The Oyster River
— An Evaluation of Watershed Sensitivity —

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I. Introduction

In recognition of the fisheries resource in the lower Oyster River and the requirement for a water quality that is consistent with potable water standards, a review of the forest land use in the upper Oyster River was conducted. This review considered the accumulated effects of forest land use practices by both TimberWest and Weyerhaeuser and included an evaluation of hydrologic regeneration recovery, slope stability, sediment sources associated with roads, riparian zone stability and channel stability. All of the data upon which the evaluation was based was collected from maps and airphotos at a scale of 1:20000.

In order to ensure the review was sufficiently sensitive, the Oyster River Watershed was stratified into four sub-basins: Little Oyster, Woodhus, Upper Oyster and Piggot (see Figure 1).

This report summarizes the results of the Oyster River Watershed sensitivity review with respect to the effects of accumulated forest land use on water quality.

II. Hydrologic Regeneration Recovery

It has been accepted by a substantial number of forest hydrologists that forest harvesting has the potential for increasing peak flows. Further, an increase in peak flows may negatively impact water quality due to increased streambank and streambed erosion and scour.

Forest harvesting may affect peak flows in two ways. Forest roads have the potential for intercepting surface and subsurface flows and expediting the delivery of this water to stream channels. The road ditch system has the potential for diverting water away from a flow path that provides buffering by the distance the water must travel to reach a stream channel and/or the soils or surficial materials through which the water would normally move downslope to a natural water course.

Clear-cut forest harvesting has the potential for increasing what is known as rain-on-snow peak flows. These peak flows are generated when a ripe, shallow snowpack is subjected to convection and condensation melt processes and added rainfall inputs associated with a warm, moist Pacific frontal system. Hydrologic regeneration recovery describes the rate and amount by which the growth of the forest regeneration provides shelter to the snowpack from the convection and condensation melt process.

Clear-cut forest harvesting can buffer rain-on-snow peak flows by desynchronizing the delivery of snowmelt water to the stream channel. If some landscapes, such as clear-cuts deliver rain-on-snow water to a channel faster than others, then the peak flow will be reduced by spreading the delivery of water to the stream channel over a longer period of time (Figure 2). In order to capture the desynchronizing effect, it is generally considered that, at any time, approximately one third of the watershed should constitute unrecovered clear-cuts and two thirds recovered.

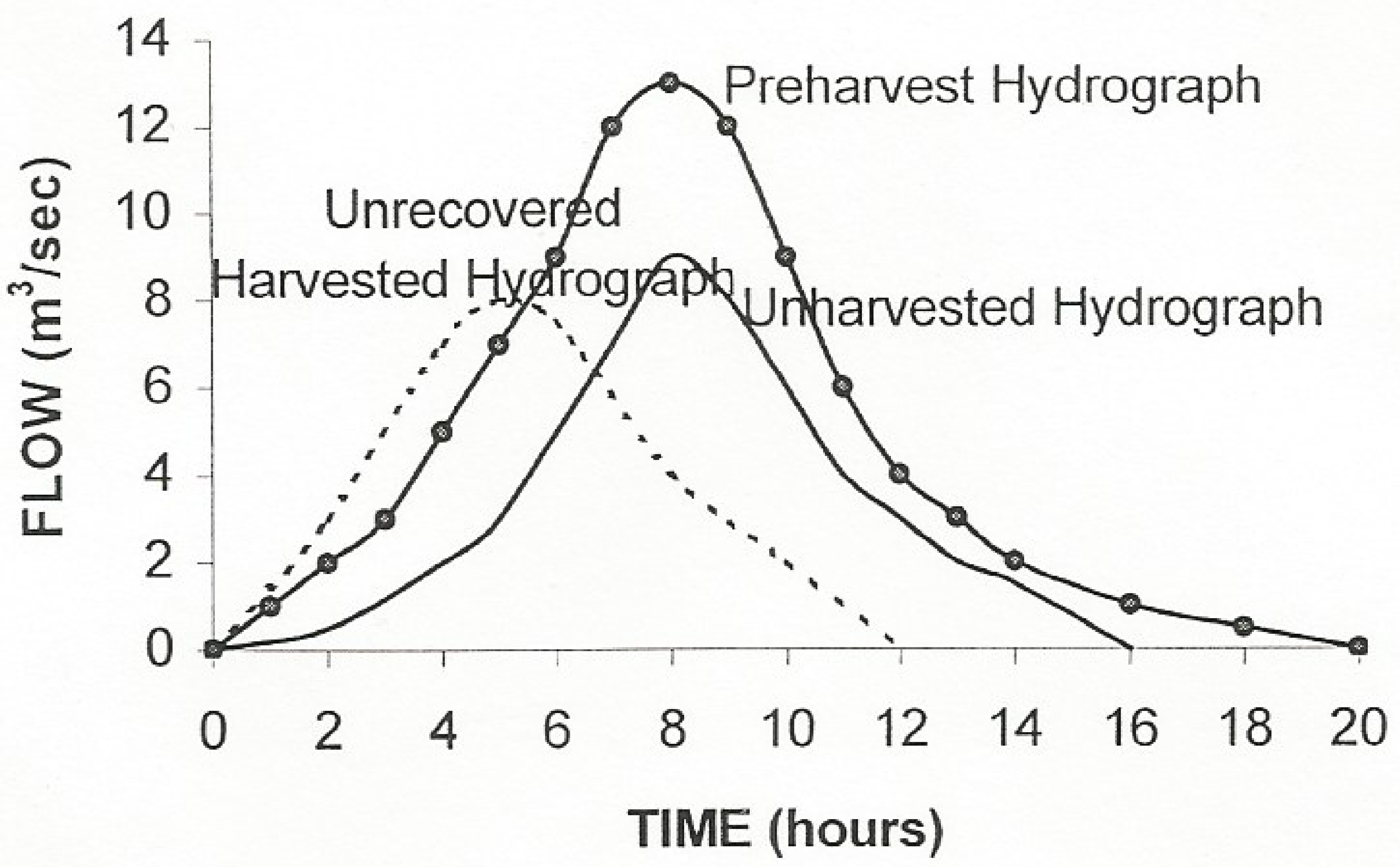

Figure 2: Schematic diagram of effects of partial watershed harvest on runoff, compared to unharvested runoff, resulting from a rain-on-snow event.

It has been generally accepted by forest hydrologists that hydrologic regeneration recovery begins when the regeneration is about 3m high and is equivalent to pre-harvest levels when it is about 10m high and the plantation has at least 70% crown closure. Thus, when the regeneration is less than 3m high the equivalent clear-cut

Equivalent Clear-Cut

area (ECA) is 100% and when it is over 10m high it is considered more or less recovered. Recovery credit is allocated to regeneration between heights of 3m and 10m relative to full recovery.

Table 1 summarizes the current (year 2000) ECA's for each of the sub-basins on a managed forest land area basis and on a total sub-basin area basis. As shown in the table, all the sub-basins reflect reasonable ECA's and the Oyster River watershed can be considered substantially hydrologically recovered with respect to the forest regeneration effect on a rain-on-snow peak flows. This is based on an accepted risk ranking where an ECA below 30% is considered Low, 31% to 42% is considered Moderate and greater than 42% is considered High.

Table 1. Current ECA's for the Oyster River Watershed sub-basins

	ECA %	
Sub-basin	**Managed forest land basis**	**Total sub-basin area % basis**
Little Oyster	22.1	19.4
Woodhus	5.2	5.2
Upper Oyster	11.6	8.4
Piggott	29.0	22.2
Total Oyster Watershed	**16.3**	**12.7**

III. Slope Stability – Harvesting

Historically, past harvesting in the watershed was conducted before the relationship between forest harvesting and terrain stability was understood as well as it is today.

Harvesting unstable terrain can increase the potential for mass wasting and the consequent degradation of water quality.

Fortunately, a relatively small area of unstable terrain was historically harvested in the Oyster River watershed. During the time subsequent to this harvest, which amounted to 52.8 ha., regeneration recovery has provided sufficient root strength to compensate for the loss of the root strength in the stumps left from the harvest.

The number of observable and mappable slides in the Oyster River Watershed at a scale of 1:20000 (usually limiting a mappable unit to being larger than 4 ha.), that have terminated in streams that appear to be associated, but not necessarily caused, by the forest roads and harvesting is 54. These older slides are now mostly stabilized and are substantially less than the 141 natural slides into streams that have been noted as having started in land within Strathcona Park. Of the 54 events, 19 were observed as having occurred in the Upper Oyster sub-basin and 35 in the Piggott sub-basin. These translate into 0.09 slide events per square kilometre and 0.38 slide events per square kilometre respectively for the Upper Oyster and Piggott sub-basins. These represent very low risks considering that the upper limit for the low risk class is 1.0 slide event per square kilometre.

IV. Road Influences

Roads, due to the exposure of mineral material and their frequent proximity to stream channels, particularly at crossings, represent a potential significant contribution to stream sedimentation. One measure used to estimate the potential impact of roads on water quality is the density of roads (km/km^2) within a watershed. An effective means of reducing the density of roads, when an unacceptable risk is recognized, is by way of road deactivation. Table 2 summarizes the initial road density, the amount of road deactivation, the amount of overgrown road which is considered to have been naturally stabilized and the net present road density for both the managed forest land base and the total land base in each of the sub-basins.

Table 2. Road density reductions associated with the aging process over time and with road deactivation in the Oyster River Watershed.

Sub-basin	Initial Total Road Density (km/km^2)		Overgrown Road (km)	Deactivated Road (km)	Net Road Density (km/km^2)	
	Managed Forest Land Basis	*Total Land Area Basis*			*Managed Forest Land Basis*	*Total Land Area Basis*
Little Oyster	2.74	2.70	29.33	0.10	1.83	1.63
Woodhus	2.58	2.57	20.64	8.57	1.75	1.74*
Upper Oyster	1.89	1.63	48.00	79.93	1.11	1.13**
Piggott	3.16	2.43	157.7	16.25	0.68	0.52

* Includes 10.39 km of other roads
** Includes 52.03 km of other roads

More often than not a road density of 1.63 km/km^2 and 1.74 km/km^2, as indicated for the Little Oyster sub-basin and Woodhus sub-basin respectively, would represent a moderate surface erosion risk. However, the age of many of the roads and the generally gentle terrain which they traverse reduces the risk to what is considered less than moderate. The road densities for the other sub-basins suggest low risks for the Upper Oyster and Piggott sub-basins.

Perhaps a more effective index of the potential effect of roads a source of stream sedimentation than road density, is the number of stream crossings. Table 3. summarizes the number of stream crossings, by sub-basin, that are shown in 1:20000 scale mapping with a reduction for both older, overgrown and potentially naturally stabilized crossings and the number of crossings which have been physically deactivated.

Table 3. Oyster River Watershed road stream crossings by sub-basin with reductions for naturally stabilized and deactivated crossings.

Sub-basin	**Initial Number of Crossings/km^2**		**Naturally Stabilized Crossings**	**Deactivated Crossings**	**Net Active Crossings/km^2**	
	Managed Forest Land Basis	Total Land Area Basis			Managed Forest Land Basis	Total Land Area Basis
Little Oyster	1.65	1.51	15	0	1.24	1.10
Woodhus	1.83	1.82	22	0	1.20	1.19
Upper Oyster	0.87	0.67	21	55	0.35	0.27
Piggott	3.04	2.34	140	31	0.60	0.46

Table 3 shows, that while the initial road crossing densities for the Little Oyster and Piggott sub-basins represented a high risk, natural stabilization and deactivation have reduced the risks to low levels.

While crossing densities for the Woodhus sub-basin and the Upper Oyster sub-basin represented initially moderate and low risks, the processes associated with natural stabilization and deactivation have reduced the risks to low for both sub-basins.

V. Riparian Stability

Water quality can also be negatively affected by the harvest of streamside vegetation. The removal of trees from the immediate streamside area can lead to the loss of root strength and the resisting integrity of the streambanks to erosion by channel flow. Since soil moisture and nutrition in the riparian zone tends to promote rapid revegetation, streambank root strength loss by harvesting is a temporally limited situation. In the Oyster River Watershed much of the streamside harvesting occurred in excess of 40 years ago and revegetation recovery is considered significant. Table 4 summarizes the total measured lengths of stream, as shown on 1:20000 scale mapping, in each of the sub-basins and the percentages of these stream lengths that riparian vegetation is estimated to have yet to fully recover.

Table 4. Sub-basin stream lengths and the percentages of harvested streamsides still in the process of vegetation recovery.

Sub-basin	**Stream Length (km)**		**Harvested Streamside Lengths (km)**		**Recovering (%)**	
	Managed Forest Land Basis	*Total Land Area Basis*	*Managed Forest Land Basis*	*Total Land Area Basis**	*Managed Forest Land Basis*	*Total Land Area Basis**
Little Oyster	93.95	101.56	27.71	27.71	29.5	27.3
Woodhus	67.60	67.60	4.59	4.59	6.8	6.8
Upper Oyster	222.85	249.97	42.58	42.58	19.1	17.0
Piggott	200.23	228.13	56.67	56.67	28.3	24.8

* Does not include 7.61 km of stream in the Little Oytser sub-basin, 20.58 km in the Upper Oyster sub-basin or 27.9 km in the Piggott sub-basin since any streamside vegetation alternation was done by other tenure holders.

While the percentages of stream length where regeneration root strength is recovering from streamside logging for the Little Oyster and Piggott sub-basins is indicative of potentially high risks, it must be remembered that the data for the calculation was determined from forest cover maps. Even with the assistance of orthophotos, scale limitations inhibit the determination of the actual streambank vegetation and root strength integrity. The only way of verifying the actual conditions is by conducting field inspections by way of low level helicopter or ground reviews or by low level aerial photography.

While the lengths of recovering, harvested streams for Woodhus and Upper Oyster sub-basins represent moderate and low risks respectively, field reviews will likely indicate that the risks are actually lower than shown in Table 4.

VI. Channel Stability

Using a series of airphotos for the lower Oyster River channel covering a time span between the early '40's and the mid '90's, Mr. Ian Norie, a private consultant based at the University of Victoria determined the lateral channel dynamics that have occurred. Since this information has been presented to the Oyster River Committee and other local concerned public, inclusive of a field trip to several locations on the lower Oyster River, details of his findings are not repeated herein. Suffice to say that his findings suggest that the instability of the lower Oyster Sub-basin is likely more a result of historic railway logging of the area currently occupied by rural and agricultural development downstream of the Duncan Bay Mainline, the devastating effect of the Sayward and Merville forest fires and recent past bank armouring works than that which may have accrued as a result of the downstream translation of upstream forest harvesting activities.

VII. Summary

Recent water quality sampling by TimberWest indicates very high water quality in the Oyster River at the Duncan Bay Mainline crossing and, unfortunately, less acceptable water quality at the highway crossing. Observed and measured turbidity levels indicate very low suspended sediment levels. These findings would appear to indicate that while road length and stream crossing densities and unrecovered streamside harvesting in some of the Oyster River sub-basins, as discussed earlier and shown in Table 5, may be suggestive of sediment risks they are not being manifested as deleterious downstream water quality impacts.

Table 5. Aggregate watershed sensitivity for the Oyster River watershed sub-basins based on previously reported sensitivities for ECA, Slope Stability, Road Influences and Riparian effects from forest management activities.

SENSITIVITIES					
Sub-basin	**ECA**	**Slope Stability**	**Road Influences**		**Riparian***
			Net Road	***Crossings***	
Little Oyster	Low	Nil	Moderate	Moderate	High
Woodhus	Low	Nil	Moderate	Moderate	Low
Upper Oyster	Low	Low	Moderate	Low	Moderate
Piggott	Moderate	Low	Low	Low	High
Total Watershed	**Low**	**Low**	**Moderate**	**Low**	**Moderate**

* Based on 1:20000 scale review, more detailed field reviews which are expected to result in lower sensitivities are currently being scheduled.

Table 5 suggests that the aggregate effect of past forest land management activities are low to moderate sensitivity levels with respect to deleterious effects on water quality and fish habitat in the lower, deltaic reach of the Oyster River.

Figure 1. Sub Basin and tenure holdings in the Oyster River Watershed. Scale 1:160,000