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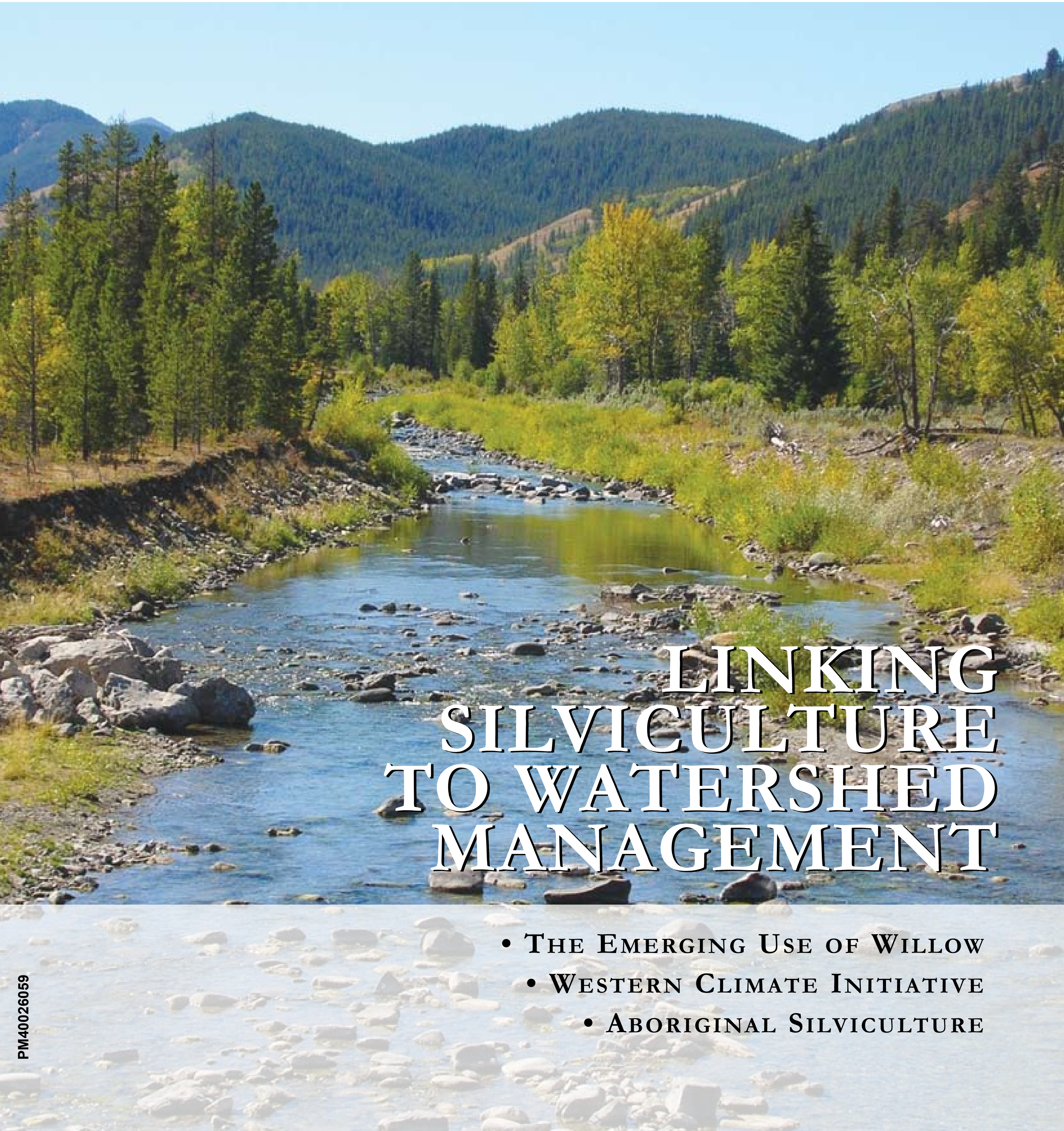

LINKING SILVICULTURE TO WATERSHED MANAGEMENT

- The Emerging Use of Willow
- Western Climate Initiative
- Aboriginal Silviculture

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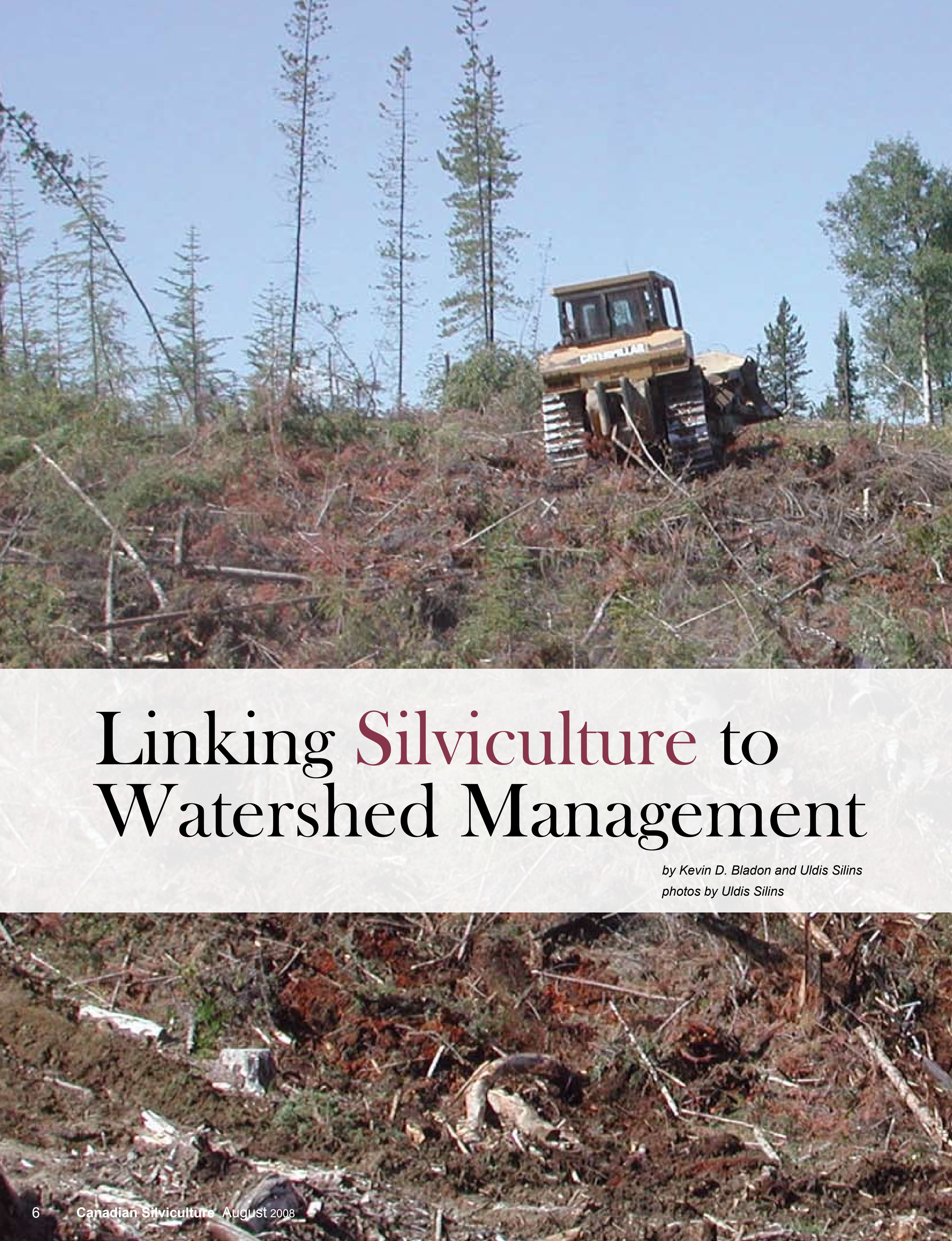


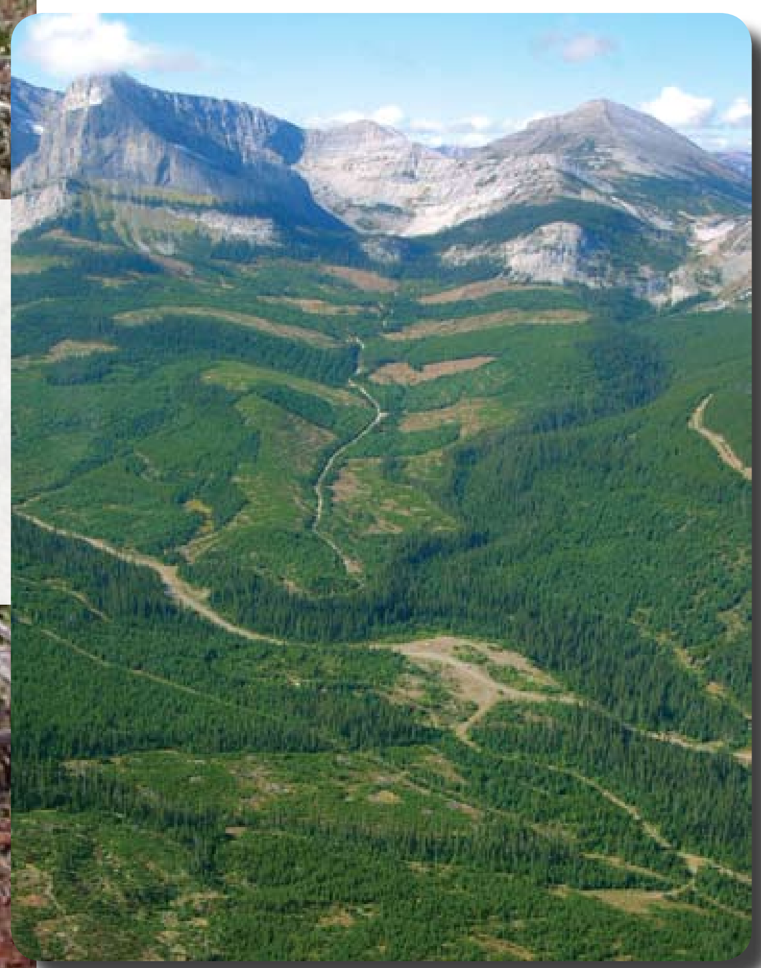
Linking Silviculture to Watershed Management

by Kevin D. Bladon and Uldis Silins
photos by Uldis Silins

Public perception of the importance of both water quantity and quality originating from forested regions of Canada has steadily increased in the past decades. Water now likely ranks near the top of a list of non-fibre forest values considered important by most Canadians.

Since both natural and human-caused forest disturbances can produce significant effects on a range of water values including water quality, quantity, and timing of stream flows, integrated management of forest watersheds for a range of fibre and non-fibre outputs has also become a more challenging element of the sustainable forest management planning process than has been the case in previous decades.

However, despite the increasing complexity of the planning process, many of the key issues in integrated watershed management are more closely tied to the implementation and success of silvicultural systems than is often appreciated by many forest practitioners.



Watershed impacts

Forest disturbances (e.g. harvesting, wildfire, and pest outbreaks) generally affect hydrology and water quality by reducing evaporative losses from the forest canopy (interception and subsequent re-evaporation of precipitation, and reduction in water loss by canopy transpiration), and by disturbance of water flow paths through the forest floor and soils.

Though the combined effects of canopy and soil disturbance on hydrology of forests differ strongly among climatic regions, small to moderate increases in annual water production (yield) and changes to timing of stream flows (timing of snowmelt runoff, occurrence of peak and low flow events) are among some of the more general hydrologic effects. Soil disturbance is often associated with erosion and sedimentation in streams, and the combined changes to water cycling along with erosion can produce deterioration in water quality, changes in aquatic ecology, or other adverse downstream effects.

At the site scale, the magnitude of hydrologic impacts due to harvesting are influenced by several factors, including the amount of crown removal, forest floor disturbance, and density of linear disturbance features such as skid trails and in-block roads. Generally speaking, the greater the degree of crown removal, the greater the potential for hydrologic impacts. Thus even-aged silvicultural systems (clear cutting, low density shelterwood) produce greater impacts on hydrology due to more intense changes in water cycling compared to variable retention harvest, commercial thinning, or uneven-aged silviculture systems.

Likewise, the degree of forest floor disturbance during harvest operations or afterwards during site preparation is an important factor in potential hydrologic effects. Heavier ground-based logging equipment (feller bunchers, forwarders, and skidders) typically produce greater soil disturbance than their lighter weight (low ground pressure) counterparts. Similarly, wet season harvesting will typically produce more soil disturbance, such as rutting, than dry or winter season harvesting. Soil disturbance during post-harvest site preparation using heavy drag scarification, ripping/plowing, mulching, or even high density mounding can also dramatically increase the extent of soil disturbance. Thus, there can be potential short-term conflicts between silvicultural objectives for site preparation and those aimed at watershed protection.

Impacts at the larger watershed scale largely reflect the cumulative intensity or “footprint” of areas disturbed in the basin. While the percentage of watershed area disturbed is often used as a coarse scale indication of potential impacts on water production, timing, and water quality, numerous factors such as climate, physiography, and age of disturbances contribute to high variation in impacts observed among watersheds. In particular, the cumulative network of linear disturbances created by skid trails, in-block roads, and haul roads are capable of transporting sediment and other contaminants and thus, are important contributing factors governing landscape scale impacts.

However, while some silviculture practices used in site preparation for forest regeneration may appear to be in conflict with landscape goals for watershed protection in the short term, success of silvicultural strategies aimed at targets for regeneration, stocking, and juvenile growth are often closely in line with broader watershed management objectives in the longer term.

Watershed recovery

Watershed recovery with respect to linear features, such as roads, is generally

... both the rate and degree of watershed recovery is very closely tied to the success of silvicultural practices and landscape objectives

addressed in provincial forest regulations reflecting best management practices for erosion. Mitigative measures most often involve stabilization of ditches, cut and fill slopes, and erosion control measures (including cross drainage structures for permanent roads), and decommissioning and road reclamation in the case of temporary roads and trails.

However, the broader recovery of hydrologic processes after forest disturbance generally depends on re-establishing the evaporative processes and hydrologic flow paths that were present prior to the disturbance. Recovery of the natural functioning of many of these processes is largely regulated by re-establishing the forest canopy along with understory vegetation and forest floor litter. Thus, both the rate and degree of watershed recovery is very closely tied to the success of silvicultural practices and landscape objectives for stocking and juvenile performance of regenerating stands.

Not surprisingly, watershed recovery after harvesting is generally quite rapid in warm and moist eastern and western North American coastal regions, where rapid stand development and juvenile canopy closure occurs comparatively quickly. Significant watershed recovery within 5-10 years has been observed in many of these regions. In contrast, slow growth rates characteristic of harsher environmental conditions such as high elevation upper montane or sub-alpine forests can be associated with much slower watershed recovery after disturbance (50-80 years, or more in some cases).

Furthermore, long-term changes in the hydrology of forest landscapes have been observed where larger landscape scale changes in forest stand composition have occurred after harvesting. Conversion of tree species composition involving the relative mix of hardwoods and softwoods, or changes in tree species composition involving differential transpiration demands, have produced long-term changes in hydrology of some landscapes. These have been driven by watershed scale changes in evaporative water losses by the forest because of changes in canopy interception of precipitation and transpiration.

Because of the long time scales required to study changes in forest stand condition (stand canopy dynamics, forest species composition, etc.), much more is generally known about the magnitude and short-term effects of forest disturbance on hydrology than is known about how these long-term forest dynamics affect water values. However, this type of information is needed for integrated forest watershed management plans that typically involve very long time scales.

Integrated forest-watershed planning

Watershed management plans most often evaluate hydrologic impacts of forest disturbance using expert opinion and published scientific literature on watershed research conducted in broadly similar forest settings, or using hydrologic models capable of predicting

the hydrologic effects over long time scales characteristic of strategic planning horizons.

One of the challenges in such planning exercises is representing the time frame of hydrologic recovery over long time scales. Because the hydrologic effects of a unit area harvested diminish over time with canopy re-development, hydrologic models used for integrated forest watershed management must be able to predict the decreased hydrologic impact of disturbances as time progresses.

Of the more broadly used procedures for this purpose, the Water Resource Evaluation of Silviculture Sources (WRENSS) and Equivalent Clear-cut Area (ECA) procedures developed in the US several decades ago are particularly well suited to the spatial and temporal scales needed for strategic forest planning. These most often use hydrologically important forest stand attributes (basal area, stand height, periodic annual increment, or even canopy leaf area index) as proxies for hydrologic recovery of old disturbances.

These procedures allow forest managers to represent the partial or intermediate state of hydrologic recovery of existing disturbances in a watershed, and explore how a proposed harvesting plan might produce incremental hydrologic effects. Use of such procedures often involves evaluating how the magnitude and timing of new proposed disturbances in a watershed might be balanced against (or interact with) recovery of older existing disturbances in a watershed.

... good forest management is a crucial foundation for good watershed management

These types of analyses have been used routinely in BC for well over a decade (and more recently in Alberta) to balance both the harvest intensity and timing against recovery of older disturbances to limit watershed impacts from forest harvesting.

Such analyses most often show a clear connection between acceptable magnitude of proposed harvests with the state and growth rate of the growing stock in existing older disturbances. Indeed, forest management issues often viewed as solely silvicultural problems such as regeneration lags, establishment, stocking, and juvenile growth often have a demonstrable effect on allowable future harvest levels where watershed management procedures such as ECA or WRENSS analysis have been employed as regulatory constraints to harvest levels.

Unfortunately, hydrology and management of forest watersheds has often been viewed by forest practitioners as a distinctly separate forest management issue from the more traditional or "bread and butter" forestry issues of silviculture and forest growth and yield. However, the implementation and success of silvicultural practices and systems is more closely connected to forest watershed management objectives than is often appreciated.

This notion was captured by one of North America's best known forest hydrologists, John D. Hewlett, in his classic book titled *Principles of Forest Hydrology*. In it, Dr. Hewlett states, "In a sense, land, watershed, and habitat are synonymous terms; you cannot manage one without simultaneously managing the others."

Indeed, good forest management is a crucial foundation for good watershed management.

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