Key factors in streams 2

Limnology

Lecture 18

Key Factors in Rivers

- Flow
- Permanence
- Substrate
- Temperature
- Chemistry

Organizing principle:
Directional flow

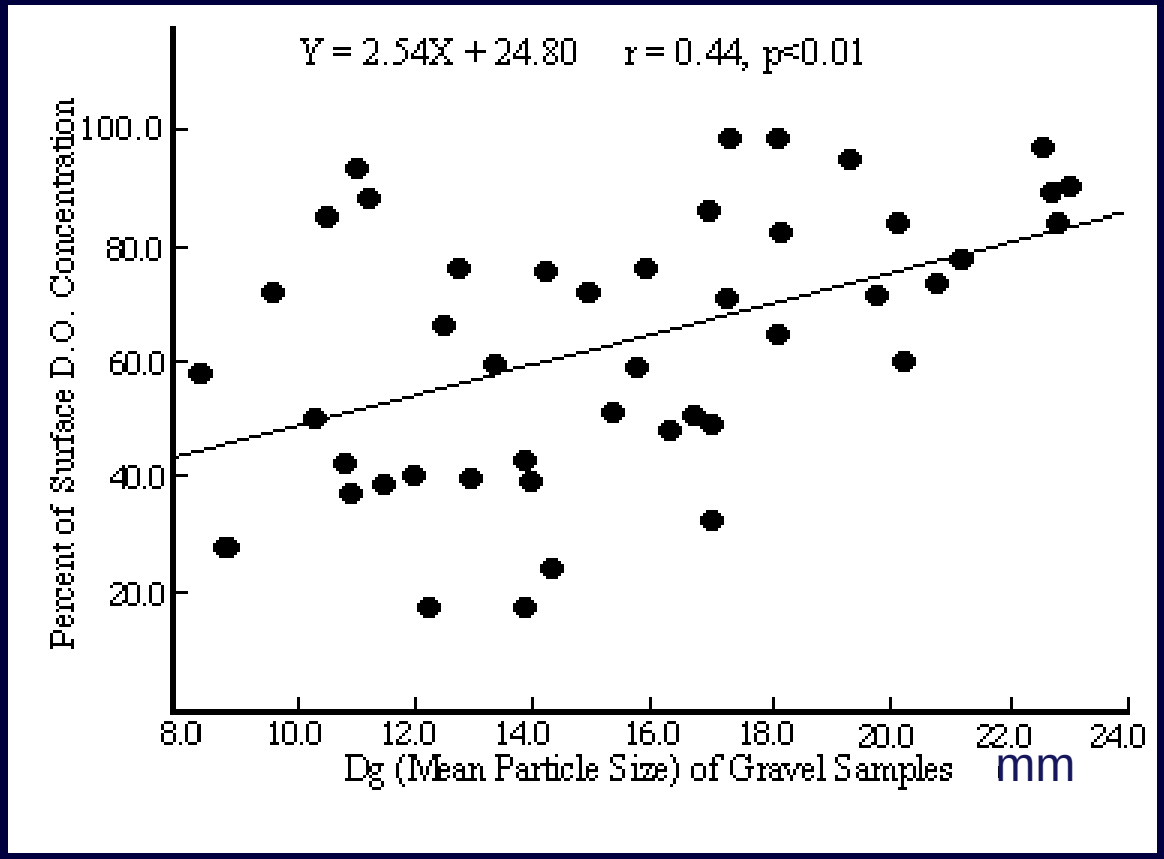
→

Ecological
patterns
(e.g. the niche)

Substrate effects on organisms

- Stability
  - Sand least diverse
- Shelter
  - Larger rocks
- Detritus trapping
- Gas exchange
  - Silt has low exchange

Substrate



Source: Reproduced from Scrivener and Brownlee, 1989

Human effects on substrate

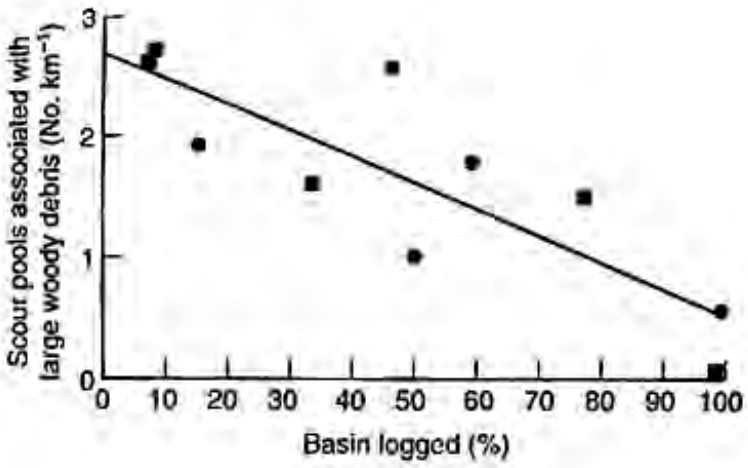


FIGURE 14.11 Frequency of pools associated with large woody debris in ten Oregon coastal streams with different logging histories and differing geology. ■, Basalt; ●, sandstone. (From Bisson *et al.*, 1992.)

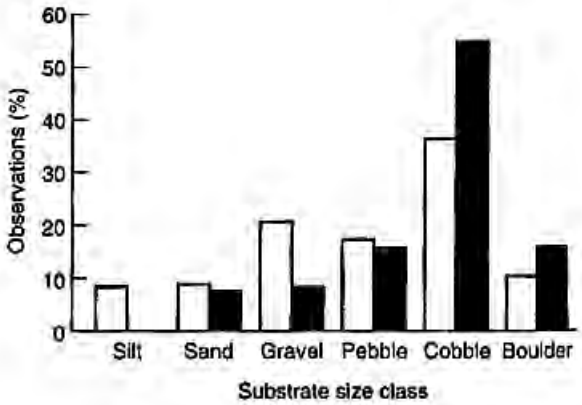
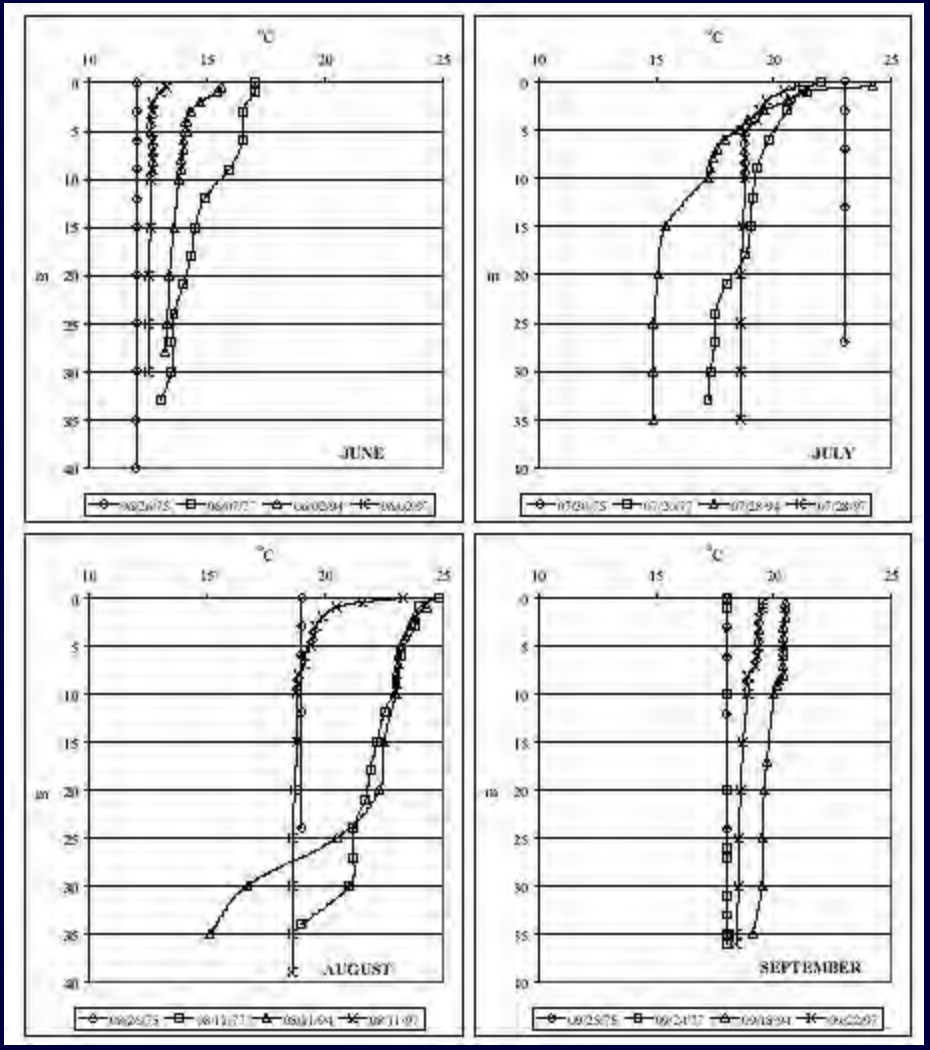


FIGURE 14.16 Distribution of substrates in different stream reaches for 23 streams in uncut forests (solid areas) and 20 streams in logged stands (clear areas). (From Corn and Bury, 1989.)

Temperature



Generally temperature the same from top to bottom

Only deep > 15 m rivers have different temps on bottom vs. top

Often affected by dams

Temperature

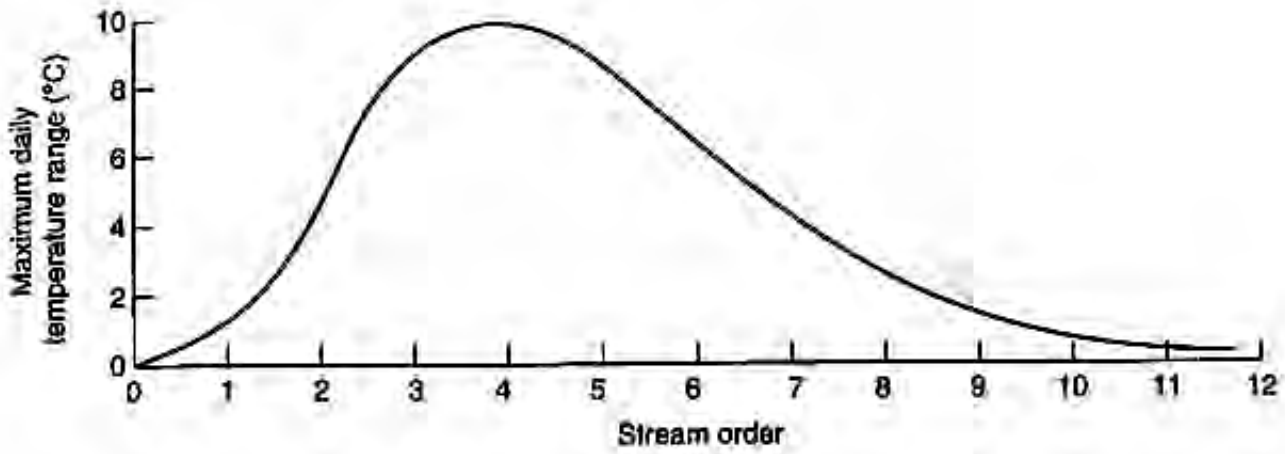


FIGURE 3.11 Maximum daily temperature range in relation to stream order in temperate streams. (From Vannote and Sweeney, 1980.)

Temperature

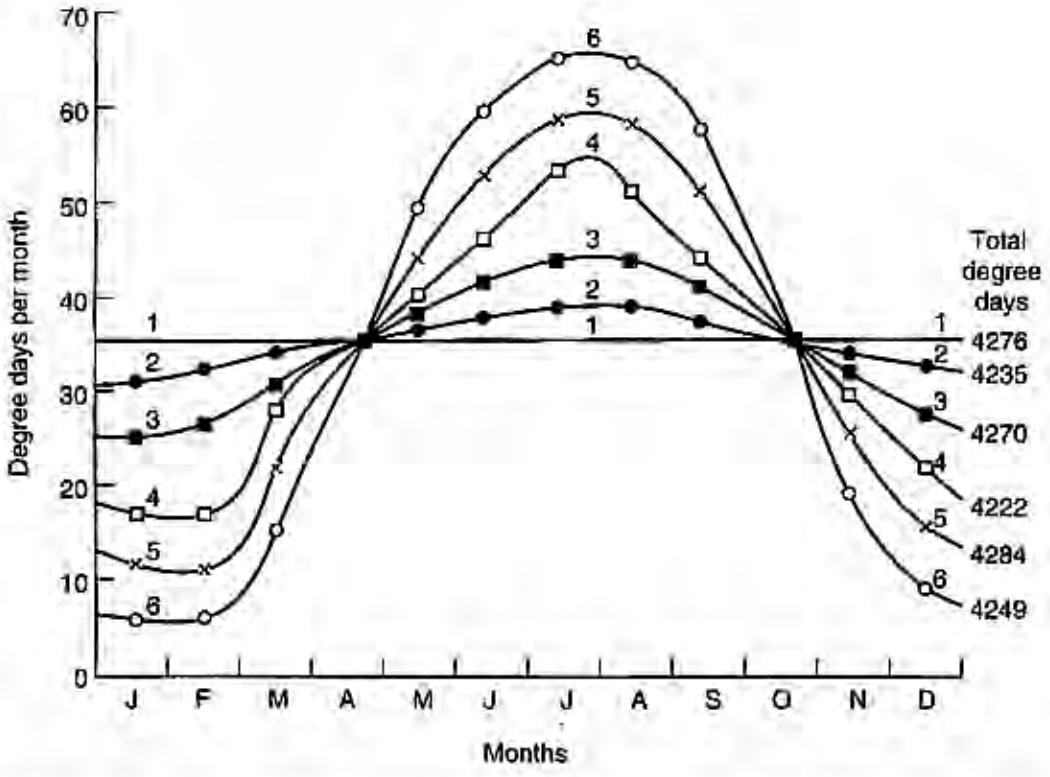


FIGURE 3.13 Degree-day accumulations and monthly totals at six sites along White Clay Creek, Pennsylvania. 1, Groundwater; 2, spring seeps, 3, first-order springbrooks; 4, second-order streams; 5, upstream segment of third-order stream; 6, downstream segment of third-order stream. (From Vannote and Sweeney, 1980.)

! Groundwater temperatures approximate mean annual air temp. !

Cold temperatures

→intermittent stream
→adaptations to deal with lack of (free-flowing) water
resistant life history stages
e.g., eggs

Cold temperatures

Frazil ice

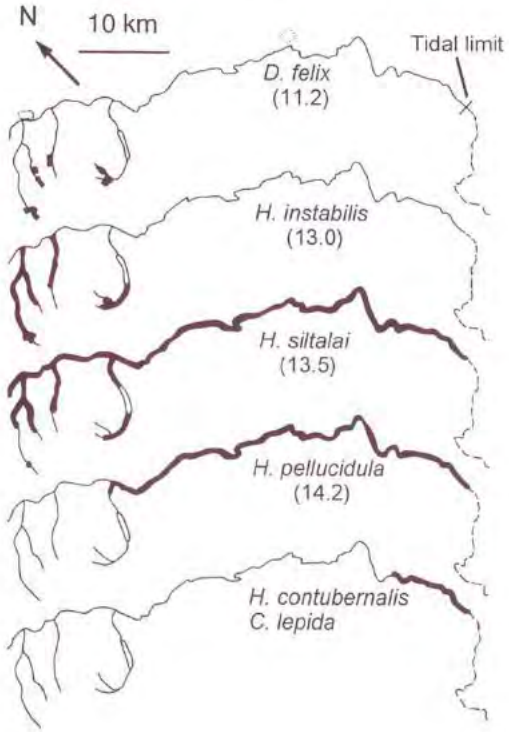
- Ice forms on substrate at -6 C or colder
- needle-like slush
- turbulent water loses heat rapidly

Anchor ice

- Sticks to cold bottom objects
- Rips off inverts

Temperature

Fig. 3.3 The distribution of hydropsychid caddis larvae in tributaries and lower reaches of the River Usk in Wales. The values in parentheses give the mean summer temperatures (°C). (Redrawn from Hildrew and Edington, 1979.)



Temperature and species

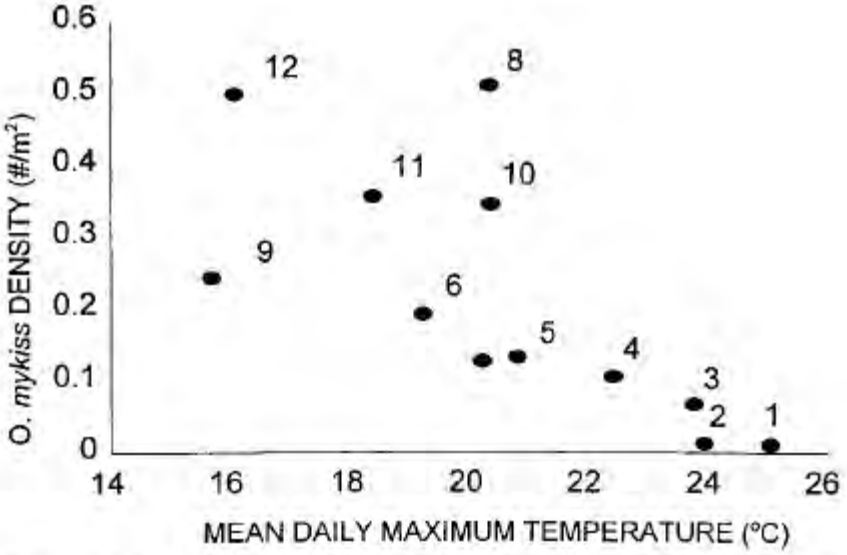


Fig. 3. Relationship between mean rainbow trout density and mean daily maximum water temperatures of 12 study reaches. The numbers refer to map codes for study reaches listed in Table 1.

Ebersole et al. 2001

Riparian zones

Riparian zone – stream banks and surrounding area

Anywhere from 10 – 100 m

! Controversial !

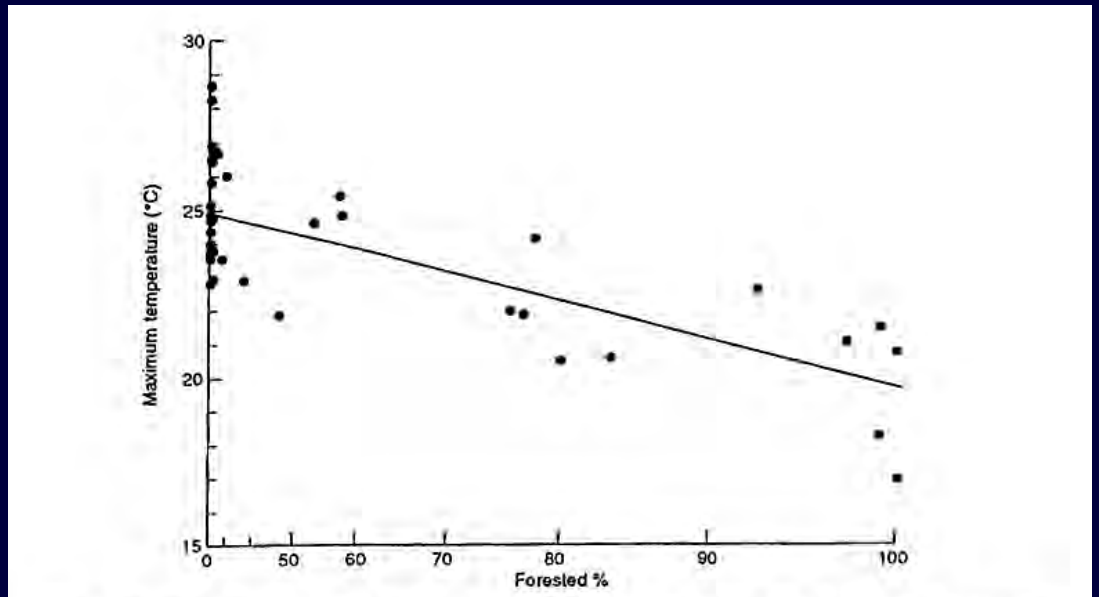


FIGURE 14.14 Weekly maximum stream temperature compared with the percentage of forested streambank upstream of the study site. Note that the horizontal axis is non-linear. (From Barton, Taylor and Bietta, 1985.)

Riparian zones

Shading

Sediment transport

Nutrient uptake

Allochthonous inputs

Stream flow

Hubbard Brook

Small – watershed approach ~ Field manipulations

sensu lake manipulations by Hasler, Schindler

Hubbard Brook deforestation - temperature

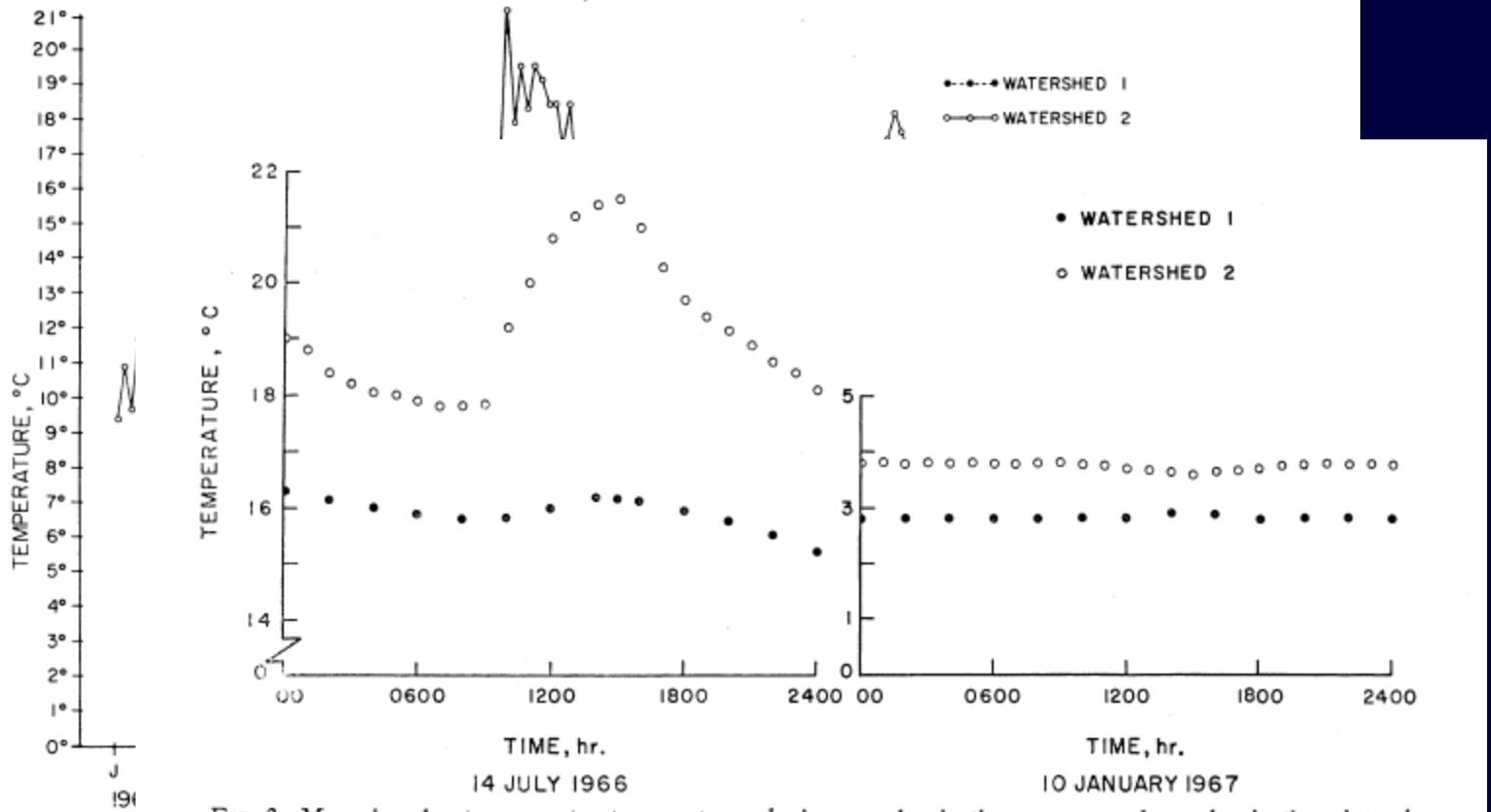
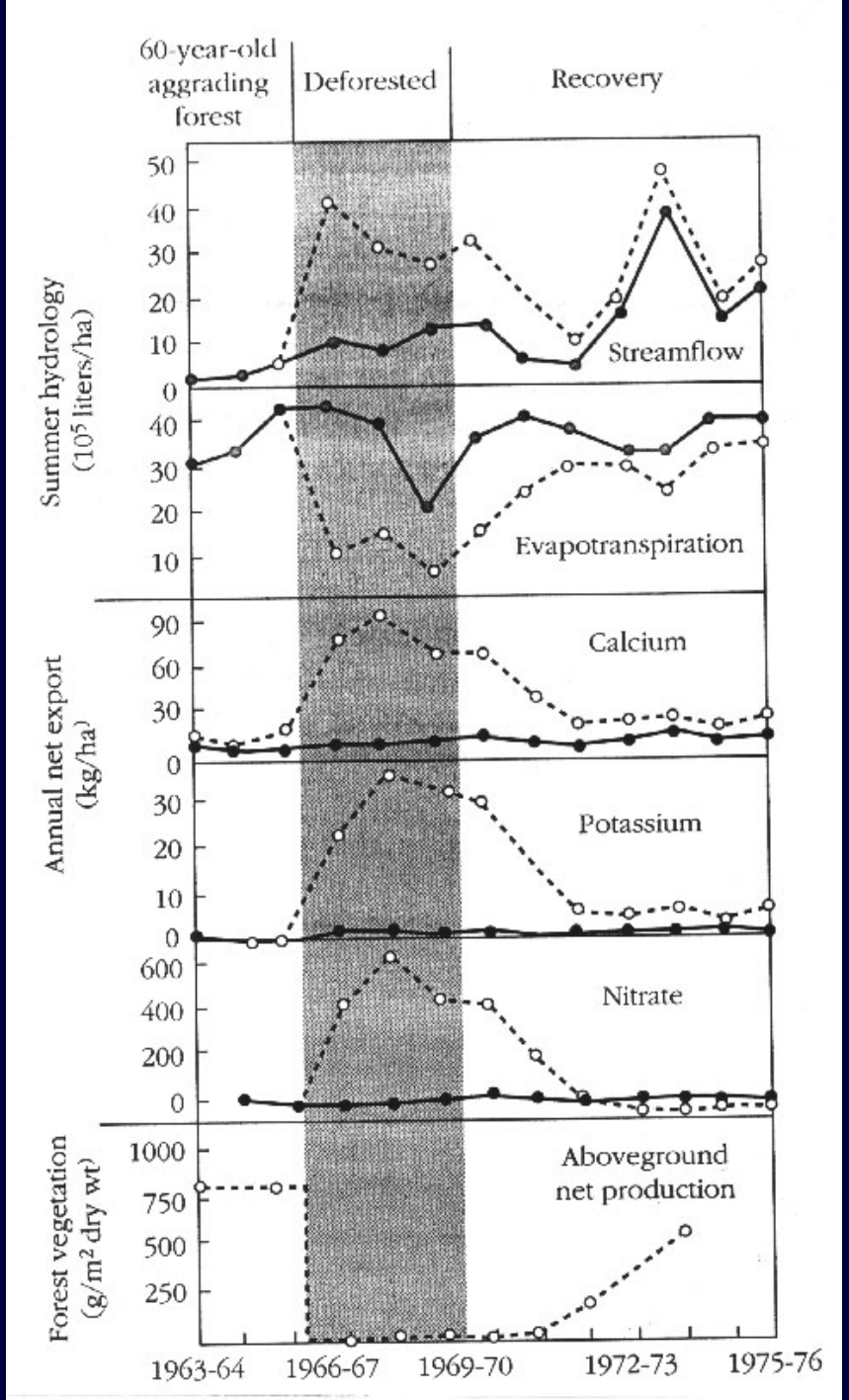


FIG. 2. M
recording th
periods when the stream discharge was negligible or when the thermograph functioned improperly.

FIG. 3. Mean hourly stream water temperatures during one day in the summer and one day in the winter in Watersheds 1 and 2 (deforested).



Deforestation leads to High stream flows

low evapotranspiration

Chemistry: Large Scale

3 mechanisms impact chemistry on a regional scale:

1. Precipitation
2. Evaporation
3. Weathering

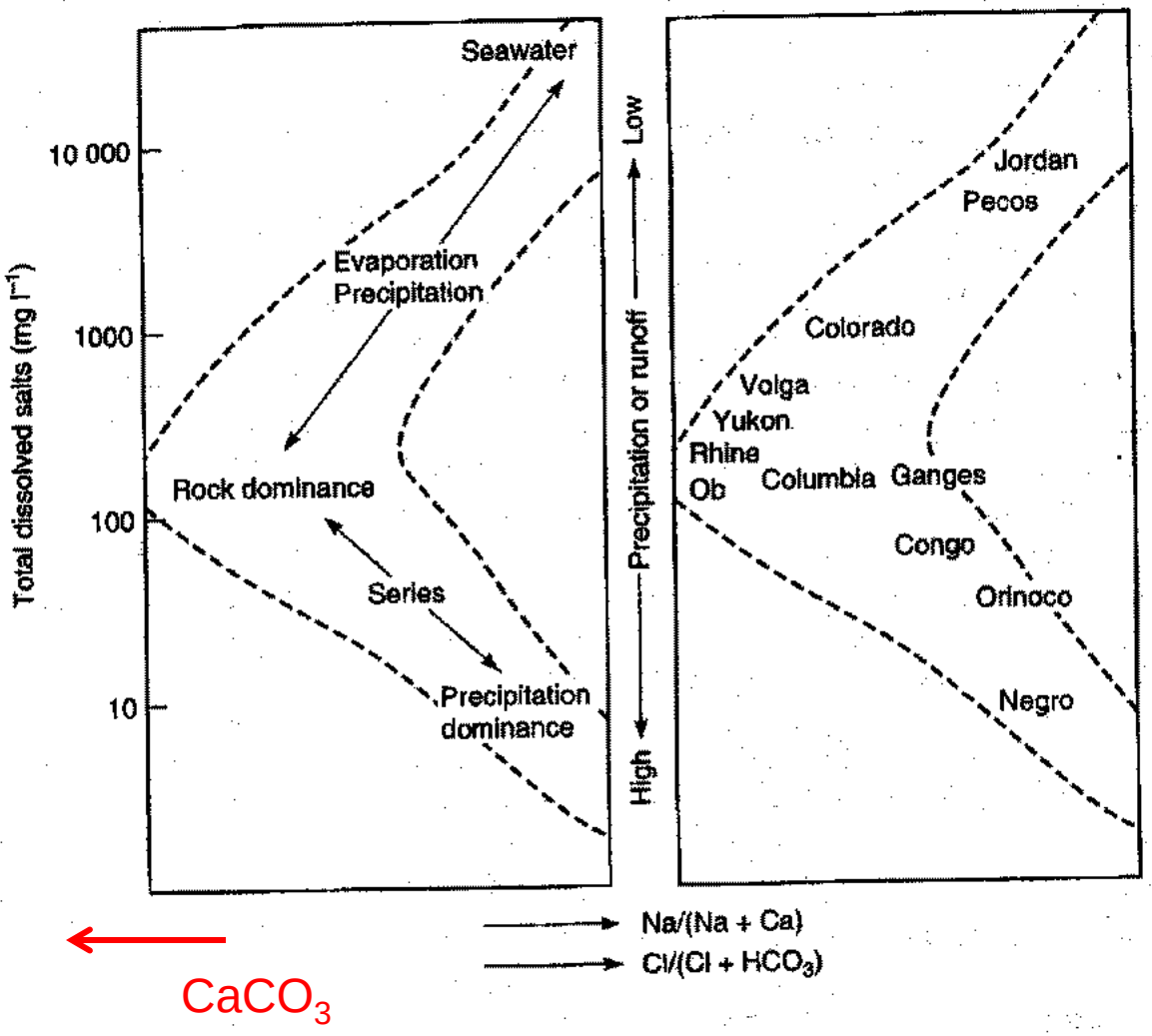
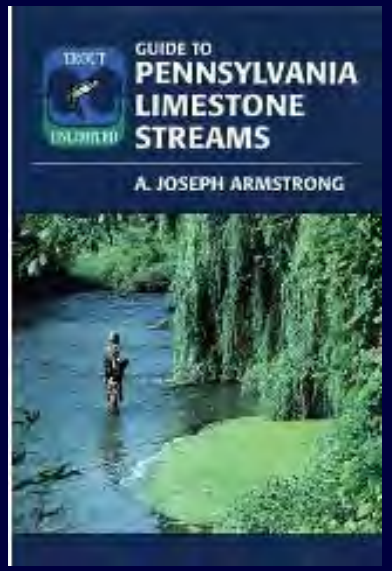


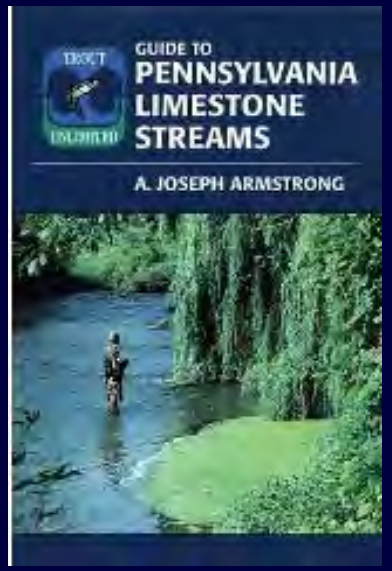
FIGURE 2.6 A classification of surface waters of the world based on ratios of sodium to calcium and chloride to bicarbonate, in relation to total dissolved salts. As one proceeds from left to right along the lower arm, inputs shift from a dominance of rock dissolution to a dominance of precipitation. The majority of large tropical rivers are found to the lower right. As one proceeds from left to right along the upper arm, sodium and chloride increase. These high salinity rivers lie in arid regions where evaporation is great. Note the vertical axis also reflects a gradient from high precipitation and runoff at the base to arid regions at the top. (Modified from Gibbs (1970) and Payne (1986).)

Chemistry: Effects on Ecology

- Most evidence is observational
  - Calcium and Magnesium (Hardness)
    - Acid neutralizing capacity
    - Affects mollusc distribution
    - Recall carbonate cycle



Chemistry: Effects on Ecology



- pH
  - Affects trout (< 6, poor spawning)
- Salinity
  - Affects broad range of species at extreme values

Oxygen

Flowing water

Turbulent creates saturated oxygen conditions

Pools and stagnant bays
Or high organic content

Low oxygen
Pond - like

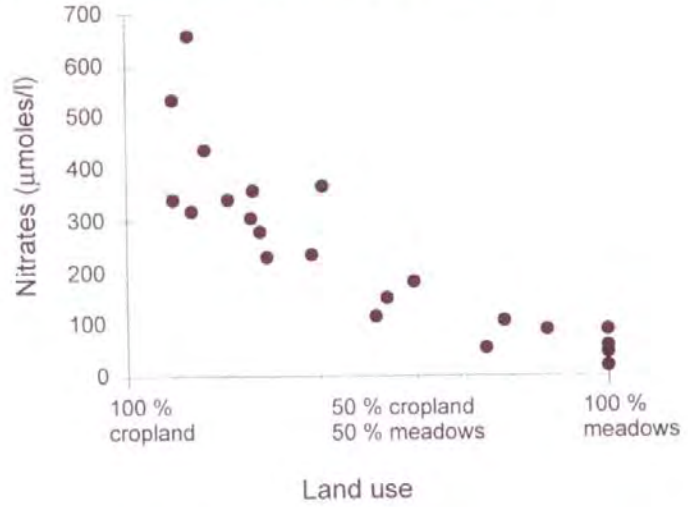
Oxygen

Other factors that limit Oxygen

- Temperature
- Nighttime respiration
- Ice

Nutrients

Fig. 3.5 The relationship between mean annual nitrate concentration and the ratio of meadows to arable land in catchments of small streams draining agricultural areas of the Meuse river basin , France. (Redrawn from de Becker *et al.*, 1984.)



P, N often limiting
Increases in nutrients increase vegetation
Leads to high BOD, low oxygen