

Chapter 2. Development of Riparian Perspectives in the Wet Pacific Northwest Since the 1970s

Frederick J. Swanson and Stanley V. Gregory

Introduction

Streams and riparian zones have been fertile ground for ecosystem science and a battleground for forest policy and management in the wet Pacific Northwest west of the crest of the Cascade Range for many decades. Competing, high-value resources of salmon and big Douglas-fir timber and their iconic places in cultures of the region sharpened the clash of values. Landslides from forestry operations and roads and elevated water temperature in streams where forest cover had been removed were points of physical connection between steep slope forestry and cold-water fishes. Logging slash from harvest operations had dammed streams and depleted dissolved oxygen, leading fisheries agencies and advocates to call for removal of wood from streams in the 1950s and 1960s.

In the decades since, science has played important roles in characterizing ecosystem components and dynamics and in identifying issues and management options. Social conflicts have propelled the science forward. In this essay, we offer a brief historical overview of steps in the development of concepts about riparian zones in this region and societal context from the perspective of the large, interdisciplinary science team—the Stream Team—based on the Oregon State University campus in Corvallis and at the H.J. Andrews Experimental Forest in the Willamette National Forest east of Eugene. Team members come from the University, Forest Service research and land management branches, and other institutions; and the participants have roots in stream ecology, fisheries and forest science, geomorphology, and other fields. The nucleus of the Stream Team has been large research programs—the International Biological Program in the 1970s and the Long-Term Ecological Research program since 1980, both supported by the National Science Foundation and the Forest Service, and based in Oregon State University. Important work occurred elsewhere in the region, most notably based in Seattle in fisheries and forestry research, and outreach programs based at the University of Washington (e.g., Naiman et al. 2005), but we do not attempt to cover that work in this chapter.

An apparent contrast in the perceptions of riparian zones between the dry interior west and the wet Pacific Northwest west of the crest of the Cascades may stem in part from the contrasts in the stature of vegetation. Riparian zones in many arid lands can be conspicuous as lush stands of shrubs and scattered trees in a sea of knee-high sagebrush. Westside conifer forests, on the other hand, can be 70+ m tall, dwarfing streamside willow (*Salix* spp.) and red alder (*Alnus rubra*) stands and creating continuous forest canopy from stream banks to ridge. Westside forest ecologists naturally focused their science on the interactions among forests, streams, and riparian zones. In the case of the

Andrews Forest team, stream ecologists pressured the forest scientists to extend their work down into the riparian zone.

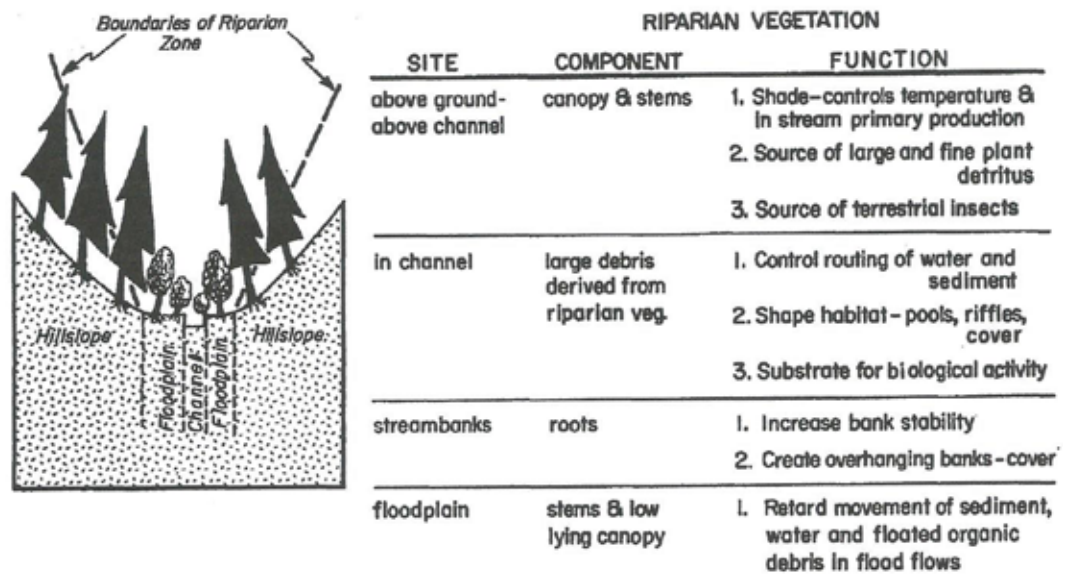
The evolution of thinking about riparian zones in the Andrews Forest team was the gradual awakening to the many interactions between forests and streams. Driven by both science and policy questions, big wood in streams became a pivotal issue in the mid-1970s. The policy question: Should loggers be required to remove wood from streams to provide for fish passage and limit biological oxygen demand? The science question: What does big wood contribute to the geomorphic structure, organic matter and nutrient budgets, and overall functioning of stream ecosystems? The history of logging slash and stream management often is characterized as, “First they told us to take wood out of streams and now they are telling us to put it back. When will those darn scientists change their minds again and tell us to take it out again?”

But, the management history was more nuanced; early rules called for leaving the pre-existing wood in streams and removing only logging debris. The pendulum swung from having too much wood in streams—especially readily mobilized logging slash—to removing too much wood from streams, especially wood of a natural size distribution, including big, stable pieces. The arguments about how much wood is appropriate continues, but the general thread of the story is that wood is a natural part of stream systems so policy now sustains that function through direct intervention in streams and management of riparian forests for future wood supply. The big wood connection between forest and stream turned out to be vital to the interdisciplinary spirit of the science team—the work required integrating the perspectives of stream and forest ecologists and geomorphologists.

By the latter half of the 1970s, the Andrews group had made substantial progress on their studies of nitrogen and organic matter budgeting (Triska et al. 1984), addressing both processes and standing stocks of materials all with attention to how forests affect streams. A succession of papers (in chronological order: Cummins 1975; Meehan et al. 1977; Swanson et al. 1982; Gregory et al. 1991) developed the thinking about forest-stream interactions in terms of regulation of light levels influencing primary productivity, water temperature, fish foraging efficiency, and other processes. Also summarized in figure 1, the roles of forests in supplying organic matter range from fine litter to whole old-growth trees that shape stream channels, provide cover, and provide substrates for biological activity. This evolution led to the notion of defining riparian zones in ecosystem terms as the zone of interaction rather than on the basis of hydrologic, botanical, or soil considerations (Gregory et al. 1991). Unlike lowland fluvial systems with well-defined floodplains, hydrologic criteria do not work well in steep mountain streams with their high levels of topographic complexity imposed by boulders, big wood, and narrow valley floors.

Botanical criteria have limitations in part because the great stature of vegetation means that trees distant from the stream can have important influences. Studies of riparian vegetation have been rather limited in these mountain environments. In the Andrews Forest, for example, in 1979 and 1990 forest ecologists established several large (2–2.4 ha) stem maps straddling streams of different size, but it took some years and a major flood to develop a record of sufficient length to reveal the disturbance dynamics of the riparian system (Acker et al. 2003). Hydric soils criteria for defining riparian

Figure 1—Forest-stream interactions as a basis for defining the riparian zone, as viewed in 1978 (source: Meehan et al. 1977, public domain).



systems in the forest setting are far too narrow and fail to encompass the terrestrial-aquatic interactions that strongly influence stream ecosystems.

Also, during the late 1970s, the highly influential River Continuum Concept (RCC) project was in full swing (Vannote et al. 1980, which had been cited more than 8,300 times as reported in Google Scholar as of 22 March 2017). A national program led by Robin Vannote of the Stroud Water Research Laboratory in southeastern Pennsylvania explored concepts of how forest influences on stream ecosystems varied from small headwater streams to large rivers. As the stream widened downstream, more light reaches the channel, so food resources for aquatic organisms shift from productivity driven dominantly by forest litter to in-stream primary production. A cascade of ecological consequences follows, including shifts in composition of the aquatic invertebrate community from one that processes organic inputs from the surrounding forest to grazers that process algae and diatoms produced in the channel itself. Many other aspects of the stream ecosystem, including big wood, were examined at four stream sizes from first- to seventh-order channels. The Andrews Forest was one of four study areas in the RCC project scattered across the country. This work helped place stream ecosystems in a landscape context by explaining variation along the longitudinal profile of the stream system. The RCC also argued for connectivity through the stream network via the influence of upstream areas as sources of nutritional resources for downstream rivers and floodplains.

A key feature of the Andrews Forest program has been its close partnership with land managers of the Willamette National Forest. Preparation of the forest management plan culminating in 1990 included a prime example of that partnering in the form of a 65-page supplement for stream and riparian management guide authored by two researchers working in collaboration with National Forest personnel (Gregory and Ashkenas 1990). This guide affirms the many important ecological functions of riparian zones, the policy direction to sustain them, and the necessary management standards and guidelines in the context of a full watershed perspective. The collaborative approach has been mutually beneficial; researchers bring the most up-to-date science and the land managers bring a great deal of real-world experience plus exposure to the competing

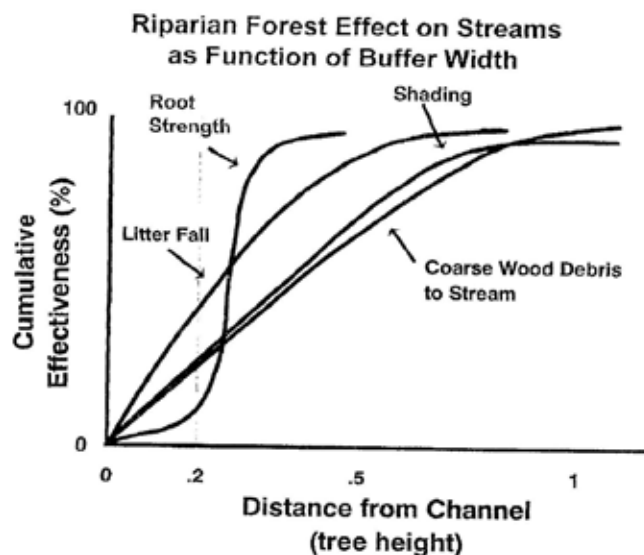
values within society. Therefore, the ultimate plan has the best chance to be credible on science, societal, and operational fronts.

This sense for integrating science and land management practices was valuable a few years later during the Forest Ecosystem Management Assessment Team (FEMAT) process convened by President Clinton in April 1993, to move beyond the injunction that Judge Dwyer had leveled on logging on Federal lands in the range of the northern spotted owl—10 million hectares along the Pacific Coast (FEMAT 1993). The FEMAT process set the path to the Northwest Forest Plan (NWFP) signed by the secretaries of Agriculture and Interior in 1994. A synthesis of some of the findings from Andrews Forest science and other sources was encapsulated in a figure that helped shape thinking about width of riparian reserves to maintain many functions of streamside forests within cutting units (fig. 2).

This conceptual framework was a dramatic departure from the policy debates about riparian buffer widths over the previous 20 years. One of the first questions that emerges in riparian zone management is: How wide should buffers be? Most discussions focused on uniform distances from the streams edge based on the operational willingness to forego some or all timber harvest within that distance. The Riparian Reserves of the NWFP designed riparian widths based on site-potential tree heights (the height of an average tree in late succession stage of stand development). As a result, riparian zone widths were conceived as varying among areas with different forest composition and site productivity. Riparian reserve widths could also be variable and shaped to local topography and potential interactions with the stream. As a result, riparian management areas were ecologically defined and based on the overall landscape rather than the tape measure.

The fixed-width riparian reserves prescribed in the Matrix land allocation of the NWFP, where some logging was to be permitted, were expected to be modified after “watershed analysis” provided a comprehensive, watershed-wide view of biotic and geomorphic conditions that might motivate widening or narrowing of the reserve widths. However, these modifications did not occur in most areas for a variety of reasons.

Figure 2—Effectiveness of streamside forest in providing litter fall, root strength in streambanks, shading, and large wood to the channel as a function of distance from the channel as measured in proportion of tree height (source: FEMAT 1993, public domain).



The NWFP also charged the research-management partnership team based at the Andrews Forest with developing a landscape management plan based on the historic wildfire regime. This ecosystem-dynamics approach to landscape planning, developed as the Blue River Landscape Plan, contrasts with the species-specific conservation approach that dominates the NWFP (Cissel et al. 1999). A key part of the Blue River plan is to consider the frequency and severity of disturbance in the uplands as well as the streamside forest when managing for aquatic conservation objectives consistent with the historic disturbance regime. Several timber sales in native, mature-age-class (ca. 150 years) forests that are part of implementing and testing the plan are completed, but further implementation has been stopped with the region-wide cessation of logging accomplished by environmentalists over the past 20-plus years. Despite the management outcomes, the multi-discipline, multi-scale research carried out at the Andrews Forest in past decades proved to be an important part of the foundation for both the local plan and the regional conservation strategy of which stream and riparian networks are a vital part.

Even as input to policy and management proceeded, research efforts were gaining new insights to the complexity of riparian systems. Several decades of study have revealed secrets of the hyporheic system—the down-valley, subsurface flow of water beneath the streambed and within the valley-floor alluvium that experiences periodic exchange with surface waters (Wondzell and Swanson 1996). The hyporheic system facilitates interaction of surface water with root systems of riparian vegetation, which in the westside Pacific Northwest often includes red alder, a nitrogen-fixing species. An isotopic nitrogen tracer study revealed that some nitrogen in streamwater can actually flow upward into the terrestrial system via a pathway beginning as hyporheic flow is taken up by riparian plants, which incorporate the dissolved nitrogen in streamwater into foliage, which is then consumed by herbivorous invertebrates fed upon by birds that integrate with the terrestrial food web (Ashkenas et al. 2003).

Given the ever-changing perceptions of riparian systems prompted by new science, new tools, and biophysical and social disturbance events, we are confident that the next generation of students of riparian zones will make many interesting discoveries of forest-stream interactions at micro-site to large watershed scales. We often wonder: What is it that is right in front of us now that we cannot see—just like the fallen logs we tripped over in the early 1970s until recognizing their importance and building much of our science careers around them? Young scientists and land managers beginning their careers have exciting opportunities for discovery in riparian systems.

Acknowledgments

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