Condition of the Tsolum River Watershed Based on Ground Surveys of 30 Random Stream Channel/Riparian Sites

by
Derek Tripp and Katie Gair

March 2026

For the Tsolum River Restoration Society
2356-A Rosewall Crescent, Courtenay, BC, V9N 8R9

Table of Contents

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

The authors would like to acknowledge the work of all those who assisted with the field work in this study, including volunteers Ashley Bullard, Carmen Everest Wahl, Jesse Klahm, Wayne White, and co-op students Amina Turner, Cole Lochhead and Nalan Goosen. Their contributions were very much appreciated. The report also benefitted by reviews by Wayne White, Norm Weins, Colin Koszman, David Beleznay, and Kerri Brownie. Darcy Pickard (Pickard Environmental) generated the list of spatially balanced random site locations for each stream class.

SUGGESTED CITATION

Tripp, D. and K. Gair. 2026. Condition of the Tsolum River watershed based on ground surveys of 30 random stream channel/riparian sites. A report for the Tsolum River Restoration Society, 2356-A Rosewall Crescent, Courtenay, BC, V9N 8R9. 18 p.

ABSTRACT

The average number of "No" answers to a list of 15 questions about the condition of the stream channel and riparian area of 30 randomly selected sites in the Tsolum River watershed was 5.6. This suggests the watershed is close to being classified as Not Properly Functioning (NPF). The lower one-third of the watershed where agricultural businesses, small farms and residential properties predominate was in especially poor condition compared to the upper two-thirds of the watershed where it was all forest land owned by TimberWest. The average number of "No" answers at 19 sites on TimberWest land was 4.0, the same average recorded by the Province at 647 other forestry sites on the West Coast. The average number of "No" answers on the lower third of the watershed where it was Other private land was 8.5. The difference was statistically significant ($t = 5.125$, $df=28$, $P<0.001$). Old logging, followed in order by natural factors, then current logging, was responsible for most of the "No" answers on TimberWest land. On Other land, a complex mixture of other human related factors (a buried stream, farm and residential encroachment on riparian areas, ATV, horse, and foot trails, invasive plants introduced, channel excavation, water withdrawal) was responsible for most of the "No" answers, followed in order by natural factors and old logging impacts.

INTRODUCTION

This is a report on the functioning condition or "health" of 30 randomly selected stream reaches and their riparian areas in the Tsolum River watershed on eastern Vancouver Island north of Courtenay. Completed between June 2023 and October 2025, the condition of each site was assessed with the same BC Provincial Riparian Management Routine Effectiveness Evaluation (RMREE) protocol and field guide (Tripp et al. 2009a, 2009b) that has been used by the Provincial government and its contractors since 2005 to evaluate over 3,400 other stream sites on crown land in BC (P. Tschaplinski pers. com.). Essentially a checklist of 15 questions that cover 15 key physical and biological characteristics of stream channels and their adjacent riparian areas, each question requires a "Yes (pass), "No" (fail), or "Not Applicable" answer. The number of "No" answers determine the condition of the channel, i.e., the more "No" answers, the poorer the condition of the site. The typical number of "No" answers for sites in BC with little adjacent or upstream human activity ("Reference Streams") is 1.4 (SD=1.5, range 0-6, Tripp 2013). This value varied little between the main physiographic regions (mountains, plateaus, plains) of BC.

This report also summarizes the methods and results of an analysis of the factors (e.g., old logging, new logging, natural impacts, agriculture, rural development, etc.) that caused the "No" answers on the stream channel and riparian assessments. Understanding the factors that led to or directly caused the "No" answers on the assessments should help clarify the relative importance of each factor and in so doing, put human related impacts in perspective relative to natural impacts. It should also help put the relative impacts of the different types of development that predominate in different parts of the watershed in better perspective (e.g., forestry versus agriculture and other rural or residential development).

Some of the terms used in this report may be unfamiliar to non-experts and experts alike. Four of these include mass wasting, windthrow, yarding and increaser-disturbance plants. Mass wasting is the downhill movement of rock, soil or debris under the direct influence of gravity. Landslides, rock falls, debris flows, mud flows, slumps, and soil creep are all types of mass wasting. Water or human activities can trigger the mass wasting, but gravity does the work. Windthrow is when trees get blown over or snapped off by the wind. Yarding is lifting logs off a cut block or slope to a central location, usually to a landing where a loader puts them on a truck. When logs are lifted (or dragged, skidded, pulled) across a stream, that is called cross stream yarding. Increaser-disturbance plants are plant species that become relatively more abundant in terms of the total plant biomass present when an area is regularly walked on, trampled, driven over or grazed. Common examples are dandelions, clovers, plantains, bluegrasses, and pineapple weed.

STUDY AREA

The Tsolum River watershed (Figure 1) is a medium size watershed (266 km^2) divisible into seven sub-basins. The first two uppermost sub-basins are the Upper Tsolum River and Murex Creek which join to form the third sub-basin called the Middle Tsolum. Over the next 15 km, the Middle Tsolum is joined first by the fourth sub-basin (Headquarters Creek) and then the fifth sub-basin (Dove Creek). Downstream of Dove Creek, the Middle Tsolum becomes the Lower Tsolum sub-basin. Portuguese Creek, the seventh and smallest sub-basin flows into the Lower Tsolum sub-basin 4 km upstream from the mouth of the Tsolum River.

Stream names, sub-basin locations, stream order, logging era, the main channel characteristics, and reach lengths of the 30 stream sites assessed in the Tsolum River watershed, June 11, 2023, to October 10, 2025, are summarized in Appendix Table A1. Specific locations of each sample site are shown in Figure 1. The distribution of the 30 randomly selected sites closely reflected both land ownership and the sub-basin areas in the Tsolum River watershed. Approximately two thirds of the sites were located on TimberWest land, the remaining third were located on the rest of the private land. Three to five sites were in each of the seven sub-basins.

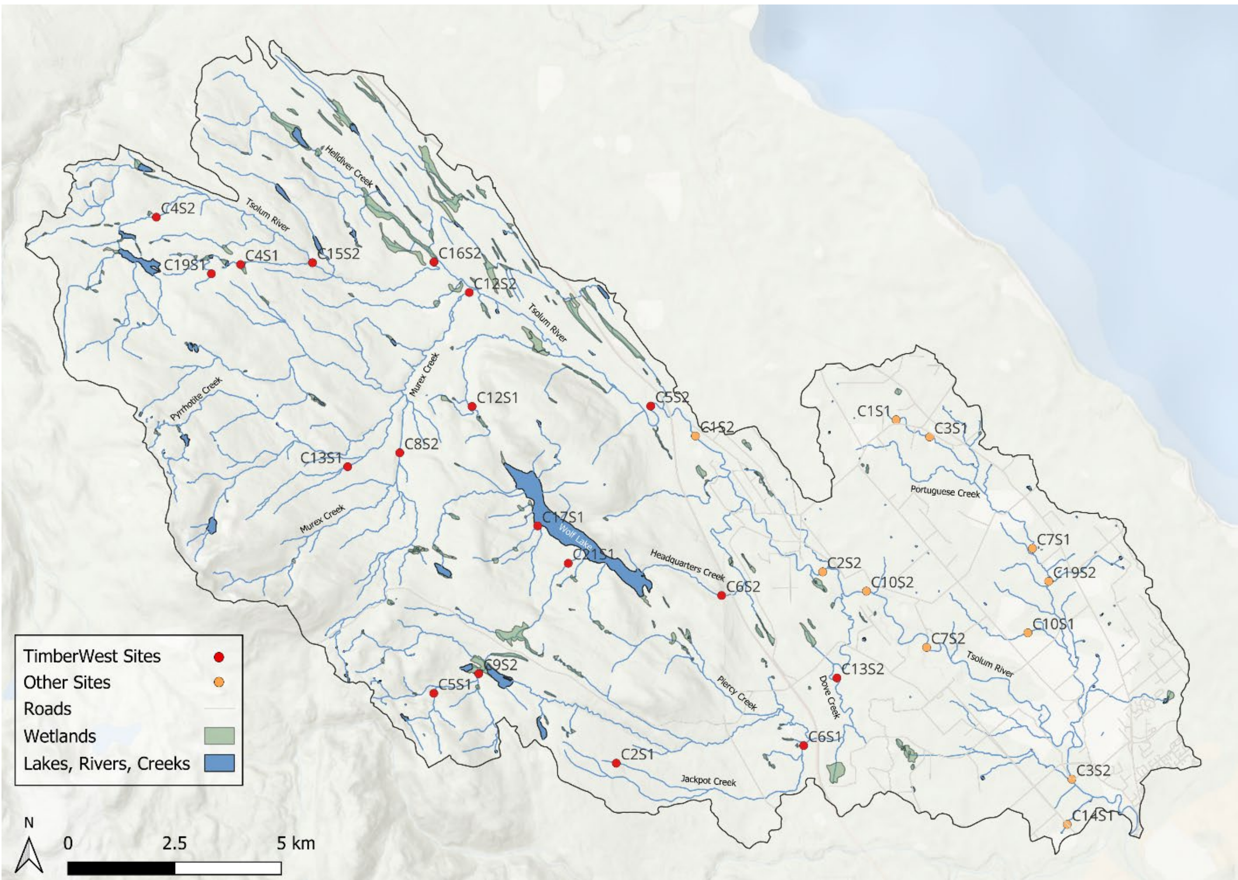

Figure 1. The Tsolum River watershed showing the location of the stream channel riparian sites sampled June 11, 2023, to October 10, 2025.

Most of the Tsolum River watershed has been logged over the past 60-125 years. Unlogged areas or timber older than 100 years represents less than 5% of the total watershed area. Most of this unlogged area is restricted to the steep southwest portions of the Murex and Dove Creek sub-basins by Mount Washington and Strathcona Provincial Park, respectively, with another small area along the edge of Wolf Lake at the base of Constitution Hill.

Lying within the unceded territory of the K'omoks First Nation, most the land in the Tsolum River watershed is privately owned. TimberWest Forest Corp. (TimberWest) owns approximately two thirds of the total watershed area, including all or almost all the Upper Tsolum, Murex, Middle Tsolum, Headquarters and Dove Creek sub-basins. Mosaic Forest Management (MOSAIC) is the forestry management company that runs the day-to-day planning, harvesting, and forest stewardship for TimberWest. The rest of the watershed, including small lower portions of the Headquarters and Dove Creek sub-basins, lower Middle Tsolum, and all the Lower Tsolum and Portuguese sub-basins are primarily owned by private agricultural businesses, individual farmers, and rural residents. Exceptions include all the public roads, small parcels like the Tsolum River Commons which is held by the Comox Valley Land Trust, and the Tsolum Spirit Park, the Comox Valley Exhibition Grounds, and the One Spot Trail which is owned/managed by the Comox Valley Regional District (government). The largest non-private parcel is the 275-hectare K'omoks Treaty Lands and Tribal Park and Wildwood Interpretive Forest, originally known as the Wildwood Demonstration Forest by Wildwood Marsh.

METHODS

Sample Site Selection

A Generalized Random Tessellation Stratified (GRTS) sampling strategy (Stevens and Olsen 1999) was used to provide random, spatially balanced lists of 40 small stream (1st and 2nd order) and 40 large stream (3rd to 5th order) sites for sampling in the Tsolum River watershed. To maintain randomness and eliminate bias, stream sites were selected in order, starting at 1 on each stream size class list and continued in order until 15 small stream sites and 15 large stream sites were completed. If a stream reach in the field proved not to be a stream, as was the case for six of the small stream and one large stream site, or access to a stream reach was deemed unsafe or permission to access the site could not be obtained, as was the case for three other large stream sites, the next stream on the list was selected until the desired number of 15 sites in each stream size class was achieved.

Site Assessments

As noted above, we used the most widely used assessment methodology currently in use for streams and riparian areas in BC to assess each site. This was mainly because it has proven to provide consistent and repeatable results. In the checklist of 15 main questions (Table 1), each main question represents a principal component of individual stream channel and riparian conditions.

Table 1. The 15 main questions asked in each stream channel and riparian assessment.

Question #	Question
1	Is the channel bed undisturbed?
2	Are the stream banks intact?
3	Are the channel large woody debris (LWD) processes undisturbed?
4	Is the channel morphology intact?
5	Are all aspects of the aquatic habitat sufficiently connected?
6	Is there a good diversity of fish cover attributes?
7	Does moss on the streambed indicate a stable and productive system?
8	Has the amount of sand or fine sediments been minimized?
9	Is there a diversity of aquatic invertebrates?
10	Has windthrow been satisfactorily minimized?
11	Has bare erodible or compacted ground been minimized?
12	Is there an adequate root network or LWD supply?
13	Is shade adequate to maintain a normal bank microclimate?
14	Have invasives, increaser disturbance species or weeds been minimized?
15	Are riparian structure, form, vigor and recruitment okay?

To answer the main questions, each main question in turn requires an answer to 2-8 more specific sub-questions. These specific sub-questions require measurements or observations of 68 to 120 parameters over the length of the sample reach, depending on channel morphology and fish bearing status. Guidance on the specific measurements and observations needed for the assessments is described in the RMREE protocol and its companion field guide. It is this guidance that ensures the assessments are consistent and repeatable for experts and non-experts alike. As an example, Question 2 asks “Are the stream banks intact?”. This is not an easy question to answer consistently even for experts. In this assessment the question is broken down for cascade-pool type channels into four more specific sub-questions that ask:

1) Does less than 15% of the total reach length have recently disturbed banks?

2) Are more than 65% of the banks on naturally erodible sections of the reach deeply rooted?

3) Does more than 50% of the naturally erodible reach length have stable undercut banks?

4) Does less than 10% of the total reach length have recently upturned (wind thrown) root wads along the bank?

Specific descriptions of what constitutes recently disturbed banks, deeply rooted banks, stable undercut banks and recently upturned root wads in the four sub-questions are provided in the RMREE protocol and field guide. Instructions are also provided on how these features should be measured, while always noting the features that overlap on opposite banks so that there is no “double counting”. A conservative approach is also taken for many questions. For example, to answer “No” to Question 2 on whether the banks are disturbed or not, the answer to at least two of the sub-questions must also be “No”. If the answer to only one sub-question is “No” and the remainder are “Yes”, then the assessment dictates that the answer to the main question must also be “Yes”. Seven of the 15 questions need more than one “No” answer to the sub-questions before the main question can also be answered “No”.

The thresholds used for the specific indicators of acceptable stream and riparian condition represent the upper range of the values normally recorded on streams undisturbed by humans. For example, the threshold for percent of stream length with recently disturbed banks in the assessment is 15%. This means that for a 100m long stream reach, there could be as much as 15 m of disturbed banks present, and that would still be considered within the range of a healthy stream reach. Values that exceed the thresholds indicate conditions are beyond the normal range of conditions exhibited by streams undisturbed by humans. In this way the assessment, by design, avoids comparing streams to a “perfect” or “ideal” undisturbed condition (Tripp 2013). Thresholds for many of the parameters used are based on extensive surveys of undisturbed streams throughout the Province of BC, while others are based on other studies in the scientific literature. Still others come from existing guidelines or expert opinion.

Not counting access, a typical assessment by 2-4 people generally took 2-6 hours to complete, depending on the length and complexity of the sample reach. Minimum sample reach length required for an assessment was equal to 30 channel widths, or 100m, whichever was greatest.

The condition of each site is determined by the number of “No” answers to the main questions. The more “No” answers to the main questions, the poorer the condition of the stream reach. If the result is 0-2 “No” answers, the site is determined to be in Proper Functioning Condition (PFC). If the result is 3-4 “No answers, the site is in Proper Functioning Condition but at Risk (of not being in Proper Functioning Condition, PFR). If the result is 5-6 “No” answers, the site is determined to be in Proper Functioning

Condition but at High Risk (PHR). More than six “No” answers and the site is deemed to be Not Properly Functioning (NPF). Proper Functioning Condition itself is defined as the ability of a stream and its riparian area to:

1) withstand normal peak flood events without experiencing accelerated soil loss, channel movement, or bank movement,
2) filter runoff,
3) store and safely release water,
4) maintain the connectivity of fish habitats in streams and riparian areas so that these habitats are not lost or isolated because of management activities,
5) maintain an adequate riparian root network,
6) maintain a large woody debris (LWD) supply, and
7) provide adequate shade and reduce bank microclimate change.

When the sample size is sufficiently large and spatially balanced, the average condition of all sites should accurately represent the condition of the watershed “on the ground”. This approach differs from other approaches to watershed assessment because stream and riparian conditions are assessed directly, rather than indirectly estimated using various GIS based risk factors such as the presence of a mine, or other proxies such as the length of gravel roads present, the number of stream crossings, the length of streams logged, area of slopes >60%, the amount of equivalent clear-cut area present, etc. Numerous studies have demonstrated significant relationships between some (but not all) of these metrics and biological attributes such as fish abundance or invertebrate diversity. Moreover, these metrics can be easily and quickly generated with GIS methods, but only if there is sufficient digital information or coverage available. This was not the case for all areas of the Tsolum River watershed.

Causal Factor Analysis

When a riparian assessment was completed, the main factors that caused a “No” answer to each of the 15 questions on the assessments were identified and recorded on the field cards. These main factors included old logging (pre-1995), new logging (post-1995), roads, livestock, other human activities, natural events, and unknown upstream factors. Typically, one factor would be identified as the cause of each “No” answer, though sometimes two or more would be identified if they were each felt to be significant. To be identified as a factor there had to be compelling evidence that the factor was indeed a cause of the “No” answer. Causes like flooding, or slope failures, sloughs, encroachment on the first 10 m of the riparian area or the stream channel itself, windthrow, old or recent logging, bare erodible ground, compacted ground, machine disturbance, animal activities (horse trails, game trails, beaver cuttings, dams), livestock trampling, or an eroding road surface that were located within or immediately adjacent to the sample reach were invariably easy to identify. Those that originated upstream of a sample reach were harder to identify and typically had to be confirmed by inspecting the reaches upstream. In most cases this was not feasible, and the cause of impact was therefore simply recorded as an “Unknown Upstream” factor.

To assess the relative importance of all the main causal factors identified in the assessments, each factor identified as a cause of a “No” answer to a question on individual assessments received a value of 1.0 if there was only one factor, 0.5 if there were two contributing factors, or 0.33 if there were three contributing factors. For example, a bare hillside or an erodible road surface hydrologically connected to the stream might be identified as the cause of a “No” answer to Question 11 due to the amount of bare exposed ground in the riparian area. If just one factor was present (e.g., the bare hillside), that factor would be given a value of 1.0. If both factors (a bare hillside and an erodible road surface) contributed to the “No” answer, each factor would be given a value of 0.5. Once identified as a main factor, no further considerations were given to the relative importance of the factor.

Specific causes were assessed in a similar manner. If logging was identified as the main cause of a “No” answer to three questions, and low retention and windthrow were identified as the specific logging impacts on each question, each specific logging impact was assigned a value of 0.5 for each question, for a total value of 1.5 (3 times 0.5) on the whole assessment. If both logging and livestock were identified as impacts on one question, but the logging impact was further broken down to cross stream yarding and ground disturbance, while the livestock impact only identified trampling, the cross-stream yarding and ground disturbance would each receive a value of 0.25, while the trampling would receive a score of 0.5 for the question.

Only the most proximate or defensible causes of a “No” answer were recorded on riparian assessments. For example, while it may be tempting to say logging was the cause of all mass wasting related impacts observed, this was only possible where the origin and cause of the mass wasting could be confirmed. It was otherwise recorded as natural or of unknown cause. One notable exception involved questions where flooding clearly affected the stream channel or stream banks. In these cases, flood related impacts on the assessment were usually attributed equally to both natural and current logging related alterations to the stream hydrology, but only where there was substantial current logging present upstream. This is because there is a well documented relationship between large harvest area and high road density upstream, and higher peak flows downstream. While recent flood intensification (including the recent Feb 2026 event) may reflect climate-driven precipitation changes, in this study flood impacts were considered primarily natural processes, mediated by watershed (i.e. harvest) conditions.

Quality Assurance

All participants on the field assessments were required to read and familiarize themselves with the RMREE protocol and field guide. One, and usually both authors was also always present for the field assessments at each sample site. All field cards were reviewed for completeness and accuracy to ensure that the averages, totals or percentages were accurately calculated and recorded. Every specific question was also checked to ensure that the answer agreed with the data recorded, and that the causal factors reported for the “No” answers were consistent and plausible. Where discrepancies could not be resolved in the office, sites were revisited in the field and reassessed as needed to conclude on the correct number of “No” answers and the causal factors that led to the “No” answers.

RESULTS

Watershed Condition

The answers to each question of the assessments are summarized in Appendix Table A2 for each stream/riparian site assessed in the Tsolum watershed. The overall average number of “No” answers (all sites) was 5.6 (SD 3.2, range 1-13), indicating that the Tsolum River watershed is at a high risk of being considered Not Properly Functioning. There are few other watershed scale assessments to compare with the Tsolum, but published and unpublished data on six other watersheds on Crown land in the Province (Table 2) suggest the condition of the Tsolum River watershed could be one of the poorest in BC (if not the poorest). All six other watersheds had a significantly lower mean number of “No” answers on the stream/riparian evaluations (P<0.05-0.001, t-tests). Unlike the Tsolum River, all but one watershed also lacked private land, and logging was the only human activity. The Owen River watershed, the one watershed closest to the Tsolum in terms of the number of "No" answers, also had two mine sites and ranching within the watershed.

Table 2. Average number of "No" answers on Riparian Management Routine Effectiveness Evaluations in the Tsolum River plus six other watersheds in BC.

Watershed	Forest District	Number of Samples	Average number of "No" answers	SD	Range
Wanakana[1]	DNI	32	2.2	2.2	0-8
Seebach[2]	DPG	57	2.5	1.3	0-5
Lamprey[1]	DSS	52	3.3	2.2	0-9
Williams[3]	DKM	52	3.7	2.4	0-9
Memekay[4]	DCR	48	3.8	2.3	0-9
Owen[5]	DSS	33	4.1	2.0	1-9
Tsolum	DCR	30	5.6	3.2	1-13

1 in prep, BC Fisheries Sensitive Watershed Program; 2 Zweibel et al. 2025; 3 Reese-Hansen, et al. 2021; 4 Pickard et al. 2019, 5 Pickard et al. 2022.

The site with the best condition (PFC) in the Tsolum River watershed with only one "No" answer was on Jackpot Creek in an 80-year-old stand of Douglas fir and Western red cedar 300-500 m upstream of the Hwy 19 crossing on Dove Creek. The poorest site with 13 "No" answers was on lower Macham Creek where the stream was buried and converted to cropland. The second poorest site with 12 "No" answers was the lower mainstem Tsolum River downstream from the Piercy Road bridge, with a dairy farm on the right side and the Comox Valley Exhibition grounds on the left side.

With an average of 4.0 "No" answers per site (SD= 2.2, range 1-9), streams and riparian areas on the forest lands owned by TimberWest are at risk of not being in properly functioning condition. Condition on TimberWest land was the same as the average condition (4.0 "No" answers) reported for 647 other west coast streams located in or adjacent to cut blocks. This suggests that logging impacts or practises on TimberWest land do not differ significantly from logging impacts or practices elsewhere on the west coast of BC.

There was a significant difference in the average condition of stream sites on TimberWest land versus Other private land in the Tsolum River watershed (Figure 2). While the average number of "No" answers for stream sites on TimberWest land was 4.0, the average number of "No" answers for stream sites on Other land in the Tsolum River watershed was 8.5 (SD=2.6, range 5-13), and very clearly not in Proper Functioning Condition. This was a significantly poorer outcome (P<0.001, t-test) than the average condition of streams on TimberWest land. On Other private lands, 2 of the 11 samples were at high risk of not being in proper condition. The remaining nine streams were all Not Properly Functioning. By comparison, only three of the 19 TimberWest sites were Not Properly Functioning.

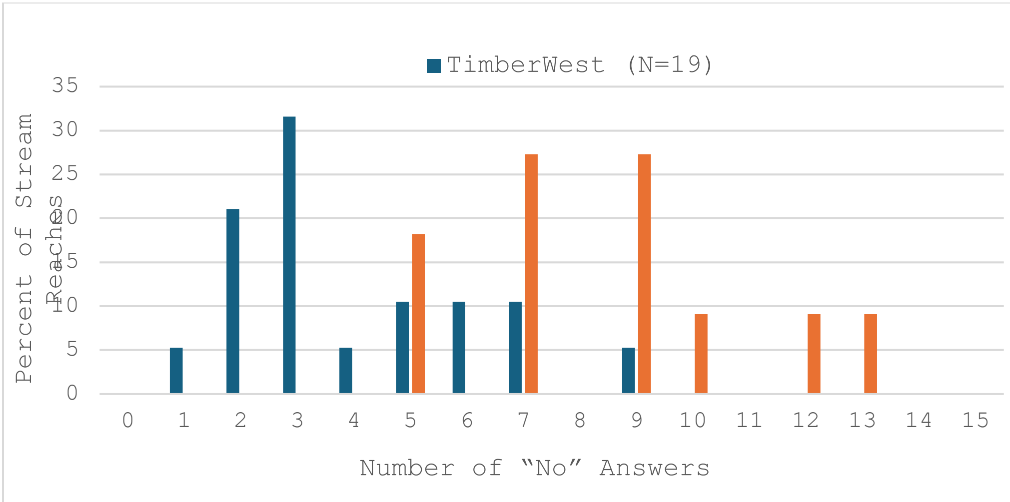

Figure 2. Percent of stream reaches with different numbers of "No" answers on TimberWest land and Other private land in the Tsolum River watershed.

Specific Stream and Riparian Attributes at Risk on the Assessments

The frequency of "No" answers for each question or attribute on the stream riparian assessments is summarized separately for TimberWest and Other private land in Figures 3 and 4, respectively. On TimberWest land, the main issues were most commonly issues with channel LWD and riparian structure, affecting approximately 2/3 of the sample sites, and due primarily to the relatively young age of the riparian vegetation. The next most common problems observed affecting 25-50% of the sites were related mainly to flooding, including excessive channel bed and bank disturbance, a simplification of the channel morphology, excessive scouring or infilling of channel moss, reduced fish cover, and increased fine sediment levels. Invertebrate diversity was reduced at four sites due to excessive sediments, or old logging related channel infilling, natural mass wasting and flooding, and possibly elevated water temperatures. Issues with bare or compacted ground, a future LWD supply, a poor bank root network, and blockages to fish or sediments were uncommon. Bank microclimate was always satisfactory. Weeds, invasives or disturbance increaser plant species were never observed, and significant windthrow was only recorded at one site.

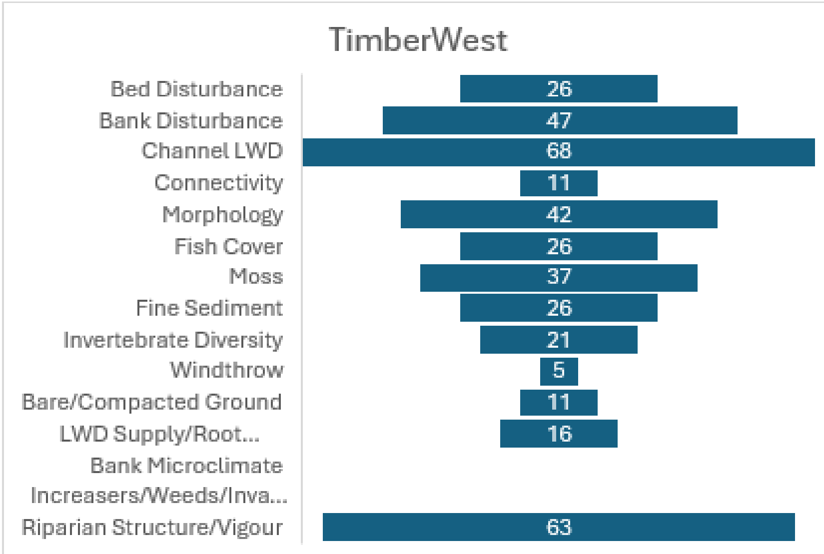

Figure 3. Percent of sites on TimberWest land in the Tsolum River watershed that that had "No" answers for each question on the 19 stream/riparian assessments completed.

For sites on Other private land in the Tsolum River watershed (Figure 4), both the range of the questions affected and the relative frequency of "No" answers associated with the questions was greater compared to the sites on TimberWest land. The only question without a "No" answer was on windthrow. "No" answers for stream bed disturbance and invertebrate diversity were also less frequent compared to TimberWest land sites. All other questions on Other land sites had a greater frequency of impacts compared to TimberWest land sites. Impacts to the bank microclimate and the presence of weeds, invasive plants or increaser disturbance plants especially were never observed on TimberWest land, but they were recorded at 36-55% of the Other land sites.

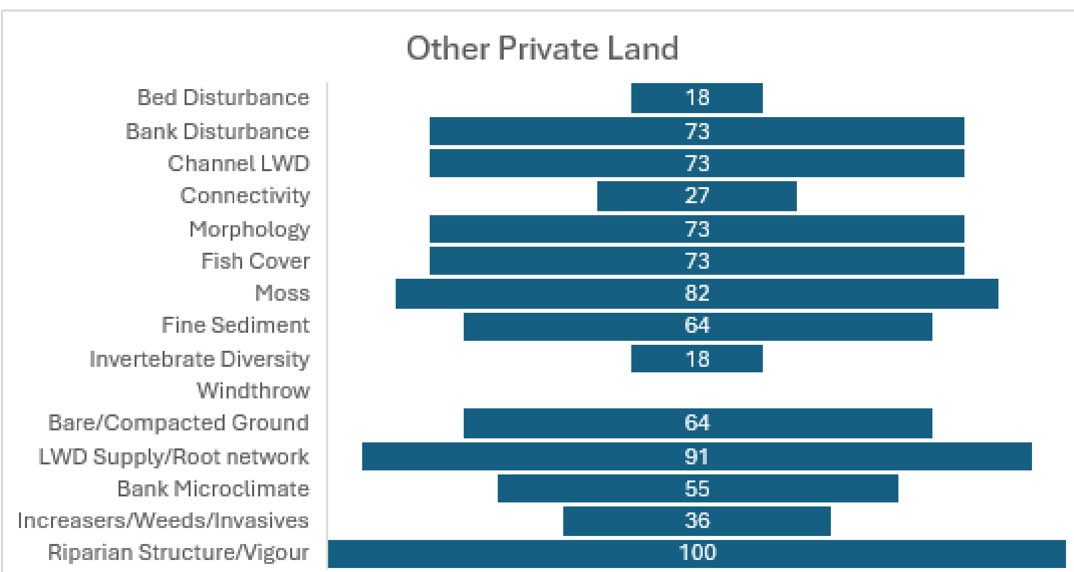

Figure 4. Percent of sites on Other private land in the Tsolum River watershed that had "No" answers for each question on the 11 stream/riparian assessments completed.

Causal Factors

Factors that caused the “No” answers on the assessments in the Tsolum River watershed are summarized in Table 3 by land ownership (i.e., TimberWest, Other) and overall (TimberWest land and Other land combined). On TimberWest land, where 16 of the 19 sites were logged to the stream edge 50-90 years ago, old logging impacts were the most significant factor, accounting for 43% of the “No” answers. Specific impacts related to old logging were mainly due to the low retention rates along streams when the land was first logged (typically zero to the stream edges), and then the slow recovery to a more natural forest structure typical of the area. At the poorest sites, tree species diversity was typically low with high stem densities. Other forest attributes such as canopy coverage, standing dead wood, understory shrubs and herbs, the lichen community, and coarse woody debris (CWD) were also often over or underrepresented. At a few sites, the residual impacts of cross stream yarding and debris buildups were still visible in the stream channels.

Only three sites in the sample were recently logged, and all three were small non-fish bearing streams, two in the headwaters of Dove Creek sub-basin, one in the headwaters of the upper Tsolum. Current logging was nevertheless deemed responsible for 21% (half the impacts of old logging) of all the “No” answers on TimberWest land. This was mainly because whenever damage due to flooding was observed in current or old logged sites, it was considered the result of both natural flooding and the altered hydrology of the current logged areas upstream. The three sites with current logging had relatively few impacts due to current logging itself.

Natural impacts, mostly flooding followed by mass wasting upstream, naturally high fine sediment levels and windthrow accounted for 26% of the “No” answers on TimberWest land, and were thus the second most important factor responsible for the “No” answers on the assessment. Roads only accounted for 4% of the “No” answers, mainly due to some surface erosion into a stream, small road failures on road crossings upstream of the sample sites, and encroachment on one riparian area. The cause of the remaining 6% of the impacts were related to mass wasting upstream due to unknown causes, and low invertebrate diversity that could not be explained.

The causal factors responsible for the “No” answers on Other private land, mostly in the Lower Tsolum River and Portuguese Creek sub-basins, differed substantially from those on TimberWest land. In contrast to TimberWest land where old logging accounted for 43% of the “No” answers, 43% of the “No” answers on Other private land were due to other human impacts. Chief among these was where a stream was buried and converted to cropland (14% of the total “No” answers), followed by farmland encroachment on riparian areas at several sites (10% of the total “No” answers). A varied list of other human impacts including residential developments that encroached on the riparian area, ATV, horse and foot trails in the riparian area, RV/boat storage in the riparian area, a channel excavation and an unlicensed water withdrawal accounted for the remaining 19% of the human caused “No” answers.

Table 3. Causal factors for the "No" answers on stream channel riparian assessments in the Tsolum River watershed, June 11, 2023, to October 10, 2025.

Specific Impacts	TimberWest Sites (N=19)		Other Sites (N=11)		All Sites (N=30)	
	# "No's"	%	# "No's"	%	# "No's"	%
Old logging	**32.8**	**43.2**	**18.5**	**19.9**	**51.4**	**30.4**
Low retention	9.1	12.0	8.4	9.1	17.5	10.4
Forest structure issues	11.1	14.6	5.7	6.2	16.9	10.0
Mass wasting upstream	2.9	3.9	2.7	2.9	5.6	3.3
Falling and yarding	5.4	7.1	0.0	0.0	5.4	3.2
Debris blockages	3.8	4.9	0.0	0.0	3.8	2.2
Mass wasting	0.0	0.0	1.1	1.2	1.1	0.6
Altered watershed hydrology	0.5	0.7	0.6	0.6	1.1	0.6
Windthrow	0.0	0.0	0.0	0.0	0.0	0.0
Current logging	**15.7**	**20.7**	**9.1**	**9.7**	**24.8**	**14.7**
Altered watershed hydrology	11.0	14.5	8.5	9.1	19.5	11.5
Mass wasting	2.0	2.7	0.0	0.0	2.0	1.2
Low retention	1.0	1.3	0.6	0.6	1.6	0.9
Windthrow	1.5	2.0	0.0	0.0	1.5	0.9
Mass wasting upstream	0.2	0.3	0.0	0.0	0.2	0.1
Roads	**3.1**	**4.1**	**7.8**	**8.4**	**10.9**	**6.5**
Culverted crossing	0.0	0.0	4.0	4.3	4.0	2.4
Road surface erosion	0.8	1.0	1.2	1.3	2.0	1.2
Encroachment on the RMA	0.5	0.7	1.4	1.5	1.9	1.1
Road related mass wasting	1.8	2.4	0.0	0.0	1.8	1.1
Streambanks riprapped	0.0	0.0	0.9	1.0	0.9	0.5
Other road erosion	0.0	0.0	0.4	0.4	0.4	0.2
Natural	**19.8**	**26.0**	**17.4**	**18.8**	**37.2**	**22.0**
Floods	12.7	16.8	9.3	10.0	22.1	13.1
Mass wasting upstream	2.2	2.9	3.5	3.7	5.6	3.3
Naturally high fine sediment levels	1.8	2.3	2.9	3.1	4.7	2.8
Windthrow	1.6	2.1	0.0	0.0	1.6	0.9
Bears	0.0	0.0	1.3	1.3	1.3	0.7
Beavers	1.2	1.6	0.0	0.0	1.2	0.7
Naturally all pool habitat	0.0	0.0	0.5	0.5	0.5	0.3
Naturally high fine sediment levels	0.3	0.3	0.0	0.0	0.3	0.1

(Table 3 Continued next page)

Table 3. Continued.

Specific Impacts	TimberWest Sites (N=19) # "No's"	%	Other Sites (N=11) # "No's"	%	All Sites (N=30) # "No's"	%
Other Human Caused	**0.0**	**0.0**	**40.2**	**43.2**	**40.2**	**23.8**
Stream filled in, converted to cropland	0.0	0.0	13.0	14.0	13.0	7.7
Farmland encroachment on RMA	0.0	0.0	9.6	10.3	9.6	5.7
Residential development	0.0	0.0	5.1	5.5	5.1	3.0
ATV trails in RMA	0.0	0.0	3.7	4.0	3.7	2.2
Invasive mint introduced	0.0	0.0	2.6	2.8	2.6	1.6
Horse trails in RMA	0.0	0.0	1.2	1.3	1.2	0.7
Foot trails in RMA	0.0	0.0	1.2	1.3	1.2	0.7
RV/boat storage in RMA	0.0	0.0	1.2	1.2	1.2	0.7
Channel partly excavated	0.0	0.0	1.1	1.2	1.1	0.7
Water withdrawals	0.0	0.0	1.1	1.1	1.1	0.6
Windthrow	0.0	0.0	0.5	0.5	0.5	0.3
Unknown	**4.6**	**6.0**	**0.0**	**0.0**	**4.6**	**2.7**
Mass wasting upstream, cause unknown	3.6	4.7	0.0	0.0	3.6	2.1
No invertebrates, cause unknown	1.0	1.3	0.0	0.0	1.0	0.6
All	**76.0**	**100.0**	**93.0**	**100.0**	**169.0**	**100.0**
Mean Number of "No" answers per Site	4.0		8.5		5.6	

Old logging and new logging on Other land were less important factors than they were on TimberWest land. While old and new logging accounted for 43% and 21% of the “No” answers on Timberwest Land, they accounted for only 20% and 10% of the “No” answers, respectively, for much the same specific reasons as on TimberWest land. Of the 11 sites samples on Other land, all were logged to the stream edge over the past 50-100+ years. While some of the original trees may still be present, the riparian areas that have not been destabilized, encroached on or modified since are still at a relatively young age in terms of providing large woody debris to stream channels. This was especially true of sites in the larger channels of the Middle Tsolum, Lower Tsolum and Dove Creek sub-basins.

There is little current logging on Other land in the Tsolum River watershed. Current logging upstream, however, almost all of which is on TimberWest land was considered a factor responsible for 10% of the “No” answers recorded on Other land. This was mainly because of the effect that current logging upstream has on increased winter flows. Whenever flood related damage was observed that resulted in a “No” answer on the assessment for a stream reach with logging upstream, the damage was attributed equally to both natural flooding and the logging related increases in fall/winter flows upstream.

Roads had a greater impact on the number of “No” answers on Other land (7.8) compared to TimberWest land (3.1). The difference is largely attributable to the large Piercy Road crossing on the lower Tsolum River that contributed to the “No” answers on ten questions on the assessment for this site, and a single culvert that contributed to the "No" answer on nine questions on the assessment at a second site. By comparison only one road crossing was in the site assessments on TimberWest land.

DISCUSSION

The results of this assessment on 30 spatially random stream channel sites and their associated riparian areas indicate that the Tsolum River watershed is in poor health - possibly the poorest in the Province if the comparison with six other watersheds assessed with the same methods is any indication. The watersheds long history of logging to the stream edges from early to mid-20th century up to 1995 (i.e. "old logging") over most of the watershed is no doubt one of the principal reasons for the poor outcome, since old logging accounted for 30% overall of all the "No" answers in the watershed. Accounting for 15% of all the "No" answers on all 30 assessments combined, the impacts due to current logging was half the impacts due to old logging.

Logging continues over a significant part of the upper watershed, so it is tempting to say that logging continues to exacerbate conditions in the watershed in the way that old logging did. Current logging practices, however, are different from old logging practices. First and foremost, the riparian areas along most streams in the forest lands of the watershed are now mostly left intact. Recovery takes time, but some of the 80–90-year-old riparian areas in the 30 samples were clearly recovering, with some starting to resemble mature old forests. Other riparian areas logged long ago, however, like the extensive bare eroding or slumping slopes along sections of the middle and lower Tsolum River are clearly not recovering very quickly.

Natural factors, of which flooding was the most significant, had about the same overall impact on the health of the Tsolum River watershed as they do in other mostly undisturbed watersheds. With a total of 37 "No" answers directly or indirectly attributable to natural factors (mostly flooding, mass wasting upstream, and naturally high background fine sediment levels), the average number of "No" answers per site due to natural impacts for the whole Tsolum River watershed per site was 1.2 This is approximately the same number per site recorded in areas with little or no development beside or upstream of the site (1.4, Tripp 2013).

Human activities other than roads or logging were the single most significant cause of the poor score on watershed condition. They were also all restricted to the Other lands downstream of TimberWest land. Accounting for 43% of the impacts on Other land, or 24% of the impacts in the whole watershed, they were the main reason why the Tsolum watershed scores so poorly on functioning condition compared to other watersheds. If there were no other human caused impacts besides logging and roads, the average number of "No" answers would drop from 5.6 to 4.3. Nine of the eleven sites assessed on Other private land were classified as Not Properly Functioning.

Logging, and old logging in particular, has had a large impact on the watershed, but the evidence collected in this survey indicates that streams are recovering from these impacts, albeit slowly. In contrast, there is no indication that the number of impacts on Other lands due to agricultural businesses, farms or residential properties is improving. In the absence of effective legislation to protect streams and riparian areas, or enforcement of existing legislation, recovery seems unlikely. Education may be the best solution.

LITERATURE CITED

Pickard, D., D. Tripp, M. Porter, L. Reese-Hansen, R. Thompson, B. Carson, P. Tschaplinski. 2019. Memekay River Watershed Status Evaluation Report. FREP WSEP Extension Note #1. 8 pp.

Pickard, D., L. Reese-Hansen, D. Morgan, D. Tripp, R. Thompson, B. Carson, M. Porter. 2022. Bii Wenii Kwa/Owen Creek Watershed Status Evaluation Report. FREP WSEP Note #3. 10 pp.

Reese-Hansen, L., D. Pickard, D. Tripp, M. Porter, R. Thompson, P. Tschaplinski. 2021. Williams & Sockeye Creeks Pilot Watershed Status Evaluation Report. FREP WSEP Note3 #2. 8 pp.

Stevens, D.L. Jr and Olsen, A. R. 1999. Aerially restricted random sampling with the generalized random tessellation stratified (GRTS) design. Environmental Monitoring and Assessment 14:213-222.

Tripp, D.B., P.J. Tschaplinski, S.A. Bird, and D.L. Hogan. 2009a. Protocol for Evaluating the Condition of Streams and Riparian Management Areas (Riparian Management Routine Effectiveness Evaluation). Forest and Range Evaluation Program, B.C. Min. For. Range and B.C. Min. Env., Victoria, BC.

Tripp, D.B., P.J. Tschaplinski, S.A. Bird, and D.L. Hogan. 2009b. Field supplement to Evaluating the Condition of Streams and Riparian Management Areas (Riparian Management Routine Effectiveness Evaluation). Forest and Range Evaluation Program, B.C. Min. For. Range and B.C. Min. Env., Victoria, BC. 44 pp.

Tripp, D. 2013. Functioning condition of randomly selected reference streams associated with recent forest harvesting in British Columbia (2005-2009). BC Ministry of Forests Lands and Natural Resource Operations, Forest Resources Evaluation Program (FREP) Extension Note No. 30. 8 pp.

Zwiebel. A.B., L. Turcotte, L. Reese-Hansen, and Z. Sary. 2025. Seebach Creek Watershed Status Evaluation Report Note #4. BC Forest and Range Evaluation Program. Omineca Region, Prince George, BC. ISBN 978-1-0399-0170-4

APPENDIX

Table A1. Tenure, stream name, sub-basin location, stream order, period logged, channel characteristics and reach length of the 30 stream sites assessed in the Tsolum River watershed, June 11, 2023, to October 10, 2025. Channel types are SP=step/pool, RCP=riffle or cascade/pool, and NA=non-alluvial.

Sample ID	Tenure	Stream	Sub-Basin	Stream Order	Year(s) Logged (Est)	Channel Width (m)	Channel Depth (m)	Channel Gradient (%)	Channel Type	Reach Length (m)
C2S1	TimberWest	Jackpot Ck Trib	Dove	1	2011-2019	2.0	0.40	8	NA	100
C4S1	TimberWest	Tsolum R Trib	Upper Tsolum	2	1970’s	2.6	0.20	3	RCP	100
C5S1	Timberwest	Dove Ck Trib	Dove	2	Unlogged	4.9	0.42	25	NA	150
C6S1	TimberWest	Jackpot Ck	Dove	2	1940’s	7.0	0.80	2	RCP	210
C8S1	TimberWest	Constitution Ck	Middle Tsolum	1	1965, 2002	2.5	0.37	9	NA	100
C12S1	TimberWest	Constitution Ck	Middle Tsolum	2	1960's	5.1	0.30	2	RCP	153
C13S1	TimberWest	McKay Ck	Murex	2	1960's	3.8	0.50	6	NA	115
C17S1	TimberWest	Wolf Lake Trib	Headquarters	1	1970	4.0	0.30	5	NA	120
C19S1	TimberWest	Tsolum R Trib	Upper Tsolum	2	2021-22	1.4	0.20	13	NA	100
C21S1	TimberWest	Wolf Lake Trib	Headquarters	2	1960's	6.0	0.60	5	SP	180
C4S2	TimberWest	Tsolum R	Upper Tsolum	4	1960	8.0	0.50	2	NA	250
C5S2	TimberWest	Tsolum R	Middle Tsolum	5	1940’s	18.0	1.03	0.2	RCP	540
C6S2	TimberWest	Headquarters Ck	Headquarters	3	1960	10.0	0.80	12	NA	300
C8S2	TimberWest	Murex Ck	Murex	3	1970's	11.5	0.80	9	SP	350
C9S2	TimberWest	Anderson Lk Trib	Dove	3	1975	8.6	0.60	1	RCP	260
C12S2	TimberWest	Murex Ck	Murex	4	1960’s	34.0	1.30	1.5	RCP	1000
C13S2	Timberwest	Dove Ck	Dove	3	1930's	15.0	0.89	1	RCP	450
C15S2	Timberwest	Tsolum R	Upper Tsolum	3	1955	10.0	0.80	5	RCP	300
C16S2	Timberwest	Tsolum R	Upper Tsolum	4	1940's	14.0	0.41	1	RCP	420

(Table A1. Continues)

Table A1. (Concluded).

Sample ID	Tenure	Stream	Sub-Basin	Stream Order	Year(s) Logged (Est)	Channel Width (m)	Channel Depth (m)	Channel Gradient (%)	Channel Type	Reach Length (m)
C1S1	Other	Portuguese Ck	Portuguese	1	1950's	1.7	0.30	1	RCP	100
C3S1	Other	Portuguese Ck	Portuguese	1	1960-65	4.5	0.44	1.5	RCP	150
C7S1	Other	Portuguese Ck	Portuguese	2	1940's	5.6	0.87	0.2	RCP	170
C10S1	Other	Machan Ck	Portuguese	1	1920's	No data	No data	1.6	RCP	100
C14S1	Other	River Meadows Ck	Lower Tsolum	1	1940's	1.0	0.20	2	RCP	100
C1S2	Other	Tsolum River	Middle Tsolum	5	1960's	19.8	1.15	0.2	RCP	600
C2S2	Other	Tsolum River	Lower Tsolum	5	Pre 1950	23.0	1.15	0.3	RCP	700
C3S2	Other	Tsolum River	Lower Tsolum	5	1970	29.0	1.40	0.4	RCP	800
C7S2	Other	Tsolum River	Lower Tsolum	5	1940	34.0	0.90	0.3	RCP	1000
C10S2	Other	Tsolum River	Middle Tsolum	5	1950's	33.0	1.30	1	RCP	1000
C19S2	Other	Portuguese Ck	Portuguese	3	1940-1990	6.5	1.30	1	RCP	200

Table A2. Answers to the stream channel and riparian assessment questions on stream sites sampled in the Tsolum River watershed, June 11, 2023, to October 10, 2025.

Sample	Tenure	Stream & Riparian Assessment Question Number															Number of "No" Answers
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
C2S1	TimberWest	N	Y	N	NA	N	NA	N	Y	N	Y	Y	Y	Y	Y	N	6
C4S1	TimberWest	N	Y	N	Y	N	NA	N	N	N	Y	Y	Y	Y	Y	N	7
C5S1	TimberWest	N	Y	N	NA	N	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y	3
C6S1	TimberWest	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	1
C8S1	TimberWest	N	N	Y	NA	N	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y	3
C12S1	TimberWest	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	3
C13S1	TimberWest	Y	Y	N	NA	Y	NA	Y	Y	Y	Y	Y	Y	Y	Y	N	2
C17S1	TimberWest	Y	Y	Y	NA	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	2
C19S1	TimberWest	Y	Y	Y	NA	N	NA	Y	Y	NA	Y	Y	Y	Y	Y	N	2
C21S1	TimberWest	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	3
C4S2	TimberWest	Y	Y	N	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	2
C5S2	TimberWest	Y	N	N	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	N	5
C6S2	TimberWest	Y	N	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	3
C8S2	TimberWest	Y	N	N	N	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	5
C9S2	TimberWest	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	N	3
C12S2	TimberWest	N	N	N	Y	N	N	N	Y	N	Y	Y	N	Y	Y	N	9
C13S2	TimberWest	Y	N	N	N	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	6
C15S2	TimberWest	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	N	4
C16S2	TimberWest	Y	N	N	Y	N	Y	N	N	Y	Y	N	Y	Y	Y	N	7
C1S1	Other	Y	Y	Y	N	N	Y	N	N	Y	Y	Y	N	Y	N	N	7
C3S1	Other	Y	N	Y	Y	Y	N	N	Y	Y	Y	Y	N	N	N	N	7
C7S1	Other	Y	N	N	Y	N	N	N	N	N	Y	N	N	Y	Y	N	10
C10S1	Other	N	N	N	N	N	N	N	N	NA	Y	N	N	N	N	N	13
C14S1	Other	N	N	Y	Y	N	NA	N	N	NA	Y	N	N	Y	N	N	9
C1S2	Other	Y	Y	N	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	N	5
C2S2	Other	Y	N	N	Y	Y	N	Y	Y	Y	Y	N	N	N	Y	N	7
C3S2	Other	Y	N	N	N	N	N	N	N	N	Y	N	N	N	Y	N	12

(Table A2. Continues)

Table A2. (Concluded).

Sample	Tenure	Stream & Riparian Assessment Question Number															Number of "No" Answers
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
C7S2	Other	Y	N	N	Y	N	N	N	Y	Y	Y	N	N	N	Y	N	9
C10S2	Other	Y	N	N	Y	N	N	N	Y	Y	Y	N	N	N	Y	N	9
C19S2	Other	Y	Y	N	Y	N	Y	Y	N	Y	Y	Y	N	Y	Y	N	5
Total "No" Answers		7	17	21	5	16	13	16	12	6	1	9	13	6	4	23	169