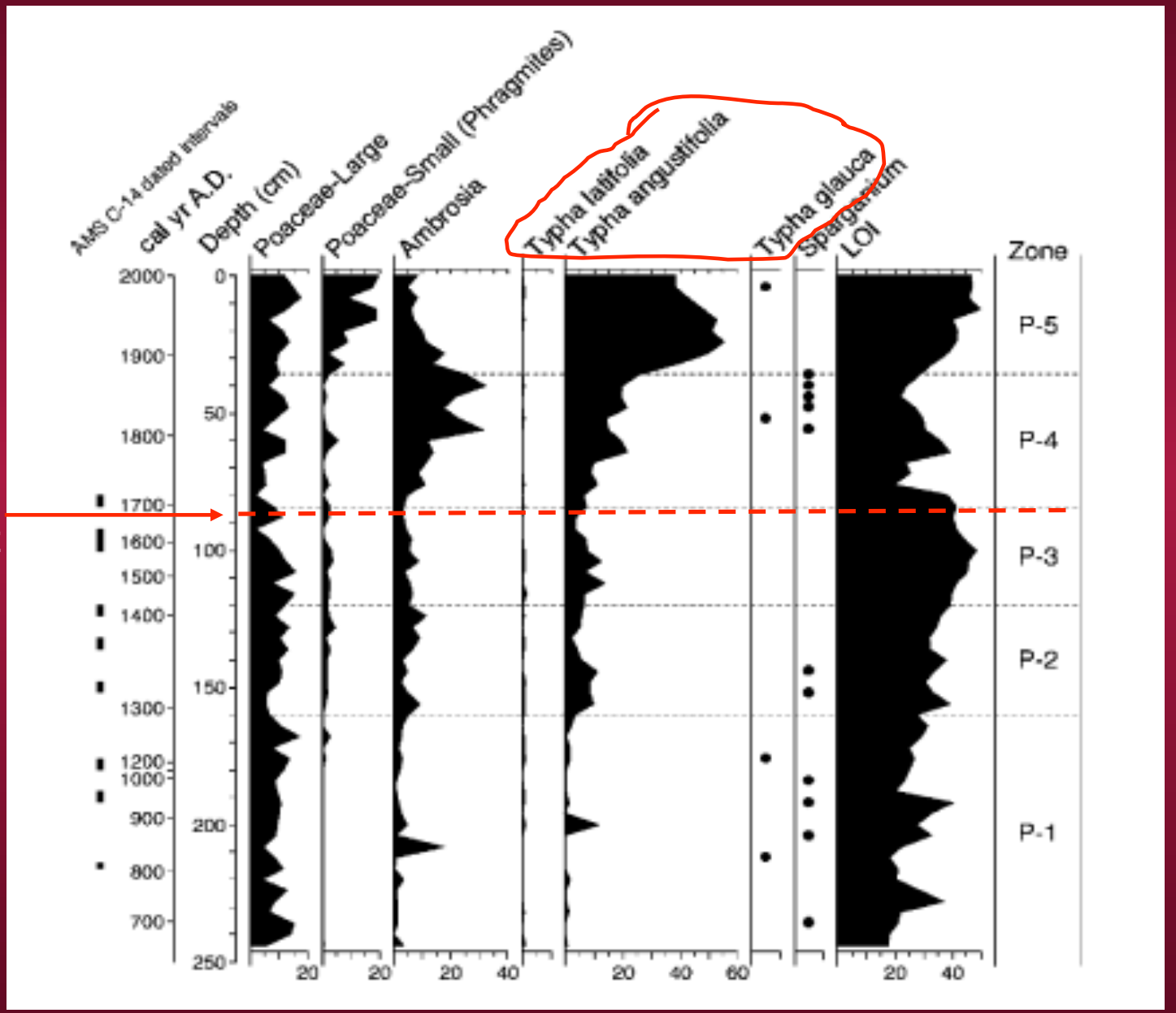
Typha angustifolia

In County map

- Present in state/Native
- Present in county/Native
- Present in state/Exotic
- Present in county/Exotic

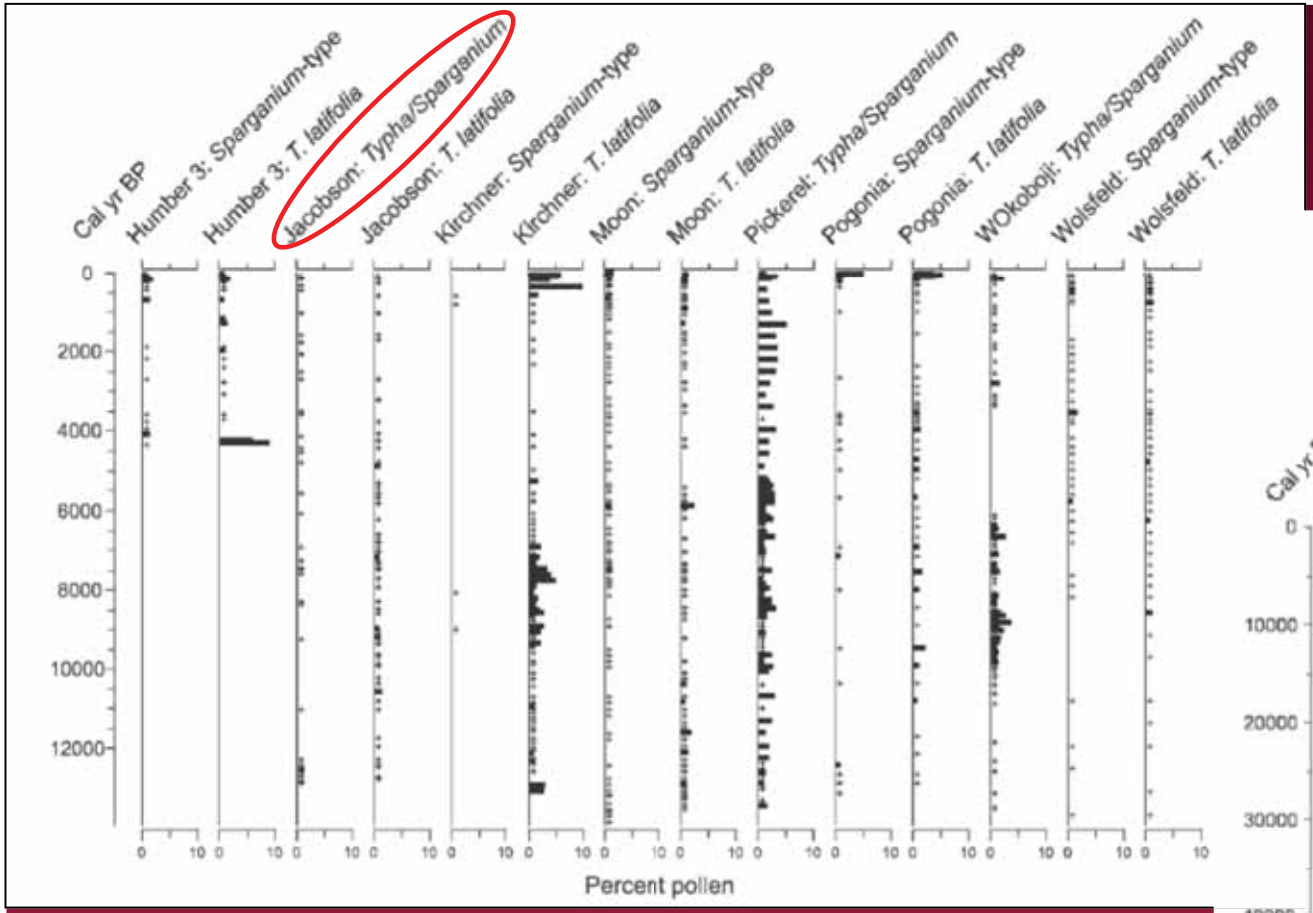
Pollen records in Piermont Marsh, NY

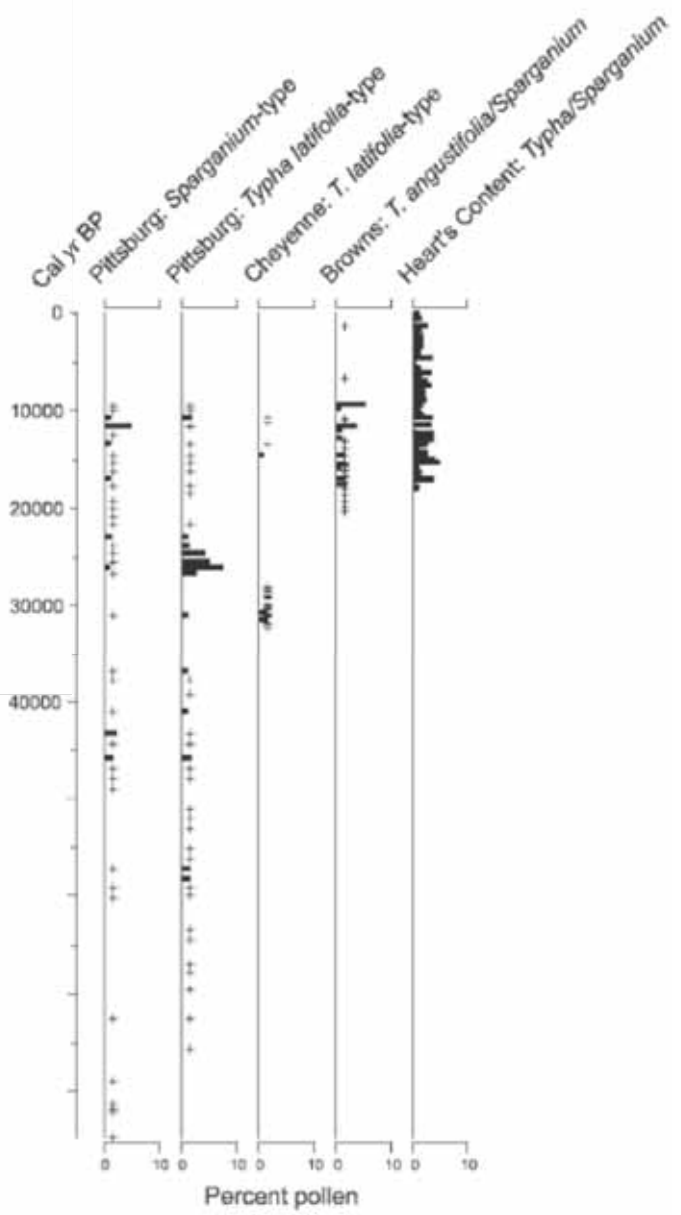
European Settlement ~ 1650



Pederson et al. 2005

Shih and Finkelstein 2008

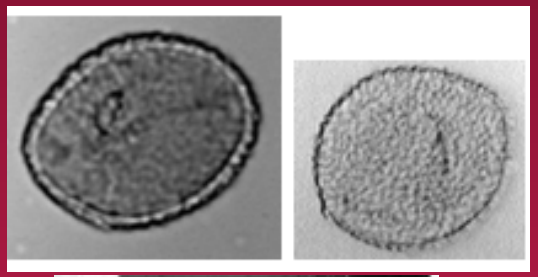


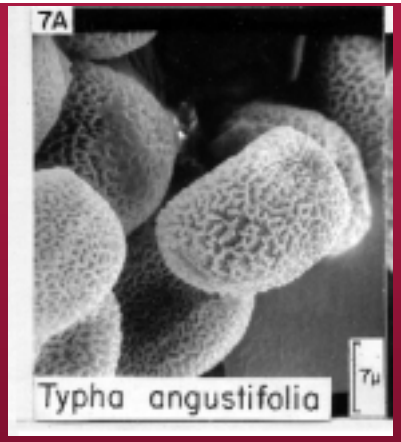


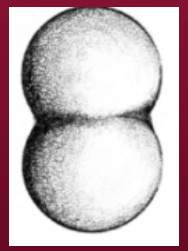
Pollen from *Typha latifolia* and *Typha angustifolia* has been present since the Holocene (~12,000 years before present)

T. angustifolia and *T. latifolia* pollen

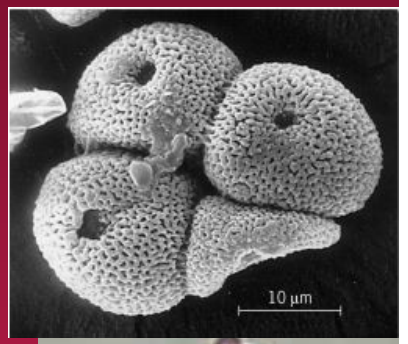
Monads

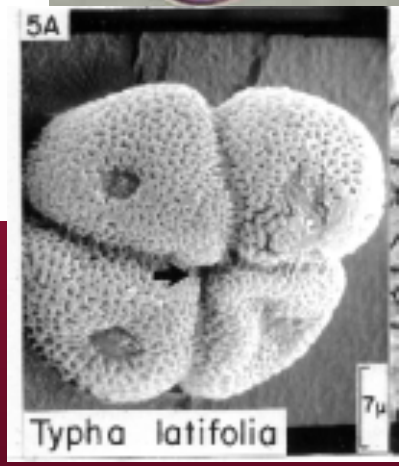






Tetrads

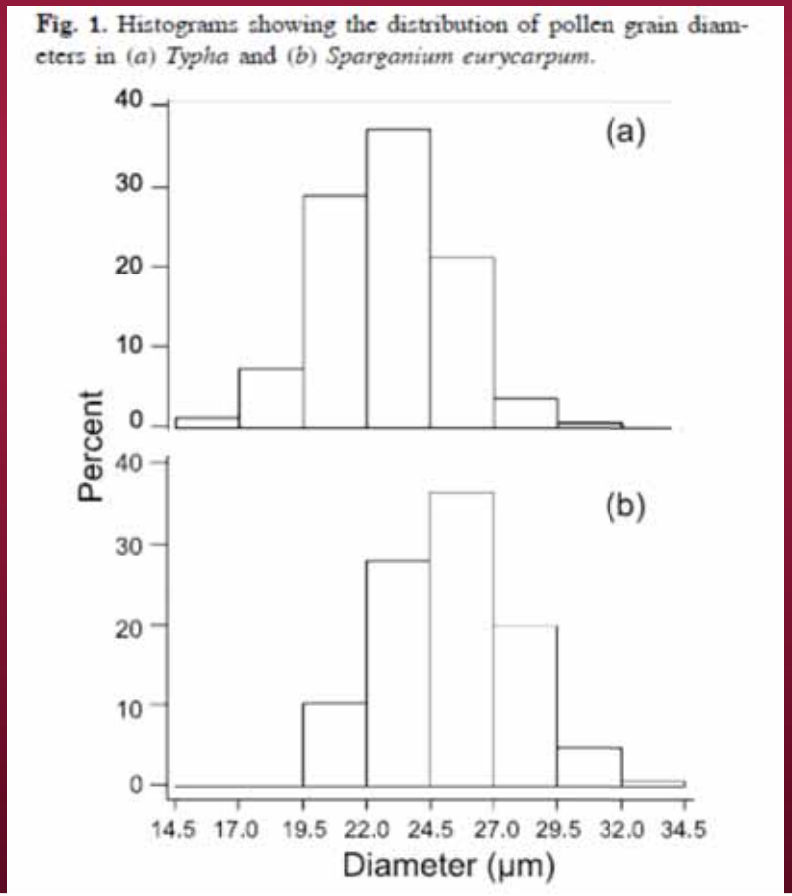




Typha x glauca = dyads / tetrads / triads

Identification based on pollen (Finkelstein 2003)

- *Typha angustifolia* = monads (22.7 +/- 2.6 μm), more angular
- *Sparganium* = monads (25.3 +/- 2.7 μm), more rounded



Separating *T. angustifolia* and *T. x glauca*

Table 4. Percent abundance of monads, dyads, triads, and tetrads on eight reference slides each of *Typha angustifolia* and *Typha* ×*glauca* (n = 8).

	% abundance (mean)	
	T. angustifolia	*T.* ×*glauca*
Monads	96.5–100 (99)	47–92 (75)
Dyads	0–3 (1)	7–30 (17)
Triads	0 (0)	0–10 (3)
Tetrads	0–0.1 (0.01)	0–14 (5)

How are invasive species defined?

- Non-indigenous species or strains that replace native vegetation, causing economic, environmental, and human health harm

Diversity and Distributions, (Diversity Distrib.) (2004) 10, 135–141

BIODIVERSITY RESEARCH

A neutral terminology to define 'invasive' species

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Great Lakes Institute for Environmental Research, University of Windsor, Windsor, ON N9B 3P4, Canada

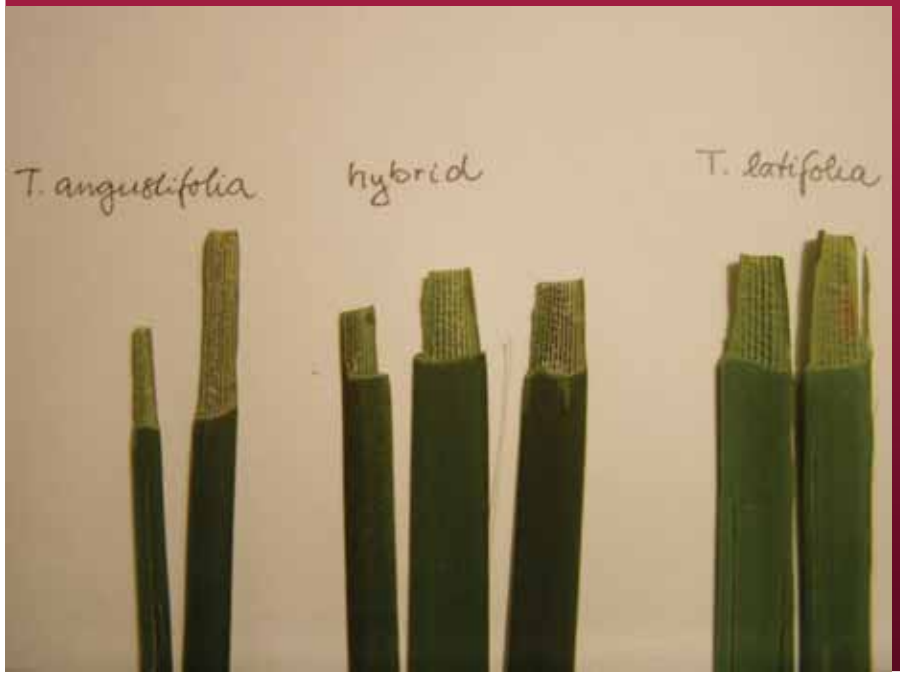
ABSTRACT

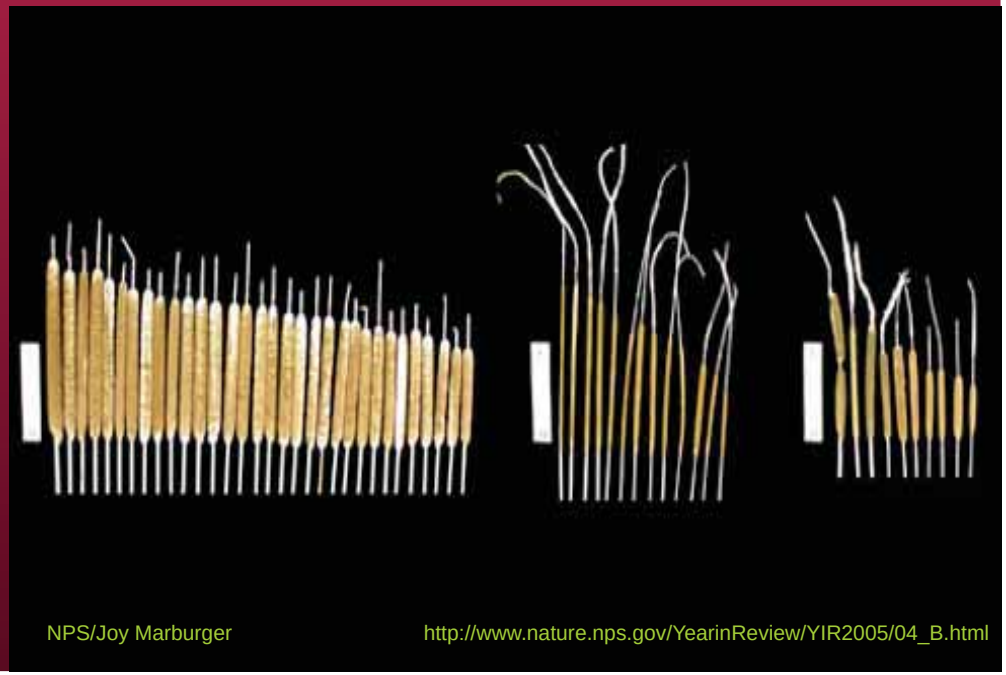
The use of simple terms to articulate ecological concepts can confuse ideological debates and undermine management efforts. This problem is particularly acute in studies of nonindigenous species, which alternatively have been called 'exotic', 'introduced', 'invasive' and 'naturalised', among others. Attempts to redefine com-

Broader definition: includes non-native AND native species that heavily colonize an area

PROBLEM 2: How do we identify *Typha* spp.?

- Morphological traits overlap between parental species and hybrids
- High variability within a species





NPS/Joy Marburger

http://www.nature.nps.gov/YearinReview/YIR2005/04_B.html

PROBLEM 3: Are hybrids sterile?

- It depends on the hybrid…
- First-generation (F1) hybrids thought to be sterile
- Introgression may be widespread
  - Back-crosses to either parent are more common than previously thought, at least for *Typha x glauca*
  - Advanced generation hybrids
  - Hybrid swarm

Problem 2 + Problem 3 = *Typha* spp. are a genetic headache

- Use of molecular markers (different mutation rates)
  - Isozymes / VNTR / AFLP / RAPD / Microsatellites / DNA Sequencing

Cattail sleuths use forensic science to better understand spread of an invasive species

By Joy Marburger, Steve Travis, and Steve Windels

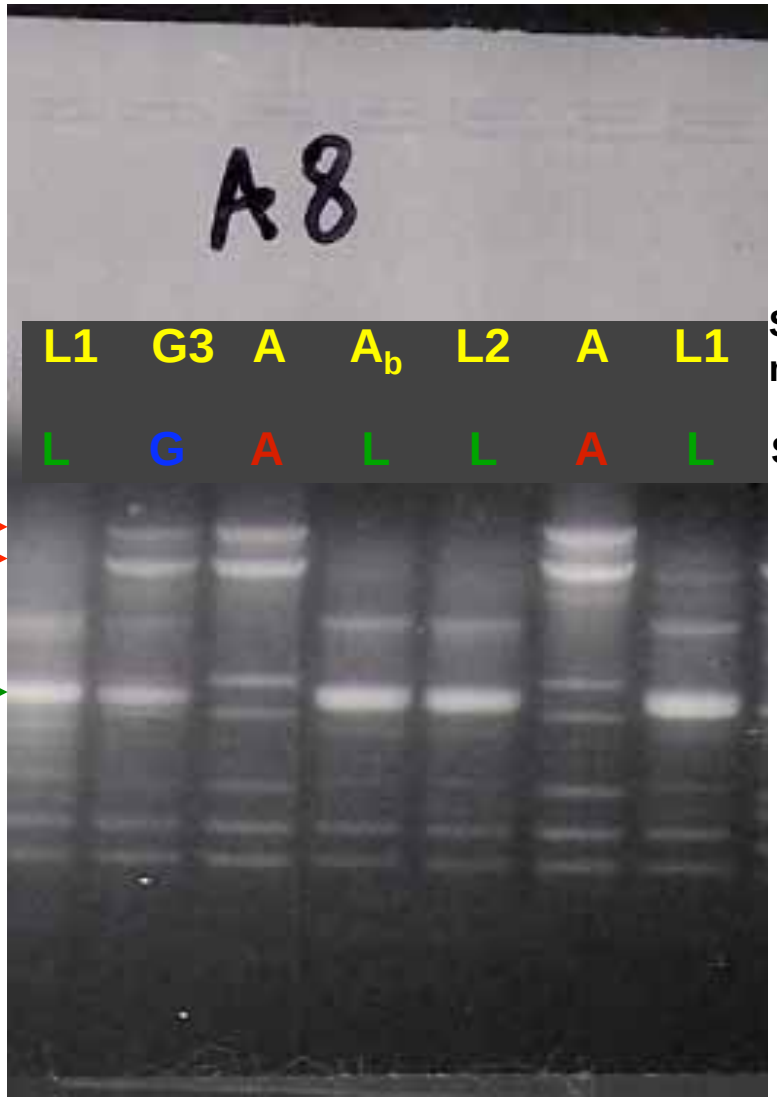
ALL CATTAILS ARE NOT CREATED EQUAL. Mounting evidence suggests that a European invader is hybridizing with native cattails in three national parks in the Great Lakes region. This is posing a threat to native biodiversity and causing a "hybrid swarm" into areas where cattails (*Typha* spp.) have never been seen. The invasive narrowleaf cattail (*T. angustifolia*), which has been spreading inland from the eastern seaboard since the early 1800s, has the ability to hybridize with the native broadleaf cattail (*T. latifolia*). In doing so, it has given rise to a new species of cattail (*T.* x *glauca*), first described in the 1960s. This hybrid has the ability to disrupt many ecosystem services traditionally associated with freshwater wetlands. This may be related to its ability to tolerate both of the habitats occupied by its parents (and then some).

All of this comes as no surprise to many taxonomists who have

Who's working with molecular tools?

- Isozymes
  - McNaughton 1965 (Stanford University)
  - Lee & Fairbrothers 1969, 1973; Lee 1975 (Rutgers University)
  - Mashburn et al. 1978
  - Sharitz et al. 1980 (University of Georgia-SREL)
- VNTR
  - Keane et al. 1999 (University of Cincinnati, OH)
- AFLP
  - Lamote et al. 2005 (Belgium)
- RAPD
  - Marcinko-Kuehn et al. 1999 (McMaster University, Ontario, Canada)
  - Snow, Selbo, Goldberg, and Wildova (Ohio State University / U. of Michigan)
  - Travis, Windels, and Marburger (University of New England / INDU)
  - Geddes and collaborators (NEIU)
- Microsatellites
  - Tsyusko-Omeltchenko et al. 2003; Tsyusko et al. 2005 (Ukraine / U of GA-SREL)
- DNA sequences
  - Zhang et al. 2008 (Florida Atlantic University; *Typha domingensis* and *Typha latifolia*)

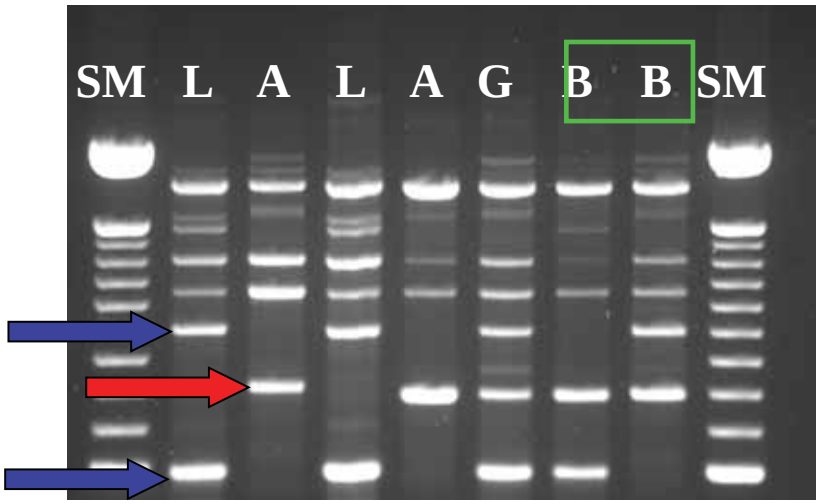
Molecular tools: RAPDs



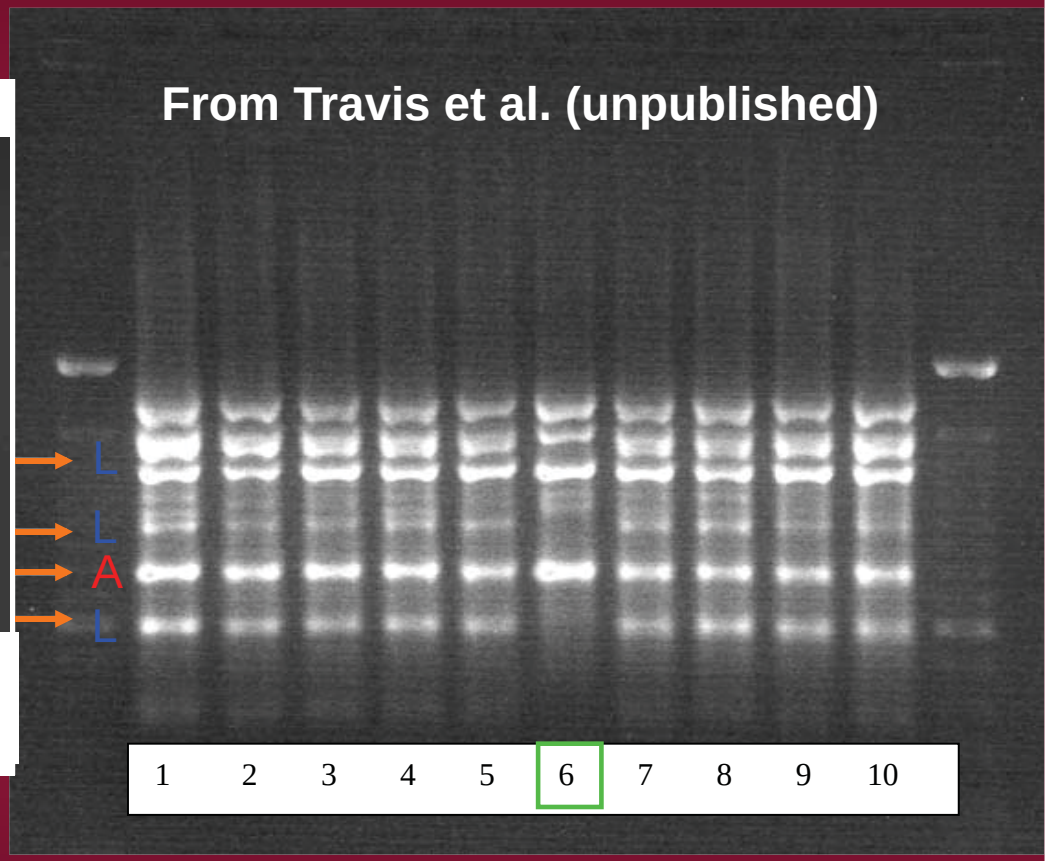
Band	latifolia	angustifolia
1.0 kb	+	–
1.8 kb	–	+
2.0 kb	–	+

Diagnostic band scores from Marcinko Kuehn et al. 1999

Back-crosses are common



From Wildova and Snow (unpublished)



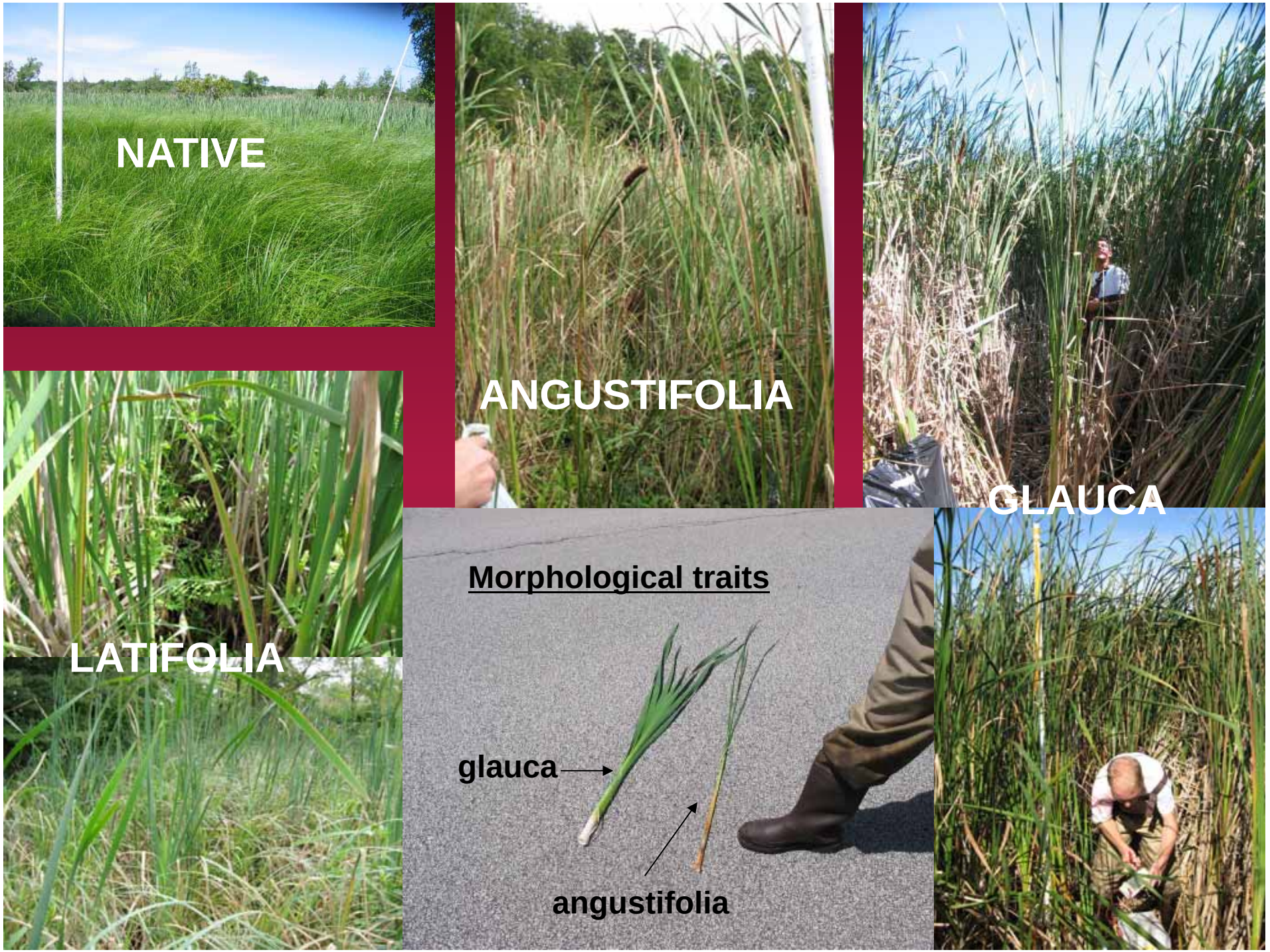
http://mipn.org/Final%20YIR%202005%20Cattail%20Sleuths%2011-26-05.doc

My research

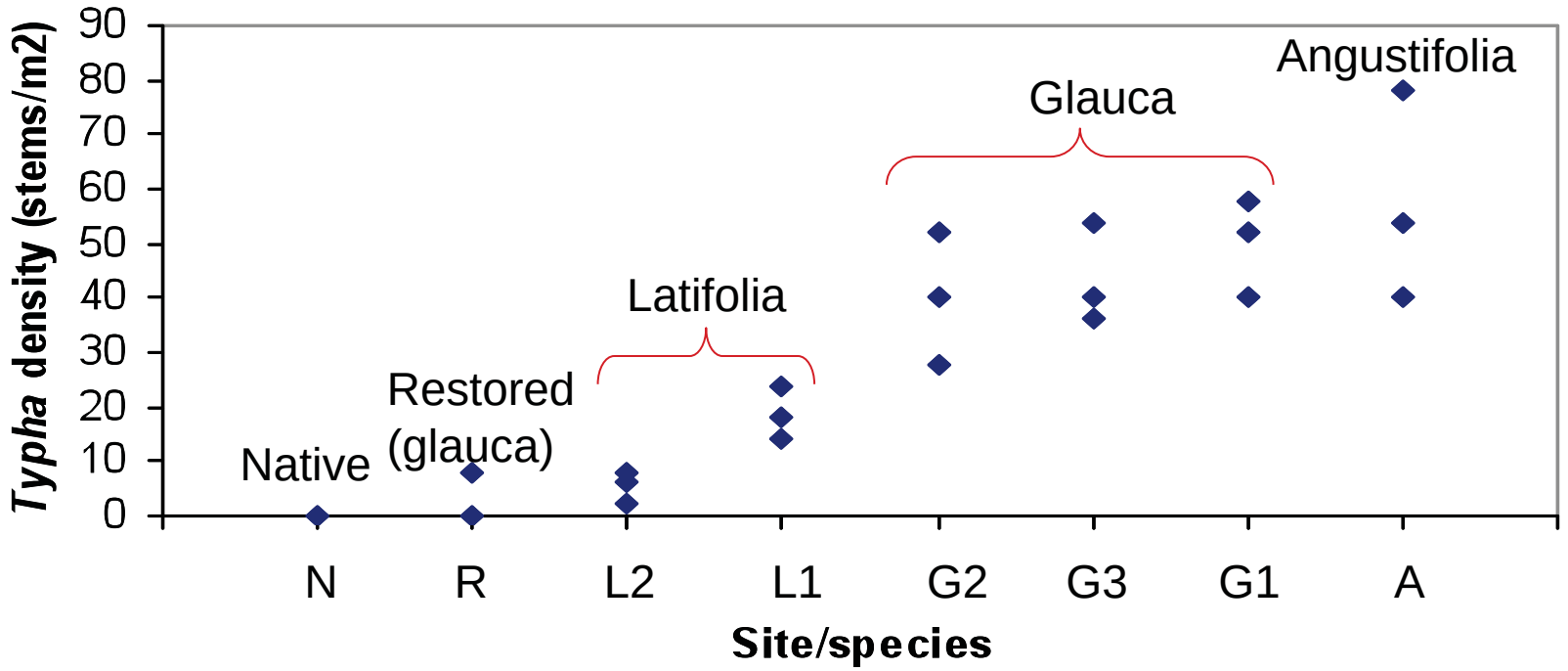
- Is there a difference in how different *Typha* species affect ecosystem properties?
  - Plant species richness
  - Nutrient pools (C, N, and P)
  - Nitrogen transformation (denitrification, nitrogen fixation)

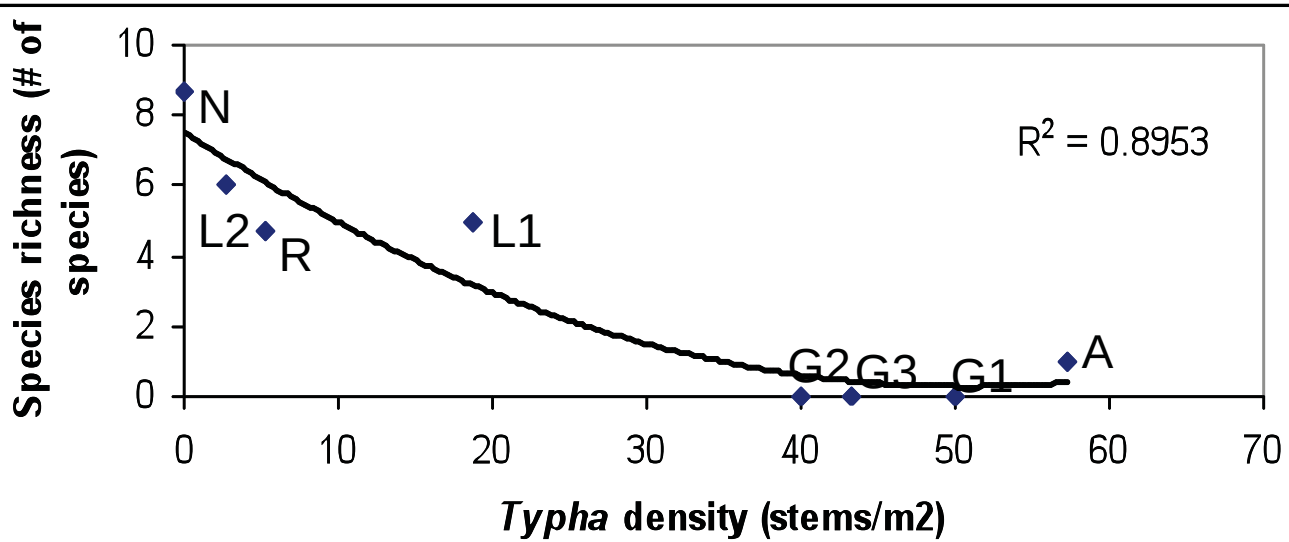
- *Typha* species identified using a complementary approach:
  - Morphological traits
  - “Ecological information”
  - Molecular tools

Field Site: Cowles Bog Wetland Complex

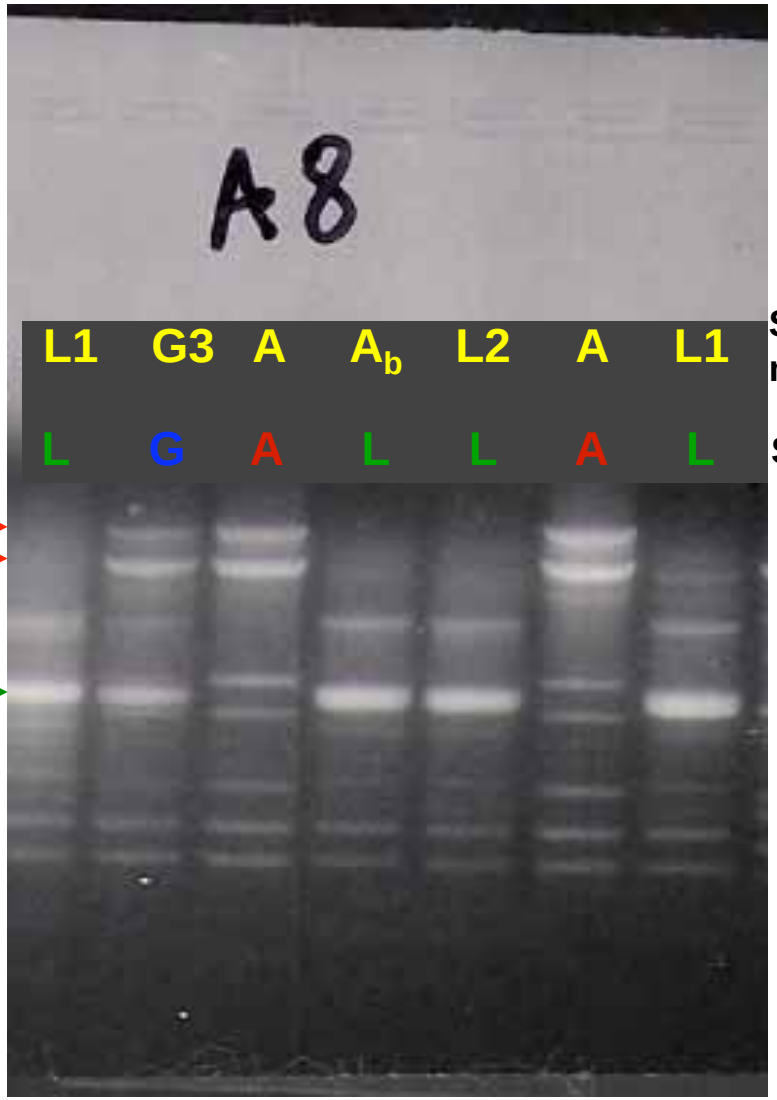

NATIVE
ANGUSTIFOLIA
GLAUCA
LATIFOLIA
Morphological traits
glauca
angustifolia

"Ecological information"





Molecular tools: RAPDs



Band	latifolia	angustifolia
1.0 kb	+	–
1.8 kb	–	+
2.0 kb	–	+

Diagnostic band scores from Marcinko Kuehn et al. 1999

Experiment to characterize species

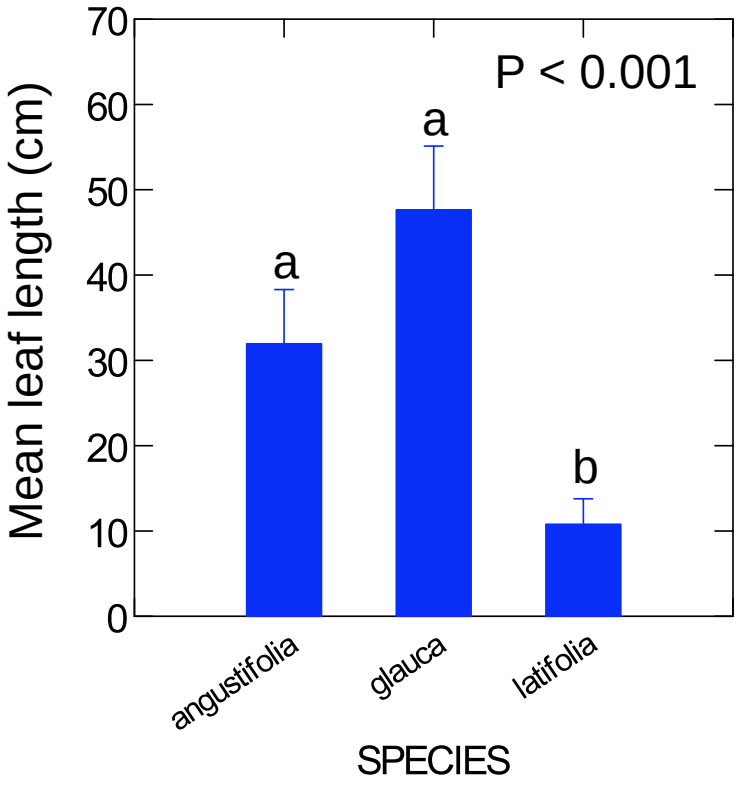
- Genetic analyses (RAPDs) and ecological information to identify species
- 3 different species were transplanted as rhizomes:
  - *Typha latifolia* (parental species)
  - *Typha angustifolia* (parental species)
  - *Typha x glauca* (hybrid)

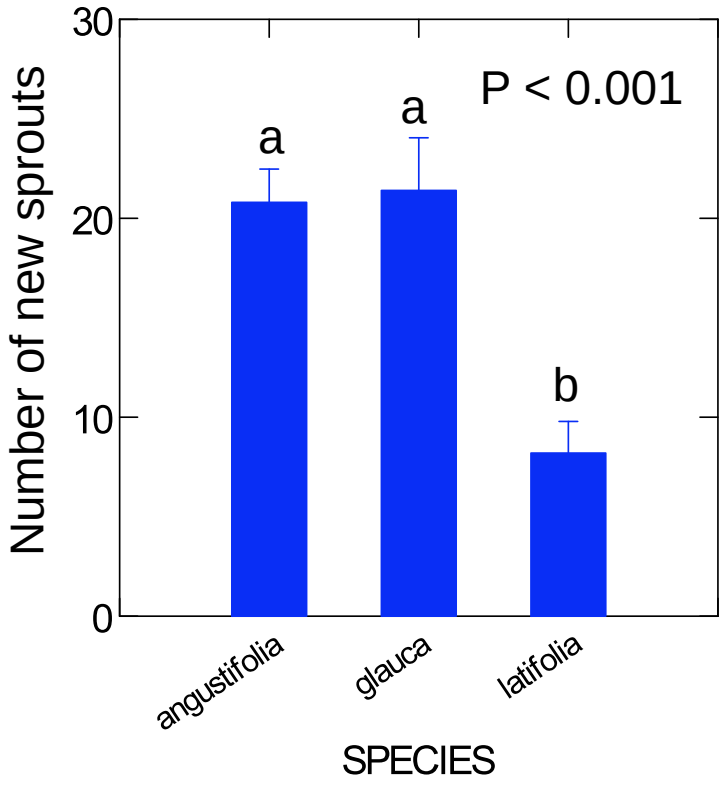
- Currently analyzing 100 specimens per species using molecular tools


LOYOLA
UNIVERSITY CHICAGO

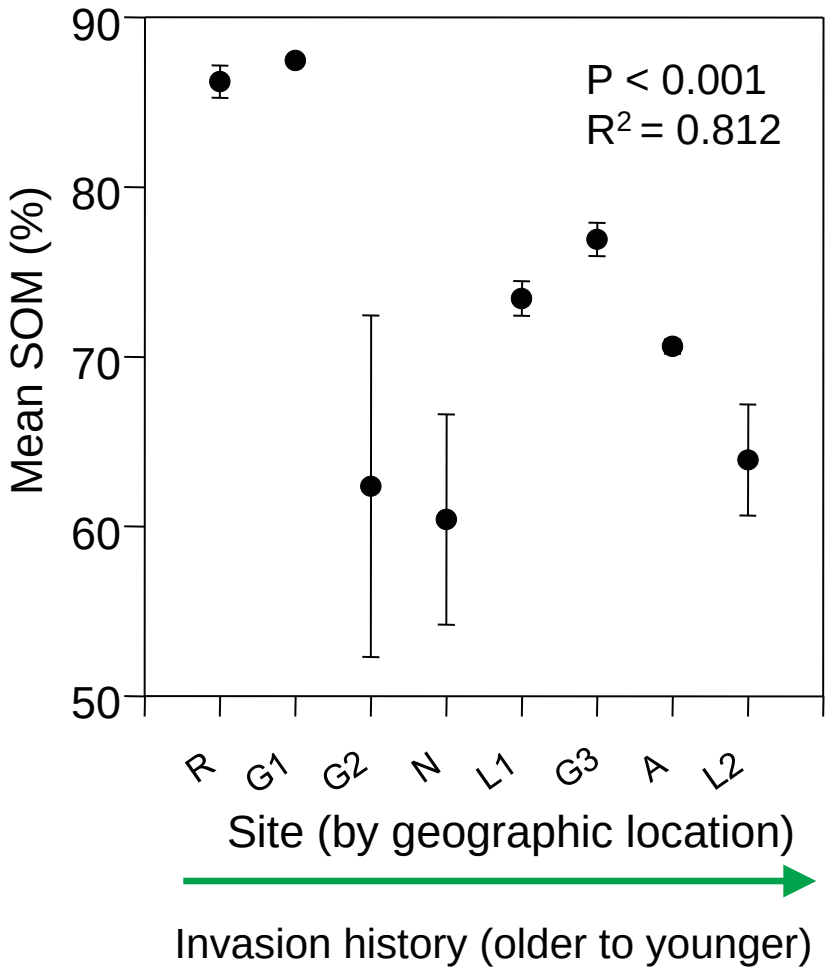
18 days

Growth pattern supports genetic identification

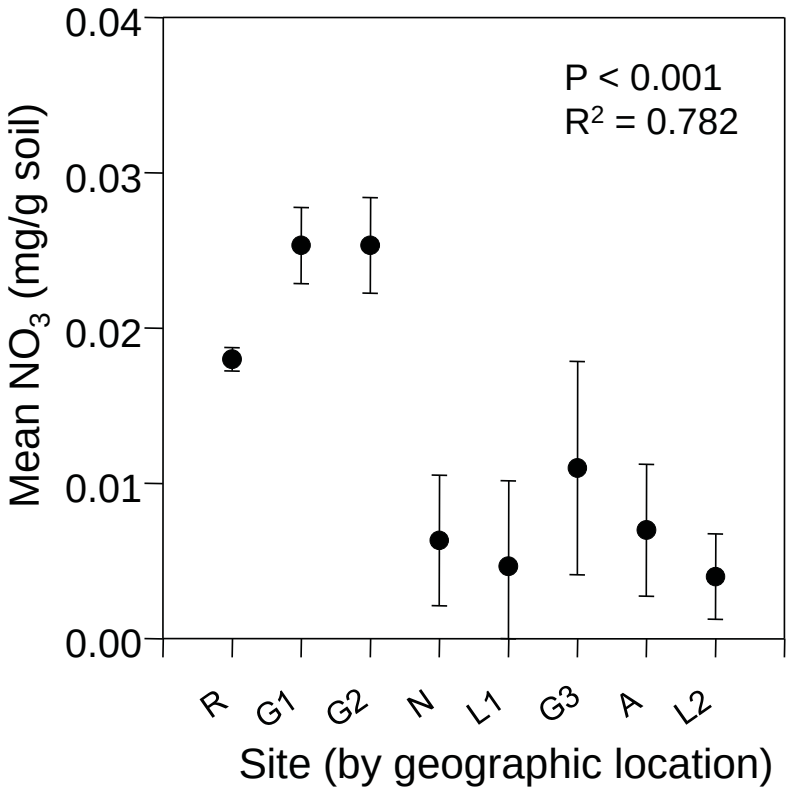


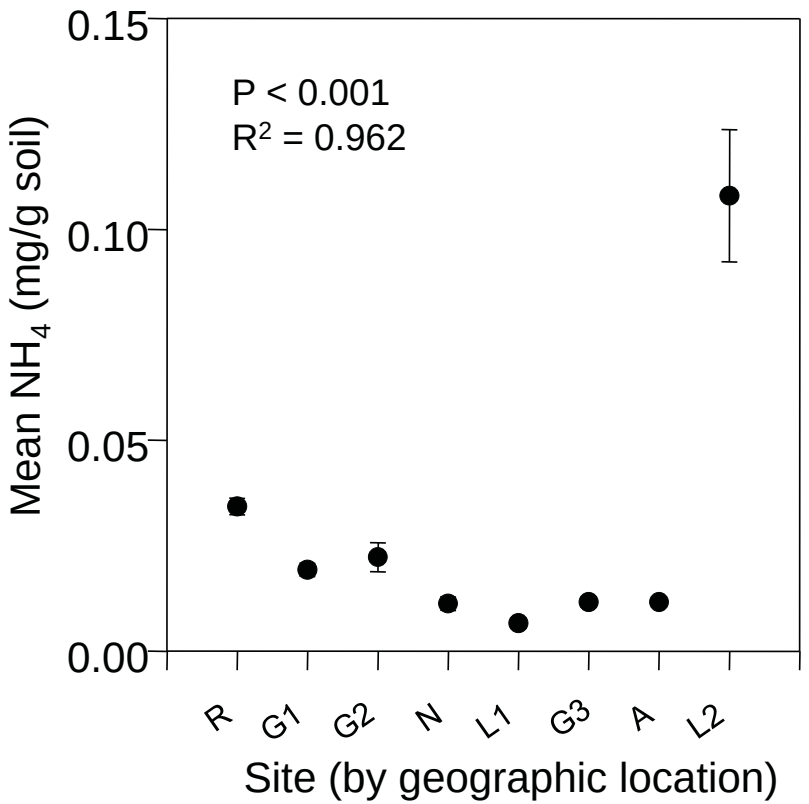


Nutrient pools: Carbon (SOM)



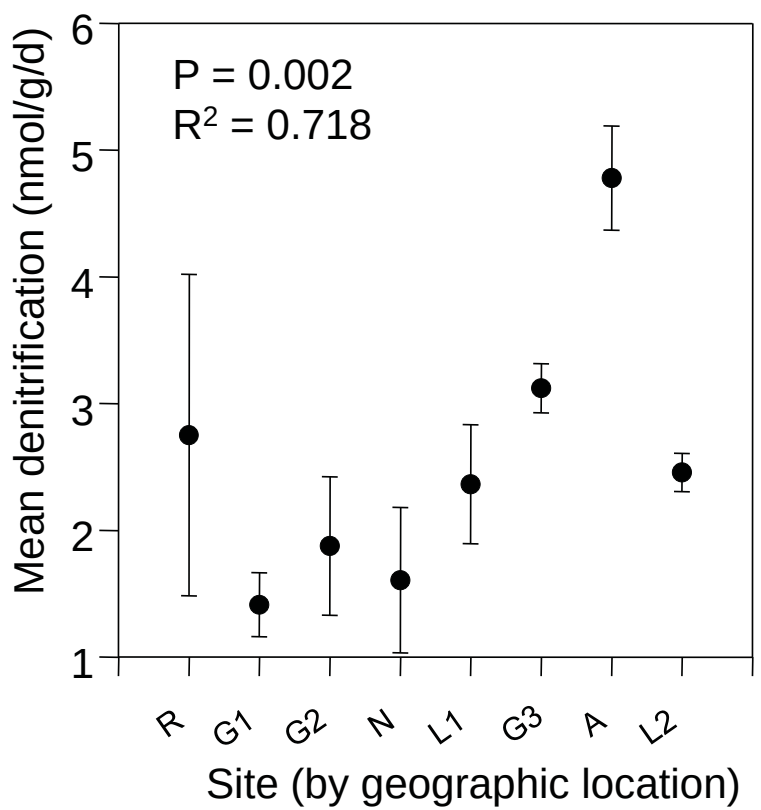
Nutrient pools: NO_3 and NH_4

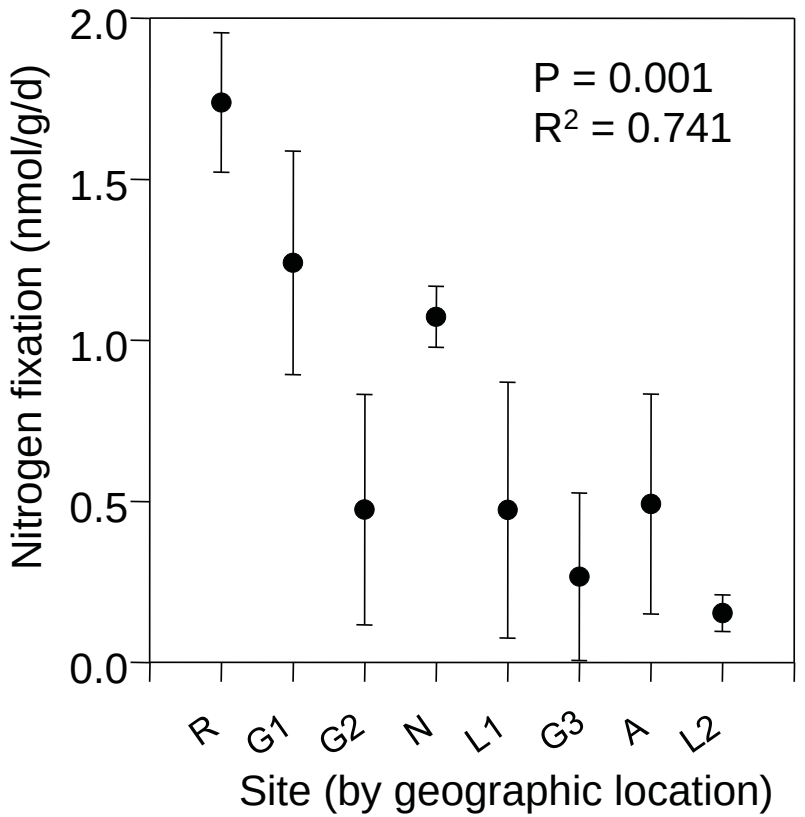




Invasion history (older to younger)

Denitrification and N fixation

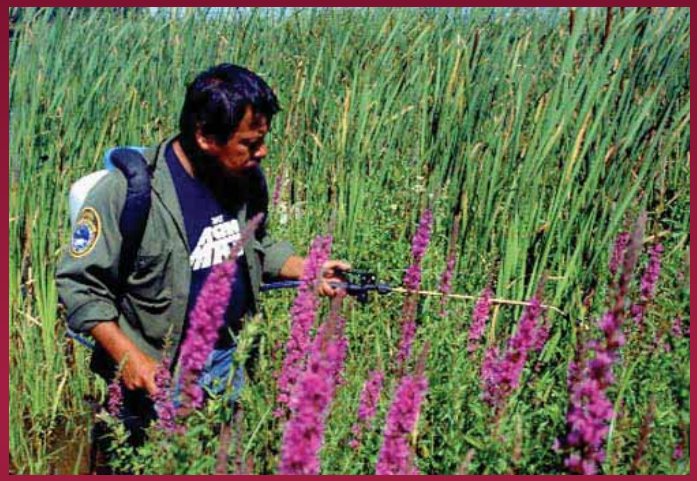




Invasion history (older to younger)

Implications for restoration practices

- Not all *Typha* are equal
  - Underscores the need for proper identification using a complementary approach
- *Typha* species differentially affect ecosystem properties
- Soil "legacy" from invasive species may have implications for restoration
  - History of invasion may be critical in determining these legacies
  - Restoration may not be effective if soil legacies are not addressed



Thanks

- NSF (DBI 0610405 to PG)
- IL-IN SeaGrant (NOAA) (co-PIs Larkin (CBG) and Tuchman (LUC))
- Carbon Scholarship (LUC) to T. Grancharova

- J. Kelly and T. Grancharova
- Bryan and Paula Pickett
- Bobbi Lammers-Campbell
- Joy Marburger (NPS), Dan Mason (NPS), Sean Burns (GLERC intern)
- Blake Anderson, Eric Appelbaum, Priscilla Andrade, Chris Calderaro, Monika Freyman, Amy Galanter, Kathi Jo Jankowski-Giefer, Jeff Kampman, Dan Larkin, Gina Lettiere, Shane Lishawa, Owen McKenna, Mark Mitchell, Michal Olszewski, Raphael Porto, Joe Schluep, Anna Sjodin, Cindy Stowell, Lane Vail, Alison Varty