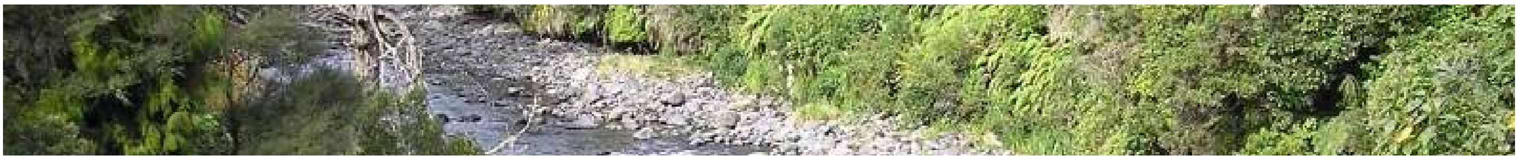

A biosurvey of the benthic macroinvertebrates and algae of the Manganui o te Ao River

An April - November 2008 comparison

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Department of Conservation
Te Papa Atawhai

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Cover photo: The upstream most site sampled on 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 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.
- 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 in both April and November. QMCI only met the minimum criteria of the Proposed One Plan at the upstream most site.
- Diatoms dominated taxonomically, but at some sites and times the algal community was numerically dominated by cyanobacteria and filamentous green taxa. Ash free dry weight of algae increased from upstream to downstream. Chlorophyll-*a* concentrations were always below the maximum levels suggested in the Proposed One Plan.
- 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 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. 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 Manganui o te Ao 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 Manganui o te Ao River. This 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. In addition, water samples were taken in November and analysed for bio-available phosphorus and nitrogen.

Methods

FIELD PROCEDURE

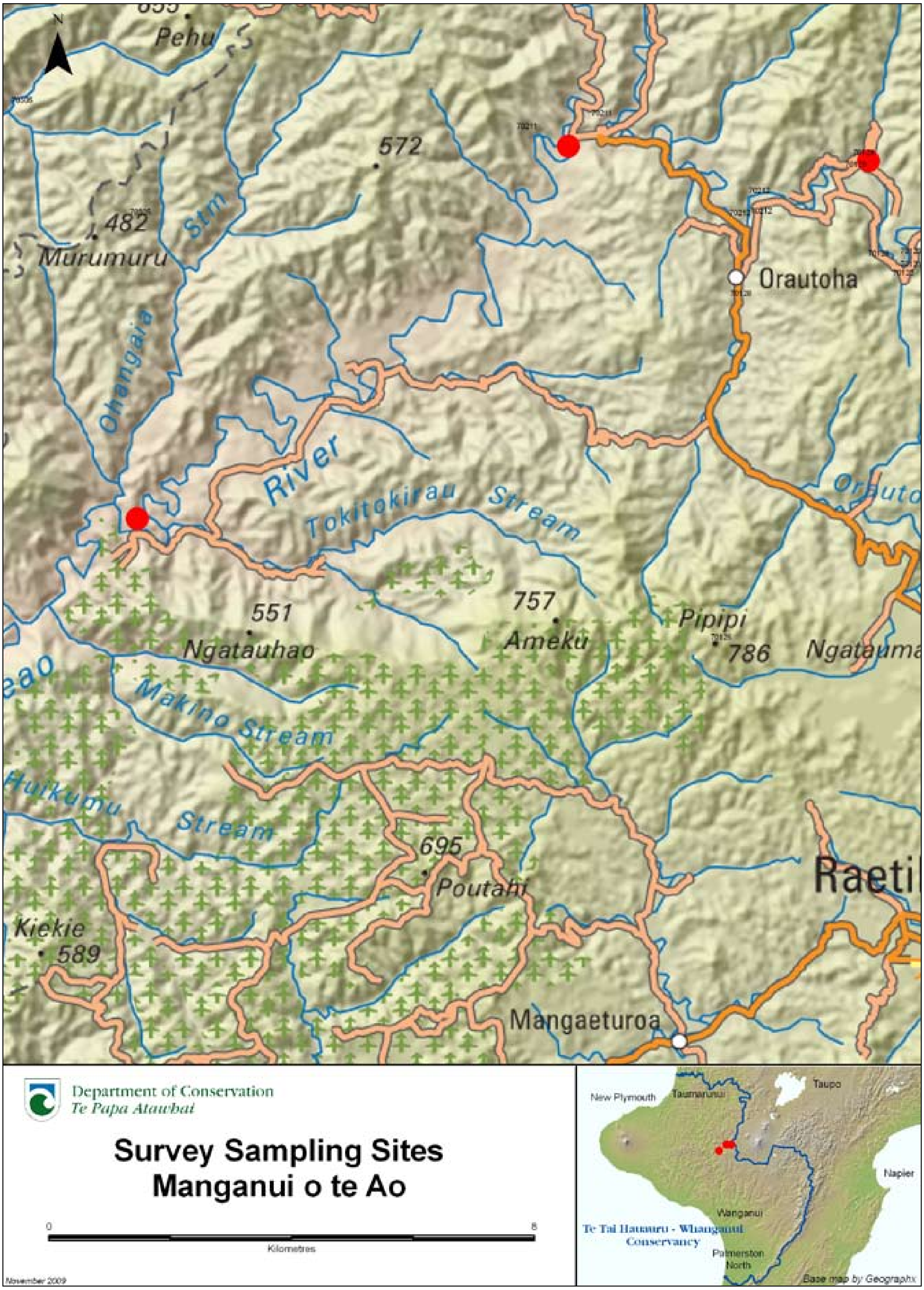
On November 15, 2008 three sites along the Manganui o te Ao River underwent a periphyton and macroinvertebrate bioassessment (Figure: 1), repeating the procedure undertaken on April 25, 2008 (James, 2008). Physicochemical measures were also taken. These sites or the general area of where a site was to 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 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 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 & 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.

FIGURE 1. THE THREE SITES ALONG THE MANGANUI O TE AO RIVER THAT WERE SAMPLED FOR PERIPHYTON AND MACROINVERTEBRATES ON NOVEMBER 15, 2008.



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 while 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 IN APRIL AND NOVEMBER 2008. ALSO INCLUDED ARE THE RESULTS OF SUBSEQUENT WATER NUTRIENT ANALYSIS FROM SAMPLES TAKEN JANUARY 23 AND FEBRUARY 19, 2009.

SITE NUMBER	R1 (UPSTREAM)	R2 (MIDDLE)	R3 (DOWNSTREAM)
Site name	Manganui o te Ao @ Hoihenga Rd (Fig. 2 & 3)	Manganui o te Ao @ Ruatiti Domain (Fig. 4)	Manganui o te Ao @ Makakahi Rd (near road end) (Fig. 5)
NZMS 260 grid ref.	S20:047077	S20:997081	S20:926017
Easting	2704703	2699751	2692638
Northing	6207812	6208053	6201911
Temperature	April: 10.0°C at 12 pm November: 15.2°C at 11 am	April: 10.9°C at 2 pm November: 18.3°C at 1 pm	April: 12.1°C at 3.30 pm November: 19.9°C at 2.30 pm
Specific conductivity	April: 96.7 µS/cm November: 107.4 µS/cm	April: 100.8 µS/cm November: 109 µS/cm	April: 97.6 µS/cm November: 105.5 µS/cm
pH	April: 6.80 November: 8.46	April: 7.40 November: 8.67	April: 7. 41 November: 8.46
Dissolved oxygen	April: 89.6% 8.41 mg/L November: 97.8% 9.77 mg/L	April: 94.7% 8.40 mg/L November: 94.4% 102.1 mg/L	April: 98% 8.69 mg/L November: 102.8% 9.25 mg/L
Soluble Inorganic Nitrogen (SIN)	November: 21 mg/m^3 January: 39.7 mg/m^3 February: 21 mg/m^3	November: 40 mg/m^3 January: 25.3 mg/m^3 February: 2.6 mg/m^3	November: 12 mg/m^3 January: < 2 mg/m^3 February: < 2 mg/m3
Dissolved Reactive Phosphorus (DRP)	November: < 4 mg/m^3 January: 8.4 mg/m^3 February: 7 mg/m^3	November: < 4 mg/m^3 January: 4.8 mg/m^3 February: 4.6 mg/m^3	November: < 4 mg/m^3 January: < 4 mg/m^3 February: < 4 mg/m^3
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.	April: >1.00 m/s November: 0.63 m/s (0.57 – 0.69 m/s)	April: 0.70 m/s (0.44 – 0.89 m/s) November: 0.71 m/s (0.40 – 0.98 m/s)	April: 0.74 m/s (0.44 – 1.21 m/s) November: 0.71 m/s (0.49 – 0.98 m/s)
Mean depth (range) - only near Surber sites.	April: 0.38 m (0.15 – 0.64 m) November: 0.45 m (0.39 – 0.53 m)	April: 0.21 m (0.12 – 0.33 m) November: 0.31 m (0.25 – 0.43 m)	April: 0.19 m (0.07 – 0.30 m) November: 0.26 m (0.16 – 0.34 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, Figures 2 - 5). The upstream and middle sites were mostly rapids. The specific conductivity was similar at all sites and sampling occasions (Table 1). Soluble inorganic nitrogen (SIN) was variable between sites and sampling occasions. SIN decreased from upstream to downstream in the January and February water samples but at no time were above the maximum levels suggested in the Proposed One Plan (upper site: 70 mg/m^3, middle and downstream sites: 110 mg/m^3) (Horizons Regional Council, 2007). Dissolved reactive phosphorus (DRP) was below detectable limits at all sites in November but was detected at the upper and middle sites in January and February. At the upper site the DRP concentrations were greater than the Proposed One Plan's suggested maximum while that at the middle site they were lower (upper site: 6 mg/m^3, middle and downstream sites: 10 mg/m^3).

FIGURE 2: THE UPSTREAM MOST SAMPLING SITE ON THE MANGANUI O TE AO (M1) RIVER FACING UPSTREAM, NOVEMBER 2008.

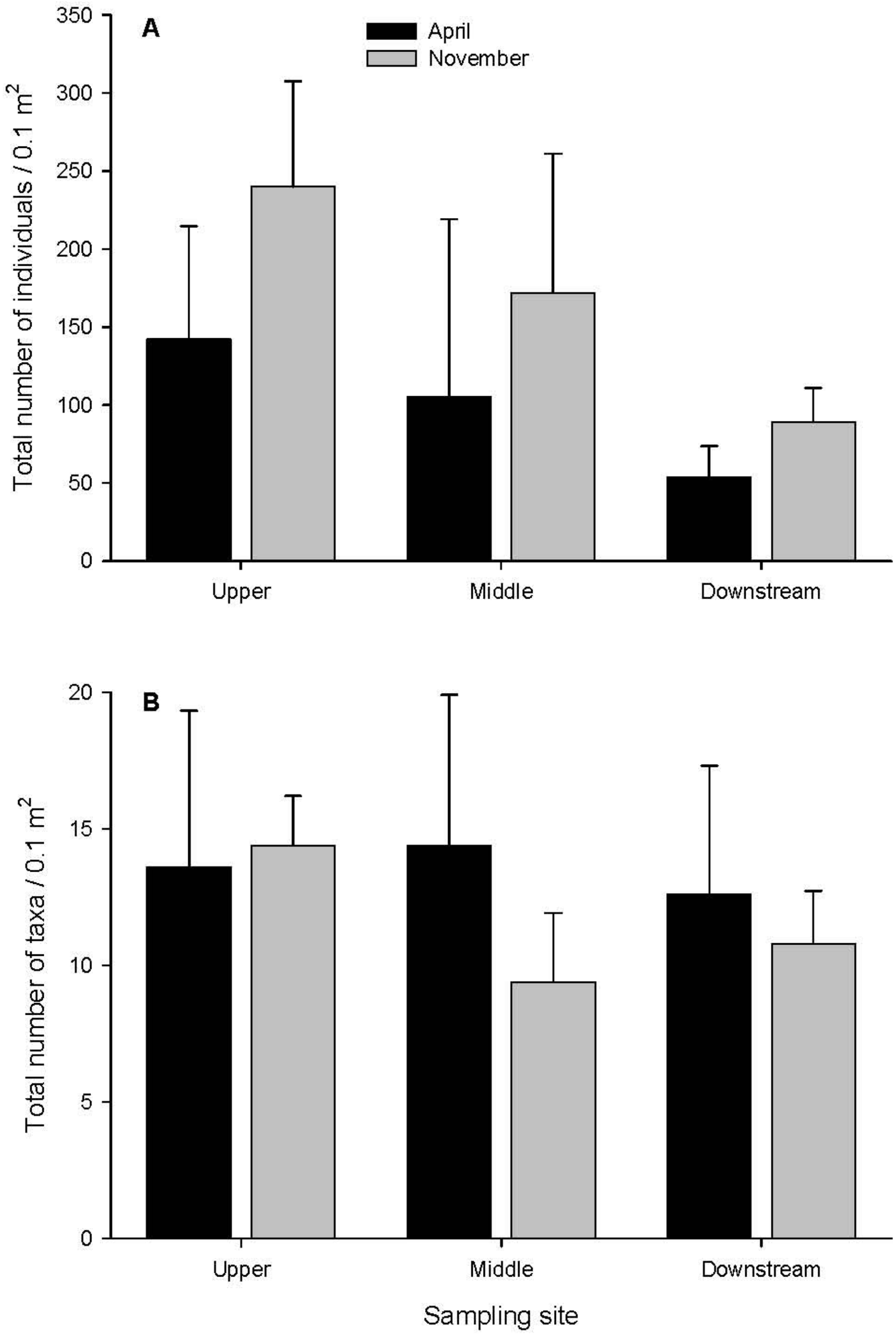
FIGURE 3: THE CHALLENGING SAMPLING CONDITIONS AT THE UPSTREAM MOST SITE ON THE MANGANUI O TE AO RIVER (M1), NOVEMBER 2008.

FIGURE 4: THE MIDDLE SAMPLING SITE ON THE MANGANUI O TE AO RIVER (M2) FACING UPSTREAM, NOVEMBER 2008.

FIGURE 5: THE DOWNSTREAM MOST SAMPLING SITE ON THE MANGANUI O TE AO (M3) FACING UPSTREAM, NOVEMBER 2008. THIS SITE IS APPROXIMATELY 15 KM UPSTREAM FROM THE MANGANUI O TE AO RIVER - WHANGANUI RIVER CONFLUENCE.

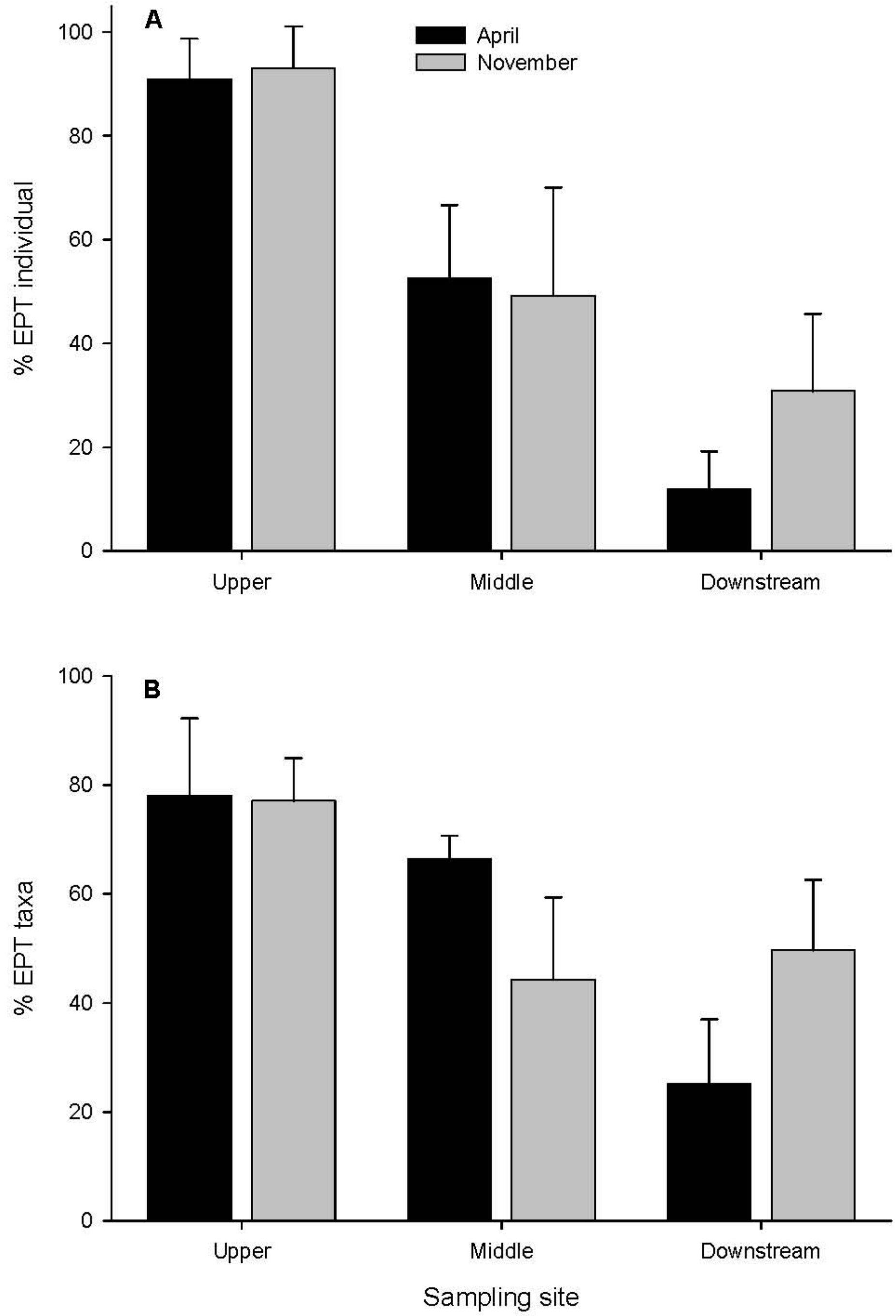
MACROINVERTEBRATES

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 MANGANUI O TE AO RIVER IN APRIL (BLACK BARS) AND NOVEMBER (GREY BARS) 2008.



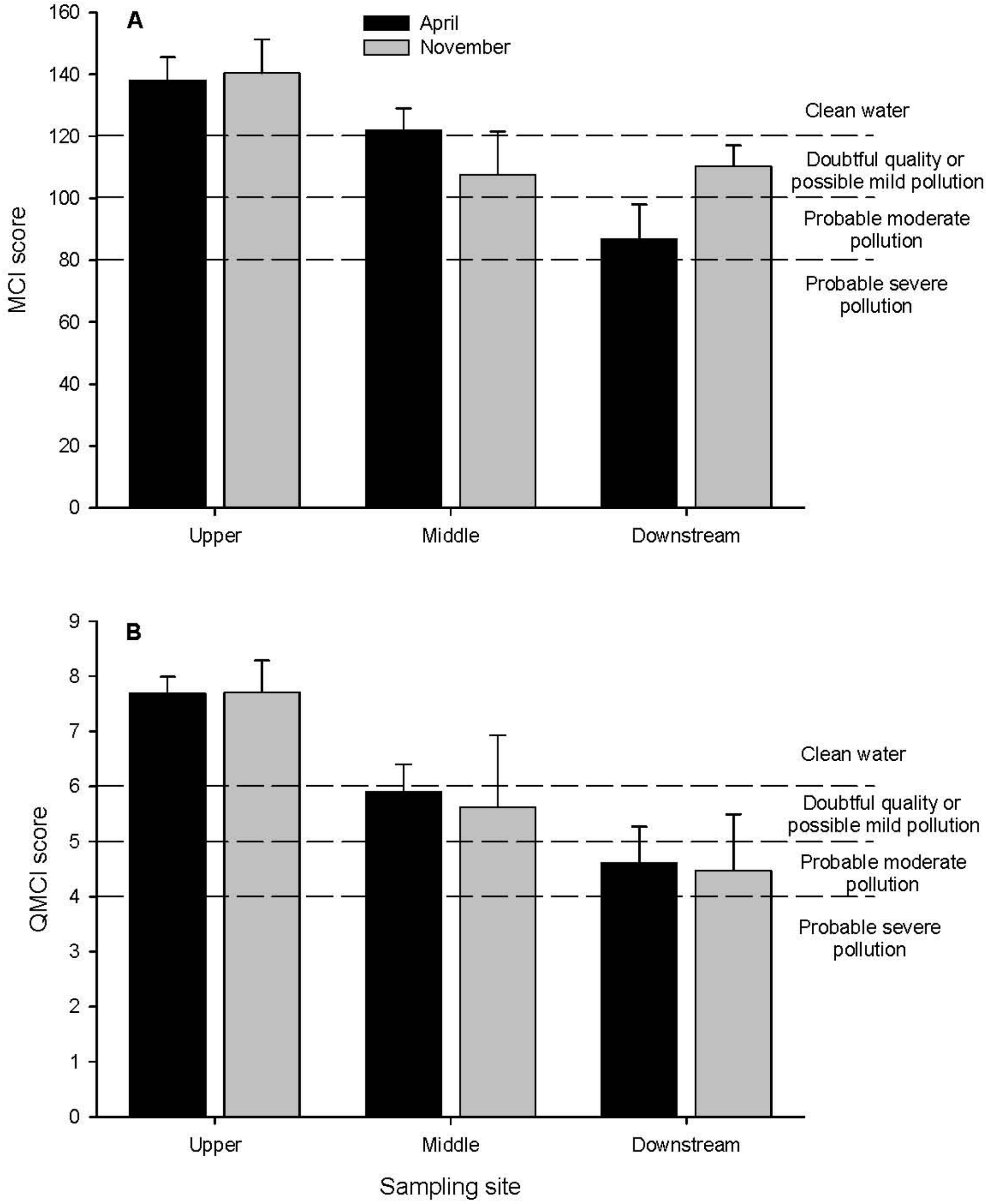
The numbers of individuals captured at each of the three sites were quite variable in April and more similar in November (Figure: 6A). The total number of taxa remained similar between the April and November at the upstream most site but was more variable at the middle and downstream sites (Figure: 6B).

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 MANGANUI O TE AO RIVER IN APRIL (BLACK BARS) AND NOVEMBER (GREY BARS) 2008.



The percentage of EPT individuals was higher in November than in April. There was a decline from upstream to downstream on both sampling occasions for EPT individuals (Figure: 7A) and EPT taxa (Figure: 7B) in April and November.

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



MCI scores were similar at both sampling occasions and showed a decline from upstream to downstream (Figure: 8A). QMCI scores also showed a decline on both sampling occasions, however, scores were higher in November at the middle and upstream sites (Figure: 8B). Only at the upstream site is QMCI at or above the minimum score of 6, suggested in the Proposed One Plan.

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 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*	0	1	0	0	6	1.4	0	4	1	0	2	1.4	0	0	0	0	0	0
	Coloburiscus humeralis	0	1	0	8	1	2	10	2	0	0	1	2.6	1	2	0	0	1	0.8
	Deleatidium sp.	1	2	13	11	9	7.2	34	5	7	6	8	12	4	1	0	1	1	1.4
	Nesameletus sp.	0	0	0	0	2	0.4	0	0	0	0	0	0	0	0	0	0	0	0
Plecoptera	*Zelandobius* sp.	0	0	1	1	0	0.4	0	2	0	1	2	1	0	2	0	0	0	0.4
	Zelandoperla sp.	0	0	0	5	0	1	12	0	1	0	0	2.6	3	0	0	0	0	0.6
	Austroperla cyrene	0	0	1	2	0	0.6	6	0	0	0	0	1.2	1	0	0	0	0	0.2
	Megaleptoperla grandis	0	0	0	0	0	0	0	0	0	0	1	0.2	0	0	0	0	0	0
Trichoptera	*Aoteapsyche* sp.	0	0	1	2	1	0.8	3	1	0	0	4	1.6	0	0	0	0	4	0.8
	Beraeoptera roria	19	25	68	104	135	70.2	60	27	25	6	17	27	1	1	1	1	0	0.8
	Confluens hamiltoni	0	0	0	0	0	0	0	1	0	0	0	0.2	0	0	0	0	0	0
	Costachorema xanthopterum	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0.8
	Helicopsyche sp.	1	1	9	24	4	7.8	0	0	0	0	0	0	0	0	0	0	0	0
	Hydrobiosis parumbripennis	0	0	0	0	0	0	3	1	0	0	1	1	1	0	0	0	1	0.4
	Hydrobiosis umbripennis	0	0	0	2	0	0.4	0	0	0	0	0	0	0	2	0	0	0	0.4
	Neurochorema armstrongi	0	0	0	0	0	0	1	0	0	0	0	0.2	0	0	0	0	0	0
	Olinga feredayi	0	0	3	5	0	1.6	5	0	0	0	0	1	0	0	0	0	0	0
	Oxyethira albiceps	0	0	0	0	0	0	0	0	0	0	1	0.2	3	5	5	7	11	6.2
	Psilochorema sp.	0	0	0	0	0	0	0	0	1	0	0	0.2	1	0	0	0	0	0.2
	Pycnocentria evecta	0	0	0	0	3	0.6	0	1	0	0	4	1	0	0	0	0	0	0
	Pycnocentrodes sp.	1	1	7	5	3	3.4	6	1	2	4	2	3	2	0	0	0	0	0.4
Diptera	*Aphrophila* sp.	0	0	0	1	0	0.2	3	16	13	9	53	18.8	9	4	7	7	5	6.4
	Austrosimulium sp.	0	0	0	0	0	0	0	1	0	0	2	0.6	5	7	4	4	14	6.8
	Empididae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0.2

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
	Diamesinae	1	2	0	4	7	2.8	1	4	9	6	42	12.4	2	1	1	2	0	1.2
	Muscidae	0	0	0	0	0	0	0	1	0	0	0	0.2	0	0	0	0	0	0
	Orthocladiinae	0	0	13	0	1	2.8	20	16	2	0	30	13.6	56	54	30	32	28	40
	Tanypodinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.4
	Tanytarsini	0	0	0	0	0	0	2	4	1	4	53	12.8	5	34	2	30	19	18
Coleoptera	Elmidae	1	0	3	0	1	1	0	1	0	0	2	0.6	0	1	1	1	0	0.6
Megaloptera	*Archichauliodes diversus*	0	0	0	0	0	0	1	0	0	0	0	0.2	0	0	0	0	0	0
Acarina		0	0	0	0	0	0	0	0	0	1	0	0.2	0	0	0	0	0	0
Oligochaeta		0	0	3	0	0	0.6	0	0	0	0	0	0	0	3	0	0	0	0.6

ALGAE

The upstream site had the least taxonomic diversity, the middle site the highest with the downstream site intermediate. Diatoms were the most diverse algal group (Table 3). The dominant taxa varied with cyanobacteria (*Phormidium* spp.), diatoms, and filamentous green algae (*Spirogyra* spp.) all dominating at different sampling times and sites (Table 3).

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

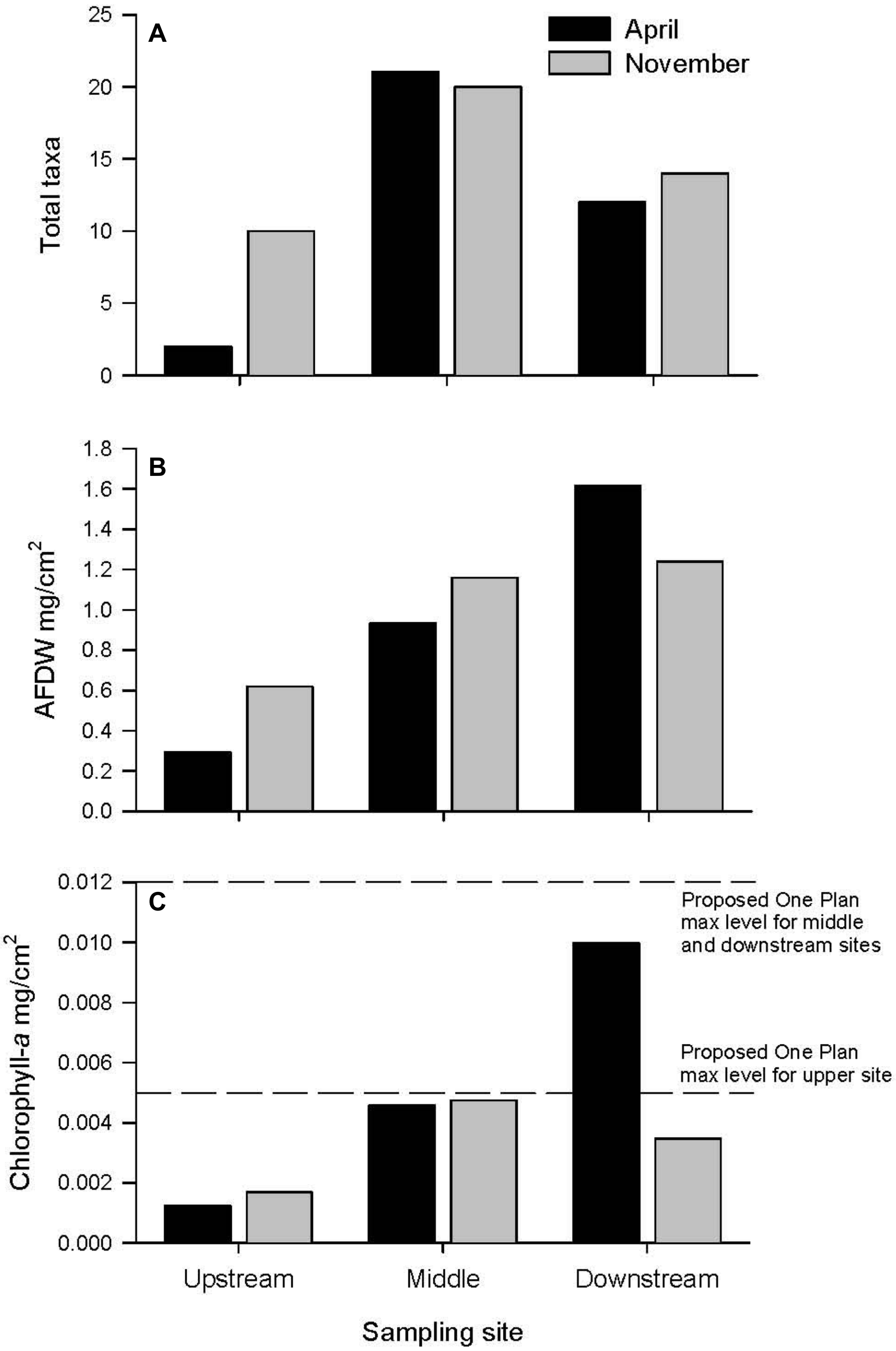
RELATIVE ABUNDANCE		UPSTREAM		MIDDLE		DOWNSTREAM	
		APR	NOV	APR	NOV	APR	NOV
Green filaments	*Cladophora* spp.			3			
	Oedogonium sp.				1		
	Spirogyra spp.			4	8	8	5
Green (Non filamentous)	*Achnanthi dium* spp. (small)						4
	Scenedesmus spp.				1		
	Little green balls/colonies/mats			3			
Diatoms	*Cocconeis pediculus*			3			
	Cocconeis placentula		2	1	2		1
	Cymbella kappii		3		3		4
	Diatoma cf. *tenuis*			4		5	
	Diatoma hiemale		3		2		
	Diatoma vulgaris	3					
	Encyonema cf. *minutissimum*			3		3	
	Encyonema cf. *minutum*		3		3		4
	Encyonema prostratum			8	1	6	
	Epithemia adnata			5	2	7	1
	Epithemia sorex			3		4	
	Fragilaria spp. (small. cf. vaucheriae)		4		3		
	Frustulia spp.				4		5
	Gomphoneis minuta var. *cassieae*			3	3	5	4
	Gomphonema spp. ~30um (small)						3
	Gomphonema cf. *parvulum*		5		4		
	Melosira varians			4	1	5	
	Navicula cf. *cryptocephala*			3			
	Navicula cf. *lanceolata*		3	4			
	Navicula spp. “dumpy shape”				3		
	Navicula spp. (small) 40x10μm			2		2	
	Nitzschia (fine) 35x5um		1	3	2	3	
	Rhoicosphenia curvata	1		4	1		
	Rhopalodia novaezealandiae			1			

RELATIVE ABUNDANCE		UPSTREAM		MIDDLE		DOWNSTREAM	
		APR	NOV	APR	NOV	APR	NOV
	Rossithidium linearis		4		4		4
	Synedra ulna			4	3	7	
	Synedra ulna cf *ramesi*			3		3	2
	Synedra spp. (short) 65um						8
Cyanobacteria	cf. *Phormidium* spp.		8		4		7
	Very fine B/G tufty filaments						5
	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

The number of algal taxa identified was similar in April and November except at the upstream site where only two taxa were identified in April. The greatest numbers of taxa were found at the middle site (Figure: 9A). The ash free dry weight of algae increased from upstream to downstream with this pattern being more pronounced in April than in November (Figure 9B). There was a distinct upstream to downstream increase in chlorophyll-*a* observed in April. This pattern was not evident in November but levels were still the least at the upstream most site (Figure: 9C). At all times chlorophyll-*a* concentrations remained below the maximum levels 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 CM²) IN APRIL AND NOVEMBER 2008. SUGGESTED MAXIMUM CHLOROPHYLL-A CONCENTRATIONS FROM THE PROPOSED ONE PLAN ARE OVERLAIN.



Conclusions

- 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 levels of soluble inorganic nitrogen (SIN) were below maximum concentrations recommended in the Proposed One Plan. In most samples dissolved reactive phosphorus (DRP) was below the limit of detection but in two instances (January and February, upstream) was above the maximum concentration recommended in the Proposed One Plan.
- There were relatively low numbers of invertebrates, usually < 150 individuals per sample (0.1 m^2). This was likely related to the low algal biomass observed. A moderate number of taxa were found, with invertebrate communities dominated by taxa typically found in such environments throughout New Zealand. The percentage of EPT individuals and taxa declined from upstream to downstream in both April and November.
- Water quality as measured by the MCI and QMCI showed an upstream to downstream decline with scores generally being slightly higher in November than in April. Only the upstream most site had QMCI scores that were equal to or greater than the minimum score of 6 suggested for the Manganui o te Ao River in the Proposed One Plan.
- Algal taxonomic composition was dominated by diatoms at all sites and times, however was numerically dominated by cyanobacteria, green filamentous or diatoms at different times and sampling sites. AFDW increased from upstream to downstream in both April and November as did chlorophyll-*a* concentrations in April. On all occasions, chlorophyll-*a* levels were below the maximum levels suggested in the Proposed One Plan.
- 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. Variation between the sampling occasions, especially with algal samples, probably results from seasonal (e.g temperature, day length) and disturbance (flood) effects.
- 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 Manganui o te Ao River.

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References

Biggs B. J. F., Kilroy, C. (2000) *Stream periphyton monitoring manual*. NIWA, Christchurch.

Boothroyd I., Stark J. (2000) Use of invertebrates in monitoring. In *New Zealand stream invertebrates: ecology and implications for management* (ed. K. J. Collier & M. J. Winterbourn), pp. 344-373. New Zealand Limnological Society, Christchurch.

Heather B. D., Robertson H. A. (1996) *The field guide to the birds of New Zealand*. Viking, Auckland.

Horizons Regional Council (2007) *Proposed One Plan – The consolidated regional policy statement, regional plan and regional coastal plan for the Manawatu-Wanganui region*. Horizons Regional Council, Palmerston North.

James A. (2008) *A biosurvey of the benthic macroinvertebrates and algae of the Manganui o te Ao River*. Whanganui Conservancy Fauna Series 2008/4, Department of Conservation, Wanganui.

Smith B., Ward J. (2005) *A guide to the New Zealand Hydrobiosidae caddisflies*. NIWA, Hamilton.

Winterbourn M. J. (1973) *A guide to the freshwater Mollusca of New Zealand*. Tuatara, 20, 141-159.

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