Barriers to colonization in sedge-dominated wetlands

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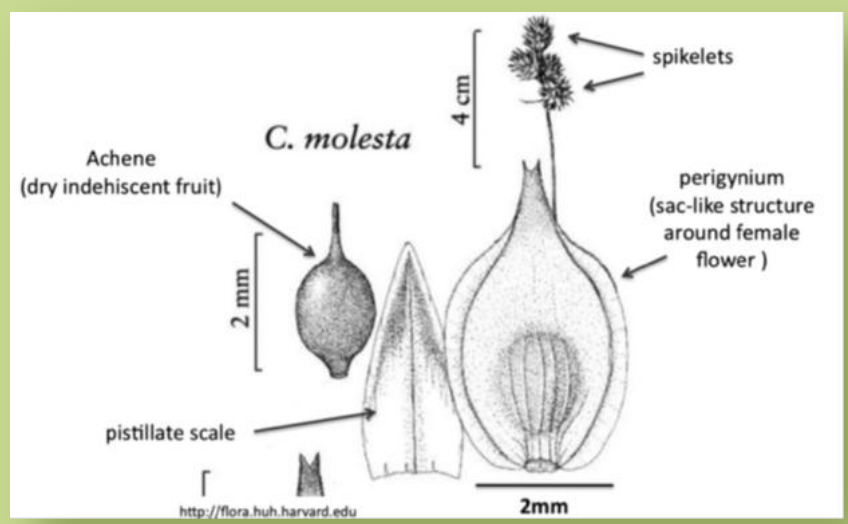
Sedges

Cyperaceae: ca. 5600 species:
>2000 species in genus *Carex*
(only 4 plant genera have 2000+ species)



***Carex* mostly found in temperate and cold regions of the northern hemisphere**

Distinctive strait: perigynium
May promote dispersal, provide seed protection (Leck and Schutz 2005)

Remarkable variation in genome structure caused by elevated chromosome rearrangement rates, and very low polyploidy likely drove speciation
(Hipp et al. 2007, Escudero et al. 2010)

No obvious adaptation for long-range dispersal but….
-- **Bipolar distributions** confirmed for 5 species (Escudero et al. 2010)

Sedge-dominated wetlands

From Klotzli 1988

Carex-dominated wetlands occur in all climatic zones except lowland tropics.

Two main vegetation types: Parvocarex (small) and Magnocarex (large).

Global distribution:

- **Tundra sedge wetlands**: northern Russia, Scandinavia, Canada, Alaska, alpine, primarily P.
- **Taiga mires**: lagg zones in raised bogs, P and M
- **Steppes** (e.g., prairie potholes): Russia, US, Canada, primarily M
- **Deciduous forest wetlands**: Europe, US, so Canada, e Asia, so South America, both P & M
- **Mediterranean woodland wetlands**: SA, Australia, Chile, California, Australia, primarily M
- **Montane/subalpine tropical forest wetlands**: Africa, A. America, Asia, primarily P
- **Temperate rainforest wetlands**: NZ, so. Chile, so Argentina, Tasmania, Primarily M

Loss and degradation of sedge wetlands….

….has triggered interest in local colonization

Colonization lags lead to “active” restoration where seedbanks and remnant populations are lacking

Advantages of using seeds for wetland restoration

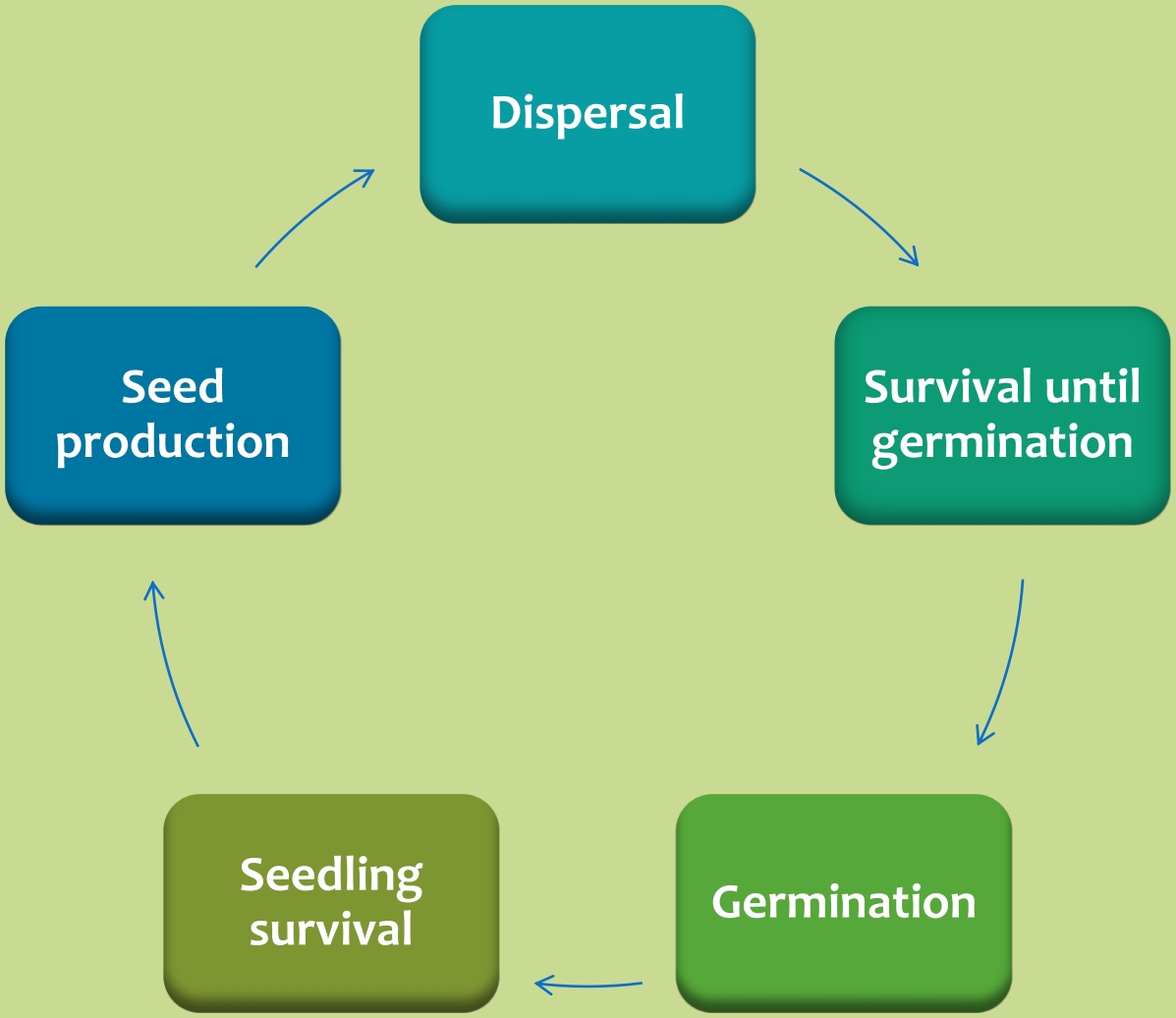
Many more founders for population potentially much greater genetic diversity

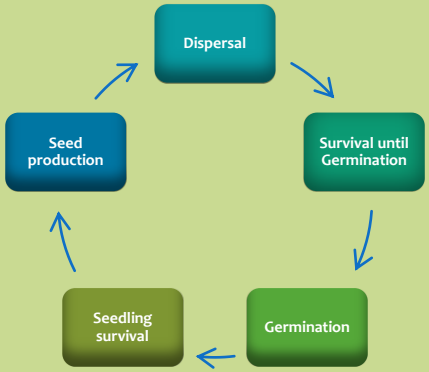
Opportunities to use “bet hedging” strategies with seed – prime some, leave others dormant

Secondary seed dispersal important where there is hydrologic uncertainty

Seeds cheaper to transport and install than plants

Restoration strategies and barriers to seed colonization





Barriers to seed dispersal and restoration options

Kettenring & Galatowitsch (2011)

Barriers:

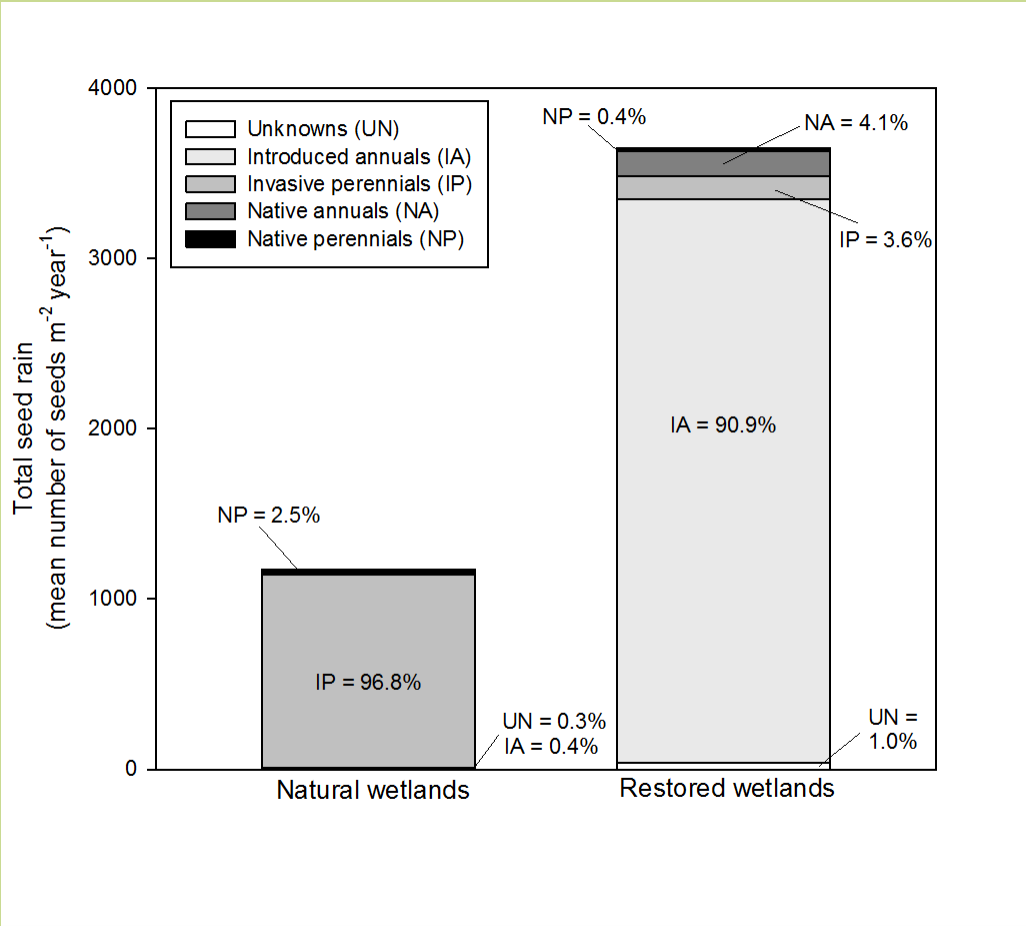
Loss of connectivity in fragmented landscapes

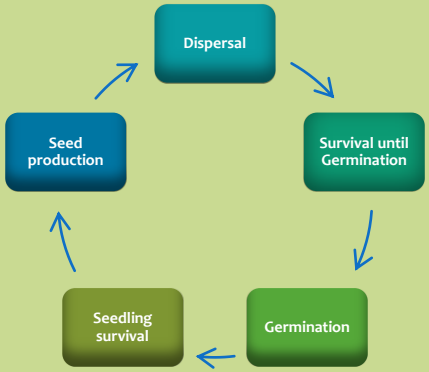
Primary dispersal vectors—water and animals

Leck and Schutz 2005

Restoration options:

Seeding – successful with quality controls





Barriers to seed survival and restoration options

Barriers:

Seed banks generally persistent,< 1 yr, but densities low, < 500 seeds m^{-2}

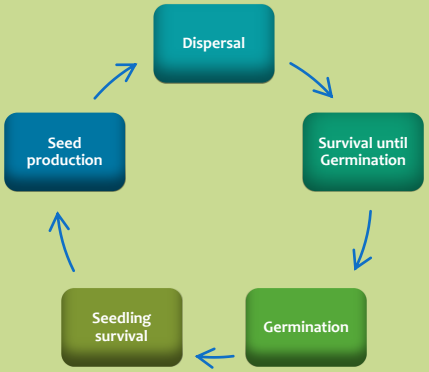
Leck and Schutz 2005

Is the barrier seed rain or survival?

Restoration options:

"Prime" seeds to germinate quickly, ensure adequate "safe sites" through site preparation – minimize unfavorable period

Ex situ seed storage problematic – wet/cool optimal but low *Budelsky and Galatowitsch 1999*



Barriers to germination and restoration options

Barriers:

Carex germination generally requires:

1) **cold moist stratification**
2) **alternating soil temperatures**
3) **light**

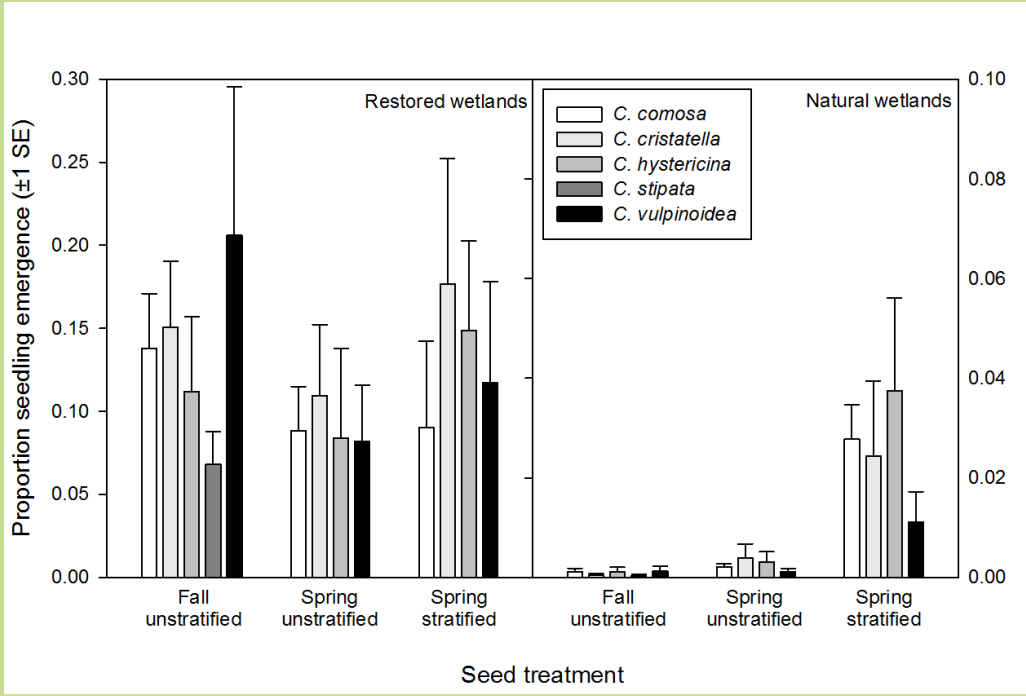
Schütz and Rave 1999, Kettenring et al. 2006, Kettenring and Galatowitsch 2007, Houseal 2011, Jones et al. 2004

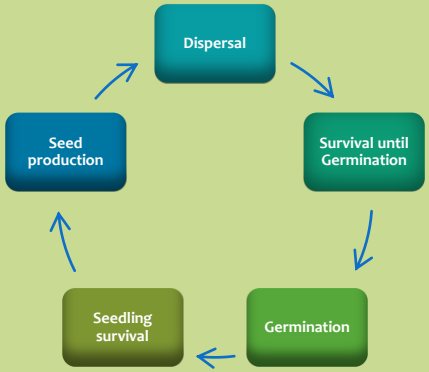
Restoration options:

Minimize cover of invasive perennial species with high ramet density

Budelsky and Galatowitsch 2000, Araki and Kunii 2008, Hall & Zedler 2010

Broadcast seed





Barriers to seedling survival and restoration options

Barriers:

Seedlings vulnerable to submergence and competition

Budelsky and Galatowitsch 2000, Araki and Kunii 2008

Restoration options:

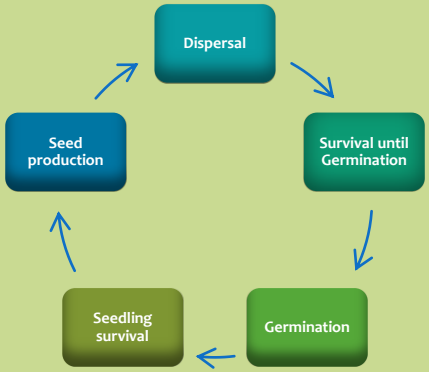
Minimize cover of invasive perennial species with high ramet density

Budelsky and Galatowitsch 2000, Araki and Kunii 2008

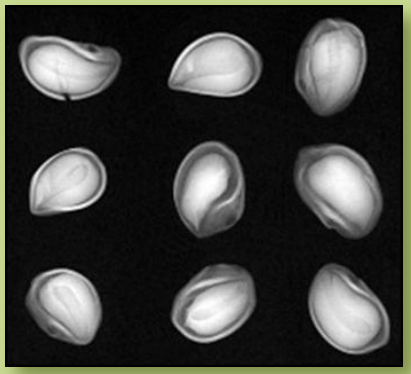
Reducing N availability shifts competitive outcome but cannot be primary strategy

Iannone and Galatowitsch 2009

Broadly seed across elevational gradient



Barriers to seed production and restoration options



Barriers:

Seed production low in rhizomatous sp.
Leck and Schutz 2005, Housel 2011

Changes in water level affects flowering
Bernard 1975

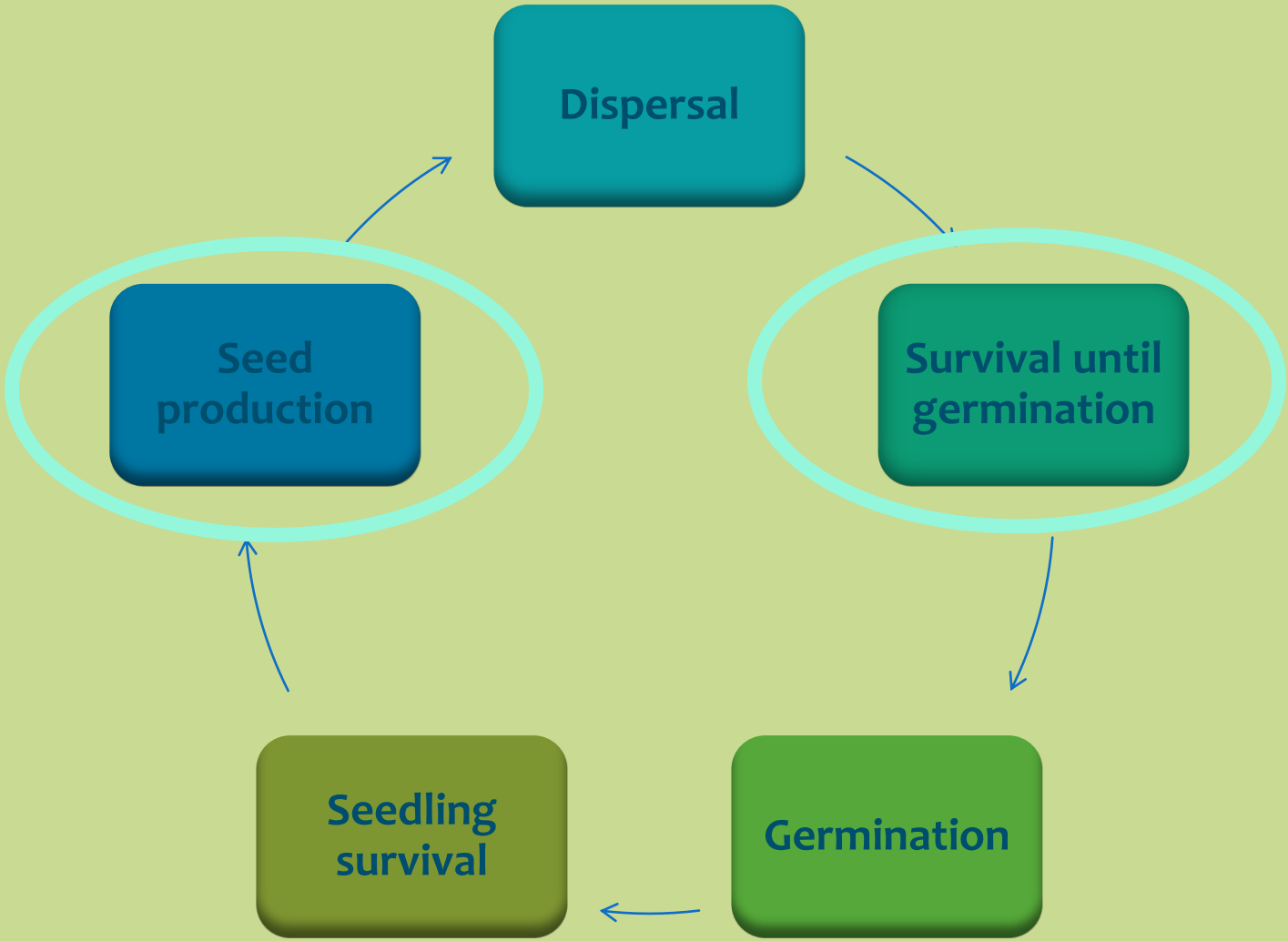
Seed production limited by wetland loss and invasive species prevalence in remnant wetlands.

Restoration options:

"Seedbanking" prior to wetland destruction?
Lack knowledge of factors affecting seed longevity

Manage some wetlands for seed harvest?
Lack adequate knowledge of factors affecting seed production

Barriers to seed colonization that limit restoration of sedge-dominated wetlands



Research needs

Can effective strategies be developed to increase *Carex* seed supply for restoration?

What factors affect seed longevity in wild populations?

How can seed longevity be maximized during storage? Are wetland *Carex* orthodox, recalcitrant, or variable?

What factors promote seed production in rhizomatous species?