

Fluvial Ecology:

Biological components.

Physical requirements ecosystem functioning.

Aquatic Habitat Evaluation

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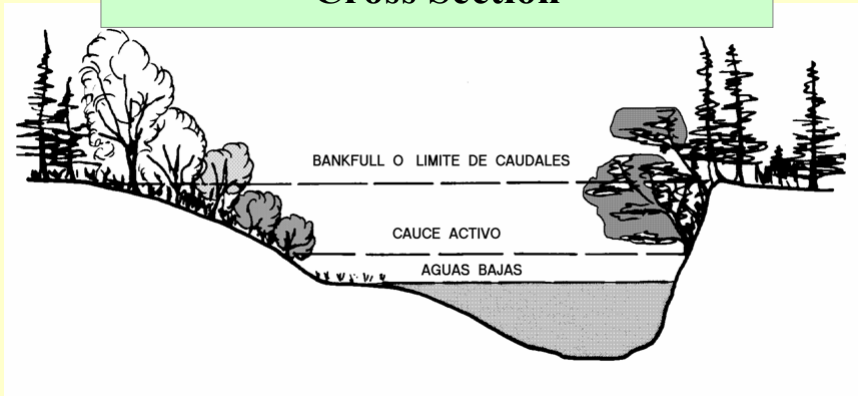
Escuela de Ingenieros de Montes

Universidad Politécnica de Madrid

Natural River Attributes

1. Channel Morphology
 - Longitudinal profile
 - Cross Sections
2. Water Column Characteristics
 - In-stream Flows
 - Water Physico-Chemical traits
3. Interstitial Environment: substrate & sediments
4. Riparian system
5. Aquatic Communities

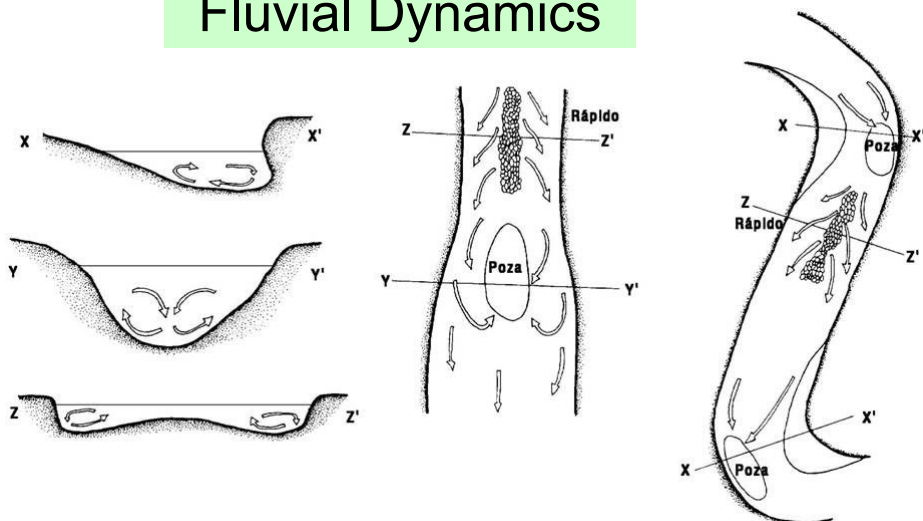
Cross Section



A Balance between **Instream Flows** (water and sediments) and **Channel Geometry** exists.

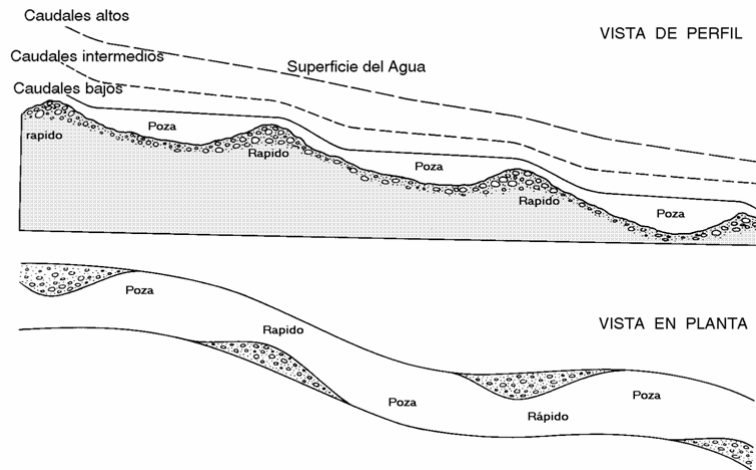
- Bankfull discharges design inside channel morphology
- Extraordinary Floods disipate hydraulic energy flooding over-bank and riparian zones (floodplains).

Fluvial Dynamics



Natural Shape: different section shapes result from alternating erosion & sedimentation processes.

Longitudinal Profile



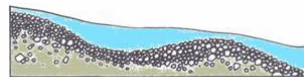
Natural Shape: alternating up & down thalweg movement provides heterogeneous habitat, that sustains aquatic biodiversity



a) Cascade



b) step-pool



c) Pool-rifle



d) glides



e) Dunes & ripples

Water Characteristics

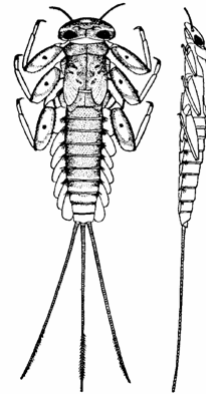
- **SEDIMENTS & SUSPENDED SOLIDS**
 - erosion and sedimentation processes
 - Turbidity: primary production limitation
- **DISOLVED SOLIDS** (mineralization)
- **Disolved OXYGEN & ORGANIC MATTER**
- **TEMPERATURE**
- **NUTRIENTS & pH**
- **CONTAMINANTS**

Flow Regime

- average flows:
 - Magnitude
- Extreme flows:
 - Magnitude
 - Duration
 - Timing
- Flow Pulses:
 - Frequency
 - Duration
- Rate of change
- Natural Variability:
 - Intra-annual
 - Inter-annual

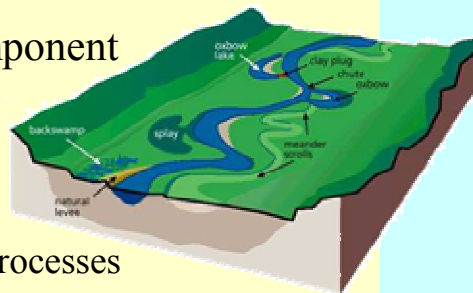
Interstitial Environment

- **Vital Refuge** for aquatic communities
 - Larval development (fish & invertebrates)
 - Macrobenthic Habitat
- **Bottom Substrate composition**
 - Mean Diameter
 - Porosity
 - Fine Sediments

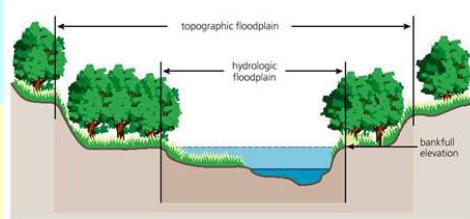


Riparian system

- Ecotone: lateral borders
- Fluvial Ecosystem component
- Controlling Factors:
 - Flow Regime
 - Geomorphological processes
 - Phreatic Water Levels
 - Riparian Vegetation

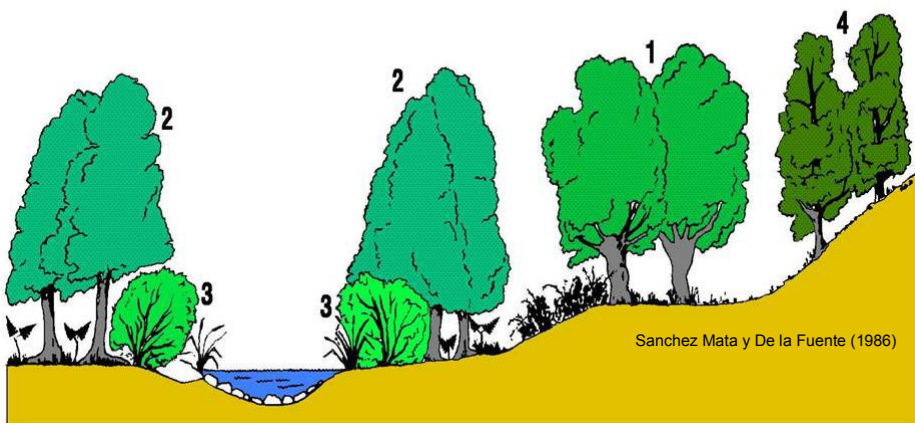


Riparian system

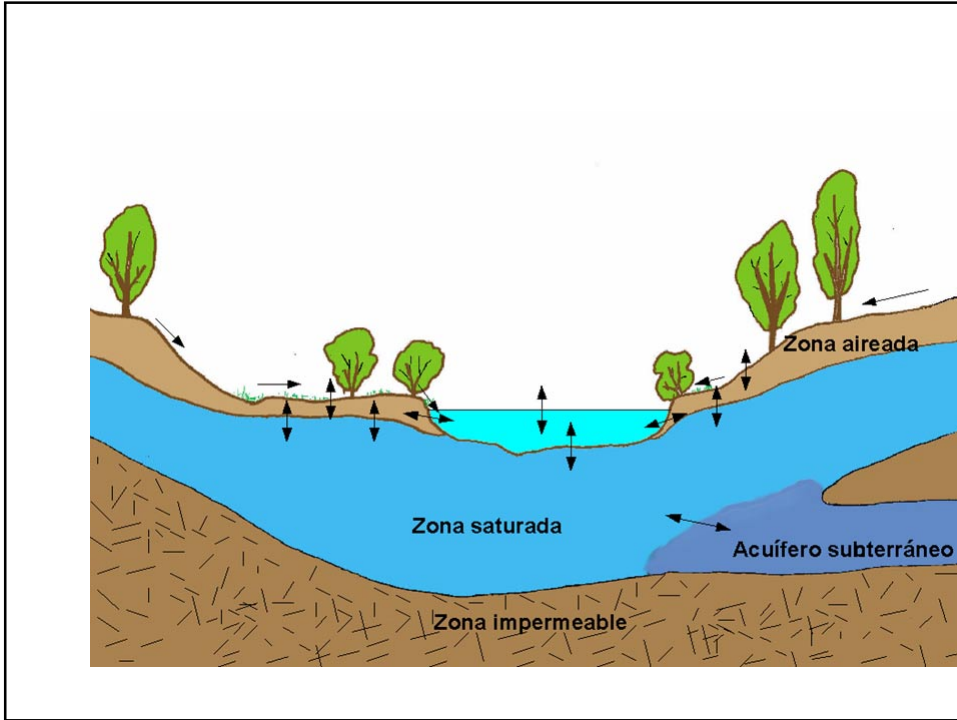


- Sediments **Trap**
- Peak-floods mitigation
- Nutrients, Dissolved substances and Pesticides **Filter**
- Fluvial **Corridor** (migration path)
- Organic Matter Source for soils and water
- Channel **Stabilization** by riparian Vegetation

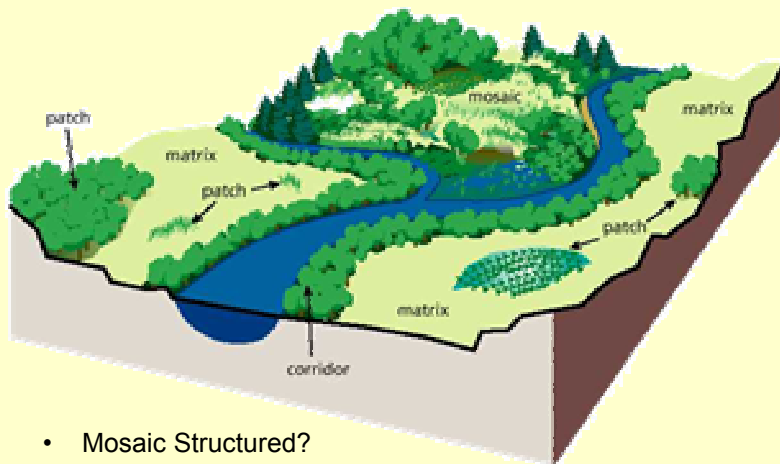
Riparian Vegetation



- Structured by water phreatic levels?



Riparian Vegetation



- Mosaic Structured?
- Structured?

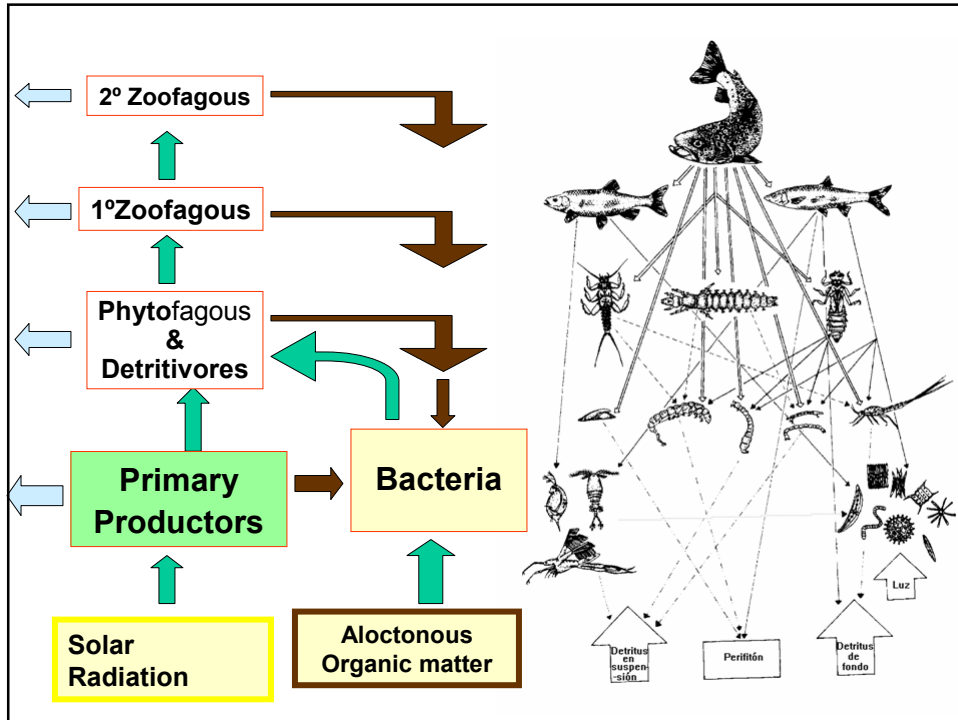
Las Comunidades Acuáticas



- Naturalidad
- Biodiversidad
- Rareza
- Endemismos
- Especies amenazadas/ protegidas
- Fragilidad

Fluvial Ecosystem's Principal Biological Components

Periphyton
Macrophytes
Phytoplankton
Macrobenthos
Fisheries



Primary Production Autotrophy

- Periphyton, Macrophytes y Phytoplankton
- Composition:
 - Plants
 - Bryophytes
 - Algae
 - Protist
 - Bacteria
- Fluvial Zonation (dominance):
 - Head streams: periphyton & bryophytes
 - Intermediate reaches: macrophytes
 - Lower reaches: phytoplankton

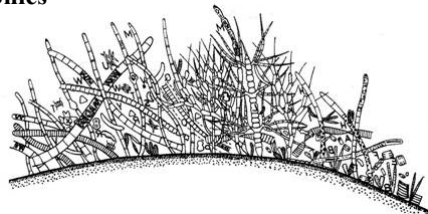
Primary Production

- **Periphyton**
 - Symbiosis including single cellular algae, bacteria and fungus, living embedded in a polysaccharide matrix.
 - Alive film that covers bottom surfaces and all submerged objects
- **Macrophytes**
 - Large Plants (g. flowered) floating or rooted
- **Phytoplankton**
 - Single cellular Algae living suspended in the water column

Periphyton

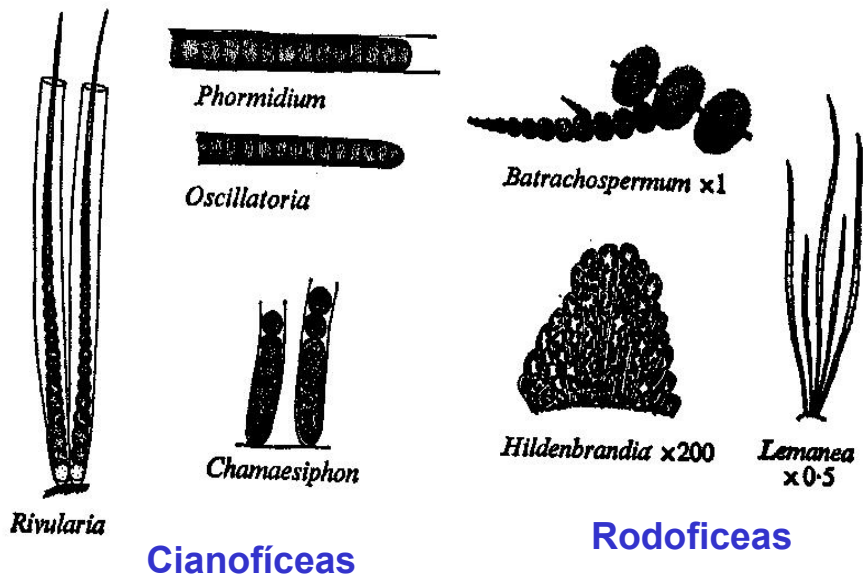
Formations:

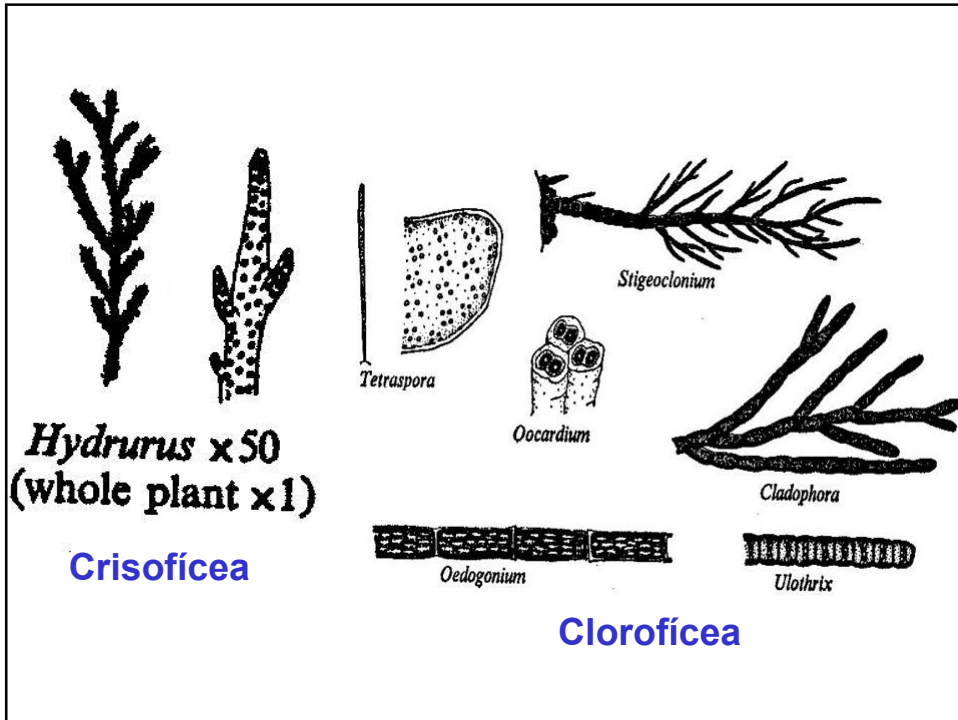
- Microalgae: Bio-films on substrates
- Macroalgae: symbiosis of different shapes
 - Cushion type
 - Brushes type
 - Filamentous colonies
 - Gelatinous colonies
- Tipos de Substrato:
 - Epilimon
 - Epifiton
 - Epipelon



Perifitón

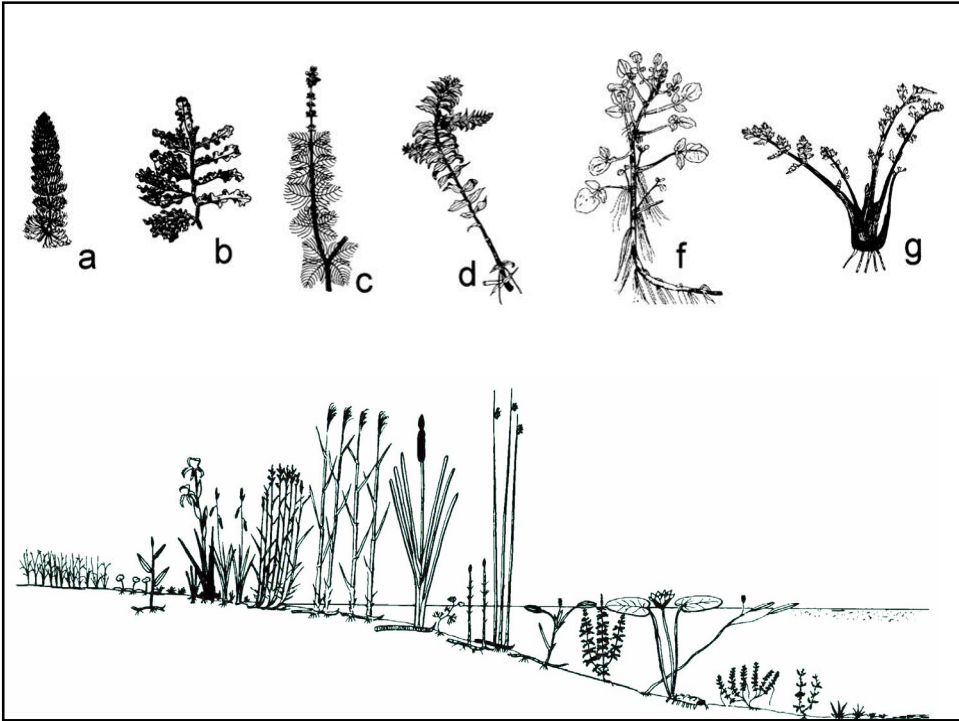
- **Diatoms**
 - *Diatoma*, *Gonphonema*, *Navicula*, *Melosira*, *Cocconeis*
- **Cianoficea (Blue-green algae)**
 - *Phormidium*, *Oscillatoria*, *Rivularia*, *Nostoc*
- **Rodoficea**
 - *Lemanea*, *Batrachospermum*, *Hildenbrandia*
- **Crisoficea**
 - *Hydrurus*
- **Cloroficea**
 - *Cladophora*, *Strigeoclonium*, *Ulotrix*, *Spirogyra*, *Chaetophora*



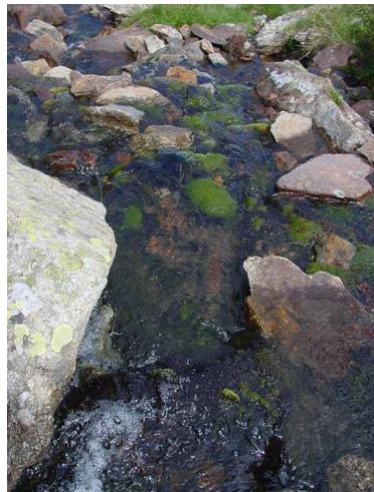


Macrophytes

- **Composition**
 - Large Algae:
 - filamentous (*Cladophora*),
 - Characeas
 - Mosses (Bryofitas): *Fontinalis*
 - Vascular Plants (Angiosperma)
- **Formations**
 - **Free** (submerged, emergents, floating on surface)
 - **Rooted:**
 - **Submerged** in running waters, *Ranunculus*, *Pot. pectinatus*)
 - **Emergent** (*Berula*, *Typha*, *Phragmites*, reefs,)
 - **Floating leaves** (water lily, *Pot. natans*, *Polygonum*)



Lemna



Fontinalis



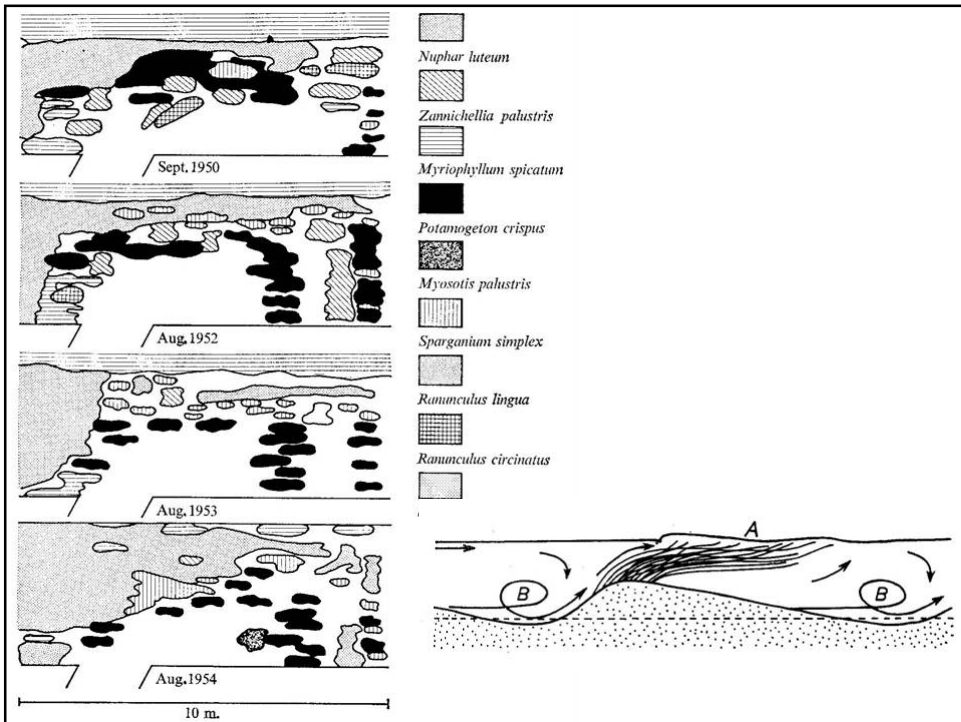
Ranunculus

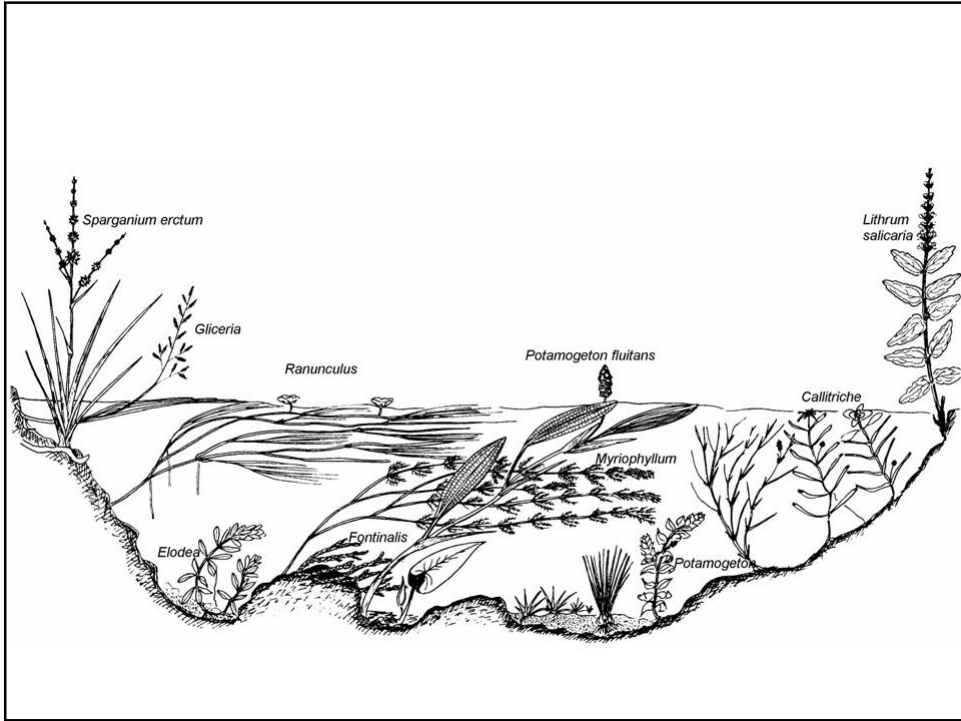


Oenanthe aquatica

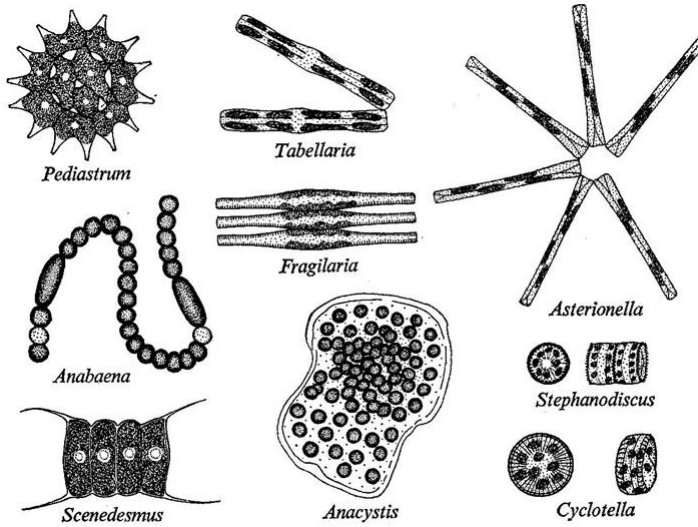


Carex





Phytoplankton



Associated Fauna to fluvial ecosystems

- Aquatic Fauna
 - Lotic or reophilic
 - Lentic
- Riparian Fauna
 - Amphibious
 - Terrestrial
- Terrestrial Fauna: They use the river for:
 - drinking (daily cycles)
 - Food (ungulates during dry season)
 - Refuge (accidental)

Terrestrial Fauna asociated to rivers



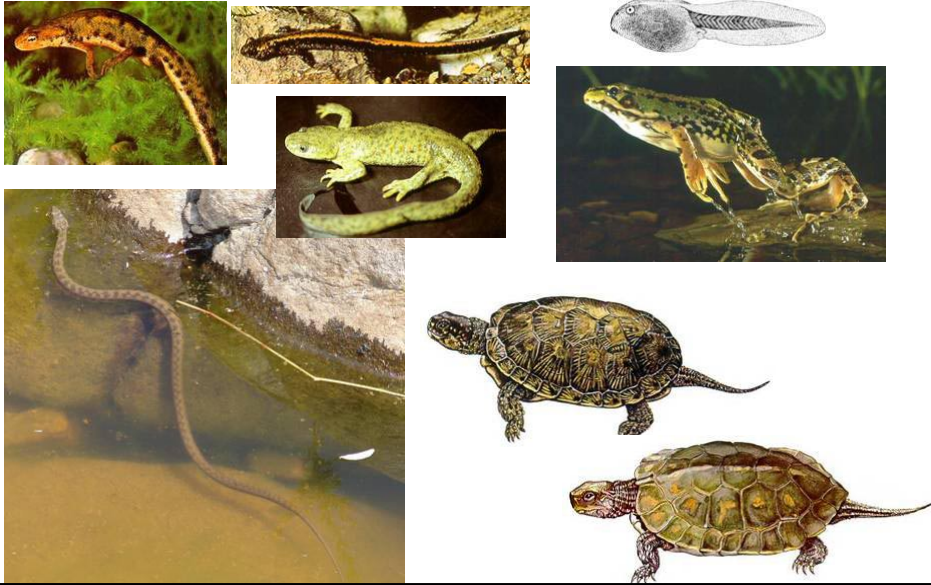
Riparian fauna



Aquatic Fauna

- **Macroinvertebrates**
- **Vertebrates:**
 - **Fishes**
 - Amphibians
 - Reptiles
 - Birds
 - Mammals

Aquatic Amphibians & Reptiles



Aquatic Avian Fauna

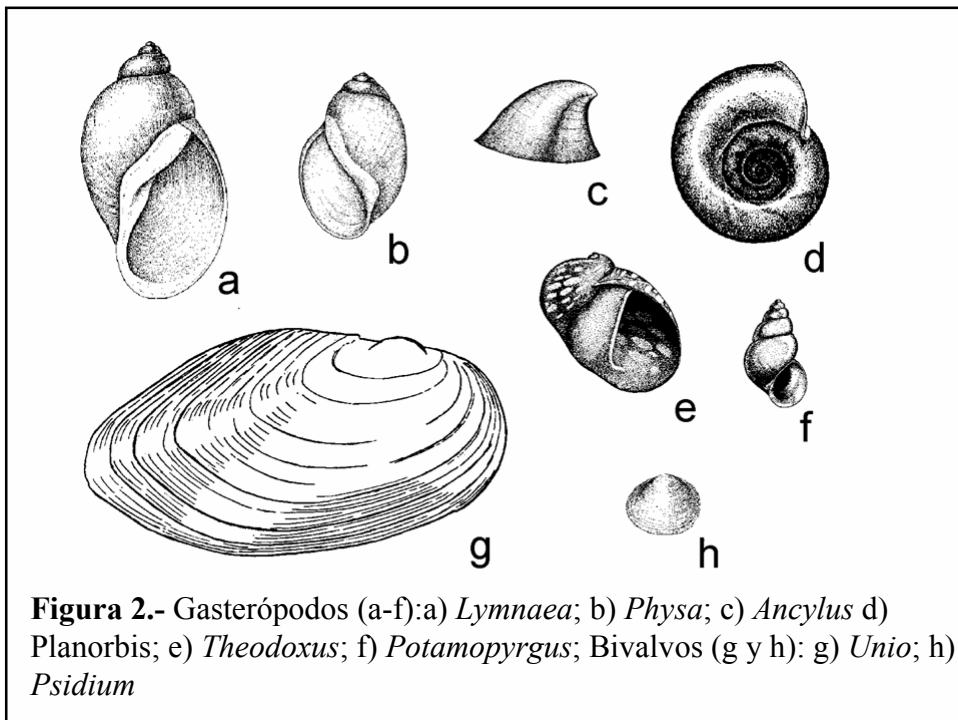
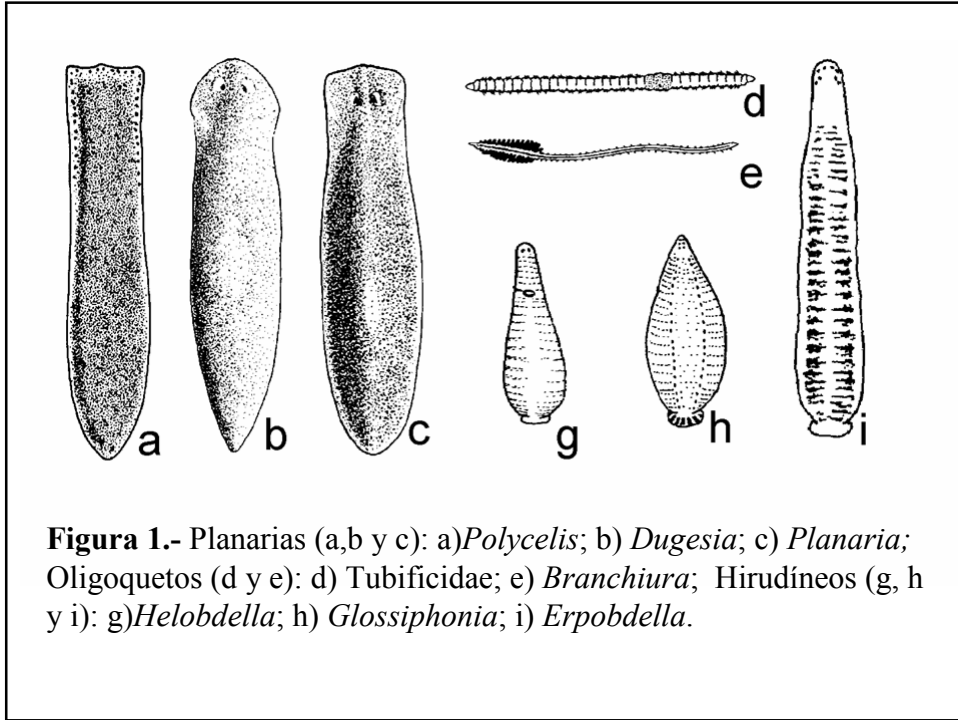


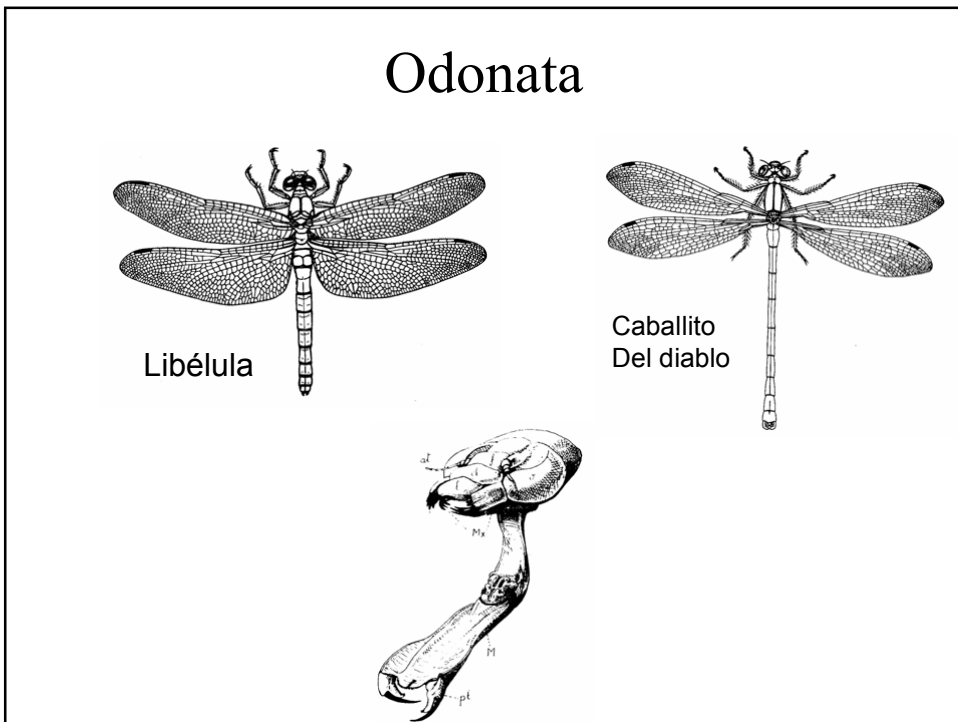
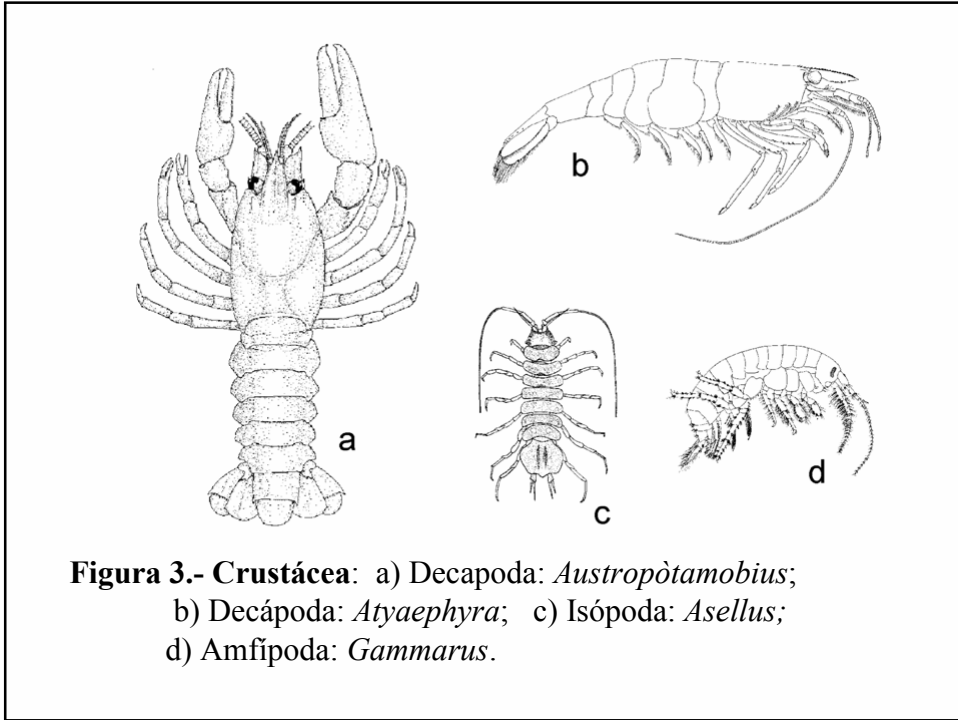
Aquatic Mammals

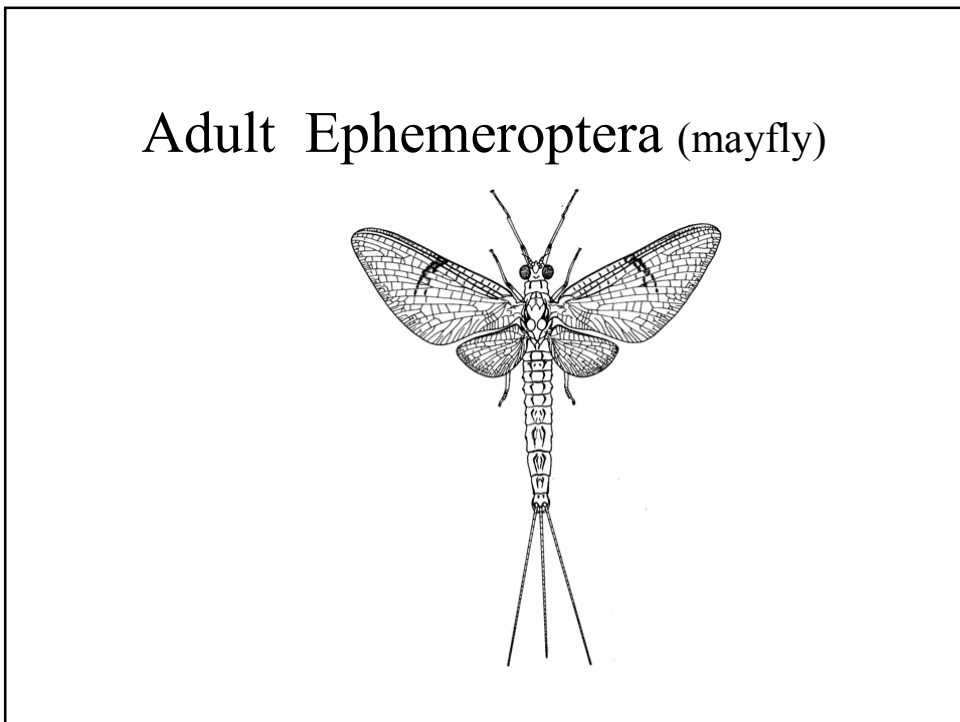
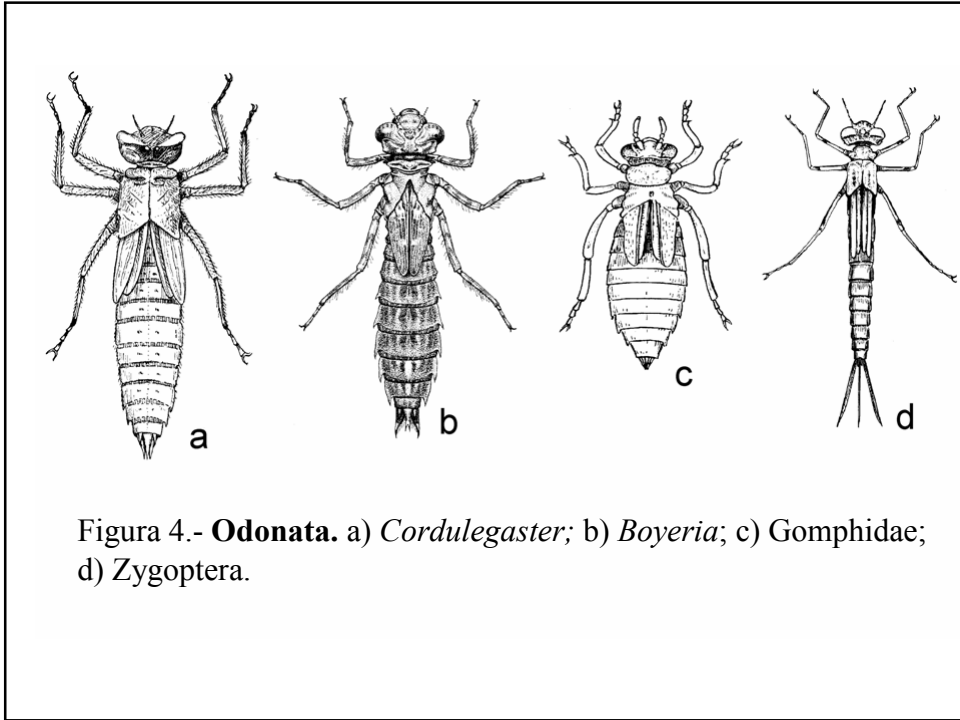


Macroinvertebrates

- Planaria
- Anelids
 - Oligochaeta
 - Hirudínea (leaches)
- Moluscos
 - Gasterópods
 - Bivalvs
- Crustacea
 - Isopods
 - Anfípods
 - Decapods
- **Insects**
 - Odonata
 - Efemeroptera
 - Plecoptera
 - Aquatic Hemíptera
 - Aquatic Neuroptera
 - Aquatic Coleoptera
 - Tricopteros
 - Aquatic Díptera







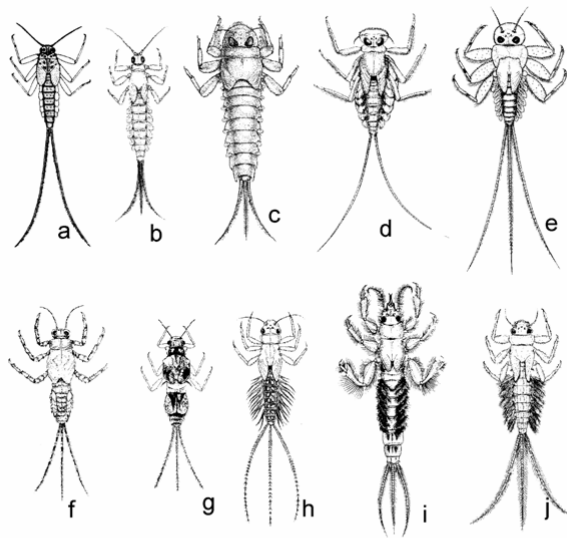
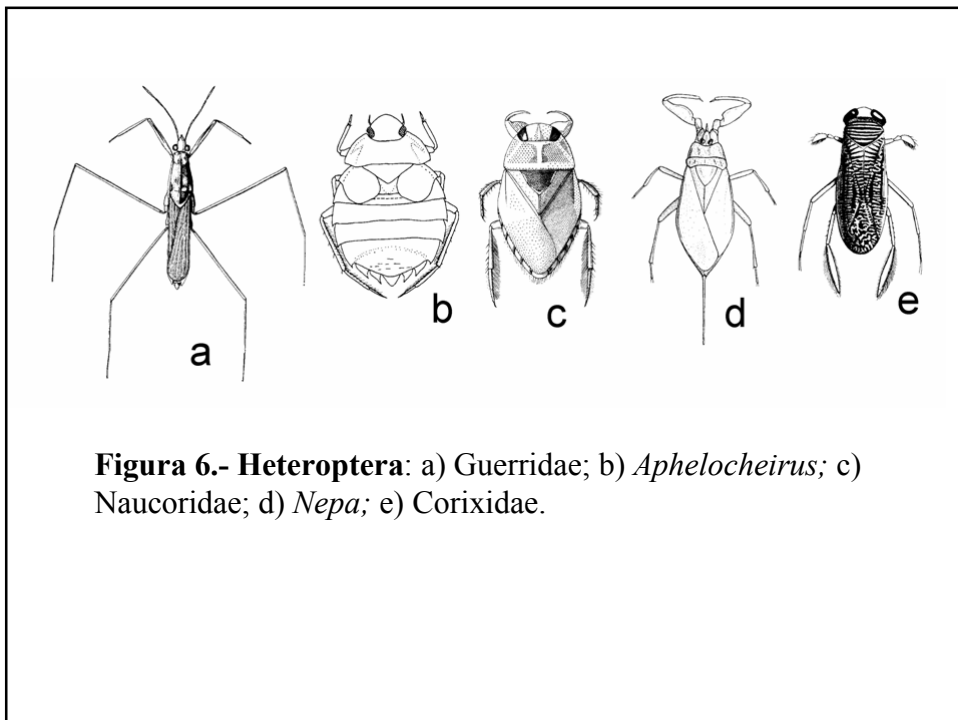
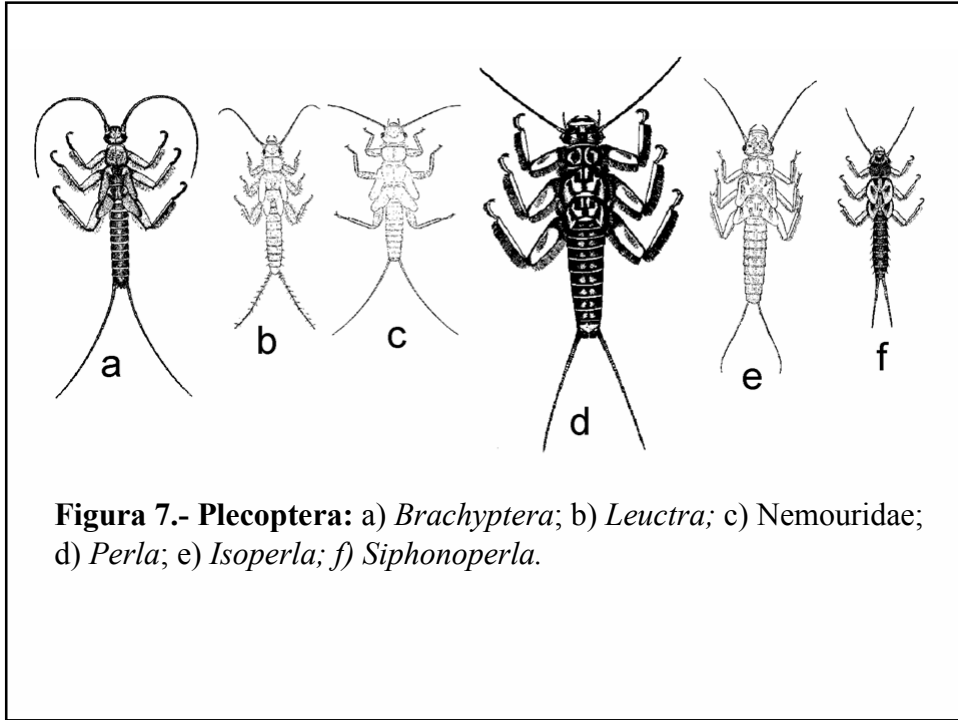
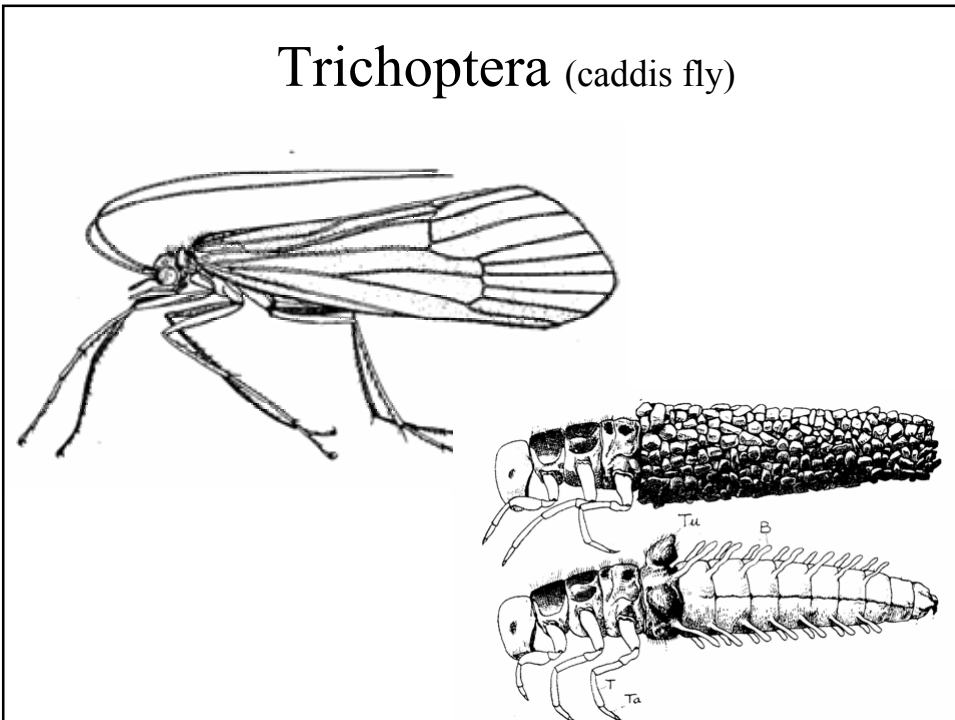
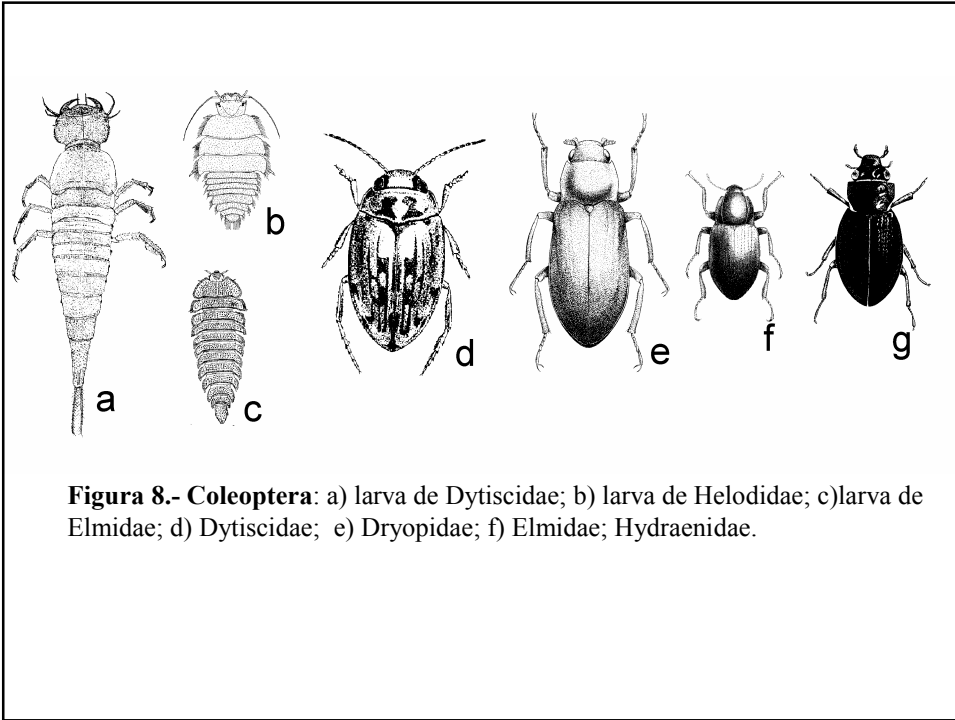


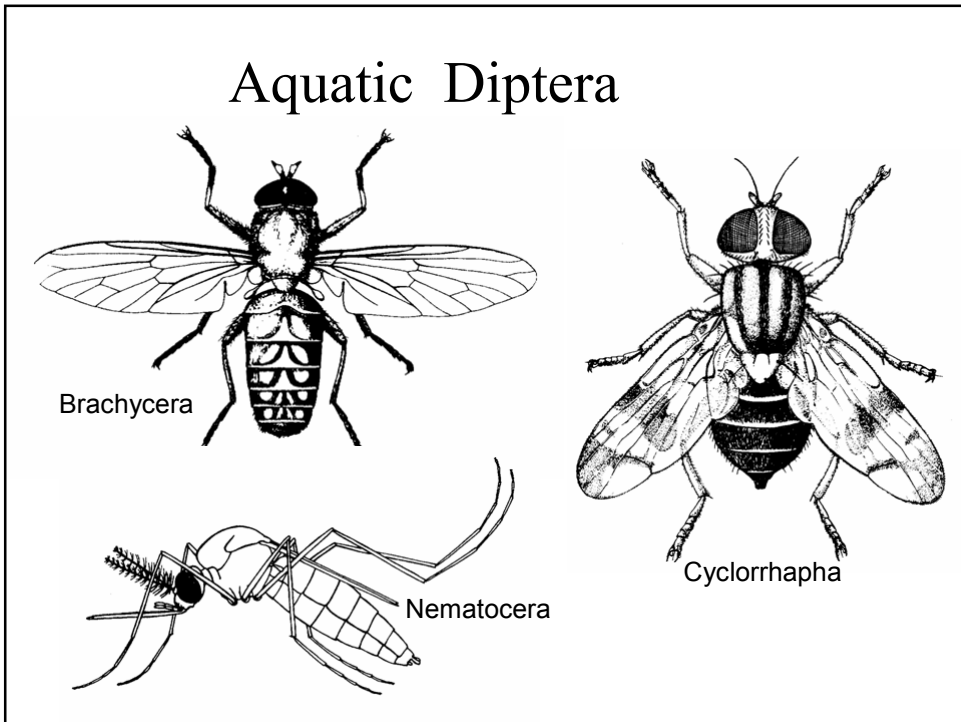
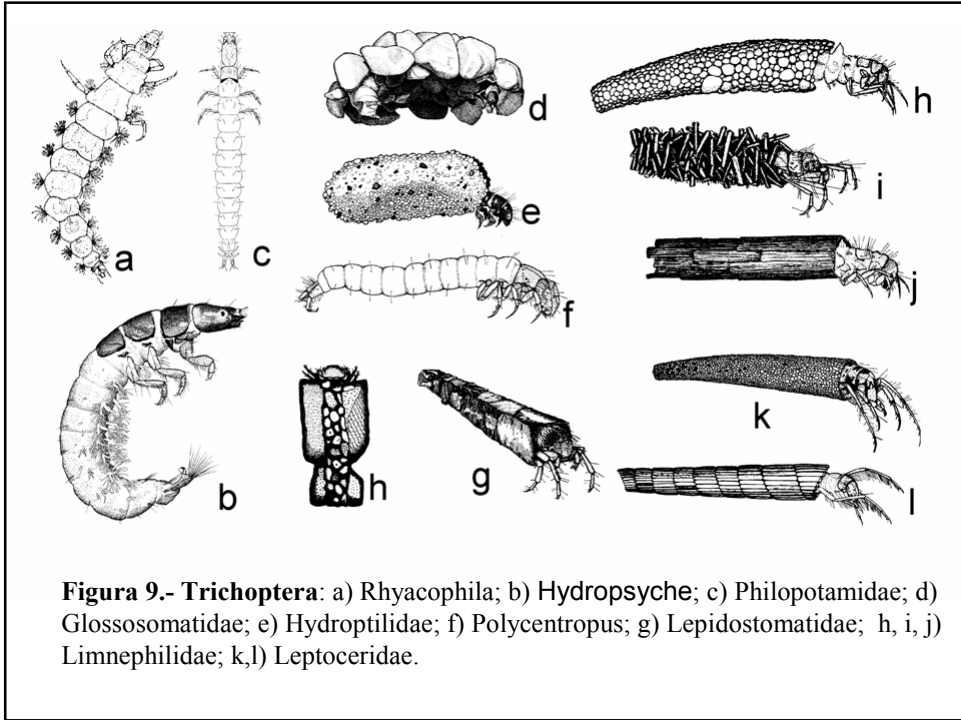
Figura 5.- Efemeróptera: a y b) *Baetis*; c) *Oligoneuriella*; d) *Epeorus*; e) *Ecdyonurus*; f) *Ephemerella*; g) *Caenis*; h) *Paraleptophlebia*; i) *Ephemera*; j) *Potamantus*.

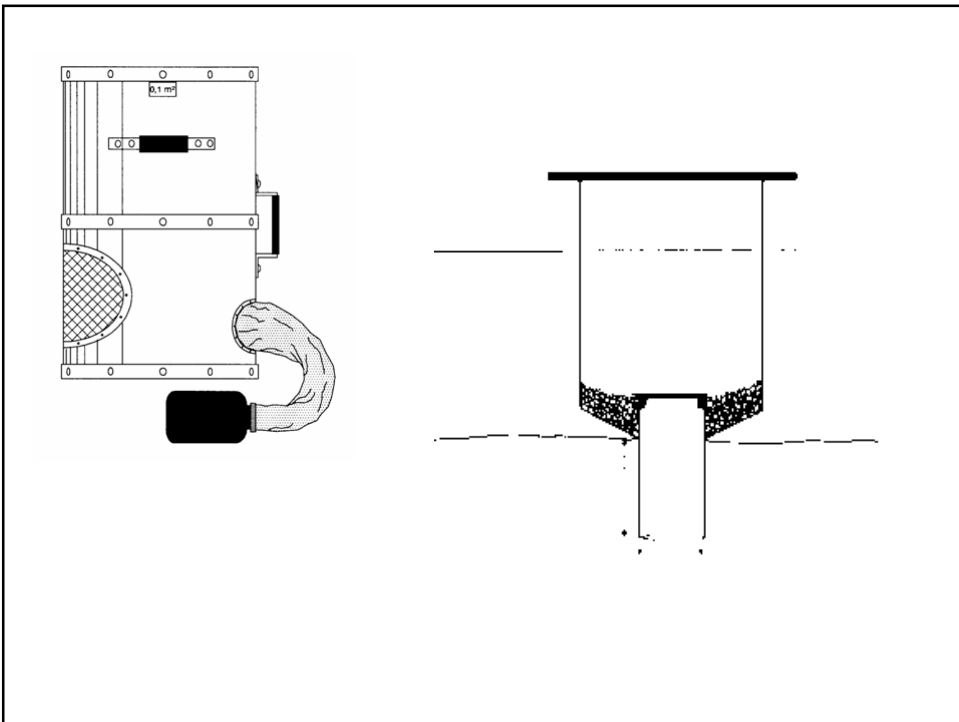
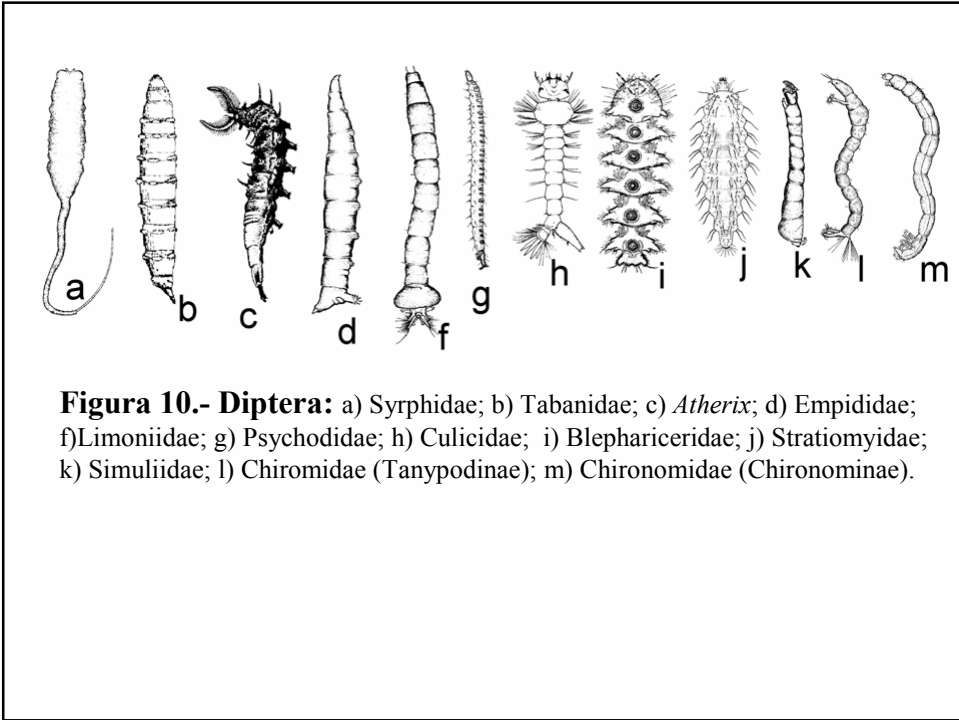
Adult Plecoptera (stone fly)







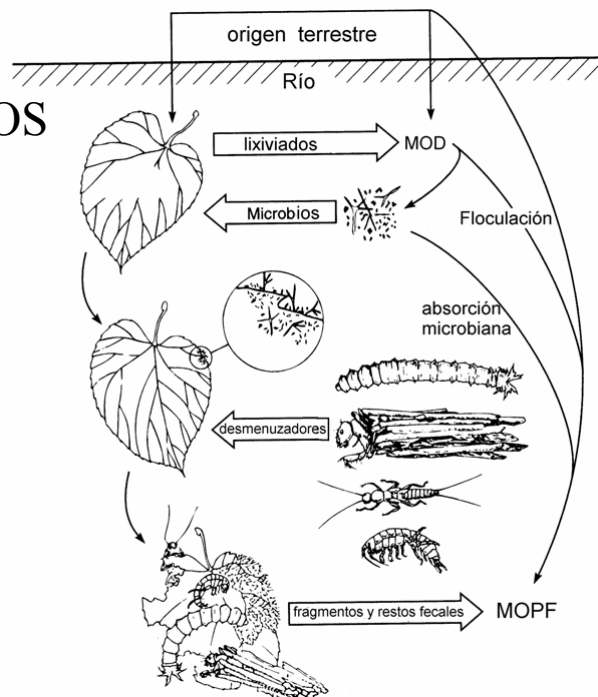




Trophic Guilds

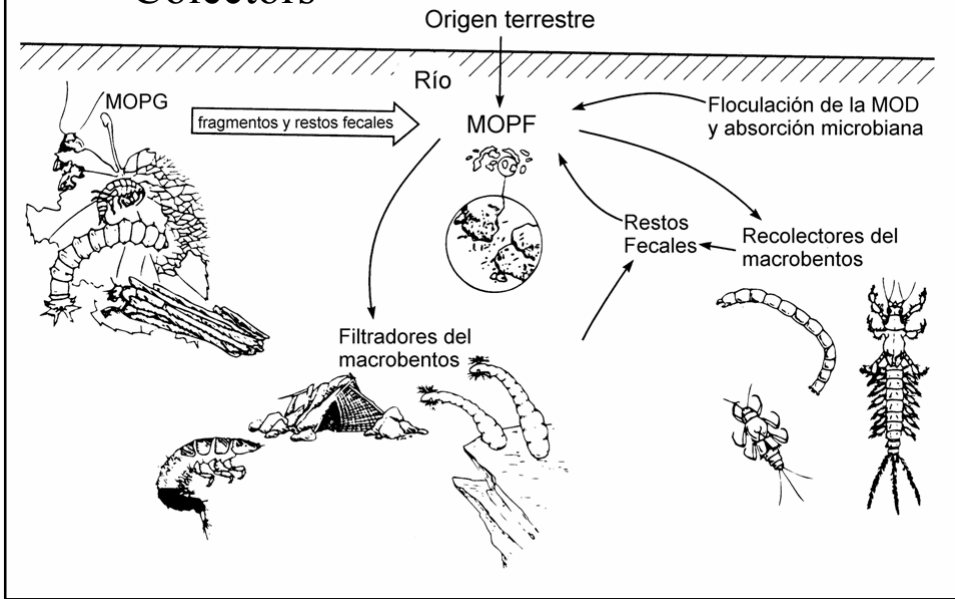
- **Shredders:** LPOM
- **Collectors:** FPOM
 - **Filters**
 - **Gatherers**
- **Scrapers:** fitofagous (periphyton)
- **Predators**
- **Parasites**

MACROBENTOS Shredders



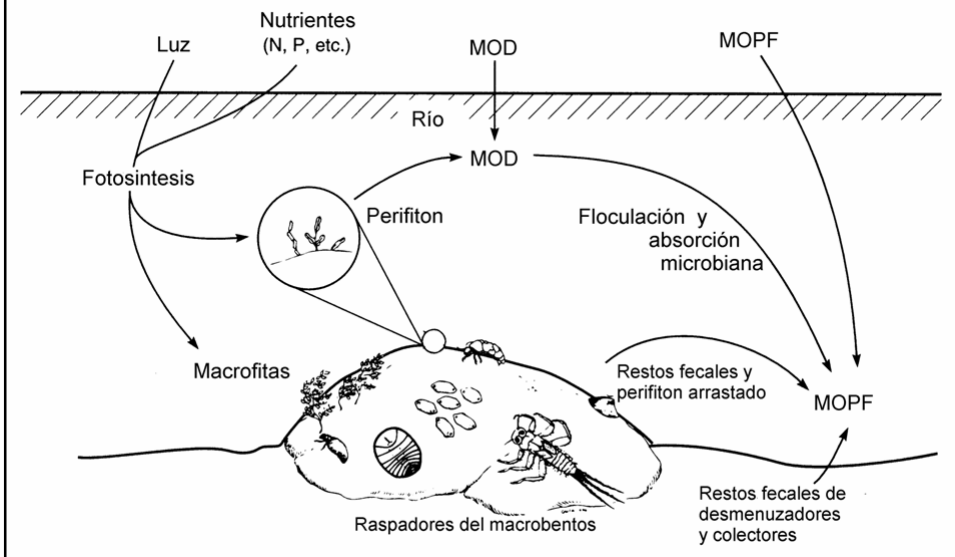
MACROBENTOS

Colectors



MACROBENTOS

Fitofagous (scrapers)





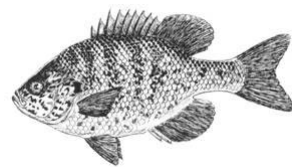
Fish bones on an
otter fecal deposit

Tadpoles
(scrapers)

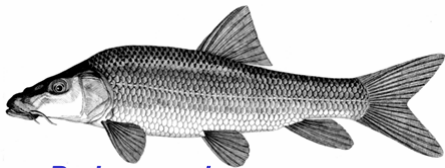


Fish typology

- **Lotic**: living in running water.
 - Aerodynamic shape; transversal section circular
 - Powerful muscles requiring great respiration capacity supported by water current (looking upstream) and high Oxygen content.
- **Lentic**: living in pools and slow waters.
 - Body laterally flattened; transversal section vertically elongated.
 - Physiology adapted to high temperatures & low oxygen concentrations
- **Bentonic**: living close to the bottom.
 - Body dorso-ventrally flattened, or elongated.
 - Eyes dorsally located, pelvic fins and gill openings located laterally.



Lotic species



Barbus comiza



Salmo trutta



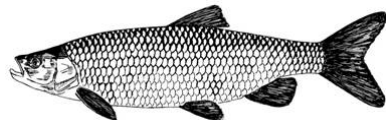
Barbus bocagei



Oncorhynchus mykiss

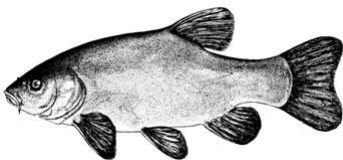


Chondrostoma polylepis



Squalius pyrenaicus

Lentic species



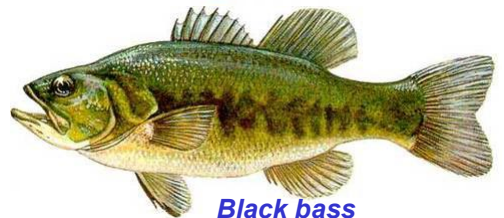
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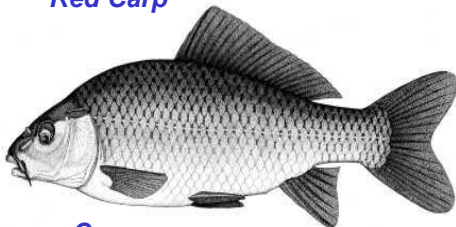
Pike



Red Carp



Black bass

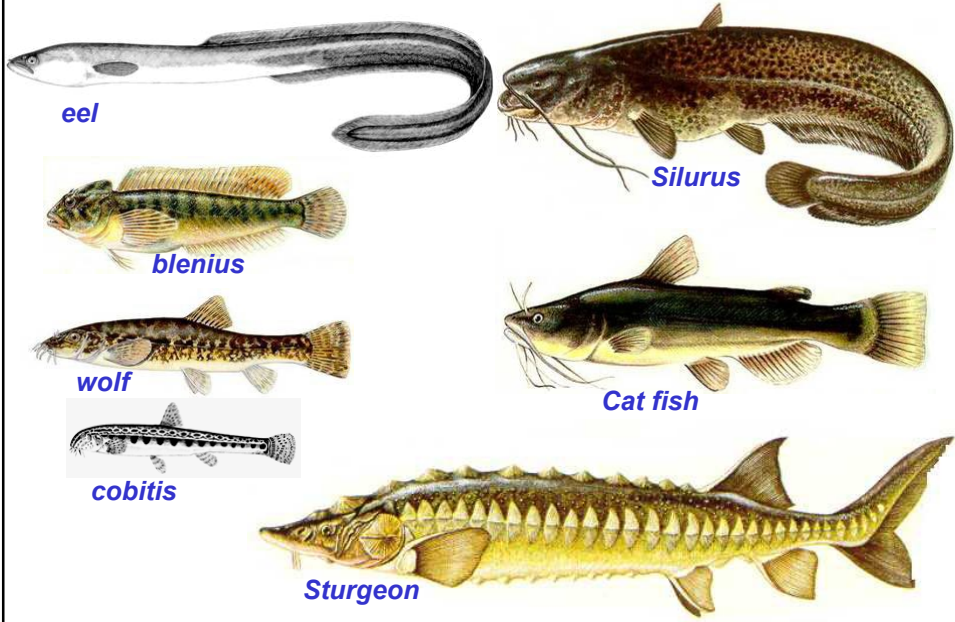


Carp

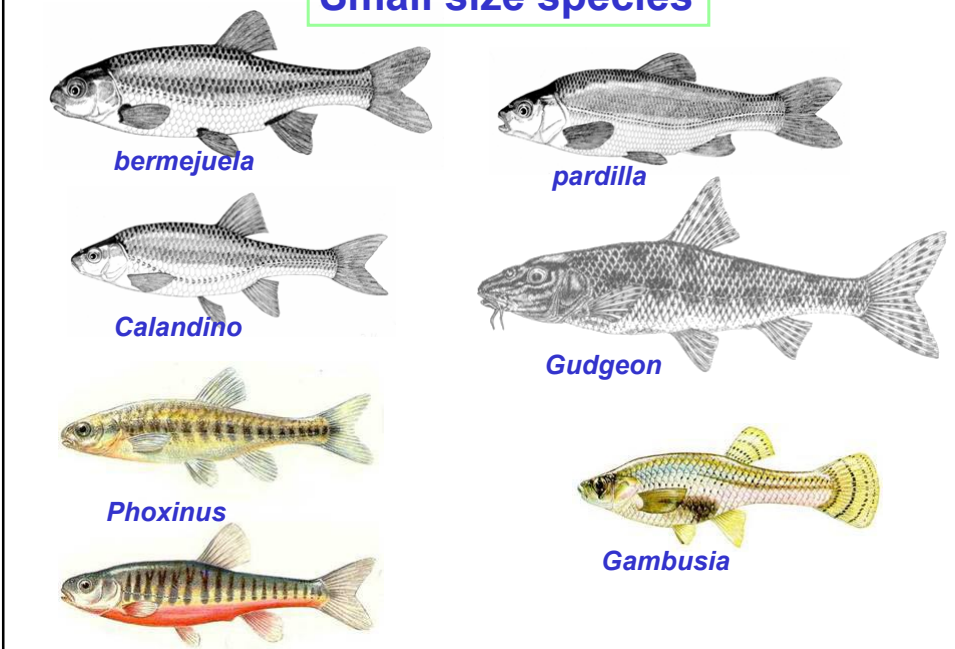


Sun fish

Benthic species



Small size species

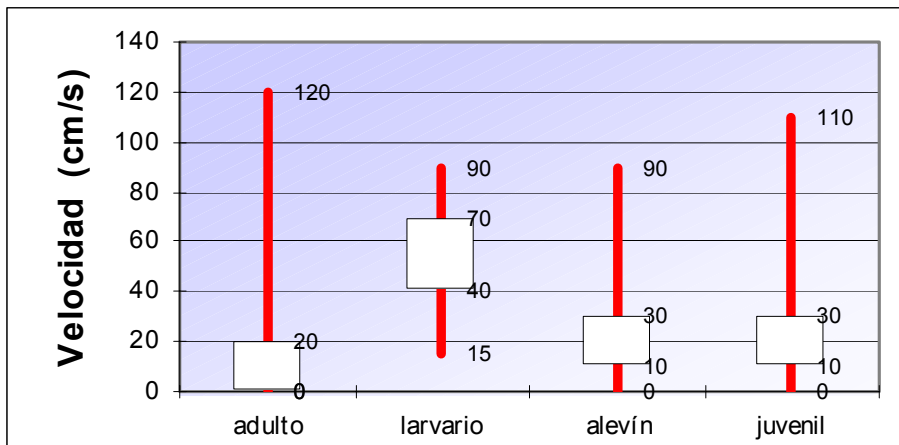


Abiotic Factors controlling Fish populations

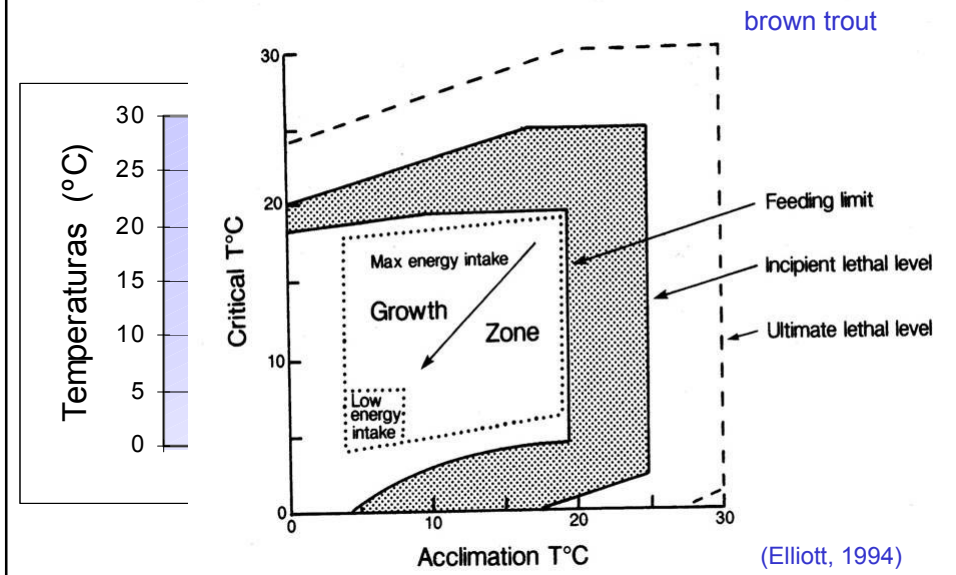
- Hydraulic conditions
- Physico-chemical conditions:
 - Dissolved oxygen
 - Temperature (metabolism control)
 - Water Hardness: growth (150mg/l CO_3Ca)
- Substrate and cover

Water velocity requirements

brown trout



Water Temperature Requirements

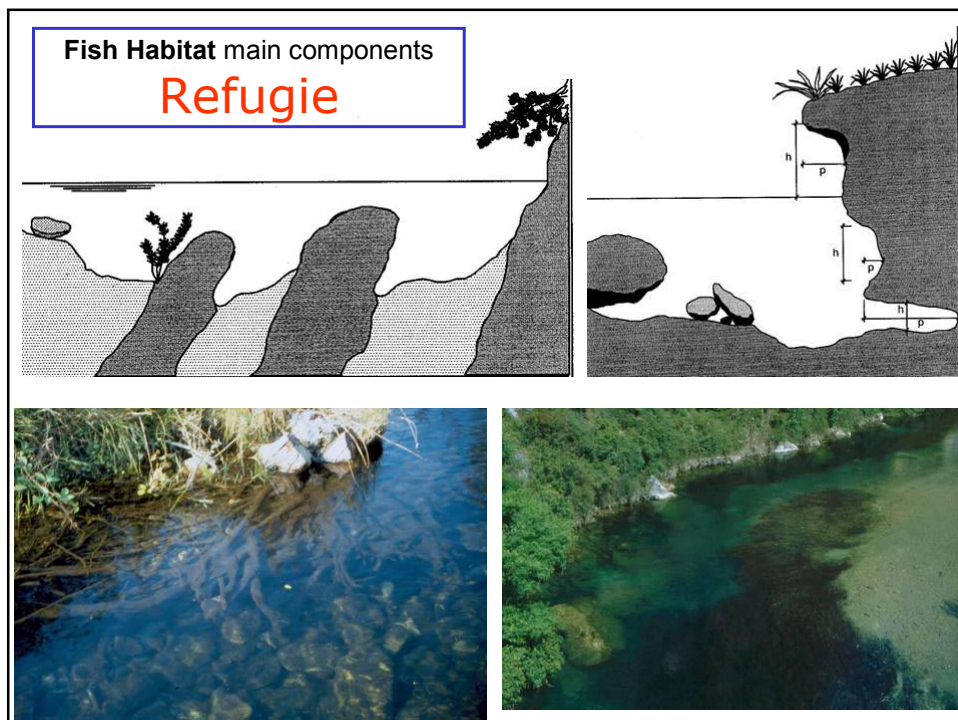


Fish Behavior Typology

- Group Behavior
 - Territorial defensive
 - Fish shoals
- Sedentary
- Migratory
 - Partially
 - Diadromous:
 - Anadromous
 - Catadromous

Fish Habitat main components

- Refuge zones
- Spawning grounds
- Feeding and food production Areas (macrobentos)
- Water Quantity (Flow regime)
- Water Quality



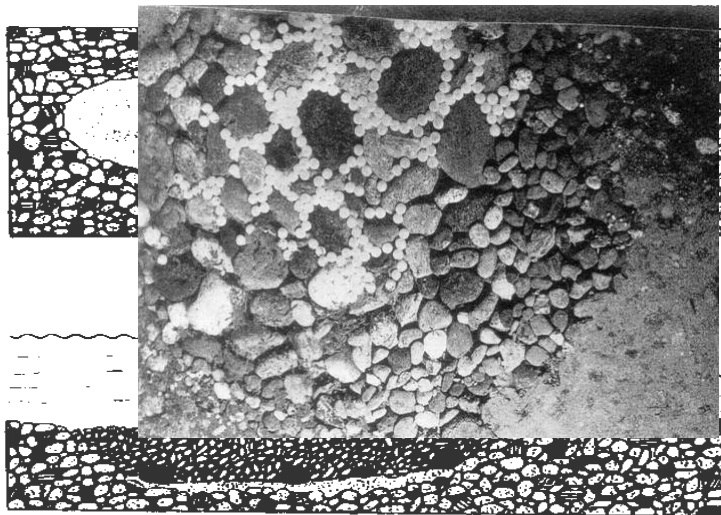
Fish Habitat main components

Refugie

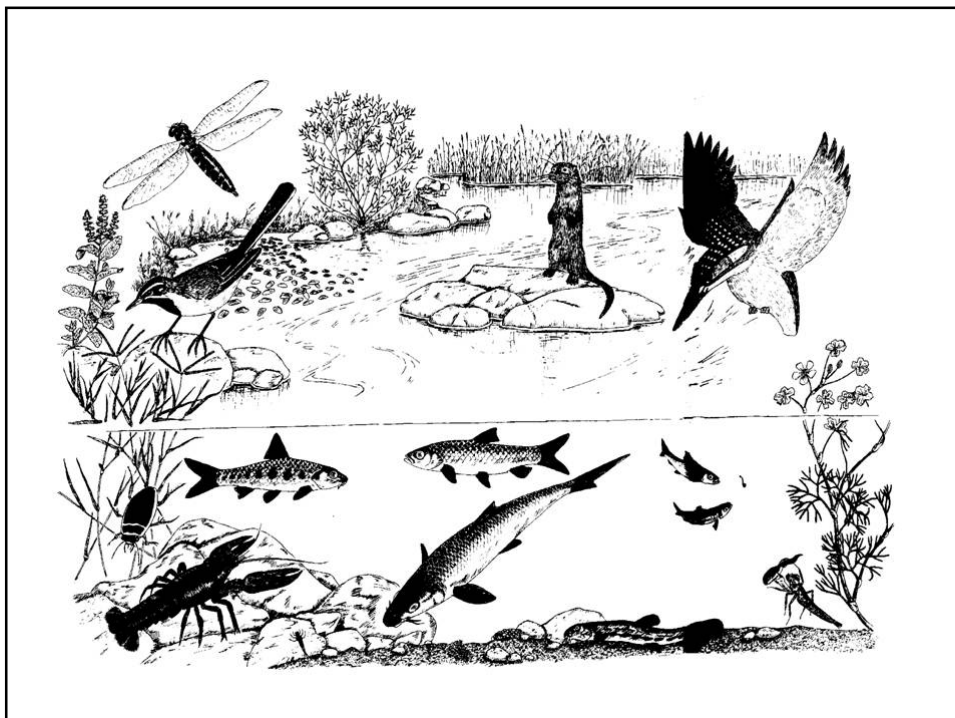
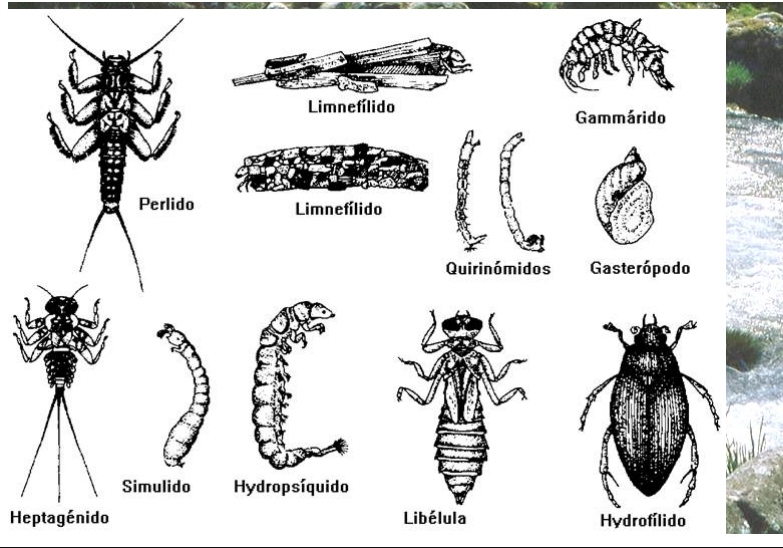


Fish Habitat main components

Spawning

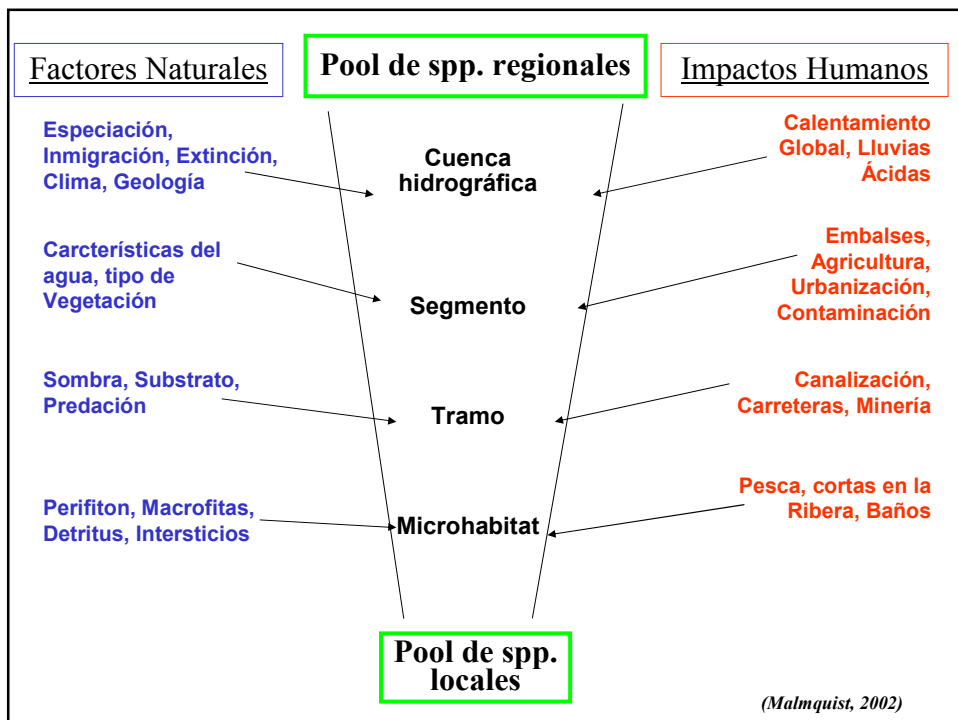


Fish Habitat main components
Feeding areas



FLUVIAL ECOLOGY

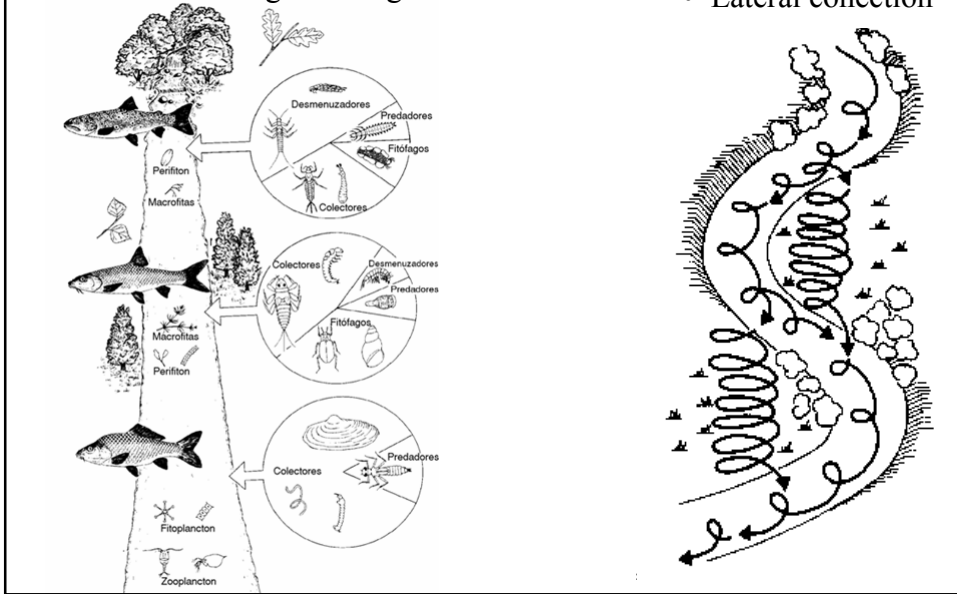
SYNTHETIC THEORIES



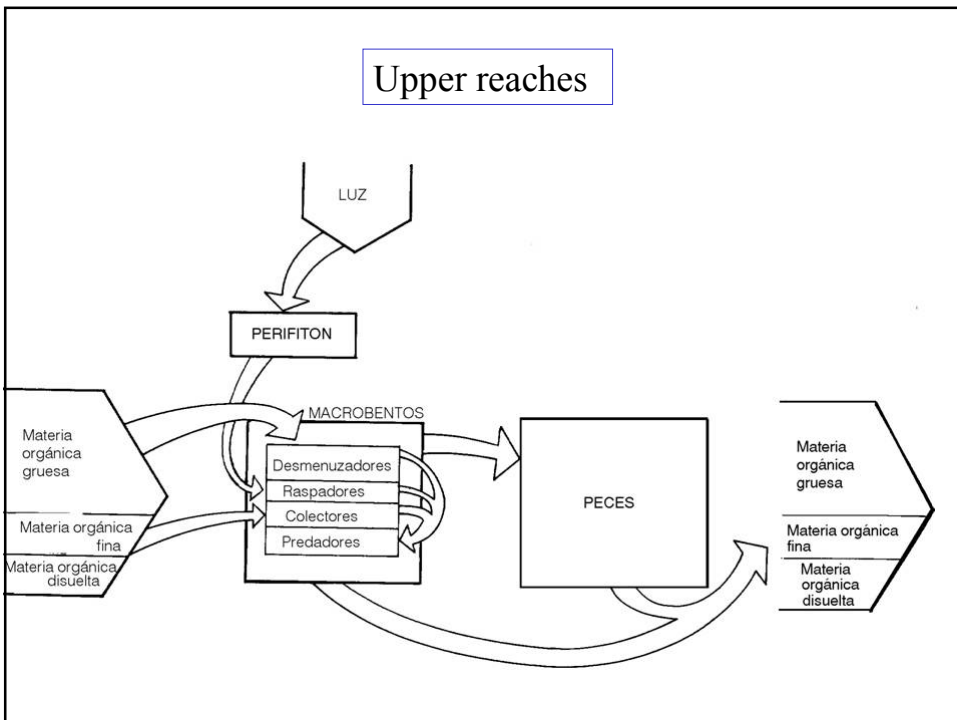
Spatial Dimension:

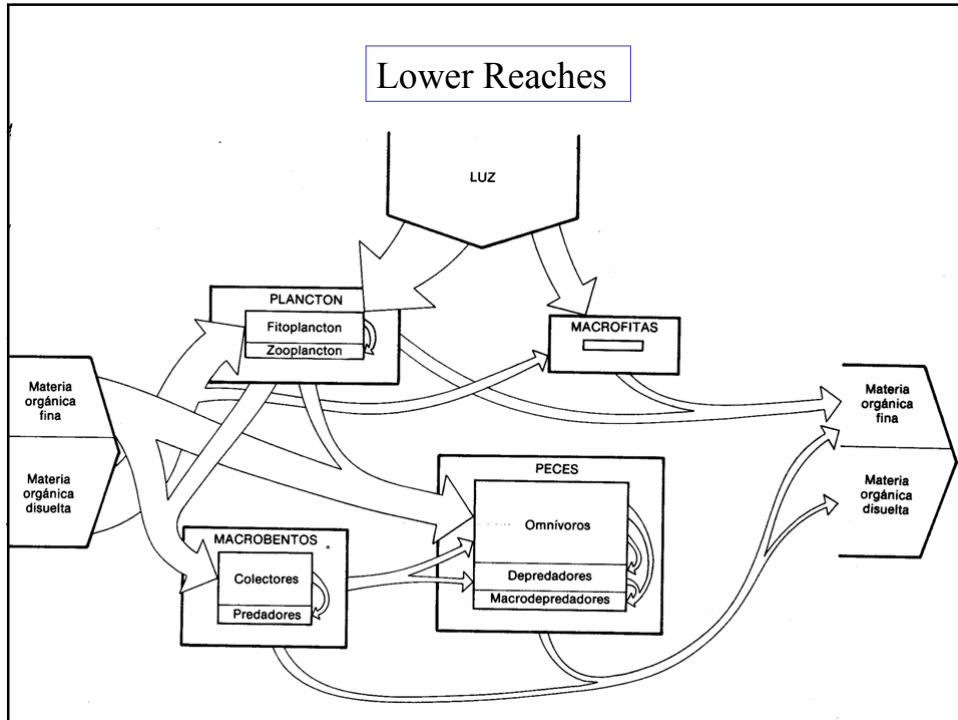
- Zonation or Longitudinal gradient

- Lateral connection



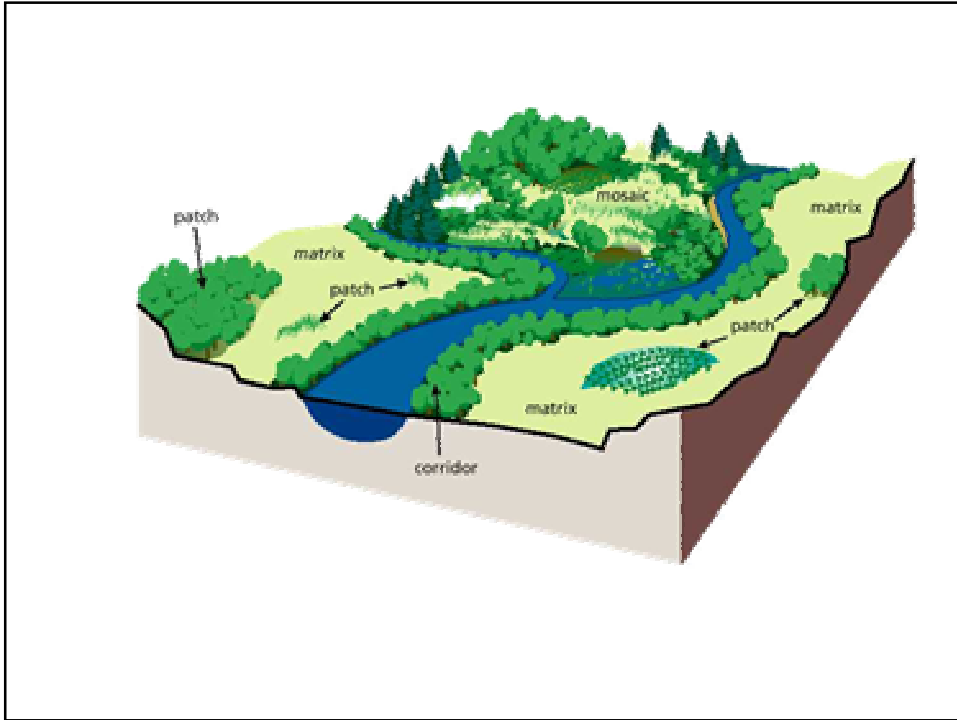
Upper reaches



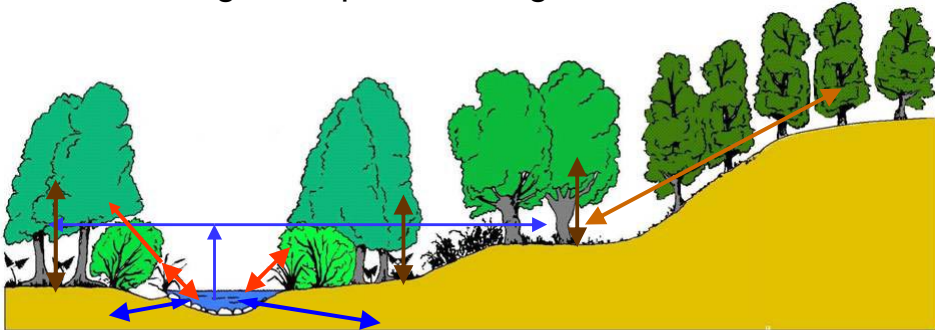


The Temporal Dimension

- **Fluvial Habitat** is not only spatially complex (heterogenic mosaic) but also temporally (expansion & contraction cycles) occupied by abundant aquatic, amphibian and terrestrial fauna.
- Biological **distribution patterns** reflect the habitat complexity and its environmental gradients
 - Life cycles depend from the changes in the spatial mosaics
 - Fluvial Species are adapted to take advantage of the habitats by means of having a great renovation rates
- Habitat complexity maintains biological communities at **different successional levels**.
- Many species **migration behavior** fits to the temporal changes that occur in the riparian habitats mosaic (floods and droughts dynamics)



Faunistic migration paths through different ecotones



1. From the water column to the riparian zone and to floodplain
2. From the water column to aquifers and interstitial system
3. From the water column to water margins
4. From the riparian soils to the tree cover
5. From the floodplains to the surrounding landscapes

Conectividad

- Lateral: aquatic habitat - riparian - landscapes
 - *Restoration*: elimination of dykes,
- Vertical: superficial water – freatic (aquifers)
 - *Restoration*:
 - Elimination of roads, buildings, soil sealed,
 - Take away earth refills, debris, slugs and clays;
 - Refill allways with permeable substrates

