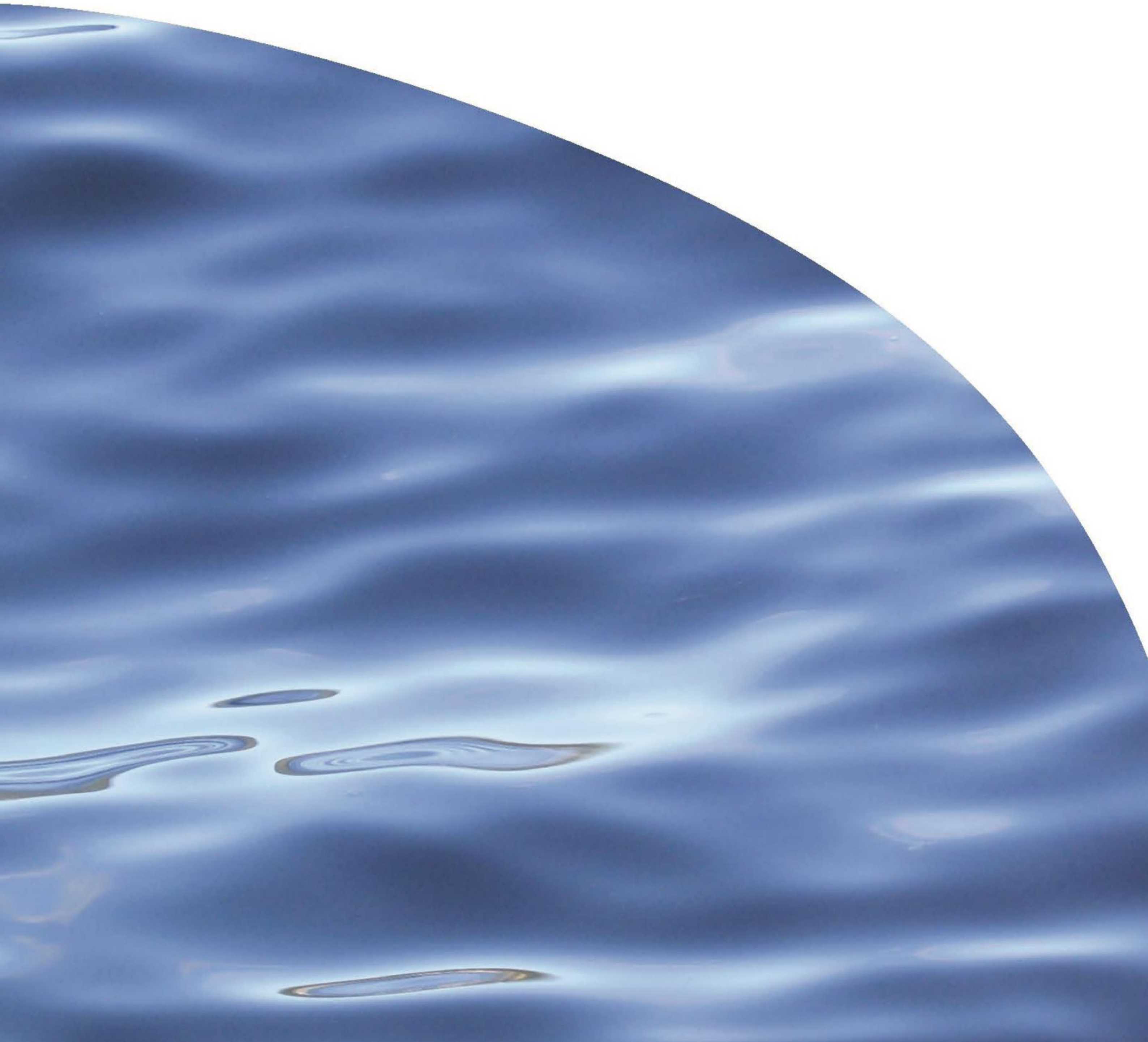
REPORT NO. 3656

MIMIHAU CATCHMENT AQUATIC HEALTH SURVEY USING AQUATIC MACROINVERTEBRATES



MIMIHAU CATCHMENT AQUATIC HEALTH SURVEY USING MACROINVERTEBRATES

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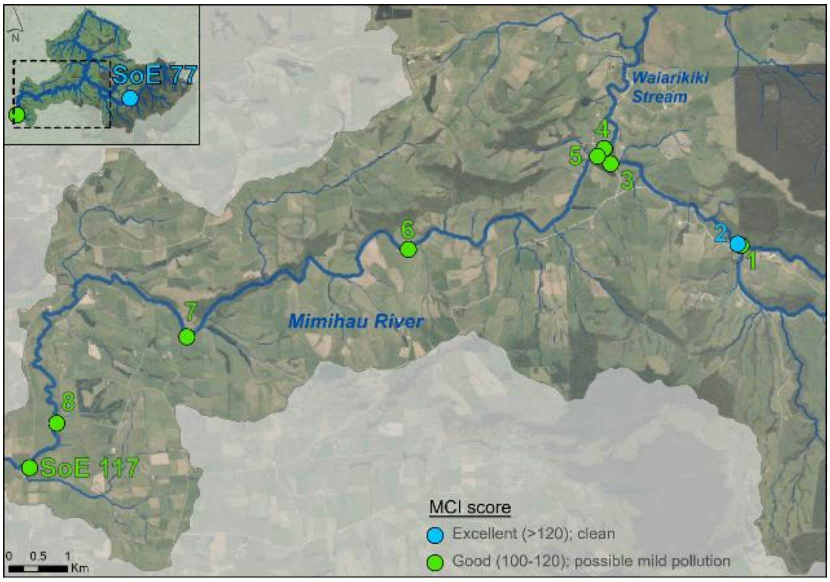
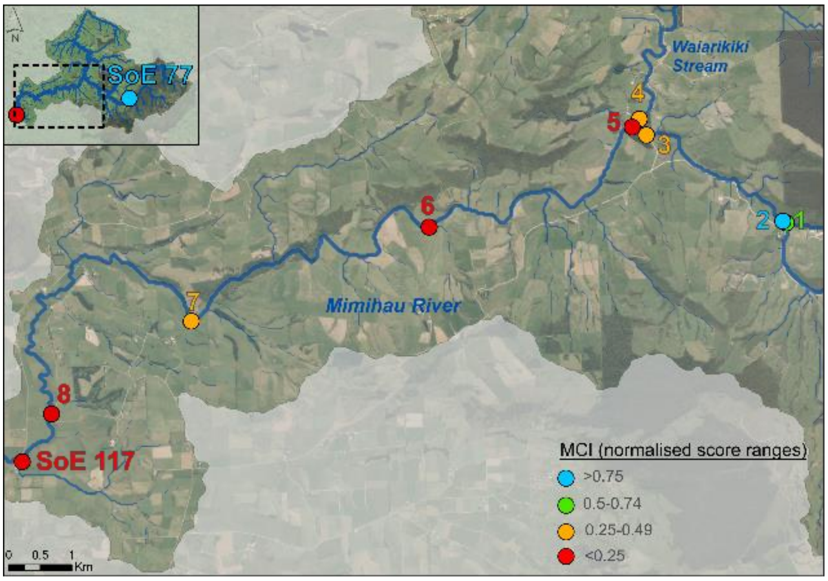
SUMMARY

A catchment-scale stream health survey was undertaken in the Mimihau Catchment to address a deficiency of ecological data in the mid-catchment. The survey focused on collecting stream macroinvertebrates (stream insects and other invertebrates that are easily visible to the naked eye), which were processed to produce Macroinvertebrate Community Index (MCI) scores to indicate stream health at the sample site locations. The figure below shows MCI results from each survey site interpreted according to national generic water quality classes (top) as well as site results relative to the highest scoring site (2) in the catchment.





Summary Figure. Top: Macroinvertebrate Community Index (MCI) scores along the Mimihau River, colour coded according to the Stark et al. (2001) generic national 'water quality classes' showing most of the MCI scores indicate 'good' water quality, or 'possible mild pollution'. Bottom: MCI scores colour-coded based on the data being scored relative to the highest scoring site (2) in the survey. It shows that some sites score better than others within categories. The lowermost site in both images shows the long-term average MCI score at Environment Southland's State of Environment monitoring site near Wyndham (117).

In general, the MCI scores indicate that most of the catchment has ‘good’ water quality—at least in terms of water quality attributes that affect macroinvertebrate communities (i.e. not including *E coli*). The spread of MCI scores within the catchment, calculated ‘*relative to the highest score in the catchment’,* shows an overall decline in stream health with increasing distance from the headwaters. Some features of the catchment, including a major tributary and a large section of remnant native riparian forest in the mid-lower catchment, appear to have a negative and positive influence on stream health, respectively.

Recommendations for how the Mimihau catchment group can build on this survey and undertake a farmer-led monitoring programme are provided at the end of this report.

1. INTRODUCTION

1.1. Purpose of this report

This report details an assessment of aquatic ecosystem health in the Mimihau River (Southland) based on a survey of aquatic macroinvertebrates and physical instream and riparian habitat. The survey has three purposes:

1. survey ecological health in the mainstem Mimihau River to identify any upstream to downstream (longitudinal) patterns,
2. provide a catchment-scale baseline assessment that can be used to assess ecological health improvements that result from any changes to land use practices and,
3. suggest ways that the Mimihau Catchment Group could continue (and lead) aquatic ecological health monitoring in the catchment.

1.2. Background

An initial summary of existing aquatic ecological data was provided by Holmes (2020) to characterise the current state of aquatic health in the Mimihau River. Overall, we determined that aquatic ecosystem health in the Mimihau catchment is typical of moderate-sized lowland farming catchments in New Zealand. Land use in the headwaters is mostly native bush and plantation forestry, with the catchment becoming dominated by high-producing pasture through the foothills and plains. Of the suite of water quality indicators measured by Environment Southland (at State of Environment (SoE) monitoring sites), bacteria (*Escherichia coli*) levels seem high in the lower catchment relative to other New Zealand rivers (Holmes 2020). Nitrogen concentrations are elevated to levels that are likely to encourage algal growth, which will likely be reducing habitat quality for sensitive macroinvertebrates.

While long-term ecological data are available from two SoE monitoring sites in the upper and lower catchment, the middle river segments were identified as being data deficient (Holmes 2020). The survey detailed in this report addresses the lack of ecological data from the mid-catchment and is intended to kick-start a farmer-led ecological monitoring programme.

1.3. What are macroinvertebrates and how can they be used to assess stream health?

The primary focus of this survey was assessing differences in the aquatic invertebrate community (macroinvertebrates) along the mainstem Mimihau River. Within streams, 'macroinvertebrates' (invertebrates that are visible to the naked eye) include insects like mayflies and other invertebrates (such as worms and snails) that live in the streambed. Sampling macroinvertebrates is relatively cost-effective when compared with collecting data on other ecosystem components, such as fish. In addition, because most macroinvertebrates have a year-long life cycle and they don't travel far within a stream (unlike fish), they can provide a good indication of the environmental condition at a site over an *annual scale.*

Sampling macroinvertebrates usually involves using a net, either a pole-mounted 'kicknet' or a frame-mounted 'Surber sampler'. This is placed on the streambed with the opening of the net facing upstream. The stream bed patch is then disturbed (with a foot, or a hand in the case of the Surber sampler) and the macroinvertebrates coming off the streambed are captured as they drift into the net with the river current. Once collected the macroinvertebrates are transferred into plastic pottles and preserved with alcohol (usually ethanol or methylated spirits). The sample can be processed in the laboratory in various ways to calculate indices that reflect the ecological health of a river at a certain point.

In New Zealand, a macroinvertebrate sample is most commonly used to calculate an index of river health called the Macroinvertebrate Community Index (MCI) score (Stark 1985). The 'Community' part of the index just means all of the populations of macroinvertebrate species that interact with one another in an area of stream or river. An MCI score calculation is based on the presence of different macroinvertebrate species. The basic principle is that different macroinvertebrates (for example mayflies, snails and worms) respond differently to the effects of pollution—some macroinvertebrates can tolerate moderate to high levels of pollution (for example increases in sediment or nutrient levels), while other animals become locally extinct from river communities as pollution levels increase. To calculate the MCI, each type of macroinvertebrate is given a score related to their pollution tolerance (ranging from 1 – very tolerant to pollution to 10 – very sensitive to pollution). Individual species scores are combined using a simple spreadsheet-based calculation. MCI scores can range between 0 and 200, although it is rare to find MCI values greater than 150 (indicating pristine, excellent water quality conditions) or less than 50 (indicating severely degraded habitat and probably ongoing pollution issues).

There are other ways to interpret macroinvertebrate community data, such as the Quantitative MCI (QMCI). This is a variant of the MCI that takes into account the presence of macroinvertebrates *and their abundances* by weighting the overall index value according to the most abundant species present. Table 1 shows some generic 'water quality classes' used to interpret MCI and QMCI score ranges.

Table 1. Water quality classes and descriptions for interpreting Macroinvertebrate Community Index (MCI) and Quantitative MCI (QMCI) scores (adapted from Stark & Maxted 2007a, 2007b).

Water quality class	Description	MCI	QMCI
Excellent	Clean	> 120	> 6.0
Good	Possible mild pollution	100–119	5–6
Fair	Probable mild pollution	80–99	4–5
Poor	Probable severe pollution	< 80	< 4

2. MIMIHAU SURVEY METHODS

On 15 April 2021, we visited eight sites along the Mimihau River with access to the river provided with the help of landowners (Figure 1). Map coordinates for the sites are provided in Appendix 1. A ninth site was also visited but unfortunately the preservation of the macroinvertebrate sample failed, and so is not reported on here.

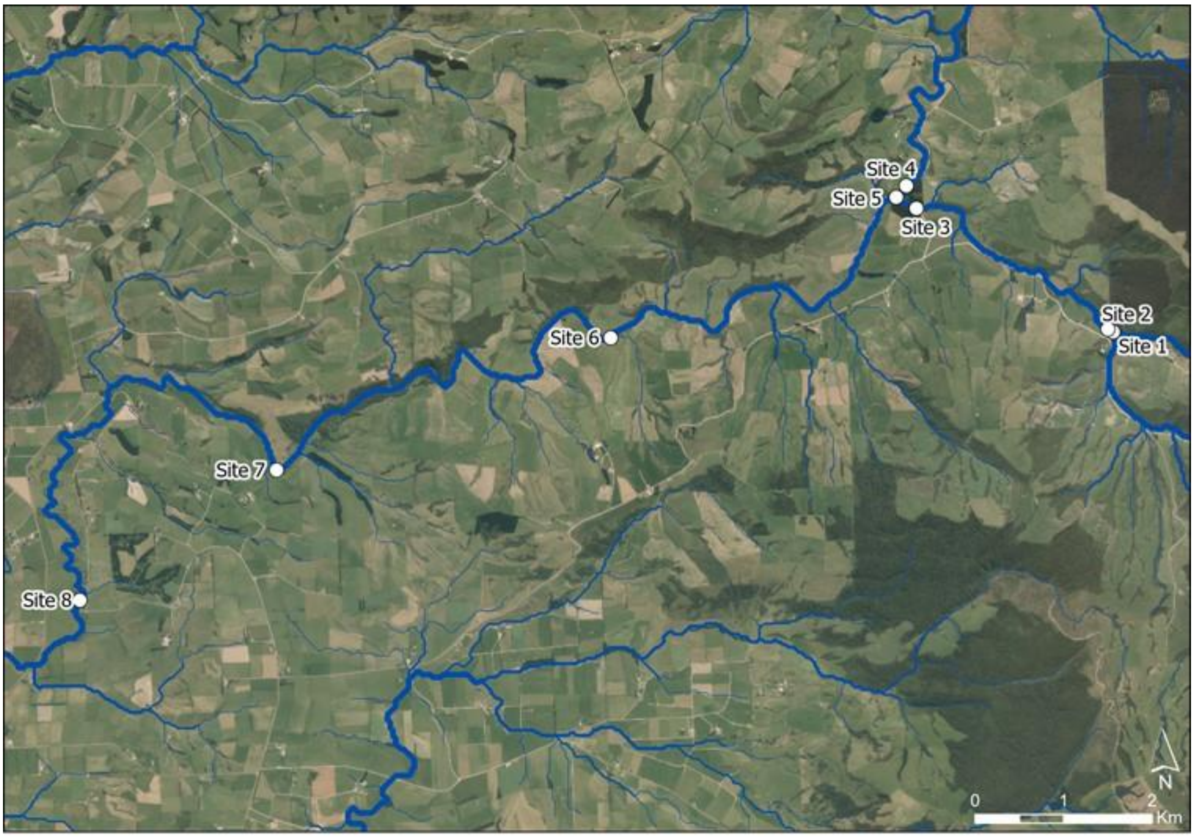


Figure 1. The Mimihau River catchment showing the location of the macroinvertebrate and habitat quality sample sites.

At each site, a single macroinvertebrate sample was taken from within riffle habitat using a Surber sampler (0.1 m^2 area; 0.5 mm mesh) applying the sampling 'Protocol C3' described in Stark et al. (2001). A Surber sampler is basically a net with a quadrat attached at right angles to the bottom of the net so that a defined area of riverbed (0.1 m^2 in this case) can be sampled. The riverbed within the quadrat was disturbed within the defined area, by scraping the surfaces of all rocks and stones with a hand brush to dislodge macroinvertebrates. Samples were then placed into a plastic pottle and preserved in the field with methylated spirts. The ratio of sample water to methylated spirits is 1 part water to 2.5 parts methylated spirits (such that the sample volume contains approximately 70% methylated spirits). Samples were taken from shallow, fast flowing areas (riffles) at each site. Riffle areas are the most oxygenated parts of the reach, and tend to support the most sensitive and diverse macroinvertebrates at a site. A typical Mimihau River sample site is shown in Figure 2.

Figure 2. Typical river habitat in the mid-Mimihau River showing mostly run habitat interspersed with small pockets of riffle habitat and a substantial portion of the stream bed comprising bed rock (photograph taken at Site 6 looking up stream).

In the laboratory, all macroinvertebrates in the samples were identified to the lowest practical taxonomic level (species level in most instances) and counted. The data were then analysed for a range of community health indices, including: taxonomic (species) richness, macroinvertebrate densities, MCI, QMCI and percentage EPT

(%EPT: percentage of the assemblage that were mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddis flies (Trichoptera)). EPT taxa are good general indicators of stream health because most are very sensitive to pollution and form an important part of the food chain for fish, birds and other components of stream ecosystems (such as predatory insects in the riparian area).

In addition to macroinvertebrate sampling, a Rapid Habitat Assessment (RHA) was undertaken at each site along the river reach surrounding the Macroinvertebrate sampling location (Clapcott et al. 2015). This was done to broadly characterise the state / quality of (physical) instream and riparian habitat. A demonstration on how to do a RHA and what it covers is available free online: (https://www.cawthron.org.nz/research/our-projects/rapid-habitat-assessment-protocol/).

2.1. Data Analysis

Spearman rank correlations were used to determine if any potential changes in macroinvertebrate and stream habitat indices from upstream (site 1) to downstream (site 2) were statistically significant (i.e. to show if a potential pattern is highly likely to be driven by an environmental gradient, rather than by chance alone). Regression analyses were used to assess if MCI scores correlated with the RHA (physical habitat quality assessment) scores.

3. RESULTS AND DISCUSSION

A full list of macroinvertebrate species present in the samples is provided in Appendix 2. A range of stream health indices were calculated from the macroinvertebrate data, but for simplicity only the MCI results are discussed below. The full range of stream health results are presented in Appendix 3. The other stream health indices presented within Appendix 3 will be useful as a baseline for comparison with future sampling results.

Overall, the results of the macroinvertebrate survey indicate that stream health in the catchment is generally ‘good’ in the lower to mid-catchment and ‘good to excellent’ in the upper catchment (Figure 3, Table 2).

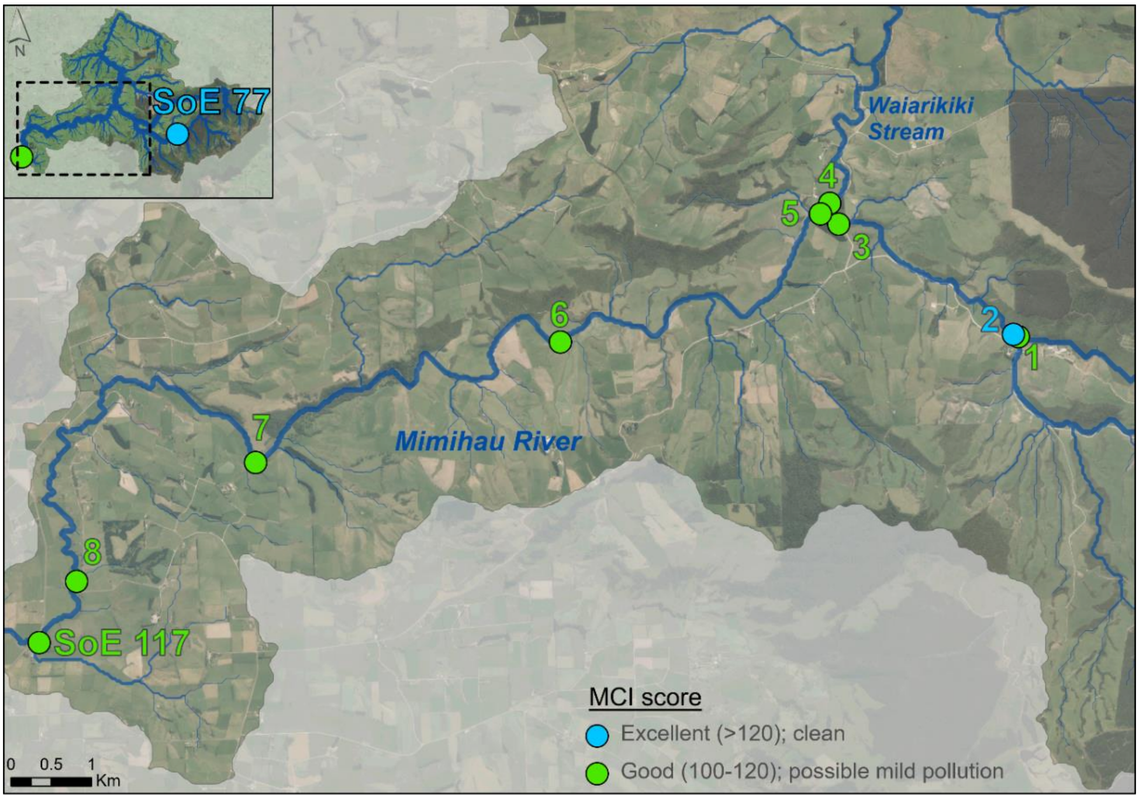


Figure 3. Map of the Mimihau River catchment showing, with the map frame defined by the dashed line in the map insert (top left). Macroinvertebrate Community Index (MCI) scores colour coded according to the national 'water quality classes' shown in Table 1. The long-term MCI score for the Environment Southland State of Environment (SoE) monitoring site near Wyndham (SoE 117) has also been included. The upper SoE monitoring site at Venlaw Forrest (SoE 77) is outside of the map frame but its position and MCI score band is shown in the map insert.

Table 2. Macroinvertebrate Community Index (MCI) and Rapid Habitat Assessment (RHA) results for eight survey sites in the Mimihau River. Sites are ordered from upstream (Site 1) to downstream (Site 8).

	Sample site							
River health index	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
MCI	115	125	114	113	104	110	114	105
RHA score	63	64	58	46	50	56	60	44

At the uppermost survey sites, the MCI scores of 115 (Site 1) and 125 (Site 2) were similar to the Environment Southland State of Environment (SoE) monitoring site at Venlaw Forest's long-term average score of 123. Similarly, the MCI score of 105 recorded at the lowermost site (Site 8) was similar to the long-term average score of 102 at the Wyndham SoE monitoring site just two kilometres downstream. The Mimihau survey independently confirmed the validity of the Environment Southland long-term monitoring in the catchment.

Although MCI scores through most of the Mimihau catchment indicate good water quality overall (on a national scale), when the scores are considered *relative* to the highest scoring site within the catchment, the MCI results suggest there is a general decline in river health with increasing distance downstream from the headwater sites to lowland sites (Figures 4 and 5). Evidence for this is provide by the MCI scores and site location being significantly negatively correlated (Spearman's Rank correlation coefficient was 0.74, P-value = 0.04, N = 8). In addition. regression analysis shows a decreasing trends for the MCI with increasing distance from the headwaters (Appendix 4)

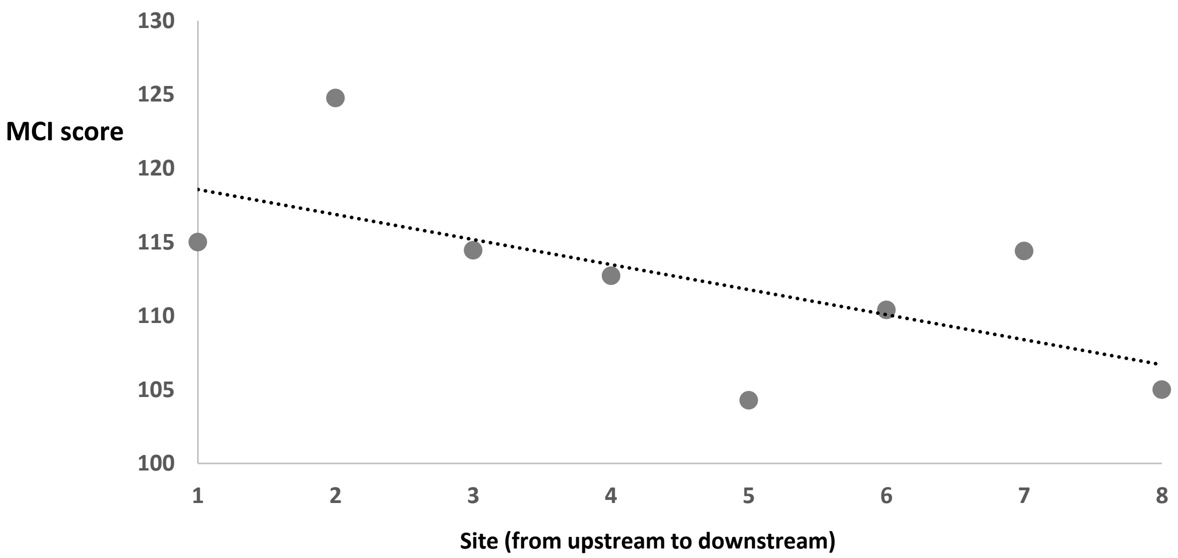


Figure 4. The Macroinvertebrate Community Index (MCI) scores for the eight sample sites in the mainstem of the Mimihau River. Site are ordered from upstream (Site 1) to downstream (Site 8).

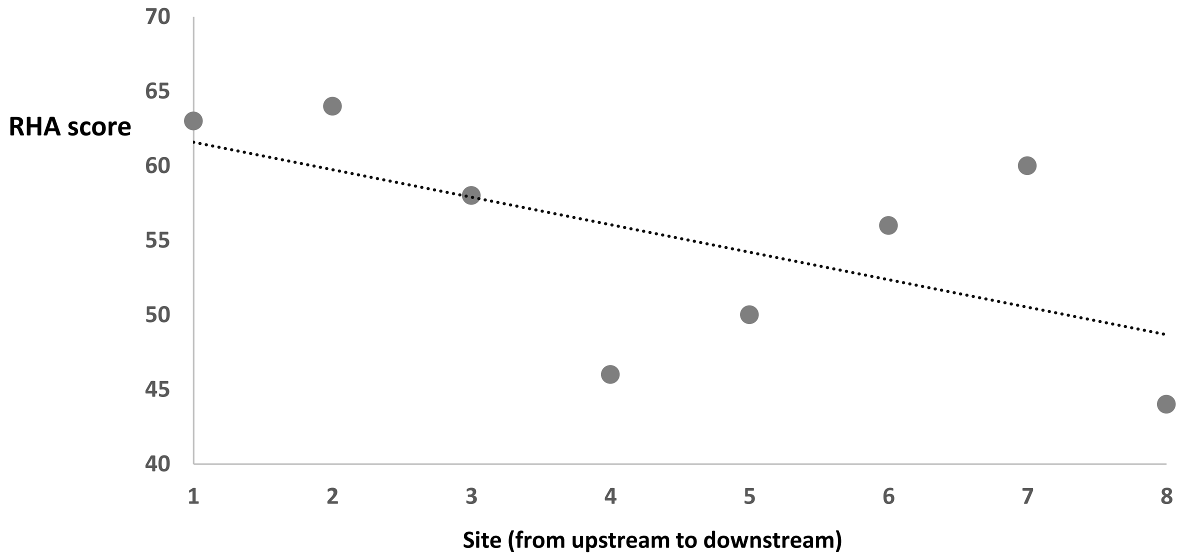


Figure 5. The Rapid Habitat Assessment (RHA) scores for the eight sample sites in the mainstem of the Mimihau River. Sites are ordered from upstream (Site 1) to downstream (Site 8).

While overall there was evidence of a general decline in MCI scores with increasing distance downstream the trend was not gradual or continuous. In the headwaters of the catchment, there were high scores, scores then decline until Site 5 before increasing at Site 7 and then show a relatively substantial drop at Site 8 (Figures 4 and 6).

Within the catchment, the relatively low MCI score at Site 8 (and at the long-term Environment Southland SoE site) is likely the result of the river segment surrounding this site having less gradient than the rest of the survey sites (pers. obs. by authors). The power of the river to remove fine sediment and flush algae from the stream bed is reduced at this point, potentially reducing habitat quality for macroinvertebrates.

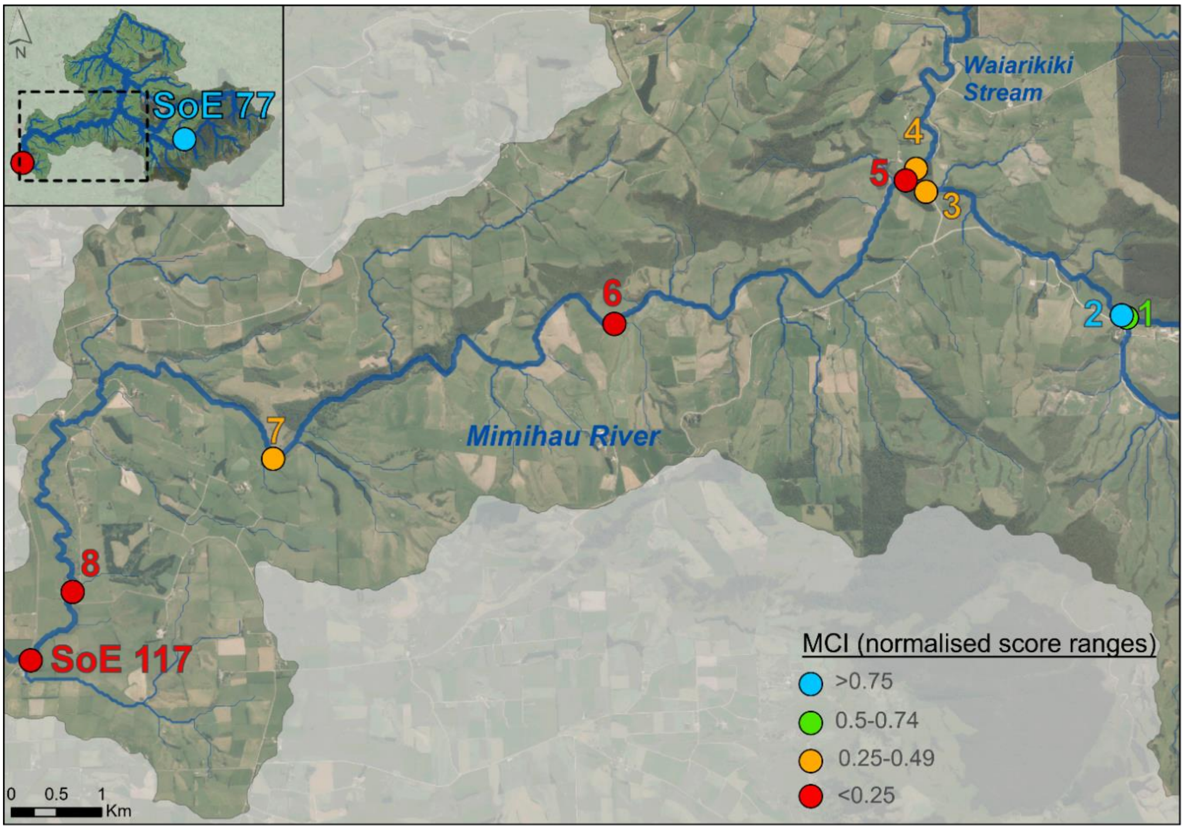


Figure 6. Map of the Mimihau River catchment, with the map frame defined by the dashed line in the map insert (top left). MCI scores colour coded based on the data being calculated *relative* to the highest scoring site in the survey sample frame (i.e. normalised MCI scores for within the catchment). The normalised score bands represented by traffic light code are split into equal quartiles. The long-term MCI score for the Environment Southland State of Environment (SoE) monitoring site near Wyndham bottom site (SoE 117) has also been included. The upper SoE monitoring site at Venlaw Forrest (SoE 77) is outside of the map fame but its position and normalised MCI score band is shown in the map insert.

The lowest MCI score of 104 was recorded at Site 5 (Table 2). This site is located a short distance below the Waiarikiki Stream confluence (Figure 6). While the sample taken in Waiarikiki Stream (Site 4) recorded a relatively high score (113), the relatively low score below the Waiarikiki Stream could mean that the tributary is contributing contaminants, such as organic enrichment, to the Mimihau at higher than background rates when compared to the Mimihau mainstem. However, this interpretation is based on just one sample at three sites (i.e. within the tributary, upstream and downstream of the tributary) and could be driven by chance. Based on these results, further sampling within the Waiarikiki tributary, and around the confluence, could be warranted to determine if the tributary is one of the major sources of land use contaminants in the catchment.

The general pattern shown in the MCI scores along the catchment is reflected by the RHA scores (Figures 4 and 5, Figures 7 and 8). Of note is the strong positive relationship between the RHA and MCI scores at the eight sites (Significant Spearman's Rank correlation coefficient of 0.85, P = > 0.01, N = 8) (Figure 9). This indicates that instream and riparian habitat quality in the reach or river segment around the sampling sites has some influence on 'local' MCI scores.

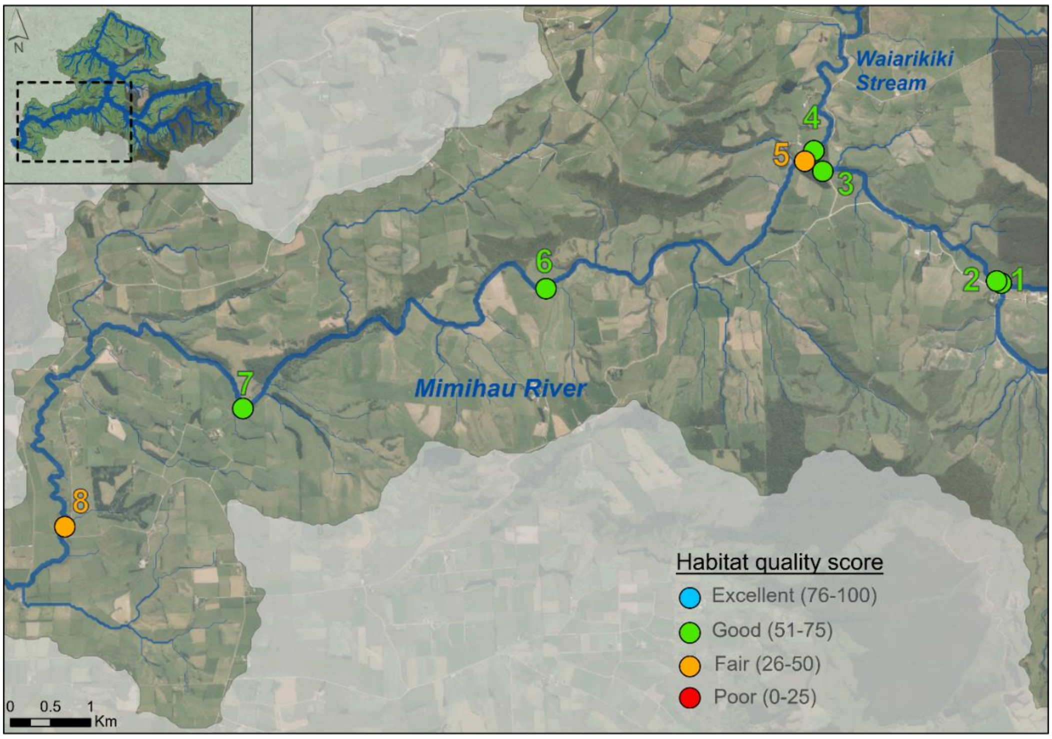


Figure 7. Rapid Habitat Assessment (RHA) scores colour coded according to quartile habitat quality bands used in Ministry for Environment reporting, with most RHA scores indicating 'good' habitat quality.

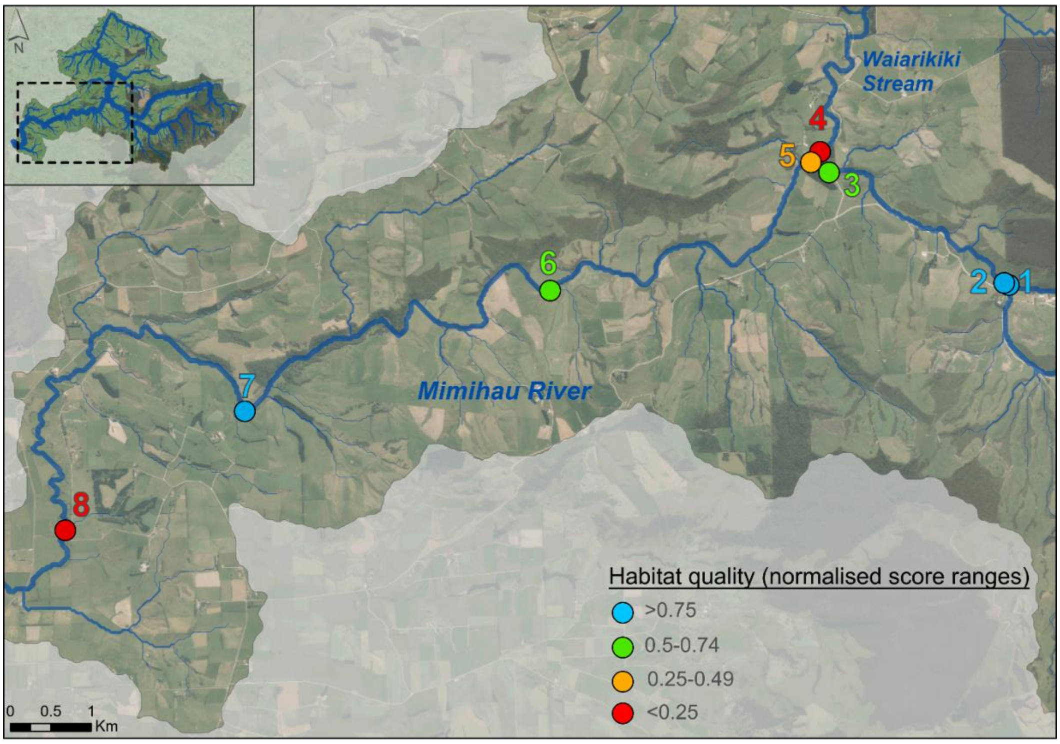


Figure 8. Rapid Habitat Assessment (RHA) scores colour coded, based on the data being normalised relative to the highest scoring site in the survey. This image shows relative instream and riparian habitat quality longitudinally down the catchment.

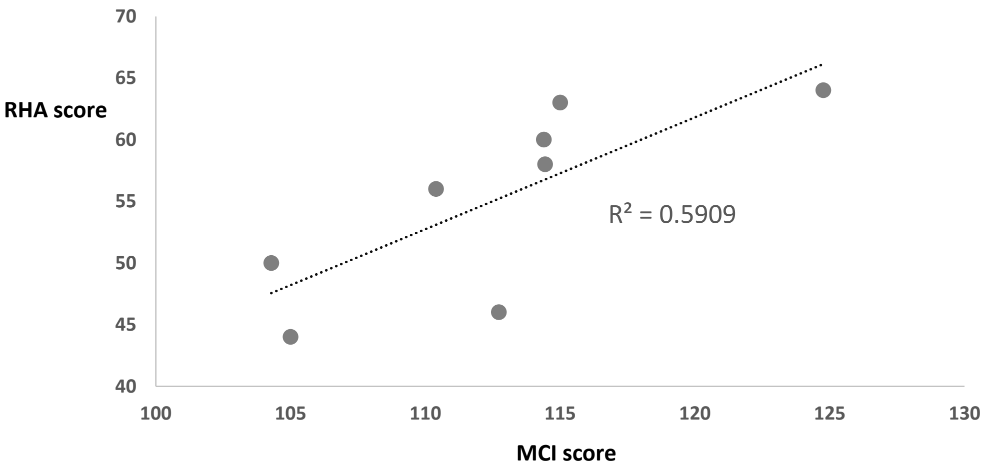


Figure 9. Correlation between the Macroinvertebrate Community Index (MCI) and Rapid Habitat Assessment (RHA) scores for the eight sample sites in the mainstem of the Mimihau River.

Put another way, MCI scores at a given site in the Mimihau River do not appear to be driven *solely* by catchment-scale factors such as water quality (e.g. nutrient levels such as nitrates and phosphates, and suspended fine sediment concentrations in the water). The relatively high MCI score at Site 7, which runs counter to the overall trend, could in part be a result of relatively high habitat quality at this site (Figure 8). In addition, Site 7 is located a short distance downstream of a long stretch of riparian native bush (approximately 2.5 kilometres long), associated within the small gorge in the mid- to lower catchment. Riparian habitat in this part of the catchment seems to have remained almost unchanged for the last 100 years (Figure 10).

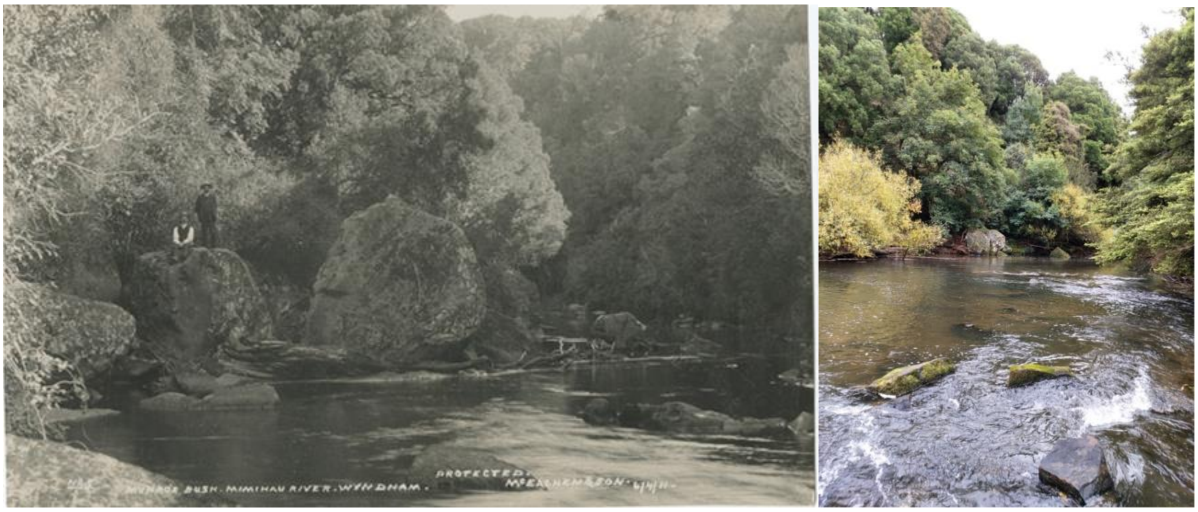


Figure 10. Two photographs of the Mimihau River looking downstream. Left, the Mimihau River at 'Munro's bush' taken around 1910. Right, a photo taken from a similar vantage point during the survey. The two photos show little change in the riparian condition over the last 110 years. Some of the large boulders seem to have been washed downstream or have become overgrown. Close inspection shows that there appears to be fewer logs and other woody debris items on the stream edge in the contemporary image. Unfortunately, the macroinvertebrate sample taken at this site could not be analysed because it was not preserved properly.

Among the many potential positive benefits for stream health, large areas of mature riparian vegetation can improve habitat for macroinvertebrates by providing shade. Stream shade reduces water temperatures and algal growth on the streambed (Quinn 2009).

4. SUMMARY AND RECOMMENDATIONS

This survey shows that stream health in the Mimihau, as determined by the macroinvertebrate community index (MCI) and a rapid habitat assessment (RHA), can be considered 'good' in the lower catchment and 'good to excellent' in the upper catchment.

These survey results agree with (and validate) long-term monitoring by Environment Southland at State of Environment (SoE) monitoring sites at the top and bottom of the catchment. This survey builds on Environment Southland's data by extending stream health assessment data through the mid-catchment—providing a more comprehensive catchment-scale ecosystem health assessment baseline. This baseline can be used to assess stream health responses to any future changes in the way the catchment farms and forestry blocks are managed.

We found relatively high MCI scores at a site in the mid-catchment associated with mature riparian vegetation. The relatively high score at Site 7 indicates that the historic protection of patches of riparian native bush have created substantial valuable ecological assets in the catchment. We found a slight decline in ecosystem health (as indicated by MCI scores) below the Waiarikiki Stream confluence, further ecological investigations within this tributary could be warranted on this basis.

4.1. Monitoring recommendations

This survey is intended to kick-start a farmer-led monitoring programme in the catchment. We recommend that macroinvertebrates are sampled at Sites 5 and 7 once annually by the catchment group (during the February to April period) using the Surber sampling method described in this report. Data from these sites can be used to assess trends in ecosystem health over time. These two sites were chosen for potential long-term monitoring because:

1. they are representative of the spread of MCI scores found within the catchment-scale survey
2. they are positioned roughly evenly to 'fill the gaps' in the mid-catchment between two (Environment Southland-run) long-term SoE monitoring sites
3. Site 5 recorded the lowest MCI score, therefore, it ought to be the most sensitive site to detect stream health responses to any improvements in ecological condition within the coming decade.

We recommend that the full catchment-scale survey, as described in this report, is repeated once every 5 or 10 years (depending on resource availability). Ten years is about the period of time over which farm environmental improvements can be expected to translate into gains for river ecosystem health at the catchment scale (Bernhardt et al. 2005). It is important to realise that there will always tend to be a time lag between on-farm improvements and how the results of these improvements might be observed in-stream with indicators such as the MCI. Repeat catchment-scale surveys could be completed with the help of Menzies College, which has expressed interest in being part of environmental monitoring in the catchment (pers. comm., Dr Kit Hustler, Head of Science, Menzies College).

The above monitoring programme, combined with data provided by the Environment Southland-run SoE monitoring sites, and followed-up with catchment-scale MCI surveys (in 2026 and / or 2031), ought to provide a cost- and effort-effective ecological monitoring programme. In our opinion, the monitoring programme design described here would the 'minimum level of effort' required to effectively assess catchment-scale ecological health improvements in the Mimihau River. Further guidance on community-led stream health monitoring can be found in MacNeil and Holmes (in prep).

5. ACKNOWLEDGEMENTS

Thanks to Sandra Campbell (Thriving Southland) and all the Mimihau farmers that took time out of their day to help us access the survey sites.

6. REFERENCES

Clapcott J 2015. National rapid habitat assessment protocol development for streams and rivers. Prepared for Northland Regional Council. Cawthron Report No. 2649. 29 p. plus appendices. https://envirolink.govt.nz/assets/Envirolink/1519-NLRC174-National-Rapid-Habitat-Assessment-Protocol-for-Streams-and-Rivers.pdf

Bernhardt ES, Palmer MA, Allan JD, Alexander G, Barnas K, Brooks S, … Sudduth E 2005. Synthesizing U.S. river restoration efforts. Science 308: 636-637.

Holmes 2020. River health summary for the Mimihau Catchment. Cawthron Institute Advice Letter. No. 2033. Prepared for Tom Orchison (Beef and Lamb) and the members of the Mimihau Catchment Group. 8 p.

MacNeil C, Holmes R 2021. River health monitoring framework. Cawthron Institute, in prep.

Quinn 2009. Riparian Management Classification Reference Manual. NIWA client report prepared for Environment Canterbury. no HAM2009-072. 60 p.

Stark JD 1985. A macroinvertebrate community index of water quality for stony streams. Water & Soil Miscellaneous Publication 87. Wellington, Ministry of Works and Development. 53 p.

Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR 2001. Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for Ministry for the

Environment. Sustainable Management Fund Project No. 5103. 57 p. https://docs.niwa.co.nz/library/public/ProtocolsManual.pdf

Stark JD, Maxted JR 2007a. A biotic index for New Zealand's soft-bottomed streams. New Zealand Journal of Marine and Freshwater Research 41: 43-61.

Stark JD, Maxted JR 2007b. A user guide for the Macroinvertebrate Community Index. Prepared for the Ministry for the Environment. Cawthron Report 1166. 58 p.

7. APPENDICES

Appendix 1. The latitude / longitude locations of the different survey sites in the Mimihau River longitudinal macroinvertebrate river health assessment. Sites are ordered from upstream (Site 1) to downstream (Site 8).

Site	Lat.	Long.
1	-46.293	169.02053
2	-46.2927	169.0197867
3	-46.2795	168.9926017
4	-46.2771	168.9913117
5	-46.2783	168.9897667
6	-46.291	168.9469083
7	-46.3027	168.8969814
8	-46.3149	168.867205

Appendix 2. Full macroinvertebrate species list and counts for eight sample sites in the Mimihau River.

Taxa	MCI taxon score	Mimihau Stream Site 1 15-Apr-21	Site 2 15-Apr-21	Site 3 15-Apr-21	Site 4 15-Apr-21	Site 5 15-Apr-21	Site 6 16-Apr-21	Site 7 15-Apr-21	Site 8 15-Apr-21
Ephemeroptera (mayflies)									
Austroclima jollyae	**9**	-	-	1	-	-	-	-	-
Austroclima sp.	**9**	-	-	2	-	-	-	1	-
Coloburiscus humeralis	**9**	-	2	3	2	3	5	3	2
Deleatidium spp.	**8**	74	23	25	197	-	100	37	140
Nesameletus sp.	**9**	1	-	-	-	-	-	-	-
Neozephlebia scita	**7**	-	-	-	-	-	-	-	1
Plecoptera (stoneflies)									
Megaleptoperla sp.	**9**	5	-	-	-	-	-	-	-
Zelandobius sp.	**5**	-	-	-	-	-	-	-	1
Zelandoperla decorata	**10**	2	10	-	-	-	-	-	-
Zelandoperla fenestrata	**10**	-	-	-	-	-	1	-	-
Zelandoperla sp.	**10**	3	2	-	-	-	-	1	-
Megaloptera (dobsonflies)									
Archichauliodes diversus	**7**	-	1	-	1	5	1	2	-
Coleoptera (beetles)									
Dytiscidae	**5**	1	-	-	1	-	-	-	-
Elmidae	**6**	9	-	-	-	-	-	-	11
Diptera (flies)									
Aphrophila neozelandica	**5**	1	-	-	16	3	3	14	2
Austrosimulium spp.	**3**	5	1	1	1	6	4	-	-
Empididae	**3**	-	-	-	1	-	-	-	-
Eriopterini	**9**	1	-	-	-	1	-	-	-
Maoridaimesa spp.	**3**	1	-	-	-	5	4	1	1
Orthocladiinae	**2**	21	2	16	24	37	104	4	21
Stictocladius sp.	**8**	1	-	-	-	-	-	-	-
Tanytarsus spp.	**3**	-	-	1	2	10	3	4	3
Trichoptera (caddis flies)									
Hydropsyche (*Aoteapsyche*) spp.	**4**	7	40	71	58	120	165	138	37
Beraeoptera roria	**8**	30	63	1	20	14	1	1	-
Confluens olingoides	**5**	-	7	1	-	-	5	-	-
Costachorema sp.	**7**	-	1	3	1	1	-	-	-
Helicopsyche sp.	**10**	338	1	-	4	28	1	22	4
Hudsonema amabile	**6**	8	-	-	-	2	-	3	8
Hydrobiosis clavigera	**5**	1	-	-	-	1	-	-	-
Hydrobiosis copis	**5**	-	4	-	-	-	2	1	-
Hydrobiosis parumbripennis	**5**	-	-	-	-	1	1	-	-
Hydrobiosis spp.	**5**	2	-	2	2	3	11	4	15
Neurochorema confusum	**6**	-	1	-	11	1	-	8	-
Neurochorema sp.	**6**	-	-	-	1	-	1	2	-
Olinga feredayi	**9**	111	16	12	15	48	31	29	1
Oxyethira albiceps	**2**	-	-	-	-	1	-	-	-
Philorheithrus agilis	**8**	-	-	-	-	-	-	-	-
Psilochorema bidens	**8**	1	-	-	-	2	-	1	2
Psilochorema sp.	**8**	1	1	3	2	-	2	-	4
Pycnocentria evecta	**7**	19	32	12	136	44	95	84	143
Pycnocentrodes sp.	**5**	536	36	13	249	275	192	428	75
Nematoda (roundworms)	**3**	42	-	-	-	4	7	16	1
Oligochaeta (worms)	**1**	398	-	3	1	12	28	10	18
Platyhelminthes (flatworms)	**3**	5	1	-	-	1	5	6	2
Mollusca (snails)									
Potamopyrgus antipodarum	**4**	413	7	17	29	141	99	151	48
Sphaeriidae	**3**	55	-	-	-	1	-	11	2
Crustacea (crustaceans)									
Amphipoda	**5**	6	3	-	10	10	2	7	5
Ostracoda	**3**	3	-	-	-	5	-		
Acarina (mites)	**5**	-	-	-	-	-	1	-	1
Collembola (springtails)	**6**	-	8	1	-	1	-	-	-
Coelenterata (hydra)									
Hydra sp.	**3**	-	-	-	-	-	-	-	-
Number of taxa		31	22	19	23	30	27	27	25
Density (no.m^2)		21010	2620	1880	7840	7860	8740	9890	5480
%EPT (by taxa)		52	68	68	57	47	56	59	52
%EPT (by abundance)		54	91	79	89	69	70	77	79
MCI		115	125	114	113	104	110	114	105
QMCI		5.13	6.60	5.20	6.10	5.02	4.91	5.13	5.98

Appendix 3. Macroinvertebrate community health indices and Rapid Habitat Assessment results for eight survey sites in the Mimihau River. Sites are ordered from upstream (Site 1) to downstream (Site 8).

	Sample site							
River health index	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Taxa richness	31	22	19	23	30	27	27	25
Invertebrate density (no.m^2)	21010	2620	1880	7840	7860	8740	9890	5480
%EPT (by taxa)	52	68	68	57	47	56	59	52
%EPT (by abundance)	54	91	79	89	69	70	77	79
MCI	115	125	114	113	104	110	114	105
QMCI	5.1	6.6	5.2	6.1	5.0	4.9	5.1	6.0
RHA score	63	64	58	46	50	56	60	44

Appendix 4. Correlation between MCI scores and distance from headwaters, where headwaters are defined as the forks where Sites 1 and 2 are located.