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Catchment environmental monitoring report: 2011/12

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1 Introduction

1.1 Background

As part of Project Watershed and Peninsula Project implementation, the Catchment Environmental Monitoring (CEM) Programme was developed to demonstrate the long term benefits of soil conservation. To date, monitoring has been established in selected priority catchments for soil conservation in the Waipa, Lower Waikato, Upper Waikato and Coromandel management zones.

The Catchment Environmental Monitoring (CEM) programme allows the Waikato Regional Council to:

- demonstrate the long term benefits of soil conservation and river management work programmes
- better utilise resources and leverage opportunities to co-ordinate monitoring internally and externally (e.g. within the Waikato Regional Council, NIWA and Landcare Research)
- integrate new monitoring requirements into existing regional monitoring networks.

Prior to the CEM programme soil conservation implementation relied on regional monitoring information being reinterpreted at a catchment scale. However, this information is often misleading because regional scale information is being applied at a finer scale (catchment scale).

This report provides CEM programme results for the 2011/2012 year. Copies of reports as described in the list of references can be obtained by contacting the Waikato Regional Council (the Library) on 0800 800 401, or in electronic format from the publications page of the Waikato Regional Council website http://www.waikatoregion.govt.nz/publications/ or email: inforeq@waikatoregion.govt.nz

1.2 Report content

This report provides information on the annual monitoring of the environmental effects of soil conservation and river management works implemented in soil conservation priority catchments across the Waikato region. It includes updated results from the 2011/12 monitoring period. Interpretations of the results, identification of trends (where applicable) and results from additional monitoring sites are also included. The report is structured so that each zone can be reviewed independently.

1.3 Monitoring approach

The aim of the CEM programme, is to provide a representative (and where possible quantitative) indication of changes in various environmental parameters, resulting from soil conservation and river management work. Parameters include changes in the hill slope erosion, stream bank erosion, riparian vegetation and fencing, sedimentation in surface water, water temperature and in-stream ecological habitat. Monitoring has been selected to measure changes on land and in surface water to provide some indication of the resulting on-site and off-site benefits. Details of the methods used are provided in the internal series report, Catchment Environmental Monitoring Methods (Grant et al., 2009a).

It is important to note that not all priority soil conservation catchments are monitored. However, the results for the monitored catchments should be more applicable to other priority catchments in a given zone than monitoring results from elsewhere in the

region. A standard monitoring approach is recommended for all monitored catchments but the specific suite of monitoring will differ from catchment to catchment. This is dependent on the type of soil conservation and river management issues within each catchment. There are several key outcomes of the CEM programme:

- An understanding of the long-term benefits of soil conservation, river management and catchment issues in the Waikato region.

- A long-term picture of the land and water quality benefits of soil conservation and river management initiatives provided by the Waikato Regional Council.

- A regional framework for obtaining, managing and implementing catchment scale monitoring information.

- Efficient integration of existing State of the Environment regional monitoring, Crown Research Institute catchment monitoring, the Waikato Regional Council implemented works consent monitoring, and the Waikato Regional Council initiatives specific catchment monitoring (e.g. Peninsula Project).

1.4 Management zone boundaries

The monitored catchments are positioned in four management zones, as described in Table 1. Zones which do not contain monitored catchments at this stage are Central Waikato (CWK), West Coast (WTC), Waihou-Piako (WPO) and Lake Taupo (TAU) zones. The priority catchments covered in this report are shown in Figure 1, in addition to the management zone boundaries.

Table 1: Location of the monitored catchments as at 2011/2012.

Monitored catchment	Management zone
Matahuru	Lower Waikato (LWK)
Mangare	Upper Waikato (UWK)
Pokaiwhenua	Upper Waikato (UWK)
Tahunaatara	Upper Waikato (UWK)
Mangatutu	Waipa (WPA)
Wharekawa	Coromandel (COR)

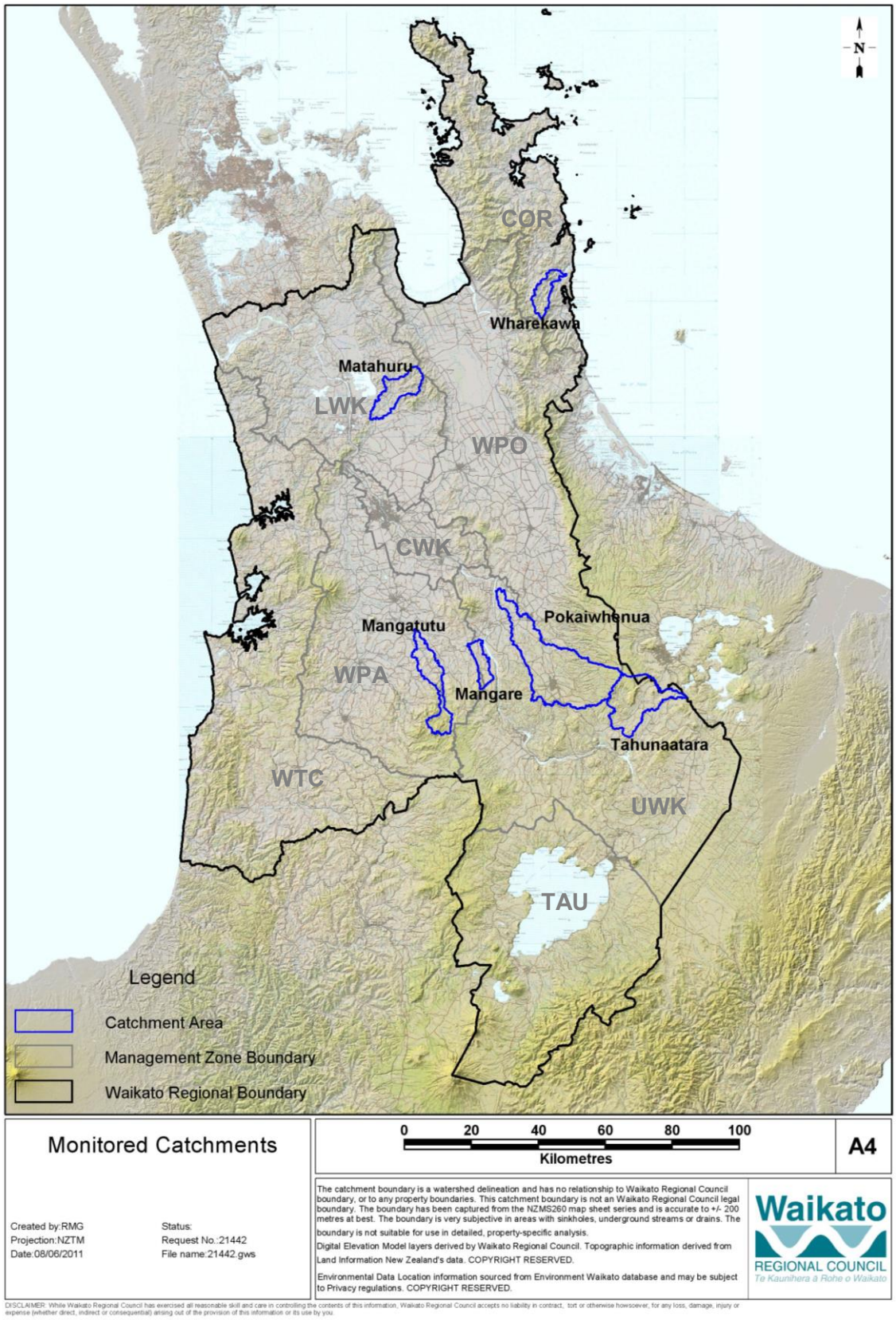

Figure 1: Monitored priority catchment locations, with management zone boundaries (labels explained in Table 1).

1.5 Monitoring information

The reported monitoring information is provided through specific catchment scale monitoring in selected soil conservation priority catchments. In addition, on-going regional monitoring information (Table 2) is utilised to increase our knowledge of the state and changes in soil erosion and sedimentation of water within the various

management zones. The changes in soil stability in the Waikato Region from 2002 to 2007 are discussed in TR2009/30 (Thompson & Hicks, 2009b). For the most recent results of the Regional Soil Stability assessment conducted in 2007 refer to TR2009/24 (Thompson & Hicks, 2009b).

Table 2: Waikato Regional Council's land and water monitoring programmes.

Programme	Main measures	Last assessment/ frequency
Regional soil stability assessment	Soil stability and soil conservation	2007; assessment 5-10 yearly
Regional riparian characteristics assessment	Riparian fencing, vegetation and erosion	2008/09; assessment 5-10 yearly
Permanent suspended sediment sites	Water quality including sediment and peak flows	8 sites; reviewed annually
River ecological monitoring sites (REMS)	Stream biological and habitat condition	Ongoing (~10yrs data)
Regional rivers	Water quality including sediment	Ongoing (>10yrs data)

2 Lower Waikato zone

2.1 Introduction

Monitoring is present in one catchment in the Lower Waikato zone; Matahuru catchment.

2.2 Matahuru catchment

2.2.1 Monitoring progress

Monitoring is focused on the lower section of the Matahuru catchment (refer to Grant et al, 2009b for survey locations). Table 3 presents monitoring completed by the end of the 2011/12 financial year.

Table 3: Lower Waikato zone monitoring completed by 2011/12.

Monitoring	Activity	Completion	Included in this report (or year last reported)
Soil stability	Soil stability and soil conservation assessment	2005	(2005/06)
Riparian characteristics assessment	Complete assessment along the lower section of the Matahuru Stream	2003/04, 2005/06, 2007/08, 2009/10, 2011/12	✓
Photo points	Complete assessment along the lower section of the Matahuru Stream	2003/04, 2004/05, 2005/06, 2007/08, 2009/10, 2011/12	✓
Permanent suspended sediment sampling site	Event driven sampling	Installed 2003 and ongoing	✓
Suspended sediment snapshots	• Low flow snapshot • Medium flow snapshot	2003 2008	(2005/06) (2007/08)
Water temperature	Install loggers and record stream temperatures along the lower section of the Matahuru Stream	2003/04, 2004/05, 2005/06, 2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12	✓

2.2.2 Soil stability

Refer to TR2005/39 (Hicks, 2005a) for the most recent assessment report for this catchment.

2.2.3 Riparian characteristics

Introduction

Eleven 1 km samples were selected for assessment through the lower section of the Matahuru Stream. The assessments on the Matahuru Stream are at locations where Waikato Regional Council funded river management and soil conservation works are scheduled, where stream riparian margin access is possible and where landowner participation is forthcoming. The initial assessment was conducted during the 2003/04 summer with the most recent assessment completed in 2011/12.

The reported data for each parameter represents a percentage of the total assessed riparian margin in the catchment. Tabled summary riparian assessment data is located in Appendix 1.

The following summary data was collected where riparian soil conservation has been recently implemented, or is planned for the Matahuru catchment. Erosion, vegetation and fencing data summaries are presented in Figures 2, 3, 4 and 5.

Vegetation

Riparian vegetation contributes to stream bank stability and the shading of the stream to help minimise increases in stream temperatures. Natural biodiversity along the riparian margin can be increased through the planting of native vegetation. Riparian vegetation is split into grass and woody vegetation (native + willow + exotic other). Figure 2 shows that during the 2011/12 reporting period 21% of the riparian margin was grass. The remaining 80% is woody vegetation, of which 43% of the total length was native, 14% was willow and 23% was other exotic species. The length of the riparian margin in grass has decreased from 51% to 19% between 2003/04 and 2011/12. The increase in woody vegetation since 2003/04 is split between woody willow and woody exotic, with the majority of the increase being woody exotic vegetation (Figure 2).

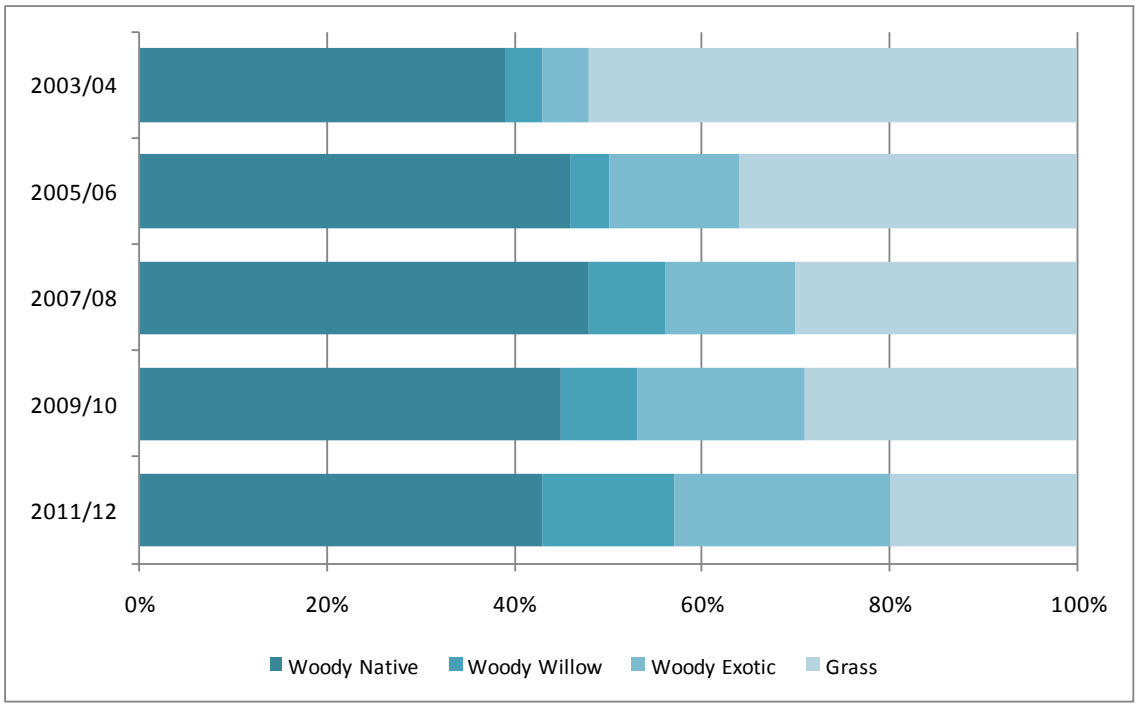

Figure 2: Matahuru riparian vegetation.

Fencing

The amount of fencing on one side or both sides of the waterway is an indicator of likely stock exclusion from the waterway. Stock exclusion reduces direct contamination of water by pathogens, direct damage to the stream ecology by trampling of the stream bed and indirectly reduces sediment load from stock trampling the banks.

During 2011/12 stock were excluded from both sides for 95% of the waterway, from one side for 5% of the waterway and are not excluded from either side for 0% of the waterway (Figure 3). There has been an increase from 46 to 95% in the length of stream fenced on both sides since the 2003/04 assessment (Figure 3).

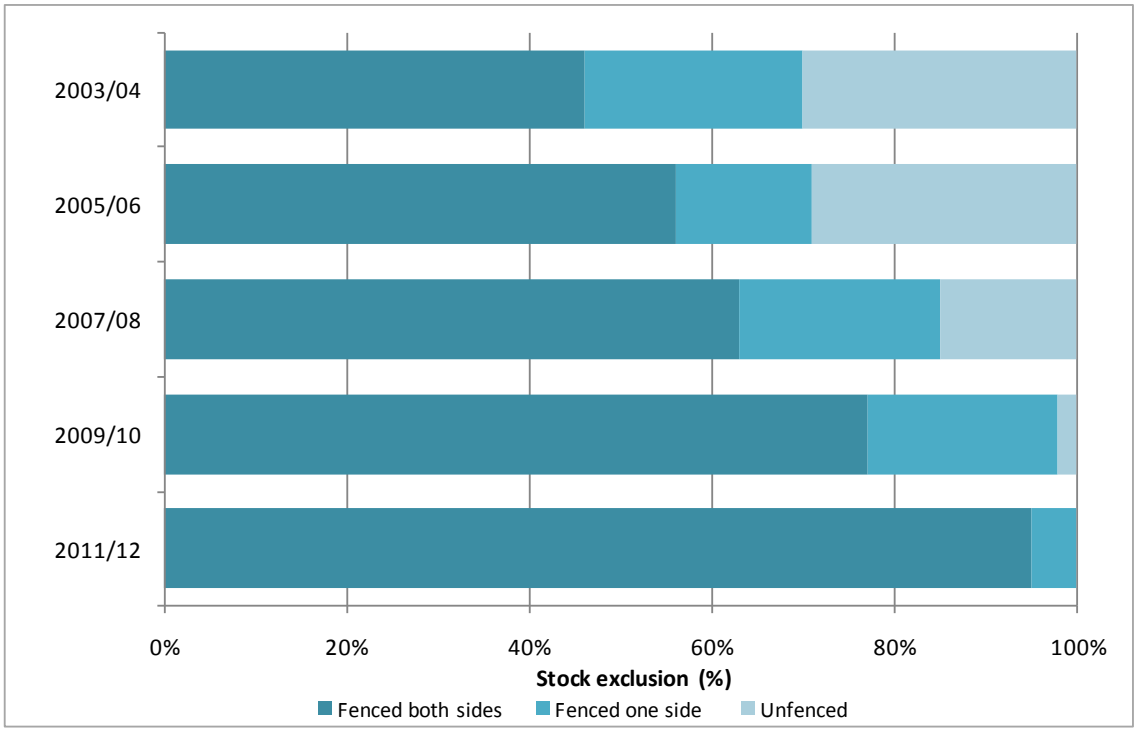

Figure 3: Matahuru stock exclusion by bank length.

There has been an increase in fencing over the total stream bank length since the baseline assessment, from 46% to 95%. The majority of the fenced banks (81% of the total fenced bank length) have woody vegetation (Figure 4). The proportion of stream bank that is fenced off and has woody vegetation has increased from 40% to 79% of the total length. There is unfenced woody vegetation on 1% of the total stream bank length.

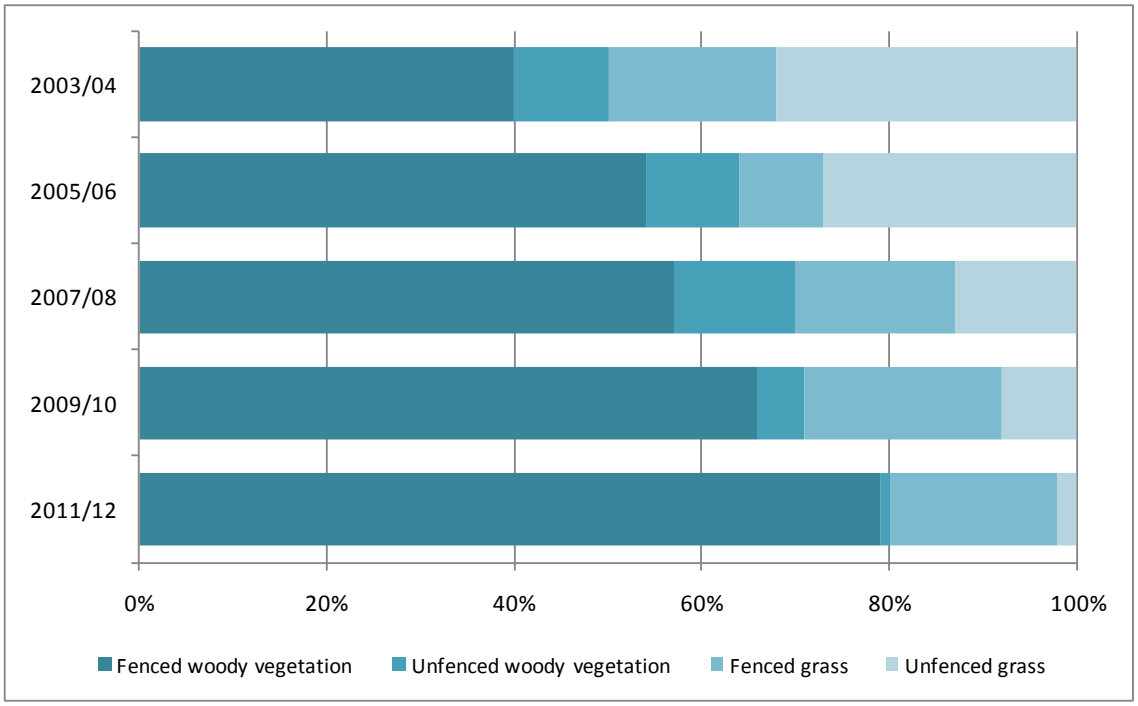

Figure 4: Matahuru bank length fencing and vegetation combinations.

Stream bank stability

Stream bank stability can be improved through planting riparian vegetation, and fencing out stock. Unstable stream banks are one of the main sources of sediment in

waterways. An estimated 94% of the assessed riparian bank length is considered stable (Figure 5), up from the 47% measured in the 2003/04 assessment. The remaining 6% is unstable. Grass vegetation is present on 2% of the total unstable bank length.

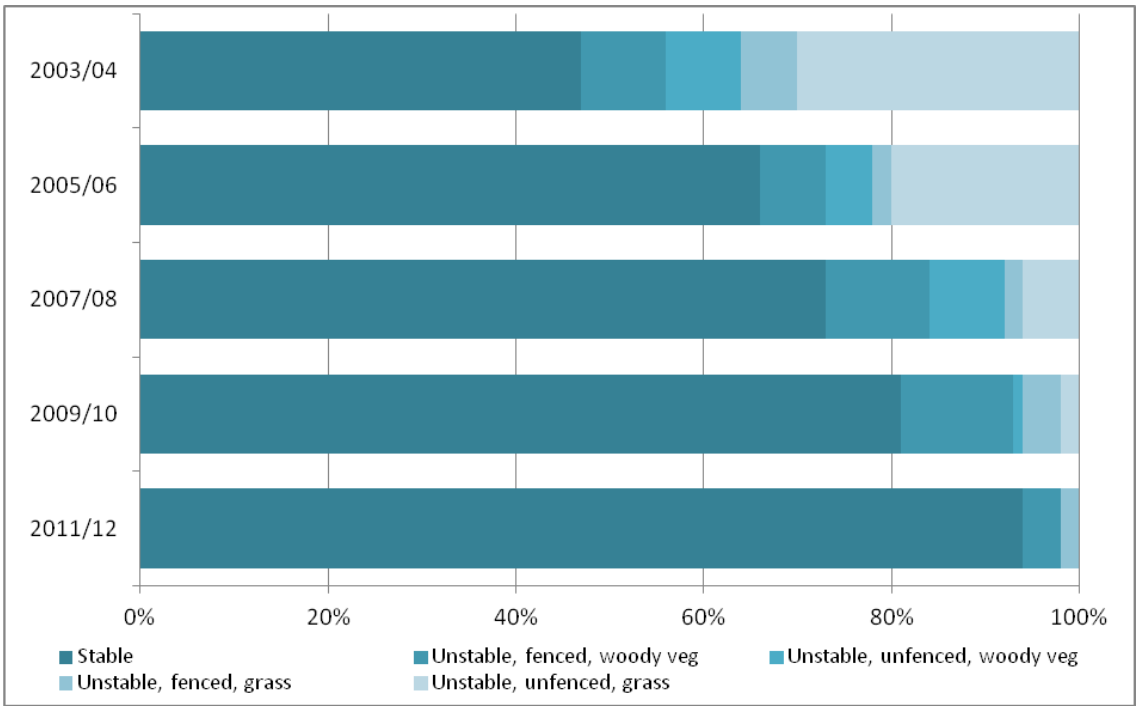

Figure 5: Matahuru erosion.

2.2.4 Water temperature

The water temperature loggers were deployed in the lower section of the Matahuru Stream; the upstream logger in the vicinity of the Mangapiko Valley Road Bridge and the downstream logger next to the Waikato Regional Council recorder station by Waiterimu Road. The distance between the two loggers is approximately 20 km.

Results

To date nine deployments have been made with data collected during each summer between 2003/04 and 2011/12. The average of the daily maximum water temperature is derived to produce a single temperature for each site. The daily average upstream and downstream maximums for 2011/2012 were 20.77°C and 20.28°C respectively. Refer to Table 29 in Appendix 3 for more detail.

The downstream temperature has been cooler than the upstream temperature for most years of assessment. There is no obvious trend in the data at this stage.

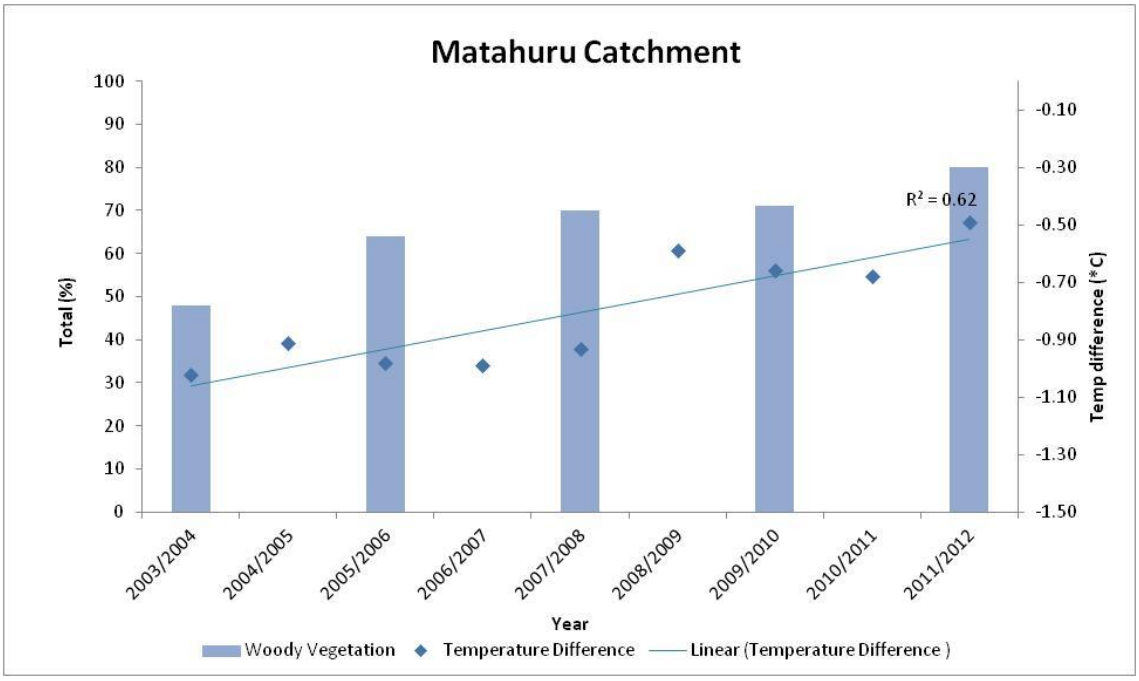

Figure 6: Annual changes in woody vegetation total and temperature difference for the Matahuru Catchment.

Shading of the Matahuru Stream is sporadic between the two sites, with a variety of vegetation types present. Figure 6 shows that the temperature difference has been variable but appears to be trending positive (r2 = 0.62). A longer data set may provide us with more insight into ongoing trends. We would expect as existing vegetation combined with any new plantings establish and grow, shading will increase and result in a larger temperature difference between the upstream and downstream monitoring sites (i.e. a net decrease in water temperature downstream).

2.2.5 Photo points

Photo assessments have been completed along the Matahuru Stream in 2003/04, 2005/06, 2007/08, 2009/10 and 2011/12. Eleven samples were assessed along the stream totalling 55 photos over a total distance of 11000m. Areas of soil conservation plantings have grown noticeably (Figure 7), and large sections of the stream have been fenced off.

	2003/04	2011/12
Assessment 2 at 750m		

Figure 7: Matahuru Stream photo point examples of visual change.

2.2.6 Suspended sediment

Permanent sampling site

A permanent suspended sediment sampling site has been in place at the Myjers farm bridge since July 2006. During this time 27 events have been sampled using an automatic sediment sampler. The data set is analysed to estimate sediment variables (Table 4). Data includes all results up until 31/12/2011. A continuing focus is to carry out manual depth-integrated suspended sediment gaugings while the automatic sampler is activated. The collection of these concurrent samples will allow for the automatic series to be calibrated to the whole river cross-section. For more detailed information refer to the Suspended Sediment Monitoring Report (Kotze et al., 2008).

Table 4: Matahuru permanent suspended sediment sampling site description and estimated sediment variables.

Site name:	**Myjers**	**Map Ref (NZMS260):**	**S13:116-095**
River:	**Matahuru**		
		Start – End Date	**No of samples**
Flow Time Series		17/07/2006 – 31/12/2011	N/A
Sediment Samples		19/07/2006 – 27/05/2010	510
ISCO Period of Record		19/07/2006 – 27/05/2010	27 events

Specific yield (t/km^2/yr)	Average sediment yield (kt/yr)	% of sediment yield in gauged range of flow	% Error in Yield Estimate
193	16	37.5	5.1

The Matahuru River has an estimated specific yield of 193 t/km^2/yr and an average sediment yield of 16kt/yr. Figure 8 shows the specific sediment yield for the Matahuru River relative to other monitored sites in the Region.

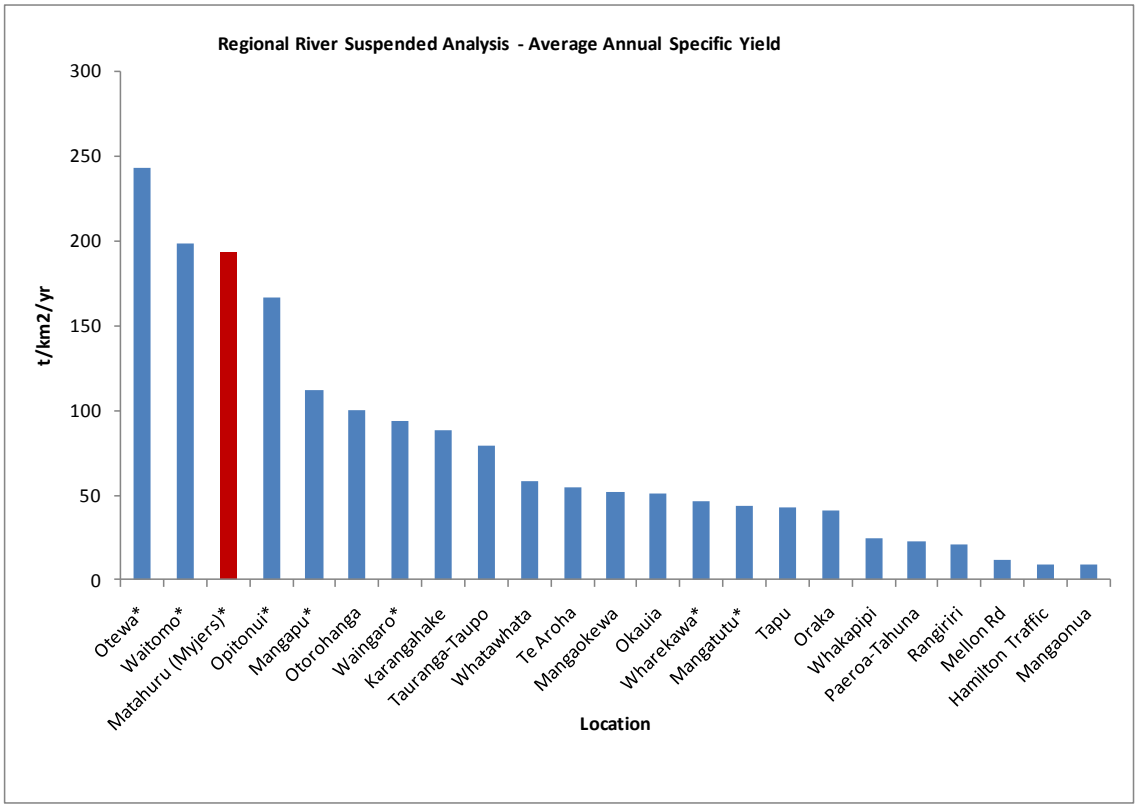

Figure 8: Average specific suspended sediment yield for monitored rivers in the Waikato Region (Matahuru site is highlighted).

The specific yield for the Matahuru can be considered high relative to many sites in the region. This may be a reflection of the topography and land cover in the catchment.

2.2.7 Main points

Soil Stability

- No soil stability assessment completed this year.

Riparian Characteristics

- The proportion of grass to woody vegetation has declined from 52% to 20% between the 2003/04 and 2011/12 assessments. Woody vegetation covers 80% of the riparian margin, of which 43% of the total length is native, and 37% is exotic (including willows).

- There has been an increase in fencing over the total stream bank length from 46% in 2003/04 to 97% in the most recent survey (2011/12).

- The proportion of stream bank that is fenced off with woody vegetation has increased from 40% to 79% of the total stream bank length over the six years separating the assessments. The length of unfenced grass has decreased to 0% of the stream bank length.

- An estimated 94% of the assessed riparian bank length was considered stable, up from 47% in 2003/04.

- Out of the total unstable length of stream bank, grass (33%) and exotic woody vegetation (non-willow) (50%) are the predominant vegetation.

Water Temperature

- The downstream temperature has been cooler on average than the upstream temperature for all monitored years.

- Since 2003/04 river management and soil conservation works have occurred, but in general, shading of the Matahuru Stream remains sporadic.

Photo Points

- Photo points have shown some improvements to areas where soil conservation plantings have occurred.

Suspended sediment monitoring

- A specific yield of 193 t/km^2/yr has been estimated based on results from the permanent suspended sediment monitoring site.

3 Upper Waikato zone

3.1 Introduction

Monitoring is present in three catchments in the Upper Waikato zone; Pokaiwhenua, Mangare and Tahunaatara catchments. Monitoring progress and results are presented for each catchment individually.

3.2 Pokaiwhenua catchment

3.2.1 Monitoring progress

The monitoring locations in the Pokaiwhenua catchment are detailed in Grant et al. (2009b). Table 5 presents monitoring completed by the end of the 2011/12 financial year.

Table 5: Pokaiwhenua catchment monitoring completed by 2011/12.

Monitoring	Activity	Completion	Included in this report (or year last reported)
Soil stability	Soil stability and soil conservation assessment	2005	(2005/06)
Riparian characteristic assessment	Complete assessment along the middle section of the Pokaiwhenua River	2003/04, 2005/06, 2007/08, 2009/10, 2011/12	✓
Photo points	Complete assessment along the mid section of the Pokaiwhenua River	2003/04, 2004/05, 2005/06, 2007/08, 2009/10, 2011/12	✓
Permanent suspended sediment sampling site	None planned	N/A	N/A
Suspended sediment snapshots	• Low flow snapshot	2003	(2005/06)
Water temperature	Install loggers and record stream temperatures along the middle section of the Pokaiwhenua River	2003/04, 2004/05, 2005/06, 2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12	✓
Stream ecological health	Assess stream ecological health along the middle section of the Pokaiwhenua River	2003/04, 2004/05, 2005/06, 2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12	✓

N/A = not applicable

3.2.2 Soil stability

Refer to Hill et al., (2006) for the most recent assessment report for this catchment.

3.2.3 Riparian characteristics

Introduction

Six 1km samples were selected for assessment through the middle section of the Pokaiwhenua Stream. The assessments on the Pokaiwhenua Stream are at locations where Waikato Regional Council funded river management and soil conservation works are scheduled, where stream riparian margin access is possible, and where

landowner participation is forthcoming. The initial assessment was conducted during the 2003/04 summer with the most recent assessment completed in 2011/12.

The reported data for each parameter represents a percentage of the total assessed riparian margin in the catchment. Tabled summary riparian assessment data is located in Appendix 1.

The following summary data was collected where riparian soil conservation has been recently implemented, or is planned for the Pokaiwhenua catchment. Erosion, vegetation and fencing data summaries are presented in Figures 9, 10, 11 and 12.

Vegetation

Riparian vegetation contributes to stream bank stability and shading the stream to help minimise increases in stream temperatures. Natural biodiversity along the riparian margin can be increased through the planting of native vegetation. Riparian vegetation is split into grass and woody vegetation (native + willow + exotic other). Figure 9 shows that during the 2011/12 reporting period 24% of the riparian margin was grass. The remaining 76% was woody vegetation, of which 20% of the total length was native, 14% was willow and 42% was other exotic species. The length of the riparian margin in grass has decreased from 55% to 24% between 2003/04 and 2011/12. The increase in woody vegetation between 2003/2004 is split between woody willow and woody exotic, with the majority of the increase being woody exotic vegetation (Figure 9).There was a 9% decrease in woody native vegetation.

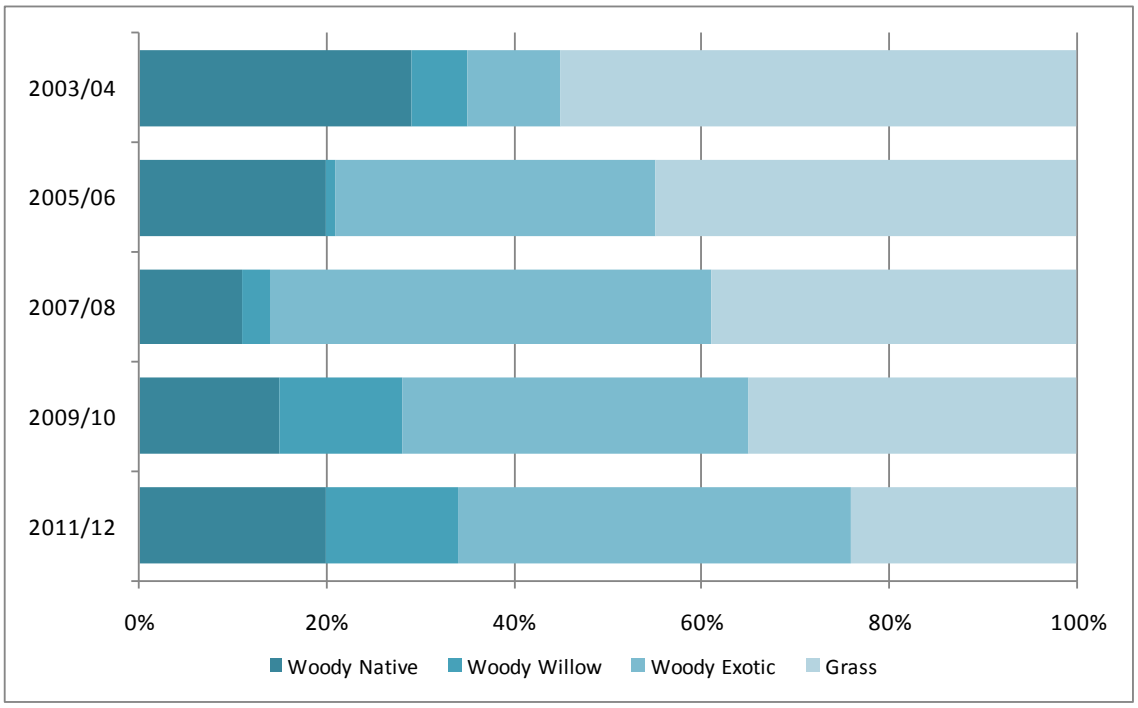

Figure 9: Pokaiwhenua riparian vegetation.

Fencing

The amount of fencing on one side or both sides of the waterway is an indicator of likely stock exclusion from the waterway. Stock exclusion reduces direct contamination of water by pathogens, direct damage to the stream ecology by trampling of the stream bed and indirectly reduces sediment load from stock trampling the banks.

During 2011/12 stock were excluded from both sides for 100% of the waterway (Figure 10). There has been an increase from 27% to 100% in the length of stream fenced on both sides since the 2003/04 assessment (Figure 10).

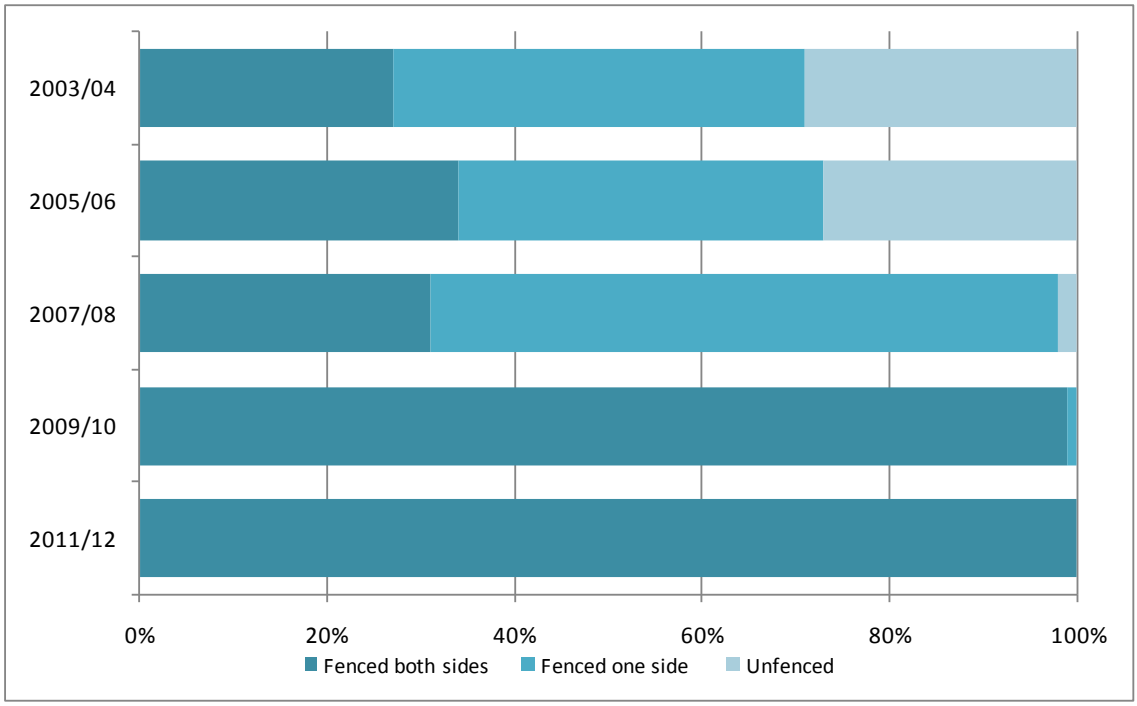

Figure 10: Pokaiwhenua stock exclusion by bank length.

During 2011/12 the majority of the fenced banks (76% of the total fenced bank length) had woody vegetation (Figure 11). Since 2003/04 the proportion of stream bank that is fenced off and has woody vegetation has increased from 18% to 76% of the total length.

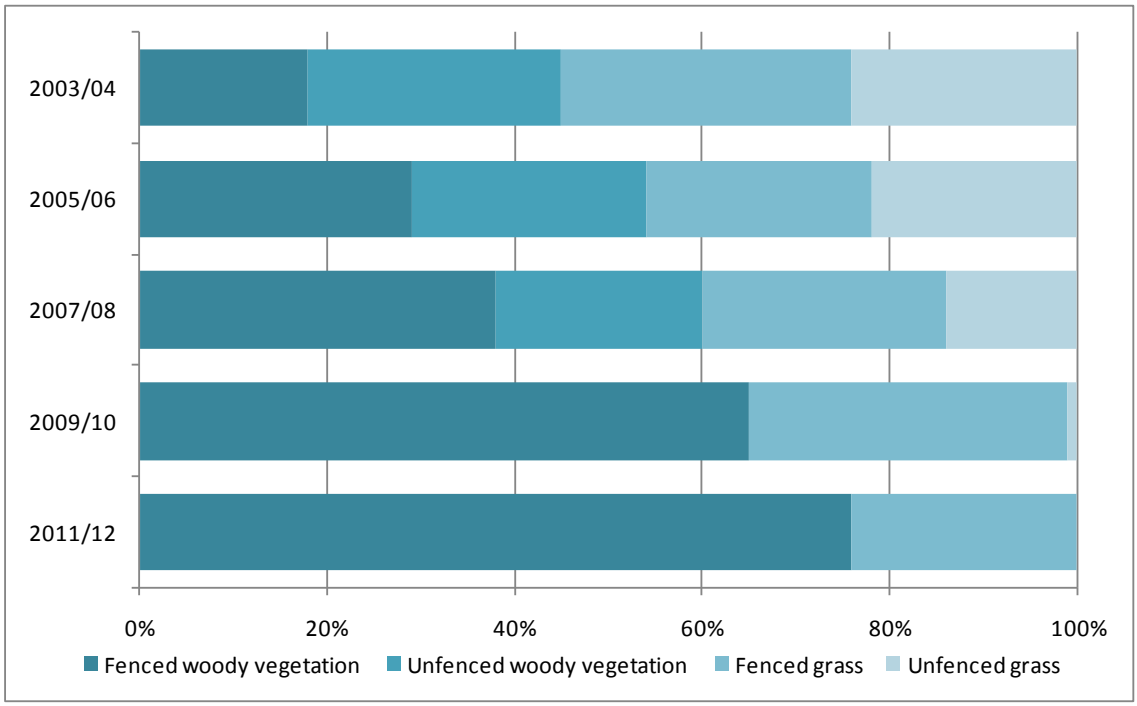

Figure 11: Pokaiwhenua bank length fencing and vegetation combinations.

Stream bank stability

Stream bank stability can be improved through planting riparian vegetation, and fencing out stock. Unstable stream banks are one of the main sources of sediment in waterways. An estimated 98% of the assessed riparian bank length is considered stable (Figure 12), up from the 88% measured in the 2003/04 assessment.

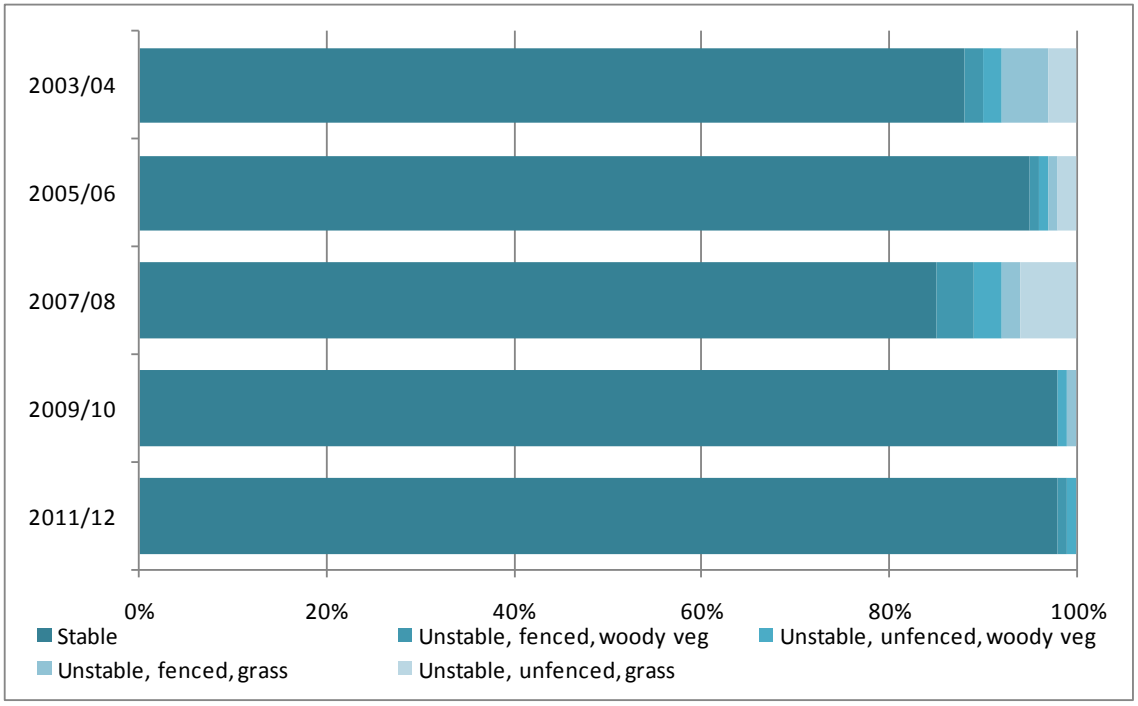

Figure 12: Pokaiwhenua erosion.

3.2.4 Water temperature

The water temperature loggers are deployed in the middle section of the Pokaiwhenua River. The distance between the two loggers is approximately 1 km. To date nine deployments have been made with data collected each summer between 2003/2004 and 2011/2012 inclusive. The average of the daily maximum water temperature is derived to produce a single temperature for each site. The daily average upstream and downstream maximums were 17.11 °C and 17.02 °C respectively. Refer to table 30 in Appendix 3 for more detail.

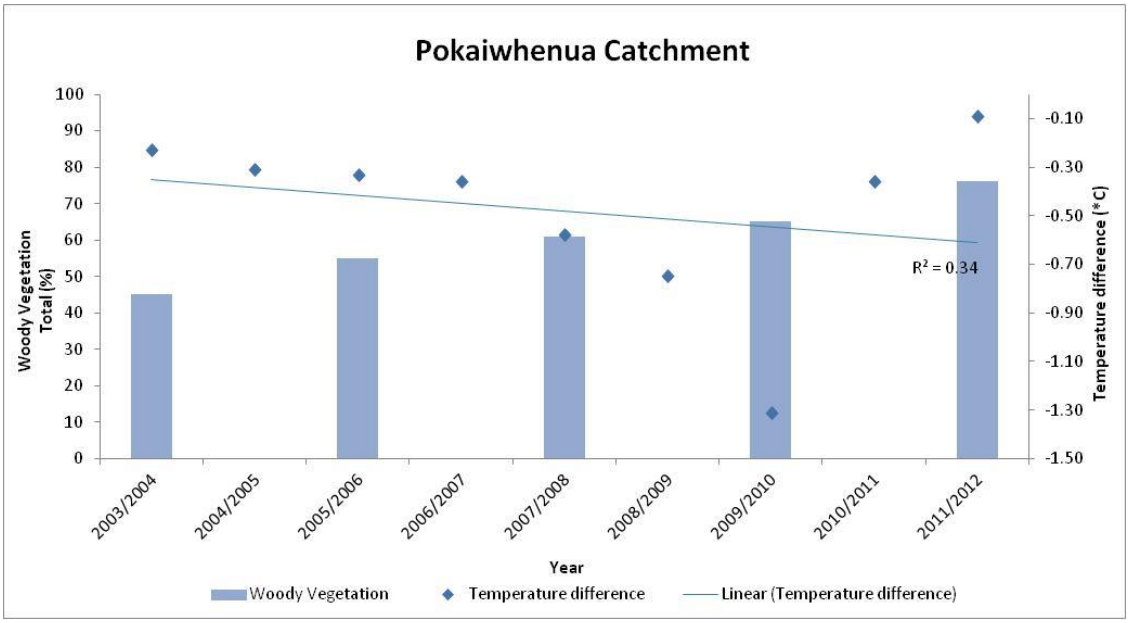

Figure 13: Woody vegetation total and temperature difference in the Pokaiwhenua Catchment. Temperature and woody vegetation data only begins from 2003/04 onwards.

Although sections of the stream have been fenced and planted, little shading occurs between the upstream and downstream monitoring sites. Between 2006/07 and 2009/10 the temperature difference between the upstream and downstream sites increased (Figure 13). However, the decrease in temperature difference between

2009/10 and 2011/12 may be attributable to an increase in fencing and riparian planting in the upper reaches of the monitored stream section (Figure 13). Denser vegetation in the upper reaches and a narrower stream width may be increasing the shading in the upper section. However, a wider stream width (5-7m) and slower growing vegetation in the lower reaches may not be as effective at reducing instream temperature and therefore results in a reduced temperature difference between the upper and lower reaches.

3.2.5 Photo points

The initial year of assessment was 2003/04 with subsequent assessments completed in 2005/06, 2007/08, 2009/10 and 2011/12.

Six 1 km samples of stream were assessed, at 250 m intervals, giving a total of 30 photos for the Pokaiwhenua catchment. Large sections of stream have shown improvements due to soil conservation planting. Other sections which have been fenced are covered in rank grass (Figure 14).

	2003/04	2011/12
Assessment 2 at 500m		

Figure 14: Pokaiwhenua River photo point examples of visual change, assessment 2 at 500m (A and B).

3.2.6 Stream Ecological Health

The dominant surrounding land use in the vicinity of both of the sampling sites in the Pokaiwhenua River is pastoral / horticultural. The stream ranges between 5-11.6m in width with the substrate predominantly consisting of a combination of cobbles and large gravel. The canopy cover is open.

Invertebrate sampling is carried out in the same two locations where the water temperature probes are deployed in the middle section of the Pokaiwhenua River. The initial year of assessment was completed in 2003/04 with subsequent assessments completed annually between January and March.

Figure 15 illustrates the MCI (Macroinvertebrate Community Index) values as calculated for the upstream and downstream sampling sites in the Pokaiwhenua River. Refer to Table 24 in Appendix 2 for more detail.

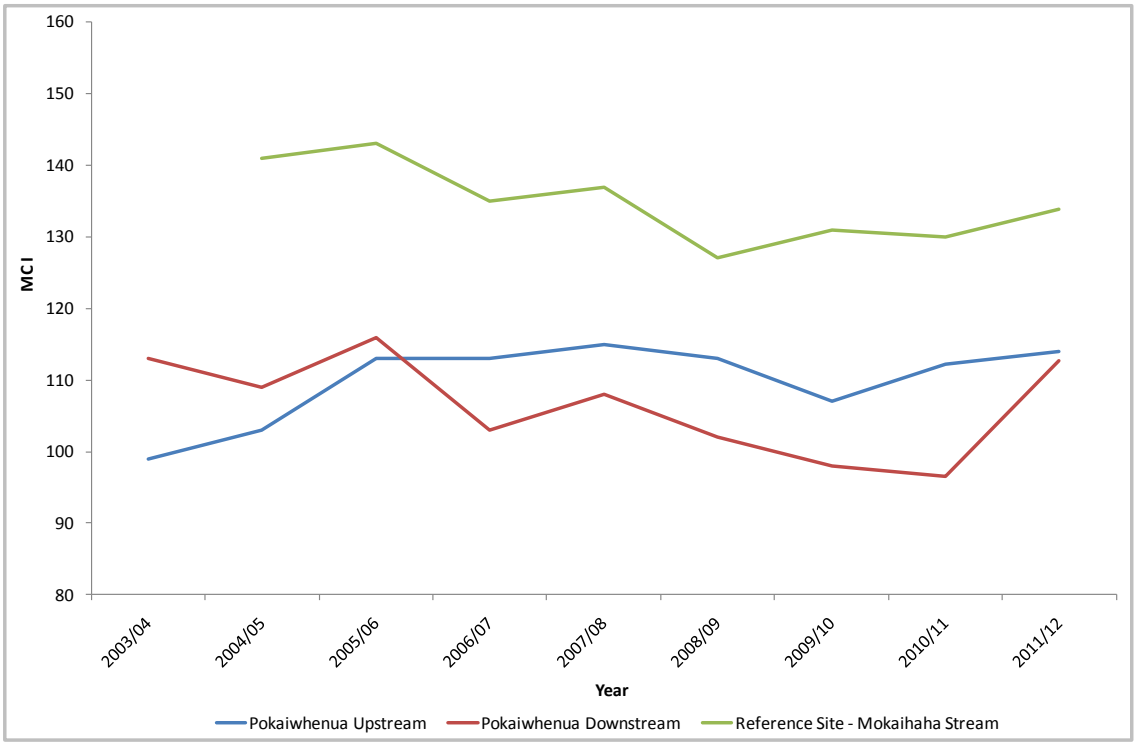

Figure 15: MCI values for the Pokaiwhenua River and nearby reference site (Mokaihaha Stream).

In the vicinity of the two sampling sites, the presence and abundance of identified invertebrate species and the associated MCI scores indicate that the stream has a mild degradation in ecological health (Wright-Stow & Winterbourn 2003). A longer monitoring period is required to identify a trend in the MCI values. The low score may be as a result of the stream often being too high to wade and therefore sampling is restricted. A reference site has been included to compare the MCI values from the Pokaiwhenua Stream. The reference site is the Mokaihaha Stream (site number 555.2). For more information on the monitored streams see Appendix 2.

3.2.7 Main Points

Soil Stability

- No soil stability assessment completed this year.

Riparian Characteristics

- The proportion of grass has declined from 55% to 24% between the 2003/04 and 2011/12 assessments. Woody vegetation covers 76% of the riparian margin, of which 20% is native, and 56% is exotic (including willows).

- There has been an increase in fencing over the total stream bank length from 50% in 2003/04 to 100% in the most recent survey (2011/12).

- The proportion of stream bank that is fenced off with woody vegetation has increased from 18% to 76% of the total stream bank length over the 9 years separating the assessments. The length of unfenced grass has decreased to 0% of the stream bank length.

- An estimated 98% of the assessed riparian bank length was considered stable, up from 88% in 2003/04.

- The unstable 2% of bank consist of Woody vegetation.

- Photo assessments have shown some changes to areas where soil conservation plantings have occurred, and where rank grass has grown.

Water Temperature

- The downstream temperature is consistently cooler on average than the upstream temperature for all monitored summers.

- Soil conservation works have occurred along some stretches of bank, but due to the width of the river, the shading effect on the stream temperature may be limited.

Stream Ecological Health

- Assessments of the invertebrates in Pokaiwhenua Stream indicate that there is a mild degradation in ecological health.

3.3 Mangare Catchment

3.3.1 Monitoring progress

For survey locations in the Mangare catchment, refer to Grant et al. (2009b). Table 6 contains monitoring completed by the end of the 2011/12 financial year.

Table 6: Mangare catchment monitoring completed by 2011/12.

Monitoring	Planned activity	Completion	Included in this report (or year last reported)
Soil stability	Not planned	N/A	N/A
Riparian characteristic assessment	Complete assessment along the middle section of the Mangare Stream	2003/04, 2005/06, 2007/08, 2009/10, 2011/12.	✓
Photo points	Complete assessment along the middle section of the Mangare Stream	2003/04, 2004/05, 2005/06, 2007/08, 2009/10, 2011/12.	✓
Permanent suspended sediment sampling site	Not planned	N/A	N/A
Suspended sediment snapshot	Not planned	N/A	N/A
Water temperature	Install loggers and record stream temperatures along the middle section of the Mangare Stream	2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12.	✓
Stream ecological health	Assess stream ecological health along the mid section of the Mangare Stream	2005/06, 2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12.	✓

N/A = not applicable

3.3.2 Riparian characteristics

Introduction

Two 1km samples were selected for assessment through the middle section of the Mangare Stream. The assessments on the Mangare Stream are at locations where Waikato Regional Council funded river management and soil conservation works are scheduled, where stream riparian margin access is possible, and where landowner participation is forthcoming. The initial assessment was conducted during summer 2003/04 with the most recent assessment completed in 2011/12.

The reported data for each parameter represents a percentage of the total assessed riparian margin in the catchment. Tabled summary riparian assessment data is located in Appendix 1.

The following summary data was collected where riparian soil conservation has been recently implemented, or is planned for the Mangare catchment. Vegetation, fencing and erosion data summaries are presented in Figures 16, 17, 18 and 19.

Vegetation

Riparian vegetation contributes to stream bank stability and the shading of the stream to help minimise increases in stream temperatures. Natural biodiversity along the riparian margin can be increased through the planting of native vegetation. Riparian vegetation is split into grass and woody vegetation (native + willow + exotic other). Figure 16 shows that during the 2011/12 reporting period 46% of the riparian margin was grass. The remaining 54% was woody vegetation, of which 2% of the total length was native, 48% was willow and 4% was other exotic species. The length of the riparian margin in grass has decreased from 94% to 46% between 2003/04 and 2011/12. The increase in woody vegetation since 2003/04 is split between woody willow and native, with the majority of the increase being woody willow vegetation (Figure 16).

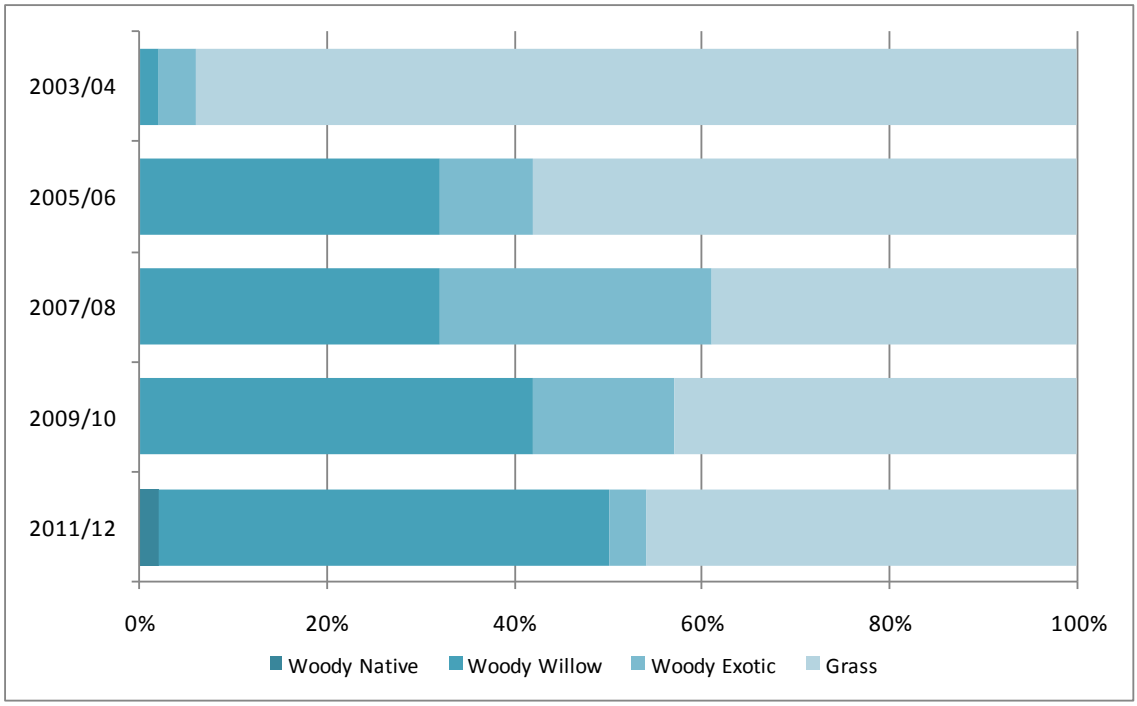

Figure 16: Mangare vegetation

Fencing

The amount of fencing on one side or both sides of the waterway is an indicator of likely stock exclusion from the waterway. Stock exclusion reduces direct contamination of water by pathogens, direct damage to the stream ecology by trampling of the stream bed and indirectly reduces sediment load from stock trampling the banks.

During 2011/12 stock were excluded from both sides for 49% of the waterway (Figure 17). There has been an increase from 31% to 49% in the length of stream fenced on both sides since the 2003/04 assessment (17).

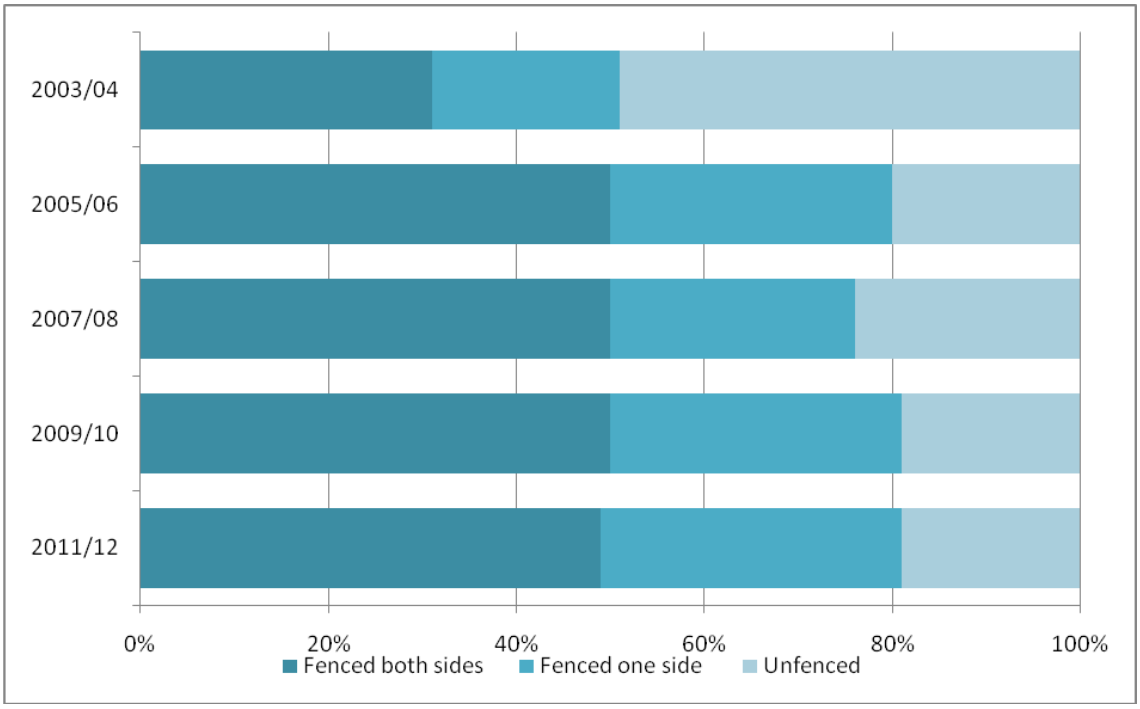

Figure 17: Mangare stock exclusion by bank length

There has been an increase in fencing from 41% to 65% over the total stream bank length since the baseline assessment (Figure 18). The majority of the fenced banks (80% of the total fenced bank length) have woody vegetation. The proportion of stream bank that is fenced off and has woody vegetation has increased from 3% to 52% of the total length. There is unfenced woody vegetation on 2% of the total stream bank length.

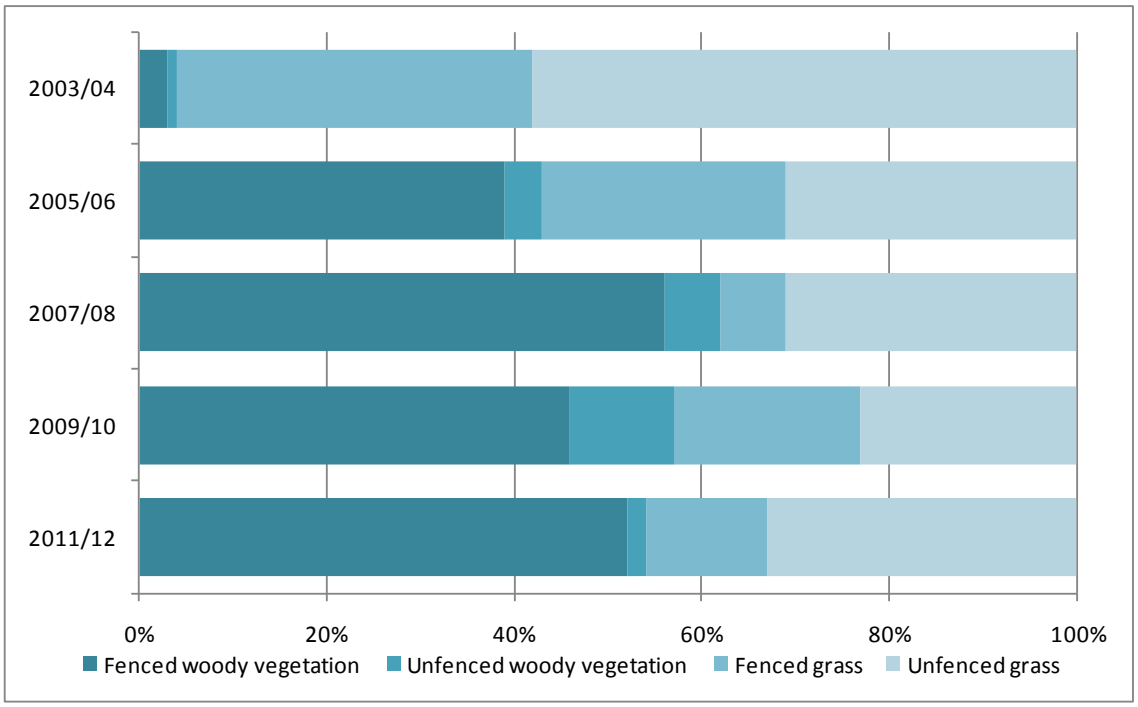

Figure 18: Mangare bank length fencing and vegetation combinations

Stream bank stability

Stream bank stability can be improved through planting riparian vegetation, and fencing out stock. Unstable stream banks are one of the main sources of sediment in waterways. An estimated 85% of the assessed riparian bank length is considered stable (Figure 19), up from the 39% measured in the 2003/04 assessment. The remaining 15% is unstable. Grass vegetation is present on 7% of the total unstable bank length.

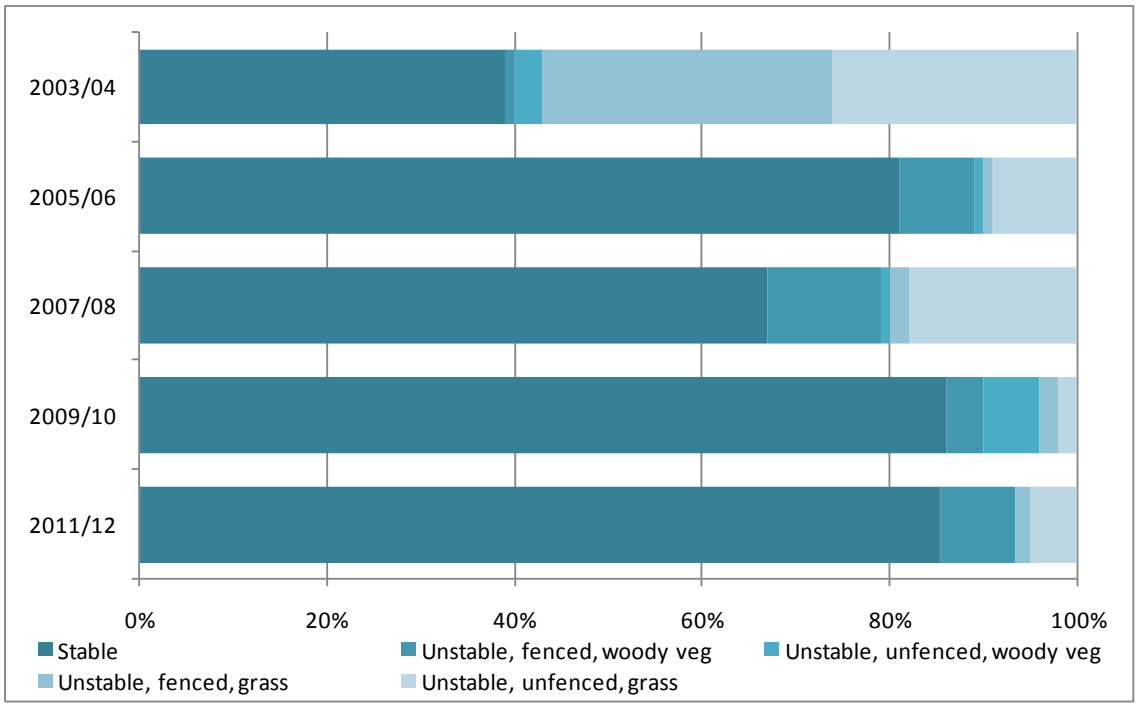

Figure 19: Mangare erosion

3.3.3 Water temperature

The water temperature loggers are deployed in the middle section of the Mangare Stream, with a distance between the two loggers of approximately 1 km. The loggers have collected summer data annually between 2006/07 and 2011/12 inclusive. The average of the daily maximum water temperature is derived to produce a single temperature for each site. The average of the daily maximum water temperature is derived to produce a single temperature for each site. The daily average upstream and downstream maximums were 18.47 °C and 18.54 °C respectively. Refer to table 31 in Appendix 3 for more detail.

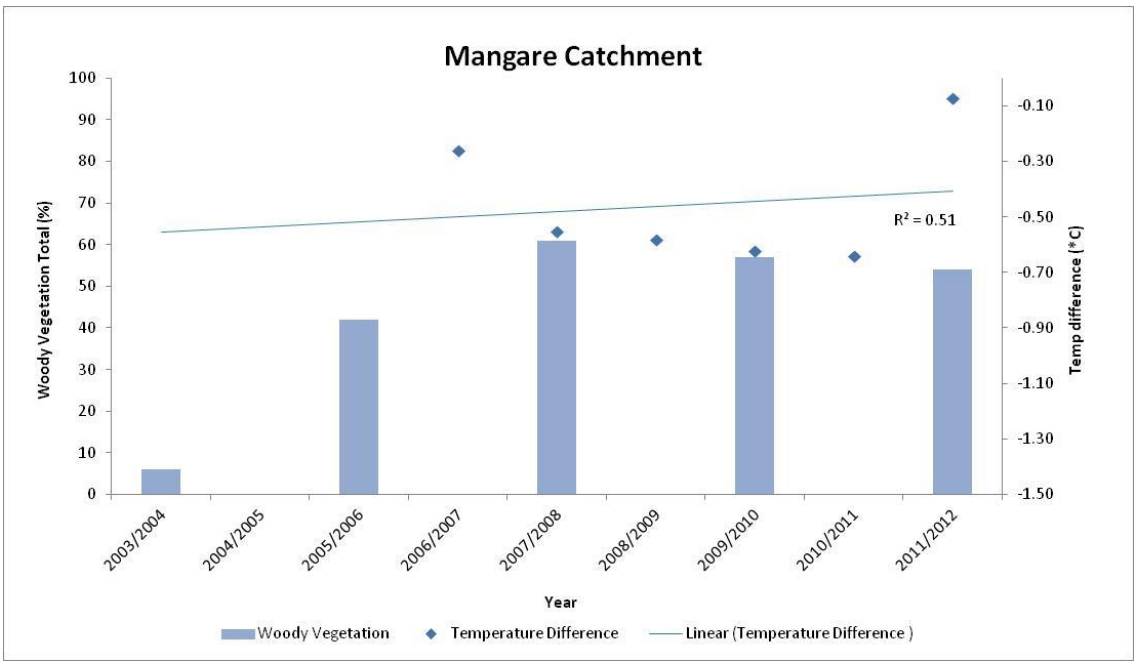

Figure 20: Woody vegetation total and temperature difference in the Mangare Catchment. Temperature and woody vegetation data only begins from 2003/04 onwards.

The downstream temperature has been slightly cooler on average than the upstream temperature with exception of 2006/2007 and 2011/2012 (Figure 20). The exceptionally cool summer of 2011/2012 is the likely cause of the lower overall temperature. It is anticipated that the low overall water temperature has resulted in less cooling from vegetative shading, resulting in a departure from the overall trend. A longer data set may provide us with more insight into ongoing trends.

3.3.4 Photo points

The initial year of assessment was 2003/04 with subsequent assessments completed in 2004/05, 2005/06, 2007/08, 2009/2010 and 2011/12. Two 1 km samples of stream were assessed, at 250 m intervals, giving a total of 10 photos for the Mangare Catchment. Baseline photos (Figure 21) from 2003/04 (left column) and 2011/12 (right column) are indicative of the increased woody vegetation and fencing along the section of stream that the temperature loggers are deployed. The other sections of the stream indicates little change in riparian characteristics during the monitored period due to little to no riparian fencing or planting.

2003/04	2012
	

Figure 21: Mangare Stream photo point examples of visual change, assessment 1 at 750m (a and b).

3.3.5 Stream ecological health

The dominant surrounding land use in the vicinity of both of the sampling sites in the Mangare Stream is pastoral. The stream ranges between 1.5 - 5.3 m in width with the substrate predominantly consisting of large gravel. The canopy cover is open however partial shading of the stream is beginning to occur from willow poles planted in 2005.

Invertebrate sampling is carried out in the same two locations where the water temperature probes are deployed in the middle section of the Mangare Stream. The initial year of assessment was completed in 2006, with subsequent assessments conducted annually.

Figure 23 lists the MCI values as calculated for the upstream and downstream sampling sites in the Mangare Stream. Samples are taken between January and March every year. Refer to Table 27 in Appendix 2 for more detail.

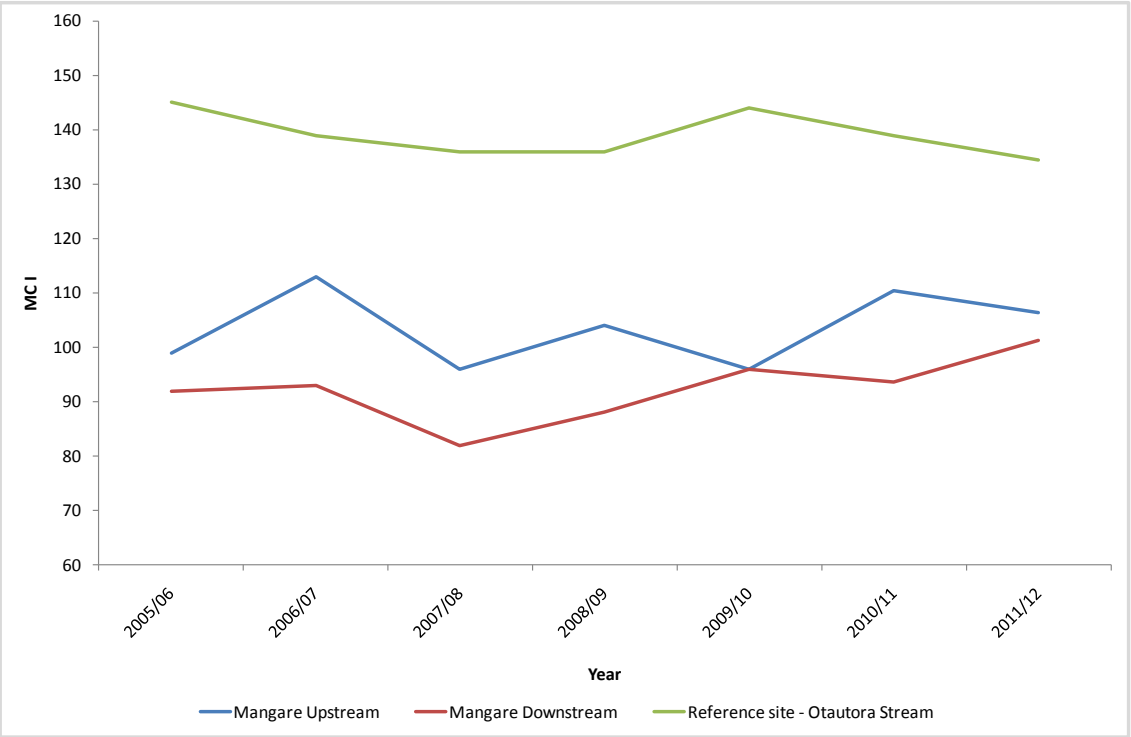

Figure 22: MCI values for the Mangare Stream and nearby reference site (Otautora Stream).

In the vicinity of the two sampling sites in the Mangare Stream, the presence and abundance of identified invertebrate species and associated MCI scores at the upstream site indicate that this stream has a moderate degradation in ecological health (Wright-Stow & Winterbourn, 2003). A longer monitoring period is required to identify a trend in the MCI values. A reference site has been included to compare the MCI values from the Mangare Stream. The reference site is the Otautora Stream (site number 1888.4). For more information on the monitored streams see Appendix 2.

3.3.6 Main points

Riparian Characteristics

- 54% cent of the riparian margin is woody vegetation, 2% of which are native species.

- There has been an increase in fencing over the total stream bank length from 41% in 2003/04 to 65% in the most recent survey (2011/12).

- Of the entire length of stream bank, 65% is fenced, and 52% is both fenced and has woody vegetation.

- An estimated 85% of the assessed riparian bank length was considered stable, up from 39% in 2003/04.

- Photo assessments have shown improvements in erosion and vegetation growth in areas of the Matahuru Stream riparian margin.

Water Temperature

- The downstream temperature has been slightly cooler on average than the upstream temperature, but a longer time period is needed before trends emerge.

- Shading has increased for half of the assessed stream reach, but the water temperature is unlikely to reflect this improvement for a number of years.

Stream Ecological Health

- Assessments of the invertebrates in Mangare Stream over the previous monitoring periods, indicate that this stream has a moderate degradation in overall ecological health in recent years.

3.4 Tahunaatara catchment

3.4.1 Monitoring progress

Monitoring focuses on the middle section of the Pokaitu Stream, a sub-catchment of the Tahunaatara Stream, which feeds into Lake Atiamuri. For survey locations in the Pokaitu catchment, refer to Grant et al. (2009b). Table 7 contains monitoring completed by the end of the 2011/12 financial year.

Table 7: Upper Waikato zone monitoring completed by 2011/12.

Monitoring	Planned activity	Completion	Included in this report (or year last reported)
Soil stability	Not planned	N/A	N/A
Riparian characteristic assessment	Not planned	N/A	N/A
Photo points	5km photo survey along the Pokaitu Stream	2003/04, 2008/09	(2008/09)
Permanent suspended sediment sampling site	Not planned	N/A	N/A
Suspended Sediment snapshot	Not planned	N/A	N/A
Water temperature	Install loggers and record stream temperatures along the middle section of the Pokaitu Stream	2003/04, 2004/05, 2005/06, 2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12.	✓
Stream ecological health	Assess stream ecological health along the middle section of the Pokaitu Stream	2003/04, 2004/05, 2005/06, 2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12.	✓

N/A = not applicable

3.4.2 Water temperature

Water temperature loggers are deployed in the middle section of the Pokaitu Stream, with a distance between them of approximately 5km. To date, the temperature data for nine summers have been recorded, between 2003/2004 and 2011/12 inclusive. The average of the daily maximum water temperatures is derived to produce a single temperature for each site. The daily average upstream and downstream maximums were 15.97°C and 15.28°C respectively. Refer to Table 32 in Appendix 3 for more detail.

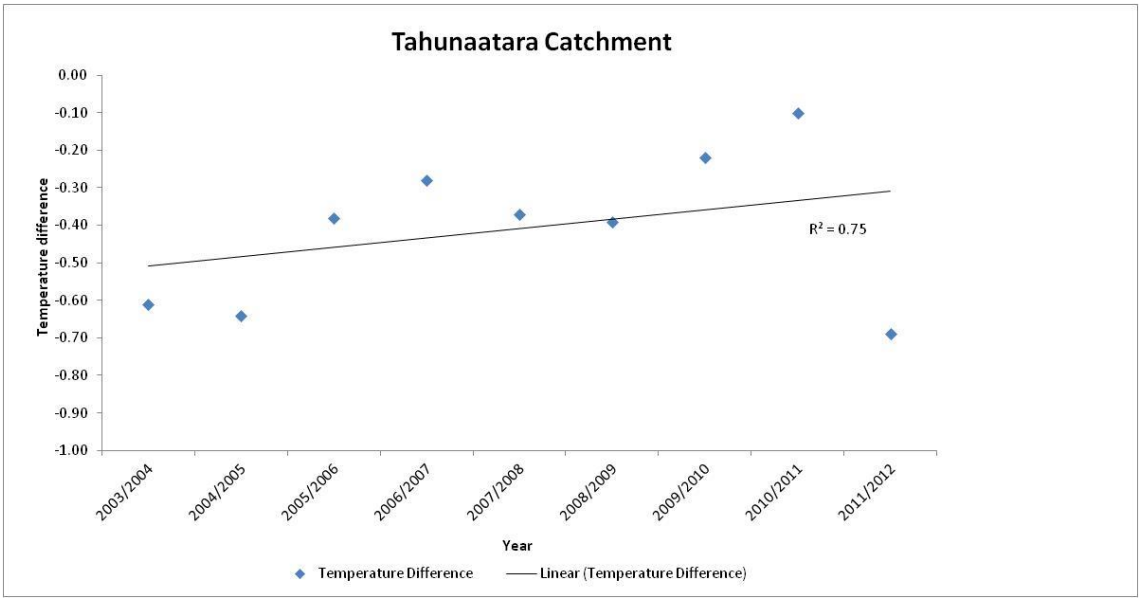

Figure 23: Temperature difference (downstream-upstream temperature) observed in the Tahunaatara Catchment (2003-2011).

Figure 23 shows that the temperature difference prior to 2011/2012 appeared to be decreasing. Historically shading of the stream has been sparse and sporadic. The trend was attributed to the clearance of pines reducing the shading along the monitored stretch of stream. The increased temperature difference evident in 2011/2012 may be attributable to regeneration of the vegetative cover; unfortunately this cannot be confirmed until the next photo survey due in 2013/2014.

3.4.3 Photo points

No photos were collected in the 2010/11 monitoring period in the Tahunaatara catchment. Refer to Grant et al. (2009b) for the most recent results and comparisons.

3.4.4 Stream ecological health

The dominant surrounding land use in the vicinity of the sampling site is pastoral. The stream is 3 - 6.6 m in width with the substrate predominantly consisting predominantly of large gravel. The canopy cover is open.

Invertebrate sampling is conducted in the Pokaitu Stream under the southern Apirana Road Bridge (where the downstream temperature probe is deployed). The initial year of assessment was in 2003/04, with subsequent assessments completed annually.

Figure 24 illustrates the MCI values as calculated for the Pokaitu Stream sampling site. Samples are taken between January and March every year. Refer to Table 26 in Appendix 2 for more detail.

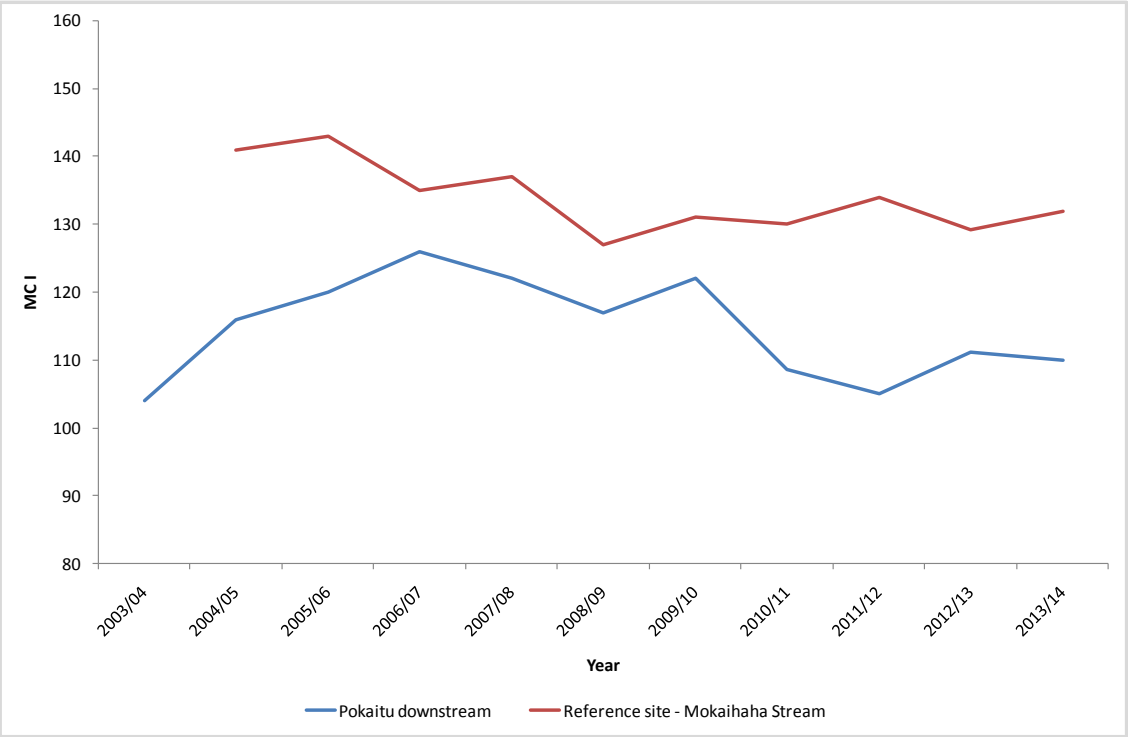

Figure 24: MCI values for the Pokaitu Stream and nearby reference site (Mokaihaha Stream).

The presence and abundance of identified invertebrate species in the vicinity of the sampling site and associated MCI scores, indicate that the stream has mild water quality in terms of ecological health (Wright-Stow & Winterbourn, 2003). A longer monitoring period is required to identify a trend in the MCI values. A reference site has been included to compare the MCI values from the Pokaitu Stream. The reference site is the Mokaihaha Stream (site number 555.2). For more information on the monitored streams see Appendix 2.

3.4.5 Main points

Riparian characteristics

- An increase in the temperature difference may indicate an increase in the vegetative cover along the stream. This cannot be confirmed until the next photo survey in 2013/2014

Water Temperature

- The downstream temperature has been slightly cooler on average than the upstream temperature for all assessed summers.

- A longer time period is required before water temperature trends will emerge.

Stream Ecological Health

- Assessments of the invertebrates in Pokaitu Stream indicate that the stream has mild water quality in terms of ecological health.

- Measurable improvements in aquatic habitat are likely to be evident after about 10 years of monitoring.

4 Waipa zone

4.1 Introduction

Monitoring is present in one catchment in the Waipa zone; Mangatutu catchment.

4.2 Mangatutu catchment

4.2.1 Monitoring progress

Monitoring focuses on the Mangatutu Stream catchment where river management and soil conservation initiatives are being implemented. For survey locations in the Mangatutu catchment, refer to Grant et al. (2009b). Table 8 contains monitoring completed by the end of the 2011/12 financial year.

Table 8: Waipa zone monitoring completed by 2011/12.

Monitoring	Activity	Completion	Included in this report (or year last reported)
Soil stability	Not planned	N/A	N/A
Riparian characteristic assessment	Complete assessment along the lower section of the Mangatutu sub-catchment	2004/05, 2006/07, 2008/09, 2010/11	(2010/11)
Photo points	Complete assessment along the lower section of the Mangatutu sub-catchment	2004/05, 2006/07, 2008/09, 2010/11	(2010/11)
Permanent suspended sediment sampling site	Event driven sampling	Ongoing since June 2004	✓
Suspended sediment snapshots	Low flow snapshot	2004	(2005/06)
Water temperature	Install loggers and record stream temperatures along the lower section of the Mangatutu River.	2003/04, 2004/05, 2005/06, 2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12	✓
Stream ecological health	Assess stream ecological health along the middle and lower section of the Mangatutu River.	2004/05, 2005/06, 2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12.	✓

N/A = not applicable

4.2.2 Riparian characteristics

No riparian characteristics data was collected in the 2011/12 monitoring period in the Mangatutu catchment. Refer to Littler et al., (2010) for the most recent results.

4.2.3 Water temperature

Three water temperature loggers are deployed along the monitored section of the Mangatutu Stream, due to its length (18km) and differences in character and management between the upper and lower sections of the stream. The downstream logger is under the Walker Road Bridge, the midstream logger is beneath the Lethbridge Road Bridge and the upstream logger is near the Wharepuhunga Road Bridge. To date nine deployments have been made with data collected for the summers between 2003/04 and 2011/2012. The 2003/2004 temperature data collected was only for the period of February to March; therefore the daily maximum average for this summer is not representative and cannot be compared to the other summer's results.

The average of the daily maximum water temperature is derived to produce a single temperature for each site. The daily average upstream, midstream and downstream maximums were 17.24°C, 18.55°C, and 18.09°C respectively. Refer to table 33 in Appendix 3 for more detail.

Figures 25 & 26 show that shading of the Mangatutu Stream remains sporadic between the temperature monitoring sites however this level of shading should increase over the long term as new plantings mature. As Figures 25 & 26, the downstream temperature has mostly been warmer than the upstream temperature, for the upper section and lower for lower section. For the total monitored length, stream temperature increases downstream. Generally, in the monitored region of the stream there is a warming effect in the upper section (between upper and midstream) compared with a cooling effect in the lower section (between mid and downstream). Only the data from the 2007/08 summer has shown the downstream temperature to be cooler than the upstream temperature. However more data would provide a better insight into ongoing trends. We would expect as existing vegetation combined with any new plantings establish and grow, shading will increase and result in a larger temperature difference between the upstream to downstream monitoring sites. In particular we would expect a larger difference observed between the downstream and midstream temperature recorders as shading begins to increase.

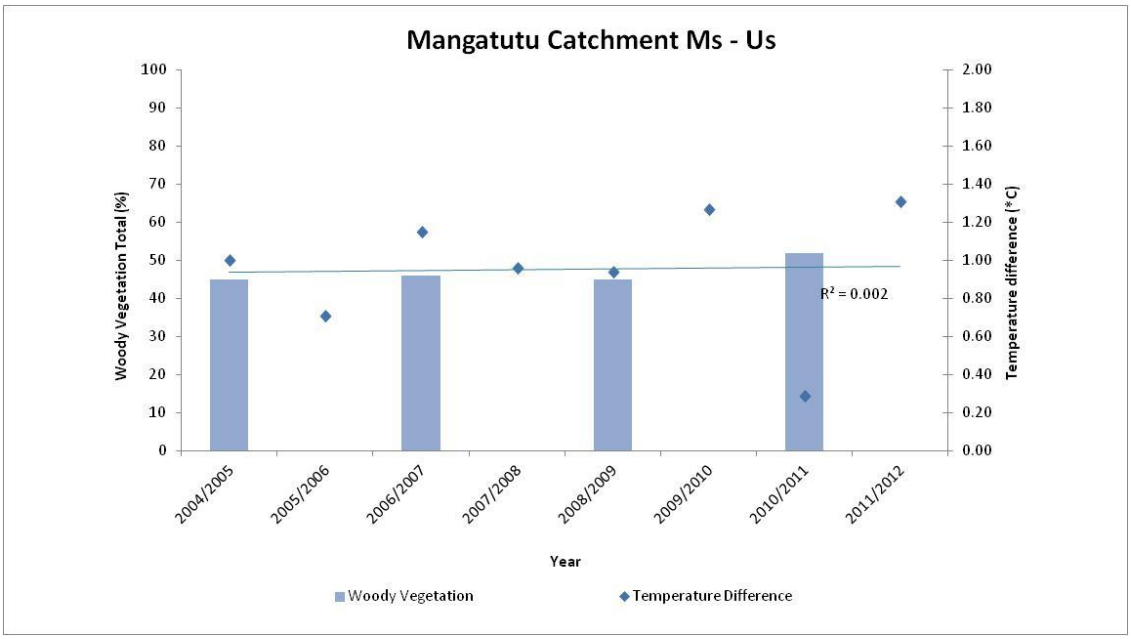

Figure 25: Woody vegetation total and temperature difference in the Mangatutu Catchment.

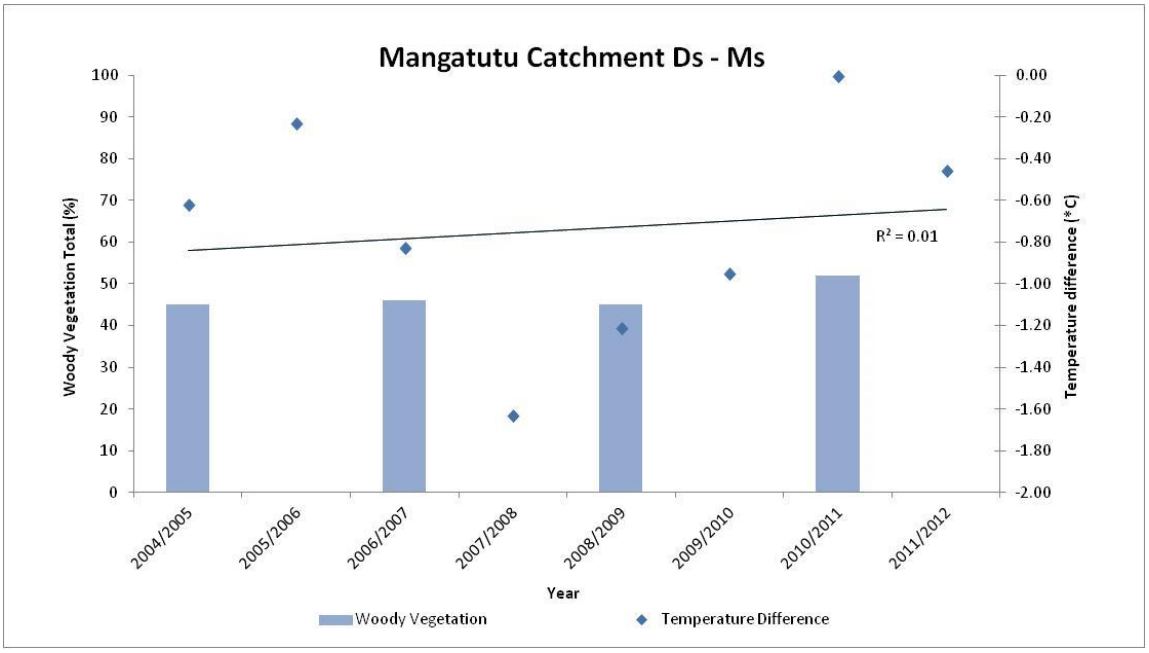

Figure 26: Woody vegetation total and temperature difference in the Mangatutu Catchment.

4.2.4 Photo points

No photos were collected in the 2011/12 monitoring period in the Mangatutu catchment. Refer to Littler et al., (2010) for the most recent results and comparisons.

4.2.5 Suspended sediment

Permanent sampling site

A permanent suspended sediment sampling site has been in place at Walker Road Bridge on the Mangatutu River since June 2004. During this time 47 events have been sampled using an automatic sediment sampler. The data set is analysed to estimate sediment variables (Table 9). Data includes all results up until 31/12/2011. A continuing focus is to carry out manual depth-integrated suspended sediment gaugings while the automatic sampler is activated. The collection of these concurrent samples will allow for the automatic series to be calibrated to the whole river cross-section. For more detailed information refer to the Suspended Sediment Monitoring Report (Kotze et al., 2008).

Table 9: Mangatutu permanent suspended sediment sampling site description and estimated sediment variables.

Site name:	**Walker Road**	**Map Ref (NZMS260):**	**S15:203-423**
River:	**Mangatutu**		
		Start – End Date	**No of samples**
Flow Time Series		08/06/2004 – 31/12/2011	N/A
Sediment Samples		22/06/2004 – 8/06/2010	959
ISCO Period of Record		22/06/2004 – 8/06/2010	47 events

Specific yield (t/km^2/yr)	Average sediment yield (kt/yr)	% of sediment yield in gauged range of flow	% Error in Yield Estimate
44	5.3	98.2	3.3

The Mangatutu River has an estimated specific yield of 44 t/km^2/yr and an average sediment yield of 5.3 kt/yr. Figure 27 shows the specific sediment yield for the Mangatutu River relative to other monitored sites in the Region.

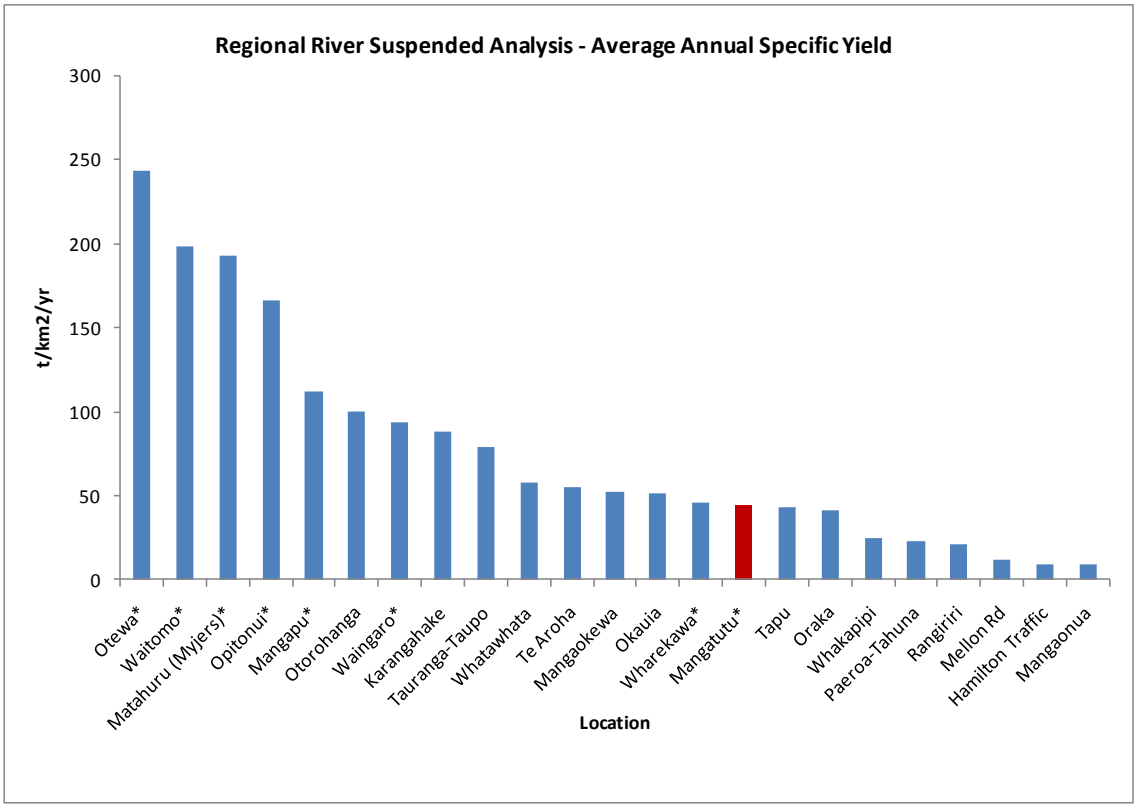

Figure 27: Average specific suspended sediment yield for monitored rivers in the Waikato Region (Mangatutu site is highlighted).

The specific yield for the Mangatutu can be considered moderate relative to many sites in the region. The dominant geology (comprising welded ignimbrite and overlying tephras) are likely reasons for this moderate specific sediment yield value.

4.2.6 Stream ecological health

The dominant surrounding land use in the vicinity of the sampling site is pastoral. The stream is 4-11.2 m in width with the substrate predominantly consisting of large to small gravel. The canopy cover is partly shaded although the removal of nuisance riparian willow will, in the short term, reduce canopy cover.

Invertebrate sampling is conducted in the Mangatutu River immediately upstream of the Walker Road Bridge, near the downstream temperature logger. The initial year of assessment using these methods was in 2005 with subsequent assessments completed annually.

Figure 28 lists the MCI values as calculated for the Mangatutu River sampling site. Samples are taken between January and March every year. Refer to Table 25 in Appendix 2 for more detail.

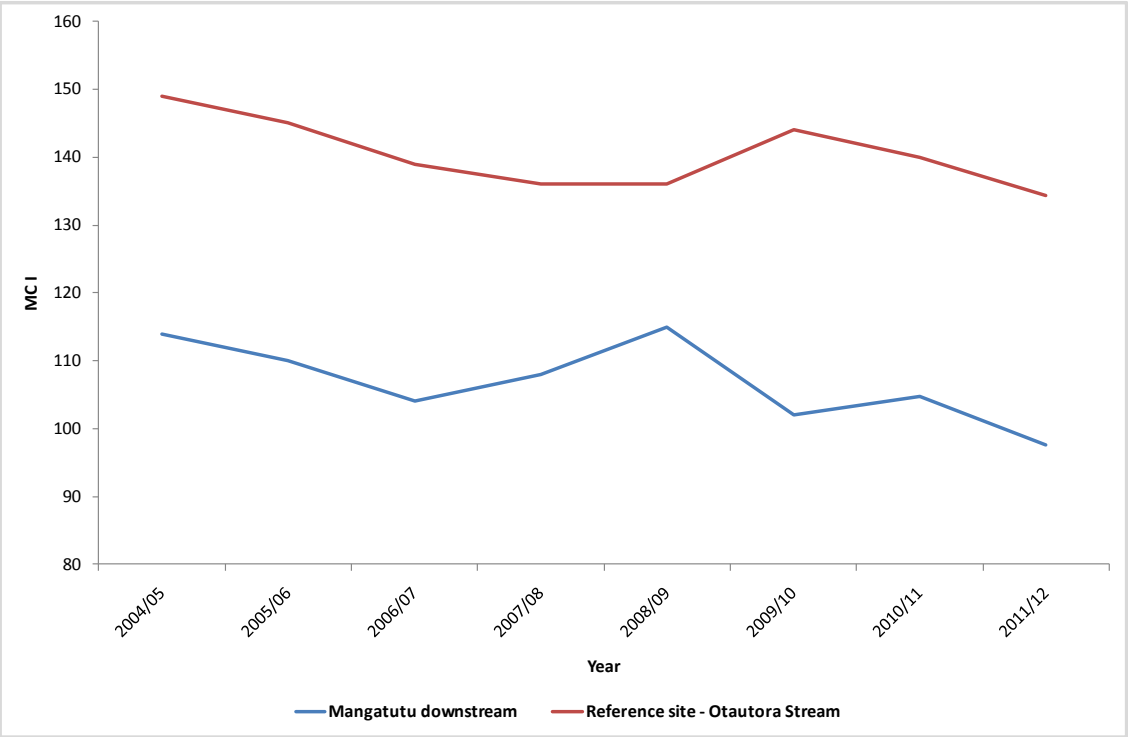

Figure 28: MCI values for the sampling site in the Mangatutu River and nearby reference site (Otautora Stream).

The presence and abundance of identified invertebrate species in the vicinity of the sampling site in the Mangatutu River and associated MCI scores, indicate that the ecological health of the stream is considered to be moderate to mildly degraded (Wright-Stow & Winterbourn, 2003). A longer monitoring period is required to identify trends in the MCI values. A reference site has been included to compare the MCI values from the Mangatutu Stream. The reference site is the Otautora Stream (site number 1888.4). For more information on the monitored streams see Appendix 2.

4.2.7 Main points

Riparian Characteristics

- No riparian characteristics data was collected in the 2011/12 monitoring period.

Suspended sediment monitoring

- The specific yield for the Mangatutu catchment above Walker Road Bridge is 44 t/km^2/yr after five years of sampling. However a longer monitoring period is required (at least 10 years) in order to produce a more accurate result.

- A low flow snapshot was taken in 2004, with results described in Hill et al., (2006).

Water Temperature

- Water temperature has been monitored annually since 2004/05. With the exception of the 2007/08 monitoring period, the downstream site has recorded warmer temperatures than the upstream site. This is likely to improve as soil conservation plantings grow and shade the water. A longer monitoring period is required before a trend can be identified.

Stream Ecological Health

- Assessments of the invertebrates in Mangatutu Stream indicate that there is a moderate to mild degradation in ecological health.

4.2.8 Other monitoring

Automatic sediment samplers are installed on the Upper Waipa River (at Otewa) and the Mangapu Stream to monitor suspended sediment in the Waipa zone. For more details, refer to the Suspended Sediment monitoring report (Kotze et al., 2008). *Mangatutu Stream Ecological Monitoring Results – 2004 to 2007* has been completed by Gibbs, (2008) as a Waikato Regional Council Internal Series report, and can be accessed internally on DOC #1212429 or by contacting Waikato Regional Council. This report describes the changes in ecological health in the Mangatutu Stream resulting from the soil conservation work which has occurred since 2004.

5 Coromandel zone

5.1 Introduction

Monitoring is present in one catchment in the Coromandel zone; Wharekawa catchment.

5.2 Wharekawa catchment

5.2.1 Monitoring progress

Monitoring will focus on the Wharekawa River catchment where river management and soil conservation initiatives are being implemented. For survey locations in the Wharekawa catchment, refer to Grant et al., (2009b). Table 10 contains monitoring completed by the end of the 2011/12 financial year.

Table 10: Coromandel zone monitoring completed by 2011/12.

Monitoring	Activity	Completion	Included in this report (or year last reported)
Soil stability	Not planned	N/A	N/A
Riparian characteristic assessment	Complete assessment along the monitored section of Wharekawa River.	2006/07, 2008/09, 2010/11	(2010/11)
Photo points	Complete assessment along the monitored section of the Wharekawa River	2006/07, 2008/09, 2010/11	(2010/11)
Permanent suspended sediment sampling site	Event driven sampling, concluded in 2003. Site reinstalled.	April 2000 until Feb 2003. Reinstalled Dec 2009.	✓
Suspended sediment snapshots	Not planned	N/A	N/A
Water temperature	Install loggers and record stream temperatures along the Wharekawa River	2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12	✓
Stream ecological health	Assess stream ecological health along the Wharekawa River	2004/05, 2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12	✓

N/A = not applicable

5.2.2 Riparian characteristics

No riparian characteristics data was collected in the 2011/12 monitoring period in the Wharekawa catchment. Refer to Littler et al., (2010) for the most recent results.

5.2.3 Water temperature

Water temperature loggers are deployed in the lower section of the Wharekawa River. The downstream logger is near the SH25 Bridge, and the upstream logger is approximately 3km further upstream, near where the river emerges from the forest. Six deployments have been made with data collected for the summers of 2006/07, 2007/08, 2008/09, 2009/10, 2010/11 and 2011/12.

Over the summers of 2009/10 and 2011/12 the logger deployed at the upstream site was swept away. The temperatures recorded at the Waikato Regional Council hydrology site (midstream) approximately 1.1 km downstream from the upstream site have been used to compensate for this missing data.

The average of the daily maximum water temperature is derived to produce a single temperature for each site (no upstream temperature data is available for 2011/12 due to the logger being washed away in a flood event). The 2011/12 daily average midstream and downstream maximums were 19.75 °C and 21.07 °C respectively. Refer to table 34 in Appendix 3 for more detail (there is no upstream data for 2009/10 and 2011/12 due to the loggers being washed away during a flood event in early 2010).

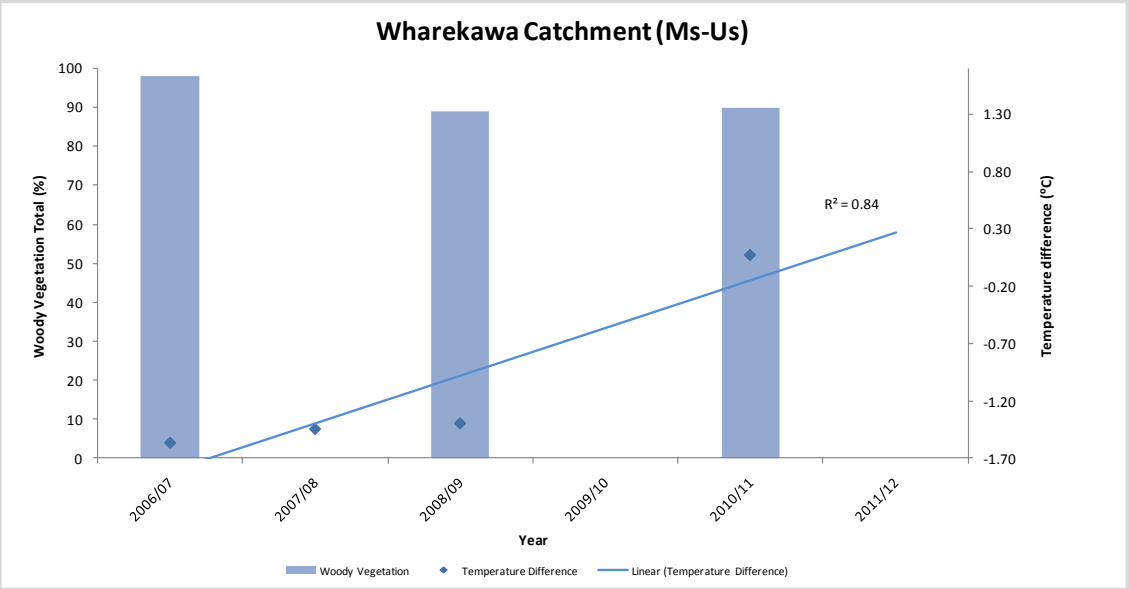

Figure 29: Woody vegetation total and temperature difference in the Wharekawa Catchment midstream minus upstream temperature. Temperature and woody vegetation data only begins from 2006/2007 onwards.

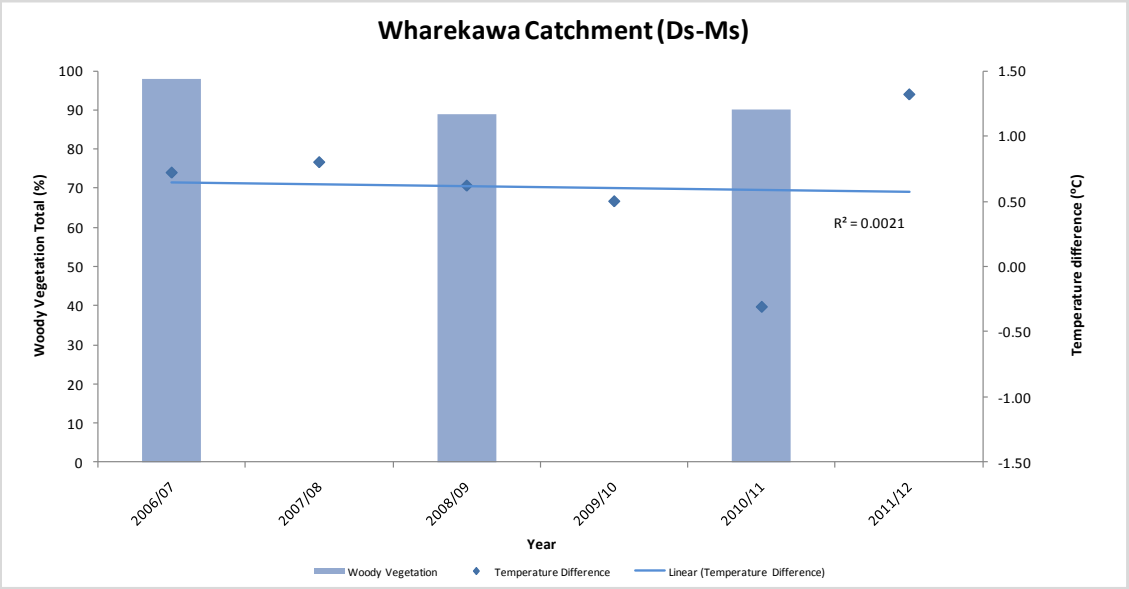

Figure 30: Woody vegetation total and temperature difference in the Wharekawa Catchment downstream minus midstream temperature. Temperature and woody vegetation data only begins from 2006/2007 onwards.

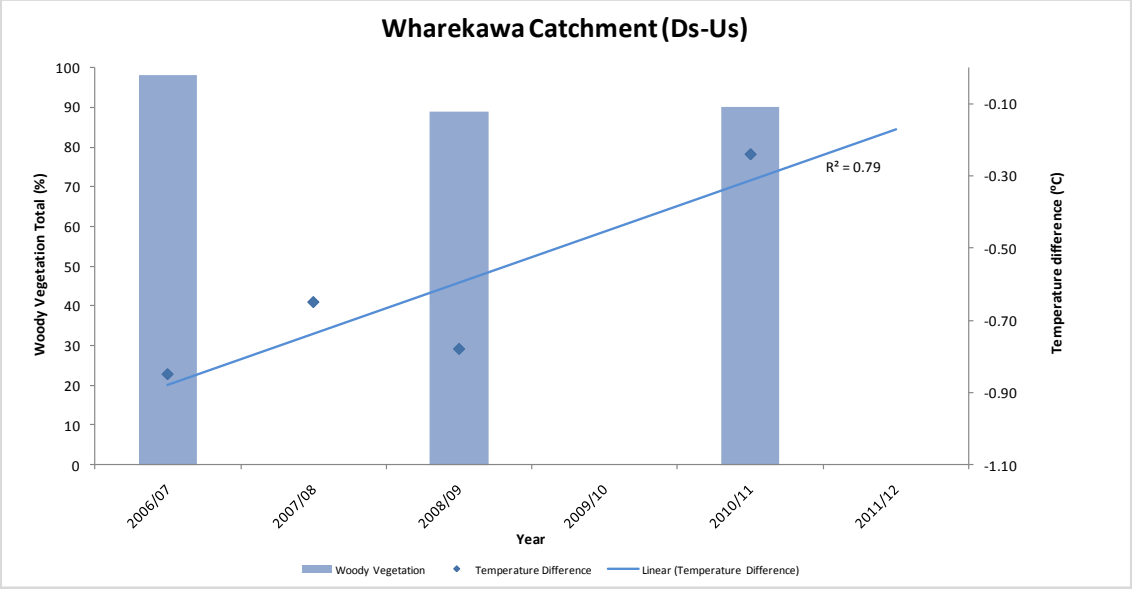

Figure 31: Woody vegetation total and temperature difference in the Wharekawa Catchment downstream minus upstream temperature. Temperature and woody vegetation data only begins from 2006/2007 onwards.

Figures 29 and 30 show the relationship between the temperature difference and the woody vegetation cover over the years between the upstream to midstream and midstream to downstream temperature loggers. It can be noted that in general the water temperature cools between the upstream and midstream loggers, and warms again between the midstream and downstream loggers. Figure 31 indicates that overall the water temperature lowers along the monitored stretch of the stream. Changes in the woody vegetation in the lower monitored stretch due to the removal of old Willows may account for the variation in temperature differences. A longer data set may provide us with more insight into ongoing trends.

5.2.4 Photo points

No photos were collected in the 2011/12 monitoring period in the Mangatutu catchment. Refer to Littler et al., (2010) for the most recent results and comparisons.

5.2.5 Suspended sediment monitoring

A permanent sediment sampling site has been in place at Adams Farm Bridge on the Wharekawa River since June 1991. During this time 21 events have been sampled using an automatic sediment sampler, which was on site between April 2000 and February 2003, and was redeployed in December 2009. The data set is analysed to estimate sediment variables (Table 11). Data includes all results up until 31/12/2011. A continuing focus is to carry out manual depth-integrated suspended sediment gaugings while the automatic sampler is activated. The collection of these concurrent samples will allow for the automatic series to be calibrated to the whole river cross-section. For more detailed information refer to the Suspended Sediment Monitoring Report (Kotze et al., 2008).

Table 11: Wharekawa permanent suspended sediment sampling site description and estimated sediment variables.

Site name:	**Adams Farm Bridge**	**Map Ref (NZMS260):**	**T12:623-468**
River:	**Wharekawa**		
		Start – End Date	**No of samples**
Flow Time Series		10/06/1991 – 31/12/2011	N/A
Sediment Samples		25/09/1991 – 31/12/2011	538
ISCO Period of Record		20/04/2000 – 31/12/2011	21 events

Specific yield ($t/km^2/yr$)	Average sediment yield (kt/yr)	% of sediment yield in gauged range of flow	% Error in Yield Estimate
46	2.15	77.1	4.5

The Wharekawa River has an estimated specific yield of 46 $t/km^2/yr$ and an average sediment yield of 2.15 kt/yr. Figure 32 shows the specific sediment yield for the Wharekawa River relative to other monitored sites in the Region.

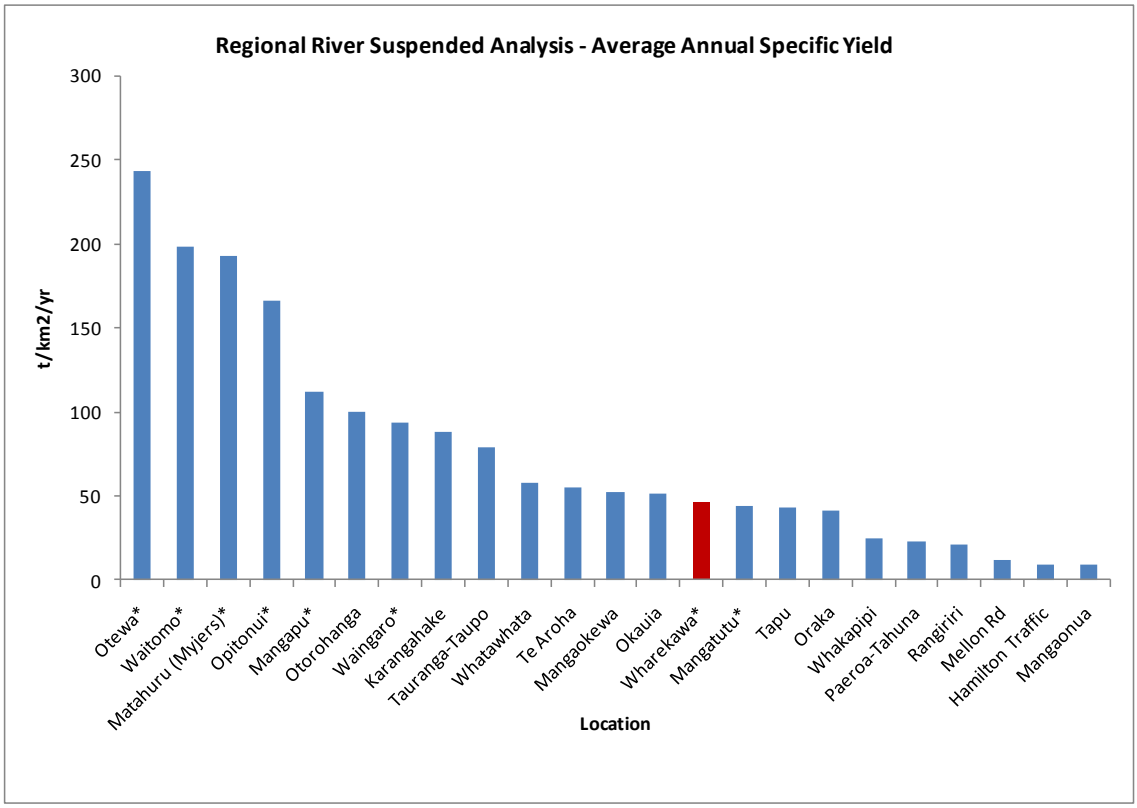

Figure 32: Average specific suspended sediment yield for monitored rivers in the Waikato Region (Wharekawa site is highlighted).

The specific yield for the Wharekawa can be considered low relative to many sites in the region. The influencing factors are likely to be the dominance of woody vegetation cover and geology.

5.2.6 Stream ecological health

The dominant surrounding land use in the vicinity of the sampling site is pastoral but the riparian zone is generally planted. The stream is up to 14 m wide with the substrate predominantly consisting of large gravel and cobbles. The canopy cover is partly shaded.

Invertebrate sampling is conducted in the Wharekawa River in the vicinity of the Adam's Farm Bridge, midway between the upstream and downstream temperature loggers. The initial year of assessment using these methods was in 2004/05 with sampling undertaken annually since then, except for in 2005/06 when no samples were taken.

Figure 33 illustrates the MCI values as calculated for the Wharekawa River sampling site. Samples are taken between January and March every year. Refer to Table 28 in Appendix 2 for more detail.

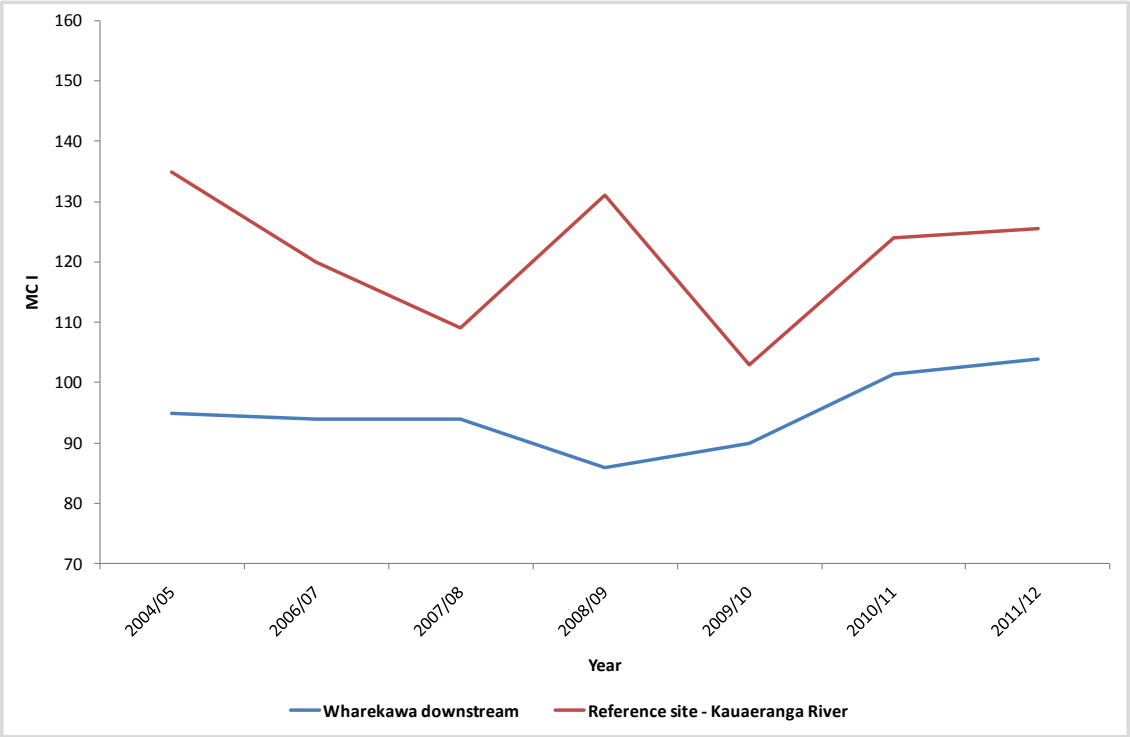

Figure 33: MCI values for the sampling site in the Wharekawa River and nearby reference site (Kauaeranga River).

In the vicinity of the sampling site the presence and abundance of identified invertebrate species and the associated MCI scores indicate that there is a moderate to mild degradation in ecological health (Wright-Stow & Winterbourn, 2003). A longer monitoring period is required before trends in the MCI values can be identified. A reference site has been included to compare the MCI values from the Wharekawa Stream. The reference site is the Kauaeranga River (site number 234.28). For more information on the monitored streams see Appendix 2.

5.2.7 Main points

Riparian characteristics

- No riparian characteristics data was collected in the 2009/10 monitoring period.

Suspended sediment monitoring

- The specific yield for the Wharekawa catchment is estimated to be 46 t/km^2/yr, based on samples taken both manually and from an automatic sediment sampler since 1991.

- Continued manual sediment sampling adds to the existing dataset.

Temperature

- As there is no upstream data for 2009/10 and 2011/12 we cannot make any inference on the difference between the upstream and downstream temperature loggers. In previous years the downstream temperature has been cooler on average than the upstream logger. A longer monitoring period is required to identify a trend.

Stream Ecological Health

- Assessments of the invertebrates in Wharekawa River indicate that there is a moderate to mild degradation in ecological health.

5.2.8 Other monitoring

An automatic sediment sampler is installed on the Opitonui River to monitor suspended sediment. Further details are in the Suspended Sediment Monitoring Report (Kotze et al., 2008).

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Appendix 1: Riparian characteristics summary

Matahuru catchment – Lower Waikato zone 2011/12

For each table the number in brackets is the change from the 2003/04 assessment, which was the first year the assessment was done.

Table 12: Matahuru erosion.

Riparian **erosion** characteristics – Matahuru (% of total bank length)									
Erosion	stable 94(+47)	unstable 6(-47)							
Fencing	nd	fenced 6(-9)				unfenced 0(-38)			
Vegetation		grass 2(-4)	willow woody veg. 0(-1)	other exotic woody veg. 3(-1)	native woody veg. 1(-4)	grass 0(-30)	willow woody veg. 0(-1)	other exotic woody veg. 0(-2)	native woody veg. 0(-5)

nd = not detailed, nc = no change

Table 13: Matahuru vegetation.

Riparian **vegetation** characteristics –Matahuru (% of total bank length)			
Grass 20(-32)	Woody vegetation 80(+32)		
	Exotic 37(+28)		Native 43(+4)
	Willow 14(+10)	Non-willow 23(+18)	

Table 14: Matahuru fencing.

Riparian **fencing** characteristics - Matahuru								
Fencing: % of stream length	**no fence on both sides** 0(-30)				**fenced on one side** 5(-19)		**fenced on both sides** 95(+49)	
Fencing: % of total bank length	**not fenced** 3(-39)				**fenced** 97(+39)			
Breakdown by vegetation	grass 2(-30)	willow woody veg. 0(-2)	other exotic woody veg. 2(nc)	native woody veg 0(-6)	grass 18(nc)	willow woody veg. 13(+10)	other exotic woody veg. 23(+20)	native woody veg. 43(+9)

For each table the number in brackets is the change from the 2003/04 assessment, which was the first year the assessment was done.

Table 15: Pokaiwhenua erosion.

Riparian **erosion** characteristics – Pokaiwhenua (% of total bank length)									
Erosion	stable 98(+10)	unstable 2(-10)							
Fencing	nd	fenced 1(-6)				unfenced 1(-4)			
Vegetation		grass 0(-5)	willow woody veg. 1(+1)	other exotic woody veg. 0(nc)	native woody veg. 0(-2)	grass 0(-2)	willow woody veg. 0(nc)	other exotic woody veg. 1(nc)	native woody veg. 0(nc)

nd = not detailed, nc = no change

Table 16: Pokaiwhenua vegetation.

Riparian **vegetation** characteristics – Pokaiwhenua (% of total bank length)			
Grass 24(-31)	Woody vegetation 76(+31)		
	Exotic 56(+40)		Native 20(-9)
	Willow 14(+8)	Non-willow 42(+32)	

Table 17: Pokaiwhenua fencing.

Riparian **fencing** characteristics - Pokaiwhenua								
Fencing: % of stream length	**no fence on both sides** 0(-29)				**fenced on one side** 0(-44)		**fenced on both sides** 100(+73)	
Fencing: % of total bank length	**not fenced** 0(-50)				**fenced** 100(+50)			
Breakdown by vegetation	grass 0(-24)	willow woody veg. 0(-3)	other exotic woody veg. 0(-8)	native woody veg 0(-16)	grass 24(-8)	willow woody veg. 14(+10)	other exotic woody veg. 42(+40)	native woody veg. 20(+8)

For each table the number in brackets is the change from the 2003/04 assessment, which was the first year the assessment was done.

Table 18: Mangare erosion.

Riparian **erosion** characteristics – Mangare (% of total bank length)									
Erosion	stable 85(+46)	unstable 15(-46)							
Fencing	nd	fenced 10(-22)				unfenced 5(-24)			
Vegetation		grass 2(-29)	willow woody veg. 8(+7)	other exotic woody veg. 0(-2)	native woody veg. 0(nc)	grass 5(-21)	willow woody veg. 0(-1)	other exotic woody veg. 0(nc)	native woody veg. 0(nc)

nd = not detailed, nc = no change

Table 19: Mangare vegetation.

Riparian **vegetation** characteristics – Mangare (% of total bank length)			
Grass 46(-48)	Woody vegetation 54(+48)		
	Exotic 52(+46)		Native 2(+2)
	Willow 48(+46)	Non-willow 4(nc)	

nc = no change

Table 20: Mangare fencing.

Riparian **fencing** characteristics – Mangare								
Fencing: % of stream length	**no fence on both sides** 19(-30)				**fenced on one side** 32(+12)		**fenced on both sides** 49(+18)	
Fencing: % of total bank length	**not fenced** 35(-24)				**fenced** 65(+24)			
Breakdown by vegetation	grass 33(-25)	willow woody veg. 2(+1)	other exotic woody veg. 0(nc)	native woody veg 0(nc)	grass 20(-25)	willow woody veg. 46(+45)	other exotic woody veg. 4(+2)	native woody veg. 2(+2)

nc = no change

Appendix 2: Macroinvertebrate Community Index (MCI)

Integrity Score (IBI), Integrity classes, Macroinvertebrate Community Index (MCI) and Quantitative Macroinvertebrate Community Index (QMCI) ranges defined for invertebrate communities (Wright-Stow and Winterbourn, 2003).

Table 21: Macro invertebrate Community Index (MCI):

IBI Score range	Integrity Class	MCI Range	QMCI range	Degradation Category
58–60	Excellent	125-200	6.2-10	Clean
48-52	Good	105-115	5.2-5.7	Mild
40-44	Fair	85-95	4.2-4.7	Moderate
28-34	Poor	<75	0-3.7	Severe
12-22	Very poor	-	-	-

Table 22: Additional information on monitored streams:

Stream name	Stream Depth	Stream Width	Main Substrate Type	Distance between u/s and d/s loggers
Pokaiwhenua	0.6m	**11**.6m	Large Gravel/cobble	1.2km
Mangare	0.5m	5.3m	Large gravel	1.3km
Tahunaatara	0.5m	6.6m	Large gravel	4.5km
Mangatutu	0.5m	11.2m	Large/small gravel	18km
Wharekawa	0.3m	13.6m	Cobble/Large gravel	3.4km

Stream depth, width and substrate type are gathered while conducting REMS surveys and are only indicative of the 100m stretch that is sampled. It does however give an idea of the size and substrate type of the streams.

Table 23: Additional information on reference streams for REMS:

Stream name	Stream Depth	Stream Width	Main Substrate Type
Mokaihaha	0.2m	7.4m	Bedrock/Sand
Otautora	0.2m	3.6m	Cobble/Sand/Gravel
Kauaeranga	0.3m	20m	Boulder/Cobble
Pohomihi	0.3m	9.8m	Large Gravel

Stream depth, width and substrate type are gathered while conducting REMS surveys and are only indicative of the 100m stretch that is sampled. It does however give an idea of the size and substrate type of the streams.

Table 24: MCI values for the Pokaiwhenua River and nearby reference site (Mokaihaha Stream).

Site	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Pokaiwhenua upstream	99	103	113	113	115	113	107	112.2	114
Pokaiwhenua downstream	113	109	116	103	108	102	98	96.6	112.7
Reference site - Mokaihaha Stream	N/A	141	143	135	137	127	131	130	133.9

Table 25: MCI values for the sampling site in the Mangatutu River and nearby reference site (Otautora Stream).

Site	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Mangatutu downstream	114	110	104	108	115	102	104.7	97.6
Otautora Stream	149	145	139	136	136	144	140	134.4

Table 26: MCI values for the Pokaitu Stream and nearby reference site (Mokaihaha Stream).

Site	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Pokaitu downstream	104	116	120	126	122	117	122	108.6	105
Mokaihaha Stream	N/A	141	143	135	137	127	131	130	133.9

Table 27: MCI values for the Mangare Stream and nearby reference site (Otautora Stream).

Site	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Mangare upstream	99	113	96	104	96	110.5	106.3
Mangare downstream	92	93	82	88	96	93.7	101.3
Reference site – Otautora Stream	145	139	136	136	144	139	134.4

Table 28: MCI values for the sampling site in the Wharekawa River and nearby reference site (Kauaeranga River).

Site	2004/05	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Wharekawa	95	94	94	86	90	101.4	104
Kauaeranga River	135	120	109	131	103	124	125.6

Appendix 3: Temperature results

The downstream temperature is then subtracted from the upstream temperature to provide a single number for the monitored section of each river within a catchment (Table 1 to 6).

Matahuru catchment – Lower Waikato zone 2003-2012

Table 29: Matahuru Stream average daily maximum water temperatures for the 10 week period commencing 1st January.

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between d/s and u/s locations (°C)
2003/04	21.86	20.84	-1.02
2004/05	22.78	21.87	-0.90
2005/06	22.20	21.22	-0.98
2006/07	22.61	21.62	-0.99
2007/08	23.34*	22.41	-0.93*
2008/09	22.34	21.76	-0.59
2009/10	22.62	21.96	-0.66
2010/11	22.93	22.25	-0.68
2011/12	20.77	20.28	-0.49

*The upstream logger was out of the water during January 2008, so the daily maximum average temperature is unlikely to be representative.

Pokaiwhenua catchment – Upper Waikato zone 2003-2012

Table 30: Pokaiwhenua Stream average daily maximum water temperatures for the 10 week period commencing 1st January.

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between d/s and u/s locations (°C)
2003/04	18.44	18.21	-0.23
2004/05	18.78	18.47	-0.31
2005/06	18.32	17.98	-0.33
2006/07	18.51	18.15	-0.36
2007/08	19.21	18.63	-0.58
2008/09	19.07	18.32*	-0.75*
2009/10	18.78	17.47	-1.19
2010/11	18.71	18.36	-0.32
2011/12	17.11	17.02	-0.08

*The downstream logger was out of the water during March 2009, so the daily maximum average temperature is unlikely to be representative.

Mangare catchment – Upper Waikato zone 2006-2012

Table 31: Mangare Stream average daily maximum water temperatures for the 10 week period commencing 1st January.

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between d/s and u/s locations (°C)
2006/07	21.53	21.27	-0.26
2007/08	22.82	22.28	-0.55
2008/09	21.85	21.27	-0.58
2009/10	21.45	20.82	-0.62
2010/11	21.64	21.00	-0.64
2011/12	18.47	18.54	+0.07

Tahunaatara catchment – Upper Waikato zone 2003-2012

Table 32: Pokaitu Stream average daily maximum water temperatures for the 10 week period commencing 1st January.

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between d/s and u/s locations (°C)
2003/04	17.52	16.91	-0.61
2004/05	17.87	17.23	-0.64
2005/06	17.01	16.63	-0.38
2006/07	17.13	16.85	-0.28
2007/08	17.53	17.18	-0.35
2008/09	17.39	17.00	-0.39
2009/10	17.06	16.84	-0.22
2010/11	17.47	17.37	-0.10
2011/12	15.97	15.28	-0.69

Mangatutu catchment – Waipa zone 2004-2012

Table 33: Mangatutu Stream average daily maximum water temperatures for the 10 week period commencing 1st January.

Year	Upstream average daily max (°C)	Temp diff btwn m/s and u/s locations (°C)	Midstream average daily max (°C)	Temp diff btwn d/s and m/s locations (°C)	Downstream average daily maximum (°C)	Temp diff btwn d/s and u/s locations (°C)
2004/05	19.85	1.00	20.85	-0.62	20.22	+0.38
2005/06	19.41	0.71	20.12	-0.23	19.89	+0.48
2006/07	20.01	1.15	21.15	-0.83	20.33	+0.32
2007/08	21.74	0.96	22.70	-1.63	21.07	-0.67
2008/09	20.07	2.13	22.20*	2.13	20.29	+0.22
2009/10	20.12	1.27	21.39	-0.95	20.44	+0.32
2010/11	19.43	0.29	19.73	0.02	19.75	+0.32
2011/12	17.24	+1.31	18.55	-0.46	18.09	+0.85

*The midstream logger was out of the water during most of February and March 2009, so the daily maximum average temperature is unlikely to be representative.

Wharekawa catchment – Coromandel zone 2006-2012

Table 34: Wharekawa River average daily maximum water temperatures for the 10 week period commencing 1st January.

Year	Upstream average daily max (°C)	Temp diff btwn m/s and u/s locations (°C)	Midstream average daily max (°C)	Temp diff btwn d/s and m/s locations (°C)	Downstream average daily maximum (°C)	Temp diff btwn d/s and u/s locations (°C)
2006/07	22.06	-1.57	20.48	0.72	21.21	-0.85
2007/08	22.51	-1.45	21.06	0.80	21.86	-0.65
2008/09	22.62	-1.40	21.22	0.62	21.84	-0.78
2009/10	*	*	21.06	0.50	21.56	*
2010/11	21.65	+0.07	21.72	-0.31	21.41	-0.24
2011/12	*	*	19.75	1.32	21.07	*
*The upstream logger was lost for the period of 2009/10 and 2011/12 due to substantial flood events.						