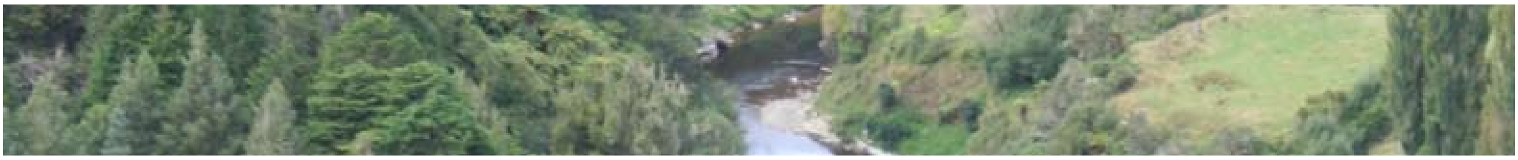

A biosurvey of the benthic macroinvertebrates and algae of the Retaruke River

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CONTENTS

Executive summary

- The Retaruke River, originating in the hill country to the west 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 Retaruke River, the food supply for blue ducks may be impacted.
- This report is a biosurvey of algae and macroinvertebrates at three sites along the Retaruke 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.
- Macroinvertebrate density and the proportion of more sensitive taxa were greatest at the upstream most site and declined downstream.
- Diatoms dominated in terms of algal relative abundance at the upstream site while filamentous green algae dominated at the middle and downstream sites.
- 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.
- It is suggested that this biosurvey is repeated at least three more times to give an indication of any seasonal variation.

Introduction

THE RETARUKE RIVER

The Retaruke River originates in the hill country to the west of Mt. Ruapehu in the central North Island of New Zealand. It flows through the farming communities of the Retaruke Valley before joining the Whanganui River at Whakahoro. The Retaruke River is important from a conservation point of view for its population of the endangered blue duck (*Hymenolaimus malacorhynchos*). 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). Currently, predator control operations are being carried out on some sections of the Retaruke 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 Retaruke 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 Retaruke 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 Retaruke River. This will give a baseline or indication of the former community should *D. geminata* be introduced to the Retaruke River. In addition, the sampling of periphyton and macroinvertebrates from the three sites along the Retaruke River provided the opportunity to perform a bioassessment to determine if water quality changes along the river.

Methods

FIELD PROCEDURE

On April 26, 2008 three sites along the Retaruke 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. Wetted width was measured at five transects with a tape measure and along each transect water depth was measured at five equal increments with a ruler. Water velocity was estimated using a velocity head rod at five points near where macroinvertebrates were sampled.

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 and 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 wetted width, 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	Retaruke @ Power Road	Retaruke @ Pukeatua Road	Retaruke @ Whakahoro
NZMS 260 grid ref.	S19:071219	S19:012349	R19:897307
Easting	2707093	2701233	2689721
Northing	6222104	6235196	6230853
Temperature	9°C at 10 am	12.4°C at 11.30 am	14.5°C at 1.50 pm
Specific conductivity	139 µS/cm	168.4 µS/cm	172.1 µS/cm
pH	7.17	7.65	7.77
Dissolved oxygen	94.1% 8.6mg/L	100% 8.7 mg/L	91.3% 7.93 mg/L
Run/riffle/pool %	15/80/5	20/70/10	20/80/0
Mean wetted width (range)	12.24 m (11.00 – 13.40 m)	22.02 m (20.10 – 24.40 m)	23.74 m (18.40 – 28.50 m)
Mean velocity (range)	0.72 m/s (0.44 – 0.89 m/s)	0.84 m/s (0.09 – 0.40 m)	1.10 m/s (0.89 – 1.25 m/s)
Mean depth (range)	0.22 m (0.09 – 0.34 m)	0.25 m (0.12 – 0.33 m)	0.24 m (0.11 – 0.44 m)
Substrate size %: Boulders(>256 mm)/ Large cobble (128-256 mm)/small cobble (64-128 mm)/gravel (2-64 mm)/sand silt (<2 mm)	10/50/30/10/0	1/48/40/10/1 (some bedrock visible)	1/30/48/20/1
Riparian character	In a reserve with native forest on both sides.	Cliff on far bank. Willows, some native scrub and pasture. Cattle have access to river.	Cliffs either side with a mix of native and exotic vegetation.

The sampling reaches at all sites were highly oxygenated and swift with a substrate of predominantly small and large cobbles. The depth of the sampled areas was similar at all the sites while specific conductivity increased from upstream to downstream (Table 1). The upstream most site was in a reserve with native forest on both banks (Fig. 1) while stock had access to the middle site (Fig. 2). The downstream most site at Whakahoro had steep banks on both sides with a mix of native and exotic scrub (Fig. 3 and 4).

FIGURE 1: THE UPSTREAM MOST SAMPLING SITE ON THE RETARUKE RIVER (R1) FACING UPSTREAM. A BLUE DUCK PAIR WAS SIGHTED HERE.

FIGURE 2: THE MIDDLE SAMPLING SITE ON THE RETARUKE RIVER (R2) FACING UPSTREAM. CATTLE WERE PRESENT ON BOTH SIDES ON THE RIVER HERE.

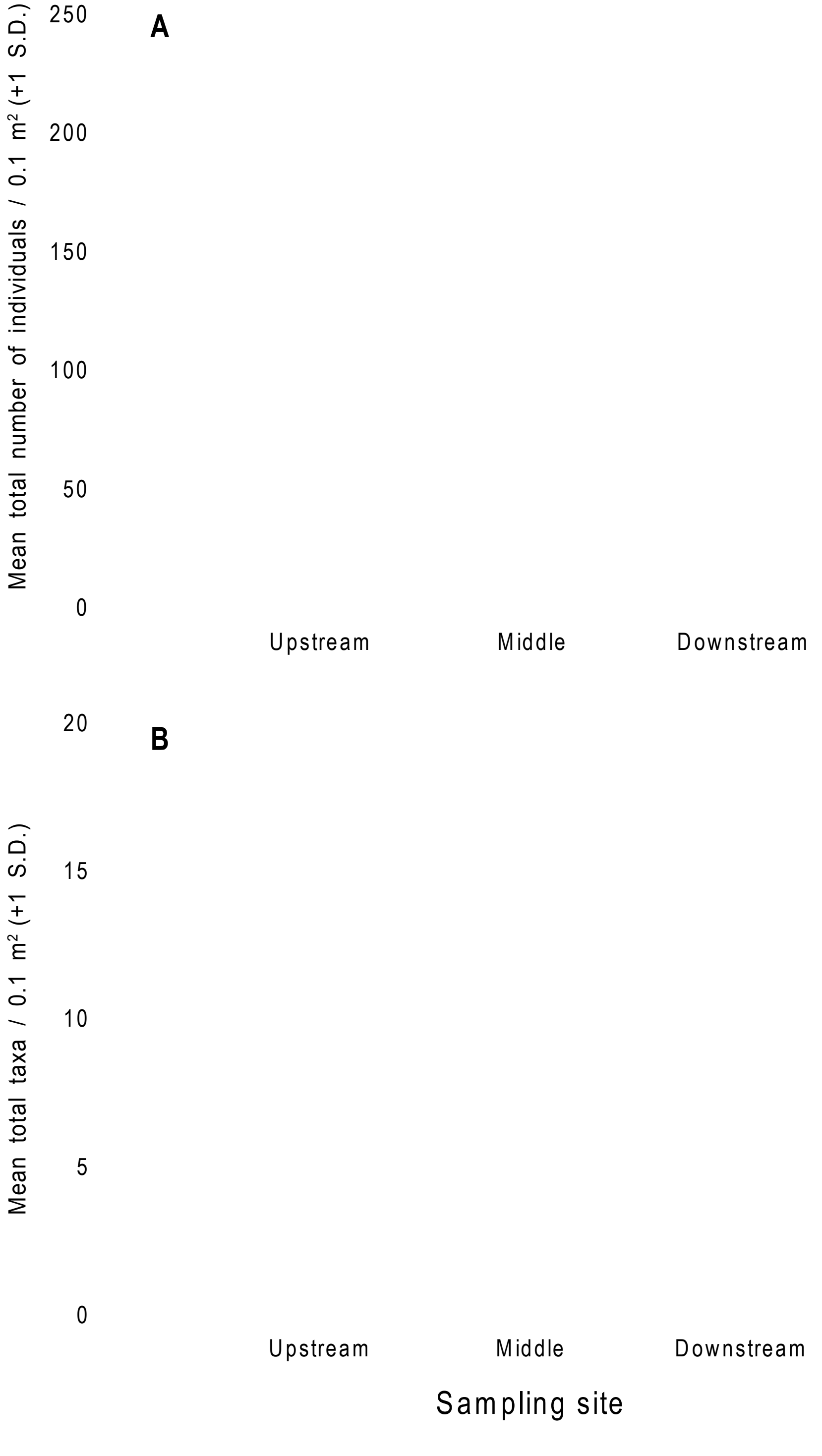
FIGURE 3: THE DOWNSTREAM MOST SAMPLING SITE ON THE RETARUKE RIVER (R3) FACING UPSTREAM. THIS SITE WAS JUST UPSTREAM OF THE WHAKAHORO BOAT RAMP.

FIGURE 4: THE DOWNSTREAM MOST SAMPLING SITE ON THE RETARUKE RIVER (R3) FACING DOWNSTREAM. A SHORT DISTANCE AROUND THE BEND IS THE RETARUKE RIVER - WHANGANUI RIVER CONFLUENCE.

MACROINVERTEBRATES

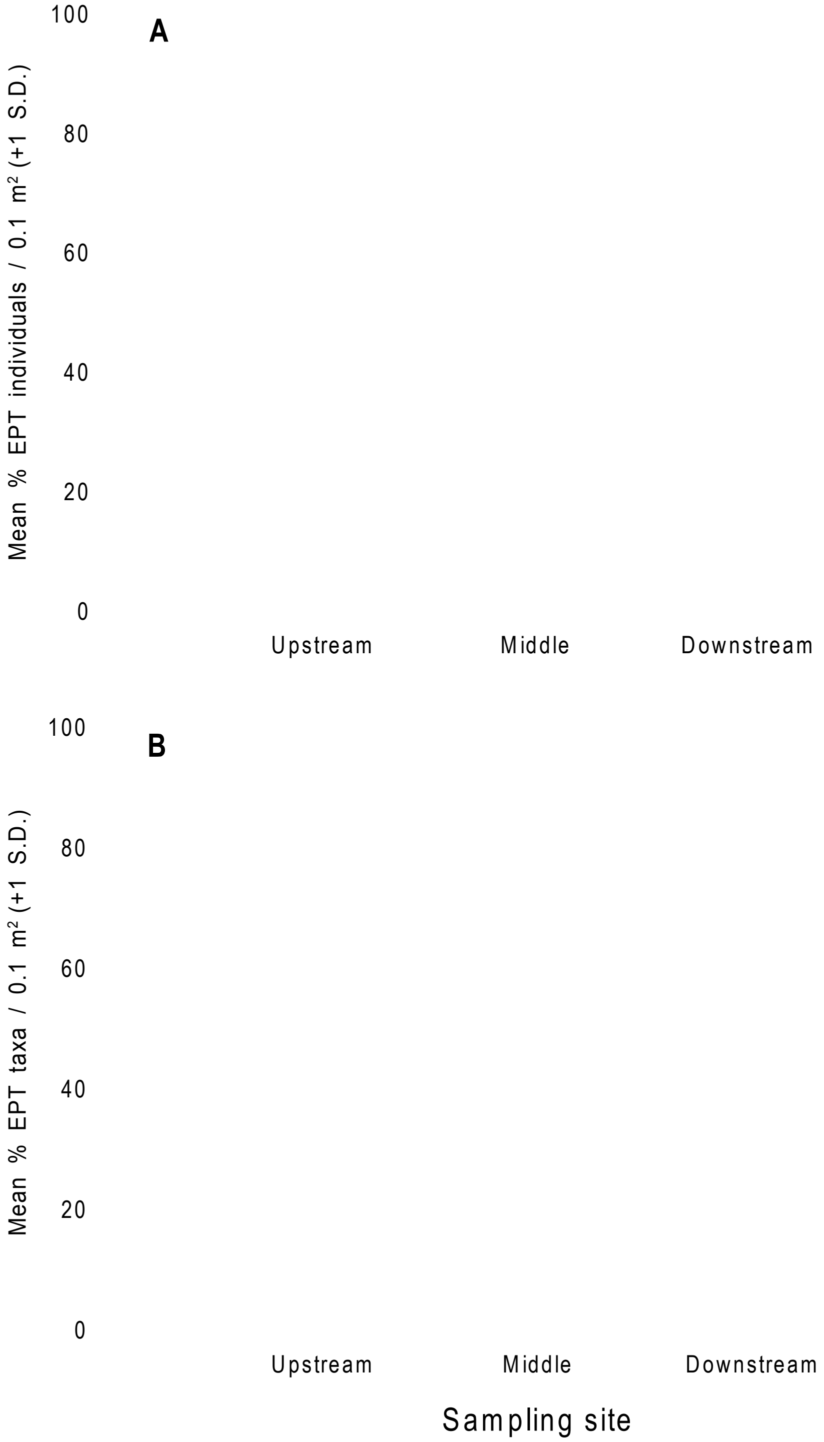
The density of macroinvertebrates decreases from upstream to downstream in the Retaruke River (Fig. 5A). The diversity of macroinvertebrates was similar at all three sites (Fig. 5B). A total of 40 taxa were found in the benthic samples (Table 2).

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 RETARUKE RIVER.



The upstream most site was dominated by EPT; both individuals and taxa (Fig. 6A, B). This dominance decreased from upstream to downstream sites sampled on the Retaruke River.

FIGURE 6: THE MEAN PERCENTAGE OF EPT INDIVIDUALS (A) AND PERCENTAGE OF EPT TAXA (B) PER 0.1 M^2 (+ 1 STANDARD DEVIATION) FOR THREE SITES ON THE RETARUKE 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' 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 RETARUKE RIVER. THE INTERPRETATION CATEGORIES ARE SHOWN.

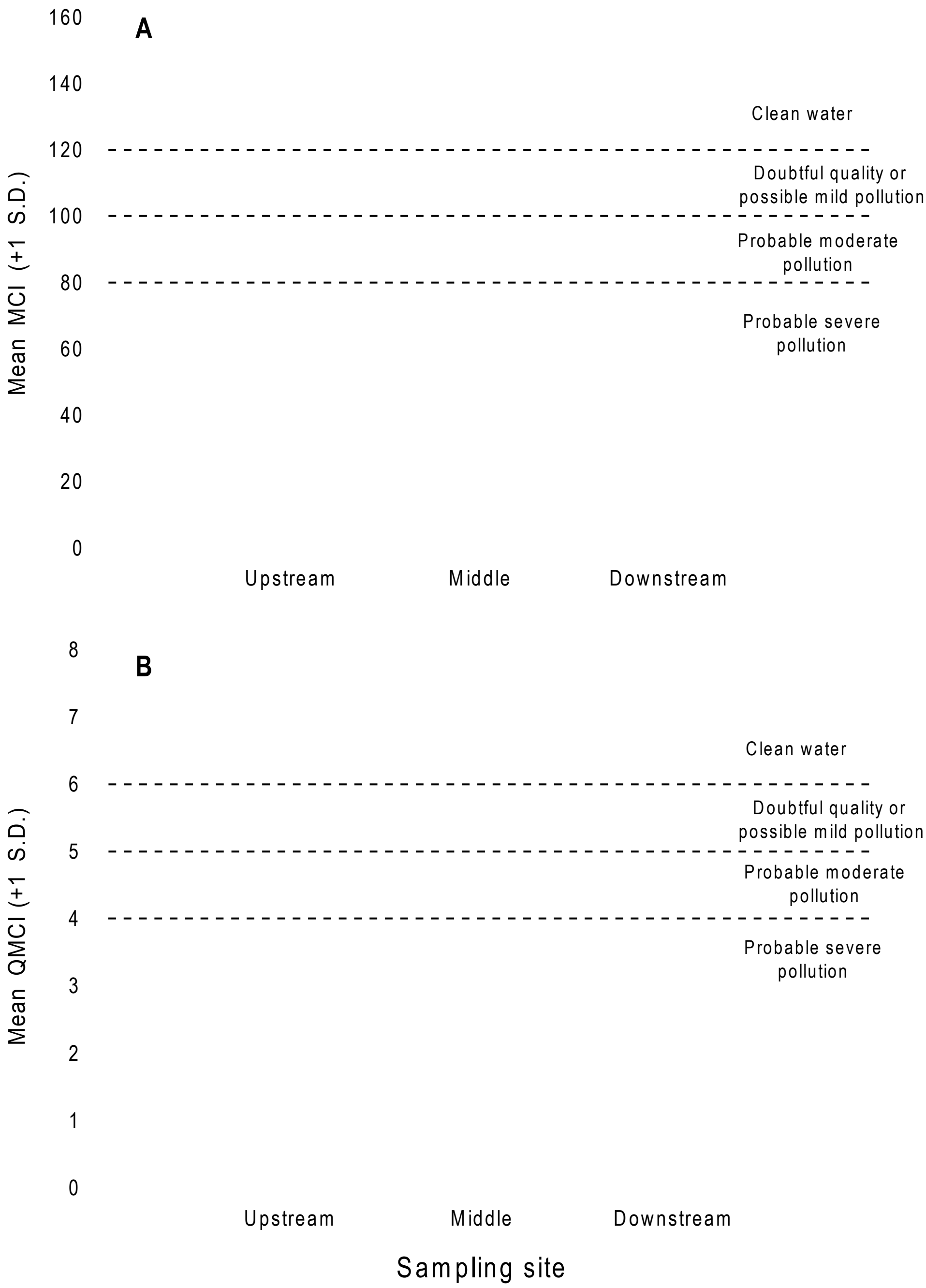


TABLE 2: INVENTORY AND ABUNDANCE (WITH MEAN) OF THE BENTHIC MACROINVERTEBRATE TAXA COLLECTED IN FIVE 0.1 M^2 SURBER SAMPLES AT THREE SITES (R1 – UPSTREAM, R2 - MIDDLE, R3 – DOWNSTREAM) ALONG THE RETARUKE RIVER.

TAXON		R1 A	R1 B	R1 C	R1 D	R1 E	UPSTREAM MEAN	R2 A	R2 B	R2 C	R2 D	R2 E	MIDDLE MEAN	R3 A	R3 B	R3 C	R3 D	R3 E	DOWNSTREAM MEAN
Ephemeroptera	*Austroclima sepia*	1	0	0	0	0	0.2	0	0	1	1	12	2.8	0	0	0	0	2	0.4
	Coloburiscus humeralis	3	11	1	0	0	3	5	1	2	1	16	5	0	1	0	1	1	0.6
	Deleatidium sp.	40	43	25	7	16	26.2	9	10	2	1	15	7.4	0	0	0	0	0	0
	Neozephlebia scita	0	0	0	1	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0
	Nesameletus sp.	1	0	5	0	0	1.2	0	0	0	0	0	0	0	0	0	0	0	0
	Zephlebia dentata	0	0	0	0	0	0	0	0	1	0	3	0.8	0	0	0	0	0	0
Plecoptera	*Zelandobius* sp.	1	0	0	0	0	0.2	0	0	1	0	0	0.2	1	1	0	1	0	0.6
	Zelandoperla sp.	11	23	7	3	8	10.4	0	1	2	0	1	0.8	0	0	0	0	0	0
Trichoptera	*Beraeoptera roria*	18	44	25	8	82	35.4	0	0	0	0	1	0.2	0	0	0	0	0	0
	Helicopsyche sp.	38	7	34	4	2	17	0	0	0	0	0	0	0	0	0	0	0	0
	Hudsonema amabile	2	0	2	0	0	0.8	0	0	2	0	4	1.2	0	1	0	0	0	0.2
	Olinga feredayi	18	32	15	2	0	13.4	0	1	2	1	5	1.8	0	3	0	0	0	0.6
	Pycnocentria evecta	0	0	0	0	0	0	0	0	0	2	3	1	0	1	0	1	0	0.4
	Pycnocentrodes sp.	8	18	23	3	17	13.8	4	7	1	10	87	21.8	0	0	0	0	2	0.4
	Aoteapsyche sp.	1	8	1	2	4	3.2	2	2	8	5	34	10.2	0	6	4	1	1	2.4
	Hydrobiosis clavigera	1	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0
	Hydrobiosis parumbripennis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.2
	Hydrobiosis styracine	0	1	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0
	Hydrobiosis umbripennis	2	4	0	1	0	1.4	2	2	3	5	5	3.4	0	1	0	0	0	0.2
	Neurochorema armstrongi	0	1	0	0	0	0.2	0	0	1	1	5	1.4	0	0	0	0	0	0
	Oxyethira albiceps	0	0	0	0	0	0	0	0	0	0	1	0.2	0	10	1	1	4	3.2
	Psilochorema sp.	0	0	0	0	0	0	1	0	0	0	0	0.2	0	0	0	0	0	0
Diptera	*Aphrophila* sp.	1	12	2	2	0	3.4	0	0	0	0	0	0	0	0	0	0	0	0
	Austrosimulium sp.	0	0	0	0	0	0	0	0	2	0	0	0.4	0	2	0	2	2	1.2

TAXON		R1 A	R1 B	R1 C	R1 D	R1 E	UPSTREAM MEAN	R2 A	R2 B	R2 C	R2 D	R2 E	MIDDLE MEAN	R3 A	R3 B	R3 C	R3 D	R3 E	DOWNSTREAM MEAN
Diptera	Empididae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0.2
	Eriopterini	0	0	0	0	0	0	0	0	0	3	6	1.8	0	1	0	1	0	0.4
	Diamesinae	1	4	0	0	0	1	0	0	5	0	2	1.4	0	1	0	1	0	0.4
	Muscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0.2
	Nothodixa	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0.2
	Orthocladiinae	8	17	1	0	0	5.2	1	1	10	3	2	3.4	4	10	2	9	6	6.2
	Tabanidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0.2
	Tanytarsini	0	0	0	1	0	0.2	0	0	6	0	6	2.4	0	9	0	2	4	3
Coleoptera	Elmidae	2	6	1	0	0	1.8	8	18	37	17	80	32	48	8	14	40	4	22.8
	Hydraenidae	3	1	0	0	0	0.8	0	0	0	0	1	0.2	0	0	0	0	0	0
Megaloptera	*Archichauliodes diversus*	3	1	0	0	0	0.8	0	0	0	0	9	1.8	0	6	1	1	1	1.8
Mollusca	*Latia neritoides*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2
	Physa acuta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.2
	Potamopyrgus antipodarum	10	0	0	0	0	2	3	3	0	1	8	3	5	7	5	6	4	5.4
Oligochaete		0	0	0	0	0	0	0	0	1	0	0	0.2	1	1	0	0	3	1
Platyhelminthes		0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	0	0	1

ALGAE

The upstream most site was dominated by diatoms with the species *Gomphoneis minuta* var. *cassieae* being the most abundant (Table 3). While a number of diatom taxa were present at the middle and downstream most sites, the algal community was dominated by the filamentous green algae, *Cladophora* spp (Table 3).

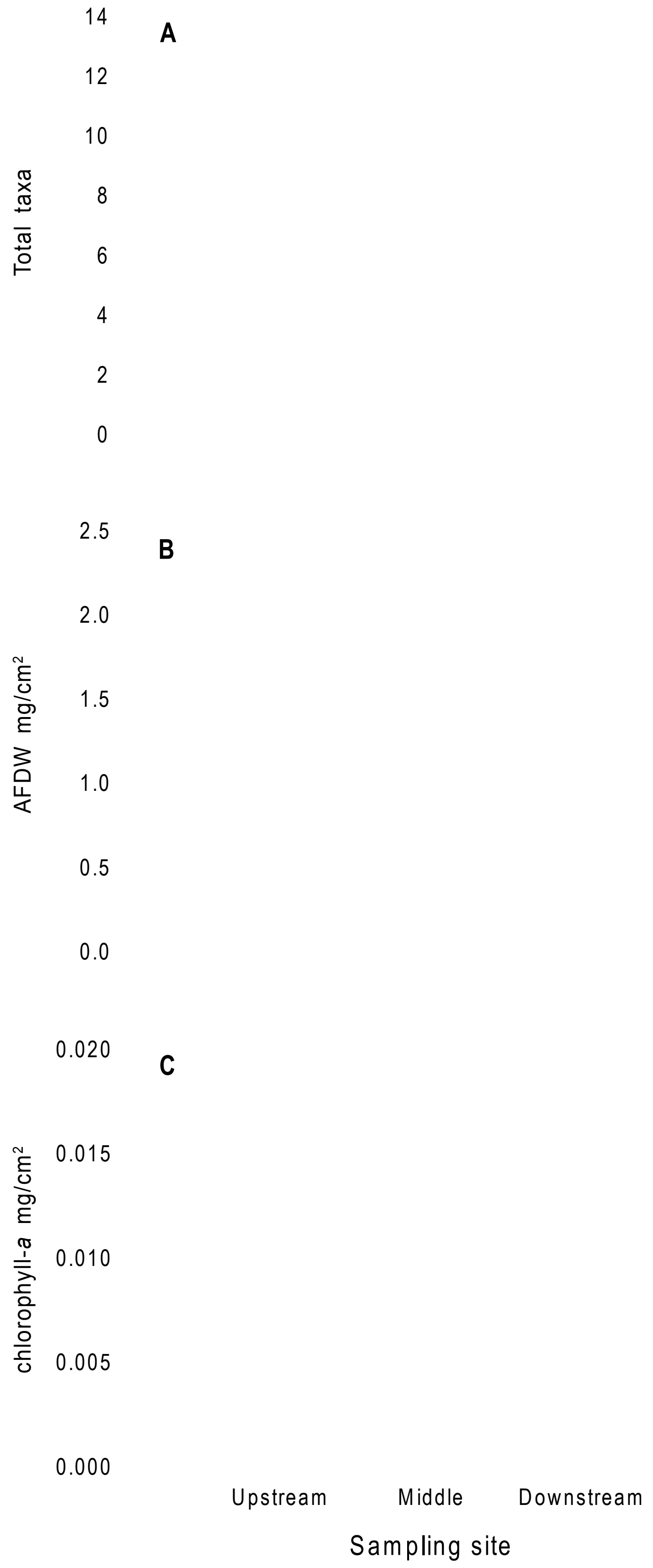
TABLE 3: THE RELATIVE ABUNDANCE SCORES OF ALGAL TAXA AT THREE SITES ON THE RETARUKE RIVER.

RELATIVE ABUNDANCE		UPSTREAM	MIDDLE	DOWNSTREAM
Green filaments	*Cladophora* spp.		8	8
	Spirogyra spp.	3		
Diatoms	*Cocconeis pediculus*		6	4
	Cocconeis placentula	2		
	Cymbella kappii	5		
	Cymbella cf. *tumida*	4		
	Diatoma vulgaris	4	5	6
	Encyonema cf. *minutissimum*	3		
	Encyonema prostratum	4		
	Epithemia adnata	3		
	Epithemia sorex		4	4
	Gomphoneis minuta var. *cassieae*	8	4	4
	Gomphonema (small)	4	3	3
	Melosira varians	4	4	3
	Navicula spp.(small 40x10μm)		2	
	Rhoicosphenia curvata		2	3
	Rhopalodia novaezealandiae			
	Rossithidium linearis		2	2
	Synedra ulna var. *ramesi*		3	4
	Synedra ulna	3	4	5
Cyanobacteria	B/G tufty/sheets	3		

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

The number of algal taxa present was similar at all three sites (Fig. 8A). Algal biomass measured as ash free dry weight (Fig. 8B) or 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 CM^2).



Conclusion

- The water at all sampling sites was swift and highly oxygenated. The substrate at all sites was predominantly small and large cobbles (64 – 256 mm). Specific conductivity increased from upstream to downstream probably resulting from the cumulative effect of land use change from forest to farm land.
- The upper site had the greatest density of invertebrates and was dominated by the EPT taxa that make up most of the blue duck diet. Invertebrate density and EPT proportions declined downstream. The total taxa was similar at all sites.
- Water quality as measured by the MCI and QMCI indicated a change from 'clean water' at the upstream site to 'probable moderate pollution' at the downstream most site. This is mirrored by the decline in the more sensitive EPT individuals and taxa observed.
- The algal community changed from one dominated by diatoms at the upstream site to one dominated by filamentous algae at the middle and downstream sites. Algal biomass measured as chlorophyll-*a* and ash-free dry weight increased from upstream to downstream.
- Overall, the longitudinal change in algae and macroinvertebrates observed in the Retaruke 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.
- 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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