Integrating Ecosystem Restoration Into Forest Management

Practical Examples for Foresters

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Society for Ecological Restoration, BC Chapter

The BC Chapter of the Society for Ecological Restoration (SER-BC) is part of the Society for Ecological Restoration International, headquartered in Tucson, Arizona. SER-International (http://www.ser.org/) has more than 2500 members in 24 countries. The BC chapter is a diverse group of ecologists, researchers and restorationists from all over British Columbia and Western Canada. They come from the ranks of consulting, business, government, universities, interest groups, and the general public. Their common bond is their concern for the health of BC ecosystems, and their direct involvement in projects to restore those systems.

SER-BC board members were involved in developing this booklet, and they hope it will contribute to restoration in BC.

SER-BC

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Integrating Ecosystem Restoration Into Forest Management

Introduction

PRACTICAL BENEFITS

Ecosystem Restoration

Ecosystem restoration is a rapidly growing endeavor worldwide, and many ecosystem restoration practices are being incorporated into day-to-day forest management in BC. Whether for sustainable forest management, forest product certification, the protection of biodiversity, or other concerns, ecosystem restoration is becoming a more prominent activity throughout BC.

Ecological restoration is the process of **assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed**. Examples in BC include the reintroduction of ground fires in NDT4 (fire maintained) ecosystems, incorporating snags, coarse woody debris (CWD) or canopy gaps in homogenous secondary forests, the rehabilitation of compacted landings and access roads, and the control of invasive species such as knapweed, thistles and broom.

Integrating ecosystem approaches into management - such as mimicking natural disturbance patterns during forest harvest - will minimize the need for restoration. However, past harvesting in BC was usually completed to standards that were developed without today's knowledge and societal expectations. As a result, there is an extensive backlog of ecological issues that can be dealt with using restoration techniques. For instance, extensive areas of dense, young, closed canopy stands provide little habitat for many forest species. Carefully designed commercial and pre-commercial thinning can increase the habitat value of these areas, while also increasing the value of future harvests.

Ecosystem restoration can be a part of good business practices:

- **Certification and Market Access** Integrating ecosystem restoration practices as part of routine operations is a key component of sustainable forest management, and is integral to management under many certification systems.

- **Potential Cost Savings**
Proactively adapting restoration practices to manage for ecological integrity and restore past damage can save money that would otherwise be required for reactive treatments.

- **Risk Management**
Dealing with ecological issues through restoration can reduce the risk of pest outbreaks, provide a more diverse portfolio of forest products, and increase certainty of future timber supplies.

Funding Opportunities

Government funding is available for most restoration activities. The Forest Investment Account is the main vehicle for 'incremental' investments on the forest land base. The Habitat Conservation Trust Fund also funds restoration projects that benefit fish and wildlife in British Columbia.

Private funding is available through various foundations. Accessing these funds will typically require a non-profit partner organization to make the application and carry out part of the work. The Stewardship Centre lists various private firms and foundations that provide funding for restoration or stewardship projects; this database is found at: http://www.stewardshipcentre.bc.ca/sc_bc/sc_funders/funderSearch.asp

Crew preparing for thinning treatments that will increase wildlife habitat and biodiversity values.
Photo: Reinhard Muller

Issues and Opportunities

Ecological Issues and Restoration Opportunities

Ecological restoration includes a very broad scope of activities – from restoring a local ecosystem such as a stream, to restoring ecological processes such as fire in a large area of forest. The following **case studies** highlight ecological issues that are top priorities for ecosystem restoration in BC. General restoration approaches are listed for each issue, and the corresponding case studies detail how groups are currently approaching these types of restoration projects. Ways to prevent ecological damage are also listed, as prevention is always the most cost-effective and ecologically effective approach to solving ecosystem problems.

Ecological Issue: Reduction and Changes to Open Habitat Types

Issue: Reduction of extent and quality of open habitat types – grasslands, savannahs and open fire-maintained forests - due to:

- Fire control
- Forest regeneration at densities greater than historic levels

Impacts:

- Loss of habitat for open-habitat and fire-dependent species
- Loss of economic values associated with open habitats - rangeland and vigorous and rapidly growing trees
- Increased risk of catastrophic fire, including increased risk of economic losses – loss of timber and loss of infrastructure.

Prevention:

- Maintain open stand structures
- Use surface fires regularly as a stand management tool

Restoration approaches:

- Commercial and pre-commercial thinning to reduce stand densities in historically open stand types
- Clearing of trees from historic grassland areas
- Controlled re-introduction of ecosystem-maintaining fire

ISSUE - REDUCTION OF OPEN HABITAT

Dense, closed Douglas Fir stand pre-treatment. Note the lack of understory vegetation. For post-treatment photos, see page 6.
Photo: Ordell Steen

Restoring Open Forest and Open Range

Case Study One: Restoring provincial forest and national park through forest harvest

Over the past several years, hundreds of hectares in the **Rocky Mountain Trench** have been thinned, slashed or harvested with the goal of recreating historically open forests and grasslands.

Fire suppression over the last several decades has produced dramatic changes in the landscape – closed forests are now common in areas that used to be open forest and grassland. The Kootenay-Boundary Land Use Plan provides targets for increasing the amount of open forest and open grassland on the landscape, in order to provide for species that use this habitat.

These species are currently crowded into the remaining open forest and open grassland areas, and some of these species are endangered or threatened due to **drastic habitat loss.** The Ministry of Forests is often involved in projects to restore open habitat, as are the local forest industry, other agencies and non-profit groups.

One of the more recent projects involves a coalition of groups that coalesced around the plight of Rocky Mountain Bighorn Sheep. The winter range of these animals is 25% of its historical size due to forest encroachment. The sheep now typically overwinter in and around the town of Radium Hot Springs on human habitat such as lawns, golf courses and highway verges. **"Bighorn in Our Backyard"** is the name of the project that brought a multi-agency working group together to cooperate on ecosystem restoration and other activities to help the sheep herd. **Restoration treatments will help bring the landscape back to its former condition,** where open forests and grasslands are maintained by periodic fire. At the same time, these treatments will provide much-needed winter habitat for the sheep and lower the risk of catastrophic fire near the town of Radium.

2003 is year two of a multi-year project. In year one, Slocan Forest Products **selectively harvested** 60 hectares of provincial forest adjacent to Kootenay National Park and Radium Hot Springs. While timber revenues were satisfactory, the main objectives for harvesting were ecosystem restoration and lowering the risk of catastrophic fire. Many of the harvested stems were not merchantable, and these were piled and burned onsite.

The next phase will be an **underburn** conducted by Parks Canada and the Province. This year's activities involved harvesting 120 hectares in Kootenay National Park. This was the **first time** in Canada that ecosystem restoration was done in a park using forest harvest**.**

A landscape view of the newly open forest and grassland.
Photo: Alan Dibb

Protecting a campsite from catastrophic fire was a secondary goal of the project. Parks contracted Slocan to do the harvesting, which again resulted in large numbers of unmerchantable stems that were burned onsite. The **target density** of Douglas-fir was 30 stems per hectare of greater than 20 cm dbh trees, dispersed in clumps to restore the open grassland ecosystem. Pre-treatment densities averaged 4500 stems per hectare, mostly in the 5-10 cm dbh class.

This project was **revenue neutral** for Slocan and Parks. An **underburn** will be done in Spring 2004 once grasses have had a chance to sprout and the slash left onsite has had time to dry out.

Bighorn sheep are already **using the treated area,** though the habitat will improve over the next few years as understory grass and vegetation re-establish. Other species that will benefit from this project are endangered or threatened species such as **prairie falcon, American badger, long-billed curlew, sharp tailed grouse and bluebunch wheatgrass**.

Future restoration efforts are planned for hundreds of additional hectares in and around the park, in order to return the landscape to within its natural range of variability.

Stem removal in progress.
Photo; Larry Halverson

Burning unmerchantable stems on site.
Photo: Larry Halverson

Post treatment tree densities are very low and reflect historical conditions.
Photo: Larry Halverson

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www.radiumhotsprings.com/village/bighorn/index_new.htm

Case Study Two: Restoring open forest through harvesting in the Cariboo-Chilcotin

Riverside Forest Products has modified timber harvesting operations to reduce Douglas-fir densities and enhance tree growth, forage production, and wildlife values on two densely ingrown dry douglas fir sites in the Cariboo-Chilcotin.

Extensive areas with densely ingrown stands like these occur throughout the interior Douglas-fir, ponderosa pine, and bunchgrass zones, as a result of decreased fire frequencies since European settlement. With the exclusion of frequent fires, these forest stands are now the prevailing condition on a landscape that was once dominated by more open-grown stands with greater species richness and diversity, increased tree vigor and growth rates, and increased forage values. These ingrown stands also have a much-increased risk of catastrophic wildfire.

The **goals** of this project were to restore the stands to their historically more open conditions to encourage shrub and herbaceous vegetation development, and to enhance Douglas-fir stem growth and vigor while not decreasing overall stand growth. This was a **trial site** - operationally applicable methods of restoration were evaluated to serve as a basis for more widespread restoration application.

As this project was designed as a trial, data collection and layout were done in a manner that will allow the results of this treatment to be compared to untreated patches, and patches treated with harvesting but no juvenile thinning. **Follow-up treatments** will need to be scheduled as part of a long-term management plan that includes timing of harvest re-entries and treatment of tree regeneration ingress.

Forest Renewal BC and the Ministry of Forests funded the juvenile thinning and the collection of **monitoring** data, and Riverside conducted the modified harvesting as part of their normal operations. Staff members of the Ministry of Forests will do the future monitoring as funding permits.

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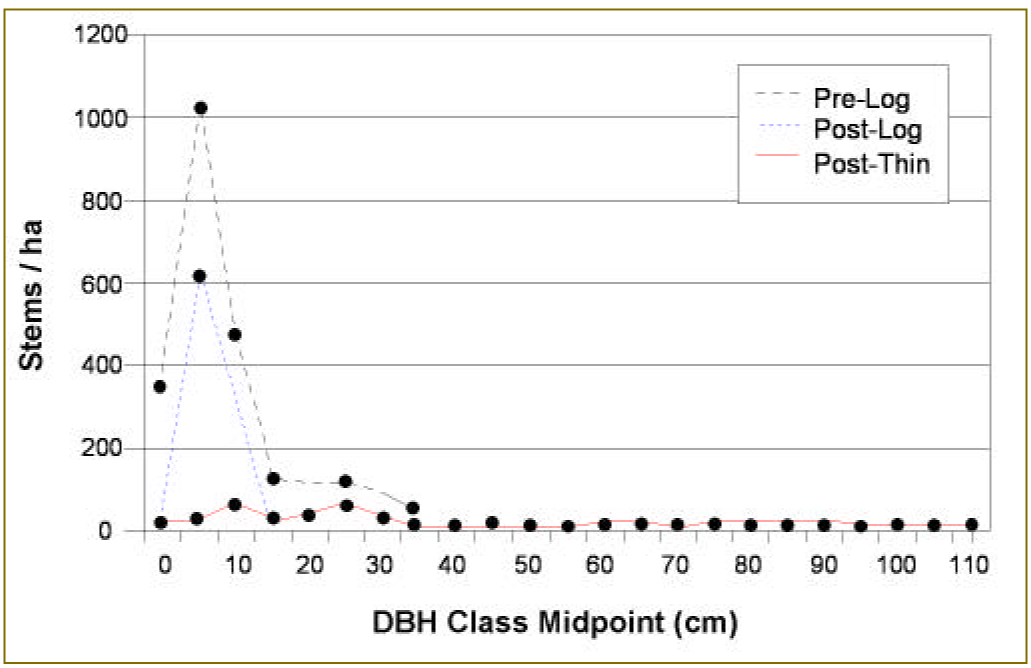

Figure 1. A comparison of the density of trees by diameter class before logging, after logging, and after thinning.

Phase One - Timber harvest. Approximately one hundred hectares were harvested, and unlike most harvesting operations, all stem diameter classes down to 12.5 cm dbh were partially harvested. Stems from 12.5 to 17.5 cm dbh constituted a large proportion of harvest volume from the blocks. Stand openings were purposely created by the harvest of these small stems and by intentional damage to many juvenile stems. Local widening of skid trails created other openings. (See page 2 for photo of pre-harvest conditions). *Photo: Ordell Steen*

Phase Two- Juvenile Thinning. This phase was done by the Ministry of Forests. The Ministry used the same contractor for the thinning that Riverside hired to do the mandatory post-harvest stand slashing, and thereby realizing some cost efficiencies in the juvenile thinning. The average cost was $284/ha. The thinning treatment removed stems not likely to have a strong growth response to treatment (i.e. had small live crown), or those that did not have a high potential to form a quality crop tree.
Photo: Ordell Steen

Following thinning an underburn of the thinning slash was conducted in cooperation with the Cariboo Fire Centre on a portion of the area. This underburn was the first stage of a two-stage burn and was conducted primarily to remove fine fuels and reduce fire hazard. A future burn will need to be done to remove larger fuels. On unburned areas, the thinning slash was left on-site. *Photo: Ordell Steen*

Restoring or Planning for a Mosaic of Diverse Stands and Stand Structure

ISSUE - EXTENSIVE UNIFORM STANDS

Ecological Issue: Extensive Uniform Stands

Issue: Development of uniform stand ages and stand characteristics over a large area as a result of:

- Fire control
- Harvesting and regenerating large areas over a short period of time

Impacts:

- Increased risk of large-scale losses due to pests, disease or fire as a consequence of species and age class uniformity over a wide area
- Loss of critical habitat over wide areas for species dependent on certain forest structures and stand ages
- Increased risk of catastrophic fire, including increased risk of economic losses – loss of timber and loss of infrastructure.

Prevention:

- Pro-active design of management activities to mimic natural disturbance patterns and to avoid lopsided stand age or structure distributions
- Pro-active design of timber harvest to create natural stand structures and mosaic patterns where logging now replaces wildfire as the dominant agent of ecological disturbance
- Increasing stand heterogeneity through management for mixed species and ages

Restoration approaches:

- Increasing stand heterogeneity through pre-commercial thinning and commercial thinning to produce a variety of stand densities and within-stand canopy openings
- Introducing stand structure in selected areas in the landscape through wildlife tree and CWD addition techniques
- Following Ecological Best Management Practices for major salvage activities

Case Study Three: Restoring structural diversity to the Kitimat Valley

The Kitimat valley has been extensively harvested, with less than 3% of its original forest remaining. Since harvest, intensive silvicultural practices have been used to maximize the economic value of the stands. Even-density spacing and intensive pruning have created second growth habitat with little horizontal or vertical structural diversity. This **extensive uniformity of habitat types** limits opportunities for wildlife and birds dependant on snags, coarse woody debris or canopy variability associated with old forests. The Kitimat Valley has approximately 19,400 hectares of these heavily managed pole sapling stands on a productive, but heavily roaded valley bottom.

A coarse woody debris pile created to provide habitat and diversity in the Kitimat Valley.
Photo: Acer Resource Consulting

Coarse-filter biodiversity measures such as streamside buffers and wildlife tree patches are no longer options in this landscape. The only option to improve biodiversity in this landscape is restoration. In 2001, a pilot project was initiated to **reintroduce old growth stand characteristics** through stand management techniques. The long-term **goal** is to encourage the reintroduction of species temporarily extirpated from the area. West Fraser Mills – Skeena Sawmills Division and the Ministry of Forests worked together to complete year one of the project.

Variable **spacing, girdling,** and installation of **snags** and **coarse woody debris piles** were used to create islands of old-growth characteristics within the mosaic of commercial forest. An important part of this project was determining the feasibility of incorporating these techniques into mainstream, volume-oriented stand management. Various baseline data were also collected to allow future monitoring of the success of this project.

The treated stands were primarily planted spruce affected by spruce leader weevil. Among this matrix there were lower densities of hemlock, balsam and cedar. These stands were chosen because of their high densities (greater than 4,000 stems per hectare), their lack of previous stand treatments, and because they were relatively young (20-30 years old). Spacing was done to 800 stems per hectare in many areas, 400 stems per hectare in others, and no treatment was chosen for other control areas. A proportion of trees were girdled as part of the treatments. Once spacing was complete, coarse woody debris piles were created, and imported snags were planted using two backhoes. The coarse woody debris piles were created by piling slashed material and placing cast-off cedar logs on top. The snags were purchased from Skeena Sawmills and were planted in upright positions using two machines. The Terrace Rod and Gun Club provided machine time and operators at reduced cost.

Adding coarse woody debris and snags to levels present in old growth forests would be extremely costly, so these were instead obtained and placed based on their availability. As a result, the snags and coarse woody debris piles were concentrated into two areas. However, it's assumed that their addition will **significantly improve habitat values** over existing conditions.

A planted snag installed using equipment for telephone pole installation. Note CWD pile in background.
Photo: Acer Resource Consulting

Forest Renewal BC funded this project, and project costs were tracked to determine operational feasibility. If one-time costs are removed and anticipated efficiencies achieved, costs would be $2,700 per hectare for the spacing, and snag and coarse woody debris addition. This **compares very favorably to restoration silviculture projects elsewhere** in the province, and is an extra $1,300 per hectare compared to standard treatment regimes.

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Case Study Four: Ecological best management practices for major pine beetle salvage operations

British Columbia is currently experiencing a major mountain pine beetle outbreak in areas of extensive old pine forest. In combination with BC's mild winters, widespread, uniform stands of lodgepole pine can encourage **mountain pine beetle outbreaks** due to the high concentration of vulnerable trees. At the same time that economic losses occur as a result of beetle attacks, environmental values such as riparian function and old growth habitat for dependant species are also severely affected. To recoup economic losses, salvage harvesting is facilitated via a significant increase in annual allowable cuts (AAC) in some areas, as well as a redistribution of AAC within supply units. This harvesting can further increase **environmental risk** if it does not explicitly address environmental values.

A recommended approach involves **planning at the landscape scale** to leave important environmental areas and areas with low levels of mortality unsalvaged. Areas that are important to leave unharvested include riparian buffers, wildlife habitat areas, ungulate winter ranges, steep areas prone to erosion or mass wasting, and old growth management areas (OGMAs). Stands with less than 30% mortality can be expected to provide similar old forest habitat values as pre-epidemic stands, and are good targets for retention in OGMAs and riparian areas. Many animal species are dependant on this type of habitat, and will only be able to persist in a landscape of young managed forests if older stands are intentionally retained during the planning of salvage harvesting.

A Mountain Pine Beetle affected landscape. *Photo: Canadian Forest Service*

Stands with greater than 70% mortality will have lost most old forest habitat values (except for snags and coarse woody debris), and should be targets for salvage harvest. Harvesting decisions in stands with 30-70% mortality should be site specific and take stand-level environmental values into account. **Using mortality levels to plan salvage harvest** ensures that harvesting decisions do not exacerbate impacts on environmental values. This type of planning requires post-epidemic stands to be classified into three categories - <30% mortality, 30-70% mortality, and >70% mortality - to form the basis for a harvest plan that includes biodiversity concerns. This type of classification is possible from remote sensed sources and is fundamental to planning major salvage harvest in many areas.

Riparian forests are of special concern in a post-epidemic landscape. Aside from being extremely important for biodiversity values and connectivity on the landscape, they also provide stream shade, bank stability, sediment filtering and large woody debris input. Riparian areas should never be harvested to the stream bank, and in most cases riparian areas should be left with wide unharvested buffers. In special cases where harvesting is deemed desirable, the methods used must result in the least amount of damage possible to non-target trees and other vegetation. In general, increasing unharvested buffer widths on small streams such as S4s is considered a good practice that will mitigate salvage impacts on the landscape. This applies regardless of stand mortality levels.

Stand-level best management practices in salvage operations include managing for future stand structure and stand diversity during harvest operations. This entails planning for the long-term supply of snags and coarse woody debris, as well as minimizing disturbance to advanced regeneration on the forest floor. Standing and fallen dead trees provide habitat for numerous species, and data suggests that episodic events like beetle outbreaks are very important to the long-term supply of these elements (Stadt 2001). Partial harvesting is often appropriate, and all sizes of deciduous and non-pine conifer trees should be left standing where safe to do so. Particular care should be taken to **minimize disturbance** in stands with abundant and healthy understory vegetation. Retaining non-target trees and understory trees (which are often spruce and subalpine fir) will help the stand develop on a different trajectory, making it less vulnerable to beetle attack in future. Reforesting with a diverse species mix will also decrease the likelihood of future beetle attack. In areas of high mortality, any living pine trees should be retained, as they may have genetic characteristics favouring beetle resistance. **Wildlife tree patches** should be focused around residual living trees incorporated with standing dead trees in order to provide cover for large mammals. Snags retained during partial harvest and in wildlife tree patches will provide habitat for the insectivorous birds that help control bark beetle populations.

Stands burned by wildfire in Tweedsmuir Provincial Park. Allowing wildfire to burn in designated areas can be a long term vegetation management strategy.
Photo: D. Cichowski

Prescribed fire can aid in mountain pine beetle control by targeting specific age classes.
Photo: Canadian Forest Service

Roads and landings are a major ecological impact associated with salvage operations (Stadt 2001). Salvage operations generally open up new roads and new spurs off existing roads, as well as reactivating existing roads. Aggressive **access management and deactivation** can reduce some of the negative impacts to wildlife and wildlife habitat. Typical effects of roads that can be mitigated with access management and deactivation include increased human presence (including increased hunting and poaching pressure), and increased wildlife mortality from collisions. Habitat fragmentation and altered predator-prey relationships are more difficult effects to address. Road densities should be kept to a minimum to lessen negative effects on wildlife and habitat. Spur roads and landings should be deactivated in preparation for reforestation while the equipment is still on site.

The stand- and landscape-level best management practices described here will be most effective if implemented within a **strategy to reduce the future risk** of beetle outbreaks. Landscapes that do not feature continuous, uniform, mature stands of lodgepole pine will not be susceptible to the same large-scale outbreaks, even if cold winters don't decrease mountain pine beetle survival. Several stand-level strategies to increase stand diversity and lower stand risk are outlined above. Other strategies include leaving a selection of post-epidemic stands to regenerate without intervention. Mountain pine beetles are part of the natural disturbance regime that has shaped these forests. It is good practice to identify some areas that will not be harvested or otherwise treated so that the natural range of variability is retained in some portions of the landscape. These stands will have high levels of snags and coarse woody debris, and will follow a different successional pathway than if they had interventions such as harvesting, planting, juvenile spacing and commercial thinning. Stands that did not experience significant mortality (<30%) should also be left intact to increase the diversity of the landscape and provide important biodiversity values. **Re-introducing fire** is another important strategy that can be used in isolated areas affected by mountain pine beetle or in portions of stands where timber salvage cannot pay for itself. Fire suppression is one of the root causes of the high levels of mature pine on the landscape - planned fires will contribute to landscape diversity and restore natural processes to the landscape. Other suggested strategies for lowering long-term risk include creating a heterogeneous forest landscape using a combination of different sized cutblocks, mixed species stands and different age classes. Harvesting some areas at a younger age is also recommended, as is reducing the susceptibility of existing mature lodgepole stands through thinning.

Restoring Under-Represented Stand Types in the Landscape

Ecological Issue: **Under-represented Stand Types in the Landscape**

Issue: Development of landscapes that do not contain the full natural range of stand types due to:

- Preferential harvesting of specific species, age classes, or stand structures at unsustainable levels
- Fire control reducing the rate of replacement of specific stand types
- Impacts of exotic pests, diseases and parasites

Impacts:

- Loss of habitat for species dependant on certain stand structures, tree species, or age classes
- Low and sometimes at-risk population levels of species that require the under-represented stand type
- Reduction of the range of future economic opportunity
- Increased risk of catastrophic damage in over-represented age or species types

Prevention:

- Design of harvesting to retain representative amounts of all stand structures

Restoration approaches:

- Silvicultural management (thinning, planting) to increase the future supply of under-represented stand types
- Use of slashing and prescribed fire to increase supply of open forest stand types in the Interior Douglas-fir and Ponderosa Pine zones
- Reintroduction or recovery, through breeding and nursery research, of species that have been devastated by exotic pests or have been over harvested

A pre-treatment stand showing high tree densities and highly uniform stand and age structure. This stand type is generally over-represented on the landscape.
Photo: Reinhard Muller

Case Study Five: Weyerhaeuser south coast variable density spacing

Weyerhaeuser has an extensive program of **variable density spacing** in its coastal British Columbia Tree Farm Licences. In the last four years, they have treated 550 hectares (approximately 55 linear km) in riparian reserve zones of S1, S2 and S3 streams, and forecast that they will treat at least another 180 hectares in fiscal year 2003/2004. The **purpose** of their riparian restoration program is to **speed up the creation of old growth conditions in key biodiversity areas**

and to enhance landscape connectivity. The specific program objective is to restore riparian zone ecosystem functioning by managing for the provision of (Peters 1999):

- Large future wildlife trees;
- Large future coarse woody debris on the ground and as large organic debris instream;
- Open areas and canopy gaps for maintenance of shrub communities;
- Ungulate and bear forage;
- Habitat for birds, amphibians, small mammals, insects, plants and other organisms;
- Shade and nutrients to the stream; and
- Overland flow filtering of run-off.

When alder dominated areas are encountered, selected alders are felled to promote understory conifers.
Photo: Reinhard Muller

Typical **stand management prescriptions** call for treatment of stands up to 45 or 50 years of age, with trees greater than 30 cm dbh always left standing. Stocking is taken down to 400 stems per hectare in treated areas, with gaps down to approximately 150 stems per hectare. The cull trees are usually hemlock, and cedar is always selected as a leave tree, as are most spruce and fir. The key is **spatial variability** and creating open space around key ecological attributes in order to enhance **vertical complexity**. The appropriate amount of bucking is determined on a site-specific basis. Five meter wide untreated leave strips are interspersed within the treatment blocks, and three meter 'no touch zones' are always left along the stream banks. Up to 50 stems/ha of western hemlock are partly screefed or girdled to develop trunks with a rotten core and a live hard shell for cavity-nesting birds and small mammals. Red elderberry is randomly cut back to a height of 1 meter to stimulate growth for deer and elk browse.

A worker creating a low density gap to promote old-growth characteristics. *Photo: Reinhard Muller*

In addition to providing for stream stability and fish habitat, these **density reduction treatments** are undertaken with the **objectives** of: (1) creating uneven stocking and distribution and horizontal and vertical diversity; (2) retaining or promoting shrub and herb layers; and (3) promoting some conifer growth (through release) on hardwood-dominated areas while retaining a hardwood component on conifer-dominated areas (Perry, J and R. Muller, 2002).

Weyerhaeuser's riparian restoration program is funded through Forest Renewal BC / Forest Investment Account. Costs for these treatments range from $2,200 - $2,800 per hectare with an experienced crew. Treating stands in this fashion can speed up attainment of **old growth characteristics** by decades, thereby increasing the quantity of this under-represented stand type on the landscape while at the same time providing for riparian ecosystem integrity.

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Restoring Landscape Connectivity

ISSUE - LANDSCAPE FRAGMENTATION

Ecological Issue: Landscape Fragmentation

Issue: Excessive fragmentation of landscapes due to:

- Lack of planning for connectivity between patches of important habitat
- Harvesting at scales and using methods that do not mimic natural disturbance

Impacts:

- Loss of habitat for some large animal species and species dependent on forest interior habitat and connected habitats
- Potential for increased losses of timber due to blow-down
- Increased pest and disease risk in regenerated stands due to reduction of buffers between stands of similar age and species mix

Prevention:

- Design of harvest activities to mimic the scale and frequency of natural disturbance

Restoration approaches:

- Restoring connective corridors through silvicultural approaches that accelerate recovery of mature forest attributes in areas designated as landscape corridors and for old-growth recruitment

Landscape connectivity is often focused around aquatic features with the use of riparian buffers.

Photo: Reinhard Muller

Case Study Six: Planning for landscape connectivity in the Morice & Lakes IFPA

Restoring landscape connectivity once it is lost is a difficult, costly and long-term endeavor. As a result, most examples of addressing landscape fragmentation are **planning** examples in areas where options still exist to connect important habitats on a **landscape scale**. One example of planning for connectivity is underway in the Morice and Lakes IFPA (Innovative Forest Practices Agreement), where members are working cooperatively on pilot projects to minimize landscape fragmentation. Both 'coarse-filter' and 'fine-filter' biodiversity conservation approaches are applied **to maximize connectivity between important habitats.**

Important ecosystems that require **fine-filter**, special management are identified on the landscape prior to harvest. Often this involves ecosystems that form critical habitat for one or more species. Using grizzly bears as an example, critical habitats would include avalanche chutes, seasonal foraging areas, denning areas, and traditional trails. Critical habitats are then mapped and an analysis is done to determine how they can be connected using coarse-filter biodiversity measures.

Coarse-filter biodiversity measures generally entail managing a proportion of the landscape in keeping with the natural disturbance regime. In areas with infrequent natural disturbance, this will require keeping a certain amount of the landscape in a less-disturbed, mature and older seral stage condition under the assumption that this will provide sufficient habitat to sustain the majority of species (with the exception of those with 'fine-filter' needs) that use the area. For the grizzly bear, coarse filter measures that pertain to connectivity include unharvested riparian corridors and old-growth management areas. In the Morice and Lakes IFPA area, important grizzly feeding, denning and trail areas can be connected using riparian corridors and old-growth patches to provide for all the bear's habitat needs on the landscape.

More information about the Morice and Lakes IFPA is available at:
www.moricelakes.ifpa.com/index.htm

Connectivity is maintained in this landscape with the use of riparian buffers that connect high and low elevations.
Photo: Alex Inselberg

Restoration of Stand Structural Elements

ISSUE - STAND STRUCTURAL ELEMENTS

Ecological Issue: Lack of Natural Structural Elements or Species in Second Growth Stands

Issue: Loss of natural stand structure or species or genetic mix due to:
- Highly uniform harvesting practices – particularly clear-cutting without appropriate retention of wildlife trees, and living and dead large wood in riparian areas and wildlife tree patches
- Silvicultural practices resulting in high stand uniformity – development of dense monocultures, highly uniform tree spacing, and very high levels of crown closure
- Short rotation forestry resulting in lack of recruitment of important stand structural attributes

Impacts:
- Limited habitat value due to high uniformity and lack of stand structural elements like large wildlife trees and coarse woody debris
- Virtual elimination of shrubs and herbs due to high crown closure
- High risk of pest or disease damage to highly uniform stands

Prevention:
- Proactive design of harvest to retain structural elements
- Maintenance of species and genetic diversity during reforestation
- Design of reforestation to produce higher diversity in densities through management of stocking levels and minimum spacings

Restoration approaches:
- Pre-commercial or commercial thinning to reduce crown closure and stand uniformity
- Introducing stand structure in selected areas through wildlife tree and CWD addition techniques

Certain species such as spotted owl require old growth stand structure to forage and reproduce.
Photo: Jared Hobbs

Case Study Seven : Commercial thinning for spotted owl habitat

Tamihi Logging Co. Ltd has tenure within a Spotted Owl Activity Centre near Chilliwack, BC. In designated spotted owl areas, timber harvest is restricted or modified in order to maintain or enhance habitat for the owl. In this case, **commercial thinning** is underway to **improve habitat for spotted owls** in a 60-year-old Douglas-fir stand, enhancing it from Type C (Suitable) to Type B (Moderate) habitat, while at the same time making a profit.

Spotted owls require relatively open habitats with large diameter trees and snags, a multi-layered canopy, and relatively high amounts of shrub and coarse woody debris cover – conditions typical in old forests. Tamihi Logging created a stand that will eventually achieve Type B habitat (suitable for owl foraging, dispersal and roosting, but not nesting) at stand age 120, **by removing trees surplus to the minimum stand attributes** specified in the Spotted Owl Management Plan. In

Left and below: **Conditions before and after the first commercial thin to create owl habitat.**
Photo: Jan Jonker

order to do this, they cruised the block and compiled the gross and net volumes available for harvest. Net volumes were calculated by deducting the target stand density from the gross stand density, equally distributed across all diameter classes. This volume was available for harvest subject to meeting other constraints specified for the post-treatment condition, such as minimum inter-tree distances of six meters, and distribution of dominant, co-dominant and intermediate stems.

Harvesting is done on a mark-to-leave basis, and stems are hand-felled and skidded to a central landing with a rubber-tired skidder. Where pre-existing access is inadequate, extraction corridors are felled using the six-meter spacing rule. Operations are conducted on snowpack to minimize site disturbance. Numbers of **snags** and **coarse woody debris** are also increased as part of the operation to within the range specified for Type B owl habitat. **Stem density** is taken down to an average of 320 stems per hectare, varying from 260 to 380 sph. **A second entry** in thirty years (stand age ninety) is scheduled to further reduce stems to an average of 210 stems per hectare.

The area is ideal for a commercial thinning operation – flat terrain adjacent to a public road, with a pure Douglas-fir timber type of above-average log size and quality for the age of the stand. As a result of this, and because of a favorable export permit, a **profit** of approximately $42.00 per cubic meter was realized on the 980 cubic meters harvested from this block to date.

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Case Study Eight: Fungal inoculation to create wildlife trees

Fungal inoculation is a relatively new and promising technique used to create wildlife trees. This technique is still under development, but appears to be a **highly efficient and effective** means for recruiting one of the most valuable structural elements of wildlife habitat – a tree that contains heart rot. Trees in this condition are excavated for use by wildlife and eventually become hollow trees, further increasing their habitat value. Eventually they break apart to become fallen woody debris and hollow logs.

A heart rot infected tree provides important feeding and nesting habitat.
Photo: Tanis Douglas

Fungal inoculation is used on live, healthy trees. The fungus does not usually kill the tree, instead a compartmentalized decay column is produced in the live tree within three to six years. The inoculated tree is able to maintain its foliage and growth form, and continues to put on new incremental growth and function as a seed source. Wildlife trees in this condition (as opposed to a dead snag) will provide habitat for a longer period of time, and will provide few worker safety or operational concerns. They will also continue to function as a seed source, and are less likely to be felled by firewood cutters.

Two **inoculation procedures** are currently under investigation in BC to determine which produces the best results. In one method, native heart rot fungus *Phellinus pini* is injected into the tree by climbing it, drilling a hole, and **inserting a wooden dowel** that is cultured with a locally collected strain of the fungus. The second technique uses a rifle to **shoot the tree trunk** with a bullet that contains a smaller wooden dowel cultured with the same fungus. Both techniques result in fungal decay spreading within the tree above and below the point of inoculation. The resultant decayed and eventually hollow centre can **provide cavity nesting and feeding habitats** that are critical for many forest species. There is virtually no risk of unwanted spread to non-target trees using these techniques because of the natural reproductive history of the fungi. Data from the Pacific Northwest show that fungal inoculation is **less**

Using modified bullets to inoculate a tree is one method of inducing heart rot.
Photo: Todd Manning

One method of introducing heart rot involves climbing the tree, drilling a hole and inserting an inoculated dowel.
Photo: Todd Manning

expensive and faster than techniques such as topping trees with a chainsaw or explosives, top girdling, or cavity creation using chainsaws. However, all these techniques have shown some success at providing habitat for cavity- and snag-using wildlife (Lewis, J.C. 1998). These wildlife tree creation techniques have the advantage of creating or enhancing habitat in a relatively short period of time (five to ten years), as opposed to recruiting similar stand structure through natural cycles. It usually requires 100 or more years to naturally recruit trees of sufficient size and condition to function as useful wildlife trees.

In British Columbia, **two operational trials** using fungal inoculation are currently underway on Vancouver Island, sponsored by Weyerhaeuser Coastal Group and Canadian Forest Products Ltd.

Uses of Fungal Inoculation:

Fungal inoculation can be used in habitats that require restoration or enhancement. For example:

- Creating stand structure and wildlife habitat in riparian management areas

- Accelerating the production of mature forest elements (e.g. wildlife trees, snags and coarse woody debris) in large areas of relatively homogeneous immature forest

- Managing for the habitat of some species that require mature forest elements either directly or indirectly (e.g., Identified Wildlife species, including woodpeckers, owls, and goshawks).

These are both in second growth Douglas-fir stands that have relatively little current stand structure (e.g. wildlife trees, coarse woody debris). Partial cutting prescriptions are being implemented at these sites with biodiversity as one of the management objectives. The ecological and operational feasibility of fungal inoculation as a habitat enhancement tool will be **evaluated over the next five years.**

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Invasive Species Removal

ISSUE - INVASIVE SPECIES REPLACING NATIVE SPECIES

Ecological Issue: Invasive species replacing native species

Issue: Invasive species replacing native species due to management activities and human disturbance

Impacts:
- Loss of native ecosystems and habitat for native species
- Reduced production of economically valuable native species, or increased difficulty in re-establishing native species

Prevention:
- Minimizing site disturbance
- Prompt revegetation and reforestation
- Careful selection and control of seed sources for erosion control

Restoration approaches:
- Proactive removal of invasives
- Seeding/planting bare ground with appropriate native species

When scotch broom is removed from sensitive Garry oak meadow habitat, endangered plant communities are allowed to recover.
Photo: Elizabeth Elle

Case Study Nine: Scotch broom control

Numerous groups and volunteers 'pull' scotch broom throughout the Coastal Douglas-fir zone on Vancouver Island. Like most **invasive species**, broom is exceptionally **difficult to control** due to its lack of natural enemies, its ability to outcompete native plants, and its profuse production of seeds that persist in seed banks. Broom can significantly reduce conifer regeneration in clearcuts, while in Garry oak meadows it threatens endangered plant communities. New invasions of broom have recently been found on the Queen Charlotte Islands, Lower Mainland, Castlegar, and Kootenay Lake (Prasad, R. 2003).

The most effective method of removal is manual cutting or pulling, and repeated cutting or pulling is usually required for any given site. Care needs to be taken to minimize soil disturbance to ensure conditions are not recreated for additional broom seeding. **Preventing the spread** of broom is the most effective control method available until an acceptable biological control agent is developed.

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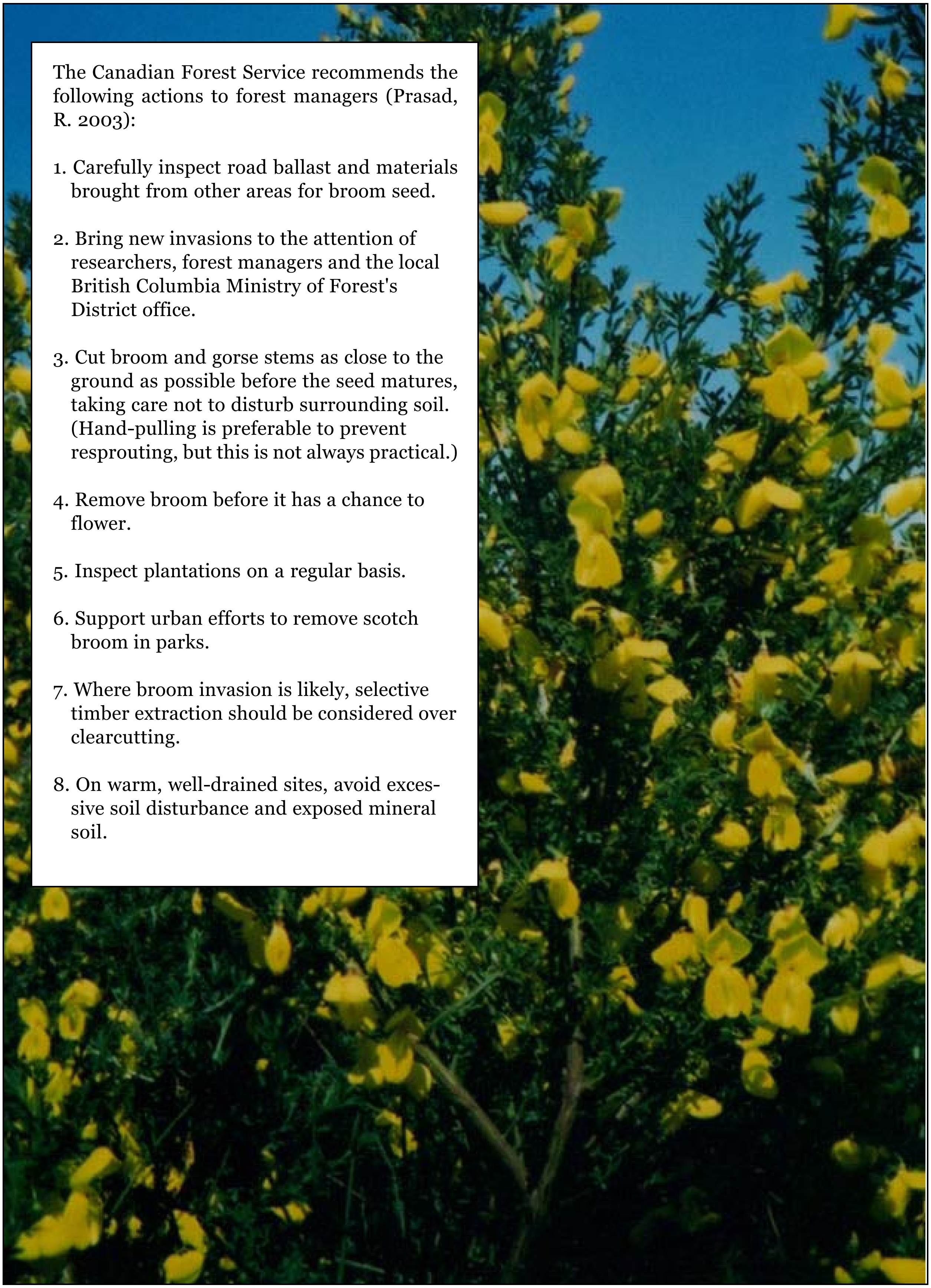

The Canadian Forest Service recommends the following actions to forest managers (Prasad, R. 2003):

1. Carefully inspect road ballast and materials brought from other areas for broom seed.

2. Bring new invasions to the attention of researchers, forest managers and the local British Columbia Ministry of Forest's District office.

3. Cut broom and gorse stems as close to the ground as possible before the seed matures, taking care not to disturb surrounding soil. (Hand-pulling is preferable to prevent resprouting, but this is not always practical.)

4. Remove broom before it has a chance to flower.

5. Inspect plantations on a regular basis.

6. Support urban efforts to remove scotch broom in parks.

7. Where broom invasion is likely, selective timber extraction should be considered over clearcutting.

8. On warm, well-drained sites, avoid excessive soil disturbance and exposed mineral soil.

Addressing Road Impacts

ISSUE -ACCESS IMPACTS

Ecological Issue: Access Impacts to Sensitive Ecosystems and Populations

Issue: Impacts to sensitive ecosystems and populations as a result of road and access development

Impacts:

- Road-induced mortality of sensitive species
- Human access to and disturbance of sensitive species (e.g. grizzly bear, bull trout)
- Fragmentation of important habitats
- Reduced value and use of retained habitat
- Spread of invasive species
- Sediment generation and slope failures as a result of poor construction or maintenance

Prevention:

- Minimizing roaded area through long-term operational planning
- Limiting public access using access management, including pre-planned road closure (physical barriers) and signage

Restoration approaches:

- Road rehabilitation to deter recreational use
- Restricted access or road closures to sensitive areas
- Signage and other extension methods to educate road users about closures and invasive species control measures
- Prompt revegetation of disturbed and deactivated areas to preclude invasive species

Case Study Ten: Developing a strategic plan for public education and involvement in access management, Canadian Forest Products Ltd. Prince George

Roads created to facilitate timber harvesting in BC have also increased **public access** to the backcountry, mainly for recreation. This increased public use has the potential to negatively **affect wildlife and plant species** as well as their habitat (Byman and Hawkins 2003). Control of human access and recreational activities in key habitats will reduce the level of disturbance, however, regulation and access management have their limits. Road closures that are created for protective reasons are often ignored because the general public has not been adequately informed about the reasons for such access control (Byman and Hawkins 2003). Educating the public about sensitive areas and species will be a crucial part of any successful access management plan.

Canadian Forest Products' (Canfor's) Prince George Woodlands Division is developing a **strategy to educate the public** about the impacts of road use in the Prince George Timber Supply Area, particularly as it affects wildlife species at risk. This strategy will be part of their Sustainable Forest Initiative.

Techniques for managing public access that may form part of an access management strategy for Canfor include physical barriers across roadways (including road deactivation and removal of bridges), winter roads, seasonal access, and designated recreation areas. The public access and education

The **species at risk** that are affected by access that Canfor is most concerned with are mountain caribou, grizzly bear, fisher, wolverine, and mountain goat (Wade 2002).

The **potential benefits** of managing public access through education and other means include (Byman and Hawkins 2003):

- Preservation of habitat
- Achieving wildlife conservation
- Minimizing backcountry disturbance
- Meeting Sustainable Forest Management and certification objectives

strategy includes several elements, with the long-term intent to educate the public and increase awareness of species at risk (Byman and Hawkins 2003). One element is the collection of baseline information for species at risk in the Prince George TSA; a second is the collection of information on land users. Canfor hopes to define appropriate land uses and address specific behaviours that result in impact to species at risk. Recreational zoning will be used to define what recreational activities can occur, and where. Informative signage will also be developed. The public will be invited to participate in the planning and implementation process in order to avoid some of the conflicts that arise when trying to use access management by itself (Byman and Hawkins 2003). **Public involvement** will increase the transparency of access management decisions, as well as resulting in a better-informed and abiding public. An education campaign for the general public will be another important part of the strategy. Canfor hopes that public education and involvement in access management will significantly reduce problems with species at risk in the Prince George TSA.

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Forest service road, Ft. St. James District.
Photo: Phil Burton

Restoring Riparian Habitat

ISSUE - RIPARIAN HABITAT INTEGRITY

Ecological Issue: Riparian Habitat Integrity

Issue: Historical harvest of riparian areas without sufficient buffers and current stand structures that do not sustain riparian habitat integrity

Impacts:
- Loss of stand structural elements (wildlife trees, CWD) and older age classes in areas highly important for biodiversity conservation
- Limited habitat value in formerly biodiverse areas
- Lack of large woody debris input to stream channels, and subsequent impacts to fish habitat
- Conversion to deciduous stands or brush in some areas
- Loss or reduction of animal movement corridors
- Possible loss of sufficient stream shading and filtering capacity

Prevention:
- Proactive design of harvest to include sufficient buffer width, taking windthrow probability into account
- Use of silviculture standards and techniques designed to maximize riparian habitat value – for instance use of more diverse species and spacing as well as retaining some structural diversity

Restoration approaches:
- Silvicultural approaches to restore stand composition (species and stocking levels)
- Reintroducing stand structural elements such as wildlife trees and coarse woody debris
- Adding large woody debris to streams through restoration thinning
- Bioengineering methods to rapidly establish cuttings of cottonwoods and willows for bank stabilization and cover production

Case Study Eleven: Western Forest Products riparian silviculture

Historic logging practices around streams have contributed to a loss of fish and riparian habitat in some important fisheries rivers in Western Forest Products' chart area. To deal with these issues, Western Forest Products surveyed candidate areas to determine priorities for restoration silviculture. Three watersheds were selected for restoration on northern Vancouver Island, and a total of 171 hectares were treated in high priority riparian areas. The **creation of stands of larger, well-spaced conifer trees and wildlife trees** was an objective of the treatments. This work will speed the recovery of fish habitat and channel stability at the same time that wildlife habitat is improved.

All the rivers in Western's chart area on northern Vancouver Island are in long-term forestry licenses. Most riparian stands were logged 25 to 45 years ago, with the exception of the retained mature or old growth timber that occupies 18-52% of the total riparian area. The harvested stands are often alder dominated, with a suppressed, scattered understory of conifers. Restoration treatments were designed to **increase and promote the conifer components** of these stands, with a secondary objective of managing for large alder. Conifer growth was improved by removing all alder within a radius of three to ten meters of each conifer tree. This resulted in the **removal of approximately 80% of the alder** in the stand – the minimum necessary to achieve a target of 40% full sunlight to the understory trees. Post-treatment conditions depended on the site – alder stands with conifer understory were thinned to 100-300 stems per

Post-treatment view of an overstocked, hemlock-dominated site. Overstory stems per hectare were reduced to 400 from 1500, and where understory was present it allowed retention of approximately 45 stems per hectare. This site is prepped for planting with sitka spruce and western red cedar to improve species diversity. Photo: Vince Poulin

View of an alder thinning treatment, where the alder overstory was thinned from 1700 sph to 500 sph to manage for large alder and release the minor component of understory alder. Photo: Vince Poulin

hectare (sph) of overstory alder. Pockets of pure alder were also thinned, and up to 600 stems per hectare were retained depending on the age and height of the stand.

The drier riparian sites were generally overstocked with conifers, particularly hemlock. These sites were also **thinned with the goal of improving conifer growth** and establishment. Both uniform and variable density thinning was used to take advantage of productive growing sites, while allowing natural gaps and clusters of trees to prevail. Thinning took densities down to 300 – 600 sph, with preferential retention of western red cedar and sitka spruce where these species were present. Cluster planting was also done in selected areas of both the alder- and conifer-dominated stands. Spruce and cedar were companion-planted with black cottonwood to increase the species and structural diversity of the riparian forests.

Thinning provided excellent opportunities for further **enhancing the biodiversity** value of these stands. Many of the cull trees were topped or top girdled to create snags, while others were damaged to initiate heart rot. Habitat features like bat slits and cavity starts were also created in some trees. Over 900 such features have been introduced into Western's riparian stands.

Thinning also provided the opportunity to **add large woody debris to the stream**. Approximately eighty structures were created using thinnings from both alder and conifer stands. The structures consisted of two to ten trees (or more) depending on the availability of thinnings and site suitability. Directional felling allowed the creation of self-locking jams that mimicked natural windthrow. Jams such as these are more likely to persist during floods.

Costs to complete these works ranged from $2,500 - $3,500 per hectare, depending on the treatments. These costs included thinning, girdling, planting, and modifications for biodiversity and instream structures. Forest Renewal BC provided project funding.

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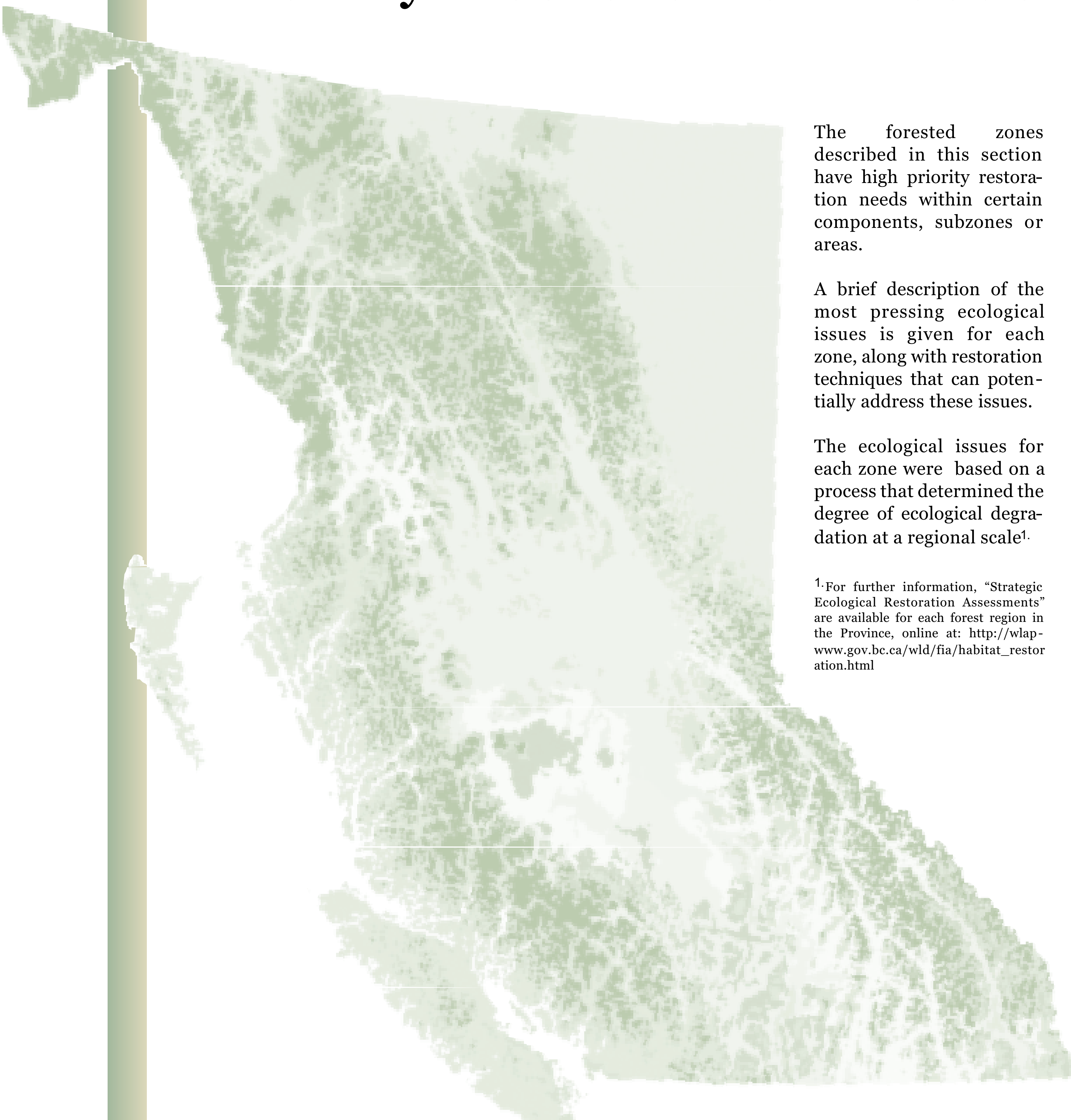
Forested Ecosystems with High Priority Restoration Needs



The forested zones described in this section have high priority restoration needs within certain components, subzones or areas.

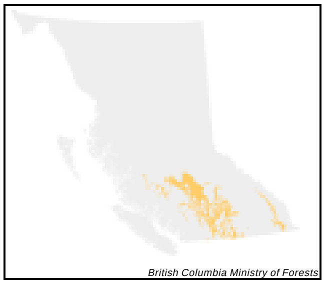
A brief description of the most pressing ecological issues is given for each zone, along with restoration techniques that can potentially address these issues.

The ecological issues for each zone were based on a process that determined the degree of ecological degradation at a regional scale[1].

[1] For further information, "Strategic Ecological Restoration Assessments" are available for each forest region in the Province, online at: http://wlapwww.gov.bc.ca/wld/fia/habitat_restoration.html

Interior Douglas-fir and Ponderosa Pine

Interior Douglas-fir and Ponderosa Pine



The Interior Douglas-fir (IDF) and Ponderosa Pine (PP) biogeoclimatic zones **support a rich diversity of plant communities and wildlife species** in a mosaic of open forest, closed forest, and grasslands. Historically, both zones have been shaped by a natural disturbance regime of **frequent stand-maintaining fires** that occurred as often as every 7-25 years. In the IDF, typical forests are dominated by Douglas-fir trees of all ages and sizes, with a grassy understory in which pinegrass is the most common. In the Ponderosa Pine zone, frequent understory fire burns off grasses and new growth, leaving behind a relatively bare forest floor and restricting regeneration of new trees. Extensive grassland communities occur throughout the drier parts of both zones. The IDF zone contains the highest number of **red and blue listed species** in the province, due in large part to the loss of open habitat and stand structure, while the PP zone has one of the highest densities of listed species per unit area for many of the same reasons.

Over the last century, a combination of fire suppression and forest management has caused a **major shift** in the structure and composition of these two ecosystems. In addition to changes from open understories towards high density cohorts of Douglas fir, the large and old Douglas fir and ponderosa pine previously distributed across the landscape are now mainly gone. These large stand features are key for maintaining many biodiversity values and listed species. These transformations have created stands with **low economic and low biodiversity value** that are highly susceptible to catastrophic fire due to an accumulation of 'ladder' fuels. Some of these stands are also increasingly susceptible to disease. Both zones are under-represented in protected areas, and the protected areas also suffer from the effects of fire suppression.

***Top*- An open Douglas Fir forest in the Rocky Mountain Trench recently treated to remove infilled trees.**
Photo: Tanis Douglas

***Bottom*- A recently burned ponderosa pine stand near Kamloops.**
Photo: Tanis Douglas

Restoration activities undertaken in these zones include those to 're-open' forest stands, using slashing, commercial thinning, and prescribed burning. Maintenance treatments are scheduled every 20 to 30 years, and all treatments are done with care to preserve large trees and wildlife trees. According to Covington et al. (1994), there is a limited time frame in which meaningful restoration of these kinds of forests will be possible, due to a steady trend away from natural stand types as a result of fire suppression. Restoration activities to reduce the prevalence of high density stands will also result in a reduced risk of catastrophic fires over time, potentially reducing large scale timber loss.

Interior Cedar-Hemlock

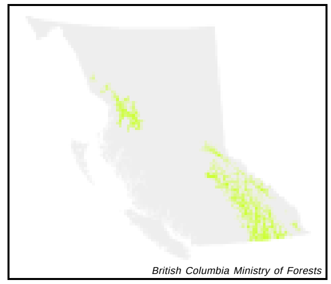
An unharvested wet, cool variant of the ICH zone.
Photo:Alex Inselberg

INTERIOR CEDAR-HEMLOCK

Interior Cedar-Hemlock

The Interior Cedar-Hemlock (ICH) Zone contains the **most productive forests** of British Columbia's Interior, and **more tree species** than any other ecological zone in the province. These highly biodiverse "interior rain forests" cover lower slopes and valley bottoms, and provide **rich habitat for many plant and animal species.** The drier parts of the zone had relatively frequent fires before fire suppression became policy in the last century, while the wetter areas burn so infrequently that they are dominated by tracts of very old, large trees.

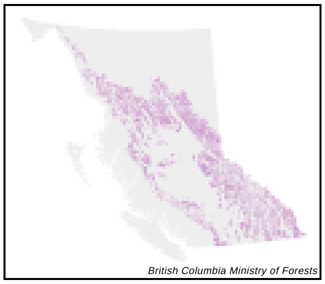
At the stand level, especially in the wetter variants of the ICH, one of the greatest ecological concerns is a **loss of historically abundant large trees, large snags, and coarse woody debris.** In addition, extensive clearcut harvesting has resulted in a loss of contiguous forest cover, particularly at low elevations, and may result in a loss of connectivity across valleys and plateaus. Such significant **stand and landscape level changes** are known to have negative impacts on rare and typically isolated populations of old-growth associated lichens, and are likely also resulting in a loss of habitat for red-listed mountain caribou.



The most pragmatic **restoration approach** to problems with loss of stand structure and connectivity is the prevention of further fragmentation and loss of stand attributes. This is especially relevant for the forest land base as some ICH variants have low representation in protected areas (e.g. 9% of the ICH is in protected areas, but the area of ecological variants protected ranges from 1-16%). Silvicultural approaches can also be taken to restore and maintain stand structural attributes such as large trees, large snags and coarse woody debris – examples of this type of work are occurring in various parts of the province.

The drier parts of the zone provide highly productive sites for **invasive species**, and very few plant communities have not experienced degradation due to an influx of invasives. Some wetter communities are also experiencing problems with invasives - marsh plume thistle is spreading rapidly in wetter sites in the North East extent of the ICH. Its proliferation is exacerbating regeneration problems, radically changing early seral plant communities and resulting in wetland infill in many areas. The potential future impacts of marsh plume thistle are massive. The probability that marsh plume thistle can be controlled depends on action taken now.

Engelmann Spruce – Subalpine Fir



Engelmann Spruce – Subalpine Fir

The uppermost forested elevations in the southern three-quarters of the BC interior are occupied by the Engelmann Spruce – Subalpine Fir (ESSF) Zone. An **enormous area** is covered by these forests, which in unharvested lower and middle elevations are dominated by spruce with a subalpine fir understory. At higher elevations and in some of the wetter regions, subalpine fir is the dominant tree, while in some dry or recently burned areas lodgepole pine is often the main species. Whitebark pine typically occurred at low densities through much of this zone. The zone provides **critical habitat for large wildlife,** including sensitive species such as mountain caribou, mountain goats and grizzly bears. This ecosystem is at the **ecological limits for tree growth,** and is slow to recover from degradation.

The greatest ecological concern in the ESSF zone is the **loss of historically abundant old growth attributes** at both the stand and landscape levels. The remaining low-elevation old growth is highly fragmented by patches of young seral forest and roads. Once-common large trees, snags and coarse woody debris are increasingly scarce. These extensive **departures from natural landscape patterns** and processes are presumed to present a biodiversity risk. Mountain caribou are a species-at-risk that inhabit this zone, and overall, the number of 'listed' species in this zone is moderate.

An unharvested wet cold variant of the ESSF zone.
Photo:Alex Inselberg

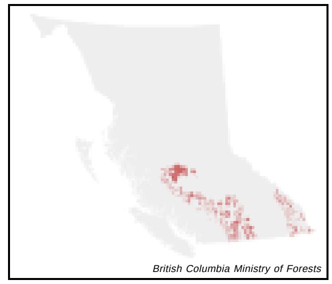
The loss of **whitebark pine** from white pine blister rust is another ecological issue in the ESSF, particularly as it appears to be a keystone species, linking multiple species throughout the ecosystem. In the wet parts of the zone, i**nvasive species** can also be a problem, particularly marsh plume thistle. The proliferation of marsh plume thistle is exacerbating regeneration problems and radically changing early seral plant communities. The potential future impacts of marsh plume thistle are massive. The probability that marsh plume thistle can be controlled depends on action taken now.

Other **restoration approaches** in the ESSF include silvicultural techniques to restore and maintain stand structural attributes such as large trees, large snags, and coarse woody debris. For example, techniques such as variable density thinning combined with snag and coarse woody debris creation are under development in various areas of the province. The most cost-effective restoration approach is prevention: avoiding fragmentation and loss of stand attributes through up-front planning at the landscape level.

Montane Spruce

A dry mild variant of the MS zone.
Photo:Alex Inselberg

MONTANE SPRUCE



Montane Spruce

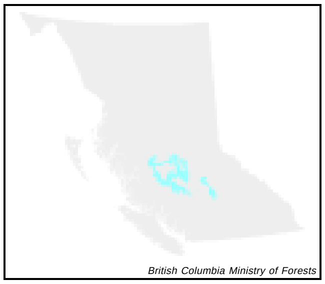
The unique combination of species that characterizes the Montane Spruce zone reflects its transitional nature. This ecological zone occupies a fairly narrow elevational band, and shares characteristics with the higher elevation ESSF zone, and the IDF and SBPS zones in elevations below. Even the **spruce in these forests is a hybrid** between the high elevation Engelmann spruce and the lower elevation, more northerly white spruce. This zone is typically shaped by a mixed-severity fire regime, resulting in extensive stands of lodgepole pine, interspersed with remnant patches (fire 'skips') and open-grown stands resulting from low severity fires. Lodgepole pine stands dominate the Montane Spruce landscape. **Stand-replacing fires are frequent in these forests, and have an intimate relationship with mountain pine beetle.** Mountain pine beetle attacks mature and old even-aged lodgepole pine stands and provides accumulations of dead trees, which set the stage for wildfire, which then sets the stage for extensive even aged stands. These stands will be susceptible to mountain pine beetle once again when they reach a certain age. Remnant patches or fire 'skips' within this matrix range from small patches of veteran trees that retain stand structure through into future stands, to large patches, and often have very large trees and snags of a diverse range of tree species, with a mossy understory. Highly atypical from the majority of stands in this zone, these stands have very high diversity and great ecological value, though they have disappeared from much of the landscape in this zone due to timber harvest.

In some regions, forestry operations guided by salvage of mountain pine beetle-affected lodgepole pine are resulting or have resulted in a very high rate of harvest and a high impact on landscape patterns. Important stand-level attributes like wildlife trees, snags and coarse woody debris are also lost as a result of beetle salvage. Fire suppression has likely reduced the ecological variability within the zone, and may be resulting in an increased probability of catastrophic fire over time.

Over the long term, various silvicultural strategies to replace older pine stands will need to be employed to reduce the amount of susceptible pine on the landscape. This will include **allowing natural fires** to burn with limited suppression in some designated areas, and the **use of prescribed fire** to target specific age classes. In the short term, best management practices can be applied to salvage operations to retain various biodiversity attributes, as well as lower mountain pine beetle risk in the future (see Ecological Best Management Practices for Major Salvage Operations, page 9).

Sub-boreal Pine-Spruce

Sub-boreal Pine-Spruce



The Sub-boreal Pine-Spruce (SBPS) Zone is a dry, cold, **low productivity zone** where lodgepole pine stands and **wetlands** dominate the landscape. Other less extensive ecosystems add important diversity to this landscape, including stands of white spruce, hybrid white-Engelmann spruce, or trembling aspen, all of which grow on the borders of wetlands and streams. The understory in the pine forests is very dry, and has an abundance of lichen species: these **terrestrial lichens** allow caribou to survive in this zone by providing their winter food. Many lichens depend on older forests that have remained undisturbed for long periods of time.

Mountain pine beetles are a natural disturbance agent in this zone, and occasional epidemics can kill most pine trees over thousands of hectares. **Wildfire** is another disturbance agent - stand-destroying wildfires used to sweep through this zone on a fairly regular basis, on average every 75-125 years. Although the exact mechanisms are unknown, mountain pine beetles and fire interact to create a mosaic of stand replacing fires and beetle outbreaks. Extensive small-scale disturbances occur in the interim period between large fires.

One ecological concern in this zone is the **rarity of large-sized patches of old or mature forest** on the landscape. While large scale disturbances are a natural phenomenon in this zone, the historic disturbance regime did allow for patches of older forest, particularly in fire refugia. Current management is lessening the extent and changing the distribution of these patches, while also reducing the extent of patches in early seral stages. This is a biodiversity concern, as early and late successional stages tend to have the highest ecological diversity. This zone is also highly under-represented in protected areas (8.6% of the SBPS is in protected areas, ranging between 0.5% and 50% for individual variants). The patches of older forest are also very important for many of the lichen species that caribou depend upon for winter survival.

SBPS near Anaheim Lake. *Photo: Alex Inselberg*

Another ecological concern is the presence of **high road densities**: this zone is highly operable, and while this easy access increases harvest efficiency, it also has impacts on the ecosystem and on the wildlife species that use it.

Managing for lichen during timber harvest is a recommended approach to retain woodland caribou forage: a combination of winter harvest and on-site processing of trees without scarification will retain the greatest abundance of terrestrial forage immediately following harvest (Kranrod 1996). Other **restoration approaches** in this zone involve planning at the landscape level to avoid stand and landscape level impacts to biodiversity. Designing harvest activities to mimic natural disturbance patterns at both the stand and landscape levels is the primary proactive approach. Where pest and disease outbreaks make large scale salvage desirable, various measures can minimize impacts on biodiversity values (see Ecological Best Management Practices for Major Salvage Operations, page 9).

Sub-boreal Spruce

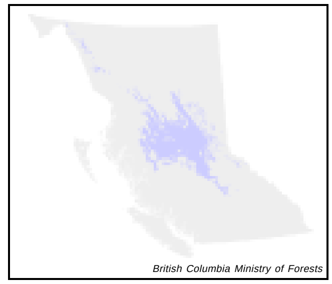
SBS near Bear Lake
Photo: Alex Inselberg

SUB-BOREAL SPRUCE

Sub-boreal Spruce

Upland forests in the Sub-boreal Spruce (SBS) Zone are **highly productive** and have a **distinctive combination of tree species**. Dominant coniferous species are hybrid white spruce, sub-alpine fir, and occasionally black spruce, as well as lodgepole pine. Douglas fir also occurs on warm, dry, rich sites. Along with forest harvesting, **fire** is a disturbance agent in the zone - as a result of fire and logging, many areas contain regenerating forests of mixed ages. Lowland sites in this zone include extensive **riparian areas and wetlands** that are exceptionally important to a variety of wildlife and bird species.

Older forest is rare on the landscape as a result of forest harvest, including harvest of beetle-killed trees. Consequently, large wildlife trees, snags, and coarse woody debris are also increasingly rare. **Fire suppression** also has ecological impacts in this zone. The lack of periodic fire, particularly in drier parts of the zone, results in higher density, stressed stands, encourages beetle outbreaks and increases the risk of catastrophic fires. The loss of old, large Douglas fir and lodgepole pine is a concern in drier parts of the zone, and old growth riparian habitat is also becoming increasingly scarce.



Restoration approaches in this zone include letting some natural fires burn in areas where they don't pose a risk to infrastructure. In some of the more forestry-intensive areas, previous harvest has removed options for establishing biodiversity measures on the landscape (e.g. coarse filter approaches such as old growth areas and riparian corridors). Silvicultural methods such as variable density thinning, and other stand-level measures are recommended to provide for biodiversity on these landscapes.

Invasive species are an issue in this zone. Marsh plume thistle poses a particularly large threat, even though populations are currently small, as it is expanding aggressively and will have a high impact on the plant communities in riparian areas and regenerating clearcuts in the future. Controlling this population before it spreads further is a very high restoration priority.

Controlling the spread of marsh plume thistle is a very high priority.
Photo: Phil Burton

Coastal Douglas-fir

Coastal Douglas-fir

The Coastal Douglas-fir (CDF) Zone covers a small area of BC's south coast on both sides of the Georgia Straight. The majority of this zone is **urbanized,** and includes the towns of Powell River, Nanaimo, and Victoria. Other land uses include forestry and agriculture. The forests that remain are largely second growth, and only 3% of the zone is represented in protected areas. Nevertheless, this zone is home to some of the province's most **diverse ecosystems** and a **mild climate** has given this area some of the province's **rarest vegetation.**

Coastal Douglas-fir is the dominant tree species, occurring in a wide range of forested sites ranging from moist to dry. The CDF zone is also home to a **unique and sensitive group of ecosystems** including seaside parkland, dry forest, rock outcrop, and wetland habitats, all of which contain many rare plants. Garry oak and arbutus are common trees in these ecosystems, though they are found nowhere else in Canada. **Garry oak parkland** is perhaps the most unusual ecosystem – in dry sites with deep soils, Garry oaks form an open tree cover above a carpet of grasses and colorful spring flowers. These habitats harbour many rare, endangered species ranging from wildflowers to butterflies. Some of these species are locally extinct due to the extensive habitat loss that has occurred in this zone.

Garry oak parkland. *Photo: Elizabeth Elle*

A combination of historic and current forestry operations, plus extensive urban and agricultural development, has resulted in an **almost complete loss of mature / old forest, as well as Garry oak ecosystems and arbutus woodlands.** Invasive species are abundant and extensive, particularly in Garry oak ecosystems. Scotch broom, gorse, thistles, foxglove and orchardgrass are main examples of **invasive species** that are causing extensive changes to plant communities in this zone. Loss of riparian / wetland systems throughout this zone due to agriculture and urban development is another serious biodiversity concern. Continuing development pressures mean that these rare terrestrial and aquatic ecosystems are still diminishing in extent and in quality. The CDF zone has one of the **highest numbers of listed species** per unit area in BC.

Restoration approaches in this zone include various volunteer and non-profit efforts to retain and restore the fragments of forest, garry oak, and aquatic ecosystems that remain. The Garry Oak Ecosystem Recovery Team is a clearing-house for some of these efforts. In Coastal Douglas-fir forests, silvicultural approaches are taken to re-claim areas from broom infestations, and to thin existing forests so that old-growth attributes will be obtained at a faster rate.

A moist mild variant of the CDF zone on Saltspring Island. *Photo: Alex Inselberg*

Coastal Western Hemlock

A very wet, mild variant of the CWH zone on northern Vancouver Island. *Photo: Alex Inselberg*

Coastal Western Hemlock

The Coastal Western Hemlock (CWH) Zone is one of Canada's **wettest climates and most productive forest areas**. This zone covers a broad swath along the province's entire coast, and these complex ecosystems are home to **trees of great age and massive proportions**. Western hemlock and western red cedar trees combine with yellow cedar, sitka spruce, and various other deciduous species to create multi-layered, multi-aged forests where large living and dead trees form a very important part of the ecosystem. Standing dead trees and fallen dead trees support a wealth of life and are vital to the life cycles of numerous birds, small mammals and fungi that are part of the forest ecosystem. This zone is dominated by a **gap-dynamic natural disturbance regime**, where wind and disease are the main disturbance agents. Windstorms and disease pockets typically create small gaps in the forest canopy that allow light to penetrate to the forest floor, where it stimulates new seedlings and shrubs.

The CWH zone probably encompasses the **greatest diversity and abundance of wildlife habitat** of any ecological zone in British Columbia. Many species rely on the habitat that old forest provides in these ecosystems. Aquatic species also rely on forests in the CWH – including the five species of pacific salmon that benefit from the high quality spawning and rearing habitat found within these forests.

British Columbia Ministry of Forests

The largest ecological issue in the CWH is the **significant change in the seral stage distribution** in some areas and variants, from mostly old to mostly young. Because natural disturbance in these forests is so infrequent and so small-scale, typical landscape patterns in managed forests vary widely from natural landscape patterns. At the **stand level**, important structures like large trees - living and dead - are lost due to short-rotation forestry, including the large trees that provide large woody debris to streams. Large inoperable areas in this zone mean that most valley bottoms, with the exception of some mid-coast valleys, have already been harvested or highly fragmented. **Rare and very ancient ecosystems** in this zone also suffer high impacts due to a lack of inventory and policy for their retention.

Salmon provide coastal forests with nutrients and in turn benefit from the high quality spawning and rearing habitat that coastal forests provide. *Photo: Laurie Stott*

Restoration approaches in the CWH typically entail variable density thinning to speed up the transition to old forest within landscapes where little old forest remains. Some restoration projects also introduce some of the stand structure typically lacking in uniform second growth forests, using methods such as girdling and topping trees, harming or inoculating trees to introduce fungus, and by adding coarse woody debris.

The Queen Charlotte Islands

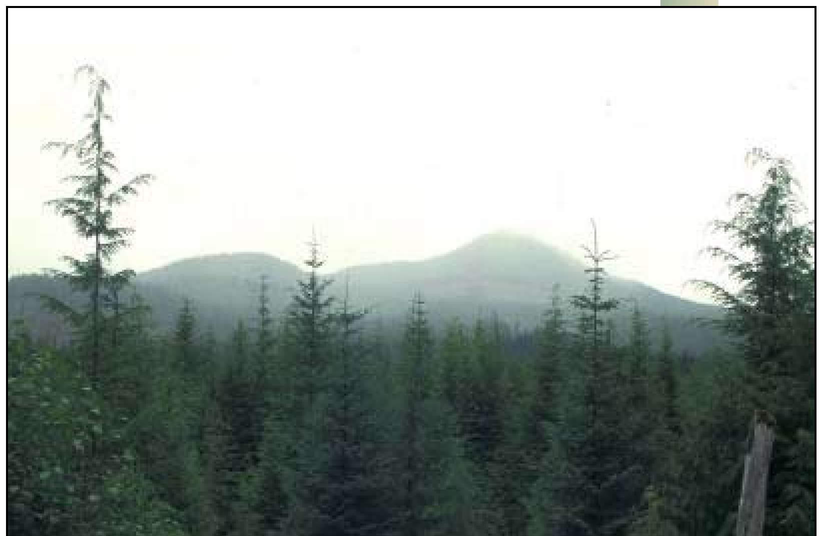
The Queen Charlotte Islands

The Queen Charlotte Islands are part of the Coastal Western Hemlock Zone, but the ecological issues and ecosystems on these islands are **unique**. These islands were an **ice-free refuge** during glacial times, resulting in high numbers of **endemic species** or subspecies and **very high biodiversity values** in highly productive and ancient forests. Plant and animal communities on these islands also evolved without the presence of common mainland animal species like deer and raccoon.

The **ancient and rare forest types** on the islands have become even more rare in recent decades, and some are globally imperiled. The typical ecological issues in the Coastal Western Hemlock zone also apply here: loss of important stand structure, and the reversal of the seral stage distribution on the landscape from mostly old to mostly young. Older forest is almost completely absent in the valleys of the Queen Charlottes, and the biodiversity effects of such **significant stand and landscape level changes** are unknown.

Invasive animal species are a major concern here. Because these island communities evolved without animals like deer, raccoons and rats, their presence has caused major ecosystem damage. Deer in particular have had a massive effect on the structure and composition of the islands' forests.

Forest **restoration approaches** on the Queen Charlottes almost always include managing deer populations or deer browse. Several deer exclosures were recently built by the Council of Haida Nations as a first step in understanding the impact of deer browse on ecosystems. Silvicultural approaches are also appropriate – as elsewhere in the CWH, approaches typically entail thinning to speed up the transition to old forest in landscapes where little old forest remains. Some restoration projects also introduce some of the stand structure typically lacking in uniform second growth forests by using methods such girdling and topping trees, harming or inoculating trees to introduce fungus, and by adding coarse woody debris.



Homogenous second growth landscape on Graham Island.
Photo: Phil Burton

Old growth forest.
Photo: Dave Polster

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