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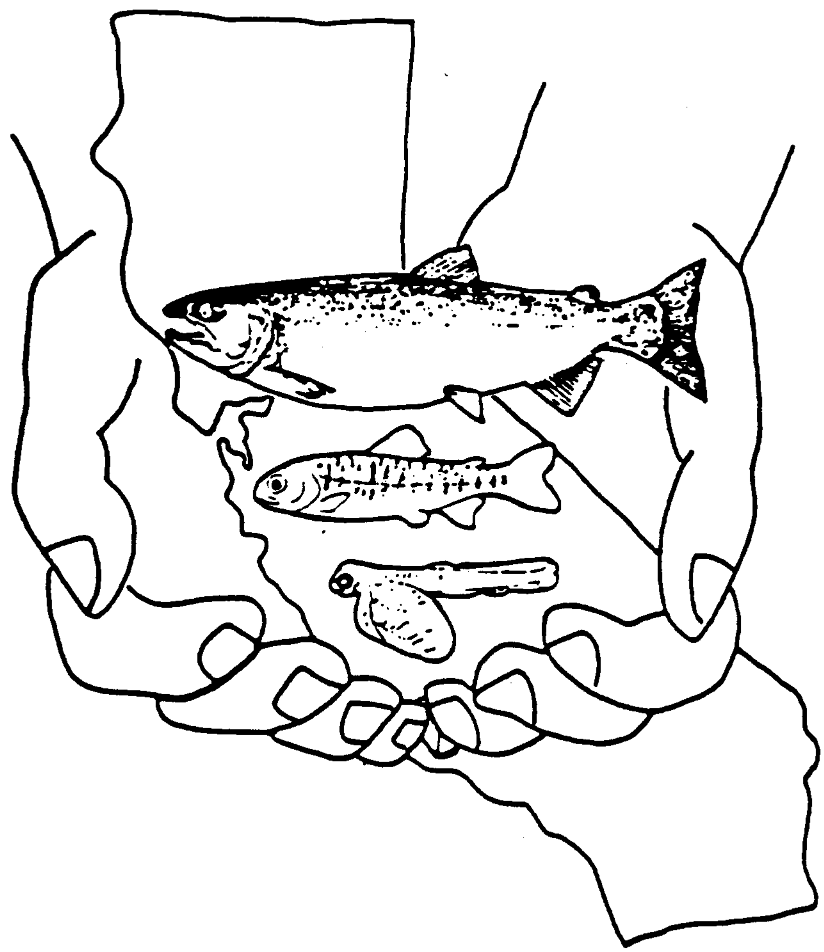
PROCEEDINGS OF THE SEVENTH CALIFORNIA SALMON, STEELHEAD AND TROUT RESTORATION CONFERENCE

FEBRUARY 24-26, 1989
EUREKA, CALIFORNIA



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CALIFORNIA SEA GRANT PUBLICATION UCSGEP-89-02

THE IMPORTANCE OF RIPARIAN ZONES TO STREAM ECOSYSTEMS

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Riparian zones occur at the interface of two major ecosystems - the aquatic ecosystem and the terrestrial ecosystem. As a consequence, riparian zones are transitional areas between ecosystems and exhibit gradients in ecological processes and community structure between the two major systems. Riparian zones often are defined according to a specific set of static attributes, such as the presence of hydrophilous plants, moisture content of soils, elevation above water level, or linear distance from the stream channel. These perspectives often form the basis for riparian management decisions that require rigid delineation of riparian boundaries. However, these views offer little insight into the structural and functional relationships between riparian zones and the stream ecosystems they encompass.

From a structural-functional perspective, *riparian zones can be viewed as three-dimensional zones of interaction betweens terrestrial and aquatic ecosystems*. The riparian zone extends outward from the stream channel to the limits of flooding and upward into the canopy of streamside vegetation (Figure 1). Riparian zones occur within dynamic portions of the landscape that are subject to both fluvial and terrestrial disturbance. Flooding reshapes geomorphic surfaces within riparian zones on a frequent basis, while movements of hillslope materials (*e.g.,* landslides, earthflows) occasionally modify riparian surfaces and their vegetation. Consequently, *riparian zones are mosaics of geomorphic surfaces that are created and maintained by disturbance*. This mosaic of geomorphic surfaces determines the spatial arrangement and succession of riparian plant assemblages. The geomorphic template and associated vegetation then determine the structure and function of stream ecosystems. This perspective of riparian zones recognizes the major linkages between terrestrial and aquatic ecosystems as manifested in riparian zones and also incorporates the physical processes that create and modify landforms along river valleys.

Critical functions of riparian zones include (1) input of litter and woody debris to streams, (2) shading of streams for temperature control, (3) bank stabilization which limits inputs of fine sediment, (4) uptake and exchange of nutrients with aquatic habitats, (5) retention of organic matter during high flow, and (6) provision of complex stream-edge habitat for both aquatic and terrestrial wildlife. This *riparian zone of influence* varies in dimension according to the specific interaction between forest and stream (Figure 1). For example, forest litter such as leaves and needles generally enter streams from a relatively narrow band of vegetation in close proximity to the stream. Woody debris, on the other hand, can enter streams from a broader zone that extends to the height of the tallest riparian trees. The zone of shading influence may vary in different basins according to orientation, local topography, and stand density.

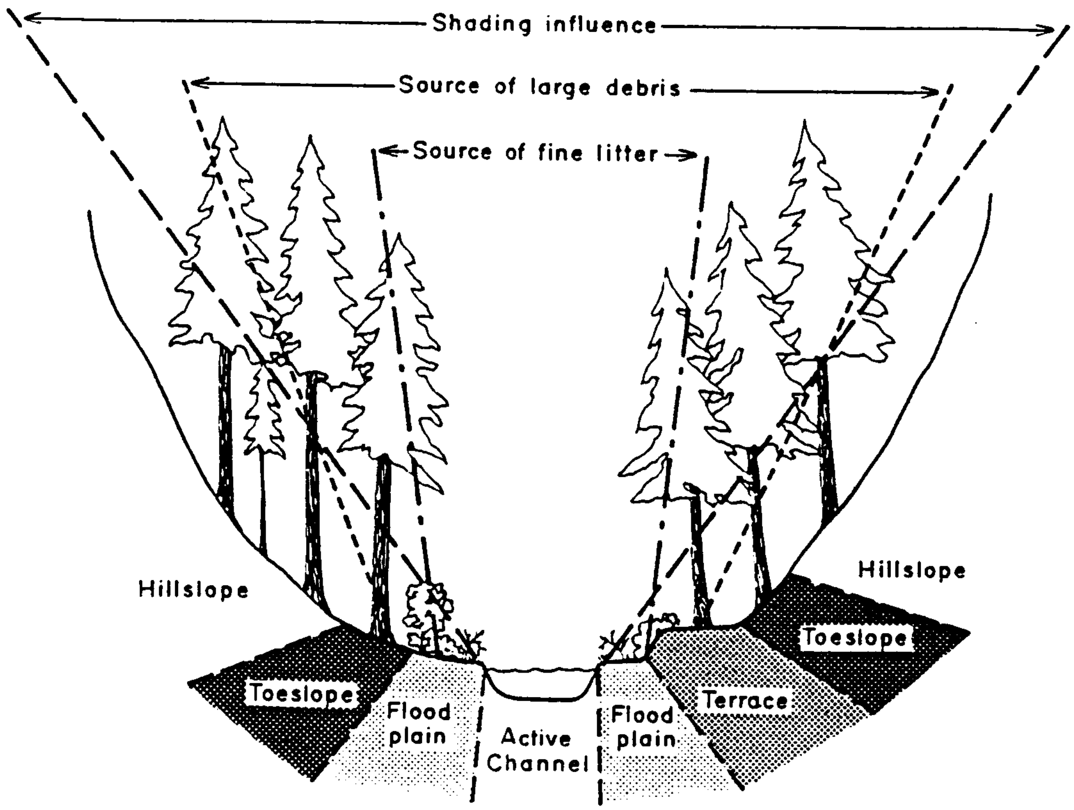

Figure 1. Diagrammatic representation of functional roles of riparian zones.

Because of their linear nature, streams are highly influenced by the adjacent system. The energy base of stream ecosystems is formed by a combination of *allochthonous* inputs (organic matter contributed by riparian zones) and *autochthonous* production (plant growth within the stream, such as algae and mosses). Riparian vegetation contributes plant litter such as leaves, needles, seeds, cones and twigs to the stream. The riparian canopy also allows infiltration of solar radiation that allows benthic primary production. Leaf litter that enters streams is colonized by heterotrophic microorganisms (bacteria and fungi) and later consumed by detritivorous stream macroinvertebrates known as *shredders*. Benthic (bottom-dwelling) plants such as algae are removed and consumed by herbivorous macroinvertebrates known as *scrapers*. Part of this organic matter is fragmented into small particles by feeding and abrasion, and then suspended into the water or deposited into slow-moving stream habitats where it is consumed by invertebrates known as *collectors*. Invertebrate and vertebrate *predators* such as stoneflies and trout consume all other groups of invertebrates.

Retention of organic matter within stream ecosystems is essential for its later processing because the unidirectional flow of water tends to transport organic matter out of stream reaches. This trapping of organic matter is enhanced by structural complexity of the stream channel. The presence of woody debris, high bed roughness, and complex lateral (stream margin) habitats all contribute to retention of organic matter. Large woody debris also provides important structural elements that stabilize and protect streambanks, while providing off-channel habitat necessary for the rearing of juvenile salmon and trout. During flood events, woody debris dissipates stream power thereby reducing the erosive action of high flow. Accumulations of woody debris store sediments for salmonid spawning gravel, impound water into pools utilized by invertebrates and fish, and trap organic matter that provides food for aquatic organisms. The wood itself is slowly decomposed by microorganisms and colonized by algae and invertebrates, thereby providing a long-term carbon source for the stream ecosystem. The maintenance of sources of woody debris, both coniferous and hardwood, in riparian zones is essential to the long-term stability of stream ecosystems throughout the Pacific Northwest.

Riparian zones with healthy plant communities provide a buffer against upslope processes with potential deleterious effects on stream habitats. For example, riparian zones intercept and retain fine sediment before it can enter stream channels and blanket sediments with their associated invertebrates or smother salmonid eggs. Riparian zones are also active sites of nutrient uptake and transformation. Riparian plants absorb nutrients and later return them to the stream in the form of nutrient-rich litter. Nutrients may be adsorbed or otherwise retained by riparian soils and later remobilized into streamwater and utilized by stream organisms. In other instances, excess nutrients may be transformed by soil microorganisms into gases, as occurs during denitrification. Shading by riparian vegetation helps limit solar heating of water, and is especially important in hot arid regions where water temperatures may routinely approach tolerance limits for fish and invertebrates. Although the proximate effects of reduced riparian canopy on water temperature may be minimal, it is important to remember that cumulative downstream effects may occur. For example, small incremental increases in water temperature in headwater tributaries may result in a large temperature rise in downstream areas. Thus, healthy riparian zones help ensure that high-quality water reaches stream ecosystems and is maintained down stream courses.

Riparian zones and stream ecosystems are modified by the configuration of the valley floors in which they reside. In steep-sided basins with narrow valley floors (*constrained* reaches), riparian zones often are limited is extent and their vegetation is similar in composition to hillslope communities. Streams are relatively straight, single channels with little lateral heterogeneity or floodplain development. The absence of lateral stream habitats required by juvenile fish may limit fish production within these reaches. By contrast, in basins with wide valley floors (*unconstrained* reaches), riparian zones are broad bands of diverse vegetation that gradate into hillslope communities. Streams in these areas often exhibit complex, braided channels with high lateral heterogeneity and floodplain development. These complex channels support diverse fish habitat and provide lateral refuge during floods. The interaction between riparian zones and stream ecosystems must be considered within the context of valley floor configuration. Management goals for riparian zones should be sufficiently robust to encompass this spatial variation in land-water interaction.

Riparian zones are one of the most physically complex and biologically diverse portions of the landscape. Riparian zones are interfaces between terrestrial and aquatic ecosystems, and incorporate physical and biological properties of both ecosystems. Stream ecosystem processes are largely controlled by the dynamic interaction between valley floor landform, riparian vegetation, and stream structure. Aquatic organisms such as salmonids are strongly influenced by the habitat and nutritional resources provided by channel structure and streamside vetetation. Thus because of their central role in forest-stream interactions, riparian zones are critical components of the landscape.

Acknowledgments: Research leading to this report was supported by the National Science Foundation (Grant #BSR-8508356), the U.S. Geological Survey, and the Water Resources Research Institute of Oregon State University.