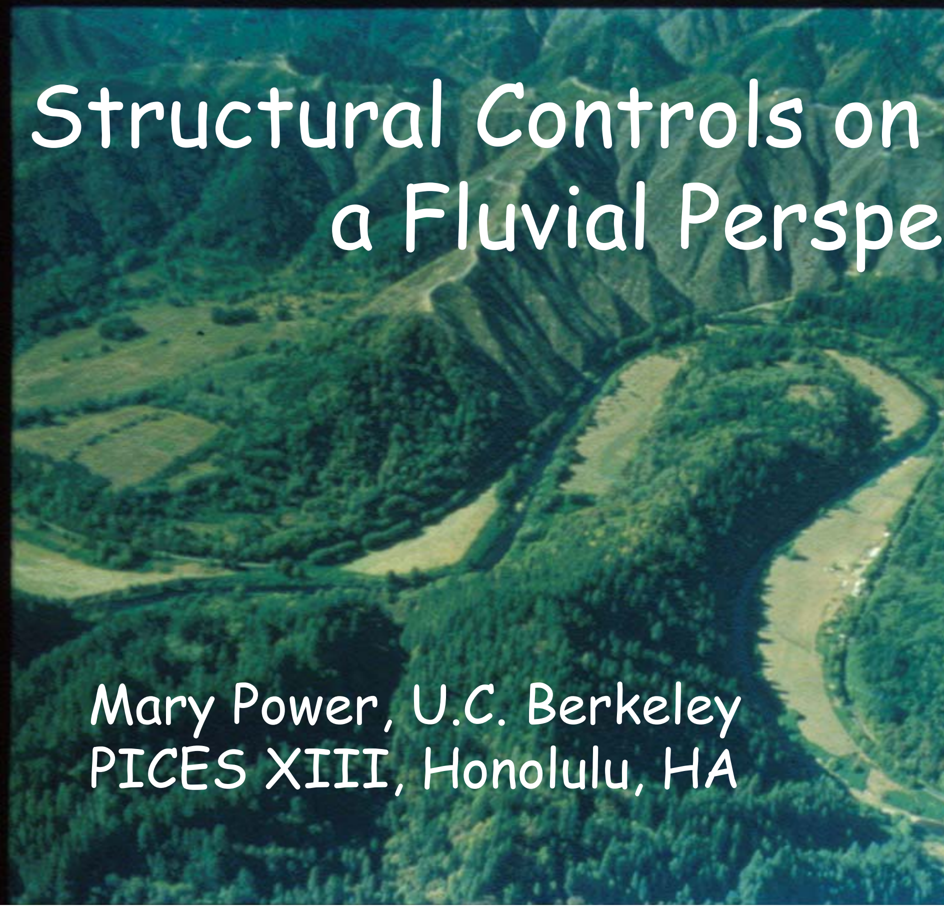
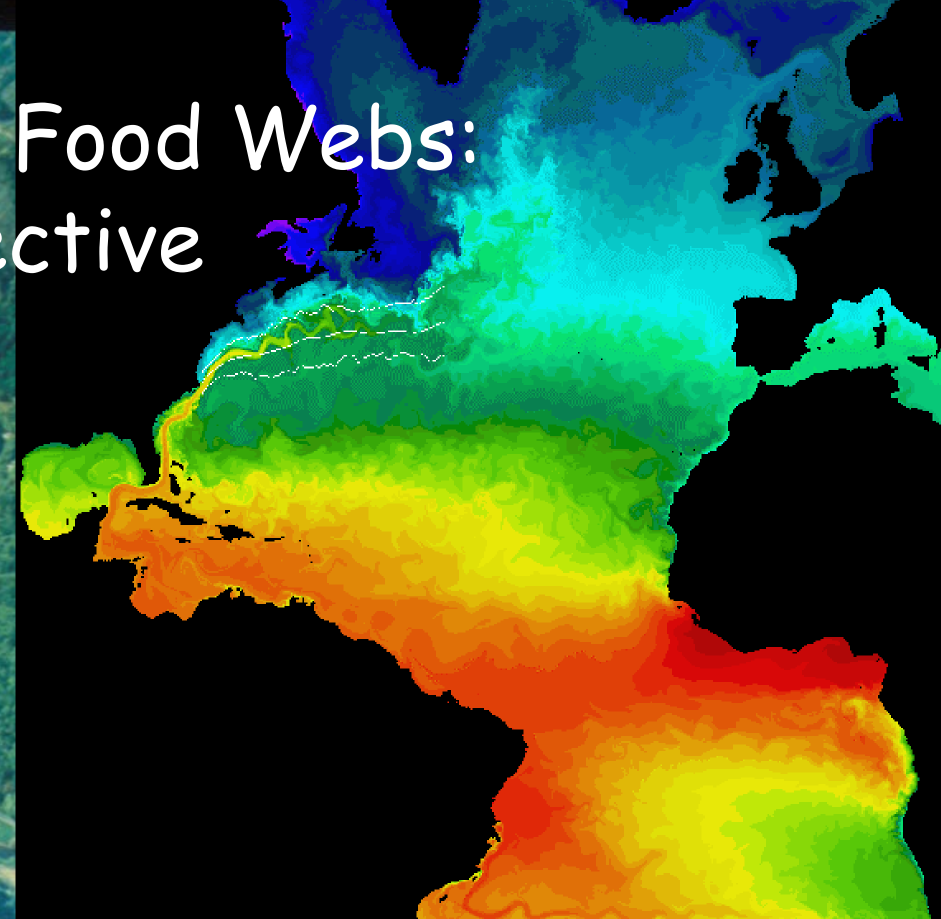
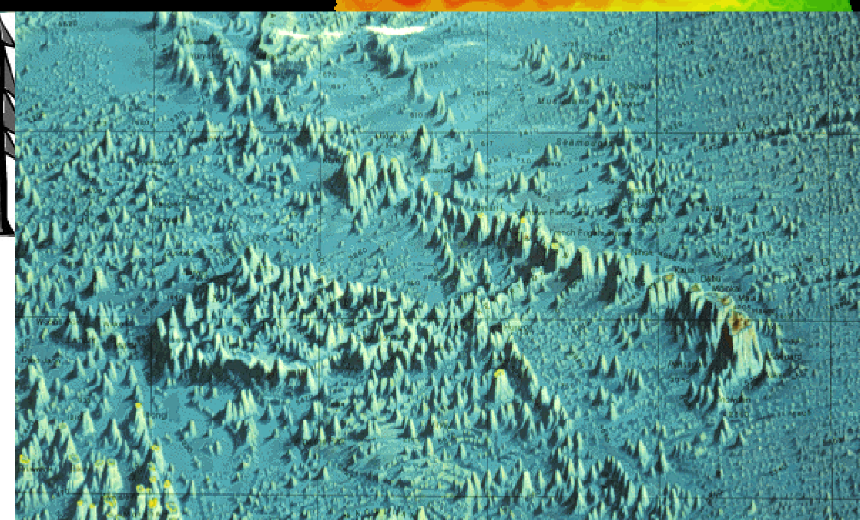
Structural Controls on Food Webs: a Fluvial Perspective

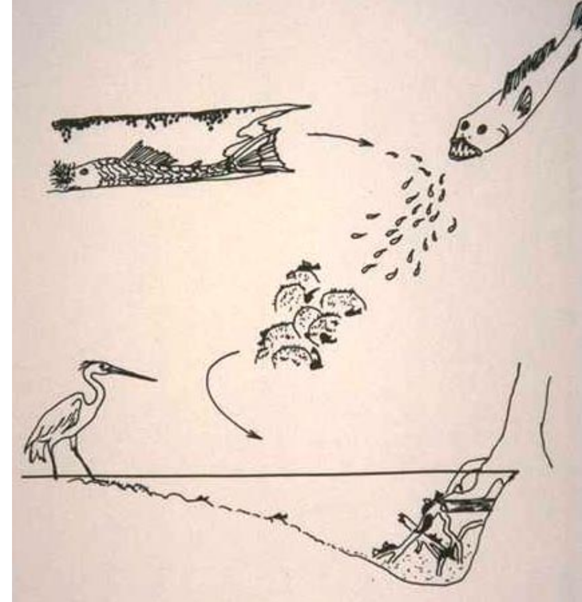




Mary Power, U.C. Berkeley
PICES XIII, Honolulu, HA



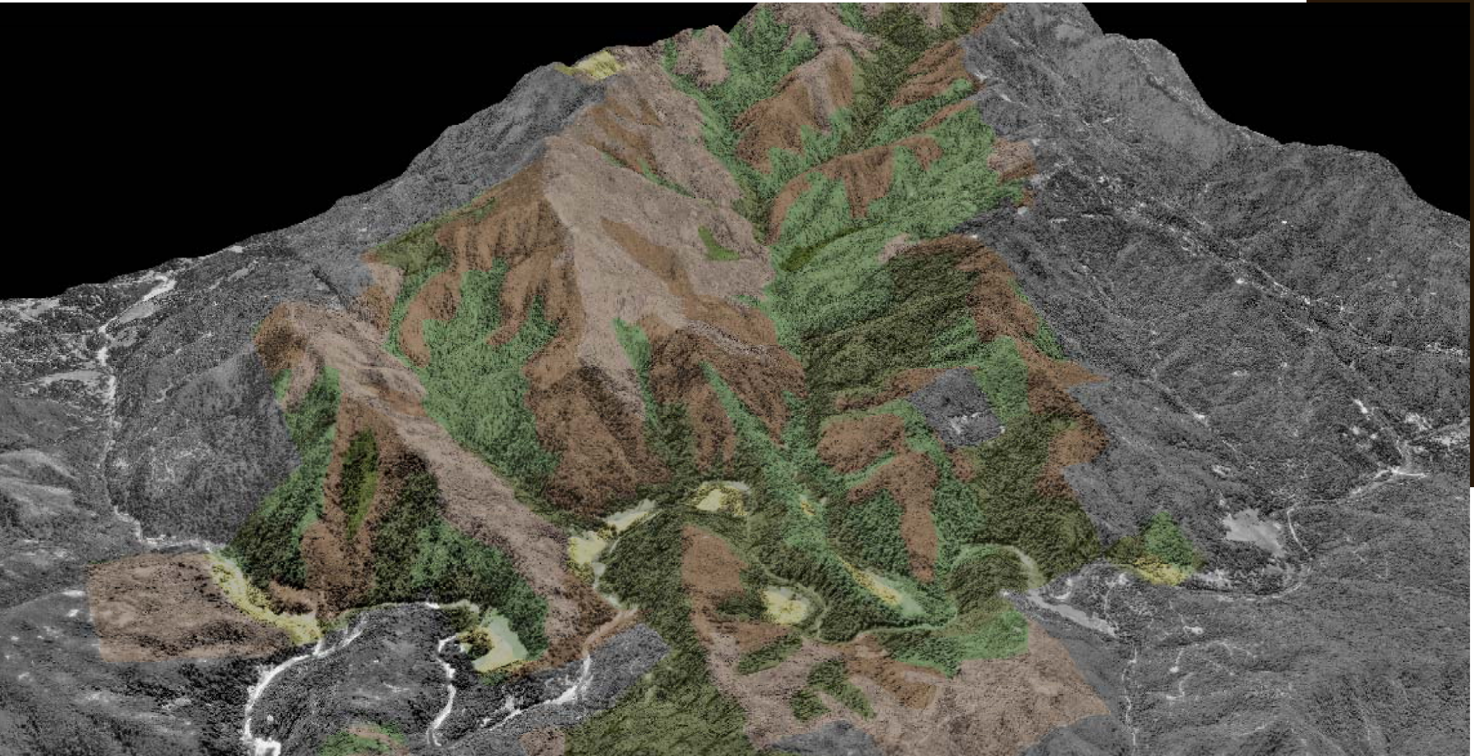
Wasp waists and beer bellies?



Size structure matters unless species has parental care

I. Grazer traits: large and armored vs small and vulnerable

II. Food web regime change down drainage networks



Eel River: **Grazing insects**

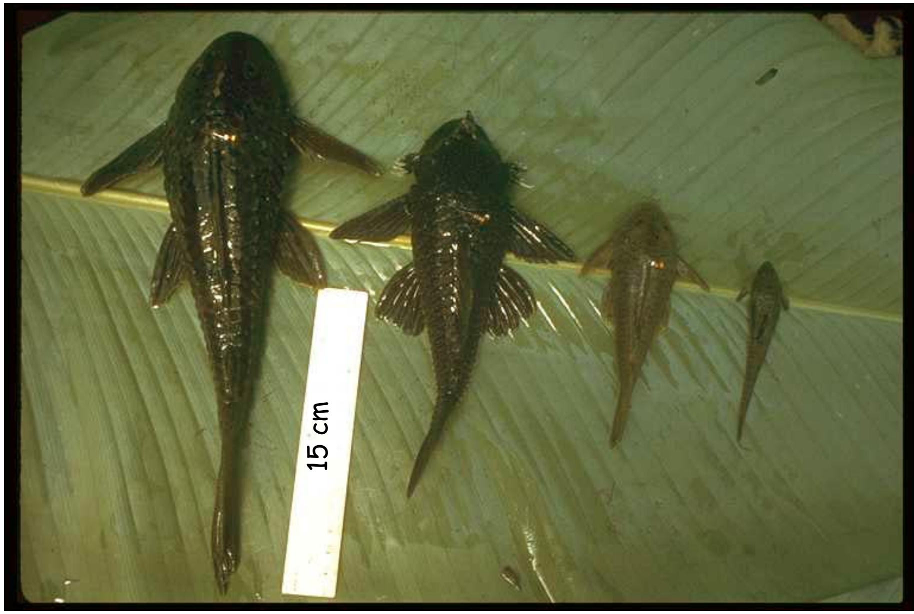
Ozark and prairie streams: snails and the grazing minnow, *Campostoma*

Rio Frijoles: four species of armored catfish

‘Replicate’ habitats (e.g. pools, riffles)

Repeated
reassembly of
webs following
flood scour or
dewatering

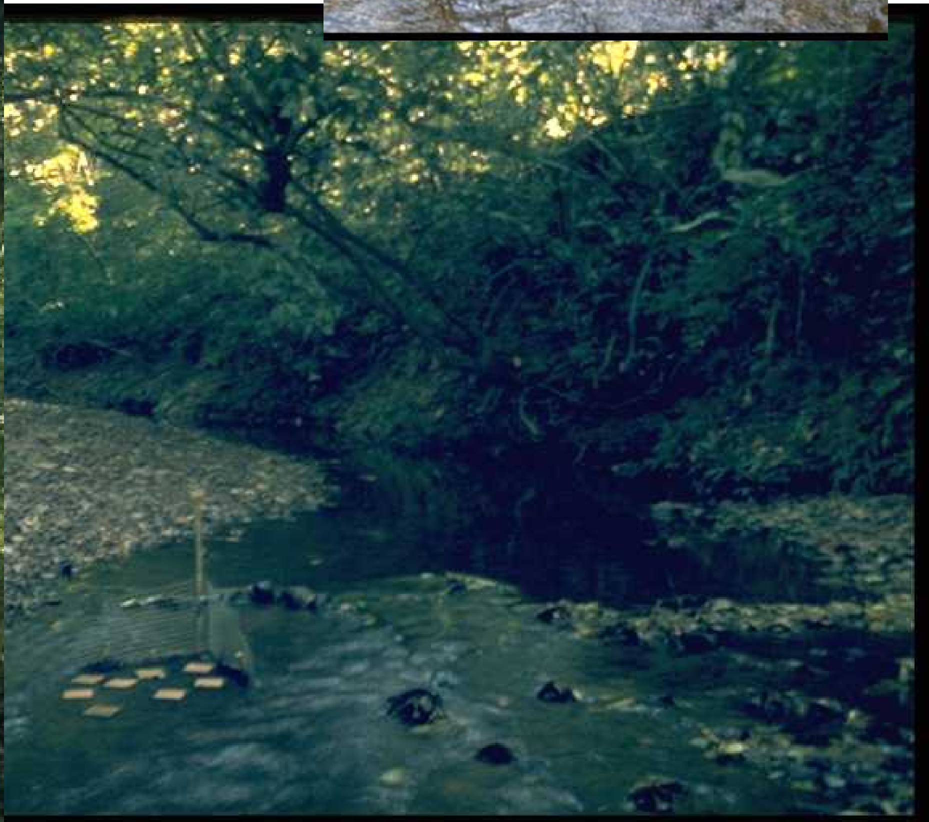
Dominant grazers: armored catfish



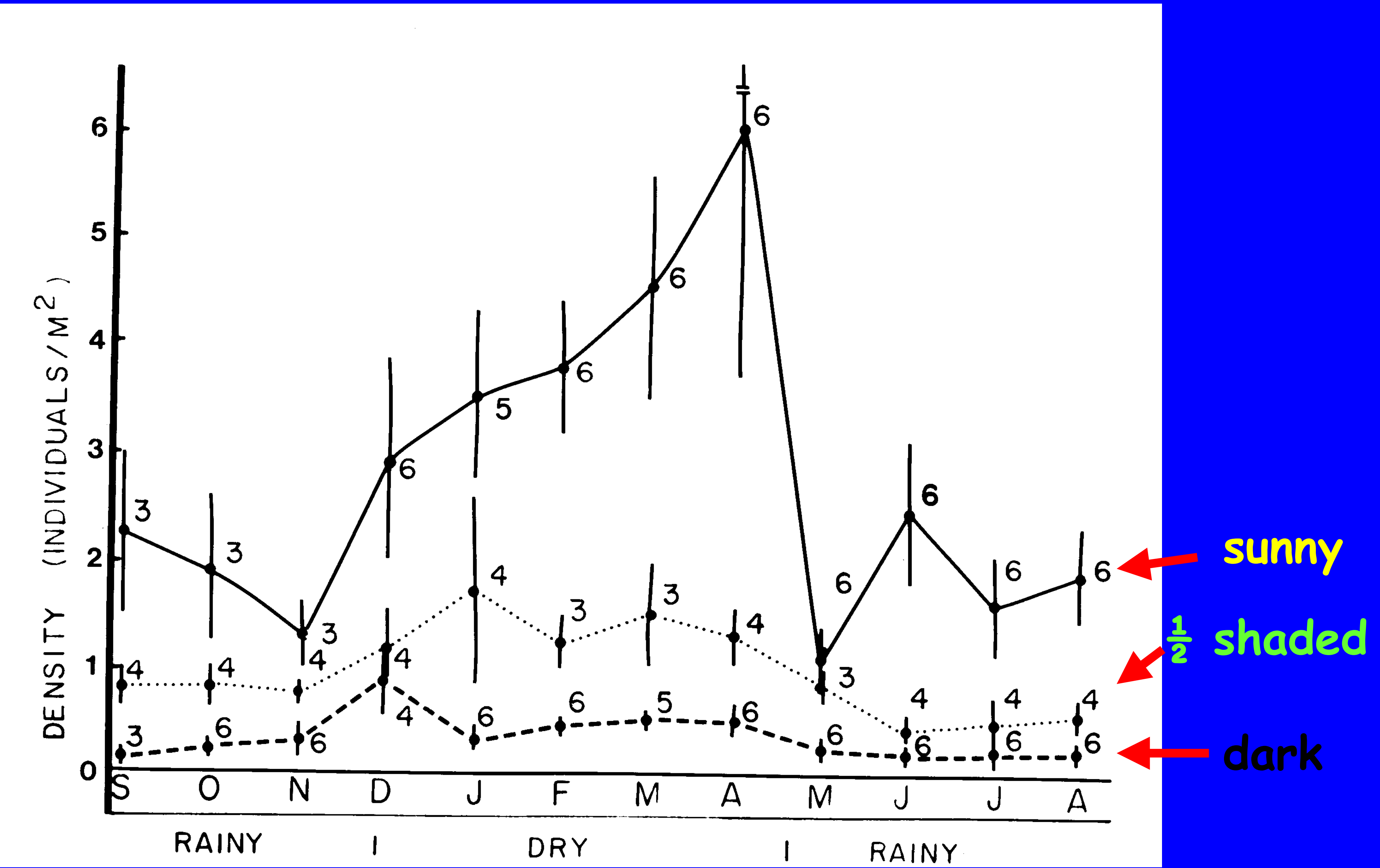
Hypostomus plecostomus, Ancistrus spinosus, Chaetostoma fischeri, Rineloricaria uracantha




Sunny vs dark pools: 16x variation in algal growth rates

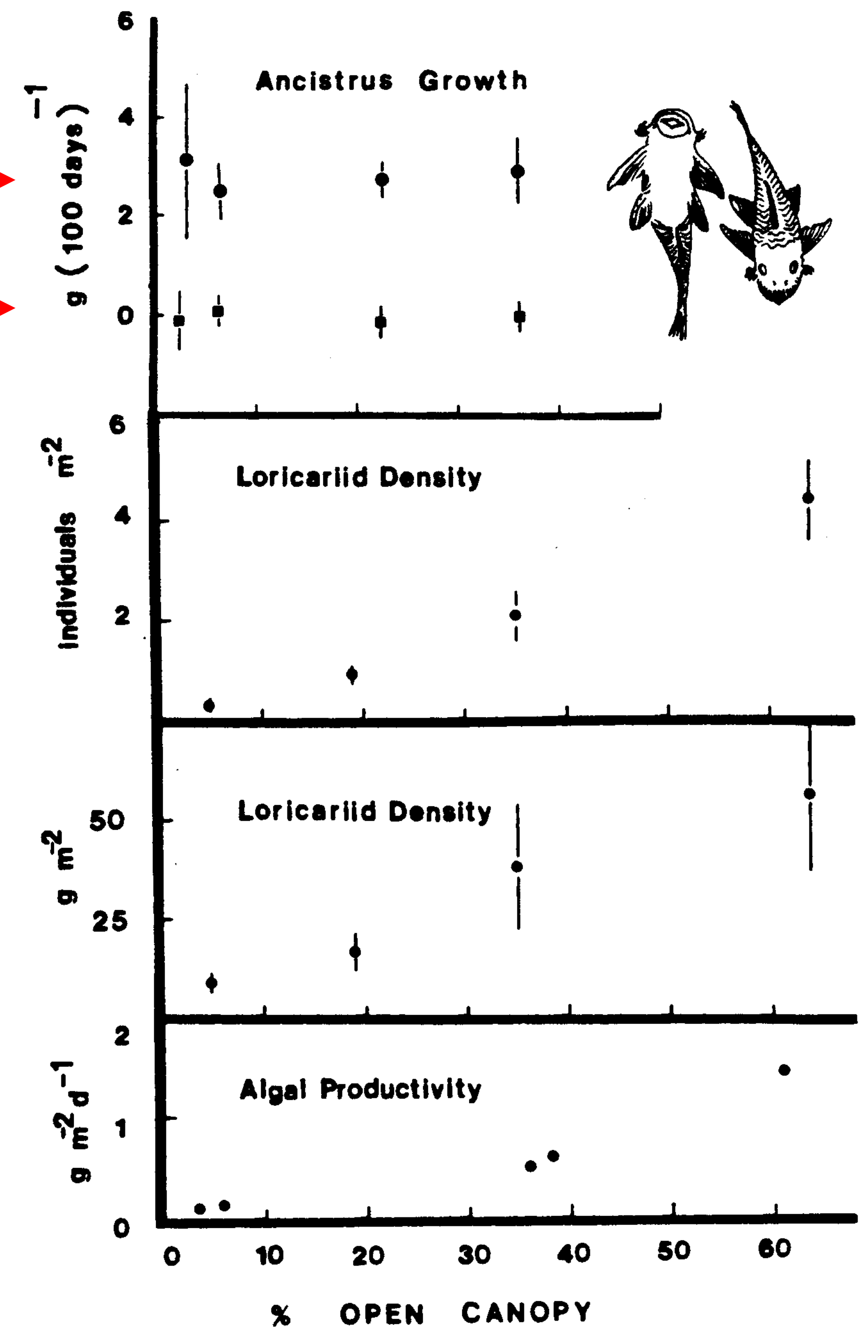


Loricariids were correspondingly denser in sunny pools



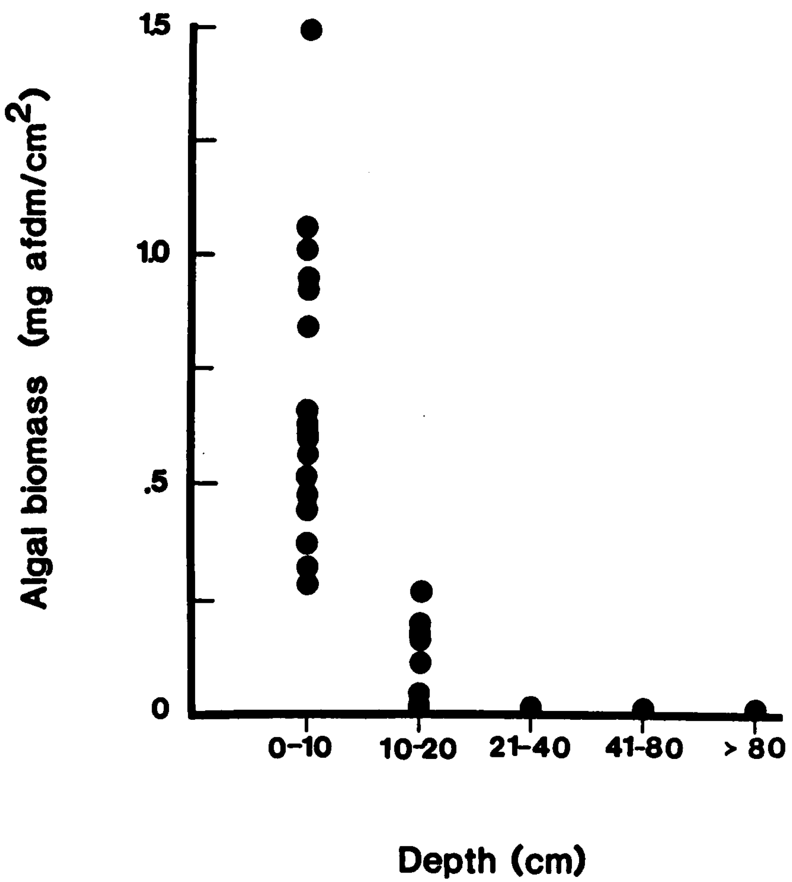
Rainy season

Dry season

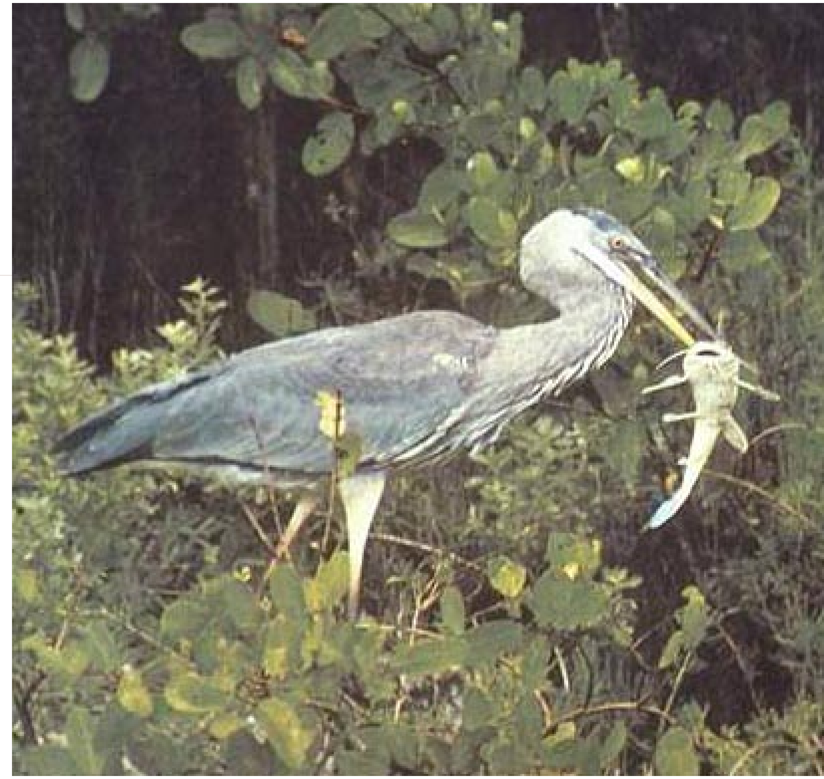


Pre-reproductive catfish also had similar growth and survival in dark, half-shaded, and sunny pools

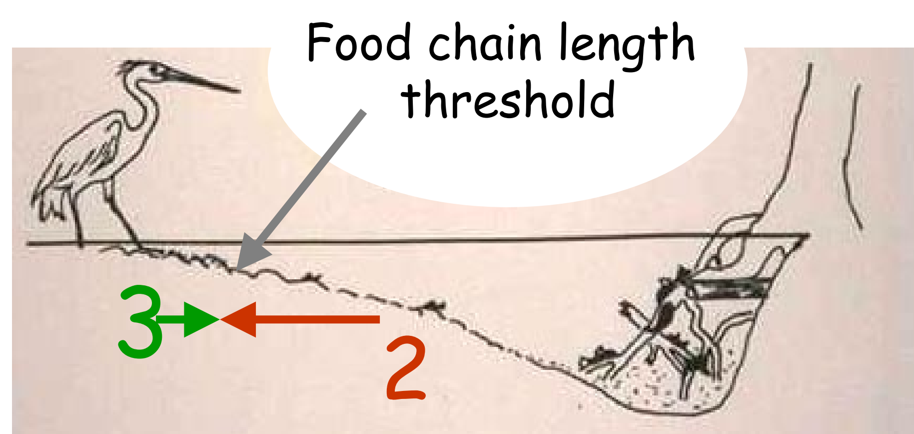
Despite the ability of loricariids to track, and therefore damp out, algal variation on a pool-to-pool scale, they did not track algal availability along depth gradients within pools.



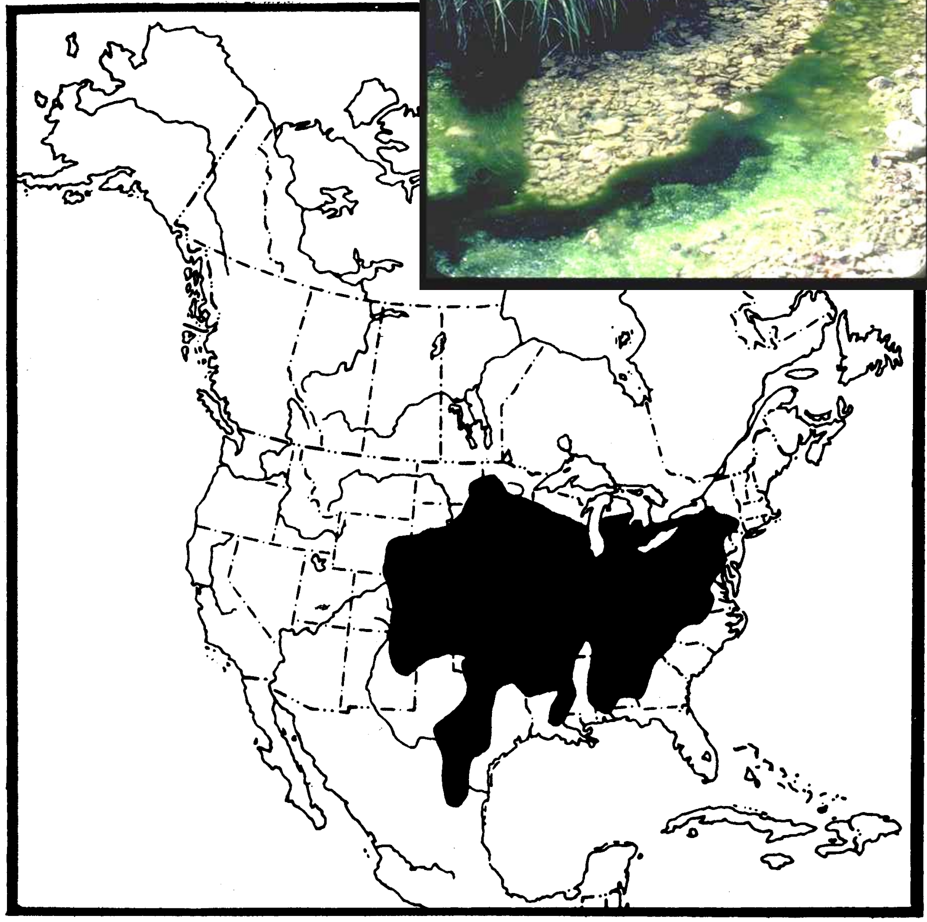
Large (hardened) loricariids outgrow most gape-limited aquatic predators…



but remain vulnerable to fishing birds and mammals, in shallow water



Grazing minnow, *Campostoma anomalum*

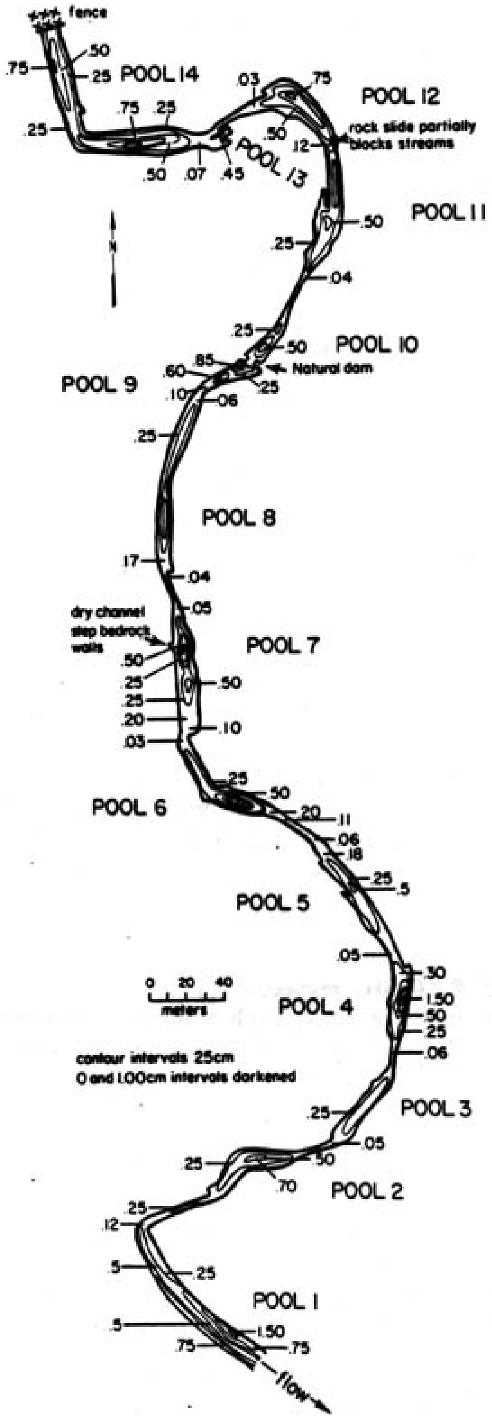


Brier Creek, south-central Oklahoma

Less pool-to-pool variation in primary productivity

In contrast to the Rio Frijoles, Brier Creek was uniformly sunny,

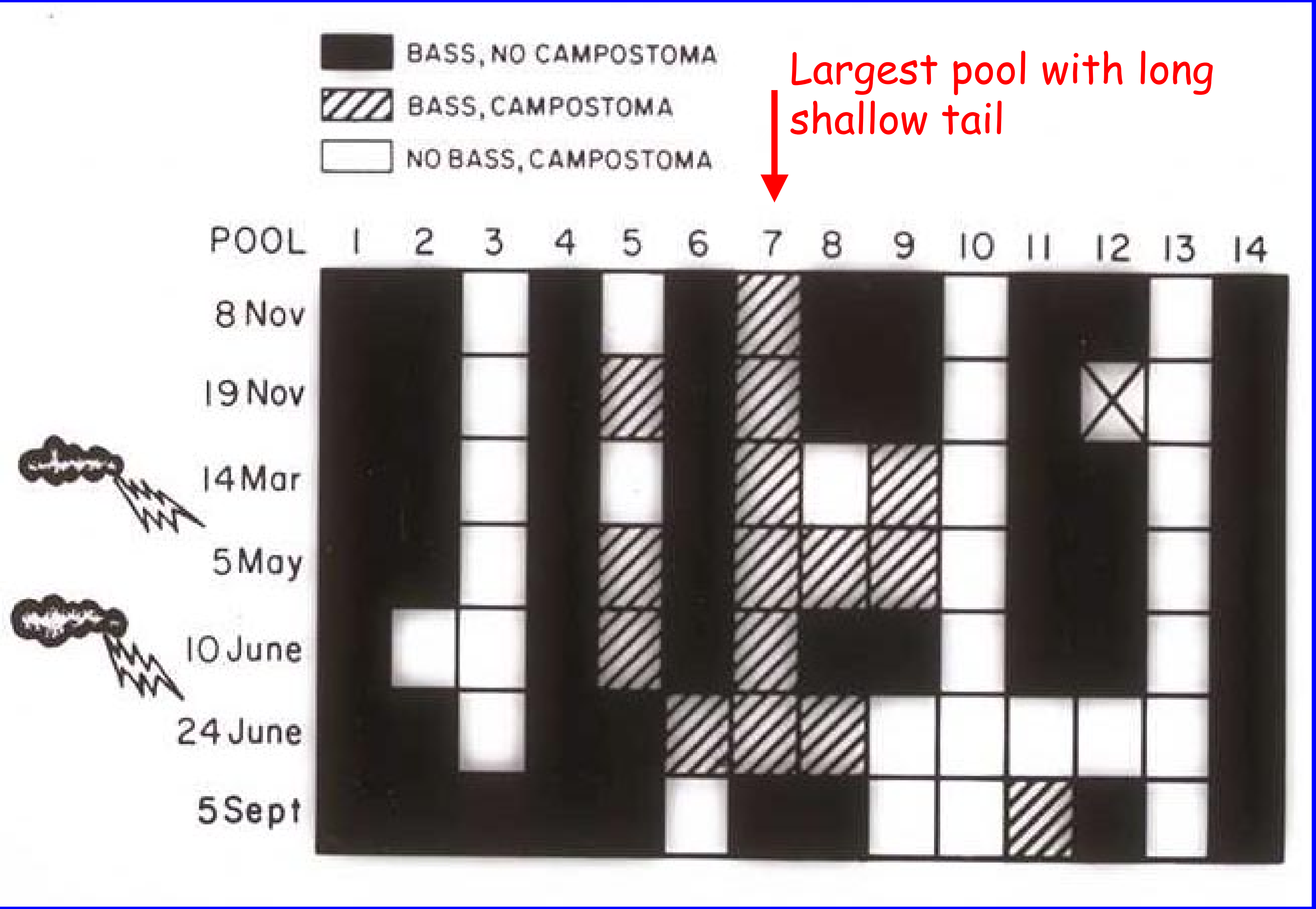
But had striking variation among pools in algal abundance



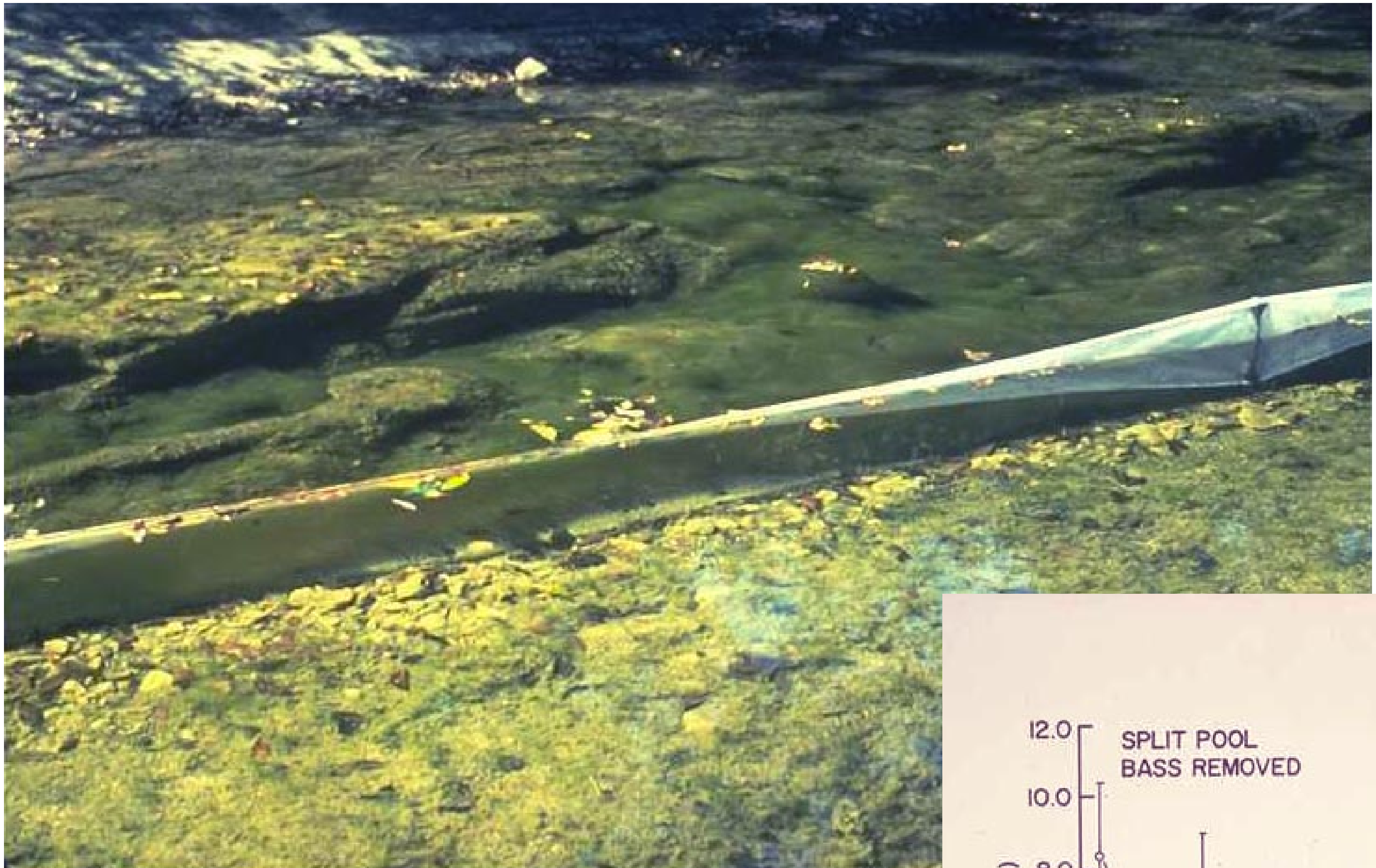
Micropterus salmoides, M. punctulatus

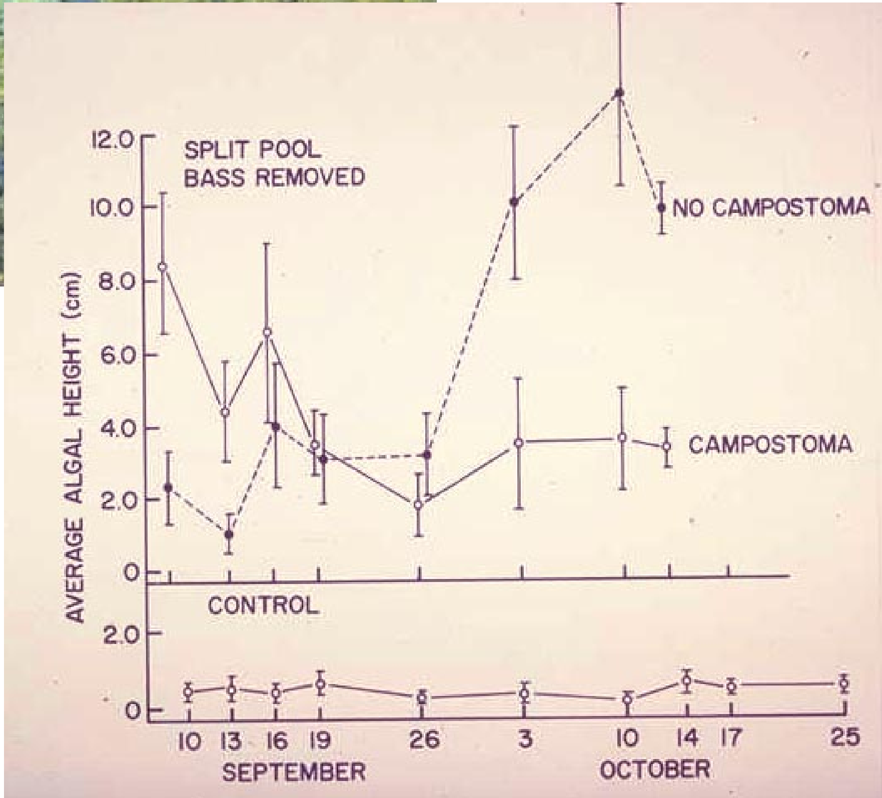
Homage to Estes...?

When floods re-arranged these players, the status of pools (green vs barren) sometimes changed but the reach scale pattern was maintained



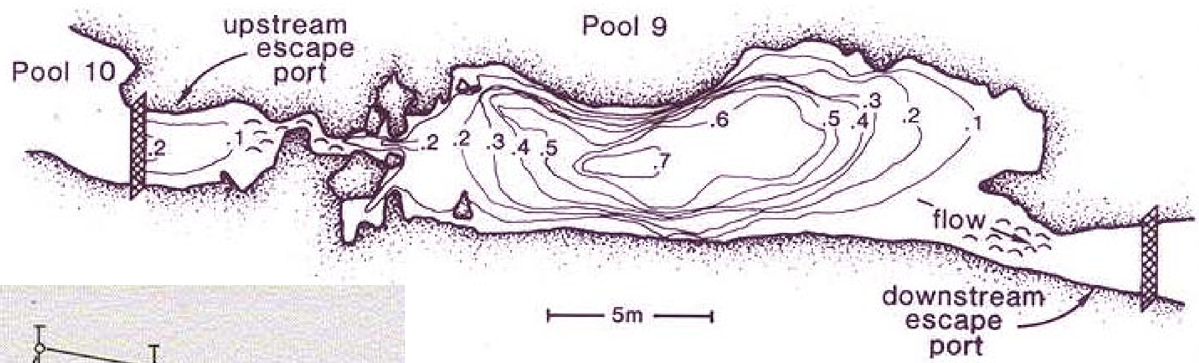
Split pool experiment: bass removed, Campostoma added to one side

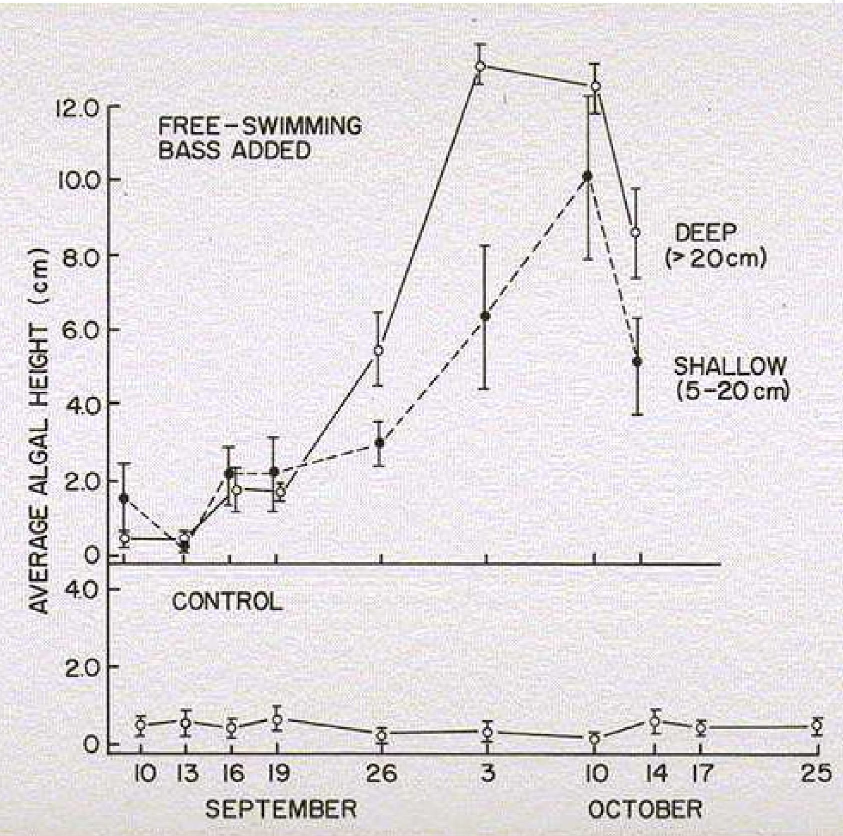




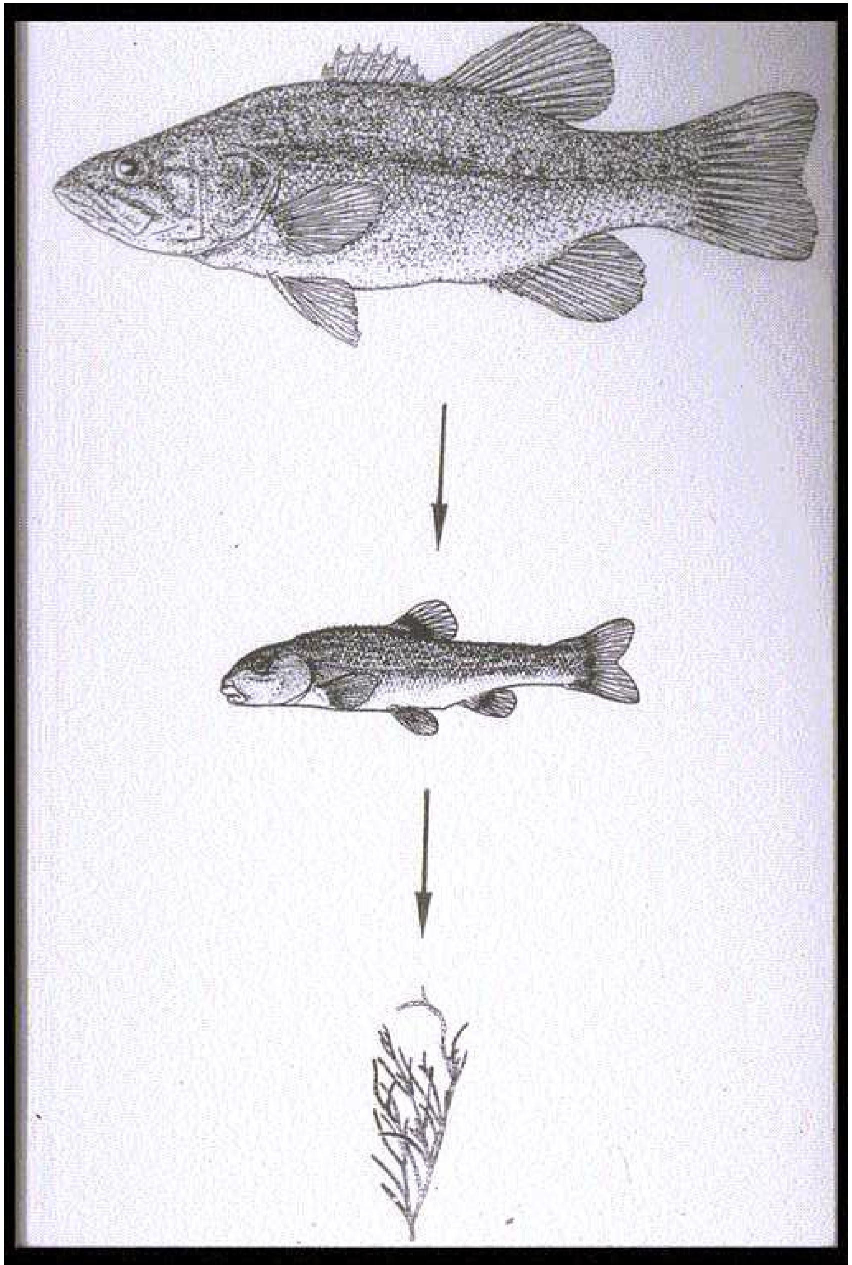
Within 5 weeks, the side to which we had added Campostoma was grazed to a barren state, while the side without the grazers remained green.

Bass addition experiment: Campostoma disappeared or emigrated. Algae recovered within 5 weeks. In one experimental run, ca. 50% of the drop in minnow numbers was due to emigration (predator avoidance).

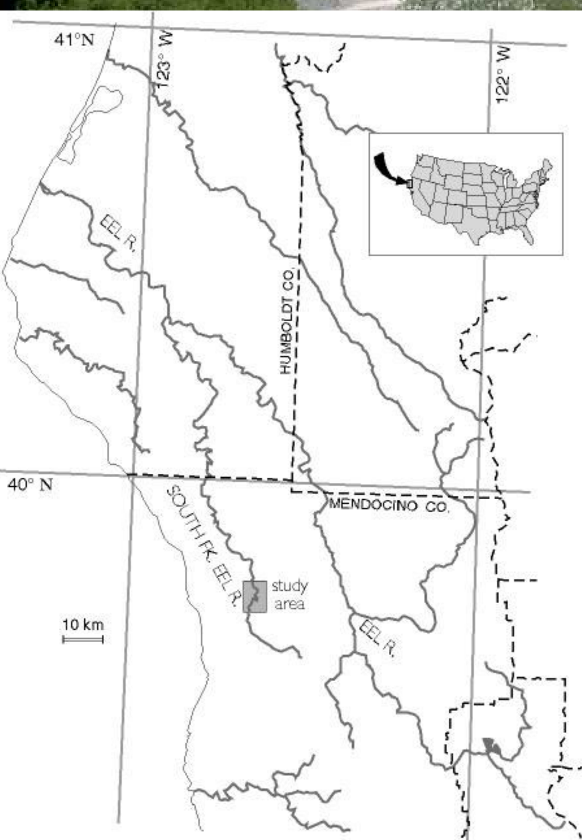




Pool-to-pool contrasts in algal states established by 2- vs 3-level food chains



Eel River, N. coastal CA: Mediterranean climate regime

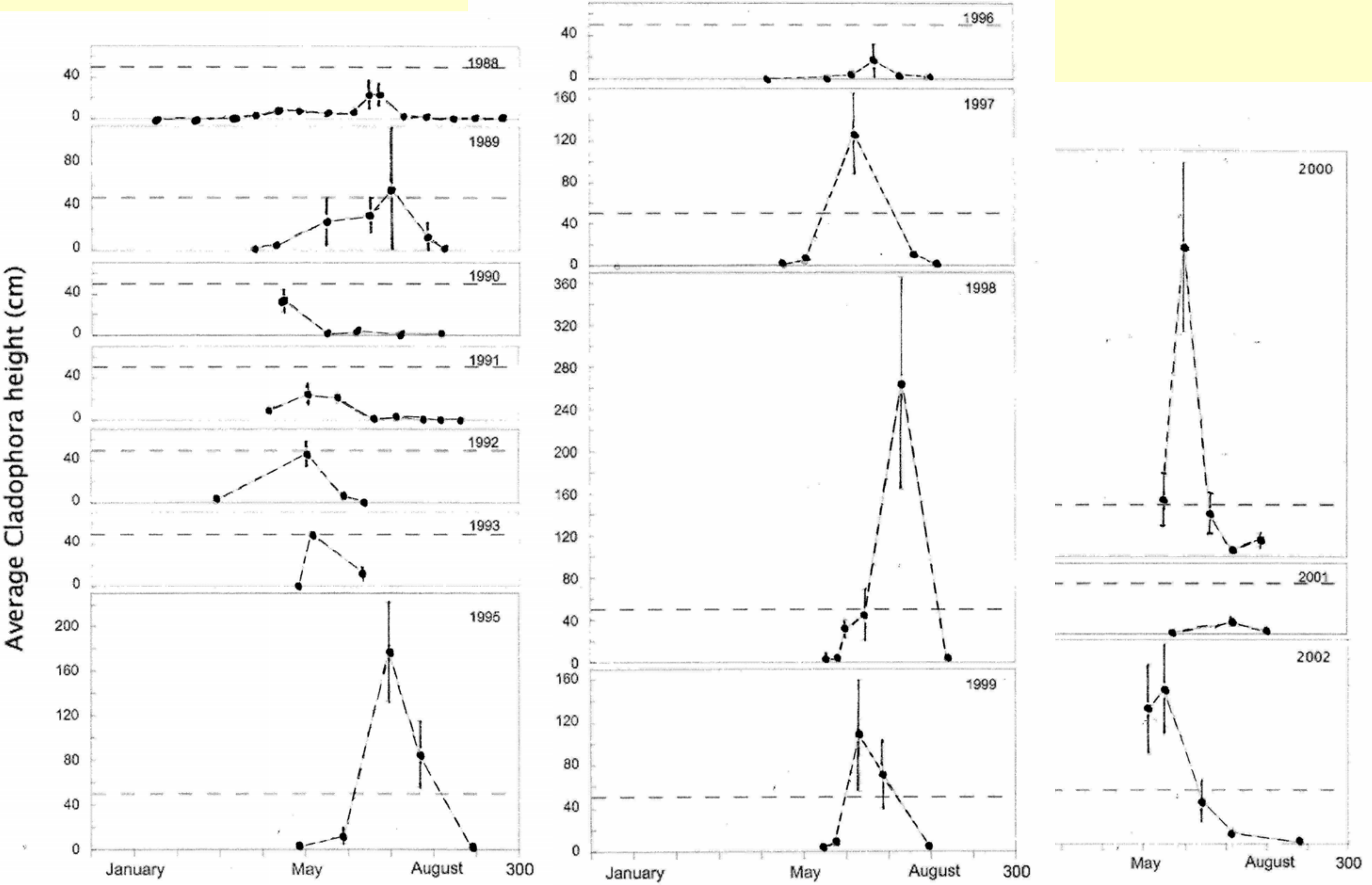


In March, scouring floods leave river bed barren of algae and rock-bound benthos

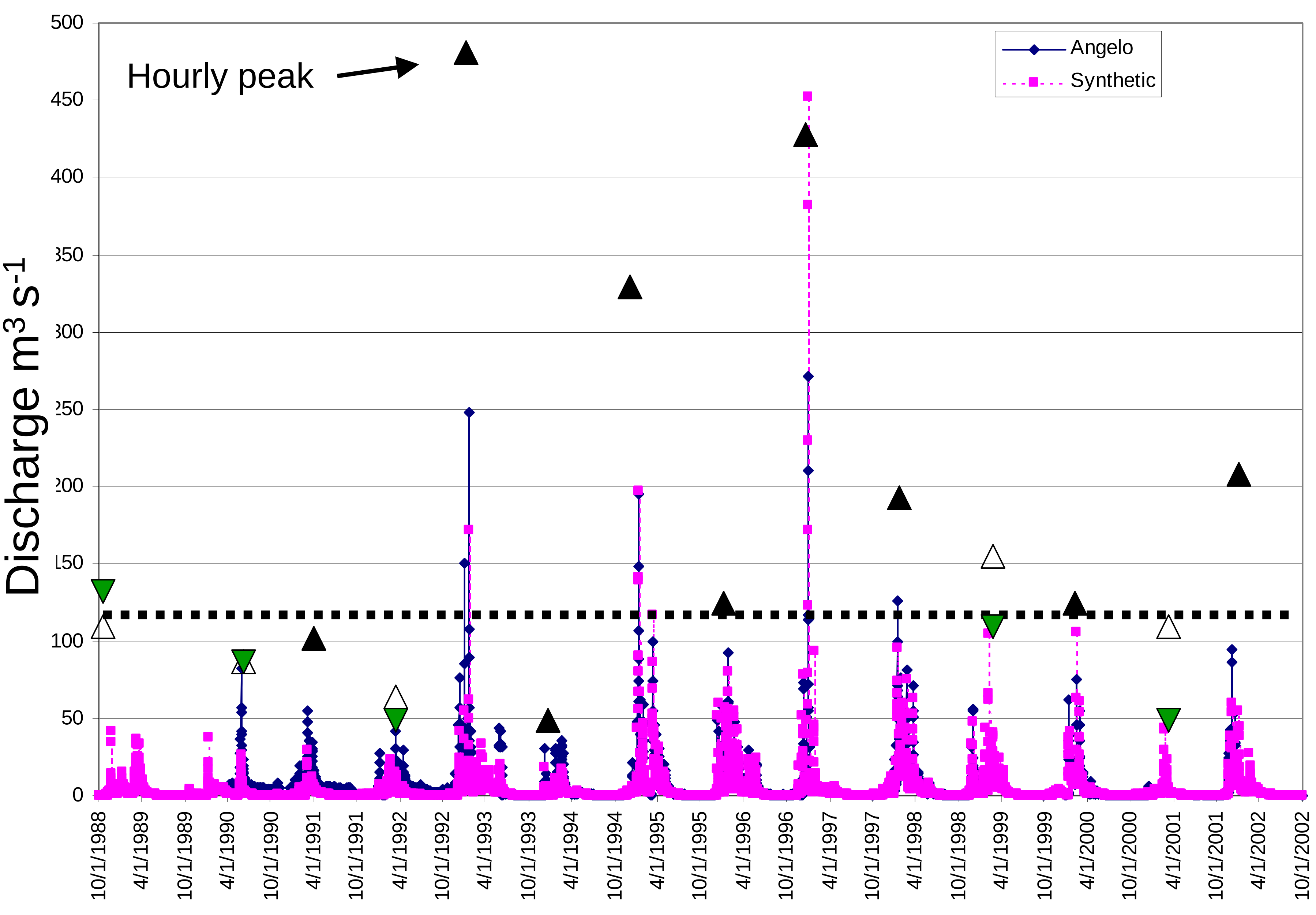
May-June: vegetative regrowth of filamentous green algae (Cladophora glomerata)

July: algae detach to form floating mats;

August: algal collapse before winter floods



Cladophora phenology, 1988-2002


Discharge m3 s-1
Hourly peak
Angelo
Synthetic
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450
400
350
300
250
200
150
100
50
0
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4/1/1989
10/1/1989
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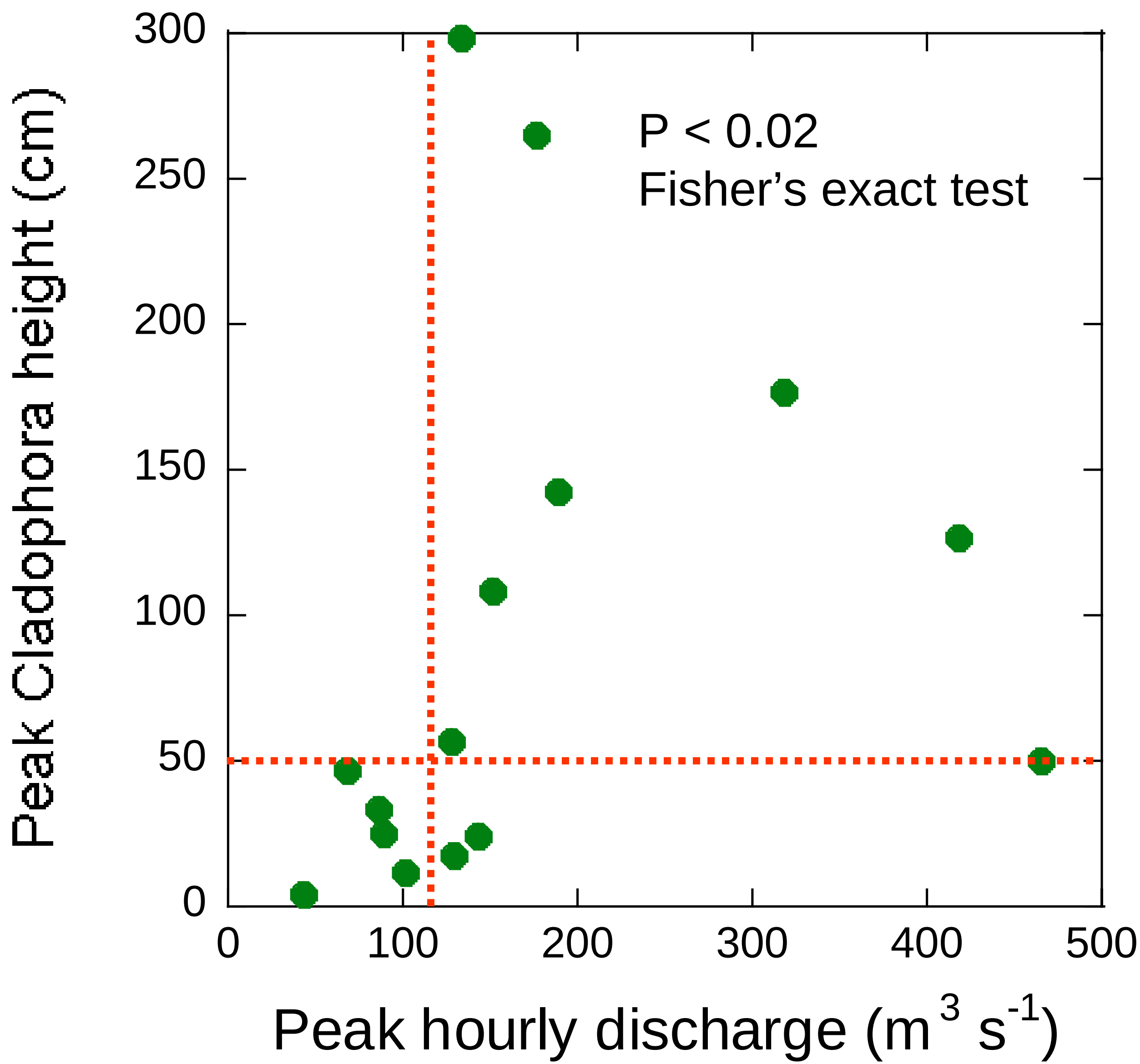
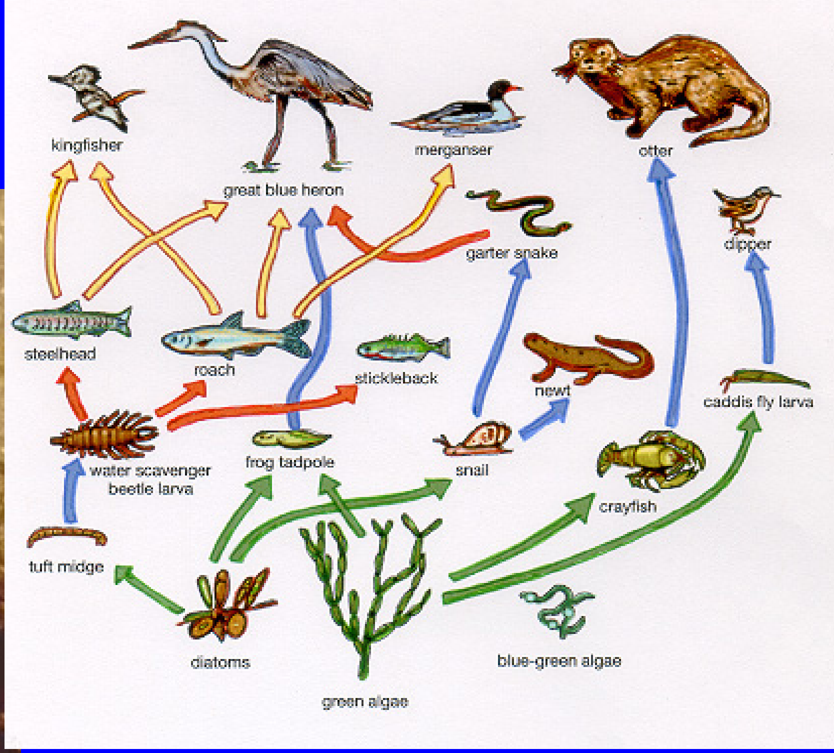
Peak discharge vs peak Cladophora height, 1988-2002



Fish effects on algae?

juvenile steelhead
(Oncorhynchus mykiss)



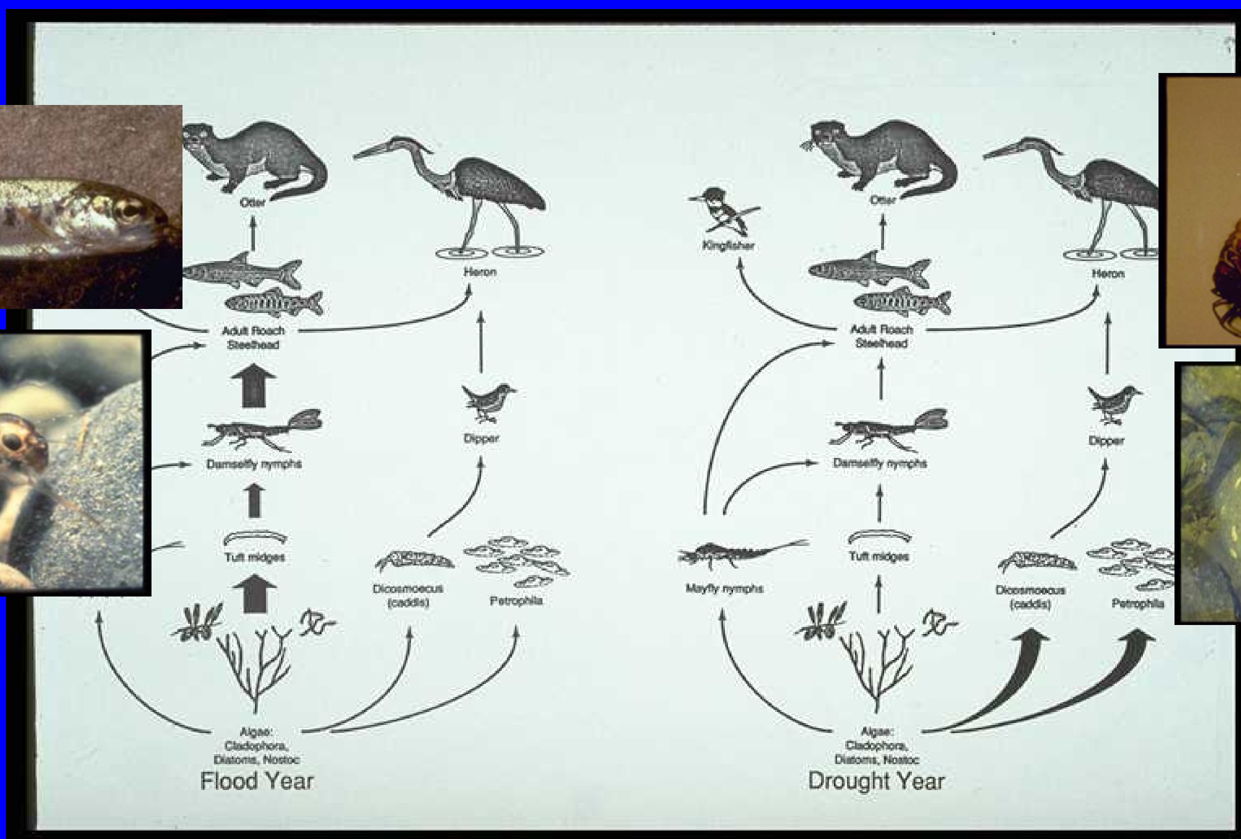
California roach
(Lavinia (Hesperoleucas)
symmetricus)


1989-flood
1990-drought
1991-drought
1993-flood, spring spate
1997-flood


Thanks, Jennifer Nielsen!

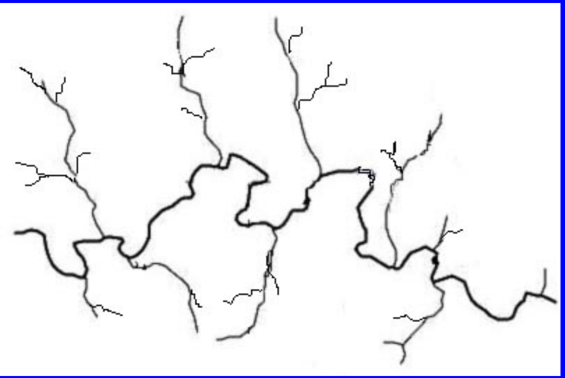
Flood: 1989: 4 level
1993: 3 level
1997: 4 level

No flood: 1990: 2 level
1991: 2 level



Edible grazers

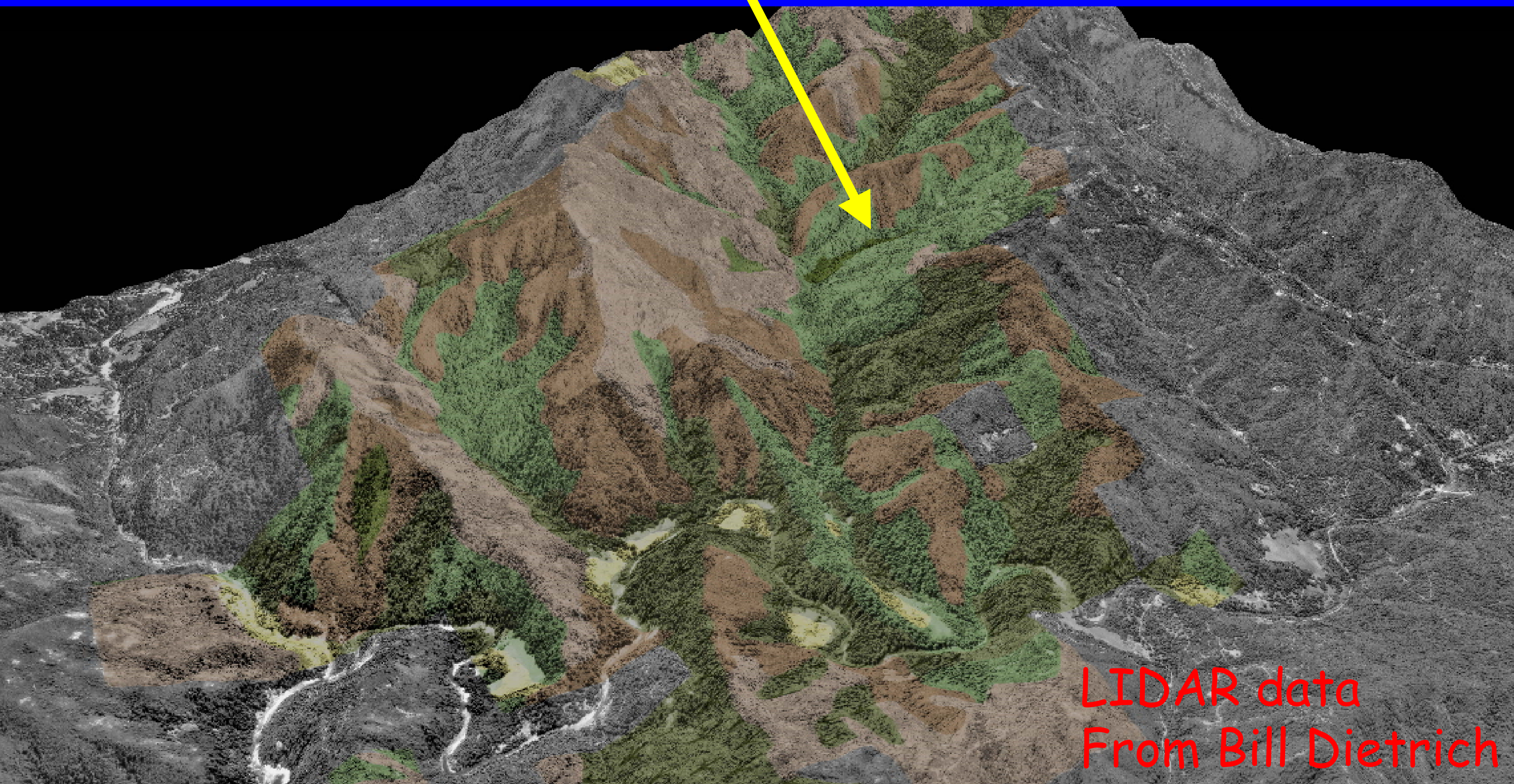
Defended grazers



- Partial predictability down drainage networks in
  - discharge,
  - habitat structure,
  - solar radiation,
  - solutes
  - disturbance

- Confluence nodes
  - pulses of enrichment
  - adjacency of contrasting habitats

Headwaters less frequently scoured, much less productive than mainstems…



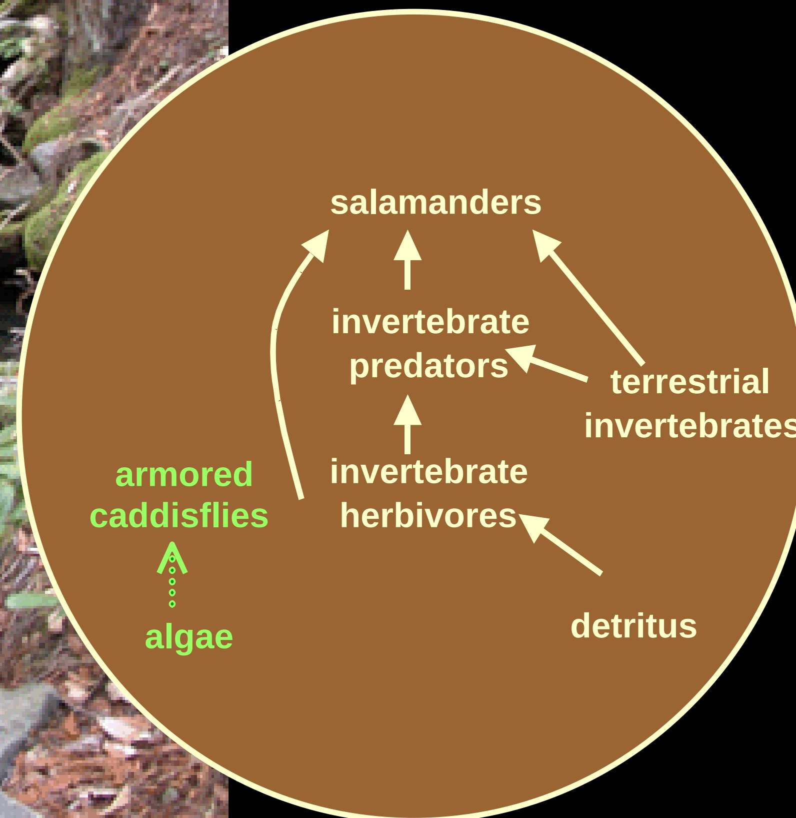
Regime change down drainage networks…

- How do food webs change down drainage networks?
  - Energy sources
  - Interactions
- Where in the landscape do 'regime changes' occur?
- How might these boundaries change with environmental change?

Jacques Finlay,
U. Minn
Camille McNeely,
Berkeley

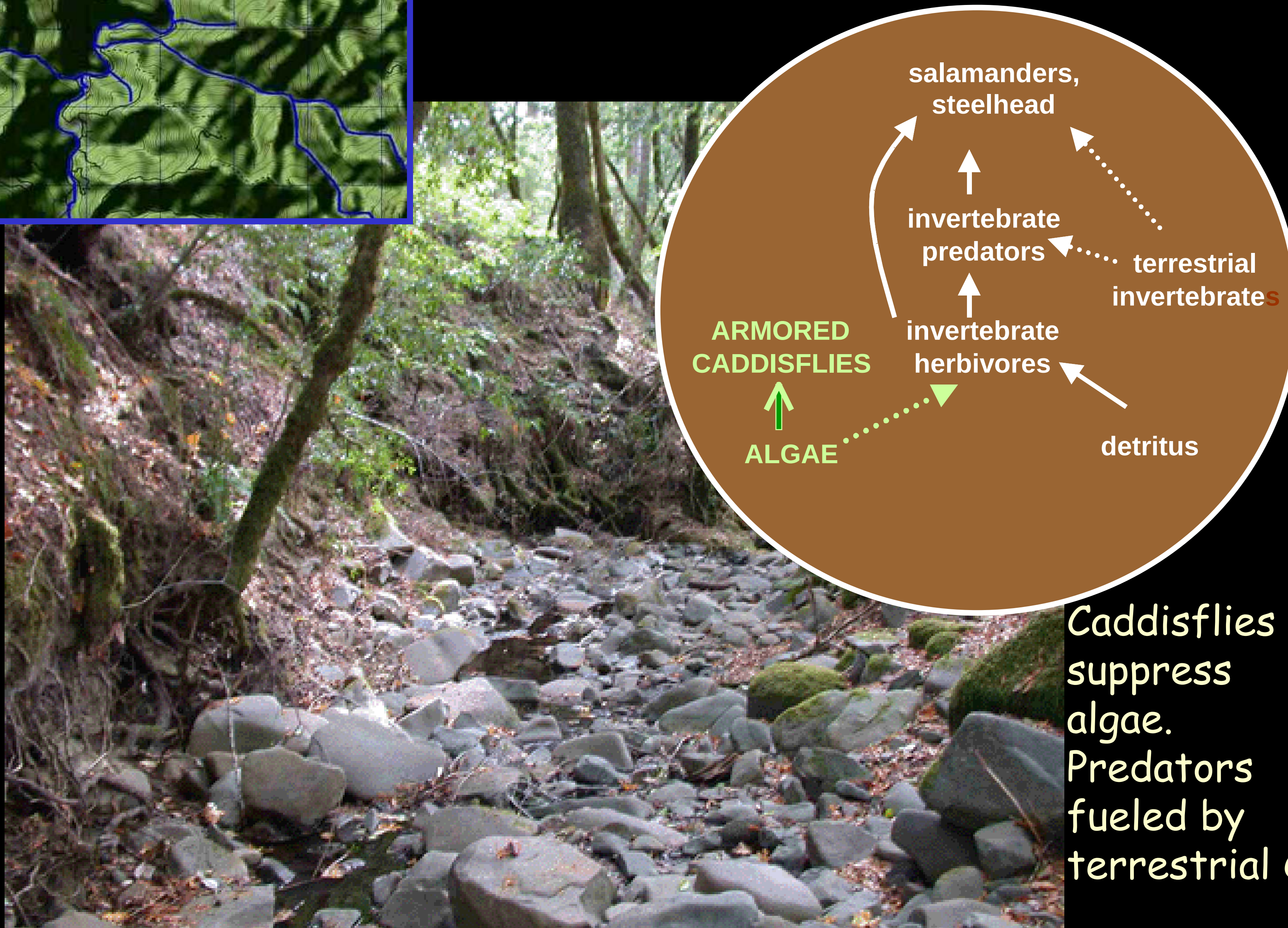
McKinley Creek, 1 km^2

Caddis eat algae but don't limit it



Finlay et al. ms; McNeely Ph.D.

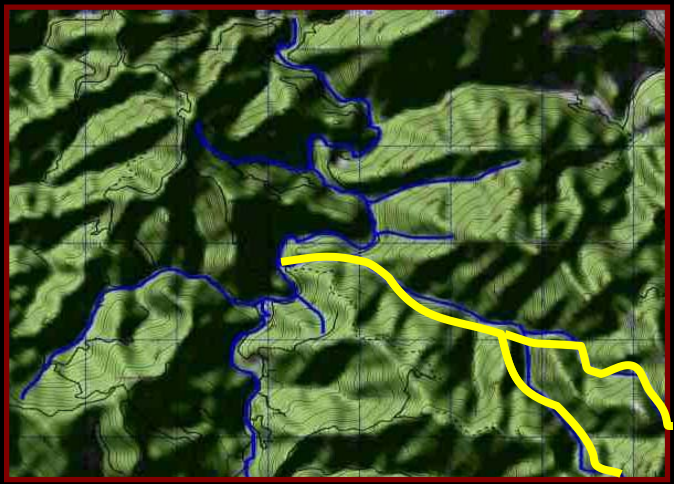
Fox Creek, 2.5 km^2

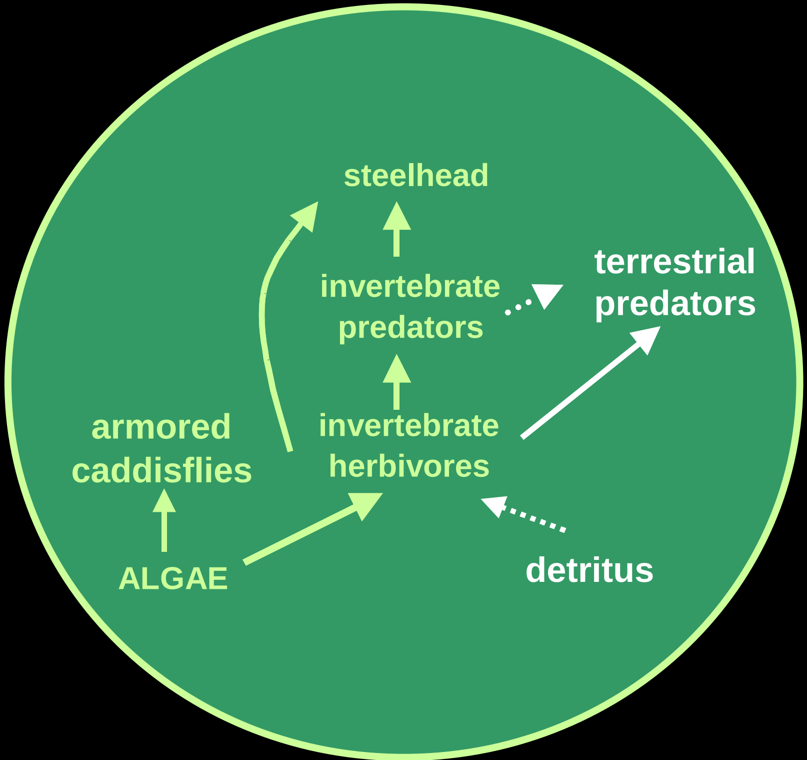


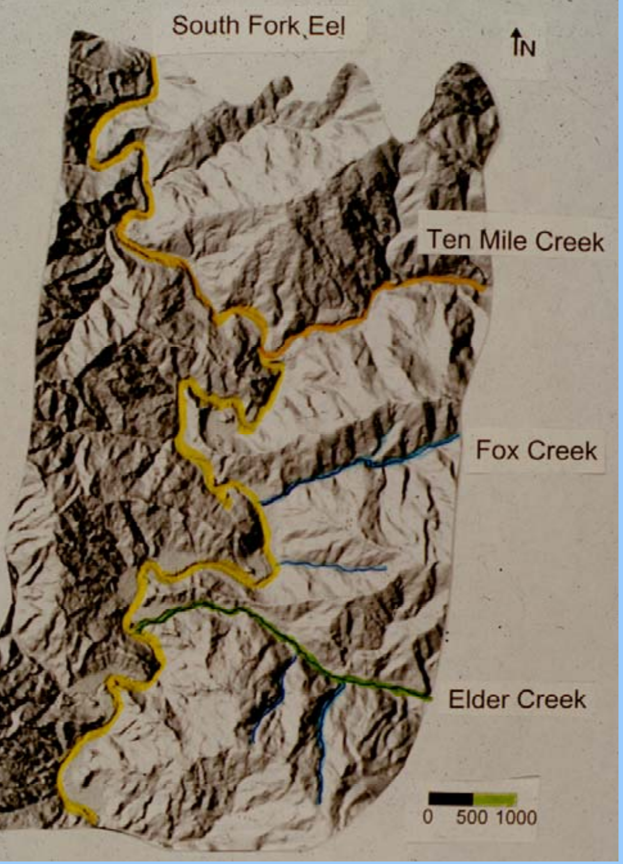
Caddisflies suppress algae. Predators fueled by terrestrial C

Elder Creek, 17 km^2

All channel consumers built of algal carbon

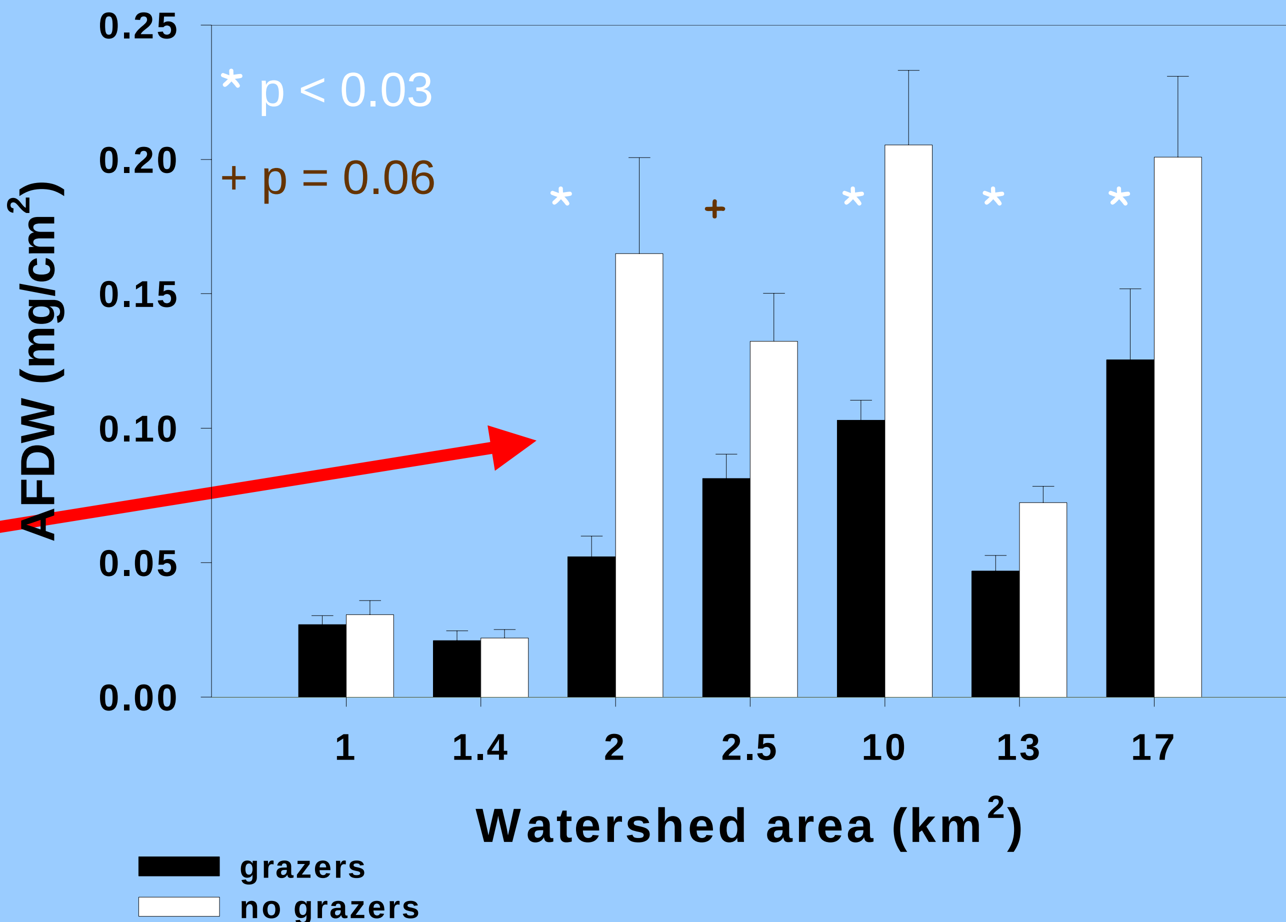






McNeely, Ph.D.:

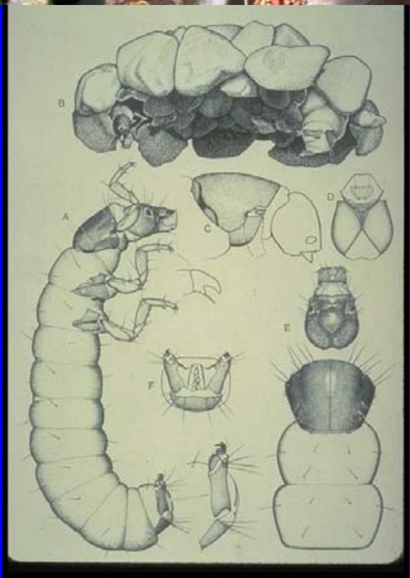
Tile grazer exclusion - early summer accumulation of algae after 25 days



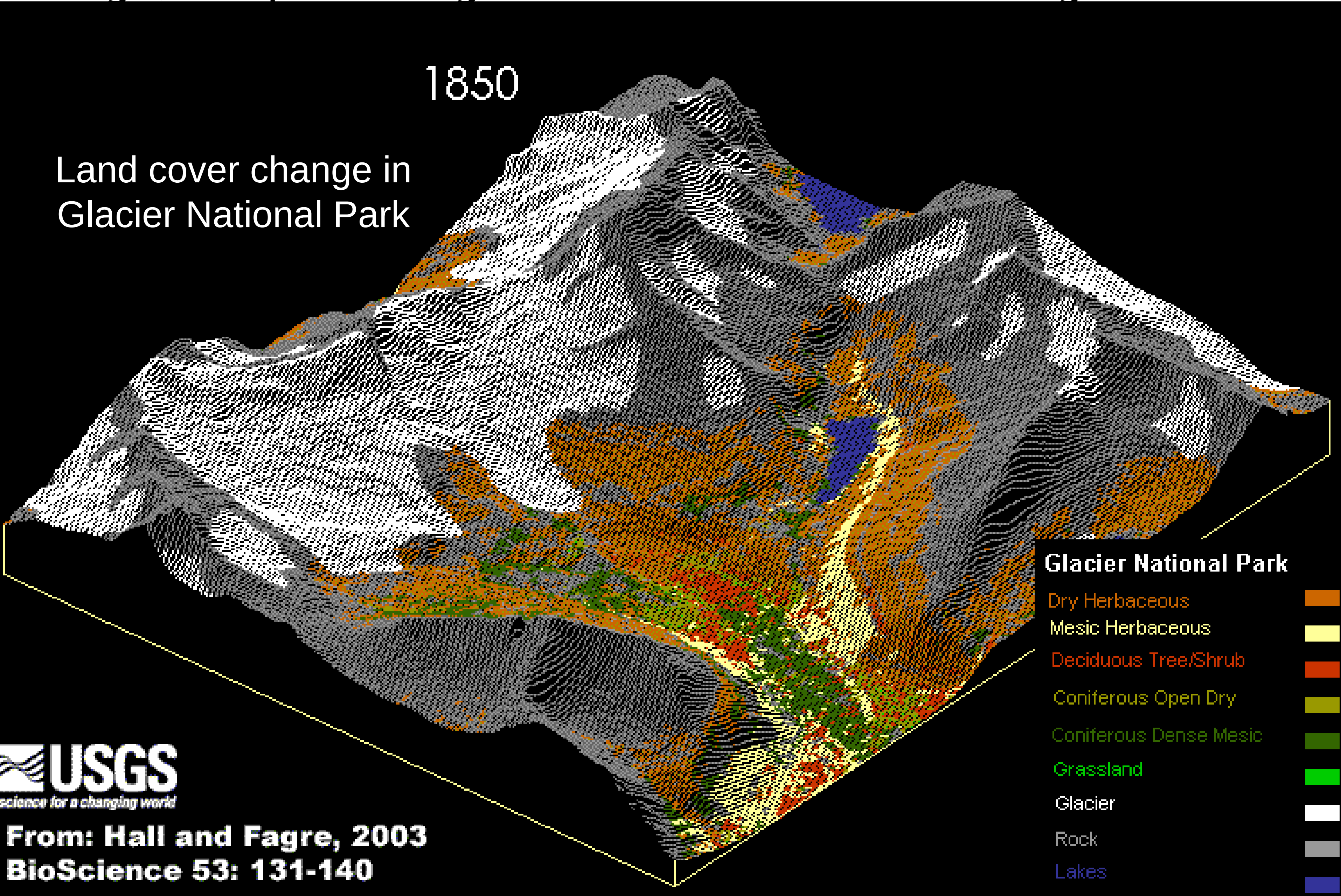
Regime change, PAR models should overpredict algal biomass

Moving upstream the threshold for algal support of predators:

McNeely et al. (JNABS 2002):
Removing armored caddisflies released diatoms and increased algal intake by mayflies



Towards mapping spatial boundaries of (trophic) regime change, and predicting shifts under altered forcing…



From: Hall and Fagre, 2003
BioScience 53: 131-140