Boffa Miskell

Hurunui Water Project

Hurunui River periphyton monitoring

prepared by

Ryder Consulting

July 2012

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Ruth Goldsmith, PhD.

Ryder Consulting

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Cover: Hurunui River at Intake Road, July 2012.

Ryder Consulting Limited
PO Box 1023
Dunedin
New Zealand
Ph: 03 477 2119
Fax: 03 477 3119

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1. Introduction

1.1 Background

The Hurunui Water Project is proposing to develop a community irrigation scheme in the Hurunui, Waipara and Kowai River catchments. The scheme will involve the abstraction of water at several points along the Waitohi and Hurunui Rivers. Included in the proposal is the construction of a new intake structure in the Hurunui River immediately downstream of the Mandamus River confluence. Water abstraction will reduce flows in the Hurunui River downstream of this point and this may result in a reduction in the capacity of flood flows to remove periphyton growths. An investigation of the relationship between flow and periphyton cover and biomass in the river is therefore required.

1.2 Report objective

Boffa Miskell engaged Ryder Consulting to undertake periphyton monitoring in the middle reaches of the Hurunui River. Periphyton cover and biomass is to be measured following a period of stable low flow conditions and then compared to repeat measurements made following a large fresh or flood. This report presents the results of initial periphyton monitoring undertaken following stable flow conditions and repeat monitoring following a high flow of 228 m^3/s.

2. Methods

2.1 Survey sites

Periphyton monitoring was undertaken in run habitat at three sites within the reach of the Hurunui River extending downstream of the Mandamus River confluence to the State Highway 7 Bridge (Figures 1 to 4).

Figure 1 *Hurunui River at the Intake Road site. Left: April 2012. Right: July 2012.*

Figure 2 *Hurunui River at the Bishells Road site. Left: April 2012. Right: July 2012.*

Figure 3 *Hurunui River at the State Highway 7 Bridge site. Left: April 2012. Right: July 2012.*

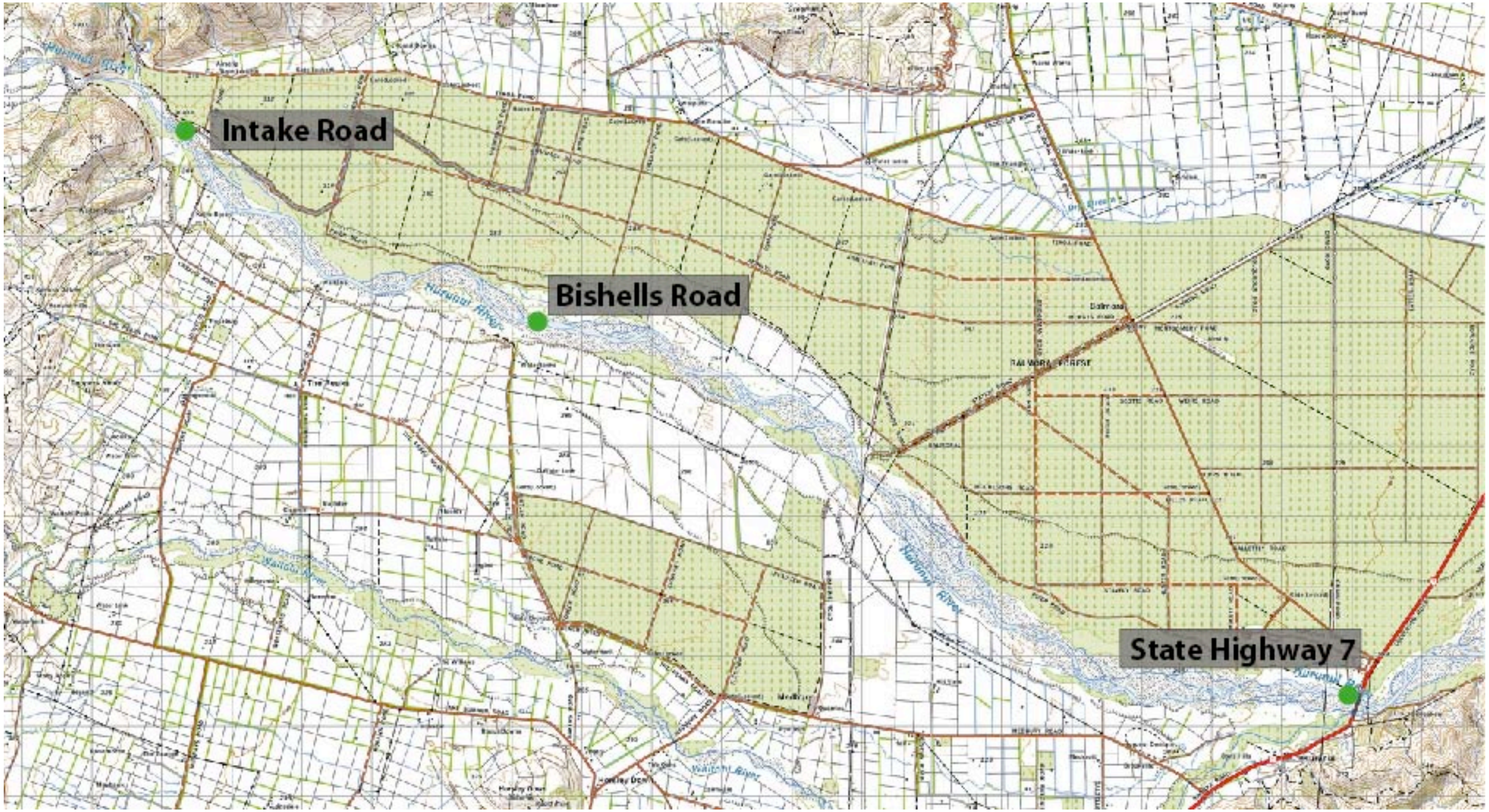

Figure 4 *Location of periphyton monitoring sites in the Hurunui River.*

2.2 Periphyton cover

Periphyton monitoring was undertaken using a combination of the two rapid assessment methods described in Biggs and Kilroy (2000). The monitoring used a quadrat method for percentage cover of a site by different categories of periphyton, which is a combination of the Rapid Assessment Method 1 (RAM-1) (quadrat method for percentage cover by filamentous green/brown algae) and Rapid Assessment Method 2 (RAM-2) (line transect – point method for percentage cover of substrates by different categories of periphyton). The method is more labour intensive than the individual RAM methods, and allows comparisons with Ministry for the Environment (Biggs 2000) periphyton guidelines (as with RAM-1) while still providing information on the types of algae contributing to the benthic community (as with RAM-2). The method is summarised below:

Ten horizontal transects lines were defined along a 50 m length of the riverbank at each site and a quadrat (0.25 m^2) sampled every 1-1.5 m along each transect for a distance of 10-15 m. A total of 100 quadrats were therefore sampled at each site, although this was reduced to 50 quadrats if the periphyton cover was very homogeneous. Transect start points were marked so that the area can be located easily for repeat measurement.

The size of 50 randomly selected substrate particles within the periphyton cover sampling area were measured with a ruler during the initial monitoring. Mean and median particle sizes were calculated to compare substrate character among sites.

2.3 Periphyton biomass

2.3.1 Sample collection

Quantitative measurements of periphyton coverage were made (during initial monitoring only) following "*Quantitative Method 1b (QM-1b): Scraping or brushing a sample from a defined area on the top of a stone*" (Biggs and Kilroy 2000).

One horizontal transect line was defined from within the site and a stone was collected approximately every 1-1.5 m along each transect for a distance of 10-15 m, giving a total of 10 samples. Stones were selected by taking the nearest stone (without looking) to each point along the transect. The near bed water velocity and water velocity at 60% depth were measured adjacent to the stone using a hand-held ADCP (FlowTracker™).

To calculate the Kilroy Biomass Index (KBI)[1] for *Didymosphenia geminata* (hereafter Didymo) a visual assessment was made of the percentage cover of Didymo on the stone surface and the average thickness of the Didymo mat measured with a ruler (Shearer *et al.* 2007). The Didymo mat was assigned a thickness score from 0 to 5 as follows: 0, none; 1, thin (<1 mm thick); 2, medium (1-5 mm); 3, thick (6-15 mm); 4, very thick (16-30 mm); 5, extremely thick (>30 mm). Percentage cover of Didymo was multiplied by the thickness score to give a biomass index between 0 and 500.

To calculate the average biomass of periphyton a scrubbing was taken from a defined area of each stone and the samples frozen and transported to the Ryder Consulting laboratory for chlorophyll *a* and ash free dry mass analysis.

2.3.2 Laboratory analysis

The 10 quantitative periphyton samples collected from each site on each sampling occasion were analyzed in the laboratory to determine their chlorophyll *a* concentration and ash free dry mass.

In the laboratory each sample was tipped into a glass beaker and blended for about 30 seconds or until the mixture was free of obvious clumps of material. The blended liquid was then made up to a known volume (e.g., 100 ml).

Chlorophyll *a* analysis

Each sample was shaken and three 5 ml aliquots were withdrawn using an automatic pipette and filtered on to a Microscience MS-GC 47 mm glass fibre filter. The filter was placed in a tube containing 20 ml of 90% ethanol, immersed in a water bath (78°C for five minutes) and into a refrigerator overnight. The tube was centrifuged for 10 minutes at 6000 rpm before the absorption of a 13.5 ml aliquot of the ethanol homogenate was measured at 665 nm and 750 nm using a 4 cm cuvette in a Shimadzu UV-120-01 spectrophotometer. The ethanol homogenate was then acidified with 0.375 ml of 0.3 M HCl then, following a 30 second delay, absorbances at 665 and

[1] KBI values are more accurate indicators of temporal changes in Didymo abundance than areal cover because they account for three dimensions (area and thickness), rather than two (Larned *et al.* 2007).

750 nm were re-read. The total amount of chlorophyll *a* was calculated using a standard formula (Biggs and Kilroy 2000) and scaled to the number of milligrams of chlorophyll *a* per m^2 of stream bed.

Ash free dry mass (AFDM)

Each sample was shaken and three 5 ml aliquots were withdrawn using an automatic pipette and filtered on to a pre-ashed (400°C for 2 hours) and pre-weighed Microscience MS-GC 47 mm glass fibre filter. The filter and sample were dried for 24 hours at 105ºC, cooled in a desiccator then weighed. The filter was ashed at 400ºC for 4 hours, cooled in a desiccator then reweighed. Values were scaled to calculate milligrams of AFDM per m^2 of stream bed.

Algal community composition (Relative abundance)

Each sample was thoroughly mixed and three aliquots removed to an inverted microscope settling chamber then allowed to settle for 10 minutes. Samples were analysed according to the "relative abundance using an inverted microscope" method outlined in Biggs and Kilroy (2000). Samples were inspected under 200-400x magnification to identify algal species present using the keys of Biggs and Kilroy (2000), Entwisle *et al*. (1988) and Moore (2000). Algae were given an abundance score ranging from 1 (rare) to 8 (dominant) based on the protocol of Biggs and Kilroy (2000).

2.3.3 Periphyton guidelines

Periphyton data was tabulated and assessed in accordance with the Ministry for the Environment's New Zealand periphyton guidelines (Biggs 2000) (Table 1).

Table 1 *Ministry for the Environment periphyton biomass guidelines for gravel/cobble streams (Biggs 2000). Maximum guideline values are averaged across the full width of the stream or river.*

Instream value/variable	Diatoms/ Cyanobacteria	Filamentous algae
Aesthetics/recreation (1 November - 30 April):		
Maximum cover of visible streambed	60% >0.3cm thick	30% >2cm long
Maximum AFDM (g/m^2)	N/A	35
Maximum chlorophyll *a* (mg/m^2)	N/A	120
Trout habitat and angling:		
Maximum cover of visible streambed	N/A	30% >2cm long
Maximum AFDM (g/m^2)	35	35
Maximum chlorophyll *a* (mg/m^2)	200	120

3. Results

3.1 General

The median and mean flows in the Hurunui River at Mandamus (1956-2003) are 39.6 and 53.1 m^3/s respectively, and the mean annual flood flow is 535 m^3/s (Duncan and Shankar 2004).

Initial periphyton monitoring was undertaken on the 26th to 27th of April 2012 when the flow in the Hurunui River at Mandamus was approximately 14 m^3/s (Figure 5). Flows in the river prior to this had been below the mean flow since early March 2012.

Repeat monitoring was undertaken on the 13th of July 2012 at a flow of approximately 30 m^3/s. This followed a high flow of 228 m^3/s that occurred on the 25th of June (Figure 5). There had also been several other high flows prior to this, the largest being a peak of approximately 90 m^3/s in early June (Figure 5). Repeat monitoring could not be undertaken following the 90 m^3/s peak as river flows remained to high to access monitoring sites.

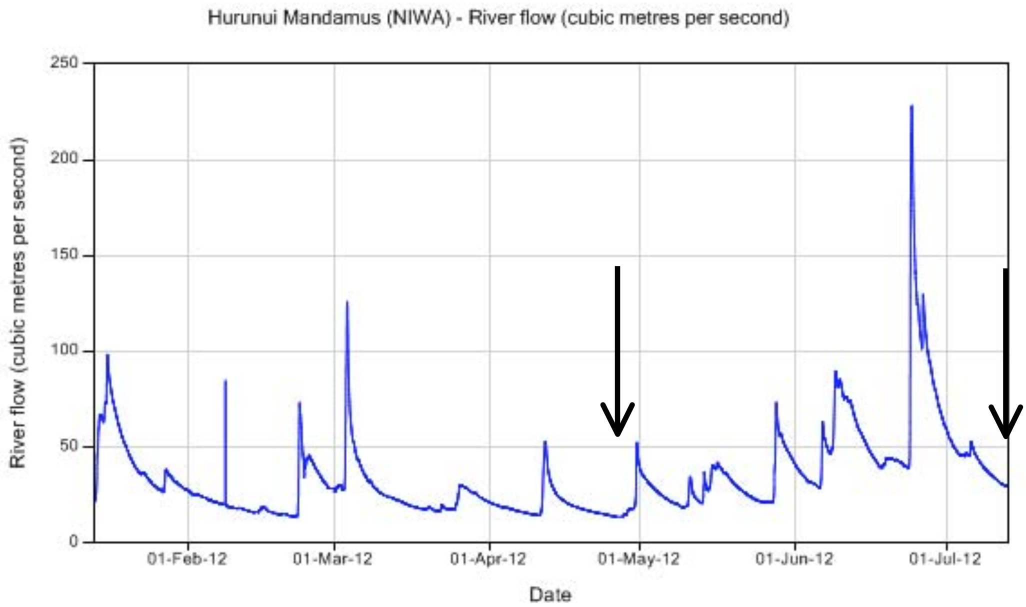

Figure 5 *Hurunui River flow (m^3/s) at the Mandamus NIWA recording site, February to July 2012 (graph sourced from the Environment Canterbury website). The arrows indicate the time of initial periphyton monitoring on the 26th and 27th of April, and the time of repeat monitoring on the 12th of July.*

3.2 Periphyton cover and substrate

Both mat and filamentous growth forms of periphyton were present at all three periphyton monitoring sites in the Hurunui River in April 2012 (Figures 6 to 10). In contrast, at the same sites in July 2012 there was minimal mat periphyton growth only, and this was just present in patches on the river margins (Figures 6 to 10).

At all sites cover of mat films was greater than that of filaments (Figures 9 and 10). Percent mat cover was similar among the sites in April 2012 (Figure 9), but filamentous cover was higher at the Bishells Road site (Figure 10). In July 2012 periphyton was only present at the Intake and Bishells Road sites, and total mat cover was less than 1% at both (Figure 9). Mat and filamentous cover guidelines for aesthetics/recreation and trout habitat and angling (filamentous only) (Table 1) were not exceeded at any sites in April or July 2012 (Figure 11 and 12).

Median substrate size was largest at the Bishells Road site in April 2012 (97mm, range 0.5-473 mm). Substrate size was similar at the Intake Road (78 mm, range 1-479 mm range) and State Highway 7 Bridge sites (81 mm, range 2-313 mm). Substrate size was not measured in July 2012.

Figure 6 *Periphyton at the Hurunui River Intake Road site. Left: April 2012. Right: July 2012.*

Figure 7 *Periphyton at the Hurunui River Bishells Road site. Left: April 2012. Right: July 2012.*

Figure 8 *Periphyton at the Hurunui River State Highway 7 Bridge site. Left: April 2012. Right: July 2012.*

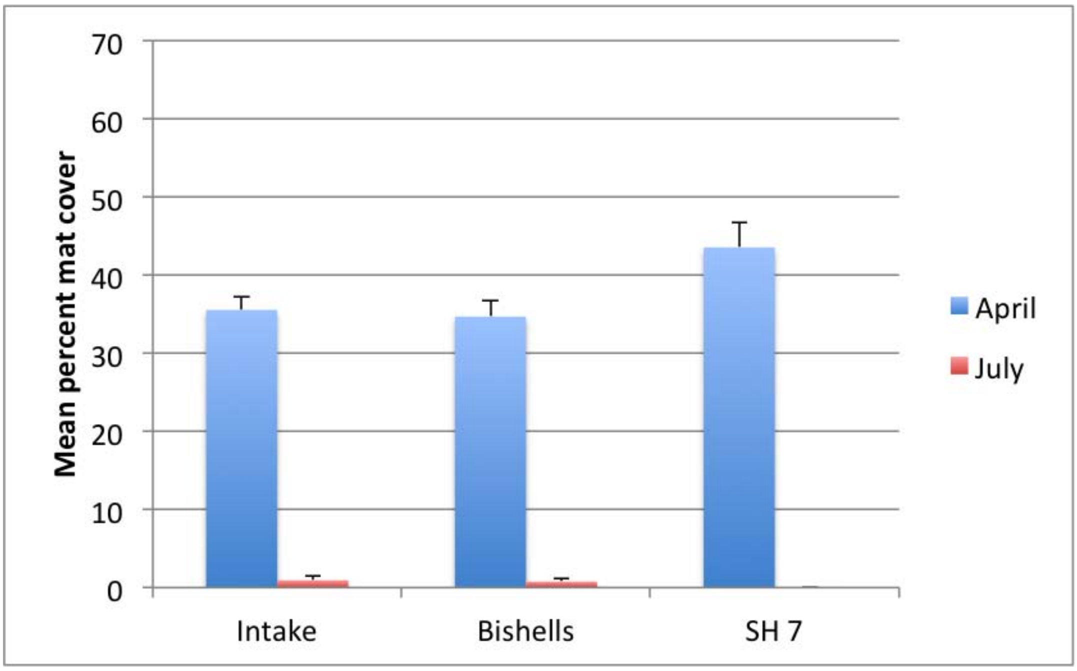

Figure 9 *Mean percent mat periphyton cover at Hurunui River sites, April and July 2012. Error bars are plus one standard error.*

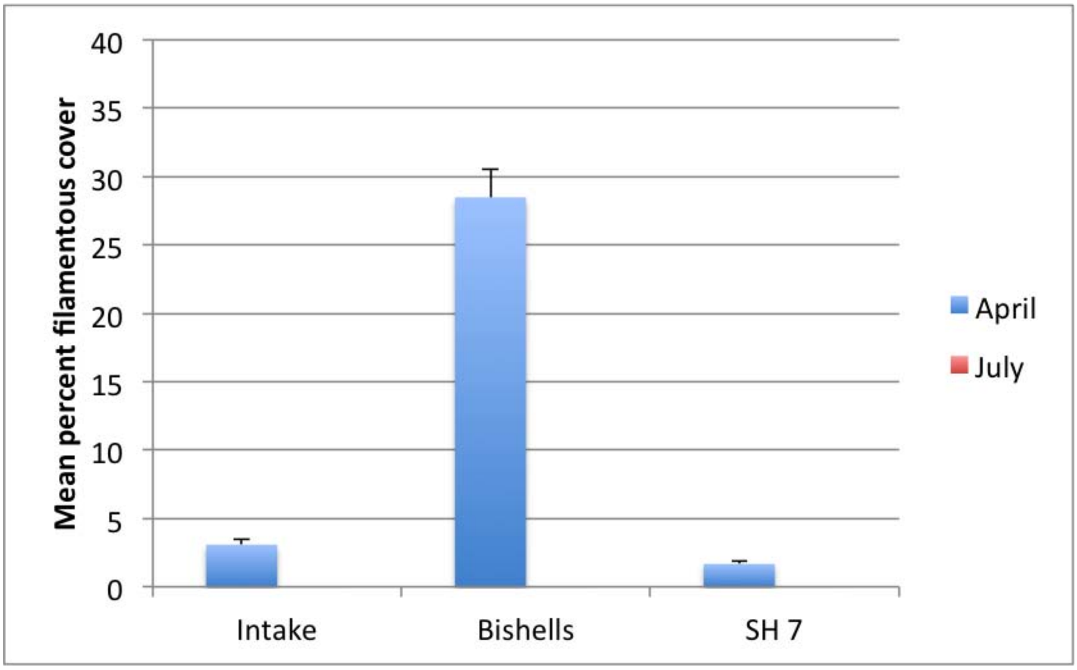

Figure 10 *Mean percent filamentous periphyton cover at Hurunui River sites, April and July 2012. Error bars are plus one standard error.*

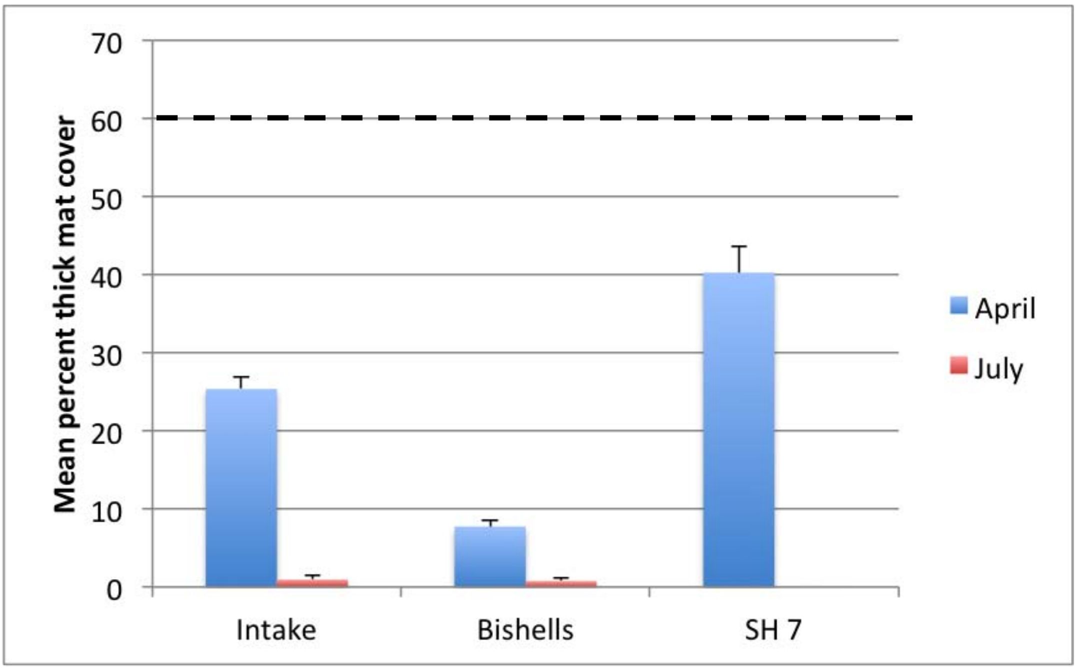

Figure 11 *Mean percent thick mat periphyton cover at Hurunui River sites, April and July 2012. The dashed horizontal line indicates the Ministry for the Environment guideline (Table 1). Error bars are plus one standard error.*

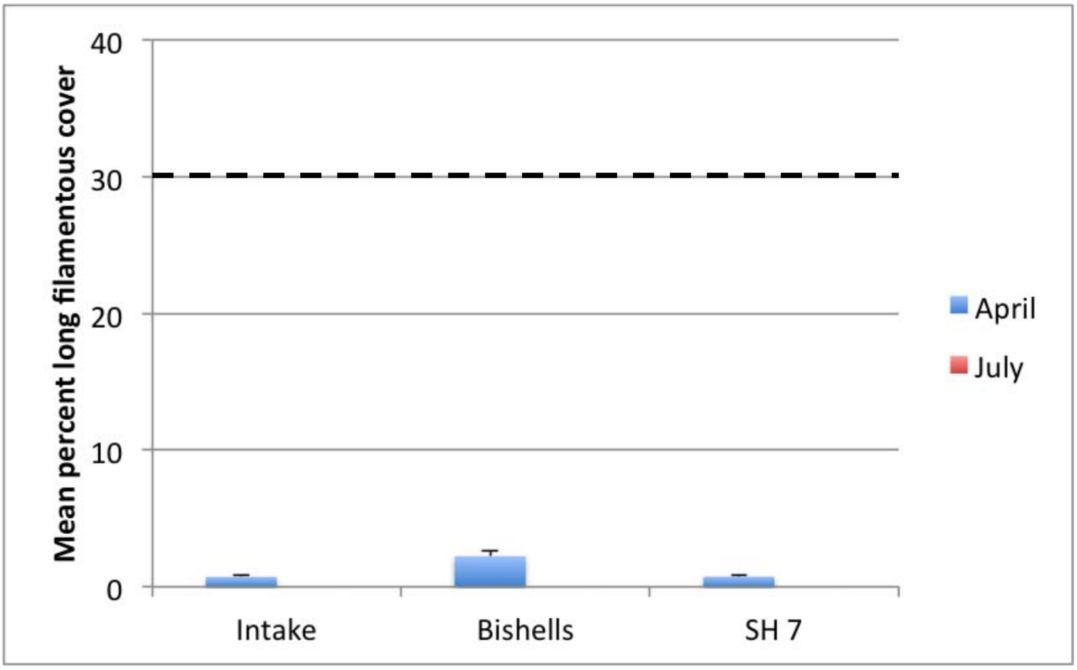

Figure 12 *Mean percent long filamentous periphyton cover at Hurunui River sites, April and July 2012. The dashed horizontal line indicates the Ministry for the Environment guideline (Table 1). Error bars are plus one standard error.*

3.3 Periphyton biomass

In April 2012 the mean substrate size of biomass sampling stones was similar among the three sites in the Hurunui River (Table 2). Mean water depths varied among sites, and were deepest at the Bishells Road site and shallowest at the Intake Road site. Mean water velocities at 60% of depth were fastest at the Bishells Road site; velocities at the other two sites were slower and similar. As expected near bed water velocities at all sites were considerably slower than velocities at 60% of depth.

Biomass samples were not collected in July 2012 due to the minimal periphyton cover (Section 3.2), however measurements of water depth and velocity were made at a similar location to those collected in April. As expected, water depths and velocities were higher in July 2012 as the flow was higher (Section 3.1) (Table 2).

Table 2 *Mean physical characteristics of periphyton biomass transects at Hurunui River sites. Standard errors are given in brackets.*

Site	Substrate size (cm)	Water depth (cm)	Water velocity 60% depth (m/s)	Near bed water velocity (m/s)
April 2012				
Intake Road	21.3 (1.5)	18.7 (0.9)	0.25 (0.04)	0.10 (0.04)
Bishells Road	19.4 (0.7)	33.2 (3.1)	0.45 (0.06)	0.10 (0.05)
State Highway 7 Bridge	17.4 (0.8)	28.0 (3.5)	0.26 (0.05)	0.05 (0.03)
July 2012				
Intake Road	-	42.4 (3.3)	0.73 (0.13)	-
Bishells Road	-	49.3 (6.2)	0.65 (0.10)	-
State Highway 7 Bridge	-	58.4 (5.6)	0.61 (0.06)	-

As was found for periphyton cover (Section 3.2), diatom mats were more abundant than filamentous growths in biomass samples at all sites (Table 3). Didymo was present in all samples, and was especially dominant in samples collected near the river's edge at the Intake Road site (Table 3, Appendix One).

Table 3 *Relative abundance of periphyton taxa in biomass samples collected at Hurunui River sites – 1 (rare) to 8 (dominant), April 2012.*

Site	**Intake Road**			**Bishells Road**			**SH 7 Bridge**		
Biomass sample	**2**	**5**	**9**	**2**	**5**	**9**	**2**	**5**	**9**
Filamentous Green Algae									
Mougeotia		1	1		2		2	2	2
Filamentous Red Algae									
Audouinella								2	
Filamentous Diatoms									
Melosira							3	2	2
Diatoms									
Cocconeis			2						
Cymbella			1	2					
Didymosphenia	8	8	3	7	3	2	3	3	5
Epithemia						1			
Gomphoneis	2	1	4		4	3		2	2
Gomphonema			2	1		2	2		1
Nitzschia		1	2		2	2			1
Rhopalodia	2	2							
Rhoicosphenia							2		
Synedra	2	2	1	2	2	1	2	2	

The dominance of Didymo at the Intake Road site was reflected in the higher Kilroy Biomass Index here than at the other two sites (Figure 13). The Kilroy Biomass Index ranges from 0-500 and therefore the values of the index are 'moderate' at the Intake Road site and 'low' at the Bishells Road and State Highway 7 Bridge sites (Figure 13).

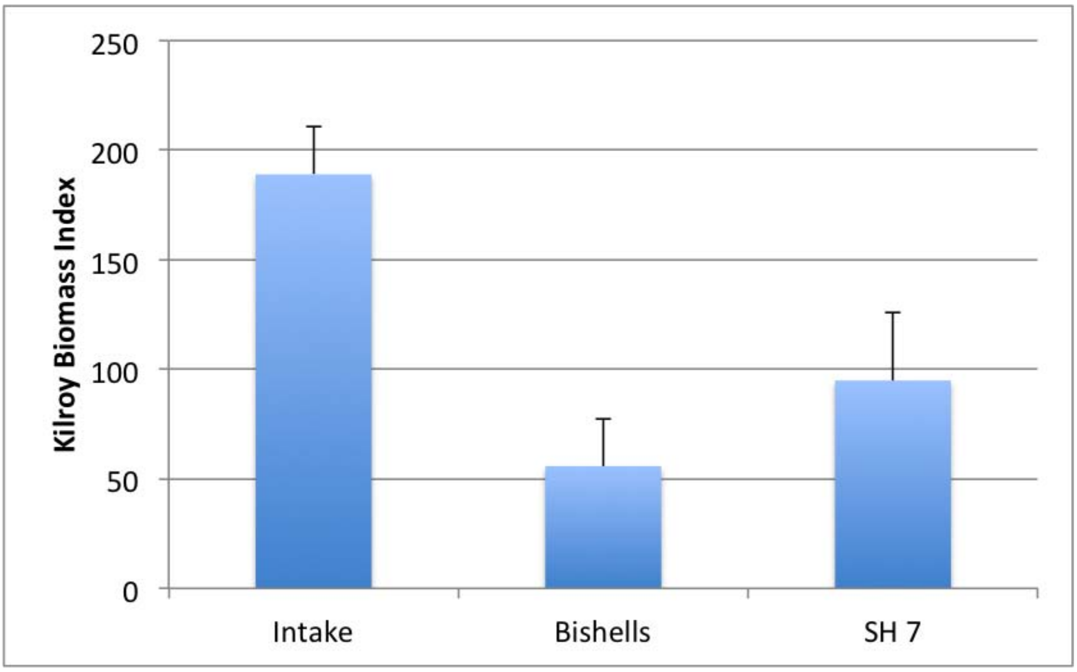

Figure 13 *Kilroy Biomass Index for Didymo at Hurunui River sites, April 2012.*

Chlorophyll *a* concentrations were below the Ministry for the Environment trout habitat and angling guideline for diatoms/cyanobacteria (and filamentous algae) (Figure 14, Table 1). Ash free dry mass concentration guidelines were exceeded at the Intake Road and State Highway sites (Figure 15). However, the Ministry for the Environment guidelines were developed prior to the introduction of Didymo to New Zealand and therefore are not applicable to Didymo dominated communities.

Ash free dry mass concentrations were higher than that of chlorophyll *a* at all three sites (Figures 14 and 15). This is probably indicative of a high biomass of non-photosynthetic Didymo stalks in the samples and is expected given the thickness of Didymo growths on some stones (Appendix One).

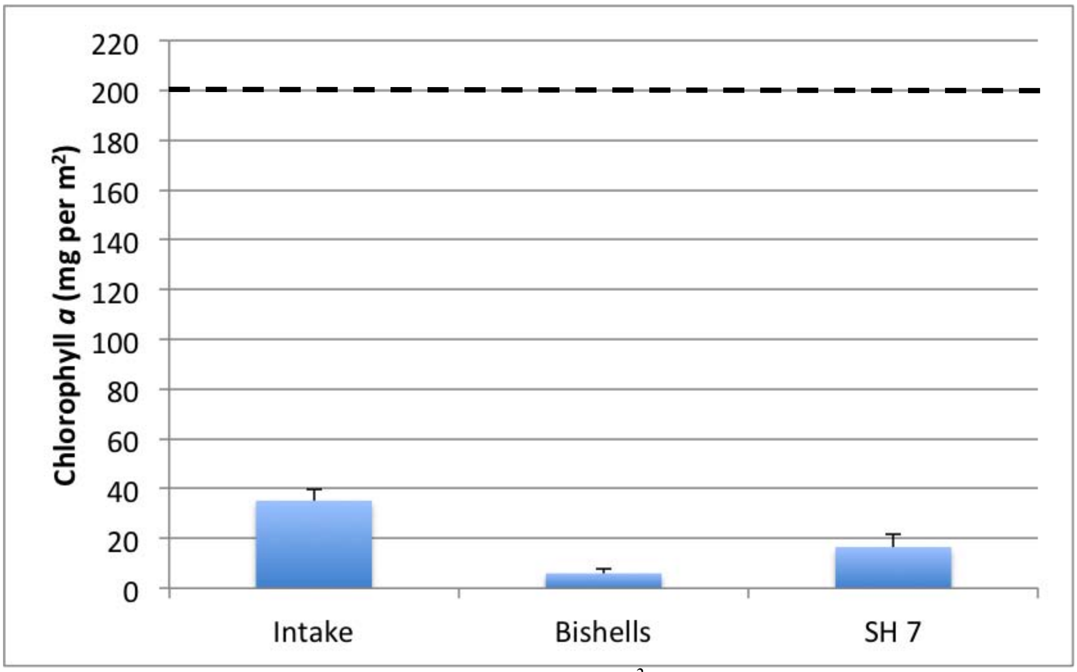

Figure 14 *Mean chlorophyll* a *concentration (mg per m^2) at Hurunui River sites, April 2012. The dashed horizontal line indicates the Ministry for the Environment trout habitat and angling guideline for diatoms/cyanobacteria (Table 1). Error bars are plus one standard error.*

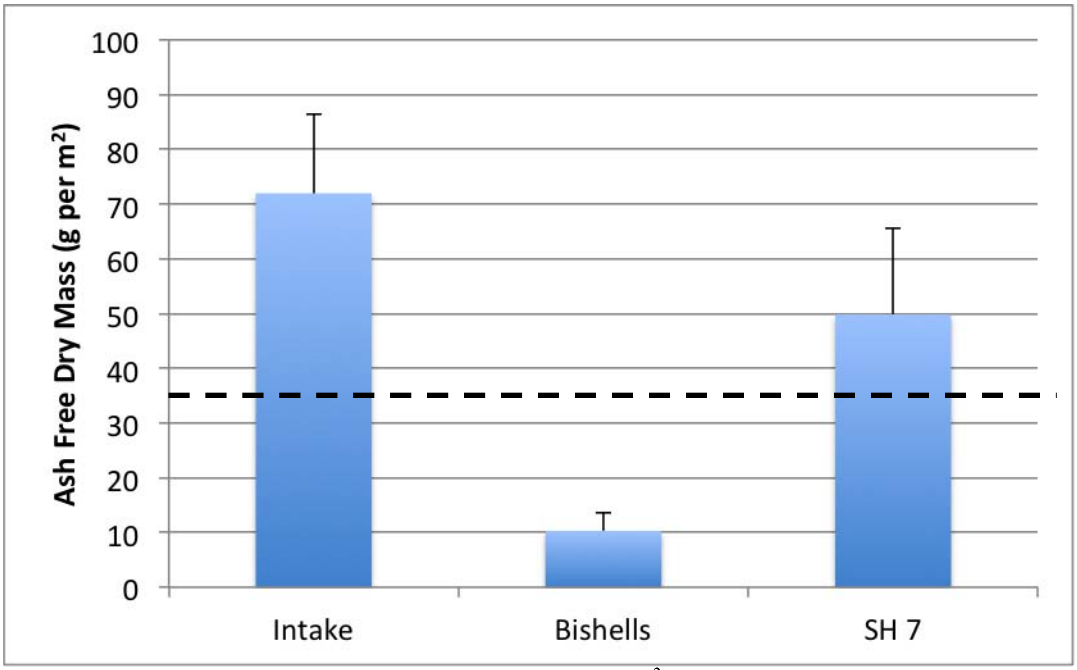

Figure 15 *Mean ash free dry mass concentration (g per m^2) at Hurunui River sites, April 2012. The dashed horizontal line indicates the Ministry for the Environment trout habitat and angling guideline for diatoms/cyanobacteria (Table 1). Error bars are plus one standard error.*

4. Conclusion

The initial survey of periphyton cover and biomass at three sites in the Hurunui River in April 2012 following stable low flow conditions identified a periphyton community that is dominated by Didymo growths of low to moderate abundance. Repeat monitoring in July 2012 following a high flow event of 228 m^3/s found only minimal periphyton remained at all sites.

5. References

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Appendix One:

Photographs of periphyton biomass sampling stones, April 2012

Figure A1.1 *Biomass sample stones at Intake Road site, April 2012.*

Figure A1.1 (continued) *Biomass sample stones at Intake Road site, April 2012.*

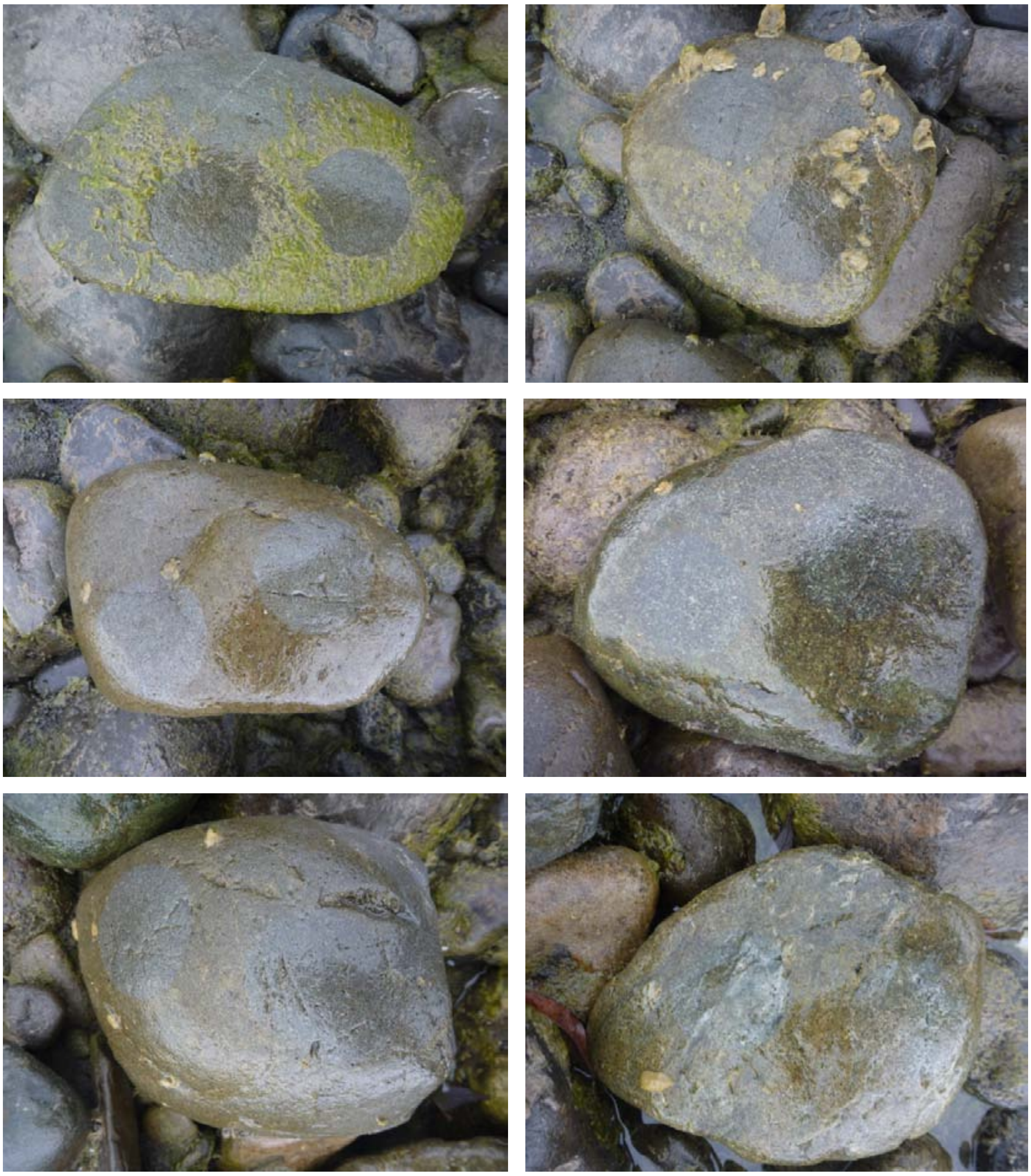

Figure A1.2 *Biomass sample stones at Bishells Road site, April 2012.*

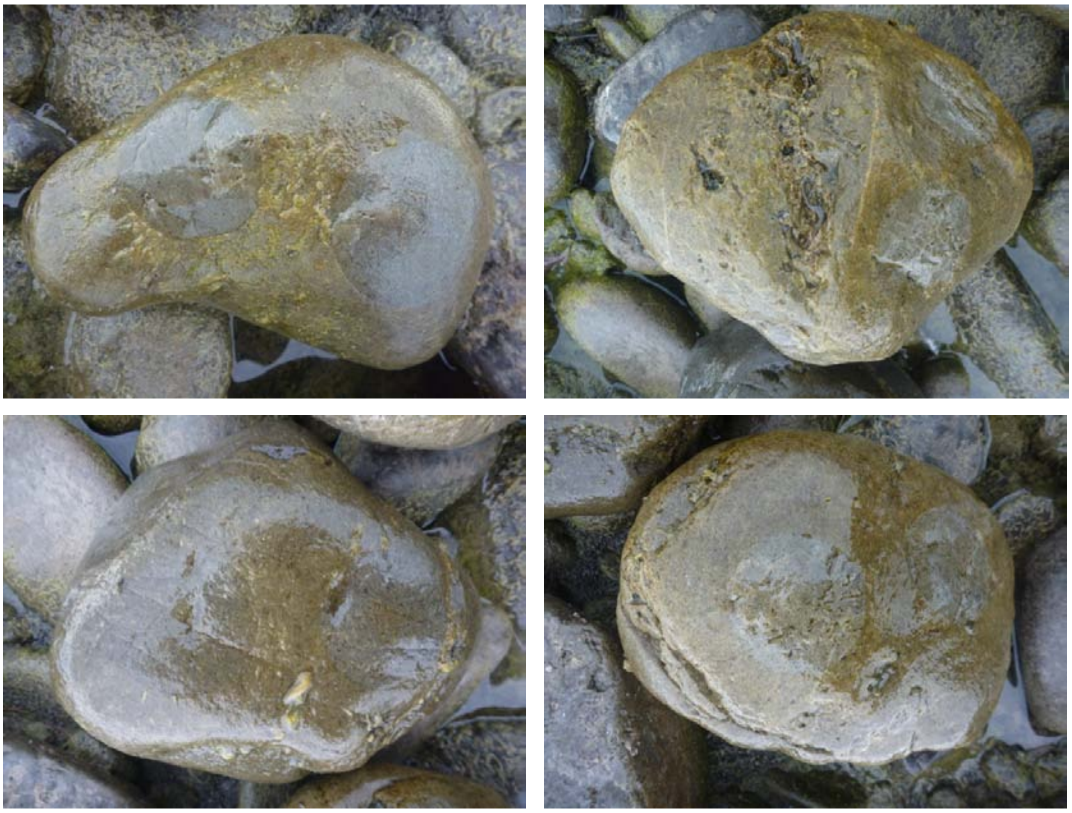

Figure A1.2 (continued) *Biomass sample stones at Bishells Road site, April 2012.*

Figure A1.3 *Biomass sample stones at State Highway 7 Bridge site, April 2012.*

Figure A1.3 (continued) *Biomass sample stones at State Highway 7 Bridge site, April 2012.*