RIPARIAN ZONE PROTECTION FOR SMALL STREAMS
A BRIEF REVIEW OF THE LITERATURE

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The Ministry of Forests uses a stream classification system that divides streams into three broad classes:

- Class A - large fish bearing streams
- Class B - small fish bearing streams
- Class C - streams that contain no game fish populations.

Of all the issues surrounding riparian areas (smaller streams, small lakes and wetlands), Silva maintains that protection for smaller streams is the most important. All water features, including small and ephemeral streams, require a degree of protection from logging. In contrast, the Ministry of Forests position is that all creeks require consideration during harvesting, but that 75% of the timber resources in the riparian zones of Class C creeks should be available for cutting.

Silva's position is based on caution. Past experience has fully demonstrated that timber cutting can negatively impact water quality and fish habitat. While the MoF chooses to concentrate on protecting fish bearing creeks, in fact, the entire hydrologic systems must be carefully maintained to protect fish habitat. This requires:

1. constraining logging activity to prevent significant alterations in annual hydrographs,
2. controlling soil disturbance and erosion to prevent unnatural increases and/or chronic increases in sediment loads, and
3. protecting stream bed structure and function throughout the watershed.

The brief literature review that follows support the contention that small creeks are a critically important part of a watershed, and that protection of small creeks is required in order to protect stream structure in upland areas, and thereby to protect water resources, aquatic habitat and fisheries resources in downstream reaches.

(Note that "Class C" creeks may also be called first and second order creeks, headwaters creeks, or Class S5 and S6 streams.)

In "Best Management Practices, Cumulative Effects, and Long-Term Trends in Fish Abundance in Pacific Northwest River Systems," Bisson et al (1992) discussed possible detrimental effects of logging in headwaters areas:

> *Long-term reductions in the supply of large woody debris as the result of timber harvest have affected other important processes within stream ecosystems (Harmon et al 1986). Small headwater streams serve as temporary storage sites for both sediment and fine particulate organic matter (FPOM) from the surrounding forest (Keller and Swanson 1979, Triska and Cromack 1980). Loss of sediment and FPOM storage capacity in small streams caused by reduced*

> *debris frequency greatly lessens the capacity of the streams to biologically process organic matter and ultimately make the energy of terrestrial plant materials available to fishes (Triska et al 1982, Triska et al 1984, Gregory et al 1987). Because their storage and processing capacities are greatly diminished, streams with simplified channels route sediment and organic matter much more quickly downstream to larger streams (Naiman and Sedell 1980, Sedell and Beschta 1991). In some cases, rapid transport of sediment can overwhelm larger stream systems (Megahan and Nowlin 1976; Megahan et al 1992)), resulting in lower biological productivity (Platts and Megahan 1975) and reduced diversity of species requiring clean gravel substrate for spawning (Berkman and Rabeni 1987).*

Remember that small, upper basin creeks total many more kilometers of overall stream length in watersheds than do Class A and B fishbearing streams. The effects of lost bed structure, lost stability, and lost storage capacity in these extensive upland networks tend to accumulate in the downstream fish habitat areas.

In the Introduction to "Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats," William Meehan (1991) stresses the importance of small streams and streamside vegetation:

> *Small streams support a large proportion of salmonid production and help maintain habitat quality downstream, but they are also the streams most easily altered by human activities.*
>
> *The value of maintaining a buffer strip of streamside vegetation to ameliorate the direct effects of logging activities has been well documented. Salmonid vegetation stabilizes streambanks and channels, provides cover, and maintains stream temperatures within fairly well-defined limits. When streamside vegetation is removed, summer water temperatures generally increase in direct proportion to the amount of increased sunlight on the water surface. Smaller streams that were completely shaded can warm more, and have greater daily temperature fluctuations, than larger streams once the riparian canopy is removed. The breakdown of streambanks is among the most persistent results of riparian harvesting, and it is among the most difficult to avoid when streamside felling or skidding and cross-stream yarding occur. Therefore, although measures exist for protecting streambanks, often the only way to avoid extensive bank damage is to avoid working in the riparian zone altogether.*

Murphy and Meehan (1991) continue this discussion in the same volume:

> *The influence of riparian vegetation diminishes as streams get larger (Meehan et al 1977). In the headwaters, small trees and brush can effectively shade the stream; farther downstream, even large trees may not provide effective shade. . . The role of woody debris also changes with stream size. In small streams, debris is distributed where it fell and influences most of the stream channel. In larger streams that can float whole trees, debris is clumped in logjams or pushed onto the banks. . . .*
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> *Where streambank trees are removed by logging . . . increased light may stimulate production of periphyton. Such increase in production generally is greater in small streams than in larger streams that are naturally more open to*

> *sunlight (Murphy and Hall 1981). Changes in primary production also may depend on the type of bedrock and nutrient supply in the watershed. If nutrients remain scarce after disturbance, primary production may not increase even when the canopy is opened. (Shortreed and Stockner 1983).*
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> *Opening the canopy, however, can cause stream temperature to increase to levels that are lethal to salmonids (Hall and Lantz 1969), nullifying any potential benefit of increased food production.*
>
> *Cumulative effects of increased water temperature and sediment from numerous disturbances in a watershed also can nullify any beneficial effects of increased food production. Increases in temperature and sediment are not just local problems restricted to a particular stream reach, but problems that can have adverse cumulative effects throughout the entire basin (Sedell and Swanson 1984). Models of thermal loading (Brown 1969) show that an increase in water temperature in the upper basin can have serious effects on salmonid habitats in downstream areas.*
>
> *Land uses that alter riparian vegetation also change allochthonous sources of organic matter for the stream (Duncan and Brusven 1985a). Streamside logging in coniferous forests switches the type of litter that enters the stream--from mostly conifer needles under mature forest, to deciduous leaves in early succession, to needles again in later years.*

In "Timber Harvesting, Silviculture, and Watershed Processes," Chamberlin et al (1991) highlight both the importance of small stream to salmon habitat and the susceptibility of small stream to modification from logging activity and forest cover removal:

> *Under most circumstances, both timber and fish can be successfully managed in the same watershed if measures to protect water quality and fish habitat are carefully coordinated with timber management operations.*
>
> *Water plays a central role in watershed processes, but equally important are the sediments it moves and the structure imposed on stream channels by bedrock and the trees, roots, and logs of the riparian ecosystem. The land-water ecosystem must be managed through space and time as an integrated whole if productive fish habitat is to be maintained.*
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> *Salmonids occupy a wide variety of streams that range in size from tiny headwater tributaries to the mainstream Columbia River. Some species even migrate to, and spawn and rear for a while in, first-order streams that may become intermittent or dry in summer.*
>
> *Most spawning and rearing in forested watersheds, however, takes place in second-to fourth-order stream . . . . Such small streams account for the majority of total aggregate stream length available to salmonids in most watersheds.*
>
> *Even when small streams are not accessible to migrating fish because of barriers or steep gradients, they are vitally important to the quality of downstream habitats. The channels of these streams carry water, sediment, nutrients, and wood debris from upper portions of the watershed. The quality of downstream habitats is determined, in part, by how fast and at what time these organic and inorganic materials are transported.*

> *Small streams are responsible for a high proportion of salmonid production in a basin, and they influence the quality of habitat in larger tributaries downstream. They also are the streams most easily altered by forest management activities. Small streams are intimately associated with their riparian zones and are highly responsive to alterations in riparian vegetation and the surrounding watershed.*
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> *Vegetative crown cover is often complete over first- through third-order streams. Because small streams depend largely on litter fall for organic energy input (Murphy and Meehan 1991), any manipulation of the canopy or streambank vegetation will influence the stream's energy supply.*

Satterlund and Adams (1992) address the same issues in "Protecting Stream Fishery Resources":

> *The linkage between the aquatic and terrestrial ecosystems is strongest in first-order headwater streams and diminishes rapidly downstream. Both the physical environment and the biota of the aquatic system are largely determined by conditions on the surrounding land in first-order streams. In low-order streams . . . water temperatures largely reflect the presence or absence of overhead or lateral shade . . .*
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> *Downstream, in higher order streams, inflow directly from the adjacent land makes only a minor contribution to total flow, which represents the accumulated flow from many different tributaries. Whether the banks are forested or not has little effect on stream temperatures. . . .*
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> *Substantial oxygen deficits have been observed in small systems heavily loaded with fine logging slash, such as leaves and branches (Ponce 1974). . . .*
>
> *Few land use activities are likely to be either completely deleterious or beneficial, but, as with most activities, it is far easier to damage the fishery resource than to improve it. . . .*
>
> *Protection of the riparian zone by leaving stable buffer strips helps insure the integrity of the stream and its banks, and provides a long-term supply of large woody debris for desirable habitat features.*

In summary, the authors cited above assert that the riparian zones on headwaters, or Class C, streams perform three major ecological functions:

1. Small streams provide natural levels of large organic debris to the stream, thereby maintaining stream bed structure. Stable stream beds resist erosion, and function as storage sites for sediment and organic inputs.
2. Small streams maintain natural levels of shade, thereby controlling stream temperature in headwaters areas, and aggregate stream temperature in lower, fishbearing reaches.
3. Small streams maintain natural levels and types of allochthonous nutrient sources to stream systems. Maintaining upland riparian forests thus maintains the flow of coniferous litter, in historical quantities, to larger water bodies.

Headwaters creeks are directly linked to downstream fishbearing waters. Because headwaters creeks are also the streams which are most closely linked to the terrestrial ecosystem, they are the most susceptible to ecological changes from human activities.

Rather than a mere appendage to fishbearing waters, headwaters streams are the location at which terrestrial ecosystem management can most severely and persistently affect aquatic ecosystems. As diffuse and distributed ecosystems, headwaters creeks are also poorly suited to ecological restoration measures. Adding structure or channel pools to a major fish bearing streams is not a trivial project, but it is feasible. In contrast, restoring lost channel structure, nutrient storage capacity, and/or vegetation communities to headwaters systems in even a small drainage basin is likely not feasible.

Therefore, maintaining a significant reserve area around all creeks is a fundamental requirement of ecosystem-based forest use and management.

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