Does Hybridization Contribute to Cattail Invasion of Wetlands in the Midwest?

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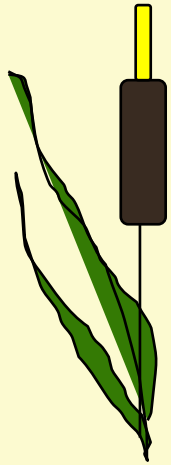
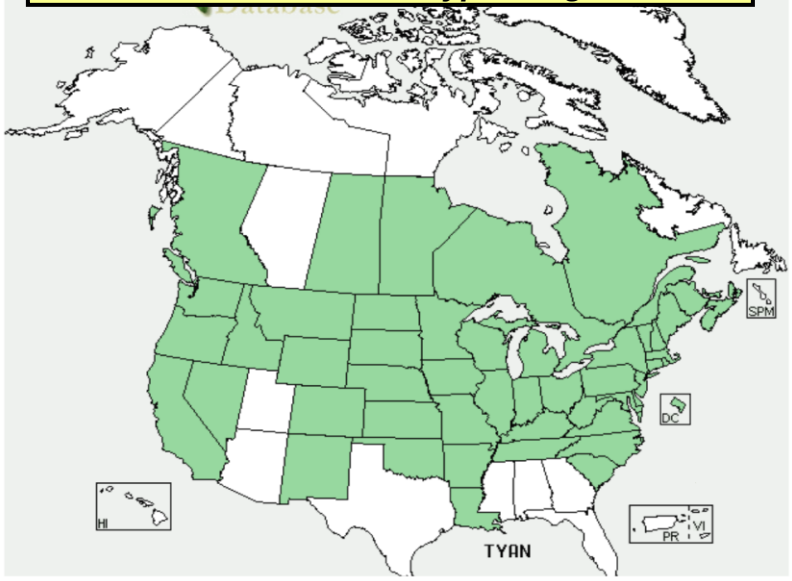
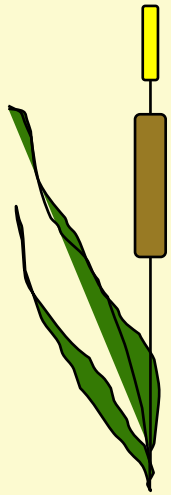
CATTAIL TAXA IN THE MIDWEST

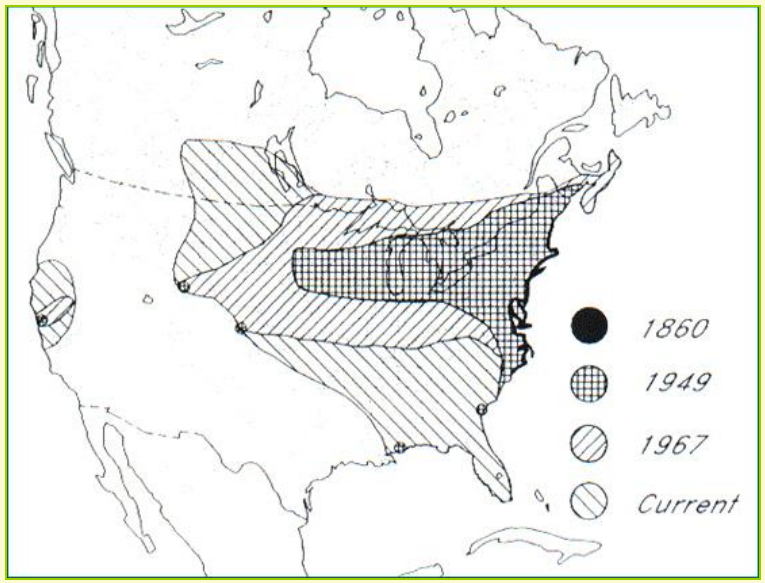
BROADLEAF CATTAIL *Typha latifolia* L.



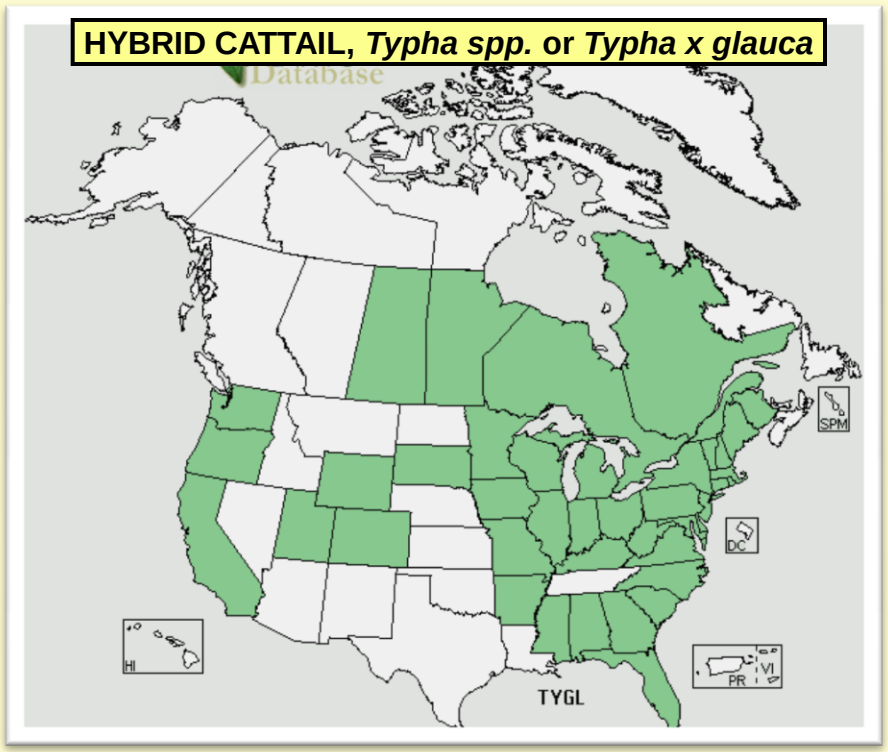
NARROWLEAF CATTAIL, *Typha angustifolia* L.





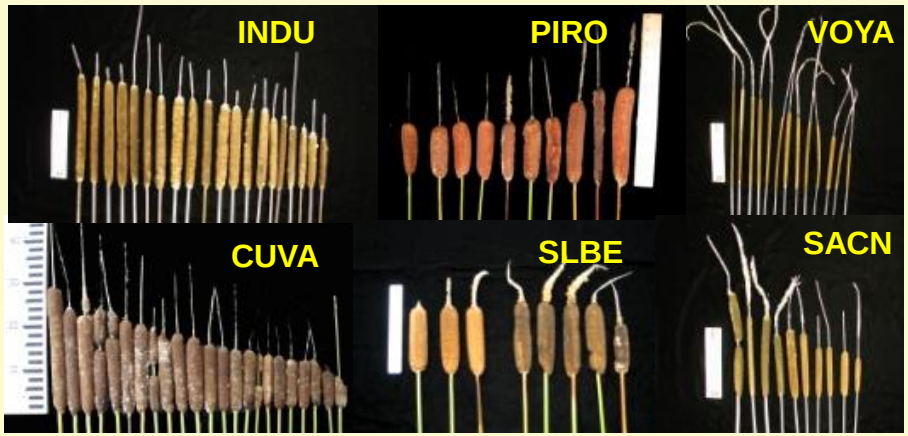


Spread of Narrowleaf Cattail (*Typha angustifolia*) (Galatowitsch et al. 1999; published in Wetlands)



WHAT KIND OF CATTAILS ARE FOUND IN MIDWEST NATIONAL PARKS?

Typha POPULATION VARIABILITY ACROSS LANDSCAPES

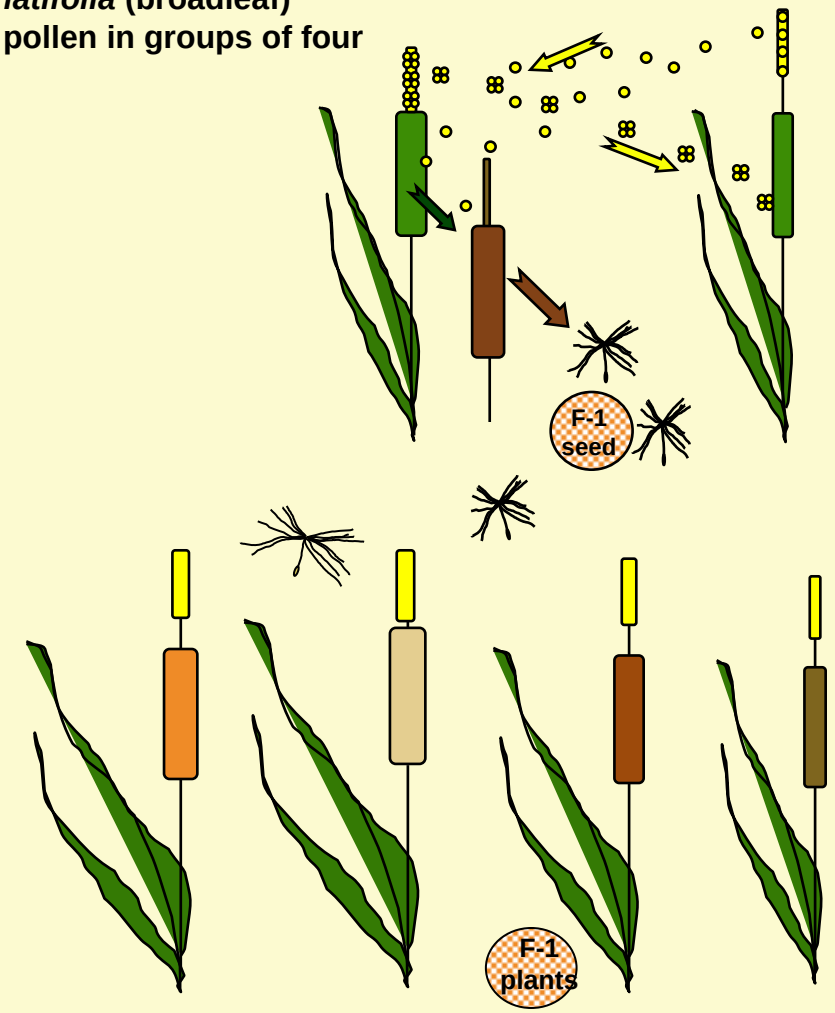


SEXUAL REPRODUCTION

Pollen with sperm cells is shed from the male spike of either species and pollinates the female spike of the other species; female spike ripens and produces fertile seeds.

Typha latifolia **(broadleaf)**
sheds pollen in groups of four

Typha angustifolia **(narrowleaf)**
sheds pollen in single units



Two species can occur in the same environment: shallow water, ditches, marshes, wet prairies allowing cross-pollination by wind.

Both species have the same chromosome number in somatic tissues (2N=30). Since each pollen sperm and egg cell in each species have half the somatic chromosomes (N=15), they can pair during fertilization and form fertile seeds (2N=30). Thousands of seeds are shed from the female spike.

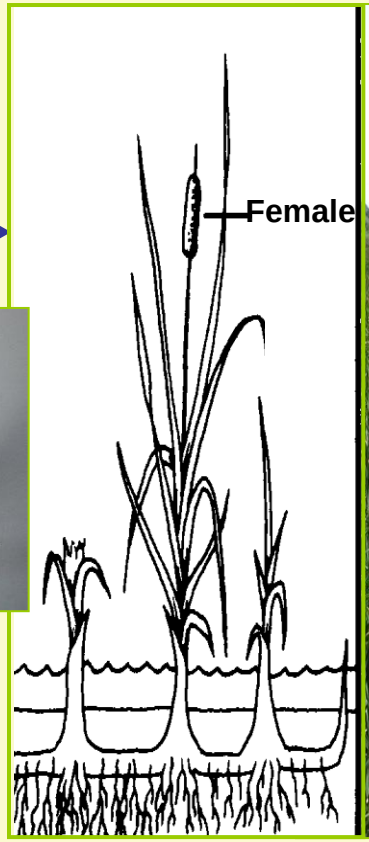
ASEXUAL REPRODUCTION

CLONES=RHIZOMES DERIVED FROM A SINGLE PLANT

(ramets from a genet!)

seedling growth in spring

rhizome growing from seedling



OBJECTIVES

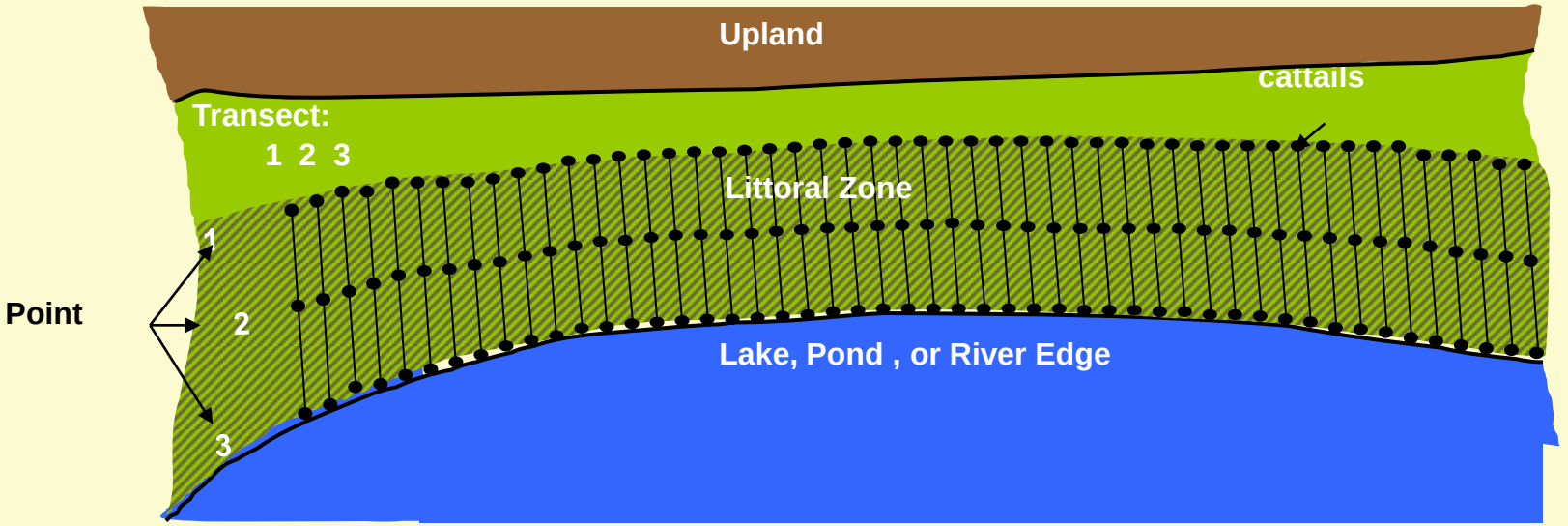
GOAL 1: CATTAIL POPULATION GENETICS

What is the distribution of the cattail taxa in selected locations in national parks?

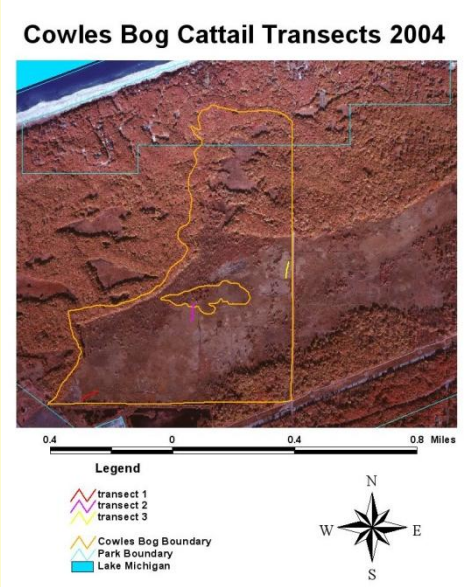
GOAL 2: SEED BANK

Are cattail hybrids and parental species retained in the seed bank?
What is their prevalence compared to other native species?

SAMPLING METHODS



Transects and points along water bodies in CUVA, PIRO, SACN, SLBE, VOYA



SAMPLING METHODS

2004 - 2011: More than 1,500 plants analyzed for genetic and morphologic characters in 6 GL parks

2005 - 2012: DNA of leaf material analyzed and scored

2009 - 2011: Final results and peer-reviewed publications for three parks

2011 - 2013: Other parks analyzed: Pt. Reyes National Seashore, Everglades National Park, Apostle Islands NL

Morphological Measurements:

- Spike Length
- Spike Width
- Leaf Width
- Spike Interval
- Stem Height
- Water Depth

8 DNA Microsatellite (SSR) Diagnostic Markers:

- TA 3
- TA 5
- TA 7
- TA 8
- TA 16
- TA 20
- Tmin01
- Tmin04

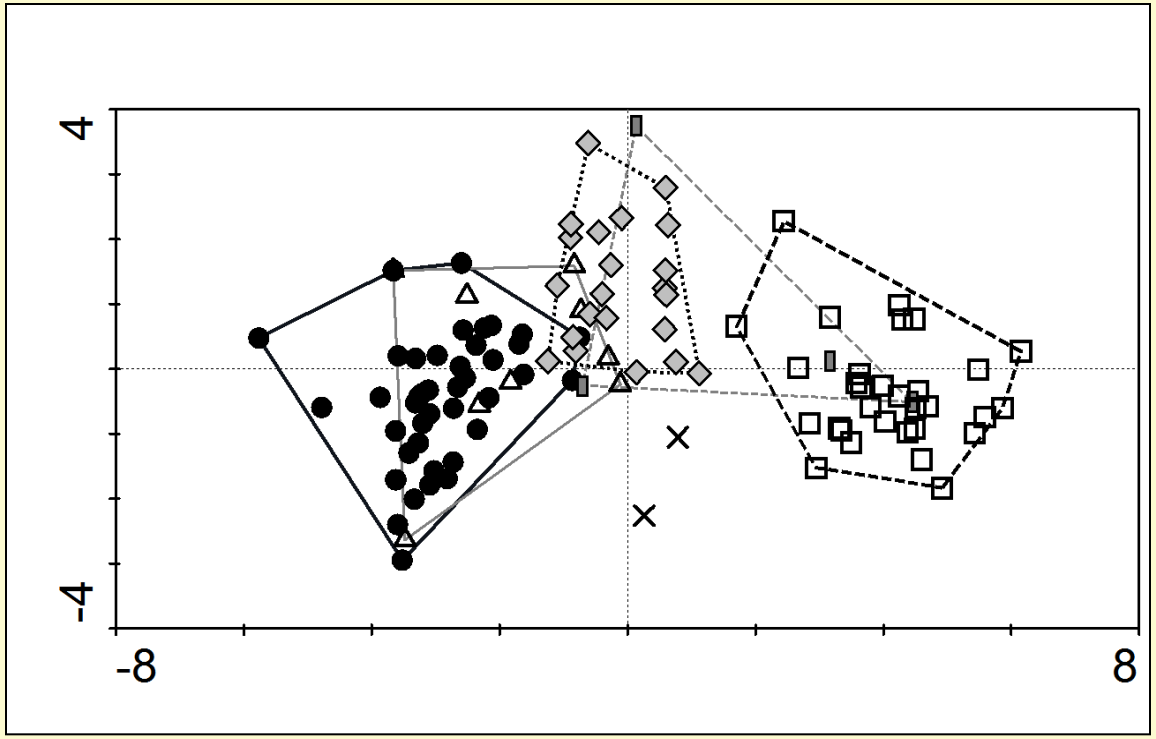
RESULTS

MORPHOLOGY

Mean (cm)	INDU	CUVA	SACN	SLBE	PIRO	VOYA
Water Depth	2.95	0.48	17.02	0.47	0.02	38.89
Stem Height	255.28	221.01	164.60	148.07	173.81	210.01
Leaf Width	1.34	1.50	0.86	1.33	1.60	1.15
Inflorescence Length	18.46	15.33	14.88	13.65	11.84	18.93
Inflorescence Width	2.11	2.12	2.11	1.98	2.94	2.19
Gap Length	1.68	0.30	1.58	0.96	0.04	1.14

RESULTS

MORPHOLOGY RELATIONSHIPS OF HYBRIDS AND PARENTS



TL - *T. latifolia*

TA - *T. angustifolia*

F1 – F1 hybrid

BA – hybrid backcrossed to *T. angustifolia*

BL - hybrid backcrossed to *T. latifolia*

Adv H - advanced hybrid

Log (leaf length/leaf width), spike gap length, and stem diameter explain much variation via linear discriminant analysis.

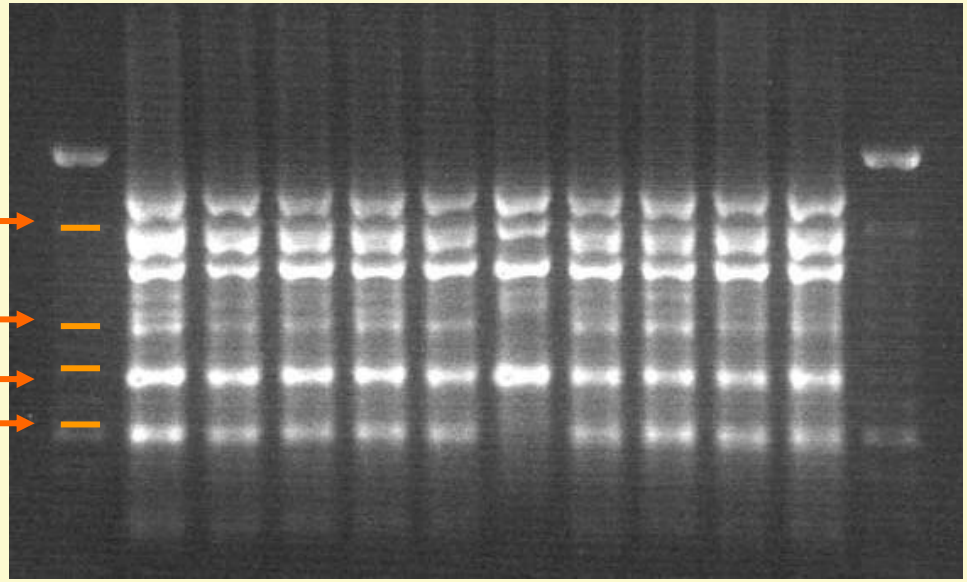
Snow, A.A., S.E. Travis, R. Wildov á, T. F é r, P. M. Sweeney, J.E. Marburger, S. Windels, B. Kubátová, D. E. Goldberg, and E. Mutegi. 2010. Species-specific ssr alleles for studies of hybrid cattails (*Typha latifolia* X *T. angustifolia*; Typhaceae) in North America. American Journal of Botany 97:2061-2067.

HOW DO WE KNOW FOR SURE THAT THEY ARE HYBRIDS?

DNA Markers = RAPDs and Microsatellites (SSRs)







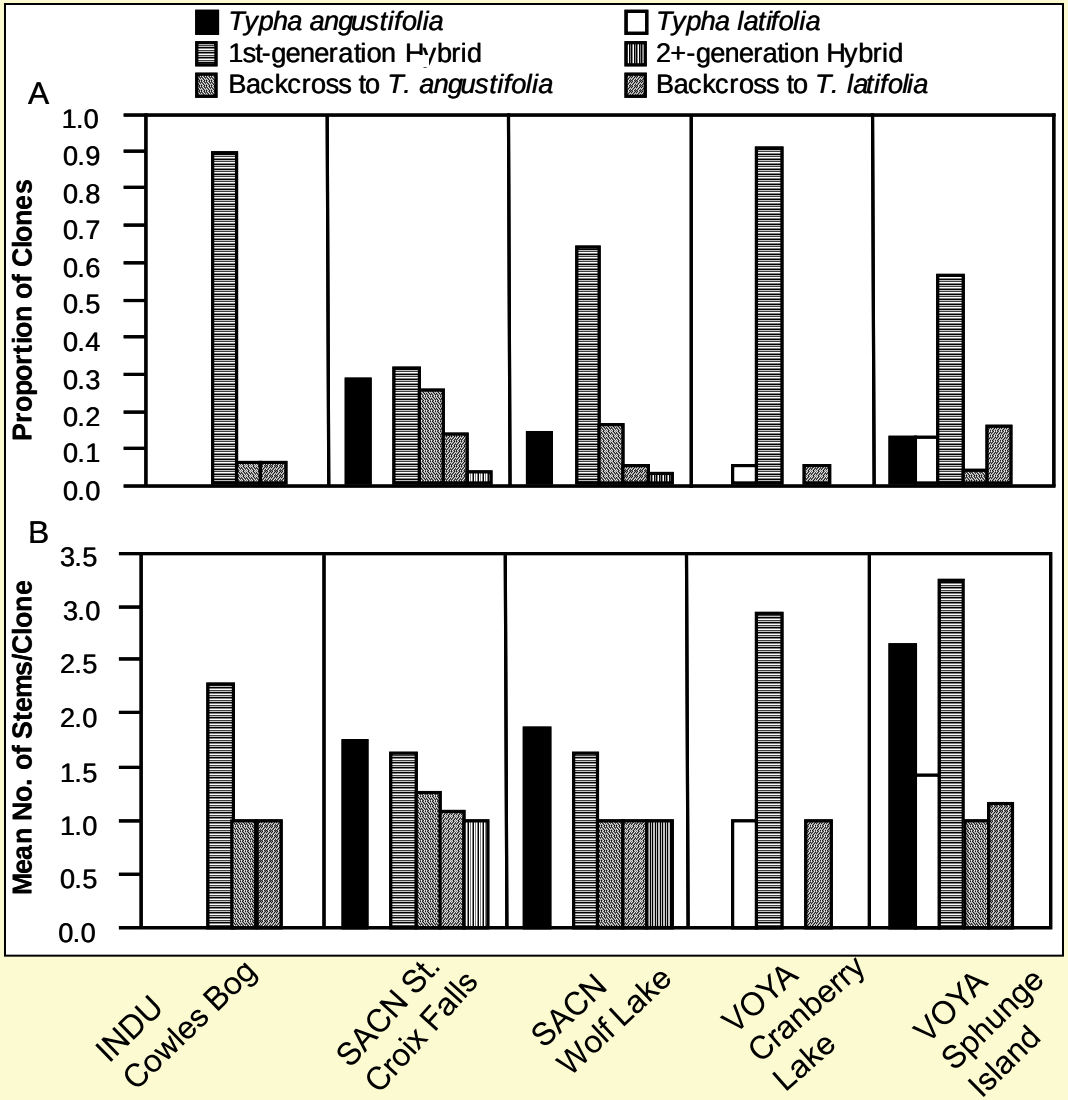
F1 F1 F1 F1 F1 ? F1 F1 F1 F1

DNA in leaves is broken up with chemicals, more fragments by PCR. The solution with an added dye is applied to a gel with electrical charge that causes the different DNA sizes and sequences to migrate in the gel.

10 Cattail Leaves From St Croix NSR (SACN) in Wisconsin using RAPD primer A2

RESULTS

Microsatellites show relationships among clones within species and hybrids.

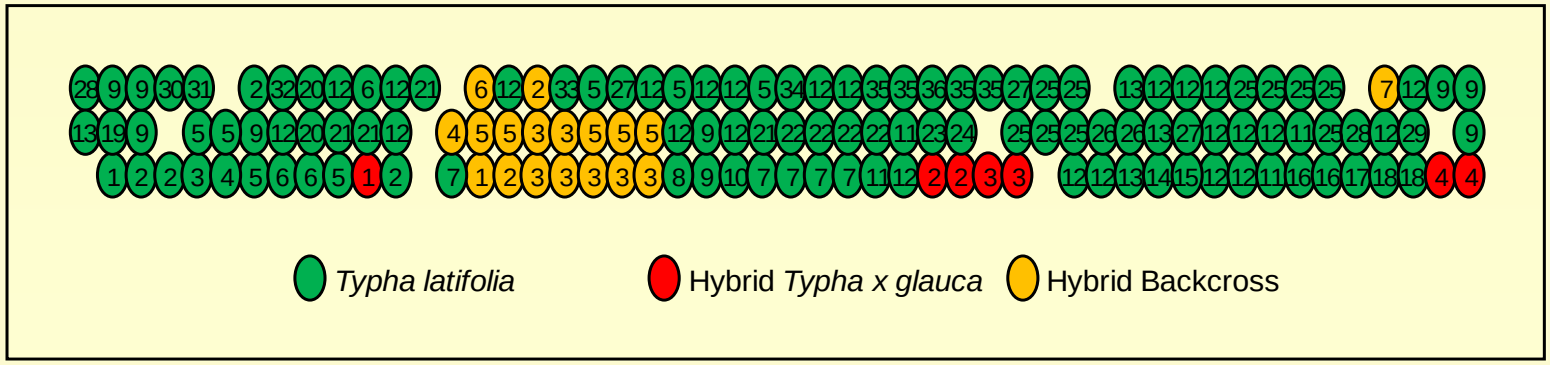


Travis, S.E., J.E. Marburger, S. Windels, and B.Kubátová. 2010. Clonal diversity and hybridization dynamics of invasive cattail (*Typhaceae*) stands in the Great Lakes Region of North America. Journal of Ecology 98:7-16.

RESULTS

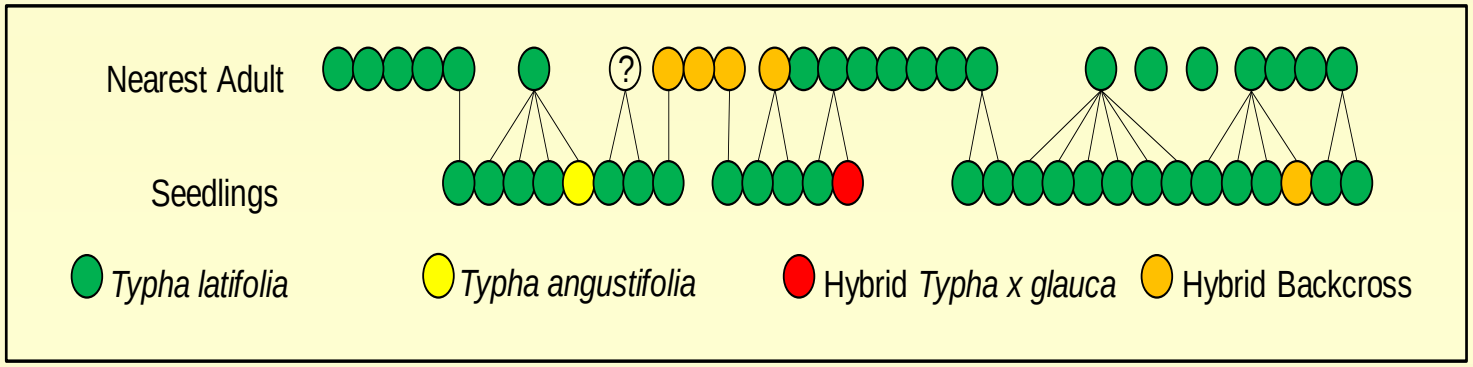
Sleeping Bear Dunes NL - Adults

82% of stems and 77% of clones were *T. latifolia*, with the remainder of the stems/clones exhibiting a mixture of *T. latifolia* and *T. angustifolia* markers.



Sleeping Bear Dunes NL – Seed Bank

89% of the seedlings showed the *T. latifolia* genotype.



RESULTS: AMBIGUITIES FOR CUVA AND PIRO

- **Genetic markers indicated plants were *T. latifolia* in adult and seedling populations.**

- **Morphological characters indicate mixed genotypes.**

- **Why the difference*:***
  - **insufficient number of biomarkers and**
  - **backcrossing of *T. angustifolia* to *T. latifolia* resulted in populations of *T. latifolia* with introgression of genes from *T. angustifolia***

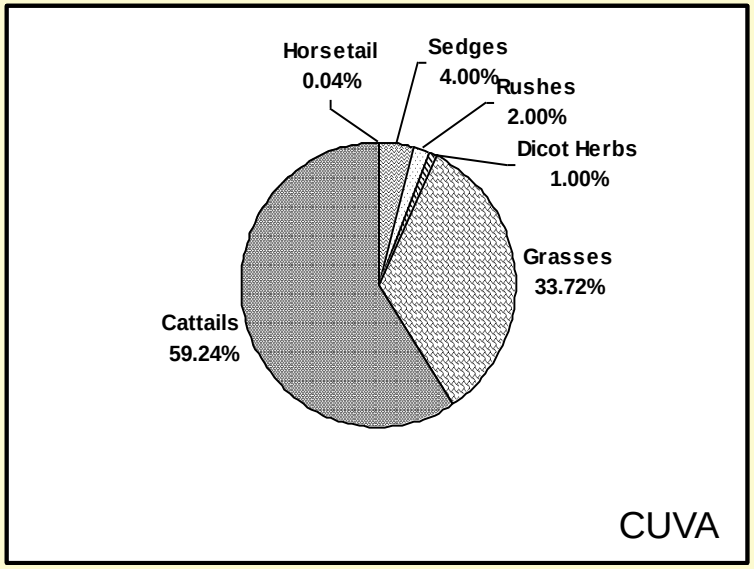
SEED BANK STUDY

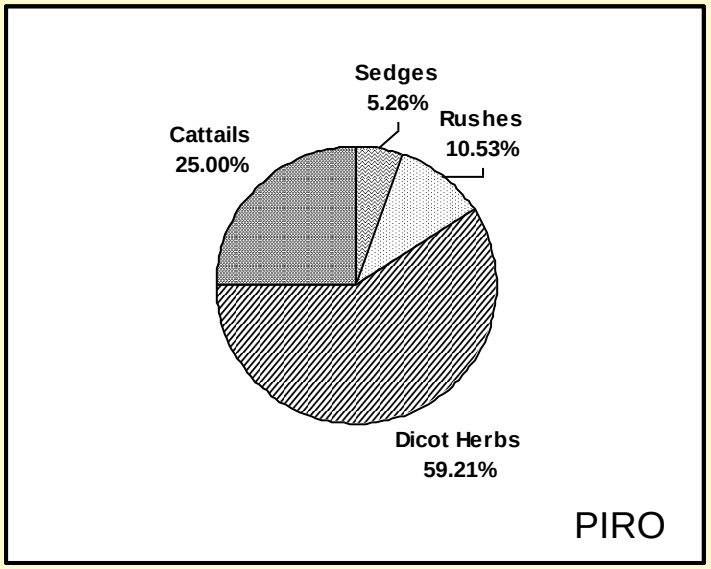
2008 – 2010: CUVA, PIRO, SLBE; collections of seed bank samples

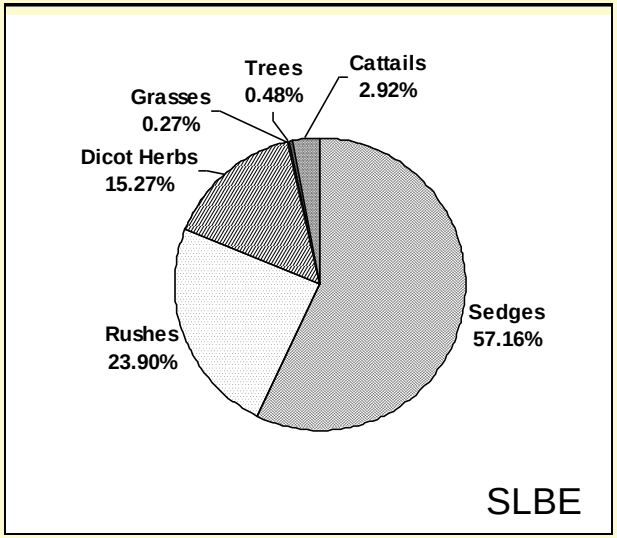
Soil was collected with a 10-cm diameter x 20-cm depth golf turf auger. Soil samples were collected in plastic ziplock bags along the middle transect every four meters at each site. Seedlings were counted and identified to species when possible.

RESULTS - SEED BANK

VARIABLE RESPONSE DEPENDING ON PARK







ACTIVE MANAGEMENT

COWLES BOG, INDU

2004

2012

Take Home Message

• Molecular data helped confirm the role of hybridization in plant invasions and species extinctions, particularly for clonal species such as *Typha*, where the boundaries separating individuals are otherwise difficult to discern.

• Nuclear DNA markers documented the prevalence and performance of hybrids in four of the six invasive *Typha* stands investigated in the Great Lakes Region. However, additional identification methods, such as chloroplast DNA markers, may be required.

• Extremely high prevalence of F1 hybrids within mixed *Typha* stands and the larger population sizes of hybrid genotypes, suggests that hybrids are capable of outperforming other *Typha* spp. and that hybridization has played an influential role in the North American cattail invasion.

• Landscape and anthropogenic conditions present specific adaptive or speciation pressures that may lead to genetic selection of cattail taxa adapted to those conditions.

• Cattail genetic evaluation using additional markers continues in other national parks; this is determined by funding support and park need.

• NPS has initiated measures for restoring cattail dominated marshes to diverse flora, particularly in INDU, where active management is occurring.

http://nwrcwebapps.cr.usgs.gov/cattail/

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