# A biosurvey of the benthic macroinvertebrates and algae of the Manganui o te Ao River

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# A biosurvey of the benthic macroinvertebrates and algae of the Manganui o te Ao River

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# CONTENTS

# Executive summary

- The Manganui o te Ao River, originating on the western slopes of Mt. Ruapehu harbours a population of the endangered blue duck (*Hymenolaimus malacorhynchos*).
- Blue duck feed almost exclusively on benthic macroinvertebrates. There is concern that if the invasive alga, *Didymosphenia geminata* was introduced to the Manganui o te Ao River, the food supply for blue ducks may be impacted.
- This report is a biosurvey of algae and macroinvertebrates at three sites along the Manganui o te Ao River. The aim was to provide a snapshot of the algal and macroinvertebrate communities in case *D. geminata* invades. The sampling program also provided the opportunity to perform a bioassessment of water quality.
- The proportion of more sensitive taxa was greatest at the upstream most site and declined downstream. The macroinvertebrate community index (MCI) and its quantitative variant (QMCI) indicted a decline in water quality from upstream to downstream.
- Few algae were found at the upstream most site. Diatoms dominated at the middle site while the downstream most site was dominated by a filamentous green alga.
- The downstream decline in water quality is typical of the longitudinal change observed in numerous New Zealand rivers and streams. This decline results from the change in land use from forest in the headwaters to farmland towards the mouth. Volcanic sediments may also have some influence.
- It is suggested that this biosurvey is repeated at least three more times to give an indication of any seasonal variation.

# Introduction

## THE MANGANUI O TE AO RIVER

The Manganui o te Ao River originates on the western slopes of Mt. Ruapehu in the central North Island of New Zealand. It is regarded as one of the best trout fishing rivers in the North Island and for most of its length, the Manganui o te Ao flows through deep gorges and is inaccessible by foot. The Manganui o te Ao River is important from a conservation point of view for its population of the endangered blue duck (*Hymenolaimus malacorhynchos*) and is protected by a National Water Conservation Order. This duck species is restricted mainly to fast-flowing and turbulent rivers and streams in forested hill country and mountains. Numbers have declined significantly since European settlement due to land use change and introduced predators (Heather & Robertson, 1996). Predator control is conducted along the Manganui o te Ao River. Blue duck dabble, dive and up-end in swift white water to feed on aquatic invertebrates which make up most of their diet. They eat mostly caddisfly larvae, but also mayfly, stonefly, and chironomid larvae that they find on the downstream sides of stones and boulders. Occasionally they take emerging adult insects on the surface as well as some algae and fruit (Heather & Robertson, 1996).

## RATIONALE AND AIM

Given the importance of the Manganui o te Ao River to blue duck there is concern to what the impacts of the invasive algae, *Didymosphenia geminata* would have on duck populations. There is the potential that this alga, if introduced to the Manganui o te Ao River, would alter the benthic macroinvertebrate community and thus impact on the blue duck diet. The aim of this biosurvey was to obtain a snapshot of the periphyton and benthic macroinvertebrate communities at three sites along the Manganui o te Ao River. This will give a baseline or indication of the former community should *D. geminata* be introduced to the Manganui o te Ao River. In addition, the sampling of periphyton and macroinvertebrates from the three sites along the Manganui o te Ao River provided the opportunity to perform a bioassessment to determine if water quality changes along the river.

# Methods

## FIELD PROCEDURE

On April 25, 2008 three sites along the Manganui o te Ao River underwent a periphyton and macroinvertebrate bioassessment. Physicochemical measures were also taken. These sites or the general area of where a site was to be located were provided by the Department of Conservation. The location of each site was determined using NZMS 260 topographic maps and a Garmin Etrex Vista GPS unit. Spot measures of temperature, specific conductivity, pH and dissolved oxygen were recorded with Extech ExStik II handheld meters. The riparian characteristics, percentage of run/riffle/pool and substrate size were estimated visually. Water velocity was estimated at five points near where macroinvertebrates were sampled using a velocity head rod. Depths were measured near where the invertebrates were sampled. The Manganui o te Ao River was not safe to cross at the sites sampled thus width was estimated.

Periphyton was sampled by taking scrapings from several rocks using scalpels. At each site a total rock surface area of 50 $cm^2$ was sampled with all the samples being pooled. Periphyton samples were frozen as soon as possible and sent to NIWA for chlorophyll-*a*, ash-free dry weight (AFDW) and relative abundance analysis using the methodologies described in Biggs & Kilroy (2000).

Benthic macroinvertebrates were sampled by taking five Surber samples (0.1 $m^2$ area, 500 µm mesh size) at each site. Samples were preserved in iso-propyl alcohol and washed through a 500 µm sieve prior to sorting and identification. Macroinvertebrates were identified to the lowest possible level using Winterbourn (1973), Smith & Ward (2005) and Winterbourn, Gregson & Dolphin (2006). Chironomids were identified to sub-family were possible.

## ANALYSIS

The means of water depth and velocity were calculated. For the macroinvertebrates, total number of individuals and taxa, the percentage of Ephemeroptera, Plecoptera and Trichoptera (EPT) individuals and taxa, and the Macroinvertebrate Community Index (MCI) and its quantitative variant (QMCI) were calculated and site means (and standard deviations) derived. The EPT invertebrates are considered the taxa that are most 'sensitive' to stream degradation whilst the MCI and QMCI are biotic indices based on individual taxon tolerances to organic pollution (Boothroyd & Stark, 2000). For the algal samples, site means (and thus standard deviations) of total taxa, chlorophyll-*a* and ash-free dry weight could not be calculated since sub-samples were pooled on site.

# Results

## PHYSICOCHEMICAL

TABLE 1: SITE LOCATION DETAILS AND PHYSICOCHEMICAL PARAMETERS RECORDED AT THREE SAMPLING SITES ON THE MANGANUI O TE AO RIVER.

| SITE NUMBER | M1 (UPSTREAM) | M2 (MIDDLE) | M3 (DOWNSTREAM) |
|---|---|---|---|
| Site name | Manganui o te Ao @ Hoihenga Rd | Manganui o te Ao @ Ruatiti Domain | Manganui o te Ao @ Makakahi Rd (near road end) |
| NZMS 260 grid ref. | S20:047077 | S20:997081 | S20:926017 |
| Easting | 2704703 | 2699751 | 2692638 |
| Northing | 6207812 | 6208053 | 6201911 |
| Temperature | 10.0 °C at 12 pm | 10.9°C at 2 pm | 12.1°C at 3.30 pm |
| Specific conductivity | 96.7 µS/cm | 100.8 µS/cm | 97.6 µS/cm |
| pH | 6.80 | 7.40 | 7. 41 |
| Dissolved oxygen | 89.6% 8.41mg/L | 94.7% 8.40 mg/L | 98% 8.69 mg/L |
| Run/riffle/pool % | 0/0/0 (100% rapid) | 0/0/0 (100% rapid) | 0/70/0 (30% rapid) |
| Mean wetted width (range) | 25-40 m (non-wadeable) | 50-60 m (non-wadeable) | 60-70 m (non-wadeable) |
| Mean velocity (range) - only near Surber sites. | >1.00 m/s | 0.70 m/s (0.44 – 0.89 m/s) | 0.74 m/s (0.44 – 1.21 m/s) |
| Mean depth (range) - only near Surber sites. | 0.38 m (0.15 – 0.64 m) | 0.21 m (0.12 – 0.33 m) | 0.19 m (0.07 – 0.30 m) |
| Substrate size %: Boulders(>256 mm)/ Large cobble (128-256 mm)/small cobble (64-128 mm)/gravel (2-64 mm)/sand silt (<2 mm) | 65/20/15/0/0 | 55/40/5/0/0 | 25/35/29/10/1 |
| Riparian character | Native trees and shrubs in steep sided gorge. | Cliff on one side with native scrub. Pasture and some trees in Domain. | Steep cliffs with native scrub. Some pasture and pine forest. |

The sampling reaches at all sites were highly oxygenated and swift with a substrate of predominantly large cobbles and boulders (Table 1, Fig. 1-4). The upstream and middle sites were mostly rapids. The specific conductivity was similar at all sites (Table 1). The cliffs at all sites were covered in predominantly native scrub (Fig. 1-4).

FIGURE 1: THE UPSTREAM MOST SAMPLING SITE ON THE MANGANUI O TE AO (M1) RIVER LOOKING UPSTREAM FROM THE HOIHENGA ROAD BRIDGE.

FIGURE 2: THE UPSTREAM MOST SAMPLING SITE ON THE MANGANUI O TE AO (M1) RIVER FACING UPSTREAM. NOTE THE LARGE BOULDER SUBSTRATE.

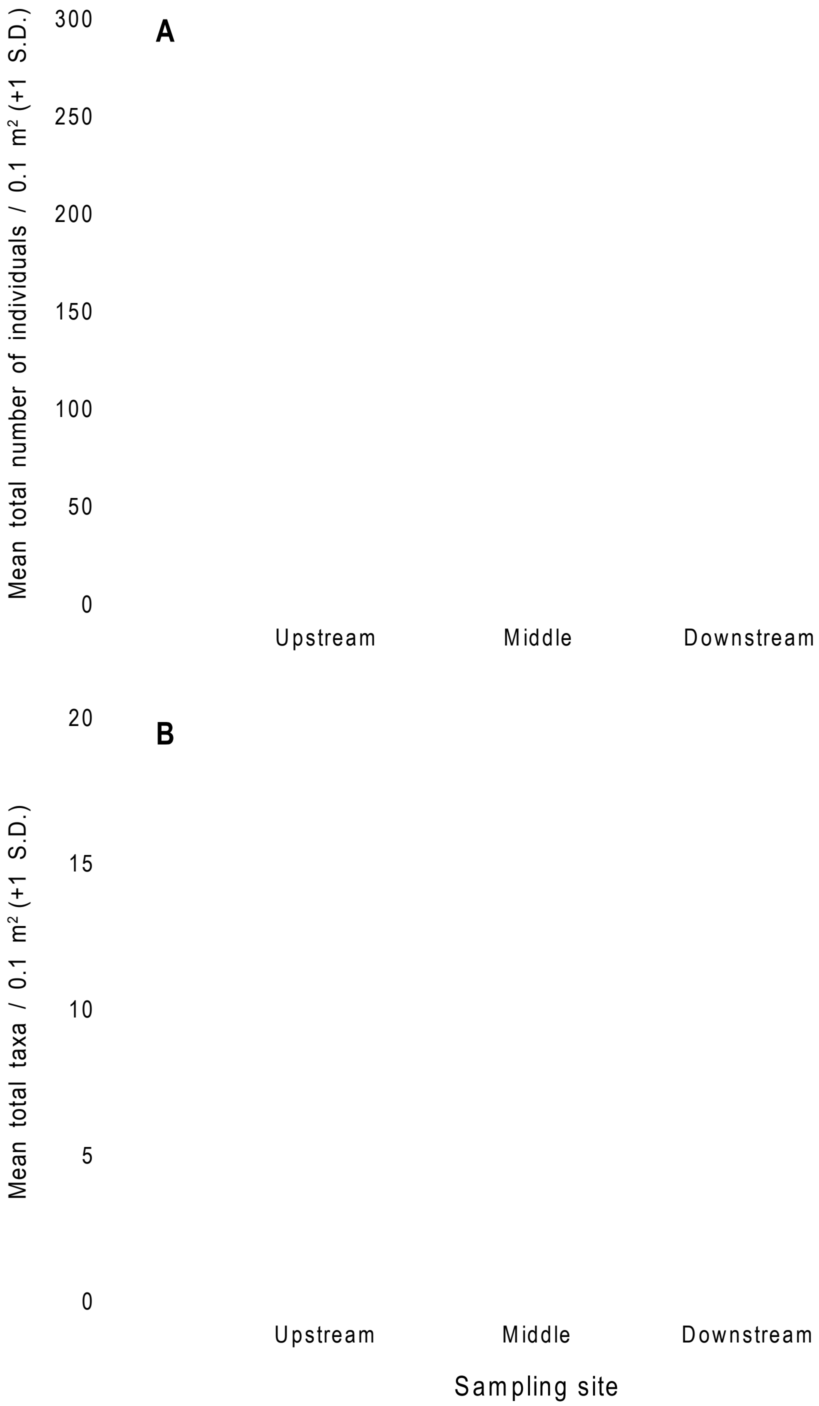
FIGURE 3: THE MIDDLE SAMPLING SITE ON THE MANGANUI O TE AO RIVER (M2) FACING UPSTREAM.

FIGURE 4: THE DOWNSTREAM MOST SAMPLING SITE ON THE MANGANUI O TE AO (M3) FACING UPSTREAM. THIS SITE IS APPROXIMATELY 15 KM UPSTREAM FROM THE MANGANUI O TE AO RIVER - WHANGANUI RIVER CONFLUENCE.

## MACROINVERTEBRATES

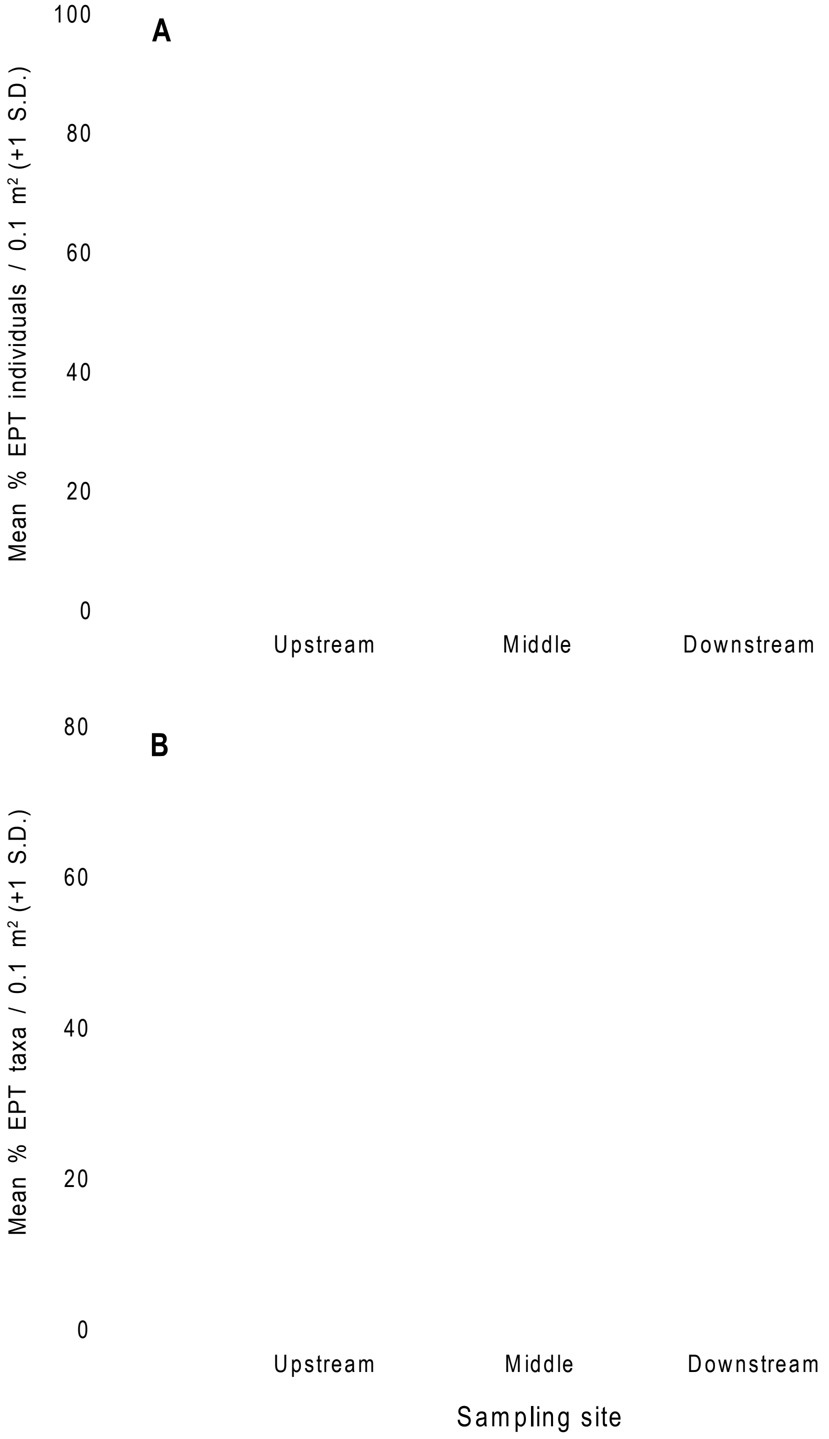
The density of macroinvertebrates was least at the middle site sampled (Fig. 5A). The diversity of macroinvertebrates was greatest at the downstream most site (Fig. 5B). A total of 34 taxa were found in the benthic samples (Table 2).

FIGURE 5: THE MEAN TOTAL NUMBER OF MACROINVERTEBRATE INDIVIDUALS (A) AND TOTAL MACROINVERTEBRATE TAXA (B) PER 0.1 M$^2$ (+ 1 STANDARD DEVIATION) FOR THREE SITES ON THE MANGANUI O TE AO RIVER.



There was a decline in the percentage of EPT individuals from upstream to downstream (Fig. 6A). The percentage of EPT taxa was similar at the upper and middle sites but much lower at the downstream most site (Fig. 6B).

FIGURE 6: THE MEAN PERCENTAGE OF EPT INDIVIDUALS (A) AND PERCENTAGE OF EPT TAXA (B) PER 0.1 M² (+ 1 STANDARD DEVIATION) FOR THREE SITES ON THE MANGANUI O TE AO RIVER.



Water quality as measured by the macroinvertebrate community index (MCI) and its quantitative variant (QMCI) declines from 'clean water' at the upstream site to 'probable moderate pollution' (MCI) and 'probable severe pollution' (QMCI) at the downstream most site (Fig. 7A, B).

FIGURE 7: THE MEAN MCI (A) AND QMCI (B) (+ 1 STANDARD DEVIATION) AT THREE SITES ON THE MANGANUI O TE AO RIVER. THE INTERPRETATION CATEGORIES ARE SHOWN.

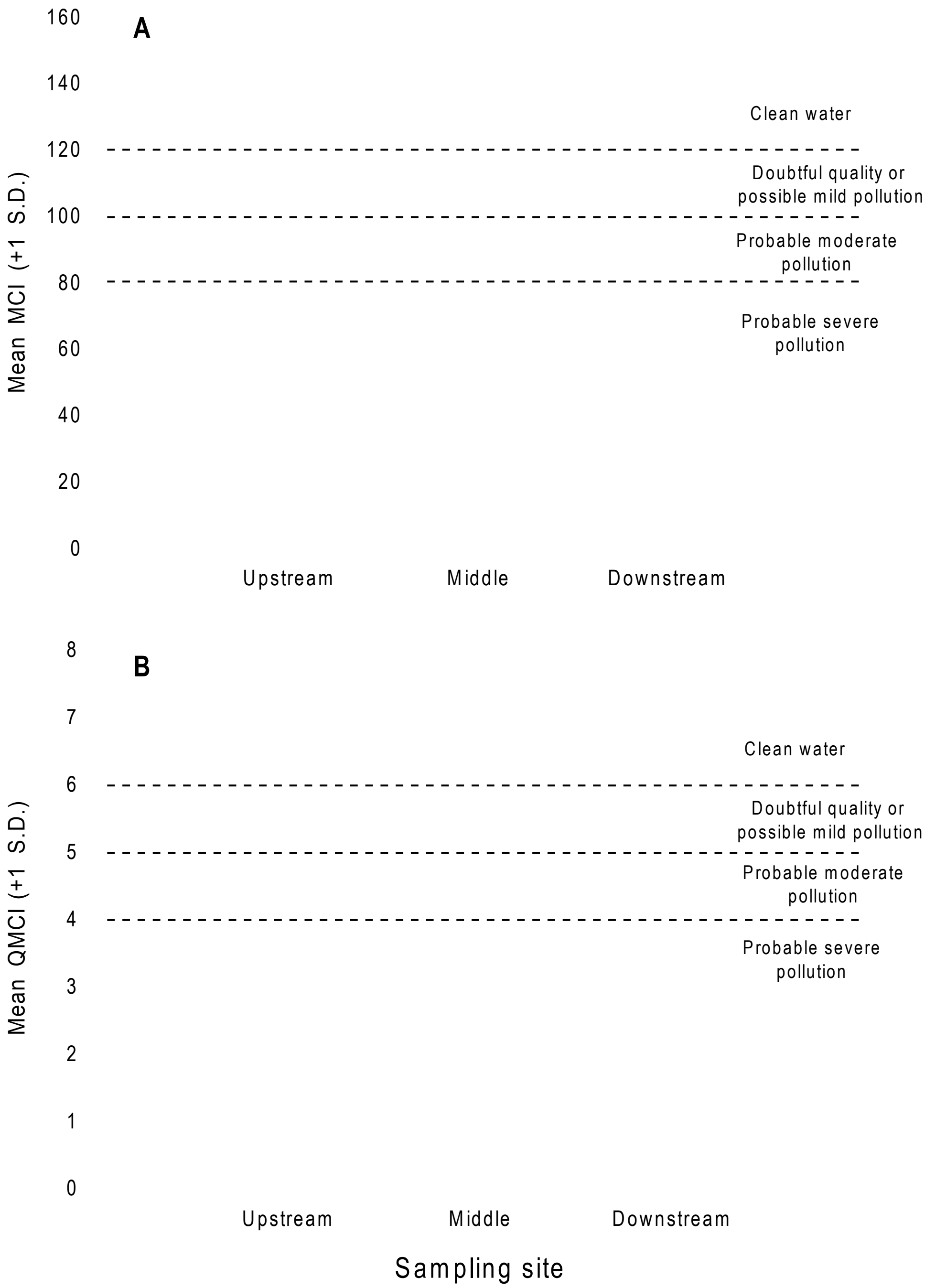


TABLE 2: INVENTORY AND ABUNDANCE (WITH MEAN) OF THE BENTHIC MACROINVERTEBRATE TAXA COLLECTED IN FIVE 0.1 $M^2$ SURBER SAMPLES AT THREE SITES (M1 – UPSTREAM, M2 - MIDDLE, M3 – DOWNSTREAM) ALONG THE MANGANUI O TE AO RIVER.

| TAXON | | M1 A | M1 B | M1 C | M1 D | M1 E | UPSTREAM MEAN | M2 A | M2 B | M2 C | M2 D | M2 E | MIDDLE MEAN | M3 A | M3 B | M3 C | M3 D | M3 E | DOWNSTREAM MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ephemeroptera | *Austroclima sepia* | 0 | 0 | 0 | 1 | 0 | 0.2 | 0 | 3 | 2 | 3 | 4 | 2.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *Coloburiscus humeralis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.2 |
| | *Deleatidium* sp. | 0 | 0 | 1 | 2 | 0 | 0.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *Nesameletus* sp. | 1 | 0 | 0 | 3 | 2 | 1.2 | 0 | 1 | 1 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Plecoptera | *Zelandobius* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.2 |
| | *Zelandoperla* sp. | 10 | 1 | 0 | 0 | 2 | 2.6 | 0 | 0 | 2 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0 | 2 | 0.4 |
| Trichoptera | *Aoteapsyche* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.2 | 5 | 5 | 0 | 11 | 42 | 12.6 |
| | *Beraeoptera roria* | 20 | 5 | 105 | 53 | 96 | 55.8 | 1 | 3 | 1 | 5 | 2 | 2.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *Helicopsyche* sp. | 3 | 1 | 0 | 8 | 0 | 2.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *Hydrobiosis parumbripennis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0.4 | 0 | 2 | 0 | 0 | 4 | 1.2 |
| | *Hydrobiosis umbripennis* | 0 | 0 | 0 | 5 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *Neurochorema armstrongi* | 0 | 2 | 0 | 7 | 9 | 3.6 | 0 | 6 | 2 | 0 | 1 | 1.8 | 2 | 3 | 3 | 0 | 11 | 3.8 |
| | *Neurochorema confusum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *Olinga feredayi* | 0 | 0 | 1 | 0 | 5 | 1.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *Oxyethira albiceps* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0.6 | 1 | 0 | 0 | 1 | 1 | 0.6 |
| | *Pycnocentria evecta* | 1 | 0 | 0 | 0 | 2 | 0.6 | 0 | 0 | 0 | 0 | 5 | 1 | 2 | 1 | 0 | 0 | 0 | 0.6 |
| | *Pycnocentrodes* sp. | 0 | 0 | 8 | 23 | 40 | 14.2 | 0 | 1 | 4 | 3 | 5 | 2.6 | 1 | 5 | 1 | 3 | 5 | 3 |
| | *Zelolessica* sp. | 0 | 0 | 0 | 0 | 1 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Diptera | *Aphrophila* sp. | 0 | 0 | 0 | 0 | 3 | 0.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | *Austrosimulium* sp. | 0 | 0 | 0 | 1 | 0 | 0.2 | 0 | 0 | 0 | 1 | 0 | 0.2 | 0 | 1 | 0 | 0 | 0 | 0.2 |
| | Empididae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 3 | 0.6 |
| | Eriopterini | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 1 | 1 |
| | Diamesinae | 0 | 10 | 10 | 14 | 35 | 13.8 | 0 | 5 | 0 | 0 | 0 | 1 | 2 | 5 | 7 | 4 | 31 | 9.8 |
| | Muscidae | 0 | 0 | 0 | 0 | 1 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0.4 |

| TAXON | | M1 A | M1 B | M1 C | M1 D | M1 E | UPSTREAM MEAN | M2 A | M2 B | M2 C | M2 D | M2 E | MIDDLE MEAN | M3 A | M3 B | M3 C | M3 D | M3 E | DOWNSTREAM MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diptera | Orthocladiinae | 6 | 24 | 4 | 25 | 10 | 13.8 | 0 | 6 | 4 | 1 | 2 | 2.6 | 39 | 42 | 70 | 22 | 51 | 44.8 |
| | Tanytarsini | 0 | 0 | 0 | 14 | 9 | 4.6 | 7 | 23 | 14 | 10 | 21 | 15 | 4 | 13 | 44 | 11 | 93 | 33 |
| Coleoptera | Elmidae | 0 | 1 | 0 | 5 | 28 | 6.8 | 0 | 0 | 0 | 1 | 0 | 0.2 | 64 | 50 | 0 | 4 | 4 | 24.4 |
| Megaloptera | *Archichauliodes diversus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 1 | 0 | 4 | 8 | 3.8 |
| Mollusca | *Ferrissia* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 29 | 2 | 4 | 0 | 9.8 |
| | *Potamopyrgus anitpodarum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57 | 14 | 1 | 28 | 14 | 22.8 |
| Acarina | 0 | 0 | 1 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Nemertea | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 0.8 | |
| Oligochaete | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 3 | 2 | 2 | 2.8 | |
| Platyhelminthes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 2 | 0 | 0 | 2 | 2 | |

## ALGAE

Only two algal taxa were present at the upstream most site. Algal diversity was greatest at the middle site with the diatom *Encyonema prostratum* being the dominant taxon. While the diatoms *Epithemia adnata* and *Synedra ulna* were abundant at the downstream most site, the algal community there was dominated by the filamentous green algae, *Spirogyra* spp (Table 3).

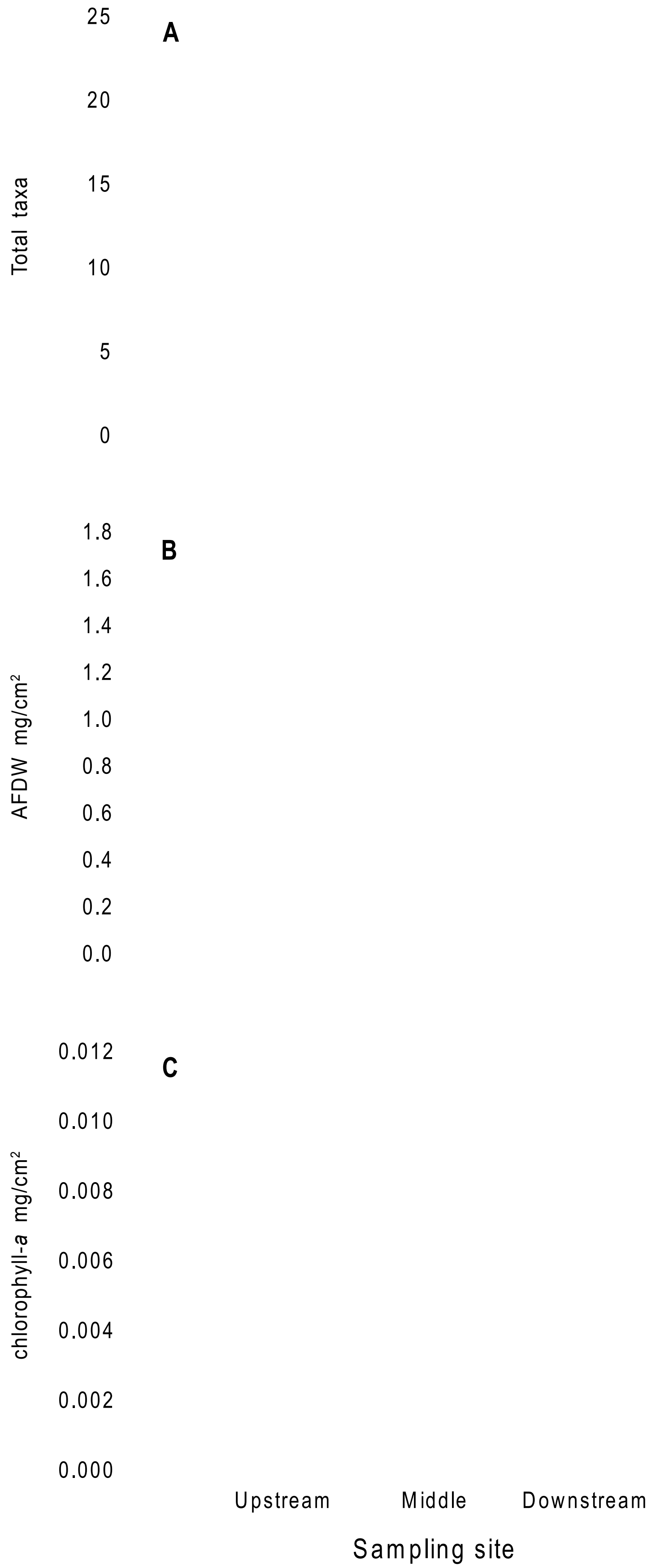
TABLE 3: THE RELATIVE ABUNDANCE SCORES OF ALGAL TAXA AT THREE SITES ON THE MANGANUI O TE AO RIVER.

| RELATIVE ABUNDANCE | | UPSTREAM | MIDDLE | DOWNSTREAM |
|---|---|---|---|---|
| Green filaments | *Cladophora* spp. | | 3 | |
| | *Spirogyra* spp. | | 4 | 8 |
| Green (Non filamentous) | Little green balls/ colonies/mats | | 3 | |
| Diatoms | *Cocconeis pediculus* | | 3 | |
| | *Cocconeis placentula* | | 1 | |
| | *Diatoma* cf. *tenuis* | | 4 | 5 |
| | *Diatoma vulgaris* | 3 | | |
| | *Encyonema* cf. *minutissimum* | | 3 | 3 |
| | *Encyonema prostratum* | | 8 | 6 |
| | *Epithemia adnata* | | 5 | 7 |
| | *Epithemia sorex* | | 3 | 4 |
| | *Gomphoneis minuta* var. *cassieae* | | 3 | 5 |
| | *Melosira varians* | | 4 | 5 |
| | *Navicula* cf. *cryptocephala* | | 3 | |
| | *Navicula* spp.(small 40x10μm) | | 2 | 2 |
| | *Navicula* cf. *lanceolata* | | 4 | |
| | *Nitzschia* (fine) | | 3 | 3 |
| | *Rhoicosphenia curvata* | 1 | 4 | |
| | *Rhopalodia novaezealandiae* | | 1 | |
| | *Synedra ulna* var. *ramesi* | | 3 | 3 |
| | *Synedra ulna* | | 4 | 7 |
| Cyanobacteria | B/G tufty/sheets | | 2 | |

Relative abundance score interpretation
8 Dominant
7 Abundant
6 Common – abundant
5 Common
4 Occasional – common
3 Occasional
2 Rare – occasional
1 Rare

Compared to the middle and downstream most sites, few algal taxa were identified at the upstream most site (Fig. 8A). Algal biomass measured as ash free dry weight (Fig. 8B) and chlorophyll-*a* (Fig. 8C) increased from upstream to downstream.

FIGURE 8: THE NUMBER OF ALGAL TAXA (A) AND ALGAL BIOMASS MEASURED AS AFDW (B) AND CHLOROPHYLL-A (C) FROM POOLED ALGAL SCRAPING SAMPLES (TOTAL AREA SAMPLED: 0.50 CM²).



# Conclusion

- The water at all sampling sites was swift and highly oxygenated. The substrate at all sites was predominantly boulders and large cobbles (128 mm to >256 mm). For much of its length the Manganui a te Ao River flows through deep gorges making access and sampling difficult. Sampling of macroinvertebrates and algae were especially difficult at the upstream most site where the substrate size and swift water only allowed sampling near the edges. This must be taken into account when interpreting the results.
- The middle site had the lowest density of invertebrates while the downstream most site had the highest diversity of invertebrates. The percentage of EPT individuals declined from around 60% upstream to 10% at the downstream most site. The percentage of EPT taxa was similar at the upper and middle sites (~60%) and was least at the downstream most site (~25%).
- Water quality as measured by the MCI and QMCI indicated a change from 'clean water' at the upstream site to 'probable moderate pollution' and 'probably severe pollution' at the downstream most site. This is mirrored by the decline in the more sensitive EPT individuals and taxa observed.
- Only two species of diatom were found in algal samples at the upstream most site. Diatoms dominated the community at the middle site while a filamentous green alga was the dominant taxon at the downstream most site. Algal biomass measured as chlorophyll-*a* and ash-free dry weight increased from upstream to downstream.
- Overall, the longitudinal change in algae biomass and macroinvertebrate assemblage observed in the Manganui o te Ao River is typical of numerous New Zealand rivers where land use changes lead to a decline in water quality from headwaters to the river mouth. Additionally, volcanic sediments may have some impact.
- It is recommended this biosurvey is repeated at least three more times to get an indication of any seasonal variation in algal and benthic macroinvertebrate communities.

# Acknowledgements

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