# STREAM HEALTH ASSESSMENT OF LAGOON CREEK, TOMAHAWK LAGOON

*Lagoon Creek facing downstream to Tomahawk Lagoon and is a small creek that runs through farm land and plantation forest.*

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# 1. INTRODUCTION

NZ Landcare Trust and ECOTAGO work with five schools as part of a citizen science monitoring programme to report on water quality of Tomahawk Lagoon. The group meet fortnightly to monitor the biodiversity, chemical and physical patterns of the Tomahawk Lagoon and its catchment.

Since the inception of the project, five locations have been monitored for nutrients and contaminants as well as physicochemical water parameters. The group produces an annual water quality report card comparing levels of nitrogen, phosphorous, turbidity and *E. coli* with the Otago Water Plan Receiving Water limits and algae with guideline values from the National Policy Statement for Freshwater Management.

Recently the group have decided to extend monitoring along Lagoon Creek to better understand the impacts of land use on stream health and the inputs into Tomahawk Lagoon. I was engaged to prepare a stream health monitoring programme and baseline information for Lagoon Creek.

# 2. METHODS

## 2.1 General

Sampling of freshwater habitats at Lagoon Creek was undertaken on 4 September 2019 during fine weather. Three reaches 10-metres long were selected (Figure 1). The upper reach runs adjacent to an exotic forestry block, the mid reach below the confluence of several tributaries and the lower reach just above the outlet to Tomahawk Lagoon. Habitat quality and periphyton surveys followed guidance from the New Zealand Stream Health Monitoring and Assessment Kit and the macroinvertebrate survey used established protocols from the Sampling Macroinvertebrates in Wadeable Streams manual.

## 2.2 Habitat quality

Habitat quality was assessed by describing the composition of the stream bed by estimating the percentage covers of different types of material making up the stream bottom, noting the presence and thickness of any loose deposited material and estimating the percentage of vegetation types in a strip 5 metres wide parallel to the water's edge.

## 2.3 Periphyton survey

Ten stones were collected from a reach and the type of periphyton (on exposed surfaces) was recorded and scores calculated.

## 2.4 Macroinvertebrate survey

Benthic macroinvertebrates were collected using a kick net with a 500 μm diameter mesh using the hard-bottomed (hb), semi-quantitative wadeable stream C1 protocol (Stark *et al.* 2001).

In the laboratory the samples were processed using the coded abundance protocol (Stark *et al.* 2001). Macroinvertebrates were identified under a dissecting microscope (10-40X) using the guides of Winterbourn *et al.* (2006) and Landcare Research (2019).

Macroinvertebrate abundance data was converted into coded abundance scores based on Stark (1998) (Table 1).

Table 1: Coded abundance scores used to summarise macroinvertebrate data (after Stark 1998).

| Abundance | Coded Abundance | | Weighting Factor |
|---|---|---|---|
| 1-4 | (R) | Rare | 1 |
| 5-19 | (C) | Common | 5 |
| 20-99 | (A) | Abundant | 20 |
| 100-499 | (VA) | Very abundant | 100 |
| >500 | (VVA) | Very very abundant | 500 |

### 2.4.1 Macroinvertebrate metrics

Traditionally, stream health assessments were focused on chemical data which reflects only the stream conditions at the moment the sample is taken and only on a defined set of parameters. In contrast, macroinvertebrates possess a life cycle of at least a year or more, do not move great distances, and are more or less confined to the area of stream sampled. Macroinvertebrates therefore integrate environmental conditions over a longer time period and can be used to determine causal relationships with land use.

For each sampled site, benthic macroinvertebrate community composition was assessed using a number of diagnostic macroinvertebrate metrics as proxies for stream health:

- *Taxonomic richness*

  A measurement of the number of taxa (a taxonomic group of any rank, such as a species, genera, or family) present.

- *Ephemeroptera, Plecoptera and Trichoptera index (EPT)*

  These groups of macroinvertebrates are generally sensitive to pollution and have high tolerance scores. High EPT metric values generally indicate clean water and undisturbed, structurally complex invertebrate habitat.

  EPT taxonomic richness is the number of taxa belonging to the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) or Trichoptera (caddisflies) in the sample and provides information on the richness/diversity of these groups in the sampled stream. % EPT taxonomic richness is calculated by counting the total number of EPT taxa in a sample and dividing that number by the sample taxa richness and multiplying by 100. The % EPT provides information on the organisation/composition of the macroinvertebrates in the sampled stream.

- *Macroinvertebrate Community Index (MCI)* (Stark 1985)

  MCI was developed in New Zealand and is used to indicate organic pollution and nutrient enrichment in stony streams. Tolerance values have been assigned to specific genera and their presence or absence is used to calculate an MCI value for the sampled site. MCI values are used to assign water quality classes (Table 2).

  Table 2: Interpretation of Macroinvertebrate Community Index values (Stark and Maxted 2004).

| Water Quality Class | MCI | SQMCI |
|---|---|---|
| Excellent | >119 | >5.99 |
| Good | 100-119 | 5.00-5.90 |
| Fair | 80-99 | 4.00-4.99 |
| Poor | <80 | <4.00 |

- *Semi-Quantitative Macroinvertebrate Community Index (SQMCI)* (Stark 1998)

  SQMCI is a variant of MCI that takes into account the relative abundances of taxa and therefore responds to changes in numerical composition and dominance unlike MCI which only reflects changes in taxonomic composition. SQMCI is useful when subtle changes in community composition need to be assessed such as where water quality changes are expected over relatively short river reaches (e.g. above and below wastewater discharges or water abstraction points). Abundance of all taxa is recorded using a five-point scale (Table 1).

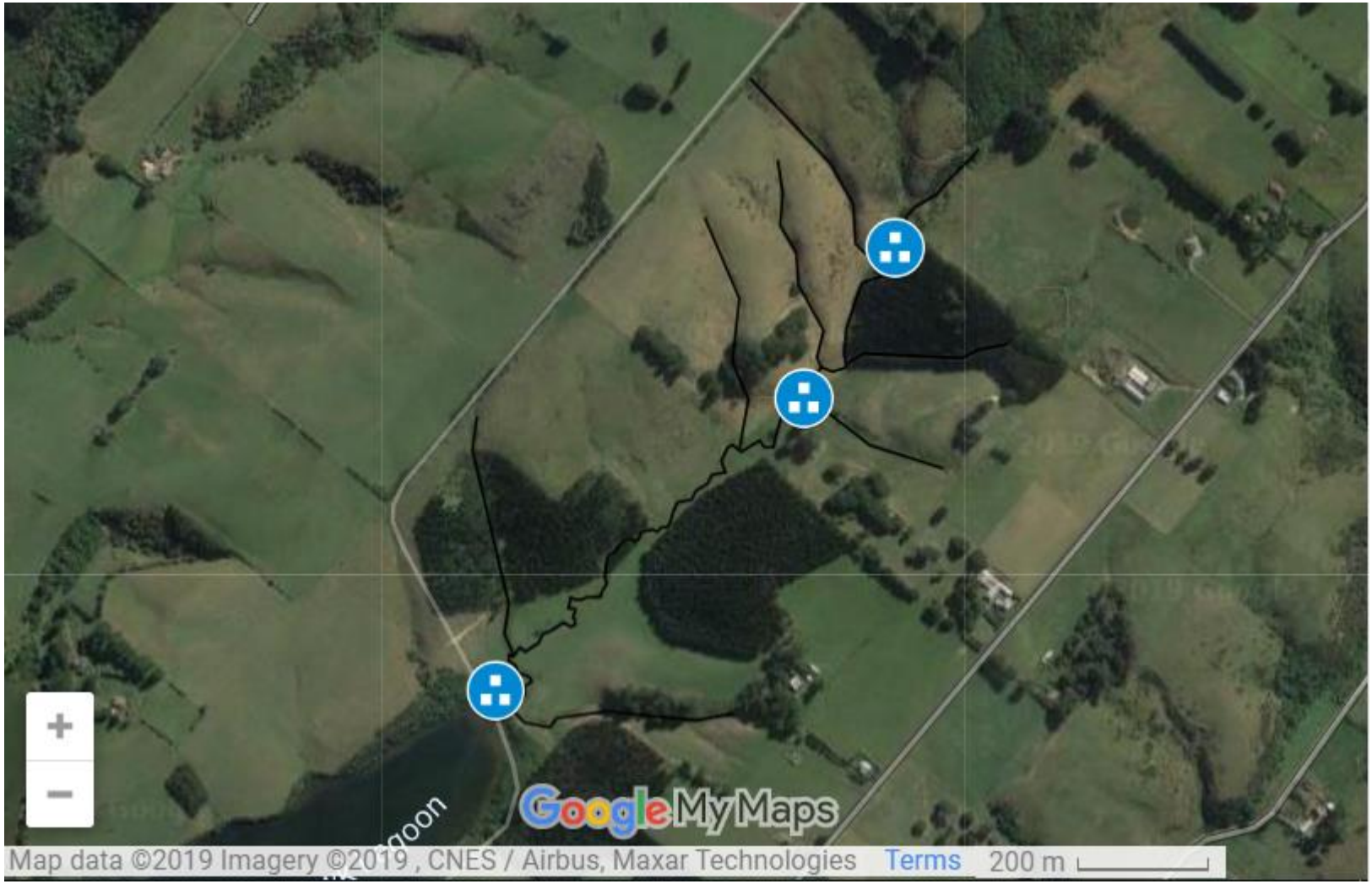

Figure 1: Lagoon Creek showing the locations of the three sampling sites, upper, mid and lower reaches.

# 3. RESULTS

## 3.1 Site 1 (3a)

### 3.1.1 Habitat quality

This site is the lower reach of Lagoon Creek just above the outlet to Tomahawk Lagoon. The land adjacent to the site is grazed, unfenced and with little riparian vegetation or shading. Vegetation was dominated by exotic pasture grasses, with abundant gorse, occasional short tussock and rush. The composition of the substrate of the stream bed was 35% mud/silt, 20% woody debris, 10% boulders, 20% large cobbles, 10% small cobbles and 5% gravels and with a thick layer (>5 mm) of deposited sediment (Plate 1)

Plate 1: Site 1 (3a) the lower reach of Lagoon Creek.

### 3.1.2 Periphyton communities

Of the ten stones collected, four had no periphyton, one had a thin mat (<0.5 mm thick) of green periphyton, three had a medium mat (0.5-3 mm thick) of green periphyton, one had a medium mat (0.5-3 mm thick) of light brown periphyton and two had short filaments (<2 cm long) of green periphyton (some stones had multiple types of periphyton). The periphyton score was 5.4 and has a rating of moderate. This rating is characteristic of streams with slightly more enriched conditions which could be due to diffuse inputs from the land (nutrients) or direct inputs from stock. This level of periphyton growth is generally not a problem but can affect macroinvertebrate communities through a reduction in habitat.

### 3.1.3 Macroinvertebrate communities

Five macroinvertebrate taxa were recorded. The sample was dominated by pollution tolerant snails, worms and flies. Stick caddis *Triplectides* were present (Plate 2). This genus belongs to a pollution sensitive group, the Trichoptera (caddisflies), however this genus has a lower sensitivity score. *Triplectides* are common in hard and soft bottom streams in areas of bush cover, farmland and urban land use and are “shredders” feeding on leaf litter. Red damselfly (*Xanthocnemis*) larvae were present (Plate 3). These larvae

frequently occur in stony and weedy streams and ponds throughout New Zealand and are predators of other invertebrate species. The MCI and SQMCI scores indicate poor-fair water quality at this site (Appendix 1, Table 1).

Plate 2: The stick caddis *Triplectides* has an MCI (hb) tolerance score of 5.

Image: Landcare Research

Plate 3: The red damselfly *Xanthocnemis* has an MCI (hb) tolerance score of 5.

Image: Landcare Research

## 3.2 Site 2 (3b)

### 3.2.1 Habitat quality

This site is the mid reach of Lagoon Creek below the confluence of several tributaries. The land adjacent to the site is grazed, unfenced and with little riparian vegetation or shading. Vegetation was dominated by exotic pasture grasses, with the occasional gorse, scotch thistle and rush. The composition of the substrate of the stream bed was 40% small cobbles, 25% mud/silt, 15% large cobbles, 10% boulders and gravels and with a thick layer (>5 mm) of deposited sediment (Plate 4).

Plate 4: Site 2 (3b) the mid reach of Lagoon Creek.

### 3.2.2 Periphyton communities

Of the ten stones collected, two had no periphyton, five had a thin mat (<0.5 mm thick) of dark brown periphyton, one had a medium mat (0.5-3 mm thick) of dark brown periphyton and one had a thick mat (>3 mm thick) of light brown periphyton. The periphyton score was 9 and has a rating of very good. This rating is characteristic of streams with low concentrations of nutrients and high abundance of macroinvertebrates, particularly sensitive taxa.

### 3.2.3 Macroinvertebrate communities

Sixteen macroinvertebrate taxa were recorded, including nine of pollution sensitive Ephemopetera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies) (EPT) taxa. The sample was dominated by Talitridae (Plate 5) a family of amphipods which are often found in small soft bottomed streams. Although this site is hard bottomed, the thick cover of deposited sediment at this site has provided the conditions suitable for this taxon to become abundant. Talitrids are "shredders" that eat decomposing plant material. They are pollution tolerant and are able to live with limited dissolved oxygen. The mayfly *Deleatidium* was also abundant at this site (Plate 6). This genus has a high sensitivity score for hard bottomed sites which is typically an indicator of good water quality, however, they have a lower score for soft bottom sites as they are more tolerant of sediment than other mayfly. The commensal flatworm (*Temnocephala novae-zealandia*) was also found, indicative of freshwater crayfish/koura in the area. The MCI and SQMCI scores indicate good-excellent water quality at this site (Appendix 1, Table 1).

Plate 5: The amphipod Talitridae has an MCI (hb) tolerance score of 5.

Image: Landcare Research

Plate 6: The single gill mayfly *Deleatidium* has an MCI (hb) tolerance score of 8.

Image: Landcare Research

## 3.3 Site 3 (3c)

### 3.3.1 Habitat quality

This site is the upper reach of Lagoon Creek adjacent to an exotic forestry block. The land on the true left side of the bank comprises pine forest and the land on the true right side of the bank comprises scrub and exotic pasture grasses. The composition of the substrate of the stream bed was 40% boulders, 20% large cobbles, 20% small cobbles,

20% gravels with a moderate to thick layer (>3 mm) of patchy deposited sediment (Plate 7).

Plate 7: Site 3 (3c) the upper reach of Lagoon Creek.

### 3.3.2 Periphyton communities

Of the ten stones collected, three had a thin mat (<0.5 mm thick) of light brown periphyton, two had a thin mat (<0.5 mm thick) of dark brown periphyton, three had a medium mat (0.5-3 mm thick) of light brown periphyton and three had a medium mat (0.5-3 mm thick) of dark brown periphyton (some stones had multiple types of periphyton). The periphyton score was 9 and has a rating of very good. This rating is characteristic of streams with low concentrations of nutrients and high abundance of macroinvertebrates, particularly sensitive taxa.

### 3.3.3 Macroinvertebrate communities

Eight macroinvertebrate taxa were recorded, including four of pollution sensitive Ephemopetera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies) (EPT) taxa. The sample was dominated by *Deleatidium* and the stonefly *Zelandobius* and *Zelandoperla* were common. *Zelandobius* and *Zelandoperla* nymphs (Plates 8 and 9) can be found in a wide range of hard bottomed streams all over the country. They are "collector-gatherers" feeding on a range of organic matter on the stream bed and have mid and high sensitivity scores respectively. The MCI and SQMCI scores indicate excellent water quality at this site (Appendix 1, Table 1).

Plate 8: The stonefly *Zelandobius* has an MCI (hb) tolerance score of 5.

Image: Landcare Research

Plate 9: The stonefly *Zelandoperla* has an MCI (hb) tolerance score of 10.

Image: Landcare Research

## 4. FUTURE MONITORING

Monitoring of Lagoon Creek is undertaken by citizen scientists to understand the inputs into Tomahawk Lagoon, identify problems and inform management. The identification of freshwater macroinvertebrates to the level of genera required to calculate macroinvertebrate community metrics is time intensive and requires professional expertise. It is therefore recommended that this task is completed annually.

The New Zealand Stream Health Monitoring and Assessment Kit (SHMAK) provides community groups with simple and scientifically sound tools to monitor the ecological health of streams. Habitat and invertebrate scores are combined to provide an overall stream health score. A periphyton survey can also be undertaken to provide a periphyton score. The manual provides excellent information for interpretation. Depending on the objectives of the group, seasonal sampling using SHMAK, would provide students with the ability to engage with science in a simple way and also provide temporal data which may aid in the understanding of the role of seasonality for the Tomahawk Lagoon catchment.

## 5. SUMMARY AND CONCLUSIONS

Lagoon Creek demonstrates a gradient of increasing impacts on stream health downstream towards Tomahawk Lagoon. The upper reach had an MCI/SQMCI score of excellent water quality and a very good periphyton score, the mid reach had an MCI/SQMCI score of good-excellent water quality and a very good periphyton score and the lower reach had an MCI/SQMCI score of poor-fair water quality and a moderate periphyton score.

MCI metrics were developed to assess organic enrichment in stony streams by sampling in stony riffles where the greatest diversity of sensitive macroinvertebrates might be expected. A variant of MCI for soft bottomed streams was later developed. The protocol for hard bottomed streams was used for this assessment as naturally the substrate is/would be dominated by particles of gravel size or over (i.e. <50% sand/silt). The MCI/SQMCI scores should be interpreted with some caution as the sites had a great amount of deposited sediment and were predominantly slow runs rather than the riffle habitat that the metrics were designed for.

The results suggest that the greatest impact from land use on stream health of Lagoon Creek is from sediment. Excessive amounts of sediment can significantly alter and degrade invertebrate habitat by filling the spaces between stones where they live, can damage the filter feeding apparatus of invertebrates and increase pollution load through the transport of attached nutrients, chemicals and bacteria from farming into waterways. Fencing and riparian planting may greatly reduce the sediment load of Lagoon Creek. Fencing prevents stock from accessing streams reducing pugging and erosion as well as decreasing nutrients and bacteria from fouling. Riparian buffers stabilize banks and channels, filter soil and contaminants from entering waterways and reduce flood flows.

## ACKNOWLEDGMENTS

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## REFERENCES

Biggs, B.J.F., Kilroy, C., Mulcock, C.M., Scarsbrook, M.R., Ogilvie, S.C. 2002: New Zealand Stream Health Monitoring and Assessment Kit. Stream Monitoring Manual. Version 2K – A tool for Kaitiaki. NIWA Technical Report 111-1. 190 p.

Landcare Research 2019: Freshwater invertebrates guide: Available at https://www.landcareresearch.co.nz/resources/identification/animals/freshwater-invertebrates (accessed 5 November 2019).

Stark J.D. 1985: A macroinvertebrate community index of water quality for stony streams. *Water and Soil Miscellaneous Publication 87*: 1-52.

Stark J.D. 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. *New Zealand Journal of Marine and Freshwater Research 32*: 55-66.

Stark J.D., Boothroyd I.K.G, Harding J.S., Maxted J.R., and Scarsbrook M.R. 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 Contract No. 5103. 57 pp.

Stark J.D. and Maxted J.R. 2004: Macroinvertebrate community indices for Auckland's soft-bottomed streams and applications to SOE reporting. *Cawthron Report No. 970.* Prepared for the Auckland Regional Council by the Cawthron Institute.

Winterbourn M.J., Gregson K.L.D., and Dolphin C.H. 2006: Guide to the aquatic insects of New Zealand. *Bulletin of the Entomological Society of New Zealand*: 14.

Table 1: Benthic macroinvertebrate communities at Lagoon Creek, Tomahawk Lagoon. Coded abundance scores after Stark (1998): r = rare, c = common, a = abundant, va = very abundant, vva = very very abundant.

| Taxa | MCI Score (hb) | Site 1 (3a) | Site 2 (3b) | Site 3 (3c) |
|---|---|---|---|---|
| **Ephemeroptera (mayflies)** | | | | |
| *Deleatidium* | **8** | | A | VA |
| **Plecoptera (stoneflies)** | | | | |
| *Acroperla* | **5** | | R | |
| *Megaleptoperla* | **9** | | R | |
| *Zelandobius* | **5** | | R | C |
| *Zelandoperla* | **10** | | | C |
| **Trichoptera (caddisflies)** | | | | |
| *Hudsonema* | **6** | | R | |
| *Plectrocnemia* | 8 | | R | |
| *Polyplectropus* | 8 | | C | R |
| *Psilochorema* | **8** | | R | |
| *Triplectides* | **5** | R | | |
| *Triplectidina* | **5** | | R | |
| **Coleoptera (beetles)** | | | | |
| Elmidae | **6** | | R | R |
| **Diptera (flies)** | | | | |
| *Chironomus* | **1** | | R | |
| *Empididae* | **3** | | | R |
| Tanypodinae | **5** | C | | |
| **Hemiptera (bugs)** | | | | |
| *Anisops* | **5** | | R | |
| **Odonata (dragonflies and damselflies)** | | | | |
| *Xanthocnemis* | **5** | R | | |
| **CRUSTACEA** | | | | |
| *Amphipoda* | **5** | | A | R |
| **MOLLUSCA** | | | | |
| *Potamopyrgus* | **4** | C | R | R |
| **OLIGOCHAETA** | **1** | C | R | |
| **PLATYHELMINTHES** | **3** | | R | |
| **Taxanomic richness** | | **5** | **16** | **8** |
| **EPT taxonomic richness** | | **1** | **9** | **4** |
| **% EPT taxonomic richness** | | **20** | **56** | **50** |
| **MCI score** | | **80** | **109** | **123** |
| **MCI Quality Class** | | **Fair** | **Good** | **Excellent** |
| **SQMCI score** | | **2.79** | **6.31** | **7.73** |
| **SQMCI Quality Class** | | **Poor** | **Excellent** | **Excellent** |