ATTACHMENT 1

Stream Ecology Background Information

The Living Stream

(*by Bert Cushing, formerly of the Environmental Sciences Department, Pacific Northwest Laboratory)*

Nearly 75% of the total miles of streams in the United States are composed of small 1st and 2nd order streams, the tiny headwater tributaries (see Figure 1). Yet, most of what we think about when we hear the words rivers or streams, are larger ones like the Mississippi, Columbia, or Colorado.

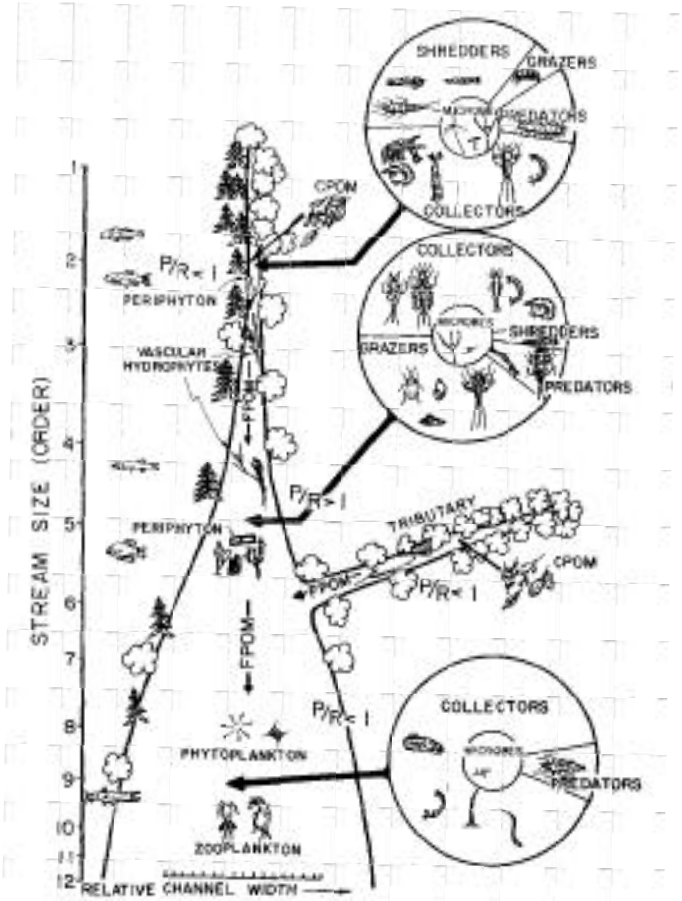


Figure 1. Stream Orders

Rivers and streams are highly diverse in terms of size, location, and surrounding landscape. Yet, despite this diversity, streams have many aspects in common that can result in certain predictable patterns such as energy flow, community structure, and physical configuration.

Several abiotic features of streams are important in providing the physical template upon which the biological features are elaborated. The geological nature of the river basin dictates such things as channel form, nutrient content of the water, and light regime. Water temperature governs the rates of photosynthesis of instream plants, metabolism of organisms, growth, and decomposition of organic matter. The water current shapes the habitat, carries food and nutrients to the organisms, and carries away their metabolic wastes, which, in turn, become the energy sources for downstream communities.

The energy upon which these ecosystems operate is derived from photosynthesis by both instream plants, and plants growing on the surrounding land. The primary instream plants are algae, mosses, and the larger flowering plants such as water lilies, pondweeds, and sedges. The instream and terrestrial plants produce oxygen and organic matter by photosynthesis; the organic matter becomes the food source for primary consumers. However, bacteria and fungi must first convert the terrestrially produced organic matter (in the form of leaves, twigs, and cones that fall into the water) into a palatable form. The larger pieces of organic matter found in streams (>than 1 mm in diameter) are called Coarse Particulate Organic Matter (CPOM). This material furnishes food to some organisms, but is eventually converted to Fine Particulate Organic Matter (FPOM) (<1 mm in diameter) by various physical and biological processes. The FPOM provides the largest pool of energy for stream organisms.

Functional Groups

Insects are the most numerous of the stream animals, at least of those that we can see without a microscope. To learn more about their function in stream ecosystems, we have developed a classification system based on how they obtain their food, in other words, what ecological niche they fill. We call these categories functional groups (see Figure 2). They include

- shredders—organisms that obtain their nourishment by feeding on CPOM
- grazers (scrapers)—organisms that have mouth parts adapted to scraping the algal film from the surface of rocks and wood
- collectors—organisms that are further subdivided into gathering-collectors that feed on FPOM wherever it occurs, and filtering-collectors that have various adaptations that allow them to filter FPOM from the water flowing past them
- predators—organisms that feed on other organisms.

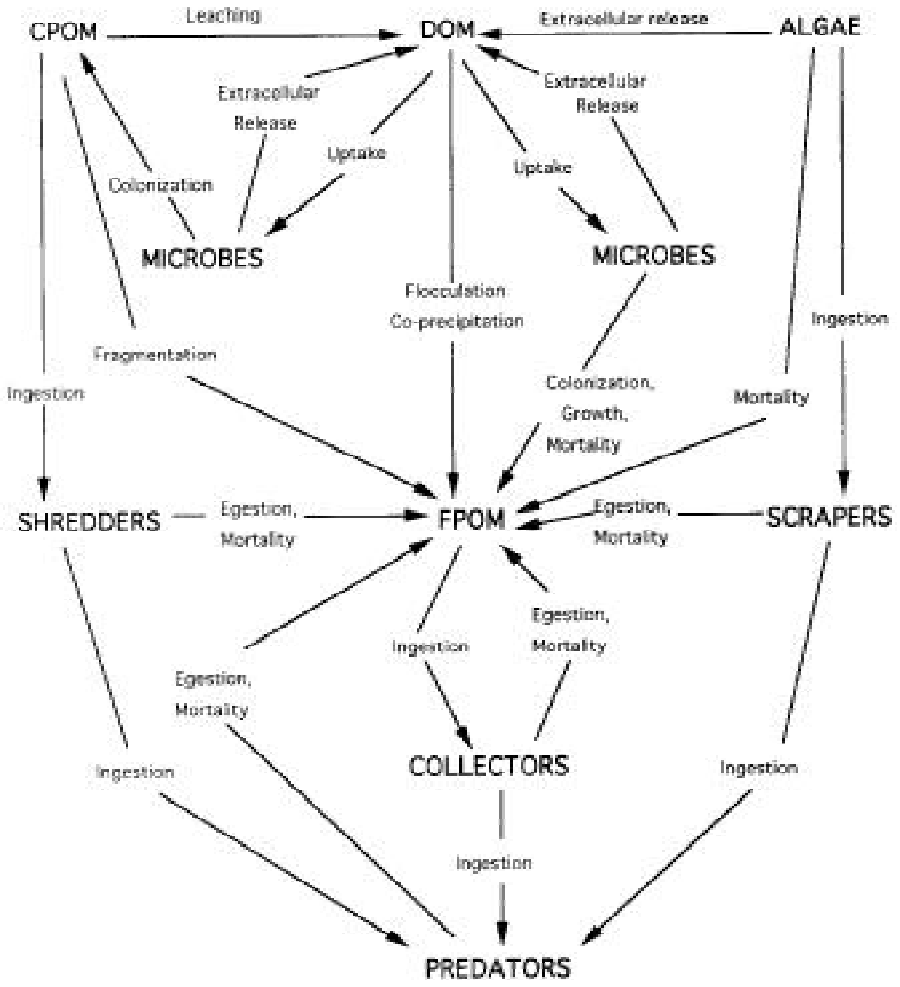
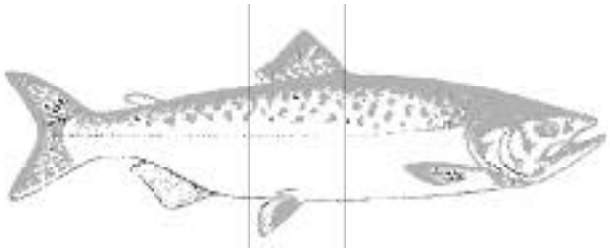


Figure 2. Functional Groups

All the above constituents fit into a model that can roughly predict the longitudinal components and communities of a river continuum from its headwaters to its mouth. The model is called the River Continuum Concept. The theory goes as follows: Small headwater streams have dense riparian canopies that shade most of the stream bottom. Thus, little algae can grow, so instream photosynthesis is negligible and the stream depends on terrestrially produced organic matter for its energy.

Hence, respiration exceeds photosynthesis in the stream. We call this a heterotrophic reach. The insect community is dominated by collectors and shredders, the latter using the large amounts of CPOM coming from the surrounding land. Grazers are rare because no algae exists on the stream bottom for them to feed on. As we proceed downstream to medium-size rivers, the stream widens, the riparian canopy is less influential, and algae flourishes on the stream bottom.

Here collectors again are co-dominant with the grazers who have replaced the shredders because the dominant food base is algae rather than CPOM. Instream photosynthesis exceeds respiration so that we call this an autotrophic reach. Finally, in

the downstream reaches of large rivers, the water is deep and turbid, the bottom soft, and no algae grows on the stream bottom because of the lack of light and a solid substratum. CPOM is virtually absent, and FPOM is dominant. Instream photosynthesis is by floating algae (phytoplankton), but is not sufficient to exceed respiration, so the river again becomes heterotrophic. Collectors, usually those that live in the soft bottom such as mollusks, worms, and some insects, dominate the organisms found here. Shredders and grazers are absent. Predators form a fairly constant percent of the community throughout the stream continuum, but differ in species and mode of capture.

By knowing how rivers and streams function as ecosystems, we can observe and evaluate the "ecological health" of streams, which are subject to perturbations such as pollution and physical disruptions.