Riparian Restoration in British Columbia: What's Happening Now, What's Needed for the Future

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Every practitioner in the province greatly appreciates the opportunities provided by the people and companies who have made riparian restoration possible. It has not been an easy task. We hope this report sends us all on a road of discovery where mutual respect and stewardship will help guide better management of riparian areas.

INTRODUCTION

Forest Renewal BC is a provincial initiative dedicated to enhancing the productive capacity and environmental value of forestlands and fish habitats while creating jobs for British Columbia's forest workers. In 1994, Forest Renewal BC established the Watershed Restoration Program to help restore fish stocks by reversing damage done to forestlands by past forest harvesting practices.

Riparian forests are forests that border the edges of streams, lakes and wetlands. They are as closely linked to fish as water itself. Without full functioning riparian areas, many elements of fish habitat are lost. Water quality is reduced and streams and rivers become hostile places for fish eggs, young fish and even adult fish. No one factor that explains the dramatic decline in British Columbia fish stocks can be singled out, but damage to fish habitat and water quality caused by removal of streamside forests is widely recognized as a contributing factor. The Watershed Restoration Program understands the linkage between trees and fish. Part of its comprehensive plan for restoring fish habitat includes restoration of riparian forests.

In summer 1998, Forest Renewal BC consulted regional stakeholders about the Watershed Restoration Program. The stakeholders identified several main issues they considered to be impediments to effective implementation of riparian restoration projects. Among those issues:

- unclear or inconsistent assessment standards
- conflicting stocking and species standards
- overlap in stewardship between the Ministry of Forests and Ministry of Environment, Lands and Parks
- lack of implementation standards
- liability for riparian work

Although some of the issues were addressed and even resolved, it was recommended that a survey of those companies and individuals who were implementing riparian restoration in British Columbia be undertaken. The purpose of the survey was to determine what is needed to enable future planning and implementation of effective and efficient riparian restoration. In addition, Forest Renewal BC wanted to better understand the need for riparian restoration and where it should direct future resources.

Riparian restoration, or “riparian silviculture” as it is referred to in forestry, is new to British Columbia. In fact, it is new to foresters and biologists alike. In this report, we look at what information is available in this field of much- needed work and strive to identify information gaps and important issues that need to be resolved for implementation to be effective in this province.

The survey and analysis summarized here are not exhaustive. Much of the material we present is based on our own knowledge, experience and work. As well, we include the views of the practitioners who provided us with advice and recommendations. A list of the practitioners who provided responses to the survey is provided in Appendix 1. All riparian assessments and works projects that have been completed in the province and were made known to us are given in Appendix 2. All of the people shown as contacts were asked to participate in the survey.

WHY RESTORE RIPARIAN AREAS?

Fish Stocks in Decline

British Columbia supports some of the world’s largest salmon stocks, yet those stocks have been in serious decline since the 1980s. Salmon streams that once supported tens of thousands of fish have been alarmingly empty or seeing only a fraction of the fish they once did. The risk of extinction has been voiced before in British Columbia by some biologists (Slaney et al. 1994), but only in the past few years have people really started listening.

Removal of Streamside Forests

In the past, logging was typically taken to the stream edge where the largest, most valuable trees grew. Early attempts at retaining stands near streams were tried, but such stands often failed or were salvaged after being partially damaged by windthrow. Losses led to the notion that all stands would fail, and practices gave way to harvesting all trees where clearcutting was prescribed. Before the Code, British Columbia’s *Coastal Fisheries/Forestry Guidelines* (1993) required retention of trees on streams in coastal regions, but these guidelines did not become mandatory until 1993. Similar steps were being made in the Interior of the province to establish a requirement for reserving trees near streams, but this was superseded by the

Forest Practices Code in 1995. The Code legislated the requirement to establish a riparian management area adjacent to all streams in British Columbia and a reserve riparian zone adjacent to all but the smallest fish streams and streams in community watersheds (Table 1).

Table 1. Widths of riparian reserve zones and riparian management zones adjacent to S1, S2 and S3 as specified in the Forest Practices Code of British Columbia Act

Riparian Classification	Riparian Reserve Zone (m)	Riparian Management Zone (m)
S1, > 20 m in channel width	50	20
S2, > 5 – <20 m in channel width	30	20
S3, 1.5 – 5 m in channel width	20	20

The net result is that the vast majority of riparian areas logged before the Code were harvested to the stream edge. Although natural revegetation and efforts by logging companies to re-establish vegetation have been successful, riparian stands that predate 1995 often contain vegetation typical of early seral communities (e.g., heavy shrub cover with small saplings or high-density pole stands. These early seral forests lack the stand characteristics that enabled pre-harvest riparian forests to function fully.

Riparian Silviculture Solution Slowly Recognized

Although searching for answers to the tragic loss of a once grand fishery has inspired all components of the Watershed Restoration Program, implementing riparian restoration has not proceeded at the same rate as has watershed restoration in streams and on hillslopes. Stream and hillslope restoration has benefited from a long history of fish/forestry research conducted in British Columbia (Poulin 1984; Hartman and Scrivener 1990) and throughout the Pacific Northwest since the 1970s (Moring 1974). The success of the results of this research can be seen throughout the province in the road deactivation, landslide rehabilitation, bioengineering and reconstruction of off-channel and instream fish habitats that have become standard forest management activities. The same cannot be said for riparian restoration.

Until recently, regeneration silviculture in British Columbia was undertaken primarily to produce a free-growing crop of trees. Considerable intensive silviculture has been done in

older stands, but it was aimed at sawlog production and commonly used herbicides. It was not until the enactment of the Forest Practices Code in 1995 that silvicultural treatments were required to accommodate other identified resource values (Silviculture Prescription Guidebook 1995). For the first time, fish, wildlife and biodiversity (Biodiversity Guidebook 1995; Riparian Management Area Guidebook 1995) required significant changes in forest practices. Awareness within the Watershed Restoration Program also increased as habitat specialists reconstructed fish habitat using instream structures built from large woody debris. Logs and rootwads needed for these projects had to be hauled from many miles away. The large conifer trees needed by streams to meet requirements for fish habitat and watershed stability were gone, having been replaced by young forests.

Now, riparian restoration is gradually starting to take hold in British Columbia. The earliest riparian restoration project involving riparian silviculture began in spring 1998 in the San Juan Watershed on Vancouver Island, where it was employed to re-establish conifer in alder-dominated areas and willow on sandbars and riverbanks (Iverson and Epps 1998). The next largest operational project was completed in fall 1998 on the Malksope River on Vancouver Island (Poulin and Simmons 1998). The primary objective of these projects and others that followed has been to accelerate the recovery of fish habitat, water quality and channel stability by restoring the ecological functions of streamside forests.

Ecological Functions of Streamside Forests

When riparian forests are cut, the ecological clock is turned back in time. Old forests are replaced with new forests that are set on a pathway of recovery toward the original pre-harvest condition (Kimmins 1992). The rate of recovery is slow. It can take several hundreds of years before old-forest characteristics are returned (Figure 1).

In forest ecosystems, the riparian functions most needed for restoration of fish and wildlife habitat, water quality and watershed stability are dependent on mature or old-forest characteristics.

The characteristics most needed for riparian function are large conifer trees, a complex stand structure, and long-lived species that provide stability to streambanks, channels and floodplains (Figure 2).

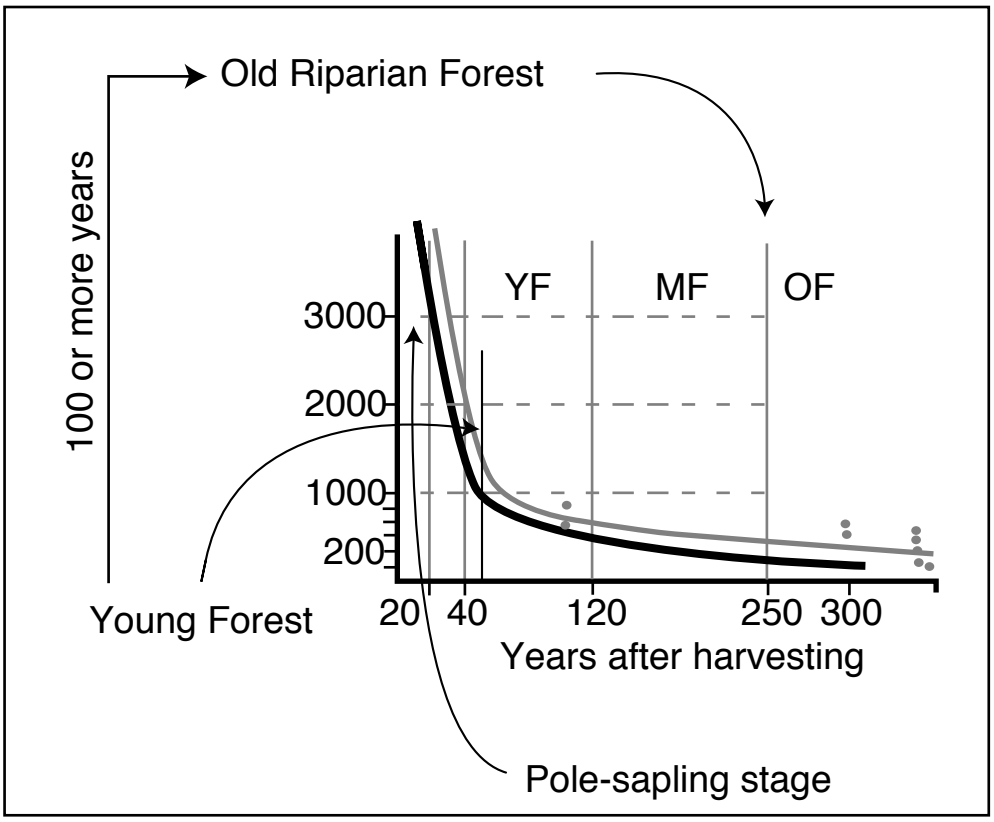


Figure 1. Natual thinning curve typical of many coastal conifer sites showing the time to achieve mature or old forest characteristics in logged stand (modified from Douglas and McLennan, (1999). Source of black line: (Douglas and McLennan); source of grey line: file data from other coastal streams assessed by the authors of this report.YF - young forests; MF - mature forests; OF - old forests.

Large trees

Large trees are an essential requirement for watershed restoration. Large-diameter trees with strong root systems provide critical elements of fish habitat in many stream systems and are necessary for preventing chronic erosion of streambanks and channels. Referred to as “large woody debris,” large trees and branches that fall into streams modify the width and depth of a stream by causing localized scour and deposition of the streambed. The resulting features create habitats that are critical to the spawning, rearing and overwintering requirements of salmon and many resident fish.

Fisheries scientists refer to “limiting factors” as those that determine the productive capacity of a stream to produce fish. Overwintering habitat and spawning areas are two limiting factors. Large pieces of stable debris that form jams or obstructions in flow are responsible for creating conditions that favor high overwinter survival. When localized scour modifies

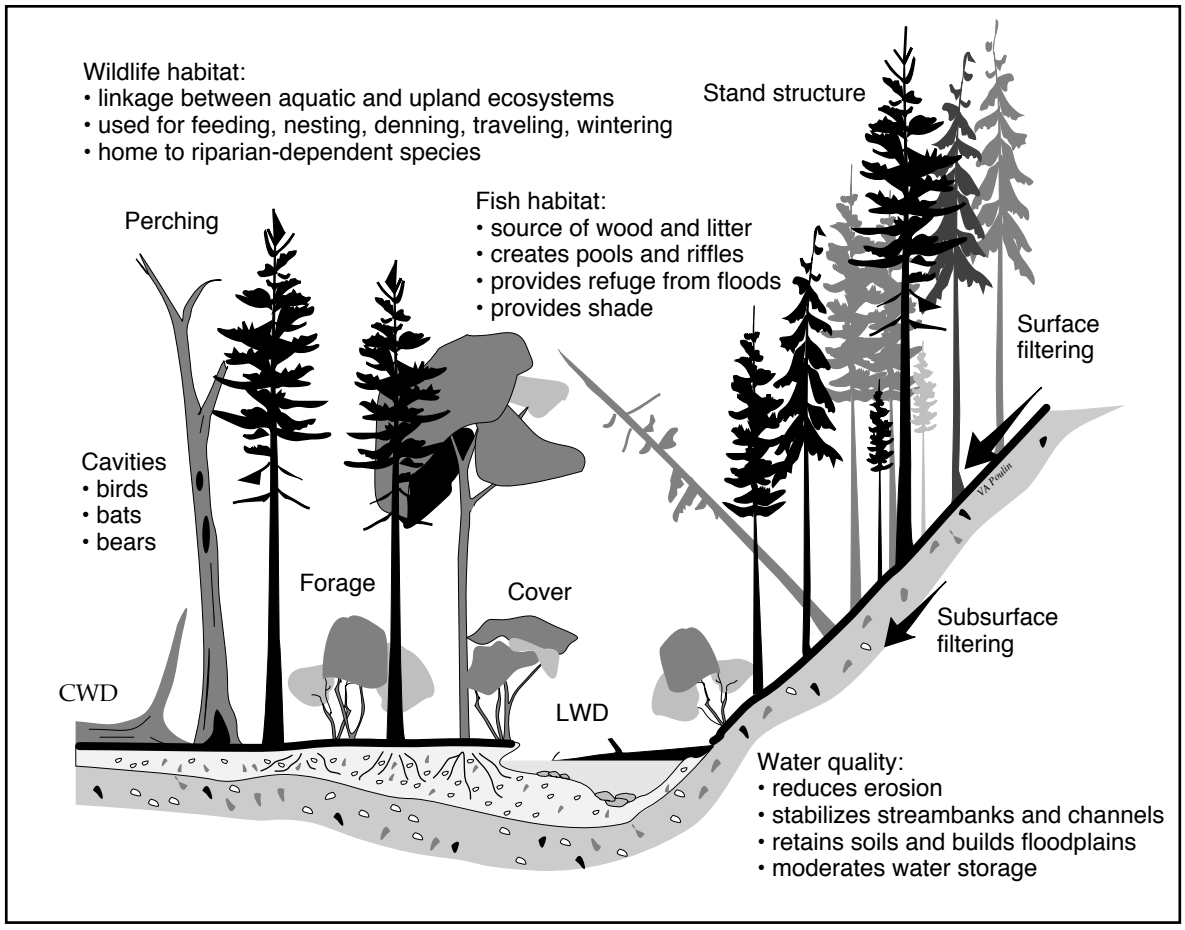


Figure 2. Attributes provided by functioning riparian ecosystems that are needed for restoration of fish and wildlife habitat, water quality and channel stability (from Koning 1999). CWD - coarse woody debris; LWD - large woody debris.

such debris structures, the backwater pools, lateral scour pools, dammed pools and underscour pools created provide refuge and hiding cover to fish. The total number of these habitats available is directly proportional to a stream’s capability to sustain fish. Small wood can create similar structures, but large-diameter trees are more stable, last longer and have a greater influence over stream flow.

As well, large trees influence streams in other ways. Fallen trees stabilize the beds and banks of streams and slow the movement of gravel through a stream system. The hydraulic stability of these structures in turn provides stable gravel environments that fish use to spawn (Tripp and Poulin 1986). Tree roots strengthen streambanks, preventing erosion and reducing sedimentation. The larger, more vigorous the tree, the greater the size of the root ball. Long sections of streambank can be stabilized by a single, large diameter, deeply rooted tree. Strong roots hold streambanks together, enabling the formation of undercuts. Undercuts are fish habitats present in old-forest streams, created when water scours beneath a streambank create a watery cavern that allows fish to hide from predators and high stream flow. They are significantly reduced in logged streams (Toews and Moore 1982; Koski et al. 1984; Tripp and Poulin 1986). Large trees increase floodplain stability. When they become anchored in streambanks and jams, they are difficult to move and thus protect areas from erosion.

Logs are also important collectors of sediment. During floods, water velocity is increased near debris, but flow quickly subsides, causing sediment to deposit immediately downstream. On bars, this process hastens soil development, enabling plants to colonize and trees to re-establish.

Stand structure

Stand structure refers to the composition and arrangement of standing dead and live trees within a stand and the characteristics the stand exhibits with respect to canopy layers, understory vegetation, and even decaying wood on the forest floor (Kimmins 1992). The more complex a stand's structure, the greater the stand's biodiversity. Stand structure provides birds, mammals, amphibians, reptiles, and invertebrates with habitat for foraging, breeding, rearing their young, hiding, resting and travelling (Stevens et al. 1995). Riparian areas contain high structural diversity—so high that of the 340 vertebrate species that live in British Columbia's forests, up to 74% use riparian areas (Bunnell and Dupuis 1993). Sixty-two of these are considered to be at risk: 7 amphibians; 5 reptiles; 26 birds; and 24 mammals, including 5 bat species (Managing Identified Wildlife Guidebook 1999).

Riparian forests tend to be open-grown, with gaps in the canopy and pockets of variable spaced trees interspersed throughout the stands. Spacing between trees is usually wide, reflecting a history of wind, insects and disease. Periodic flooding, channel movement, and

erosion and deposition work to modify and create landforms that give rise to a mosaic of plant communities that includes young hardwoods, mixed wood and pure conifer stands. Light is usually sufficient to allow conifers to become well growing while still supporting an understory of shrubs, herbs and moss. In uneven-aged riparian forests, multiple canopy layers are generally present. Understory vegetation is typically lush and dense. Berry-producing shrubs benefit from increased light and often yield full, ripe crops.

Openings created by the death of individual trees or patches of trees create gaps that stimulate shrub production and allow conifers to regenerate. Gaps permit dappled light to reach the surface of streams, where it stimulates the growth of algae and increases fish food production.

An important element of stand structure is dead and dying trees. Riparian areas tend to have an abundance of snags and downed wood. Downed wood (in the form of stumps, logs and branches) provides an important source of refuge, resting, feeding and breeding sites for a wide range of species such as shrews, salamanders, some birds and other amphibians (Bunnell and Dupuis 1993). Snags are a critical source of habitat for primary and secondary cavity-nesting birds and many mammals, including bats, squirrels, martin, ermine, fisher, and bears (Brown 1995).

Forest composition

The many species of trees present in riparian areas reflect the enormous diversity of ecosystems present in British Columbia and the natural disturbance patterns under which they have evolved. In coastal riparian forests where stand-initiating events above the floodplain are infrequent, old forests typically contain uneven-aged, long-lived conifers such as western redcedar, Sitka spruce, Douglas-fir and western hemlock. In the Interior, where fire is the principal stand-initiating event, riparian forests often consist of a mosaic of stand types and ages. Even-aged stands with snags and veteran trees that have survived previous fires may be present, as might relic stands of uneven-aged forests that survived burns because of their proximity to streams, lakes and wetlands (Biodiversity Guidebook 1995). Compared to coastal forests, Interior stands are typically shorter lived and never reach the same large size and diameter as their coastal counterparts. In all areas of British Columbia, alluvial landforms on active floodplains are largely dominated by rapidly growing hardwoods. They are present as pure deciduous forests or mix conifer-deciduous stands.

Forest composition is significant with respect to riparian restoration. In coastal forests, species such as Sitka spruce, western redcedar, Douglas-fir and western hemlock grow to great age and achieve large size. The massive root systems produced by these trees are responsible for maintaining the balance between channel stability and peak flows generated by snow and rain in the coastal forests. In the Interior, differences in rooting characteristics between riparian tree species are secondary to the disease and insect resistance offered by trees.

RIPARIAN ASSESSMENT PROCEDURES USED IN BRITISH COLUMBIA

Riparian assessment and prescription procedures have been developed by the Watershed Restoration Program to assist riparian specialists and local groups (forest licensees, First Nations, community groups, stewardship organizations) in developing and implementing riparian restoration projects. The procedure was first drafted by Oikos and Johnson (1996) and finalized with input from specialists with coastal and interior experience (Koning 1999).

A listing of all the known riparian assessments and projects completed to date are provided in Appendix 2 and 3. Projects that included implementation of riparian prescriptions are given in Appendix 2. Those that included only riparian assessments are listed in Appendix 3. Table 2 gives the number of hectares treated to date.

Riparian Assessment and Prescription Procedure (RAPP)

The Riparian Assessment and Prescription Procedure (RAPP) is intended to be an iterative process that begins with an overview assessment to identify areas of potential concern and the general nature of the disturbances. This step is followed by more highly detailed and quantitative field assessments (Level 1 and 2), leading to the development of riparian prescriptions. The RAPP guide splits the various steps into discrete tasks—Overview, Level 1 and Level 2 assessments. Training in the procedures is made available yearly through the Forestry Continuing Studies Network in coastal and interior modules.

Overview assessment

The purpose of an overview assessment is to identify riparian areas that are likely candidates for riparian restoration and Level 1 and Level 2 field assessments. The steps required to complete an overview assessment vary with the watershed and the information known about areas requiring assessment. For most practitioners, the overview assessment is a rapid mapping exercise using available aerial photography—generally high quality, low-level photographs at 1:2500 or 1:5000 scale. From the photographs, the boundaries of riparian polygons (distinct units of similar stand type) are determined and tentatively classified as conifer, deciduous or mixed conifer-deciduous stands.

Table 2. List of streams and rivers where riparian works have been completed since 1998

Coast locations	Year treated	Area treated (ha)	Proponent
1. Malksope River	1998/1999	25	International Forest Products Limited
2. San Juan River	1998/1999	29.4	Timber West Forest Limited
3. Cyper River	1999/2000	48.5	Weyerhaeuser
4. Eve River	1999/2000	30	Weyerhaeuser
5. Keogh River	1999/2000	12.6	Western Forest Products Limited
6. Little Zebellos River	1999/2000	20	Ehhattesaht First Nation
7. Malksope River	1999/2000	15	International Forest Products Limited
8. Silverhope Creek	1999/2000	13	Steelhead Society Habitat Restoration Corporation
9. Squamish River	1999/2000	11.5	Steelhead Society Habitat Restoration Corporation
10. Tzoonie River	1999/2000	44.5	International Forest Products Limited
Interior locations	**Year treated**	**Area treated (ha)**	**Proponent**
11. Little River	1999/2000	8	Weldwood of Canada Limited
12. Narrowlake Creek	1999/2000	10	Northwood Inc.

Depending on the project, stands may be further described according to stand structure (initial vegetation, shrub, pole-sapling, young forest, mature forest or old forest). Polygon size in hectares is usually estimated at this stage using a dot grid. Overlays are not finalized until polygon boundaries are field checked. The information compiled during the overview forms the basis for all subsequent assessments. The overview is an important first step in the

RAPP. It is used to prioritize sites for field visitation and allows the specialist to become familiar with the terrain and the nature of the watershed being assessed.

Level 1 and Level 2 assessment

Level 1 and Level 2 assessments are the field component of the RAPP. Initially conceived as two distinct levels in the assessment procedure, the Level 1 and Level 2 assessments in practice have been combined by most prescribing riparian specialists into a single seamless assessment. The combined assessments consist of field surveys within which field data is collected and used by the prescribing forester or riparian specialist to evaluate the need for restoration and to develop prescriptions. The work is intensive and includes ground surveys and data collection sufficient to describe the areas requiring treatment and the stand conditions. In most assessments, each riparian polygon identified in the overview assessment is examined and classified by riparian vegetation type.

In this process, the prescribing specialist or forest technician traverses the area assessed and examines the stands. Field data, including plot information sufficient to describe the physical and vegetative characteristics of the site, is collected and recorded on standard RAPP forms. Information includes polygon number, location, biogeoclimatic ecosystem classification, creek aspect, slope, stream gradient, channel width, number and species of trees by dbh class, and height and diameter of dominant tree species. Further ecological data, such as composition of understory shrub and herbaceous plants, is also compiled. Soils are examined and information (such as soil texture and coarse fragment content) provided on the most relevant soil horizons. Qualitative evaluations are made of the level of riparian impairment and notes are recorded identifying any disturbance indicator that may be relevant to restoration. The additional information collected varies with the prescribing specialist, though BEC subzone, variant and site series are typically included.

Forest cover labels are generated from the plot data and observations of the surrounding forest cover. Standard silvicultural plots are established to obtain stand density information. Plot radii vary depending on the size needed to obtain representative information. Vegetation plots are also done, not to achieve a statistical representation of the stand, but to characterize the stand condition.

Riparian vegetation types (RVTs)

Classifying riparian vegetation into similar stand types provides riparian specialists with a means of facilitating the assessment. Different approaches can be used. The RAPP recommends that riparian vegetation types (RVTs) be assigned based on stand structure and trees species. These may include recognition of understory vegetation types. Each label is given a different RVT number unless the stand structure is the same. The procedure can result in a large number of different RVTs that are not necessarily consistent between projects. Examples of RVT labels derived by this method are:

RVT 1	**PSd/Dr(Ss)/HwSs**:	A deciduous (d) pole-sapling stand (PS), dominated by red alder (Dr) with scattered Sitka spruce (Ss) in the overstory; understory has a significant stocking of western hemlock (Hw) and Sitka spruce.
RVT 2	**MFc/SsHwCw**:	A conifer (c) dominated mature forest (MF), with Sitka spruce (Ss), western hemlock (Hw), and western redcedar (Cw) in the overstory; understory is lacking.

(Source: Koning 1999, adapted from McLennan and Johnson 1997)

An alternative to this procedure is a five-class system that evolved from describing stand types that provide opportunities for riparian restoration. This alternative classification was first used on the Malksope River (Poulin and Simmons 1998). The system works well in coastal forests where factors affecting the dysfunction of riparian stands are less variable. The classification has since been widely used and is currently the approach recommended for stratifying stands on the coast in the RAPP training module (Figure 3).

The classification system is based on the four most common stand conditions that require riparian silviculture and a single category for stands that do not require treatment.

- **RVT 1** is an area where conifer stocking is low due to competition from brush, insects, frost or disease.
- **RVT 2** is a conifer-dominated site where high stocking densities have significantly reduced conifer diameter and crown development. They are usually pure conifer, but can be mixed stands of conifer and deciduous.
- **RVT 3** is a deciduous-dominated site with an understory of conifers. The overstory usually consists of alder, but may have other deciduous species such as cottonwood

or bigleaf maple. In most situations, the deciduous trees form a pronounced overstory that has the effect of suppressing the growth and survival of conifers.

- **RVT 4** stands are similar in all respects to RVT 3 stands, but contain sparse (<100 stems per hectare) to nil conifers in the understory.

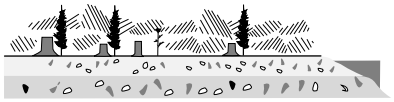
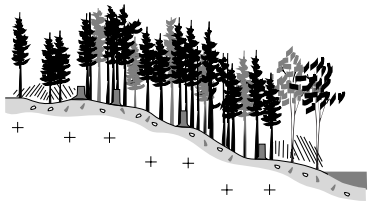
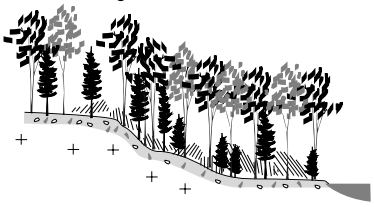
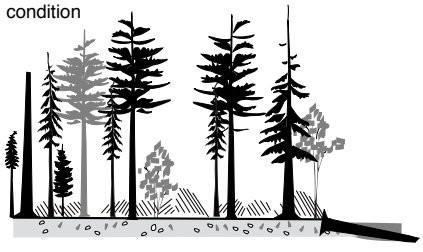
RVT	Stand condition	Function impaired	Rehabilitation action/objective	Hectares
1	poorly stocked site with dense competing vegetation of brush; conifers sparse, sometimes in clumps 	large wood, small wood, shade, bank and floodplain stability	Improve conifer stocking on critical sites; otherwise retain for biodiversity or wildlife forage production	0.8 (1%)
2	overstocked conifer site; pole-sapling or young forests with 1500 to 6000 or more sph 	large wood, bank, and floodplain stability; forage for wildlife, nesting sites, structural diversity	Achieve largest diameter trees in shortest possible time; manipulate stand structure to provide mature forest characteristics sooner; modify stand composition to favor desired tree species	19.2 (18%)
3	conifers overtopped by deciduous trees; densities variable, 100 - 700 sph; fewer on low to moderate benches and higher on better-drained sites 	large wood, bank and floodplain stability	Release advanced conifer regeneration by removing competing trees; improve light penetration to stimulate maximum growth potential of conifer understory	60.0 (58%)
4	deciduous-dominated stand with generally nil to very low conifer stocking (<100 sph) 	large wood, structural diversity, bank and floodplain stability	Options vary depending on age of stand and objectives. May include managing for large alder and individual conifer release or planting to improve conifer stocking on some sites	0.6 (1%)
5	functioning riparian stands or stands that contain attributes for desired future condition 	functioning ecosystem with old forest characteristics	No action required, but consider providing options for wildlife enhancement if second growth stands have no trees suitable for manipulation	24.0 (23%)
				104.6

Figure 3. A treatment-based classification system used to stratify riparian polygons on the Tzoonie River. Hectares show distribution of riparian vegetation type (RVT) present (Poulin and Simmons 1999d).

- **RVT 5** stands are functional riparian sites or stands that contain all of the characteristics necessary to achieve a desired future condition for the site. They may be (i) mature forests or old-growth forests that are already in the desired condition, or (ii) young forests—even pole-saplings—that are on their way to the desired future condition Evaluation of RVT 5's is an important step in riparian assessment. They provide ecological rationale for treatment recommendations and help to determine the "desired future condition or target stand" for an impaired site.

The simplicity of this classification makes it easy to use and apply. An added advantage is the ease with which forest workers are able to visualize the stand types requiring treatment.

Assessment deliverables

Standards agreements between prescribing specialists and contracting authorities must specify the outputs expected from a completed riparian assessment. The product is always an assessment with or without recommendations depending on the outcome of the assessment. The assessment provides: a description of the nature of the riparian impairment; an identification of areas or polygons where silvicultural approaches would speed the restoration of riparian function; and, depending on the level of assessment, specific treatment recommendations. An example of a riparian silvicultural plan contained a RAPP report is shown in Figure 4. Photographs depicting the stand conditions and other points of interest are used to help explain the need for the work. Maps showing the location of the treatment units, as well as aerial photographs showing polygon boundaries, are required, as is information on the area of the polygons, unit cost and total estimated project cost to complete the work. Ranking polygons in order of treatment priority may be done if funding options are needed to complete an anticipated project.

Relationship between a stand management prescription and RAPP

When a Level 1 and Level 2 riparian assessment is done as a single, seamless assessment, the product is similar to a stand management prescription. A stand management prescription is a planning tool required by the Forest Practices Code to be carried out on a free-growing stand (Stand Management Prescription Guidebook 1995). The stand management prescription was created to complement the silviculture prescription by specifying a full-rotation crop plan or stand management strategy for an individual stand.

Figure 4. Insert (manual 2.1 mb illustration)

The Code requires that a minimum number of healthy, acceptable, well-spaced trees be established on a site within a designated free-growing period. The silviculture prescription and treatment prescription are the vehicles that detail the stocking standards necessary to achieve free growing. There are differing views about the requirement for a stand management prescription when trees are modified or felled in the riparian reserve for purposes of riparian

restoration. A detailed discussion of this issue is provided in ”Administrative Processes and Jurisdiction” as it relates to the Forest Act and the Forest Practices Code.

Content

Content requirements for a RAPP are similar to those of a stand management prescription with respect to describing the location of the areas recommended for treatment and detailing management objectives, target stand condition, and treatments required for achieving the stand objectives (Table 3). However, the similarity ends there. Not all of the content of an stand management prescription is addressed in a RAPP because of the different objectives associated with the respective documents. This has been a source of confusion and had led to problems with effective implementation of some projects. Missing from RAPP documents is the content in stand management prescriptions that considers relationships to non-riparian objectives including higher-level plans and stand-level objectives such visual landscape objectives, recreation and range objectives. Other information lacking is that which pertains to tending a commercial stand. Information such as silvicultural system, variant, cutting cycles, rotation age, and year of harvest is not applicable to a riparian restoration treatment and is not included in a RAPP document.

Other sources of confusion arise from a stand management prescription requirement to establish post-treatment standards that specify particular stand structural attributes for crop trees, such as target well-spaced stems, minimum preferred well-spaced stems, and minimum inter-tree distances. Such standards do not necessarily apply to riparian treatments where biodiversity objectives are being achieved. Leaving clusters of trees for wildlife shelter and hiding cover, retaining layered windward edges on treatment edges, cutting openings for gaps in the forest canopy, and allowing for variable density thinning are definable “standards,” but they must communicate the intended range of densities and arrangements specific to riparian stands.

Requirement for signing and sealing

Stand management prescriptions must be signed and sealed by a registered professional forester who is responsible for its content and accuracy. There is no similar requirement for a riparian restoration plan prepared according to RAPP procedures. The riparian overview assessment and Level 1 field assessments may be completed by experienced field technicians, but treatment recommendations are made by an experienced riparian silvicultural specialist. The specialist may be either a professional biologist or forester.

Table 3. Content of a riparian silviculture plan produced through the riparian assessment and prescription procedure (RAPP) and a stand management prescription (SMP)

Content Required	RAPP	SMP
• description of area and site map(s)	X	X
• management objectives:	X	X
• higher level plans	-	X
• range	-	X
• recreation	-	X
• visual landscape	-	X
• wildlife	X	X
• fisheries	X	X
• watershed values	X	X
• forest products	-	X
• other forest values	X	X
• forest health (risk) and protection assessment	-	X
• current stand and site description (RVTs/polygons)[a]	X	X
• silvicultural system	-	X
• target stand condition or desired future condition	X	X
• proposed treatments	X	X
• post-treatment standards	-	X
• special areas	X	X

[a] RVT – riparian vegetation types

Cost of riparian assessments

The cost of riparian assessments has decreased significantly as riparian assessment procedures have become more streamlined and Watershed Restoration Program coordinators have prioritized watersheds before entering into contracts with practitioners. The first riparian assessments undertaken in the province tended to include large geographical areas or entire watersheds within which analysis was completed on all drainage areas that could be identified from aerial photography.

Early expectations were for data to be compiled, digitized, referenced and mapped. Enormous cost and energy went into projects where all or parts of a watershed were not realistic candidates for riparian restoration. Within the last several years, Watershed Restoration Program coordinators have reduced the risk of assessments leading to no future projects by pre-determining areas where riparian stands were suspected or known to be dysfunctional. In addition, emphasis has been placed on larger streams or stream reaches that are bounded by riparian reserve zones (S1, S2 and S3). This strategy has resulted in more cost-efficient assessments and escalation in operational projects.

Riparian assessment costs are difficult to compare when judged against almost any standard because of the different approaches and objectives demanded by each project. Average expenditures for completing a typical combined overview and Level 1 and Level 2 assessment has been approximately $25 000. Cost comparisons based on hectares under prescription tend not to be useful because average costs per hectare under prescription do not reflect the relationship between size of area assessed and the number of hectares requiring treatment. It costs just as much to place 40 ha under prescription as it would 18 ha if the assessment area is the same. The Watershed Restoration Program has tendered contracts based on costs per kilometre of stream; others contracts have been direct-awarded to available specialists with recognized expertise. Major licensees have tended to opt for the latter approach, preferring to work with individuals who are familiar with their operations and known to them for their expertise.

Riparian Silvicultural Practices in Coastal British Columbia

Riparian forests in coastal British Columbia have been logged extensively since the latter half of the 19th century (Drushka 1999). Because most logging was concentrated in valley bottoms and on lower slope positions, many riparian forests were harvested.

In 1986, the coastal logging industry worked with government and adopted the *Coastal Fisheries/Forestry Guidelines*. The guidelines attempted to protect the remaining riparian forest adjacent to coastal streams, but they were largely unsuccessful until stricter guidelines (adopted in 1993) required the retention of buffer zones adjacent to most fish streams. In 1995, the Forest Practices Code superseded the *Coastal Fisheries/Forestry Guidelines* and established in law the requirement for reserve zones adjacent to S1, S2 and S3 streams. Considering the vast amount of area logged prior to the Code, it is easy to imagine the large percentage of coastal streams where riparian silviculture is needed to restore riparian functions lost by timber harvesting.

Restoration goals and objectives

In coastal forests, second-growth stands occur as mixed conifer-deciduous, pure deciduous, or pure conifer forests. Most regenerated naturally following logging or are plantations where seeded conifer or deciduous trees have in-filled. The distribution of riparian vegetation types (RVTs) in areas recommended for riparian restoration in six coastal streams is shown in Figure 5. The stand conditions are typical of those encountered in many watersheds. Overstocked conifer stands (RVT 2) and conifer stands overtopped by deciduous trees (RVT 3) are the most frequently encountered riparian stand condition, and thus have been the stand types most addressed by the authors and other practitioners on the Coast (R. Muller, D. McGeough, and P. Kuntz, personal communication).

Overstocking is a condition that greatly influences the rate at which riparian areas recover. Conifer stands with high stocking densities and closed canopies have reduced diameter growth rates, simple stand structure, and often poor tree species diversity. The result is loss or delayed recovery of stand structural components such as multiple canopy layers, dead and dying trees, understory vegetation (shrubs and herbaceous plants), downed woody debris, and sometimes low numbers of preferred riparian tree species.

When trees compete for space and nutrients, the result is slender trees with small high crowns. These characteristics increase the risk of trees to windthrow (Mitchell 2000). Windthrow is a natural process required for many riparian functions. However, if stands aren't thinned at an early age, they may become subject to heavy wind damage, which can

exacerbate sediment production and channel erosion in watersheds already altered by logging.

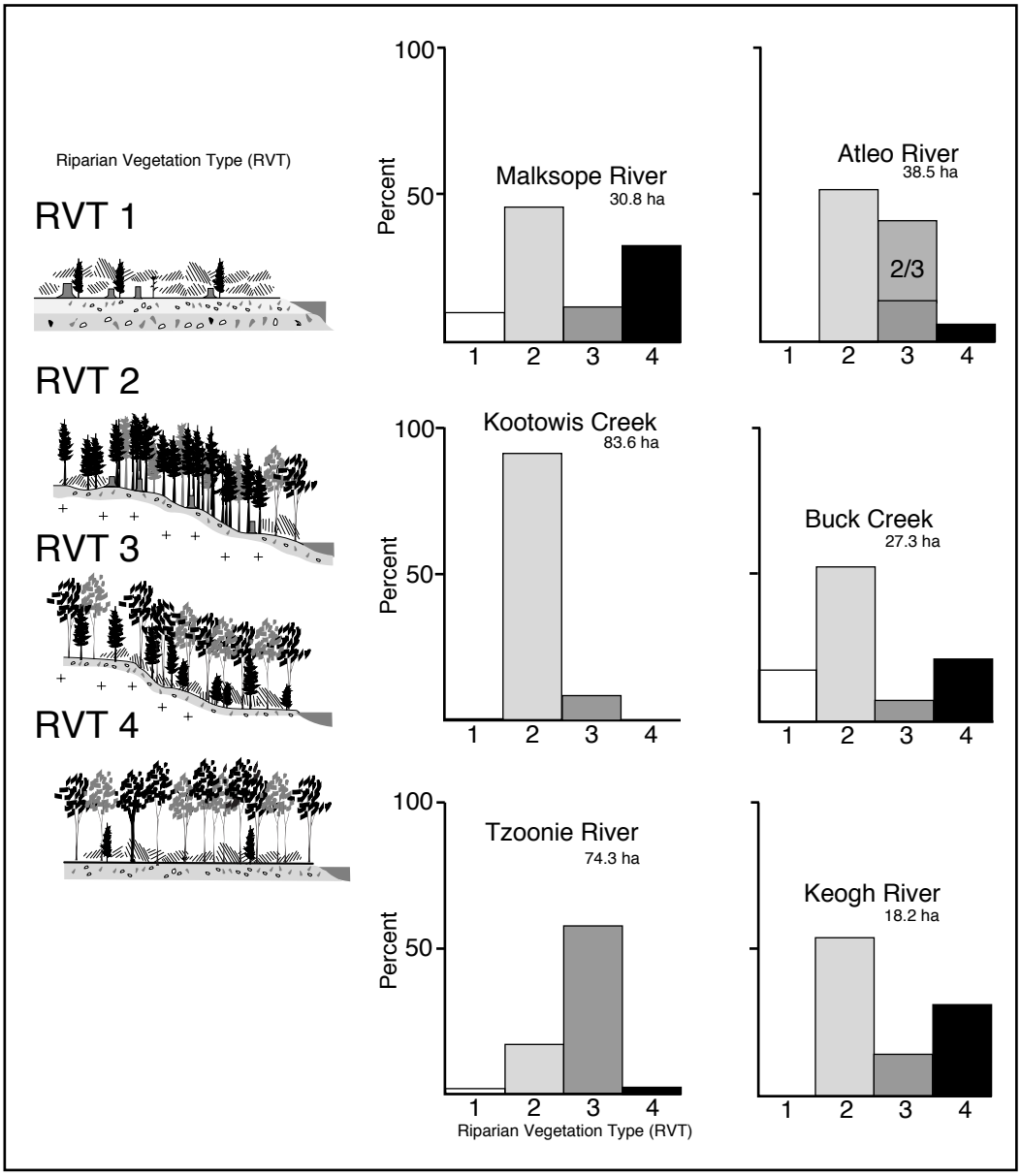


Figure 5. Percent distribution of four riparian vegetation types (RVTs) used to classify treatment areas in six coastal stream systems (Poulin and Simmons 1998, 1999a-1999d).

Alder is the most common deciduous species in coastal riparian forests. It is present on low to high bench floodplains and wet to moist upland sites. It often occurs in narrow strips that parallel watercourses. While providing some benefit to aquatic ecosystems, alder is not long-lived and does not provide the bank and channel stability that conifers do. Most alder stands

contain a sparse to moderate understory of conifers whose growth is suppressed as a result of light interception.

Riparian restoration objectives in coastal forests are primarily concerned with re-establishing conifers and enabling conifers to become well growing in both deciduous- and conifer-dominated sites. Treatments include bushing, thinning and planting. In addition, many stands allow for treatments that provide opportunities for meeting a wide range of biodiversity objectives. This can be done through manipulation of the stand structure to create snags, dead and dying trees, and actual habitats for bats, birds, bears and other wildlife.

Common riparian restoration treatments

Brushing to release conifers

Brushing is a riparian treatment done to release conifers in brush sites (RVT 1) with low densities. Salmonberry and red elderberry are two leading brush species that can quickly out-compete regenerating conifers on moist, rich sites. They are ever-present as understory in deciduous-dominated stands where high soil moisture or fluctuating water levels are present. In these areas, conifer establishment is difficult and brushing is done to help release the understory conifers that have not gained sufficient height to get above the brush. However, brushing is not recommended on all sites. Openings created by high brush competition can provide or maintain forage habitat for wildlife.

Where brush sites do not constitute a high component of the stand (they are not that extensive in many areas; Figure 5), treatment is not recommended except in spots such as where bank and channel stability is at high risk of erosion.

Thin to improve diameter growth of conifers

Overstocked second-growth conifer stands dominated by western hemlock (RVT 2) are common throughout coastal forests. Conifer stocking densities are typically very high (Figure 5). High stocking causes the canopies of stands to close at a young age, reducing light to trees and shrub-herb communities. Low light levels kill most understory plants and reduce the growth and vigor of smaller trees. It can also have a significant negative effect on tree species composition by enabling shorter-lived, more aggressive tree species to out-compete highly valued riparian trees such as Sitka spruce and western redcedar. Spruce and cedar

play a major role in watershed stability by producing massive root systems that anchor streambanks and channels.

The primary objective of riparian silviculture in overstocked conifer stands is to speed the natural thinning process so that conifers increase in diameter more quickly. Different strategies are employed depending on the age of the stand being treated, the structural objectives for the site and the individual practitioner. Treatments include uniform and variable density thinning. Pre-treatment stand densities in second-growth stands can range from 1000 sph to 5000 sph or more depending on the stand. Target stand densities prescribed by most practitioners speed up the natural thinning process by 25–75 years.

Thinning densities prescribed by practitioners mimic those found in old forests and allow for a wide range of post-treatment stocking densities. This is done to help recreate the variability found in mature or old riparian forests. A target density range of 200–600 sph is typical, with more than 600 sph being acceptable where higher densities are left to achieve a specific biodiversity objective or to help reduce windthrow risk or account for windthrow losses. Clusters and gaps are left or created in the stands to provide stand structural characteristics not present in uniformly thinned commercial forests. The most windfirm trees are retained during the thinning process. Emphasis is placed on preserving or enhancing tree species diversity by, for example, retaining preferred trees, some hardwood species and any important plants not well represented in the stand. Target densities are usually set to allow for the re-establishment of shade-tolerant conifers.

All practitioners interviewed for this project reported having designed treatments to be one entry. Single-entry treatments reflect the social and economic reality of Forest Renewal BC funding and the desire by logging companies not to incur uncertain future silvicultural liabilities. Single-entry projects can be initiated and completed within a single fiscal year, but they may not be always desirable. They limit the extent to which a stand can be modified and what objectives can be achieved. Furthermore, removing too many trees at one time can increase the risk of windthrow by eliminating too much of the support provided by adjacent trees.

Thin to improve diameter growth of deciduous trees

In stands that lack a conifer component (RVT 4), some practitioners have managed for large alder by thinning. It is a low-cost treatment that can both yield medium-size woody debris for streams and generate trees with improved root strength and good diameter. However, the treatment is age and height dependent (Peterson et al. 1996; D. Hibbs, personal communication). The treatment is applied to stands and to individual trees. When individual trees are managed for large size, trees are selected for crown response. Trees within a specified distance of the target tree are girdled or felled to provide space for the retained tree. When applied to groups of trees, most practitioners thin alder uniformly to a specified density, usually between 100 and 400 sph.

Release understory conifer by canopy removal

Alder-dominated forests that contain an understory of suppressed conifers (RVT 3) are likely the second most common riparian stand type in coastal British Columbia. They are also common throughout the Pacific Northwest. Alders are aggressive pioneering trees that grow well on disturbed sites and on medium and high bench floodplains. The same areas are favorable growing sites for salmonberry and red elderberry, which flourish in the higher light levels filtering through the deciduous canopy. These shrubs can rapidly out-compete slow-growing conifers on moist-rich sites. Competition from combined alder and understory brush results in significantly reduced growth and survival of regenerating conifers.

Practitioners use several approaches to release understory conifers. The most common is a treatment that removes the overstory alder by felling or girdling. This is often combined with a one-time brushing and fertilizing treatment if the seedlings intended for release are not above the height of the brush. The treatment mimics the natural die-off that occurs when the short-lived alder becomes old. However, the treatment is also controversial, as a minimum of 40% full sunlight is required for success in fully releasing understory alder (Chan et al. 1996; S. Chan, personal communication). Most practitioners appreciate the need to remove a significant portion of the overstory to achieve adequate light levels, but this can be at least 80–90% of the overstory. Some practitioners have been cautious, preferring to partially release conifers by creating gaps of 5–8 m and retaining all larger-diameter alder for ecological functions.

Allow partial conifer release while retaining some overstory

Coastal watersheds are dependent on well-growing conifers, not alder, for maintaining channel stability and water quality. Alders have many beneficial ecological attributes, but they are not well-rooted trees, nor do they have the root strength and mass of conifers. When undercut by destabilized stream channels, they contribute to streambank and channel erosion, prolonging the time needed for watersheds to recover from damage by logging. Despite these limitations, alder does have an important role in riparian ecology. It is a short-lived, rapidly decaying tree that builds soil, fixes nitrogen in a nitrogen-limited system and produces the litter that is an important

source of nutrients in coastal streams. Although it decays significantly faster than conifers, it still provides an interim source of woody debris (Peterson et al. 1996) and, under the right circumstances, can grow to 1 m or more in diameter. When alder falls into streams it provides material to form jams or augment other debris loading.

Managing for large alder while achieving partial conifer release is a treatment that can yield medium-sized wood quickly while achieving improvements in conifer growth. Practitioners applying the approach remove the alder overstory by felling or girdling, leaving a residual density of 100–200 sph. Brushing is usually done in combination with the overstory treatment. Girdling is the generally preferred method for removal. Felling is a significantly more expensive treatment than girdling and can cause damage to understory conifers when trees cannot be felled away from the trees being released. However, girdling can also cause damage when the tree branches and boles drop from decay. At present, both treatments are being used, but time is needed to tell which method is best, given the tradeoffs involved.

Establish conifers by planting

Alder stands that lack an understory of conifer (RVT 4) will revert to brush when the alder goes into senescence, leaving the site without trees. In many watersheds this process is important for maintaining and creating openings, and treatments are not necessary when long-term objectives include managing forage values for bears and other wildlife. Where conifers are essential for streambank and floodplain stability or erosion prevention, or where long-lived trees are needed to maintain fish habitat, planting is recommended by practitioners. However, planting is the most costly and risky of riparian treatments. It is labor-intensive and re-establishing conifers on marginal sites favored by competitive brush species is difficult at best.

Practitioners have recommended fill planting and planting in clusters in order to mitigate problems with getting conifers established. Fill planting is done at a specified density using the largest trees available (615 or 1015 container stock; 6=6 cm diameter plug, 15=15 cm deep plug). Trees are planted beneath the overstory, which may or may not be thinned. In cluster planting, trees are planted in prepared sites that are established in gaps created by felling the alder overstory. The number of trees planted depends on the number of suitable raised microsites present, and practitioners vary the number of trees planted within a cluster. Browse damage by deer and elk can be a serious problem especially to western redcedar, necessitating the use of tubes or netting to protect seedlings or the use of felled trees with heavy branches to restrict animal movement in the area treated. Spruce leader weevil is a common forest health problem in many areas and use of weevil-resistant spruce is recommended where spruce is planted.

Manipulate stand structure for biodiversity and wildlife

Second-growth forests on sites logged in the 1960s and earlier contain trees of a size that can be used to produce old-forest components needed by wildlife and to create structures for future introduction to the aquatic system. However, The need for restoring elements of forest ecosystems not directly linked to fish habitat, water quality and watershed stability has never been well understood by Forest Renewal BC. In fact, wildlife contribute to many terrestrial processes essential for healthy forest ecosystems. They eat forest pests, build soil, disperse seeds, prey on other wildlife, and exist as legitimate inhabitants of forests. Unfortunately, young forests do not have many of the stand structural characteristics needed by wildlife to sustain their numbers. Forests without homes are forests without animals.

Thinning provides opportunities to speed the recovery of forest attributes needed by wildlife. Dead and dying trees, canopy openings, uneven stand densities, multiple canopies and even cavities used by wildlife can be emulated while stands are treated for attributes needed to improve fish habitat, water quality and channel stability.

Treatments to replace wildlife habitats during riparian restoration have only recently been tried. Techniques developed by Brown (1995) have been used to incorporate habitats for bats, owls, woodpeckers and invertebrates into the Keogh River project (Poulin et al. 2000) and the Tzoonie River project (Poulin 2000). McGeough (personal communication) included

wildlife tree creation at Cypre River on Vancouver Island. Douglas and McLennan (1999) recommended conceptual prescriptions for restoration of spotted owl habitat at Statlu River.

Other widely applied techniques important for restoring and maintaining biodiversity are variable density thinnings (clusters and gaps) and retention of rare or less represented shrubs (such as Pacific yew, bitter cherry, crab apple, Pacific dogwood, cascara, big leaf maple and alder) when present in small densities in conifer-dominated stands. In these cases, habitats used by wildlife are identified and retained during treatments. Debris loading is carefully monitored and all identifiable trails are made passable by wildlife.

Riparian Silvicultural Practices in Interior British Columbia

Riparian restoration in the interior of British Columbia faces many problems not encountered in coastal forests. The differences are due in large part to significantly different forest ecology and logging history. Interior forests evolved under very different topographic, climatic and disturbance regimes, which themselves differ between dry belt and wet belt areas and with elevation. The differences are sufficient to create riparian impacts and silvicultural problems that are unique.

Although the Interior lacks the long logging history of the Coast, large amounts of forest have been logged since the 1950s and, up until the Forest Practices Code, there was no requirement to reserve trees adjacent to streams for purpose of riparian management. Wet belt areas were typically clearcut to stream edges using skidders and caterpillar tractors, although diameter limit harvesting in spruce allowed for partial retention of trees in some areas. Physical damage to streambanks was common. Dry belt areas were frequently selectively harvested and components or riparian stands were left adjacent to some streams for purposes of forest regeneration, but generally not for riparian management.

Availability and choice of logging equipment has had a significant effect on forest regeneration in riparian areas. Riparian soils tend to contain a high component of silt or clay, making them vulnerable to compaction and disturbance by ground-based equipment. Soil moisture levels increase following logging, and special site preparation practices such as mounding may be necessary to make it possible for conifers to grow.

There are other pronounced ecological differences between Coast and Interior riparian forests. Fire historically played a significant role in forest ecosystem development in drier areas of the Interior, with many stands dependent on fire for secondary succession. Vast areas are heavily impacted by epidemics of bark beetles or defoliators which kill stands of timber, including those left in reserves adjacent to streams, lakes and wetlands. Spruce leader weevils are present in some regions. As well, a number of root diseases are endemic in Interior stands, and regenerating stands in low-lying areas may be damaged by growing season frost. Browse damage can also be severe: in some years, snowshoe hare, squirrels and porcupine can inflict heavy damage by girdling trees in the process of eating into the cambium. Beavers can be extremely problematic when foresters attempt to regenerate hardwoods and will fell conifers when hardwoods are scarce.

Restoration goals and objectives

Unlike the Coast forests where forest regeneration is generally not a problem, the primary goal of riparian restoration in the Interior is simply to re-establish trees and nurture those trees that have survived the hardships of riparian life. Because most applications of riparian silviculture are still relatively new and experimental, projects undertaken in the Interior have been small scale. The Narrowlake Demonstration Project (Harris 1999) is one example of where a riparian silviculture trial has been implemented. The managers of that trial have combined existing silvicultural practices and methodologies with their own understanding of the riparian attributes needed for restoring fish habitat, water quality and channel stability.

Common riparian restoration treatments

There are several riparian restoration treatments that have been applied in the Interior and have met with success. Most are combination treatments that involve planting as well as brush control. At Narrowlake, five separate treatment unit types with 12 separate restorative trials were implemented in the spring of 1999. Permanent sample plots were established before and after each trial to monitor the success and failure of each type of treatment over time. Photographic monitoring points were also established to document the success and failure of each trial. The project is the first of its kind in the Interior, and provides a sound basis for development and implementation of riparian restoration today.

Increase conifer stocking by brushing and releasing suppressed seedlings

Twinberry, willow, Sitka alder, birch and cherry are shrubs and small trees that can quickly out-compete conifers on moist, riparian sites. Herbaceous plants such as cow parsnip, fireweed and grass are also fierce competitors for space and nutrients. Once established,

these herbaceous trees and shrubs can develop into bands of dense vegetation adjacent to streams that rapidly smother and suppress planted or naturally seeded conifers. Increases in soil moisture levels following logging can also be problematic. Relatively well-drained sites before logging can experience significant increases in soil moisture levels that discourage conifer establishment and favor brush and herbaceous plants. Brushing is generally done manually within a prescribed distance of a target conifer when individual trees are being released. Use of a brush mat is recommended, as conifer growth is relatively slow. Depending on the site, between 6 and 15 years are needed for conifers to grow above the height of the competing brush.

Establish conifers and alternative tree species by planting

In sites where conifer densities are inadequate to meet riparian requirements, planting is recommend. Several situations have been addressed in some Interior projects. In areas where spruce leader weevil are pandemic practitioners have recommended planting weevil-resistant spruce, subalpine fir and cottonwood. Although the commercial value of these species is reduced, these species have the ability to occupy the site and establish a new forest. Various planting strategies are being tested for the trees being planted. Conifer strategies include cluster planting on raised microsites (mounding), uniform planting, and planting at the dripline of already established conifers.

- *Mounding*

  Planting coniferous trees on mounds is a common practice used in conventional silviculture. The technique is used to provide raised microsites for seedlings to establish. In the Interior, soils in the riparian zone can be composed of clay soils, therefore inhibiting water drainage and root establishment and maintaining cool soil temperatures in the spring. The mound creates a refuge for the new seedling from both high water tables and frost pockets, as well as providing warmer soil temperatures for earlier root and tree growth in the spring. Mounding also follows what occurs naturally. As on the Coast, after a stand is harvested in or near a riparian area, the natural ingress of seedlings is most successful on raised microsites. These sites are often near the base of stumps of the harvested trees. Protection from the climatic elements, as well as an elevation advantage over water and frost, enable the new tree to establish much quicker than its exposed counterparts.

- *Uniform planting*

Planting using standard silvicultural techniques is the easiest and most cost-effective method to apply in riparian silviculture because the methodologies are known and practised on a continual basis in standard reforestation. In the riparian area, however, there are disadvantages. For one, planting within riparian areas is extremely difficult and success of the future seedlings is based on the planter choosing the best microsites. Microsite selection cannot be over-emphasized in riparian areas, as climate and physical elements are at their most severe. The reality is that planting densities and inter-tree spacing guidelines are difficult to establish and hard for planters to follow unless the planters are given ultimate flexibility in choosing appropriate microsites.

- *Dripline clusters*

  Planting seedlings in groups under the dripline of established trees is a technique being tested at Narrowlake Creek. The method was developed to mimic what can already occur naturally in a severely impacted riparian area. Seedlings re-establish naturally in harsh riparian environments adjacent or close to the protection of other residual trees. With this method, the established tree provides an elevated mound for the seedling to establish roots away from high water tables, and provides protection from growing season frost. In addition, the existing tree provides the seedling with shade and protection from harsh climatic elements (snow, ice, wind and harsh summer sunlight) and with moisture and nutrient cycling. Examples of this form of regeneration are seen in areas logged during the late 1950s to 1970s, where intermediate utilization (the removal of large commercially viable trees only) was a standard forestry practice in many spruce and balsam stands. In the many areas where this occurred, only the trees adjacent to the leave trees have survived, and left dense bands of willow and alder scattered with coniferous clusters. The riparian restoration goal is to slowly expand the areas of these clusters so that the future forest will again be coniferous throughout.

- *Use cottonwood as "buddy" trees*

Cottonwood has been planted by Weldwood of Canada Ltd. (Poulin and Simmons 1998) as an alternative to conifers on sites with severely depressed conifer stocking and to serve as "buddy" trees. Cottonwood whips were planted within 1.0–1.4 m of spruce seedlings subjected to growing season frost damage and weevil attacks. It is hoped that the cover provided by the fast-growing cottonwood will provide shelter from frost and make it less likely that the seedlings will be attacked repeatedly by the leader weevil. The deciduous trees are

being planted to provide a nurse crop for the spruce seedlings and ultimately a level of cover to the seedling that will thwart multiple attacks by leader weevil.

ADMINISTRATIVE PROCESSES AND JURISDICTION

The legal mandate for the administration of the forest and its resources in British Columbia lies under the umbrella of numerous Acts, regulations and standards, all of which are supported by interpretive sets of policy and guidelines. It is the Forest Practices Code Act of British Columbia (Bill 40) and the Forest Act that are most relevant to issues concerning review, approval and implementation of riparian restoration projects.

Roles and Mandate of the Ministry of Forests

Chapter 272 of the *BC Forests Legislation Manual* provides for the existence of the Ministry of Forests of British Columbia. In general, this body is charged with managing, conserving and protecting the forest and its resources while encouraging maximum productivity of the forest and range resources. In carrying out this responsibility, government must concern itself with the immediate and long-term economic and social benefits that can accrue to the Province.

The Ministry of Forests is responsible for the coordinated use of all forest resources. It must ensure that management of timber, range, recreation, fish, wildlife and other natural resource values are coordinated with the activities of other ministries, provincial agencies and the private sector. The Ministry of Forests has an additional role of encouraging a competitive timber processing industry in the province while still asserting the financial interest of the Crown on its forest and range resources in a systematic and equitable manner.

Obligations under the Forest Practices of British Columbia Act

The Forest Practices Code of British Columbia Act (Bill 40) was passed in July 1995. The legislation provided the Ministry of Forests with the authority to regulate and enforce forest

practices on Crown land and established certain statutory obligations with respect to riparian management areas.

The Forest Practices Code is one of three Acts that govern forest resource management. When the Code was passed, the Forest Act and Range Act were amended to focus on resource allocation, leaving the Code to be the legal vehicle for enforcing forest practices. The Code takes a hierarchical approach to management and responsibility. Through it, broad-based policy and provincial laws are enforced by regulations and standards within the province and regions. Although the Code strictly regulates forest practices, there is room for interpretation and judgment at the local level. The only person accountable to make local interpretation of forest practice law is the Ministry of Forests District Manager.

Where and how riparian restoration fits into the Forest Practices Code

Activities associated with riparian restorations are forest practices that involve cutting and modifying trees. These activities are subject to the regulations and to the authority of the District Manager.

The Forest Practices Code is a complex set of rules and regulations. Determining exactly where riparian restoration fits is difficult and subject to interpretation. Part of the problem is that the Code has no provisions that specifically deal with riparian restoration. The vast majority of regulations contained in the Code aim at conserving and managing forest resources required for the harvesting and re-establishing of commercial free-growing stands. This is not the intent of riparian restoration. Riparian restoration attempts to manipulate established vegetation or augment existing vegetation by planting to achieve a desired future condition that reflects riparian attributes needed for fish, wildlife and water quality. Thus, applying Code regulations (designed to ensure that forests achieve maximum timber production) in cases where the restoration of riparian function is needed can be frustrating, and many problems have arisen in the approval and implementation of riparian projects. As a result, riparian restoration has no fixed place in the forests legislation.

There is no question about the authority of the Ministry of Forests over the regulation and enforcement of forest practices as they relate to riparian silviculture. Riparian treatments are clearly silvicultural practices applied to riparian areas. Problems concerning riparian projects have more to do with legal ramifications, approval protocols and standards that are not

applicable to riparian silviculture. Several regulations give the Ministry of Forests authority for riparian restoration and establish options for their approval (Table 4).

The relationship between these regulations and the approval protocols for riparian restoration projects is illustrated in Figure 6. The Vancouver Forest Region developed the flow chart as an attempt to clarify policy and legislation protocol to conduct a riparian restoration project in a riparian reserve zone (Jack Hamey personal communication). It is not an official document and should not be used to replace the actual policy and legislation. However, it is a useful decision tree that accurately depicts the prescription requirements legislated by the Code. Regardless of the avenue for approval followed, all riparian restoration treatments undertaken within

Table 4. Forest Practices Code Act and regulations applicable to riparian restoration projects

Relevant Code Regulations	Section	Connection
Operational Planning Regulation, Part 8, Div.1	60	Establishes a specified riparian reserve and management zones.
Silviculture Practices Regulation, Part 2.	4 (1) (b)	Provides authority for felling or modifying trees in a riparian reserve zone for managing fisheries and wildlife values.
Timber Harvesting Practices Regulation	10 (30) (b)	Provides approval authority for harvesting or modifying a riparian reserve zone for managing fisheries and wildlife values.
Forest Practices Code of BC Act, Part 3, Div. 1	12, 13	Defines silviculture prescription content and signing authority. The intent is to ensure that the prescription is consistent with forest development plans and higher level plans.
Forest Practices Code of BC Act, Part 3, Div. 2	22	Establishes a legal requirement for preparing a silviculture prescription to cut timber.
Forest Practices Code of BC Act, Part 3, Div. 2	23	Defines the legal requirement for preparing a silviculture prescription for carrying out silviculture treatments in backlog areas.
Forest Practices Code of BC Act, Part 3, Div. 2	23 (7) (c)	Establishes that a silviculture prescription is not required for an area that is subject to a stand management plan.
Forest Practices Code of BC Act, Part 3, Div. 2	24	Establishes that a stand management plan is required to carry out a silvicultural treatment on a free-growing stand.
Forest Practices Code of BC Act, Part 3, Div. 3	30	Provides the District Manager with the ability to exempt a silviculture prescription for an experimental purpose or any use incompatible with the establishment of a free-growing stand.
Forest Practices Code of BC Act, Part 3, Div. 3	31	Provides the District Manager with the ability to exempt a silviculture prescription for backlog areas not larger than 1 ha or for areas where the

		District Manager is satisfied that the person will carry out planting to supplement previous planting or natural regeneration.
Forest Practices Code of BC Act, Part 3, Div. 3	32	Provides the District Manager with the ability to exempt a stand management plan for areas not larger than 1 ha.
Forest Practices Code of BC Act, Part 3, Div. 3	33	Allows a District Manager to make any of the above exemptions only if the requirement is not necessary to adequately manage and conserve forest resources.
Operational Planning Regulation, Part 5, Div.1	40	Allows the District Manager to place restrictions on silviculture prescription exemptions.

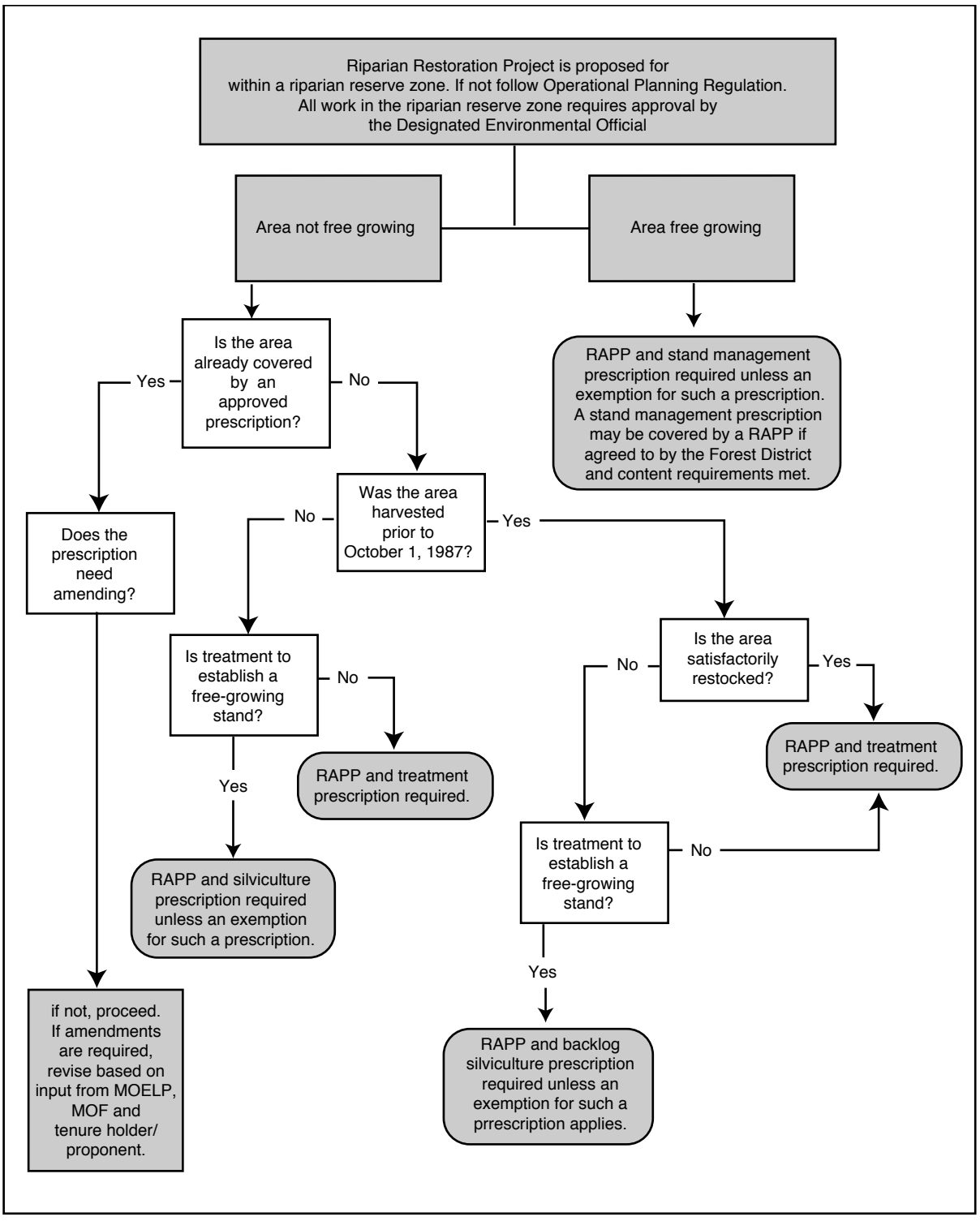


Figure 6. Flow chart developed by the Vancouver Forest Region to illustrate the prescription requirements of the Forest Practices Code for work undertaken in riparian reserve zones.The flow chart is not official policy and is only used to help clarify legislation and protocal for conducting a riparian restoration project.

riparian reserve zones require joint approval by the Ministry of Forests and the Ministry of Environment, Lands and Parks.

Within the Code, there are several avenues that a riparian restoration project may take. They depend on the age and condition of the stand, the size of area being treated, whether the stand is free growing and whether it is a demonstration trial, whether there are outstanding silvicultural obligations, and the willingness of the Forest District to expedite the process. Depending on the situation, a proponent may be required submit a silviculture prescription or stand management prescription or may be exempted from submitting either of these.

Silviculture prescription

The regulations require a silviculture or backlog silviculture prescription whenever the area considered for treatment is not free growing. As most riparian stands in need of restoration are free growing and lack any outstanding silvicultural obligations, silviculture prescriptions are generally not required. However, as more stands are considered for restoration, opportunities will arise where trees may be recommended for harvesting or may include stands that are not free growing. In young forests, there may be situations where timber removal can be used to facilitate riparian treatments while providing some economic benefit. All treatments that involve timber removal will require a silviculture prescription. Silviculture prescriptions must be signed and sealed by a registered professional forester.

Stand management prescription

The vast majority of sites (amalgamated treatment areas) recommended for riparian restoration will exceed 1 ha in size, be free growing, and not have any outstanding silvicultural obligations. The regulations require that a stand management prescription be prepared to carry out a silvicultural treatment on a free-growing stand. Like a silviculture prescription, a stand management plan must contain the content specified in the regulations and must be signed and sealed by a registered professional forester. Content requirements for a stand management prescription are provided in Operational Planning Regulation, Part 6 (50).

Several problems with stand management prescriptions need to be overcome before riparian restoration projects can be effectively implemented:

- For one, stand management prescriptions, like silviculture prescriptions, were not designed to handle the variability associated with riparian treatments. Target number of preferred and acceptable well-spaced trees, minimum number of preferred trees, minimum inter-tree distances, and minimum number of preferred and acceptable well-spaced trees are standards that apply to plantations—not to areas being restored for ecological function. Practitioners trying to undertake riparian restoration activities can feel open to criticism if they don't do exactly as specified by the regulations.
- Another issue has been the requirement by some Forest Districts that stand management
- prescriptions be provided on such forms as FS68 HFP 98/6. As assessment results are frequently combined with treatment recommendations, practitioners have not wanted to incur the additional cost of a FS68 HFP 998/6 submission. .
- As well, while the reporting requirements for a RAPP are similar to those specified for a stand management prescription, they are not entirely the same. The RAPP prescribes restorative treatments that are unlike those anticipated in the regulations.

Silviculture prescription and stand management prescription exemption

This avenue makes it possible for the Ministry of Forests to exempt riparian restoration projects from the requirement of a silviculture prescription or a stand management prescription. It is the most efficient and effective way to overcome the multitude of problems associated with implementing works that are restorative in nature rather than being done for a commercial purpose. To be truly effective, the Forest Practices Code would have to be amended. Section 30 of the Code (Part 3, Division 3) provides the District Manager with the ability to exempt a silviculture prescription if the area is used for an experimental purpose or for any use that is incompatible with the establishment of a free-growing stand.

In our view, it is fair to say that each and every riparian restoration project undertaken in the next five years will be experimental. As we have stated many times in this document, riparian silviculture is new to British Columbia. Other than the projects undertaken by Watershed Restoration Program, no existing trials in the province have tested silvicultural techniques for the specific purpose of restoring riparian function. Given the ecological and biological diversity of the province, each riparian restoration project—whichever forest region or biogeoclimatic zone it is located in—is a valid demonstration trial.

Riparian treatments also have little to do with establishing a free-growing stand. Although trees may be made to become free growing in the traditional sense, many riparian objectives are not intended to produce free-growing trees but rather the mix of stand structural attributes found in natural forests. In a single treatment area, stands may be partially thinned to relatively low riparian densities or so that trees are left in dense clusters. Other portions of the same treatment area may be opened to produce gaps in the forest canopy. Standing trees may be made to become dead and dying. Thus, riparian treatments defy the Forest Practices Code definition of a free-growing stand: “a stand of healthy trees of a commercially valuable species, the growth of which is not impeded by competition from plants, shrubs or other trees.” It would be easy to conclude that an area being treated for riparian restoration is not compatible with the establishment of a free-growing stand.

Since most riparian restoration projects will be undertaken in stands considered to be free growing, Section 32 of the Forest Practices Code (Part 3, Division 3), which provides the District Manager with the ability to exempt a stand management prescription, offers the most applicable legislation pertaining to riparian restoration. However, to exempt an area from the requirement of a stand management prescription, the area must not be larger than 1 ha. The treatment area in this case means “one or more areas of a standard unit that are proposed for treatment and have the same area identifier, and includes special areas located in the treatment area.” Thus, in areas where the total treatment area exceeds 1 ha, a stand management prescription cannot be exempted by the District Manager. This means the majority of situations where operational restoration will be undertaken.

We think this is an issue where the regulations can be streamlined for effective implementation of riparian restoration works. Amendments to the regulations could be established that provide the District Manager with authority to exempt restorative projects from the requirement of a stand management prescription. Section 40 of the Operational Planning Regulation (Part 5, Division 1) allows the District Manager to place restrictions on silviculture prescription exemptions. This clause could be expanded to enable the District Manager to place restrictions on any restoration project as he or she sees fit, including monitoring and accountability. This means that no project would ever be approved without it being done in a manner acceptable to the Ministry of Forests and the Ministry of Environment, Lands and Parks. Exempting riparian restoration projects from the requirements of a silviculture prescription or stand management prescription is the easiest way to streamline the review and approval of restoration works and avoids the extensive legal

hurdles associated with the plethora of changes that should be done to make riparian silviculture fit the regulations. Exempting restorative projects would also eliminate the need for registered professional forester sign-off. It would make it possible for skilled riparian specialists to prepare riparian prescriptions.

Roles and Mandate of the Ministry of Environment, Lands and Parks

The Ministry of Environment, Lands and Parks is responsible for the management, protection and enhancement of British Columbia's environment. This includes: the protection, conservation and management of provincial fish, wildlife, water, land and air resources; the management and allocation of Crown land; and the protection and management of provincial parks, recreation areas and ecological reserves. Authority is provided under many Acts and regulations. The responsibility of the ministry and its staff in the management and protection of the forest and its resources was raised by the Forest Practices Code. The Code provided the ministry with the authority to review and approve timber harvesting plans and to establish objectives for managing and protecting the environment. The ministry is also responsible for enforcing and complying with the Code regulations.

Obligations under the Forest Practices of British Columbia Act

The responsibility of the Ministry of Environment, Lands and Parks with respect to riparian restoration lies in the development and implementation of strategies for management, protection and enhancement of fish, wildlife and water resources. The ministry's mandate is to ensure that all of these resources are adequately conserved, maintained and protected within the framework of a socially and economically sustainable timber industry.

The Forest Practices Code regulations give the ministry joint responsibility for the management of the environment. The ministry exercises this responsibility by establishing landscape and stand level objectives for the identification, protection and conservation of fish and wildlife habitats and to guide compliance and enforcement of forest practices required by legislation. The Code established the position of the Designated Environmental Official (DEO) within the ministry and empowered that individual under many sections of the Act to ensure ministry responsibilities were achieved. Sections of the Act that are relevant to riparian restoration are given in Table 5. The table is not intended to be a complete listing, but

provides a view of the scope and complexity of the regulations and involvement of the Ministry of Environment, Lands and Parks in

forest management—and specifically where the DEO has a legislated role in the restoration of riparian areas.

Outstanding silvicultural obligations for free-to-grow status

An interesting obstacle to riparian restoration in some areas is the conflict between the statutory requirement to achieve free- to-grow status and the stand structural attributes required for ecological restoration of a stand. Attributes that produce the desired conditions for restoration of ecological function are not the same as for producing a commercial stand—nor is establishing “free to grow” necessarily a desired or required outcome for a riparian restoration treatment.

Table 5. Relevant sections of the Forest Practices Code Act and regulations that empower joint ministry approval for riparian restoration projects

Relevant Code Regulations	Section	Connection
Forest Practices Code of BC Act, Part 2	4	Landscape units and objectives
Forest Practices Code of BC Act, Part 2	5 (1,6)	Sensitive areas and objectives
Forest Practices Code of BC Act, Part 3, Div. 3	28 (2)	Exemption for forest development plans
Forest Practices Code of BC Act, Part 3, Div. 3	40 (2)	Giving effect to operational plans prepared by the District Manager
Forest Practices Code of BC Act, Part 3, Div. 3	41 (6,7, 10, 11)	Approval of plans by the District Manager or Designated Environment Official
Forest Practices Code of BC Act, Part 3, Div. 3	42 (3)	Approval in emergency cases
Forest Practices Code of BC Act, Part 3, Div. 3	43 (2)	Approval of minor changes to operational plans
Operational Planning Regulation, Part 2	2 (1,2)	Joint approval of forest development plans
Operational Planning Regulation, Part 8, Div 1	60 (3,4)	Minimum widths of riparian reserve zones and riparian management zones
Timber Harvesting Practices Regulation	10 (3)	Felling adjacent to streams, wetlands, and lakes
Timber Harvesting Practices Regulation	20	Maintenance of streambank stability
Transitional Provisions, Part 11	228 (5)	Designated Environment Official approval required for amendments to forest

		development plans in effect on June 15, 1995

Treatments such as those that produce large trees with many limbs, clusters of trees, openings and gaps, dead and dying trees (including human-made snags), and mixed-wood stands cannot be achieved where free- to-grow requirements are not relaxed.

In areas were free-to-grow status has not been achieved, outstanding silvicultural obligations may apply. If the area is already covered by an approved prescription, the prescription will be legally binding and, in all probability, involve a treatment intended to establish a commercial stand. In these situations, prescriptions should be reviewed by a riparian specialist or silvicultural forester and amended as appropriate. This avenue for conflict resolution is depicted in the flow chart shown in Figure 6.

Revising silviculture prescriptions with outstanding silvicultural obligations may have the net effect of reducing liability, because what may be perceived as a failure to a commercial forester may be a success to a riparian specialist. This issue is especially relevant in the Interior, where re-establishing conifers in riparian areas for commercial objectives is an uphill battle, with trees being highly vulnerable to insects, disease, changes in soil moisture and microclimate. Interior foresters have faced a tough challenge in attempting to meet objectives for re-establishing commercial stands—not necessarily the same objectives as those for restoring riparian function. The most significant differences are in the latter's acceptability of lower stocking densities, more random distribution of trees and a greater range of acceptable tree species. Revising outstanding silviculture prescriptions to reflect realistic goals and outcomes for riparian areas should be an incentive for forest companies to identify these areas and determine in conjunction with the Ministry of Forests and the Ministry of Environment, Lands and Parks how best to manage the sites for riparian objectives.

ASSESSMENT PROCEDURES IN OTHER RESTORATION JURISDICTIONS

The nearest approach to the riparian restoration procedure used in British Columbia is a procedure developed by a team of US Forest Service and Bureau of Land Management specialists for assessing proper functioning (Prichard 1998).

The procedure is a checklist style assessment that asks a practitioner to make a determination of the overall health of a riparian-wetland system by evaluating its hydrology, vegetation and erosion/deposition processes and attributes. Proper Functioning Condition (PFC) is defined as a “state of resiliency that will allow a riparian-wetland area to hold together during high flow events with a high degree of reliability”—or simply “how well the physical processes are functioning.” The procedure is relatively narrow in scope.

Unlike the RAPP, where riparian forests are evaluated for silvicultural functionality, the PFC assessment applies to the hydrology, vegetation, and geomorphology of only that portion of the riparian-wetland system that makes up the actual stream channel or the immediate streambank area. Outcomes of a PFC assessment provide a determination of functionality and identification of factors that may influence actions to be taken. Recommendations for riparian restoration are not a result. If areas are deemed non-functional or functional/at risk, mitigating these problems must be addressed by stakeholders at another time. The most relevant distinction between the assessment procedures is the lack of a riparian silvicultural prescription being developed by the PFC. The outcome of a Level 1/Level 2 riparian assessment is riparian treatment recommendations that are equivalent to silvicultural prescriptions. For this reason, the PFC assessment procedure is better suited to dealing with bioengineering issues associated riparian-wetland systems found on range rather than forestland.

Outside of a formal approach, US practitioners undertake riparian restoration projects in much the same manner as silviculture prescriptions are prepared in British Columbia. The US Forest Service prepares vegetation management prescriptions that are written by (or at least signed off by) a certified silviculturist (Dan Karnes, personal communication). Each prescription is a legal tool for doing the work. It becomes an integral part of an environmental assessment that can be appealed by law. The prescription has two parts: the operational prescription and the vegetation management analysis. The prescription states what is going to be done and the vegetation analysis indicates why. The process is focused heavily on the implementation stage at the stand level. Planning level work is done under larger umbrellas and flows down to the site. For instance, a particular project is tied to a watershed analysis, which is tied to a regional assessment, which is tied to the highest level forest plan.

Within a project, some number of thinning units may be undertaken while various other projects (such as riparian planting or riparian thinning) are accomplished. General treatment areas are usually identified in the watershed analysis or may be identified during reconnaissance surveys of the current project. Prescriptions are written for areas where work is suitable. The system is strong on general landscape planning and project implementation, but weaker on planning

prescriptions and having a standardized way of approaching riparian prescriptions. The strength in the US Forest Service process lies in the expertise of the local silviculturist, not in the procedure. The RAPP model, with its reliance on assessment protocols, has the potential for better standardizing practices and may provide a more meaningful strategy for effectiveness monitoring.

Alberta has used an adaptation of the PFC since 1992. Under the “Cows and Fish Program,” riparian assessments are being conducted in a number of areas. The information collected during the assessments is similar to the RAPP Level 1 and Level 2 approach to riparian assessment. However, it uses simplified PFC data forms developed specifically for Alberta riparian ecosystems. The short form (similar to British Columbia’s Level 1 assessment) assesses a number of factors to determine riparian function (physical and vegetative characteristics, plant species, bank structure and erosion, etc.). Attributes are scored as a percentage to determine the overall health of the riparian ecosystem. This methodology has been implemented on many occasions in the last four years. Additionally, Alberta is conducting more in-depth “riparian inventories.” These assessments involve detailed inventories of physiological and biological factors within riparian systems. This work has been conducted over the last 3 years. Like PFC, it does not result in riparian silvicultural prescriptions.

Outside of the PFC approaches used in the US and Alberta, we know of no other formalized riparian assessment procedure that attempts to generate operational prescriptions for riparian restoration.

RECOMMENDATIONS FOR EFFECTIVE RIPARIAN RESTORATION

The primary purpose of this project was to determine what is needed to enable future planning and implementation of effective and efficient riparian restoration. We elicited the input of Watershed Restoration Program coordinators and practitioners to help identify barriers to riparian silviculture and find solutions where they occurred. A list of the practitioners and Watershed Restoration Program coordinators who responded to the questionnaire is provided in Appendix 1. Recommendations pertaining to solving problems associated with the Forest Practices Code are those that we feel are in the best interest of restoring riparian areas effectively and efficiently.

Barrier 1. Understanding about riparian silviculture and its benefits is lacking

The single greatest impediment to riparian restoration has been a fundamental lack of understanding of riparian silviculture and why it is needed. The information gap has no boundaries. Staffs of both the Ministry of Environment, Lands and Parks and the Ministry of Forests are equally unfamiliar with the need and methods required for manipulating riparian stands to restore riparian function. The level of uncertainty has slowed the approval of projects, prevented others, and made some frustrating to execute.

Recommendations:

a) Reports such as this have been prepared to inform people about riparian silviculture and the strategies needed to bring about changes in riparian forests that are essential for the long-term recovery of fish habitat, water quality and channel stability. This report should only be a beginning. Riparian silviculture is new to British Columbia. The vast majority of technical papers and research conducted on riparian silviculture have been done in the Pacific Northwest. Many papers have been cited in this document and an annotated bibliography has been provided to help make information available to practitioners and government staff involved in the review and approval of projects.

b) The Forest Continuing Studies Network offers a 2.5-day RAPP training course in riparian assessment procedures and riparian silvicultural strategies. All Watershed Restoration Program coordinators in the Ministry of Forests and the Ministry of Environment, Lands and Parks, as well as all silvicultural foresters involved in review and approval of projects, should take advantage of the training.

Barrier 2. Riparian restoration is an activity not specifically identified in the Forest Practices Code

The Forest Practices Code does not contain specific provisions for dealing with riparian silviculture and therefore does not provide clear policy direction on matters pertaining to the authority for restoration works and the content of riparian treatments. Clear policy interpretation and implementation of riparian restoration has varied widely among Forest Districts and District Managers. It is clear from the response of practitioners that if restoration is to be implemented effectively, there must be provisions within the Code that set provincial policy on riparian restoration and help district staff implement plans in a responsible and cost-efficient manner.

Recommendations:

a) The Forest Practices Code should be amended to include riparian silviculture as a forest practice distinct from traditional silviculture.

b) Where riparian prescriptions are required by legislation, their content requirement should be outlined and that content should make acceptable the range of standards required to achieve riparian objectives.

Barrier 3. Administrative review and approval is inconsistent and sometimes unclear

The ease and speed at which riparian restoration projects have been reviewed and approved has varied considerably with Forest District and staff. Although the trend has been to a more efficient process, the statutory requirements for a silviculture prescription or stand management

prescription have resulted in unnecessary delays and increased costs for implementation of riparian restoration projects. The decision path developed for the Vancouver Forest Region clarifies the current statutory requirements of the Forest Practices Code. Depending on the situation, a proponent may be required to submit a silviculture prescription or a stand management prescription or be exempted from submitting either one.

Given the significant difference between the purpose and objectives of a silvicultural treatment in restoring riparian functions and those of a commercial stand, we believe it is appropriate to exempt riparian silviculture from the requirements to prepare a silviculture prescription or stand management prescription if the stand has no outstanding silvicultural obligations. Other agencies have not generally been included in the review and approval of riparian restoration projects to date. This has the potential of being increasingly problematic

as the number of projects increase and agencies such as the Department of Fisheries and Oceans renew their interest in becoming more involved in forest management.

Recommendations:

a) Under Part 3, Division 3, Sections 30, 31 and 32 of the Forest Practices Code Act, riparian restoration projects should be allowed to be exempted from the requirement for a silviculture prescription or stand management prescription.

b) Where outstanding silvicultural obligations exists, prescriptions should be amended to meet objectives for riparian restoration.

c) Plans developed by the riparian assessment and prescription procedures should be allowed to become acceptable approval mechanisms.

d) A single approval method prior to assessment should be agreed to so that administrative costs and conflict in the approval process are reduced.

e) Approval efficiency should be increased by involving the Department of Fisheries and Oceans or any other appropriate party from the local area as early in the process as possible. On-site review or an office presentation can speed the approval process by enabling a riparian specialist to articulate the purpose and objectives of the project. Joint follow-up reviews of the work undertaken should also be conducted.

Barrier 4. The requirement to have a registered professional forester sign and seal a riparian prescription is costly

Where a silviculture prescription or stand management prescription is made exempt by a District Manager and the riparian restoration plan is prepared by a riparian specialist the plan would not necessarily require the signing and sealing of a riparian treatment by a registered professional forester. Section 40 of the regulations would enable a District Manager to make this a requirement for project approval. This can increase the cost of a riparian treatment if the specialist team does not include a registered professional forester. Several of the most experienced provincial riparian specialists are not registered professional foresters, yet have demonstrated capability to prescribe and undertake riparian restoration treatments.

Recommendations:

a) A riparian specialist should be allowed to sign and seal a riparian restoration treatment when a treatment is made exempt from the requirement of a silviculture prescription or stand management prescription. The specialist should have recognized expertise in riparian silviculture and be a registered professional biologist.

Barrier 5. The format and content of stand management prescription is not entirely compatible with riparian restoration objectives

Under existing law, a stand management prescription is required before a silvicultural treatment is carried out on a free-growing stand. The majority of riparian stands that are candidates for riparian restoration are likely to have been declared free to grow. Thus, a stand management prescription will be the most common prescription required for approval by Ministry of Forests (unless otherwise exempted by the District Manager). Riparian assessment and prescription procedures evolved under the guidance of the Ministry of Environment, Lands and Parks. The process was a logical extension of the ministries' responsibility for the management, protection and enhancement of fish, wildlife and water resources. However, the framework for assessing and prescribing treatments to restore riparian function is a hybrid of a traditional silvicultural assessment that is sufficiently different to require its own content and format.

Some riparian specialists prepare descriptive documents to enable reviewers to better understand the need for restoration and the treatments recommended. The purpose is to overcome barrier No. 1. Reports prepared through RAPP better articulate the rationale behind treatments and provide a greater level of documentation for effectiveness monitoring. Unfamiliar with the RAPP "products," some Ministry of Forests districts have slowed approval or increased cost of projects by insisting proponents also submit plans in silviculture prescription or stand management prescription format. The Code does not determine the format of a stand management prescription, but it does establish the content requirement for a prescription.

Recommendations:

a) The manner in which riparian restoration projects are documented and submitted for review and approval by the Ministry of Forests and the Ministry of Environment, Lands and Parks should not be constrained by any current Ministry of Forests prescription format.

b) Either a RAPP report should be accepted as a valid stand management prescription or appropriate changes should be made to the existing content requirements for a silviculture prescription or stand management prescription and all relevant standards revised.

c) The RAPP procedure outlined in Technical Circular No. 6 does not require practitioners to provide all the relevant content of a silviculture prescription or stand management prescription as required by the regulations. Where not contained in a report, this information should be provided as directed by the Ministry of Environment, Lands and Parks and Ministry of Forests in final letters of project approval.

Barrier 6. Prescription standards required for commercial stands do not work in riparian restoration

Uncertainty about the purpose and objectives of riparian restoration has led to confusion over standards associated with riparian treatments. Problems arise when one attempts to apply standards developed for commercial silviculture to riparian restoration.

Throughout this report, the term “riparian silviculture” has been used. Silviculture as it is practiced in British Columbia is the art of cultivating a commercial forest. Post-treatment standards that apply to commercial forest operations are not the same as those to produce the desired future condition for a riparian stand, nor are the required treatments the same.

Recommendations:

a) The desired future condition or target stand is a seral stage of a riparian forest that contains all of the elements needed to achieve stated riparian objectives. Old forests often reflect a stand condition that can serve as ecological templates. Ecological templates, combined with strategies to meet riparian objectives determine the desired future condition and the standards required to manipulate the stand.

b) Stand structural attributes required in riparian silviculture are dependent on the seral stage of the current condition and the desired future condition. Riparian areas are, by natural condition, highly variable. Therefore, recognition should be given to the fact that stand structural attributes such as number of well-spaced stems, minimum preferred well-spaced stems, minimum inter-tree distances, total well-spaced stems and

maximum total well-spaced stems are not compatible with all riparian treatments and therefore may be inappropriate parameters for post-treatment standards.

c) Riparian specialists should provide adequate detail to ensure that riparian prescriptions can be implemented as prescribed, yet the prescriptions must be flexible enough to enable practitioners to respond to opportunities presented in the field for achieving riparian objectives. Actions needed to achieve objectives (such as leaving non-modified patches of trees, creating gaps in the forest canopy with nil to low number of trees, and applying windthrow mitigation tactics) defy fixed post-treatment standards and demand latitude in prescriptions and application.

d) Ministry staff or company foresters responsible for post-treatment inspections should anticipate that a wide range of actions may be undertaken, depending on the range of objectives that can be achieved in any given stand. Specialists implementing riparian projects should be allowed professional discretion to achieve objectives when undertaking riparian treatments. This may include treating or not treating portions of a riparian polygon otherwise slated for treatment in a prescription or plan. Practitioners must be allowed to modify treatments to suit the site. Riparian restoration is as much an art as it is a science.

e) Plot-based approaches for determining what needs to be done in a riparian stand should be avoided in favor of the more effective approach of walking polygons and using creative awareness. Riparian prescriptions must always reflect the site, not the plot.

Barrier 7. Qualified riparian specialists are lacking

Riparian silviculture is a specialized area of expertise that is generally lacking in British Columbia. In the absence of a workforce with previous experience, registered professional biologists, professional foresters, experienced field technicians, and silvicultural surveyors have undertaken riparian assessments. Responses from Watershed Restoration Program coordinators indicate that while all are capable of delivering a satisfactory assessment, where experienced foresters and silvicultural specialists were not available, the recommendations were weak and, for the most part, prescriptions and restoration not recommended at all. It was also noted that some contractors followed guidelines too strictly and did not provide adequate professional input into recommendations for prescriptions. Some of this stems from

biologists generally lacking in silvicultural experience, and foresters generally having an industrial bias.

Recommendations:

a) Riparian restoration requires multi-disciplinary thinking that blends knowledge of hydrology, biology, geomorphology, riparian ecology and silvicultural together. Experienced technicians can complete components of riparian assessments, but only a specialist or specialist team with demonstrated capabilities in successfully assessing, prescribing and implementing a riparian restoration project should lead the work.

Barrier 8. Senior supervision on implementation projects is sometimes questioned

Tremendous pressure is placed on completing riparian restoration projects in the most cost-effective manner in order to prove that riparian restoration can be done within accepted costing parameters associated with traditional silviculture. Senior supervision above the normal crew supervisor adds to costs and may be viewed as unwarranted when compared to the supervision required for traditional silvicultural work such as brushing, spacing and pruning.

Recommendations:

a) Riparian silviculture is still in its infancy in British Columbia. Riparian treatments are not repetitive actions like mechanical spacing, brushing and pruning. Field decisions are complex and numerous. It is unrealistic to assume that without careful supervision, ongoing evaluation, and a high level of professional intuition, restoration will meet with success. It is essential that during this early period of implementation, riparian restoration be as successful as it can be given our overall lack of experience. Senior supervision should be provided on all implementation projects and maintained until work crews have a clearly demonstrated ability in executing ecologically based treatment prescriptions.

Barrier 9. Prioritizing areas requiring riparian restoration should remain focused on riparian reserve zones, but not be limited to them

Some Watershed Restoration Program coordinators considered that effective riparian restoration should not be constrained by administrative boundaries such as riparian reserve zones, but rather according to ecological and other needs. Recommendations for prioritizing riparian treatments to S1, S2, and S3 streams in the RAPP were not intended to constrain

riparian restoration, but to help direct people to those areas that had the highest probability of requiring riparian silviculture.

When riparian assessments were first being done, considerable effort was expended in assessing portions of watersheds with low to nil probability of being candidate areas for riparian restoration. Recommendations to prioritize segments of streams with larger channels were seen as a way of maximizing benefits and costs and getting projects under way. All S1, S2 and S3 streams lie in portions of watersheds with the oldest logging history, and they generally contain the highest-valued fish habitat. As well, they tend to be those most at risk to changes in hydrology and geomorphology following logging. It was also thought that by limiting work to the riparian reserve zone, problems associated with conflicting mandates of the Ministry of Forests and the Ministry of Environment, Lands and Parks could be solved.

Recommendations:

a) Riparian restoration treatments should not be constrained to any administrative boundary and in some instances it is in the mutual benefit of corporate proponents, the Ministry of Forests and the Ministry of Environment, Lands and Parks to encourage riparian restoration within any ecologically suitable unit or area such as the riparian management zone.

b) Notwithstanding the above, it should be recognized that the province contains many thousands of hectares of riparian forest that require riparian silviculture. It is a simple mathematical fact that more streamside forest can be treated for the same amount of available funding if the width of the area treated is less.

Barrier 10. Liability for riparian work can be long term

Long-term maintenance and liability is a stumbling block for companies considering riparian restoration. Some restoration treatments require multiple entries, such as brushing and thinning and therefore proponents incur future obligations.

Recommendations:

a) Riparian treatments that incur unacceptable long-term liabilities for corporate sponsors should be discouraged if they are an impediment to a company's willingness to engage in restoration work. Many single-entry treatments are available that have no associated long-term maintenance requirements. They are one-time opportunities and can yield the highest return on investment.

b) Riparian specialists need not achieve all riparian objectives at this point. Nudging a forest in a positive direction is an acceptable riparian restoration goal. It is equally important to ensure that what is done today does not squander opportunities for tomorrow. Once trees are cut, they cannot be put back. Partial treatments should not discourage or impede restoration.

Barrier 11. Monitoring of riparian restoration has been lacking

Riparian silviculture is a new science. Each and every project undertaken here is, in effect, a demonstration trial or operational research project. To effectively implement riparian restoration and enjoy the highest benefit cost, we need to know that what we are doing works.

Recommendations:

a) Effectiveness monitoring should be built into all contracts where riparian projects are implemented.

b) An annual compendium of riparian restoration projects should be developed.

c) Watershed Restoration Program efforts to continue offering annual workshops that allow exchange of information between regions and jurisdictions should be supported. British Columbia relies heavily on technical exchanges. In a few short years, the province will be in a strong position to reciprocate as more operational projects are completed.

Barrier 12. Funding and prioritizing of riparian restoration projects is inequitable

Future investments by Forest Renewal BC will be aimed at restoring and protecting fish habitat and domestic water supplies in priority watersheds. Within the next 5 years, Forest Renewal BC investments in the Watershed Restoration Program will be targeted at completing 20% of the highest priority watersheds in each region. Forest Renewal BC confirms that 177 target watersheds are eligible. Priority watersheds are ranked on the basis of whether or not the watershed contains important fish stocks or supplies drinking water.

Watersheds that are eligible under the new guidelines are further broken into three categories. “Key watersheds” are those watersheds that were classified as having high values for either or both fish habitat and water supply. “Target watersheds” are key watersheds that do not have a significant proportion of private land and have a high likelihood

of restoration success. And “transitional watersheds” are those that do not have high fish or water values, but have on-the-ground works that have already begun. Hence, the goals of Forest Renewal BC are to restore watersheds that are known to have important fish stocks or be important sources for drinking water. While drinking water is a reasonable criterion for helping to set priorities for restoration, it does not work well in the vast areas of the province where drinking water is not a watershed attribute. The current process does not allow forest companies whose operations lie outside of community watersheds to enjoy opportunities for future funding through Forest Renewal BC.

Recommendations:

a) Riparian restoration should be an integral component of forest management. It is required for the long-term ecological restoration of fish, wildlife and water quality. Funding is imperative and should not be limited to criteria that are a disincentive to undertake the work.

b) Drinking water should not be considered a useful criterion for companies interested in pursuing riparian restoration when their areas of operation lie outside of community watersheds or in watersheds that provide drinking water to only some users.

c) A level of funding appropriate to meet the needs of Forest Renewal BC should be established and companies then allowed to rank and prioritize watersheds that reflect their needs.

d) Many companies in British Columbia are seeking environmental certification for their products. Certifying bodies have established criteria for assessments and monitoring that will require consideration be given to ecological restoration of areas where past forest practices have degraded forest conditions required for fish, wildlife and water quality. Companies should be allowed to define special management areas such as “High Conservation Value” forests—and Forest Renewal BC funding should be applied to these areas—to help both the companies and the Province meet the level of stewardship implicit in certification.

e) Fish habitat restoration is inextricably linked to the successful restoration of riparian function. Other sources of funding should be aggressively pursued where provincial programs like Forest Renewal BC don’t succeed. Other potential sources of funding are:

- Habitat Restoration and Salmon Enhancement Program (federal $)
- EcoAction 2000 – Wildlife and Habitat Enhancement (federal $)
- Fish Restoration BC (provincial $) – first riparian project funded is completion of the Malksope Riparian Restoration Project, a project started by Forest Renewal BC
- Pacific Salmon Foundation (provincial $)
- Habitat Conservation Trust Fund (federal $)
- Biosphere 2000 Legacy Projects (federal $)

Barrier 13. Riparian silvicultural research is lacking

Riparian restoration projects have proceeded despite little history in research and development having been done in British Columbia. Practitioners are able to do this using well-established silvicultural principles, mimicking ecological templates, and applying the biogeoclimatic ecosystem classification system developed by Dr. V.J. Krajina to riparian problems. Researchers from the Pacific Northwest have also played a role by providing sound advice from years of research. However, there is a need to advance the understanding of riparian restoration techniques. Information on stocking densities, shade tolerance, water tolerance, increasing tree complexity (large boles with many branches), size of riparian areas requiring treatment, planting strategies on marginal sites, mixed wood silvics are a few of the areas where more data would help to increase our chances for effective riparian restoration.

Recommendations:

a) Riparian silvicultural research should be supported through the Ministry of Forests, Research Branch and established programs at universities and colleges.

Barrier 14. Timber removal for economic gain is not viewed as an acceptable practice in a riparian reserve zone

It may be beneficial in some areas to remove timber not required for achieving the target stand condition. Stands that have achieved the size required for pre-commercial thinning offer the greatest possibilities. The Ministry of Environment, Lands and Parks has expressed concern that this option is risky and will lead to “clearcut as usual.” This is not a valid argument. It is derived from the ministry’s perceived lack of management in riparian management areas, which is a separate issue from that of selective removal of timber from a riparian reserve zone where riparian restoration treatments are being undertaken.

Stands being thinned to riparian densities can have 15–50% of the basal area removed as a by-product of the treatment. Where the basal area removed is in downed wood that is in excess of the coarse woody debris requirements for the site, or where harvesting would result in favorable re-establishment of preferred riparian species, extracting some wood as part of a harvesting operation may be desirable. The best opportunity for this would be in second-growth stands that are situated adjacent to approved logging operations. Section 4, Part 2, of the Silviculture Practices Regulations allows for the felling of trees in a riparian reserve zone for the purpose of managing fisheries and wildlife values. Section 35, Part 3, of the Timber Harvesting Practices Regulation allows for timber harvesting within a riparian reserve zone with the agreement of the DEO when managing for fisheries and wildlife values.

Recommendations:

a) Where timber is in excess of that required to achieve riparian restoration objectives, and it can be economically removed without compromising the intent of the restoration works, its removal should be permitted.

Barrier 15. Use of chemicals in riparian restoration treatments

Standard silvicultural practices use both chemical and manual methods for brush and alder control. Over the years, restrictions on the use of chemicals have discouraged their use and many companies no longer apply chemicals. Treatments aimed at releasing conifers under alder require removal of all or part of the overstory. This is now being done manually by girdling. Chemicals have been used in the past to kill alder, and they do it such that a tree dies from the top down. Girdling kills the tree at breast height. Some trees “melt-down” from the top, as with chemicals; others break at the girdle, even those of large diameter.

Use of chemicals in riparian restoration treatments must be more fully explored and opportunities for their use considered by the Ministry of Environment, Lands and Parks. Chemical used to control alder overstory could cut treatment costs by 50% or more.

Recommendations:

a) The Ministry of Environment, Lands and Parks specialist should clarify the policy on the use of chemicals in riparian reserve zones as a cost-effective treatment for alder removal.

SUMMARY OF STEPS TO EASIER RIPARIAN RESTORATION

Many recommendations have been provided that have the potential for improving the implementation of riparian restoration projects. The fastest and most direct way to enable this work to be done is summarized in the following seven points:

Consider a formal Memorandum of Understanding between the Ministry of Forests and the Ministry of Environment, Lands and Parks stating riparian restoration works are acceptable silvicultural practices to be undertaken in a riparian management area and that riparian silviculture is exempt from silvicultural and stand management prescriptions.

Consider an "Interpretative Policy letter" from the Chief Forester stating that riparian restoration works are acceptable within the riparian reserve zone and that these works will be conducted throughout the province under Sections 30, 31, and 32 of the Operational Planning Regulations. The interpretative policy letter would be circulated to all District Mangers and their staff in the province.

- Amend the Forest Practices Code to enable the District Manager to exempt. Add under the Code, Part 3, Division 3, Section 30 (1) (a) "riparian restoration." Take this intent and add it to Sections 31 and 32.
- Amend the Act to include the words "riparian restoration" as appropriate.
- Amend the word "prescription" to "plan" for riparian treatments only.
- Provide incentives for forest companies and the Ministry of Forests to undertake riparian restoration by allowing them to establish priorities based on ecological restoration of riparian stands.
- Establish multi-year planning and funding for riparian restoration.

Practitioners' Quick Steps to Effective and Efficient Delivery of a Riparian Restoration Plan:

1. State objectives.
2. Use Technical Circular No. 6 for Level 1 baseline data. Include all appropriate content required to describe a vegetation plan needed for District Manager approval

of silviculture prescriptions or stand management prescriptions. Modify as appropriate for a riparian restoration plan.

3. Provide maps with all polygons identified along with treatment for each polygon (leaving room for on-the-ground flexibility).
4. Limit work to within the riparian reserve zone.
5. Ensure that a riparian specialist with recognized skills in riparian silviculture submits the work.
6. Attach the plan to the 2-page silviculture prescription or stand management prescription exemption form, signed by the riparian specialist who prepared the work.

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————. 1998b. Riparian assessment: Little River: recommended prescriptions. November 1998. Prepared for Karen Campbell, Weldwood of Canada Limited, Williams Lake, BC. 73 p. plus appendices.

————. 1999a. Riparian assessment: Atleo River: recommended riparian silvicultural plan. February 1999. Prepared for Warren Warttig, International Forest Products, Campbell River, BC. 65 p. plus appendices.

————. 1999b. Riparian assessment: Kootowis Creek: recommended preliminary silvicultural plan. March 1999. Prepared for: Warren Warttig, International Forest Products, Campbell River, BC. 32 p. plus appendices.

————————. 1999c. Keogh River (Western) riparian assessment and recommendations for riparian silviculture along 4.2 km of river being restored for fish habitat. August 1999. Prepared for Ken Hall, Western Forest Products Limited, Vancouver, BC. 49 p. plus appendices.

————————. 1999d. Buck Creek riparian assessment and recommendations for restoration of riparian areas between 1.2 km and 6.0 km. August 1999. Prepared for Warren Warttig, International Forest Products, Campbell River, BC. 52 p. plus appendices.

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Appendix 1. List of practitioners and WRP coordinators who participated in survey. Note only participants who have undertaken riparian works responded to requests to complete questionnaires.

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Appendix 2. List of riparian assessments that included implementation of field projects (works). Excellent demonstration sites and field trials. Details are provided where supplied.

1. Malksope River (Level 1/2 and works). International Forest Products Ltd, Warren Warttig: subcontracted to: Vince Poulin, VA Poulin & Associates Ltd, 2153 West 46th Avenue, Vancouver, BC V6M 2L2; email: vpoulin@istar.ca ; and Bart Simmons, Quillicum Forestry Services Ltd, 1258 Haywood Avenue, West Vancouver, BC V7T 1V1; email: barts@bc.sympatico.ca
2. Tzoonie River (Level 1/2 and works). International Forest Products Ltd, Dennis Lozinsky: subcontracted to: Vince Poulin, VA Poulin & Associates Ltd, 2153 West 46th Avenue, Vancouver, BC V6M 2L2; email: vpoulin@istar.ca ; and Bart Simmons, Quillicum Forestry Services Ltd, 1258 Haywood Avenue, West Vancouver, BC V7T 1V1; email: barts@bc.sympatico.ca
3. Malksope River (works). International Forest Products Ltd, Warren Warttig under *Fish Restoration BC*: subcontracted to: Vince Poulin, VA Poulin & Associates Ltd, 2153 West 46th Avenue, Vancouver, BC V6M 2L2; email: vpoulin@istar.ca ; and Bart Simmons, Quillicum Forestry Services Ltd, 1258 Haywood Avenue, West Vancouver, BC V7T 1V1; email: barts@bc.sympatico.ca
4. Keogh River (Level 1/2 and works). Westen Forest Products Ltd, Mike DesRoches, Port McNeill, BC: subcontracted to: Vince Poulin, VA Poulin & Associates Ltd, 2153 West 46th Avenue, Vancouver, BC V6M 2L2; email: vpoulin@istar.ca ; and Bart Simmons, Quillicum Forestry Services Ltd, 1258 Haywood Avenue, West Vancouver, BC V7T 1V1; email: barts@bc.sympatico.ca
5. Narrowlake Creek (Overview, Level 1/2, and works). Cathy Harris, Aquafor Consulting Ltd. RR7, S16, C7, Prince George, BC. V2N 2J5; email: auafor@mg-net.com
6. Cypre River – Clayoquot (Level 1/2 and works). Weyerhaeuser Ltd: subcontracted to: Dean McGeough, Integra Forest Consulting, 5000 Glinz Lake Road, Sooke, BC V0S 2G5; email: mcgeough@island.net
7. Eve River (Level 2 and works). Weyerhaeuser Ltd: subcontracted to: Reinhard Muller, RPF., RPBio., Fen Forest Consulting, 7390 Walton Mountain Road, Duncan, BC, V9L 5W8
8. San Juan Watershed (works). Bud Iverson, San Juan Watershed Agreement, Timber West Forest Limited: work by: Reinhard Muller, RPF., RPBio., Fen Forest Consulting, 7390 Walton Mountain Road, Duncan, BC, V9L 5W8; and Eric Muller, Fulcrum Forest Consultants
9. Little Zeballos River (Level 1/2 and works). Ehhattesaht First Nation: subcontracted to: LGL Limited, 9768 Second Street, Sydney, BC, V8L 3Y8, Peter Kuntz, email: pkuntz@lgl.com
10. Squamish River Tributaries (Level 1/2 and works). Steelhead Society Habitat Restoration Corp, Steve Pettit, Tel: 604-684-6242 ext 119#103 - 131 Water Street, Vancouver, BC V6B 4M3; email: steve_pettit@watershedrestoration.com
11. Silverhope (Overview, Level 1/2 and works). Steelhead Society Habitat Restoration Corp - Mike Engelsjorg 831-0423 and Steve Pettit 684-6242 , #103 - 131 Water Street, Vancouver, BC V6B 4M3; email: mike_engelsjord@watershedrestoration.com and

steve_pettit@watershedrestoration.com : assessment contracted to: Oikos Ecological Services Ltd - Donald McLennan, Tel: 250-847-1946 Box 985, 3855 2nd Avenue, Smithers BC V0G TN0; email: oikdon@bulkley.net

12. Little River (works). Karen Campbell, Weldwood of Canada Limited, Williams Lake works by Weldwood, prescriptions by: Vince Poulin, VA Poulin & Associates Ltd, 2153 West 46th Avenue, Vancouver, BC V6M 2L2; email: vpoulin@istar.ca ; and Bart Simmons, Quillicum Forestry Services Ltd, 1258 Haywood Avenue, West Vancouver, BC V7T 1V1; email: barts@bc.sympatico.ca

13. Alice LakeTributary (Level 1/2 and works). Renewal Investment Corporation and Weyerhaeuser Company Limited: subcontracted to: LGL Limited, 9768 Second Street, Sydney, BC, V8L 3Y8, Peter Kuntz, email: pkuntz@lgl.com

Appendix 3. List of riparian assessments undertaken to date since 1998. Details are provided where known. Not all projects may be included if information was not forth coming from WRP coordinators. Details are provided where supplied.

Prince George and North Coast

1. Kenneth Creek (Overview and Level 1). Cathy Harris, Aquafor Consulting Ltd., RR7, S16, C7, Prince George, BC V2N 2J5; email: auafor@mg-net.com Torpy River tributaries (Overview and Level 1). Cathy Harris, Aquafor Consulting Ltd., RR7, S16, C7, Prince George, BC V2N 2J5; email: auafor@mg-net.com
2. Watersheds within TFL 30 (Overview and Level 1). Cathy Harris, Aquafor Consulting Ltd., RR7, S16, C7, Prince George, BC V2N 2J5; email: auafor@mg-net.com
3. Kenneth Creek (Overview and Level 1). Cathy Harris, Aquafor Consulting Ltd., RR7, S16, C7, Prince George, BC V2N 2J5; email: auafor@mg-net.com
4. Nancut Creek (Overview). Scott Davidson, AGR A Earth and Environmental Ltd., Box 3966 #3–3167 Tatlow Road, Smithers, BC V0J 2N0; email: agra@mail.netshop.net
5. Dome Creek (Overview and Level 1). Dwight Hickey, Environmental Dynamics Inc., 9031 North Nechako Road, Prince George, BC V2K 4Z8; email:. dwight_hickey@edynamics.com
6. Port Simpson Band Traditional Territory (Overview). Shelterwood Forest Management.
7. Bowron River Tributaries (Overview and Level 1). Bruce Ford, Triton Environmental Consultants Ltd., #120-13511 Commerce Parkway, Richmond, BC, V6V 2L1; email: bford@trition-env.com

Williams Lake and Cariboo

1. Beaver Valley (Needs Assessment). Prepared for Karen Campbell, Weldwood of Canada by Vince Poulin, VA Poulin & Associates Ltd, 2153 West 46th Avenue, Vancouver, BC V6M 2L2; email: vpoulin@istar.ca ; and Tom Johnson RPF,T. Johnson and Associates, Box 4097, Smithers, BC V0G 2N0
2. Little River (Level 1/2). Prepared for Karen Campbell, Weldwood of Canada, by: Vince Poulin, VA Poulin & Associates Ltd, 2153 West 46th Avenue, Vancouver, BC V6M 2L2; email: vpoulin@istar.ca ; and Bart Simmons, Quillicum Forestry Services Ltd, 1258 Haywood Avenue, West Vancouver, BC V7T 1V1; email: barts@bc.sympatico.ca

Vancouver/Squamish/Sechelt

1. Phillips River (Overview and Level 1). Steelhead Society Habitat Restoration Corporation: contracted to EBA Engineering, Sunlife Plaza, Suite 550, 1100 Melville Street, Vancouver, BC V6E 4A6.
2. Chapman Creek (Overview and Level 1). EVS Environmental Consultants, subcontracted to: A.J. (Alan) Whitehead and Associates, RR#1, CH11, Bowen Island, BC, V0N 1G0; email: aljw@ibm.net

3. Skwaka/Tzoonie/Orford (Overview, Level 1 and Level 2). International Forest Products Ltd, P.O. Box 381, 208-5760 Teredo Street, Sechelt, BC, V0N 3A0: subcontracted to Forrester and Associates, Sechelt, BC; email: dennis_lozinsky@sunshine.net

4. Indian River (Overview). Coast River Environmental Services Ltd., 1672 West 75th Ave, Vancouver, BC: subcontracted to: Karen Christie, Talisman Land Resouce Consultants Ltd, 1670 West 75th Avenue, Vancouver, BC

5. Eldred River (Overview and Level 1). Hatfield Consultants - Alan Stockwell: Tel: 926-3261201 - 1571 Bellevue Ave, West Vancouver, BC V7V 3R6; email: astockwell@hatfieldgroup.com ; subcontracted to: A.J. Whitehead and Associates; Tel: 604-947-0144, RR#1 CH11, Bowen Island, BC V0N 1G0; email: aljw@ibm.net

6. Theodosia River (Overview, Level 1 and Level 2). Klohn Crippen Consultants; Tel: 273-0311 (no longer have any employees that worked on this project) subcontracted to: Joe Kuhn, Hope, BC

7. Chehalis River (Overview and Level 2). Oikos Ecological Services Ltd - Donald McLennan; Tel: 250-847-1946; Box 985, 3855 2nd Avenue, Smithers, BC V0G TN0; email: oikdon@bulkley.net

8. Norrish Creek: (Overview, Level 1 and Level 2). Canadian Forest Products, subcontracted to: Integrated Resources Management (IRM) Ltd, Suite 208-1351 Merklin Street, White Rock, BC V4B 4C2; Tel: 604-536-1273; Fax: 604-536-1271; email: irmvan@direct.ca

9. Cogburn Creek: (Overview, Level 1 and Level 2). Prepared for the BC Ministry of Environment, Lands and Parks by C. Mellor, Bioterra Consulting, #201-197 Second Ave. North, Williams Lake, BC V2G 1Z5; Tel: 250-392-7887; Fax: 250-392-5887; email**:** bioterra@wlake.com

10. Slesse Creek and Upper Pitt River (Overview and Level 1). Prepared for Steelhead Society Habitat Restoration Corp. by Donald S. McLennan, Oikos Ecological Services Ltd. and Tom Johnson RPF,T. Johnson and Associates, Oikos Ecological Services Ltd: Donald McLennan; Tel: 250-847-1946; Box 985, 3855 2nd Avenue, Smithers, BC V0G TN0; email: oikdon@bulkley.net

11. Slesse Creek (Level 1). Prepared for Steelhead Society Habitat Restoration Corp. by Donald S. McLennan, Oikos Ecological Services Ltd. and Tom Johnson RPF,T. Johnson and Associates, Oikos Ecological Services Ltd: Donald McLennan; Tel: 250-847-1946; Box 985, 3855 2nd Avenue, Smithers, BC V0G TN0; email:: oikdon@bulkley.net

12. Spuzzum Creek (Overview and Level [?]). Prepared for BC Minsitry of Environment, Lands and Parks by James McQuibban, SNC Lavalin Inc., 1800 West Georgia Street, Vancouver, BC V6E 3C9; Tel: 604-662-3555; Fax: 604-662-7688; and by Shaun Freeman, Nlaka' pamux Tribal Council PO Box 430, Lytton, BC VOK 1ZO

13. Slesse Creek (training site). Prepared for Watershed Restoration Program at UBC by Vince Poulin, VA Poulin & Associates Ltd, 2153 West 46th Avenue, Vancouver, BC V6M 2L2; email: vpoulin@istar.ca ;and Bart Simmons, Quillicum Forestry Services Ltd, 1258 Haywood Avenue, West Vancouver, BC V7T 1V1; email: barts@bc.sympatico.ca

Vancouver Island

1. Atleo River (Level 1/2). International Forest Products Ltd, Warren Warttig: subcontracted to: Vince Poulin, VA Poulin & Associates Ltd, 2153 West 46th Avenue, Vancouver, BC V6M 2L2; email: vpoulin@istar.ca ; and Bart Simmons, Quillicum Forestry Services Ltd, 1258 Haywood Avenue, West Vancouver, BC V7T 1V1; email: barts@bc.sympatico.ca
2. Kootowis Creek (Level 1/2). International Forest Products Ltd, Warren Warttig: subcontracted to: Vince Poulin, VA Poulin & Associates Ltd, 2153 West 46th Avenue, Vancouver, BC V6M 2L2; email: vpoulin@istar.ca ; and Bart Simmons, Quillicum Forestry Services Ltd, 1258 Haywood Avenue, West Vancouver, BC V7T 1V1; email: barts@bc.sympatico.ca
3. Buck Creek (Level 1/2). International Forest Products Ltd, Warren Warttig: subcontracted to: Vince Poulin, VA Poulin & Associates Ltd, 2153 West 46th Avenue, Vancouver, BC V6M 2L2; email: vpoulin@istar.ca ; and Bart Simmons, Quillicum Forestry Services Ltd, 1258 Haywood Avenue, West Vancouver, BC V7T 1V1; email: barts@bc.sympatico.ca
4. Keogh River (training site). Prepared for WRP at UBC by Vince Poulin, VA Poulin & Associates Ltd, 2153 West 46th Avenue, Vancouver, BC V6M 2L2; email: vpoulin@istar.ca ; and Bart Simmons, Quillicum Forestry Services Ltd, 1258 Haywood Avenue, West Vancouver, BC V7T 1V1; email: barts@bc.sympatico.ca

Appendix 4. Riparian reserve zone restoration flow chart developed by Vancouver Forest Region (Jack Hamey, personal communication). He flow chart is not official policy and is only used to help clarify legislation and protocol for conducting a riparian restoration project.