Managing Coarse Woody Debris in British Columbia's Forests: A Cultural Shift for Professional Foresters?[1]

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Abstract

Coarse woody debris (CWD) is recognized as an important component of British Columbia's forest ecosystems linked to biodiversity and ecosystem processes. CWD represents high centers of biological interaction and energy exchange, symbolizing in many ways the complexity of forest ecosystems. Our research on lichens and bryophytes demonstrates that many species are either partially or entirely dependent on CWD. Long-term management of this resource is vital to maintain ecosystem integrity. Previous attempts to recommend province-wide CWD management practices were not successful because of potential increased logging costs and conflicts between utilization standards and recommended CWD volume targets. I demonstrate that small changes to existing forest practices will go a long way in minimizing impacts on the CWD resource without affecting logging costs or access to timber. I propose that a cultural shift in how foresters perceive CWD is a necessary ingredient to improve present practices. This paper promotes such a cultural shift by explaining key CWD management principles and by providing some operational examples.

Introduction

The value of retaining decaying wood in forest ecosystems may be counter-intuitive to many foresters trained in traditional silviculture, which has focused on converting old "decadent" forests into "productive" plantations. The view that decadence (decaying wood) in forests is either undesirable or not necessary has had a profound influence on how foresters and loggers perceive and manage dead wood. A better understanding of the ecological services provided by coarse woody debris (CWD) is essential to initiate sustainable management of this resource.

Many of the ecological services provided by CWD may even help foresters attain some wood production objectives more efficiently and at lower cost. For example, CWD may assist foresters directly with natural tree regeneration by providing safe sites for seedlings (e.g., nurse logs), by protecting seedlings from snowcreep in high-elevation forests, and by reducing trampling damage by livestock in range management areas. Coarse woody debris is also believed to contribute to

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long-term forest productivity (Stevens 1996) by improving soil-moisture retention, contributing to soil structure, maintaining soil stability, and providing nutrient pools.

Long-term forest productivity is obviously linked with timber supply. The contributions of CWD to forest productivity are likely both direct and indirect, resulting from complex interactions among organisms of the detritus food web, the net effect of which is to transfer and transform organic matter, nutrients, and energy from CWD to the forest soils (Harmon and others 1986). In addition to the direct and indirect benefits to wood production, CWD is also an important habitat component for a wide variety of organisms representing the five biological kingdoms. Although the importance of retaining coarse woody debris in managed forests is obvious for a range of values, the development of operational recommendations has not been easy.

The abundance and distribution of coarse woody debris is highly variable in forest ecosystems and depends largely on stand history, stand age, tree species composition, ecosystem type, and decomposition rates. Coarse woody debris will also vary in size and stages of decay even within the same forest. Maintaining the natural variability of deadwood at both the stand and landscape levels is probably a worthy objective for sustainable forest management. However, there are many real and perceived constraints that make the retention of coarse woody debris in forestry operations challenging. Some of the issues that need to be considered when addressing the retention of CWD in British Columbia's forests include: workers' safety, logging costs, maximum utilization policy, resistance to change, harvesting techniques, pulp markets and salvage initiatives, silvicultural objectives, fuel management, range management, and forest health. In addition, the natural variability of coarse woody debris precludes the development of simple or static retention targets, especially considering the dynamic nature of ecosystems over time and space.

In British Columbia, the ecological value of CWD has been recognized within forestry legislation since 1995 (Stone and others 2002). However, the negative perception associated with CWD in traditional forestry and the difficulty of integrating multiple values has made the development and application of CWD management objectives rather challenging. This paper illustrates the ecological importance of CWD with recent research on non-vascular plants, describes briefly the history of CWD management, and provides an overview of a short-term strategy recently adopted in the Kamloops Forest Region to improve the management of CWD.

Non-Vascular Plants and CWD

Non-vascular plants (i.e., lichens and bryophytes) are important organisms in forest ecosystems. These taxa contribute to biological diversity or the many associated ecological processes and constitute critical indicators of environmental change. The importance of coarse woody debris as habitat for certain bryophyte species (particularly hepatics) has been well documented in the literature (Jovet and Jovet 1944, Muhle and Leblanc 1975, Shuster 1949, Soderstrom 1988). The reasons behind the close association between some non-vascular plants and CWD are not fully understood. They probably involve a competitive advantage conferred to these organisms over vascular plants when occupying elevated organic substrates as well as a combination of unique environmental conditions (i.e., substrate moisture, texture, and chemistry), which may be specifically required for some species.

In southern British Columbia several hundred species of lichens, mosses, and hepatics are associated with coarse woody debris. However, only a portion of these species are truly dependent on CWD for their survival. A recent review of the literature and consultations with expert botanists revealed that 16 species of lichens and 23 species of liverworts are strongly dependent on coarse woody debris *(table 1)*.

Table 1—*Preliminary list of hepatics and lichens specializing on coarse woody debris (Godfrey 1977; Goward and others 1994; Goward 1999; Goward, pers. comm.; Schofield, pers. comm.). All of these are considered very strongly dependent on coarse woody debris for survival in the forest. Some are also found on other substrata, but as forest species they are valuable indicators of specific conditions.*

Hepatics
Anastrophyllum hellerianum (Nees) Schust
Bazzania denudata (Torr.) Trev.
Blepharostoma trichophyllum (L.) Dum.
Calypogeia muelleriana (Schiffn.) K. Müll.
Calypogeia azurea Stotler and Crotz
Cephalozia bicuspidata (L.) Dum.
Cephalozia lunulifolia (Dum.) Dum.
Geocalyx graveolens (Schrad.) Nees
Jamesoniella autumnalis (DC.) Steph.
Jungermannia leiantha Grolle
Kurzia makinoana (Steph.) Grolle
Lophocolea bidentata (L.) Dum.
Lophocolea heterophylla (Shrad.) Dum.
Lophozia guttulata (Lindb. Et H. Arn.) Evans
Lophozia incisa (Shrad.) Dum.
Lophozia ventricosa (Dicks) Dum.
Mylia taylorii (Hook.) S. Gray
Odontoschisma denudatum (Nees in Mart.) Dum.
Ptilidium pulcherrimum (G. Web.) Vainio
Riccardia palmata (Hedw.) Carruth.
Riccardia latifrons (Lindb.) Lindb.
Scapania umbrosa (Schrad.) Dum.
Tritomaria excectiformis (Breidl.) Loeske
Lichens
Cladonia borealis S. Stenroos
Cladonia carneola (Fr.) Fr.
Cladonia chlorophea (Sommerf.) Sprengel
Cladonia cornuta (L.) Hoffm.
Cladonia crispata (Ach.) Flotow
Cladonia ecmocyna Leighton
Cladonia furcata (Hudson) Schrader
Cladonia gracilis (L.) Wild.
Cladonia pleurota (Flörke) Schaerer
Cladonia pyxidata (L.) Hoffm.
Cladonia singularis S. Hammer
Microcalicium arenarium (A. Massal.) Tibell
Lobaria retigera (Bory) Trevisan
Nephroma articum (L.) Torss.
Peltigera aphtosa (L.) Wild.
Peltigera britannica (Gyelnik) Holtan-Hartwig & Tønsb.

In Sweden, many species of bryophytes, lichens, fungi, and invertebrates that specialize on decaying wood are in decline (Esseen and others 1992) and some of these species are considered threatened (Berg and others 1994). The decline of log-dwelling hepatic species appears to be the result of both a reduction in large logs and a drier microclimate in managed forests (Soderstrom 1988). At present none of the species of lichens or hepatics specializing on coarse woody debris are considered threatened or in decline in British Columbia, illustrating the critical role B.C. can play in maintaining species at risk globally. This is an obvious incentive for the retention of CWD in managed forests of British Columbia.

Another important consideration from a conservation biology perspective is that on certain sites the number of species dependent on CWD will be higher. For example, in a study of lichen distribution in interior-cedar-hemlock forests of south central British Columbia, Arsenault and Goward (2001) found that over 90 percent of terricolous (ground-dwelling) lichens were associated with elevated woody substrates of which CWD was the most important component. For lichens at least, it appears that the number of species that depend on CWD will increase with increasing soil moisture and snow-depth. The variable level of dependence between non-vascular plants and CWD on different sites probably also applies to other organisms and suggests that CWD retention objectives in managed forests should be site-specific insofar as possible.

Historical Perspective on CWD Management

There have been three main historical periods for CWD management in British Columbia. In the early days of logging low mechanization often meant that only the best wood would be taken out, resulting in considerable amounts of CWD when low quality timber was left on site. This was followed by a period during which clean cut-blocks were considered preferable for silviculture and "fuel management." More recently, with a shift towards an ecosystem management approach, illustrated by the Forest Practices Code of British Columbia, CWD has been recognized as an important value and its retention is required.

Although the present policy calls for the retention of CWD in cutblocks, the perceptions of prescribing foresters and other forestry professionals have not entirely changed from past views. The operational reality of CWD management is further complicated by the diversity of "specialists" involved. Numerous disciplines and issues are involved with CWD management, often measuring it in different ways, referring to it by different names, and even working with different objectives in mind. For example, fire protection officers are concerned with fuel loading, forest ecosystem specialists are concerned with biodiversity, silviculture foresters are concerned with planting spots, harvesting foresters are concerned with logging costs, and scaling foresters are concerned with utilization standards.

CWD management has been the subject of heated debate ever since the implementation of the Forest Practices Code. The approach of using specific CWD targets within the biodiversity guidebook (Ministry of Forests and BC Environment 1995a) was delayed in 1995 as a result of a potential conflict between the timber utilization policy (e.g., zero waste policy) and CWD retention targets. Since then, several attempts to reach a consensus on CWD management have been unsuccessful. In the interim the timber utilization standards take priority over CWD retention. The result is that CWD management is presently focused on the retention of uneconomic wood. In addition, companies can leave a small amount of green sawlogs behind without being billed for waste but are charged volume against the annual allowable cut.

Towards a CWD Management Strategy

Despite the lack of specific CWD management guidelines, foresters are still required to set CWD management objectives in forest development plans and silvicultural prescriptions. In addition, foresters also have to balance CWD management with other potentially competing stand management objectives such as stocking standards, range, and fuel management. In order to provide better guidance for CWD management, the Kamloops Forest Region recently developed a short-term strategy for CWD management. The general approach of the strategy is to clarify the policy and legislation pertaining to CWD management, providing prescribing foresters key information to assist in managing CWD. The focus of the strategy is educational, i.e., to provide CWD management guiding principles, planning and prescription considerations, and CWD management tips. The strategy will be implemented for a period of three years, during which monitoring programs will be used to assess its efficacy.

Guiding Principles for CWD Management

In order to assist prescribing foresters in the development of CWD management objectives in forest developments and silviculture prescriptions, the following key guiding principles have been developed. In general these principles will help foresters avoid wasteful practices, encourage an integrated management approach and promote the maintenance of variability across the landscape.

- CWD accumulations, especially on landings and roadsides, should be minimized, bearing in mind that some accumulations will be inevitable for reasons of safety and operations. Some small CWD piles dispersed in cutblocks may be necessary to provide valuable habitat for some mammals.
- Larger pieces of CWD are more valuable than smaller pieces—they last longer, hold more moisture, are useable structures for a greater number of organisms and cannot be easily replaced.
- Ecologically, it is advantageous to maintain the full range of decay and diameter classes of CWD on every site—different functions and ecosystem processes require CWD in different stages of decay.
- Coniferous material decays much more slowly than deciduous material and therefore remains part of the useable structure of a stand for a much longer period of time. However, the faster decay rate of deciduous CWD also provides significant short-term ecological benefits. Retention of a diversity of species is advantageous.
- CWD can be managed in conjunction with wildlife trees and other constrained or reserve areas. Standing live and dead trees and/or stubs retained on cutblocks represent important sources of CWD recruitment.
- CWD has additional value in riparian areas, which are a valuable habitat resource for many species of wildlife. CWD entering or falling across a

stream produces habitat for fish, invertebrates, and vegetation. Most importantly, it contributes to stream geomorphology. However, excessive amounts of woody debris can have negative effects on stream biology.

- The composition and arrangement of CWD should be managed within acceptable levels of risk of wildfire, insect pest, and forest disease outbreaks.
- The retention of CWD should be harmonized with all other silvicultural objectives.
- Variability in the levels of CWD should be maintained at the landscape level. The natural distribution and amounts of CWD will vary according to biogeoclimatic gradients, stand types, and stand development history. Although the natural distribution of CWD cannot be mimicked exactly, it is important that CWD management capture landscape variation and site-specific variations through different management practices.

Sources of CWD

In many cases, logs already lying on the forest floor will be left after harvesting. This constitutes an obvious source of CWD. In addition, all other uneconomic wood resulting from harvesting (such as breakage, short pieces, tops, and low-grade timber) also provides existing sources of CWD. When the intent is to leave these behind as CWD, efforts should be made not to damage them during harvesting operations.

Ensuring that large pieces of CWD will be maintained through several rotations will be a challenge. It would be wise to plan ahead and identify “low cost sources” of CWD recruitment. Long-term CWD recruitment may be addressed by leaving reserves and wildlife trees, possibly including cull trees. “Stubbing” (leaving high stumps, often several meters in height) may be used to complement these reserves, particularly when there are few wildlife retained trees or when wildlife trees are restricted to portions of the cutblock.

CWD and Risk Management

The risk of bark beetle activity should be evaluated where wildlife trees blow down or if many large live trees are felled and left in place. If fallen trees are near an existing infestation, preventative actions may need to be taken, particularly with Douglas-fir and spruce. The actions will depend on the risk of spread of bark beetles, the value of the timber, the value of the CWD, and the impact of different actions to the standing trees. The level of risk to timber is determined by the probability of bark beetle damage (based on the susceptibility of the stand and the proximity of existing beetle infestations). The bark beetle management guidebook provides further information on hazard and risk rating criteria (Ministry of Forests and B.C. Environment 1995b).

Fuel management plans are no longer required under the Forest Practices Code. However, the Forest Fire Prevention and Suppression Regulation states that a person who, on Crown or private land that is in a Tree Farm Licence or a Woodlot Licence, harvests timber or carries out a prescribed activity must assess the fire hazard existing on that land. Fine fuels, i.e. pieces less than 7.5cm in diameter, pose the primary fire hazard associated with woody debris. Prescribed burning, under the appropriate conditions, can remove these fine fuels and have minimal impact on CWD.

CWD Management and Salvage Operations

When stands affected by catastrophic disturbances (e.g., wildfires, windthrow, bark beetle infestations) are salvaged, efforts should be made to ensure a good distribution of CWD over the area. Care is necessary when contemplating salvage operations within wildlife tree reserves or riparian buffers. In cases where salvage is required for risk management, consideration should be given to designating an equivalent replacement area. It may be possible to retain incidental windthrow in sensitive ecosystems such as riparian areas and wildlife tree patches (WTPs) for long term CWD. The Small-scale Salvage Program removes standing dead and downed trees from harvested areas. The recovery of this material poses a potential risk to the biodiversity values provided by wildlife trees and CWD. However, the integration of CWD management within forest district procedures for small-scale salvage will help minimize this risk. These procedures may include: identification of areas of access and operation; designation of high value habitat; instructions concerning salvage from sensitive ecosystems such as WTPs and riparian management zones (RMZs); information on CWD and wildlife tree values; and safety concerns.

CWD and Silviculture Activities

Management of harvest and post-harvest activities should minimize adverse impacts on CWD. The main objectives are to avoid piling CWD, avoid damaging CWD with heavy machinery or broadcast burning, and plan stand-tending activities to ensure some CWD recruitment.

In some special circumstances it may be appropriate to modify stocking standards to meet CWD objectives due to debris accumulation and reduction of plantable spots. Options include: modifying target-stocking levels; modifying the minimum allowable distance between trees; and utilizing clumped planting patterns.

CWD Management Field Tips

The following field tips have been employed to manage CWD in different parts of the province. They are not necessarily applicable to all situations but provide several options and perhaps a template, which foresters can use to innovate and develop other solutions that would be suitable to specific situations.

- Bucking on site: An approach to avoid CWD accumulations on landings is to buck on the site rather than at the landing. This approach can be applied over the whole cutblock or over a portion of it.
- Delimbing and topping: Where whole tree harvesting is carried out, CWD levels can be increased by delimbing and topping on site rather than at landings and roadsides.
- Leaving cull trees standing: Trees (live or dead) that have obvious defects are often referred to as cull trees and will usually produce low-grade lumber. In many cases the costs of harvesting and manufacturing outweigh any economic gain, making cull trees ideal candidates for long-term CWD recruitment. Identifying cull trees during operations as potential sources of CWD is a good example of improving CWD management and reducing logging costs. The major types of defects are forks, multiple tops, spiral grain, extensive rot, insect damage, and scars of various kinds.

- Avoiding yarding of uneconomic wood to landings and roadsides: Yarding uneconomic wood to landings and roadsides reduces its ecological and habitat values and can add costs. In addition, it may be expensive and time-consuming to redistribute this material back onto the site.
- Reducing the number of empty trips: Redistributing CWD has been successful in blocks with very little initial CWD volume. When the burning of cull and debris piles is eliminated or lessened, costs may be reduced. Licensees will want to determine if the redistribution of uneconomic wood should be done over the entire cutblock or only on a portion of it. To help facilitate the redistribution of uneconomic wood back onto the cutblock, the bucker might be able to place pieces of uneconomic wood in a pile easily accessible to the skidder. As the skidder comes to the landing, the operator will be able to release a load of incoming logs, grab a turn of uneconomic wood and return it to the cutblock. The general approach of returning uneconomic wood during operations can also be used in conjunction with some grapple yarding operations where safety considerations and terrain permit. Communication with the yarding crew to identify uneconomic wood is an efficient means of improving CWD retention on the site.

Red Flags

Although a detailed assessment of CWD management in the field has yet to be conducted, it is clear that certain sites deserve close attention. For example, we already know of at least three specific situations that may become problematic:

- Observations in second harvest stands of coastal temperate rainforests suggest very few large pieces of CWD be left behind.
- Some young thrifty stands being harvested in the southern interior of British Columbia have very little decay and leave few opportunities for CWD retention within the present policy framework.
- In dry forests, prescribed burning often eliminates large pieces of CWD in the advanced decay stages. Although it is not a widespread practice at this time, renewed interest in the application of prescribed burning in these forests may pose a serious threat to species dependent on well-decayed logs and stumps.

Assessing CWD management in the field over the next 3 years will help to identify other problem areas and make improvements to the CWD management strategy.

Conclusion

The short-term CWD management strategy proposed by the Kamloops Forest Region should assist in minimizing the impact of harvesting on the CWD resource and will provide baseline information helpful in the development of more specific guidance. Although there is interest in developing CWD volume retention targets, it is not clear that this will necessarily translate into “better” CWD management. One of the key ingredients to achieving this end is to help professional foresters to develop an understanding of the ecological value of CWD and its role in the ecosystem. For some, this may involve a profound cultural shift because the CWD resource, often known as slash, waste, fuel has been perceived as a problem for a very long time. Addressing the many conflicting forest management objectives that deal directly or indirectly with CWD is a perfect example of integrated forest management in action, and will no doubt continue to generate a great deal of interest and debate.

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