

Protocol for Evaluating the Condition of Streams and Riparian Management Areas

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FREP Abstract

The *Forest and Range Practices Act* (FRPA) introduces the transition to a results-based forest practices framework in British Columbia. Under this new approach to forest management, the forest industry is responsible for developing results and strategies, or using specified defaults, for the sustainable management of the 11 resource values (subject areas) identified under FRPA. The role of government is to ensure compliance with approved results and strategies, and other practice requirements, and evaluate the effectiveness of forest and range practices in achieving government's objectives for FRPA's resource values.

Resource stewardship monitoring (RSM) is a key component of the provincial FRPA Resource Evaluation Program (FREP).

Resource stewardship monitoring will help identify implementation issues regarding forest policies, practices, legislation, and Forest Stewardship Plan results and strategies. As a result, RSM will be a fundamental component for implementing continuous improvement of forest management in British Columbia.

FREP has been put in place as a multi-agency program to evaluate whether practices under FRPA are meeting not only the intent of the current FRPA objectives, but to determine whether the practices and the legislation itself are meeting government's broader intent for the sustainable use of resources.

FREP is a long-term commitment designed to:

- assess the effectiveness of FRPA and its regulations in achieving stewardship objectives
- determine if forest and range policies and practices are achieving government's objectives, with a priority on environmental parameters, and consideration for social and economic parameters, where appropriate
- identify issues regarding the implementation of forest policies, practices and legislation as they affect achieving stewardship objectives
- implement continuous improvement of forest management in British Columbia.

In order to accomplish these objectives, FREP will:

- develop specific monitoring and evaluation questions to be addressed
- document the status and or trends of resource values over time through the use of detailed protocols
- identify causal factors where the status or trend is found to be undesirable
- determine whether resource values are being managed in a sustainable manner through proven or alternative forest practices
- communicate the results of evaluations
- recommend changes to forest and range policies and legislation, where required.

Foreword

This handbook is for anyone with a basic working knowledge of streams and/ or riparian habitats, including forest and range planners, developers, and other land users. It is not essential that a person have expert knowledge on any aspect of the subject. In fact, generalists are apt to be more consistent in their assessments because they are less likely to interpret the questions and their indicators, or get overly involved in detailed measurements at the expense of other indicators.

This handbook and the associated checklist are like having a professional or expert on stream-riparian interactions and land-use impacts in your back pocket. The checklist guides the user to a conclusion on the relative health of a stream and its riparian habitat in a timely fashion. Field experience indicates that, with a little practice, riparian assessments can be completed in 1–2 hours.

Even experts can benefit from using the riparian checklist because it covers almost all the basic information required to support “expert opinions” which can be difficult to defend without data. The checklist encourages observation with a repeatable methodology that can be used to support the results of a field review. The methodology has been field tested by people with varied backgrounds and levels of experience, and found to be a consistent method of assessing the health of streams in BC. Perhaps more importantly, the conclusions drawn from the checklist make sense and ring true because they can usually be clearly linked to specific indicators that can be consistently observed or measured.

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Document Purpose

The following protocol was created to provide background information and instructions for data collection for riparian-fish Resource Stewardship Monitoring of the BC Ministry of Forests FRPA Resource Evaluation Program.

Goal of Riparian and Stream Channel Monitoring

The goal of monitoring the condition of stream channels and their adjacent riparian management areas is to determine whether FRPA standards and practices governed by regulation are achieving the desired result of protecting fish values by maintaining channel and riparian functions.

“Are riparian forestry and range practices effective in maintaining the structural integrity and functions of stream ecosystems and other aquatic resource features over both short and long terms?”

Objectives of the Evaluation Process - Why Assess Effectiveness

The routine riparian evaluation arose out of a need to assess the effectiveness of riparian management practices, rather than compliance with a highly prescriptive set of rules. Prior to the *Forest and Range Practices Act*, there was an implicit assumption that compliance with legislation and regulations would lead to improved riparian management. Only rarely, however, was this assumption ever tested.

In 2000, the Forest Practices Board of British Columbia conducted a special investigation on the impacts of coastal logging on streams five years after implementation of the Forest Practices Code. The results showed marked improvements over the level of impacts in most streams prior to the Code (Tripp 1992, 1995); however, some streams were still being impacted. That study assessed relatively few attributes of streams, and even fewer attributes of the riparian area. The properly functioning condition of the streams and their riparian habitats as a whole was not assessed.

Principles of Site Selection

A number of statistical design principles were used to develop site selection protocols for resource stewardship monitoring. These principles ensure that the data collected and analyzed can be used at multiple scales (district, region and province) with statistical validity and credibility.

The sampling population is the entire population of potential sites that could be sampled for a given resource value. To ensure the results are objective and defensible, all sites sampled under resource stewardship monitoring will be selected using random sampling.

The number of sites sampled can vary depending on available resources, variability across the population, or the anticipation of problem sites. For 2005, the number of sites sampled per forest district is set at 15, although a district may choose to sample more sites.

For additional information on the site selection process, refer to *Protocol for 2005 Resource Stewardship Monitoring* at: (http://www.for.gov.bc.ca/hfp/frep/7_rsm.html).

Site Selection Criteria for Riparian-Fish for 2005

For riparian-fish, each participating district will be provided with a population list of 200 sites randomly generated from the Forest Tenure Administration (FTA). The list is located on the Forest Practices Branch FTP server at: (ftp://hfp/mof_internal/publish/resource_stewardshipmonitoring).

From the list of 200 sites, each district will begin at the top of the list and select 15 sample sites, working down in sequential order. Site selection criteria include:

- Cutblocks limited to those harvested under the Forest Practices Code based on silviculture prescriptions (SPs) approved after June 15, 1997 to ensure that SPs were prepared and forest practices were conducted under full knowledge of Code regulations and the principles and objectives of riparian management guidelines.
- Cutblocks limited to those harvested no later than the end of 2003 to ensure all streams were exposed to at least two years of post-harvest environmental conditions (e.g., storms).

The sites for the riparian-fish population are actually defined as the individual stream reaches within streams that occur on the sampled cutblocks. It is assumed that all individual streams are statistically 'independent' even if they occur together within one cutblock and/or watershed. Thus, cutblocks will be ignored in the data analysis.

If all of the streams on a cutblock can not be sampled due to their great number then at least one of each stream type present will be sampled. Individual streams to be sampled will be chosen using random selection.

If a district completes sampling the first 15 blocks from the list and wishes to collect additional data, the next sites should continue to be selected sequentially from the random list.

Sites should only be removed from the list for very specific reasons which must be recorded. If a site clearly does not belong to the population, it can be deleted. Questions regarding whether a site is in or out of the defined population should be referred to the Resource Value Team (RVT). One reason a site may be deleted from the population is if active nearby harvesting or other activities in the block make it too dangerous to sample. If there are other reasons for considering deleting a site, these should be discussed with the RVT.

Indicators

The indicators used to assess riparian and stream channel monitoring include:

- channel bed disturbance
- channel bank disturbance
- LWD processes (jams)
- channel morphology
- aquatic connectivity
- fish cover diversity
- moss abundance and condition
- fine sediments
- aquatic invertebrate diversity
- windthrow frequency
- riparian soil disturbance
- LWD supply
- shade and microclimate
- disturbance-increaser plants
- vegetation vigour, form and structure.

Introduction

What is Properly Functioning Condition?

As a measure of overall riparian health, properly functioning condition is a concept that has not been used much in forest harvest planning in BC, but is a widely accepted concept in range planning. The *Riparian Management Area Guidebook* (Province of B.C. 1995) states that riparian habitats will be maintained in properly functioning condition if the impacts of development on the attributes of the riparian area are:

1. on average, small or within the range of natural variability of the habitat; or
2. large and beyond the range of natural variability in no more than a small portion of the habitat.

The key underlying assumption is that if the range of impacts attributable to the management activity affecting the riparian habitat lies “within the range of natural variability over most of the habitat, it is likely that the natural ecological functions of the habitat will be maintained.”

Properly functioning condition as defined in the Forest Practices Code is the ability of a stream, river, wetland or lake and its riparian area to:

- a. withstand normal peak flood events without experiencing accelerated soil loss, channel movement or bank movement;
- b. filter runoff; and
- c. store and safely release water.

The above definition is expanded here to include the need for fish habitat in streams and riparian areas to be fully connected so that fish habitat is not lost or isolated as a result of some management activity. The ability of the riparian habitat to maintain an adequate root network or large woody debris (LWD) supply, and to provide shade and reduce bank microclimate change, is also included in the definition of properly functioning condition. This is in keeping with recommended best management practices for logging by different stream types in the *Riparian Management Area Guidebook* (Province of B.C. 1995).

How is Properly Functioning Condition Assessed?

To assess the properly functioning condition of each reach, 15 “main” questions are asked about key characteristics of healthy streams and their riparian habitats. These are the types of questions that stream and riparian experts might ask themselves if required to assess the condition or health of a stream. The answers to the questions determine the properly functioning condition of the stream.

To help experts and non-experts alike answer each main question, a number of “indicator” statements are provided that also require a Yes or No answer. The indicator statements refer to specific attributes that can be more easily assessed or measured than the more general main questions. The number of Yes or No answers to the indicator statements determines if the answers to the main questions are Yes or No. The properly functioning condition of the stream is based on the total number of No answers to the main questions.

Question 1 below is provided as an example to illustrate a main question and its associated indicator statements. For Question 1, two Yes answers to the indicator statements are required in order to answer Yes to the main question. The need for only two out of three Yes answers indicates that some of the indicators are inherently quite variable, and that the question as a whole is judged more leniently.

	Yes	No	N/A
The "main" question →	Question 1. Is the channel bed undisturbed? ☐ ☐ ☐		
<i>Note: For Questions 1–4, decide what the predominant channel morphology is and then complete the section for that morphology only (i.e., Part A, B or C, not all three).</i>			
A) Riffle-pool or cascade-pool channels			
The "indicator" statements →	a) Less than 50% of the reach length is occupied by active sediment wedges, mid-channel bars, or braided bars. ☐ ☐ ☐		
	b) Less than 50% of the reach has active multiple channels and/or braids. ☐ ☐ ☐		
	c) More than 50% of the reach has lateral, side or point channel bars, or a thalweg that meanders from bank to bank even if lateral bars do not seem obvious. ☐ ☐ ☐		
<i>If answer "Yes" to 2 or more, mark Yes box in Question 1.</i>			

TIP: Read all indicator statements carefully. Sometimes the meaning or intent of the statement is not immediately clear. This is because all statements are phrased so that a Yes answer is "good" or "healthy." No answers are always "not good" or "unhealthy."

Question 8 below is an example of a question where less lenience is allowed. If the answer is Yes to all of the indicator statements, then the answer to Question 8 is Yes. If any of the answers are No, then the answer to Question 8 is No. Question 8 does not allow for any No answers because of the sensitivity of streams to visible increases in sedimentation.

	Yes	No	N/A
The "main" question →	Question 8. Has the introduction of fine sediments been minimized? ☐ ☐ ☐		
The "indicator" statements →	a) Inorganic fine and sand-sized sediments that blanket the substrate are best described as little or lacking. ☐ ☐ ☐		
	b) Wetted areas of gravel, sand or fine-sized sediments that a foot can be easily pushed into represent less than 1% of the total wetted area. Mark 'N/A' if the stream is dry. ☐ ☐ ☐		
	c) Gravels and cobbles are not embedded in a matrix of sand or finer sized particles. The sides of individual gravel and cobble particles can generally be seen touching each other. ☐ ☐ ☐		
	d) Invertebrates sensitive to the effects of sedimentation can be easily found on the undersides of rocks in riffles. Mark 'N/A' if the stream is dry. ☐ ☐ ☐		
<i>If the answer is "No" to any statement, mark the "No" box for Question 8. Otherwise, mark the "Yes" box.</i>			

All 15 “Main” Questions

- Question 1. Is the channel bed undisturbed?
- Question 2. Are the channel banks undisturbed?
- Question 3. Are channel LWD processes undisturbed?
- Question 4. Is the channel morphology undisturbed?
- Question 5. Are all aspects of the aquatic habitat sufficiently connected to allow for normal, unimpeded movements of fish, organic debris, and sediments?
- Question 6. Does the stream support a good diversity of fish cover attributes?
- Question 7. Does the amount of moss present on the substrates indicate a stable and productive system?
- Question 8. Has the introduction of fine sediments been minimized?
- Question 9. Does the stream support a diversity of aquatic invertebrates?
- Question 10. Has the vegetation retained in the RMA been sufficiently protected from windthrow?
- Question 11. Has the amount of bare ground or soil disturbance in the riparian area been minimized?
- Question 12. Has sufficient vegetation been retained to maintain an adequate root network or LWD supply?
- Question 13. Has sufficient vegetation been retained to provide shade and reduce bank microclimate change?
- Question 14. Have the number of disturbance-increaser plants or noxious weeds present been limited to a satisfactory level?
- Question 15. Is the riparian vegetation within the first 10 m from the edge of the stream generally characteristic of the normal plant community?

Concluding on Properly Functioning Condition

The number of No answers to the 15 main questions is used to come to a conclusion on the properly functioning condition of the reach, as follows:

- a. 0–2 No answers, the stream is in properly functioning condition.
- b. 3–4 No answers, the stream is in properly functioning condition, but at risk.
- c. 5–6 No answers, the stream is in properly functioning condition, but at high risk.
- d. 7 or more No answers, the stream and riparian habitat is not functioning properly.

How to Assess Properly Functioning Condition

Selecting Eligible Reaches

As much preliminary information as considered necessary should be collected for review prior to selecting reaches or initiating routine riparian evaluations in the field. This information could include the best topographic maps available, road maps or road management plans, silviculture plans or prescriptions, logging plans, pasture locations, range use plans and maps, and air photos.

For areas where the impacts of logging is the main concern, the simplest way of selecting a reach is to consider any stream with the same stream classification and management activity on it within the block to be a reach. In most cases, the stream will probably have similar physical characteristics as well. Gradient and channel confinement are probably the most important characteristics to consider. If the pre-field information or your familiarity with a block or range area is sufficient to clearly distinguish multiple reaches with different physical characteristics within a harvest area, by all means do so. More often than not, this will not be possible until you are actually on site.

TIP: Roads, including ditch lines and cut and fill slopes, and cattle crossings can often cause significant changes to streams. They should always be considered when establishing reach boundaries or assessing the effects of any management activities.

TIP: If the stream reach or management activity is significantly less than 30 channel widths or 100 m in length, (e.g., 15 channel widths or 50 m), then the stream is not a good candidate for assessing effectiveness. That said, the definition of the management activity being assessed could be expanded to include multiple impacts. For example, an otherwise uniformly logged reach with a road crossing should probably be subdivided into an upper reach above the road and a lower reach below the road. If this means the reaches end up too short, then the upper and lower reaches could be combined into one reach. The reach would be a sample of a harvest treatment with a road crossing and could be compared to harvest treatments without road crossings.

Reach Verification in the Field

Once in the field, ensure that the management activity or streamside treatment is more or less the same throughout the reach. The reach should also be homogeneous with regard to logging history, gradient and confinement. If significant differences exist, the reach boundaries should be adjusted to ensure the reach is more or less the same throughout.

TIP: Road crossings frequently mark reach breaks. This is because roads are often located at the upper or lower end of confined stream reaches or the upper end of gully headwalls where it is easiest to cross streams and maintain suitable road grades.

When to do Riparian Evaluations

Properly functioning condition can be effectively assessed anytime of the year as long as the streambed and the ground conditions in the riparian area are clearly visible. However, the optimum time for assessment is a low flow period during the active growing season, when the streambed, stream banks and ground in the riparian area are clearly visible, and vegetation foliage is fully developed. Several indicators such as the length of reach with gravel bars or the presence of dewatering are stage dependent, and therefore best observed at the lowest flow period. Conducting the assessment at higher flow periods means the evaluation may not be as sensitive to declines in properly functioning condition.

For most areas of BC, the optimum conditions for evaluations coincide with the summer low flow period from July 1 to September 30. Many streams, however, particularly streams in areas that lack snow cover, can be assessed at other times of the year (e.g., lower-elevation sites in coastal BC prior to deciduous leaf fall).

Seasons have an effect on riparian evaluations, just as the year of the evaluation has an effect. Streams and riparian habitats are dynamic, and therefore constantly changing. Windthrow can differ from month to month or even day to day. Fine sediments that are introduced during high flow periods may only be visible on the streambed during low flow periods. Shade will be impossible to estimate after leaf fall unless “twig” or “branch” density can somehow be related to leaf density.

How Long Should the Reach Be?

A distance equal to 30 channel widths, or 100 m, whichever is greatest, is considered the minimum distance necessary for a riparian evaluation. This means that a stream with an average width of 20 m should be assessed over 600 m. A stream 5 m wide would be assessed over 150 m. A stream 2 m wide would be assessed over 100 m.

If there is still some doubt about the accuracy or completeness of the assessment after a reach has been evaluated, then more of the stream should be examined. For example, it may not be clear if large quantities of fine sediments noted on the streambed are related to conditions within the reach (e.g., windthrow) or to some other sediment source above the stream reach in question. This should be determined by walking to the upstream limit of the treatment being assessed.

As another example, it may be noted in the field that the reach section selected in the office does not really capture the effects of some windthrow because of the patchiness of the windthrow. In these cases, it may be necessary to assess longer sections of the reach, or to conduct separate assessments, one in the windthrow section and one outside the windthrow.

How Wide Should the Riparian Area Be?

Questions 10–15 focus on the riparian conditions beside the stream. Unless otherwise specified, the minimum width of the riparian area to consider for these questions is 10 m. Wider widths should be considered for Question 10 on windthrow if there are reserves present or management zones with prescriptions for some retention. In these cases, the entire reserve or management zone is assessed for windthrow.

For Question 11, the amount of bare ground or disturbed ground beyond the first 10 m from the stream edge is only considered if the ground is hydrologically linked to the first 10 m. Any ground on a 10% slope, from the edge of the first 10 m of riparian area up to the first topographic break is considered hydrologically linked to the first 10 m of the riparian area. Bare ground further away is hydrologically linked if a distinct channel or slide track connects the bare ground to the first 10 m of the riparian area. It is also hydrologically linked if the channel is connected to steep ground below the topographic break, as long as the steep ground below the break is directly connected to the first 10 m of the riparian area.

How Many Questions Need to Be Answered?

There are fifteen questions to answer after the reach is traversed and information on the various indicators has been collected. This is one more question than in September/October 2004 when the Ministry of Forests first began to train staff on the use of the routine riparian checklist. The additional question (Question 15) is intended to primarily cover the effects of grazing on riparian vegetation and soil characteristics.

All questions should be answered, or at least indicated as “Not Applicable” (NA) if that is the case. Otherwise, NA will be the default answer selected if the checklist has not been completed. If some applicable questions are not answered, the effects of the treatment being assessed may be underestimated.

Are All Questions Applicable in All Cases?

Not all questions will be applicable to all sites. When a question is “Not Applicable” it should be marked NA. For example, Question 4 on stream morphology is not applicable if the stream has no morphology formed by water, (i.e., it is considered a “non-alluvial” stream). Small (<2 m), steep (>30%) streams are typically non-alluvial because the stream lacks the energy to sort the bedload into recognizable patterns. Gravity is more important. Even large streams, however, can sometimes be non-alluvial if the bedload is too large for water to move and gravity is the dominant force responsible for bedload movement.

Other examples of questions that may be NA include:

- Question 6 on fish cover characteristics if the stream is non-fish bearing;
- Question 9 on the diversity of benthic invertebrates present if the stream is dry, or known to be dry virtually all year; and
- Question 15 on the vegetation characteristics of the riparian area if the stream is bedrock controlled.

Note: Riparian evaluations are not affected by questions that are NA for one reason or another. The conclusions about properly functioning condition depend only on the number of No answers. Eliminating questions that apply mainly to steep, dry, non-fish bearing streams may reduce the sensitivity of the assessment, but this may not be entirely inappropriate for these types of streams.

Note: Each question in the checklist has equal weighting. Some attributes may naturally be more important or sensitive than others, but these differences in importance have been taken into account by varying the thresholds for each indicator or changing the number of indicators that need to be met to obtain a Yes answer to a main question. Attributes that are naturally quite variable, such as the amount of eroding bank present, have a relatively high threshold. Others that have low variability or are naturally rare, such as the amount of bare ground present, have a lower threshold.

What If You Can't See All of the Reach?

In some cases, you may not be able to see all of the stream banks or the channel because of excessive debris or brush. Be aware that many thresholds are based on a percentage of “observable” reach length, not total reach length.

Measurement thresholds based on the length of the stream channel (e.g., % of reach with stable undercut banks, % of reach with mid-channel bars) should only be based on the length of the channel that is actually observed, not the total possible length. Similarly, areas of riparian indicators recorded (e.g., % bare ground) should only be based on the area of the riparian habitat measured. If sections of the riparian area are not observed, do not include these areas in the calculations of % coverage or occurrence.

What is Stream Channel Morphology (Questions 1 to 4)?

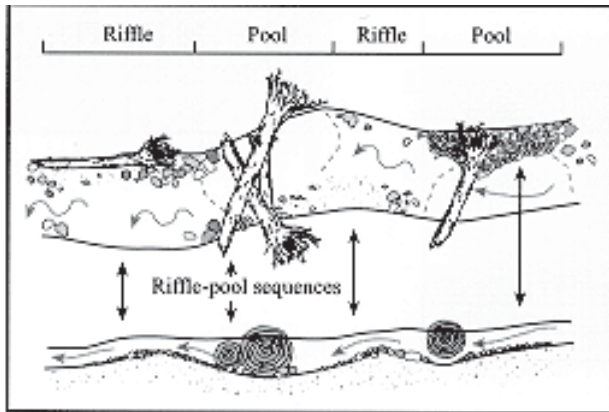
Questions 1 to 3 have three different sets of indicators, depending on the predominant morphology of the stream (or lack thereof). There is one set of questions for riffle pool or cascade pool type streams, one set for step pool type streams, and one set for non-alluvial streams. You only complete the section that best represents the stream reach.

Question 4 has two different sets of indicator questions, one for cascade/riffle pool type streams and one for step pool type streams. Since the main question is whether or not channel morphology has been altered, the question is Not Applicable for non-alluvial streams. By definition, non-alluvial channels have no morphology that is formed by water, and it therefore cannot be changed.

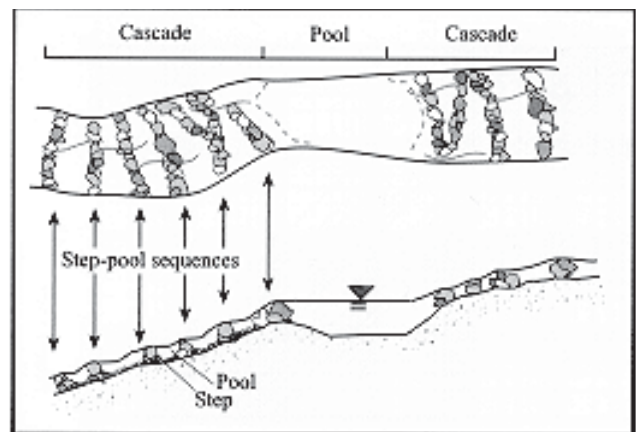
The three types of channel morphologies to know for the first two sets of indicator statements in Questions 1 to 4 are illustrated in Figure 1. They include:

1. Riffle pool and cascade pool type streams – low to moderate gradient streams (0-6% approximately), usually with abundant alluvial materials arranged by water into repeating sequences of riffles or cascades and pools. For riffle pool streams the main type of pool is usually a lateral scour type pool that has formed along one side of the channel. The main type of pool in a cascade type pool stream are is usually a small plunge pool or scour pool that has formed behind a boulder.

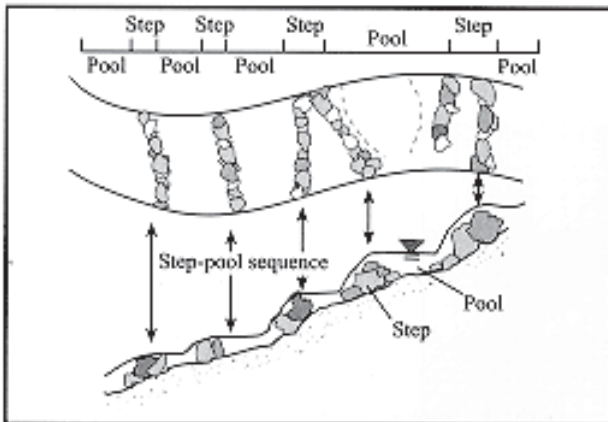
2. Step pool type streams –moderate to steep streams (6-30% approximately) with distinct steps where boulders are lined up across the channel (“stone lines”), usually with a distinct plunge pool below the step.



a) Riffle-pool morphology (RP_g and RP_c)



b) Cascade-pool morphology (CP_c and CP_b ; after Grant et al. 1990)



c) Step-pool morphology (SP_r , SP_b and SP_{b-w} ; after Church 1992)

Figure 1. The three channel morphologies for small- and intermediate-sized alluvial type stream channels.

An apparent variant of step pool types of stream is where roots or pieces of woody debris on small streams form a series of distinct steps, with small plunge pools below the step. However, these should not be considered step pool type streams because it is not the interaction between mineral sediments and water that is responsible for the steps at these spots, but the roots and woody debris. Streams with root or debris controlled steps should be either cascade/riffle pool streams or non-alluvial streams, depending on gradient.

Non-alluvial streams have no distinct morphology related to fluvial processes (water movement) because the flow of water in the stream does not have the energy to move the substrate material into any kind of recognizable pattern. Most movement of substrate is by gravity, possibly assisted by water.

Most non-alluvial streams are small, steep streams, especially in areas where the colluvial materials are large. These small streams are considered to be non-alluvial because the stream does not have enough energy to sort the parent bank material. The main force moving the channel sediment downslope is gravity, assisted by water. Large, powerful streams, however, can also be non-alluvial if there is no sediment small enough to be moved by the stream.

TIP. Non-alluvial streams have non-erodible banks. If the banks have any materials exposed that can be moved by flows in the stream, then the stream is alluvial.

TIP. If in doubt about the morphology, try answering the indicator questions for each type of morphology. Quite often the answer to the main question is the same regardless of stream morphology.

Getting Started

The following is a list of materials required to conduct a routine riparian evaluation:

- Normal field gear (e.g., rain gear, hard hat, vest, pencils, a 6-ring notebook, safety/first aid supplies).
- Suitable footwear. Riparian evaluations involve walking in, down and across streams. Unless the streams are small, with little water, waterproof boots are recommended at a minimum. Waders may be needed for larger, deeper streams.
- Measuring devices (at a minimum, a hip chain, a hand-held tape, clinometer and compass).
- Flagging tape.
- Cover class standards.
- Density-distribution standards.
- Benthic invertebrate example pictures.
- List of weed and disturbance species, with pictures of the most common species.

Other equipment that could be used, depending on experience or personal preference includes:

- GPS receivers;
- Small white plastic tray (for examining benthic invertebrates);
- “Cruise vest friendly” kick net (for benthic invertebrate sampling);
- Hand lens (for examining benthic invertebrates); and
- A “Teti” angular canopy densiometer (for measuring shade cover).

Basic Components of Routine Riparian Evaluations

There are five basic steps to a routine riparian evaluation:

1. Describing the Reach
2. Collecting the Field Data
3. Answering the Questions
4. Determining Functioning Condition
5. Commenting on the Assessment.

Describing the Reach

The first part of a routine riparian evaluation is the descriptive information needed to identify the reach. It includes basic information such as the opening # or pasture ID, the license # or range use plan, the licensee, the cutblock, the stream, the year of harvest, etc. It also includes the stream RMA classification and the stream ID of the reach being assessed.

The evaluation is sensitive to small differences in the reach section assessed, especially if management-related impacts are present. For this reason, it is important to describe the exact position of the reach. By convention, the exact distance from a convenient landmark such as a block boundary crossing or road crossing, to the lower (downstream) end of the reach should be recorded.

Collecting the Field Data

Collecting information or data on the various indicators used to answer the main questions on properly functioning condition is arguably the most important aspect of the evaluation. When completed, this data is a record of your observations on most of the indicators used in the evaluation. It will help decide which threshold values have been exceeded for most of the indicators used to answer the main question. Other people can use the information to double-check the answers in case there is a discrepancy between the number of Yes and No answers to the indicator statements and the Yes or No answer to the main question. This information can also be used to complete the checklist if a question was overlooked.

Many attributes can be measured in different ways. The methods suggested in this handbook are believed to be practical in terms of consistency and/or time, but other methods may be suitable if the results provide a fair assessment. For example, some experienced people may be comfortable making visual estimates of stem density for % windthrow. Others may not be familiar with windthrow and will want to use a consistent or straightforward method, such as direct counts of standing versus down trees.

Conduct the assessment by walking along the reach in the stream or along the bank, and back down again if necessary, measuring, estimating or noting indicators as required. The assessment can be done by one person, but is easier if done with a two-person crew.

Experience indicates that a two-person team is initially best for inexperienced people, or even experienced people who might be unfamiliar with the riparian evaluation procedures.

One member of the team should have a hip chain to record the overall reach length sampled, and thus the total riparian area surveyed. Both members should also have retractable style meter tapes to measure indicators like pool lengths, bar lengths, recently eroded banks, upturned root wad lengths on the banks, and lengths of multiple channels. Divide up the indicators so that one person measures (and records) certain indicators, while the other person measures other indicators and calls out the results to the recorder. Not all indicators will need to be measured since some will be obviously over or under the threshold values in the indicator statements. Experience suggests that most indicators will require at least some measurement at least until the thresholds are exceeded.

Initially, it may be difficult to remember all the measurements and/or observations that need to be made during a riparian evaluation. However, this becomes much easier with experience using the data form and conducting the measurement processes. The process also becomes easier as users become familiar with the threshold values that determine Yes or No answers to the indicator statements.

Recording the Field Data

The field data table at the end of the riparian checklist contains the most common indicators to be measured, with additional space for the actual measurements. The question the indicator relates to (e.g., Q7, Q8, Q9, Q13) is provided down the left-hand side of the form, while spaces for the average, mean or total value of each indicator are provided down the right-hand side.

The form has three different types of indicators – “Point,” “Continuous,” and “Other.”

Point Indicators

Point indicators are normally measured at discrete points along a traverse, and then averaged to arrive at a mean value. Where the reach seems highly variable, a minimum of six measurements spaced at equal intervals along the traverse is recommended. Fewer measurements may be needed if users are confident the measurements are accurate for the whole reach, or it is clearly evident whether the threshold value for the indicator is exceeded or not.

Specific point indicators and suggested methods of measuring them are as follows:

Moss abundance – Record as not abundant (i.e., little, lacking or occasional, <5% coverage), or abundant (i.e., frequent, common or abundant, >5% coverage).

Moss condition – Record as 1 (dead), 2 (stressed – i.e., desiccated, scoured, buried) or 3 (healthy).

Benthic invertebrate diversity – Record the number of different invertebrates observed in hand or kick net samples. Keep track of the total number of different types observed for the whole reach. It’s helpful to record the actual types observed in the notes (e.g., 1 mayfly type, 2 case-builder types, 1 snail, 1 leech).

% fines – Record percent coverage by inorganic fines or sands <4 mm in diameter along a line across the channel.

% shade – Visually estimate or record % shade using a “Teti” angular canopy densiometer, by comparison to percent shade example photographs, or by comparison to accepted cover class standards. % shade at any one point is the average of the two shadiest of E, S or W aspects. Measure shade at a 60 degree angle above the horizontal.

% vegetative cover – Record as % of ground protected from the direct impacts of rainfall. Sometimes this is best visualized as the opposite of % bare ground directly exposed to rainfall.

Disturbance-increaser species (m^2 or %) – Record the area or % of area occupied by disturbance-increaser species in the first 10 m of the riparian area.

Noxious weeds (m^2 or %) – Record the area or % of area occupied by noxious weed species in the first 10 m of the riparian area.

Heavy browse (% of browse plants) – Record the % of browse plants present with heavy browse down to second year wood.

Heavy grazing (% of forage plants) – Record % of plants with stubble height less than the recommended minimum stubble height.

Continuous Indicators

Continuous indicators are better measured or estimated over the entire length of the reach, rather than at discrete points. Ideally, users would document the occurrence of each indicator over the entire reach, but this may not be necessary if it is obvious the threshold value has been exceeded or not exceeded. If it is obvious the threshold value of an indicator has been exceeded (e.g., length of reach with pool habitat is greater than 25%), a note in the data sheet should indicate the approximate value.

Specific continuous indicators and suggested methods of measuring them are as follows:

Mid-channel bars, wedges (m) – Record the reach length occupied by mid-channel bars and sediment wedges. Use a hip chain or hand-held tape to directly measure the length of the reach with the bar types, or visually estimate the length in short manageable sections of known length.

Lateral bars (m) – Measure as per mid-channel bars and wedges.

Multiple channels (m) – Record the reach length where multiple channels are present. The latter includes wetted channels that are separated by bare gravel bars, and dry side channels separated by vegetated islands. Do not measure the reach length twice where side channels overlap.

Recently eroded bank (m) – Record the reach length with recently eroded banks, regardless of which side of the channel the eroded bank is located on. Be aware that non-erodible boulder or bedrock banks are not to be included in the calculations of % of reach with recently eroded banks.

Undercut bank (m) – Record the reach length with stable, vegetated undercut banks present, regardless of which side the undercut bank is located on. Be aware that non-erodible boulder or bedrock banks are not to be included in the calculations of % of reach with undercut banks.

Deep rooted bank (m) – Record the reach length with deeply rooted stream banks on the side(s) adjacent to the treatment(s) that is (are) being assessed.

Upturned bank root wads (m) – Record the reach length with recently upturned rootwads at the edge of the bank. Measure the length of each rootwad from the upstream edge to the downstream edge.

Recent debris jams (No.) – Record the number of recent (i.e., post-treatment) log jams that span all or most of the channel, and impede the normal downstream movements of sediment and debris.

Pool length (m) – Record the length of each pool present until satisfied the amount of pool habitat present exceeds the threshold for the indicator statement.

Deep pools (No.) – Record the number of pools present where depth from the bottom of the pool to the top of the channel is twice the channel depth in the riffle below the pool. Only two deep pools are needed to answer Yes to the indicator statement about the number of deep pools present.

Recent windthrow (No.) – Count the number of recent (i.e., post-harvest) windthrown trees present in the designated reserve or management area. A simple visual estimate of % windthrow is appropriate if the % of trees windthrown is clearly much greater than 10% of the trees, or less than 1%.

Old windthrow (No.) – Count the number of old (i.e., pre-harvest) wind thrown trees present if it looks like the amount of old windthrow needs to be accounted for in assessing the significance of recent windthrow.

Standing trees (No.) – Count the number of standing trees present if the % of trees windthrown could be between 1–10% of all stems. Rougher estimates of the number of trees standing are appropriate if windthrow is clearly less than 1% or greater than 10%.

Bare soil in first 10 m (m^2) – Locate and visually estimate the area of each patch of bare ground present. Where bare ground is not present as discrete bare patches that can be measured individually, but is dispersed throughout the vegetation, use the percent cover class card to estimate the amount of bare ground.

Bare soil hydrologically connected to first 10 m (m^2) – Look beyond the first 10 m of the riparian area to see what bare erodible ground may be hydrologically connected to the first 10 m. Bare ground outside the first 10 m of the riparian area could include any eroded road surfaces, cut/fill slopes, failures, sloughs, slides, torrents, etc. that may be far from the riparian area but nevertheless hydrologically connected in some fashion, either by ditchlines, slide tracks, or stream channels.

Disturbed ground in first 10 m (m^2) – Disturbed ground is affected by pugging, hummocking, or rutting, usually by animals or vehicles. It may have bare soil associated with it, but the main characteristic or concern associated with disturbed ground is soil compaction.

Disturbed ground hydrologically connected to first 10 m (m^2) – Because it is generally drier, disturbed ground outside of the first 10 m of the riparian area tends not to be as common as disturbed ground within the riparian area.

Other Indicators

There are several other less specific indicators that should be noted during the traverse; however, they don't need to be measured at 5–6 discrete points or continuously along the traverse. Record these observations or features as they are encountered. These more general observations include:

Instream Woody Debris Characteristics (i.e., new, old, logging related, across or parallel, natural debris intact).

Substrate Sediment Texture (i.e., uniform or not). Check in two or more riffles and pools to evaluate sediment characteristics.

Connectivity (i.e., open-bottomed crossing structures such as box culverts versus closed-bottomed metal culverts in fish streams; temporary blockages; down cutting (erosion) of the channel bed; sediment or debris accumulations; dewatering (no surface flow); isolation of overland flow areas from the stream channel.

Number of Fish Cover Types Present (i.e., deep water, boulders, void spaces, undercut banks, woody debris, aquatic vegetation, overhanging vegetation). Note: To be considered present, each fish cover type must occupy at least 1% of the channel area assessed. For example, a deep-water area in a channel 5 m wide by 150 m long (750 m²) must occupy at least 7.5 m² (1%) of the total channel area to be considered present.

Fine Sediments (i.e., check for blanketing of substrate by fines or sands, that the substrate is not embedded in a matrix of sand).

Wildlife Trees (i.e., any designated wildlife trees present? Were they protected from windthrow?).

Soils (i.e., are streamside soils cool, moist and unchanged within 10 m of the channel bank?).

Vegetation (i.e., are all expected layers present within the riparian management area – trees, tall shrubs, low shrubs, herbaceous plants, mosses, lichens; is the form normal, not mushroomed or hedged; is the recruitment normal; are seedlings and saplings present?).

Answering the Questions

After completing the reach inspection and indicator data collection aspects of the evaluation, answer each of the 15 questions about the reach's channel, bank and riparian characteristics. Guidance, definitions, tables, graphs and tips to help answer each question are provided in the "The Routine Riparian Evaluation Questions" section.

The Summary Page

The last page of the checklist is a summary page to record the Yes, No or NA answers to each main question. Add up and record the number of No answers, and conclude on properly functioning condition as described in the "Concluding on Properly Functioning Condition" section.

Additional Comments

Use the “Comments” section to complete the assessment by describing the effects of the management activity. Make note of which main questions or indicators were affected by the treatment (e.g., road deactivation, culvert blockages, falling and yarding). If possible, also indicate which attributes were affected by factors related to the treatment (e.g., post-harvest windthrow), and which attributes were affected by pre-treatment conditions (e.g., old logging or natural factors such as floods, slides, fires, pre-harvest windthrow). Distinguishing the attributes of the stream/riparian area that were negatively affected by the management activity from those that were affected by other factors will provide a clearer picture of the effectiveness of the overall management activity.

- Note which No answers are related to the management activity being assessed, and which No answers are unrelated.
- Note what aspects of the management activity contributed to the No answers (example 1. windthrow caused the bare ground and/or the observed high fine sediment levels and subsequent low benthic invertebrate diversity; example 2. excessive erosion on the fill slopes and ditch at the road crossing caused observed channel infilling, fine sediment accumulations, dewatering at low flow, and newly eroded banks).
- Note anything outside the reach or riparian area that may be contributing to the No answers, such as slides, upslope torrents, or excessive windthrow in other cutblocks upstream of the reach.
- Summarize your general impressions of the reach or the management activity (e.g., successful, generally successful but in need of improvement, unsuccessful).

A sample REE field assessment is appended for reference (see Appendix 1).

The Routine Riparian Evaluation Questions

Question 1. Is the channel bed undisturbed?

A significant increase in the supply of sediment to a stream system can lead to severely aggraded channels. This condition is often noted in watersheds with many recent or active slides, eroding roads, or collapsing/eroding banks. As a channel aggrades, or fills in, channel morphology becomes simpler because the riffles extend longitudinally into pools. In severely aggraded streams, the pools get filled in, eventually disappearing altogether. Resting and feeding areas with good cover for fish are lost.

The opposite of channel aggradation is channel degradation. In this case, the damage to fish habitat is the result of too little sediment. This condition is often noted downstream of obstructions such as weirs or dams (man-made, beaver), log jams, or culverts that block or impede the natural downstream movement of sediment (boulders, cobbles, gravel, sand, silt). As the local channel sediment below obstructions is moved downstream by normal fluvial processes, with no replacement of sediment from either upstream or the banks, channel morphology becomes less complex. It may ultimately result in severe fish habitat loss. Spawning habitat is especially affected.

For both excessive aggradation and degradation, the result is usually a reduction in deep or shallow sections of the channel (i.e., channel depth becomes more uniform, the number of pools is reduced, and the amount of productive fish habitat is reduced).

Indicator Statements

To determine the answer to Question 1, first decide what the predominant channel morphology is as described previously then complete the section for that morphology.

Question 1 needs information on three indicators to answer the question. Only two out of three indicator statements need a Yes answer in order to answer Yes to the main question. Some of the answers will be quite easy. The thresholds should also be relatively easy to remember (e.g., 25 or 50% thresholds in the case of how much of the reach has different types of bars and multiple channels)

The answer to indicator statements may be obvious in some streams. When the answer isn't obvious, measurements may be required. For example, for Question 1, a measurement of the length of reach occupied by the different bar types may be required.

TIP: Mid-channel bars should be treated the same as sediment wedges. They both indicate aggrading channels (see Figure 2).

TIP: Lateral bars, point bars and sidebars are different names for essentially the same type of gravel bar (see Figure 2). These bars are typical of stable, meandering medium to large gravel-bedded streams, where a gravel bar forms on the inside of the meander bend. The bars are formed mainly from sediments that are being continually eroded out of a bank on the opposite side of the stream, usually opposite or just upstream of the gravel bar. To form the bars, the stream must therefore have enough energy to erode the stream banks. Since not all streams have the energy to continually erode the stream banks, not all streams have lateral bars. Once a channel is eroded, the remaining bank material may be too large for the stream to continue to erode.

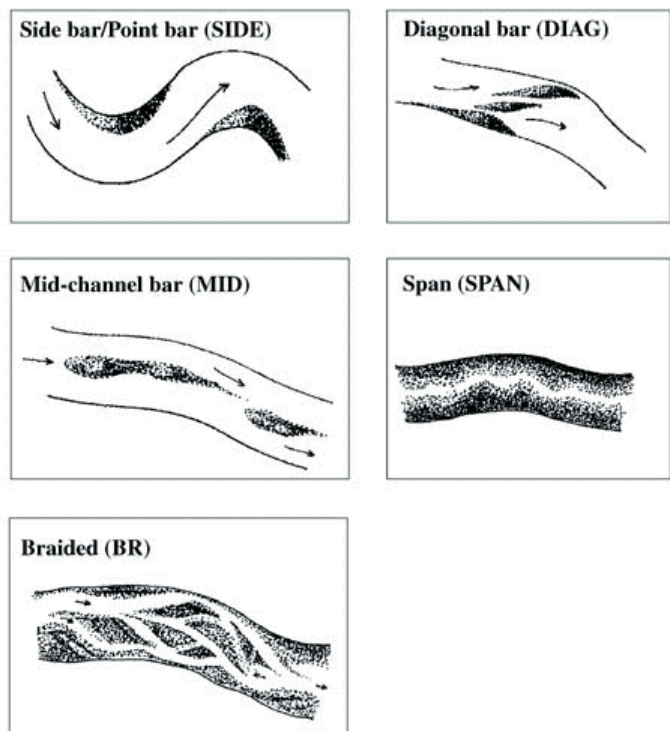


Figure 2. Types of channel bars.

Question 2. Are the channel banks undisturbed?

Streams and stream channel banks by definition are erosion features. When we ask if the channel banks are undisturbed, we are really asking if they are *recently* disturbed. Over time, banks do stabilize and become vegetated if there is adequate soil. The tops of the banks especially become vegetated because they are high enough above the mean annual flood level to escape the constant negative effects of flow on germinating seeds and seedlings that lack developed root systems. As vegetation grows and encroaches on the stream, overhanging banks develop because the root mat is strong enough to be “cantilevered” out over the stream when stream flows erode the soil out from underneath.

The banks of most streams, lakes and wetlands in their natural undisturbed state are protected from excessive fluvial erosion or wave action by vegetation with well-developed root systems. Most trees, shrubs and native grasses will serve this function. These plants also trap sediments to build and restore banks.

Forest harvesting or excessive grazing can reduce or eliminate the amount of deep rooted vegetation present on the banks of aquatic habitats, thereby reducing the ability of the banks to withstand erosion through fluvial erosion or wave action. When the sediment load in a channel is increased, banks can be further eroded as the channel widens in order to deliver the sediment-laden flow downstream. Falling, yarding, windthrow, and trampling by large animals can also directly crush, collapse, shear or otherwise damage stream banks.

Recently disturbed stream banks, if widespread enough, can be directly responsible for filling in or blanketing the substrates with fine and sand sized sediments. They can also contribute substantial quantities of coarser sediments (gravel, cobbles and boulders), leading to further channel aggradation and dewatering.

Recently eroded banks can be identified by some of the following characteristics:

- there is no overhang;
- banks are sloped backwards or vertical with no vegetative cover;
- live exposed roots have a ragged appearance, with numerous fine rootlets exposed;
- live roots have de-barked areas with no signs of recent healing;
- exposed soil is largely unoxidized;
- exposed soil lacks any evidence of natural armoring; or
- clumps of bank material that have collapsed or been sheared off rest on the stream bottom.

Measure the total length of recently eroded stream bank or stable undercut bank present and compare it to the total reach length to determine what % of the reach has eroded or stable undercut banks. To determine how much recently eroded bank or undercut bank is present, consider both sides of the stream even if the management activity being assessed occurs on only one side of the stream. Do not count both sides of the stream where an eroded or undercut bank on one side occurs opposite an eroded or undercut bank on the other side. Measure only the length of reach with recently eroded or stable undercut banks present, regardless of whether one or both banks are eroded.

To measure % of the reach with deeply rooted vegetation or upturned rootwads on the edge of the stream, consider only the bank(s) adjacent to the treatment being assessed. If the treatment is confined to the right side of the stream, only measure deeply rooted vegetation and upturned rootwads on the right bank. If the treatment is present on both sides of the stream, then consider both banks.

TIP: Banks that have lost or lack deeply rooted vegetation are not considered disturbed until there is also evidence of recent erosion on the face of the bank.

TIP: Only banks that are potentially erodible are considered. Non-erodible banks (i.e., banks composed of large rock or bedrock) are not considered part of the reach when assessing bank condition. If the banks are composed entirely of non-erodible material, the question is considered Not Applicable.

TIP: When assessing the amount of bank with deeply rooted vegetation, consider only the vegetation within 1 m of the rooted edge (i.e., the natural mean annual high-water mark).

Question 3. Are channel LWD processes undisturbed?

Channel large woody debris (LWD) processes are the how, when and where of what happens to LWD after it enters a stream channel (i.e., how, when and where it is stored, broken down, and transported down the channel. Changes in channel LWD processes can have a major impact on the fish habitat characteristics of streams, regardless of whether the streams are dependent on LWD or not.

In Question 3, there are up to five indicator statements for each of the three categories of channel types – riffle-pool/cascade-pool, step-pool, and non-alluvial. The focus is mainly on the impacts of timber harvesting as opposed to range use. To answer the question, first decide what the predominant channel morphology is, then complete the answers to the indicator statements. Answer Yes to the Question 3 if there is no more than one No answer to the indicator statements.

All three channel types share four of the same indicator statements, as follows:

1. Most debris is old and does not appear to have been freshly deposited.

TIP: “Old” debris means it was present before the treatment (i.e., the most recent harvesting or road building). “Freshly deposited” debris means it was deposited after road building and harvesting was completed.

TIP: To be considered “debris in the channel,” the debris must actually extend into the channel. Logs that are suspended on the banks above the channel are not included, but any branches associated with the log could be in the channel.

TIP: Post-harvest windthrow-related debris is considered “recently deposited debris” if it extends into the channel.

2. Most debris accumulations lack recent logging debris (e.g., branches, treetops, bark, small logs and LWD with cut ends, recently crushed or shattered logs).

3. Woody debris oriented parallel to the channel banks (particularly small logs and limbs with lengths much shorter than the bankfull channel width) is not abundant.

TIP: Parallel means not angled away or toward a bank more than 30 degrees off parallel. A long log that is more or less pointing downstream but which goes from one bank to the other bank is not parallel to the stream banks. Abundant means more than a third of the small logs and limbs << bankfull width.

4. There is no indication that natural debris was intentionally removed from the channel.

TIP: Look for saw cuts on debris that was embedded in the stream banks, or on old pre-harvest logs perched on the banks. Also look at debris piles placed on the banks and decide if any of the debris was old, pre-harvest stream debris.

Riffle/cascade-pool and step-pool type streams have an additional indicator – presence of recently formed accumulations of debris (e.g., logjams). For riffle/cascade-pool type streams, it is the number of recent debris accumulations that *span* the channel that need to be counted. For step-pool channels, the indicator is the number of debris accumulations present, *regardless if they span the channel or not*. For both stream types, answer Yes if there are fewer than two debris accumulations for every five channel widths of stream length inspected. Answer No if there are more.

TIP: A “debris accumulation” is the same as a logjam in a large stream. In small streams, where logs are too large to fit in the channel, debris accumulations may include only limbs, small chunks of logs, pieces of bark, etc.

TIP: Strictly speaking, a debris accumulation is any more than one piece of debris. Practically speaking, consider a meaningful accumulation of debris to be at least 5–10 pieces that are as long as the channel is wide.

Question 4. Is the channel morphology undisturbed?

Question 4 only has indicators for riffle/cascade-pool type streams and step-pool type streams. Only complete the indicators for the type of stream being assessed. If the stream is non-alluvial, then it has no flow-related morphology, and the question is therefore Not Applicable.

The frequent repetition of distinct pool-riffle sequences in streams is one of the hallmarks of productive fish streams. Factors that blur the differences between pools and riffles or cause an actual reduction in the number of pools or riffles often reduce the amount of productive fish habitat. In this question, the two key indicators are:

- the number of deep pools – there should be at least two to be considered healthy; and
- the amount pool area – more than 25% of total reach length should be pool habitat in riffle/cascade-pool type streams. In step-pool streams, steps and pools should alternate over at least 75% of the stream length. Long cascades should be less than 25% of the channel length.

TIP: A deep pool is any pool where the maximum channel depth is twice the average channel depth at riffle crests.

Maximum pool channel depth is the distance from the top of the bank to the deepest part of the pool. Channel depth at the riffle crest is the distance from the top of the bank to the deepest part of the riffle at the pool/riffle break.

- The last indicator in Question 4 is a heterogenous substrate. A heterogenous substrate indicates a healthy channel morphology. A heteogenous substrate is well sorted, with distinct clusters or lines of boulders, and conspicuous concentrations of gravels and cobbles. In streams with strongly heterogenous substrates, there are clear differences in substrate composition between pools, pool-riffle breaks, and riffles. There is usually a large number of different sediment size classes present.

The opposite of heterogenous is homogeneous. Homogeneous substrates may be composed of different sediment size classes (e.g., small gravels, large gravels and cobbles), but the different size classes are uniformly mixed with each other. A list of commonly accepted size classes for different sediment types is summarized in Table 1.

Table 1. Sediment size classes

Class	Size (mm)	Description
Fines and sands	< 4	Smaller than ladybug size
Gravels	4–64	Ladybug to tennis ball size
Cobbles	65–256	Tennis ball to basketball size
Boulders	257–2000	Basketball size to table size
Rock	> 2000	Larger than table size, including bedrock

Question 5. Are all aspects of the aquatic habitat sufficiently connected to allow for normal, unimpeded movements of fish, organic debris, and sediments?

Many aspects of forest harvesting can compromise or block fish access to upstream, tributary or off-channel habitats.

- Newly formed logjams, especially those formed with logging debris, are usually effective sediment traps that can adversely affect fish habitat in the short term (<10 years) by blocking sediment movement downstream.
- Bridges or culverts can also block sediment movement downstream, but they may also constrict flow and create velocity barriers or impassable jumps for fish.
- Roads that lack drainage structures can directly block off-channel areas.
- Access to tributaries or off-channel areas from the main channel can also be blocked if the streambed degrades as a result of a constriction or blockage that impedes sediment movement downstream.
- Excessive aggradations (accumulations of sediment) may similarly block fish access upstream due to dewatering.

Question 5 uses seven indicator statements to cover the scope of land use impacts on aquatic connectivity. Because of the importance of maintaining connectivity at all times, the answer to Question 5 is No if the answer to even one indicator statement is No.

There may be more than one reason for a lack of connectivity. Knowing all the reasons why connectivity is affected is important for assessing the effectiveness of the riparian treatment because it may indicate that landscape- or watershed-scale events upstream are contributing factors.

TIP: Dewatering refers to a lack of surface flow. The channel appears dry; however, there may in fact be water flowing beneath the surface. To see if the channel is truly dry or not, look for bedrock outcrops or very large in-stream boulders where any water present will be visible at the base of these features. Streams typically dewater first in the most downstream, low gradient reaches of a channel because this is where sediments tend to accumulate. Widespread dewatering can result in large-scale fish kills when fish become trapped in isolated pools that subsequently dry up.

TIP: A stream should be considered incised and cutoff from its adjacent floodplain if the average two-year flood cannot escape the channel.

Question 6. Does the stream, lake or wetland support a good diversity of fish cover attributes?

Question 6 determines the presence of seven possible different types of fish cover. The answer to Question 6 is Yes if there are at least five different fish cover types present. The answer is No if there are less than five different cover types present. The seven types of cover include:

- Deep, quiet water – slow moving water that is twice as deep as the average channel depth in riffles. Pools usually have some deep, quiet water, but also often contain some shallow parts as well.
- Stable, unembedded boulders – provide both overhead cover from predators and resting areas from the current. Boulders with moss and/or organic stains are considered stable. Unembedded means that the edges of two boulders (if present) are touching each other. To estimate the total area of stable boulder cover, multiply the average boulder footprint area by the number of boulders.
- Stable woody debris or rootwads – provides protection from the current and predators. More complex arrangements provide better protection from flows and better the cover from predators. A single smooth log in a riffle provides minimal cover, whereas a large permeable logjam on top of a pool provides very good cover. Multiply the estimated length of individual pieces or clumps of woody debris by the estimated width to estimate total area coverage.
- Stable, deep-rooted undercut banks – provide excellent protection from predators and the current. The lower the bank and the deeper the undercut, the better the cover. Measure the length and depth of the undercut to estimate total area.

- Submerged or emergent aquatic vegetation – aquatic vegetation refers to flowering plant species only, not moss. Measure the approximate length and width of the coverage to estimate total area.
- Overhanging vegetation – terrestrial vegetation that arches over the channel is considered cover if it is within 1 m of the water surface when the channel is full. Measure the length and extent of the arching vegetation over the channel surface to estimate total coverage.
- Stable substrate with void spaces for fish to hide in – stable, unembedded gravel, cobbles, boulders or debris with obvious nooks and crannies underneath them represents good cover for small young and juvenile fish. Unembedded means the sides of the gravels, cobbles or boulders can be seen touching each other.

To qualify as cover, each cover type should represent at least 1% of the total channel area. For a 2 m wide by 100 m long stream, with a total channel area of 200 m², each cover type should have a total area of 2 m² to be considered present.

A diversity of fish cover types is typical of undisturbed aquatic systems with well-developed riparian habitats. Actual amounts of fish cover can vary substantially, but it is rare for stable streams and riparian habitats in properly functioning condition to not have at least five different types of cover present. The number of different cover types available can be reduced when riparian vegetation is removed, banks begin eroding, and sediment supplies are suddenly increased or reduced.

Be aware of the different types of cover present as you walk up or down the stream, or along the banks. Make a mental note of whether or not there is enough of each cover type to qualify as being present. Some types of cover tend to be very common. Overhanging vegetation for example is often present along the entire stream. Other types of fish cover, such as aquatic vegetation, tend to be uncommon and confined to low-gradient, slow flowing streams.

Question 7. Does the amount of moss present on the substrates indicate a stable and productive system?

A healthy growth of moss on stream channel substrates and in-stream LWD indicates clean water, stable flows, a stable streambed, and adequate shading and nutrient levels. The relative abundance of moss on streambeds is correlated to fish numbers and/or invertebrate productivity. Poor moss growth usually indicates an unstable substrate, low nutrient levels, or both.

TIP: Moss is almost always restricted to shallow riffles and the margins of pools that are dry during low flow periods. Moss will not grow where it is completely covered with water for too long. It is therefore naturally absent in deep pools of all streams and the deep central sections of riffles/cascades in large streams.

TIP: Shallow, low flowing streams directly exposed to sun will frequently have patches of bright green, filamentous material waving in the water. It is limp and threadlike when pulled out of the water, with a slightly slippery feel. This is green algae, not stream moss which closely resembles the common terrestrial species of moss.

Question 7 has three indicator statements. The first indicator statement is a measure of abundance:

- a) Moss patches are easily observed from almost any point along the margins, riffles or shallow pools of the stream.

Answer Yes if you feel the abundance of the moss in the reach is described by the statement. Also answer Yes if you feel that the number of moss patches can best be described as present, common, frequent or abundant, not lacking, little or occasional. For more guidance on moss abundance, consider 5% coverage the cutoff for a Yes answer if you wish to use the Cover Standards (see Figure 3). Consider Class 3 the cutoff for a Yes answer if you wish to use the Density/Distribution Standards (see Figure 4).

The second and third indicator statements for Question 7 are related to the condition of the moss. If no moss is present, then the statements are marked Not Applicable. Unless the moss is intact and vigorous, the answers to indicator statements b) and c) will be No. The moss will be either dead, desiccated, scoured or buried.

TIP: Healthy moss has a thick spongy appearance, with bright green tips on top of dark green or black stems when new growth is present.

TIP: Thin brown patches on the largest rocks mark patches of moss that have had their green stems washed away, leaving only a smooth, brown root mass. In severely scoured areas, dark blackish stains on the largest rocks may all be that is left of the moss.

TIP: Rolling stones gather no moss.

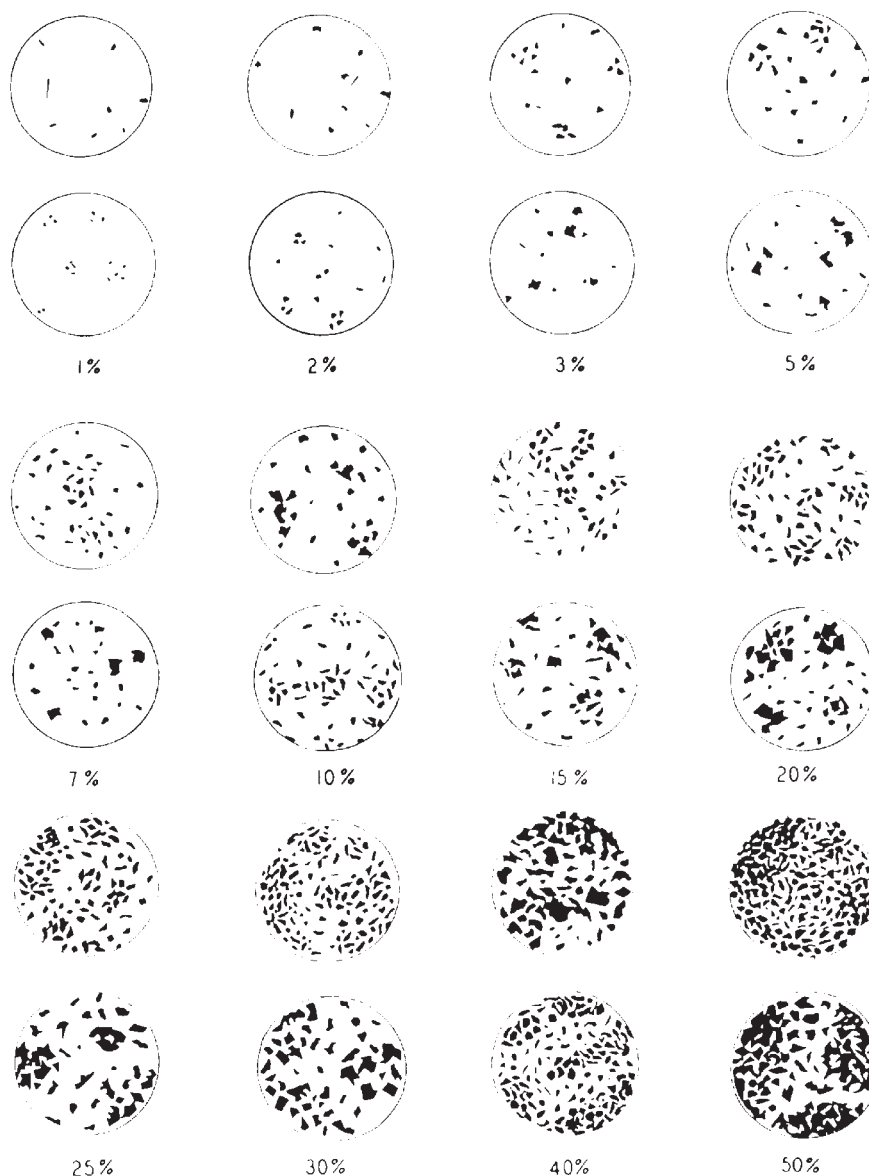


Figure 3. Comparison charts for visual estimation of foliage cover (from Luttmerding et al. eds. 1990).

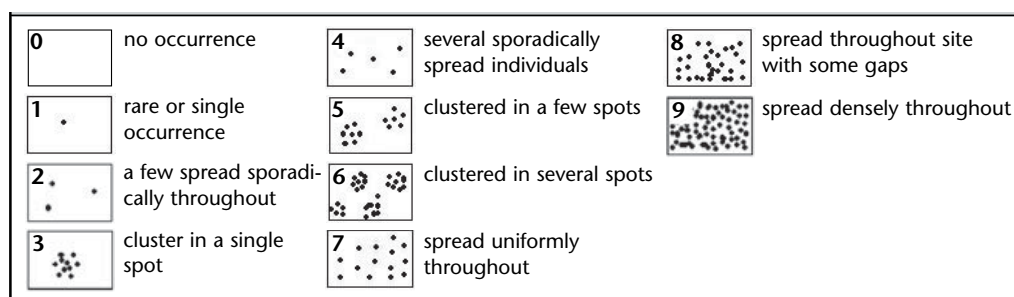


Figure 4. Comparison charts for visual estimates of plant density/distribution.

Question 8. Has the introduction of fine sediments to the stream been minimized?

An increase in sediment supply can lead to harmful channel aggradations. If the sediment supply is fine textured, it can also lead to harmful impacts on inter-substrate fish and invertebrate habitats by filling in the nooks and crannies in the substrate, or blanketing the surface.

Fine sediments may be easily observed on the surface of the streambed, particularly when recently deposited. Over time, fine sediments may be incorporated into the streambed where they are not as visible. In some cases, the streambed may be so completely filled in with fine or sand-sized sediments as to be completely impermeable, yet the streambed may still look fine on the surface.

Because of the complex nature of fine sediment impacts on streambeds, four very different indicator statements are used to assess the impacts of fine and sand-sized sediments on streambeds. Many other potential assessment methods exist (e.g., measurements of subsurface dissolved oxygen concentrations, flow rates, % composition), but these are typically time consuming and expensive to conduct.

The four indicator statements for Question 8, with explanatory notes, are as follows. If the answer to any indicator statement is No, then the answer to Question 8 is also No.

- a. Inorganic fine and sand-sized sediments that blanket the substrate are best described as little or lacking.

TIP: Organic materials are not considered to be sediments. Sand-sized particles are particles up to 4 mm in diameter. "Little" can be interpreted to be no more than 10% coverage on average, with no sites with more than 75% coverage. If the amount of fine and sand-sized sediments present is not obvious then estimate the coverage along a line across the stream at 5–6 points along the reach traverse to confirm the approximate amount of sediment in the stream.

- b. Wetted areas of gravel, sand or fine-sized sediments that a foot can be easily pushed or wiggled into represent less than 1% of the total wetted area. Mark "NA" if the stream is dry.

TIP: Wetted areas that a foot can be pushed or wiggled into feel like "quick-sand" or "quick-gravel."

- c. Gravels and cobbles are not embedded in a matrix of sand or finer sized particles. The sides of individual gravel and cobble particles can generally be seen touching each other.

TIP: Gravels and cobbles that are embedded in fines and sand feel like they are "cemented into place." Fines and sands occupy the space between the gravel or cobble particles.

- d. Invertebrates sensitive to the effects of sedimentation can be easily found on the undersides of rocks in riffles. Mark "NA" if the stream is dry.

TIP: Because they have external gills, caddisflies (i.e., “case-makers”), mayflies, and stoneflies are the insects most commonly considered sensitive to the effects of fine and sand-sized sediments. “Easily found” should be interpreted as being present at any suitable site inspected along the traverse. A suitable site is a riffle with stable subangular cobbles and boulders that can be easily picked up and examined by hand.

Question 9. Does the stream support a diversity of aquatic invertebrates?

Healthy gravel, cobble or boulder bedded streams that flow most or all of the year will almost always have many different kinds of invertebrates. Easily affected by a wide range of substances, such as sand, silt, toxic compounds, inorganic or organic pollutants, the diversity of the benthic invertebrate community is a good direct assessment of properly functioning condition.

TIP: Question 9 is considered Not Applicable if the stream is dry, or strongly suspected of being dry most of the year.

Most of the aquatic invertebrates in streams are called “benthic invertebrates.” The word “benthic” means bottom. Benthic invertebrates therefore live on the stream bottom, mostly under the rocks, but also on the top and sides of rocks if the rocks are stable or protected from flows. They also occur on aquatic plants or woody debris if present. Generally, the more angular and stable the rocks are, the higher the number of benthic invertebrates living on them.

Sample Methods: There are many different ways invertebrates can be sampled in streams. For the riparian checklist, simple hand collections with a small portable net and small white tray are recommended. While holding the net on the streambed, stir, rub, or otherwise wash off the rocks and gravel upstream of the net so that invertebrates clinging to the substrate are washed off into the net. Empty the net into the white tray with a little water. Any invertebrates should be quite visible. A hand lens is very useful for identifying/confirming the invertebrates. As a person gains experience, rocks can be picked up and examined directly to identify the type of invertebrates present.

Number of Sites to Sample: It may be possible to determine that the stream has many different kinds of invertebrates by lifting and looking at the bottom of a few rocks at one site. If this is not the case, investigate the site more thoroughly. If it still looks like there are very few varieties of invertebrates, then at least two other locations should be sampled before drawing conclusions on invertebrate diversity.

Identifying Invertebrates: Look at the illustrations in Figure 5 for some of the most common benthic invertebrates found in streams. Most invertebrates will be insects, but other major groups include “worms” (nematodes, flat worms, true worms) or snails and clams (molluscs). Crustaceans (freshwater shrimp, water fleas) may also be found if lakes or wetlands are flowing into the stream. The most common stream benthic invertebrates found in streams typically include mayflies, caddisflies, chironomids (midges), other Diptera (true flies) larvae, oligochaetes (small worms), and stoneflies.

Sensitive Species: Insects with external gills and freshwater clams are considered to be sensitive species. Insects with external gills include mainly mayflies, stoneflies and caddisflies. Mayflies and stoneflies can be readily identified by the two to three tails present in both species. Caddisflies can also be easily identified because they build distinctive cases to live in made of sand, small pebbles, wood, twigs, or needles.

Scoring: Answer Yes to Question 9 if two or more of the indicator statements are answered Yes.

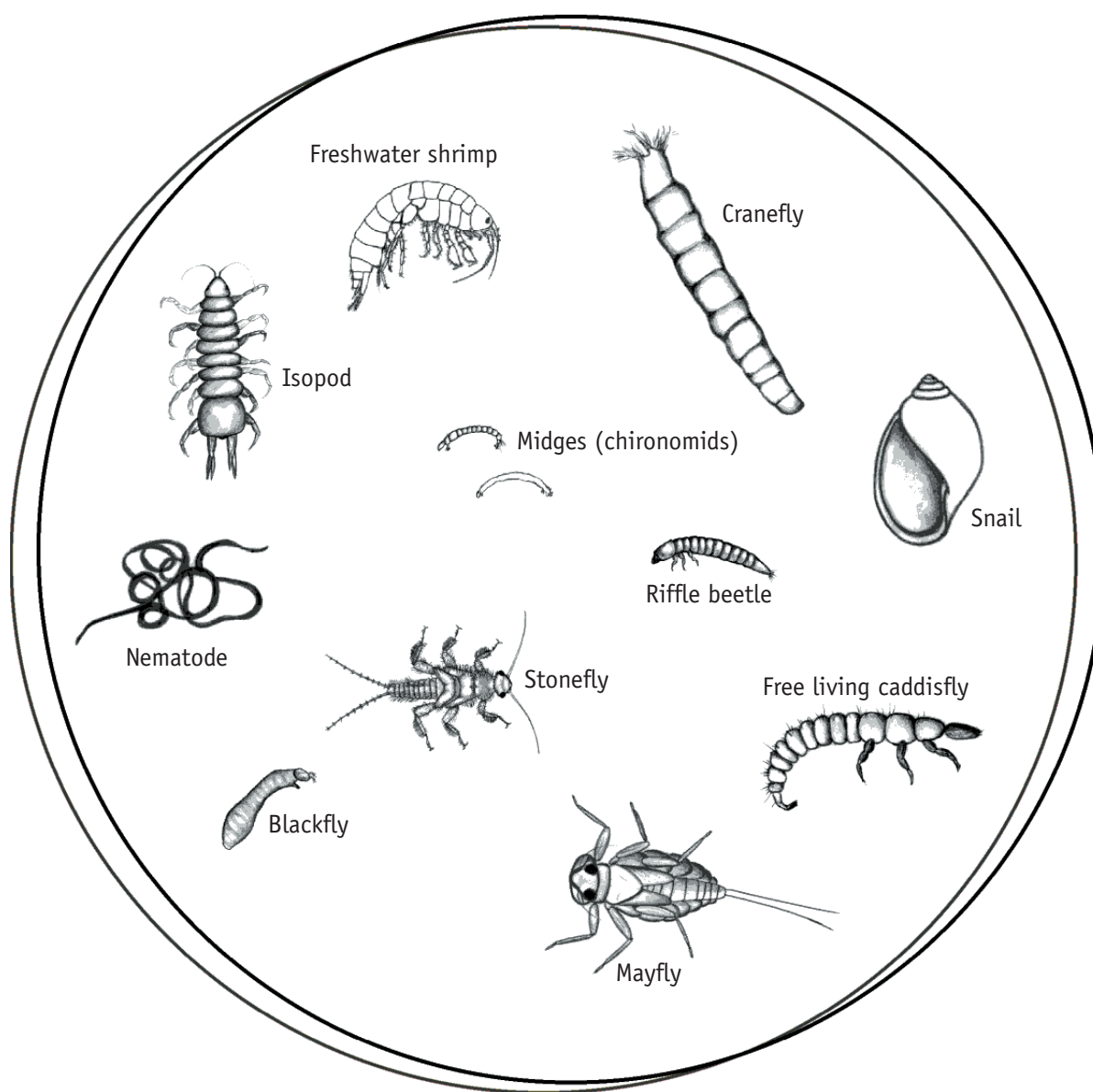


Figure 5. Examples of common benthic invertebrates.

To help with identifying invertebrates, refer to the *Field Guide to Freshwater Invertebrates* in Appendix 2.

Question 10. Has the vegetation retained in the RMA been sufficiently protected from windthrow?

One of the main objectives of a riparian management zone is to protect riparian reserves from excessive windthrow. The amount of windthrow present in riparian reserves is therefore a direct indicator of how successful or effective the management zone is in protecting the reserve.

On streams that lack riparian reserves, management zones are mainly for retaining key wildlife habitat attributes characteristic of natural riparian systems, providing some shade to reduce bank microclimate changes, and maintaining bank and stream stability. In this regard, windthrow is a direct indicator of management success or failure. If retained trees blow down, then it is likely that key wildlife attributes will also be disrupted. If windthrow is extensive, then there is a good chance that the integrity of the stream and streambank environment is also compromised.

Question 10 has three indicator statements, only one or two of which will be applicable to any given stream. The number of applicable statements depends on if a reserve is present, if only a management zone is present, or if designated wildlife trees or wildlife tree patches are present beside the stream.

Sample Methods: Percent (%) windthrow over and above what was naturally present in the riparian area prior to the treatment must be estimated in order to answer the indicator statements. A simple visual estimate of % windthrow is appropriate if the % of trees windthrown is clearly less than 1%. A visual estimate is also appropriate if the amount of windthrow is greater than 10% of the trees in reserve zones, or 20% of the trees in management zones.

More quantitative measures of windthrow are needed if the threshold values in the indicator statements have not obviously been met or exceeded. Any method is suitable, provided it is reasonably accurate and readily reproducible. A direct count of all standing and windthrown trees is the simplest and most straightforward method. All trees in the reach can be enumerated this way, or the reach could be subsampled.

Types of Trees to Count: Only the dominant and co-dominant trees intentionally left as retention should be included in windthrow calculations. In some cases, this may include young trees if they were the only trees intended to be retained.

Width of Riparian Area to be Assessed: In a riparian management area, if a reserve is present, the entire reserve or wildlife tree patch should be assessed for windthrow. Also check for windthrow in the adjacent management zone if trees were retained. If there is no reserve or wildlife tree patch, then the entire management zone should be assessed, provided some retention was prescribed.

Calculating % Windthrow:

1. % Old Windthrow = $\frac{(\# \text{ Old Windthrown Trees})}{(\# \text{ Standing Trees} + \# \text{ Old Windthrown Trees} + \# \text{ New Windthrown Trees})} \times 100$
2. % New Windthrow = $\frac{(\# \text{ New Windthrown Trees})}{(\# \text{ Standing Trees} + \# \text{ New Windthrown Trees})} \times 100$

To calculate % new windthrow over and above the natural pre-treatment windthrow, subtract (1) from (2).

Question 11. Has the amount of bare erodible ground or ground disturbance in the riparian area been minimized?

Bare ground is any soil not covered by plants, litter, lichens, moss, downed wood or rocks larger than 6 cm (2.5 in.). 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 rootwads and windthrow scars, slides and slumps. It also includes animal trails or recreation trails if mineral soil is exposed. Exposed soil subject to erosion contributes to stream channel infilling and bank erosion, reduces sediment entrapment, alters rainfall run-off rates, and provides an opportunity for invasion by weeds.

Bare ground includes discrete patches of ground such as root wad scars left when a tree blows over. 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 rootwad scar, which may still contain soil that can erode.

Bare ground also includes the ground exposed in thinly vegetated areas, possibly due to over grazing. For this type of bare ground, use the percentage cover cards to estimate total bare ground area (see Figure 3).

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

Disturbed ground includes ground disturbed by animals that results in pugging and hummocking. It also includes paved surfaces and machine impacts such as wheel or track ruts. Disturbed ground may still have vegetative cover, but its characteristics (mainly the degree of compaction) have been changed.

Hydrological Connection

All bare ground is considered within the first 10 m past the edge of the stream, even if it is not obviously hydrologically connected to the stream. Bare ground outside of the first 10 m must be hydrologically connected to the first 10 m of the riparian area before it is considered. Examples of bare erodible ground outside of the riparian area could include road surfaces, slides or debris torrents in tributary streams. There is no limit on how far away the bare ground is from the first 10 m of the riparian area, so long as it is hydrologically connected to the stream. To be considered hydrologically connected,

the bare ground must either be on a steep side slope within 30 m of the stream edge, or contain a channel that leads to such a slope or into the first 10 m of the riparian area (see Figure 6).

The hydrological connection of some exposed soils will be obvious. For example, a slide or slump that starts 50 m above the riparian area and extends to the stream is obviously connected. Other sources will not be so obvious. Cross-ditches or culverts on roads will frequently form short channels on the slopes below the road, but dissipate further down the slope. To be considered connected to the stream, the channels should reach the first 10 m of the riparian area, or the first 30 m of a steep slope leading to the stream. Bare ground on level slopes with no distinct drainage channels leading to the first 10 m of the riparian area or a steep slope within 30 m of the stream is not hydrologically connected.

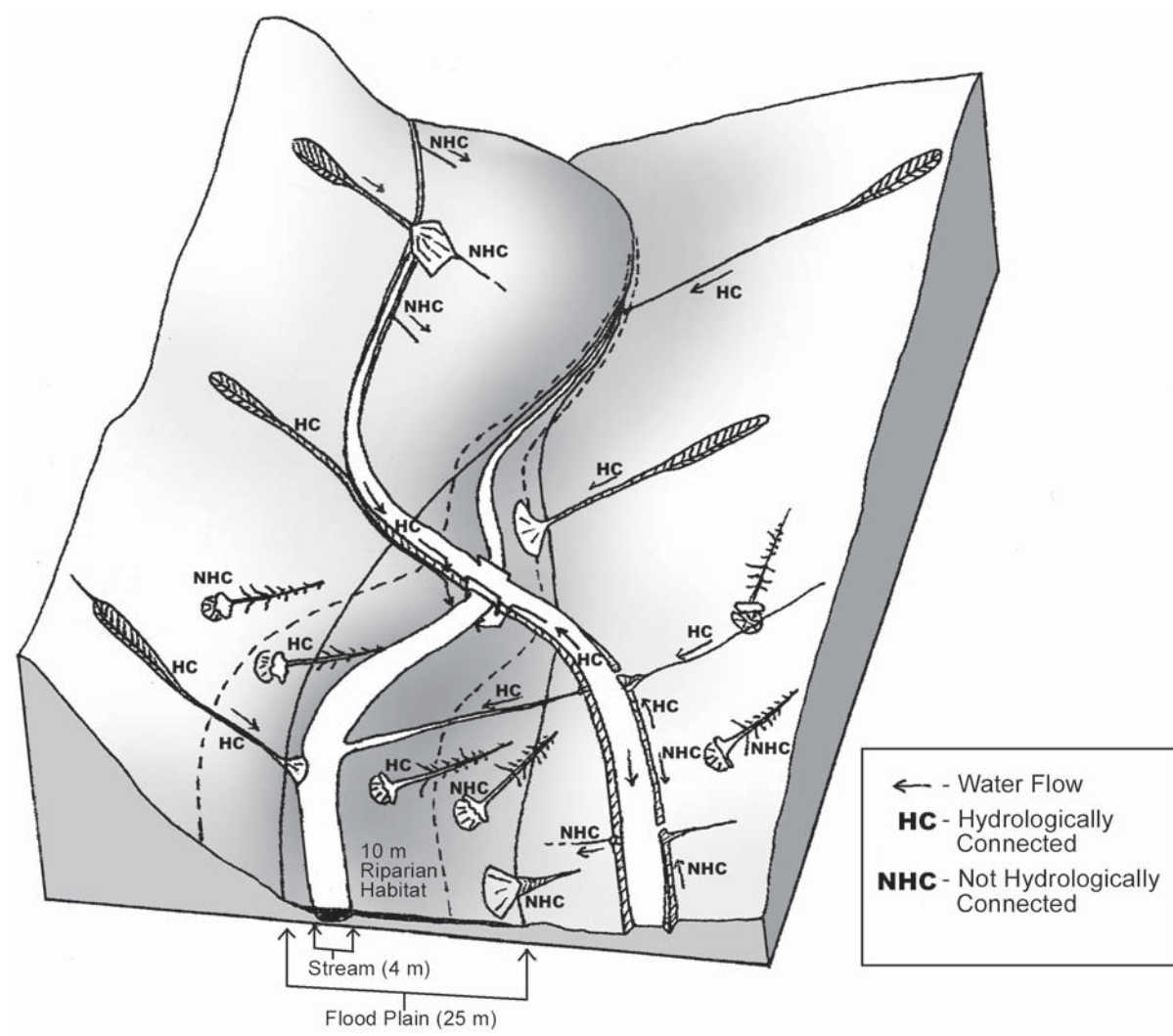


Figure 6. A hydrological connection diagram, showing where erodible soils (from windthrow, road surface, ditch or slope failures) are hydrologically connected to a non-gully type stream reach.

Question 12. Has sufficient vegetation been retained to maintain an adequate root network or LWD supply?

An adequate root network is needed to maintain bank strength in all streams. Together with LWD, roots also help to maintain the channel form of many small streams <2 m in width. Roots become less important in maintaining channel form in streams larger than 2 m; however, many streams 25–40 m in width continue to be dependent on LWD for much of their form, depending on slope gradient. To determine whether a stream is dependent on LWD, refer to Figure 7.

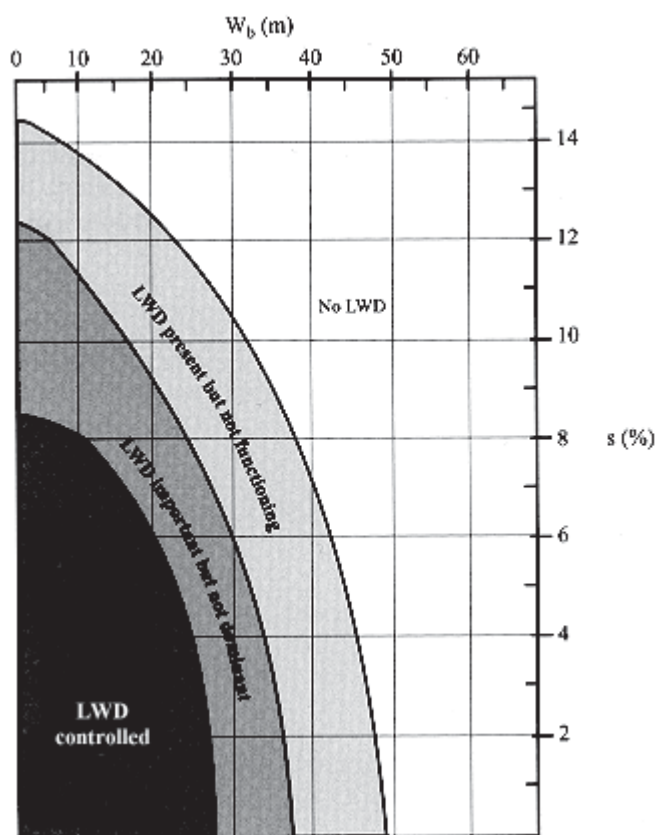


Figure 7. Determining the influence of LWD on channel morphology.

LWD can fall directly into a stream from the adjacent bank, it can float downstream from upstream areas, or it can enter a stream from upslope areas via slides. In streams where there is no upstream or upslope supply of debris, 99% of the LWD supply comes from the first 10 m of the riparian area.

The seven indicator statements needed to answer Question 12 are based on the stream classification and retention levels recommended as best management practices in the *Riparian Area Management Guidebook* (Province of B.C. 1995). Determining retention levels is fairly straight forward, and can be estimated visually very quickly. It is not the intention of a riparian evaluation to confirm that an intact 20 or 30 m reserve has been retained, only that the supply of LWD is adequate within the first 10 m.

Only one of the seven indicator statements is applicable to all streams (statement a). To answer Question 12, first answer Yes or No to indicator statement (a), and then proceed to the one additional statement that matches the classification of the stream reach being assessed.

TIP: The stream's riparian classification should be indicated in the Silviculture Prescription or logging plan maps. Record the riparian class as indicated in these documents. If no stream classification is indicated, try to assign the class on the basis of gradient (< 20 %) and channel width (see the *Riparian Management Area Guidebook* or the *FRPA Forest Planning and Practices Regulation*). Fish-bearing status will not be possible to confirm unless a fish is sighted. Riparian classification for difficult sites may need to be addressed after the survey is completed.

TIP: Windthrown trees are included in the retention levels. If all of the trees in an otherwise intact 10m reserve zone have blown over, the retention level is still 100%.

Question 13. Has sufficient vegetation been retained to provide shade and reduce bank microclimate change?

Vegetative cover includes trees, shrubs and grasses in riparian areas that moderate the direct impacts of rainfall on exposed soils as well as serving many other functions. For example, trees and shrubs also supply food and habitat for terrestrial and aquatic invertebrates, both of which are critical food sources for many vertebrates including fish. Harvesting or intensive browsing and grazing can significantly reduce the vegetative cover of trees, shrubs and grasses along streams, wetlands, and lakes.

Shade in riparian habitats is particularly critical on sunny days for moderating air temperatures, and maintaining soil moisture levels. Shade cover varies with plant species, height and density, and is also sensitive to the time of year, aspect and latitude because it involves a lateral measurement of light penetration by direct rays of the sun.

Question 13 has four indicator statements, three of which must be answered Yes in order to check the Yes box for the overall question.

a) Canopy and ground vegetation together cover more than 99% of the riparian habitat in plan view.

Canopy cover is the area encompassed by the outside edge of the overhead canopy. This edge is sometimes called the "drip line." It differs from foliar cover, which is a measure of foliage density.

TIP: Canopy and ground cover together shield bare ground from direct rainfall. If there is no bare ground, then canopy and ground cover is 100%. Canopy and ground cover may still be 100% if there are some bare ground surfaces, provided all the bare surfaces are located underneath the overhead canopy.

b) Shade (the average amount of sky not visible due to vegetation) averages more than 60%, as estimated visually for any two of the east, south and west aspects at 60° above the horizontal, or as estimated with a "Teti" angular canopy density meter (operator's manual provided by the supplier).

Other acceptable methods for estimating shade include: 1) comparisons of visual observations to reference photographs containing examples of percent shade, and 2) comparisons against vegetation cover standards (cover classes) (see Figure 3).

- c) Moisture sensitive species, such as mosses, certain ferns and other bryophytes, are all in vigorous condition, with no indication of sunburn, drought or desiccation.
- d) Soil in the riparian habitat is cool and moist to the touch.

Where to Measure Canopy Cover and Shade: Canopy cover and total shade (cover provided by all vegetation types) may be measured at 5–6 evenly spaced points along the stream reach. Canopy cover should be measured within the riparian management area. Shade is measured from the edge of the stream, while standing in the stream.

Question 14. Have the number of disturbance-increaser plants or noxious weeds present been limited to a satisfactory level?

Question 14 has two indicator statements:

- a) Disturbance-increaser plants (e.g., domestic grasses, dandelions, red alders, bracken, fireweed) occupy less than 25% of total area in the first 10 m of the riparian area.

Disturbance-increaser species are native or introduced plants that are typically absent, or present in low numbers, in undisturbed habitats. Populations of these species can become more prevalent with certain kinds of disturbances such as grazing, road building, clearcutting and fire.

Disturbance-increaser species are regarded as undesirable because they tend to not provide a deep-binding root mass for bank protection. An increase in the number of disturbance-increaser species indicates a trend away from the natural plant community in riparian areas, and a decline in the proper functioning condition of the riparian habitat. Most of these species provide less soil-holding and sediment-trapping capabilities, as well as less desirable forage and wildlife values. Although the presence of disturbance-increaser species may be natural, they often suppress the growth of other species that may be better at maintaining or re-establishing root networks and bank strength.

A list of disturbance-increaser species is provided in Table 2.

Table 2. Increaser-disturbance species list

Strawberry	Pineapple weed
Silver cinquefoil	Dock
Yarrow	Pasture sage (<i>Artemisia frigida</i>)
Baltic rush	Gumweed (<i>Grindelia squarrosa</i>)
Dandelions	Pussytoes (<i>Antennaria</i> spp.)
Sow thistles	Buttercup species (<i>Ranunculus</i> spp.)
Foxtail barley	Red alder
Bluegrasses (Kentucky, Canada, Annual)	Fireweed
Goatsbeard	Bracken

b) Noxious weeds occupy less than 5% of total area in the first 10 m of the riparian area.

Noxious weeds are considered separately from disturbance-increaser species. While they can also be disturbance-increaser species, most noxious weeds are invasive, non-native species that are highly competitive. Noxious weeds can spread rapidly to cover large areas and prevent the development of healthy, native riparian communities.

A list of noxious weeds is summarized in Tables 3 and 4.

Table 3. Common noxious weeds within all regions of BC

Annual Sowthistle (<i>Sonchus oleraceus</i>)	Purple Nutsedge (<i>Cyperus rotundus</i>)
Canada Thistle (<i>Cirsium arvense</i>)	Rush Skeletonweed (<i>Chondrilla juncea</i>)
Crupina (<i>Crupina vulgaris</i>)	Scentless Chamomile (<i>Matricaria maritima</i>)
Dalmatian Toadflax (<i>Linaria dalmatica</i>)	Spotted Knapweed (<i>Centaurea maculosa</i>)
Diffuse Knapweed (<i>Centaurea diffusa</i>)	Tansy Ragwort (<i>Senecio jacobaea</i>)
Dodder (<i>Cuscuta</i> spp.)	Velvetleaf (<i>Abutilon theophrasti</i>)
Gorse (<i>Ulex europaeus</i>)	Wild Oats (<i>Avena fatua</i>)
Hound's-tongue (<i>Cynoglossum officinale</i>)	Yellow Nutsedge (<i>Cyperus esculentus</i>)
Jointed Goatgrass (<i>Aegilops cylindrica</i>)	Yellow Starthistle (<i>Centaurea solstitialis</i>)
Leafy Spurge (<i>Euphorbia esula</i>)	Yellow Toadflax (<i>Linaria vulgaris</i>)
Perennial Sowthistle (<i>Sonchus arvensis</i>)	

Unless their abundance is obvious (i.e., the plants are absent or obviously greater than the threshold values in the indicator statements), record the coverage for disturbance-increaser species and noxious weeds at six points or plots along the reach to estimate overall coverage along the traverse. Plots can be standard circular plots centered 5 m from the stream bank or 2 m wide transects that extend 10 m from the stream bank. At each point, if coverage is suspected of being close to the threshold values, use the cover classes provided in Figure 3 to estimate abundance.

Table 4. Common noxious weeds within the boundaries of the corresponding regional districts

Blueweed	<i>Echium vulgare</i>	Cariboo, Central Kootenay, Columbia-Shuswap, East Kootenay, Okanagan-Similkameen, Thompson-Nicola
Burdock	<i>Arctium</i> spp.	Bulkley-Nechako, Cariboo, Columbia-Shuswap, Fraser-Fort George, Kitimat-Stikine, North Okanagan, Okanagan-Similkameen, Peace River, Thompson-Nicola
Cleavers	<i>Galium aparine</i>	Peace River
Common Bugloss	<i>Anchusa officinalis</i>	Kootenay-Boundary
Common Tansy	<i>Tanacetum vulgare</i>	Bulkley-Nechako, Central Kootenay, Columbia-Shuswap, East Kootenay, North Okanagan
Field Scabious	<i>Knautia arvensis</i>	Bulkley-Nechako, Kootenay-Boundary, Thompson-Nicola
Green Foxtail	<i>Setaria viridis</i>	Peace River
Hoary Alyssum	<i>Berteroa incana</i>	Kootenay-Boundary
Hoary Cress	<i>Cardaria</i> spp.	Columbia-Shuswap, North Okanagan, Thompson-Nicola
Kochia	<i>Kochia scoparia</i>	Peace River
Marsh Plume Thistle	<i>Cirsium palustre</i>	Bulkley-Nechako, Fraser-Fort George
Meadow Knapweed	<i>Centaurea pratensis</i>	Columbia-Shuswap
Night-Flowering Catchfly	<i>Silene noctiflora</i>	Peace River
Orange Hawkweed	<i>Hieracium aurantiacum</i>	Bulkley-Nechako, Cariboo, Central Kootenay, Columbia-Shuswap, East Kootenay, Thompson-Nicola
Oxeye Daisy	<i>Chrysanthemum leucanthemum</i>	Cariboo, North Okanagan, Thompson-Nicola, Peace River
Perennial Pepperweed	<i>Lepidium latifolium</i>	East Kootenay, Thompson-Nicola
Plumeless Thistle	<i>Carduus acanthoides</i>	Central Kootenay
Puncturevine	<i>Tribulus terrestris</i>	Okanagan-Similkameen
Purple Loosestrife	<i>Lythrum salicaria</i>	Comox-Strathcona (by regional district bylaw)
Quackgrass	<i>Agropyron repens</i>	Peace River
Russian Knapweed	<i>Acroptilon repens</i>	North Okanagan
Russian Thistle	<i>Salsola kali</i>	Peace River
Scotch Thistle	<i>Onopordum acanthium</i>	North Okanagan
Sulphur Cinquefoil	<i>Potentilla recta</i>	Columbia-Shuswap, North-Okanagan, Okanagan-Similkameen, Thompson-Nicola
Tartary Buckwheat	<i>Fagopyrum tataricum</i>	Peace River
White Cockle	<i>Lychnis alba</i>	Peace River
Wild Chervil	<i>Anthriscus sylvestris</i>	Fraser Valley
Wild Mustard	<i>Sinapsis arvensis</i>	Peace River

Question 15. Is the riparian vegetation within the first 10 m from the edge of the stream generally characteristic of the “normal plant community”?

Most riparian areas support a diversity of trees and shrubs, with an understory of herbaceous plants and ground cover (mosses, lichens). The presence of woody plants in all age classes (especially young plants), in vigorous condition and in their natural form, is a good indication of a healthy riparian area.

Question 15 uses four indicator statements. In order to mark Yes to the question, three of the four indicator statements need to be answered Yes. Mark Not Applicable if the reach has no potential for trees and/or shrubs. For example, a bedrock controlled channel or a sedge fen would have no meaningful potential for trees or shrubs.

- a) All of the major vegetation layers (trees, tall shrubs, low shrubs, herbaceous plants, mosses and lichens) expected of the normal plant community are present over more than 75% of the stream reach.

A healthy riparian area is a tangle of herbaceous vegetation, shrubs and trees. Unhealthy riparian areas may still support trees, but there is typically a lack of structural diversity. Answer Yes if all of the expected main vegetation layers (trees, shrubs and ground cover) occur over more than 75% of the stream reach.

- b) The dominant species present in the tree and shrub layers exhibit high vigor, normal growth form, and good recruitment of seedlings or saplings.

Answer Yes if fewer than 30% of the branches on the shrubs and trees are dead; if less than 30% of the plants show a mushroom or hedged appearance; and if healthy seedlings or saplings are present.

- c) Heavy browse is present on a preferred browse species in the shrub layer. Heavy browse on a plant is browse down to second year wood over most (>50% of the branches) of the plant (see Figure 8).

To determine if there is heavy browse in the reach, look for a preferred browse species that is accessible to animals at each of six evenly spaced sites along the reach. Examine the plant and decide approximately what percent of the branches are nipped back to second-year wood. Record the percentage at each site, and then average the six sites to estimate the overall average browse level for the reach. Do this for the stream side closest to the treatment being assessed. If both sides of the stream are treated, assess the browse level on both sides.

TIP: If beaver-cut stems are noted at a site, record this as “heavy browse.”

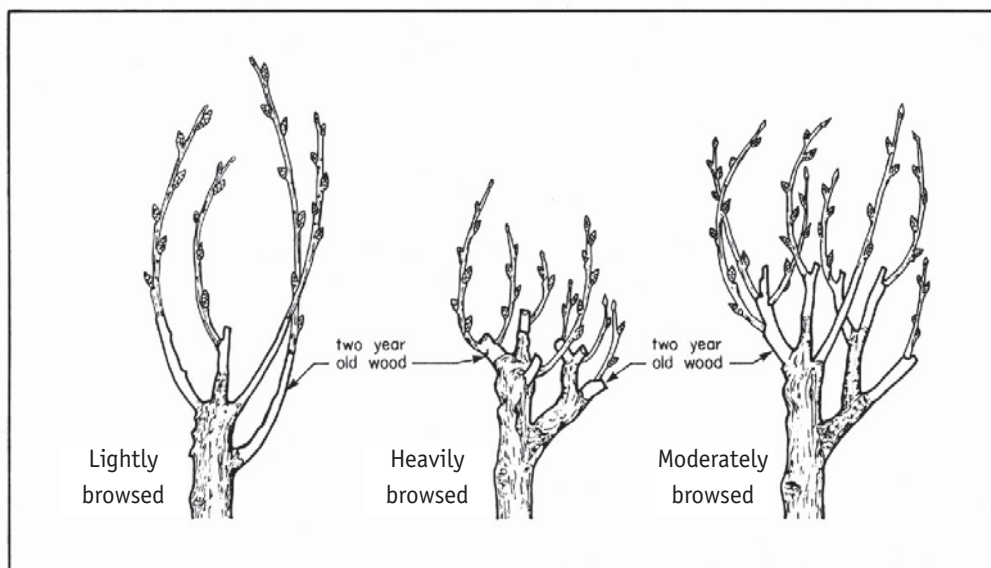


Figure 8. *Comparative browse forms for estimating levels of browse impacts within riparian areas.*

- d)** Heavy grazing occupies <10% of the herbaceous vegetation. Heavy grazing is defined as less than the recommended target stubble height for the dominant forage species present.

To determine if there is heavy grazing in the reach, measure the stubble height of the dominant forage species (the species most consumed) at six evenly spaced sites along the stream reach. If possible, measure the stubble height of 10 plants at each site to determine the average stubble height. The overall average stubble height is the average of the stubble heights at each of the sample sites.

Answer Yes to the indicator statement if the overall average stubble height exceeds the target stubble height for the dominant forage species. Target stubble heights for riparian and upland forage species are summarized in Tables 5 and 6 (Fraser 2003).

TIP: Forage in overgrazed areas has a “slick” or “smooth” appearance. Undergrazed areas have a “ragged” appearance if there is any grazing at all.

Table 5. Average stubble heights for riparian species

Species	Average stubble height (cm)
Baltic rush	10
Bluegrasses	10
Bullrushes	incidental use
Canada reedgrass (Bluejoint)	12
Cattails	incidental use
Desert saltgrass	7
Foxtail barley	10
Hairgrass, tufted	12
Kobresia	8
Sedges (large)	20
Spikerush	15

Table 6. Average stubble heights for upland species

Species	Average stubble height (cm)
Bluegrasses	8
Bromes (introduced)	10
Fescue, Altai	17
Fescue, creeping red	7
Fescue, Idaho	12
Fescue, rough	17
Needlegrass	12
Orchardgrass	10
Pinegrass	15
Ricegrass, rough-leaved	8
Timothy (alpine)	10
Timothy (domestic)	8
Wheatgrass, bluebunch	15
Wheatgrass, crested	8
Wheatgrass, northern	15
Wheatgrass, slender	15
Wheatgrass, western	12
Wildrye, blue	15

Help

If you require assistance on the use of the riparian management resource stewardship monitoring forms and/or protocol, please contact one of the following:

Derek Tripp (250) 714-0754 or db-tripp@telus.net
Peter Tschaplinski (250) 387-3025 or Peter.Tschaplinski@gems4.gov.bc.ca
Dan Hogan (604) 222-6752 or Dan.Hogan@gems9.gov.bc.ca
Stephen Bird (604) 536-5702 or sbird@fluvial-systems.com

Glossary

Alluvial – water-borne material.

Channel aggradation – accumulation of too much sediment in a stream channel, commonly attributed to slides, road erosion, and collapsing/eroding stream banks.

Channel degradation – a reduction in biological productivity or diversity due to reductions in sediment input.

Dewatering – conditions in a stream channel where all the flow occurs within permeable streambed sediments so that no surface water is left; common in small streams with considerable accumulations of gravel.

Indicator – A measurable attribute or component (often environmental or social) of a resource value that provides reliable information on the status or state of that resource.

Properly functioning condition – Streams, wetlands, and lakes and their adjacent riparian areas are functioning properly when adequate vegetation, landform, or large woody debris is present to maintain the physical and biological integrity of the riparian-aquatic system. Functions include dissipating stream energy associated with high waterflows, reducing riparian soil and channel erosion, filtering sediments from runoff, storing and safely releasing floodwater, moderating streambank and channel movement, maintaining full connectivity of aquatic and fish habitats, providing LWD, nutrients, and organic matter for aquatic ecosystems, and providing shade to maintain water temperatures and streambank microclimate conditions.

Stream reach – a length of channel exhibiting homogeneous characteristics and patterns.

Substrate – the mineral and organic components comprising the streambed.

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For an updated version of references and support information of this document, please consult the FREP web site at http://www.for.gov.bc.ca/hfp/frep/3_indicators.html.

Appendix 1. Sample REE field assessment completed forms

Routin e Riparian Management Effectiveness Evaluation - Page 1



BRITISH
COLUMBIA

FRPA Resource
Evaluation ProgramRoutine Riparian Management
Effectiveness Evaluation Page 1

Date: July 30/05 Sample No.: 6 Evaluator(s): DT, BB

[illegible]

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Routine Riparian Management Effectiveness Evaluation - Page 10

Sample no. 6 Routine Riparian Management Effectiveness Evaluation Page 10

SUMMARY		Yes	No	N/A
Question 1.	Is the channel bed undisturbed?	☒	☐	☐
Question 2.	Are the channel banks undisturbed?	☐	☒	☐
Question 3.	Are channel LWD processes undisturbed?	☒	☐	☐
Question 4.	Is the channel morphology undisturbed?	☒	☐	☐
Question 5.	Are all aspects of the aquatic habitat sufficiently connected to allow for normal, unimpeded movements of fish, organic debris, and sediments?	☐	☒	☐
Question 6.	Does the stream support a good diversity of fish cover attributes?	☒	☐	☐
Question 7.	Does the amount of moss present on the substrates indicate a stable and productive system?	☒	☐	☐
Question 8.	Has the introduction of fine sediments been minimized?	☐	☒	☐
Question 9.	Does the stream support a diversity of aquatic invertebrates?	☒	☐	☐
Question 10.	Has the vegetation retained in the RMA been sufficiently protected from windthrow?	☐	☒	☐
Question 11.	Has the amount of bare ground or soil disturbance in the riparian area been minimized?	☐	☒	☐
Question 12.	Has sufficient vegetation been retained to maintain an adequate root network or LWD supply?	☒	☐	☐
Question 13.	Has sufficient vegetation been retained to provide shade and reduce bank microclimate change?	☐	☒	☐
Question 14.	Have the number of disturbance-increaser plants or noxious weeds present been limited to a satisfactory level?	☒	☐	☐
Question 15.	Is the riparian vegetation within the first 10m from the edge of the stream generally characteristic of the normal plant community?	☒	☐	☐
<p>Number of "Yes" answers: <u>9</u></p> <p>Number of "No" answers: <u>6</u></p> <p>Specific "No" answers attributed to treatment or forest practice being assessed: <u>All 6 "No" answers attributed to blowdown.</u></p> <p>Conclusion on FC: Proper (0-2 "No's")</p> <p>At Risk (3-4 "No's")</p> <p><u>At High Risk (5-6 "No's")</u></p> <p>Non Functioning (>6 "No's")</p> <p>This stream reach would probably have been completely intact were it not for the blowdown.</p>				

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Routine Riparian Management Effectiveness Evaluation - Page 12

Sample no. 6 Routine Riparian Management Effectiveness Evaluation Page 12

FIELD DATA							
Start point and traverse direction (US/DS): <u>Lower block boundary</u>							
Reach length: <u>150 m</u> Reach gradient (%): <u>2-4</u> Reach confinement: <u>Part</u>							
Point Indicators (Measure at 5-6 points along the reach being assessed, or until satisfied the threshold values are met or not.)							Mean or Total
Q7	Moss (abundance)	A	A	A	-	Buried	
Q7	Moss (condition)						
Q8	Benthic invertebrates (# taxa)	3	1	2	1	-	7
Q9	Fines/sands (%)	0	1	1	0	90	30
Q13	Shade (%)	40	30	20	20	20	<40
Q13	Vegetative cover (%)	95	100	95	100	85	94
Q14	Disturbance-increaser species (%)	0	0	—	—	—	0
Q14	Noxious weeds (%)	0	—	—	—	—	0
Q15	Heavy browse (% of browse plants)	0	—	—	—	—	0
Q15	Heavy grazing (% of forage plants)	0	—	—	—	—	0
Continuous indicators (Measure along the total length of the reach being assessed, or until satisfied the threshold values are met or not.)							Total
Q1	Mid-channel bars, wedges (m)	3, 2, 2, 8, 2, 5, 6, 12, 10					50
Q1	Lateral bars (m)	2, 1					3
Q1	Multiple channels (m)	4, 3, 12					19
Q2	Recently eroded bank (m)	4, 2, 1, 5, 6, 1, 15, 9, 6, 2, 6					57
Q2	Undercut bank (m)	2, 3, 2					7
Q2	Deep rooted bank (m)	All except upturned R. wads, % 150-34=116					
Q2	Upturned bank root wads (m)	8, 6, 6, 3, 3, 8					34
Q3	Recent debris jams (No.)	2 (blowdown branches)					2
Q4	Pool length (m)	lots, > 25%					
Q4	Deep pools (No.)	1, 1					
Q10	Recent windthrows (No.)	3, 1, 5, 4, 5					18
Q10	Old windthrow (No.)	2, 3, 1, 1					7
Q10	Standing trees (No.)	19, 11, 6, 11					47
Q11	Bare soil in first 10 m (m ²)	6, 6, 7, 15, 15					49
Q11	Bare soil hydrologically connected to first 10 m (m ²)	5 x 30, 8, 10					168
Q11	Disturbed in first 10 m (m ²)	0					0
Q11	Disturbed ground hydrologically connected to first 10 m (m ²)	0					0

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Routine Riparian Management Effectiveness Evaluation - Page 13

Sample no. 6 Routine Riparian Management Effectiveness Evaluation Page 13

Other Observations to Note

Channel Gradient, Width

2 – 4%, width – 3, 3.5, 2.9, 3.3, 4.7 m, % 53 ✓

Benthic Invertebrates Observed

2 types caddisflies, 1 snail, 2 dip. l., 1 “worm”

Woody Debris Characteristics (new, old, logging related, across or parallel, natural debris intact)

Old, pre-logging debris present + intact, but lots of new branches, JWD from blowdown across stream.

Sediment Texture (uniform or not?)

Varied, sorted % heterogeneous

Connectivity (open-bottom structures on fish streams, temporary blockages, down cutting, sediment or debris buildups, dewatering, overland flow areas nor isolated)

Fish Cover (deep water, boulders, void spaces, undercut banks, woody debris, aquatic vegetation, overhanging vegetation)

Fine Sediments (check no blanketing, substrate not embedded, no “quicksand/gravel”)

Some upper sections blanketed with fines from upturned root wads

Wildlife Trees (any designated, protected from windthrow?)

None

Soils (cool, moist, unchanged?)

Some exposed banks by upturned root wads dried out

Vegetation (all expected layers expected present? - trees, tall shrubs, low shrubs, herbaceous plants, mosses, lichens)

OK

Vegetation (form, recruitment normal?)

OK

Routine Riparian Management Effectiveness Evaluation - Page 14

Sample no. 6 Routine Riparian Management Effectiveness Evaluation Page 14

Other Notes, Sketch Maps, Calculations

Benthic Inverts – common in lower reach with cobbles, boulders, absent in sand US.

$$\begin{aligned} \% \text{ Windthrow} &= \frac{(\text{no. down trees} \times 100)}{(\text{no. down} + \text{standing})} \\ &= \frac{1800}{(47 + 18)} = \frac{1800}{65} = 28\% \end{aligned}$$

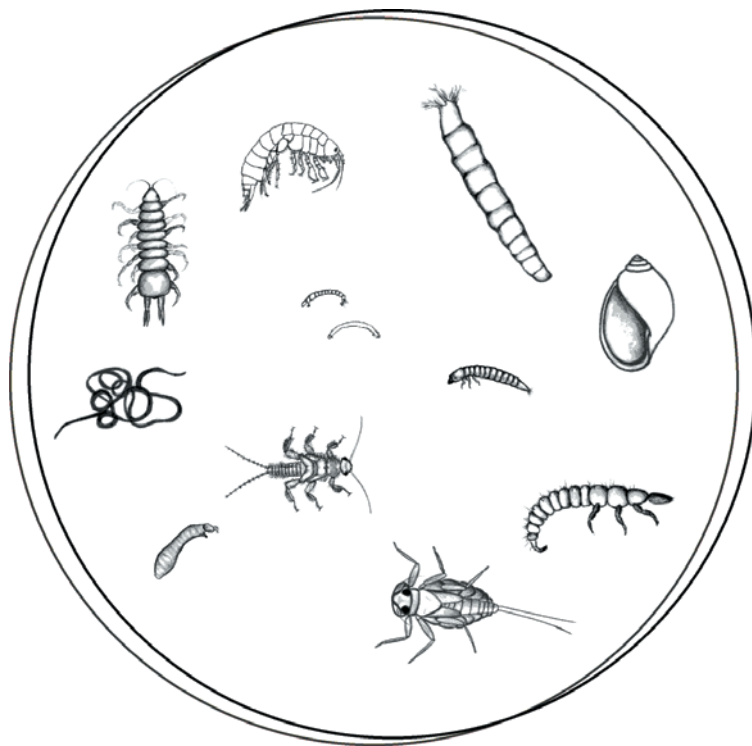
$$\begin{aligned} \% \text{ Old windthrow} &= \frac{(\text{no. old throw} \times 100)}{(\text{no. old, down} + \text{standing})} \\ &= \frac{700}{(47 + 18 + 7)} = \frac{700}{72} = \approx 10\% \end{aligned}$$

$$\% \text{ Bare ground} = \frac{49 \times 100}{150 \times 10} = \frac{4900}{1500} = 3+ \%$$

Appendix 2. Field guide to freshwater invertebrates

(from Leska S. Fore; Annabel Wildrick [illustrations])

The animals living in a stream provide the best indicators of that stream's overall health and ecological condition. Human activities that alter a watershed and interfere with the natural processes of a stream have immediate as well as long-lasting effects on the animals that live in the stream. We monitor invertebrates because they represent an enormous diversity of body shapes, survival strategies, and adaptations. Many invertebrates require clear, cool water, adequate oxygen, stable flows, and a steady source of food in order to complete their life cycles. These animals, in turn, provide food for trout, salmon, herons, and kingfishers. Below are descriptions of the invertebrates you might expect to find at an excellent stream site (i.e., a site unchanged by humans), a moderate site, and a poor (i.e., degraded) site.



Petri dish of invertebrates illustrates their approximate, relative size.

<http://www.seanet.com/~leska>

Excellent stream site

Here we find a variety of organisms with very different body shapes and ways of making a living. High biodiversity (or taxa richness) indicates a site with low human influence: most of the animals on this guide sheet should be present in a riffle sample. Several different types (or taxa) of stoneflies, mayflies, and caddisflies indicate a healthy site. More than one type of riffle beetle may also be identifiable, some are longer and skinnier than others. Some caddisflies are tolerant of degradation, so a large number of caddisflies does not necessarily indicate a good site, especially if they are the same species.

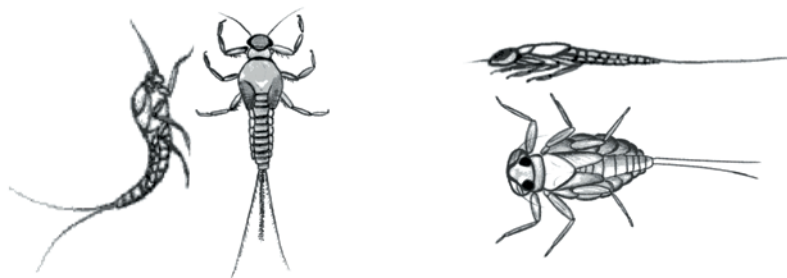
Moderate stream site

The total number of different types of organisms (taxa richness) declines as degradation increases. About half to two-thirds the number of taxa found at an excellent site are found in a moderate site. The primary change from an excellent site is that there will be many fewer taxa of stoneflies. Mayflies will be present, but probably fewer taxa as well. Several types of caddisflies may be present depending on the type of degradation. The relative proportions of soft-bodied worms, baetid mayflies, simuliid flies, or amphipods may increase. Beetles are probably still present; molluscs are not.

Poor stream site

The total number of taxa will be low. Most of the taxa found are soft-bodied animals, e.g., fly larvae, oligochaetes, nematodes, and in very poor sites, leeches and planaria. Worms are often difficult to distinguish from each other because their shapes are similarly adapted to living in soft sediments. Stoneflies are absent entirely. The only mayflies present are probably baetids (a family of mayflies). Caddisflies may be present, but only a few tolerant types. Amphipods are often present. There may be a large proportion of a single type of animal. In general, animals present may be smaller than those found at an excellent site.

Mayfly nymphs (*Order Ephemeroptera*)



Mayflies are insects that spend most of their lives in streams, emerging briefly as adults (“ephemerally”) to mate and lay eggs. Gills are often visible along the abdomen. If an animal has three tails it’s a mayfly; but some mayflies have two tails. Mayfly nymphs are strong swimmers and move like dolphins. As immature nymphs many mayflies feed on algae; as adults they do not eat. Mayfly diversity declines as streams are degraded; mayflies are particularly sensitive to mine waste.

Stonefly nymphs (*Order Plecoptera*)



Stonefly nymphs are typically found on or near stones in the stream. They are rather primitive and may have been among the first insects to develop flight. Adult males and females emerge from the water to mate and locate each other by drumming with their abdomens. Stoneflies move like turtles and many are predators that hide and stalk their prey between stones and cobble. Stoneflies look similar to mayflies but are stockier. Diversity of these animals declines rapidly at the first signs of human disturbance.

Caddisfly larvae (*Order Trichoptera*)



Caddisflies use silk (like butterflies) to build cases from gravel, twigs, needles, or sand. Different species build distinct cases, but they often lose them when removed from a stream. Caddisflies are insects that emerge to mate as winged adults. Caddisfly larvae make a living in a variety of ways: some capture food in nets, others scrape algae or shred leaf litter. Free-living caddisfly larvae do not build cases; many are predators and need to move quickly to capture other animals for food. Some caddisflies are very sensitive to human disturbance; others are tolerant.

Adult mayfly, stonefly, caddisfly



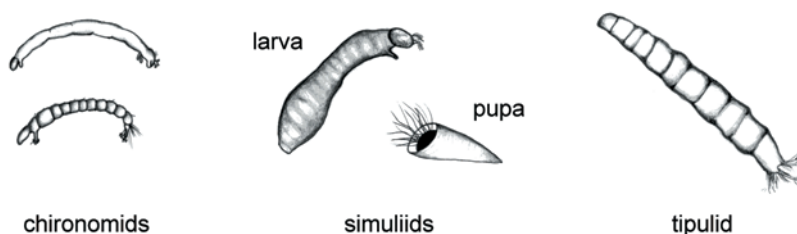
All three of these groups leave the water to mate as winged adults. Large swarms of mating mayflies and caddisflies often occur when all the individuals of a single species emerge at the same time. Stoneflies crawl out of the water and mate on the ground. The females of all three groups fly upstream and drop their eggs onto the water or dive into the stream to attach them to rocks or leaves.

Riffle beetles (*Order Coleoptera*)



Riffle beetle larvae are specially adapted to cling to smooth rocks in fast-flowing water (riffles). After emergence, adults fly for a short time but return to the water to feed in the same habitat as the larvae. Both the larvae and adults are rather small, dark-colored, and tend to drift to the bottom of a sample so they may be hard to see. Riffle beetles collect and gather a variety of different foods.

Fly larvae (*Order Diptera*)



There are many species of true flies, but you are likely to recognize three main groups or families. Midge larvae (or chironomids) are very small, often C-shaped, and have a spastic squirming movement. They are often attached to debris by their tiny legs. Black fly larvae (or simuliids) are dumb-bell shaped and soft. They attach themselves to the substrate and prefer soft sediment. Crane fly larvae (or tipulids) are large and fleshy with very short "tentacles" at one end.

Aquatic worms



planaria



nematode



oligochaete

Flatworms (planaria), roundworms (nematodes), and freshwater earthworms (oligochaetes) are properly called worms; but don't confuse them with the soft-bodied larvae of flies, for examples, which are not. Nematodes and oligochaetes are long and thin and writhe like snakes. Note that these animals do not have legs.

Crustaceans



amphipod



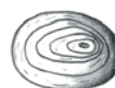
isopod

Amphipods (or "scuds") are very fast swimmers that look like shrimp. They have many appendages and look fuzzy. High proportions of these animals are present in very degraded sites. Isopods (or sowbugs) are usually found creeping through leaf litter.

Molluscs (Classes Gastropoda & Pelecypoda)



snails



limpet



clam

Most snails and limpets eat algae they scrape from rocks. Check to see if the animal is still in the shell. As larvae, freshwater mussels (or clams) may hitch a ride by attaching themselves to migrating fish. Mussels are very sensitive to sediment because they feed by filtering stream water through their shells. Mature mussels indicate an undisturbed site and may be up to 40 years old.

