River Water Quality

Section **3c**: Anthropogenic Influence on Running water Hydromorphology & Water Quality

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Ευρωπαϊκή Ένωση
Ευρωπαϊκό Κοινωνικό Ταμείο

ΕΠΙΧΕΙΡΗΣΙΑΚΟ ΠΡΟΓΡΑΜΜΑ
ΕΚΠΑΙΔΕΥΣΗ ΚΑΙ ΔΙΑ ΒΙΟΥ ΜΑΘΗΣΗ
επένδυση στην κοινωνία της γνώσης
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Anthropogenic Influence on Running water Hydromorphology & Water Quality

Other Anthropogenic Stresses

Dams & Canals

Section Contents

1. Dams & River Continuum Concept
2. Impact of River Regulation by Dams
3. Interruption of the River Continuum
4. Downstream Impacts of Reservoirs
5. Canalization & Channelization

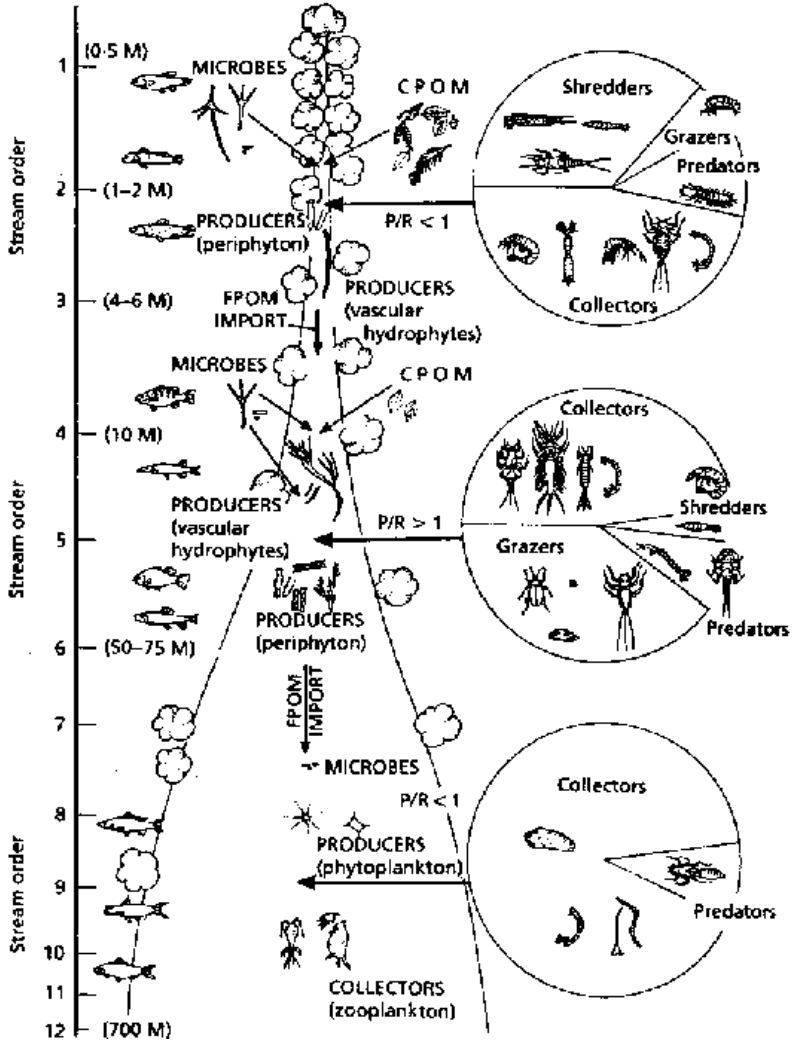
Dams & River Continuum Concept

- The River Continuum Concept (Vannote *et al.* 1980) is a theory that describes a river ecosystem, fully, from its source to its mouth.
- The physical base is the river size & its localisation along the gradient (stream to large river). The order, the flow rate & the (sub-) catchment area are the physical measurement along the continuum
- Biological adaptations & changes in the biological communities, observed from the head waters to the mouth of the river, can be predictable to a certain extent
- Sources of energy vary along the continuum (autochnonous-allochtonous food sources)

Dams & River Continuum Concept

General Description of the relationship between the size of rivers, energy inputs & biocenosis along the continuum (Vannote *et al.* 1980)

- Headwaters - external inputs of coarse particulate organic matter (CPOM) constitute a food resource for numerous organisms (Primary Production/Respiration, P/R<1)
- Middle River course - broadened river, CPOM abundance decreases & fine particulate organic matter (FPOM) increases, peryphyton development
- Downstream - , macrophytes grow, and phytoplankton develops, autotrophic status, (P/R>1)



Dams & River Continuum Concept

- RCC – general concept/ norm that was developed on the basis of observations of unaltered watercourses of temperate regions. Aids the distinction between ecosystem types
- The changes during the course affect benthic consumer communities & ecosystem functioning
- No clear distinction between herbivores, carnivores, detritivores – depends on developmental life stage – most are polyphagous
- Preferable distinction between grazer, shredders, collectors, & predators – depends on availability of food particles & food size

Dams & River Continuum Concept

Table for a typical classification of macroinvertebrates on the basis of their feeding mode

Feeding mode	Food sources	Examples
Fragmentor – shredder	CPOM (Coarse particulate organic matter) non lignous and associated microbiota	Trichoptera (Limnephilidae, Lepidostomatidae, Sericostomatidae), Crustaceans (Asellidae, Gammaridae), Plecoptera (Nemuridae, Leuctridae), Diptera (Tipulidae, Chironomidae)
Shredder-gouger	CPOM Wood particles & assosiated microbiota	Diptera, Coleoptera, Trichoptera
Filterer-collector	FPOM (Fine particulate organic matter) and associated microbiota	Diptera (Simulidae), Trichoptera (Hydropsychidae, Oligoplectrum)
Collector-gatherer	FPOM & assosiated microbiota	Ephemeroptera, Diptera (Chironomidae, Ceratopogonidae), Coleoptera(Elmidae), Trichoptera(Sericostomatidae).
Predator	Animal preys	Odonata, Megaloptera, Trichoptera, Hirudinae, Plathelminthes, Coleoptera,
Piercer	Macrophytes	Trichoptera (Hydroptilidae)
Grazer	Periphyton & biofilm	Gasteropoda (Ancylus sp., Theodoxus sp.), Plecoptera (Taenopterigidae, Ceptophlebiidae), Ephemeroptera(Heptageniidae), Trichoptera(Glossomatidae,),

Dams & River Continuum Concept

- Human activities alter the RCC properties & reduce the model predictability
- Multiplication of dams/reservoirs on watercourses makes hazardous the validity of such schemes strictly based on hydrological continuity (Testard *et al.* 1995)
- Alterations on river beds, water course, stream flow, siltation, D.O. etc. affect directly structure and distribution of macro-invertebrate communities

Impact of River Regulation by Dams

- 2/3 of freshwater courses running out to the oceans are slowed down by big (h>15 m) or small dams for exploitation
- Scientists interest original focus was on potential impacts these dams could have on the rivers that feed them instead of reservoir limnology
- Even though dams are beneficial for mankind (energy, irrigation, potable water, fool control) have several negative impacts on river ecosystem & biota

Interruption of the River Continuum

- A dam on a river causes the replacement of running water benthic fauna with lacustrine fauna
- Distinction in 3 zones:

✓ Filling zone: high turbidity, low primary production, high (aerobic) decomposition rates, inputs of allochtonous organic matter

✓ Transition zone: decreased flow rates, high sedimentation & high water transparency, adequate conditions for phytoplankton growth

✓ Lacustrine zone: characteristics simillar to lakes, plankton production, nutrient limitation, sedimentation of organic matter & decomposition in the hypolimnium

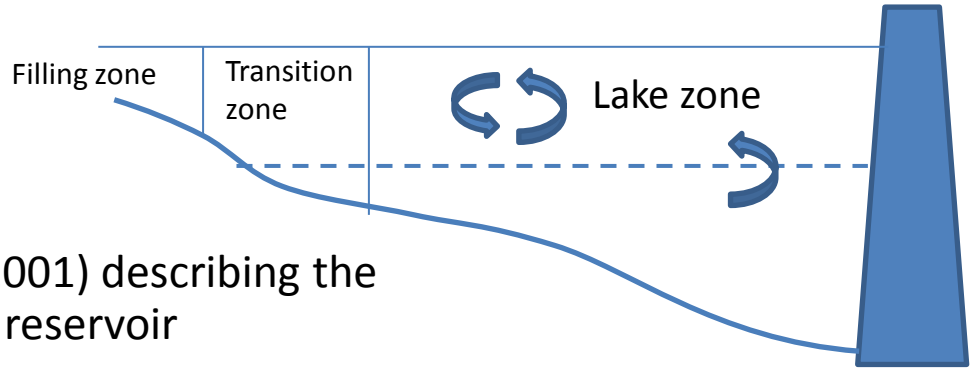


Image based on Wetzel (2001) describing the longitudinal zonation in a reservoir

Interruption of the River Continuum

- Water level variation prevents the growth of a stable plant girdle & modifies the habitat (survival) of macroinvertebrates in the reservoir.
- Reservoirs act like nutrient traps → increase of the production and of the organic load can induce anoxia in the hypolimnium along with the adduct features
- Suspended particles transported downstream sink in the reservoir leading to its progressive filling (reduction of the storage capacity) and fixation of allochtonous organic matter (Cortes *et al.* 1998). Plankton growth (N-fixing cyanobacteria) can increase the nitrate flow downstream

Downstream Impacts of Reservoirs

- Hydraulic regime & temperature are the 2 most altered parameters in downstream dams (Cereghino & Lavandier, 1998)
- Residence time affects downstream water quality & chemistry (especially if dam releases come from hypolimnium)
- Chemical elements, usually: temperature, pH, conductivity, Nitrogen (in all forms) & Phosphorus are affected in most cases
- Variation in alterations can be observed depending on the use of the dam (electric production, agricultural, flood control)
- Seasonal variations (temperature & flow) are reduced in most cases
- The dam type & management strongly influence the inducted effects

Downstream Impacts of Reservoirs

- In low water flow & upstream alteration, the relations between the river and its flood areas are suppressed [reduced productivity in both habitats (Allan, 1995)]
- In cases of increased transparency, productivity rises (periphyton & macrophytes)
- In cases of lockfalls (electricity production) the river bank erodes, which usually eradicates edge plants & affects greatly macroinvertebrate communities (abundance & biodiversity) in response with each species sensitivities (changes competition, alters food source-availability, fluctuate hydraulic regimes with occasional daily flow rate variation)
- Migration of fish is blocked. Some salmon & eels populations are totally eliminated affecting upstream & downstream biota

Canalization & Channelization

- Channelization – improvement of the flow of the river, particularly in flood conditions by modifying its course so that it follows a restricted path
- Canalization – the hold of the flow (navigation & power generation) by introducing weirs & locks to a river so as to secure a defined depth despite seasonal variation & up/down-stream morphology
- Obstruction removal increases channel discharging capacity & lowers the height of floods upstream
- Reduction of the channel's length (straight cuts instead of a winding course) can increase the effective fall (in large rivers can be temporary)

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