Feature

Riparian Restoration in the Squamish and Lillooet River Watersheds

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Partnerships between the Ministry of Environment, Lands and Parks (MELP), currently the lead proponent, and the Watershed Committees of the Squamish and Lillooet Rivers were formed in 1995 to undertake restoration activities in portions of their respective watersheds. Overviews and detailed assessments have identified seven drainages in the Squamish system and thirteen drainages in the Lillooet system as suitable candidates for restoration works. To date, dam removal and weir placement has been conducted in one stream, large woody debris (LWD) structures have been placed in several streams, and step-pool construction and further LWD placements are planned for others. In addition to channel and fish habitat projects, restoration activities in the riparian zones have been conducted as part of an integrated restoration strategy.

Riparian vegetation communities are generally characterized by high plant species diversity, high structural heterogeneity and high productivity. Thus the primary goal of riparian restoration is to re-establish a diverse and structurally complex vegetation community (e.g., see McLennan and Johnston 1996). The riparian zone can be divided into five key habitat elements which perform or provide for the functions listed below:

1. mixed coniferous/deciduous forest of several tree species
    - diversity of wildlife habitat
    - stream shading
    - LWD and small organic debris (SOD) to streams
    - stream bank stability
    - surface sediment and subsoil nutrient filtering
    - invertebrate production for fish consumption
2. large coniferous trees
    - LWD input to streams (for structure, biodiversity, cover, insect substrata, trapping of salmon carcasses for nutrient supply)
    - nesting by raptors and marbled murrelets
    - snow interception
3. snags
    - nests for wildlife such as woodpeckers, small owls, and flying squirrels
4. diverse shrub and herb communities
    - breeding opportunities for wildlife
    - foraging for wildlife such as grizzly bears
    - Traditional foods
    - organic inputs to streams including leaf litter
    - surface sediment and subsoil nutrient filtering
5. coarse woody debris
    - soil stability
    - LWD for streams
    - breeding areas for "fish food" invertebrates
    - feeding, resting and breeding sites for wildlife

Riparian restoration is a crucial activity within watersheds, given the many functions listed above. The reliance on natural vegetative recolonization alone to restore degraded riparian zones may be risky, as the high-quality soils required for regrowth can be subjected to erosional losses. Replanting efforts can accelerate natural restoration in the riparian zones, and better coincide with instream, side channel and upslope restoration efforts.

Riparian Restoration Objectives

Provision of habitats for the many wildlife and fish species that utilize or are dependent on riparian areas.

In the Coastal Western Hemlock biogeoclimatic zone approximately 74% of terrestrial vertebrate species are associated with riparian areas (Bunnell and Dupuis 1993). In the Flathead River area of southeastern B.C., 13 years (1979-1991) of radio-telemetry data on grizzly bears determined that although only 8.5% of the study area was covered by riparian habitat, average riparian use (% of time per individual bear) was 40% during the spring (McLellan and Hovey 1993). As well, nest sites of harlequin ducks are most often located in riparian habitats such as dense stream-side vegetation, overturned root wads, log jams, on rocks and sometimes tree cavities (Cassirer 1993). These examples affirm the importance of various riparian habitat elements to wildlife species. Riparian habitats also provide a key role in maintaining linkages or wildlife movement corridors between low and high elevation habitats.

Fish species and their productivity are dependent on riparian areas for reasons included in the above table, especially in the provision of LWD, which contributes to channel complexity, cover, and food. The lengthy lag time (150-200 years) to obtain natural recovery of LWD recruitment (especially key conifers), makes both riparian and instream restoration crucial. The link between stream and riparian zone is also demonstrated by the trapping of salmon carcasses by LWD and the resultant redistribution of nutrients and carbon to both the terrestrial and aquatic food chains (Willson and Halupka 1995). Riparian areas can also detain or filter large sediment loads carried by runoff from hillslope areas, thus reducing deleterious effects on fish.

Stabilization of banks
The integrity of riparian soils is protected and important soil nutrients are retained by the presence of a healthy riparian community. Loss of this vegetation, especially near stream channels reduces the stability of banks. Deep root strength is necessary to prevent channel overwidening and excessive erosion of sediments along the banks. Therefore planting a mix of deciduous trees such as cottonwoods and willows, and coniferous trees such as cedar and spruce in riparian zones will help achieve this objective. Since erosion can significantly reduce or limit the amount and quality of soil required for vegetation to successfully recolonize, timely replanting can be essential to the success of restoration projects.

Re-establishment of a vegetative canopy over the stream
Fish benefit from a canopy over the stream in several ways. If the vegetation directly overhangs the water surface, it provides protection from aerial predators. A canopy of taller vegetation also, provides shade which maintains cooler water temperatures. Finally, part of the aquatic food web is fuelled by deciduous leaf litter and the slower-decaying coniferous needles as food for macroinvertebrates, which are in turn consumed by fish. Some deciduous species such as alder, fix atmospheric nitrogen, one of the key nutrients for algal growth at the base of the food chain.

The re-establishment of plants of traditional value to First Nations
Many riparian plants such as the berry-producers are traditionally used as food sources. Both black cottonwood and willows are easily propagated and widely used in restoring riparian habitats; traditionally both species have high value as structural material, and various cottonwood components have medicinal values. Cedars are also frequently found in riparian habitats and have had an extraordinary traditional value, including uses for shelter, clothing and tools (Pojar and MacKinnon 1994).

Figure 1. The crews prepare the whips for planting.

Recent Riparian Restoration Activities

One of the primary methods we have used to restore riparian habitats has been the planting of cuttings (i.e., whips) of deciduous tree species such as black cottonwood, willow and alder (Figure 1). Given suitable site and planting conditions, these species quickly become established in riparian areas resulting in the aforementioned habitat benefits and stream bank stability. A pilot project in November 1996 involved planting of whips (~2500) along an exposed reach of Chance Creek in the Squamish River watershed (Figure 2 and Figure 3). Chance

Figure 2. A pre-restoration view of the Chance Creek pilot project site is shown.

Figure 3. The whips were densely planted in the riparian zone of Chance Creek.

Creek is located just above the Cheakamus River which is fish bearing (Figure 4). The primary objectives of the fall plant were to stabilize stream banks and to determine the success of planting whips after the growing season. One metre-long whips were cut from naturally regenerating willow, alder and cottonwood plants established beside roads and under hydrolines within the watershed. Cutting was conducted once plants had entered the dormant phase (i.e., after leaf-fall). Preliminary monitoring results of survival plots established on the pilot project indicate promising growth rates of most whips.

Additional whip planting was conducted in spring 1997 along Chance Creek, and along South Lizzie and Rogers Creek in the Lillooet River watershed (Figure 5). To obtain a supply of whips for the spring plant, whips were cut in March of the dormant season in both the Lillooet and Squamish River watersheds. Whips were then stored in burlap bags and placed in snowbanks to keep them in the dormant phase until areas became available for planting. Because of high snowfalls during the winter of 1997, many areas proposed for planting were inaccessible until well into the spring. Some logistical problems arose because of whip stock that was nearing the flushing stage but with few areas available to plant them. To avoid seasonal constraints in the future, consideration is being given to ordering stock from nurseries which can supply stock on an as-needed basis. In either case, it is advisable to complete the planting prescriptions one year in advance and either locate a natural source of whips or order stock in the fall for the spring of the following year.

Other riparian restoration techniques were utilized along Kakila Creek in the Lillooet River watershed. An opening along the upper reaches of the creek was planted with both western red cedar and cottonwood. This planting technique is called a 'nurse tree shelterwood', where hardwoods act as a nurse crop decreasing the growth and vigour of shade-intolerant

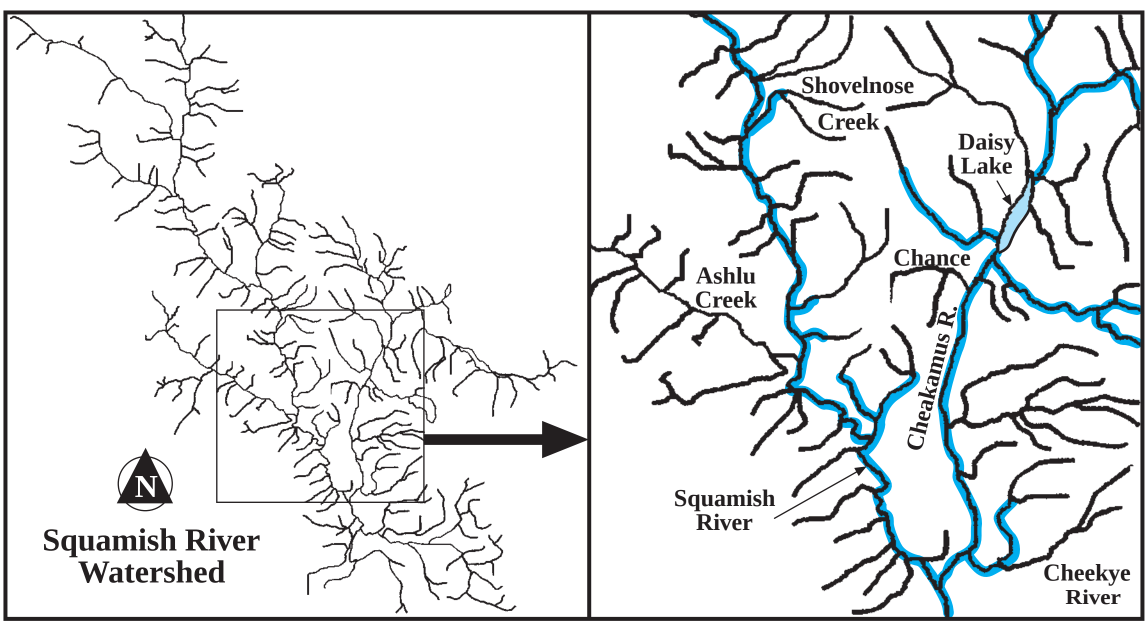

Figure 4. The Squamish River watershed showing project locations: Chance Creek and Cheekye River. Fish bearing streams are marked in blue on the insert map only.

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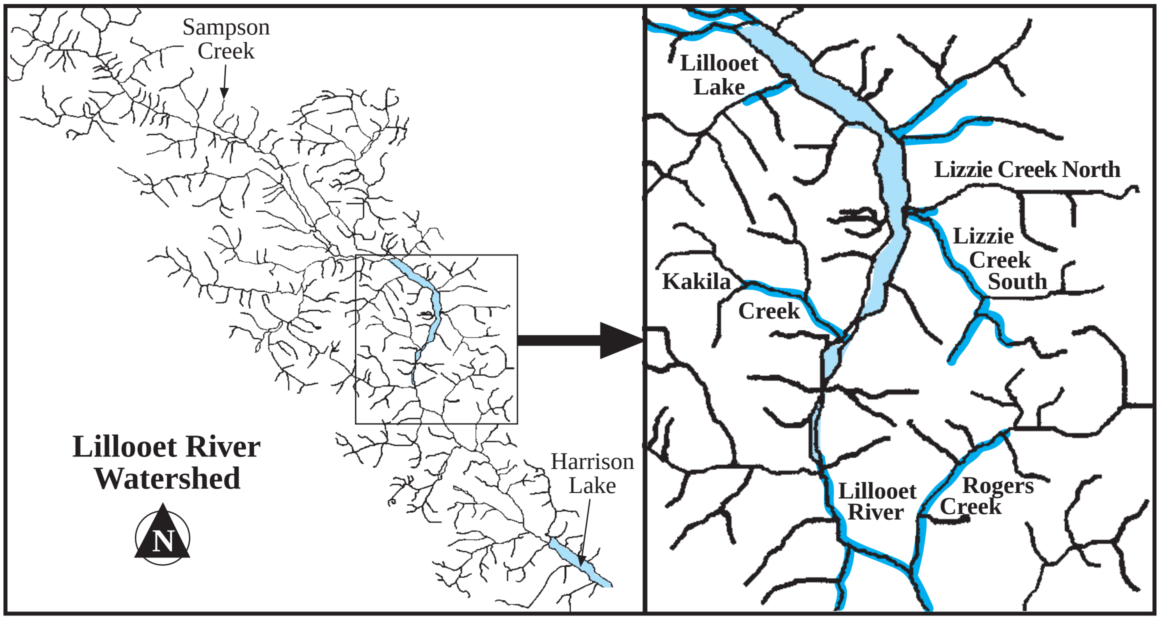

Figure 5. The Lillooet River watershed showing project locations: South Lizzie, Rogers, Sampson and Kakila Creeks. Fish bearing streams are marked in blue on the insert map only.

shrub species, while permitting an acceptable growth of shade-tolerant conifers. Over time, the hardwoods die out and conifers grow through the forest canopy. The hardwoods provide increased stream bank stability, soil nutrient filtering, shading, and wildlife habitat in the short-term; the emerging conifers, such as cedars, provide a long-term supply of LWD to streams.

Understocked forested stands along Sampson Creek in the Lillooet River watershed have been planted with western red cedar. Because of the brushy nature of the site, manual brushing of a one metre radius area for each seedling was conducted prior to planting. Cedars were planted in clusters of three with two metre spacing between trees in a cluster, and spacing of five metres between clusters. Important riparian shrub and deciduous tree vegetation will be maintained between clusters, and cedars will provide increased habitat complexity and a source of LWD.

Survival plots (i.e., 3.99 m radius) were established in most planted areas a few weeks after planting to monitor the success of restoration activities. Plots were located in areas considered to be representative of the site as a whole. Various characteristics of the plants, planting techniques, and habitat conditions were assessed to determine the factors influencing plant survival and growth. These factors included size of whip or seedling (i.e., length and diameter), whip collection methods, whip/seedling planting techniques, competing vegetation, and weather. Survival plots will be assessed at least twice a year, once in the spring shortly after leaves flush, and once in the fall prior to leaf-fall. Photo documentation is an important component of the survival plots. For accurate comparisons, photo points are marked and photographic equipment and methods are similar for each monitoring session. Manual brushing will be conducted in some of the survival plots to assess the effects of competing vegetation on whip or seedling survival.

In 1997 a bioengineering method termed wattling was utilized effectively in the riparian zones of Upper Chance Creek and the Cheekeye River in areas with terrain stability problems. According to Chatwin et al. (1994), wattling consists of placing bundles of flexible interwoven live branches (the wattle) which root easily, into shallow trenches along consecutive horizontal or diagonal rows on an embankment (cut or fill slope). The wattle stabilizes soil layers (this stabilization effect results from the combined effect of the wattle bundle and stakes), and promotes vegetation establishment. Wattling is most effective on loose surface soil exhibiting sheet or small gully erosion.

The following methods were used to install the wattling:

- Layout wattling trenches 2 - 9 m apart; if they are placed any closer the amount of soil may be insufficient to cover the trenches. Estimate the lineal metres of bundles required.

- To prepare the bundles, place 3 - 4 live, dormant hardwood whips horizontally in your hand and gently weave the ends together. Generally 1 m whips work well. Prepare a few more lineal metres of bundles than estimated. If planting stock is live or susceptible to damage, bundles may be prepared each morning to meet daily requirements. Ensure all planting stock is stored in a cool dry place to reduce stress.
- When creating the horizontal trenches, ensure that they are wide enough to accommodate the width of a bundle and a stake. Boot pack trenches as laid-out in the field. It is preferable to work from the top of the slope down-hill.
- Place bundles in trenches and stake. To improve survival and effectiveness, stake with 30 - 50 cm hardwood whip (>2 cm diameter).
- To cover the trenches, pull soil from upslope and cover your staked bundles. This may be done as each trench is completed.
- Monitor results. Several survival checks are recommended: the first shortly after planting to check if the plants have leafed out, and a second after the heat of the summer (mid-September). Subsequently, an annual survival check is recommended.

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