Community and ecosystem interactions

A freshwater potpourri

Lecture outline

- Facilitation
- Competition
- Disturbance
- Ecosystem views

Mutualism and facilitation

- Mutualism (earlier examples); facilitation…

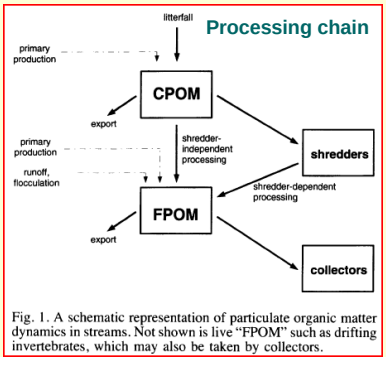


Fig. 1. A schematic representation of particulate organic matter dynamics in streams. Not shown is live "FPOM" such as drifting invertebrates, which may also be taken by collectors.

Heard & Richardson (1995)

Competition in the benthos

- Stream in MT

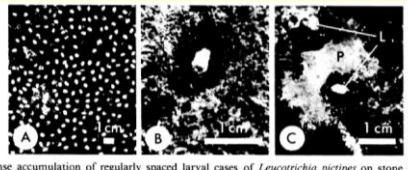


Fig. 1. A. Dense accumulation of regularly spaced larval cases of *Leucotrichia pictipes* on stone surface. B. Solitary *Leucotrichia* case showing the elliptical territory from which periphyton has been grazed. C. Silken retreat of *Parargyractis* (P) conforming to the presence of two *Leucotrichia* (L).

Microcaddisfly

Aquatic lepidopteran

McAuliffe (1984)

Some experimental evidence

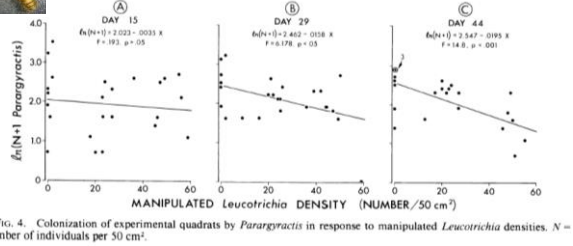


Fig. 4. Colonization of experimental quadrats by *Parargyractis* in response to manipulated *Leucotrichia* densities. *N* = number of individuals per 50 cm².

McAuliffe (1984)

Why coexistence then?

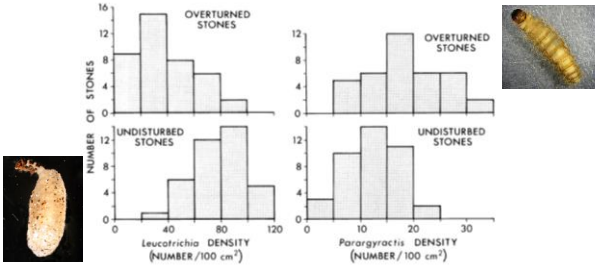


Fig. 7. Densities of *Leucotrichia* and *Parargyractis* on overturned stones (surfaces without *Leucotrichia* formerly present) and on undisturbed stones with prior *Leucotrichia* occupants.

McAuliffe (1984)

Disturbance

- "You cannot step twice into the same river"

  Heraclitus (c.535 - 475 BC)
- "In fact, to some of us, disturbance is not only the most important feature of streams to be studied, it is the dominant organizing factor in stream ecology".

  Resh et al. (1988)

Disturbance (2)

- Response to disturbance depends on characteristics of disturbance and organisms
- Disturbance
  - intensity
  - areal extent
  - frequency
- Organisms
  - colonization ability
  - resistance (e.g. diapause)
  - distance to refugia
  - growth rate

Some chronic disturbances

Table 1. Examples of some chronic disturbances that may influence benthic community structure for many years[a]

Type of disturbance	Time (years) since original disturbance	References
Volcano eruption	5	Anderson and Wisseman (1987)
Highway construction	2–6+	Taylor and Roff (1986)
Heavy metals and mining	10–12	Laurie and Jones (1938), Zanella (1982), Chadwick and others (1986)
Industrial pesticide release	14	Reich and others (1986)
Chronic long-term use of pesticides	25+	Heckman (1981, 1982)
Logging and clear-cutting	5–35	Tebo (1955), Woodall and Wallace (1972), Murphy and Hall (1981), Newbold and others (1980), Haefner and Wallace (1981), Hawkins and others (1982), Murphy and others (1981), Noel and others (1986), Wallace and others (1988)
Acidification	48	Hall and Ide (1987)
Beaver	ca. 50?	McDowell and Naiman (1986)
Acid mine drainage	17–60	Napier and Hummon (1976), Vaughan and others (1978), Herricks (1977)
Severe forest fire	ca. 100+?	Molles (1982)
Deep release dams	>40–100+?	Ward (1976), Petts (1987), Rader and Ward (1989)
Channelization and debris removal	5–25	Moyle (1976), Edwards and others (1984)

[a] At the time of these studies, benthic communities continued to display differences in densities and community structures compared with reference reaches or long-term data.

Wallace (1990)

Early view of a freshwater ecosystem

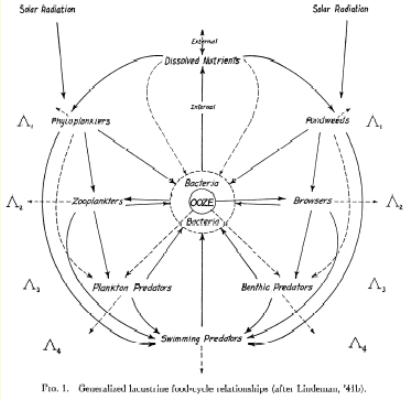


Fig. 1. Generalized lacustrine food-cycle relationships (after Lindeman, '41b).

Cedar Bog Lake, MN

'Trophic dynamic concept of ecology'

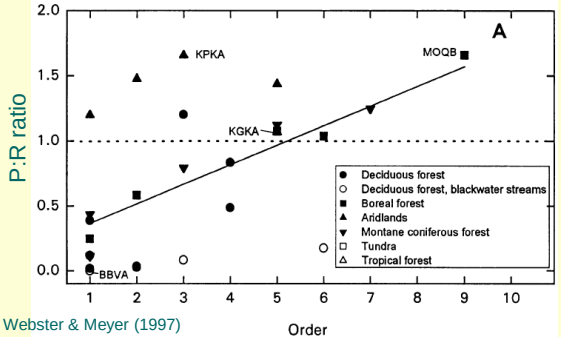
Lindeman (1942)

Stream ecosystems

- Autochthonous vs. allochthonous production
- Nutrient spiraling
- River Continuum Concept
- Flood Pulse Concept

Autochthonous vs. allochthonous production

- Metabolic measurements suggest almost all streams are net heterotrophic, some just more so than others



Webster & Meyer (1997)

Forested headwater stream

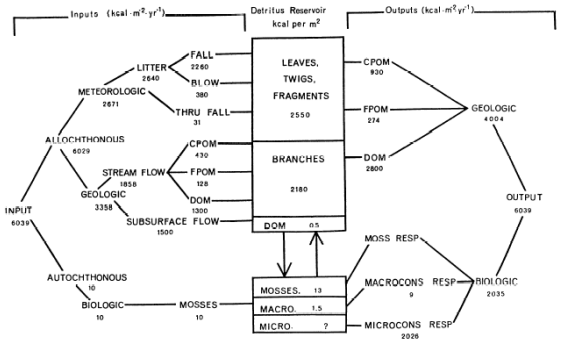
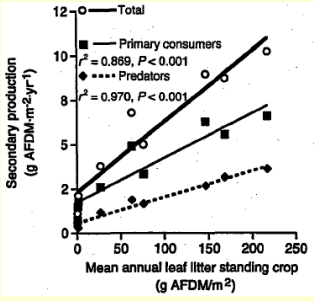


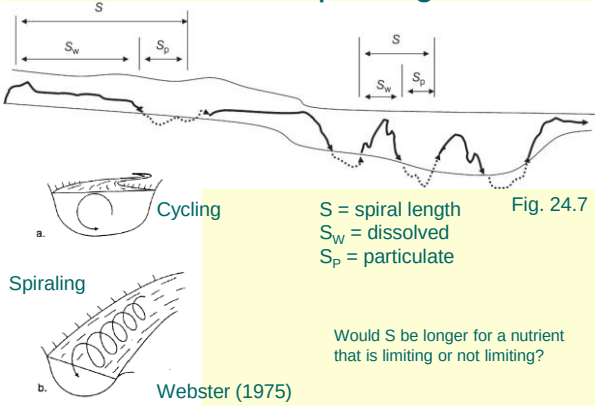
FIG. 9. Annual flux of energy in the Bear Brook ecosystem. Summer standing crop is indicated in the intrasystem compartments. (After Fisher and Likens 1972).

Importance of 'litter'



Wallace et al. (1999)

Nutrient spiraling



Cycling

Spiraling

S = spiral length
S_W = dissolved
S_P = particulate

Fig. 24.7

Would S be longer for a nutrient that is limiting or not limiting?

Webster (1975)

One control on spiraling length

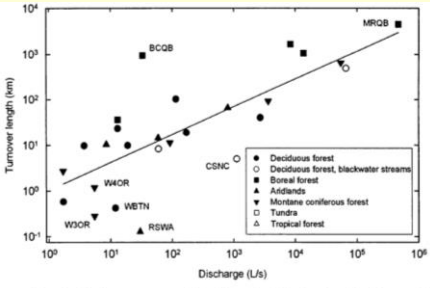
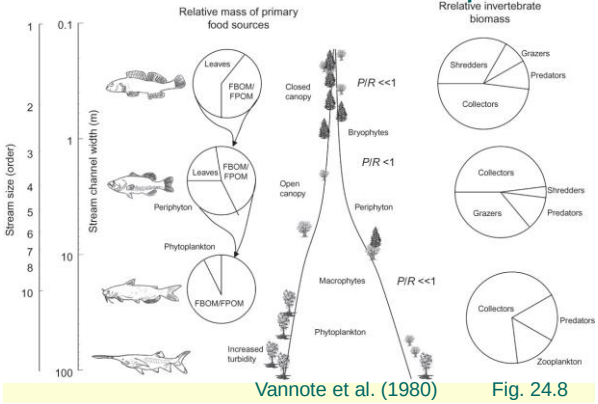


FIG. 7. Turnover lengths for the streams used in this study. The line is a fitted regression line. Stream acronyms are defined by Webster and Meyer (1997).

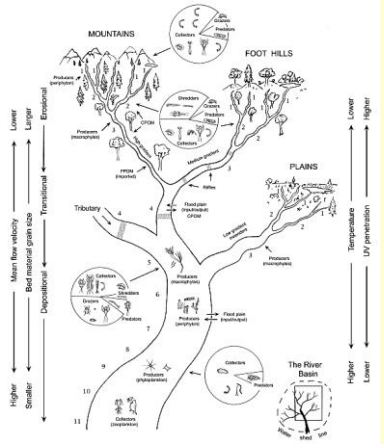
Webster & Meyer (1997)

River Continuum Concept



Vannote et al. (1980) Fig. 24.8

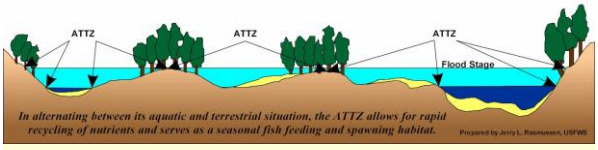
RCC (2)

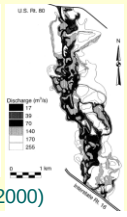


Doug Craig

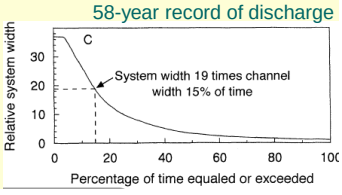
Flood Pulse Concept

- Floods as a disturbance or an integral component (Junk 1985)?





58-year record of discharge



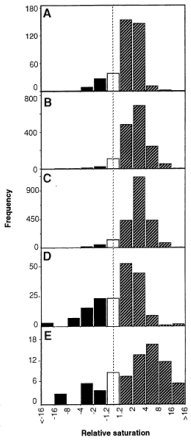
Benke et al. (2000)

Lakes and reservoirs

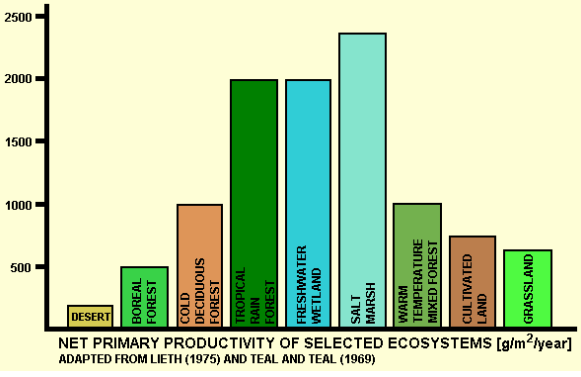
- View of lake ecosystems has expanded to include watershed (vs. Forbes' view)
- Global surveys suggest that shallow lakes are more common than deep (littoral zone important part of ecosystem)
- Surveys of CO_2 shows supersaturation in most lakes, indicating that net heterotrophy is the norm

On this scale, water with twice the P_{CO_2} of the atmosphere has a value of 2; water with half the value of the atmosphere has a value of −2. The vertical dotted line represents equilibrium with the atmosphere (RS = 1.0), and the open bars represent the samples in near equilibrium with the atmosphere (±20% of equilibrium). See Table 1 for characteristics of the data sets.

Cole et al. (1994)



Wetland productivity



Wetland hydrology and productivity

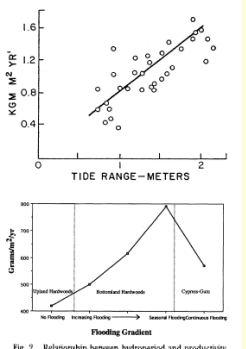


Fig. 2. Relationship between hydroperiod and productivity. The upper graph illustrates tidal amplitude as it varies with biomass production in *Spartina* salt marshes (from Steever et al. 1976). The lower graph illustrates the productivity of bottomland forests along a flooding gradient (from Birch and Cooley 1983).

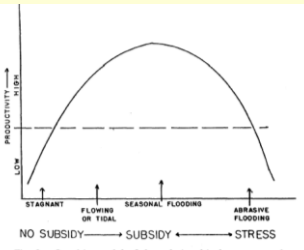


Fig. 3. Graphic model of the relationship between productivity and a flooding gradient in wetlands, shown as a subsidy-stress model.

Odum et al. (1995)