RIVER ECOLOGY

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- **Rivers** are large bodies of water with a typically unilateral directional flow. Every river must have a source where it begins known as the headwaters and an estuary where it meets the ocean or sea.

- Rivers are categorized as major, medium, and minor, depending of the number of tributaries, the stage of development, and its use as a resource.

- A river ecosystem is recognized by these specific characteristics:

- **River ecosystems have:**

- flowing water that is mostly unidirectional
- a state of continuous physical change
- many different (and changing) microhabitats
- variability in the flow rates of water
- plants and animals that have adapted to live within water flow conditions.

Top Down View Of A River

- **Cascade:**When water flows over larger rocks and boulders, it becomes a **cascade**. Cascades are rough places to live. If you've seen one, you know that water often beats onto rocks so hard that it creates foam and spray. But there is a lot of life in cascades because of the high oxygen levels.

❖**Falls**

As harsh as the environment is in a cascade, it is even more brutal in a falls. But like the cascade, the water is highly oxygenated. Diatoms are able to cling to vertical services quite well. Any animal that wants to live in a falls is going to have to be able to perform the same feat. After all, as the water drops, it is going very fast.

❖**Pool**

Pools provide darkness and slow movement of water. Their oxygen levels are often low. During droughts, pools are sometimes the only parts of a stream that stay wet. The stream's water suddenly slows down, dropping its load of silt and organic materials.

❖**Run**

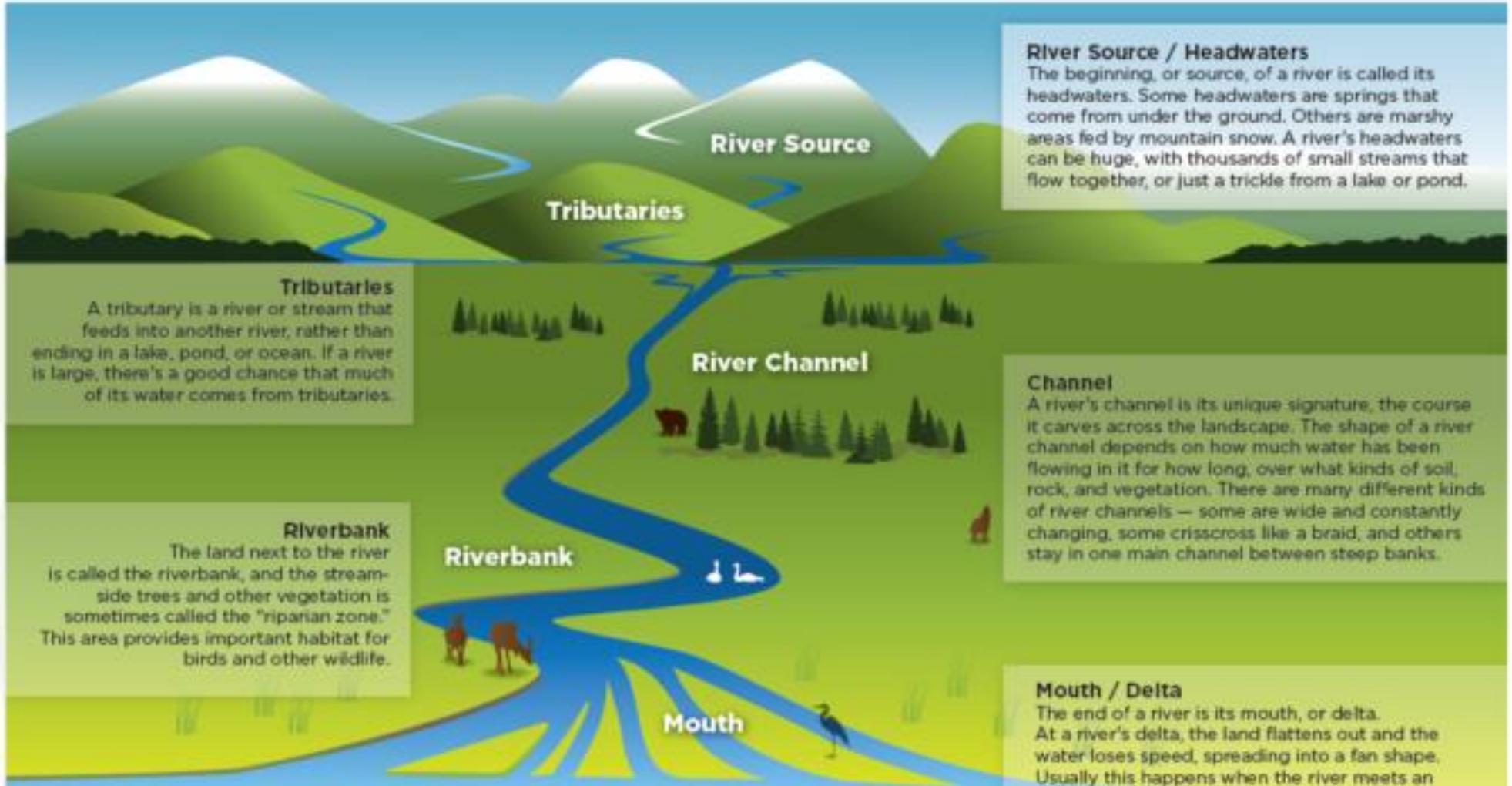
In large rivers most people think of long, smooth-flowing stretches of fast water. These are called runs. Smaller streams have them, too, of course. The surface may seem smooth, or it may have whirls of turbulence--but there is no froth or spray.

❖**Riffle**

Riffles are a rich part of any river

RIVER ANATOMY

The United States has more than 250,000 rivers — a total of 3.5 million miles. No two of these rivers are the same. Each river is unique to its landscape, winding through low foothills and valleys, rushing clear and cold from mountain forests, or sweeping warm and muddy down desert canyons. No matter how different our rivers are, however, they share some basic features:



River Source / Headwaters
The beginning, or source, of a river is called its headwaters. Some headwaters are springs that come from under the ground. Others are marshy areas fed by mountain snow. A river's headwaters can be huge, with thousands of small streams that flow together, or just a trickle from a lake or pond.

Tributaries
A tributary is a river or stream that feeds into another river, rather than ending in a lake, pond, or ocean. If a river is large, there's a good chance that much of its water comes from tributaries.

Channel
A river's channel is its unique signature, the course it carves across the landscape. The shape of a river channel depends on how much water has been flowing in it for how long, over what kinds of soil, rock, and vegetation. There are many different kinds of river channels — some are wide and constantly changing, some crisscross like a braid, and others stay in one main channel between steep banks.

Riverbank
The land next to the river is called the riverbank, and the stream-side trees and other vegetation is sometimes called the "riparian zone." This area provides important habitat for birds and other wildlife.

Mouth / Delta
The end of a river is its mouth, or delta. At a river's delta, the land flattens out and the water loses speed, spreading into a fan shape. Usually this happens when the river meets an ocean, lake, or wetland.

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CHARACTERISTICS

A) Water flow

Water flow is the main factor that makes river ecology different from other water ecosystems. This is known as a lotic (flowing water) system. The strength of water flow varies from torrential rapids to slow backwaters. The speed of water also varies and is subject to chaotic turbulence. Flow can be affected by sudden water input from snowmelt, rain and groundwater. Water flow can alter the shape of riverbeds through erosion and sedimentation, creating a variety of changing habitats.

B) Substrate

The substrate is the surface on which the river organisms live. It may be inorganic, consisting of geological material from the catchment area such as boulders, pebbles, gravel, sand or silt, or it may be organic, including fine particles, leaves, wood, moss and plants. Substrate is generally not permanent and is subject to large changes during flooding events.

C) Light

Light provides energy for photosynthesis, which produces the primary food source for the river. It also provides refuges for prey species in the shadows it casts. The amount of light received in a flowing waterway is variable, for example, depending on whether it’s a stream within a forest shaded by overhanging trees or a wide exposed river where the Sun has open access to its surface. Deep rivers tend to be more turbulent, and particles in the water increasingly weaken light penetration as depth increases.

D) Temperature

Water temperature in rivers varies with the environment. Water can be heated or cooled through radiation at the surface and conduction to or from the air and surrounding substrate. Temperature differences can be significant between the surface and the bottom of deep, slow-moving rivers. Climate, shading and elevation all affect water temperature. Species living in these environments are called poikilotherms – their internal temperature varies to suit their environmental conditions.

E)Water chemistry

The chemistry of the water varies from one river ecosystem to another. It is often determined by inputs from the surrounding environment or catchment area but can also be influenced by rain and the addition of pollution from human sources.

F)Oxygen is the most important chemical constituent of river systems – most organisms need it for survival. It enters the water mostly at the surface, but its solubility decreases as the water temperature increases. Fast, turbulent waters expose a wider water surface to the air and tend to have lower temperatures – achieving more oxygen input than slow backwaters. Oxygen is limited if water circulation is poor, animal activity is high or if there is a large amount of organic decay in the waterway.

G)Bacteria

Bacteria are present in large numbers in river waters. They play a significant role in energy recycling. Bacteria decompose organic material into inorganic compounds that can be used by plants and by other microbes.

H)Plants

Plants photosynthesise – converting light energy from the Sun into chemical energy that can be used to fuel organisms' activities.

A variety of plants can be found growing within a river system. Some plants are free-floating while others are rooted in areas of reduced current.

Algae are the most significant source of primary food in most rivers or streams. Most float freely and are therefore unable to maintain large populations in fast-flowing water. They build up large numbers in slow-moving rivers or backwaters. Some algae species attach themselves to objects to avoid being washed away.

Plants are most successful in slower currents. Some plants such as mosses attach themselves to solid objects. Some plants are free-floating such as duckweed or water hyacinth. Others are rooted in areas of reduced current where sediment is found. Water currents provide oxygen and nutrients for plants. Plants protect animals from the current and predators and provide a food source.

Invertebrates have no backbone or spinal column and include crayfish, snails, limpets, clams and mussels found in rivers. A large number of the invertebrates in river systems are insects. They can be found in almost every available habitat – on the water surface, on and under stones, in or below the substrate or adrift in the current. Some avoid high currents by living in the substrate area, while others have adapted by living on the sheltered downstream side of rocks. Invertebrates rely on the current to bring them food and oxygen. They are both consumers and prey in river systems.

Fish;The ability of fish to live in a river system depends on their speed and duration of that speed – it takes enormous energy to swim against a current. This ability varies and is related to the area of habitat the fish may occupy in the river. Most fish tend to remain close to the bottom, the banks or behind obstacles, swimming in the current only to feed or change location. Some species never go into the current. Most river systems are typically connected to other lotic systems (springs, wetlands, waterways, streams, oceans), and many fish have life cycles that require stages in other systems. Eels, for example, move from freshwater to the sea.

Birds

A large number of birds also inhabit river ecosystems, but they are not tied to the water as fish are and spend some of their time in terrestrial habitats. Fish and water invertebrates are an important food source for water birds

THE RIVER CONTINUUM CONCEPT VANNOTE ET AL. (1980)

The River Continuum Concept (RCC) describes the entire river system as a continuously integrating series of physical gradients and associated biotic adjustments as the river flows from headwater to mouth.

Physical changes along the river continuum alter the nature of organic matter inputs which causes changes in the trophic structure of stream communities.

And consequently, river ecosystems are longitudinally linked i.e., changes upstream have measurable effects downstream.

The River Continuum Concept

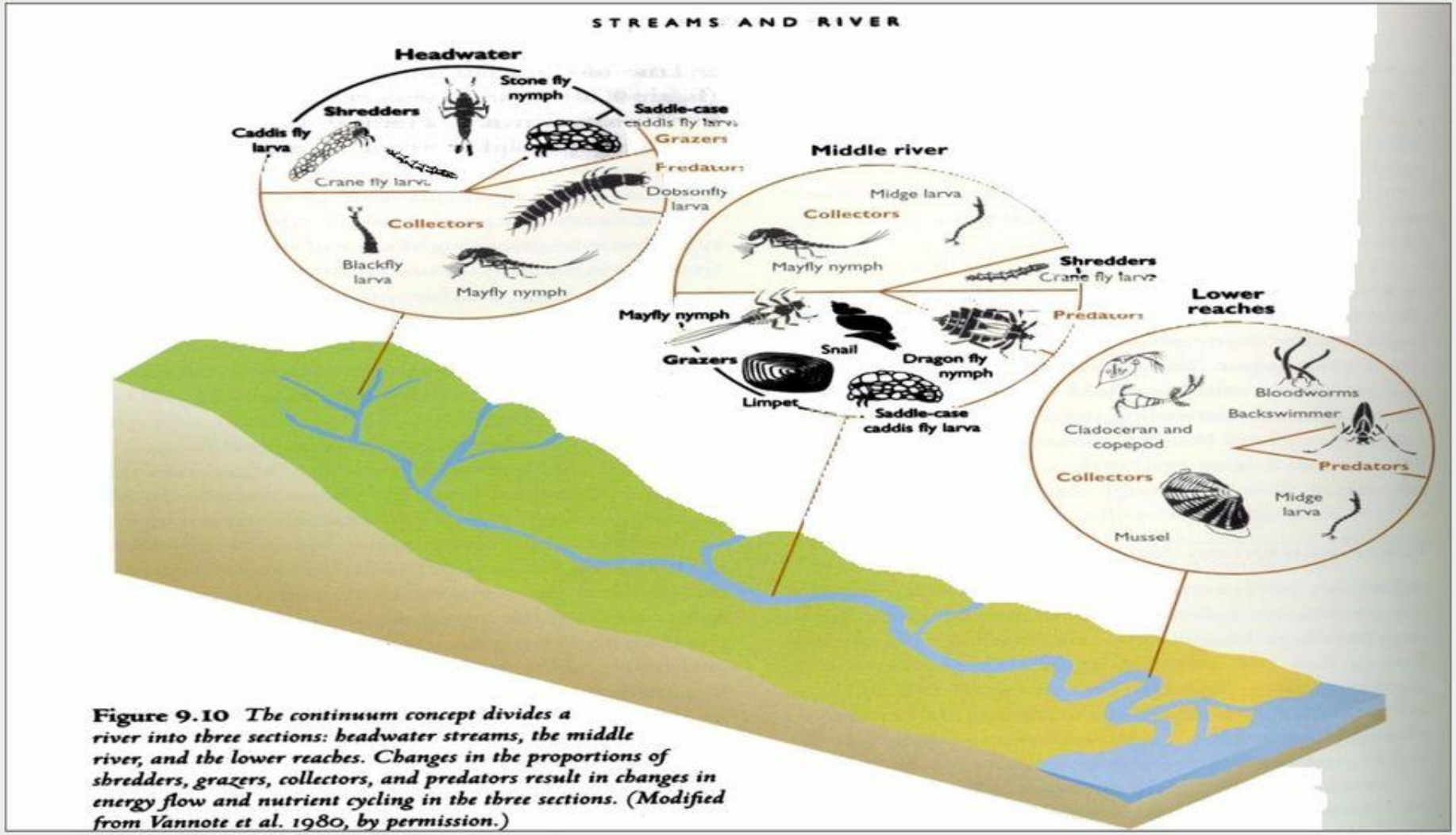
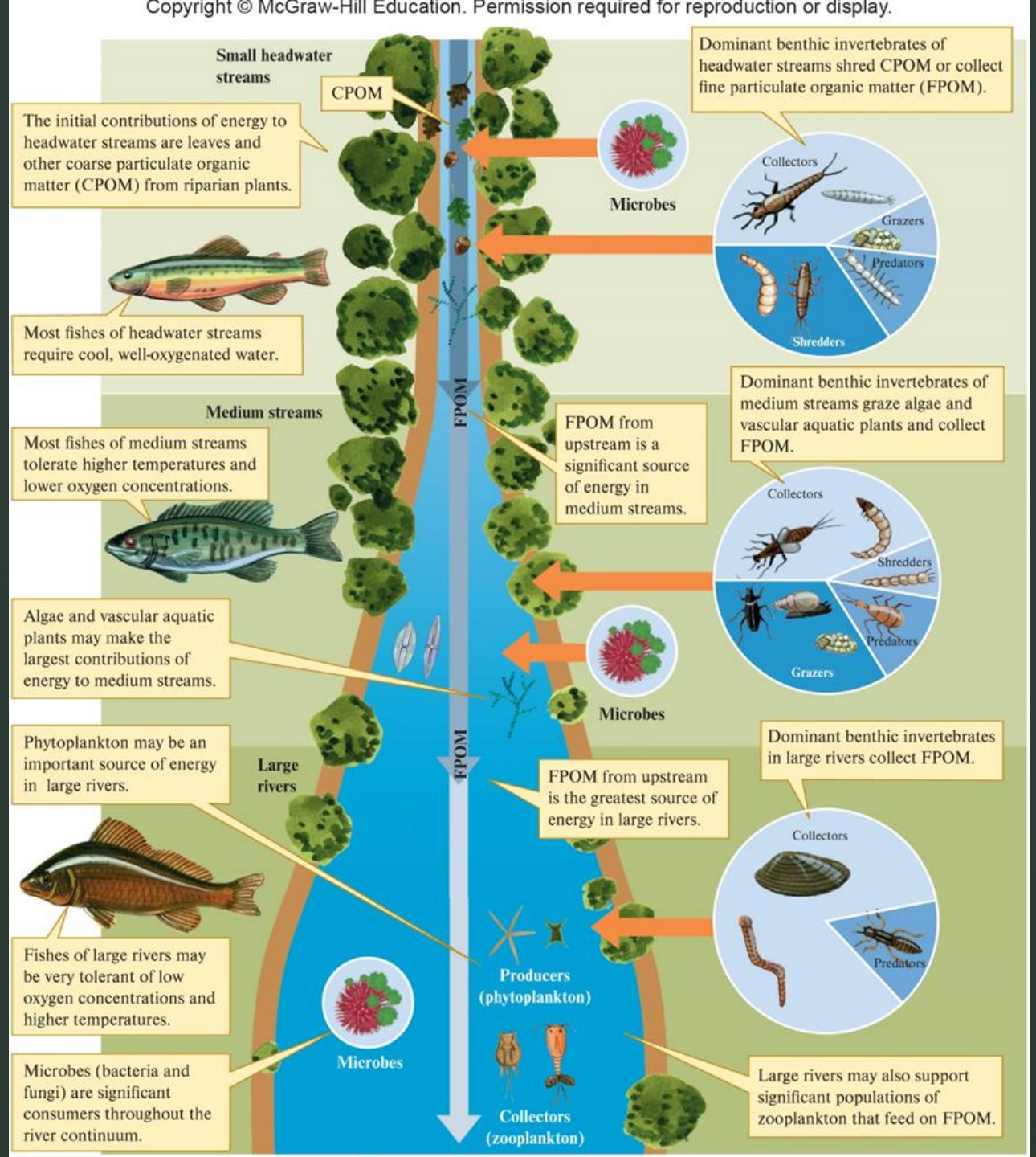


Figure 9.10 *The continuum concept divides a river into three sections: headwater streams, the middle river, and the lower reaches. Changes in the proportions of shredders, grazers, collectors, and predators result in changes in energy flow and nutrient cycling in the three sections. (Modified from Vannote et al. 1980, by permission.)*



Human beings have an impact on river ecosystems. The relationship living organisms have with each other and with their environment is extremely complex. Impacts on a species or a non-living element may have long-term consequences for a river ecosystem.

Several key areas of human impact on river ecosystems are:

- pollution
- flow modifications
- exotic species
- harvesting.

1)Excess nutrients contribute to river pollution
Agricultural intensification has resulted in nutrient and chemical loss to nearby rivers. This can lead to eutrophication of backwater areas of rivers.

Pollution

Pollution is difficult to control because it is often the result of human infrastructure around a river. Pollution enters the river, sometimes in small amounts, at many different locations along the length of the river. Common sources of pollution come from rural and urban areas.

The clearing of forests to produce farmland has led to on-going erosion, with large quantities of sediment deposited into rivers. Agricultural intensification (substantial increases in fertiliser application and increased stock numbers) has resulted in nutrient and chemical loss to nearby streams and rivers. Elevated nutrient concentrations (especially nitrogen and phosphorus – key components of fertilisers) can result in the eutrophication of slow-moving waterways.
Urban areas add to this pollution when contaminants (PAHs and heavy metals) are washed off hard surfaces such as roads and drain into water systems.

Sulfur dioxide and nitrous oxide emitted from factories and power stations enter river systems through acid rain. Sewage and effluent are discharged into rivers in some areas.
Pollution can lower the pH of the water, affecting all organisms from algae to vertebrates. Biodiversity decreases with decreasing pH.

Flow modifications

Dams alter the flow, temperature and sediment in river systems. Reduced flow alters aquatic habitats – reducing or removing populations of fish, invertebrates and plants that depend on the flow to bring food. Reduced flow also decreases tributary stream flow, changing habitats and altering the water table in the stream aquifer. Consequently, riverside vegetation may be affected and decline in numbers. This may affect animal biodiversity, for example, bird species may leave the area if their habitat is lost or altered. Changes in water temperature due to flow modification can affect insect development by not allowing them to complete their life cycle.

Rivers are connected systems, and barriers such as dams, culverts and floodgates disconnect one area from another. They prevent species such as eels from migrating – isolating previously connected populations.

Exotic / Invasive species

Exotic species have been introduced to river systems sometimes intentionally (for example, for fishing purposes or as food for other species) and sometimes unintentionally (for example, species come in on the bottom of boats or on fishing gear or they escape from pond areas during flooding, such as koi carp). These organisms can affect native species. They may compete with them for prey and habitat. They may prey on native species, alter habitats, breed with native species to produce another species or they may introduce harmful diseases and parasites. Once established, these species can be difficult to control or eradicate, particularly because of the connectivity of the flowing river. They can easily migrate to many areas affecting native species.

Harvesting

Excessive fishing in river ecosystems can drastically reduce numbers of species. For example, numbers of eels and whitebait in the Waikato River have reduced since the 1970s. Commercial eeling began in the 1960s and peaked in the 1970s with an annual average catch of 2000 tonnes. In the early 1980s, 400–450 tonnes per annum were harvested, with less than 200 tonnes per annum harvested since 2000.

Whitebait tonnage has also drastically reduced from an average of 46 tonnes per annum in the 1950s to 3 tonnes in 2000. Reducing stocks of a particular species can have an effect on other species such as birds that feed off river fish. The birds leave the area when river fish decline. Find out more about whitebaiting.