An assessment of the freshwater environments at the Longbush Eco-sanctuary

Prepared for the Longbush Ecological Trust, September 2014

Nga Mahi Te Taiao




Contents

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Summary and discussion

Initial surveys of both the Waikereru and Waituhi streams at Longbush exhibit high levels of biological value, as determined by macroinvertebrate, periphyton and physical habitat evaluations. Similarly, physico-chemical attributes provide confidence of very good water quality. Four years after removing stock access to the Waikereru hills, with some planting and indigenous regeneration these streams are now providing increasing confidence of being of a sufficiently high standard to be utilised as 'Reference' sites, against which environmental stressors may be evaluated in the wider regional riverscape context.

An example of the value of the Longbush stream sites, for instance, involved a comparison of turbidity in the downstream Waimata River (measured at Goodwins Rd bridge), which reached very high levels after a week of rain, while the contribution of sediment from the Longbush catchments was hardly any greater than the small amount transported by the streams during stable low flows. Similarly, the stream banks beneath the restored indigenous vegetation remained largely intact with little sign of erosion from the recent flood.

Relatively elevated levels of nitrates present in the regenerating bush streams at Longbush, and their dilution during subsequent rainfall events, appear to indicate a different process than that in pastoral farming landscapes, where rainfall is typically associated with increased nitrate levels. The presence of large beds of periphyton available to fix nitrogen compounds in the open farm streams, and their subsequent removal during high flows, may at least partly explain this difference (pers com Dr Mike Joy 2014). Further research in this area should enhance an understanding of wider landscape interrelationships at Longbush (soil, water, air, anthropogenic and other animal impacts) and in similar regenerating indigenous forest settings elsewhere in the region.

There is a concern about the perched culverts just below the stream survey sites, which present a barrier to fish passage. Over time, the drop-offs below the culvert outlets should be mitigated with a build-up of boulders and the creation of small 'resting pools' and sheltered passage, using, for instance, recycled mussel lines. In the short term, however, there would be merit in leaving the upper streams blocked in this way to facilitate in-situ breeding of threatened invertebrate species and growing to maturity of threatened fish species. This question is discussed further in the recommendations below.

Like the streams, the constructed wetlands at Longbush (two farm ponds which have been planted) do not initially appear impacted by current or historical land use patterns. Early macroinvertebrate surveys, for example, indicated a rich taxa diversity and trophic patterning at both sites. There is, however, current sign of elevated phosphorous levels in the upper wetland, possibly because of the low water level at the site over summer 2014. The wetlands are fed by an irrigation pipe from the Waikereru stream, which in spring 2013 was turned off by the farmer who grazes the site, allowing the wetland to almost dry up over the summer, and the clay base to develop a leak (pers com Anne Salmond). Recent low water levels also appear to be reflected in reduced macroinvertebrate taxa diversity here. Further research will be able to identify whether this situation can be addressed by sealing the clay base with Gisborne bentonite, and ensuring consistently higher wetland water levels in the future.

Recommendations

1. A logical expansion of the Longbush freshwater survey program would be to include other waterways in the Waimata catchment representative of differing land-use environments, such as: pastoral farming, in-growth and harvested plantation forestry, intensive mixed farming, and the like. This could commence in the spring survey period if suitable sites are available.
2. As part of an expanding program, the overall monitoring and survey methodology should be reviewed in the context of ongoing regional and national developments. This might involve collaboration with external parties, such as NIWA, other CRI's and universities, and local authorities.
3. Consider retaining the perched culverts as barriers to eel upstream migration to the stream headwaters while the wetlands are being developed for koura and native fish breeding. This would provide an environment relatively free of predatory species and could potentially enhance survival of these animals' offspring.
4. Review the integrity of the lining at both wetland sites, and the feasibility of maintaining high water levels across seasons, providing optimum conditions for threatened species breeding success.
5. Identify a group of sites throughout the wider catchment where remnant populations of threatened species might be at risk of land use change, and thus provide candidates for breeding within the Longbush eco-sanctuary. Retaining genetic integrity within the Waimata river catchment is an important consideration, particularly for the koura (*Parenthrops sp.*), while the diadromous fish might be sourced from east coast sites as close as possible to the Waimata.
6. Consider further freshwater research initiatives at Longbush, for instance:
    a. Investigate the processes associated with nitrogen compounds and particularly the presence and source of elevated nitrate levels at certain times in indigenous forest streams.
    b. Identify potential sources of Total Phosphorous (upper wetland) and Dissolved Reactive Phosphorous (stream sites) and the potential for ecosystem impacts and the implementation of mitigation measures.
    c. Study the ecology of hill country springs at Longbush.
    d. Compare high conductivity and pH levels across the Tairawhiti Gisborne region with those elsewhere.
    e. Quantify levels of sediment and nutrients from indigenous forest streams compared with those from other land use settings.

Background

History

When the first Europeans arrived in Te Turanganui a Kiwa, the flats and foothills in the Waimata valley were covered with managed fernlands or gardens, and with dense lowland bush and trees in the high valleys and inland. Settlements were located throughout the landscape, and the remains of a small unfortified village stands on a low hill at Longbush (Pa Hill), looking up and down the Waimata River valley.

In the mid-1860s Raharuhi Rukupo, one of the leading rangatira (chiefs) in the district, set aside the Whataupoko block (which included Longbush) and sent men to fetch European settlers from Hawkes Bay to establish a sheep farm on the property. Henry Parker took up the offer and began farming sheep on the block, followed by his brother William Parker. In 1885 the ownership of the Whataupoko No.9 block passed to the New Zealand Native Land Settlement Company, which subdivided the land and sold part of it to John Dunlop. From that time, the Longbush Station (3300 acres) was worked as a pastoral farm, with two families, the Donners and the Hegartys, running the farm from 1895 to 1990.

The Hegartys created a pond below Pa Hill, and planted a stand of Italian poplars. By 1989 the surrounding hills had been cleared, leaving only a strip of lowland bush alongside the Waimata River. This was known as Longbush, a favourite picnic spot for local families. After the trees on the land had been felled, the slopes of the Waimata Valley, including Longbush, became highly vulnerable to erosion. During Cyclone Bola in 1988, there was severe slumping in the foothills, and large quantities of sediment migrated into the Waimata River.

In 2000 when Anne and Jeremy Salmond purchased the farm, the site which has become the Longbush Ecosanctuary was under severe ecological threat. Cattle grazed the hills and the riverside bush, and the forest floor was barren. Garden rubbish and other refuse including cars were dumped in the gullies or beside the river. Over the last 14 years, however, the removal of grazing stock from the majority of the Longbush Ecosanctuary catchments and the restoration of indigenous forest species has transformed the nature of the landscape and the waterways flowing through the Longbush stream catchments.

Goodwin's Rd Bridge monitoring site 3km downstream of Longbush after 66.mm of rain had fallen in the previous week. Photo M. Palmer September 2014.

Geophysical landscape of the Waimata Valley

The underlying geology of the Waimata Valley is largely comprised of Neogene sedimentary sandstones and siltstones, and predominantly the highly erodible mudstone referred to locally as Papa. This type of mudstone weathers easily when exposed to successive wetting and dessication, a characteristic enhanced in the Gisborne Tairawhiti region by fracturing of the rock from the uplift and faulting associated with the regions position above the confluence of the Pacific and Indo-Australian tectonic plates. Overlain on this young substrate is a soil derived from pumice ash (referred to as Gisborne ash, or Taupo Gravelly Ash) deposited in three showers commencing c. 1700 years ago.

The steep hill country and rolling colluvial lands that comprise the Longbush landscape are typical of the uplifted, fractured, and dissected hill country of the mid and upper Waimata River catchment, and indeed of much of the wider Tairawhiti region. Although retaining greater structural integrity under mixed forest and dense, woody vegetation, an open pastoral farming landscape would typically be characterised by ongoing erosion from the deforested headwater catchments (including the potential for gully erosion in the steeplands), leading to large colluvial fans, and pulses of fine sediment into the Waimata River. This was the situation prior to the protection of Longbush and its return to a forested state.

Right: sedimentary mudstones from the Waikereru streambed, clearly exhibiting their soft and erodible nature. 2014.

Longbush freshwater project

Positive outcomes anticipated for freshwater and associated ecosystems, rivers, lakes, wetlands, and estuaries, are frequently a major focus of indigenous terrestrial restoration projects. This is so for the Longbush project, and in 2011, a plan to survey and describe the aquatic settings here was conceived. Practical ecosystem surveying commenced the following year, with the author of this report and Claire Hebert, on an internship from L'ecole Agrotech de Paris, beginning to gather and record information on the habitat and biological and physico-chemical components of the streams and wetlands at the eco-sanctuary.

This program was further developed in 2013 with the assistance of funding from the J.D. Stout Trust. The overall focus on aquatic restoration at Longbush has now crystallised into three key components:

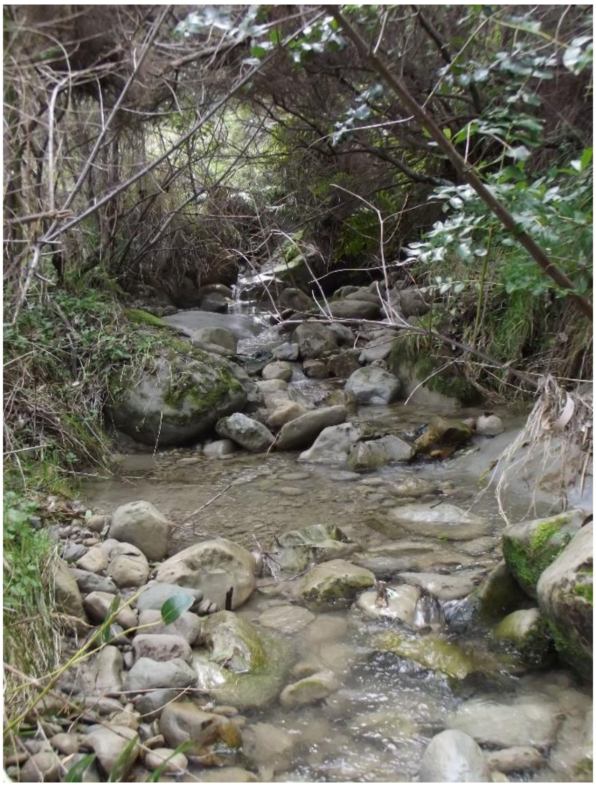
1. Measuring ecosystem processes and change over an extended time frame at the Longbush streams and wetlands (initially a year, and with plans for an ongoing program). This will provide information for the eco-sanctuary itself and its wider terrestrial initiatives, and highlight anticipated outcomes, and potential management and monitoring tools, for restoration projects elsewhere.
2. Incorporating into the survey waterways from neighbouring production landscapes, making comparisons between the impacts of varying land use practices on aquatic health and water quality, and assessing the potential for ecosystem improvement (NPSFM 2014).
3. Laying the ground work (water quality and ecosystem analysis) for establishing Longbush as a sanctuary and nursery for threatened and declining aquatic species, initially within the Waimata catchment, and potentially as a regional centre. Initial species targeted include freshwater crayfish (Koura, *Paranephrops planifrons*), freshwater mussels (Kakahi, *Echyridella menziesi*), the Giant Kokopu (*Galaxias argenteus*) and, later, Hochstetter frogs (*Leiopelma hochstetteri*).

To the north of the Waimata River, the steeper slopes are frequently covered in a mix of indigenous restoration or exotic plantation forest (above left). Adjacent to the river and to the south, the colluvial slopes and river terraces are the venue for a blend of production activities, including pastoral farming, annual cropping, perennial horticulture and exotic forestry (above right). In the upper right hand corner of the riverscape to the right, there appears to be a large, probably pre-European Maori settlement site. 2013.

Freshwater environments of Longbush ecosanctuary

Two first order streams on the property, Waikereru to the south and Waitui to the north, carry water from a 54 ha catchment and a 32 ha catchment respectively. Both of these catchments have slope gradients from Steep to Moderate (the latter at the point of our monitoring stations, which occur near the middle of a combined colluvial fan). A third, smaller and unvisited stream, Waihuna, traverses the southernmost boundary of Longbush. There are also two constructed wetlands on the property providing still water habitat: a 1600 sq metre open pond, adjacent to the Pa site and Italian poplar plantation (the Upper Wetland), with a maximum depth of approximately 2 metres; and a small pond of 80 sq m (Lower Wetland), 2m deep and surrounded by kanuka bush.

Figure 1 Longbush stream and wetland survey sites



Above left: Waitui at the entrance to the monitoring site.
Above right: Waitui looking north from the mid-point of the monitoring site.

Above right: Waikereru looking southeast from the mid-point of our monitoring site.
Above left: Waikereru looking northwest from the mid-point.

Survey methodology

Objectives

The current year-long survey of the Longbush freshwater landscape is designed to:

- Provide an accurate assessment of the hydrology and freshwater ecology of the Longbush Ecosanctuary as restoration initiatives here progress (including reforestation and native bird, reptile and invertebrate breeding programs) measuring incremental change in the context of such initiatives alongside ecosystem responses to climatic variation;
- Initiate an ongoing assessment of the state of waterways under differing land use scenarios in the Waimata and wider Te Tairawhiti river catchments;
- Help inform the management of upland waterways in production landscapes, particularly in the Waimata River catchment;
- Integrate with a wider Waimata River catchment planning and restoration process, supported by the work of Te Awaroa and Gisborne District Council.

Background

The surveys of the Longbush streams and wetlands include water chemistry and physical habitat assesments alongside detailed biological monitoring (periphyton, macroinvertebrates, macrophytes and fish). The physico-chemical and biological assessments will be conducted seasonally (four per annum) to assess any ongoing micro-effects of the ecological restoration programs, and also weather and climate related changes affecting the Longbush waterbodies. Habitat assessments will be made at six month intervals. Fish species will be surveyed annually. Other sampling times may be included to 'pick up' on specific climatic or land use variables.

Integrated with this survey work, a koura (*Parenthrops*, freshwater crayfish) breeding and restoration project is being implemented utilising the Longbush waterways.

The protocols utilised for physico-chemical and biological sampling and assessment derive from Ministry for the Environment *Monitoring Protocols and Quality Assurance Guidelines (Part 2)* for regional freshwater reporting (Davies-Colley *et* al, 2012); *Categories of periphyton for visual assessment,* Kilroy 2011; *A User Guide for the Macroinvertebrate Community Index,* Stark and Maxted, 2007; *Review of the New Zealand instream plant and nutrient guidelines and development of an extended decision making framework: Phases 1 and 2 final report*, Matheson, F., Quinn, J. and Hickey, C. 2012; and those of the GLOBE program, an international standard consistent with field-based freshwater monitoring, such as is in use by educational and community groups www.globe.gov The survey also incorporates the Attribute assessment methodology of the NPSFM 2014 and the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC) in its reporting.

Physico-chemical water characteristics

The physical and chemical characteristics of the streams and wetlands are assessed using the following: recent rain (during the previous week and previous four weeks); flow velocity and volume (where possible); air temp, water temp, dissolved oxygen, water clarity, Ammoniacal N (g/m3), Nitrate N (g/m3), TKN (g/m3), Total P (g/m3), Phosphate, pH, Conductivity and Salinity.

The program of physico-chemical attributes was amended from the original March 25^{th} survey period to take into account the National Policy Statement for Freshwater Management (NPSFM 2014), which provides a statutory framework within which to assess river and lake water quality. Since that time, the author of this report has also conducted an assessment of fourteen stream sites within the Waipaoa and associated catchments. In the process of this work, a monitoring and assessment methodology has been established that attempts to bring together the most current thinking and suite of evaluation tools. This suite has been applied to the Longbush survey to allow the direct comparison of the sites at the eco-sanctuary with others in the Waimata catchment and wider region.

Macroinvertebrates

Aquatic macroinvertebrates play a crucial role in water quality and aquatic ecosystem assessments. At Longbush, they are gathered from a stream reach of up to 50 metres in length that is indicative of the wider stream environment. The method of surveying the site is 'Riffle only', aiming to gather samples from the riffle areas, where these are present. This is the current preferred method amongst regional councils, and its use facilitates the comparison of Longbush data with that from other survey work.

Gathering of invertebrates is from five replicates (a total area of approximately 0.6 to 0.8sqm). For sampling, a 0.5mm mesh D net with an approximately 400mm bottom dimension is employed. Where this involves substrate disturbance, an area approximately 400mm by 400mm upstream of the net is disturbed, and the dislodged invertebrates gathered.

In addition, if other habitat types are present (e.g. macrophyte beds, undercut banks, woody debris) two further replicates from these sites may be gathered. This provides an 'All Habitat' assessment, gathering samples primarily from the substrate, but also from differing habitats present within the site that are representative of the overall stream habitat. Scores from all-habitat sampling are retained separately from those of the riffle-only method. The reasons for including the all-habitat method as an additional component is:

- It can be applied with a high level of consistency across a wide range of freshwater settings, including hard substrate (upland) and soft substrate (lowland) environments;
- Sampling from undercut banks, woody debris, macrophyte beds, pool environments and vegetated littoral margins, provides a better picture of the

food webs and trophic structures in a given setting, and hence the potential resources for native fish and other taxa (e.g. koura *Parenthrops sp.*). This is a particularly valuable consideration given the strong tangata whenua and wider community interest in the protection and restoration of he taonga tuku iho (treasures of the natural world) and mahinga kai (food gathering sites and activities) in our region.

Individual taxa are identified and their Macroinvertebrate Community Index (MCI), Quantified Macroinvertebrate Community Index (where an average sensitivity score per animal is then allotted to the site, QMCI) and Site Tolerance Score (STS) are recorded (Stark and Maxted, 2007, Appendix 1). This latter metric is currently being employed in the Parallel Water Monitoring Project (Te Roopu Waitohu o Turanganui a KIwa) with the intention of making the comparison between the MCI and the QMCI more easily recognisable to untrained participants (Storey, 2014). Further assessments of the invertebrate data are also performed, including total taxa and animal abundance, the percentage of the Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa, the aquatic invertebrate families most sensitive to impacts of contaminants and degraded aquatic environments, and the relative abundance of EPT animals present at the site.

The MCI is calculated from presence-absence data as follows.

$$\mathrm{MCI} = \frac{\sum_{i=1}^{i=S} a_i}{S} \times 20$$

where S = the total number of taxa in the sample, and a_i is the tolerance value for the ith taxon (see Table 1).

The QMCI is calculated from count data as follows.

$$\mathrm{QMCI} = \sum_{i=1}^{i=S} \frac{(n_i \times a_i)}{N}$$

where S = the total number of taxa in the sample, n_i is the abundance for the ith scoring taxon, a_i is the tolerance value for the ith taxon (see Table 1) and N is the total of the coded abundances for the entire sample.

10% or an indicative number of survey samples will be conveyed to an appropriate university or Crown Research Institute for auditing.

Periphyton

Periphyton is the slimy organic layer attached to submerged surfaces such as stones and wood, and is comprised mainly of microorganisms (e.g. algae, bacteria, microscopic animals) and the materials they secrete. Periphyton can take two general forms:

- Microscopic, single-celled algae forming thin layers (films) on stream bed materials;

- Algal colonies, growing in the water as filaments or mats.

Periphyton is a foundation of many stream food webs, and can provide an important food for stream macro-invertebrates which in turn provide food for fish and birds. Excess growths of periphyton, however, can make the stream habitat unsuitable for many invertebrate species. This reduces the ecological health of the stream, and can make the stream unattractive for swimming and other recreation (Biggs and Kilroy, 2000; Storey, 2014).

Periphyton is also an important indicator of water quality, and responses of these biological communities to contaminants can be measured at a variety of scales from the physiological to community. In general, periphyton is utilised as an indicator of water quality because:

- It has a naturally high number of species;
- It has a fast response to environmental change;
- It is relatively easy to sample;
- The threshold for tolerance or sensitivity to change (in particular the presence of nutrients e.g. nitrogen and phosphate) is reasonably well documented.

Since the ecological tolerances for many species are known, changes in community composition can be used to diagnose the environmental stressors affecting ecological health, as well as to assess biotic integrity. Along with Ammoniacal Nitrogen, Periphyton is a key attribute that must be monitored by local authorities for river Ecosystem Health (NPSFM 2014).

Periphyton assemblages have traditionally been visually assessed using the SHMAK Rapid Assessment Method (RAM1 or RAM2), the RAM2 method identifying 12 periphyton categories which are then recorded and interpreted utilising the SHMAK Stream Periphyton Monitoring Assessment Matrix.

> *Such analyses, if combined with some physical measurements (e.g. shading, water velocities, depths and/or substrate composition), can provide useful insights into the primary factors controlling the local development of different periphyton communities and assessment of causes of stream habitat degradation* (Biggs and Kilroy, 2000, p42).

The RAM2 allows for a good level of precision for activities such as State of the Environment reporting and detailed regional water quality assessments (*ibid*). During the period of lowered (summer) flows, it is anticipated that the visual assessments will be complemented by a quantitative laboratory assessment of Chl-a.

Currently, a visual assessment method is recommended that is an adaption of the RAM2 and that may also provide an accurate indication of levels of Chl-a without laboratory analysis (Kilroy *et al* 2011, 2013). For this, a minimum for four transects are employed, with five sampling points on each. Each sampling point comprises a 50cm diameter view, and is assessed for the percentage cover for each periphyton category and multiplied (i.e. weighted) by a pollution score to give a general assessment of water quality conditions (Periphyton Enrichment Score, PES) and visual levels of algal biomass (equivalent to mg/m2 Chl a). This method has been recommended by Richard Storey of NIWA for use in the Gisborne region (Storey, 2012) and will be employed at Longbush.

Table 1 **Periphyton assessment categories and scores (Kilroy, 2011; Storey, 2014)**

Observations	*Score*
Didymo	-
Cyanobacteria mats	1
Green filaments	2
Other filaments	1
Other Mats > 2mm thick (excluding Didymo & Cyano)	7
Sludge	8
Thin Films	9
Bare Area	10

Typical periphyton assemblages from cobble streams with sufficient light and nutrients: displaying levels of filamentous, mats >2mm thick, fine films and bare area. Photo: M. Palmer. Waitui, March 25 2014.

Figure 2 **Ecosystem health as measured by periphyton (mg chl-a/m2) (NPSFM 2014)**

Value	Ecosystem Health	
Freshwater Body Type	Rivers	
Attribute	Periphyton	
Attribute Unit	mg chl-a/m^2 (milligrams chlorophyll-a per square metre)	
Attribute State	**Numeric Attribute State**	**Narrative Attribute State**
	Annual Maximum*	
A	<50	Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat.
B	50-120	Occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat.
C	120-200	Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or alteration of the natural flow regime or habitat.
National Bottom Line	200	
D	>200	Regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat.

* Exceeded on no more than 2 occasions, with no exceedances in successive months (based on a monthly monitoring regime)

Macrophytes

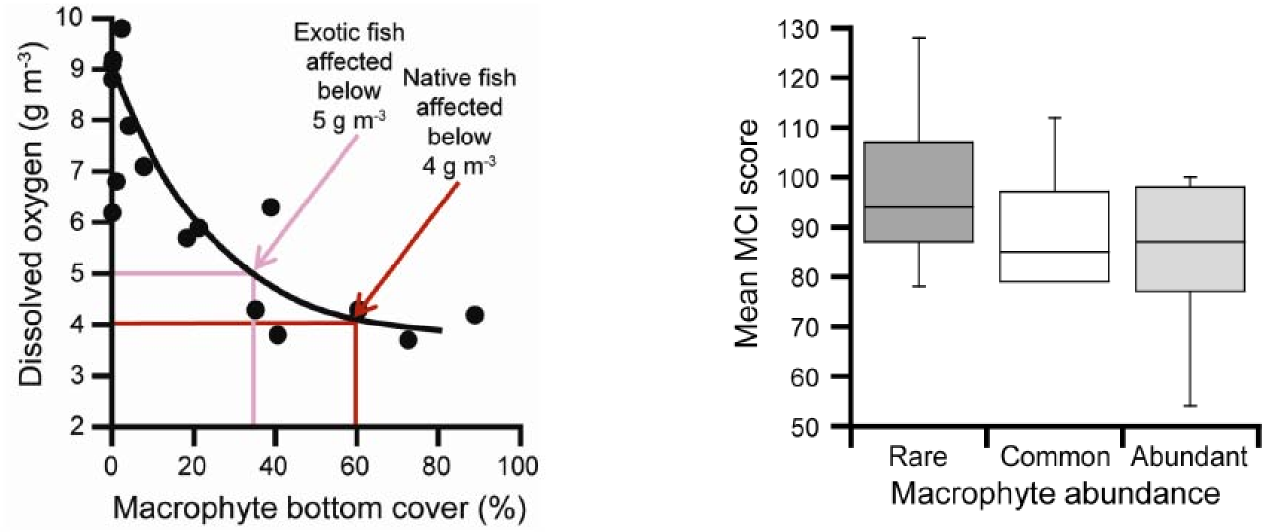
Macrophytes are conspicuous aquatic plants from a diverse assemblage of taxonomic groups frequently separated into four categories based on their habit of growth: e.g. floating unattached, floating attached, submersed, and emergent. Macrophytes are an important component of wetland, lake and river ecosystems, contributing to services such as carbon fixation, nutrient cycling and sequestration, and providing food and habitat for fish, invertebrate and bird populations. Overabundance of macrophytic growth can, however, impact on aquatic and human values, such as:

- Hindering recreational use;
- Reducing aesthetic quality;
- Restricting land drainage;
- Clogging water intakes;
- Reducing ecological habitat quality (e.g. through dramatically fluctuating DO levels and/or altering pH, smothering substrate and increasing deposited sediment).

Although macrophytes have been a part of state of environment reporting for some time, due to insufficient data no macrophyte abundance or nutrient guidelines for macrophytes has been identified for NZ rivers and streams. Despite a continuing paucity of empirical data, however, collation of current information has recently made possible the application of provisional guidelines for the protection of in-stream ecological condition, flow conveyance, recreation and aesthetics. These are:

50% or less of channel cross section area or volume (CAV); or 50% of the water surface area (SA) (Figure 4 below).

Figure 3 Indications of effects of macrophytes on periphyton and macroinvertebrates (Matheson *et al*, 2012).



These guidelines also provide the basis for our assessment categories for the Waipaoa catchment. As with other monitoring indices and stream characteristics and parameters measured, the raw figures are included in the site summary data sheets, should the guidelines need to be revisited and a re-assessment of the categories made. Figure 5 below identifies the range of assessment criteria currently available.

Figure 4 Provisional macrophyte abundance guidelines (Matheson *et al*, 2012)

Section summary:

- There are currently no national nuisance macrophyte abundance guidelines or protocols for macrophyte measurement available for streams and rivers but a need for these has been identified.
- Macrophyte abundance in streams and rivers should be quantified as a proportion of channel cross-sectional area or volume (CAV) and water surface area (SA) as these are the best indicators of nuisance effect. A suggested protocol for undertaking these measurements is provided in this report.
- A provisional guideline of ≤50% of channel CAV is recommended to protect instream ecological condition, flow conveyance and recreation values.
- A provisional guideline of ≤50% of channel water SA is recommended to protect instream aesthetic and recreation values.
- Research linking macrophyte abundance levels to effects on key instream values is required to refine these provisional guidelines.

Figure 5 Existing and new instream plant abundance guidelines to protect river values (Matheson *et al*, 2012)

Table 9-1: Existing and new instream plant abundance guidelines to protect river values. Guidelines generated by this project shown in bold font.

Value	Indicator	Guideline to protect value
Benthic biodiversity/ stream health/ life supporting capacity	Macrophyte channel cross-sectional area/volume (CAV)	**max. ≤50% (provisional)** [ab]
	Periphyton biomass (chla/AFDM)	max. ≤50 mg m^{-2} mean monthly ≤15 mg m^{-2} diatoms or filaments [ac]
	Periphyton weighted composite cover	**max. <20% excellent, 20-39% good, 40-55% fair, >55% poor (provisional)** [ac]
	Periphyton filamentous cover	- [de]
	Periphyton mat cover	- [de]
Trout fishery/angling	Macrophyte CAV	**max. ≤50% (provisional)** [abf]
	Periphyton biomass (chla/AFDM)	max. ≤200 mg m^{-2} (diatoms), ≤120 mg m^{-2} (filaments) ≤35 g AFDM m^{-2} [ag]
	Periphyton weighted composite cover	- [dh]
	Periphyton filamentous cover	max. ≤30%
	Periphyton mat cover	- [dh]
Aesthetic	Macrophyte water surface area cover (SA)	**max. ≤50% (provisional)** [ij]
	Periphyton weighted composite cover	**max. Nov to Apr ≤30%** [ij]
	Periphyton filamentous cover	max. Nov to Apr ≤30%
	Periphyton mat cover	max. Nov to Apr ≤60%
	Periphyton biomass (chla/AFDM)	max. Nov to Apr), ≤120 mg m^{-2} (filaments), ≤35 g AFDM m^{-2} [ij]
Contact recreation	Macrophyte CAV and/or SA	**max. ≤50% (provisional)** [ij]
	Periphyton weighted composite cover	**≤30%** [ij]
	Periphyton filamentous cover	max. Nov to Apr ≤30%
	Periphyton mat cover	max. Nov to Apr ≤60%
	Periphyton biomass (chla/AFDM)	max. Nov to Apr ≤120 mg m^{-2} (filaments), ≤35 g AFDM m^{-2} [ijk]
	Cyanobacterial mat cover	<20% surveillance, 20-50% alert, >50% action [il]
Flow conveyance	Macrophyte CAV	**max. ≤50% (provisional)** [m]
Water supply	Periphyton cover (weighted composite, filamentous, mat)	- [il]
	Periphyton biomass	- [il]
	Cyanobacterial mat cover	- [il]

[a] requires further data collection to refine.
[b] macrophyte CAV linked to diurnal dissolved oxygen minima data.
[c] periphyton chl *a* or cover as appropriate linked to macroinvertebrate community metrics.
[d] gaps could be filled with further analysis of the NRWQN database.
[e] examining relationships between periphyton filamentous and mat cover and macroinvertebrate community metrics.
[f] would also be advisable to examine relationships between macrophyte CAV and trout or trout prey item abundance.
[g] or research, examining periphyton chl a linked with trout or trout prey item abundance.
[h] examining relationships between periphyton composite, filamentous and mat cover and macroinvertebrate trout prey items (i.e., mayflies, net-spinning caddisflies) or deriving from biomass recommendation using periphyton chl a-cover relationship.
[i] requires research to develop/refine.
[j] relating on-site measurements of macrophyte SA or periphyton cover/biomass as appropriate to human perceptions of what constitutes an instream aesthetic or contact recreation nuisance.
[k] could also be derived from cover recommendation using periphyton chl *a*-cover relationship.
[l] linking cyanobacterial mat cover to toxin production threatening human/stock health, or periphyton biomass/cover to water supply taste and odour indicators.
[m] linking macrophyte CAV measurements to flow conveyance problems and flood events.

Stream habitat

Stream physical habitat is assessed utilising the following characteristics, informed by the *Stream habitat assessment protocols for wadeable rivers and streams in New Zealand* (Matheson, *et al*, 2009):

- Riparian and littoral margins
- Shade
- Erosion
- Stream type
- Adjacent land use
- Upper catchment land use
- Stream substrate
- Stream form
- Stream embeddedness
- Recent (sediment) deposits
- Recent weather
- Stream width and depth
- Stream velocity

These details are recorded on an Excel spreadsheet. The results are assessed through the Physical Habitat Assessment matrix (Storey, 2014), although the original data remains available for recording fine grained changes in habitat and for testing against other matrices. This provides one or more quantified metrics that can complement those of the invertebrate, periphyton and macrophyte surveys, identifying a wider background to current ecological status and the level of ecosystem health of the Longbush streams, and others that may be included in the program, and any changes to these that may occur over time.

March/April and August 2014 survey results

Background: recent weather and water levels

The two stream and two wetland monitoring sites are identified in Figure 1 above.

To initiate the project, the stream sites were surveyed on the 25th March 2014, just at the end of the summer dry spell, when 23.6mm of rain had fallen in the previous week and 71mm over the previous four weeks. In order to check some of the sample results, and compare the impacts of subsequent significant rain on these streams and on the main river stem at Goodwin's Road Bridge, a further sampling visit was undertaken on April 10th utilising only physico-chemical water quality parameters. The data retrieved from the sites at both times is outlined below.

Intermittent winter rainfall made access to the sites difficult until August 30th. The stream sites, surveyed on that date, had experienced 7mm and 143.4mm of rainfall for the respective week and 28 day periods.

The wetlands were almost dry at our Longbush visit on 25th March, making water quality surveying unreliable and were revisited on May 21st. While the upper wetland appeared to be about one third to a half full at this time, enabling sampling to be undertaken, there was still virtually no water in the lower wetland.

June proved to be almost twice as wet as the historical average, and precluded accurate biological assessment of stream health (macroinvertebrates and periphyton). We revisited the Longbush wetland sites on August 28th 2014, after there had been 11mm rain in the preceding week, and 147.4mm in the preceding 28 days, and conducted a complete survey of the upper wetland. The lower pond still had insufficient water to provide a realistic assessment of the water quality and biotic potential of the setting.

Water quality samples for lab analysis were taken from the upper wetland and the Waikereru and Waitui streams and provided to Hydro Technology Ltd for laboratory analysis.

Survey results: Habitat evaluation

Upper catchment land use

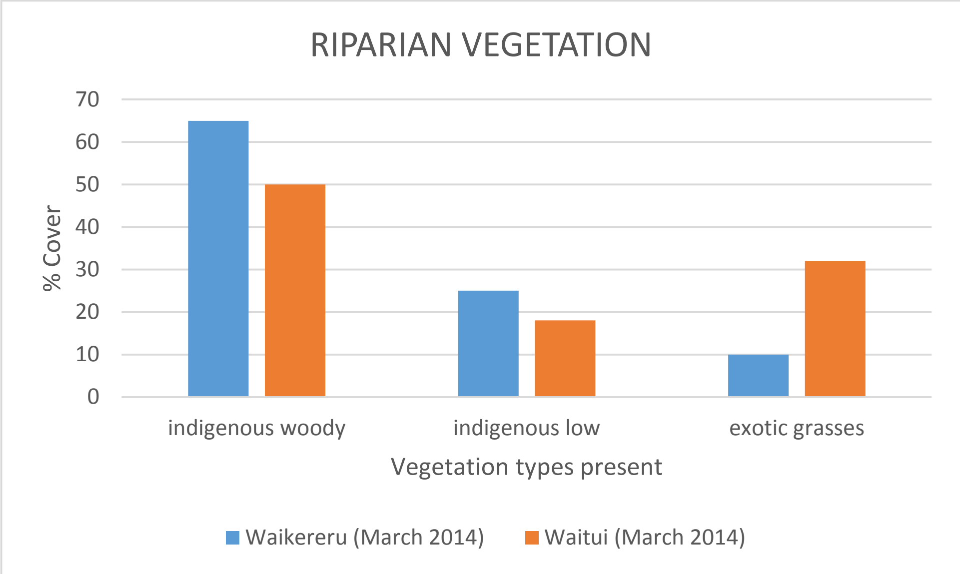
The upper catchment environment of the Longbush streams is largely comprised of regenerating native forest with some remnant grassland. This includes existing old trees scattered amongst the previous pastoral landscape, naturally emerging successional species, and specifically planted trees. Special attention has been provided to the riparian areas, and these have been fully planted, commencing in 2001 and completed this season.

Riparian and littoral environment

At our initial habitat survey (March 25th 2014) both streams exhibited good stands of woody indigenous vegetation (tall shrub and tree species) and levels of indigenous low vegetation (e.g. ferns, tall sedges) comprising 90% of Waikereru and 68% of Waitui stream riparians. Remnant grassland species occupied the remaining 10% and 32% respectively of the two sites. The more open aspects with grassland present reflects the situation of the survey sites adjacent to the access track. Nevertheless, both sites exhibited good shade, 90% (Waikereru) and 65% (Waitui), and there was no bank erosion at either.

After the August survey period, further growth of the indigenous species was noted, and it is expected that this will be reflected in the six-monthly habitat assessment detail.

Figure 6 Longbush streams riparian vegetation



In-stream habitat

Stream form at both sites was dominated by riffles, with pools, runs, and undercut banks present at each also. There was a bed of macrophytes, largely watercress, at Waitui, reflecting the more open aspect near the track. Stream substrates at both sites were comprised largely of gravels (2-58mm), with a good percentage of mixed size cobbles (25%), and evenly distributed amounts of boulders, sand and fine silt.

Embeddedness was good overall at both sites, with stable cobbles and gravel infill. Recent sediment deposits were only evident at Waikereru, however they are insufficient to affect the overall quality or habitat available at the site, and may reflect the combination of a small erosion lens upstream and the absence of a 'flushing' flow prior to March 25.

Macrophyte beds adjacent to the access track, Waitui stream.

Stream settings
Above: Waikereru (March 25, 2014)
Left: Waitui (March 25, 2014)

Figure 7 Longbush streams form

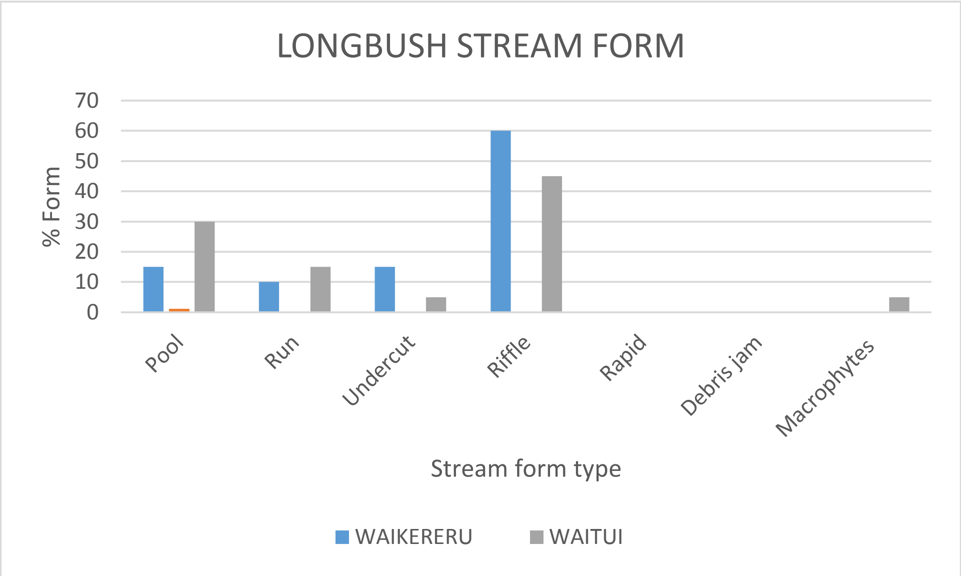


Figure 8 Longbush stream substrate

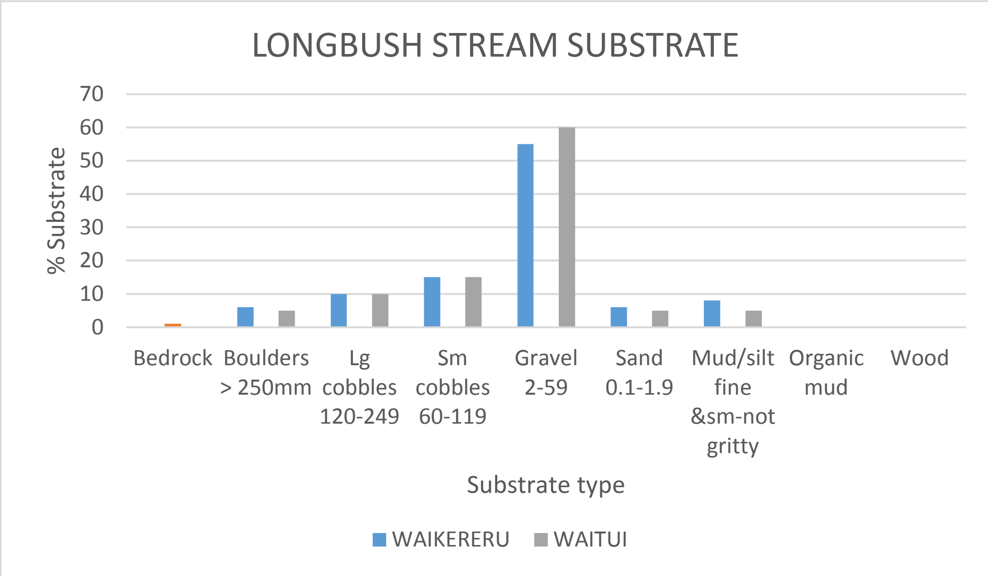


Figure 9 Longbush stream recent sediment deposits

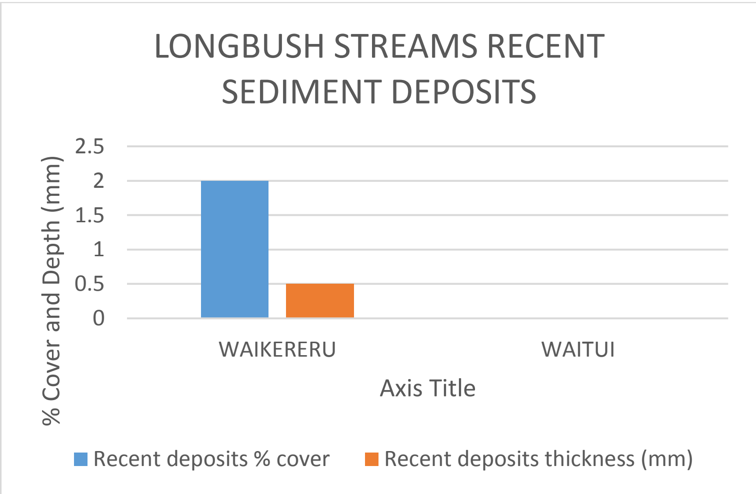
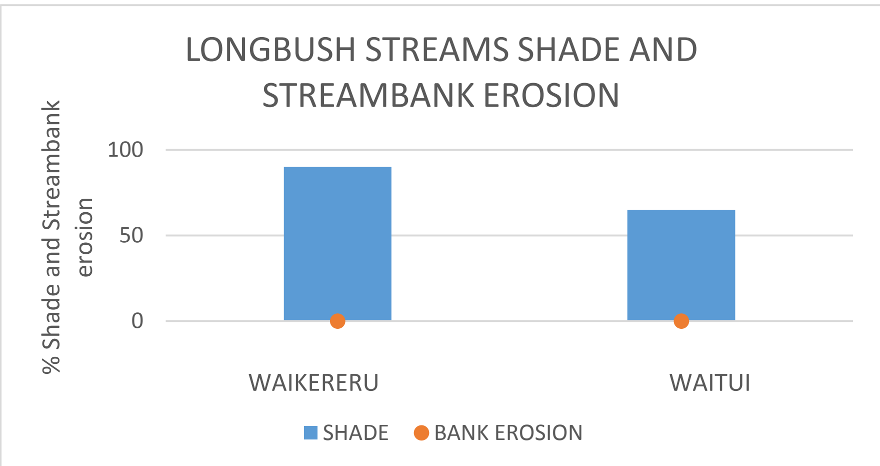


Figure 10 Longbush streams shade and streambank erosion



When assessed against the Physical Habitat Assessment matrix (Storey, 2014), the physical habitat characteristics of both streams were extremely high, Waikereru at 87% and Waitui 93%, placing them in the highest habitat grouping as currently assessed for our region. From indications at our August survey period (increased riparian vegetation growth, changes to stream morphology), it is anticipated that this assessment value may be enhanced at the next habitat survey period.

Survey results: periphyton

Periphyton were surveyed by a selection of 10 cobbles within the site reach (50m), complemented by a full-site visual assessment. The small size of the streams and the opportunity for survey participants to closely observe and identify the whole of the survey stream bed, make a combined use of a full visual survey alongside a selection of quadrats or stones the anticipated monitoring method.

Results were assessed using the Parallel Monitoring Assessment method (Storey 2014), which allows for a quantified assessment of stream enrichment and eutrophication, and also a mechanism for a visual indication of Chl-a, a key indicator attribute for ecosystem health in the proposed amendments to the NPSFM2014.

Despite the warm weather and low flows, the absence of significant levels of filamentous algae and sludge, and the presence of thin films and mats <2mm, provided for a periphyton enrichment score at Waikereru of 9.39, and at Waitui of 8.20, both falling into the PES Excellent category (Storey, 2014). Similarly, visually assessed levels of Chl-a measured as mg/m2 were assessed as 1.6 (Waikereru) and 1.18 (Waitui). Assessment matrices are outlined in Table 2 (Storey, 2014) and Table 3 (MfE, 2014) below.

Assessed against the PES, levels of periphyton enrichment in the late winter monitoring period remained at both stream sites in the Excellent (PES) and potentially the A categories (NPSFM 2014), unlikely to cause nuisance growths or dramatic DO fluctuations impacting on stream ecosystem functioning.

Figure 11 Longbush Streams Periphyton Enrichment Score

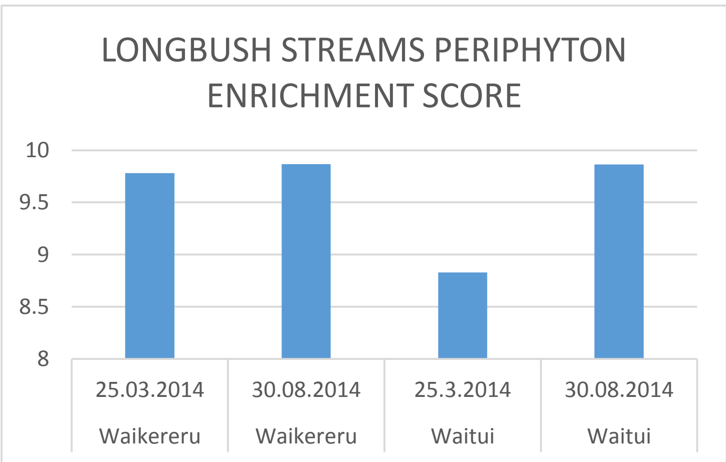


Figure 12 Visual assessment of algal biomass

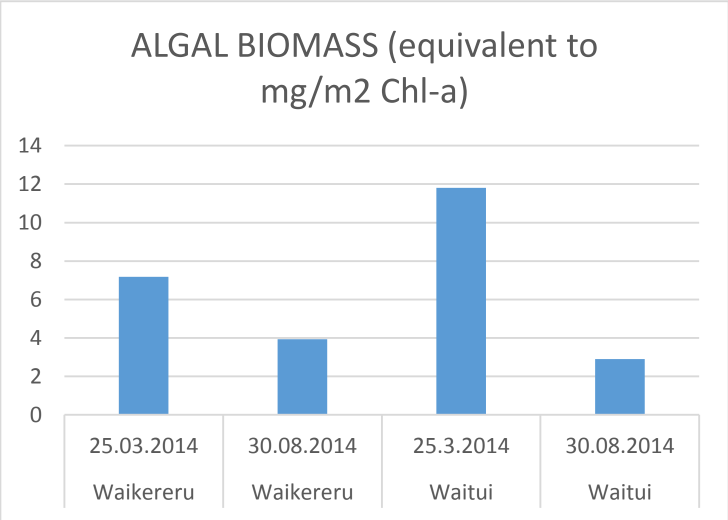


Table 2 Assessment grade PES and visual Chl-a (mg/m2)

Measure	**Assessment grade**				
	Excellent	Good	Fair	Somewhat poor	Poor
PES	>8	6-8	4-6	2-4	<2
Chl-a (mg/m2) (see Table 4 below)	<50	50-120	120-200	>200	

Table 3 Ecosystem health (Rivers) mg chl-a/m2

Value	Ecosystem health		
Freshwater Body Type	Rivers		
Attribute	Periphyton (Trophic state)		
Attribute Unit	mg chl-a/m^2 (milligrams chlorophyll-a per square metre)		
Attribute State	Numeric Attribute State (Default Class)	Numeric Attribute State (Productive Class[1])	Narrative Attribute State
	Exceeded no more than 8% of samples[2]	Exceeded no more than 17% of samples[2]	
A	≤50	≤50	Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat.
B	>50 and ≤120	>50 and ≤120	Occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat.
C	>120 and ≤200	>120 and ≤200	Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or alteration of the natural flow regime or habitat.
National Bottom Line	**200**	**200**	
D	>200	>200	Regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat.

1. Classes are streams and rivers defined according to types in the River Environment Classification (REC). The Productive periphyton class is defined by the combination of REC "Dry" Climate categories (i.e. Warm-Dry (WD) and Cool-Dry (CD)) and REC Geology categories that have naturally high levels of nutrient enrichment due to their catchment geology (i.e. Soft-Sedimentary (SS), Volcanic Acidic (VA) and Volcanic Basic (VB)). Therefore the productive category is defined by the following REC defined types: WD/SS, WD/VB, WD/VA, CD/SS, CD/VB, CD/VA. The Default class includes all REC types not in the Productive class.

2. Based on a monthly monitoring regime. The minimum record length for grading a site based on periphyton (chl-a) is 3 years.

Figures 11 and 12 above do, however, reflect the effect of winter rainfall on flushing any build-up of periphyton, particularly in the more open aspects of Waitui. This flushing effect was also evident in the alteration to stream form and substrate particularly at Waitui, with a larger percentage of bedrock, boulders and large cobbles exposed, and the deeper pools replaced with more riffle/run sequences.

The role of high flows in removing periphyton and macrophyte build-up and deposited sediment and facilitating stream habitat diversity is a focus of research regionally (Palmer, 2014).

Survey results: macrophyte growth

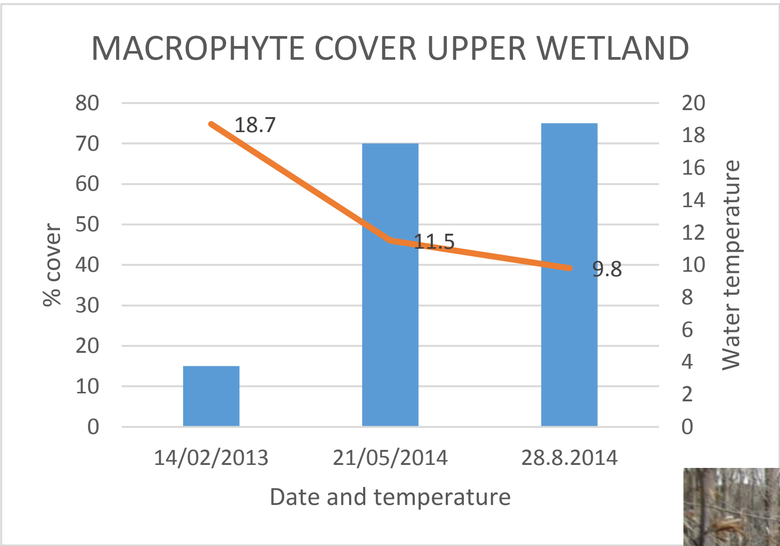
Stream sites

No macrophytes were present at either stream site at our August survey period, although a small clump of watercress was visible at the northern limit of the Waitui site.

Wetland sites

The Upper Wetland, however, was 70% covered with a dense mat of *Spirodela punctata* (duckweed), a free-floating exotic macrophyte. Macrophyte cover records for the Upper Wetland are outlined in Figure 13 below.

Figure 13 Macrophyte cover Longbush Upper Wetland



Macrophyte blooming at the Longbush Upper Wetland does not appear to be associated with water conductivity or levels of nitrate or ammonia. Nor was temperature an apparent factor.

Total Phosphorous, however, was extremely high at 66mg/m3, the threshold for unacceptable (degraded) status being an annual median of 50mg/m3 (NPSFM 2014). Shallowing of the wetland from av. 1.6m deep to av. 1m appears to be a possible contributing element, potentially concentrating the P levels present.

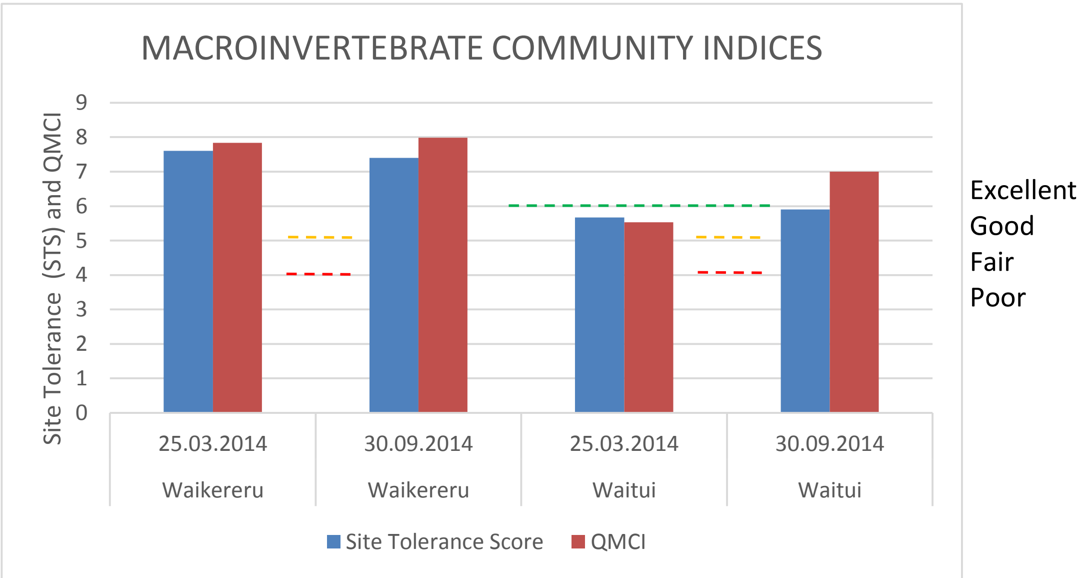
Survey results: macroinvertebrates

Stream sites

Macroinvertebrate animals were collected from a 50 metre reach indicative of the wider stream environments. Because of the relatively low flows at both streams, and the embedded and diverse character of the substrate, samples were largely gathered from individual stones along with some collected from the disturbance of adjacent sediments. At each site, a total of 5 to 7 replicate samples were taken from the riffle areas and combined for identification and counting.

As outlined at Figure 14 below, the macroinvertebrate taxa recovered from the Longbush streams provide evidence for waterways in the upper Good to Excellent categories for biological condition when assessed by the presence or absence of specific indicator taxa (Site Tolerance, STS, or Macroinvertebrate Index, MCI, scores), or the abundance of the taxa present (QMCI) (Stark and Maxted, 2007).

Figure 14 Macroinvertebrate community indices Longbush ecosanctuary



Similarly, the presence of the most sensitive indicator taxa (*Ephemeroptera, Plecoptera, Trichoptera,* EPT) and their relative abundance indicate similar levels of high ecosystem well-being.

Figure 15 EPT taxa and EPT animals Longbush streams

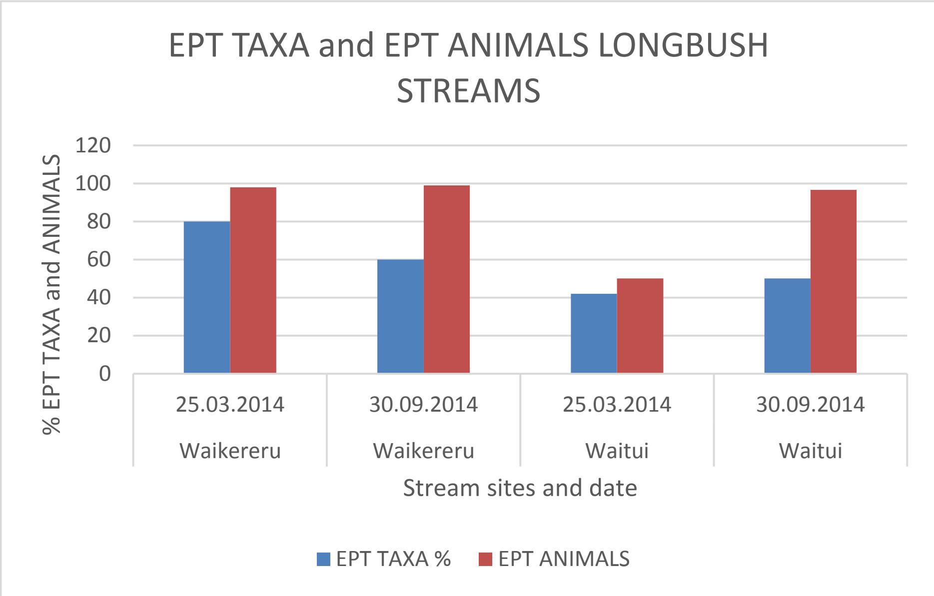


Table 4 Interpretation of MCI scores

Interpretation of MCI scores (Stark and Maxted, 2004, 2007; Storey, 2014)				
Index	Excellent	Good	Fair	Poor
Narrative description	Clean water	Doubtful quality or possible mild pollution	Probable moderate pollution	Probable severe pollution
Taxa total	TBE	TBE	TBE	TBE
Macroinvertebrate community index (MCI)	>119	100-119	80-99	<80
Quantitative macroinvertebrate community index (QMCI)	>5.99	5-5.99	4-4.99	<4
Site tolerance score (STS)	>5.99	5-5.99	4-4.99	<4
EPT Taxa %	TBE	TBE	TBE	TBE
EPT animals %	>50	15-49	1 to 14	<1

Overall, the Waikereru stream appears relatively stable in terms of the macroinvertebrate indices measured during our current survey and previous monitoring visits, while the Waitui shows a distinct, albeit gradual sign of improvement. While this latter may be due to higher flows and improving conditions for the more sensitive taxa, the data gathered previously from 2012 and 2013 appear to support this perception (Figure 12 below). It is considered that a likely explanation for the possible improvement is the ongoing growth of the indigenous riparian vegetation and subsequent shading at the site, and in the upper headwaters.

Thus, Waikereru has been situated in the Excellent category for MCI for three of the four sampling periods, slipping into the upper Good in mid-February 2013. When abundance values were estimated for this sample period, however, Waikereru scored 6.88 (Semi-quantified macroinvertebrate community index, SQMCI, Excellent). Interestingly, previous surveys providing comparisons of medium with low flow conditions, indicate a tendency regionally for lowered MCI and QMCI or SQMCI scores with reduced flow conditions and stream levels (Appendix 3 below).

Figure 16 Waikereru and Waitui streams MCI Oct 2012 to August 2014

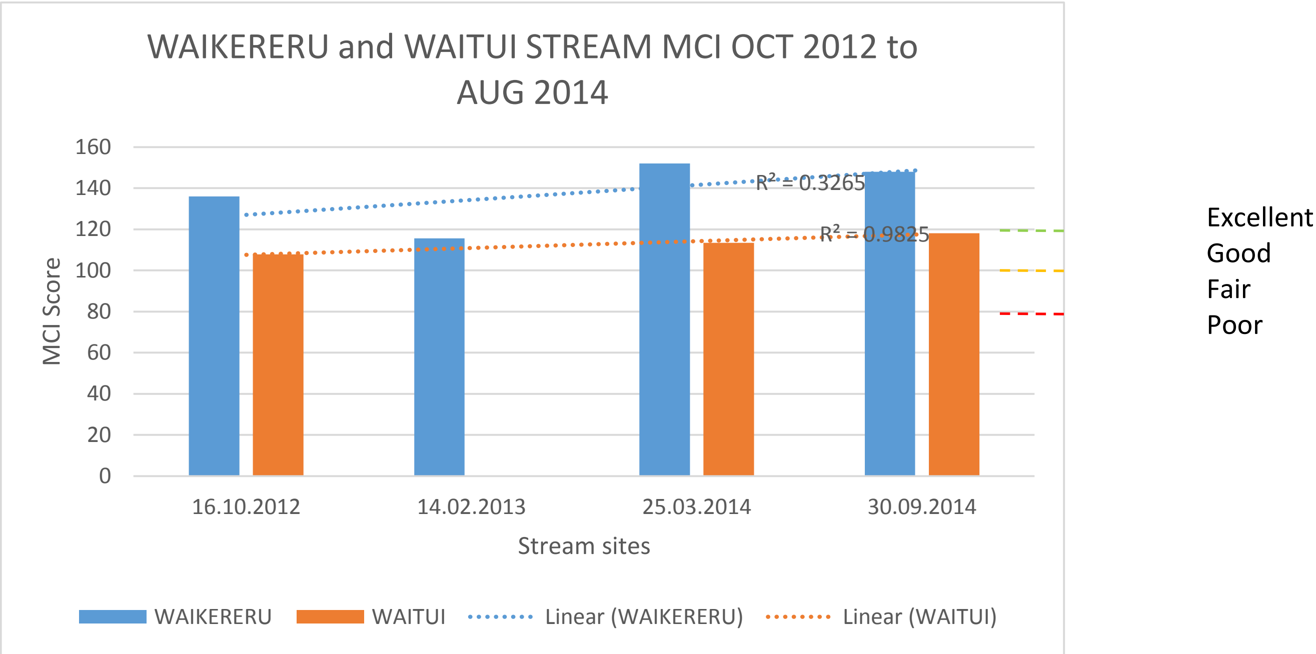


Table 5 Overall macroinvertebrate indices 2014 survey period

SITE	Waikereru	Waikereru	Waitui	Waitui
Date	25.03.2014	30.09.2014	25.03.2014	30.09.2014
TOTAL ANIMALS	129	136	139	76
TOTAL TAXA	5	5	12	10
MCI	152	148	113.4	118
QMCI	7.84	7.99	5.53	7
STS	7.6	7.4	5.67	5.9
EPT TAXA %	80	60	42	50
EPT ANIMALS	98	98.9	50	96.6

One unexpected outcome of the most recent sampling visit was a large number of leeches (*Hirudinea sp.*) attached to the cobble undersides at Waitui, and to a lesser extent at Waikereru. Although common in good quality as well as degraded streams, the presence of these predatory animals in the numbers evident has not been observed by the author previously in indigenous forest and restoration landscapes.

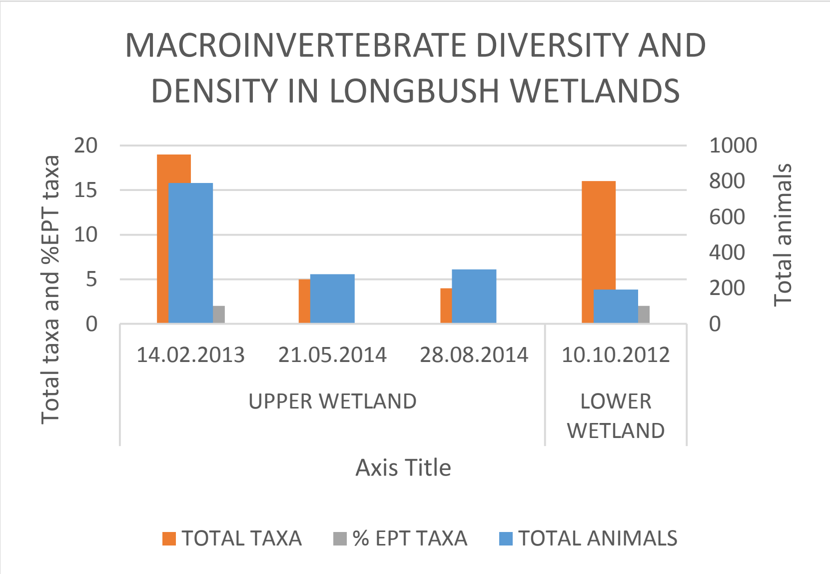
Wetland sites

Although invertebrate taxa and community assemblages are not assessed quantitatively for lakes and wetlands as they are for flowing waters, nevertheless they do provide an important component in any reporting on wetland ecology. At Longbush, overall taxa diversity was greatest when the wetlands were full of water, despite the season when the sampling took place.

In mid-October 2012, 16 different invertebrate taxa were found in the lower wetland, and on February 14th 2013, 19 taxa in the upper, including two sensitive EPT taxa in each. Water levels at both venues were high (c.2m and c.1.6m average respectively).

Sampling from the upper wetland in late-May and late-August when water levels were moderately low (average depth estimated < 1.2m) yielded only five and four different taxa respectively. Water levels at both periods were too low to allow for sampling from the lower wetland.

Figure 17 Macroinvertebrate diversity and density in Longbush wetlands



Dominant invertebrate taxa in the wetlands were as follows:

Table 6 Dominant invertebrate taxa Longbush wetlands

SITE	Upper Wetland			Lower
Date	14.02.2013	21.05.2014	28.08.2014	10.10.2012
DOMINANT TAXA	Potamopyrgus	Oligachaete	Copepoda	Potamopyrgus
TAXA MCI SCORE (SB)	2.1	3.8	2.4	2.1
TOTAL ANIMALS (est)	500	250	300	100
DOMINANT TAXA % TOTAL	63.3	89.6	98	52.1

Water quality: physico-chemical assessment

Background

As referred to earlier, we have recently instituted a physico-chemical survey regime for the Longbush streams and wetlands that is designed to provide a robust level of information and consistency relating to key water quality parameters as identified at a national level through the monitoring protocols provided by the MfE (Davies-Colley *et al*, 2012) and the attribute values established by the NPSFM 2014. The following narrative assessment of the total survey periods thus provides a blend of field and laboratory information, and reflects a transition to such a wider consistency, including the parameters chosen and the laboratory techniques employed.

Stream sites

Any quantitative ranking of water clarity should be viewed in the context of the recent rainfall data, with the Waikereru and Waitui streams having clarity-tube readings of 82 and 78cm respectively after a previous 6-day rainfall of 26.3mm (71mm over the previous four weeks) on March 25th 2014. This only decreased to 76cm and 74cm respectively on April 10th, despite an increase of rainfall to 73.8mm over the previous six days (144.8mm over the previous four weeks).

The minimal effects on water clarity of this marked increase in rainfall can be viewed as a positive outcome of the riparian and catchment vegetation restoration process, and the associated reduction of inputs of sediment to the stream both from upper catchment slopes and stream banks. While during these high rainfall events clarity at Longbush remained stable, at the Goodwin's Road bridge GDC monitoring site approximately three kilometres downstream, the clarity on the 10th April had fallen to 3cm from 73cm seven days earlier.

Levels of pH across both Longbush stream sites on both survey days ranged from 8.16 to 8.5. The strict use of pH as an indicator of water quality in the Tairawhiti setting is problematic, however, as even the highest quality waterways in the region tend to be slightly to moderately alkaline, probably reflecting the young, calcium-rich sedimentary geology from which they derive.

Similarly, conductivity levels in the Longbush streams, as elsewhere across the region, are considerably greater than 250µS/cm threshold for Poor (SHMAK 2002; Storey, 2014). In a survey of over twenty five streams across the Gisborne Tairawhiti region since the summer of 2011-12, only one stream was found (Wharekopae at Rere Falls) with conductivity levels lower than 250µS/cm. This was true even of streams with the highest ecological value, where conductivity levels could even rise to between 400 to 580µS/cm (Palmer 2014). Such findings would suggest the use of conductivity per se may also be of little value as a direct indicator of water quality or stream biological condition, although it may provide indications of elevated stressor impacts against established base line or reference levels for each site, reflecting catchment landscape or land use change.

Stream nitrate levels provided a more unexpected result for the survey assessment. At the March 25th survey period nitrate levels at Waikereru and Waitui were 1.78 mg/L and 1.33 mg/L respectively. These were significantly elevated against the impacted pastoral farm sites surveyed around this period. At Goodwin's Rd bridge site, for instance, on April 3rd nitrate levels were 0.22mg/L, the lowest level measurable with our field equipment. This was also the case at the Hamanatua Stream that drains a largely pastoral farming and peri-urban catchment, and whose outlet is adjacent to the Wainui Beach surf-lifesaving club.

In order to assess the accuracy of these readings, we returned to Longbush 10 days later after the significant rainfall at the beginning of April. After 73.8mm of rain had fallen, nitrate levels had dropped here to 0.89mg/L (Waikereru) and 0.443mg/L (Waitui). This compared to increases in nitrate levels to 0.44 and >3.54 at the Goodwin's Road and Hamanatua sites respectively. Thus, unlike the impacted sites where nitrate levels markedly increased with moderate rainfall and the associated farm run-off and removal of periphyton beds, at the regenerating Longbush sites, nitrate levels were reduced. At our August survey period, nitrate levels were well below the NPSFM 2014 median for A status both at Waikereru (0.3mg/L) and at Waitui (0.29mg/L).

Because of the potential significance of these and similar findings to water quality assessments in the context of land use patterns and associated freshwater ecosystem management, particularly the use of threshold values for specific chemical parameters, and to ensure consistency with other regional monitoring programs, subsequent physico-chemical analysis of the Longbush waterways is being provided by Hydro-Technologies Laboratory (Gisborne) and Hills Laboratories (Hamilton).

Table 7 Nitrate (mg N03-N/L) assessment guidelines (proposed MfE, 2013)

Level	Band p/a (med; 95th)	Narrative values
A	<1 <1.5	A: 99% species protection level: No observed effect on any species tested
B	1–2.4 1.5-3.5	B: 95% species protection level: Starts impacting occasionally on the 5% most sensitive species
C	2.4-6.9 3.5-9.8	C: 80% species protection level: Starts impacting regularly on the 20% most sensitive species (12% reduction in growth)
D	>6.9 >9.8	D: Impacts on growth of multiple species, and starts approaching acute impact level (ie risk of death) for sensitive species at higher concentrations (>20 mg/L)

Levels of toxic Ammoniacal N at both streams were at or below the level of detection (<0.01mg/L) at our August survey period, well within the NPSFM median for A status. Levels of Dissolved Reactive Phosphorous (DRP) levels were relatively high compared with the median for the nearest downstream GDC monitoring site (LAWA, Goodwins Rd Bridge). Dissolved Oxygen (DO), a critical indicator of the life supporting capacity and well-being of ecosystems, at the August period was high for both streams (well within the NPSFM 2014 median for A status) and *E coli* levels extremely low at 5MPN/100ml (Waikereru) and 2MPN/100ml (Waitui).

More empirical data needs to be assembled, however, before conclusions can be drawn around the overall physico-chemical characteristics and ecological resilience of these first-order waterways, and those similar, in the context of the multiple stressors of nutrients, temperature, reduced flows, pH and dissolved solids (sediment and entrained nutrients) and, in particular, diurnally fluctuating levels of DO.

Wetlands

Clarity in still waters such as lakes and wetlands is frequently indicative of levels of micro-algal and planktonic biomass. Despite differences in temperature and rainfall levels prior to our sampling periods, water clarity remained consistent, suggesting a level of stability in nutrient inputs and micro-algal growth. At our August sampling period, Chl-a levels in the upper wetland were measured at 18mg/m3, suggesting that elevated nutrient levels may be slightly impacting on ecological communities in the wetland (NPSFM 2014). This appears consistent with our laboratory assay for Total Phosphorous, which, at 66mg/m3 would fall into an unacceptable category if it were to reflect the median value for the site (*ibid*), and indeed might be a driver for the heightened Chl-a count.

In terms of nitrogenous compounds, both Ammoniacal-N and Nitrate-N at the upper wetland at this time were at, or below, the level of detection.

More empirical data will be required to assess this initial sampling result, however, in the interim, there would appear to be value in developing an assessment of the potential sources of P to the wetland, including entrainment in the wetland sediments themselves, and methods of reducing this in order to facilitate good habitat for indigenous species introduction.

At 240MPN/100ml, the Upper Wetland on August 28th exhibited moderate to low *E coli.* Levels. A median of >1000MPN/ml is similarly considered the threshold for degraded (river) status (NPSFM 2014). The most likely source of the bacteria in the upper wetland, however, would be avian from waterfowl and possibly run-off from the gazed areas nearby.

Details of monitored physico-chemical parameters are outlined in Tables 9 and 10 below.

Table 8 Physico-chemical characteristics of Longbush Waikereru and Waitui Streams

Site	Waikereru			Waitui		
Date	25.3.14	10.4.14	30.8.14	25.3.14	10.4.14	30.8.14
Time started	10.15am	11am	11.45am	2pm	12.30pm	1pm
Weather conditions today	Fine	Showery	Overcast	Fine	Showery	Fine
Rainfall (mm) in previous week[1]	23.6	73.8	7	23.6	73.8	7
Rainfall (mm) in previous month[2]	71		147.4	71		147.4
Flow (high/med/low)	Low	Med	Med	Low	Med	Med
Air temperature °c	16.9	19.2	13.5	23.1	20	15
Water temperature °c	14.2	16.3	9.8	16	15.8	10.7
Water clarity (clarity tube) cm	82	78	82	76	74.3	86
pH	8.38	8.5	8.65	8.16	8.38	8.15
Dissolved oxygen (mg/L)	n/a	9.1	11.7	n/a	7.6	11.5
Conductivity (micro-S/cm)	680	580	550	540	500	540
Ammoniacal Nitrogen (mg/L)			<0.01			<0.01
Nitrate (mg/L NO3-N)	1.78	0.443	0.3	1.33	0.89	0.29
Dissolved reactive phosphorous (DRP) g/m3			0.056			0.018
Salinity			0.3			0.3
E coli (MPN/100ml)			5			2

NMTT field equipment
Hydro Technologies/Hills Laboratories

[1] Gisborne airport
[2] Gisborne airport

Table 9 Physico-chemical characteristics of Longbush Wetlands						
Site	**Upper**			**Lower**		
Date	14.02.13	21.05.14	28.08.14	10.10.12		
Time started	10.10am	10.15am	9.45am	12.55am		
Weather conditions today						
Rainfall (mm) in previous week[3]			9.2			
Rainfall (mm) in previous 28 days[4]			15.2			
Water level (high/med/low)	High	Low	Low	High		
Air temperature °c	25	19.1		19		
Water temperature °c	18.7	11.5	9.8	14.5		
Water clarity (clarity tube) cm	57	46	62	55		
pH	6.75	7.52		7.98		
Dissolved oxygen (mg/L)			9.4			
Conductivity (micro-S/cm)	500	310	210	250		
Ammonia Nitrogen (mg/L)			<0.01			
Nitrate (mg/L NO3-N)		<0.22	<0.002			
Phosphate		0.007				
Total Phosphorous			0.066			
Chlorophyll A (mg/m3)			18			
Salinity	0.3			0.13		
E coli (MPN/100ml)			240			

[3] Gisborne airport

[4] Gisborne airport

References

Biggs and Kilroy, 2000. *Stream periphyton monitoring manual.* Ministry for the Environment.

Davies-Colley, R.J., Hughes, A.O., Verburd, P. and Storey, R. 2012. *Monitoring Protocols and Quality Assurance Guidelines (Part 2).* Ministry for the Environment.

Kilroy, C. 2011. *Categories of periphyton for visual assessment.* For ECan periphyton monitoring program.

C Kilroy, DJ Booker, L Drummond, JA Wech & TH Snelder. 2013 'Estimating periphyton standing crop in streams: a comparison of chlorophyll a sampling and visual Assessments'. New Zealand Journal of Marine and Freshwater Research, 47:2, 208-224, DOI:10.1080/00288330.2013.772526

Matheson, F., Quinn, J. and Hickey, C. 2012. *Review of the New Zealand instream plant and nutrient guidelines and development of an extended decision making framework: Phases 1 and 2 final report.* Ministry of Science and Innovation.

New Zealand Government. *National Policy Statement for Freshwater Management 2014.*

Palmer, M.J. 2014. *Winter biomonitoring survey for the Waipaoa River and associated catchments: Gisborne District Te Turanganui a Kiwa*. Gisborne District Council.

Stark, J.D. and Maxted, J.R. 2007. *A User Guide for the Macroinvertebrate Community Index*. Ministry for the Environment. Cawthron Report No.1166.

Storey, R. 2012. *Biological monitoring of rivers in Gisborne District: Benefits, costs and recommendations*. Prepared for Gisborne District Council.

Storey, R. 2014. *Guidelines for Stream monitoring in NIWA's community monitoring study*. NIWA.

Appendix 1 Longbush field reporting sheet		
SITE RECORD SHEET	CATCHMENT/RIVER:	
Site name	STREAM FORM %	PHYSICO-CHEMICAL
Site #	Pool	Air temp ©
Date	Run	Water temp ©
Time	Undercut	Clarity (cm)
Altitude (m.asl)	Riffle	Conductivity (µS)
Easting	Rapid	pH
Northing	Debris jam	Salinity (ppt)
Tide (high)	Macrophytes	Ammoniacal N
RECENT RAIN (week)	Slumped bank	Nitrate
RECENT RAIN (4 weeks)	Other	Phosphate
RIPARIAN & LITTORAL MARGINS (%)	EMBEDDEDNESS %	DO
Taha matau	Tight	Other
indigenous woody	Good	
indigenous low	Moderate	
indigenous wetland	Loose	
pasture grasses	RECENT DEPOSITS % COVER	
exotic woody	RECENT DEPOSITS THICKNESS	MCI SAMPLING METHOD
exotic low	STREAM SUBSTRATE (mm) % cover	
riverbed	Bedrock	Total animals
man made	Boulders > 250	Total taxa
Taha maui	Lg cobbles 120-249	Total EPT taxa
indigenous woody	Sm cobbles 60-119	Total % EPT animals
indigenous low	Gravel 2-59	Total %EPT taxa
indigenous wetland	Sand 0.1-1.9	MCI score
pasture grasses	Mud/silt (not gritty)	QMCI score
exotic woody	Organic mud	SQMCI score

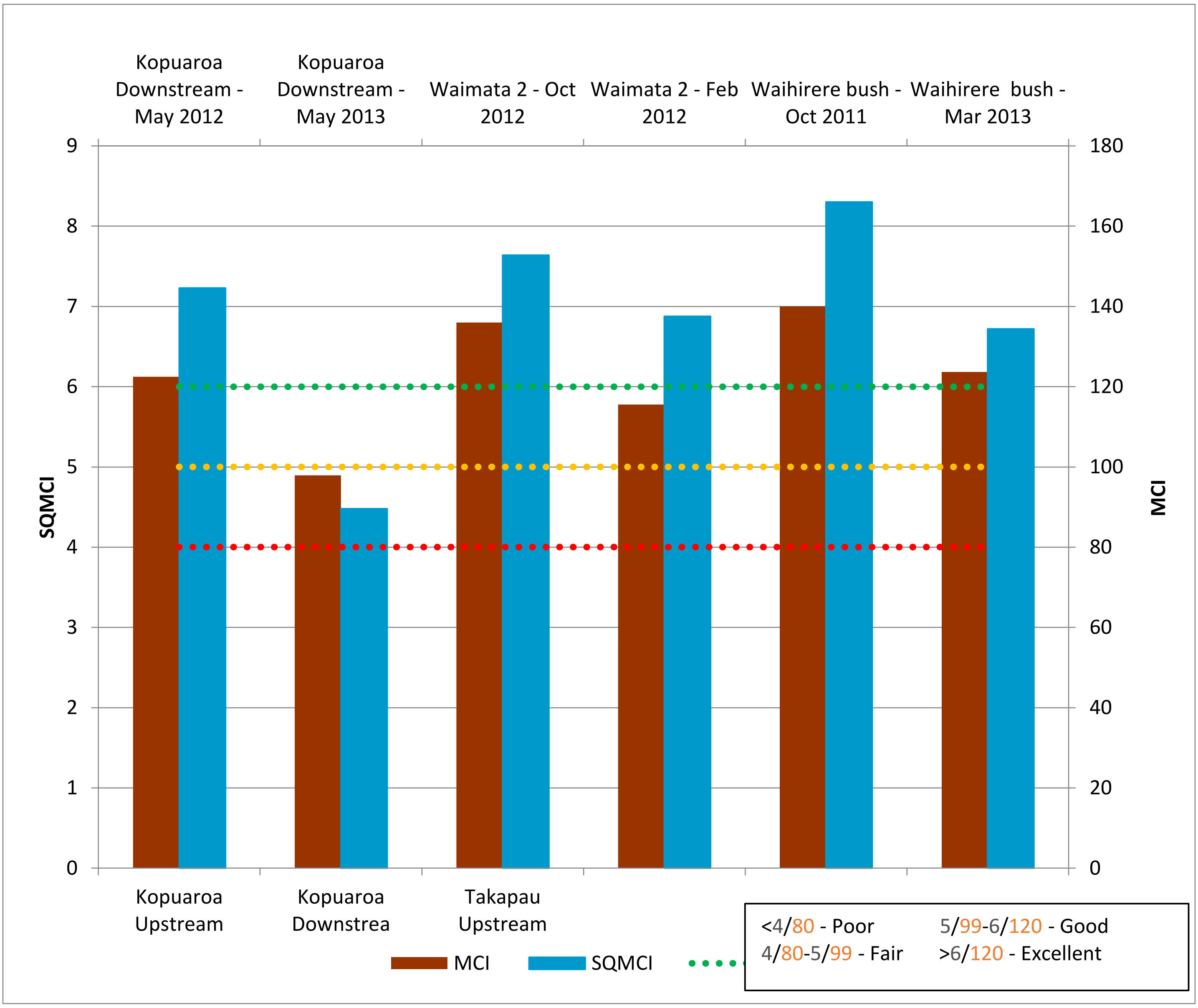
exotic low	Woody debris	
riverbed	Other	
manmade	STREAM WETTED WIDTH (Av)	
SHADE %	STREAM DEPTH (Av)	
BANK EROSION %	STREAM CHANNEL WIDTH(Av)	
Taha matau	VELOCITY (m/sec)	
Taha maui	FLOW (cum/sec)	
STREAM TYPE (hb/sb)	PERIPHYTON % COVER	
ADJACENT LAND USE	CE, DE or BG0*	
	Didymo	
UPPER CATCHMENT LAND USES	Cyanobacteria mats	
	Green filaments	
MACROPHYTES % cover	Other filaments	
Emergent plants	Other Mats > 2mm thick (excluding Didymo & Cyano)	
Surface-reaching plants		
Below-surface plants	Sludge	
Av height below-surface plants as % channel depth	Thin Films	
	Bare Area	
Total plants		

Appendix 2 Macroinvertebrate species Longbush streams

SITE	Waikereru	Waikereru	Waitui	Waitui			Substrate derived sensitivity scores (hard bottom; soft bottom)	
Date	25.03.2014	30.08.2014	25.03.2014	30.08.2014				
Sample protocol		rock/kick net/riffle		rock/riffle			**hb**	**sb**
Invertebrate taxa								
Plecoptera/Stoneflies								
Acroperla			1				5	5.1
Ephemeroptera/May.F								
Coloboriscus	2	32	4	3			9	8.1
Deleatidium	120	78	60	52			8	5.6
Nesameletus				1			9	8.6
Trichoptera/Caddis.F								
Aoteapsyche			1	1			4	6.0
Costachorema	2		1				7	7.2
Hydrobiosis	1		1				5	6.7
Olinga			1				9	7.9
Orthopsyche		6		1			9	7.5
Pycnocentrodes	1						5	3.8
Megaloptera/Dobson.F								
Archicauliodes	1	14	1				7	7.3
Coleoptera/Beetles								
Elmidae			3				6	7.2
Odonata/Dragonflies and Damselflies								
Diptera/True flies								
Chironimidae			1				2	3.8
Stratiomyidae			1				5	4.2

Hemiptera/Bugs								
Crustacea								
Arachnida								
Dolomedes				1			5	6.2
Acarina								
Mollusca								
Potamopyrgus	2		40	6			4	2.1
Nematoda								
Nematomorpha								
Platyhelminthes								
Cura			20	2			3	0.9
Oligachaete								
Hirudinea		5	2	9			3	1.2
TOTAL ANIMALS	129	136	139	76				
TOTAL TAXA	5	5	12	10				
MCI	152	148	113.4	118				
QMCI	7.84	7.99	5.53	7				
EPT TAXA %	80	60	42	50				
EPT ANIMALS	98	98.9	50	96.6				

Appendix 3 Medium cf low flow conditions (Tairawhiti survey detail)



In the graph above, the higher sets of scores were during periods of moderate flows, even though the periods were spread across late autumn and spring, while the lower scores from each site reflect low flow conditions (despite the season). In May 2012, for instance, water levels at Kopuaroa (Ruatorea) were very low, and periphyton levels and surface sediment deposits elevated, the associated macroinvertebrate communities tending to reflect this lowering in habitat quality. Although these monitoring periods were at random times across two years, the streams themselves had changed little in form or adjacent and upper catchment land use. Despite the impacts of such climatic variables, however, the Waikereru and Waihirere streams remained in the Excellent category for biological value as assessed by the Semi Quantified MCI (SQMCI).