Snake Creek Restoration Project

This project involved the large scale restoration of Snake Creek, a tributary of the Selwyn/ Waikirikiri. Over 3km of stream was transformed by bank repair, native planting and the installation of in stream features and sediment traps.

The main goals were to improve the conditions for stream life and improve water quality at Coes Ford, a once popular swimming hole. There was also the question as to whether the fortunes of a spring-fed stream could be turned around by carrying out interventions restricted to the mainstem and its riparian area, significant though these interventions were.

Participants

The project was led by the Water & Wildlife Habitat Trust, in conjunction with North Canterbury Fish & Game. The Ministry for the Environment was the largest funder, but other groups also contributed including: Environment Canterbury, Living Waters (DOC/Fonterra), the Selwyn District Council, Pub Charity & the Rata Foundation. Thanks to all those groups who helped with this project, including the landowners in the Snake Creek Catchment where the restorations occurred.

Key Findings

Shade proves a good alternative to mechanical excavation

The shading from plants has drastically reduced problem weed growth originating from the bank, proving shade can replace the need for mechanical excavation. Now that excavation has ceased leaf litter and woody debris have built up quickly which benefits stream life.

A paucity of undercut habitat exists (that is, the area where the bank overhangs the water). This is a legacy of decades of mechanical excavation and may take some time to re-establish.

Sediment input remains significant. Traps are very effective.

Sediment traps continue to infill indicating large amounts of sediment continue to be brought into the stream from adjacent land use.

The data shows a reduction in sediment on the streambed and improvement in macroinvertebrates, however this cannot be attributed to the restoration without further study.

More data needed to shows trends in water quality and aquatic species.

Quarterly monitoring is not sufficient to show long term trends in water quality, but based on what was available there is no indications yet that E. coli or nitrate concentration has improved.

However, phosphorus and fish abundance appear to be showing signs of improvement. More study is needed to see if there truly is a trend and if it is linked to the restoration.

Snake Creek before the restoration

Site description

The project focused on Snake Creek in the Silverstream catchment. The Silverstream catchment drains into the Selwyn/ Waikirikiri River located the Canterbury region of New Zealand.

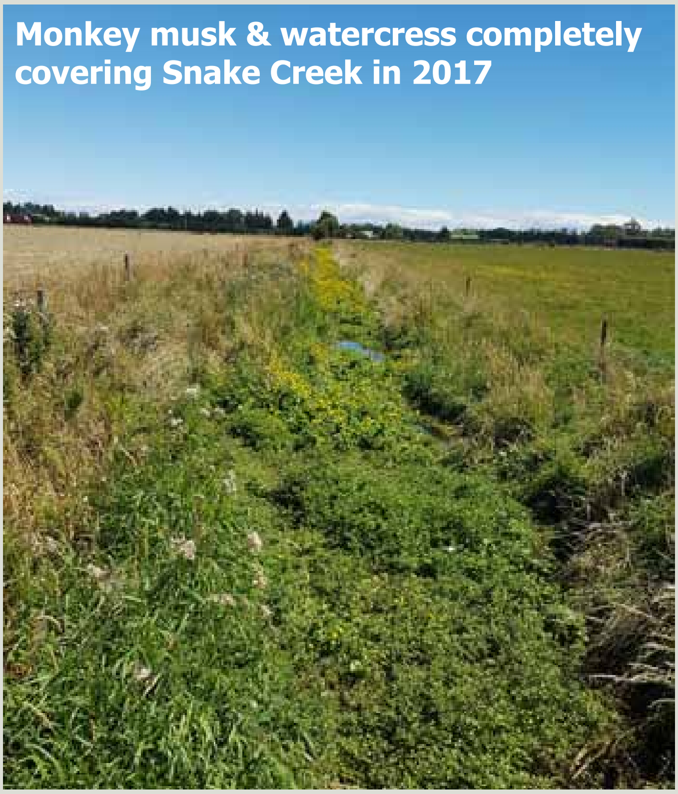
Snake Creek is a spring-fed stream with a mainstem of approximately 4.6 km in length (during the four year period of the project). There is one major side stream that feeds into it, known as McReas Drain and a smaller tributary as well as multiple ephemeral side drains.

Snake Creek is the largest of the three Silverstream tributaries with a catchment of 742 hectares. The soils are primarily Flaxton silty loams which are poorly drained.

By far the majority of the catchment is used for dairy and dairy support, but there are also some smaller lifestyle blocks that contain sheep and beef cattle.

The stream has been largely channelised making it an almost continuous run. A run is defined as an area of swiftly flowing water with little or no turbulence, as opposed to the other two dominate river features of pool (deep with slow water) and riffle (shallow with fast turbulent water flowing over rocks).

Macrophytes & shade



Monkey musk & watercress completely covering Snake Creek in 2017

At the beginning of the project (2017) there was little in the way of riparian vegetation.

The lack of shade had led to excessive macrophyte growth dominated by introduced monkey musk/ Erythranthe moschata (below left) and watercress/ Nasturtium officinale (below right). These macrophytes trap sediment, adding to the buil up in the stream.

Monkey musk and watercress root from the bank and spread out over the water column. This leads to raised water levels which can lead to water backing up on farm paddocks, and, if the weeds are dislodged in a high rainfall event, can lead to culvert blow outs and other property damage. For this reason they are regularly cleared mechanically and some areas are sprayed with herbicide.

Drain clearing & bank slope

Continued drain clearing had led to over-widened channels that have steep sided banks in many areas. These steep sided areas are prone to erosion.

Mechanical drain clearance has improved in recent years with attempts made to minimise damage by operators, however the stream profile that has been created over the years remains in place and damage does still occur depending on the operator.

Streambed

Continued weed clearance had resulted in little build up of leaf litter and woody debris. The surface of the streambed was instead fairly homogenous. Either predominately cobbles and gravel (in higher gradient sections) or cobbles and gravel covered in fine silt (in lower gradient sections).

In some areas there is a fine covering of silt and in other areas it has deposits of up to 20cm deep. It does not take too much of a drop in gradient for this sediment to drop out and accumulate.

Irrigators

Just prior to commencing the project the two main landowners (comprising of 80% of the project area) had centre pivot irrigators installed.

Over the project area these irrigators cross the stream over concrete bridges approximately every 100m of the waterway, with the exception of approximately 800m of the restored reach.

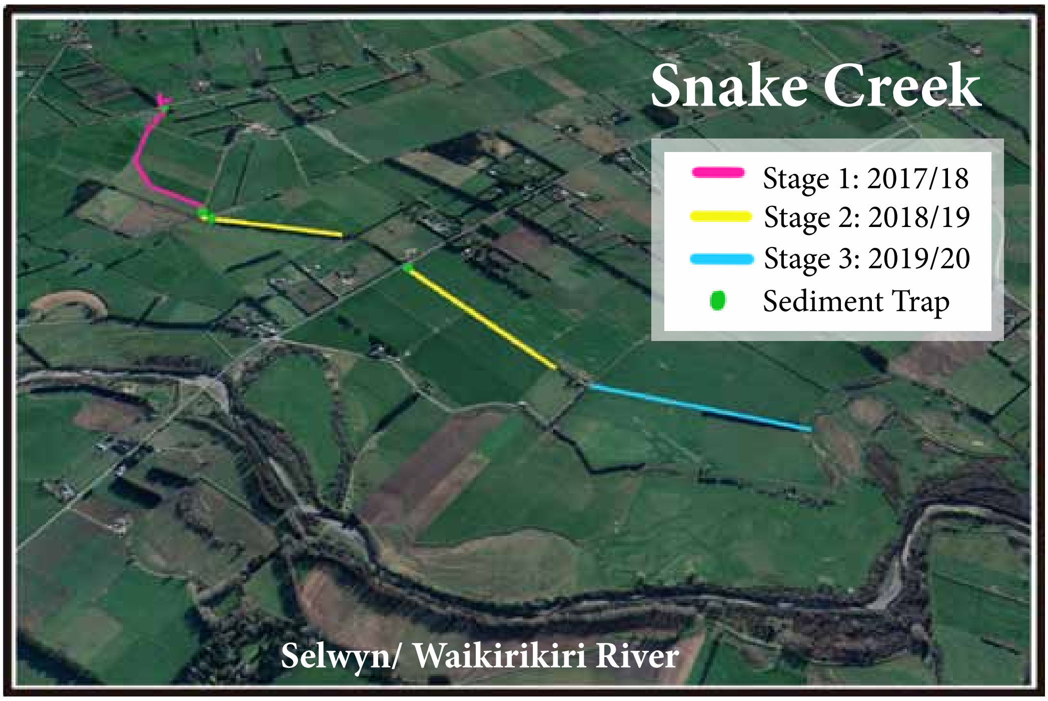
The irrigator nozzles dangle to 1.8m from the ground. This affected the species of riparian plants that were able to be planted, restricting it to low growing shrubs and grasses.

Interventions

Staging of work

Snake Creek is 4.6 km long including its two spring heads. The total reach that received interventions was 3,255m, made up of 3,135m (mainstem) and 120m (two tributary spring heads). In total 1,347m did not receive any interventions. This was where the stream went through three lifestyle blocks and one final stretch of 868m before it entered the Silverstream. In total 71% of the stream was restored. This did not include side streams that come in below the spring heads.

Work commenced at the top of flow permanence and was carried out over three stages (one per year).



Riparian buffers

The buffer widths (area available to work within) varied depending on the landowner and paddock and ranged from 2.5 – 10m (either side), although the majority of the buffer areas were 2.5 – 4m wide (either side).

Along the waters edge Carex secta was planted at 1 – 1.5m intervals. These were planted at the bottom of the slope so as be close to the water's edge. A second row of Carex secta was planted just up the bank from the first.

Two rows of low stature shrubs were planted. Low stature plants were selected due to the presence of the low irrigator. Initially the plant selection was dominated by small divaricating shrubs, however due to the time taken to cover ground, in stages two and three the plant list was shortened to be dominated by the following (pictured below): toe toe (Cortaderia richardii), mountain flax (Phormium cookianum), Coprosma propinqua, koromiko (Hebe salicifolia), swamp ribbonwood (Plagianthus divaricatus) and Coprosma robusta. The latter will have to be pruned periodically.

Repairing the bank

The bank was scraped back to a more gentle slope (from an average of 45° to an average of 19°). Topsoil was set aside and replaced.

Bank repair was needed to enable sedges to be planted low enough on the bank to allow them to hang over and reach the water's edge and thus create adequate shade. Note in catchments without low irrigators, trees planted higher up on the bank can achieve this result if positioned well.

Bank repair reduces bank erosion and increases flood carrying capacity, enabling plants to be planted on the banks.

The excavators did not scrape the bank below the waterline, but started 30cm above it. This was to reduce the sediment run-off into the stream, preserve any undercut habitat and also reduce costs.

Instream features

To create more diversity in the habitat in stream features were placed approximately every 50m over the restored reach. This involved adding boulders to create pinch points and mid and side-stream eddies. Wooden V weirs were also trialed.

These features created riffles and small pools. Pockets of clean gravel were created where fast flowing water flushed the sediment from the substrate. In addition some areas have led to a build up of sediment.

Sediment traps

Four sediment traps were created. These are deeper areas of stream (at Snake Creek approximately 10m in length) that slow the water and allow sediment to drop out.

One was located near the top of flow permanence (2017) and the others just below where small tributaries entered the mainstem. Refer to the map on page 5.

The traps were cleared several times over the project and emptied onto the paddock a safe distance from the stream.

Stream narrowing

Due to the stream being over-widened by mechanical excavation, trials were conducted to narrow the stream. This was carried out using hessian bags filled with cobbles. Some bags were filled with soil and Carex secta plants were planted into them.

As the plants rooted this helped to stabilise the bank and narrowed the stream effectively. The new bank has weathered changes in water level thus far.

Photos supplied by Brailsfords Ltd.

Weed clearance during the restoration

Following completion of the restoration of a reach mechanical weed clearing ceased. Hand weeding was carried out until the shading of the banks was established. Pictured on the right are volunteers helping out.

Monitoring

Following baseline monitoring, quarterly and annual monitoring was carried out at four monitoring sites along the stream.

The monitoring included measuring the flow, water quality and stream features (substrate, bank slope, undercut habitat, leaf litter, woody debris, macrophytes and riparian vegetation). Stream life monitoring included annual invertebrate sampling and electric fishing.

Due to this staging of restoration some stretches received more monitoring prior to restoration initiatives than others. For more information on the results contact North Canterbury Fish & Game.

Mapping run off

Due to concerns about the ongoing quantity of sediment being trapped in the traps it was decided to carry out overland flow path mapping to see where this sediment might be coming from. The mapping identified run off paths likely under certain rain events. The results could help guide future interventions, such as where to locate extra buffer areas or detention bunds and the size of such interventions. This technology could be a useful tool in fresh water farm planning.

Key Findings

1. Shade proves a good alternative to mechanical excavation

The shading from plants has drastically reduced problem weed growth originating from the bank, proving shade can replace the need for mechanical excavation. Leaf litter has quickly built up in the absence of mechanical excavation, and woody debris is slowly showing up. In some areas there has been a switch in the dominant macrophyte species.

Prior to the restoration project, the Selwyn District Council was mechanically clearing Snake Creek. As described earlier, this was predominately to control problem macrophytes which do well in an environment with little shading and high in nutrients.

The bank repair allowed Carex secta to be planted low on the bank, and, as they grew, the overhanging sedges shaded the bank where these species root from, thus suppressing their growth. It took two years growth to achieve a sufficient level of shading to stop the hand weeding.

Reach mechanically cleared in 2015

Reach mechanically cleared in 2020

A change in macrophyte dominance

With hand weed clearing of sprawling emergent macrophytes monkey musk and watercress (refer to the diagram below for explanation of growth forms) there was an increase in submerged macrophtyes, particularly threadleaf crowfoot (Ranunculus trichophyllus) and the native Stonewort (Nitella pseudoflabellata)

With increased riparian plant growth these submerged macrophytes were also shaded out in narrower sections, but in wider sections it is unlikely the riparian plants suitable for growing under centre pivot irrigators will be able to achieve the level of shading required. However, it appears these plants, while still having the negative feature of trapping sediment, do not increase the risk of flood damage as significantly as the sprawling emergent macrophtyes.

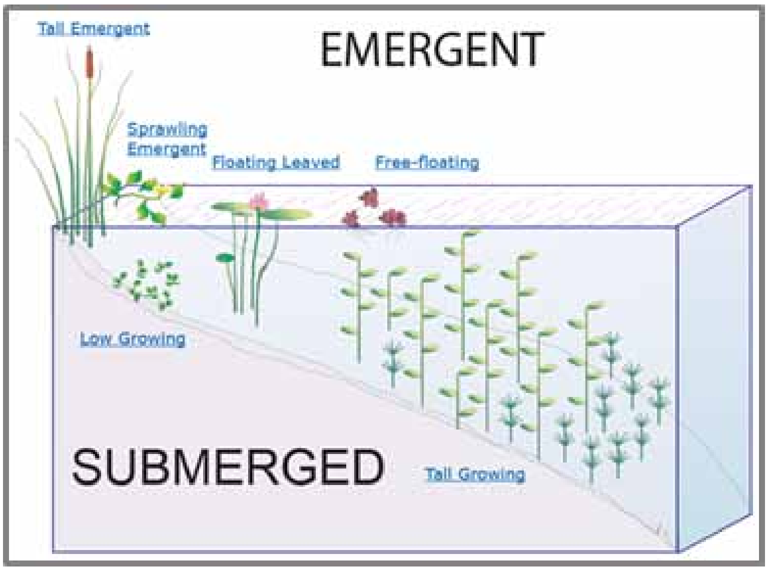


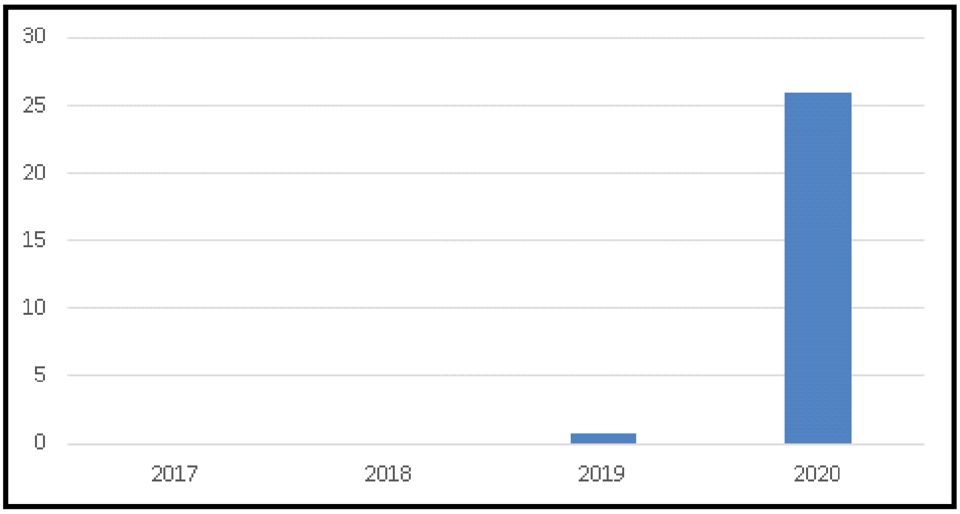
Diagram courtesy of NIWA.

The emergent macrophyte 'crowfoot'

Leaf Litter & woody debris increased

Leaf Litter is a valuable energy source. It provides food for invertebrates and Kekewai (freshwater crayfish) and increases nitrate absorption. Baseline monitoring showed no leaf litter in any of the four monitoring locations prior to restoration. This is likely due to annual mechanical weed clearance and a paucity of riparian vegetation. The study showed that leaf little quickly builds up in the absence of mechanical clearance and the introduction of riparian sedges and shrubs. Some woody debris is starting to appear on the stream bed.

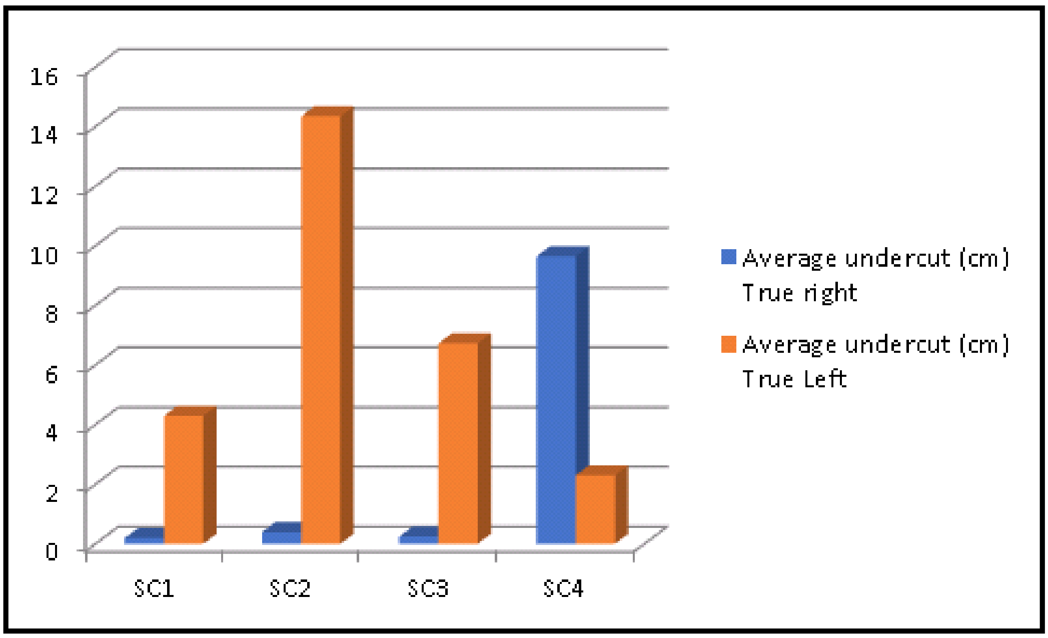
Table 1: Percentage of leaf litter at the stage 1 monitoring site



A paucity of undercut habitat

At Snake Creek the streams were cleared mechanically from one favoured bank. This is typically the bank that provides the easiest access. Our analysis shows that the side of the stream that excavation was historically conducted from has significantly less undercut habitat than the other side. This has potential implications for species that utilise this habitat, such as trout, long finned eel (tuna) and freshwater crayfish (kekewai). It is likely that, in time, undercut habitat will re-establish now that mechanical excavation has ceased.

Table 2: Degree of bank undercut at Snake Creek monitoring sites. SC1, SC2 & SC3 were historically cleared mechanically from the true right. SC4 was cleared from both sides.



2. Sediment input remains significant. Traps are very effective.

Sediment traps continue to infill indicating large amounts of sediment continue to be brought into the stream from adjacent land use.

The data shows a reduction in sediment on the streambed and improvement in macroinvertebrates, however this cannot be attributed to the restoration without further study.

Sediment

Over approximately 2½ years 100.5 tonnes (dry weight) of sediment was removed from the four sediment traps. The majority of sediment removed was from three traps.

The last trap created (SED 4) caught comparatively little sediment. Refer to the table below which shows the amount removed from the traps during the project. Further collection of trap data is required to see if there is a trend in the amount of sediment entering the stream.

It is hard to know exactly how this sediment is coming in, but it is likely to be from overland flow during significant rain events. Smaller side drains may also be a significant contributor to mainstem sediment loads. These small side drains have the greatest interface with paddocks. No interventions were carried out on side drains, although it is worth noting that the majority of these side drains were fenced prior to the project commencing.

The project did not involve any interventions to reduce run-off outside of the riparian area of the mainstem.

A side drain (small tributary) of Snake Creek.

Table 3: Amount of sediment removed (dry weight in tonnes)

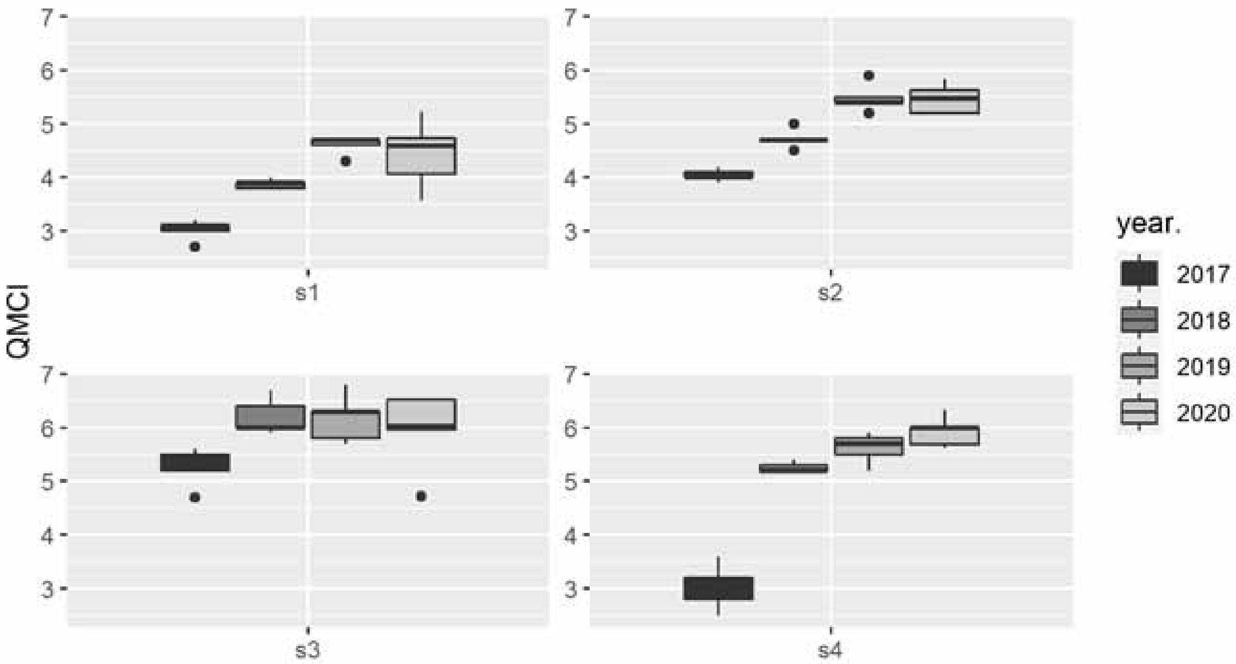
Sediment Trap	Date Created	1st clearing	Amount removed	2nd clearing	Amount removed	3rd clearing	Amount removed	4th Clearing	Amount removed
SED 1 (just below Chamberlains	6-Nov-17	28-May-18	8	8-Nov-18	8	7th May 19	2.5	29th May 20	10.1
SED 2 (just below Hurley drain)	6-Nov-17	Not cleared	N/A	8-Nov-18	19.5	7th May 19	14	29th May 20	12.4
SED 3 (just below McReas Drain)	6-Nov-17	Not cleared	N/A	8-Nov-18	14	7th May 19	5	29th May 20	5.2
SED 4 (just below Leeston Road)	23/10/2018	Not created	N/A	Not created	N/A	7th May 19	0	29th May 20	1.8
Totals:			8		41.5		21.5		29.5

Macroinvertebrates

Macroinvertebrates samples were taken from the streambed prior to any restoration work being carried out in 2017, then again in 2018,19 and 20. Refer to the graph below which shows improvements in the QMCI (Quantitative Macroinvertebrate Community Index).

A higher score QCMI score represents the presence of more sensitive macroinvertebrates and thus better habitat. Unfortunately, due to a drought that occurred in 2017 it is not possible to attribute the improvements solely to the restoration works, as this same shift in QMCI was seen in neighbouring streams with the return of flow. Further monitoring would be required to confirm the correlation.

Table 4: QMCI at sites 1-4 between 2017-2020 based on five replicate Surber Samples. Box plots show the median value, 25th & 75th percentile, 1.5 x the interquartile range and outliers



Boulders placed in the stream have provided good habitat for macroinvertebrates

3. More data needed to shows trends in water quality and aquatic life

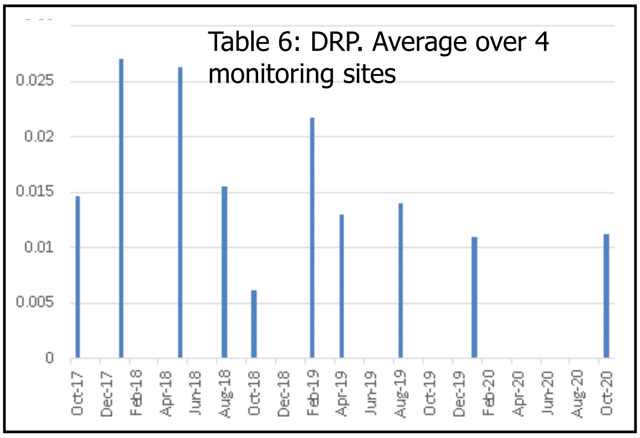
Quarterly monitoring over four years is not sufficient to show trends in water quality, but based on what was available there is no indications that E. coli or nitrate concentration have improved.

Phosphorus and fish abundance appear to be showing signs of improvement (refer to table 5) but more study is needed to see if there truly is a trend and if it is linked to the restoration.

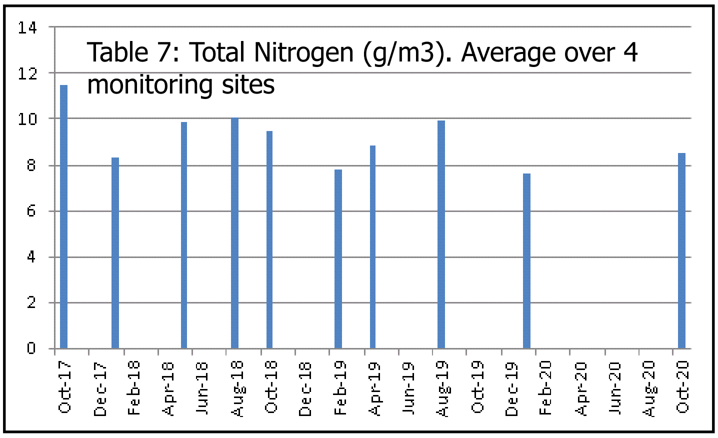
Table 5: Vertebrate species found in Snake creek at the annual October monitoring round for the four monitoring sites. The reaches electric fished each were 20m long.

Species	2017	2018	2019	2020
Upland bully	52	62	61	109
Common bully	38	93	34	8
Unidentified bully	0	0	70	121
Total bully	90	155	165	238
Longfin eel	4	1	3	7
Shortfin eel	26	13	5	8
Unidentified eel	3	0	3	0
Brown trout	74	92	103	114
Freshwater crayfish	1	2	2	1
Inanga	0	0	1	0

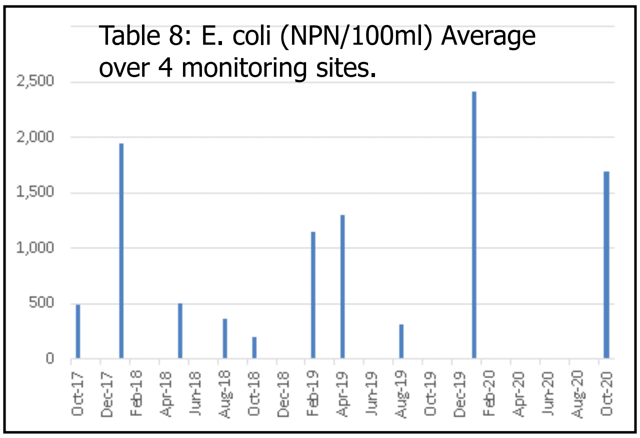
Phoshorus



Nitrogen

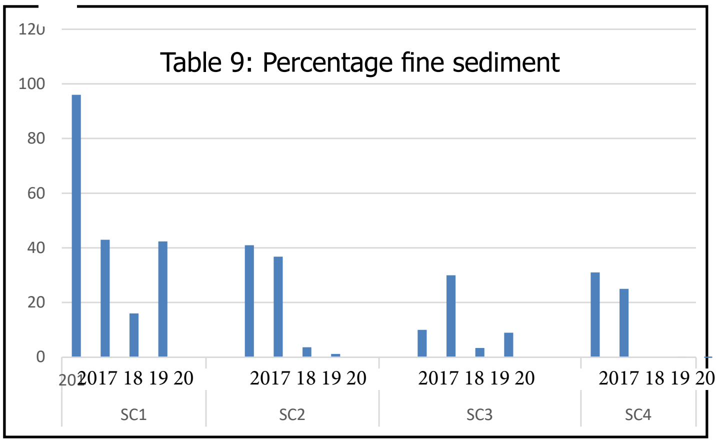


E. coli



*Note lab analysis only goes to 2420 NPN/100ml so some results were actually higher than this.

Sediment Cover



Recommendations

1 Bank repair and riparian plantings are effective in controlling macrophytes that root from the bank, and could be used more widely to break the cycle of mechanical drain clearance.

2 Sediment traps are effective but only capture a portion of the sediment coming into the system. It would be preferable to use them in conjunction with other interventions, such as increased buffers, especially around overland flow path discharge points.

3 It would be helpful to see more examples of the practical application of interventions, such as detainment bunding and targeted buffers areas, including studies into their effectiveness.

4 Run- off mapping is a good tool to target high risk areas for intervention and could be very useful in farm planning.

5 When planning centre pivot installations, it is preferable to install higher centre pivots, or, if costs allow, avoid stream crossings. This allows for a more natural riparian community and improved shading of all macrophytes.

Snake Creek 2017

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