Stream communities & ecosystems

Limnology

Lecture 22

Resource partitioning

Coexistence through resource partitioning

3 Major Axes Typically Evaluated

1. Habitat
2. Diet
3. Time (season or time of day)

Schoener, T.W. 1974

Habitat Partioning

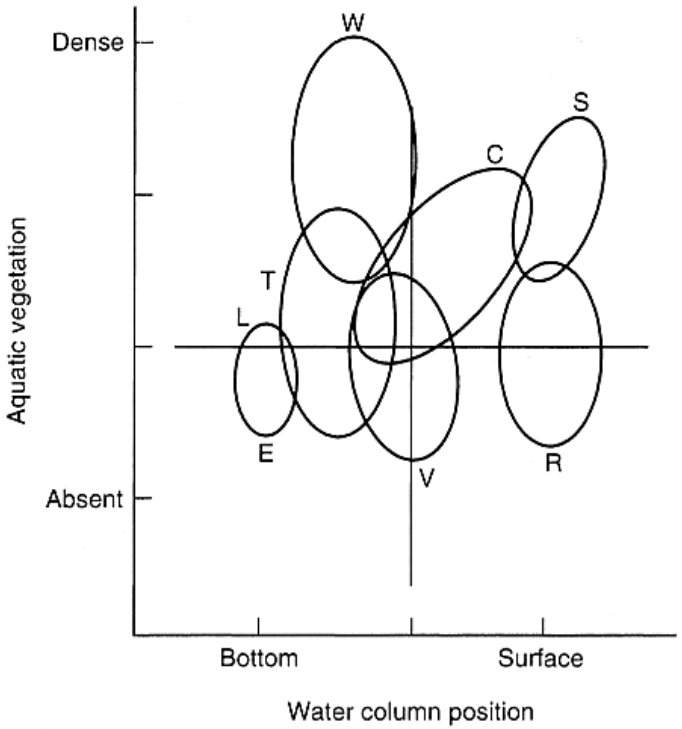


FIGURE 9.1 Ecological segregation among eight species of cyprinids in a Mississippi stream. Only *Ericymba buccata* and *Notropis longirostris* failed to separate on the axes shown, and the former was the sole nocturnal feeder in the assemblage. W, *Notropis welaka*; S, *N. signipinnis*; V, *N. venustus*; R, *N. roseipinnis*; T, *N. texanus*; C, *N. chrysocephalus*; L, *N. longirostris*; E, *Ericymba buccata*. (From Baker and Ross, 1981.)

Notropis longirostris

Notropis welaka

Diet Partitioning

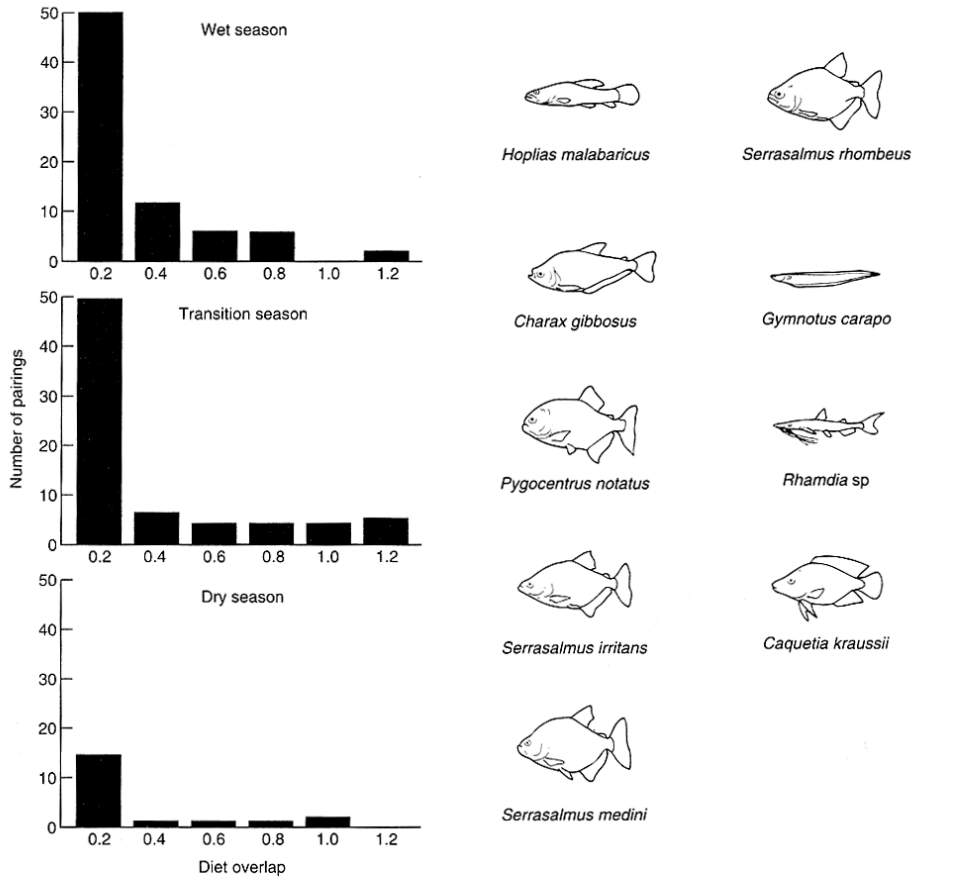


FIGURE 9.3 Frequency histograms of dietary overlap exhibited by each of nine piscivorous fish during different seasons at a lowland creek-and-marsh site in Venezuela. Wet season lasts from May to August, transition season from September to December, and dry season from January to April. Diet overlap was computed from pairwise comparisons of ingested prey after converting prey abundance to volume as an approximation of biomass. Dry season data are less extensive because not all species were present and many had empty guts. Over half of overlap estimates were less than 0.10. (From Winemiller, 1989.)

Serrasalmus rhombeus

Hoplias malabaricus

Temporal Partitioning

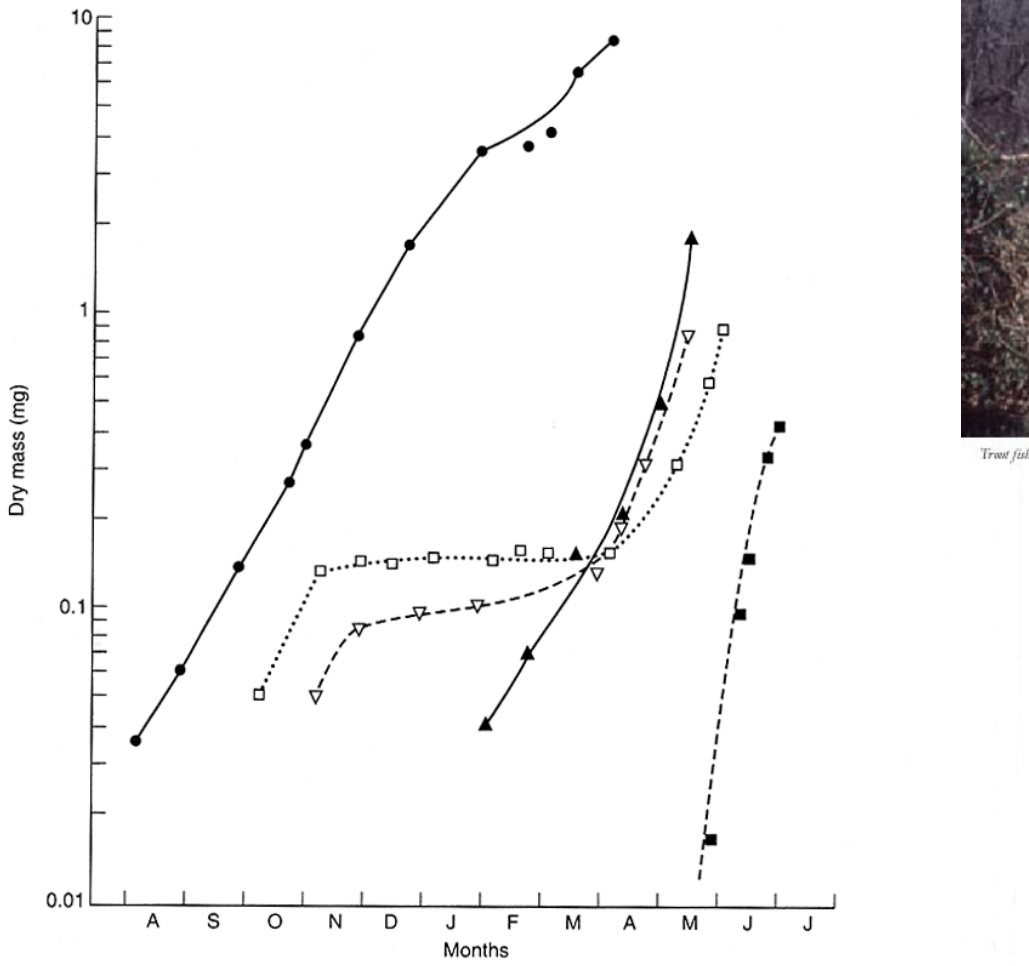


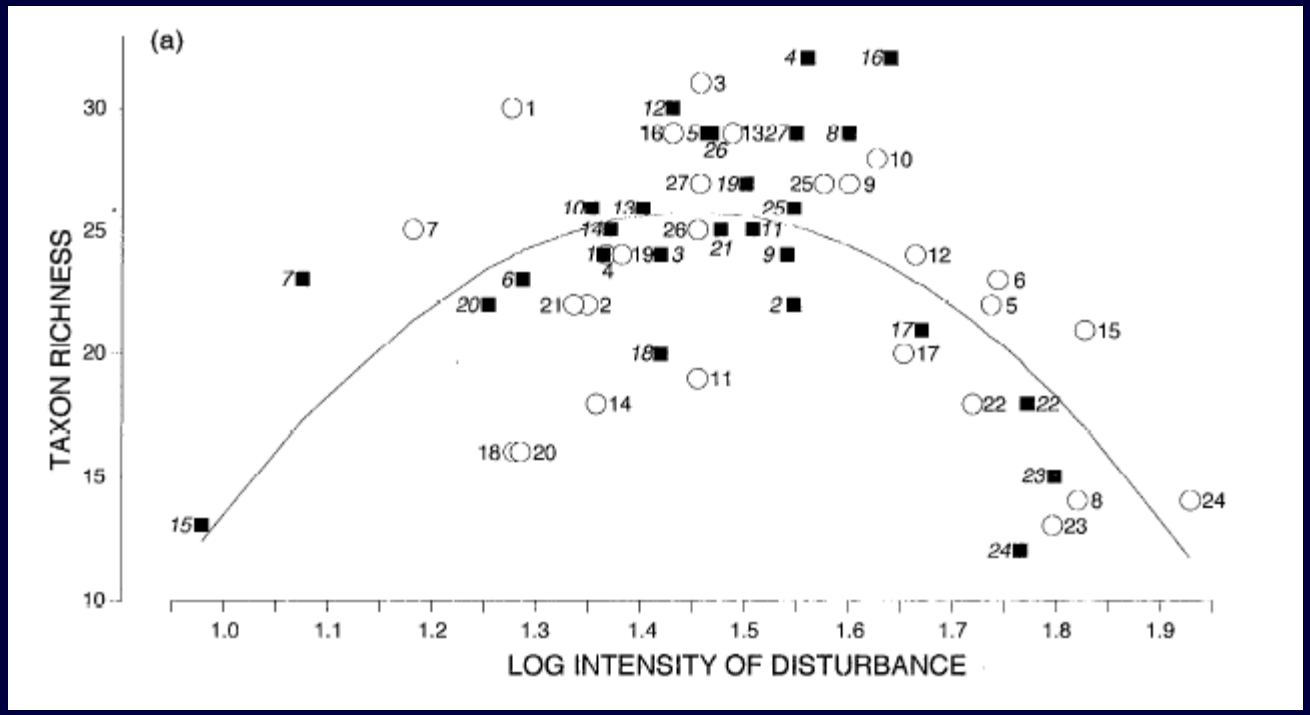
FIGURE 9.4 Larval growth period for five species of riffle-inhabiting ephemerellid mayflies in White Clay Creek, Pennsylvania. ●—● *Ephemerella subvaria*; ▲—▲ *E. dorothea*; □—□ *Seratella deficiens*; ■—■ *S. serrata*; ▽—▽ *Euryophella verisimilis*. (From Sweeney and Vannote, 1981.)

Trout fishing is a popular activity in the White Clay Creek.

Ephemerella subvaria

White Clay Creek, PA

Intermediate disturbance hypothesis in rivers

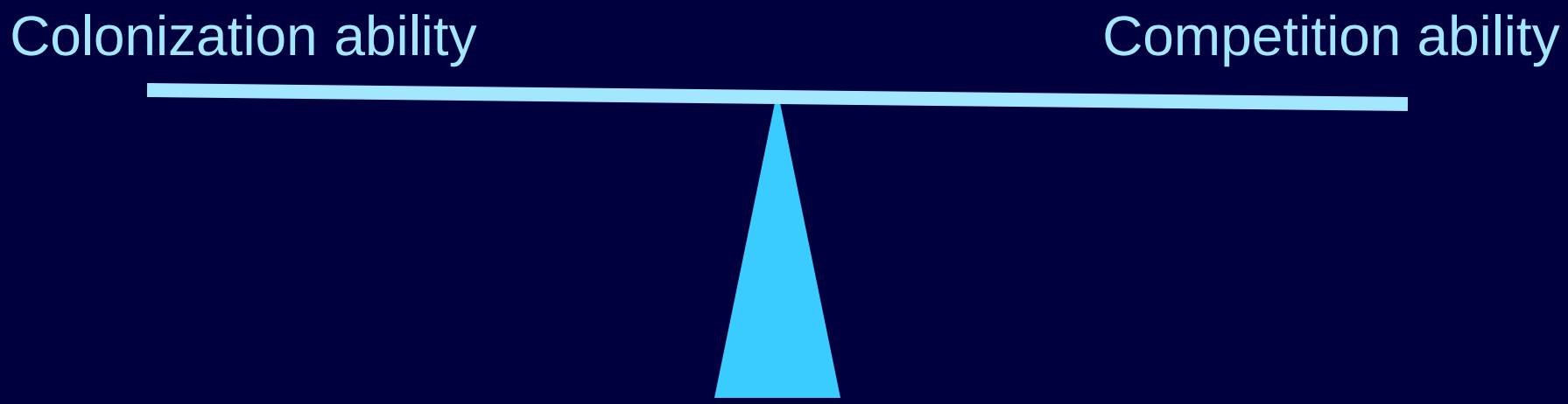


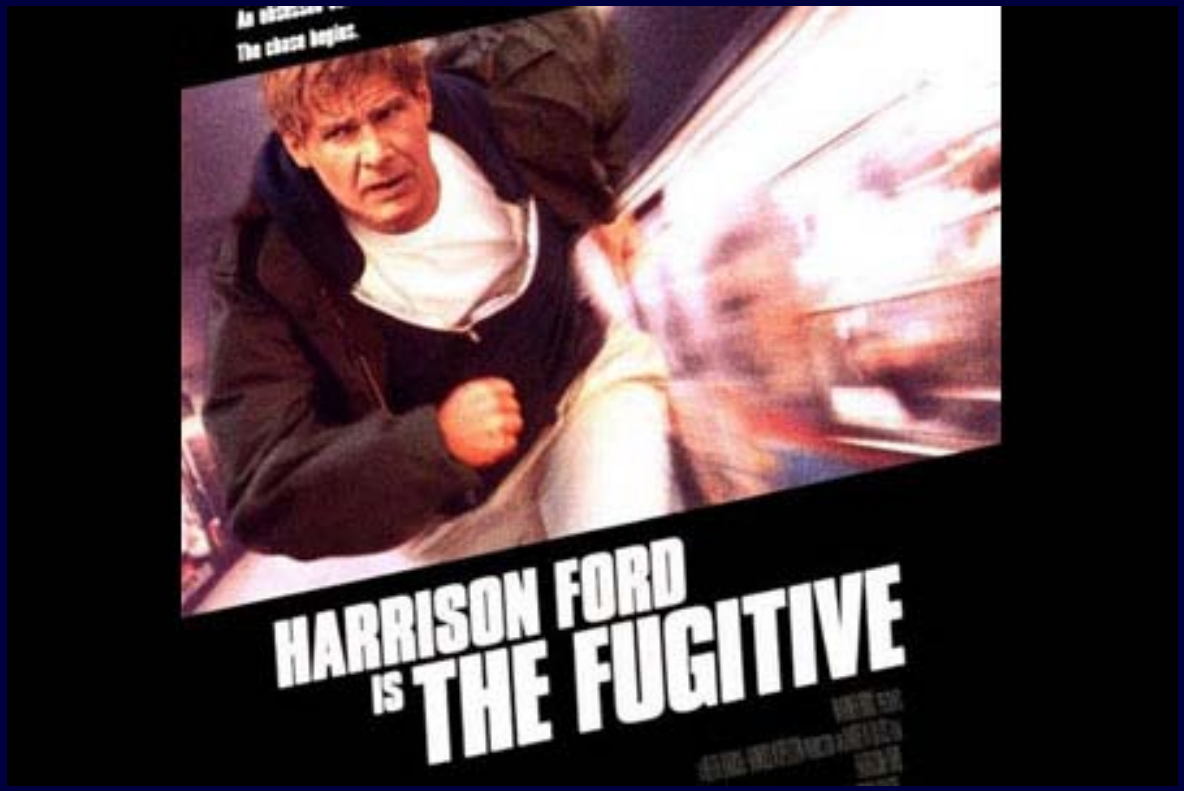
Townsend & Scarsbrook 1997

Partition habitat by disturbance-biotic interaction tradeoff

Colonization-competition tradeoff

Some evidence for tradeoff between two traits



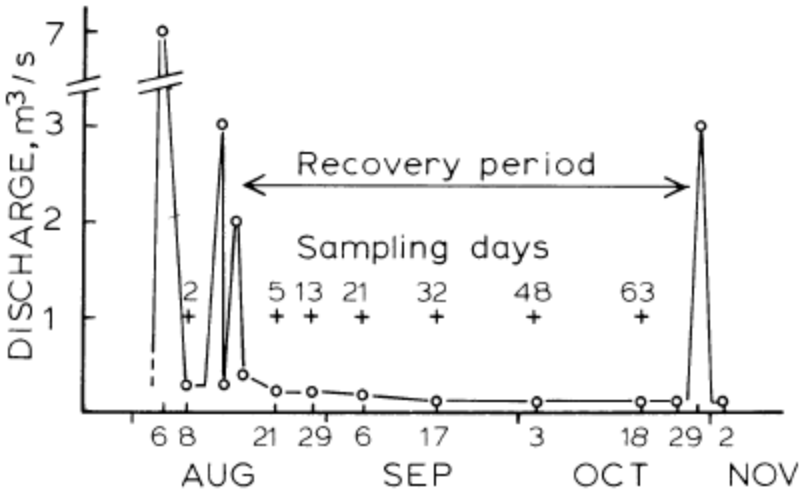

The chase begins.
HARRISON FORD
IS THE FUGITIVE

Succession in rivers

Succession – predictable changes in community following disturbance or creation of new habitat

What do you expect to happen in streams?

Rapid recovery after disturbance



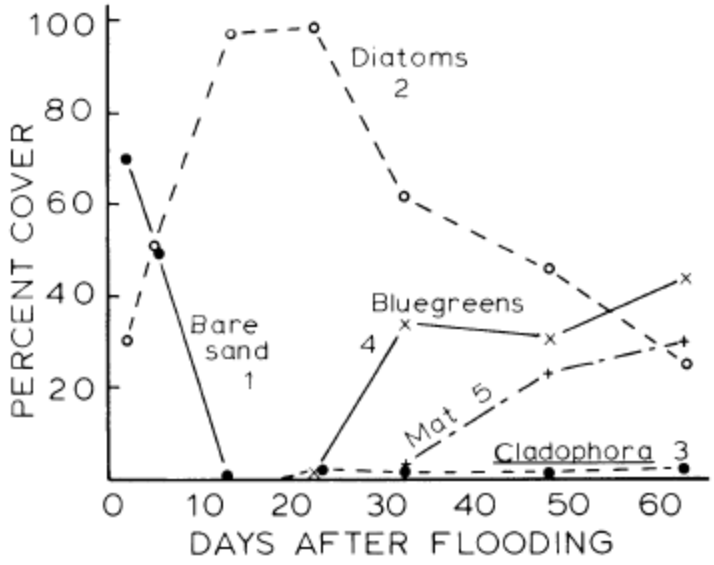


FIG. 3. Percent cover of algal patch types following flooding.

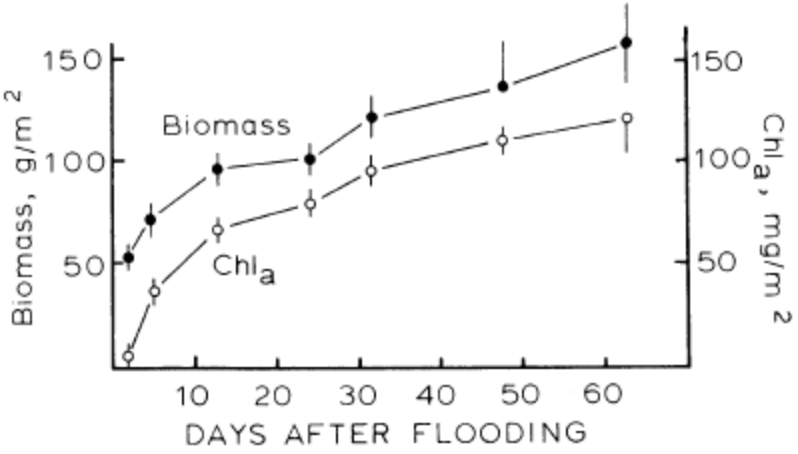


FIG. 4. Recovery of mean biomass and chlorophyll *a* after flooding. "Biomass" is determined as ash-free dry mass and thus includes living and nonliving organic matter. (± 1 SE).

Rapid recovery after disturbance

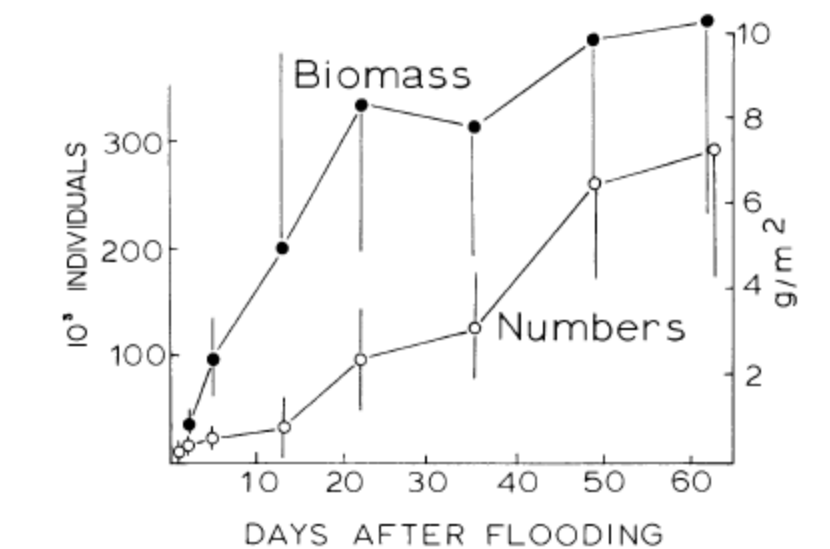


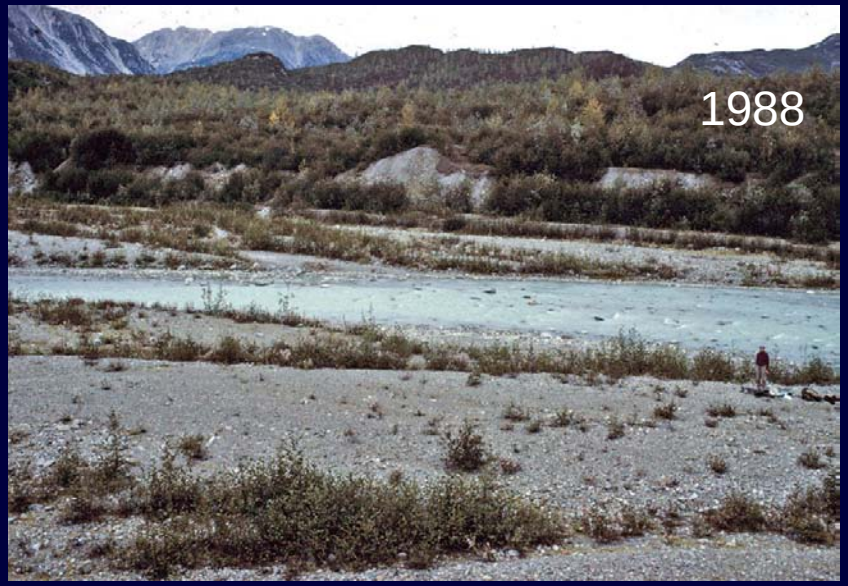
FIG. 6. Changes in mean invertebrate numbers and biomass after flooding. (Vertical bars show 95% CI.)

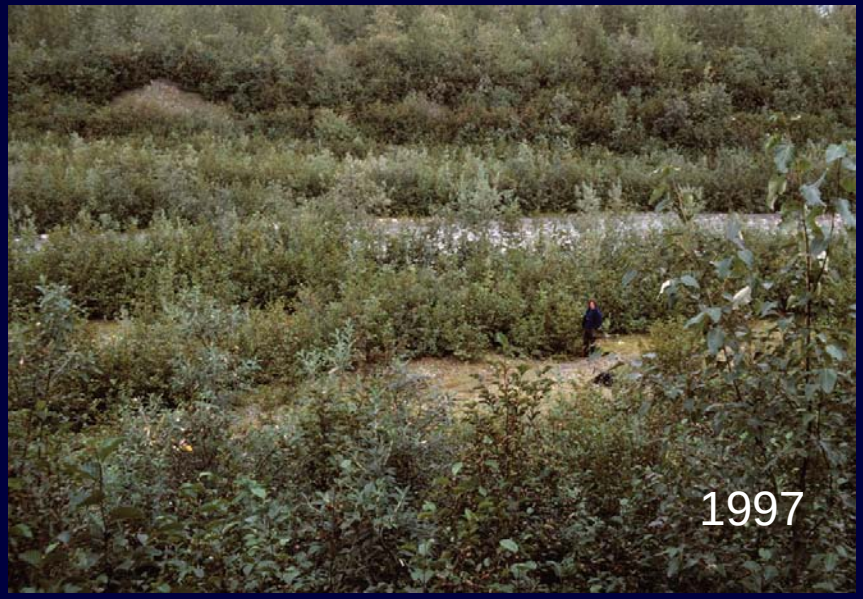
Small ephemeroptera, chironomids, beetles, simulidae flies colonize rapidly

Muir and Riggs Glaciers


CANADA
UNITED STATES
PACIFIC
MOUNTAINS
NATIONAL PARK
FAIRWEATHER RANGE
GLACIER BAY
BRADY ICEFIELD
BRADY GLACIER
ICY STRAIT
Mt. Quincy Adams 4161 13,650
Mt. Salisbury 3658 12,000
Mt. Cooper 2066 6780
Mt. Abbe 2657 8750
Mt. Bertha 3110 10,204
Mt. Crillon 3879 12,726
Mt. LaPerouse 3270 10,728
Mt. Wright 1566 5139
RUSSELL ISLAND
Wolf Point
Interglacial Forest Stumps
Muir Point
Tlingit Point
NORTH MARBLE ISLAND
SOUTH MARBLE ISLAND
DRAKE ISLAND
FRANCIS ISLAND
WILLOUGHBY ISLAND
BEARDSLEE ISLANDS
Visitor Center
Glacier Bay Lodge
Park Headquarters
Campground
Airport
Gustavus
15.0 km 9.3 mi.
PLEASANT ISLAND
LEMESURIER ISLAND
Icy Point
Tarr Inlet
Muir Inlet
Wachusett Inlet
Adams Inlet
Tidal Inlet
Queen Inlet
Rendu Inlet
Hugh Miller Inlet
Geikie Inlet
Johns Hopkins Glacier
Carroll Glacier
Muir Glacier
Riggs Glacier
Casement Glacier
McBride Glacier
Cushing Glacier
Margerie Glacier
Lamplugh Glacier
Reid Glacier
1794
1750–1780
1860
1857
1845
1892
1879
1907
1929
1966
1961

Wolf Point Creek





Long-term assembly at Wolf Point Creek

First non-flying invert.

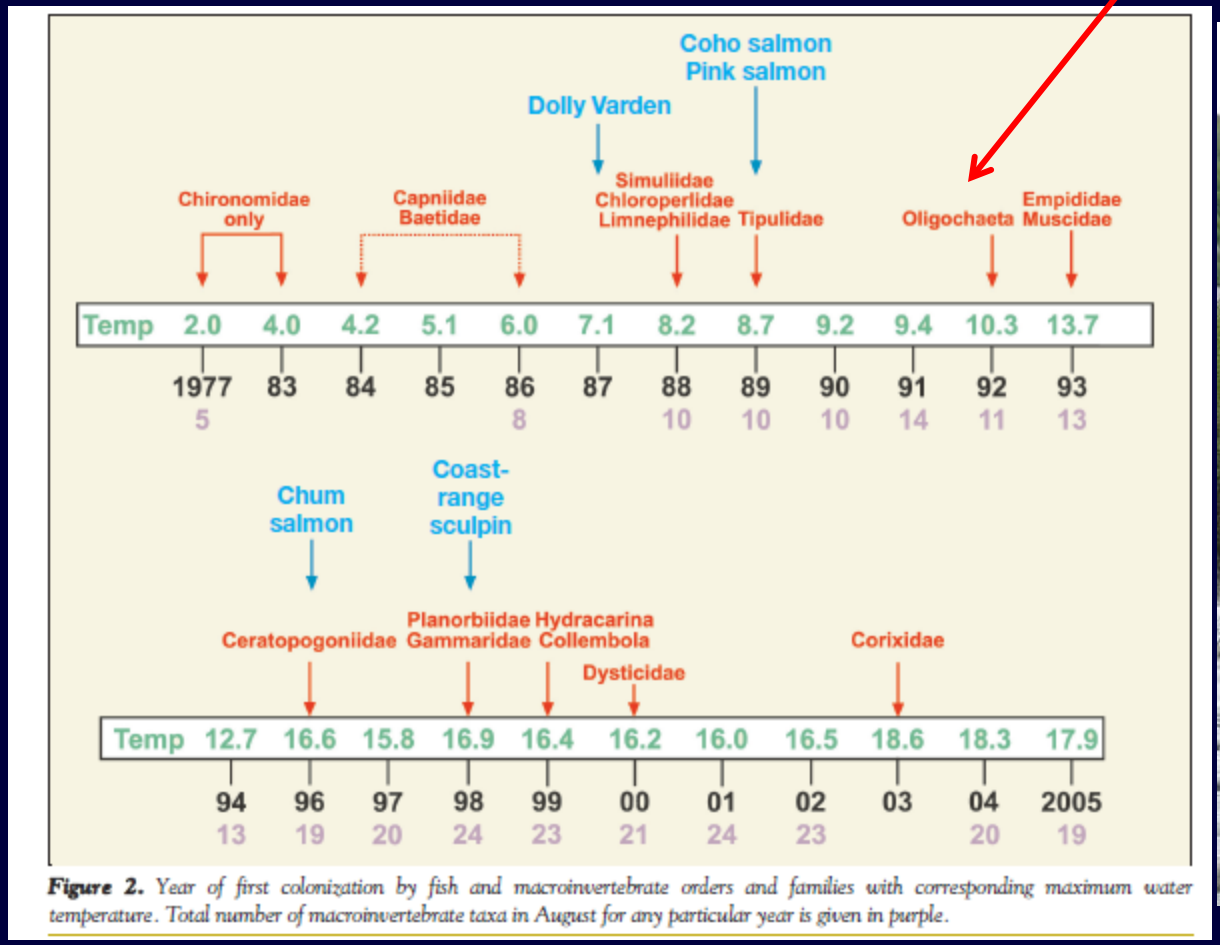
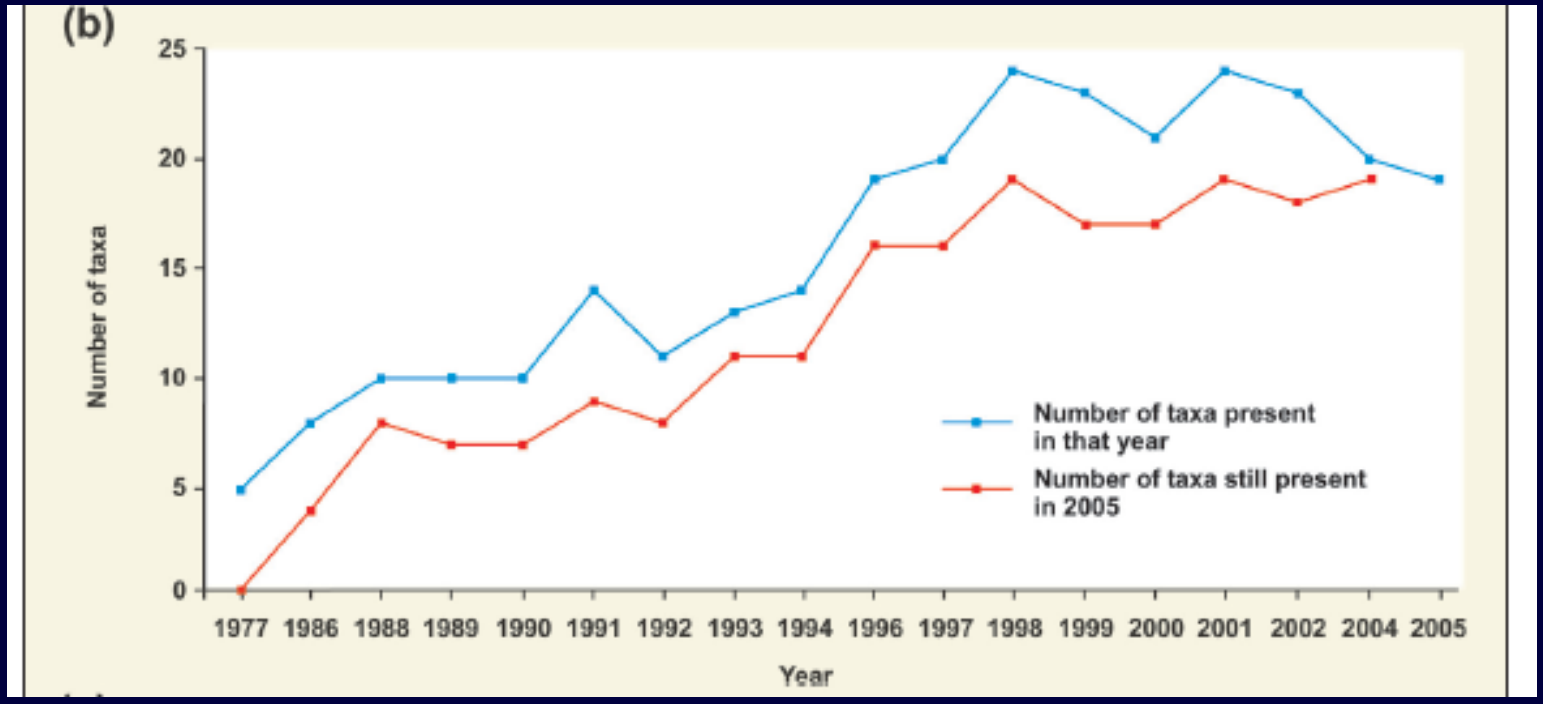


Figure 2. *Year of first colonization by fish and macroinvertebrate orders and families with corresponding maximum water temperature. Total number of macroinvertebrate taxa in August for any particular year is given in purple.*

Wolf Point Creek

Major groups still colonizing after 30 years



Food Webs

Broadstone stream

One of best understood streams in world

Woodward et al. 2005 AER

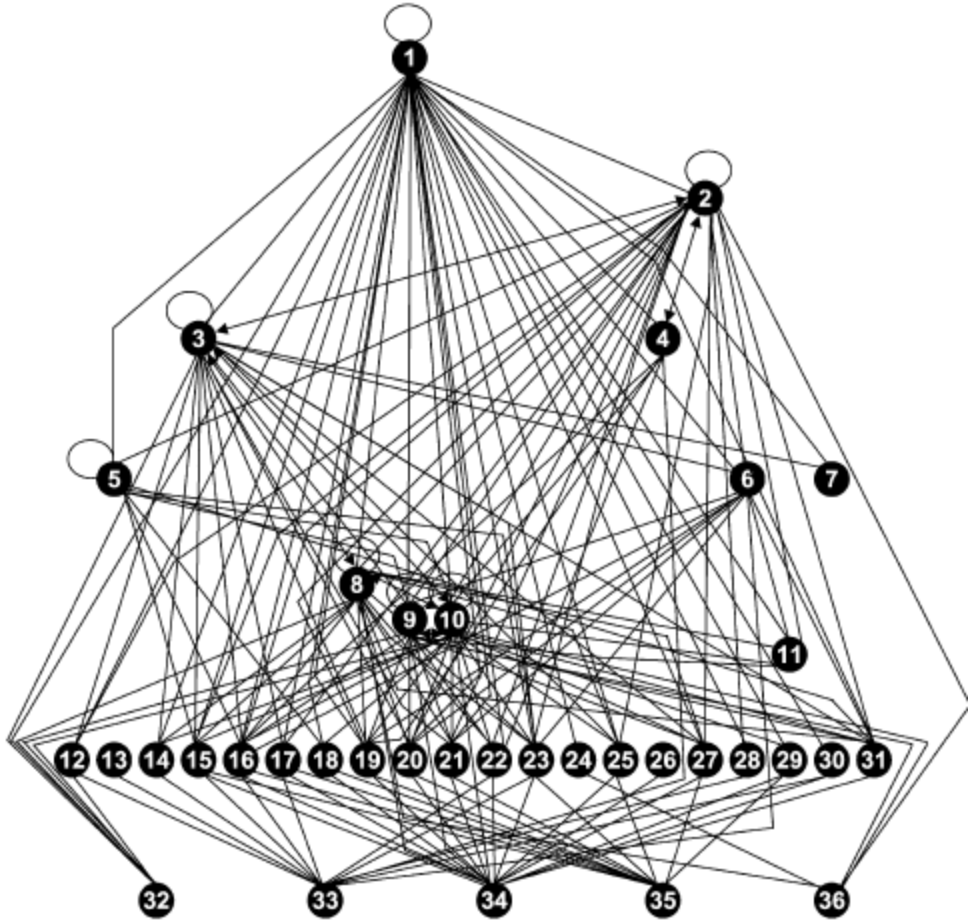


Figure 2 Summary connectance food web for the macrofaunal assemblage of Broadstone Stream (1996–1997). Double-headed arrows depict mutual predation, circular arrows cannibalism. Key to species: 1. *Cordulegaster boltonii* (Donovan); 2. *Sialis fuliginosa* Pict; 3. *Plectrocnemia conspersa* (Curtis); 4. *Pedicia* sp.; 5. *Siphonoperla torrentium* (Pictet); 6. *Dicranota* sp.; 7. *Platambus maculatus* (Pictet); 8. *Macropelopia nebulosa* (Meigen); 9. *Zavrelimyia barbatipes* (Kieffer); 10. *Trissopelopia longimana* (Staeger); 11. *Bezzia* sp.; 12. *Potamophylax cingulatus* (Stephens); 13. *Adicella reducta* (McLachlan); 14. Tipulidae (non-predatory); 15. *Nemurella pictetii* Klapalek; 16. *Leuctra nigra* (Olivier); 17. *Leuctra hippopus* Kempny; 18. *Corynoneura lobata* Edwards; 19. *Prodiamesa olivacea* (Meigen); 20. *Heterotrissocladius marcidus* (Walker); 21. *Micropsectra bidentata* (Goetghebuer); 22. *Brillia modesta* (Meigen); 23. *Polypedilum albicorne* grp.; 24. *Paraleptophlebia submarginata* (Stephens); 25. oligochaetes; 26. *Pisidium* sp.; 27. *Simulium* sp.; 28. Helodidae sp.; 29. *Niphargus aquilex* Schiödte; 30. *Asellus meridianus* Racovitza; 31. cyclopoids; 32. Terrestrial invertebrates; 33. CPOM; 34. FPOM; 35. Iron bacteria; 36. Algae.

Food Webs

Food web interactions change through time

Many weak interactions at any given point

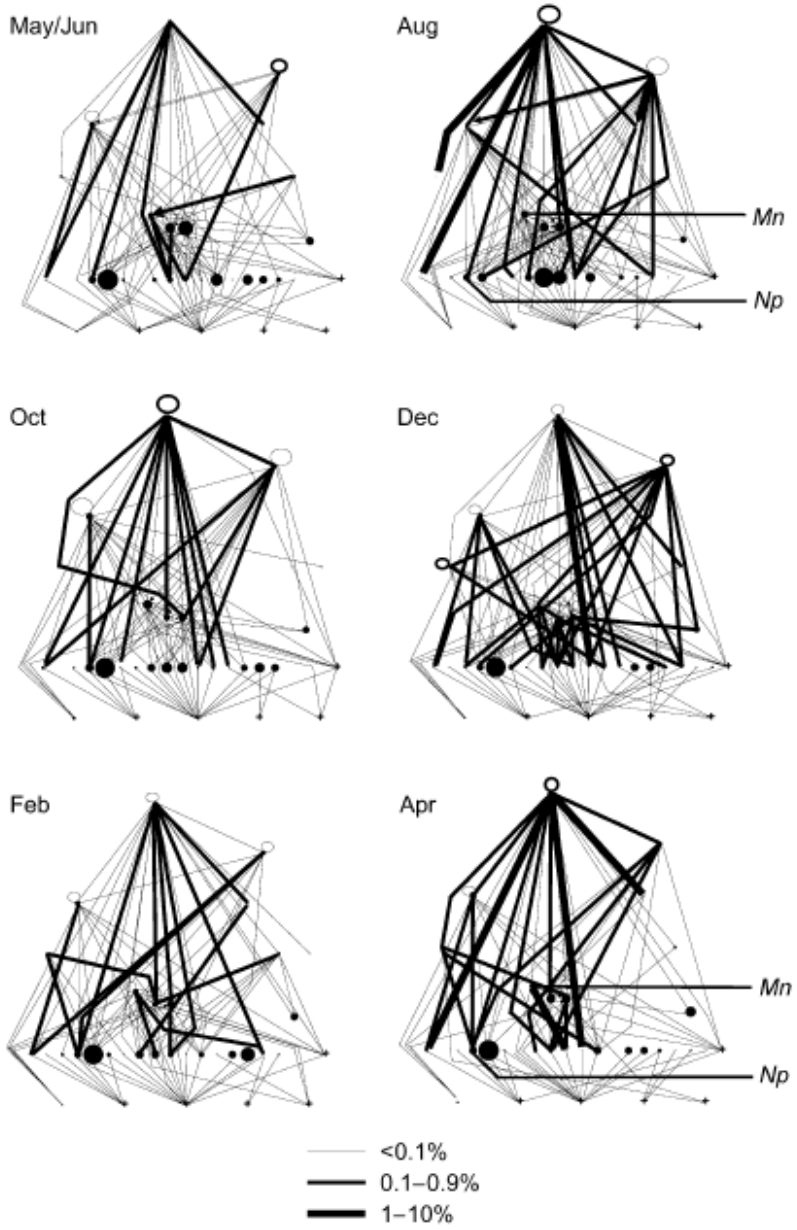


Figure 7 Quantified food webs representing numbers of macrofaunal prey (individuals > 10 μg) eaten *per capita* 24 h^{-1} (as a percent of numbers m^{-2}) during 1996–1997. The area of each circle is proportional to total numerical standing stock within sampling occasions (see Fig. 5 for absolute values). Links to basal resources and the meiofaunal cyclopoids were not quantified (see Fig. 2 for comparison with connectance web and identity of taxa).

Food Webs

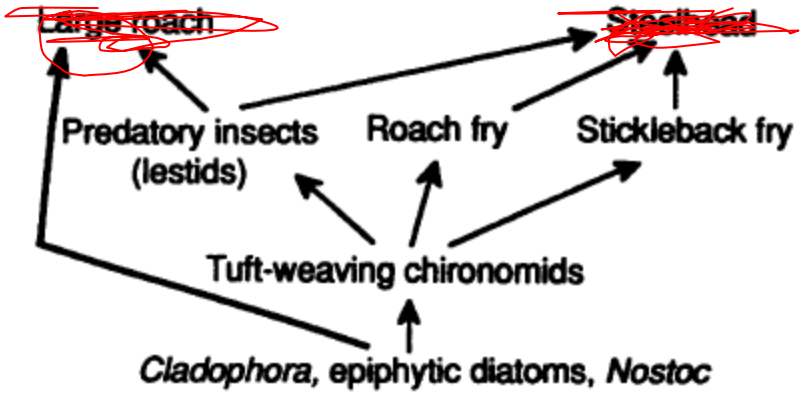
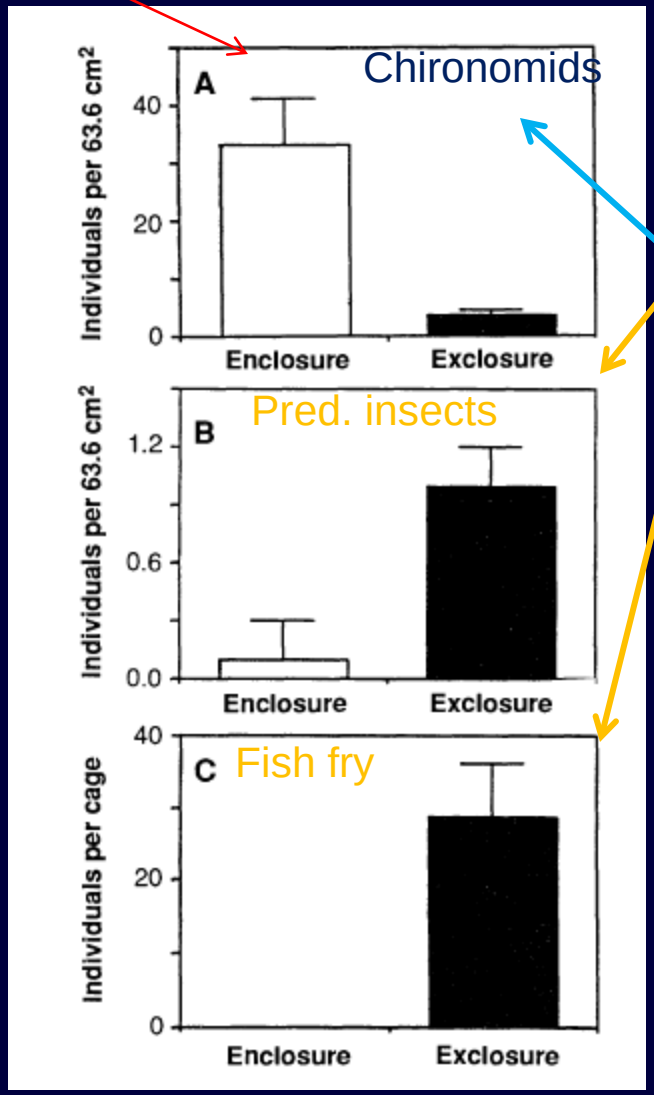


Fig. 2. Trophic relations of dominant biota in and around algal turfs during the summer low-flow period. Arrows point from prey to their consumers.

Power 1990

Food Webs

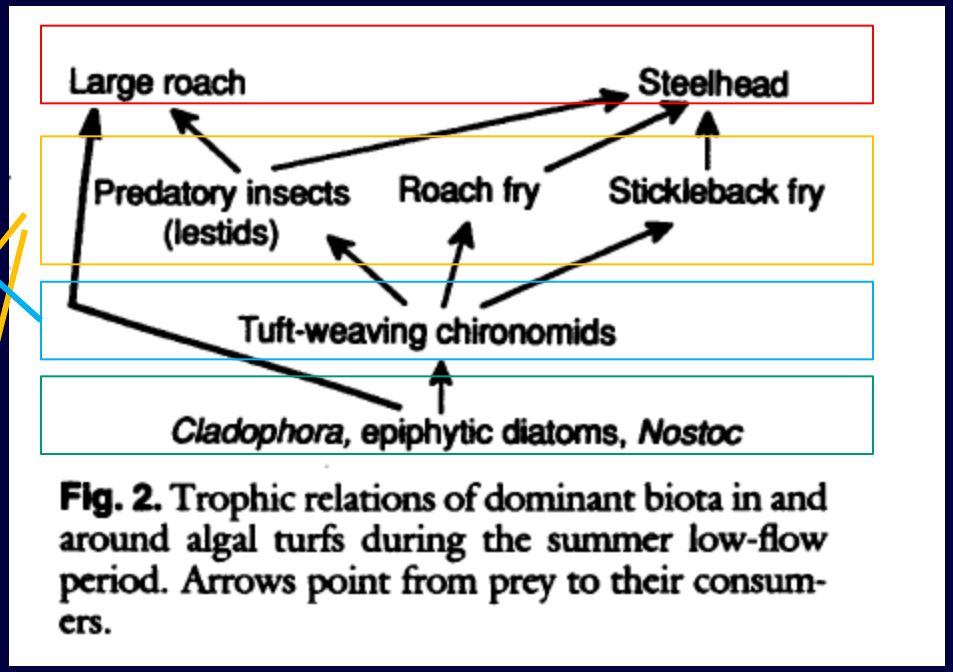
With fish



Chironomids

Pred. insects

Fish fry



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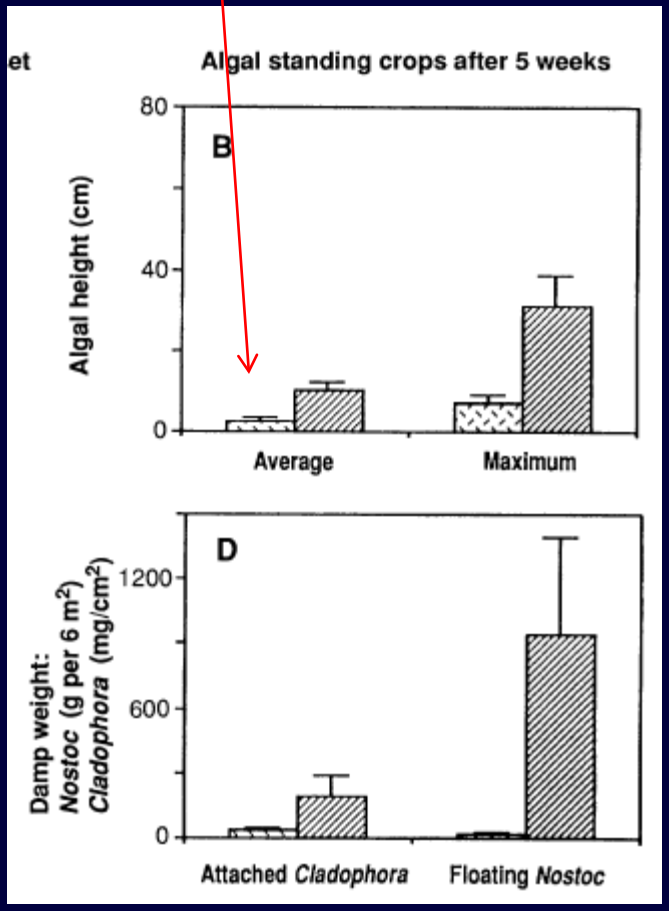
Food Webs

With fish



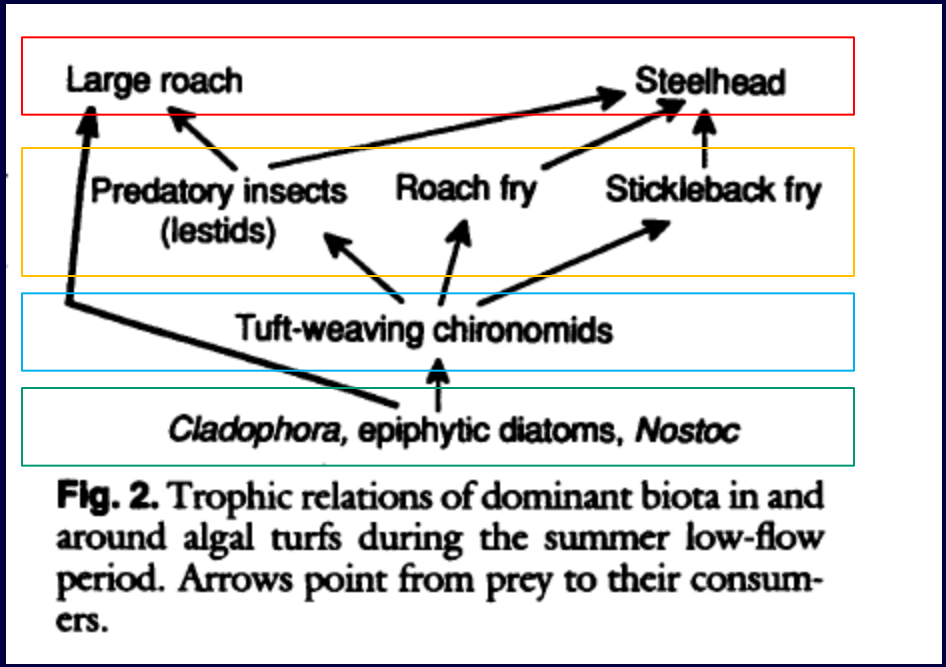


Fig. 2. Trophic relations of dominant biota in and around algal turfs during the summer low-flow period. Arrows point from prey to their consumers.

Odd food chain

Even food chain

Diversity patterns in streams



EPT index – Ephemeroptera – Plecoptera – Trichoptera

why these taxa?

Easily ID’d
Tend to be sensitive to human disturbance

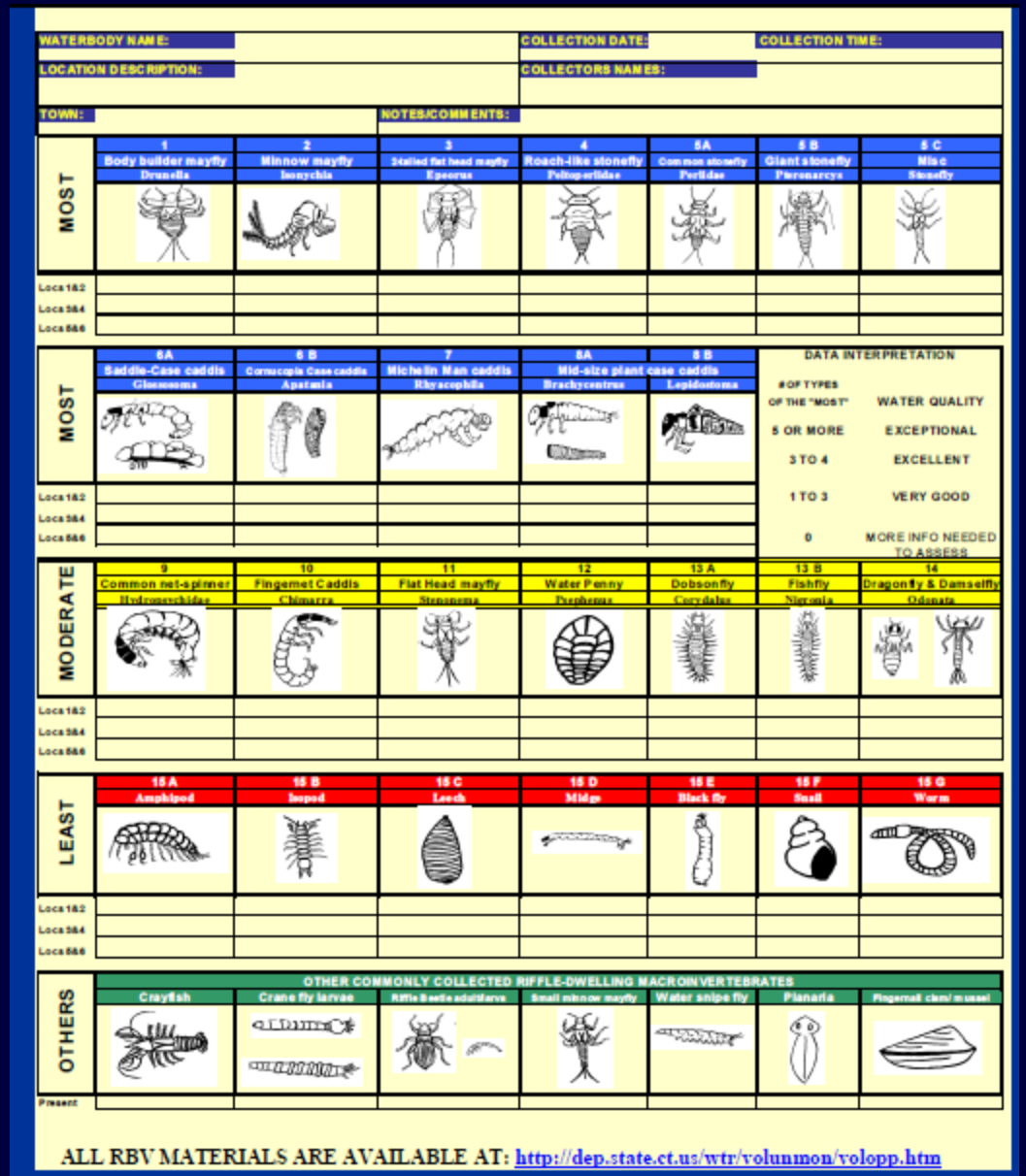
Diversity patterns in streams

Tolerance – ability to withstand (human) disturbance

Usually based on finding them in “healthy” habitats

What is “healthy”?

Should be based on eco-toxicology



Comparing stream & lake communities

	Small rivers	Large rivers	Ponds	Lakes
Macrophyte habitat				
Sediment stability				
Sediment loading				

Comparing stream & lake communities

	Small rivers	**Large rivers**	**Ponds**	**Lakes**
Macrophyte habitat	Low	Moderate	High	Moderate
Sediment stability				
Sediment loading				

Comparing stream & lake communities

	Small rivers	**Large rivers**	**Ponds**	**Lakes**
Macrophyte habitat	Low	Moderate	High	Moderate
Sediment stability	Low, catastrophic flooding	Low, shifting sands	High	High
Sediment loading				

Comparing stream & lake communities

	Small rivers	**Large rivers**	**Ponds**	**Lakes**
Macrophyte habitat	Low	Moderate	High	Moderate
Sediment stability	Low, catastrophic flooding	Low, shifting sands	High	High
Sediment loading	Low	High	Moderate	Low

Comparing stream & lake communities

	Small rivers	**Large rivers**	**Ponds**	**Lakes**
Benthic richness				
Important guilds				
Dominant food sources				

Comparing stream & lake communities

	Small rivers	**Large rivers**	**Ponds**	**Lakes**
Benthic richness	Low	High	High	Low
Important guilds				
Dominant food sources				

Comparing stream & lake communities

	Small rivers	**Large rivers**	**Ponds**	**Lakes**
Benthic richness	Low	High	High	Low
Important guilds	Shredders, collectors	Grazers, collectors	Grazers, collectors, shredders	Grazers, collectors, shredders
Dominant food sources				

Comparing stream & lake communities

	Small rivers	**Large rivers**	**Ponds**	**Lakes**
Benthic richness	Low	High	High	Low
Important guilds	Shredders, collectors	Grazers, collectors	Grazers, collectors, shredders	Grazers, collectors, shredders
Dominant food sources	CPOM, periphyton	FPOM	CPOM, periphyton, phytoplankton, macrophytes	CPOM, phytoplankton, macrophytes

Comparing stream & lake communities

	Small rivers	**Large rivers**	**Ponds**	**Lakes**
Benthic production				
Fish communities				
Fish production				

Comparing stream & lake communities

	Small rivers	**Large rivers**	**Ponds**	**Lakes**
Benthic production	Low	High	High	Low
Fish communities				
Fish production				

Comparing stream & lake communities

	Small rivers	**Large rivers**	**Ponds**	**Lakes**
Benthic production	Low	High	High	Low
Fish communities	Few	Many	Few	Many
Fish production				

Comparing stream & lake communities

	Small rivers	**Large rivers**	**Ponds**	**Lakes**
Benthic production	Low	High	High	Low
Fish communities	Few	Many	Few	Many
Fish production	Moderate	High	Low, moderate	Moderate