Ecosystem IV: Disturbance and Herbivory

Disturbance

Keddy 2000: A short-lived event that causes a measurable change in the properties of an ecological community.

Properties of disturbance:

1. Duration
2. Intensity (severity)
3. Frequency (recurrence interval)
4. Area

Disturbance

Flooding & drought (water level fluctuations)

Duration
Intensity
Frequency
Area

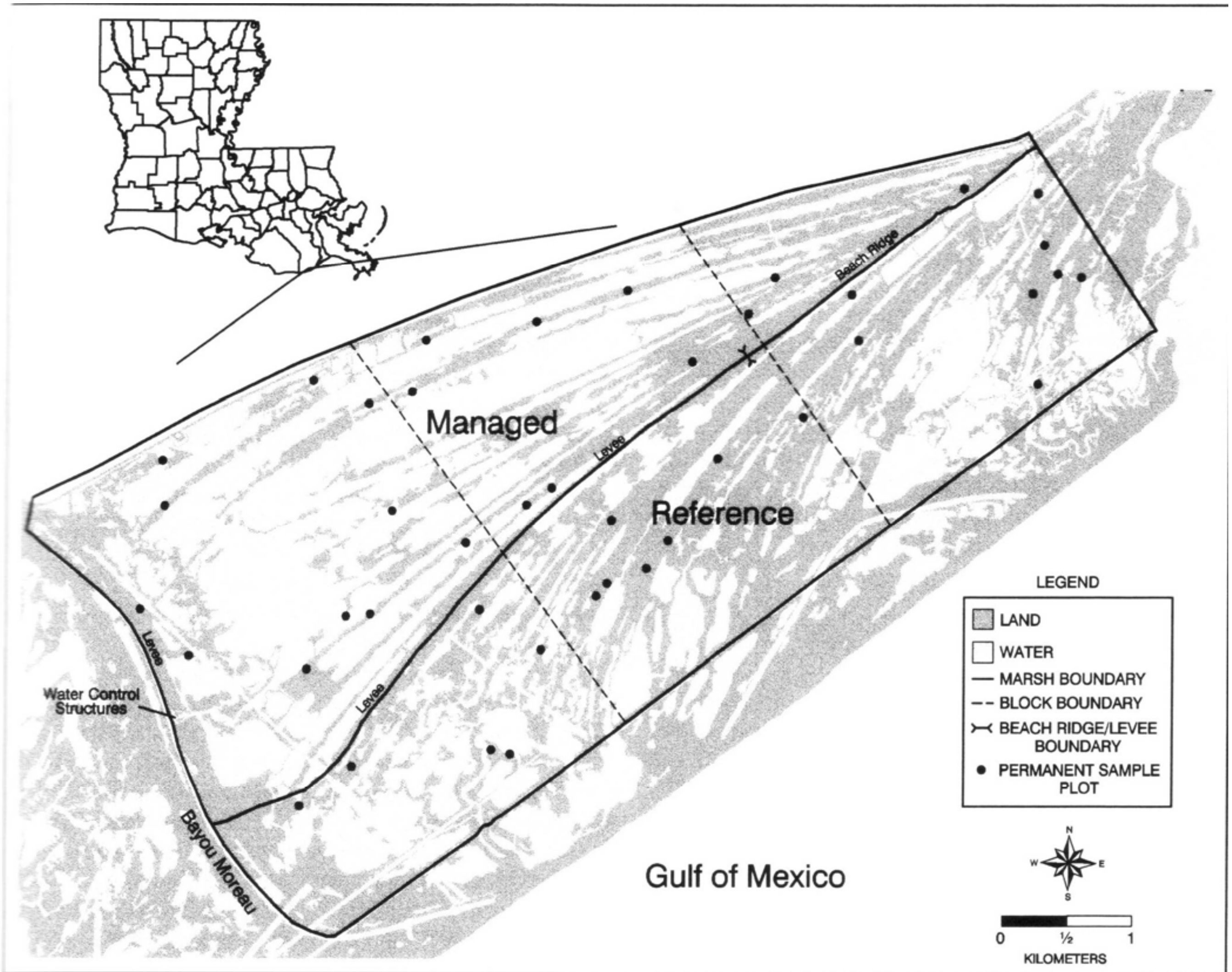
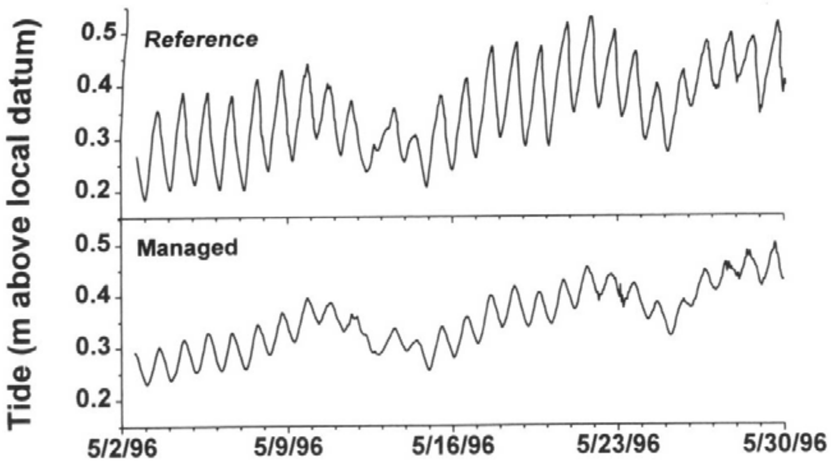
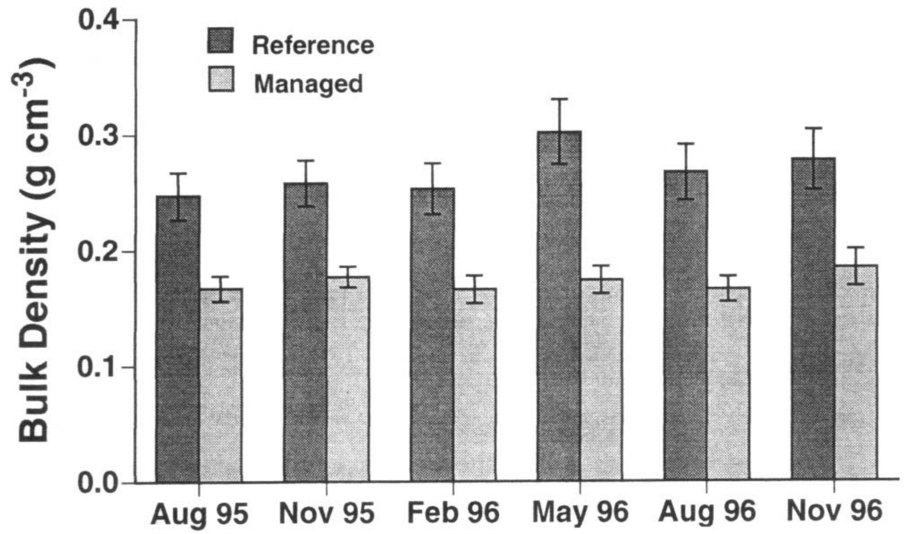


Figure 1. Location of managed and reference marshes on the Louisiana coast.

Kuhn, Mendelssohn & Reed 1999

Disturbance – altered water level fluctuations





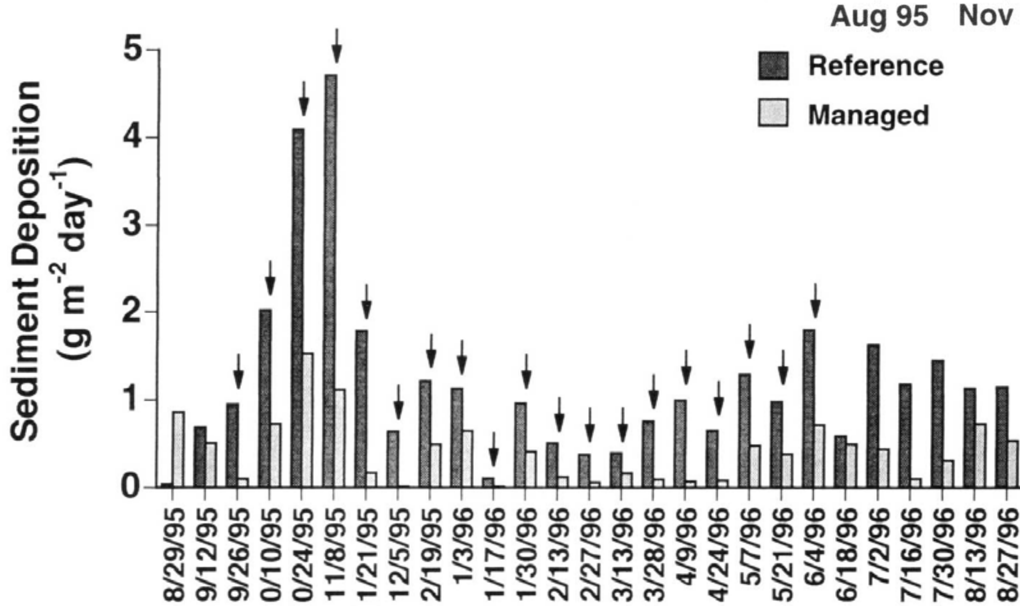


Figure 5. Marsh surface sediment deposition in reference and managed marshes. Data are medians for each biweekly sampli with arrows showing significant differences ($p \leq 0.05$) between two marshes for a given collection date ($n = 18$).

Duration
Intensity
Frequency
Area

Kuhn, Mendelssohn & Reed 1999

Disturbance – erosion and scour

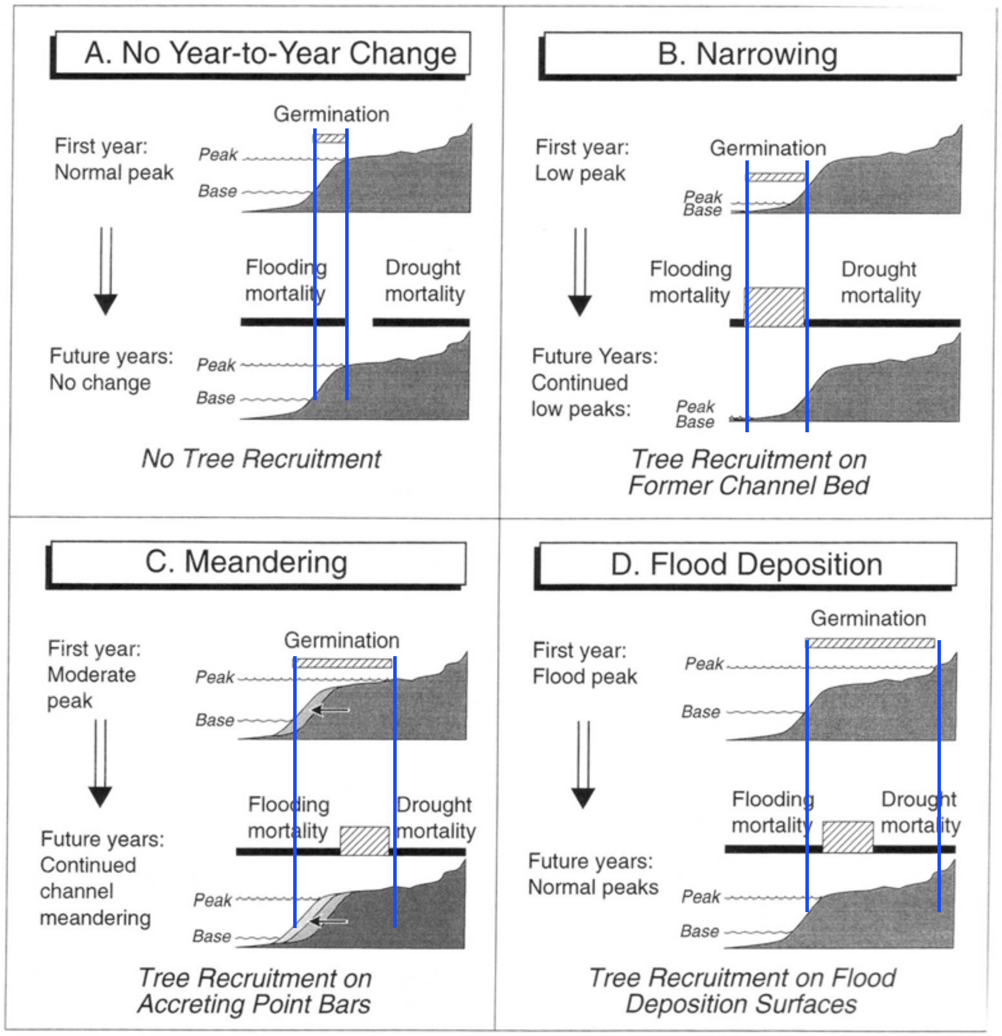
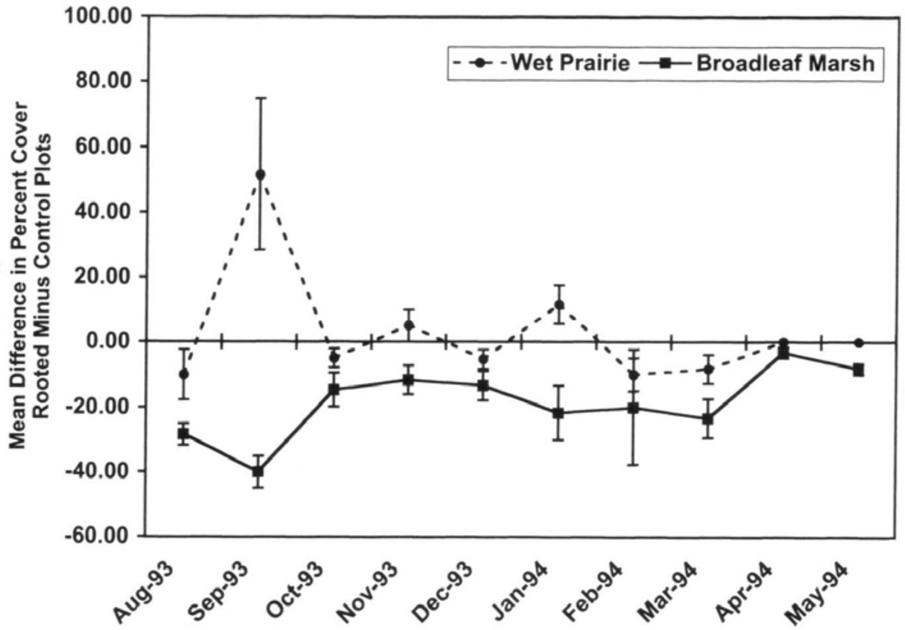


Figure 4. Hydrogeomorphic control of cottonwood recruitment: diagrammatic representations of cottonwood seed germination, early seedling mortality, and tree recruitment in relation to annual high and low flow lines along a bottomland elevational gradient. Four idealized situations are depicted using a single bottomland cross-section: (A) little or no tree recruitment in the absence of inter-annual flow variability and channel movement, (B) channel narrowing with recruitment on the former channel bed, (C) recruitment on point bars of a meandering river, and (D) tree recruitment at high elevations associated with infrequent floods and no channel movement.

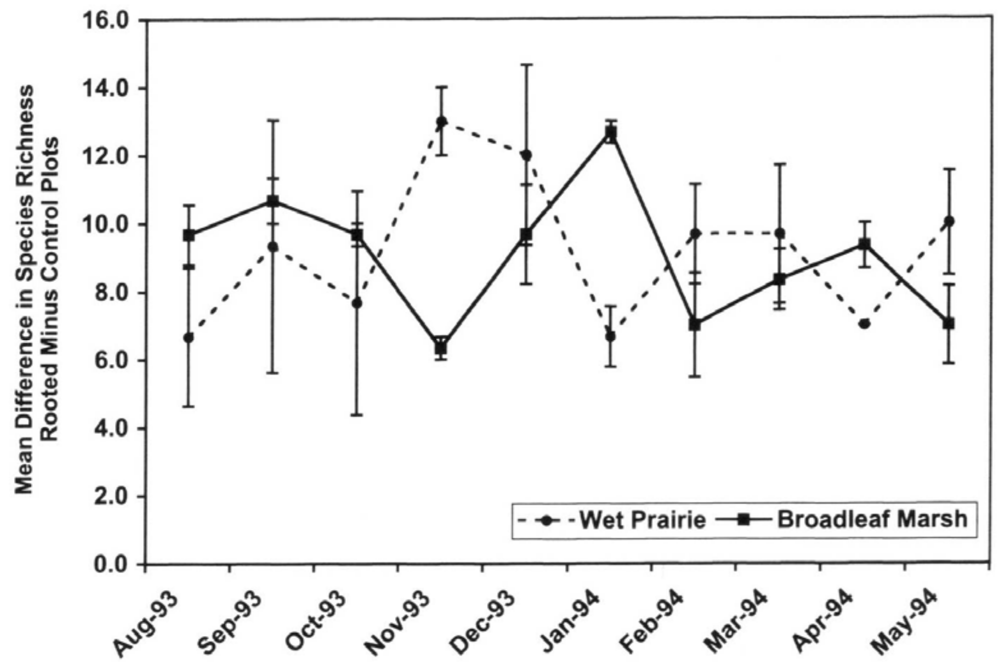
Duration
Intensity
Frequency
Area

Auble & Scott 1998

Disturbance – animals (hog rooting)



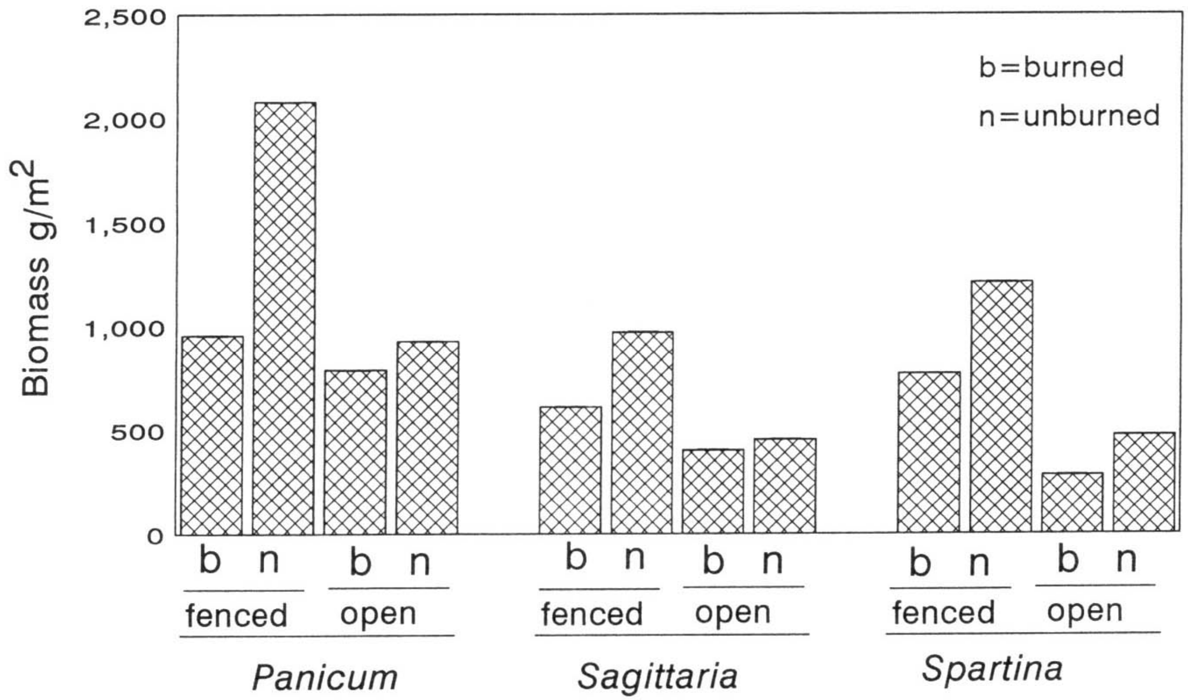
Duration
Intensity
Frequency
Area



Arrington, Toth, and
Koebel, Jr. 1999

Disturbance – fire

Duration
Intensity
Frequency
Area

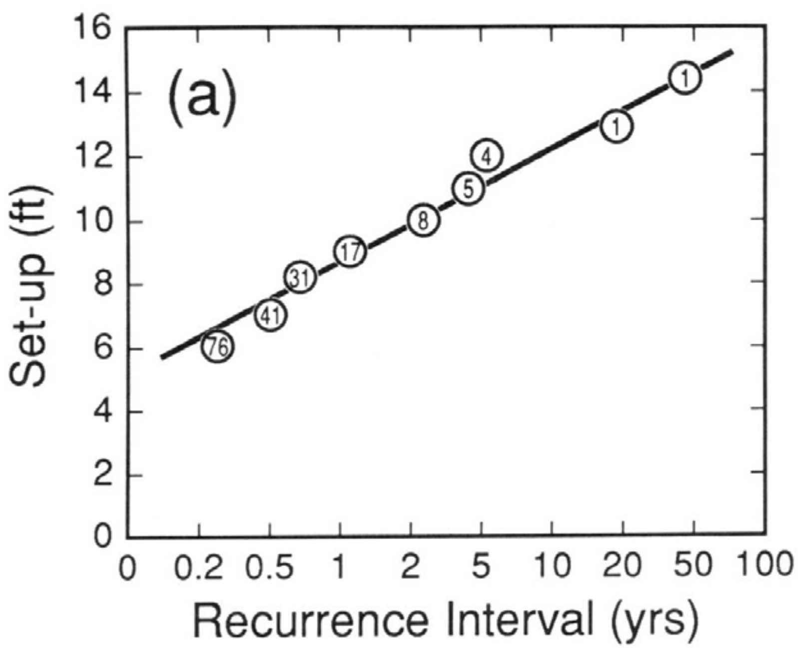


Ford and Grace 1998

Disturbance – ice scour

Duration
Intensity
Frequency
Area

Disturbance – waves



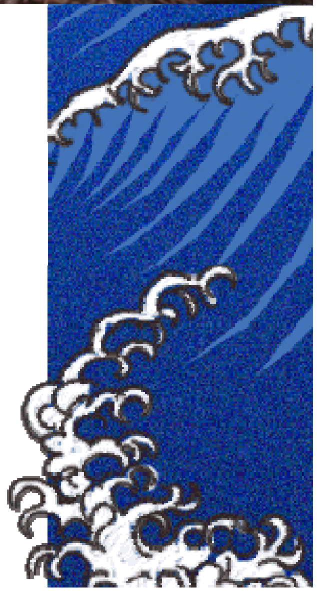
Duration
Intensity
Frequency
Area

Bedford 1992

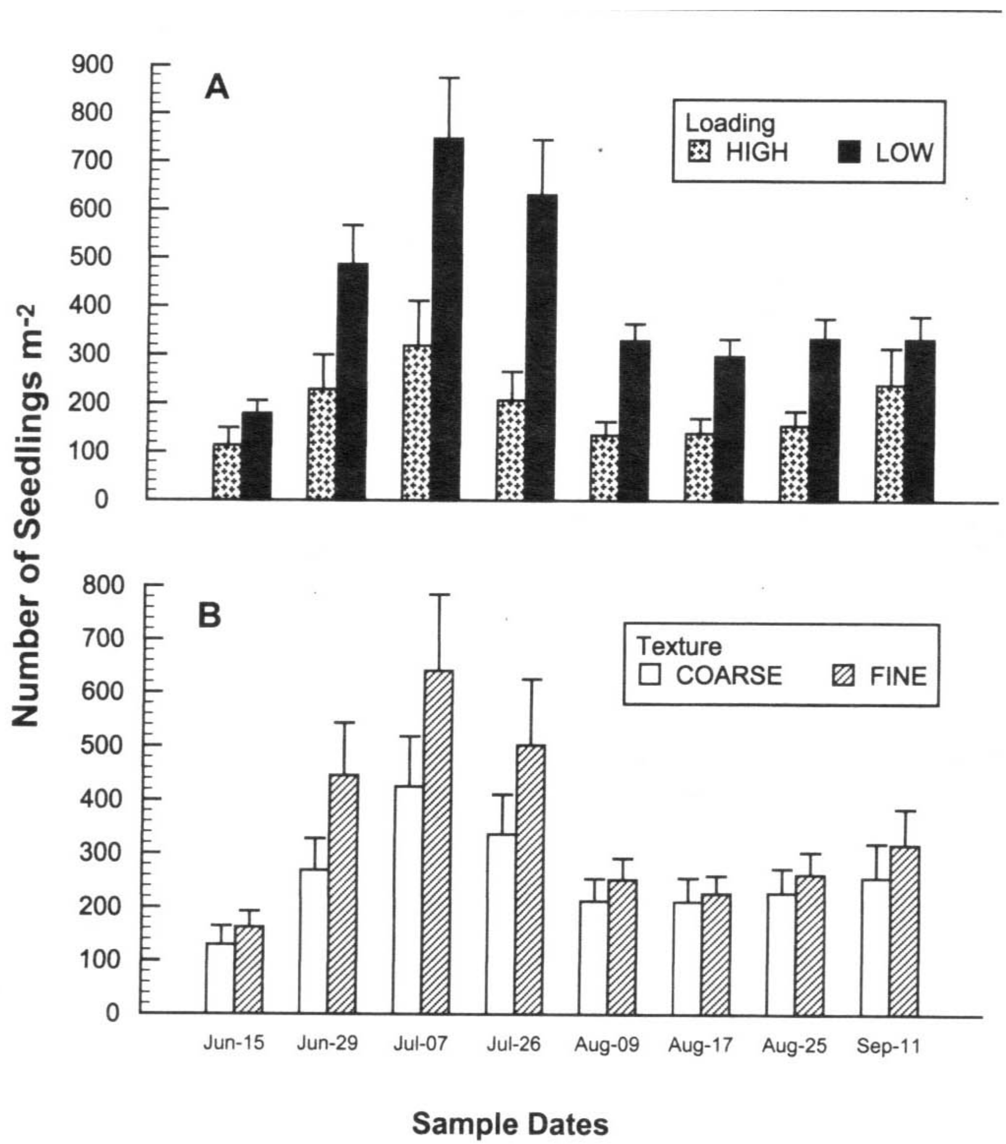
Disturbance – burial

Duration
Intensity
Frequency
Area





Disturbance – burial



Dittmar and Neely 1999

Duration
Intensity
Frequency
Area

Disturbance

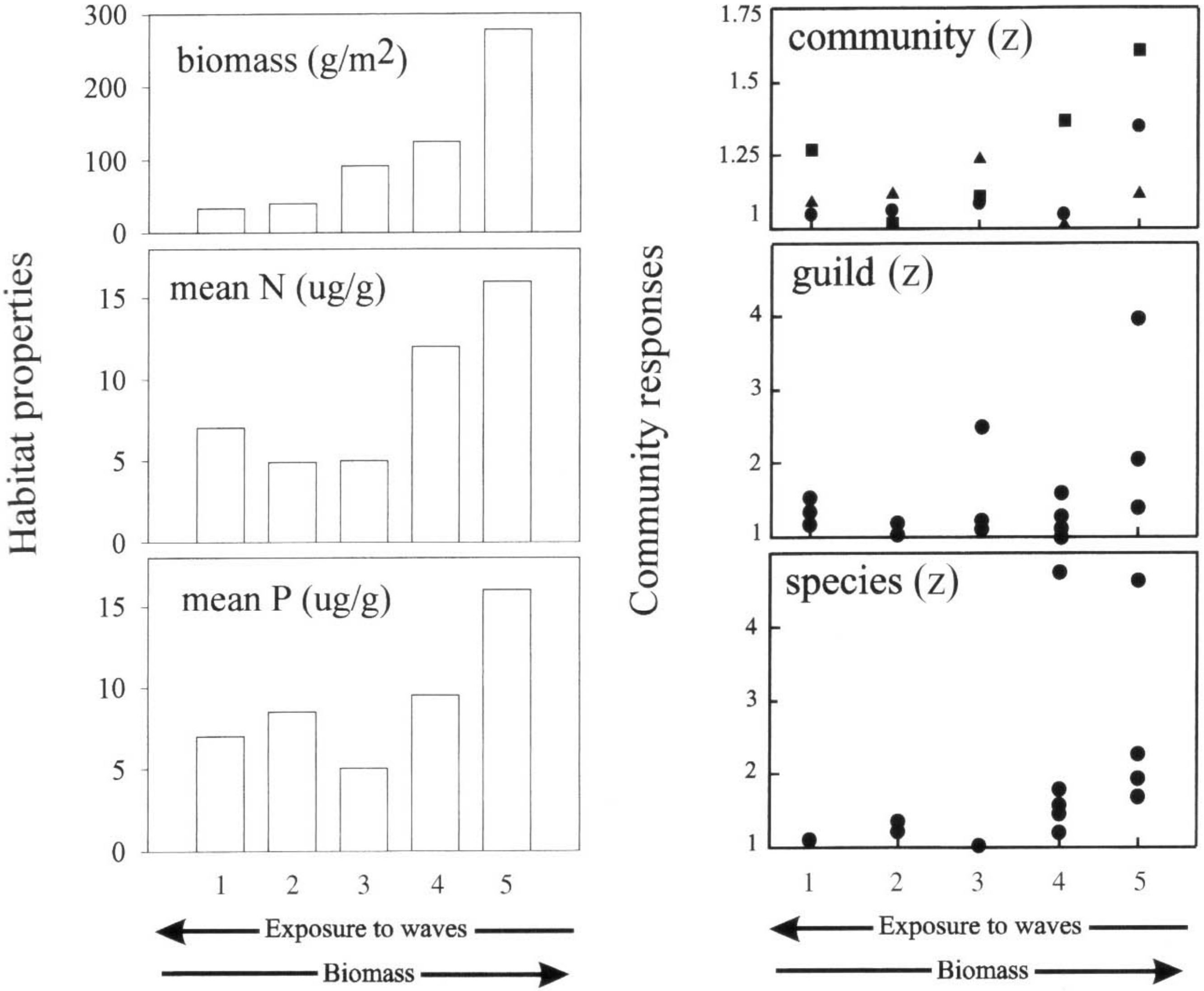
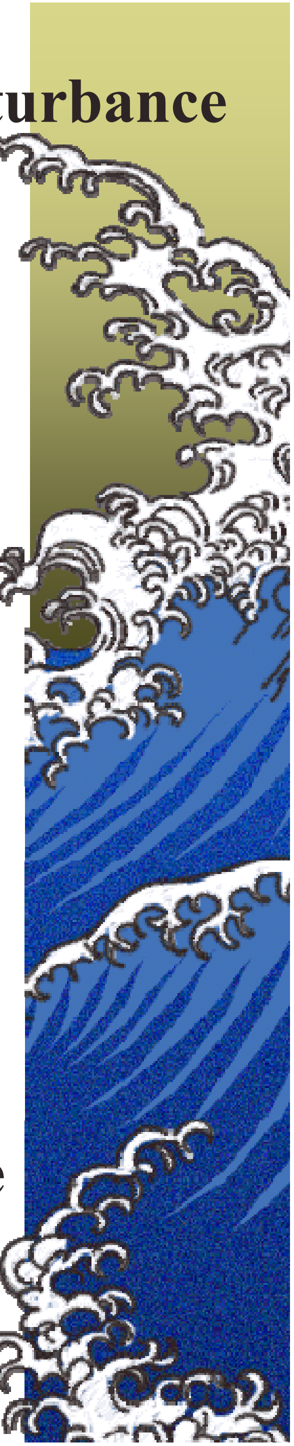


Figure 6.19 Effects of experimental disturbance (removal of all biomass) upon five different wetland communities of increasing biomass and fertility (*left*). Z is a measure of departure from control plot values, and is scaled so all change is greater than 1. The greater Z, the greater the departure from control values. Effects had largely disappeared by year two, and so are not included in the figure (after Moore 1998).

Resistance

Resilience

Moore 1998



Disturbance

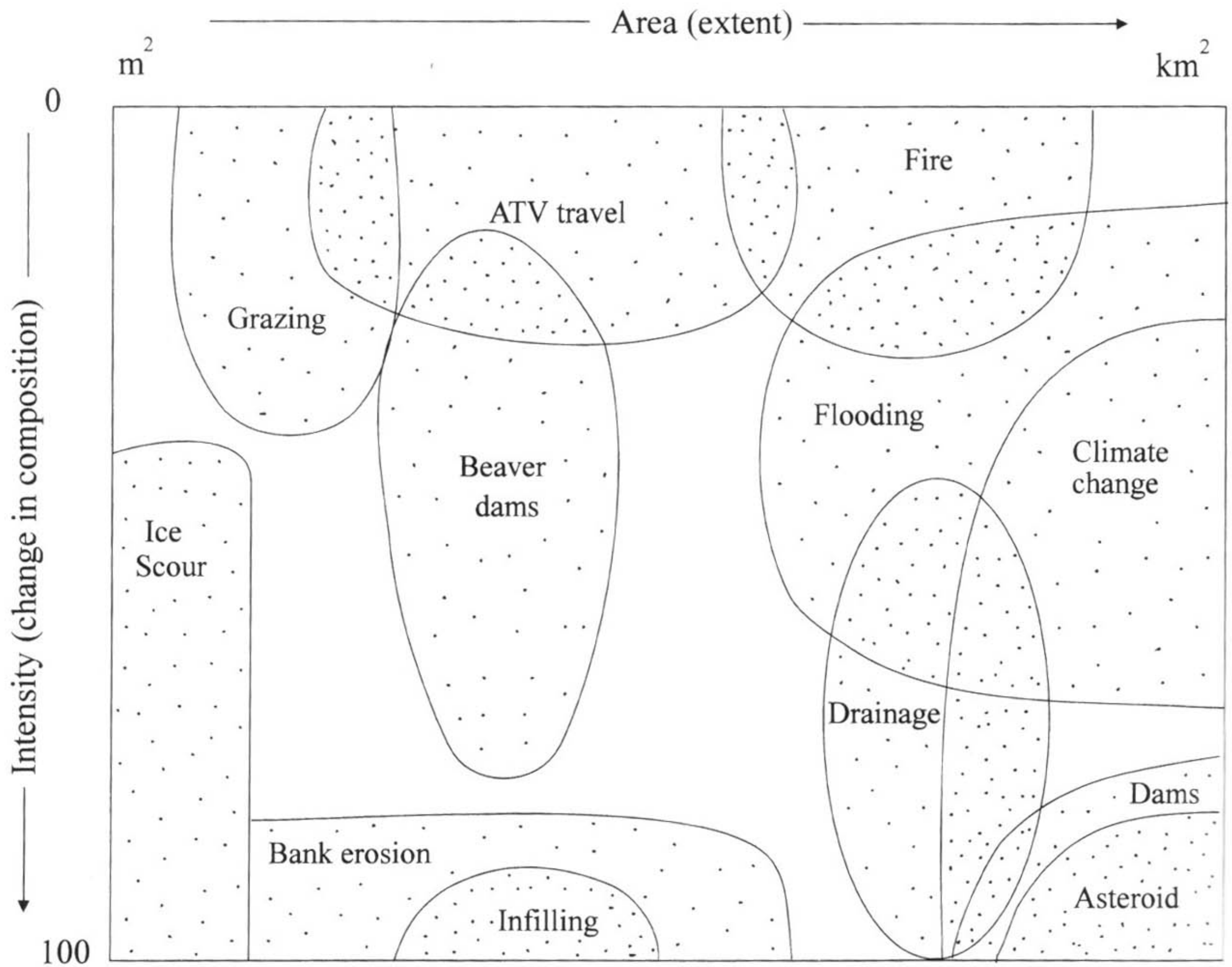


Figure 6.20 Intensity and area plotted for an array of natural disturbances in wetlands.

Herbivory

<u>Wetland herbivores:</u>

Invertebrates	Waterfowl	Muskrats
Beaver	Fish	Small rodents
Moose	Nutria	Others?

Does herbivory have a significant impact on wetland plants?

- < 10% of vegetation biomass consumed
- Very little physical protection created by plants

- Evidence from dietary studies
- Algae highly consumed
- More effect than just consumption

Herbivory

Dietary evidence:

•Fassett's "Manual of aquatic plants": has a 15 page appendix of the use of macrophytes by birds, mammals, and fish.

•Review by Gaeveskaya (1969) lists 620 species that eat live macrophytes.

Destruction of plant tissue:

•Many herbivores destroy more plant tissue than is consumed:

- •Crayfish
- •Muskrats

•Increased susceptibility to disease

Herbivory

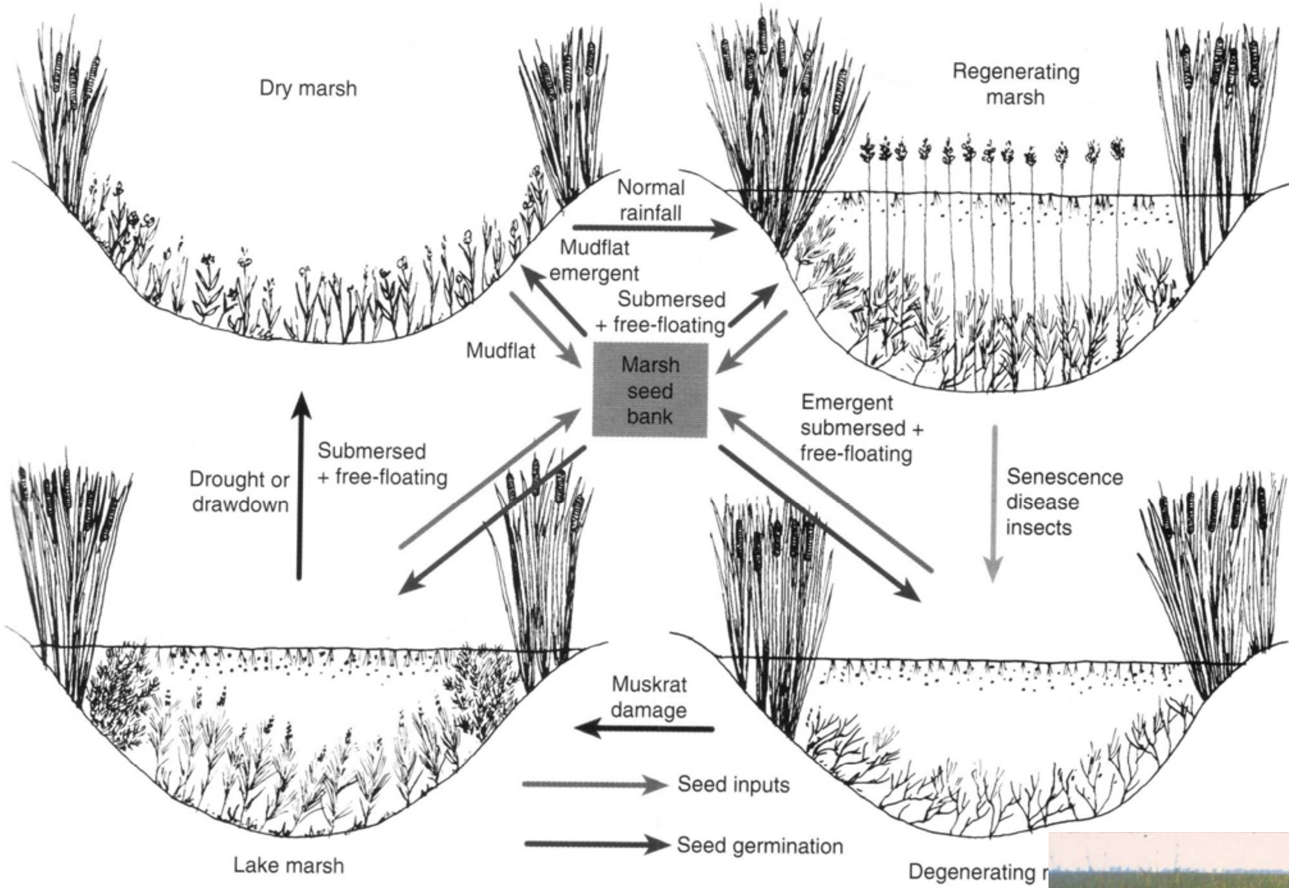


Figure 30.6 Cyclic replacement of vegetation in a prairie glacial marsh. The cycle is initiated by periods of drought followed by periods of normal rainfall, but the key to replacement is the seed bank in the marsh mud. (After van der Valk and Davis 1978.)

Herbivory

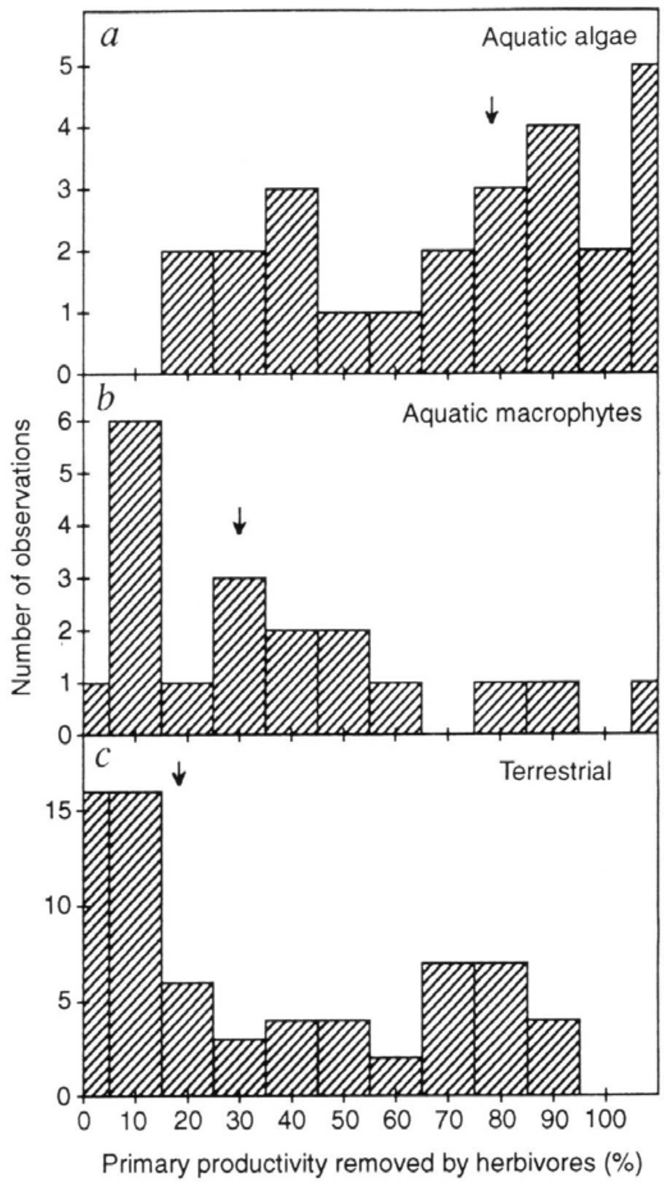
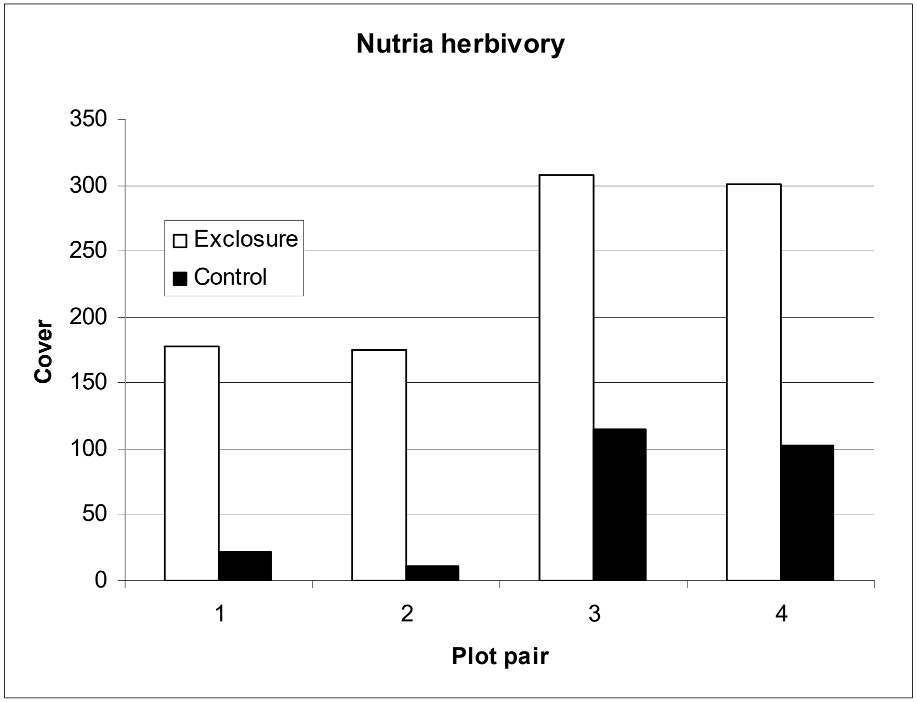
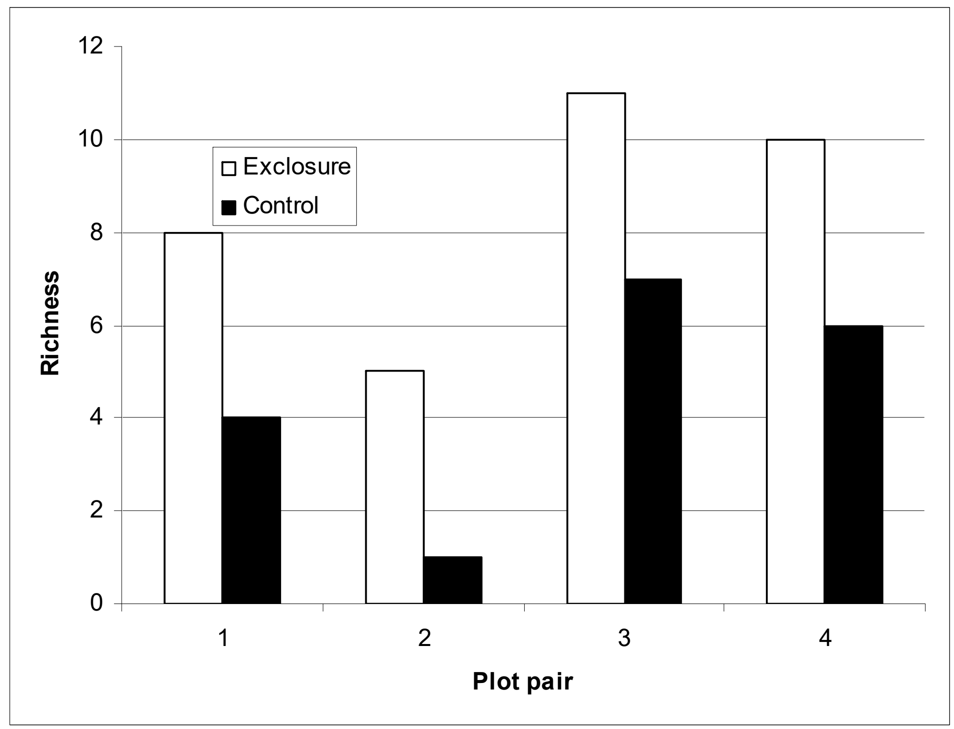


Figure 8.7 Frequency distributions of the proportion of annual net primary productivity removed by herbivores in (*a*) aquatic algae (phytoplankton, $n = 17$, and reef periphyton, $n = 8$); (*b*) submerged ($n = 5$) and emergent ($n = 14$) vascular plants; and (*c*) terrestrial plants ($n = 67$). Arrows indicate median values (aquatic algae, 79%; aquatic macrophytes, 30%; terrestrial plants, 18%) (from Cyr and Pace 1993).

Herbivory





Shaffer et al. 1992

Herbivory

	Biomass	Composition
Submersed macrophytes		
Invertebrates	0-100% (8 of 9)	Y (measured in 5)
Vertebrates	0-100% (5 of 5)	Not measured
Emergent macrophytes		
Invertebrates	5-75% (2 of 2)	Not measured
Vertebrates	?-83% (6 of 8)	Y (measured in 6)
Floating-leaved		
Invertebrates	7-27% (1 of 1)	Not measured
Vertebrates	10-22% (1 of 1)	Not measured

Lodge 1991

All vegetation showed substantial biomass losses

Most biomass reduction not caused by consumption

- Tissue destruction
- Increased susceptibility to disease

Herbivory

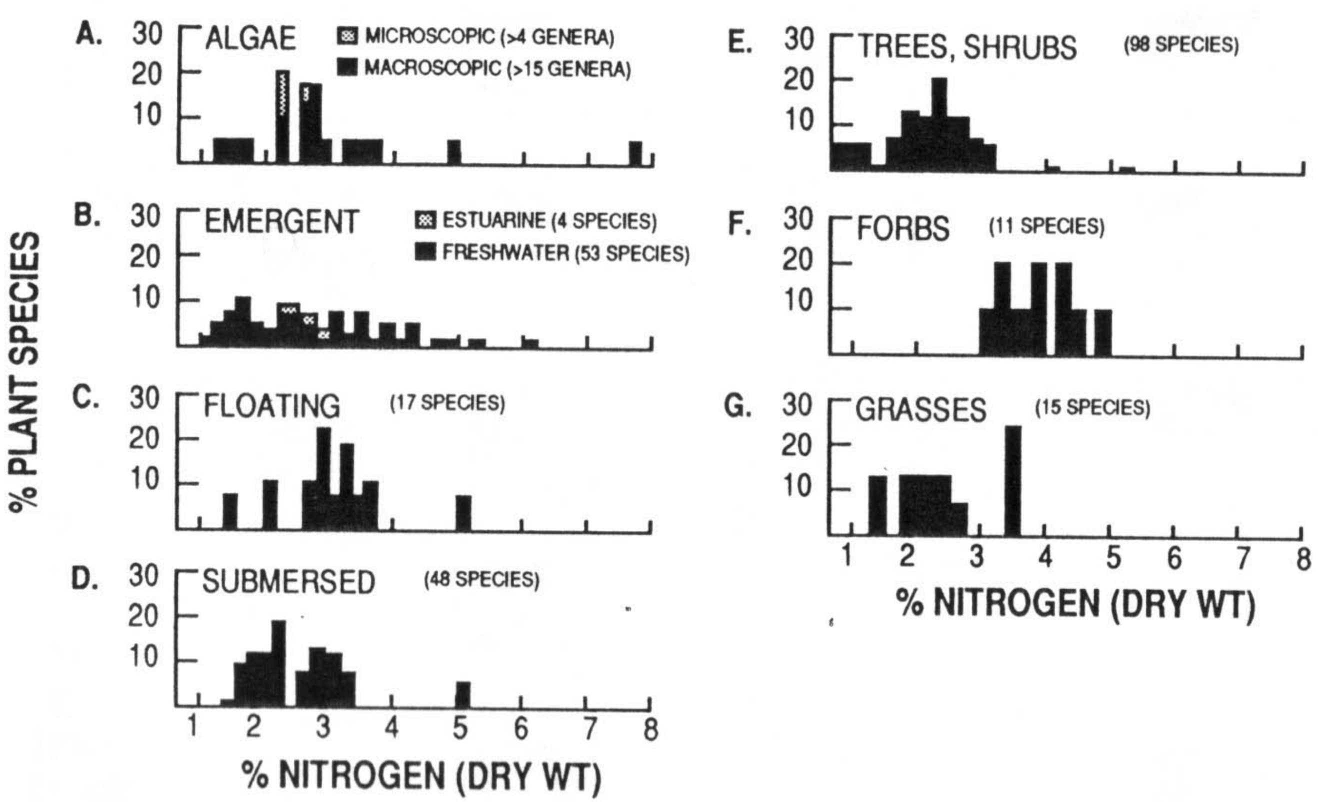
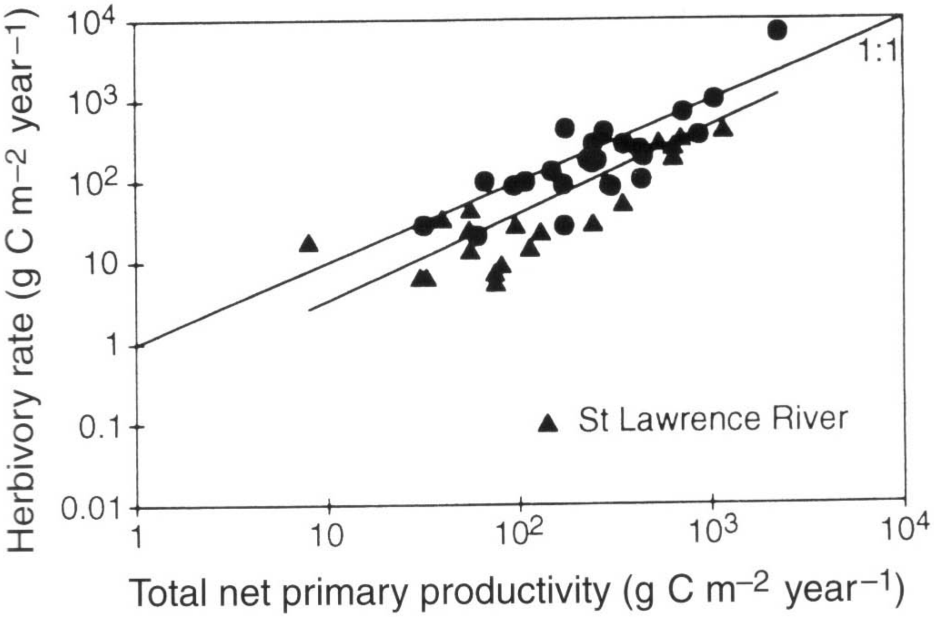
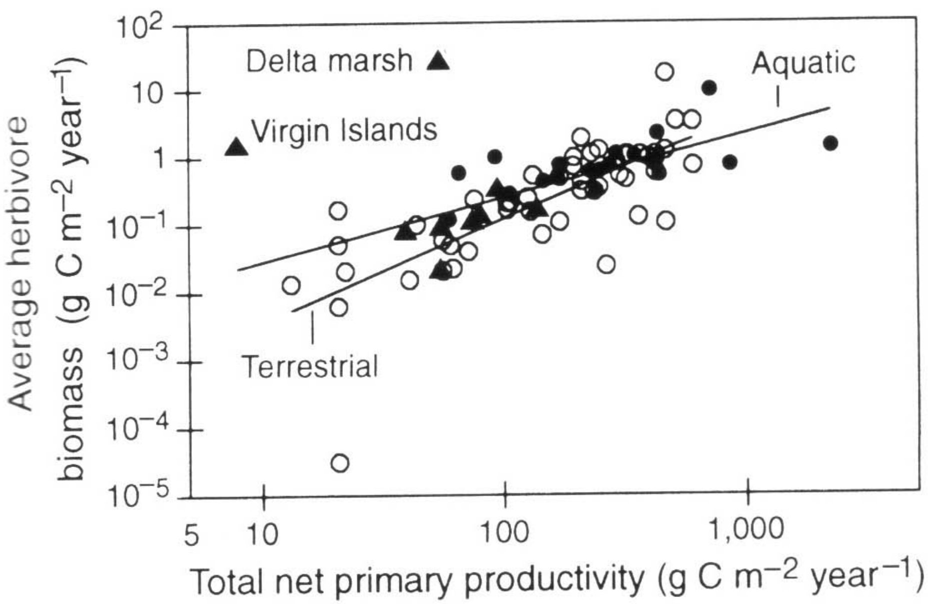


Fig. 1. Mean nitrogen content (as a percentage of plant dry weight) in: (A) freshwater algae, (B) freshwater and estuarine emergent macrophytes, (C) freshwater floating or floating-leaved macrophytes, (D) freshwater submersed macrophytes, and (E–G) non-cultivated terrestrial plants. One mean is plotted for each plant species. For studies reporting temporal patterns of *N*, the mean of the temporal data was used. For studies reporting on multiple sites, a mean across sites is plotted. Values for emergent plants, floating plants, and trees and shrubs are for leaves. Means for submersed aquatic plants include combinations of values for whole plants (roots and shoots), above-ground biomass, 'shoots', and leaves. Similarly, means for forbs and grasses include values for leaves and shoots. Data sources are indicated with the relevant letter (A–G) at the end of each source entry in the references.

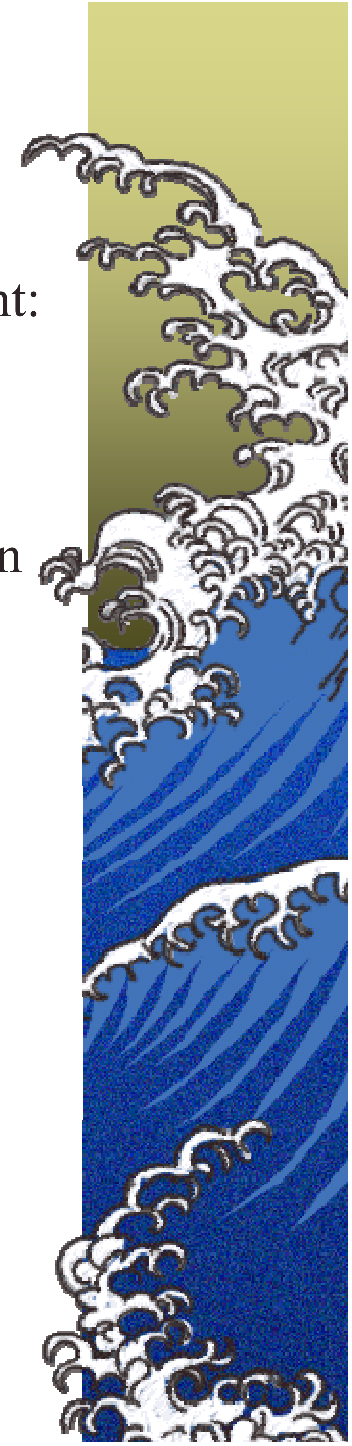
Herbivory





Productivity enhancement:

- •Nutrient regeneration
- •Less self-shading
- •Removal of older tissue
- •Grazer saliva stimulation
- •Reduced competition



Herbivory

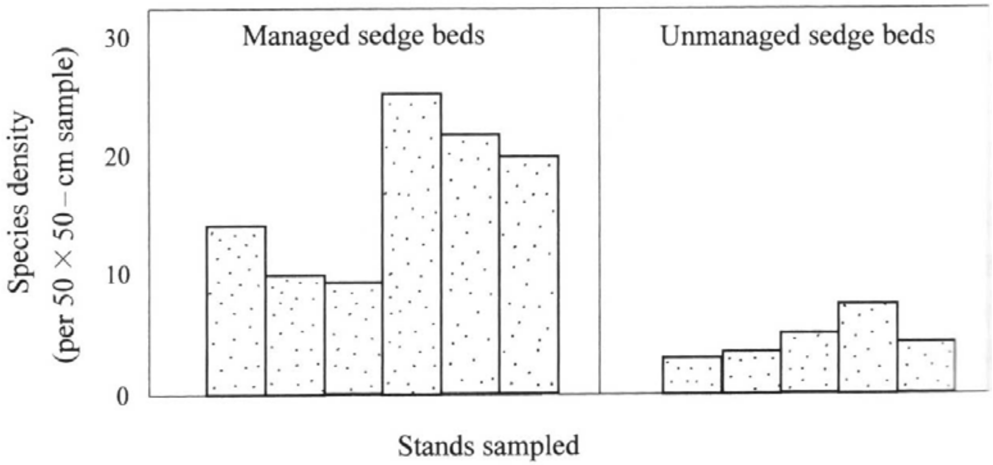


Figure 8.11 Mowing by humans can change species density in English sedge beds. Figure 7.5 provides the data on biomass (after Wheeler and Giller 1982).

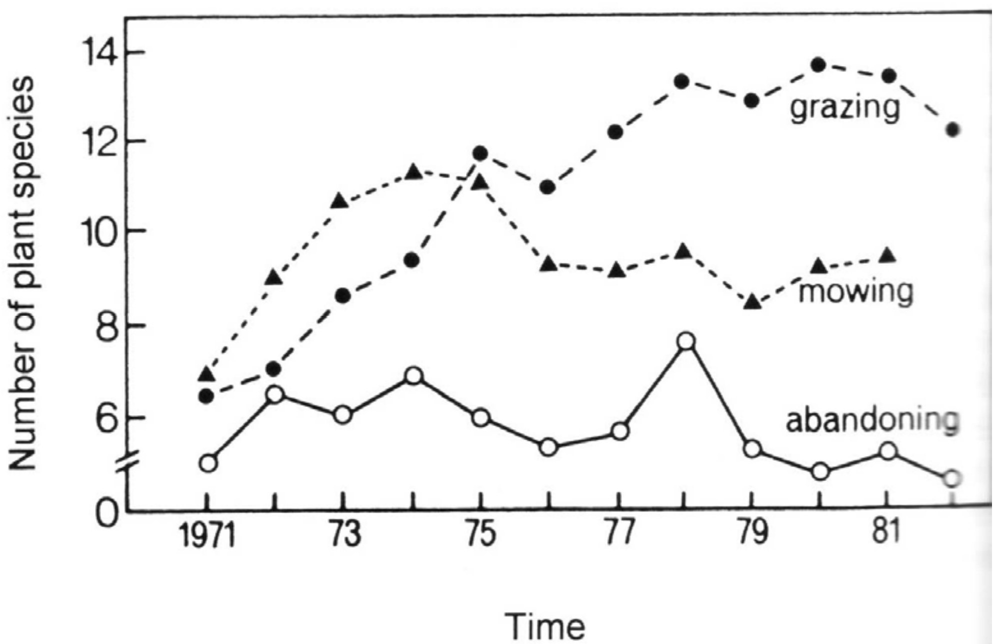


Figure 8.12 Species richness plotted against time in European saltmarshes with three contrasting types of management ($n = 5$, 2×2 m^2 quadrats) (after Bakker, 1985).

Herbivory

$$dP/dt = gP[(K-P)/K]-G$$

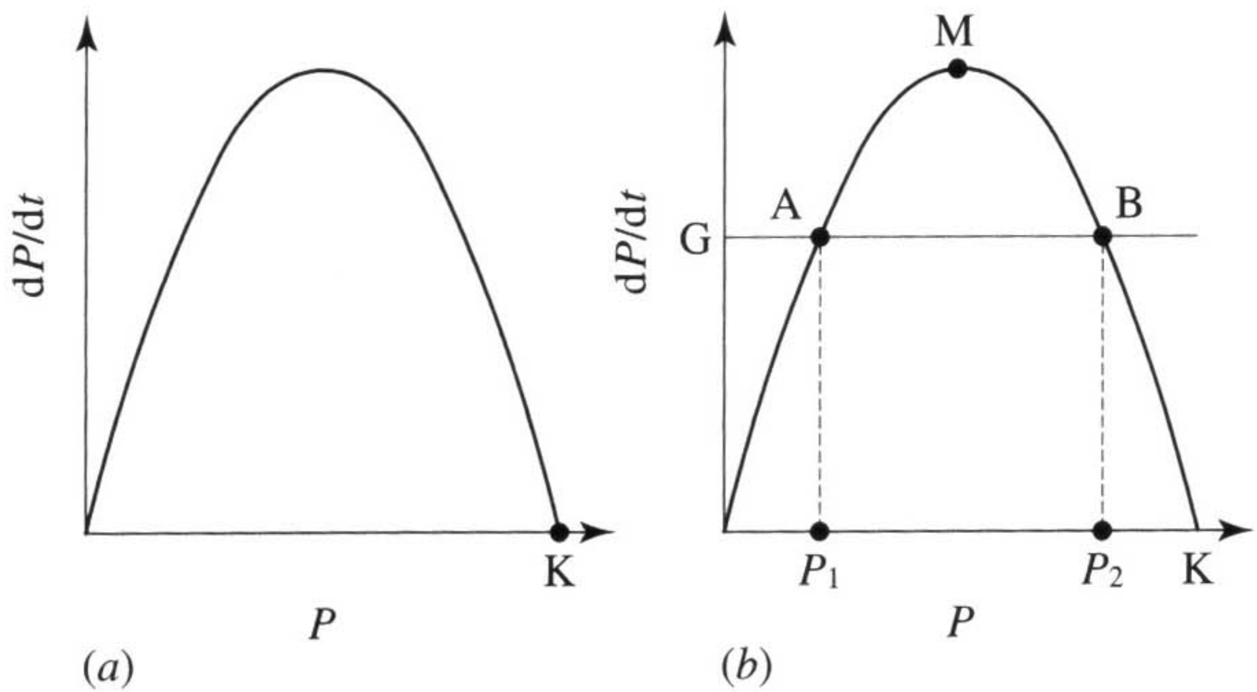
dP/dt = plant growth rate

g = rate of increase

P = plant biomass

K = carrying capacity

G = grazing



Attributes of Developing vs. Mature Ecosystems

Attribute	**Developing**	**Mature**
Biomass	Low	High
Production (quality)	High (low)	Low (high)
Nutrient cycles	Leaky	Tight
Diversity	Low	High
Food webs	Simple	Complex
Life cycles	Simple	Complex
Detritus	Unimportant	Important
Organization	Low	High

Ecosystem Development

Development insulates the ecosystem from its environment

Biomass:

- Modify & stabilize hydrologic regimes (riparian zones, peatlands)
- Nutrient and energy storage
- Regenerative ability (seed banks, energy reserves)
- Physical protection (wave & wind energy)