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Applying the River Continuum Concept to a 1st and 4th Order Stream Pairing

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This issue of **Our Watersheds** is inspired by a recent reading of the River Continuum Concept paper (Vannote, et. al. 1980). This paper describes some of the fundamentals of stream ecology and has long been one of the first resources used when describing variability in the structure, function, and stability of aquatic systems. The primary source for the information discussed below is The River Continuum Concept paper.

The task at hand which brought me to The River Continuum Concept was a project that required us to compare and contrast the aquatic "functions and services" of an intermittent headwater tributary (1st order) and a 4th order stream within the Valley and Ridge of Virginia as required by *33 CFR Part 332 Compensatory Mitigation for Losses of Aquatic Resources*. The River Continuum Concept paper was particularly applicable since it differentiates between 1st through 3rd order streams (headwaters) and 4th through 6th order streams (medium-sized streams) which allowed me to discuss the study streams from our current project using these groupings.

One contrasting characteristic between these two groups of streams is the extent of riparian vegetation. Headwater streams typically have extensive riparian vegetation which covers the stream channel from side to side, providing a plentiful source of food for shredding macroinvertebrates, which also keeps the water temperature cool. The process of introducing organic material into the stream starts in the headwaters with the breakdown of leaf litter that has fallen into the stream. This leaf litter is also known as Course Particulate Organic Matter (CPOM). Medium sized streams have much less edge associated with riparian vegetation and therefore less CPOM. These medium sized systems also have much more available light which leads these systems to rely much more heavily on autotrophic organic inputs from in-stream sources such as algae, bacterial biomass, and other primary producers leading to greater diversity in aquatic communities from more diverse sources of food.

CPOM from the headwater streams tends to move downstream and become a source of Fine Particulate Organic Matter (FPOM) through the process of shredding and mechanical erosion in flow. FPOM becomes a source of food for macroinvertebrates from the collector-gatherer and collector-filterer functional feeding groups. CPOM is available to support healthy populations of shredders and these medium sized streams also support healthy populations of scrapers and grazers who thrive on the algae and microbial mass that is more prevalent in these larger systems.

The fish species in the smaller streams tend to be more dependent on invertebrates for a food sources where fish communities in medium sized systems include invertevores, piscavores, and omnivores which rely on diverse food sources including smaller fish. This shift to predation and other functional feeding groups in the medium sized stream systems supports more diverse aquatic communities in these larger systems.

Another contrasting characteristic between headwater and medium sized streams is the variation in temperature within the aquatic system. The range in temperatures along the stream continuum starts low in the headwaters where water temperatures tend to remain relatively stable due to groundwater sources and riparian canopies which stabilize water temperature. Medium sized streams have greater ranges in temperatures due to less influence from groundwater sources and less riparian canopy cover as the streams get wider and harder for canopy cover to provide shade for the entire reach. Large streams (> 6th order) have a smaller range in temperatures due to the tendency for large water bodies to buffer changes in temperature.

The variation of water temperatures in medium sized streams helps to support the increased diversity of aquatic communities. This diversity can be attributable to a wide range of food sources (CPOM, FPOM, invertebrates, fish), temperatures, habitats, and numerous other variables. Each population thrives under a specific range of temperatures which this wide range of temperatures facilitates. Individual populations must survive less than ideal temperatures during some periods. However, the net result is a large number of populations regularly experiencing the temperatures that they need to thrive. Conversely, small tributaries will have a smaller range in water temperatures which can result in less diverse populations. Lower diversity in headwater systems does not necessarily mean that the system is less stable. It merely shows that these headwater systems thrive with narrow temperature ranges and fairly uniform food sources.

The River Continuum Concept has helped to highlight some differences in aquatic functions and services between first order headwater streams and medium sized streams. The functions and services of headwater streams are centered on incorporating CPOM from the surrounding landscape into the aquatic system which also provides an important source of organic matter for the entire downstream system. Headwater systems don’t have nearly the diverse aquatic communities as the medium sized streams but don’t need diverse communities to thrive. Medium sized streams tend to have greater community diversity with more populations of aquatic species which prosper under greater variability in food sources, temperature regimes, and microhabitats. Medium sized streams provide diverse habitats, diverse temperature regimes, and variable food sources. Medium sized streams typically provide a greater range of functions and services than the smaller headwater streams.

Anyone who is interested in the dynamics of aquatic systems is encouraged to read the River Continuum Concept. There is a wealth of information that can help form a framework for comparisons of aquatic systems.

References:

Vannote, R. L., G. W. Minshall, K. W. Cummings, J. R. Sedell, and C. E. Cushing. 1980. The River Continuum Concept. Canadian Journal of Fisheries and Aquatic Sciences 37: 130-137.

33 CFR Part 332, *Compensatory Mitigation for Losses of Aquatic Resources*