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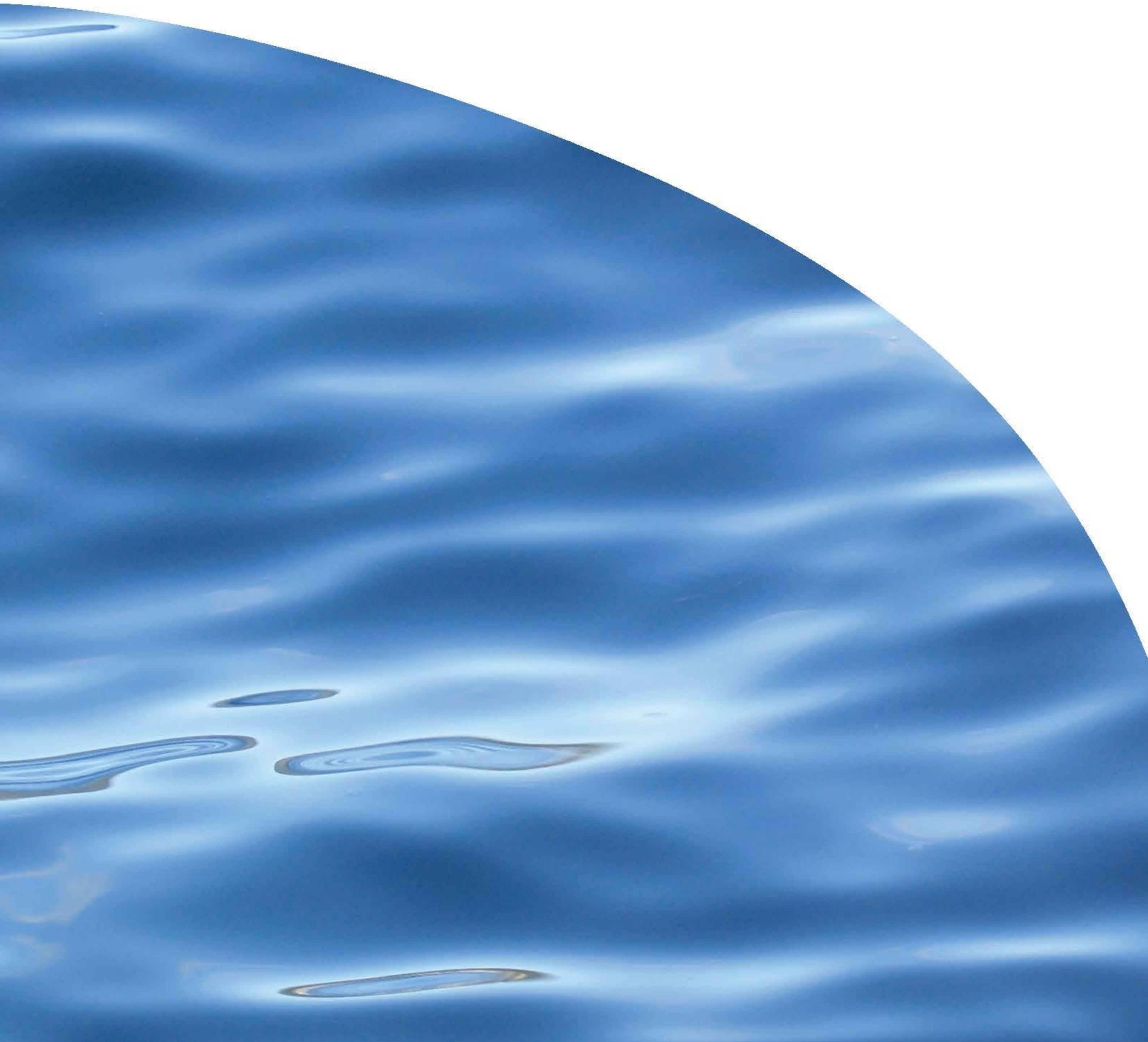
LONGFIN TUNA AND BROWN TROUT HABITAT QUALITY INDICES FOR INTERPRETING HABITAT QUALITY SCORE DATA



LONGFIN TUNA AND BROWN TROUT HABITAT QUALITY INDICES FOR INTERPRETING HABITAT QUALITY SCORE DATA

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EXECUTIVE SUMMARY

The rapid habitat assessment protocol used to calculate a Habitat Quality Score (HQS) for rivers and streams is a nationally standardised tool. It is used by regional councils during routine State of Environment river monitoring.

This report adds value to the HQS method by providing a technique to calculate fish habitat quality indices based on data collected using the HQS protocol. The HQS tuna and trout habitat parameter scores are derived from existing literature reviews and fish habitat quality indices which are documented in the Broad-scale Stream Habitat Mapping Protocol report series.

An alternative HQS field sheet is provided with provision for calculating tuna and trout habitat quality index scores in the field. In addition, an Excel spreadsheet is provided for calculating fish habitat quality scores from existing HQS data. This can be found at http://www.cawthron.org.nz/publication/toolsmodels/longfin-tuna-and-brown-trout-habitat-quality-calculator/.

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1. INTRODUCTION

A standardised national rapid habitat assessment protocol that gives a Habitat Quality Score (HQS) for rivers and streams was recently developed (Clapcott 2015). The HQS provides a measure for a river reach which indicates the general condition of its physical habitat. Currently most regional councils use the HQS during routine monitoring (e.g. at State of Environment monitoring sites) and increasingly as part of farm environmental plans.

In parallel with the HQS development, a Broad-scale Stream Habitat Mapping Protocol (BSHMP) was also developed—along with a suite of riparian and fish habitat quality indices that can be applied to the BSHMP data (Holmes et al. 2011, Holmes et al. 2012, Holmes et al. 2013, Holmes et al. 2015). Although the BSHMP is intended to be applied at the catchment scale, at the individual reach scale the measured habitat parameters and assessment procedures of the BSHMP and HQS protocol are largely comparable. Therefore, with some minor alterations, their respective habitat quality scores / indices are compatible also.

This Envirolink funded report (1632-ESRC161) documents the alteration of the existing BSHMP-based longfin eel (tuna) and brown trout habitat quality indices to be applicable to habitat data collected using the HQS protocol. Longfin tuna are a taonga species and have high conservation values, and both tuna and trout support highly valued cultural, commercial and recreational fisheries. It is intended that the HQS-compatible fish habitat quality indices detailed in this report can be incorporated into assessments of ecosystem health and the life-supporting capacity of streams. The indices will aid in the identification of priority sites for protection or rehabilitation. Eventually, trends in fish habitat quality could be assessed at long-term monitoring sites.

The following link supplies an Excel spreadsheet that enables regional councils to interpret existing HQS data with respect to the quality of tuna and trout habitat: (http://www.cawthron.org.nz/publication/toolsmodels/longfin-tuna-and-brown-trout-habitat-quality-calculator/).

1.1.1. Existing 'General stream habitat condition' Habitat Quality Score

The HQS methodology is detailed in Clapcott (2015). In short, it involves scoring 10 parameters (below) on a 1-10 scale directly on a standardised field assessment sheet (Appendix 1). Parameter scores are assigned based on numerical and narrative guidelines that were developed by a panel of river ecologists and regional council staff. The total score (out of a 100) can be scaled to a reference site score to provide a %HQS for reporting:

1. deposited sediment
2. invertebrate habitat diversity

3. invertebrate habitat abundance
4. fish cover diversity
5. fish cover abundance
6. hydraulic heterogeneity
7. bank erosion
8. bank vegetation
9. riparian width
10. riparian shade.

1.1.2. Broad-scale Habitat Mapping Protocol and habitat quality indices

For the BSHMP, using a catchment scale stratified sample design riparian habitat information is collected by 'ground-truthing' habitat features directly onto aerial photographs. Instream habitat information is collected using survey field sheets. With the exception of depth measurements, the BSHMP and HQS protocols have provision for the collection of data on equivalent stream habitat parameters (Table 1).

Table 1. Broad-scale stream habitat mapping protocol (BSHMP) instream and riparian habitat parameters alongside their corresponding Habitat Quality Score (HQS) parameters.

BSHMP instream habitat feature parameters (% or m^2 estimates and measurements)		Corresponding HQS habitat feature parameters (scored based on numerical and narrative criteria)
1	Stream substrate particle size and degree of fine sediment infilling	1/ Deposited sediment, 2/ Invertebrate habitat diversity, 3/ Invertebrate habitat abundance
2	Depths category measurements	*No equivalent in HQS*
3	Fish cover	4/ Fish cover diversity, 5/ Fish cover abundance
4	Meso-habitat type	6/ Hydraulic heterogeneity
5	Stock pugging and bank slumping	7/ Bank erosion
6	Riparian vegetation type	8/ Bank vegetation
7	Riparian area	9/ Riparian width
8	Area of trees overhanging the stream and trees adjacent to stream	10/ Riparian shading

The longfin tuna and brown trout habitat quality indices are calculated from BSHMP data using weighting factors derived from a series of conceptual models. These conceptual models are based on expert opinion and a review of relevant literature (see reports: Holmes et al. 2011, Holmes et al. 2012, Holmes et al. 2015). Essentially, at each site, percentage estimates and area-cover measurements of habitat parameters 1–4 (Table 1) are multiplied by their respective weighting factors to give a parameter score. The habitat parameter scores are then summed (with equal weighting) to give an overall fish habitat quality score.

The Riparian Habitat Quality Index (RHQI) is a GIS-based assessment procedure that can be applied to riparian habitat information collected using the BSHMP (i.e. parameters 5 – 8 in Table 1, column one). This index rates the functional ability of 100 m reaches of riparian area to support instream habitat for fish and mitigate the loss of sediment and sediment-bound contaminants from the adjacent farmland. The conceptual model basis and calculation procedures of the RHQI are described in detail in Holmes et al. (2013).

2. ADAPTING THE BSHMP FISH AND RIPARIAN HABITAT QUALITY INDICES TO APPLY TO HQS DATA

The HQS alongside the alternative tuna and trout habitat quality index parameter scores are shown in Appendix 2 and in the accompanying Excel spreadsheet (Sheet 2: Field sheet in http://www.cawthron.org.nz/publication/toolsmodels/longfin-tuna-and-brown-trout-habitat-quality-calculator/). An automated HQS / tuna and trout habitat quality index score conversion table is also provided in the Excel spreadsheet (Sheet 3: Index conversion calculator).

There were three key differences between the BSHMP and HQS assessment methods that needed addressing in order to align the two stream habitat ratings systems. These are discussed below.

1. **The HQS system is based purely on qualitative assessments (i.e. scores), whereas, the existing tuna and trout habitat quality indices are based on a combination of estimated percent cover and measured areas (m^2) of various habitat features.**

Alternative fish habitat quality scoring values (for parameters 1- 6) were generated by aligning the numerical and narrative guidelines, which underpin the HQS habitat parameter scores, with the parameter weighting values from the literature-based conceptual models in Holmes et al. (2012) and Holmes et al. (2015).

Compared to the BSMHP, the HQS data collection process is simple and fast. Data collection is rapid because it relies purely on bank-side visual observations using experienced field assessors. To complete an assessment of a 100 m stream reach using the respective habitat assessment methods takes approximately 15 minutes for the RHA compared to 60 minutes for the BSHMP. Furthermore, additional data processing effort is required to calculate habitat quality indices from BSHMP data.

An obvious trade-off for using the HQS, instead of a more time-intensive protocol such as the BSHMP, is that it is less precise and more prone to inter-observer variation. Consequently, trout and tuna index scores calculated from HQS data will only be useful for detecting gross differences in fish habitat quality across space or time. Nevertheless, because the HQS-based fish indices have potential to be applied nationally, and over long time periods (e.g. through the State of Environment monitoring programmes), the large data sets will likely prove useful in a management context.

2. There is no provision for the collection of stream depth data in the HQS.

Average stream depth and residual pool depth are key factors that determine the carrying capacity of a stream for large fish such as adult trout (Lisle 1987, Jowett 1992, Harding et al. 2009). For this reason, depth data are an important input variable for calculating the tuna and trout habitat quality indices from BSHMP data. However, depth data are not collected under the HQS protocol.

The absence of depth data when calculating HQS-based fish habitat quality indices means that the indices will not be able to discriminate between the habitat qualities for different fish size-classes. Therefore, the indices provided in this report are broadly applicable to all size classes of tuna and trout. However, caution should be used when applying the index to shallow waterways (i.e. mostly less than 300 mm deep). In these instances, the scores will be unsuitable to indicate the quality of the habitat for fish that are large enough to be of interest to fishers (i.e. trout larger than 200 mm and tuna larger than 400 mm). This is because during the day, large tuna and trout prefer water deeper than 300 mm. In addition, deep water is essential for these larger fish in the absence of structural cover. As a rule of thumb, if more than 90% of the reach is less than 300 mm deep then index scores should be considered to indicate habitat quality for juvenile trout (< 200 mm) and small tuna (< 400 mm) only.

3. The HQS combines riparian and instream habitat measurements into a single score

Interpretation of BSHMP data is split by separate riparian and instream fish habitat quality indices. This allows the effects of riparian management actions on instream habitat condition to be examined (e.g. Holmes et al. *in review*, Holmes & Goodwin *in review*). In contrast, the HQS combines both the instream and riparian parameter scores into a single habitat condition score.

We have created alternative tuna and trout habitat quality scores for the HQS riparian habitat parameters (7–10 in Table 1) based on the weighting factors which underpin the Riparian Habitat Quality Index (Holmes 2013). Consistent with the HQS assessment method these are combined with the instream habitat parameter scores into a single overall fish habitat quality score (Appendix 2). This more inclusive assessment of stream habitat provides for easy reporting. However, this approach is problematic when considering the potential influences of land use on the riparian environment, which in turn, can affect fish habitat quality in complex ways depending on broader catchment scale factors. For example, stream shading (e.g. more than 80%) in a deep Southland stream may be detrimental for trout and tuna habitat because reduced productivity and water temperatures may reduce growth potential, whereas, in small Northland streams, temperatures will reach lethal values for sensitive fish (such as trout) without plenty of shade. To address this issue we suggest that tuna and trout habitat quality index scores are calculated as a percentage of a reference stream scores for reporting. This is the same approach suggested by Clapcott (2015) for reporting the existing HQS. Finally, we suggest that when entering HQS data all parameter scores are recorded separately as well as the overall HQS. This will enable future analysis of the effects of riparian management actions on the condition of instream habitat. These investigations will be able to take account of regional and catchment specific circumstances as necessary.

3. REFERENCES

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4. APPENDICES

Appendix 1. The Habitat Quality Score (HQS) rapid field protocol (from Clapcott 2015).

Habitat parameter	Condition category										SCORE
1. Deposited sediment	*The percentage of the stream bed covered by fine sediment.*										
	0	*5*	*10*	*15*	*20*	*30*	*40*	*50*	*60*	*≥ 75*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
2. Invertebrate habitat diversity	*The number of different substrate types such as boulders, cobbles, gravel, sand, wood, leaves, root mats, macrophytes, periphyton. Presence of interstitial space score higher.*										
	≥ 5	*5*	*5*	*4*	*4*	*3*	*3*	*2*	*2*	*1*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
3. Invertebrate habitat abundance	*The percentage of substrate favourable for EPT colonisation, for example flowing water over gravel-cobbles clear of filamentous algae/macrophytes.*										
	95	*75*	*70*	*60*	*50*	*40*	*30*	*25*	*15*	*5*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
4. Fish cover diversity	*The number of different substrate types such as woody debris, root mats, undercut banks, overhanging/encroaching vegetation, macrophytes, boulders, cobbles. Presence of substrates providing spatial complexity score higher.*										
	≥ 5	*5*	*5*	*4*	*4*	*3*	*3*	*2*	*2*	*1*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
5. Fish cover abundance	*The percentage of fish cover available.*										
	95	*75*	*60*	*50*	*40*	*30*	*20*	*10*	*5*	*0*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
6. Hydraulic heterogeneity	*The number of of hydraulic components such as pool, riffle, fast run, slow run, rapid, cascade/waterfall, turbulance, backwater. Presence of deep pools score higher.*										
	≥ 5	*5*	*4*	*4*	*3*	*3*	*2*	*2*	*2*	*1*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
7. Bank erosion	*The percentage of the stream bank recently/actively eroding due to scouring at the water line, slumping of the bank or stock pugging.*										
Left bank	*0*	*≤ 5*	*5*	*15*	*25*	*35*	*50*	*65*	*75*	*> 75*	
Right bank	*0*	*≤ 5*	*5*	*15*	*25*	*35*	*50*	*65*	*75*	*> 75*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
8. Bank vegetation	*The maturity, diversity and naturalness of bank vegetation.*										
Left bank AND Right bank	*Mature native trees with diverse and intact understorey*		*Regenerating native or flaxes/sedges/tussock > dense exotic*			*Mature shrubs, sparse tree cover > young exotic, long grass*			*Heavily grazed or mown grass > bare/impervious ground.*		
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
9. Riparian width	*The width (m) of the riparian buffer constrained by vegetation, fence or other structure(s).*										
Left bank	*≥ 30*	*15*	*10*	*7*	*5*	*4*	*3*	*2*	*1*	*0*	
Right bank	*≥ 30*	*15*	*10*	*7*	*5*	*4*	*3*	*2*	*1*	*0*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
10. Riparian shade	*The percentage of shading of the stream bed throughout the day due to vegetation, banks or other structure(s).*										
	≥ 90	*80*	*70*	*60*	*50*	*40*	*25*	*15*	*10*	*≤ 5*	
SCORE	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
TOTAL	(Sum of parameters 1-10)										

Appendix 2. The HQS rapid field protocol with tuna and trout habitat quality index scaling factors included (adapted from Clapcott 2015).

Habitat parameter	Condition category										Parameter score
Deposited sediment	*The percentage of the stream bed covered by fine sediment*										
	0	5	10	15	20	30	40	50	60	≥70	
Habitat Quality Score	10	9	8	7	6	5	4	3	2	1	
Longfin Tuna Habitat Score	10	10	10	10	8	6	4	4	4	4	
Trout Habitat Score	10	10	8	6	4	0	0	0	0	0	
Invertebrate habitat diversity	*The number of different substrate types such as boulders, cobbles, gravel, sand, wood, leaves, root mats, macrophytes, periphyton. Presence of interstitial space score higher.*										
	≥5	5	5	4	4	3	3	2	2	1	
Habitat Quality Score	10	9	8	7	6	5	4	3	2	1	
Longfin Tuna Habitat Score	10	9	8	7	6	5	4	3	2	1	
Trout Habitat Score	10	9	8	7	6	5	4	3	2	1	
Invertebrate habitat abundance	*The percentage of substrate favourable for EPT colonisation, for example flowing water over gravel-cobbles clear of filamentous algae/macrophytes.*										
	95	75	70	60	50	40	30	25	15	5	
Habitat Quality Score	10	9	8	7	6	5	4	3	2	1	
Longfin Tuna Habitat Score	10	9	8	7	6	5	4	3	2	1	
Trout Habitat Score	10	9	8	7	6	5	4	3	2	1	
Fish cover diversity	*The number of different substrate types such as woody debris, root mats, undercut banks, overhanging/encroaching vegetation, macrophytes, boulders, cobbles. Presence of substrates providing spatial complexity score higher.*										
	>5	5	5	4	4	3	3	2	2	1	
Habitat Quality Score	10	9	8	7	6	5	4	3	2	1	
Longfin Tuna Habitat Score	10	10	10	10	10	10	10	8	4	1	
Trout Habitat Score	10	10	10	10	10	10	10	8	4	1	
Fish cover abundance	*The percentage of fish cover available.*										
	95	75	70	60	50	40	30	25	15	5	
Habitat Quality Score	10	9	8	7	6	5	4	3	2	1	
Longfin Tuna Habitat Score	10	9	8	7	6	5	4	3	2	1	
Trout Habitat Score	1	4	6	8	10	8	6	4	2	0	
Hydraulic heterogeneity	*The number of hydraulic components such as pool, riffle, fast run, slow run, rapid, cascade/waterfall, turbulence, backwater. Presence of deep pools score higher.*										
	>5	5	4	4	3	3	2	2	2	1	
Habitat Quality Score	10	9	8	7	6	5	4	3	2	1	
Longfin Tuna Habitat Score	10	10	10	10	10	10	10	10	5	5	
Trout Habitat Score	10	10	10	10	10	10	5	5	5	1	
Bank erosion	*The percentage of the stream bank recently/actively eroding due to scouring at the water line, slumping of the bank or stock pugging.*										
left bank	0	<5	5	12	25	35	50	65	75	≥75	
right bank	0	<5	5	12	25	35	50	65	75	≥75	
Habitat Quality Score	10	9	8	7	6	5	4	3	2	1	
Riparian Habitat Score	10	8	4	1	1	1	1	1	1	1	
Bank vegetation	*The maturity, diversity and naturalness of bank vegetation.*										
	Mature native trees with diverse and intact understorey		Regenerating native or flaxes/sedges/tussock > dense exotic			Mature shrubs, sparse tree cover > young exotic, long grass			Heavily grazed or mown grass > bare/impervious ground.		
Habitat Quality Score	10	9	8	7	6	5	4	3	2	1	
Riparian Habitat Score	8	9	10	10	10	5	5	5	0	0	
Riparian width	*The width (m) of the riparian buffer constrained by vegetation, fence or other structure(s).*										
left bank	>30	15	10	7	5	4	3	2	1	0	
right bank	>30	15	10	7	5	4	3	2	1	0	
Habitat Quality Score	10	9	8	7	6	5	4	3	2	1	
Riparian Habitat Score	10	10	10	9	9	8	7	6	3	0	
Riparian shade	*The percentage of shading of the stream bed throughout the day due to vegetation, banks or other structure(s).*										
	≥90	80	70	60	50	40	25	15	10	≤5	
Habitat Quality Score	10	9	8	7	6	5	4	3	2	1	
Riparian Habitat Quality index score	5	6	8	9	10	8	6	4	2	0	

Total HQS score		
Total tunaHQI score		
Total troutHQI score		