Many plants are wanted, but are they colonizing constructed wetland?

Börje Ekstam

2011-10-06

Linnæus University

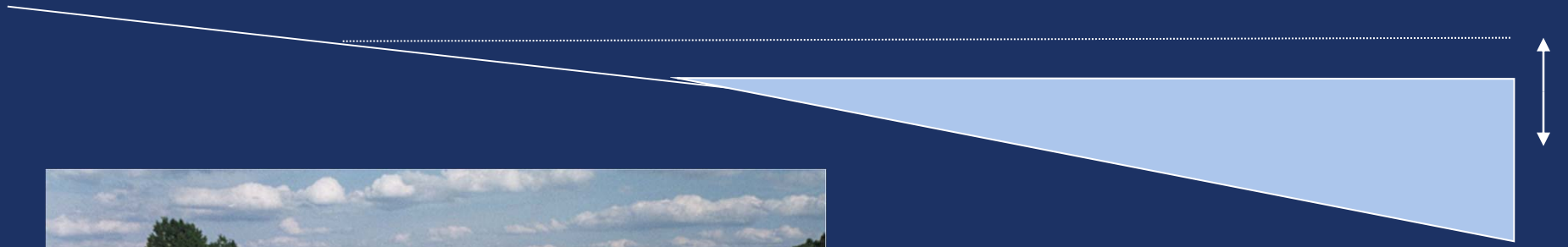
Restored and Constructed wetlands

LOVA in Sweden
”Local water management subsidies”
2009-2010: 146 MSEK
2011: 100 MSEK

Höje å, Lomma
Ekologgruppen

Self design of constructed wetlands

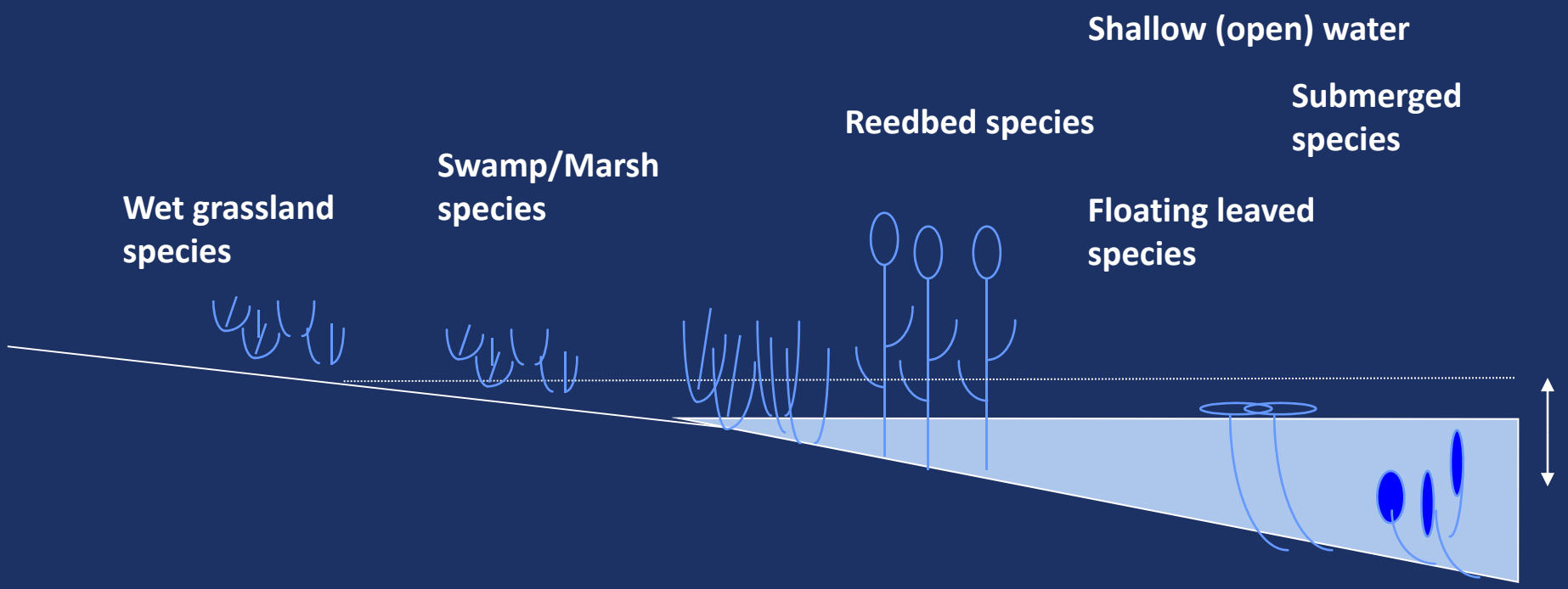
Often, only habitatfactors , morphometry and hydrologeochemistry, are considered



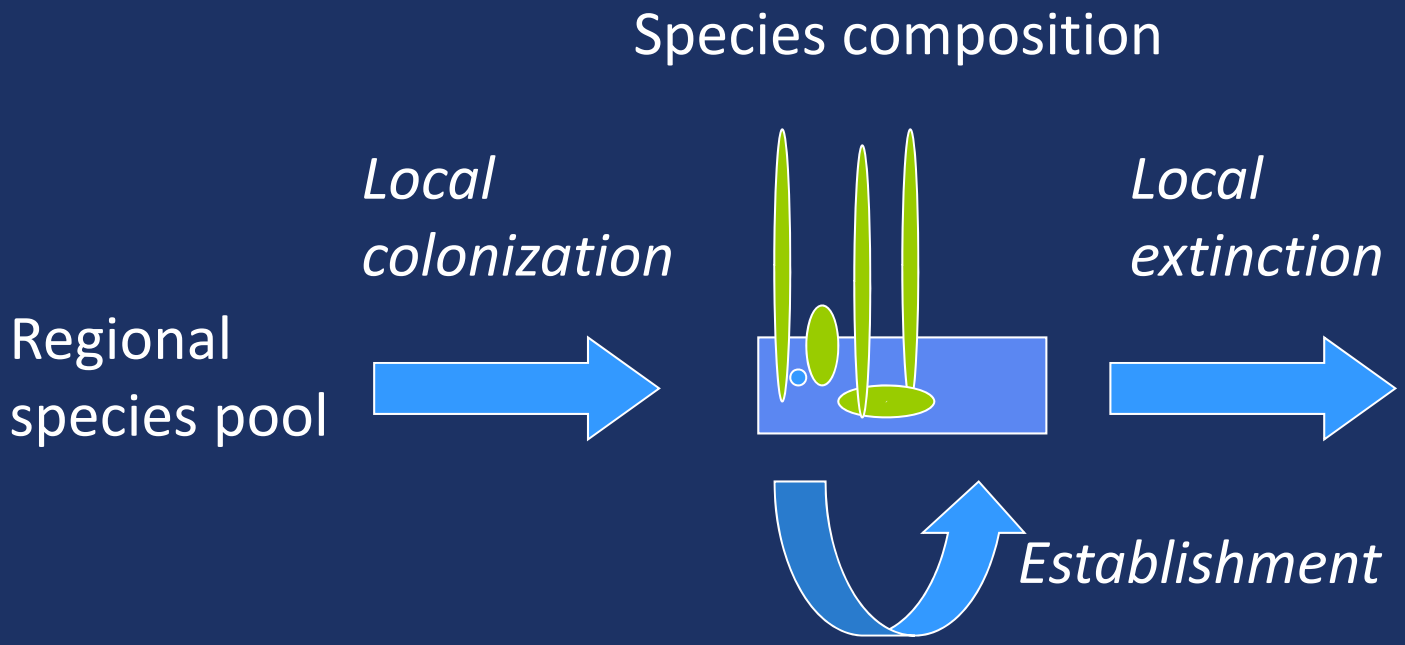
Efficient community hypothesis (Galatowitsch and van der Valk 1996)

Assembly of the ecological community

- ✓No habitat limitation
- ✓No dispersal limitation
- ✓Landscape matrix and species pool not important



Species pools, colonization and extinction



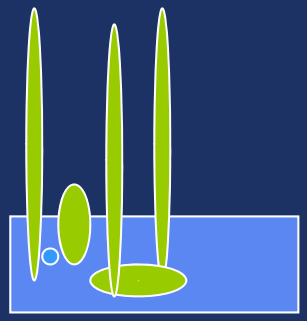
Species pool hypothesis (Eriksson 1993)

Species richness (S)

Regional species pool (N)

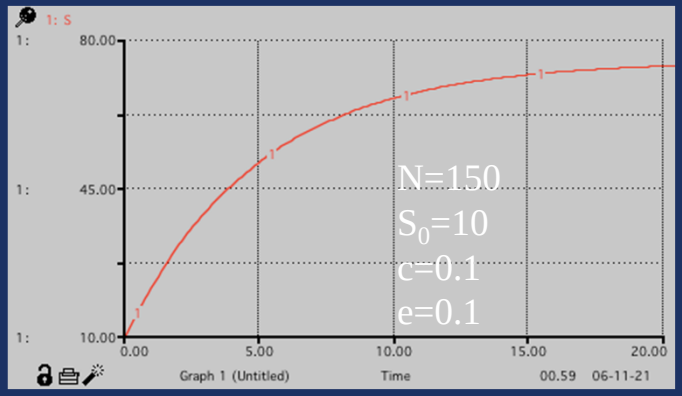
Local colonization

c*(N-S)



Local extinction

e*S



dS/dt = c (N-S) - e S

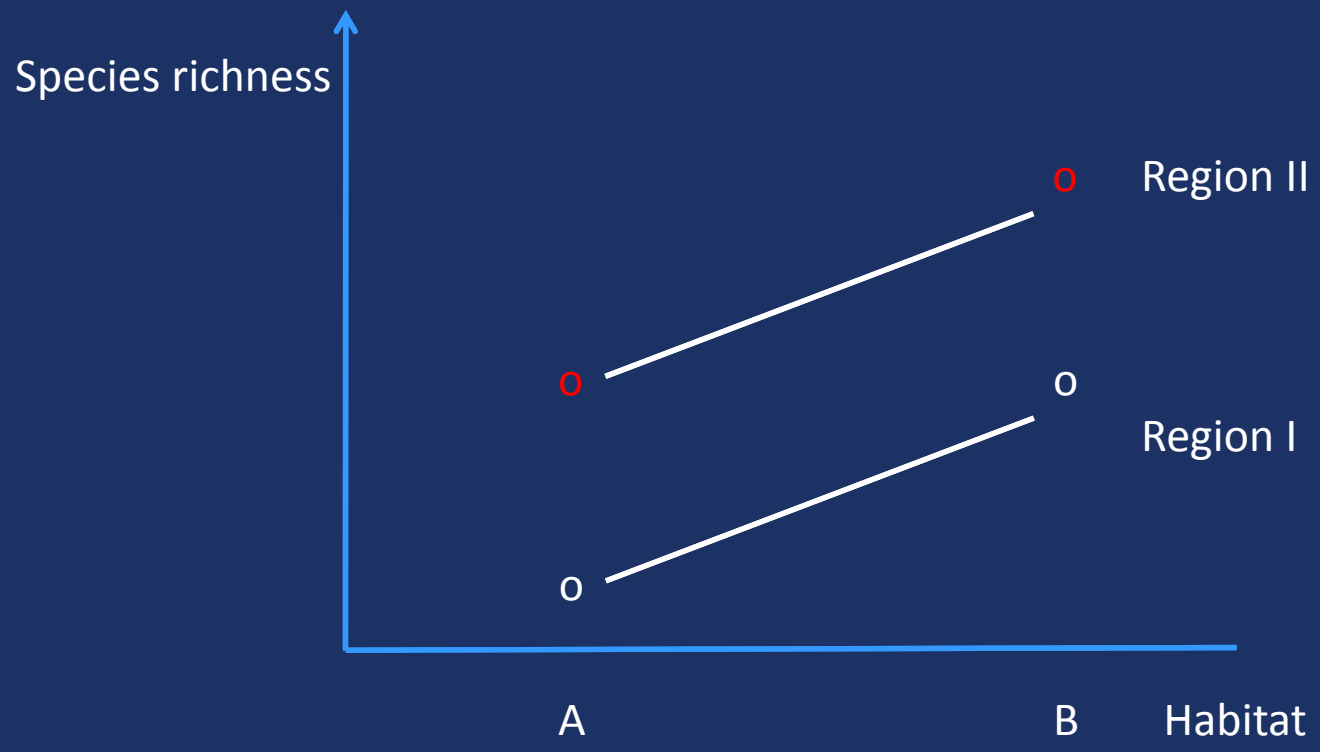
S* = N(c/(c+e))

S - no of species in a local community

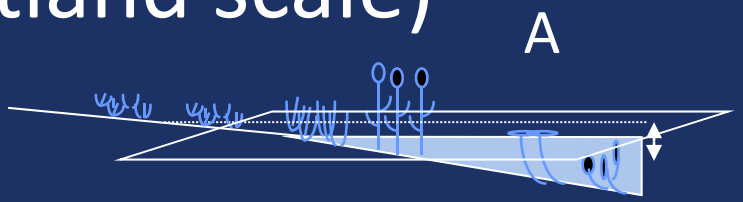
N - species pool

c and e are constants

Regional (species pool) and local (habitat) effects



Local (habitat) effects (wetland scale)



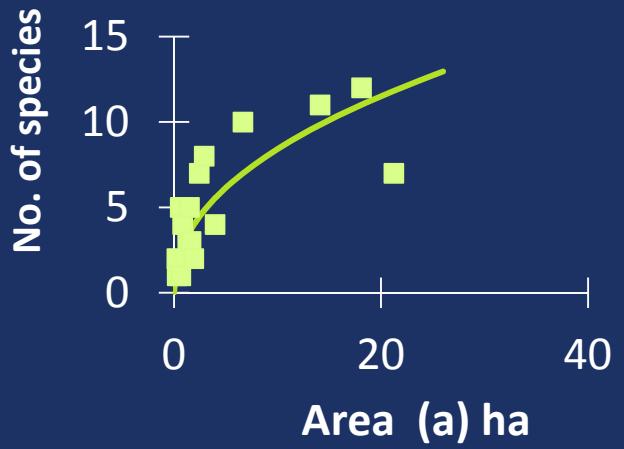
Species-area relationships

$S = cA^z$

$\log S = \log c + z \log A$

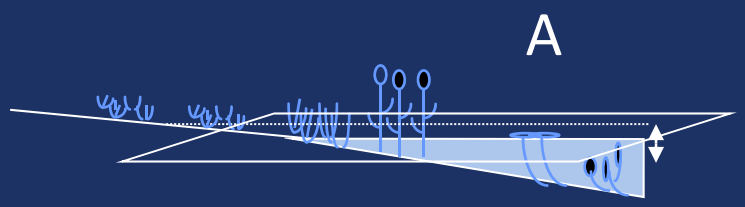
S: no. of species, A: area, c: constant, z: slope of log/log regression line
comparatively low z in wetlands: 0,2 < z < 0,29 (weaker area effect)
smaller species pools ? (Weiher & Boylen 1994)

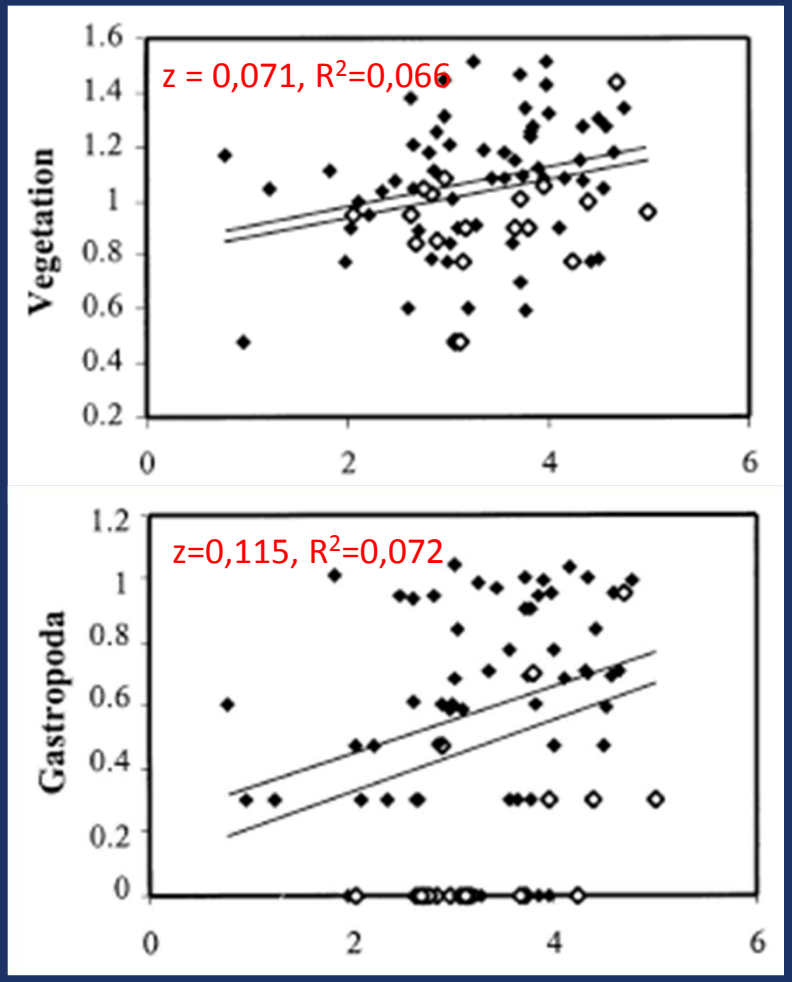
Gastropods in shallow
"alvar lakes" and ephemeral waterbodies
z = 0,45; R^2=0.588
(Liderfeldt et al. unpubl)

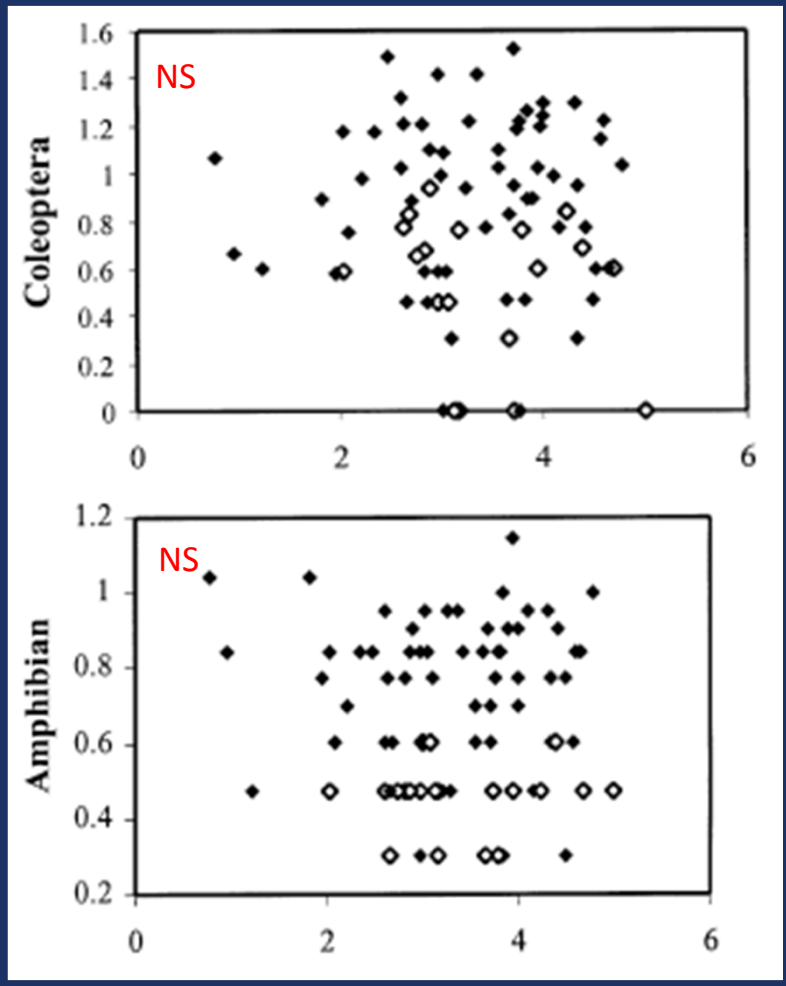


Local effects (wetland scale)
Species area relationship

80 ponds Switzerland (Oertli et al. 2002)







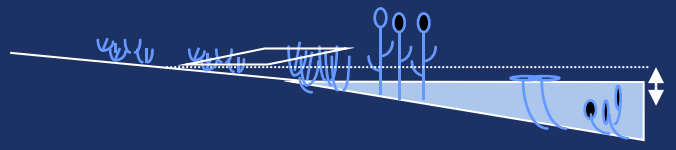
Log_{10} S

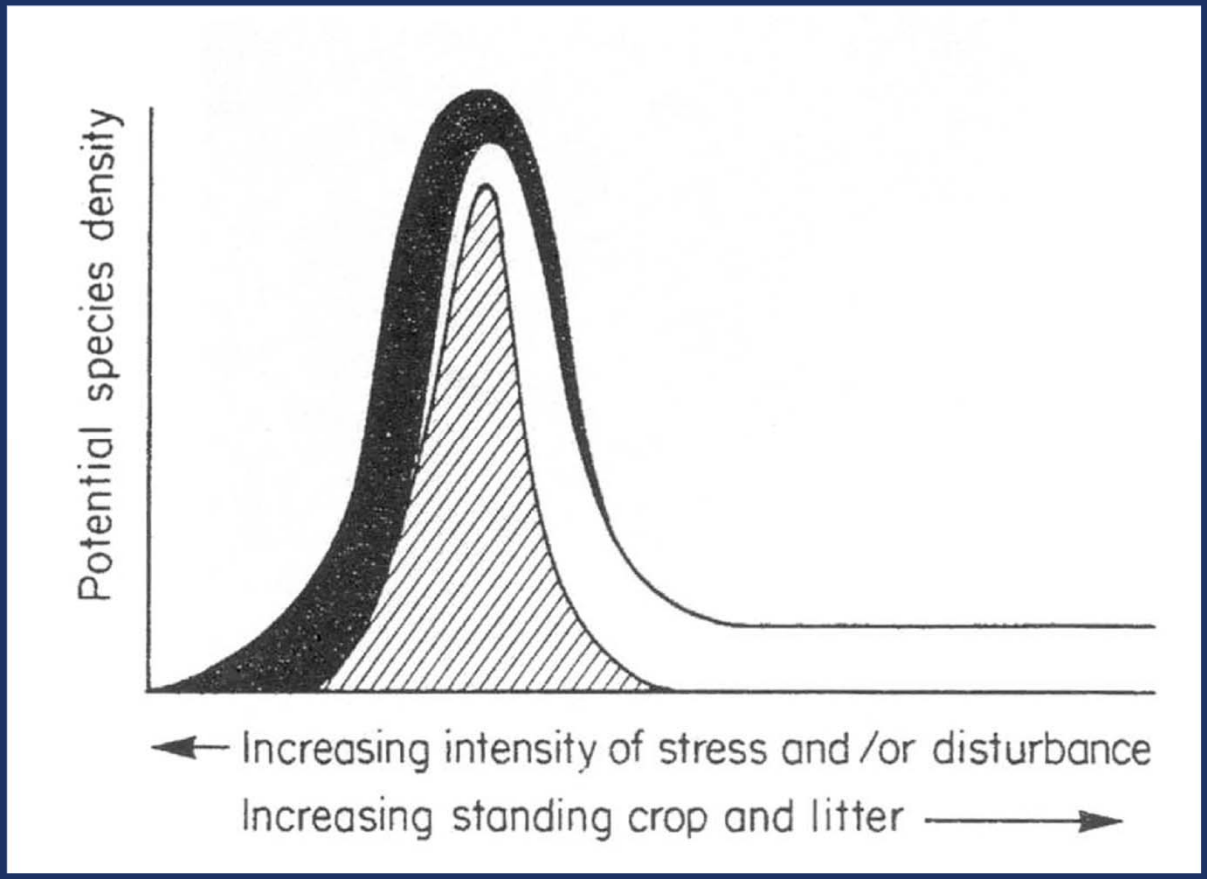
Log_{10} Area (m^2)

Local effects (plot scale)

Species biomass relationship
“The humped back model”

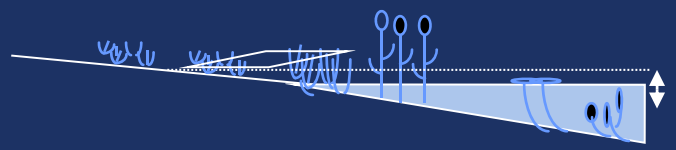
C-S-R theory (Grime 2001)





Local effects (plot scale)

Species biomass relationship

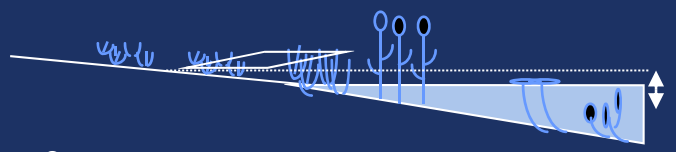


Wetland type	**Location**	**Biomass–species richness relationship** (proxy for productivity)	**Shape** of relation	**Sp. richness peak** (percent of range in productivity)	**Reference**
Fresh and salt marshes	Louisiana USA	St.crop+litter biomass	Negative	0	Gough et al. 1994
Fen	UK	St. crop biomass	Negative	0	Wheeler and Giller 1982
Fen	UK	St. crop production	Negative	0	Wheeler and Shaw 1991
Various wetlands	Canada	St. crop biomass	Negative	0	Moore and Keddy 1989
Lakeshore marsh	Canada	St.crop+litter biomass	Negative	0	Wisheu and Keddy 1989
Shoreline	Canada	St. crop biomass	Humped	25.7	Shipley et al. 1991
Salt marsh	Spain	St. crop biomass	Humped	40.0	Garcia et al. 1993
Lakeshore	Canada	St. crop biomass	Humped	41.5	Wilson and Keddy 1988
Riparian marshes	Alaska, USA	Productivity estimate	Humped	46.0	Pollock et al. 1998
Lakeshore	Sweden	Growing days	Humped	54.0	Nilsson and Wilson 1991
Lakeshore	Canada	St. crop + litter biomass	Humped	54.9	Wisheu and Keddy 1989

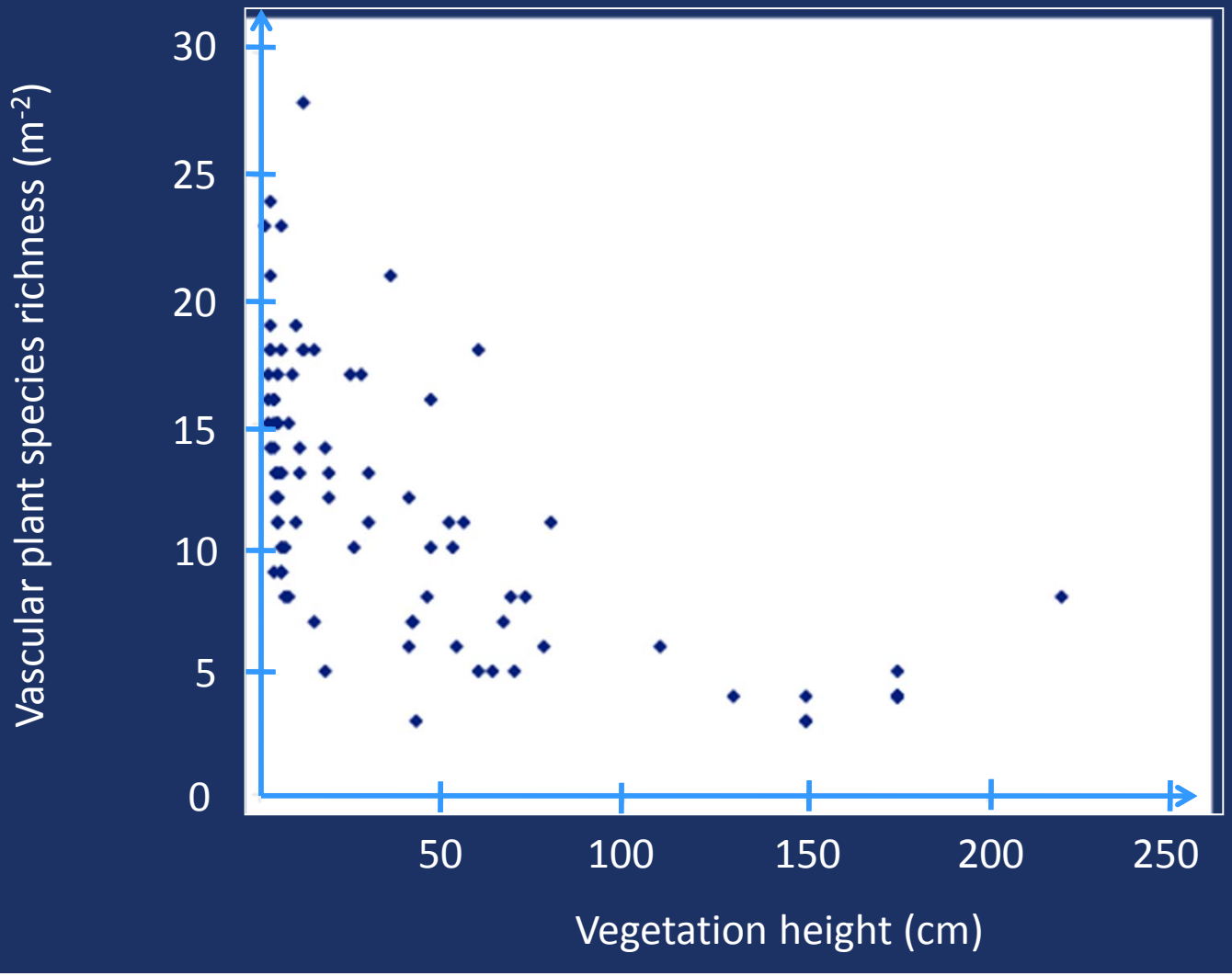
(Cornwell & Grubb 2003)

Local effects (plot scale)

Species biomass relationship

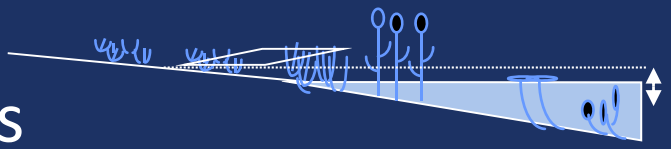


Littoral vegetation, Lake Tåkern Sweden. Data from 1m^2 plots in 4 transects (Ekstam, unpubl.)

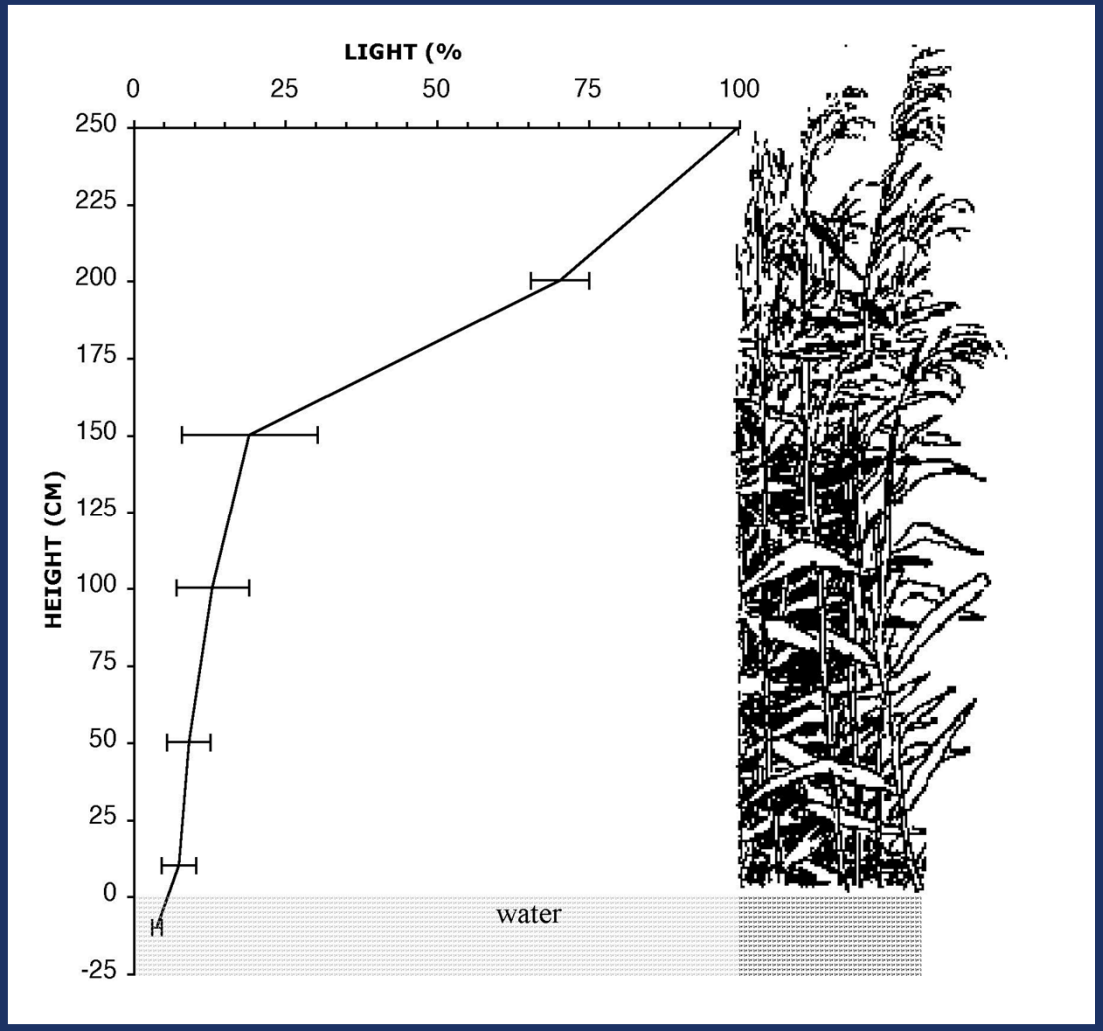


Local effects (plot scale)

Light monopolization by tall plants

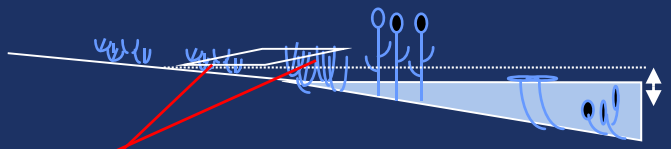


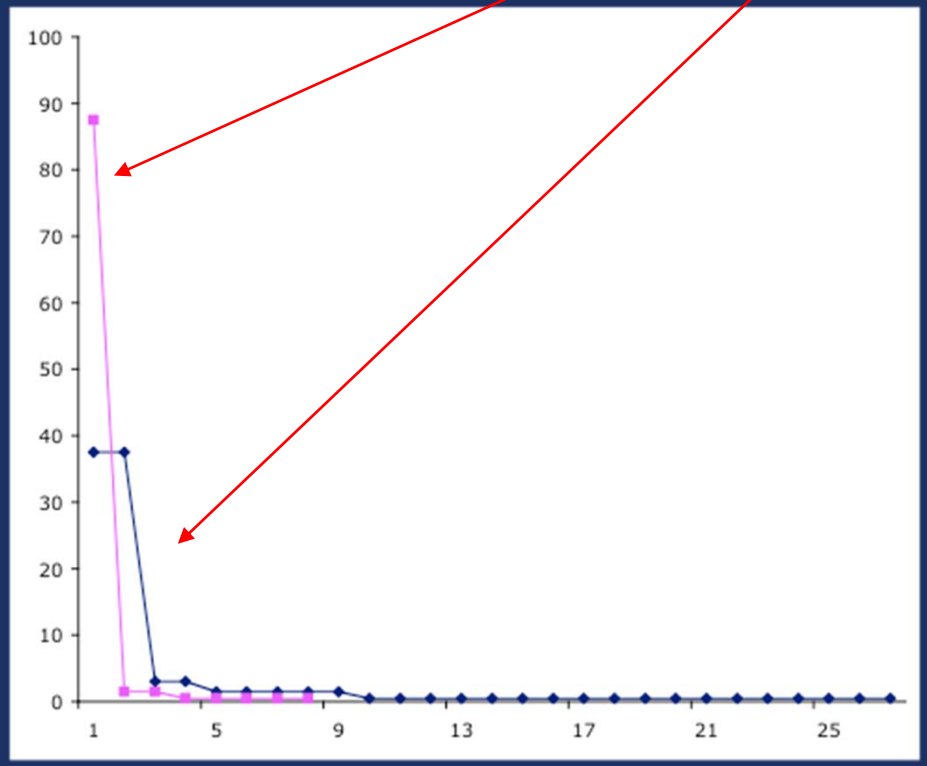
Light availability in a Phragmites stand (Ekstam et al. 1983)



Local effects (plot scale)

Rank abundance curves

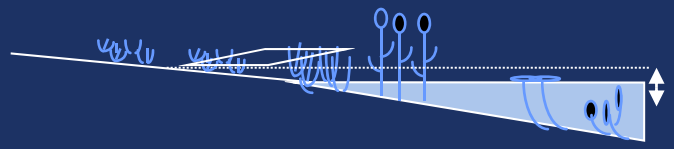




Short and tall sedge (Carex) communities in littorals of lake Tåkern

Local effects (plot scale)

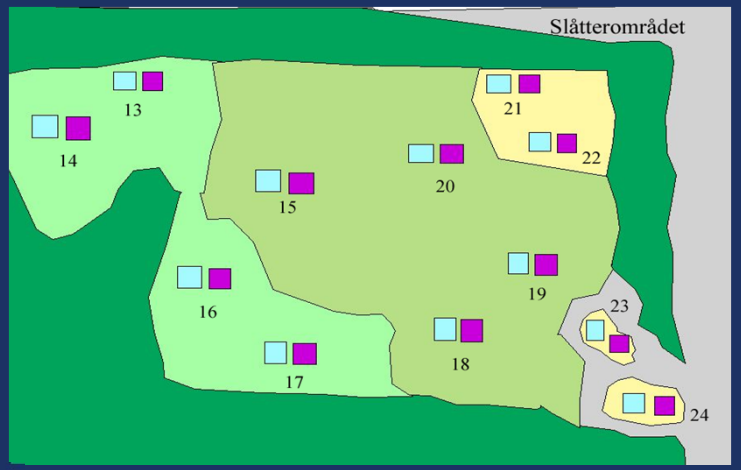
Species biomass relationship



Calcareous fen vegetation, Öland, Sweden (unpubl data)

Management experiment 2002-2013
in three vegetation types:

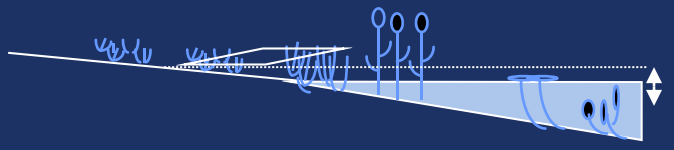
- Sesleria-Molinia type
- Schoenus type
- Cladium type



Local effects (plot scale)

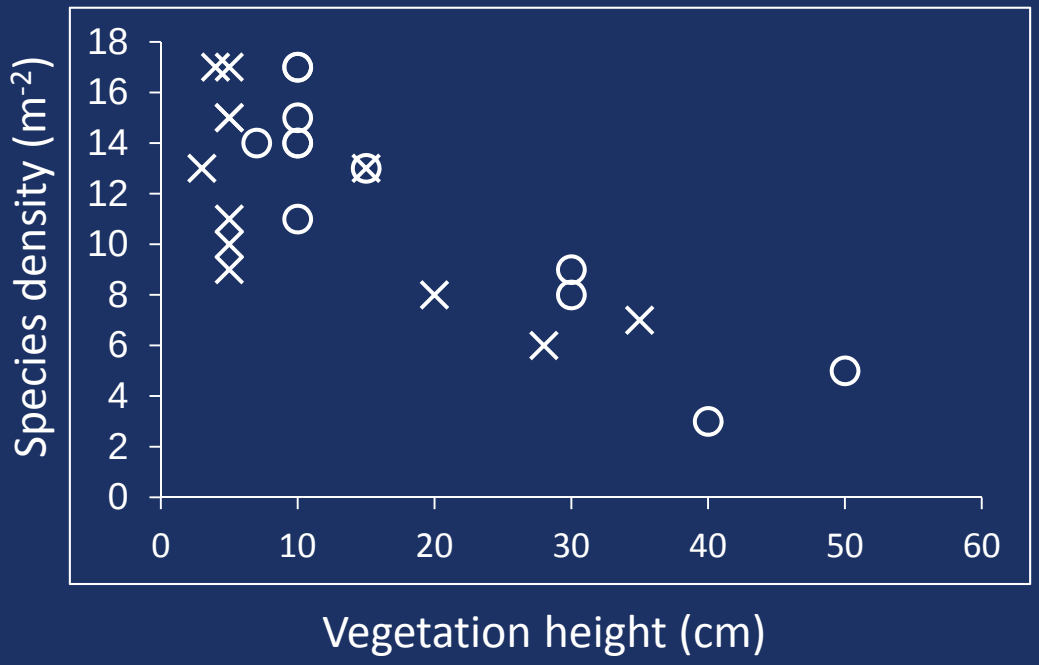
Species biomass relationship

Management, calcareous fens Öland (unpubl data)



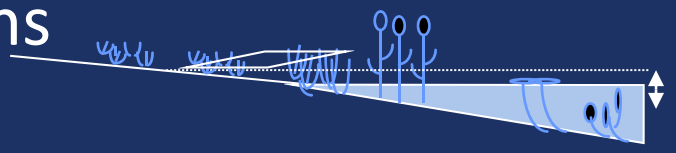
2007:

x grazing
o control



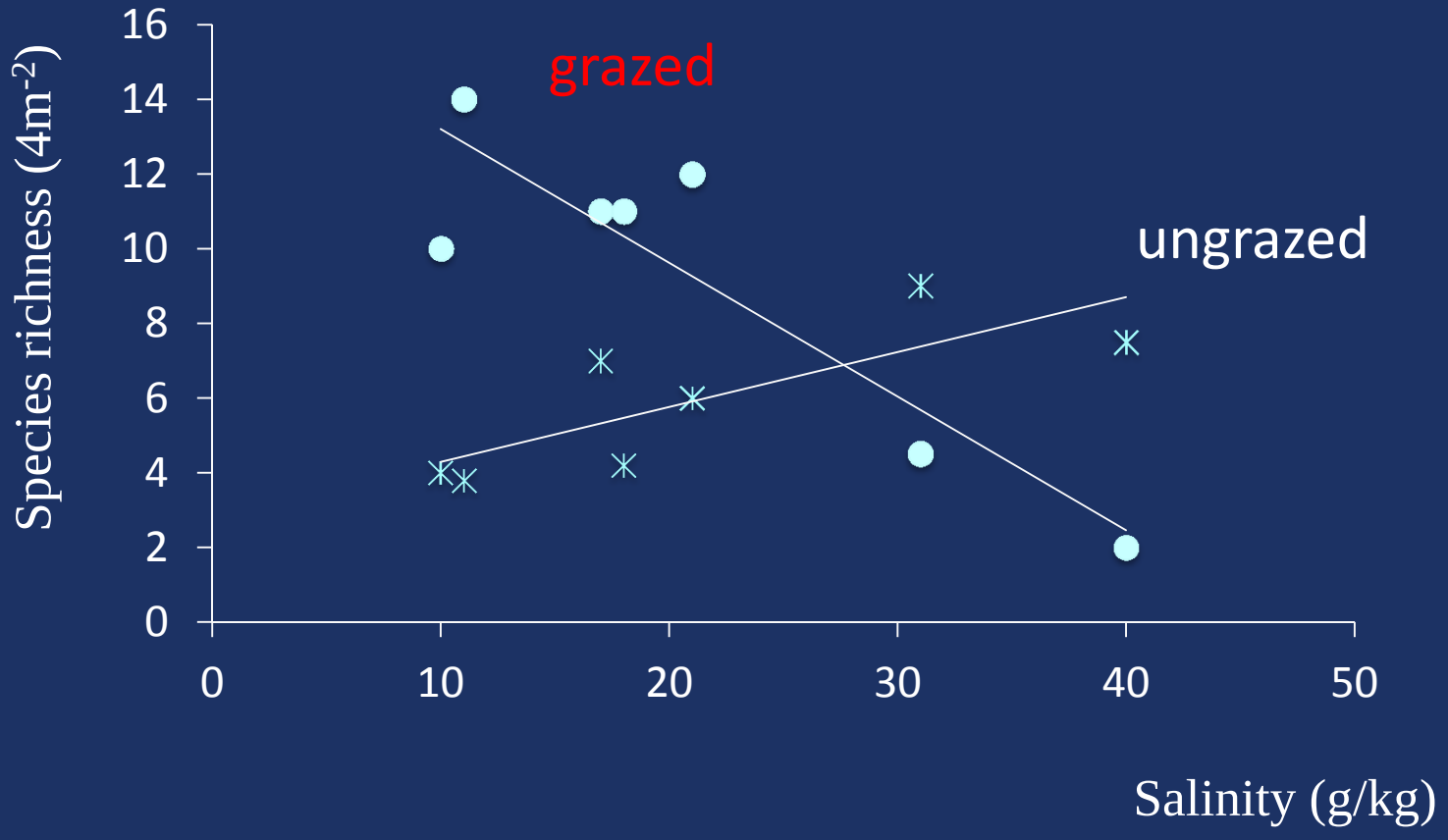
Local effects (plot scale)

Stress and disturbance interactions

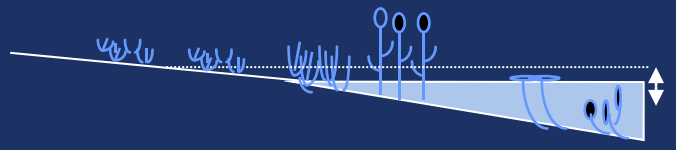


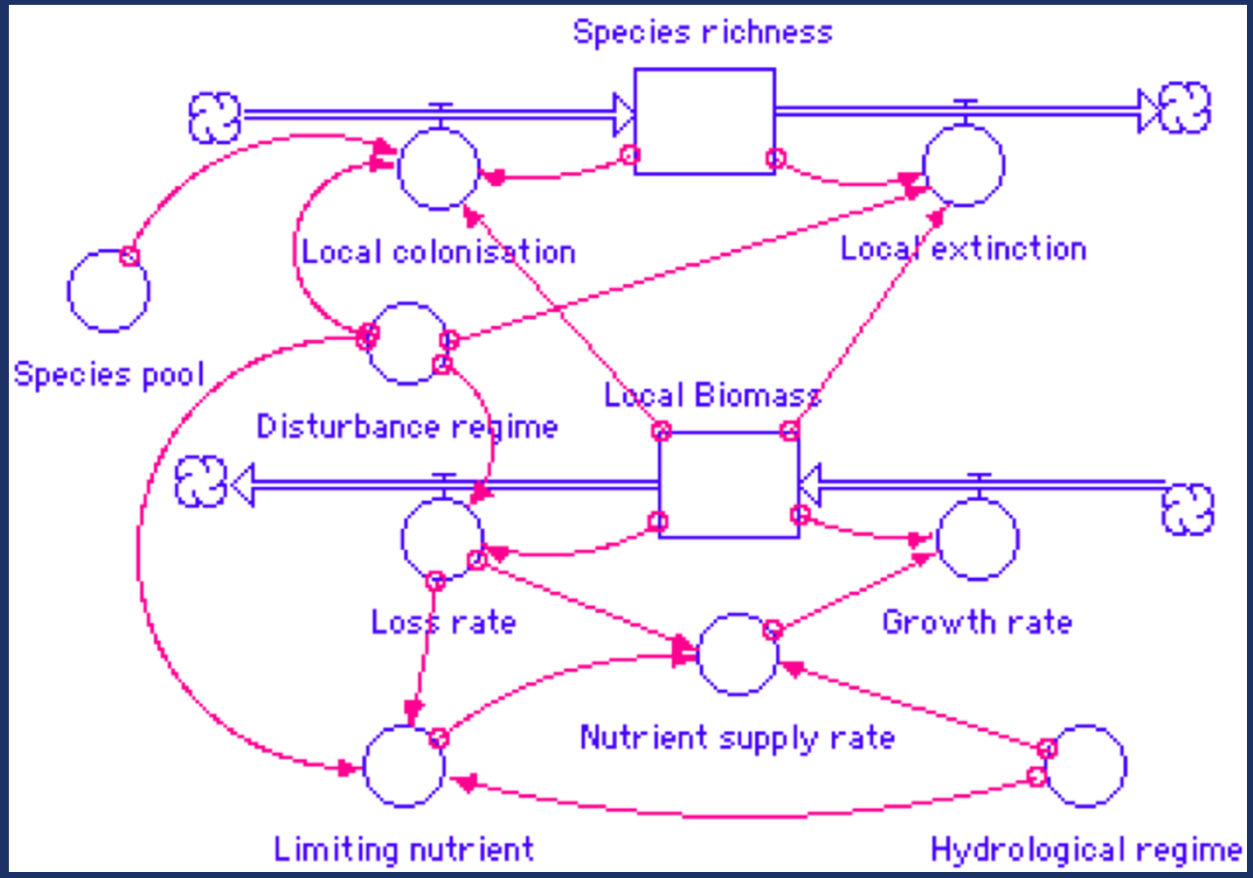
Stress (salinity) x disturbance (grazing)

Salt marshes (redrawn from *Bakker 1989*)

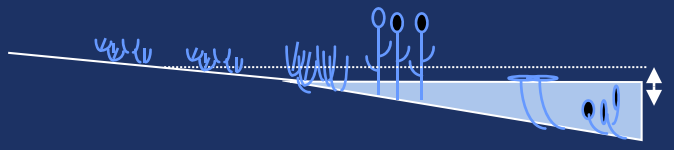


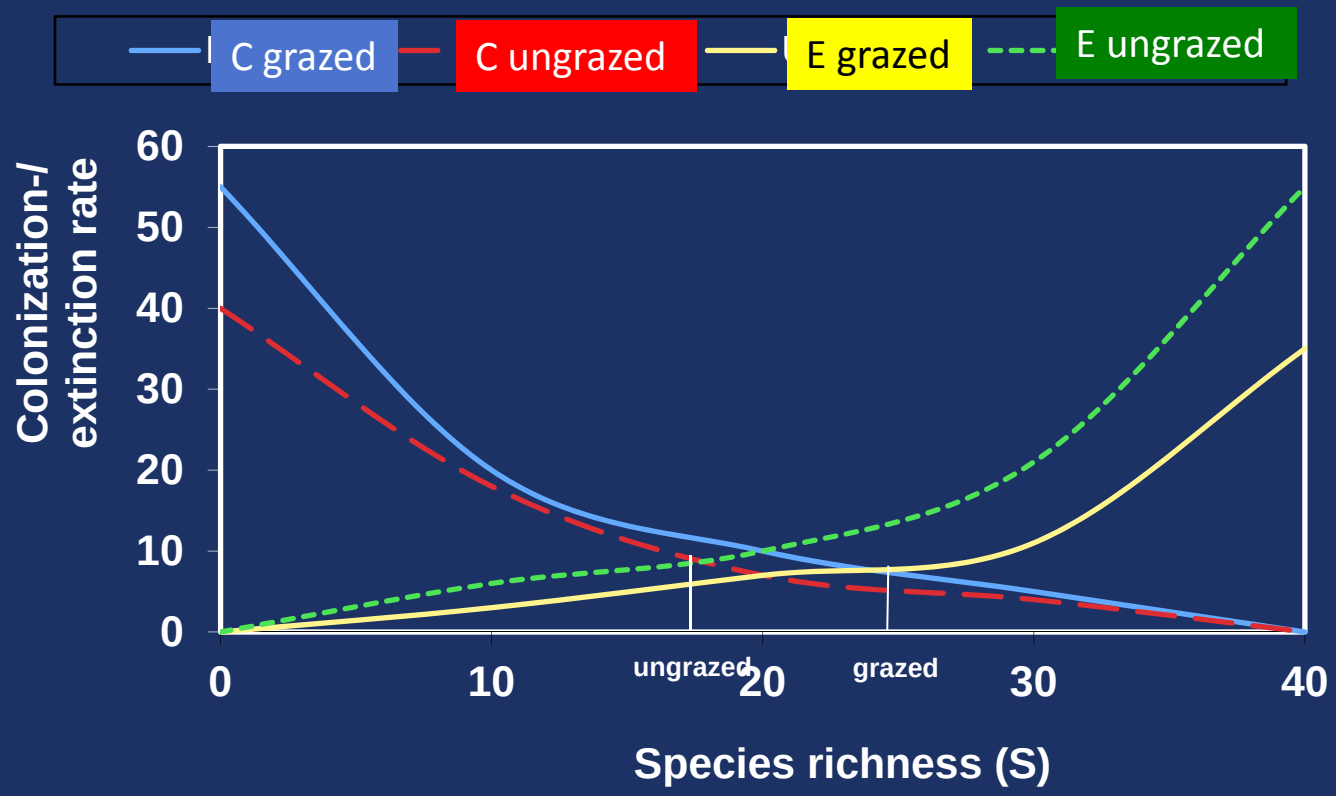
Mechanisms



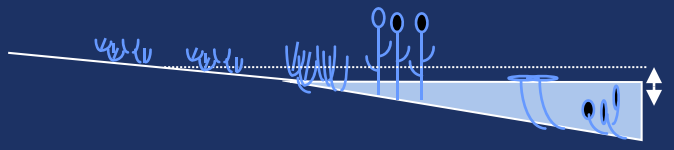

Species richness
Local colonisation
Local extinction
Species pool
Local Biomass
Disturbance regime
Loss rate
Growth rate
Nutrient supply rate
Limiting nutrient
Hydrological regime

Island biogeography theory
Equilibrium?





Which plants are colonizing constructed wetlands ?



How is colonization affected by long period low habitat levels, local extinctions and declining local abundance of wetland populations

Do common species become more common and do rare species remain rare?

Core-satellite hypothesis (Hanski 1982)

- Positive relationship between local and regional abundance
- If variation in local extinction or colonisation rates are sufficiently large
- theory predicts a bimodal pattern where species are either common (core species) or rare (satellite species) at a landscape and local scale

- Species between the two extremes are merely species *becoming* common or rare

Historical changes in species pool - Consequences for colonization of constructed wetlands?

Predictions:

- The Core-Satellite Hypothesis (Hanski 1982) predicts a bimodal pattern of species distribution
- A constant period with low habitat levels can reinforce the bimodal pattern
- Regionally common species will be the most successful colonizers in constructed wetlands

Material:

- Wetland species abundance data from Sothern Sweden

  two periods (Weimarck and Weimarck 1985, Tyler 2007, Tyler and Olsson 1997)
  - 1938 to 1975
  - 1987 to 2006
- Colonization patterns from 35 newly constructed wetlands in the same region (Reuterskiöld 2000 and 2001)

Constructed wetlands in two river basins
Höje å and Kävling å

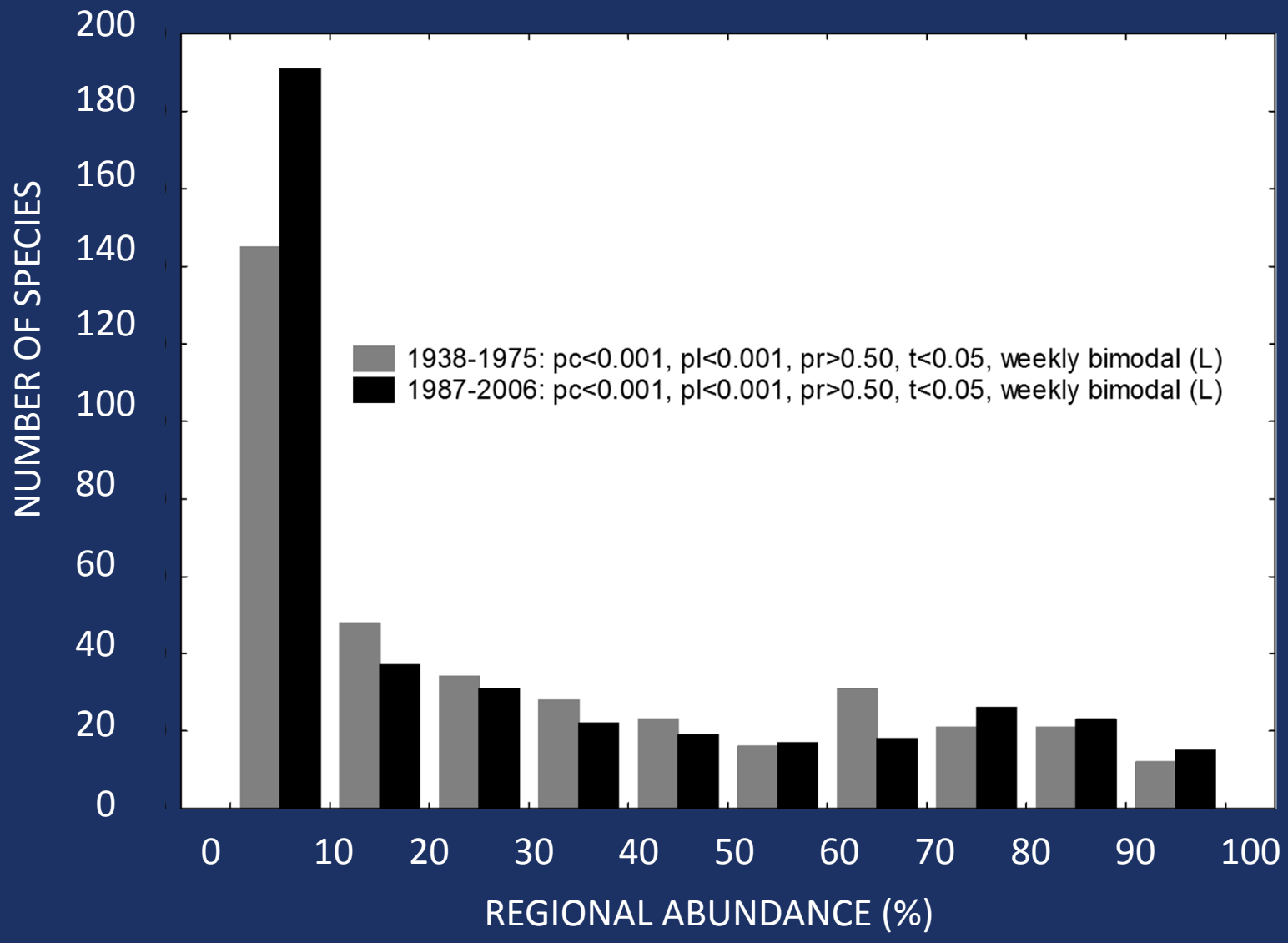
Regional species pool

Regional species pool consist of 403 species

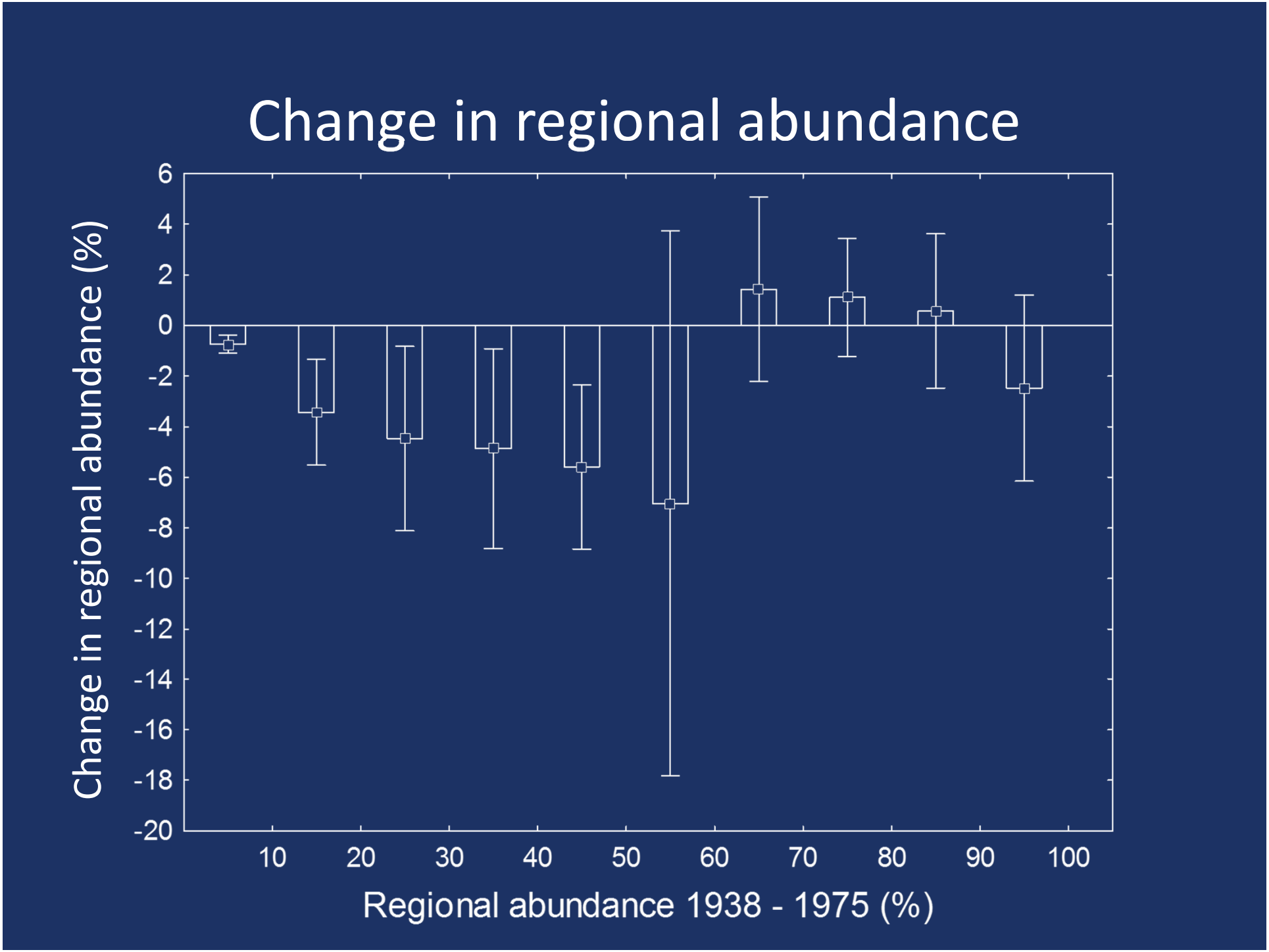
Four different criteria of which at least one must be fulfilled (Bertilius 2003)

- Grime et al. (1996) Species in moisture class C-F
- Gärdenfors (2000) Category L or V
- Krok och Almquist (1994), Mossberg et al. (1992), Weimarck och Weimarck (1985). Species that are described as growing on moist ground or wetter, in at least two of the three ref.
- Ellenberg et al. (1991) moisture 7-12, light>5, and salinity 0-1

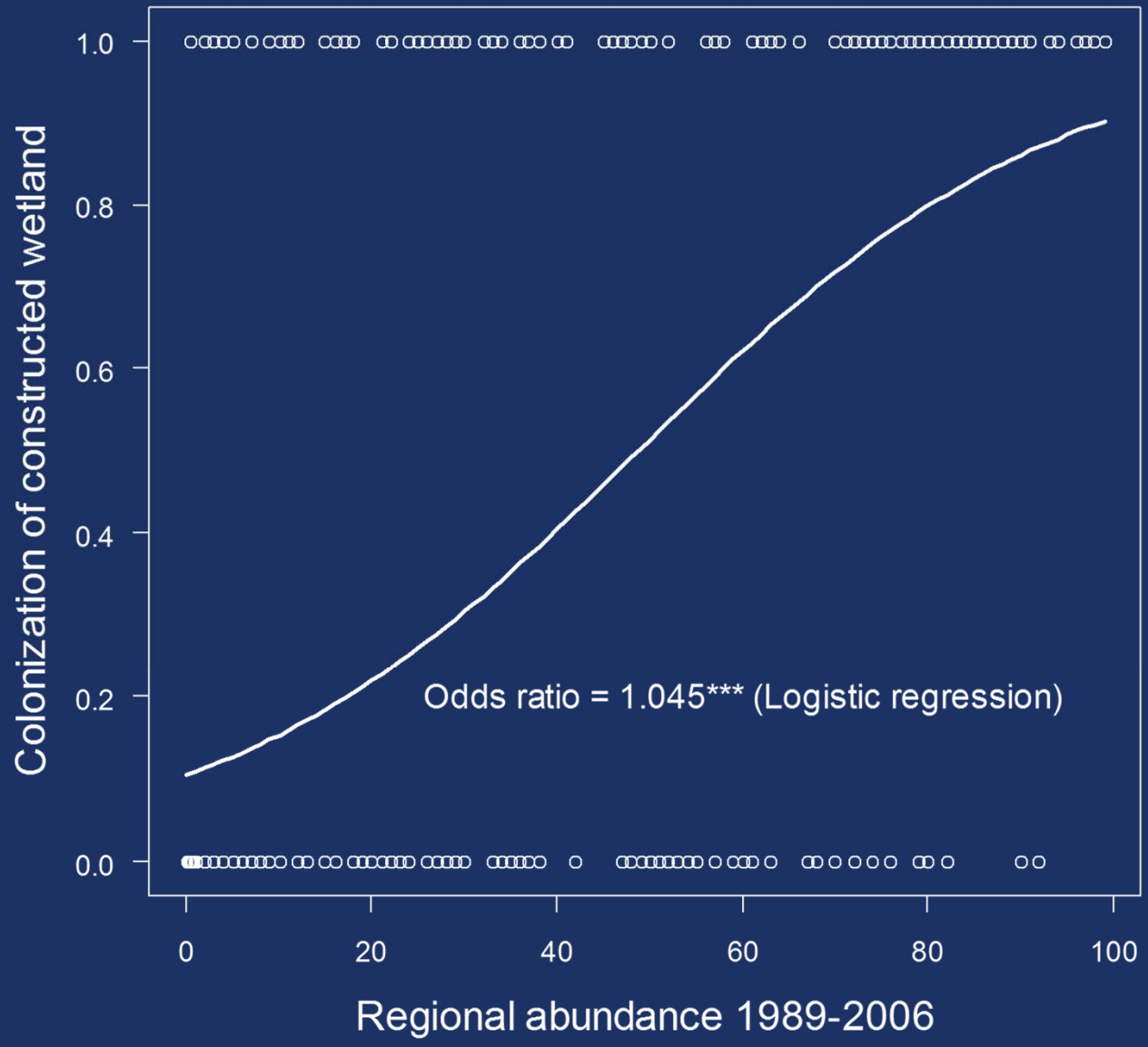
Regional abundance
1938-1975 and 1987-2006



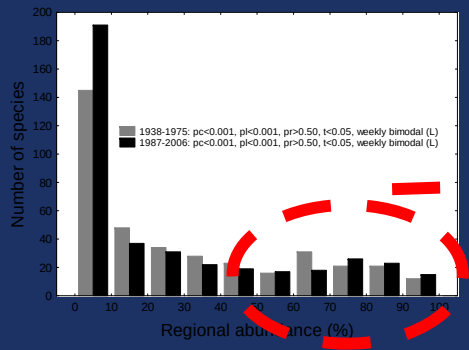
Change in regional abundance

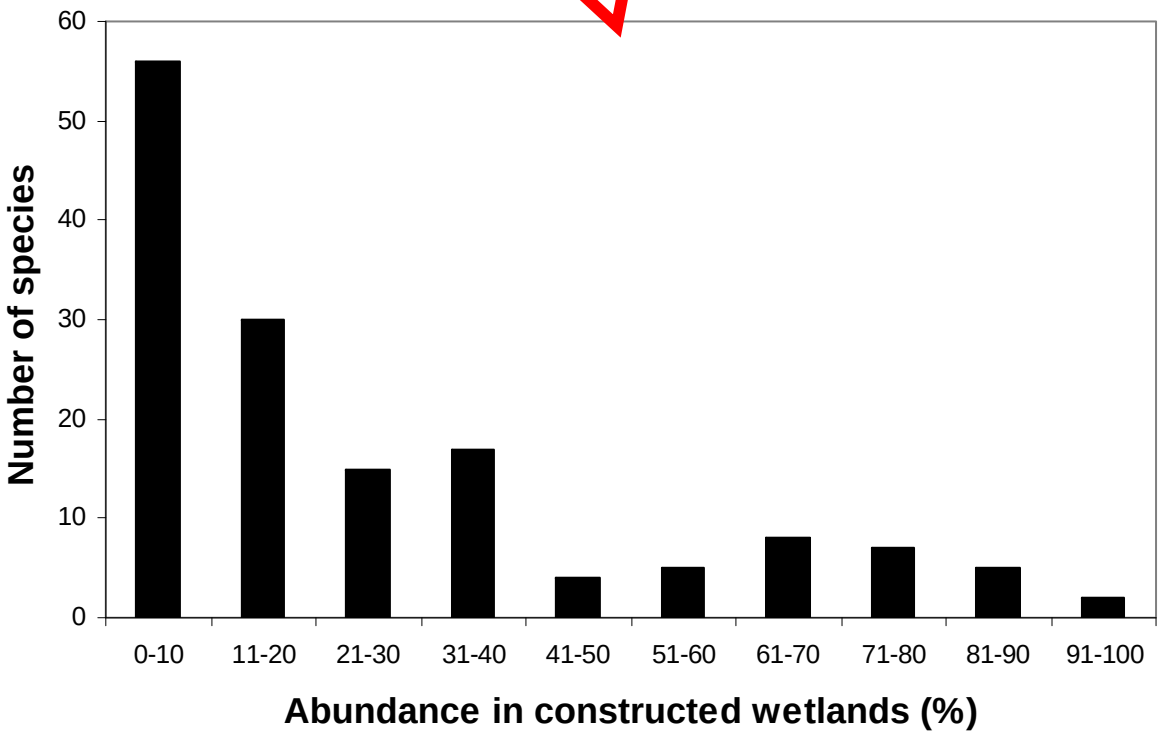


Successful colonization

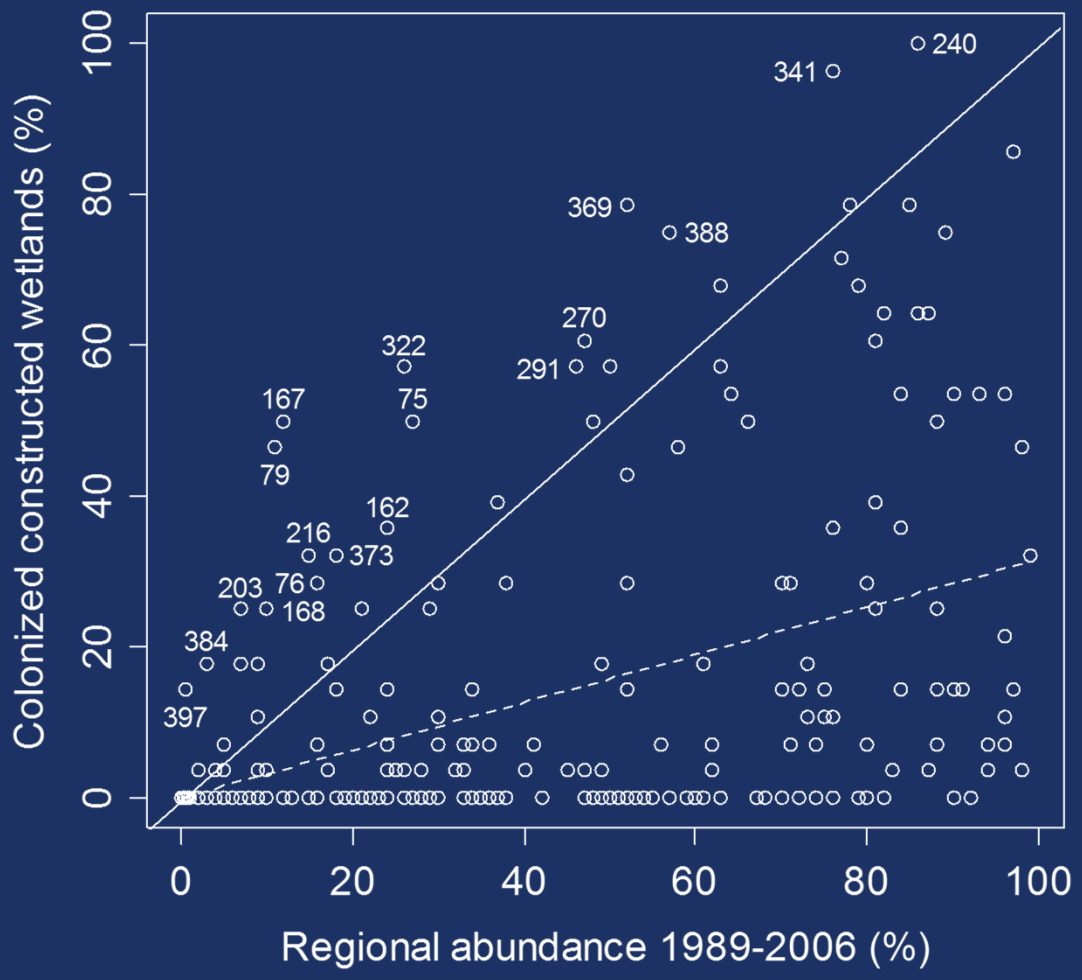


Abundance pattern in constructed wetlands





Proportion colonized



Conclusions

- Regional distribution patterns were weekly bimodal for both time periods
- The degree of bimodality increased from mid 20th to late 20th century.
- The most successful colonizers are species that also increased in regional abundance during the second half of the 20th century.
- Some rare species succeed to colonize the new habitat but it is more common that common species become more common, and that the rare become even rarer

Thanks!

- Patrik Dinnetz, co-author
  Södertörn University

- Kristin Bertilius, final exam student
- Anna Rask, final exam student

- Torbjörn Davidsson, Ekologgruppen
  Landskrona, inventory data

- Economic support
  - Linnaeus university