Stream Ecological Valuation (SEV)

A User's Guide

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Stream Ecological Valuation (SEV): A User's Guide

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Contents

Preface

The first edition of the Stream Ecological Valuation (SEV) Technical Report (Rowe *et al*., 2006; Auckland Regional Council Technical Publication 302) was released in June 2006 and was followed by an updated second edition in January 2008 (Rowe *et al*., 2008). These reports were the result of a series of workshops at which an expert panel of freshwater ecologists sought to develop an ecosystem valuation system for Auckland streams. The reports provide the scientific background and reasoning behind the development of the SEV, together with a technical description of the variables and functions which are used in the SEV scoring system.

The widespread use of the SEV since its initial publication in 2006 has provided an abundance of SEV data and practical experience of the methodology, and much feedback has been received (both positive and negative) raising many issues and questions. During 2010, the former Auckland Regional Council reconvened the expert panel to review the SEV and consider the feedback received.

The panel recognised the sound scientific basis of the SEV method, but saw opportunities to resolve some redundancy and duplication issues within the method and also to address variables or functions that were not performing as well as anticipated. The result is a revised SEV (Storey *et al*., 2011) that is simpler and more efficient to carry out, yet has not lost any important information.

In conjunction with the 2010 review, we have delivered this user's guide that provides practical and photographic guidance to carrying out an SEV, and is robust enough to survive the wettest and dirtiest day in the field.

Introduction

When the first edition of the SEV was published as a technical publication in June 2006 (Rowe *et al*., 2006), it was anticipated that it would act as a reference text for the scientific and technical details of the SEV method, and that a more practical, illustrated user's guide would be published at a later date. In the meantime, SEV training workshops have offered practical guidance for users of the SEV. A review of the SEV in 2010 resulted in the production of this user's guide which provides practical guidance on scoring each variable, combining the variables into function and SEV scores and reporting the results.

Whilst this guide could be used independently to carry out an SEV assessment, it is recommended that it is read in conjunction with the revised technical report (Storey *et al.*, 2011) and that potential SEV users attend the training workshop. This will help to ensure that users are fully aware of the background, practicalities and limitations of the SEV.

History of the SEV

The SEV project was initiated because it was recognised that a stream ecosystem valuation system was required for Auckland streams. A global review of such valuation systems (Rowe, 2003) identified that a methodology being applied to wetlands by the US Environmental Protection Agency and US Army Corps of Engineers (Brinson & Rheinhardt, 1996) showed great promise. A team of inter-disciplinary experts was subsequently assembled and tasked with developing a stream ecosystem valuation system for Auckland streams based on this methodology. The team comprised of scientists from two Crown Research Institutes (NIWA and Landcare), Massey University, Waikato Regional Council and the former Auckland Regional Council.

The team identified the main ecological functions of Auckland streams through a series of workshops, and developed a system for assessing the extent to which these functions change in modified streams compared with unmodified reference streams. This work resulted in the publication of the first SEV technical publication in June 2006 (Rowe *et al*., 2006). This was followed by an updated second edition in January 2008 (Rowe *et al*., 2008), which incorporated the knowledge gained from additional field surveys, and guidance on legal principles and terminology arising from the Environment Court. A paper based on the second edition was subsequently published in the international peer-reviewed literature (Rowe *et al*., 2009).

When the SEV was first published it was recognised that improvements to the method would become apparent as user experience and field data accumulated and as the science underlying the method advanced. Since then, extensive feedback on all aspects of the method has been gathered from a wide range of SEV practitioners, particularly attendees of the training courses, through the application of the SEV to the Auckland

Council's monitoring network, and through two independent peer reviews. Given this extensive volume of feedback, it was considered timely to reconvene the expert panel to review the feedback and performance of the SEV. This occurred through two workshops held in October 2010, where a thorough review led to a series of proposed modifications to the SEV. This was followed by field trials of the revised methodology in April 2011 and resulted in the publication of a revised version of the SEV technical report (Storey *et al*., 2011). The publication of this user's guide is the final output of the SEV review.

Structure of the SEV

The SEV is based on the 14 functions that were identified by the expert panel as being the most important, and that could be practically assessed. For reference, these functions are briefly described below according to the function type to which they belong. For a full description refer to Storey *et al*. (2011).

- Hydraulic functions
  - Natural flow regime (NFR) assesses the ability of the test reach to maintain a natural flow regime by measuring the extent of channel modification.
  - Floodplain effectiveness (FLE) assesses the efficacy of the test reach's floodplain to mitigate flood flows by measuring the connectivity to, and complexity of, the floodplain.
  - Connectivity for natural species migrations (CSM) assesses the ability of the test reach to allow species migrations by measuring artificial barriers to migration.
  - Natural connectivity to groundwater (CGW) assesses the capacity of the test reach to interact with groundwater by measuring the extent of channel modification.
- Biogeochemical functions
  - Water temperature control (WTC) assesses the ability of the test reach's riparian zone to maintain cool water temperatures by measuring the extent of channel shading.
  - Dissolved oxygen levels maintained (DOM) assesses the ability of the test reach to maintain oxygen levels by measuring indicators of oxygen reducing processes.
  - Organic matter input (OMI) assesses the ability of the test reach to provide organic matter by measuring the extent and type of woody vegetation in the riparian zone.
  - In-stream particle retention (IPR) assesses the ability of the test reach to retain organic matter by measuring channel modification and macrophyte growth.
  - Decontamination of pollutants (DOP) assesses the capacity of the test reach to process contaminants by measuring in-stream substrate and riparian zone complexity.

- Habitat provision functions
  - Fish spawning habitat (FSH) assesses the ability of the test reach to provide spawning habitat for native fish by measuring in-stream substrate and riparian conditions.
  - Habitat for aquatic fauna (HAF) assesses the suitability of the test reach to provide habitat for aquatic fauna by measuring the nature of physical habitat.
- Biodiversity provision functions
  - Fish fauna intact (FFI) assesses the condition of the test reach's fish community by comparison with a modelled prediction.
  - Invertebrate fauna intact (IFI) assesses the condition of the test reach's invertebrate community by comparison with reference conditions.
  - Riparian vegetation intact (RVI) assesses the ability of the test reach's riparian vegetation to provide a range of functions by measuring the type and extent of the riparian vegetation.

This guide

This guide has been produced to provide practical guidance for assessing each of the variables that comprise the SEV, including photographic examples of the key features to look for. The guide has been produced using robust materials, with the intention that it can be taken into the field.

There are seven broad steps to carrying out an SEV assessment, and this guide is divided into seven corresponding sections:

1. Site identification
2. Equipment checklist
3. Biological samples
4. Cross-sectional measures
5. Reach scale measures
6. Desk-based measures
7. Calculating and reporting your results

This guide has been deliberately restricted to the information required to carry out an SEV assessment. For a more detailed description of the technical background of the SEV refer to the revised technical report (Storey *et al*., 2011). The latest version of the SEV calculator, IBI software and field sheets can be downloaded from the Auckland Council website or the Knowledge Auckland website (http://www.knowledgeauckland.org.nz/).

Part 1: Site identification

The general site location, i.e. the stream and position in catchment, and the exact location of the test reach, are likely to be determined by the purposes of the assessment and are not covered here. In cases where the location is not predetermined, a test reach that it is representative of the stream or catchment in which it is contained should be selected. The River Environment Classification (REC: Snelder *et al*., 2004) or the Freshwater Ecosystems of New Zealand (FENZ: Leathwick *et al*., 2010) may assist in locating and evaluating a suitable test site.

It is essential to incorporate any site access issues, hazards and any other health and safety issues into your site selection process. The SEV has been designed to be used on wadeable streams and requires the user to enter the stream multiple times along the test reach. If this activity poses an unacceptable risk to personal safety it should be avoided. Furthermore, it is recommended that SEV assessments are not undertaken by lone fieldworkers.

The length of stream reach to assess can be determined by the purpose of the assessment. For example, if a specific activity, such as a resource consent application for stream works, or a stream rehabilitation project is to occur over 60 metres of stream, then the SEV should be carried out at this scale. In other cases, the stream reach for assessment may not be so clear. In such cases, a reach length of 20 times the average stream width, with a minimum length of 50 metres is recommended. If the intention is to repeat the SEV assessments in order to monitor change over time, the reach length must be consistent between surveys. For example, SEV assessments are carried out at the Auckland Council's State of the Environment monitoring sites over a consistent and representative 100 metre reach length, with the cross sectional measures completed every ten metres. The use of GPS measurements are encouraged for repeat visits.

A maximum reach length is not specified, as the SEV score should not change substantially by lengthening the test reach beyond the minimum length. However, the reach should not extend across a major change in land use or stream physical characteristic. If such a major change exists at your site, undertaking multiple SEV assessments, above and below this change, is recommended.

Once your test reach has been selected and prior to commencing the SEV assessment, we recommend that a tape measure is unrolled along the stream bank to clearly delineate the reach (Fig. 1). This will ensure the biological samples are collected within the chosen reach and help to identify the locations at which the cross-sectional measures should be taken.

Fig. 1 Tape measure rolled out along test reach

Part 2: Equipment checklist

The list below is what we consider is the minimum equipment required to undertake an SEV assessment:

General SEV requirements

- Two people with waders or gumboots (depending on the depth of the stream)
- A GPS device
- 100 metre tape measure
- A Wolman (particle size) stick (Fig. 2)
- A one metre flat-bladed metal ruler (Fig. 3)
- Field sheets or electronic data capture device
- Access to aerial photography (for determining desk-based measures). In Auckland, the Auckland Council GIS viewer is a useful resource (www.aucklandcouncil.govt.nz).

For the invertebrate sample collection

- Kick net (Fig. 4)
- Sieve bucket (Fig. 4)
- Sample containers
- Water-proof and preservative-proof sample labels
- Preservative

For the fish sample collection

- Electric fishing machine (Fig. 5)
- Fishing nets

Fig. 2 Wolman (particle size) stick

Fig. 3 One metre flat-bladed metal ruler

Fig. 4 Kick net and sieve bucket

Fig. 5 Electric fishing machine

Part 3: Biological samples

Information on the invertebrate and fish communities present at test sites is required to calculate an SEV score. The collection and processing of the biological samples is the most onerous part of the SEV method, but the value of the information provided by these biological samples is high.

Where practical, it is recommended that the invertebrate and fish sampling is carried out on different days, as the collection of one sample may affect the other. Where this is not practical, collect the invertebrate sample first, followed by the cross-sectional and reach scale SEV assessments. Sample the fish community last, leaving as much time as possible between the in-stream activities and sampling the fish community.

3.1 The invertebrates

Well-established national protocols for sampling macroinvertebrates in wadeable streams exist (Stark *et al*., 2001), and their use is advocated. Sample the invertebrate community using the appropriate semi-quantitative method, i.e. C1 for hard-bottomed sites or C2 for soft-bottomed sites. The samples can be processed using either the P1 or P2 protocols, as only presence-absence data is required to calculate the invertebrate variables and functions in the SEV. The samples should be identified to at least the level contained in the Macroinvertebrate Community Index (MCI) user's guide (Stark & Maxted, 2007). Enter the taxa list produced for your sample into the SEV calculator, and the 3 variables that are based on the invertebrate data will be automatically calculated according to the formulae below.

- **V_{mci}**
  - This variable uses the MCI index calculated from your data (MCI_{test}) and scales it between 0 and 1 based on the range of MCI scores found at Auckland sites.
  - If MCI_{test} is less than 40 then V_{mci} = 0, and if MCI_{test} is greater than 130 then V_{mci} = 1. If MCI_{test} is between 40 and 130 use the formula below.
  - **$V_{mci} = (MCI_{test} - 40)/90$**
- **V_{ept}**
  - This variable uses the number of EPT taxa calculated from your data (EPT_{test}) and scales it between 0 and 1 based on the range of number of EPT taxa found at Auckland reference sites.
  - EPT_{ref} is 6 for soft-bottomed sites and 18 for hard-bottomed sites.
  - If V_{ept} is greater than 1, then it defaults to 1.
  - **$V_{ept} = EPT_{test}/EPT_{ref}$**

- **V_{invert}**
  - This variable compares the taxa from your data with those that are commonly found at Auckland reference sites.
  - The number of taxa from your sample ($Taxa_{test}$) that are in the relevant reference taxa list (see Table 1 - note there are separate lists for soft-bottomed and hard-bottomed sites) is divided by the average found at Auckland reference sites ($Taxa_{ref}$).
  - $Taxa_{ref}$ is 8.58 for soft-bottomed sites and 18.2 for hard-bottomed sites.
  - **$V_{invert} = Taxa_{test}/Taxa_{ref}$**

Table 1: The invertebrate reference taxa list for Auckland streams

Soft-bottomed site taxa	Hard-bottomed site taxa	
Taxa	Taxa	
Polyplectropus	Elmidae	*Helicopsyche*
Polypedilum	*Archichauliodes*	Orthocladiinae
Paradixa	*Hydrobiosis*	*Potamopyrgus*
Potamopyrgus	*Zephlebia*	*Orthopsyche*
Paratya	*Polypedilum*	*Coloburiscus*
Tanypodinae	*Stenoperla*	*Zelandoperla*
Arachnocolus	Hydraenidae	*Psilochorema*
Zephlebia	*Hydrobiosella*	*Austroclima*
Tepakia	*Acanthophlebia*	*Latia*
Talitridae	*Austroperla*	*Ichthybotus*
Triplectides	*Olinga*	*Austrosimulium*
Paraleptamphopus	Ptilodactylidae	*Costachorema*
	Aphrophilia	*Megaleptoperla*
	Ameletopsis	*Tanytarsus*

3.2 The fish

Unlike invertebrates, there are no standard procedures for the sampling of fish communities in New Zealand, although such protocols are currently (as of June 2011) in development as an Envirolink project (www.envirolink.govt.nz). Nevertheless, there are common techniques that have been used to sample fish populations and the most appropriate of these should be used to sample the fish community at your test site.

The use of an electric fishing machine is the preferred method of sampling the fish community in your sample reach. However, if this method is not suitable for a particular site, i.e. it is too deep, or there are no qualified electric fishing operators, Gee minnow traps and fyke nets can be used as an alternative. If these are used, they should be left overnight and retrieved the following day. In order to adequately sample the fish community within the test reach, at least 50 metres should be fished by electric fishing, or a minimum of ten Gee minnow traps plus an appropriate number of fyke nets should be used.

In some locations a comprehensive record of the fish community may be available, most likely in the New Zealand Freshwater Fish Database. If an up-to-date comprehensive record exists, then sampling the fish community may not provide any additional information and it may be appropriate to use the existing fish information as a substitute for a fish survey. Such situations are the exception, rather than the norm, and if using existing data, the reason for doing so should be clearly made in the SEV report along with an acknowledgement of the data source.

The fish community information in the SEV requires the use of the IBI Index and software which is available on the Knowledge Auckland website (http://www.knowledgeauckland.org.nz/). Enter the fish species present at your site into the IBI software to calculate an IBI index for your test site. The IBI index is used to produce the V_{fish} variable as follows;

$$\mathbf{V_{fish} = IBI/60}$$

Part 4: Cross sectional measures

You should now be situated at the start of your test reach with a tape measure unrolled along the bank. The measures in this part of the guide are carried out at ten equally spaced cross sections along your test reach, with 10% of your overall test reach length between each cross section.

At each of your cross-sections, carry out the following five assessments.

4.1 Depth

Using the metal ruler, measure the stream depth at the cross section at 10%, 30%, 50%, 70% and 90% of the distance across the channel (i.e. make 5 depth measurements at each cross section).

The mean of the 50 depth measurements is used to produce $\mathbf{V_{depth}}$.

4.2 Substrate assessment

Use the Wolman, or Particle Size Stick, to measure the B-axis (i.e. second longest) of ten randomly selected particles taken from the stream bed across your cross-section (Figs. 6-9). Ensure your randomly selected particles are selected from the full width of your cross-section, a useful approach is to walk across the stream and at each step pick up the particle directly in front of your foot.

If a leaf, aquatic plant, algae or plant root overlies the stream bed, record that in the "Organic material category" and also record the inorganic particle or wood underneath it. However, if wood overlies the stream bed, do not record the inorganic particle underneath. For the purposes of this assessment, wood is treated the same as inorganic particles.

The substrate assessment field sheet should be completed so that the inorganic or wood table always has a total of 100 data points (10 for each cross-section) based on the dominant stream bed substrate. The "organic material" table may contain anything from zero to 100 data points dependent on the occurrence of organic material over the dominant bed substrate.

Fig. 6 Measuring a small gravel particle (2 to 8mm) using the Wolman stick

Fig. 7 Measuring a medium-large gravel particle (16 to 32mm) using the Wolman stick

Fig. 8 Measuring a large gravel particle (32 to 64mm) using the Wolman stick

Fig. 9 Measuring a large cobble particle (128 to 256mm) using the Wolman stick

When entered into the SEV calculator the data from this assessment is used to produce two variables (V_{surf} and $V_{gobspwn}$) thus;

- **V_{surf}**
  - This variable uses the proportional cover of the substrates in Table 2 to provide an assessment of the abundance of surfaces suitable for biofilm colonisation.
  - The result is scaled between 0 and 1 based on the range at Auckland reference sites.
  - **$V_{surf} = \Sigma(WxP)/0.76$**

Table 2: V_{surf} scoring table

Substrate type	Weighting (W)	Proportional cover (P)	W x P
Leaf litter	1		
Periphyton and submerged macrophytes	1		
Wood, roots and emergent or floating vegetation	0.5		
Boulders	0.4		
Gravel and cobbles	0.3		
Silt and bedrock	0.1		
		Sum WxP	

- **$V_{gobspwn}$**
  - This variable uses the proportional cover of hard stable substrates to provide an assessment of the abundance of surfaces suitable for spawning by Gobiidae fish species.
  - The combined proportional cover of large cobbles, boulders and medium or large wood is calculated (P) and **$V_{gobspwn}$** is determined as follows;
    - If P > 10% then $V_{gobspwn}$ = 1
    - If P is between 5 and 10% then $V_{gobspwn}$ = 0.8
    - If P is between 2 and 4% then $V_{gobspwn}$ = 0.2
    - If P < 2% then $V_{gobspwn}$ = 0.1

4.3 Shade

Select the category from Table 3, below, that best describes the extent of shading provided by vegetation, topographic features (i.e. stream banks and valley sides) and artificial structures at your cross section. The table's frequency column should always contain ten data points (one for each cross section).

- **V_{shade}**
  - The mean of the shading measurements is used to calculate V_{shade} thus;
  - **$V_{shade} = \Sigma(WxF)/10$**

The V_{shade} variable score is also used in the calculation of $V_{watqual}$ in section 6.1.

Table 3: V_{shade} scoring table

Shading description	Weighting (W)	Frequency (F)	W x F
No effective shading; shading from vegetation and topographical features < 10% (Fig. 10)	0		
Very low shading; shading from vegetation and topographical features 11 – 30% (Fig. 11)	0.2		
Low shading; shading from vegetation and topographical features 31 – 50% (Fig. 12)	0.4		
Moderate shading; shading from vegetation and topographical features 51 – 70% (Fig. 13)	0.6		
High shading; shading from vegetation and topographical features 71 – 90% (Fig. 14)	0.8		
Very high shading; shading from vegetation and topographical features > 90% (Fig. 15)	1		
		Sum WxF	

Fig. 10 Stream channel with no effective shading

Fig. 11 Stream channel with very low shading

Fig. 12 Stream channel with low shading

Fig. 13 Stream channel with moderate shading

Fig. 14 Stream channel with high shading

Fig. 15 Stream channel with very high shading

4.4 Macrophytes

This macrophytes measure is based on the Macrophyte Channel Clogginess Index developed for Waikato Regional Council (Collier *et al.*, 2007). Assess the proportional cover of macrophytes in a one metre band upstream of your cross section. Score the cover of 'surface reaching' macrophytes (SRM, which includes emergent or bank side vegetation) and 'below surface' macrophytes (BSM) separately according to Table 4 (Figs. 16-19). The combined proportional cover for each cross-section should not exceed 1.

- **V_{macro}**
  - The mean cover of the two types of macrophytes, based on the ten cross section measurements, is used to produce the V_{macro} variable;
  - **V_{macro} = 1-(mean SRM + (mean BSM x 0.5))**

Table 4: V_{macro} scoring table

Cross section	Surface reaching macrophytes (SRM)	Below surface macrophytes (BSM)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Mean cover		

Fig. 16 Stream channel with extensive surface reaching macrophytes (SRM = 1)

Fig. 17 Stream channel with moderate surface reaching (SRM = 0.4) and low below surface (BSM = 0.1) macrophytes

Fig. 18 Stream channel with low surface reaching (SRM = 0.2) and low below surface (BSM = 0.15) macrophytes

Fig. 19 Stream channel with no macrophytes (SRM = 0, BSM = 0)

4.5 Velocity

We have adopted the 'ruler method' for measuring water velocity (see page 114 in Harding *et al*., 2009) as it provides a suitable level of information for the purposes of an SEV assessment. Measure the water depth twice at the fastest point on each cross section using a flat bladed metal ruler. For the first measurement, position the ruler parallel to the current and record the depth (d1). For the second measurement, turn the blade so that it is perpendicular to the current and a 'bow wave' forms on the upstream face of the ruler. Record the depth at the top of this bow wave (d2) (Figs. 20-25). The difference in these two depth measurements (d2-d1) can be used to calculate the water velocity within 10% of flow meter readings (Harding *et al*., 2009).

If the difference (d2-d1) is less than 2mm (Figs. 20 and 21), then the usefulness of the method is compromised. In such cases, measure the distance a floating particle travels in a fixed time period (commonly 10 seconds). Therefore, for each of your cross sections, you will have either a measurement based on either the ruler method or the floating particle method (Table 5). These measurements are used in the SEV calculator to estimate the maximum flow velocity (m/s) at each cross section;

The velocity estimate (v) based on the ruler method is calculated as, $v = \sqrt{(196 \times (d2-d1))}$.

The velocity estimate (v) based on the floating particle method is calculated as, v = distance travelled/time taken.

- **V_{veloc}**
    - the mean of the ten velocity estimates is used to calculate V_{veloc}

Table 5: V_{veloc} scoring table

Cross section	Ruler method	Floating particle method		Velocity
	d2-d1 (mm)	Distance travelled (m)	Time taken (s)	estimate
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
			Mean velocity	

Fig. 20 Slow velocity; difference (d2-d1) = 1mm, so use floating particle test

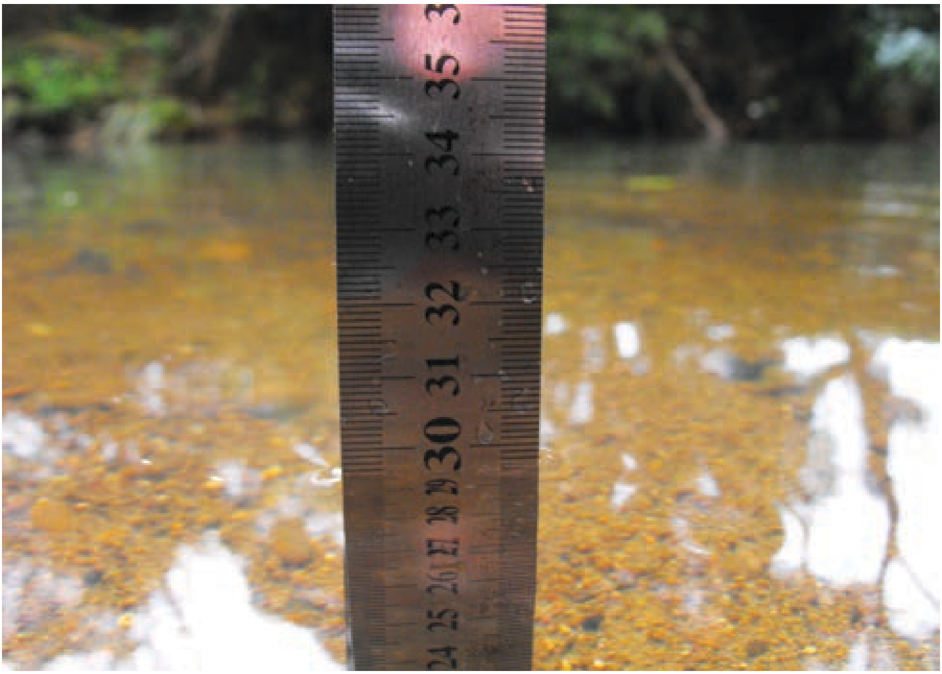

Fig. 21 Slow velocity; difference (d2-d1) = 1mm, so use floating particle test

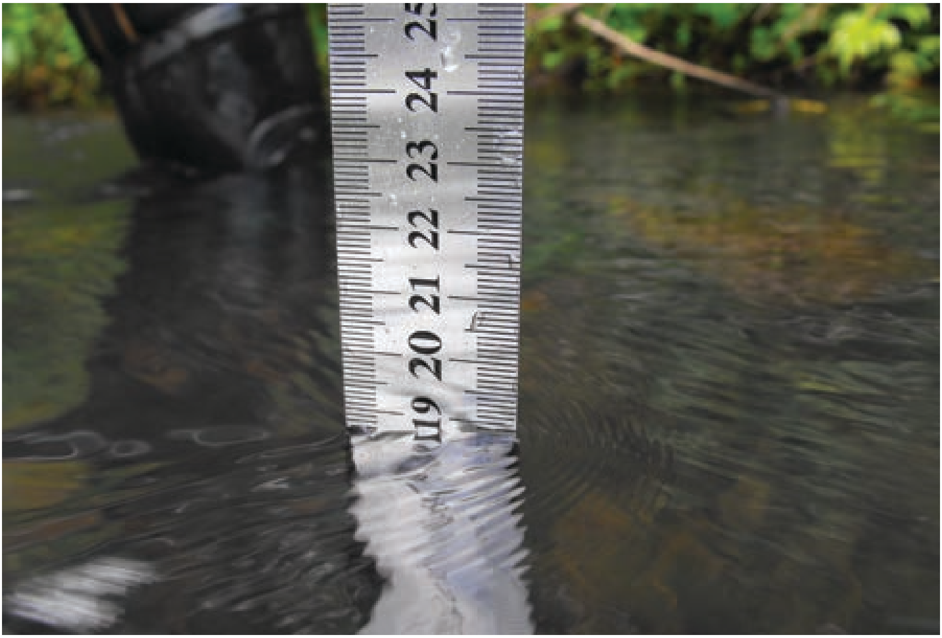

Fig. 22 Moderate velocity; difference (d2-d1) = 12mm

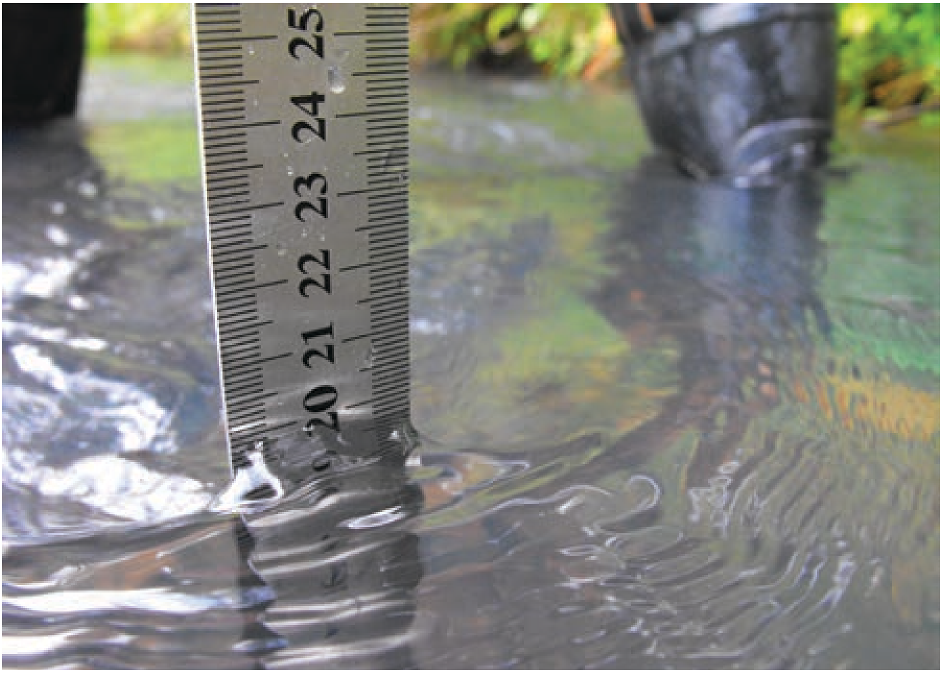

Fig. 23 Moderate velocity; difference (d2-d1) = 12mm

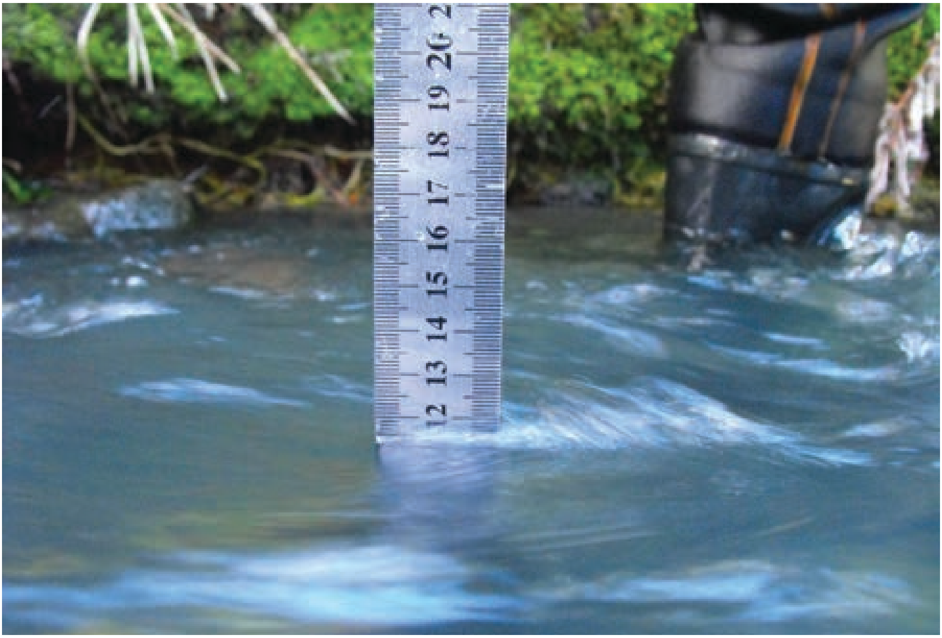

Fig. 24 Swift velocity; difference(d2-d1) = 53mm

Fig. 25 Swift velocity; difference(d2-d1) = 53mm

Part 5: Reach scale measures

You should now be at the end of your test reach having carried out a series of measurements at ten cross sections.

The measures in this part of the guide are those that require an assessment of the conditions over the entire test reach. For new SEV users, this may involve a few more trips along your test reach to assess each of these measures, but as your experience of using the SEV increases, you will automatically observe the key features required for the reach scale measures as you complete the cross sectional measures.

There are 14 reach scale measures required for the SEV, although some of these measures are used multiple times and hence they contribute to 17 variable scores. For example, the channel modification assessment is used in the calculation of three variables (V_{chann}, $V_{chanshape}$ and V_{retain}). This approach was incorporated into the 2010 review to reduce the duplication of data collection that existed in the first version of the SEV.

Carry out each of the following reach scale assessments for your test site.

5.1 Piped inflows

Assess the number and size of stormwater pipes and mole or tile drains that flow into your test reach. The number and size of piped inflows is used to score $\mathbf{V_{pipe}}$ as per Table 6.

The variable score for V_{pipe} is also used in the calculation of $V_{ripconn}$ in section 5.14.

Table 6: V_{pipe} scoring table

Size and number of piped inflows	V_{pipe}
No piped inflows to stream channel	1
One piped inflow, smaller than 20cm in diameter (Fig. 26)	0.7
Either multiple piped inflows or inflow greater than 20cm in diameter (Figs. 27-29)	0.3

Fig. 26 Single piped inflow, less than 20cm in diameter

Fig. 27 Multiple piped inflows

Fig. 28 Single piped inflow, greater than 20cm in diameter

Fig. 29 Single piped inflow, greater than 20cm in diameter

5.2 Channel modification

Assess the extent of channel modification by estimating the proportion of the test reach that is affected by each of the channel modifications listed in Table 7. If more than one modification occurs at a particular place, score the lowest ranked of the modifications present in Table 7. The sum of the values in the proportion of channel column in Table 7 should always be 1.

Table 7: Channel modification scoring table

Rank	Type of channel modification	Proportion of channel (P)	Weighting (see table 8) (W)	W x P
1	Natural channel with no modification (Fig. 36)			
2	Natural channel, but flow patterns affected by a reduction in roughness elements (e.g. woody debris, or boulders) (Fig. 30)			
3	Channel not straightened or deepened, but upper banks widened to increase flood flow capacity (Fig. 31)			
4	Natural channel, but evidence of channel incision from flood flows (Fig. 32)			
5	Natural channel, but flow patterns affected by increase in roughness elements (e.g. excessive macrophyte growth) (Fig. 33)			
6	Flow patterns affected by artificial in-stream structure (e.g. ponding due to culvert, weir or unnatural debris) (Fig. 34)			
7	Channel straightened and/or deepened (Fig. 35)			
		Sum WxP		

The information on channel modification contributes to the calculation of three variable scores (**V_{chann}, $V_{chanshape}$** and **V_{retain}**). The three variables are all calculated using the proportion of the reach affected by each of the channel modifications, but different variable-specific weightings (Table 8) are used to calculate each variable score. The SEV calculator automatically calculates these three variable scores from the data you collect, but if you wish to calculate the variable scores manually, use the appropriate weightings from Table 8. Sum the W x P values to produce the variable score.

Table 8: Channel modification variable-specific weightings

Rank	Type of channel modification	Variable-specific weightings		
		V_{chann}	$V_{chanshape}$	V_{retain}
1	Natural channel with no modification (Fig. 36)	1	1	1
2	Natural channel, but flow patterns affected by a reduction in roughness elements (e.g. woody debris, or boulders) (Fig. 30)	0.8	0.4	0.6
3	Channel not straightened or deepened, but upper banks widened to increase flood flow capacity (Fig. 31)	0.5	0.6	0.6
4	Natural channel, but evidence of channel incision from flood flows (Fig. 32)	0.5	0.6	0.8
5	Natural channel, but flow patterns affected by increase in roughness elements (e.g. excessive macrophyte growth) (Fig. 33)	0.4	0.9	0.2
6	Flow patterns affected by artificial in-stream structure (e.g. ponding due to culvert, weir or unnatural debris) (Fig. 34)	0.1	0.9	0.2
7	Channel straightened and/or deepened (Fig. 35)	0.1	0.2	0.2

Fig. 30 Natural channel with reduction in roughness elements

Fig. 31 Upper bank widened to increase capacity

Fig. 32 Natural channel shape, but evidence of channel incision (note the flood debris in the tree is below bank full height)

Fig. 33 Channel affected by increase in roughness elements

Fig. 34 Flow patterns affected by artifical instream structure (downstream view can be seen in Figure 59)

Fig. 35 Channel straightened and deepened

5.3 Channel lining

Assess the extent of channel lining by estimating the proportion of the test reach that is affected by each of the channel lining types listed in Table 9. The sum of the values in the 'proportion of channel' column in Table 9 should always be 1.

The information on channel lining is used to calculate $\mathbf{V}_{\mathbf{lining}}$ by multiplying the proportion of channel affected by the weighting for that type of channel lining. Sum the W x P values to produce the $\mathbf{V}_{\mathbf{lining}}$ variable score.

Table 9: Channel lining scoring table

Type of channel lining	Proportion of channel (P)	Weighting (W)	W x P
Natural channel with no modification (Fig. 36)		1	
Bed with unnatural loading of fine sediment (Fig. 37)		0.8	
Bank OR bed lined with permeable artificial lining (e.g. gabion baskets) (Fig. 38)		0.6	
Bank OR bed lined with impermeable artificial lining (e.g. concrete)(Fig. 39)		0.4	
Bank AND bed lined with permeable artificial lining (Fig. 40)		0.2	
Bank AND bed lined with impermeable artificial lining (Fig. 41)		0	
	Sum WxP		


Fig. 36 Natural channel with no modification


Fig. 37 Bed with unnatural loading of fine sediment

Fig. 38 Bed lined with permeable artifical lining

Fig. 39 Banks lined with impermeable artificial lining

Fig. 40 Bank and bed lined with permeable artifical lining

Fig. 41 Bank and bed lined with impermeable artifical lining

5.4 Connectivity with floodplain

Assess how well flood waters can interact with the floodplain at your test site. Take into account the presence of a floodplain and any artificial barriers that prevent flood waters from entering the floodplain. Estimate the proportion of the test reach that matches each of the categories in Table 10. The sum of the values in the 'proportion of channel' column in Table 10 should always be 1.

The information on floodplain connectivity is used to calculate $\mathbf{V_{bank}}$ by multiplying the proportion of channel affected by the weighting for that category. Sum the W x P values to produce the $\mathbf{V_{bank}}$ variable score.

Table 10: Floodplain connectivity scoring table

Floodplain description	Proportion of channel (P)	Weighting (W)	W x P
Movement of flood flows onto and across the floodplain is not restricted by any artificial structures or modifications (Fig. 42)		1	
Floodplain present, connectivity to floodplain is restricted by artificial modification (for example stop banks or urban development) (Fig. 43)		0.4	
Floodplain present, but connectivity to floodplain reduced by channel incision or bank widening so that most flood flows are unlikely to reach the floodplain (Fig. 44)		0.2	
No hydrological connectivity with floodplain as all flows are likely to be artificially contained within the channel (Fig. 45)		0	
	Sum WxP		

Fig. 42 Floodplain connectivity not restricted by artifical structures

Fig. 43 Floodplain connectivity restricted by development

Fig. 44 Floodplain connectivity restricted by channel incision

Fig. 45 Floodplain connectivity restricted by modified channel

5.5 Riparian vegetation

Assess the type and extent of riparian vegetation by estimating the proportion of the test reach banks that is covered by the vegetation types listed in Table 11. The sum of the values in the 'proportion of channel' column in Table 11 should always be 1.

Table 11: Riparian vegetation scoring table

Vegetation type	Proportion of channel (P)	Weighting (see table 12) (W)	W x P
Mature indigenous vegetation with diverse canopy and understorey (Fig. 46)			
Regenerating indigenous vegetation in late stage of succession (Fig. 47)			
Natural, diverse wetland vegetation on banks (Fig. 48)			
Mature native trees, but damaged understorey (Fig. 49)			
Mature exotic trees (e.g. willows and plantation forest) (Fig. 50)			
Low diversity regenerating bush (e.g. manuka scrub) with stock excluded, or tall (> 2m) exotic shrubs (Fig. 51)			
Mature flax, long grasses and sedges (Fig. 52)			
Low diversity regenerating bush with stock access, or early stage restoration planting, or short (< 2m) exotic shrubs, or immature plantation forest (Fig. 53)			
Mainly long grasses (not grazed or mown) (Fig. 54)			
Grazed wetlands (Fig. 55)			
Mainly short grasses (grazed or mown) (Fig. 56)			
Disturbed bare soil or artificial surfaces (Fig. 57)			
	Sum WxP		

Fig. 46 Mature indigenous vegetation

Fig. 47 Regenerating indigenous vegetation

Fig. 48 Natural wetland vegetation

Fig. 49 Native trees with damaged understorey


Fig. 50 Mature exotic trees


Fig. 51 Low diveristy regenerating bush


Fig. 52 Mature flax


Fig. 53 Early stage restoration planting


Fig. 54 Long grasses


Fig. 55 Grazed wetland vegetation


Fig. 56 Short grasses (mown)


Fig. 57 Artifical surface

The information on riparian vegetation contributes to the calculation of two variable scores (**V_{rough}** and **$V_{ripcond}$**). The two variables are both calculated using the proportion of the reach covered by each of the vegetation types, but different variable-specific weightings (Table 12) are used to calculate each variable score. The SEV calculator automatically calculates these two variable scores from the data you collect, but if you wish to calculate the variable scores manually, use the appropriate weightings from Table 12. Sum the W x P values to produce the variable score.

Table 12: Riparian vegetation variable-specific weightings

Vegetation type	$V_{ripcond}$	V_{rough}
Mature indigenous vegetation with diverse canopy and understorey	1	1
Regenerating indigenous vegetation in late stage of succession	0.8	1
Natural, diverse wetland vegetation on banks	0.8	0.8
Mature native trees, but damaged understorey	0.7	0.6
Mature exotic trees (e.g. willows and plantation forest)	0.7	0.7
Low diversity regenerating bush (e.g. manuka scrub) with stock excluded, or tall (> 2m) exotic shrubs	0.6	0.8
Mature flax, long grasses and sedges	0.4	1
Low diversity regenerating bush with stock access, or early stage restoration planting, or short (< 2m) exotic shrubs, or immature plantation forest	0.3	0.6
Mainly long grasses (not grazed or mown)	0.2	0.5
Grazed wetlands	0.2	0.2
Mainly short grasses (grazed or mown)	0.1	0.2
Disturbed bare soil or artificial surfaces	0	0

5.6 Barriers to migration

Assess the number and type of artificial barriers to fish and invertebrate migration in your test reach. Natural barriers, such as waterfalls, are not included in this assessment. The number and type of barriers is used to score $\mathbf{V_{barr}}$ as per Table 13. If there is more than one artificial barrier present, score the most severe barrier.

Examples of barrier types are illustrated on the following page. A partial barrier is one that limits the migrations of some species, for example, poorly designed or maintained weirs and culverts. Be aware that some structures may only become barriers at times of high or low flow. A total barrier is one that limits the migrations of all species, for example, a perched culvert.

Table 13: V_{barr} scoring table

Barrier type	V_{pipe} score
No barriers to migration	1
Partial or intermittent barrier to migration (Figs. 58-59)	0.3
Total barrier to migration (Figs. 60-61)	0

Fig. 58 Partial barrier - swimming species unable to pass

Fig. 59 Partial barrier - swimming species unable to pass

Fig. 60 Total barrier - swimming and climbing species unable to pass

Fig. 61 Total barrier - swimming and climbing species unable to pass

5.7 Oxygen demand

Select the category from Table 14 that best describes the indicators of oxygen reducing processes that are present in your test reach to produce D.

This information is used to calculate the variable V_{dod} as follows;

- **V_{dod}**
  - If D is 1, then $V_{dod} = 1$.
  - If D is less than 1, then $V_{dod} = D \times (V_{veloc}/V_{depth})$

The V_{dod} variable score is also used in the calculation of $V_{watqual}$ in section 6.1.

Table 14: V_{dod} scoring table

Status	Indicators of oxygen reducing processes	D
Optimal	• No anaerobic sediment • No odours or bubbling when sediments are disturbed • Little or no macrophyte biomass (summer), or no areas of slow flow, low shade and soft substrate (winter)	1
Sub-optimal	• No anaerobic sediment • Some bubbling when sediments are disturbed, but no sulphide odour • Moderate macrophyte biomass (summer), or moderate areas of slow flow, low shade and soft substrate (winter)	0.75
Marginal	• Small patches of anaerobic sediment • Some bubbling and sulphide odour when sediments are disturbed • Some sewage fungus may be present • Dense macrophyte biomass (summer), or large areas of slow flow, low shade and soft substrate (winter)	0.5
Poor	• Much black anaerobic sediment • Extensive bubbling with sulphide odour when sediments disturbed • Surface scums present • Abundant sewage fungus may be present	0.25

5.8 Riparian canopy cover

Assess the proportion of the riparian zone, defined as 20 metres either side of the stream channel, that is covered by woody vegetation (trees or shrubs). The variable $\mathbf{V_{ripar}}$ is simply the proportion value produced from this assessment (Figs. 62-65).

5.9 Riparian cover seasonality

Assess the proportion of the riparian cover indentified in Step 5.8 that is not deciduous (i.e. none of the riparian cover is deciduous = 1, all of the riparian cover is deciduous = 0). The variable $\mathbf{V_{decid}}$ is simply the proportion value produced from this assessment.

The deciduous species most commonly found on stream banks are Willow and Poplar.

5.10 Riparian zone filtering capacity

Assess the capacity of the riparian zone to filter overland run-off by estimating the proportion of the riparian zone in your test reach that matches the categories in Table 15. The sum of the values in the proportion of channel column in Table 15 should always be 1. This filtering capacity measure is based on that developed for Environment Canterbury to inform riparian management (Quinn, 2009).

In Table 15, when we refer to drainage channels we specifically mean where surface run-off is confined to small channels, or 'rills', so that run-off rapidly passes through the riparian zone, with little time for filtering or infiltration. Exclude any large tributaries in this assessment. The sum of the values in the 'proportion of channel' column in Table 15 should always be 1.

The information on riparian zone filtering capacity is used to calculate $\mathbf{V_{ripfilt}}$ by multiplying the proportion of channel that matches each description by the weighting for that description. Sum the W x P values to produce the $\mathbf{V_{ripfilt}}$ variable score.

Fig. 62 Very high cover of woody vegetation in the riparian zone (**V**$_{ripar}$=1)

Fig. 63 High cover of woody vegetation in the riparian zone (**V**$_{ripar}$=0.7)

Fig. 64 Moderate cover of woody vegetation in the riparian zone (**V**$_{ripar}$=0.5)

Fig. 65 Low cover of woody vegetation in the riparian zone (**V**$_{ripar}$=0.1)

Table 15: Riparian vegetation scoring table

Riparian zone description	Proportion of channel (P)	Weighting (W)	W x P
Very high filtering activity (Fig. 66) • Dense ground cover vegetation OR thick organic litter layer under a tree canopy, AND • Run-off into stream diffuse, with only minor defined drainage channels, AND • Width of buffer greater than 5x channel width		1	
High filtering activity (Fig. 67) • Dense ground cover vegetation OR thick organic litter layer under a tree canopy, AND • Run-off into stream diffuse, with only minor defined drainage channels, AND • Width of buffer less than 5x channel width		0.8	
Moderate filtering activity (Fig. 68) • Uniform ground cover vegetation OR abundant organic litter layer under a tree canopy, AND • Run-off into stream mostly diffuse, with few defined drainage channels		0.6	
Low filtering activity (Fig. 69) • Patchy ground cover vegetation OR little organic litter layer under a tree canopy, AND/OR • Some run off into stream in small defined drainage channels		0.4	
Very low filtering activity (Fig. 70) • Short (mown or grazed) vegetation with high soil compaction, AND/OR • Run-off into stream mostly contained in small defined drainage channels		0.2	
No filtering activity (Fig. 71) • Banks bare or impermeable		0	
	Sum WxP		

Fig. 66 Very high filtering activity - thick organic litter layer, greater than 5x channel width

Fig. 67 High filtering activity - thick organic litter layer, less than 5x channel width

Fig. 68 Uniform ground cover with few defined drainage channels

Fig. 69 Patchy ground cover with some defined drainage channels

Fig. 70 Short grazed vegetation

Fig. 71 Bare and impermeable stream banks

5.11 Extent of Galaxiidae spawning habitat

Measure the length of near-flat surface ($<10^o$) on both stream banks that would be inundated by a small floods or spring tides (i.e. where a spring tide causes stream water to flood the banks (Figs. 72-75). Reaches receiving salt water influence should not be assessed using SEV). Express this length as a proportion of the total bank length (i.e. length of suitable flat surface (2 x reach length)) and call this value R.

This information is then used to calculate the variable $\mathbf{V_{galspwn}}$ according to the following;

- $\mathbf{V_{galspwn}}$
  - If R is greater than 0.25 then $V_{galspwn} = 1$
  - If R is less than 0.01 then $V_{galspwn} = 0$
  - For other values of R, $V_{galspwn} = 0.25 + (3 \times R)$


Fig. 72 Near flat stream banks that would be inundated by small floods


Fig. 73 Near flat stream banks that would be inundated by small floods


Fig. 74 Near flat stream banks that would be inundated by small floods


Fig. 75 Near flat stream banks that would be inundated by small floods

5.12 Quality of Galaxiidae spawning habitat

Select the category from Table 16 that best describes the quality of the stream bank identified as suitable for Galaxiidae spawning habitat in 5.11. For tidally influenced reaches (i.e. reaches in which the flow is slowed by a high tide) assess the quality of habitat for inanga; above tidally influenced reaches assess the quality of habitat for kokopu species (banded, giant and shortjaw) and koaro.

The $\mathbf{V_{galqual}}$ score corresponds with the category that best describes the Galaxiidae spawning habitat in your test reach.

Table 16: Galaxiidae spawning habitat quality scoring table

Quality	Tidally influenced reaches	Above tidal influence	$V_{galqual}$ Score
High (Fig. 76)	• Nearly flat (<1°) stream bank, with near total (>60%) cover by dense stemmed, low growing vegetation. • Inundated by spring tides and/or floods.	• Under a dense tree canopy (>80% shade). • Nearly flat (<1°) stream bank with heavy cover of (>50%) of dense stemmed, low growing vegetation, twigs or gravels. • Inundated by high rainfall events	1
Medium (Fig. 77)	• Gently sloping (1-5°) bank, with moderate (20 to 60%) cover of low growing vegetation. • Inundated by spring tides and/or floods.	• Under a moderate tree canopy (50 to 80% shade). • Gently sloping (1-5°) bank, with moderate (20 to 50%) cover of low growing vegetation, twigs or gravels. • Inundated by high rainfall events	0.75
Low (Fig. 78)	• Sloping bank (5-10°) with sparse (10 to 20%) cover of low growing vegetation. • Inundated by spring tides and/or floods.	• Under a partial tree canopy (10 to 50% shade). • Sloping bank (5-10°) with sparse (1 to 20%) cover of low growing vegetation, twigs or gravels. • Inundated by high rainfall events	0.25
Unsuitable (Fig. 79)	• Bank slope >10°, or less than 10% cover of low growing vegetation	• Less than 10% shade from tree canopy, or bank slope > 10°, or < 1% cover of low growing vegetation, twigs or gravels	0

Fig. 76 High quality spawning habitat - heavy cover of low growing vegetation under a dense tree canopy

Fig. 77 Medium quality spawning habitat - moderate cover of twigs and gravels under a moderate tree canopy

Fig. 78 Low quality spawning habitat - sparse cover of twigs and gravels under a partial tree canopy

Fig. 79 Unsuitable spawning habitat - less than 10% shade from tree canopy

5.13 Physical habitat quality

Assess the physical habitat of your stream reach using the scoring framework in Table 17. For each of the five categories in the table, select the quality class (optimal, sub optimal, marginal or poor) that best describes the condition in your test reach, and within the quality class select the appropriate score. Note the riparian vegetation integrity is scored independently for each bank.

This information is then used to calculate the variable $\mathbf{V_{physhab}}$ according to the following;

- $\mathbf{V_{physhab}}$
  - Sum the six scores produced by your assessment and divide by 100 to produce H
  - H is then standardised using the mean score for Auckland references sites (0.85)
  - $\mathbf{V_{physhab} = H/0.85}$

Table 17: Physical habitat quality scoring table

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
Aquatic Habitat Abundance - proportion of stream channel occupied by suitable habitat features for in-stream fauna	> 50% of channel favourable for macroinvertebrate colonisation and fish cover; includes woody debris, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat.	30-50% of channel contains stable habitat.	10-30% of channel contains stable habitat.	< 10% of channel contains stable habitat. Note: Algae does not constitute stable habitat.
	20 19 18 17	16 15 14 13 12	11 10 9 8 7 6	5 4 3 2 1 0
Aquatic Habitat Diversity	Wide variety of stable aquatic habitat types present including: woody debris, riffles, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat.	Moderate variety of habitat types; 3-4 habitats present including woody debris.	Habitat diversity limited to 1-2 types; woody debris rare or may be smothered by sediment.	Stable habitats lacking or limited to macrophytes (a few macrophyte species scores lower than several).
	20 19 18 17	16 15 14 13 12	11 10 9 8 7 6	5 4 3 2 1 0

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
Hydrologic Hetero-geneity	Mixture of hydrologic conditions i.e. pool, riffle, run, chute, waterfalls; variety of pool sizes and depths.	Moderate variety of hydrologic conditions; deep and shallow pools present (pool size relative to size of stream).	Limited variety of hydrologic conditions; deep pools absent (pool size relative to size of stream).	Uniform hydrologic conditions; uniform depth and velocity; pools absent (includes uniformly deep streams).
	20 19 18 17	16 15 14 13 12	11 10 9 8 7 6	5 4 3 2 1 0
Channel Shade	>80% of water surface shaded. Full canopy.	60 - 80% of water surface shaded; mostly shaded with open patches.	20 - 60% of water surface shaded; mostly open with shaded patches.	<20% of water surface shaded. Fully open; lack of canopy cover.
	20 19 18 17	16 15 14 13 12	11 10 9 8 7 6	5 4 3 2 1 0
Riparian Vegetation Integrity (within 20 metres)	No direct human activity in the last 30 years; mature native tree canopy and intact native understorey	Minimal human activity; mature native tree canopy or native scrub; understorey shows some impact (e.g. weeds, feral animal grazing).	Extensive human activity affecting canopy and understorey; trees exotic (pine, willow, poplar); understorey native or exotic.	Extensive human activity; little or no canopy; managed vegetation (e.g. livestock grazing, mowed); permanent structures may be present (e.g. building, roads, car parks).
Left bank	10 9 8	7 6 5	4 3 2	1 0
Right bank	10 9 8	7 6 5	4 3 2	1 0

5.14 Riparian zone connection

Assess the connection between the riparian zone and the stream channel in your test reach. Determine the proportion of your test reach where the connection between the riparian root zone and the stream channel is not obstructed by artificial structures, such as culverts (Fig. 80) or channel lining (Fig. 81), or prevented by channel incision (Fig. 82) where the water level is below the root zone of existing riparian vegetation. If there are no impediments to connection, then the score for C is 1, if there is no connection the score for C is 0.

This information, in addition to the score for V_{pipe} (see section 5.1), is then used to calculate the variable $\mathbf{V_{ripconn}}$ according to the following;

- $\mathbf{V_{ripconn}}$
  - $\mathbf{V_{ripconn} = C \times ((1+V_{pipe})/2)}$

Fig. 80 Riparian root zone connection limited by culvert

Fig. 81 Riparian root zone connection limited by channel lining

Fig. 82 Riparian root zone connection limited by channel incision

Part 6: Desk-based measures

Whilst most of the SEV method is based on measurements and assessments taken in the field, the following two variables are partly determined using aerial photography of the catchment upstream of your test reach.

6.1 Water quality

Assess the extent of the stream length upstream of your test site that is shaded by riparian vegetation, using Table 18 to produce S.

This information, in addition to the score for V_{dod} (see section 5.7) and V_{shade} (see section 4.3), is then used to calculate the variable $\mathbf{V_{watqual}}$ according to the following;

- $\mathbf{V_{watqual}}$
  - $\mathbf{V_{watqual} = V_{dod} \times ((V_{shade} + S)/2)}$

Table 18: Catchment shading scoring table

Extent of stream shading	S
Well shaded (>50% of stream length upstream forested)	1
Partially shaded (<50% of stream length upstream forested)	0.5
Minimally shaded (mainly pasture, but some riparian cover present)	0.2
No upstream shade	0

6.2 Catchment impervious surface

Using aerial photography or an impervious surface GIS layer, assess the extent of the catchment upstream of your test reach that is covered by impervious surface. The REC (Snelder *et al*., 2004) and FENZ (Leathwick *et al*., 2010) may also be useful for this assessment.

Also required is an assessment of the presence of flow control measures such as stormwater detention ponds that are present in the catchment. This can be determined solely using aerial photography or relevant GIS layers, but a field inspection can also be useful.

The information about impervious surface and flow control measures in the catchment are combined to produce the variable $\mathbf{V_{imper}}$ according to Table 19. However, if there are no impervious surfaces upstream of your test reach, $\mathbf{V_{imper}}$ defaults to 1.

Table 19: V_{imperv} scoring table

Catchment impervious surface	Extent of flow control measures		
	Much control	Some control	No control
Less than 10%	0.9	0.8	0.7
10 to 25%	0.5	0.4	0.3
Greater than 25%	0.3	0.2	0.1

Part 7: Calculating and reporting an SEV score

You should now have a full set of field and desk derived SEV data. Whilst it is possible to use the raw field data collected to calculate an SEV score manually using the algorithms in this user's guide and the companion technical report, the SEV calculator semi-automates much of this procedure. Entering your test site data into the SEV calculator is simple and its use limits the scope of errors in the calculation of variable or function scores. Each of the calculator's data entry sheets has a clear set of instructions that advise which data needs to be entered and where. It is important to read the instructions on each page before attempting to enter the data. Note that some sheets require no manual input as the data may be sourced from another sheet.

The calculator automatically calculates the 14 individual function scores and the overall SEV score in the 'function scoring' worksheet. However, each of the function scores can be calculated manually using the information in Table 20.

7.1 Calculating function and SEV scores

The 29 variables scores collected for the SEV assessment are used to calculate the 14 function scores as described in Table 20.

The overall SEV score for a test site is simply the mean of the 14 function scores.

Table 20: The variables and algorithms for calculating SEV function scores

Function	Variables required	Algorithm
Natural flow regime	V_{pipe} (section 5.1) V_{chann} (section 5.2) V_{lining} (section 5.3)	$NFR = ((2V_{chann} + V_{lining})/3) \times V_{pipe}$
Floodplain effectiveness	V_{bank} (section 5.4) V_{rough} (section 5.5)	$FLE = V_{bank} \times V_{rough}$
Connectivity for natural species migrations	V_{barr} (section 5.6)	$CSM = V_{barr}$
Natural connectivity to groundwater	V_{lining} (section 5.3) $V_{chanshape}$ (section 5.2)	$CGW = (2V_{lining} + V_{chanshape})/3$
Water temperature control	V_{shade} (section 4.3)	$WTC = V_{shade}$
Dissolved oxygen levels maintained	V_{dod} (section 5.7)	$DOM = V_{dod}$
Organic matter input	V_{ripar} (section 5.8) V_{decid} (section 5.9)	$OMI = V_{ripar} \times ((1+V_{decid})/2)$
In-stream particle retention	V_{macro} (section 4.4) V_{retain} (section 5.2)	IPR = the lesser of V_{macro} or V_{retain}
Decontamination of pollutants	V_{surf} (section 4.2) $V_{ripfilt}$ (section 5.10)	$DOP = (V_{surf} + V_{ripfilt})/2$
Fish spawning habitat	$V_{galspwn}$ (section 5.11) $V_{galqual}$ (section 5.12) $V_{gobspwn}$ (section 4.2)	$FSH = ((V_{galspwn} \times V_{galqual}) + V_{gobspwn})/2$
Habitat for aquatic fauna	$V_{physhab}$ (section 5.13) $V_{watqual}$ (section 6.1) V_{imper} (section 6.2)	$HAF = (V_{physhab} + ((V_{watqual} + V_{imperv})/2))/2$
Fish fauna intact	V_{fish} (section 3.2)	$FFI = V_{fish}$
Invertebrate fauna intact	V_{mci} (section 3.1) V_{ept} (section 3.1) V_{invert} (section 3.1)	$IFI = (V_{mci} + V_{ept} + V_{invert})/3$
Riparian vegetation intact	$V_{ripcond}$ (section 5.5) $V_{ripconn}$ (section 5.14)	$RVI = V_{ripcond} \times V_{ripconn}$

Table 21: SEV assessment scores from 19 sites in Auckland

Site	Marawhara Stream	Cascades Stream	Okura River	Nukumea Stream	West Hoe Stream	Mahurangi River	Orere Stream	Opanuku Stream	Vaughan Stream	Aroara Stream
Easting	1730764	1735628	1753241	1749408	1748314	1747626	1796911	1742086	1755414	1789893
Northing	5910714	5916378	5940408	5951420	5950610	5964866	5903704	5915581	5938729	5903498
Catchment land cover	Native forest	Native forest	Native forest	Native forest	Native forest	Exotic forest	Exotic forest	Rural	Rural	Rural
Function										
Natural flow regime	1.00	1.00	1.00	1.00	1.00	0.59	0.97	0.99	0.53	0.72
Floodplain effectiveness	1.00	1.00	1.00	1.00	1.00	0.48	0.92	0.76	0.14	0.12
Connectivity for species migrations	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Natural connectivity to groundwater	1.00	1.00	1.00	1.00	1.00	0.81	0.99	0.99	0.83	0.86
Hydraulic function mean	1.00	1.00	1.00	1.00	1.00	0.72	0.97	0.94	0.63	0.67
Water temperature control	0.76	0.80	0.94	0.94	0.80	0.76	0.90	0.56	0.20	0.48
Dissolved oxygen levels maintained	1.00	1.00	1.00	1.00	1.00	0.68	1.00	1.00	0.34	0.68
Organic matter input	1.00	1.00	1.00	1.00	1.00	0.70	1.00	0.70	0.00	0.20
In-stream particle retention	1.00	1.00	1.00	0.94	0.98	0.56	0.98	1.00	0.20	0.84
Decontamination of pollutants	1.00	1.00	1.00	0.96	1.00	0.86	0.88	0.80	0.74	0.80
Biogeochemical function mean	0.95	0.96	0.99	0.97	0.96	0.71	0.95	0.81	0.30	0.60
Fish spawning habitat	0.93	0.47	0.55	0.90	0.60	0.50	0.76	0.63	0.40	0.22
Habitat for aquatic fauna	0.97	0.98	0.82	0.98	0.94	0.77	0.99	0.81	0.36	0.54
Habitat provision function mean	0.95	0.72	0.68	0.94	0.77	0.64	0.88	0.72	0.38	0.38
Fish fauna intact	0.77	0.80	0.73	0.70	0.63	0.47	0.57	0.87	0.70	0.43
Invertebrate fauna intact	0.96	0.80	0.93	0.93	0.98	0.74	1.00	0.48	0.36	0.91
Riparian vegetation intact	1.00	0.80	1.00	0.80	1.00	0.64	0.80	0.59	0.30	0.28
Biodiversity function mean	0.91	0.80	0.89	0.81	0.87	0.62	0.79	0.65	0.45	0.54
Overall SEV score	0.96	0.90	0.89	0.94	0.92	0.68	0.91	0.80	0.44	0.58

Table 21: continued

Site	Puhinui Stream	Papakura Stream	Waiwera River	Omaru Creek	Avondale Stream	Oakley Creek	Botany Creek	Paremuka Stream	Chatswood Stream
Easting	1770072	1771240	1747612	1766268	1750685	1754917	1769788	1743365	1752861
Northing	5903308	5900290	5953946	5916749	5912301	5914269	5915080	5917644	5924029
Catchment land cover	Rural	Rural	Rural	Urban	Urban	Urban	Urban	Urban	Urban
Function									
Natural flow regime	0.99	0.37	0.63	0.20	0.67	0.04	0.06	0.77	0.94
Floodplain effectiveness	0.92	0.00	0.13	0.34	0.44	0.00	0.00	0.48	0.86
Connectivity for species migrations	0.30	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Natural connectivity to groundwater	0.97	0.67	0.80	0.74	0.77	0.20	0.33	0.80	0.93
Hydraulic function mean	0.80	0.51	0.64	0.57	0.72	0.31	0.35	0.76	0.92
Water temperature control	1.00	0.08	0.70	0.40	0.64	0.60	0.22	0.78	0.84
Dissolved oxygen levels maintained	1.00	0.45	1.00	0.50	0.40	0.68	0.45	1.00	1.00
Organic matter input	1.00	0.00	0.57	0.03	0.80	0.00	0.00	1.00	0.80
In-stream particle retention	1.00	0.20	0.80	0.80	0.77	0.20	0.20	0.90	0.98
Decontamination of pollutants	0.75	0.60	0.76	0.81	1.00	0.50	0.60	0.80	0.98
Biogeochemical function mean	0.95	0.27	0.76	0.51	0.72	0.40	0.29	0.90	0.92
Fish spawning habitat	0.57	0.15	0.63	0.23	0.78	0.40	0.05	0.55	0.61
Habitat for aquatic fauna	0.85	0.30	0.77	0.25	0.50	0.22	0.20	0.59	0.74
Habitat provision function mean	0.71	0.23	0.70	0.24	0.64	0.31	0.13	0.57	0.67
Fish fauna intact	0.67	0.50	0.43	0.17	0.23	0.23	0.30	0.43	0.50
Invertebrate fauna intact	0.58	0.21	0.83	0.12	0.35	0.19	0.12	0.24	0.23
Riparian vegetation intact	1.00	0.00	0.60	0.18	0.41	0.00	0.00	0.60	0.90
Biodiversity function mean	0.75	0.24	0.62	0.16	0.33	0.14	0.14	0.42	0.54
Overall SEV score	0.83	0.32	0.69	0.41	0.63	0.30	0.25	0.71	0.81

7.2 Reporting and interpreting SEV assessments

The purpose of your SEV report will determine the format you use to communicate the results. Whichever format you choose, it is recommended that individual function scores are reported along with the overall SEV score. The function scores provide a great deal more information than a single SEV score, and allow the reader to understand what functions may be under-performing if a sub-optimal SEV score is produced. The results contained in Table 21 provide an example of how this can be done.

A question that is often raised during the SEV training workshops is 'what does my SEV score mean?' To provide some context for the SEV scores that are produced, the results from 19 sites where the revised 14-function SEV was tested have been presented in Table 21. These SEV assessments cover a range of sites, from highly impacted urban rivers to pristine streams in the Waitakere Ranges. SEV users can compare these results with the results of their own assessments and it is hoped they will provide some context for interpretation.

7.3 Feedback

We welcome feedback and queries on the SEV. Please direct your enquiries to sev@aucklandcouncil.govt.nz.

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