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

An April - November 2008 comparison

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Cover photo: The upstream site sampled on 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 Retatuke River with sampling undertaken in April and November 2008. 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. The QMCI score at the downstream site was below the minimum score suggested in the Proposed One Plan on both sampling occasions.
- Diatoms (April) or cyanobacteria (November) 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.

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. In April 2008, a biosurvey (James, 2008) was completed to obtain a snapshot of the periphyton and benthic macroinvertebrate communities at three sites along the Retaruke River. This was repeated in November 2008 and compared to the results from April to get an idea of any seasonal effects. These biosurveys will give a baseline or indication of the former community should *D. geminata* be introduced to the Retaruke River. This 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. In addition, water samples were taken in November and analysed for bio-available phosphorus and nitrogen.

Methods

FIELD PROCEDURE

On November 16, 2008 three sites along the Retaruke River underwent a periphyton and macroinvertebrate bioassessment (Figure 1), repeating the procedure undertaken on April 26, 2008. 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 and depth was estimated using a velocity head rod at five points near where macroinvertebrates were sampled.

Periphyton was sampled by taking scrapings from four cm diameter circles from four rocks using scalpels. Rocks from close proximity to the invertebrate sampling points were randomly selected. 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).

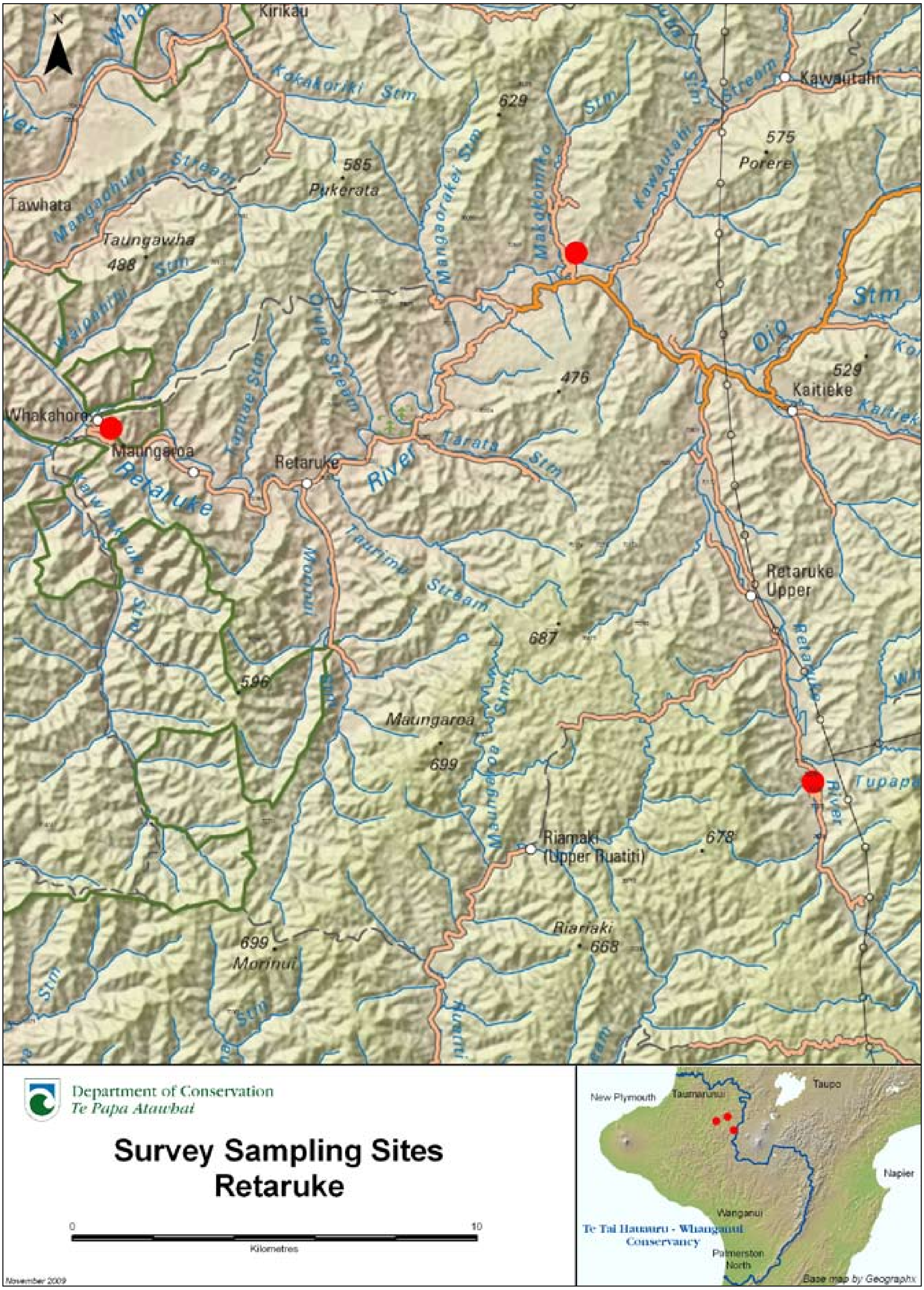
Benthic macroinvertebrates were sampled by taking five Surber samples (0.1 m^2 area, 500 µm mesh size) at each site. Samples were preserved in iso-propyl alcohol and washed through a 500 µm sieve prior to sorting and identification. Macroinvertebrates were identified to the lowest possible level using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

One litre water samples were taken at each site and chilled as soon as possible after collection. These were sent to R J Hill Laboratories Ltd in Hamilton for total ammoniacal-N, nitrate-N, nitrite-N (the composite of which is soluble inorganic nitrogen or SIN) and dissolved reactive phosphorus (DRP) analysis.

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.

FIGURE 1: THE THREE SITES ALONG THE RETARUKE RIVER THAT WERE SAMPLED FOR PERIPHYTON AND MACROINVERTEBRATES ON NOVEMBER 16, 2008.



Results

PHYSICOCHEMICAL

TABLE 1: SITE LOCATION DETAILS AND PHYSICOCHEMICAL PARAMETERS RECORDED AT THREE SAMPLING SITES ON THE RETARUKE RIVER IN APRIL AND NOVEMBER 2008. ALSO INCLUDED ARE THE RESULTS OF SUBSEQUENT WATER NUTRIENT ANALYSIS FROM SAMPLES TAKEN ON JANUARY 13 AND 23, AND FEBRUARY 19, 2009.

SITE NUMBER	R1 (UPSTREAM)	R2 (MIDDLE)	R3 (DOWNSTREAM)
Site name	Retaruke @ Power Rd (Fig. 2)	Retaruke @ Pukeatua Rd (Fig. 3)	Retaruke @ Whakahoro (Fig. 4 & 5)
NZMS 260 grid ref.	S19: 071219	S19: 012349	R19: 897307
Easting	2707093	2701233	2689721
Northing	6222104	6235196	6230853
Temperature	April: 9°C at 10 am November: 14.7°C at 9.20 am	April: 12.4°C at 11.30 am November: 18.7°C at 10.40 am	April: 14.5°C at 1.50 pm November: 19.4°C at 12 pm
Specific conductivity	April: 139 µS/cm November: 101.6 µS/cm	April: 168.4 µS/cm November: 128.9 µS/cm	April: 172.1 µS/cm November: 127.9 µS/cm
pH	April: 7.17 November: 7.01	April: 7.65 November: 7.30	April: 7.77 November: 7.04
Dissolved oxygen	April: 94.1% 8.6 mg/L November: 99.2% 9.94 mg/L	April: 100% 8.7 mg/L November: 104.3% 9.68 mg/L	April: 91.3% 7.93 mg/L November: 103.2% 9.37 mg/L
Soluble Inorganic Nitrogen (SIN)	November: 44 mg/m^3 January: 13: 19 mg/m^3 January: 23: 9.4 mg/m^3 February: 19 mg/m^3	November: 57 mg/m^3 January: 13: 18 mg/m^3 January: 23: < 2 mg/m^3 February: 13 mg/m^3	November: 36 mg/m^3 January: 13: 11 mg/m^3 January: 23: < 2 mg/m^3 February: 22 mg/m^3
Dissolved Reactive Phosphorus (DRP)	November: < 4 mg/m^3 January: 13: < 4 mg/m^3 January: 23: < 4 mg/m^3 February: 5 mg/m^3	November: < 4 mg/m^3 January: 13: 5.4 mg/m^3 January: 23: 5.7 mg/m^3 February: 50 mg/m^3	November: 5.7 mg/m^3 January: 13: 5.8 mg/m^3 January: 23: 5.6 mg/m^3 February: 11 mg/m^3
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) - only near Surber sites	April: 0.72 m/s (0.44 – 0.89 m/s) November: 0.67 m/s (0.49 – 0.80 m/s)	April: 0.84 m/s (0.63 – 1.21 m/s) November: 0.62 m/s (0.49 – 0.85 m/s)	April: 1.10 m/s (0.89 – 1.25 m/s) November: 0.81 m/s (0.57 – 1.06 m/s)
Mean depth (range) - only near Surber sites	April: 0.22 m (0.09 – 0.34 m) November: 0.22 m (0.17 – 0.27 m)	April: 0.25 m (0.09 – 0.40 m) November: 0.146 m (0.125 – 0.165 m)	April: 0.24 m (0.11 – 0.44 m) November: 0.199 m (0.11 – 0.28 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.	Cliffs 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 and pH was circum-neutral. Specific conductivity was least at the upstream site and was greater in April than in November (Table 1). No upstream – downstream pattern was observed for soluble inorganic nitrogen (SIN). Levels of SIN were higher in November than in January and February, however all samples were well below the maximum level recommended in the Proposed One Plan for the Retaruke River (110 mg/m^3) (Horizons Regional Council, 2007). Levels of dissolved reactive phosphorus (DRP) were below detection limits at the upstream most site except in February (Table 1). At the other sites sampled, levels are below the maximum recommended in the Proposed One Plan for the Retaruke River (10 mg/m^3) except for the February samples which had a particularly high DRP level at the middle site.

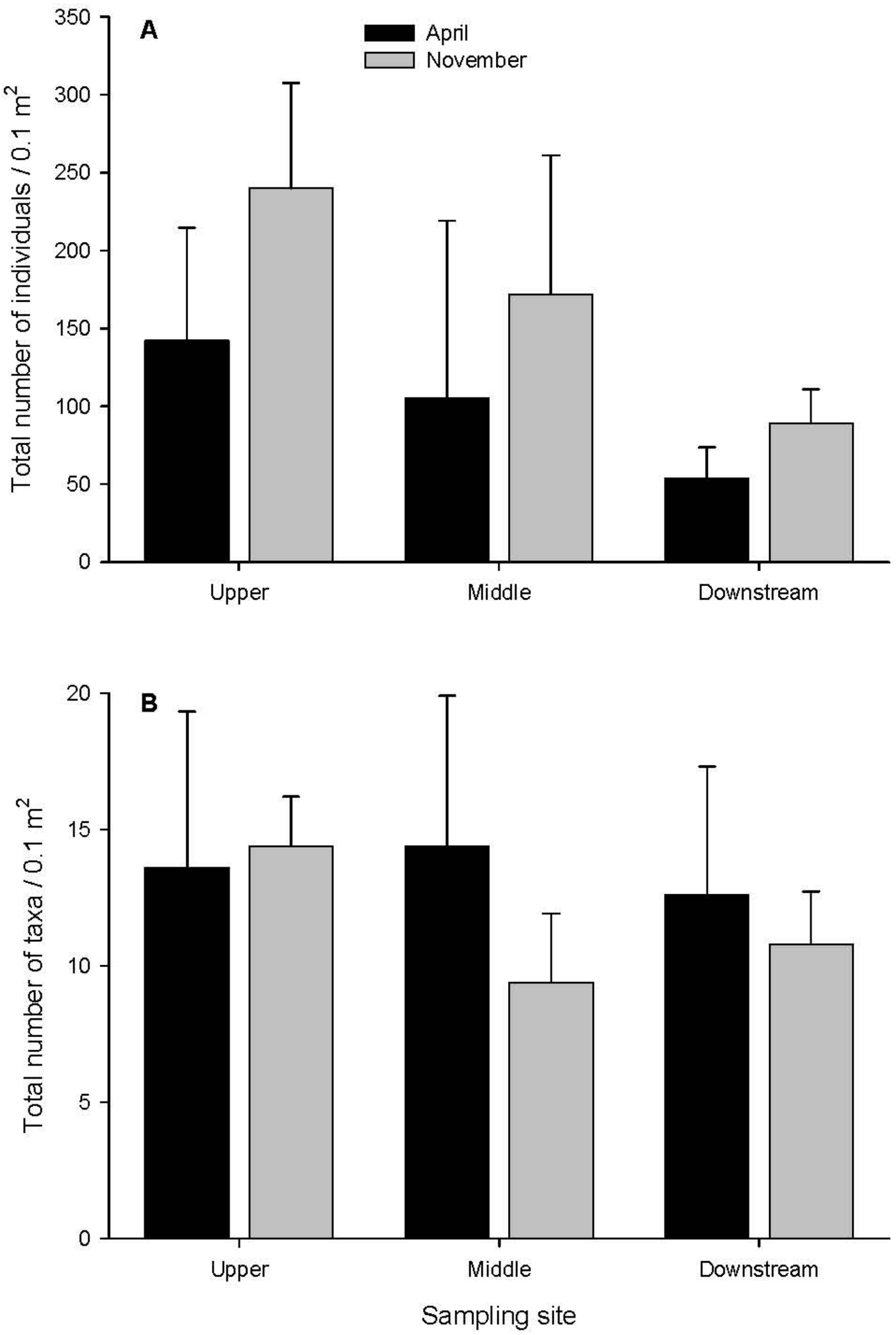
FIGURE 2: SURBER SAMPLING AT THE UPSTREAM MOST SAMPLING SITE ON THE RETARUKE RIVER (R1), NOVEMBER 2008. A BLUE DUCK PAIR WAS SIGHTED HERE.

FIGURE 3: THE MIDDLE SAMPLING SITE ON THE RETARUKE RIVER (R2) FACING UPSTREAM, NOVEMBER 2008.

FIGURE 4: THE DOWNSTREAM MOST SAMPLING SITE ON THE RETARUKE RIVER (R3) FACING UPSTREAM, NOVEMBER 2008.

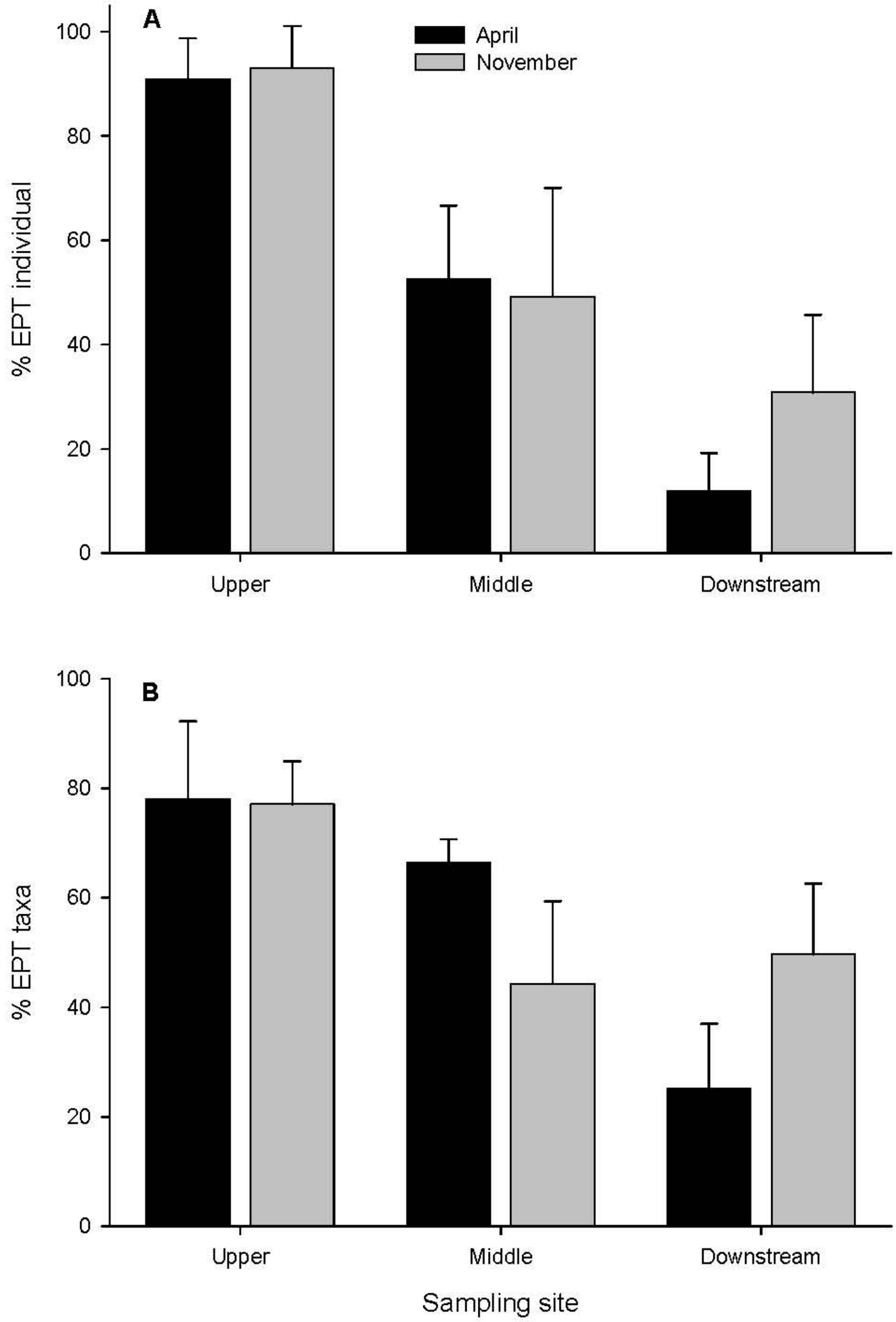
FIGURE 5: THE DOWNSTREAM MOST SAMPLING SITE ON THE RETARUKE RIVER (R3) FACING DOWNSTREAM. NOVEMBER 2008. A SHORT DISTANCE AROUND THE BEND IS THE RETARUKE RIVER - WHANGANUI RIVER CONFLUENCE.

FIGURE 6: 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 IN APRIL (BLACK BARS) AND NOVEMBER (GREY BARS).



The density of macroinvertebrates decreases from upstream to downstream in the Retaruke River and was greater in November than in April (Figure 6A). The diversity of macroinvertebrates was similar at all three sites in April but higher at the upstream site in November (Figure 6B).

FIGURE 7: 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 IN APRIL (BLACK BARS) AND NOVEMBER (GREY BARS) 2008.



The percentage of EPT individuals and taxa declined from upstream to downstream, however the percent EPT taxa was similar at the middle and downstream sites in November (Figure 7A & B).

MCI scores were highest at the upstream most site and declined with distance downstream in April but in November the middle and downstream sites had similar scores (Figure 8A). QMCI scores at all sites were similar in April and November. QMCI progressively showed a decline in water quality from upstream to downstream (Figure 8B). The downstream site had QMCI scores below the minimum of 5 suggested in the Proposed One Plan.

FIGURE 8. THE MEAN MCI (A) AND QMCI (B) (+ 1 STANDARD DEVIATION) AT THREE SITES ON THE RETARUKE RIVER IN APRIL (BLACK BARS) AND NOVEMBER (GREY BARS) 2008. THE INTERPRETATION CATEGORIES ARE SHOWN.

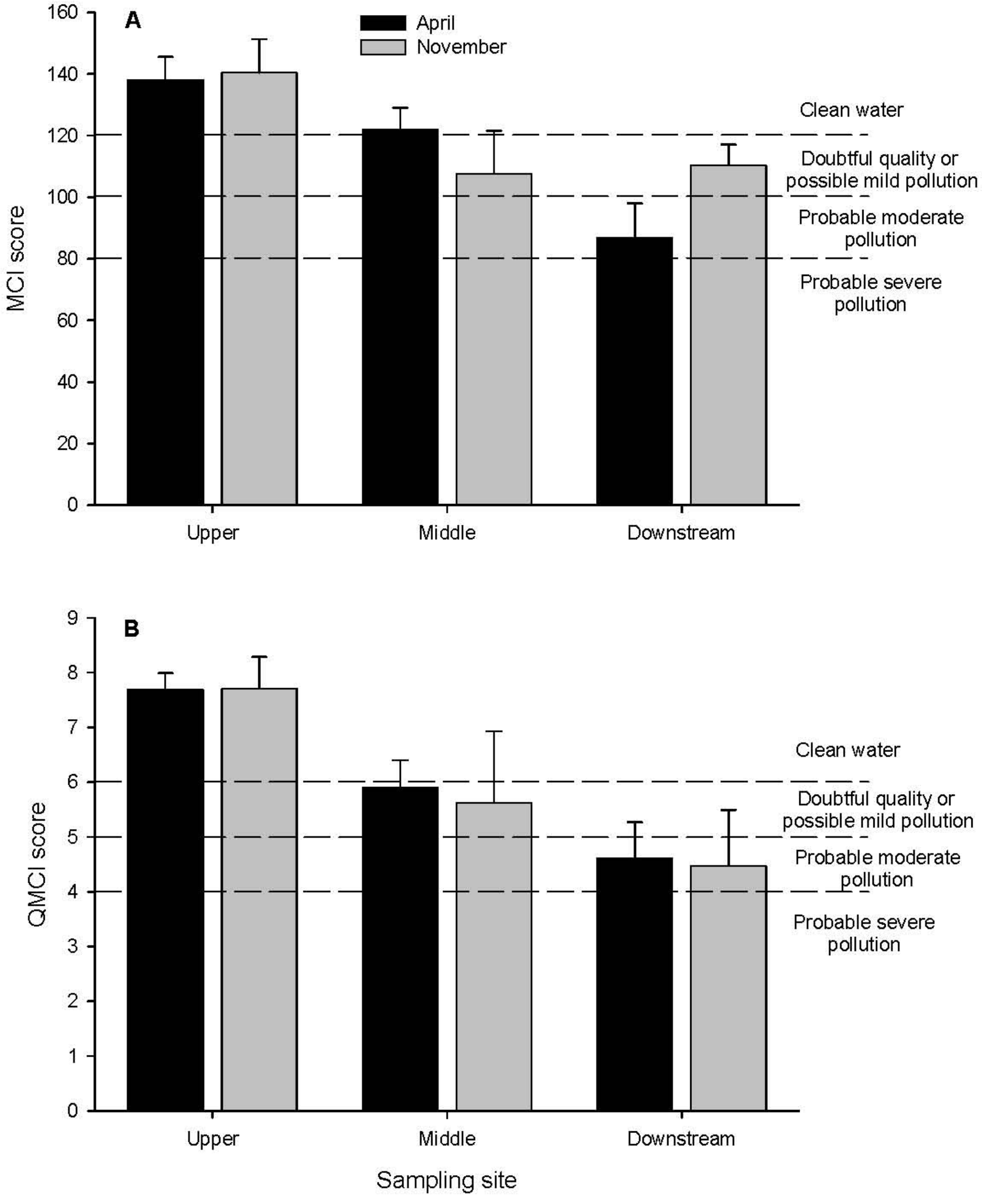


TABLE 2. INVENTORY AND ABUNDANCE (WITH MEAN) OF THE BENTHIC MACROINVERTEBRATE TAXA COLLECTED IN FIVE 0.1 M^2 SURBER SAMPLES AT THREE SITES (R1 – UPSTREAM, R2 – MIDDLE, R3 – DOWNSTREAM) ALONG THE RETARUKE RIVER IN NOVEMBER 2008. THE INVERTEBRATES SAMPLED IN APRIL 2008 ARE LISTED IN JAMES (2008).

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	2	2	0	1	1.2	0	0	1	0	0	0.2	0	0	0	0	0	0
	Coloburiscus humeralis	13	1	12	24	9	11.8	0	0	0	0	0	0	1	1	0	0	2	0.8
	Deleatidium sp.	44	45	132	87	95	80.6	51	88	124	63	23	69.8	21	26	6	14	25	18.4
	Neozephlebia scita	2	0	1	0	1	0.8	0	0	0	0	0	0	0	0	0	0	0	0
	Nesameletus sp.	0	0	3	6	4	2.6	0	1	0	0	0	0.2	0	0	0	0	0	0
	Zephlebia dentata	0	0	1	0	0	0.2	0	0	0	0	0	0	0	1	0	0	0	0.2
Plecoptera	*Acroperla trivacuata*	0	1	0	0	0	0.2	0	0	0	1	0	0.2	1	0	1	0	0	0.4
	Austroperla cryene	0	0	0	1	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0
	Zelandobius sp.	1	0	0	0	0	0.2	1	0	0	0	0	0.2	0	3	0	0	0	0.6
	Zelandoperla sp.	6	1	0	4	0	2.2	0	0	1	0	0	0.2	0	0	2	2	2	1.2
Trichoptera	*Beraeoptera roria*	52	35	53	45	63	49.6	0	0	18	0	0	3.6	0	0	0	0	0	0
	Helicopsyche sp.	0	16	43	9	24	18.4	0	0	0	0	0	0	0	0	1	0	0	0.2
	Olinga feredayi	39	12	21	32	44	29.6	0	1	10	0	0	2.2	0	0	0	0	0	0
	Pycnocentria evecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0.2
	Pycnocentrodes sp.	11	20	15	5	54	21	0	5	0	5	0	2	0	1	1	0	2	0.8
	Aoteapsyche sp.	3	5	12	7	2	5.8	0	1	1	0	0	0.4	0	2	1	0	2	1
	Costachorema xanthopterum	1	0	0	0	1	0.4	0	0	0	0	0	0	0	0	0	0	0	0
	Hydrobiosis clavigera	0	0	1	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	2	0	0	0	0.4	0	0	0	0	0	0
	Hydrobiosis umbripennis	0	0	0	0	0	0	0	0	2	0	1	0.6	2	1	0	3	1	1.4
	Neurochorema armstrongi	0	1	0	0	0	0.2	0	0	1	0	0	0.2	0	0	0	0	0	0
	Psilochorema sp.	0	0	0	0	0	0	0	0	0	0	1	0.2	0	0	0	0	0	0
Diptera	*Aphrophila* sp.	0	8	7	3	1	3.8	0	0	0	1	1	0.4	1	1	9	4	4	3.8
	Austrosimulium sp.	0	0	0	0	0	0	1	2	0	1	0	0.8	3	6	5	8	2	4.8

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	Eriopterini	0	0	0	0	0	0	0	0	0	0	1	0.2	0	0	0	0	0	0
	Maoridiamesa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2
	Orthocladiinae	0	23	0	0	1	4.8	11	34	59	16	136	51.2	13	39	79	60	27	43.6
	Tabanidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.2
	Tanytarsini	0	4	0	0	0	0.8	0	2	4	0	1	1.4	0	0	0	1	1	0.4
Coleoptera	Elmidae	2	0	5	5	2	2.8	25	12	84	16	21	31.6	15	15	7	6	8	10.2
	Hydraenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0.2
Megaloptera	*Archichauliodes diversus*	1	1	5	0	3	2	0	0	1	3	1	1	0	0	0	1	0	0.2
Mollusca	*Potamopyrgus antipodarum*	0	0	0	0	0	0	1	0	0	0	0	0.2	0	0	0	0	1	0.2
Oligochaeta		0	1	0	0	2	0.6	0	0	12	11	0	4.6	0	0	0	0	0	0

A L G A E

The upstream most site was dominated by the diatom, *Gomphonema minuta* var. *cassieae* in April, and the cyanobacteria, *Phormidium spp*. in November. The middle and downstream sites were dominated by green filamentous algae on both sampling occasions. At all sites and occasions, diatoms were the most diverse algal group (Table 3).

TABLE 3: THE RELATIVE ABUNDANCE SCORES OF ALGAL TAXA AT THREE SITES ON THE RETARUKE RIVER IN APRIL AND NOVEMBER 2008.

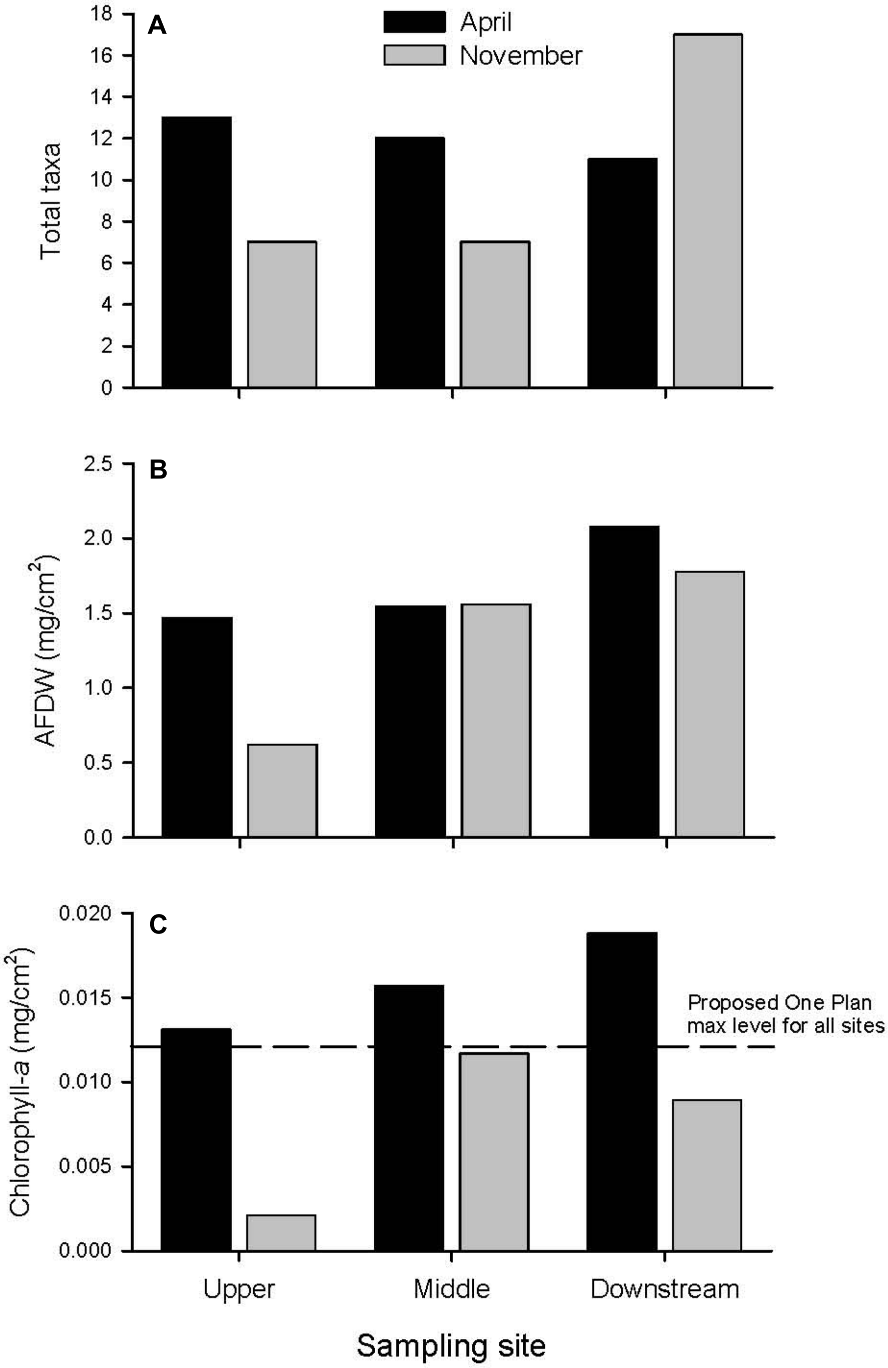
RELATIVE ABUNDANCE		UPSTREAM		MIDDLE		DOWNSTREAM	
		APR	NOV	APR	NOV	APR	NOV
Green filaments	*Cladophora* sp.			8		8	8
	Spirogyra spp.	3					
	Stigeoclonium spp.				8		
Diatoms	*Achnanthidium* spp. (small)						4
	Cocconeis pediculus			6		4	
	Cocconeis placentula	2	1				2
	Cymbella kappii	5					3
	Cymbella cf. *tumida*	4					
	Diatoma cf. *tenuis*						2
	Diatoma vulgaris	4		5		6	
	Encyonema cf. *minutissimum*	3					
	Encyonema cf. *minutum*						3
	Encyonema prostratum	4	1				
	Epithemia adnata	3					
	Epithemia sorex			4		4	
	Fragilaria spp. (small. cf. *vaucheriae*)						2
	Gomphonema minuta var. *cassieae*	8		4		4	
	Gomphonema spp. ~30um (small)	4	3	3	7	3	6
	Melosira varians	4		4		3	3
	Navicula cf. *lanceolata*		5				3
	Navicula spp. "dumpy shape"				5		5
	Nitzschia spp.(small)		2	2			1
	Nitzschia cf *dissipata?*				2		
	Reimeria spp.						4
	Rhoicosphenia curvata			2	2	3	4
	Rossithidium linearis		2	2		2	3
	Synedra ulna	3		4	2	5	
	Synedra ulna cf *ramesi*			3	6	4	4
Cyanobacteria	cf. *Phormidium* spp.		8				3
	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 total number of algal taxa was similar among sites in April while in November the downstream site had many more taxa than the upstream and middle sites (Figure 9A). Ash free dry weight increased from upstream to downstream in April and November (Figure 9B). In April chlorophyll-*a* concentrations increased from upstream to downstream and were above the maximum level suggested in the Proposed One Plan at all sites. Chlorophyll-*a* concentrations in November did not show such a pattern but were least at the upstream site and were below the maximum level suggested in the Proposed One Plan (Figure 9C).

FIGURE 9: 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) IN APRIL AND NOVEMBER 2008. THE SUGGESTED MAXIMUM CHLOROPHYLL-A CONCENTRATION FROM THE PROPOSED ONE PLAN IS OVERLAIN.



Conclusions

- 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). Soluble inorganic nitrogen (SIN) and dissolved reactive phosphorus (DRP) did not show any upstream to downstream pattern. All sites were below the maximum levels suggested in the Proposed One Plan except for DRP in February at the middle and downstream sites.
- Invertebrate abundance decreased from upstream to downstream. Overall, modest numbers of invertebrates were found, with more being present in November. The percentage of EPT individuals and taxa decreased from upstream to downstream sites.
- Water quality as measured by the MCI and QMCI decreased from upstream to downstream. The QMCI scores in April and November at the downstream site were below the minimum suggested in the Proposed One Plan.
- The algal community changed from one dominated by diatoms (April) or cyanobacteria (November) at the upstream site to one dominated by filamentous green algae at the middle and downstream sites. Algal biomass measured as ash-free dry weight increased from upstream to downstream as did chlorophyll-*a* in April. Chlorophyll-*a* concentrations in April were above the maximum level suggested in the Proposed One Plan at all sites.
- 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 one more time, preferably during a sustained period of low flow when algal biomass is high to get an idea of drought/low flow impacts on the Retaruke River.

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