FREP

FOREST AND RANGE EVALUATION PROGRAM

Field Supplement to

Evaluating the Condition of Streams and Riparian Management Areas

(Riparian Management Routine Effectiveness Evaluation)

Version 3.0

March, 2009

BRITISH COLUMBIA

Resource Stewardship Monitoring

Citation:

Tripp, D.B., P.J. Tschaplinski, S.A. Bird and D.L. Hogan. 2009. 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, Victoria, B.C.

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http://www.for.gov.bc.ca/hfp/frep/indicators/table.htm#fish

Table of Contents

List of Figures

List of Tables

Introduction

This field document provides guidance on how to collect the information needed to evaluate the functioning condition of streams and riparian management areas. It is a supplement to the Ministry of Forests and Range (MoFR) *Protocol for Evaluating the Condition of Streams and Riparian Management Areas*. The supplement does not replace the full protocol, a complete knowledge of which is still required to select and sample stream reaches and answer each of 15 questions asked in the evaluation on the field cards (FS 1248 FREP Riparian Resource Stewardship Monitoring, http://www.for.gov.bc.ca/hfp/frep/indicators/table.htm#fish).

The field supplement provides guidance on what information is needed and how it should be collected and recorded for each indicator listed on the riparian field cards. While not as complete as the full protocol, the supplement also tries to describe the indicators so that they can be readily identified in the field.

The field supplement does not offer guidance on how to answer each of the 15 questions on the riparian field cards. This guidance is provided in the protocol and to a large extent by the questions themselves. However, with a complete understanding, evaluation and measurement of each indicator on the field cards, completion of the questions should be straight forward.

Recommended Steps for a Riparian Evaluation

STEP 1 – Before starting any measurements, first confirm the stream is in fact a stream and not an NCD (Non-Classified Drainage), a FSZ (Fisheries Sensitive Zone), or a wetland. Only streams are eligible for assessment. If not sure, use the Stream Reference Card (Table 1) to help decide if the drainage feature is a stream.

STEP 2 – For streams situated adjacent to the block boundary, confirm the stream meets the adjacency criteria of having all of the eligible sample reach within 2 RMA widths of the block edge. RMA widths are summarized by stream class in Table 2.

Confirm also that there is enough reach length within or adjacent to the block. Example: S2 stream has a channel width (CW) of 15 m. To be eligible, 450 m of this stream (15 m x 30 CW) should all be within the block, or all within 100 m (2 RMA widths) of the block edge. Note also that the harvest treatment has to be the same along the whole reach. Stream reaches which go from one type of retention to another, or which are partly in and partly out of a block cannot be assessed as one reach.

STEP 3 – Once you have confirmed the stream is in fact an eligible stream, fill out as much of page 1 of the field cards as possible, including what the channel morphology is mainly, and what the riparian retention is. Describe the riparian retention present separately for each side of the stream reach. If you feel the information on riparian retention on page 1 does not adequately describe the condition of the riparian area, please provide additional information on page 18 of the checklist. A photograph or two of the riparian area can be invaluable in describing the riparian conditions. A sketch of a typical cross section can also be extremely useful.

To help decide what the channel morphology is, locate what appears to be representative of the stream width and measure this width from rooted edge to rooted edge. Also measure stream gradient, then use the width and gradient information to help decide on channel morphology from Figure 1. Note that Figure 1 is only suitable for alluvial channels that are mainly sediment deposition zones. It cannot be used for non-alluvial channels which are mainly transport zones. Look at the other indicators in Table 3 for additional help on channel morphology.

Small non-alluvial streams are typically streams that do not have the energy to move the dominant substrate material. In S4 to S6 size streams, these are typically cobble and boulder size glacial and/or colluvial deposits that have been washed out of the banks. Because they do not move after being washed out of the banks, these cobbles and boulders usually have rough or sharp edges. They are often also very “mossy”.

Rounding up to the nearest meter, use the width information to also estimate the length of your sample reach and the distance between sample points. Channel width is also used to determine how much a bank has to be undercut before it is called “undercut”. This minimum undercut is 2% of the channel width.

Table 1. A Key for Identifying Fish Streams, Non-Fish Streams, FSZs and NCDs.

1	Does the drainage feature have any alluvial deposits and/ or scour to a mineral substrate, or continuous definable banks?	Y (4)	N (2)
2	Does the drainage feature have a gradient < 20%?	Y (3)	N (NCD)
3	Does the drainage feature flow into known non-fish-bearing water, or end before reaching a water body with no possibility of a connection at high flows?	Y (NCD)	N (FSZ)
4	Does the drainage feature have any alluvial deposits or scour to a mineral substrate?	Y (5)	N (13)
5	Are the alluvial deposits or scour to a mineral substrate continuous or in sections less than 10 m apart?	Y (6)	N (13)
6	Is the drainage feature < 100 m long?	Y (7)	N (10)
7	Does the drainage feature flow into known non-fish-bearing water, or end before reaching a water body with no possibility of a connection at high flows?	Y (NCD)	N (8)
8	Is the drainage feature directly connected to potential fish bearing water (stream, wetland, lake, or FSZ), or potentially connected to these features at high flows?	Y (9)	N (NCD)
9	Is the gradient <20%?	Y (S1-S4)	N (S5-S6)
10	Does the drainage feature flow into a known non-fish bearing stream?	Y (S5-S6)	N (11)
11	Is the gradient < 20%?	Y (S1-S4)	N (12)
12	Is there any potential fish habitat upstream?	Y (S1-S4)	N (S5-S6)
13	Is the drainage feature < 100 m long?	Y (14)	N (17)
14	Is the drainage feature directly connected to a potential fish-bearing stream, wetland, lake or FSZ, or potentially connected to any of these features?	Y (15)	N (NCD)
15	Is the gradient < 20%?	Y (16)	N (S5-S6)
16	Does the drainage feature receive more than 2/3 of its water from groundwater seepage, overland flow, or floodwater from adjacent water bodies, with less than 1/3 of its water from a lake, wetland or stream?	Y (FSZ)	N (S1-S4)
17	Is the gradient < 20%?	Y (18)	N (NCD)
18	Does the drainage feature flow into known non-fish-bearing water, or end before reaching a water body with no possibility of a connection at high flows?	Y (19)	N (20)
19	Does the drainage feature receive more than 2/3 of its water from groundwater seepage, overland flow, or floodwater from adjacent water bodies, with less than 1/3 of its water from a lake, wetland or stream?	Y (NCD)	N (S5-S6)
20	Does the drainage feature receive more than 2/3 of its water from groundwater seepage, overland flow, or floodwater from adjacent water bodies, with less than 1/3 of its water from a lake, wetland or stream?	Y (FSZ)	N (S1-S4)

* If the stream reach, FSZ or NCD in question has hydrophytic plants and subhydric or hydric soils, wetland is probably a more appropriate classification

STEP 4 – After deciding on channel morphology, channel depth should be determined next at the upstream end of an undisturbed riffle. At this point, string a line or tape across the channel from one bank to the other at the high water mark (i.e., the rooted edge), and measure the deepest point between the line and the streambed. This is your channel depth. Three separate measurements at three different riffles are ideal, but one measurement will get you started.

Channel depth is used to determine what diameter wood has to be to be considered "wood" (10% of channel depth). Channel depth is also used to determine how deep a pool has to be to be called a "deep" pool (2X the channel depth).

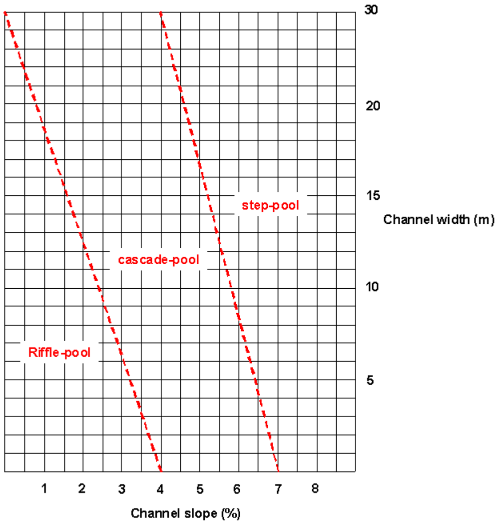

Figure 1. How channel morphology changes with increases in channel width and stream slope. As channel width increases, the slopes that define different morphologies decline.

Table 2. Determining Stream Adjacency.

Stream RMA Class (default channel width)	Minimum stream length to be within 2 RMA widths of the block edge	
	Min. stream length (m)	**2 RMA widths (m)**
S1 (20 m)	600	140
S2 (5 m)	150	100
S3 (1.5 m)	100	80
S4 (1.5 m)	100	60
S5 (3 m)	100	60
S6 (1.5 m)	100	40

STEP 5 – Place a ribbon at one end of your sample reach and mark the ribbon with the RSM stream sample number, date, and "POC = 0+00." For example, for the first riparian sample, write "RSM Stream # 1, July 10/06, POC = 0+00." This is your first "Point Indicators" sample station.

STEP 6 – Collect and record the information needed on moss, fines, benthic invertebrates, shade, disturbance-increaser species, and noxious weeds at your first "Point Indicators" sample site as per the brief descriptions under the "Point Indicators" section of this field guide.

STEP 7 – After completing the first point sample station review the list of "Continuous Indicators" and "Other Indicators" to decide what indicators you need to note and which ones you don't. Then walk the rest of the reach and locate the next five point sample stations (reach sample length ÷ 5 to get the inter-station distance). When you get to the last Point Sample station, repeat the measurements you recorded at the first station (i.e., moss, fines, benthic invertebrates, shade and increaser/disturbance plants and noxious weeds).

STEP 8 – As you walk along the reach locating and flagging out the Point Indicator stations, try to measure a few other indicators along the way. Do not, however, try to measure all the indicators at once because it is too easy to miss measurements this way. Also, try not to have one person measure while the other person records. This is not only slow, but it also has a greater risk of missing measurements or recording information incorrectly.

Table 3. Channel Morphology – General Features of Small to Medium Size Streams.

Channel Feature	Riffle-Pool	Cascade-Pool	Step-Pool	Large Non-Alluvial	Small Non-Alluvial
Gradient (%)	0 - 3	> 3 - 7	> 5	variable	variable
Stones	small, smooth	medium, smooth	large, smooth	large, sub-angular	small, angular
Pools	lateral	pockets, plunge	plunge	plunge	plunge
Moss	present on stable stones in riffles	present on stable boulders in riffles	common on steps, sides	common on sides of channel	common every-where
Wood	typically present, with effects on sediment movement and pool-riffle form	often absent, with minor effects on pool formation if present	typically absent, little to no effect on pool formation if present	typically absent, no effects on channel morpho-logy if present	often present, roots and small logs across stream may form small plunge pools
Main bank materials	alluvium	alluvium, colluvium.	bedrock, colluvium, alluvium	bedrock, colluvium, glacial deposits	colluvium, glacial deposits
Flood-plains	yes	yes	limited	no	no
Gravel bars	yes	yes	limited	no	no
Deposition or transport character-istics	mainly deposition	mainly deposition	mixed	mainly transport	mainly transport

Experience indicates the best approach to measuring indicators is for each team member to focus on measuring no more than 2-4 indicators at a time, and recording the information independently of other team members. In choosing indicators to measure, try selecting those that relate to each other. For example, one person might tally the wood accumulations and their characteristics in Table 2 of the riparian field cards, while also measuring the main stream bed indicators (gravel bars, side channels, and braided channels for alluvial channels, moss along the stream bed in non-alluvial channels). Another person might focus on the bank indicators (non-erodible banks, recently disturbed banks, stable undercut banks, upturned bank rootwads). Pool length and deep pools are two more indicators that by themselves are simple to record. The specific indicators selected for measurement will depend on the channel morphology since not all indicators are measured on every type of stream.

STEP 9 – By this step, you should have completed two "Point Indicator" stations, and marked out the stations still to be completed. You should have also collected the information you need for a few "Continuous Indicators" (e.g., disturbed banks, pool length, number of deep pools, mid-channel bars and sediment wedges, etc.) and "Other Indicators" (e.g., number of wood accumulations, number with new wood, number that span the channel, main age and orientation).

Record the information you collected on the field cards, then review the other "Continuous Indicators" to decide which ones you still need to measure. Also complete the "Yes/No" checklist for the "Other Indicators", or note which "Other Indicators" you still need to assess specifically when you walk back along the reach to finish the other "Continuous Indicators". At some point on almost every stream assessment you will probably find that there are some "Continuous Indicators" or "Other Indicators" that you do not have to measure. For example:

- If there is no new debris in the channel, you will not have to count the number of wood accumulations with new wood, or determine the main age of the debris. However, you will still need to note how many accumulations span the channel, and what the main orientation of the debris is - across/diagonal or parallel.
- If there is no windthrow present, or if the windthrow is cata-strophic, you should not have to count or subsample the number of old windthrows, new windthrows or standing trees present. Simply note what is present or not present (e.g., "Clearcut", "No windthrow", "All windthrown") in the space reserved for recording the counts to justify the number in the "Total" column.

- If there is no bare erodible ground or disturbed ground, you will not have to measure any bare ground, bare ground exposed to the sky, bare ground hydrologically linked to the first 10 m, disturbed ground in first 10 m, or disturbed ground hydrologically linked to the first 10 m. Record zeros in the space reserved for recording the data, the "Total" column and the "%" column.

The need to measure other variables may be similarly obvious after you walk along the stream and through the riparian area. Remember, it is very difficult to walk up or down a stream just once to complete an assessment. Usually one has to walk both up and down the stream, sometimes more than once.

STEP 10 – Walk back along the stream to your remaining point sample stations, measuring along the way, the channel, bank, and riparian indicators you skipped on the first walk.

STEP 11 – After finishing your assessment of the stream, review your notes to identify any missing information or measurements. Walk back along the sample reach to finish off any missing measurements.

STEP 12 – After all the measurements or counts are completed, calculate the total for each of the point or continuous indicators and enter that number in the column marked "Total". For the point indicators, divide the total by the number of stations sampled for the indicator and record that number in the "Mean" column. For the continuous indicators, divide the total by the reach length or the riparian area and multiply this number by 100 to get % of reach length or % of reach area. Record this number in the "%" column. The exception is windthrow where the percentage recorded in the "%" column is the percent of all trees originally standing.

STEP 13 – Go through the rest of the field cards and answer each question using the data collected for each indicator. Summarize the Yes/No/NA answers on page 16 of the field cards, then summarize the causes of each No answer on the small table at the bottom of page 16. Complete the last two pages of the field cards at this time, perhaps walking or driving further upstream above the sample reach or into an unlogged area to clarify the cause of the impacts.

Recording Data and Sub-Sampling

Every space in the "Total", "Mean", or "%"column for the Point and Continuous Indicators should have a number if the indicator was measured, or "NA" if not. There should be no blanks, nor any other text (e.g., "estimate", "approx") or symbols (e.g., ">", "<") in these columns. Confine text or symbols to the space provided for recording individual measurements or notes.

For the Point Indicators, the number in the "Total" column should be the sum of the numbers recorded at each point station, while the number recorded in the "Mean" column will be the number in the "Total" column divided by the number of stations sampled. It is not always necessary to sample all six stations. Fewer stations are acceptable if the stations sampled are representative of the reach as a whole, and the threshold for the indicator has or has not been clearly exceeded.

For the Continuous Indicators, the number recorded in the "Total" column should be a value that represents the entire reach. Done properly, the number in the "Total" column divided by total reach length, total naturally erodible reach length (for undercut banks and deeply rooted banks), or total riparian area will yield the correct number for the "%" column. The exception is windthrow where the number in the "%" column is based on the number of trees originally standing in the RRZ or RMZ.

Sub-sampling is acceptable for the Continuous Indicators, but the value determined for the sub-sample must be extrapolated to the entire reach before it is recorded in the "Total" column. For example, if it is clear that pool length present in a 120-m-long reach exceeds the threshold because 30 m of pool was present in the first 40 m of the stream, indicate that the 30 m was measured over 40 m of the reach (e.g., "30 m over 40 m of reach"). The number recorded in the "Total" column would then be 90 (30/40 X 120), the estimate of total pool length in the reach. The number in the "%" column would be 75 (90 ÷ 120 x 100).

Visual estimates are acceptable where the measured value for the indicator over the entire reach would be clearly and significantly lower or higher than the threshold value. Record the visual estimate for the whole reach in the "Total" column, but indicate that the value is a visual estimate in the space provided for recording numbers, text or symbols. Do not use visual estimates if the estimate is close to the threshold value.

Point Indicators

There are nine point indicators to record at each of six sample sites. Field guidance on measuring these indicators is as follows.

Moss

Visually estimate moss cover to the nearest 0.1% at the closest riffle to each sample point. If there is no riffle before reaching the next sample point, leave the space for recording coverage blank, or write "NA". Do not include moss on the sides of the banks, on woody debris, or on the "tops" of very large rocks that stick out of the channel. If coverage is less than 0.1%, record 0% coverage.

To estimate moss cover at each sample site, use a square plot equal in width and length to the width of the stream channel. In a 1-m-wide stream, a patch of moss 10 cm x 10 cm would be 1% coverage, while an area approximately 3 cm x 3 cm would be 0.1%. In a 5-m-wide stream, a patch 50 cm x 50 cm is 1% coverage.

Question 7 on "Moss" is not applicable if all of the stream has an organic substrate. "All" means at least 90% of the reach length should have an organic substrate, and at least 5 of the 6 point sample stations should be 100% organic.

Organic substrates in forest streams are composed mainly of particulate leaves and wood. Sphagnum mosses become more important as conditions become more bog-like. In the uppermost headwater areas of a stream where definable channels are starting to form, organic substrates tend to be mainly saturated soils which may include some inorganic fines mixed in with the organic components.

Fines

Visually estimate the amount of sand and smaller-sized particles that occupy a line across the channel bed, from the bottom of one bank to the bottom of the other. These are the "fines". To calibrate your eye, stretch a tape across the channel and measure the length of the fines present along the line. Divide the length of line with fines by the total length of the line, then multiply by 100, to get the percent coverage by fines. Only measure inorganic, mineral-type fines, not organic fines.

Like Question 7 on "Moss", Question 8 on whether or not the introduction of fine inorganic substrates has been minimized is not applicable if the substrate is naturally organic.

Benthic Invertebrates

The collection method described here will work for most streams with a mineral substrate. See the protocol for hints on sampling other stream types (e.g., streams with organic or mud substrates, beaver ponds).

At each sample point, select the nearest riffle with a substrate that can be stirred up by hand (avoid large boulders or mud deposits). While holding the net on the streambed (so nothing can escape under the net), pick up the larger rocks and clean them off in the net and then stir up the substrate upstream of the net so that invertebrates clinging to the substrate are washed into the net. Empty the net and its contents into the white tray with a little water, and identify the types of different invertebrates present.

For large samples with abundant debris or sediment, try placing only small portions of the sample in the tray at any one time. The more white space visible the easier it is to identify the invertebrates. Try limiting the amount of sediment or debris in the tray to 50% or less of the tray area.

There are four separate indicators for benthic invertebrates:

1. the number of different sensitive invertebrates types (or "species") present;
2. the number of different major invertebrate groups present (e.g., insects, worms, crustaceans, other arthropods like spiders and mites);
3. the number of different insect types (species) present;
4. the number of different benthic invertebrates types (species) present.

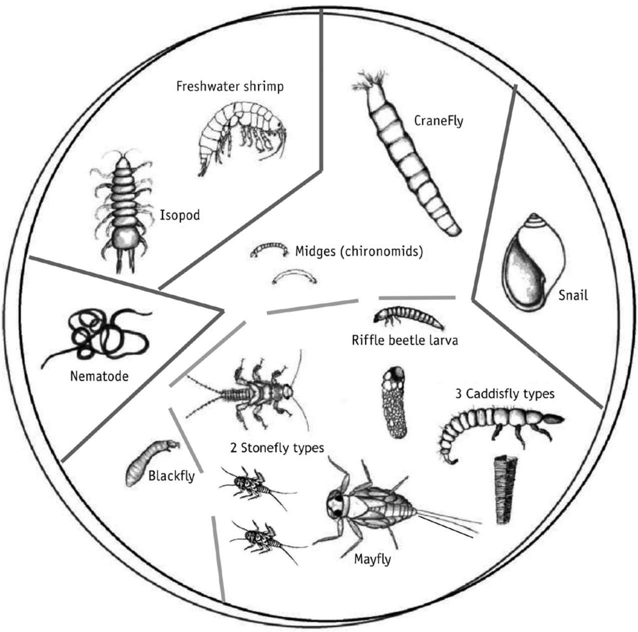

Figure 2. There are four major groups in this collection of invertebrates. (Note that there are three stonefly individuals shown, but only two types. There are also two different "midges")

Figure 2 illustrates a diverse collection of invertebrates. Altogether there are four major groups, including worms, crustaceans, insects, and a snail. Among the insects there are 11 different types (or "species"), seven of which are considered sensitive. The latter include two stoneflies, one mayfly, one riffle beetle larva and three caddisflies. Other sensitive invertebrates not shown include Dobson flies ("helgrammites"), water pennies (Coleoptera), riffle beetles (larvae and adults), snails with the opening on the right side (this diagram has the opening on the left = not sensitive) and clams.

Record the number of sensitive invertebrates, major groups, insects, and total invertebrate types present in the appropriate space for each sample site. For the example shown in Figure 2, you would record:

- No. of sensitive invertebrate types – 7
- No. of major invertebrate groups – 4
- No. Insect types – 11
- Total no. invertebrate types – 15

A second table is provided below the Point Indicators to assist in identifying and summarizing the number of different invertebrates found at each sample point by major group, sub-group and type. Small example figures of the different kinds of invertebrates likely to be found are also provided, along with the general "sensitivity" of each sub-group to sedimentation.

For more help and information on the sensitivity of invertebrates not shown, consult:

1. the field guide to freshwater invertebrates in Appendix 2 of the riparian protocol (good),
2. Appendix 1 (Field Identification and Pollution Tolerance Charts) and Appendix 2 (Key to Invertebrate Groups) from the the DFO/BC Streamkeepers' Training Module 4 (better), or
3. the field guide and companion CD on Macroinvertebrates of the Pacific Northwest by Jeff Adams and Mace Vaughan of the Xerces Society (best).

When the last site is completed, tally up the totals for all sites sampled in the "Total" column. Calculate the average for each invertebrate indicator, and record it in the last column under "Mean."

Shade

At each of the six point samples, estimate the amount of shade present at each side of the stream, then average the two estimates to determine average shade at each sample point.

To determine shade on each side of the stream, stand along the edge of the bank, make a circle with your thumb and fore-finger, and hold it straight up at a 60-degree angle above the horizontal. While looking through the circle, estimate the proportion of the circle that has vegetation not sky. Use the foliage cover standards in Figure 3 to calibrate your eye. Do this for the two shadiest of the E, S or W aspects, and average the two estimates for an average estimate of shade on each side of the stream. The average of the estimates for each side of the stream is the value you record for each sample station.

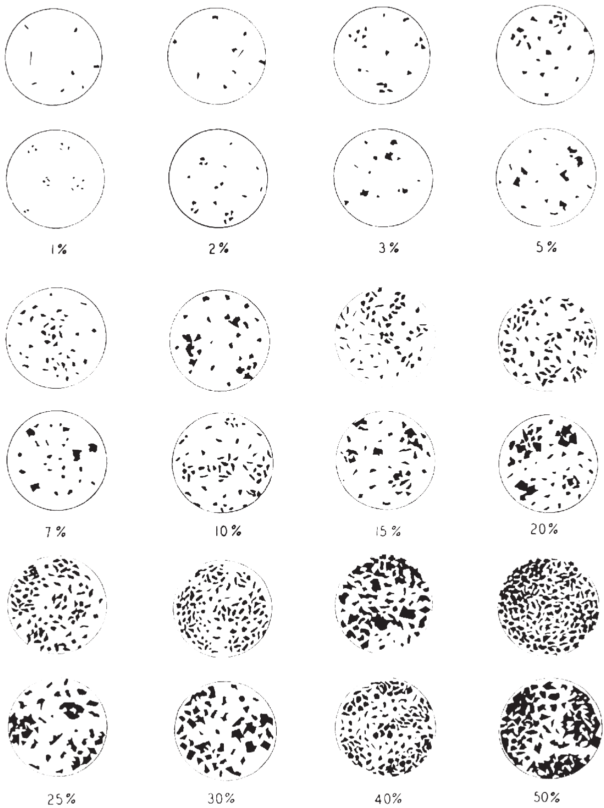

Figure 3. Comparison charts for visual estimation of foliage cover (from Luttmerding et al. 1990).

Disturbance-Increaser Species and Noxious Weeds

Disturbance-increaser and noxious weed species are listed in Appendix 1. Familiarize yourself with the list and their appearance in the field. A number of field guides are available, including the Field Guide to Noxious and Other Selected Weeds of British Columbia (Cranston et. al. 2005). There is also Weeds of Canada (Royer and Dickerson 1999).

Record what percent of a transect line 10 m long on both sides of the stream at each point sample station is touched or occupied by disturbance-increaser species and also by noxious weeds. All transect lines should extend from the top of the stream bank at right angles to the main axis of the stream. Record percent coverage to the nearest 5% for disturbance-increasers, and the nearest 1% for noxious weeds.

Continuous Indicators

Continuous Indicators are indicators you measure along the entire length of the sample reach. The first 10 continuous indicators from “Mid-channel Bars and Sediment Wedges” to “Pool Length” are indicators you measure in the stream and along the banks. The last 8 indicators cover windthrow, bare erodible ground and disturbed ground in the riparian area on both sides of the stream.

Mid-channel Bars and Sediment Wedges

A “bar” is an accumulation of sediment in a stream channel. If it is composed mainly of gravel size stones, it is called a”gravel bar”, but bars can also be composed mainly of sand, cobbles or even boulders.

Unless it is obvious that much more or much less than half the sample reach has mid-channel bars or sediment wedges, measure the length of the stream reach that is occupied by these types of bars.

Mid-channel bars and sediment wedges are the types of bars that are signs of sediment accumulation in a stream. Mid-channel bars are bars that will have some evidence of flow on both sides of a high point on the bar. Sediment wedges are bars that are essentially accumulations of sediment that have formed above (i.e., “upstream of”) a partial or complete obstruction in the channel, such as a log or debris jam that extends partway or all the way across the channel.

Lateral Bars

Unless it is obvious, measure the length of the stream reach that has lateral bars to determine if half or more of the reach has lateral bars. If it is obvious that the channel has few if any bars, then just note this in the space provided for the measurements. Alternatively, watch for the presence of a thalweg that smoothly curves from bank to bank (the thalweg is the deepest part of the stream's channel) and record this observation.

Lateral bars are characteristic of large, low gradient streams. They are usually only present on the inside curve of unobstructed meander bends, and most will have a pool beside them on the outside of the curve. Lateral bars also always have a smooth continuous slope from the stream bank to the waters edge. If there is any evidence of another channel or dip between the bank and the outside edge of the bar, then the bar is probably not a lateral bar, but more a mid-channel bar or part of a sediment wedge.

Multiple Channels

Unless it is obvious that much more or much less than half the sample reach has multiple channels, measure the length of the sample reach with multiple channels present. These include channels separated by non-vegetated gravel bars (i.e., mid-channel bars), plus side channels separated from the main channel by vegetated "islands." Don't measure the reach length twice where one extra channel overlaps with another extra channel.

Moss Along the Channel Bed

On non-alluvial streams only, record the length of stream reach that has moss on the streambed between the "toe" of each bank. This is not an area measurement of abundance like the measurements made for moss at each point sample station. It is a linear measurement of moss presence along the length of the sample reach. As an example, a continuous thin line of moss along the entire length of the stream may only cover a very small area of the streambed, but it is recorded as present over 100% of the stream reach because there is no point along the reach that does not have some moss on the streambed.

Non-Erodible Banks

Record the reach length where naturally non-erodible banks are present on both banks at the same time. Note that this does not include man-made changes to the bank that are non-erodible such as rip-rap or culverts. These are considered disturbed banks.

Naturally non-erodible banks are banks consisting of bedrock, or large boulders on small streams if the stream is incapable of transporting the boulders downstream.

Reach length with naturally non-erodible banks on both sides of the same section of stream is subtracted from total reach length to give total "erodible" reach length. Percent of reach length with undercut banks or deep rooted vegetation is based on "erodible" reach length, and not total reach length.

Recently Disturbed Banks

Measure the length of stream reach occupied by recently disturbed banks, regardless of which side of the channel the disturbed banks are located. Where a section of disturbed bank on one side of the stream overlaps a section of disturbed bank on the other bank, do not measure the overlap twice. Total percent of reach length with recently disturbed banks cannot exceed 100.

Recently disturbed banks are banks that have been negatively affected by stream flows, windthrow, infilling, animals (hoof shear, trampling), roads (culverts, rip-rap), or harvest and silviculture activities.

Stable Undercut Banks (see Figures 4 and 5)

Record the total reach length with stable undercut banks, regardless of which side the undercut bank is located on. Do not measure the reach length twice where undercut banks overlap each other. To determine the percent of reach with stable undercut bank, divide the total length of reach with stable undercut banks by the length of erodible stream reach present, all multiplied by 100.

To be called undercut, the depth of the undercut should be at least 2% of the total channel width. The height of the undercut above the mean annual highwater mark should also be within two times this distance (4%). Thus stable undercut banks on a 2–m–wide stream should be at least 4 cm deep (2% of 2 m) with the stream edge of the overhang no more than 8 cm above the mean high water mark.

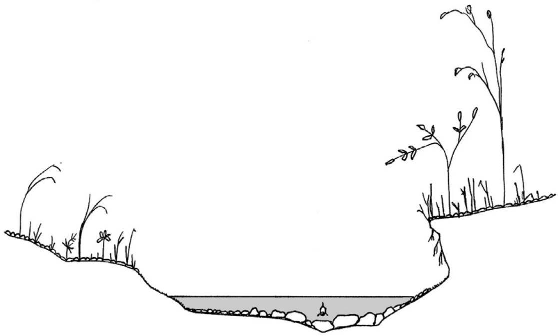

Figure 4. A cross-sectional view of a small stream with an unstable, overhanging bank on the right.

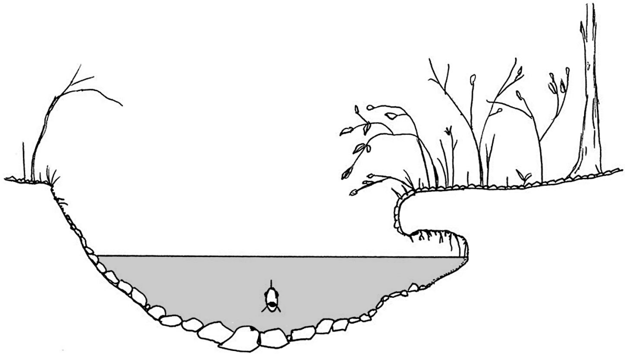

Figure 5. A cross-sectional view of a small stream with a stable vegetated overhanging bank on the right.

Deep Rooted Banks

Deep rooted banks are banks with deep rooting grass species, shrubs or trees – not moss, shallow rooting grass species, small herbs or forbs. Only consider vegetation within 1 m from the edge of the bank. Consider any part of the bank that lies within the crown width or drip line of deeply rooted grasses, shrubs or trees to be deeply rooted.

Record the naturally erodible reach length with deeply rooted stream banks on both sides. Because most banks are well rooted, it might be easiest to record the reach length in the space provided, **minus** what bank length is **not** deeply rooted on either side of the stream.

Upturned Bank Rootwads

Measure the length of the reach occupied by recently upturned bank rootwads or bank rootwad scars. Upturned bank rootwads are rootwads that were once part of the bank, but which are now tipped over. Include bank rootwads that were tipped over, but which may now be upright because the stem was salvaged.

Pool Length (see Figure 6)

Measure the length of the pools present to determine if 25% or more of the reach length has pools. Measure only pools that are main features, not small back eddies, or pockets of quiet water behind boulders in a cascade.

Pools are easiest to identify when flows are lowest. They start to get "drowned out" at higher flows, which means their length may be underestimated at these times.

To more accurately measure pool length at higher flows, step into the pool and walk slowly downstream. As you walk downstream, you will feel yourself walking uphill until you reach the end of the pool and the start of the next riffle. The ground will feel level at this point, or start to feel like it is going downhill. This point marks the end of the pool and the start of the next riffle.

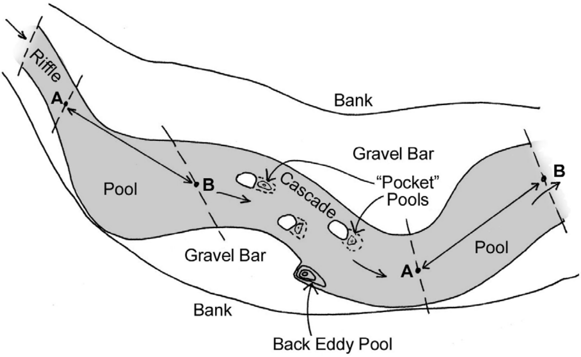

Figure 6. A plan-view sketch of two pool-riffle/cascade sequences in a stream.

Recent Windthrow

Windthrow is measured over the entire riparian reserve zone for S1-S3 streams, or the riparian management zone for S4-S6 streams. Do not measure windthrow in management zones if there is a reserve zone. Also, only count windthrow or standing trees that grew in the area of concern. Do not count trees or windthrow that fell into the area of concern. Live trees that snapped off at the stem are included as windthrow, as long as the snag or stump the tree came from can be identified.

The word "recent" is the same as "new" or "post-treatment." Recent windthrow is any windthrow that happened during or after the treatment you are assessing. If the treatment is harvesting that occurred 10 years ago, then recent windthrow is any windthrow that occurred in the past 10 years.

It is not always necessary to count recent or new windthrown trees. If all the trees were harvested or it is obvious that the number of windthrown trees is clearly very low (i.e., essentially absent), a note in the space provided is sufficient (e.g., "Clearcut," or "No windthrow present"). Similarly, if the number of windthrown trees is clearly very high, record what the estimated windthrow is (e.g., "25% est.") in the space provided for the counts. Indicate that the number is an estimate (e.g., "25% est.").

If it is not clear what the percentage of windthrown trees is above the percentage of old windthrows, you will have to count the number of old and new windthrows present, plus the number of standing trees. The threshold for new or recent windthrow in a reserve (riparian or wildlife tree) is 5% of the trees originally left standing, over and above what the background level of windthrow is. The threshold for new or recent windthrow in a management zone (where there is no reserve) is 10% of the trees originally left standing. Do not bother to estimate old or new windthrow in a management zone if there is also a reserve zone present. The only time you do so is when windthrow in both the reserve and management zones is similar, and it is easiest to combine the two zones to estimate windthrow in the reserve.

Only count dominant and codominant trees unless subdominant trees were the only trees retained. When comparing percent old windthrow to new windthrow, remember to only compare like size trees. The areas being compared must also be the same.

Old Windthrow

Old windthrow is windthrow that occurred before the treatment you are assessing, but is still recognizable as windthrow. To be considered old windthrow as opposed to "ancient" windthrow, the windthrow should still have a rootwad (major lateral roots present).

Count and record the number of old (i.e., pre-treatment) windthrown trees present.

Standing Trees

Record NA in the space provided if a standing tree count is not needed, with a brief note why (e.g., "Riparian area clearcut," or "Windthrow >50% – visual estimate").

If the number of standing trees is needed to determine percent windthrow, count the standing trees present in the area of concern, or subsample the riparian area to get a total stem count. Three 10 m x 10 m square plots on each side of the stream are recommended for subsampling. Record the average and the number of plots used in the space provided (e.g., average plot count 6.0, n=6).

Bare Soil in the First 10 m of the Riparian Area

Bare soil and bare erodible ground are the same thing. Bare erodible ground includes any soil or fill with particles smaller than 4 mm ("small, lady bug size sand") that is not covered by plants, litter, lichens, moss, downed wood, or coarse gravel. Bare erodible ground is exposed soil or erodible mineral deposits that water can wash into the adjacent stream. Examples include road cut-and-fill slopes, bladed trails, gouges and scalps due to yarding, tipped over root wads,[1] and windthrow scars, slides, and slumps. It also includes animal trails or recreation trails if mineral soil is exposed.

Sediment deposited on the ground from upslope sources is considered bare ground for Question 11, but not the sediment that is deposited due to flooding (i.e., overbank deposits – these are considered natural).

With the exception of active roads, measure and record the amount of bare erodible ground present in the first 10 m of the riparian area. In estimating the amount of bare ground, remember to net out the vegetation, gravel, rocks, roots, debris, etc. that are not erodible.

Inactive roads and road crossings are to be considered potential bare erodible ground in the first 10 m of the riparian area. Inactive road crossings are road crossings where the stream crossing is removed, the stream bed restored to its natural gradient, and the approaches pulled back. Roads that have only been temporarily or seasonally deactivated are still "active" if the crossing is still in place.

Active roads in the first 10 m of the riparian area are not recorded as bare ground within the first 10 m of the riparian area. If they were, then every stream with an active road crossing would probably result in a No answer to Question 11. This would bias the evaluation against management steps that could be taken to reduce erosion off of roads.

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1 For this type of bare ground, estimate and record the area of the ground exposed at each site, and tally up the total at the end of the survey. For root wads, there may be two surfaces to consider, the root wad itself if it has soil attached to it and is susceptible to erosion, and the root wad scar, which may still contain soil that can erode away.

Bare erodible ground on active roads within the first 10 m of the riparian area (including the crossing itself) should only be recorded as “bare erodible soil hydrologically linked to the first 10 m of the riparian area” if there is visual evidence of sand and smaller particles eroding into the stream. (see “Bare Soil Hydrologically linked to the First 10 m of the Riparian Area” below).

Bare erodible ground on active roads includes the entire road surface plus all the cut-and-fill slopes associated with the road right-of-way. Remember to always “net out” the non-erodible portions of a surface (e.g., gravels, cobbles, vegetation, roots, wood, litter, etc.) when estimating “bare erodible ground” area.

Bare Soil Exposed to Rain in the First 10 m of the Riparian Area

For each patch of bare erodible ground recorded as “bare soil in the first 10 m of the riparian area,” consider if it is directly exposed to rainfall. This is bare soil exposed to rain. In many cases, the two numbers will be the same. However, bare soil exposed to rain could be much lower than the bare soil in the first 10 m if all of the bare soil is protected by a canopy of tall shrubs and (or) trees.

Bare Soil Hydrologically Connected to the First 10 m of the Riparian Area

Bare soil hydrologically connected to the first 10 m of the riparian area is any soil that can be reasonably expected to reach the riparian area if exposed to rainfall or stream flows. This includes:

- bare soil on any non-vegetated slopes immediately adjacent to the 10 m riparian area;
- bare soil on vegetated slopes of 10% gradient or steeper that are immediately adjacent to the riparian area, up to the first topographic break;
- bare soil past the topographic break if there is a channel showing a clear connection to the first 10 m of the riparian area;

- bare soil on active road surfaces within the 10 m riparian area, including the crossing, if there is evidence that fines eroded off the road surfaces can reach the stream. This includes the road surfaces plus all cut-and-fill slope surfaces associated with the road, within the first 10 m of the riparian area;
- bare soil on active road surfaces beyond the first 10 m of the riparian area if there is evidence that fines eroding off these road surfaces will reach the stream.

If there is a vegetated flat area, depression or "sump" between the toe of the slope and the riparian area, then the bare soil on the slope is not hydrologically connected unless a channel is present showing that erodible material is being transported to the 10 m riparian area.

On active road surfaces at stream crossings, including the cut-and-fill slopes, estimate the area of bare erodible material present that is hydrologically linked to the stream. Since not all surfaces will have the same amount of erodible material exposed or the same degree of connectivity to the stream, do separate estimates for each surface. Then add up the estimates of bare erodible ground in each section for an estimate of total bare erodible ground on the road that is hydrologically connected to the stream.

As with all bare-soil measurements within the first 10 m of the riparian area, non-erodile materials such as vegetation, debris, mulches, gravel, rock, etc. must also be netted out of the total area being considered as bare soil hydrologically linked to the riparian area or stream (for active roads).

Disturbed Ground in the First 10 m of the Riparian Area

Disturbed ground is ground that is compacted and sheds water quickly. It is not otherwise susceptible to erosion because it is still largely covered with vegetation, wood, mulch, duff, gravel, or rock. Examples include skid trails, backspar trails, or animal trails. Disturbed ground also includes pavement and the pugging and hummocking found where cattle or other ungulates walk through heavy, saturated soils.

Disturbed Ground Hydrologically Connected to the First 10 m of the Riparian Area

Disturbed ground hydrologically connected to the first 10 m of the riparian area is any disturbed ground in the first 30 m of a 10% or steeper gradient slope that is immediately adjacent to the riparian area. To be hydrologically connected to the first 10 m of the riparian area, any disturbed ground on slopes less than 10% or further than 30 m away on slopes steeper than 10% should show signs of surface water transport that connects the disturbed ground to the first 10 m of the riparian area.

Other Indicators

These are the indicators to note as you mark ("ribbon") your point sample stations and collect your data on the "Point" and "Continuous" indicators. "Other" indicators are mainly observations, though some of these need to be tallied to keep track of the overall conclusions. Table 1 on the riparian field cards is there to help keep track of the boulder line characteristics of step-pool channels. Tables 2-4 are there to help track in-channel wood and riparian area characteristics. As with all indicators, a second walk along the stream or through the riparian area may be needed to confirm some of your observations. Don't hesitate to walk back along the stream if you are not sure.

Boulder Line/Step Pool Characteristics (For Step-Pool Channels Only)

Another term for “boulder lines” is “stone lines.” Both terms refer to boulders that are arranged by stream flows into a line across the channel.

Water flowing over “stone lines” will scour out a plunge pool below the stone line, creating a “step” that looks like a small waterfall over the stones into the pool. Sometimes excess gravel, cobbles and boulders will fill in the plunge pools, leaving only the tops of the stone lines visible. Typically a stone line spans the channel in a straight line from one bank to the other. Extreme floods or sediment pulses, however, will bury or scatter part or all of the boulders that make up the stone lines.

Only cascade-pool or step-pool streams have these “stone lines,” and they are only used as an indicator in step-pool channels. Mark “NA” for all these indicators if the stream has some other morphology.

If the stream has a step-pool morphology, determine if 50% or more of the steps or stone lines actually span the channel. Some may only go partway across. Do this by counting subsamples or all of the stone lines. Also determine if 25% or more of the stone lines have moss growing on at least one of the stones, or if 25% of the stone lines have “deep plunge pools” associated with them.

The measurement for “deep plunge pools” differs from the measurement for “deep pools” which was the depth from the deepest part of the pool up to the mean annual high water mark (assumed to be where the rooted vegetation edge is located). For deep plunge pools, the depth measurement needed is “residual pool depth”. This is the depth of the pool when the water just stops flowing out of the pool. To estimate “residual pool depth”, subtract the deepest water depth of the riffle below the plunge pool from the deepest water depth in the plunge pool. Compare this depth to the “middle” dimension of the largest stone in the stone line above the plunge pool. All stones have three dimensions, the longest, the shortest, and a middle. Use the middle dimension to see if the plunge pool is as deep as the largest stone.

Use Table 1 on the riparian field cards to help track how many stone lines are present, how many span the channel, how many have moss and how many have deep plunge pools. Use this table to also track the length of the reach where there are no stone lines with plunge pools, just cascading riffles or rapids.

Boulder-line/step characteristics of a step-pool type reach 7 m wide by 210 m long

Number of boulder lines/steps	Number of channel spanning boulder lines/steps	Number of boulder lines/steps with moss	Number of boulder lines/steps with a deep plunge pool	Length of reach with no boulder steps and plunge pools
~~||||~~ ~~||||~~ ~~||||~~ ~~||||~~ ~~||||~~ ||	~~||||~~ ||||	~~||||~~ |	~~||||~~	25, 33, 10 (Total = 68 m)

The example table above shows what a completed table might look like for a "disturbed" step-pool reach 7 m wide by 210 m long. Altogether there were 27 stone lines identified. Because only 9 of these spanned the channel, check the No answer to the first indicator question "Do 50% or more of the boulder lines/steps span the channel?" Because 6 of the stone lines had moss, check the No answer to the second indicator question "Do 25% or more of the boulder lines/steps have moss?" Because only 5 of the stone lines had a deep plunge pool, check No to the third indicator question "Do 25% or more of the boulder lines/steps have plunge pools as deep as the largest rock in the line?" Finally, because more than 25% of the reach (68 m out of 210 m) lacks boulder steps and plunge pools, check No to the fourth indicator question "Do cascades lacking boulder lines/steps represent less than 25% of the reach?"

Sediment and lWD Storage (For Non-Alluvial Channels Only)

Check that sediments and woody debris do not completely fill the channel for any more than 5% of the total channel length. Channels that are completely filled will look like they have no banks. Sediment wedges that pile up behind ("upstream of") debris jams frequently fill the entire channel, sometimes causing the channel to flow elsewhere.

Wood Characteristics

For the purposes of this assessment, only consider wood with a diameter equal to or greater than 10% of the channel depth. Thus any wood in a channel 30 cm deep has to be at least 3 cm in diameter to be considered, while wood in a channel 1 m deep has to be at least 10 cm in diameter. Small branches and twigs in most cases will not be considered wood.

Only count wood that is "in" the channel. Wood suspended above the channel or lying across the channel on the banks is not in the channel. To be considered "in" the channel, wood has to be between the banks and below the high water mark. Wood that is suspended over the channel does not count, but branches from the suspended wood that reach into the channel do count.

New or recent wood is any wood that was introduced as a result of the treatment you are examining. In most cases, this will be wood that has been introduced where there has been falling and/or yarding across a stream. Look for saw-cut ends to be positive the wood is logging related. Windthrow is also new wood if it happened after the treatment (logging). "Fall down" from trees killed by insects, fire and/or self-thinning can also be recent wood.

Try to organize the wood, in your mind, along the reach into recognizable accumulations or "clumps". An accumulation of wood is any accumulation with two or more pieces of wood. Then use Table 2 on Page 6 of the riparian field cards to help track the characteristics of the wood in the channel. In Table 2, for each accumulation of wood identified, determine if the accumulation has any "new" or "post-treatment" debris associated with it and record it under the column "Number of accumulations with new wood". A wood accumulation with even one piece of "new" wood qualifies as an accumulation with new wood. Next look at the accumulation and decide if the accumulation spans the channel. If it does, record this in the column "Number of channel spanning accumulations". Then decide if the wood in the accumulation is mainly new or old wood in terms of the overall volume present. Record this as "O" or "N" in the column "Main age of wood in each accumulation". Finally decide if the wood in each accumulation is mostly parallel to the main axis of the channel as opposed to across or diagonal. To be mostly parallel, more than half the volume of the accumulation should be pointing within 30 degrees of directly downstream.

Repeat the above assessment for each accumulation of wood tallied. The example table below shows what a completed Table 2 might look like for a reach where 13 separate accumulations of wood were identified.

Wood Characteristics of Riffle-Pool Type Sample Reach

Number of wood accumula-tions	Number of wood accumula-tions with new wood	Number of channel spanning wood accumula-tions	Main age of wood in each accumulation (Record "O" for old, "N" for new)	Main orientation of wood in each accumulation (Record "P" for parallel, "X" for diagonal or across)
|||| |||| |||	|||| ||||	|||	OOONOOONOOOOO	XXXPXXPPXXXXP

Of the 13 accumulations of wood, most (9) had new wood associated with them, 3 spanned the channel, most of the wood (at 11 of 13 accumulations) was old, and most of the wood was oriented across or diagonal to the stream (at 9 of 13 accumulations).

To determine if wood in the channel is intact (i.e., not recently lost or removed by hand, catastrophic floods, debris flows, or debris torrents), look for wood that is piled up along the banks, deposited there by flood flows or during excessive hand cleaning operations. Also look up and down the channel. If the channel looks open, with little or no wood across the channel, then floods have probably washed most of the wood away. Old logged streams or streams beside roads or developed areas frequently have this appearance because there has been little new recruitment of wood to the channel, to replace what is normally lost every year.

A stream that is completely full of wood has an "infinite" number of small clumps or accumulations, not one long clump. In these cases where half or more of the stream is completely full of wood, record a number greater than 12 for the number of accumulations present so that the result is a NO answer for this indicator. Otherwise, very large and apparently single accumulations of wood would be recorded as being within the normal range of 1-12 accumulations and result in a YES answer or false positive.

Surface Sediment Characteristics

Record if more than half the reach has a mainly heterogenous or homogenous substrate. Most streams have heterogenous substrates. These are substrates that have several sediment size classes sorted by stream flows so that boulders tend to be more apparent in the faster flowing middle sections of the stream, while the smaller gravels and sands end up closer to the sides of the stream. Different size classes of sediment tend to be "clumped," with recognizable groups of boulders or cobbles separated by smaller cobbles or gravels.

In most cases, a stream with a homogeneous substrate will have streambed materials primarily made up of only one sediment class (e.g., only mud, or sand, or cobbles, etc.). Homogenous streams tend to be those with little ability to move sediment, excessive new sediment introductions, or conversely, those that lack sediment input.

In rare cases, a streambed made up of several sediment classes is also homogeneous if the sediments are unsorted by stream flows, and thus still randomly mixed. (A truck load of boulders, cobbles, gravel, and sand all mixed together would be called homogenous.).

Deep Pools

Count the number of deep pools present to determine if there are at least two in the sample reach.

To be a "deep pool", pool depth from the deepest part of the pool to the mean annual high water mark (assume this to be the same as the "rooted edge") has to be twice the average channel depth at stable, undisturbed pool/riffle breaks (a "break" is the boundary where the water surface of a pool "breaks" at the upper end of a riffle). Ignore the water level when assessing pool depth or channel depth (see Figure 7). Water level is not relevant for measuring the presence of "deep" pools.

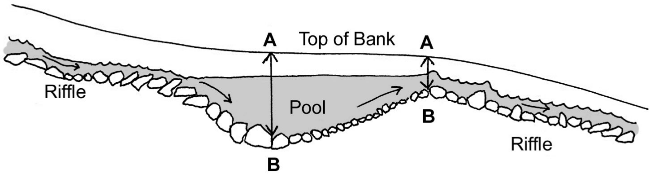

Figure 7. To see if you have a "deep" pool, measure pool depth from the deepest part of the pool to the top of the bank (A to B), not the water. This is channel depth for the pool. Channel depth at deep pools needs to be at least twice as deep as the channel depth at stable, undisturbed pool/riffle breaks or boundaries (A′ to B′).

In streams where pools are separated by water flowing over logs, the logs represent riffles. In these cases, measure channel depth from the deepest spot along the top of the log to the rooted edge of the banks. Log steps can often be the only "riffles" in low gradient streams, especially streams with organic substrates.

For step-pool type channels, do not confuse "deep pools" with the "deep plunge pools" you are also asked to measure in step-pool channels. A "deep plunge pool" in a step-pool channel only has to be as deep at zero flow as the largest rock in the boulder step or line that forms the plunge pool. This may or may not be as deep as twice the channel depth for the step.

When measuring channel depth in step-pool type streams, do not measure channel depth at a riffle right at the step. Instead, measure riffle depth from the channel bed just **upstream** of the step to the rooted edge of the bank.

Connectivity

Make a note here of any structure or channel characteristic that breaks the normal movement of fish upstream or flow of sediments and debris downstream. On fish-bearing streams, round metal culverts are automatically considered impediments to fish movement unless it is clear that fish passage objectives were to be achieved by embedding the culvert into the channel bed to maintain channel gradient and to recruit a natural stream bottom. Any culvert or bridge can also block or impede sediment and debris movement if the opening is too small to accommodate peak flows. Look for evidence of significant debris or sediment buildup at the entrance to any crossing structure.

Log jams or beaver dams that completely span the channel are frequent blockages to sediment and debris if they are solid, with little room for water to flow through. Consider them blockages if more than two-thirds of the water present at bank-full or lower flows has to seep through or flow over the structure.

Other examples of a lack of connectivity include "dewatering" where short or long sections of the channel are completely dry because the water is flowing entirely beneath excess deposits of gravel instead of on top of the gravel. The stream may also be down cutting into the streambed at such a rate that tributary streams or floodplain areas are no longer accessible to fish. Roads that lack suitable drainage structures, particularly in floodplains, can also effectively isolate off-channel areas from the main stream channel.

Fish Cover

There are seven basic types of fish cover – deep water, woody debris, undercut banks, overhanging vegetation, unembedded boulders, interstitial spaces, and instream vegetation. Interstitial spaces are the nooks and crannies in unembedded gravels and cobbles that small fish can hide in. Woody debris typically includes the woody material derived from the branches, stems and root wads of trees. In this case, it also includes other organic debris such as shredded wood or leaves that fish can hide in.

To be considered present, each type of cover should represent at least 1% of the channel area sampled. For example, in a 5 m wide by 150 m long stream reach sample, there would have to be 7.5 m^2 of each cover type (1% of $5 \times 150 = 7.5$ m^2) present.

Fine Inorganic Sediments

Note if there are any local concentrations or deposits of coarse sand and finer-sized sediments that entirely cover the streambed such that there are no larger particles (gravel, cobbles, boulders) visible. This is what is meant by fine sediments "blanketing" the substrate. To be considered present, at least one such deposit by itself should cover at least 1% of the total channel bed area present.

Note whether or not the dominant substrate particles present are buried or embedded in a matrix of smaller-sized particles. Gravels, cobbles, and boulders that are covered, buried, or embedded in sand and finer size particles are the main concern. However, boulders can also be embedded in small gravels. You can't see the sides of embedded particles, only the tops of the particles.

Note if there are any parts of the channel bed present that you sink into easily when you walk on it, or areas that you can easily wiggle your foot into. This is what we are calling "quick-sand" or "quick-gravel."

Bank Microclimate Soils

Moisture loving plants are invariably present in riparian habitats. They include true aquatics such as pond weeds, emergent plants that have their "feet" in water such as cat tails and rushes or sedges, and plants dependent on a high water table or seasonal inundations such as skunk cabbage, Devil's Club, salmon berry and willows. Moisture loving plants also include a wide variety of bryophytes such as ferns, mosses and liverworts. Mark Yes to Question 13 c if these plants are present and in good condition, not scorched, mottled, desiccated, brittle or otherwise stressed due to the habitat drying out. Do not confuse dead vegetation at the end of the growing season or last years growth with vegetation dried or killed by drought conditions. Determine if the soils that form the banks are mostly cool or warm, moist or dry, or intact or not (not collapsing or sloughing into the stream). "Mostly" would mean half or more of the reach length. However, for most streams, all bank soils should be cool, moist, and intact. Any conspicuous deviation from this should be noted.

Note if the banks support moisture loving mosses, bryophytes, herbs or shrubs. Note also if they are in vigorous condition, not dry, brittle, or scorched. Bare, trampled, culverted, rip-rapped or collapsing banks will lack moisture loving plants typical of riparian areas. Naturally dessicated or recently exposed sites may also lack these species.

Riparian Structure

Note if there are any vegetation layers or components of healthy, unmanaged riparian areas that are missing or under-represented. Consider the site characteristics and the biogeoclimatic zone. To be considered missing or under-represented, the number of plants in any particular layer should be less than 75% of the expected number. If you do not know what the expected structure of the normal plant community is or what the relative abundance of the main components should be, look at an otherwise undisturbed site upstream and use this as a benchmark.

Be conservative in your assessments. Try not to compare your site to an “ideal” site. Forest structure is naturally variable, so consider this variability when deciding if any one component is under represented.

Use Table 3 on the riparian field cards to help answer this Other Indicator question. This table is a guide that is best used where the riparian vegetation has been recently altered. It is not needed if the mature forest is intact and undisturbed. For each box under a vegetation layer or structural component in Table 3, record approximately what percentage of that component you feel is present compared to an otherwise healthy, unmanaged area. In most cases this will be a comparison made with a mature climax forest. Do this for each layer and component. In the second-to-last box, record the total of all the percentages. Divide the total of the percentages by the number of vegetation layers or structural components assessed and record this number in the last box. This is your answer for Q15(a) in “Other Indicators”.

The example table below shows what a completed table might look like for a second growth forest in the CWH that was first harvested 60 years ago. It has a tall, closed canopy formed exclusively of Douglas firs, no snags, little CWD except what was left when the forest was first harvested, few under-story trees, heavy browse on the few small shrubs present, an under developed lichen community, and only old, very decayed CWD. A score of “100” was recorded for the main tree layer, but a score of “50” was recorded for under-story trees because they were almost absent. Similarly, scores of “0” were recorded for the snags and gaps because these components were missing altogether. The moss layer was well represented, but not the low shrub or herbaceous layers, possibly due to shading and heavy browse by deer.

The number of species in the lichen community was also very limited, as was the number of CWD decay classes present. Total score for the 10 layers was 500%, for an average score of 50% (500 ÷ 10). Because this is less than the 75% established as a cutoff, the answer to Q 15(a) would be No.

A 60 Year Old Managed Stand in the CWH

Snags (%)	Gaps (%)	Over-story trees (%)	Under-story trees (%)	Tall shrubs (%)	Low shrubs (%)	Herbs (%)	Mosses (%)	Lichens (%)	CWD (%)	Total (Sum of %s)	Average % (Answer to Q15a)
0	0	100	50	100	50	50	100	25	25	500	50

Each score assigned to a vegetation layer or structural component should be based on what you believe the minimum value would be. If you know that the shrub layer is highly variable but typically covers 20 - 80% of the area in a certain BEC zone or BEC zone variant, then any coverage of 20% or more should get a score of 100%. If shrubs only covered 10% of the area, then your score might then be 50%.

For some areas you may know that a certain layer or component should be present, but more specific information on what the coverage should be is lacking. In this case, any representation at all should probably get a score of 100%. As an example, you may know that the normal healthy, unmanaged riparian area has standing snags, but not how many. In this case it is probably wisest to give a score of 100% for one snag, and 0% if there are no snags.

Note that not all riparian areas are expected to have each of the layers or components listed in Table 3. Natural grasslands, sedge meadows, and shrub-carr complexes to name a few vegetation communities naturally lack snags and trees. CWD levels and the lichen community can similarly be expected to be quite different. Other riparian areas may naturally have a well developed tree layer with few openings, but lack herbaceous vegetation or moss cover. For these simpler types of communities, record “NA” for the layers or components not expected. Base the overall average percentage in the last box on the number of layers or components expected.

Riparian Form, Vigor, Recruitment

Decide if the form, vigor, and recruitment of the vegetation layers and other forest components present collectively approach 75% of what a healthy, unmanaged riparian area would normally be along the reach. Use Table 4 on the riparian field cards to help answer this Other Indicator question. In Table 4, each vegetation layer and structural component of the riparian community is given a Yes or No answer in terms of its form, its vigor, and its recruitment. Where one or more layers or components are naturally lacking in the mature, healthy, unmanaged state, record "NA" for those layers. Also record "NA" where the vigor of a gap, snag, or CWD component makes no sense. Record the total number of Yes answers in the third column from the right, and the total possible number of Yes answers in the second column from the right. Calculate the percent of eligible cells with Yes answers and record this in the last column. If the last number is 75% or more, mark Yes for the question indicating that collectively the form, vigor, and recruitment of the riparian approaches what is expected at similar but otherwise healthy, unmanaged riparian areas.

The table below is an example of an assessment for a 60-year-old stand that started as a clear cut. As before, it has a tall, closed canopy formed exclusively of Douglas fir, no snags, little CWD except what was left when the forest was first harvested, few under-story trees, heavy deer browse on the few small shrubs present, and an under developed lichen community.

Riparian Vegetation Form, Vigor and Recruitment for a Riparian Area Clear-cut to Both Edges of the Stream 60 Years Ago

	Snags	Gaps	Over-story trees	Under-story trees	Tall shrubs	Low shrubs	Herbs	Mosses	Lichens	CWD	Total possible number of Yes answers	Actual number of Yes answers	% of cells with Yes answers (Answer to Q15b)
Form	N	N	Y	N	Y	Y	Y	Y	N	N	25	17	(17/25 x 100) = 68%
Vigor	NA	NA	Y	NA	N	Y	Y	Y	NA	NA			
Recruitment	Y	Y	N	N	Y	Y	Y	Y	Y	Y			

With no snags or under-story layer, no gaps in the over-story, and all of the CWD in an advanced state of decay, a No answer is given to these layers and components for form. The over-story trees were given a Yes answer, though it could have been answered No if other tree species were felt to be under-represented. The lichen community was similarly under developed.

Vigor is conceptually impossible to score for snags, gaps and CWD and so "NA" is recorded for these components. "NA" is also recorded for the under-story and lichen layers that are missing and cannot be assessed. With the exception of the low shrubs, all other layers showed normal vigor. Vigor for the low shrubs was given a No answer due to the heavy deer browse evident.

A Yes answer is recorded for snags, gaps, and CWD by recruitment because there is a well developed tree layer present that should soon start contributing to the snag and CWD components and forming gaps in the canopy. Recruitment to the tree and under-story layers themselves is poor due to the absence of any seedlings. All other layers showed some recruitment in the form of smaller or younger specimens. The total score was 17 Yes answers out of a possible 25, for an overall average of 68%. Although close to the target of 75%, a No answer is given for this Indicator Question as a whole.

Browsing/Grazing

A heavily browsed shrub is a shrub with half of its stems browsed down to second year wood. The presence of just one heavily browsed shrub in the riparian area is all you need to conclude there is heavy browse present in the riparian area. A stem that has been chewed off by a beaver also constitutes heavy browse.

Heavy grazing is where stubble height of a forage species is less than the recommended minimum for that species. Consider the riparian area free of heavy grazing if 90% or more of the available forage has a stubble height greater than the recommended minimum.

Appendix 1

Disturbance-increaser species list

Strawberry (*Fragaria* spp.)
Cinquefoil (*Potentilla* spp.)
Yarrow (*Achillea millefolium*)
Baltic rush (*Juncus balticus*)
Dandelions (*Taraxacum* spp.)
Sow thistles (*Sonchus* spp.)
Foxtail barley (*Hordeum jubatum*)
Goatsbeard (*Tragopogon dubius*)
Clovers (*Trifolium* spp.)
Pineapple weed (*Matricaria matricariodes*)
Dock (*Rumex* spp.)
Pasture sage (*Artemisia frigida*)
Gumweed (*Grindelia squarrosa*)
Pussytoes (*Antennaria* spp.)
Buttercups (*Ranunculus* spp.)
Bluegrasses (*Poa* spp.)
Plantains (*Plantago* spp.)

Common noxious weeds within all regions of British Columbia

Common name	Latin name	Page number[a]	Description
Annual sowthistle	*Sonchus oleraceus*	p57, P13	milky juice in stem (garden and roadside weed)
Purple nutsedge	*Cyperus rotundus*	p14b	
Yellow nutsedge	*Cyperus esculentus*	p362, P21	weed of cultivated fields (leaves triangular)
Canada thistle	*Cirsium arvense*	p32, P4&55	leaves & stems prickly, flowers less than 2.5 cm (aggressive crop weed, can reduce yield by 100%)
Rush skeletonweed	*Chondrilla juncea*	P15b	yellow flowers, deep rooted, tiny leaves on stems
Crupina	*Crupina vulgaris*	P5b,c	
Scentless chamomile	*Matricaria maritima*	p48, P16	daisy like flowers (forage area weed)
Dalmatian toadflax	*Linaria dalmatica*	p136, P6,23	yellow flowers up to 1.2 m – pasture, rangeland and roadside weed
Yellow toadflax	*Linaria vulgaris*	p138, P23	aggressive rangeland weed

Common name	Latin name	Page number[a]	Description
Spotted knapweed	*Centaurea maculosa*	p28	purple flowers (pasture and roadside weed) – not in Field Guide to Noxious Weeds… of BC
Diffuse knapweed	*Centaurea diffusa*	p29, P7	white flowers (pasture and roadside weed)
Yellow starthistle	*Centaurea solstitialis*	p29, 22c	yellow flowers
Tansy ragwort	*Senecio jacobaea*	p59, P18,28	yellow ray flowers – distinguishes it from common tansy, toxic to livestock
Dodder	*Cuscuta spp.*	p260, P8	climbing parasite on agricultural crops – no green parts
Velvetleaf	*Abutilon theophrasti*	p228, P19	can grow to 2 m plus, weed in corn or soy crops
Gorse	*Ulex europaeus*	P10b	spiny shrub, south coastal and islands
Wild oats	*Avena fatua*	p172, P20	serious crop weed, annual
Hound's-tongue	*Cynoglossum officinale*	P9b	seeds like velcro
Jointed goatgrass	*Aegilops cylindrica*	P11b,c	
Leafy spurge	*Euphorbia esula*	p368, P12	weed of pastures, range and roadsides, poisonous to livestock. Greenish yellow flowers with 2 yellow bracts
Perennial sowthistle	*Sonchus arvensis*	p54, P13	crop weed, clasping stem with milky latex in stems

a Page numbers following a lowercase 'p' are given for the descriptions found in Weeds of Canada. 1999. Royer and Dickerson. Lone Pine Publishing and The University of Alberta Press. Page numbers following an uppercase 'P' are from the Field Guide to Noxious Weeds and Other Selected Invasive Plants of British Columbia. 2005. Cranston et al. British Columbia.

Common noxious weeds within the boundaries of the corresponding regional districts

Common name	Latin name	Regional district	Page number[a]
Blueweed	*Echium vulgare*	Cariboo, Central Kootenay, Columbia-Shuswap, East Kootenay, Okanagan-Similkameen, Thompson-Nicola	p76, P24
Burdock	*Arctium spp.*	Bulkley-Nechako, Cariboo, Columbia-Shuswap, Fraser-Fort George, Kitimat-Stikine, North Okanagan, Okanagan-Similkameen, Peace River, Thompson-Nicola	p21, P25
Cleavers	*Galium aparine*	Peace River	p72, P26
Common bugloss	*Anchusa officinialis*	Kootenay-Boundary	pNA,[b] P27
Common tansy	*Tanacetum vulgare*	Bulkley-Nechako, Central Kootenay, Columbia-Shuswap, East Kootenay, North Okanagan	p58, P28
Field scabious	*Knautia arvensis*	Bulkley-Nechako, Kootenay-Boundary, Thompson-Nicola	p382, P29
Green foxtail	*Setaria viridis*	Peace River	p198, P30
Hoary alyssum	*Berteroa incana*	Kootenay-Boundary	pNA, P27
Hoary cress	*Cardaria spp.*	Columbia-Shuswap, North Okanagan, Thompson-Nicola	p272, P32
Kochia	*Kochia scoparia*	Peace River	p158, P33
Marsh plume thistle	*Cirsium palustre*	Bulkley-Nechako, Fraser-Fort George	pNA, P34
Meadow knapweed	*Centaurea pratensis*	Columbia-Shuswap	pNA, P35
Night-flowering catchfly	*Silene noctiflora*	Peace River	p326, P36

Common name	Latin name	Regional district	Page number[a]
Orange hawkweed	*Hieracium aurantiacum*	Bulkley-Nechako, Cariboo, Central Kootenay, Columbia-Shuswap, East Kootenay, Thompson-Nicola	p40, P37
Oxeye daisy	*Chrysanthemum leucanthemum*	Cariboo, North Okanagan, Thompson-Nicola, Peace River	p30, P38
Perennial pepperweed	*Lepidium latifolium*	East Kootenay, Thompson-Nicola	pNA, P39
Plumeless thistle	*Carduus acanthoides*	Central Kootenay	p27, P40
Puncture-vine	*Tribulus terrestris*	Okanagan-Similkameen	p96, P41
Purple loosestrife	*Lythrum salicaria*	Comox-Strathcona (by regional district bylaw)	p224, P80
Quackgrass	*Agropyron repens*	Peace River	p170, P42
Russian knapweed	*Acroptilon repens*	North Okanagan	pNA, P44
Russian thistle	*Salsola kali*	Peace River	p162, P43
Scotch thistle	*Onopordum acanthium*	North Okanagan	pNA, P45
Sulphur cinquefoil	*Potentilla recta*	Columbia-Shuswap, North-Okanagan, Okanagan-Similkameen, Thompson-Nicola	p357, P46
Tartary buckwheat	*Fagopyrum tartaricum*	Peace River	p82, P89
White cockle	*Lychnis alba*	Peace Rive	p328, P36
Wild chervil	*Anthriscus sylvestris*	Fraser Valley	pNA, P47
Wild mustard	*Sinapsis arvensis*	Peace River	p266, P48

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b NA = not available in the Weeds of Canada publication.

Invasive plant species of British Columbia

Common name	Latin name	Page number[a]
Anchusa	*Anchusa officinalis*	pNA, P27
Baby's breath	*Gypsophila paniculata*	p320, P50
Black knapweed	*Centaurea nigra*	pNA, PNA
Blueweed	*Echium vulgare*	p76, P24
Brown knapweed	*Centaurea jacea*	pNA, PNA
Bull thistle	*Cirsium vulgare*	pNA, P55
Canada thistle	*Cirsium arvense*	p32, P4
Common burdock	*Arcticum minus*	pNA, P25
Common tansy	*Tanacetum vulgare*	p58, P28
Dalmation toadflax	*Linaria dalmatica*	p136, P6
Diffuse knapweed	*Centaurea diffusa*	P29, P7
Field scabious	*Knautia arvensis*	P382, P29
Giant knotweed	*Fallopia sachalenensis*	PNA, PNA
Gorse	*Ulex europaeus*	pNA, P10
Hoary alyssum	*Berteroa incana*	pNA, P31
Hoary cress	*Cardaria draba*	P272, P32
Hound's-tongue	*Cynoglossum officinale*	pNA, P9
Japanese knotweed	*Fallopia japonica*	p91, P71
Leafy spurge	*Euphorbia esula*	p368, P12
Marsh plume thistle	*Cirsium palustre*	pNA, P34
Meadow hawkweed	*Hieracium caespitosum*	pNA, P37

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Common name	Latin name	Page number[a]
Meadow knapweed	*Centaurea debeauxii*	pNA, P35
Nodding thistle	*Carduus nutans*	p26, P40
Orange hawkweed	*Hieracium aurantiacum*	p40, P37
Oxeye Daisy	*Leucanthemum vulgare*	p30, P16
Perennial pepperweed	*Lepidium latifolium*	pNA, P39
Plumeless thistle	*Carduus acanthoides*	p27, P40
Puncture-vine	*Tribulus terrestris*	p96, P41
Purple loosestrife	*Lythrum salicaria*	p224, P80
Rush skeletonweed	*Chondrilla juncea*	pNA, P15
Russian knapweed	*Acroptilon repens*	pNA, P44
Scentless chamomile	*Matricaria perforata*	p48, P16
Scotch broom	*Cystisus scoparius*	pNA, P82
Scotch thistle	*Onopordum acanthium*	pNA, P45
Spotted knapweed	*Centaurea biebersteinii*	p28, P17
St. John's-wort	*Hypericum perforatum*	pNA, P85
Sulphur cinquefoil	*Potentilla recta*	p357, P46
Tansy ragwort	*Senecio jacobaea*	p59, P18
Teasel	*Dipsacus fullonum*	pNA, PNA
Yellow iris	*Iris pseudacorus*	pNA, PNA
Yellow starthistle	*Centaurea solstitialis*	p29, P22
Yellow toadflax	*Linaria vulgaris*	p138, P23