Habitats Invaded by European Frogbit (*Hydrocharis morsus-ranae*) in Lake Ontario Coastal Wetlands

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Great Lakes RESTORATION

What Is *Hydrocharis morsus-ranae*?

- Member of Hydrocharitaceae
- Similar to and confused with American frogbit (*Limnobium spongia*)
  - Native to SE United States
- Range
  - Native to most of Europe and northern Asia
  - Introduced and invasive in United States and Canada
- Non-rooted, floating aquatic plant
- Shallow water, little to no wave energy


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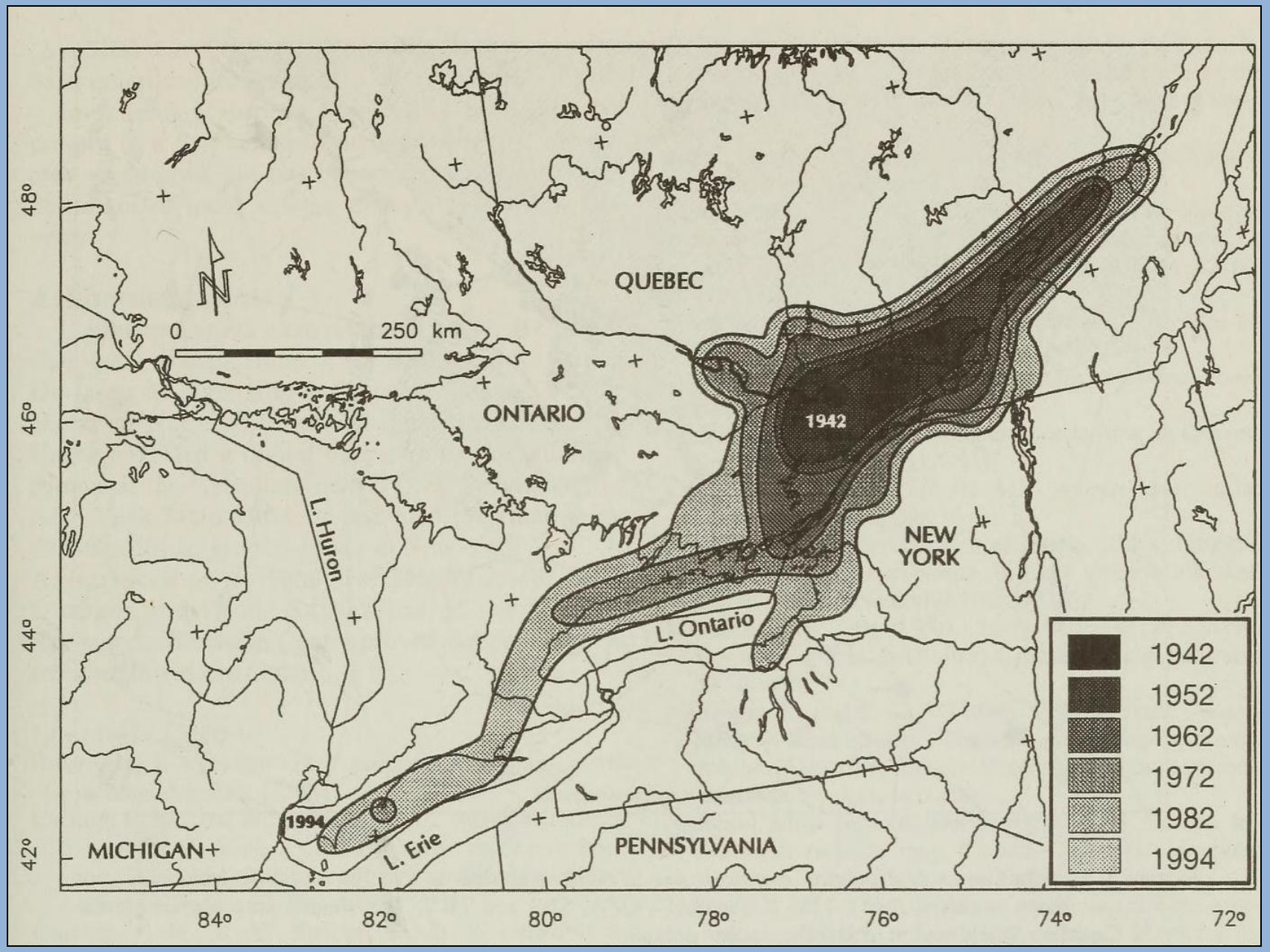
Roberto Pellegrini

Introduction and Dispersal

- 1932- Central Experiment Farm arboretum in Ottawa, Ontario
  - From trench, to Dows Lake, to Rideau Canal and onward (Minshall 1940)
- Common in St. Lawrence River, Lake Ontario, Lake Champlain, and inland
- Less common in Lake Erie

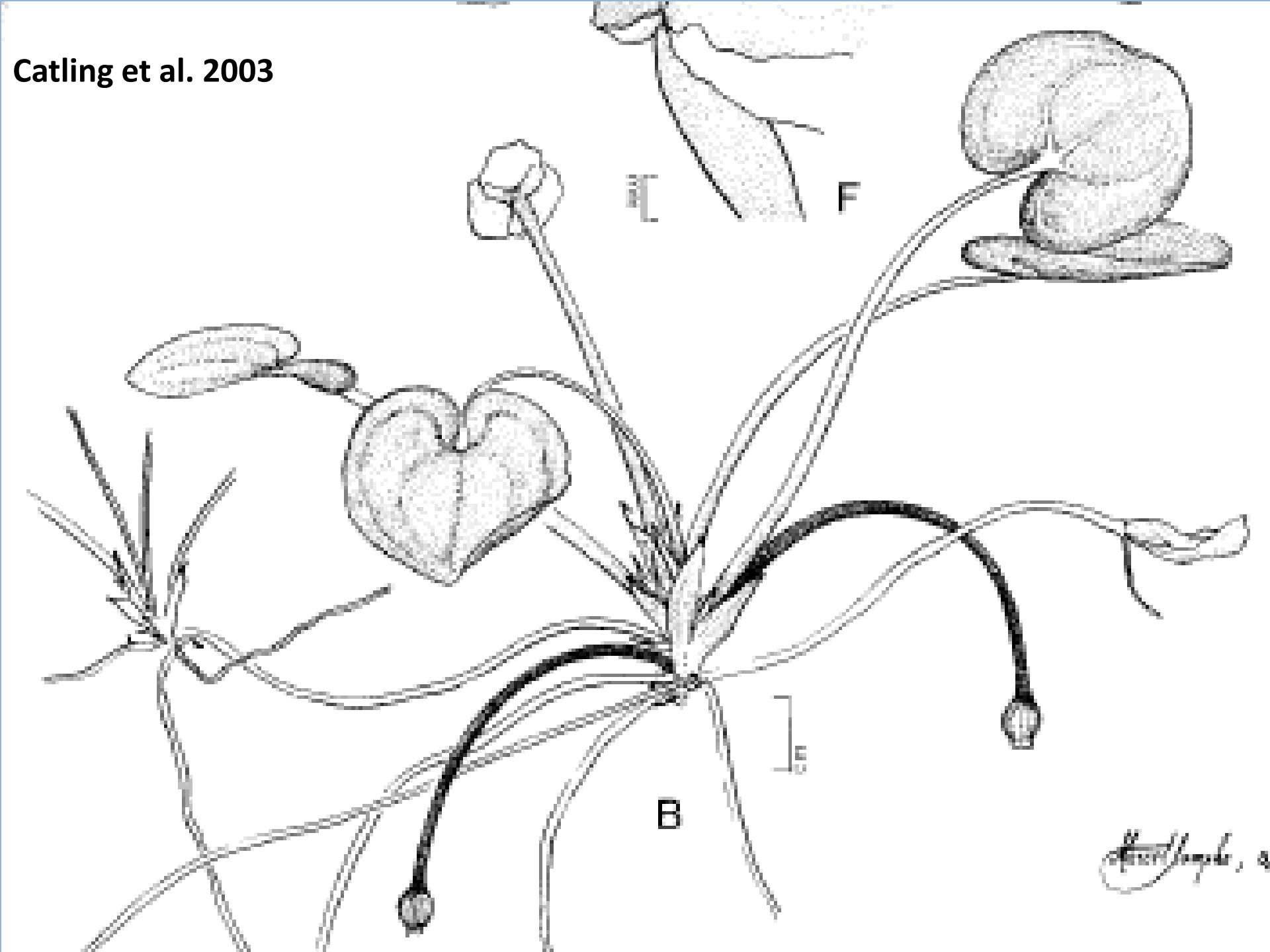
- Map from Catling and Porebski 1995



Reproduction

- Turions (asexual winter buds) form on stolons
  - Abscess in fall
  - Float to surface in spring
- Up to 10 ramets grow from each new turion
  - Each ramet can produce 10 new turions
- Turions viable for 16-24 months (Burnham 1998)
- Sexual reproduction is possible
  - Much less prevalent (Burnham 1988)

Catling et al. 2003



Impacts

- Rapid population growth rate creates dense mats
- Tough yet flexible stolons interlock
  - Creates thick, floating mats
- 95% decline in native submersed vegetation species (Catling et al. 1988)
- Fewer snails, crustacea, and insect larve under mats (Catling et al. 1988)
- Inhibits recreational boating activity

Goals

- Quantify invasion characteristics
  - Spatially within wetlands
  - Among hydrogeomorphic classes
  - Correlations with hydrologic, chemical, and physical data
- Data from Great Lakes Indicators Consortium: Implementing Great Lakes Coastal Wetland Monitoring Project
  - EPA-GLRI 2010
  - Only using Lake Ontario Data

Data Collection

- 45 vegetation quads per wetland
  - Three vegetation zones (not always)
    - SAV, emergent, meadow marsh
  - Three transects per wetland, perpendicular to elevation gradient
  - Five qauds per transect in each zone


•15 quads per transect
•3 transects

Plant Quad Data Used

- Species cover and occurrence
  - Frogbit
- Habitat data
  - Water depth
  - Organic depth
  - Detritus cover
  - Invasive cattail (*Typha angustifolia*, *Typha* X *glauca*)
    - Dominant emergent species

Water Quality Data Used

- Site level data
  - Mostly collected in SAV
- Parameters
  - TN, NO_2 /NO_3-N, TP, OP, alkalinity, specific conductance, chloride, and color

Statistical Analyses

- Kruskal-Wallace for cover and occurrence
  - HGM
  - Zone
- Principal Components Analysis
  - Chemistry and physical habitat characteristics
    - Transformed for normality and standardized (z-score)
- Non-parametric correlations
  - Principal components vs frogbit cover and occurrence

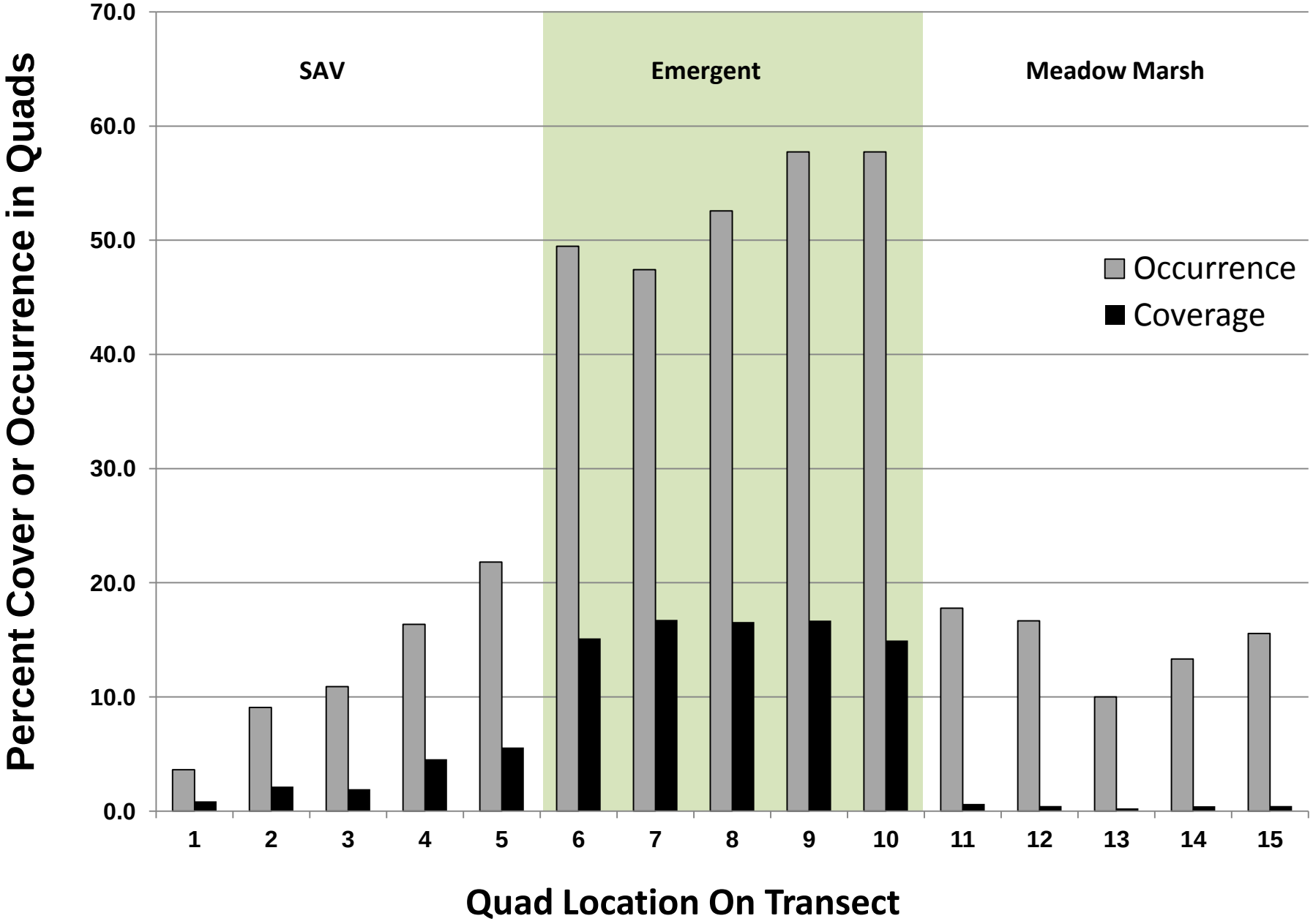
Results: Average Cover

- Present in 29 of 34 sites (85%)
- All zones: 7.54%
  - Range: 0.0-35.4%
- Emergent zone: 16.0%
  - Range: 0.0-39.7%
- Greatest cover in emergent zone
  - $\chi^2 = 36.196$, df = 2, p=0.000
  - SAV ≈ Meadow Marsh

Results: Quad Occurrence

- All zones: 29.8%
  - Range: 0.0-100%
- Emergent zone: 51.5%
  - Range: 0.0-100%
- Most prevalent in emergent zone
  - $\chi^2 = 30.099$, df = 2, p=0.000
  - SAV ≈ Meadow Marsh

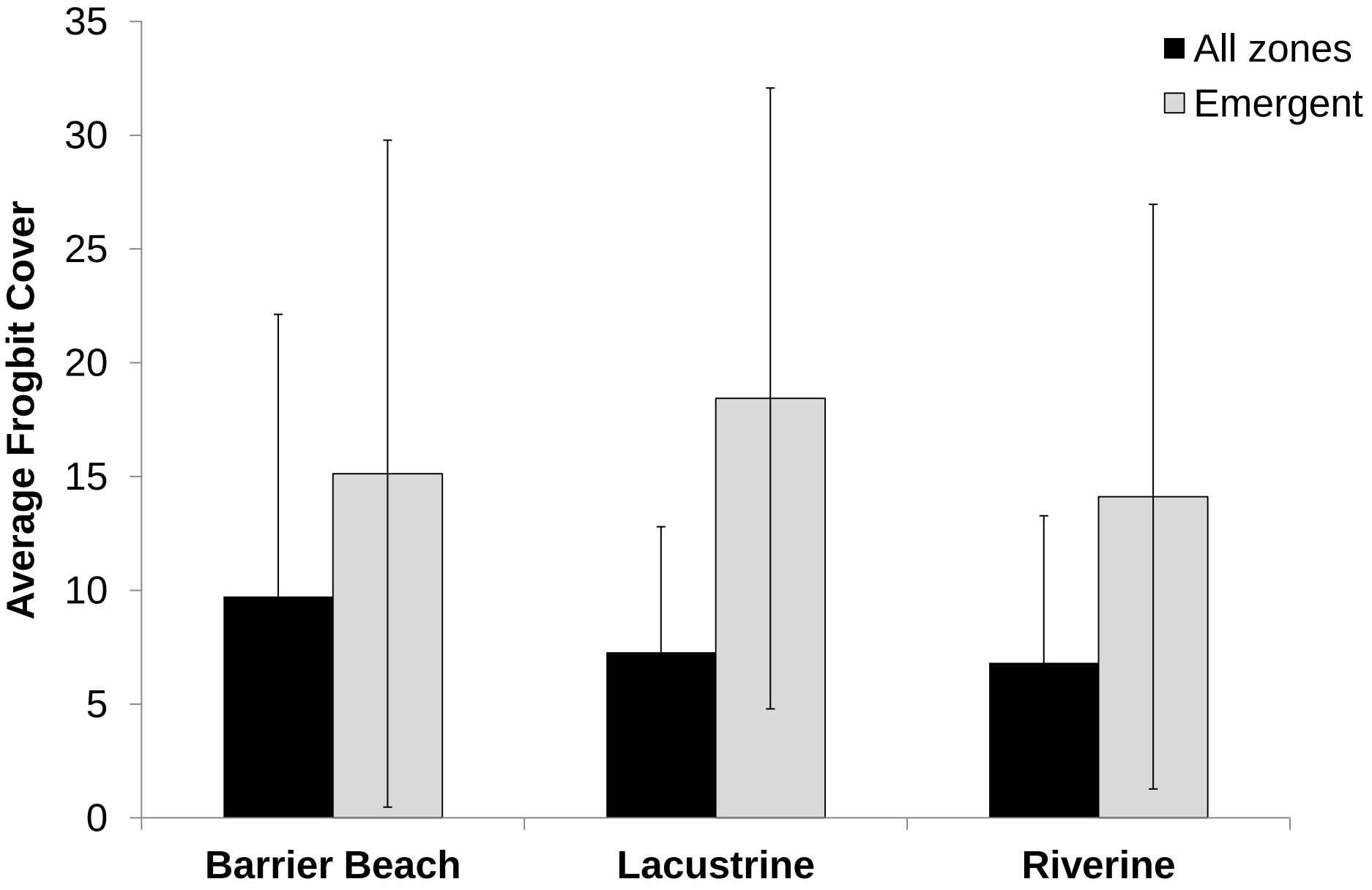
Frogbit Cover and Occurrence Along Vegetation Transect

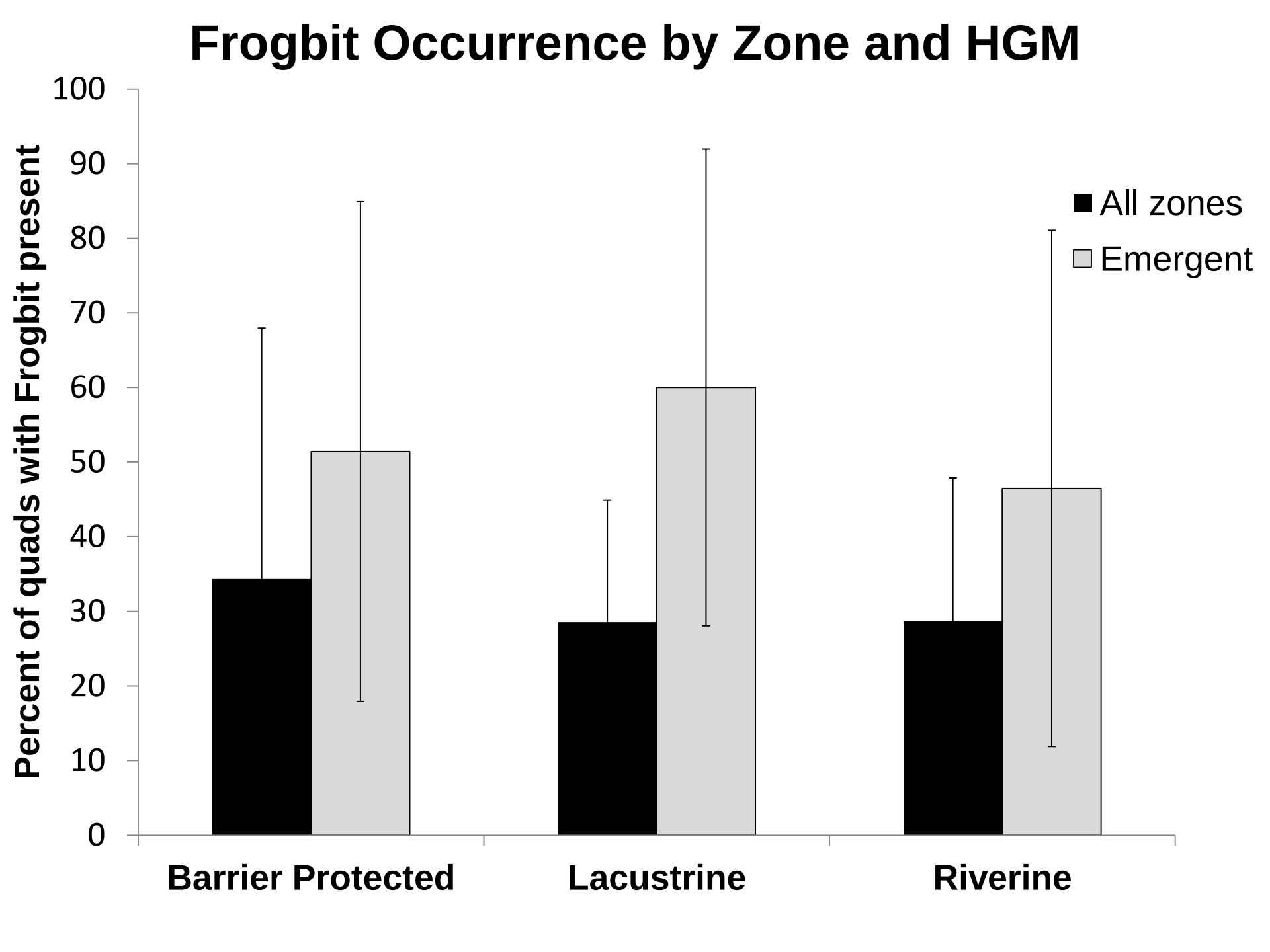


Results: Cover and Occurrence by HGM

- No significant differences among HGM
  - Cover
    - All zones: $H(2) = 0.132$, $P = 0.936$
    - Emergent zone only: $H(2) = 0.609$, $P = 0.738$
  - Occurrence
    - All zones: $H(2) = 0.025$, $P = 0.988$
    - Emergent zone only: $H(2) = 0.609$, $P = 0.738$

Frogbit Cover by HGM and Zone




Frogbit Occurrence by Zone and HGM
Percent of quads with Frogbit present
100
90
80
70
60
50
40
30
20
10
0
All zones
Emergent
Barrier Protected
Lacustrine
Riverine

Results: PCA

- Three PCs retained 68.8% of variance

PC1 "Runoff"	**PC2 "Growth Inhibitors"**	**PC3 “Water and Phosphorus"**
Specific Conductance (+)	Detritus Cover (+)	Water Depth (+)
Chloride Ion (+)	Organic Depth (+)	Total P (+)
Alkalinity (+)	Color (+)	Ortho P (+)
Total N (+)		
NO_2/NO_3-N (+)		

Results: Correlations

PC	Emergent		All Zones	
	Cover	Occurrence	Cover	Occurrence
Runoff	r= -0.346, p=0.048	r= -0.370, p= 0.034	r= -0.286, p= 0.107	r= -0.264, p= 0.137
Growth Inhibitors	r= -0.054, p= 0.766	r= -0.062, p= 0.732	r= 0.001, p= 0.997	r= 0.115, p= 0.525
Growth Enhancers	r= 0.111, p= 0.537	r= 0.101, p= 0.577	r= 0.162, p= 0.369	r=0.108, p= 0.548

- "Runoff" was the only correlated PC
  - Emergent
    - Cover and Occurrence significant
  - All Zones
    - Not significant
  - All negative correlations

Discussion

- European frogbit prevalent throughout Lake Ontario
- Frogbit can achieve high densities
  - Site level maximum: 35.4%
  - Emergent zone maximum: 39.7%
  - Individual quads: 100%
- Ecosystem effects

What was most invaded?

- No differences among HGM
- Drastic differences among vegetation zones
  - Mostly in emergent
    - Protection from waves
    - Deep enough water
  - Meadow marsh
    - Only if sufficient standing water
  - SAV
    - Only if protected

Discussion: Runoff

- Frogbit decreased with increasing “runoff”
  - Europe: mesotrophic and low salt waters
  - What if we clean up the lakes?
- Mechanism still unknown
  - Direct chemical inhibition?
  - Indirect effects?
  - Need controlled experiments

The Other Great Lakes and Beyond

- Extrapolating results may be tricky
  - Lake Ontario is unique
  - Hydroperiod, nutrient combinations, species assemblage, etc.
- Most vulnerable areas:
  - Any HGM
  - Emergent zones
  - Low runoff

Literature Cited

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