Waituna Landcare Group

An environmental health assessment of the Waituna Catchment

Prepared by

Ryder Consulting

August 2003


PROVIDED WITH HELP FROM THE NZ LOTTERY GRANTS BOARD
AND THANKS ALSO TO LOTTO PLAYERS

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An environmental health assessment of the Waituna Catchment

Prepared as a precursor to the preparation of a catchment management plan

By

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EXECUTIVE SUMMARY

- Waituna catchment consists of three major streams that drain into the Waituna Lagoon and wetland system. This system is an internationally significant example of a coastal lagoon and wetland of its type.

- The catchment has been subject to extensive pastoral development and land use intensification continuing up to the present time.

- Water quality in the catchment, particularly in terms of nutrient, faecal pathogen and ammonia concentrations, is poor. This appears to be directly related to pastoral development.

- Ammonia concentrations in the streams are amongst the highest in Southland and represent a significant risk to native and sports fisheries.

- Land use practices such as land disposal of effluent, riparian grazing and stock access to waterways present a risk to the aquatic environment of the catchment and ultimately to the Lagoon and wetlands.

- Recommended actions in the catchment include encouragement and implementation of riparian fencing, reappraisal of land disposal practices, and catchment-wide efforts to achieve best land management practice.

ACKNOWLEDGEMENTS

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SECTION ONE

Introduction

1.1 Background

This Catchment Management Plan was prepared at the request of the Waituna Landcare Group (WLG). The WLG was formed in response to concerns that land management practices within the catchment of Waituna Lagoon were negatively affecting the health of the Lagoon.

1.2 Summary of Waituna Lagoon report

Waituna Lagoon is a large, oligotrophic "waituna-type" lagoon on the southern coast of the South Island, near Invercargill. The Lagoon is a dynamic system, periodically open to the sea for long periods, then closing through natural coastal sedimentation processes, gravel being pushed in by the sea. The biology of the Lagoon is distinctive, with aquatic vegetation dominated by *Ruppia* and a diverse wetland plant flora in the margins. The Lagoon is thought to be the local centre of abundance for a number of native fish species, and is home to over eighty species of birds.

The Department of Conservation contracted Ryder Consulting to produce a report detailing the current state of Waituna Lagoon. That report (Thompson and Ryder 2002) identified a number of issues which were of concern to the future of the Lagoon. Evidence was found for possible high rates of sedimentation in the Lagoon, contributing to expansion of rush beds and physical changes in the bed of the Lagoon. This was attributed to high sediment supply from the inflows. The report also showed that levels of ammonia and nutrients in the inflows were elevated well above the relevant water quality guidelines. This may have contributed to nuisance algal blooms in the Lagoon at times.

Thompson and Ryder (2002) concluded that land use changes in the catchment of the Waituna Lagoon have resulted in reductions in the water quality of the Lagoon inflows. They expressed the concern that a continuation of those patterns could result in algal blooms in the Lagoon that would permanently alter the Lagoon ecosystem. A number of recommendations were made to try and avoid this possibility. These included:

- expansion of monitoring of water quality in the catchment to include additional sites on other inflows and within the Lagoon itself.
- development of a research program in order to gain a greater understanding of circulation of nutrients in the Lagoon.
- surveys of botanical and animal communities in the Lagoon and catchment.

The low water quality of the inflows to the Lagoon was identified as a primary threat to the health of the Lagoon, and the need for management of land use in the catchment to remedy this was emphasised.

1.3 Objectives

This document is intended to complement the Thompson and Ryder (2002) report by summarising information on the Waituna Lagoon catchment, identifying issues and recommending actions to address those issues. This is done by meeting the following objectives:

- summarising existing information on water quality, sedimentation and aquatic biota (predominantly macroinvertebrate and fish populations).
- Reviewing relevant information from similar catchment management studies.
- Identifying key issues in the management of the Waituna Lagoon catchment.
- Proposing land management practices which will address the key issues identified.

SECTION TWO

Review of existing information on the catchment

2.1 Physical overview

The Waituna catchment is underlain by a Pleistocene gravel outwash plain. These alluvial gravels overlay a sequence of mid-tertiary gravels, sands and mudstones (Department of Lands and Survey 1984). Over the underlying geology there has been extensive peat development, particularly to the west and north of the lagoon and stretching some 6km inland. In places the peats reach depths of over two metres (Kelly 1968), and up to 4m in places (WLCG, pers. comm.). The organic soils of the catchment are classified as two types; the Invercargill soils (predominant in the catchment), and Otanomomo soils (small areas to the east). In addition, the central part of the catchment and sections of the upper catchment exhibit podzolised yellow-brown earths in the Tisbury soil grouping.

The catchment drains south from low rolling hill country to Waituna Lagoon (Figure 2.1). Three main waterways are present; Waituna Creek to the west, and Moffatt Creek, and Currans Creek to the east. Waituna Creek is the largest stream present (average discharge approximately 1800 L/sec) and is a fourth order stream draining a catchment of 12555 ha. Currans Creek is considerably smaller (average discharge 790 L/sec, catchment area 5700 ha), while Moffatt Creek is smaller still (average discharge 190 L/sec, catchment area 1700 ha). A number of smaller streams enter the Lagoon, particularly along the western and northern shores.

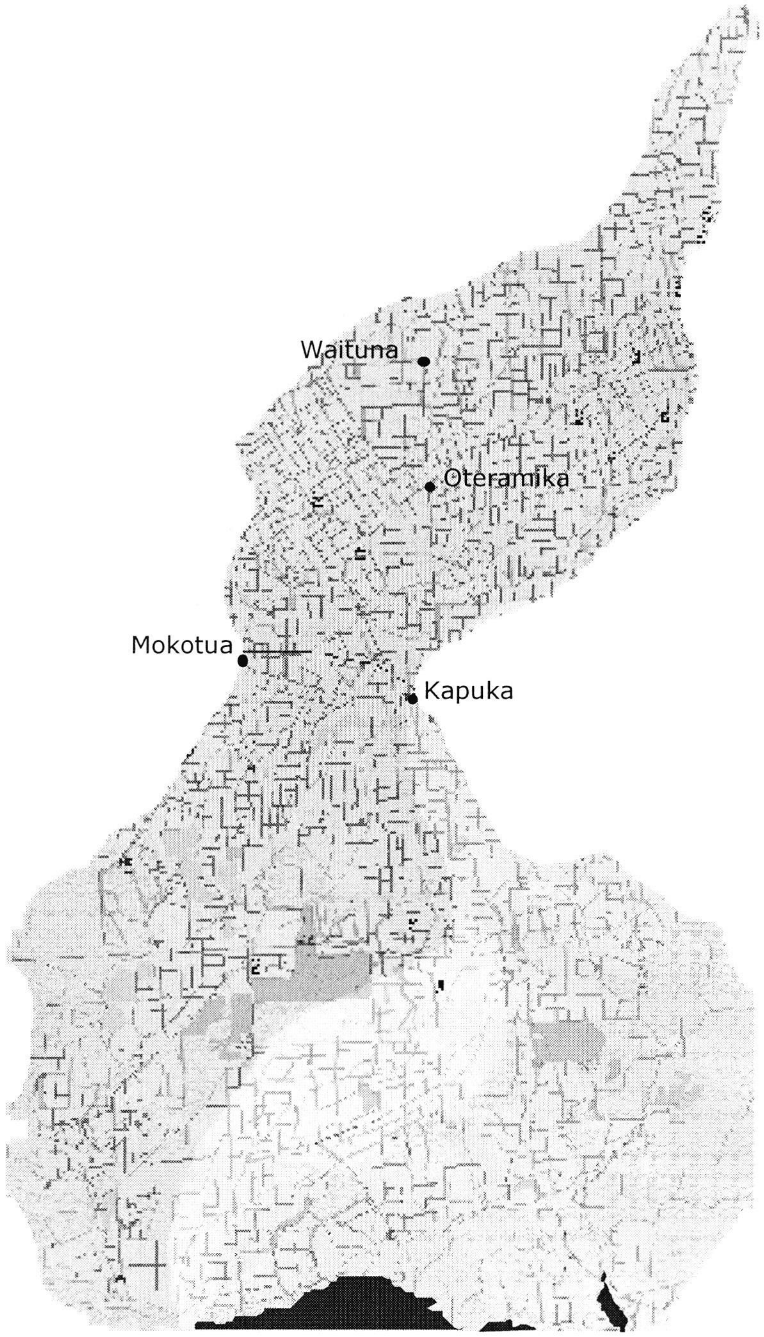


Figure 2.1 *Major sub-catchments in the Waituna catchment; Waituna Creek (pink shading), Moffatt Creek (yellow) and Currans Creek (blue). The northern portion of the Lagoon is in the bottom centre of the figure (dark blue).*

2.2 Land use and land use change

Historically the Waituna catchment was dominated by wetland vegetation, with areas of lowland podocarp forest, manuka (*Leptospermum scoparium*)/*Dracophyllum* scrubland and tussock. The wetland plant associations are particularly notable, and include cushionbog communities, sedges and rushlands. In drier areas there are, and were, extensive areas of flax (*Phormium* species) and toetoe (*Cortaderia* spp.), with wire rush (*Empodisma minus)* and tangle fern (*Gleichenia dicarpa*). Sandier areas are dominated by tussocks and mat-daisies.

Beginning in the late 19th Century, areas of the catchment were drained or cleared and converted to pasture. This trend has continued to the present day. By 1993, the catchment was dominated by pasture land (Table 2.1), although significant areas (primarily within Department of Conservation reserves to the east and west of the catchment) (Robertson 1993) remain in wetlands. The Waituna Creek catchment is the most developed of the catchments, with 85% of its area in pasture (Environment Southland database 2003, unpublished data). The Moffatt Creek catchment is also largely developed (approximately 65% pasture), but Currans Creek (particularly the eastern part of its catchment) retains significant areas of undeveloped wetlands, and has a significantly smaller proportion of pasture (approximately 30%).

Table 2.1 *Land use in the Waituna Lagoon catchment (in percentage of total catchment area). Adapted from Robertson, 1993.*

Land use	***% of catchment (1993)***
Pasture	*64.81*
Tussock pasture	*1.42*
Indigenous forest	*0.58*
Wetland	*33.19*

In the early part of the 20th Century, the primary land use activity in the Waituna catchment was sheep farming. However in the latter part of the 20th Century there has been ongoing intensification and diversification, with increasing amounts of dairy farming and deer farming in the catchment.

2.3 Water quality

This section summarises water quality data for the catchment of Waituna Lagoon, up to March 2003. The data is interpreted in the context of changes in water quality through time, relationships with the status (open or closed) of the Lagoon, and in relation to national water quality guidelines.

2.3.1 Existing water quality monitoring

Environment Southland has been collecting water quality data from the Waituna catchment as a part of their State of the Environment monitoring since 1995. A number of water quality parameters including physico-chemical characteristics (temperature, clarity, pH, conductivity, nutrient chemistry) and faecal indicator bacteria have been monitored (Table 2.2). Sampling was initially limited to Waituna Creek, but has subsequently been extended to all of the major inflows to Waituna Lagoon, and to the Lagoon itself (Figure 2.2, Table 2.2). Further expansion of monitoring of the Lagoon and catchment is intended (Michelle White, Environment Southland, pers. comm.).

Additional data has been collected by the Waituna Landcare Group at a number of locations in the catchment (Figure 2.2). This has entailed monthly sampling of temperature, pH, conductivity and clarity.

Table 2.2 *Water quality sampling carried out by Environmental Southland in the Waituna catchment.*

Waterbody	**Waituna Crk. (Marshall's Rd.)**	**Waituna Crk. (Mokotua)**	**Currans Crk. (Lagoon Rd.)**	**Trib. near Currans Crk. (at Lagoon Rd.)**	**Moffatt Crk. (Moffatt Rd.)**	**Waituna Lagoon (centre)**
ES Site code	63	150	152	153	154	164
Commenced	July 1995	Aug 2001	Aug 2001	Aug 2001	Aug 2001	Oct 2001
Frequency	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly
Temperature (^0C)	✓	✓	✓	✓	✓	✓
pH	✓	✓	✓	✓	✓	✓
Conductivity ($\mu S/cm$)	✓	✓	✓	✓	✓	✓
Dissolved O_2 (mg/L)	✓	✓	✓	✓	✓	✓
Ammonia (mg/L)	✓	✓	✓	✓	✓	✓
Nitrate (mg/L)	✓	✓	✓	✓	✓	✓
Total nitrogen (mg/L)	Jan 99 on	✓	✓	✓	✓	✓
DR phosphorus (mg/L)	✓	✓	✓	✓	✓	✓
Total phosphorus (mg/L)	Jan 99 on	✓	✓	✓	✓	✓
Clarity (cm)	✓	✓	✓	✓	✓	✓
Faecal coliforms (CFU/100mL)	Aug 99 on	✓	✓	✓	✓	✓
Escherichia coli (CFU/100mL)	Aug 99 on	✓	✓	✓	✓	✓
Chlorophyll ($\mu g/L$)	✗	✗	✗	✗	✗	✓

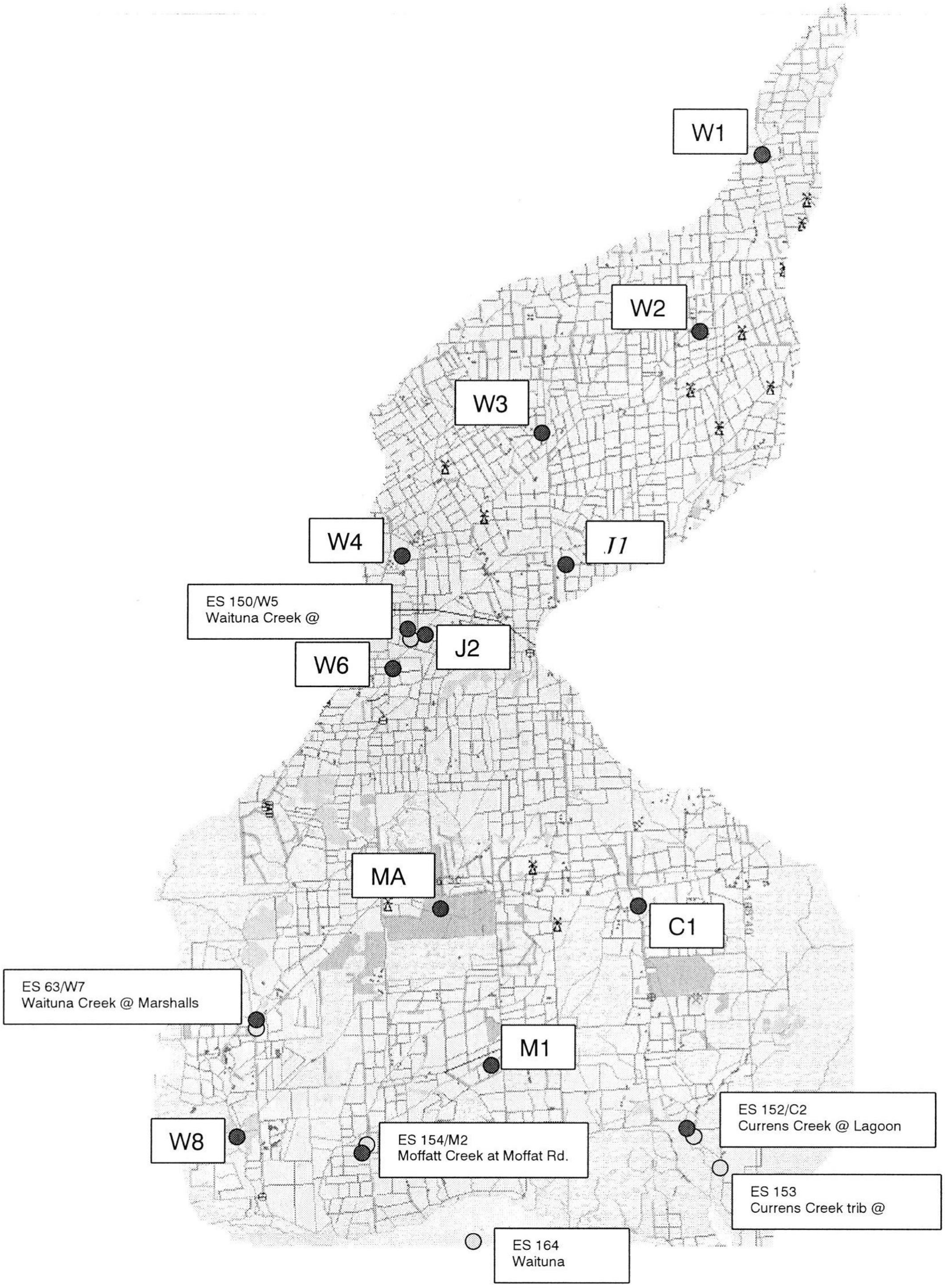


Figure 2.2 *Locations in Waituna catchment currently sampled by; Environment Southland (yellow circles) as part of State of the Environment monitoring, and Waituna Landcare Group (red circles).*

2.3.2 Water quality overview

Measurements of water quality assess a range of parameters that are important for environmental and public health reasons. The parameters monitored in the Waituna catchment represent a range of these variables. For many, national guidelines have been established to indicate what values can be considered acceptable in terms of protection of environmental quality and public health (Table 2.3).

Table 2.3 *Water physico-chemistry guidelines (ANZECC, 2000) with typical values for Southland (Thompson and Edwards, 2002). The ANZECC values shown are the default trigger values for slightly disturbed lowland streams. The faecal coliform levels are for primary contact (e.g. swimming) and secondary contact (e.g. boating, fishing).*

Parameter	Unit	Southland range	Water quality guideline
Temperature	°C	4.5-11.6	<15
pH		4.5-7.6	4.7[1]
Clarity	metres	-	0.8[2]
Conductivity	µS/cm	20-9860	150[3]
Total ammoniacal nitrogen	mg/L	1-3000	<2.43
unionised ammonia (NH_3)	g/m^3	0.01-2.4	<0.021
Nitrate (+ nitrite)	mg/L	0.01-2500	<0.44
Total phosphorus	mg/L	0.01-0.33	<0.03
Faecal coliforms	CFU/100mL	0-62 000	<150 (primary), <1000 (secondary)
Chlorophyll-a	µg/L	Not known	5[4]

Notes:
1. Streams draining wetlands often have naturally low pH. The value shown is the average for the least modified site, the Currens Creek tributary, which is taken as a reference condition.
2. National guideline for lowland river clarity
3. The saline influence at Waituna Lagoon means that water quality guidelines are not applicable. The value shown is for the least modified site, the Currens Creek tributary, which is taken as a reference condition.
4. Based on values for south-western Australia. Values for NZ have not been determined.

Water temperature in aquatic systems has direct effects on the growth of aquatic plants (macrophytes and periphyton), algae, bacteria and animals. In addition, temperature interacts with other contaminants (such as ammonia) in determining their toxicity. Most aquatic organisms have a preferred temperature range for their growth and metabolism, a range beyond their preferred range that they can tolerate, and extreme high and low ranges which they can not tolerate (thermal maxima and minima).

Most New Zealand native fish species are relatively tolerant of extremes of temperature (Richardson *et al.* 1994), but the introduced brown trout (*Salmo trutta*) has a relatively low thermal maximum (Collier *et al.* 1995). The trout fishery in the Waituna catchment is highly valued, so the guideline value for water temperature has been set to provide protection to brown trout (Table 2.3).

pH measures how 'acid' water is. Values range from 0 (very acidic) to 14 (very basic or alkaline), with most natural waters being around 7.0 (neutral). The pH of streams flowing from wetlands can be low, because decomposing plant material produces humic acids.

Extremes of pH are not tolerated by most aquatic organisms because of direct toxicity, and because low pH can increase the toxicity of other chemicals present in the water.

The Waituna catchment is predominantly underlain by organic soils with a very high humic content. For that reason many of the waterways have naturally low pH, which aquatic life will be adapted to cope with. National guidelines for pH have been set, but are not appropriate to Waituna because of the naturally acid nature of the water. For that reason, the guideline value shown in Table 2.3 is based on the average pH experienced in a tributary of Currans Creek which is largely unaffected by land use change and can be thought of as representing the historical ('reference') state of streams in the catchment.

Clarity measures how 'clear' water is by testing how far it is possible to see a standard object (usually a black disc or a Secchi disc – a metal disc marked with black and white quarters) through the water. Water clarity affects aquatic plant and algae growth by limiting how much light reaches the stream bottom. Clarity also affects fish behaviour, with visual feeding fish (e.g. trout, kokopu) being less successful in waterways with lower clarity. National guidelines for lowland river clarity have been established (Table 2.3).

Low water clarity can indicate that sediment is entering waterways and remaining in suspension. This may occur where the bed of the stream is disturbed (by channel clearance, straightening or other in-stream works), or where banks are disturbed (primarily by stock). In the Waituna catchment low clarity is likely to be an indicator of sediment entering streams, but is confounded by the discolouration due to peat (humic and tannic acid) staining.

Conductivity, expressed in micro Siemens per centimetre (µS/cm), measures how readily water will conduct electricity. This value is higher where there are many charged particles in the water (normally dissolved ions). The presence of a number of chemicals, including nutrients and salt, in water can lead to high conductivity. High conductivity in a freshwater environment often indicates the presence of excess amounts of nutrients in the water.

Because the Waituna catchment can be influenced by the marine environment in its lower reaches, conductivity at those sites may be higher than expected due to the effects of salinity. For that reason the guideline value shown in Table 2.3 is based on the average values from the reference site on Currans Creek.

Ammonia is a waste compound produced by animals during metabolism and released in urine. Ammonia is actually two compounds – unionised ammonia (NH_3) and ionised ammonia (NH_4^+). Unionised ammonia is the more toxic compound and is present in higher concentrations at higher water pH and temperature. High levels of ammonia are of concern because fish have a relatively low tolerance for the compound (Thompson and Edwards 2002). High levels of ammonia in streams or in the outflow of the Lagoon (when open) may act as a disincentive to fish to enter the catchment. Ammonia values in this report refer to unionised ammonia (NH_3).

Because water temperatures tend to be relatively low, and pH is also low, in the Waituna catchment, the water quality standard set for ammonia (Table 2.3) is relatively high.

Nitrate is the main nitrogen-based nutrient important for the growth of aquatic plants and algae. Together with phosphorus, a lack of nitrate is the most common factor limiting algal and plant growth. Agricultural activities, such as application of nitrate fertiliser and nitrates present in animal wastes, increase the amount of nitrate present in waterways. Provided that light is available and conditions are sufficiently warm, this can encourage nuisance growths of algae and plants that are unsightly, can clog drains, and can generate toxic by-products (Environment Southland 2000). In extreme conditions, excessive plant growth can result in overloading of waterways with organic material. As this material decomposes, it extracts oxygen from the water, a process that can result in the death of fish and invertebrates.

Water quality guidelines have been established for nitrate levels in lowland streams (Table 2.3). These are appropriate for use in the Waituna catchment.

Phosphorus is the second major nutrient that is needed for aquatic plant and algae growth. Two forms of phosphorus are commonly measured; dissolved reactive phosphorus (DRP), which is the most readily available form to algae and plants, and total phosphorus, which includes all forms of phosphorus present (including DRP). Phosphorus is present in many soils, and is also applied on all farms as superphosphate fertiliser. Farming activities tend to increase phosphorus concentrations in streams through a combination of bank disturbance, which allows soils to enter streams, fertiliser application and animal wastes.

Water quality guidelines have been established for total phosphorus levels in lowland streams (Table 2.3). These are appropriate for use in the Waituna catchment.

Faecal bacterial indicators are bacteria which, when present in waterways, indicate that faecal matter has contaminated the water. The two indicators used in New Zealand are faecal coliforms (which are no longer the preferred indicator) and *Escherichia coli* (for which the most recent guidelines have been established). The presence of these groups at high levels in waterways indicates that there is a risk to animal or public health from ingestion or contact. High levels occur where animal wastes enter waterways from animals defecating into waterways, via overland flow, or via tile drains.

Faecal coliform levels are measured by Environment Southland in the Waituna catchment. Two guideline values are relevant for interpretation of these values (Table 2.3). Levels higher than 150 colony forming units (CFU) per 100mL of water are considered to represent an unacceptable health risk for people engaging in primary contact (e.g. swimming). Levels higher than 1000 CFU/100mL are considered to be unacceptable for secondary contact (e.g. fishing, boating) and stock consumption.

Chlorophyll-*a* levels indicate the amount of algae present in a water body. In shallow 'clear water' lakes like Waituna Lagoon, most productivity occurs on the bed of the lake, where aquatic plants grow (in the case of Waituna Lagoon, predominantly *Ruppia*). These plants stabilise the bed of the lake, trapping sediment and nutrients. If nutrients in the water column of the lake become high, algae can start to grow (or 'bloom') in the water column. This makes the water turbid, meaning that light can no longer reach the plants on the lake bottom. Those plants then die, destabilising the lakebed and allowing sediment and nutrients to be re-suspended into the water column by wave action. This further increases turbidity and nutrient levels, encouraging further water column algal growth. Ultimately, this situation can result in loss of plants in the lake and a permanent switch to the lake being turbid. High turbidity reduces the aesthetic appeal of water bodies and negatively affects sports fisheries.

Environment Southland monitor chlorophyll-*a* concentrations in Waituna Lagoon. While guidelines have not yet been established for New Zealand lakes, in south-western

Australia levels in excess of 5 micrograms per litre are considered to indicate that a lake is becoming degraded (Table 2.3).

Table 2.3 shows the water chemistry parameters used, together with the relevant national guidelines using the ANZECC (2000) approach. This approach establishes guideline values based on the criteria of protecting 80% of species from adverse environmental effects, and has been extensively applied in New Zealand. If the values in Table 2.3 are exceeded in the Waituna catchment there can be considered to be a significant risk of loss of species from the system.

Where water quality guidelines are not appropriate for use in the Waituna catchment, because of the specific nature of the waterways present, guidelines have been set based on the average values obtained from the least impacted site in the catchment, the Currans Creek tributary.

2.3.3 Methods

The results from the WLG monitoring were summarised and graphed to show trends through time. Results for temperature, pH, conductivity and clarity were graphed and compared to national water quality guidelines, where appropriate. A subset of water chemistry results from the Environment Southland database were selected for analysis (Table 2.3). These were chosen to focus on issues that are known to be important at Waituna.

2.3.4 Results and interpretation

In the figures below, results are shown in the units given in Table 2.3. Guidelines are shown on the graphs as dotted lines. For sites in the lower reaches of streams and for the Lagoon, the status of the Lagoon is shown by green shading (open/tidal) or by the absence of shading (closed to the sea).

Results from the Waituna Landcare Group monitoring of the catchment show clear seasonal patterns in water temperature that are consistent across the different streams (Figure 2.3). Temperatures vary from approximately 5°C in winter to 25°C in summer. Highest temperatures were recorded from the upstream sites on Currans Creek, Moffatt Creek and Waituna Creek. The temperatures recorded in mid summer would be considered excessive for trout (Elliot and Elliot 1995) and stonefly invertebrate larvae

(Quinn and Hickey 1990), but below the lethal temperatures for most native fish species (Richardson *et al.* 1994).

The pH of the streams ranged from acidic (4.0) to neutral (7.0), but tended to be acidic on average (Figure 2.3). This was true of all sites, regardless of degree of catchment development. The most acidic site was Currans Creek. It is assumed that the low pH in the streams is due to the wetland source of most of the waterways. Wetlands generate humic and tannic acids, which can result in naturally acidic waters.

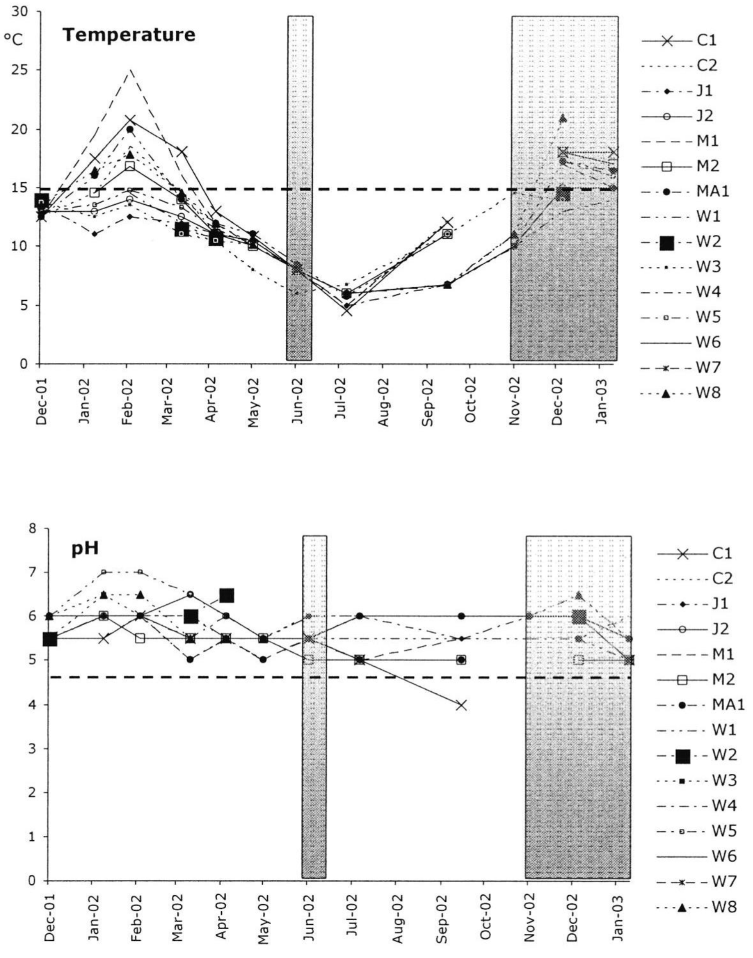


Figure 2.3 *Temperature (°C) and pH for WLG sites, December 2001-January 2003. Refer to Figure 2.2 for site locations.*

Conductivity in all of the streams was elevated over that which has been found in the reference stream, which does not have extensive farming in its catchment (Figure 2.4). There were no clear seasonal patterns in the WLG data, nor was there any evident association with Lagoon open/closed status. Conductivity did not appear to increase moving downstream, suggesting that supply of nutrients is approximately balanced by uptake by macrophytes and algae and dilution by undeveloped tributaries closer to the Lagoon.

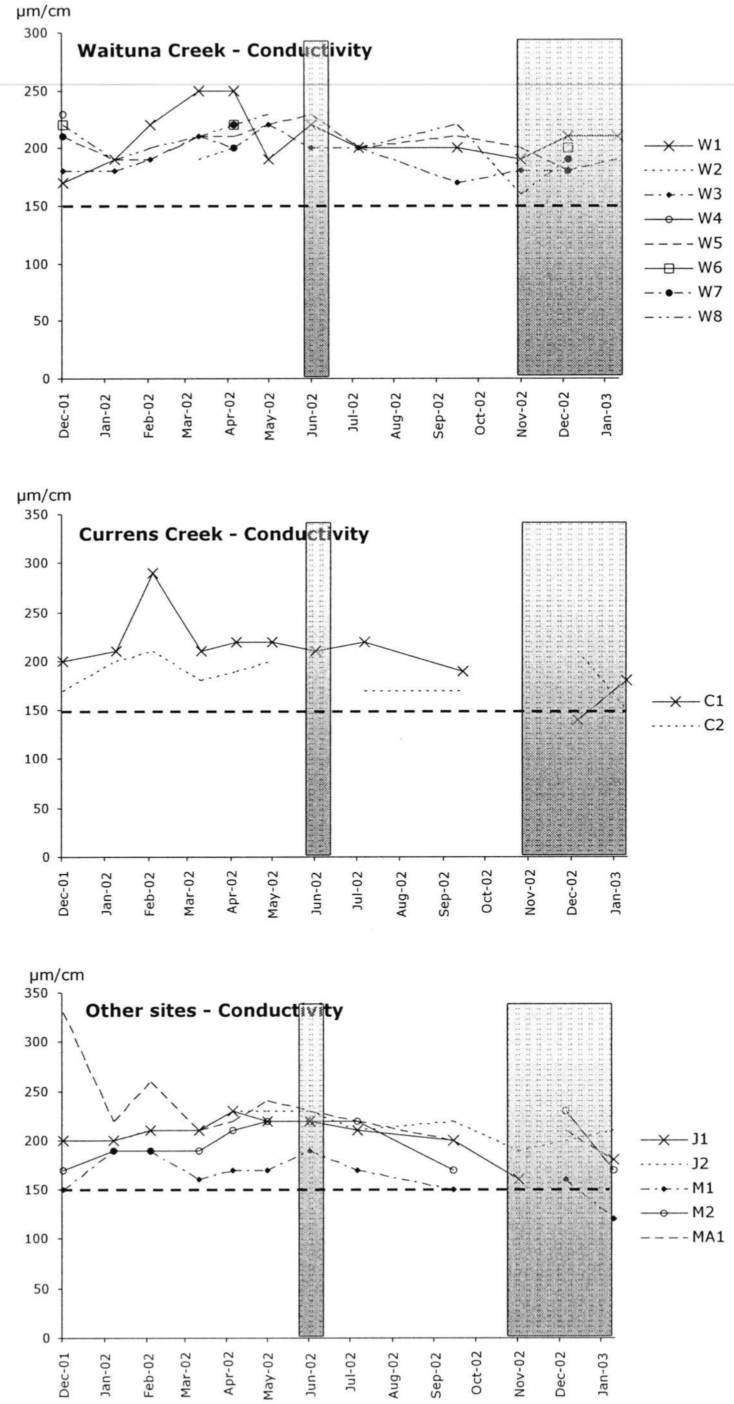


Figure 2.4 *Conductivity (in µS/cm) for WLG sites, December 2001-January 2003. Refer to Figure 2.2 for site locations.*

Clarity in the streams was highly variable (Figure 2.5), but appeared to be declining through time in Currans Creek. Clarity in Waituna Creek was extremely low in January 2003, which may have been due to channel clearance activities in the catchment at that time.

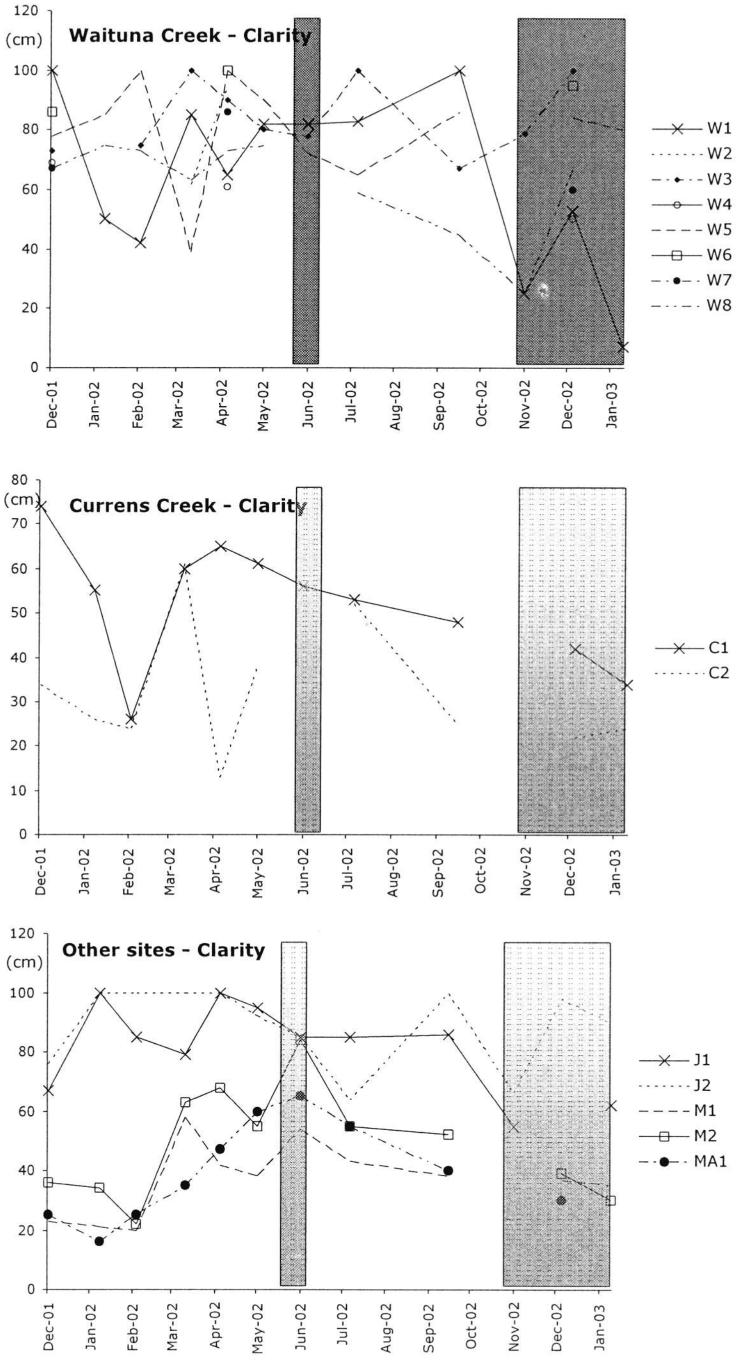


Figure 2.5 *Clarity for WLG sites, Dec 2001-Jan 2003. Refer to Figure 2.2 for site locations.*

Environment Southland monitor the water chemistry in the Waituna catchment at five locations on a monthly basis (Figure 2.2):

Waituna Creek	At Mokotua (ES 150) At Marshalls Road (ES 63)
Moffatt Creek	At Moffatt Road (ES 154)
Currans Creek	Mainstem at Waituna Lagoon Road (ES 152) A tributary near the Lagoon (ES 153)

An additional site is monitored in the centre of the Lagoon (ES 164). It is intended to add additional sites on the Lagoon in the future (Michelle White, Environment Southland, pers. comm.). Waituna Creek has been monitored at the Marshalls Road site since 1995, while the additional sites were added in mid 2001 (Currans Creek, Moffatt Creek, Waituna Creek at Mokotua) and late 2001 (Waituna Lagoon) (Table 2.2).

Waituna Creek

Waituna Creek at Mokotua (Figure 2.6) has high conductivity, and is very high in nitrate, usually exceeding the water quality guidelines. Ammonia exceeds the guideline only sporadically (Figure 2.6), however levels of phosphorus (Figure 2.7) exceed the guideline frequently and appear to have exceeded the guidelines most commonly in the early part of both 2002 and 2003. Levels of faecal coliforms in the stream can exceed the guideline (Figure 2.7), with high values possibly becoming more common in recent years.

Waituna Creek at Marshall Road is the site that has been sampled for the longest period. The site is consistently high in phosphorus, nitrate and faecal coliforms, and is generally also high in ammonia (Figures 2.8, 2.9). The data show no clear relationship with the status of the Lagoon. There appears to be a trend towards a slight increase in conductivity since the beginning of 1998, which may indicate degradation of water quality (Figure 2.8).

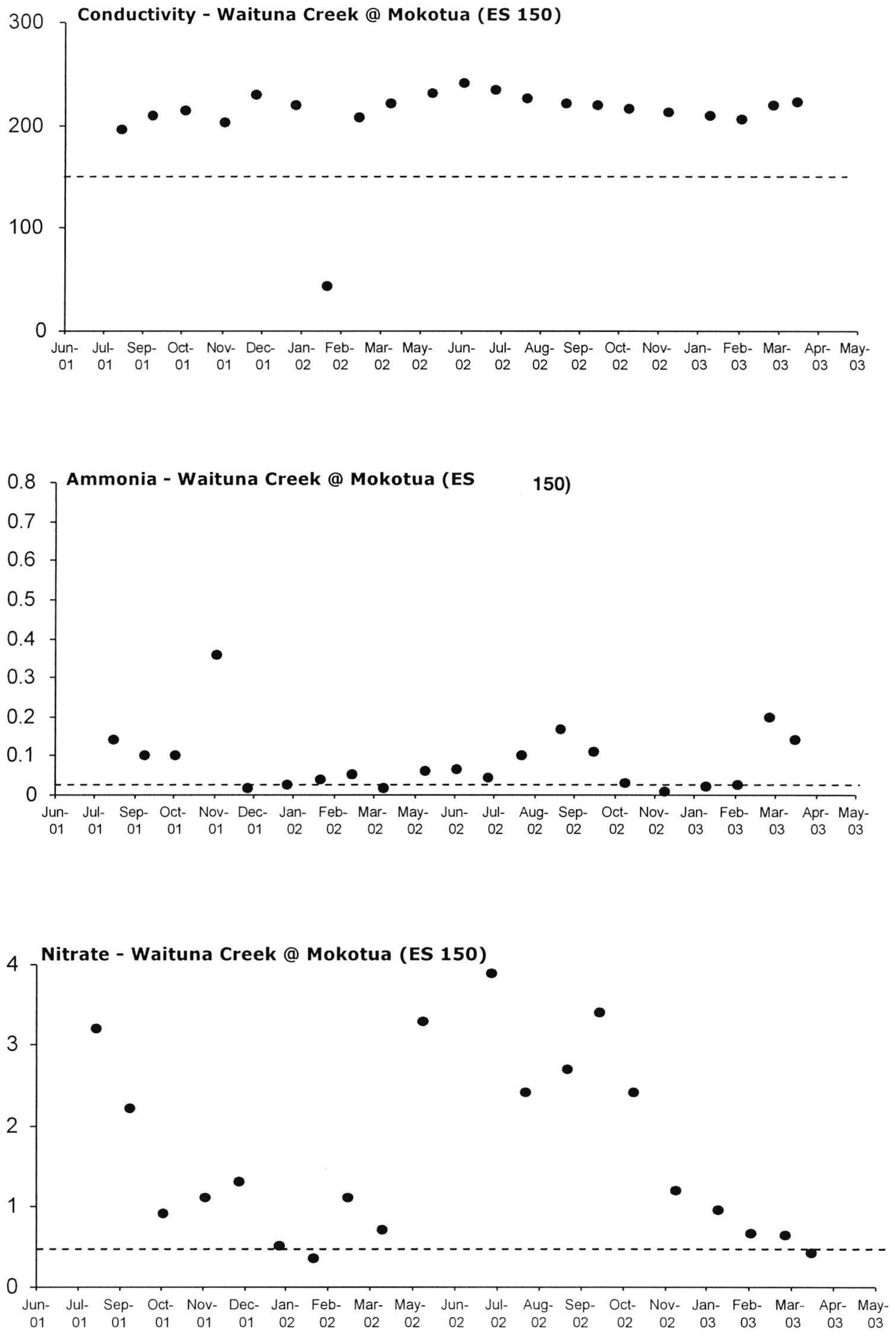


Figure 2.6 *ES water quality data for Waituna Creek at Mokotua. Dashed lines indicate ANZECC 2000 guideline values.*

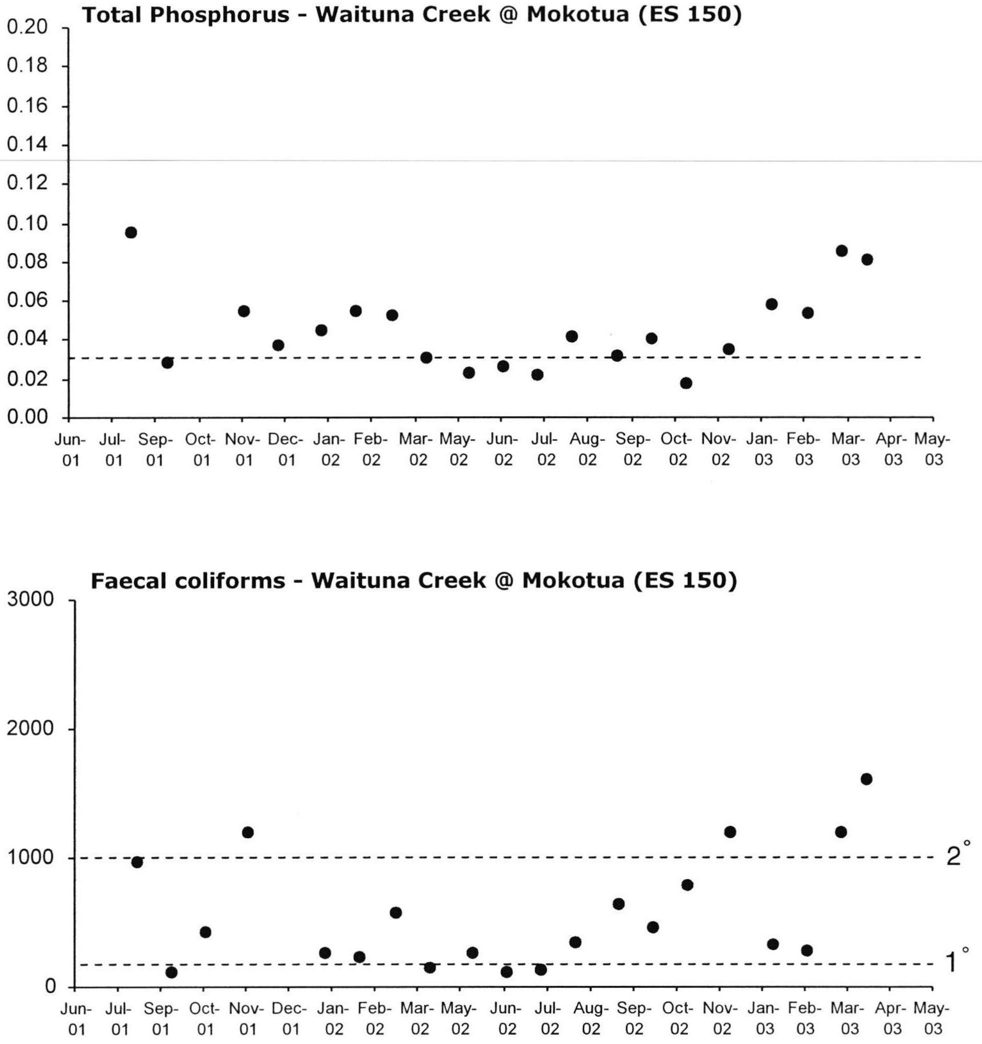
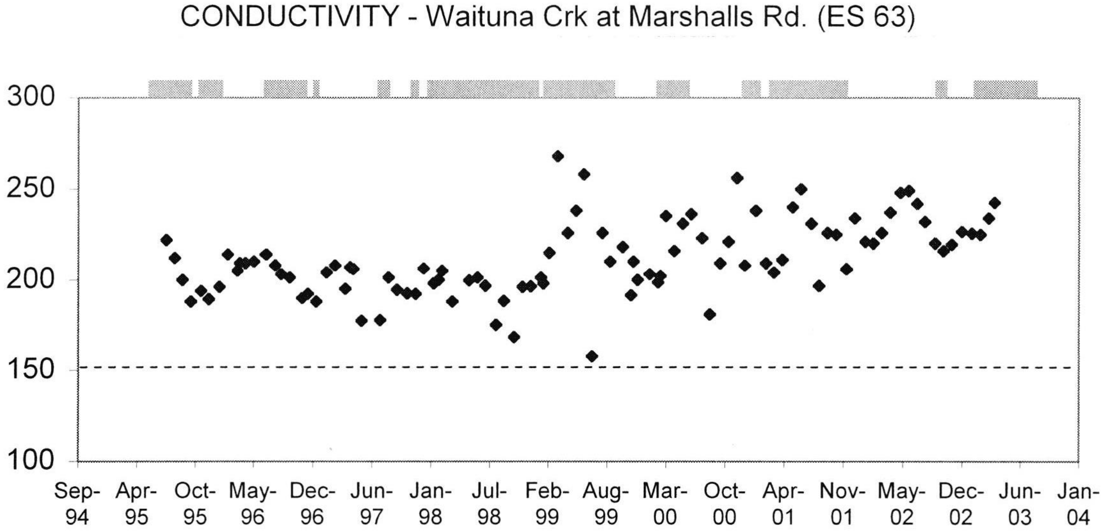
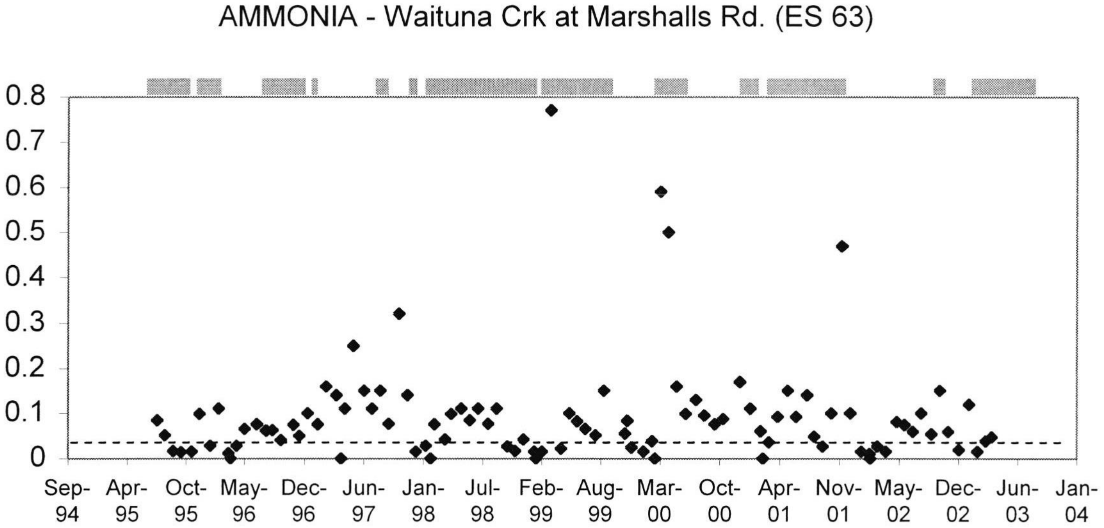


Figure 2.7 *ES water quality data for Waituna Creek at Mokotua. Dashed lines indicate ANZECC 2000 guideline values.*





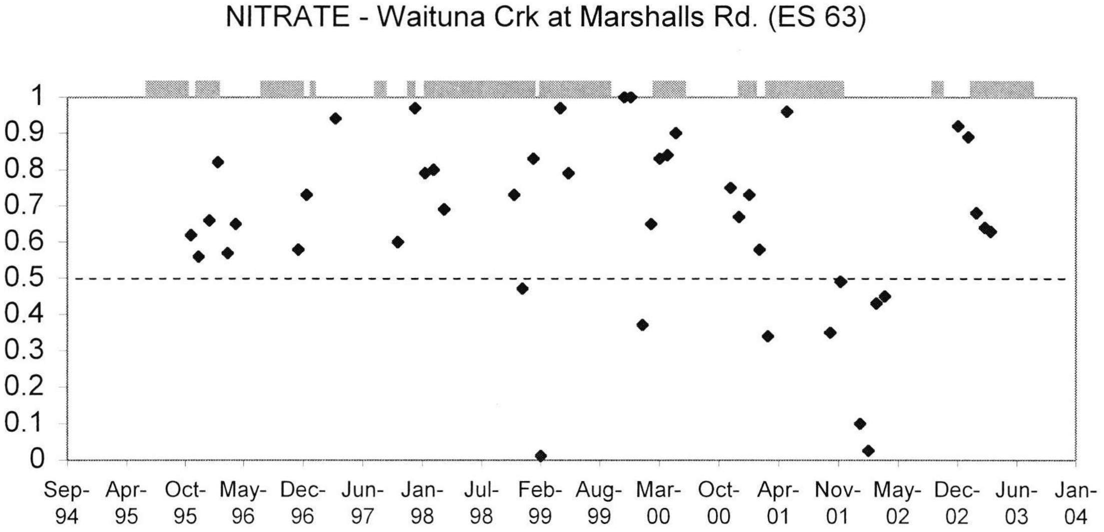


Figure 2.8 *ES water quality data for Waituna Creek at Marshalls Rd. Green bars indicate when Lagoon is open..*

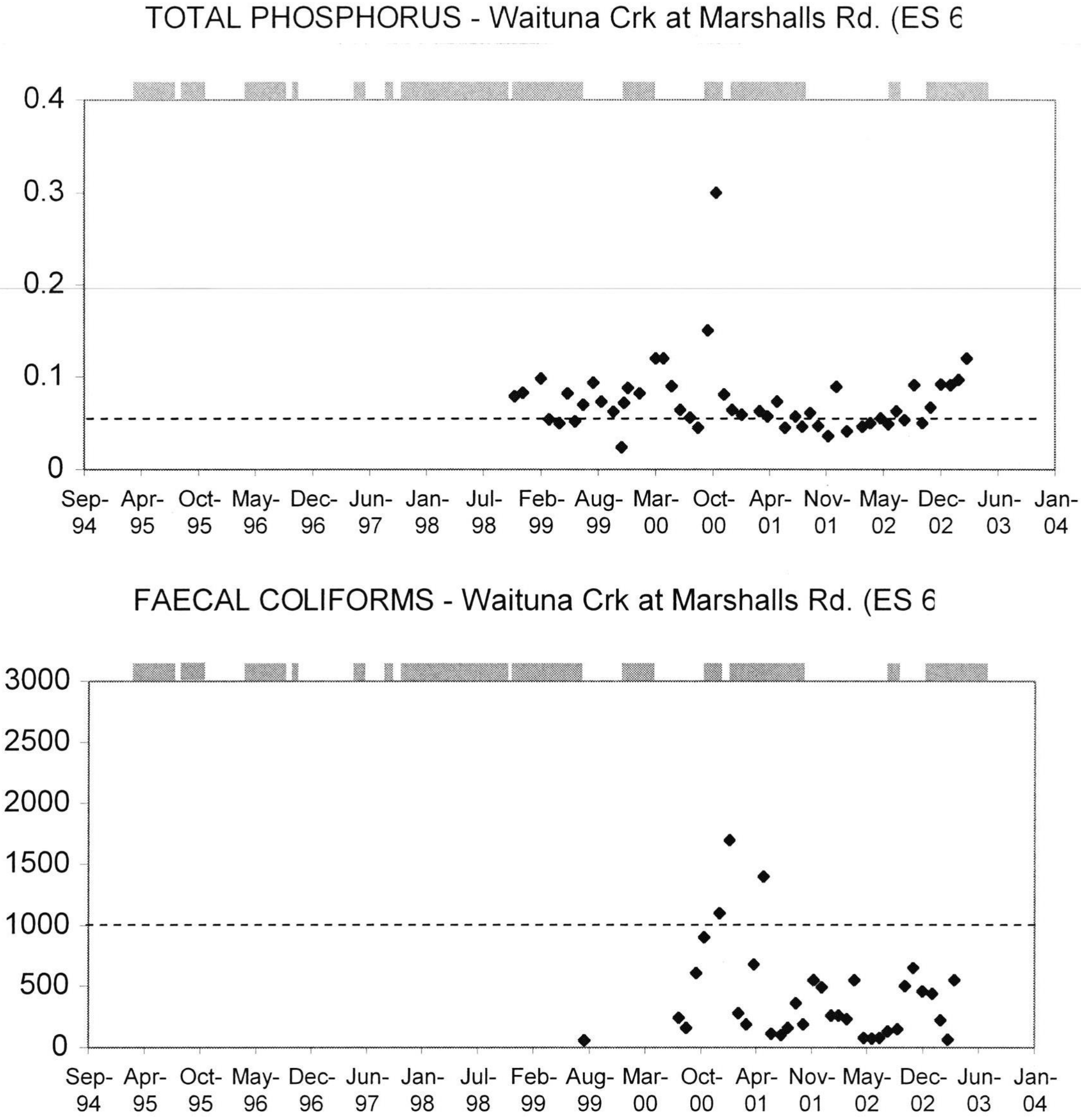
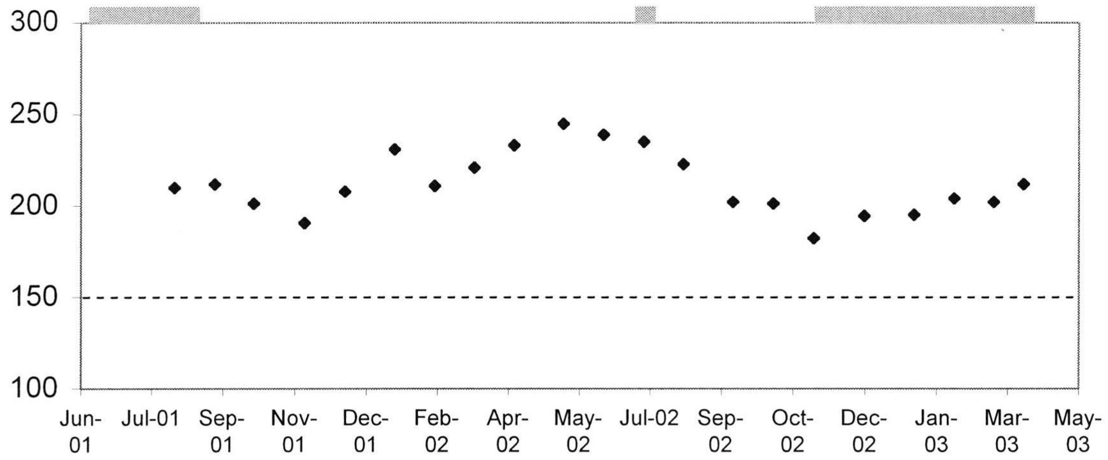


Figure 2.9 *ES water quality data for Waituna Creek at Marshalls Rd. Green bars indicate when Lagoon is open..*

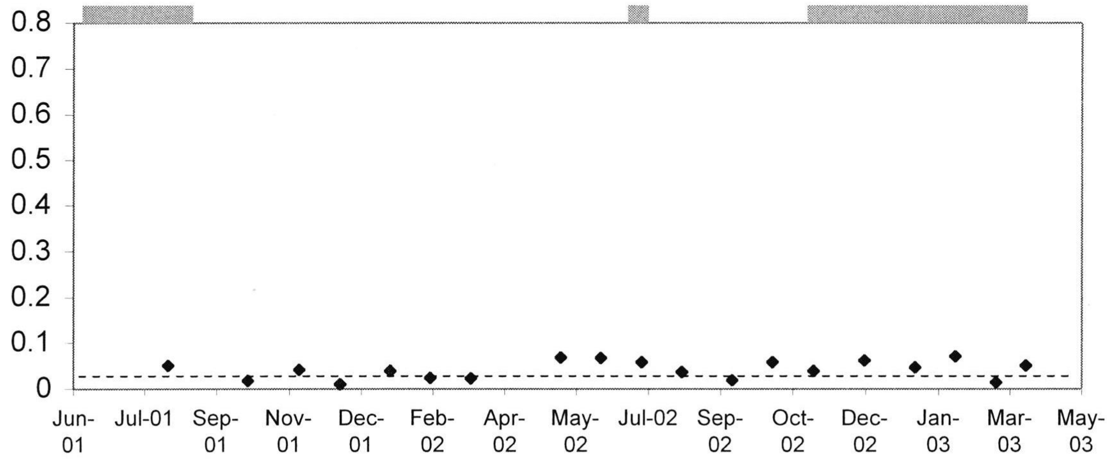
Moffatt Creek

A single site has been monitored on Moffatt Creek since 2001. In general water quality is better than in Waituna Creek, but there are winter peaks in conductivity, which coincide with higher nitrate (Figure 2.10). Levels of phosphorus in the stream are consistently high, and faecal coliform levels can be high on occasion (Figure 2.11). There are no clear associations with the status of the Lagoon, except that phosphorus levels may be higher when the Lagoon is open. A much larger data set would be needed to establish if this was in fact the case.

CONDUCTIVITY - Moffatt Creek at Moffat Rd (ES 154)



AMMONIA - Moffatt Creek at Moffat Rd (ES 154)



NITRATE - Moffatt Creek at Moffat Rd (ES 154)

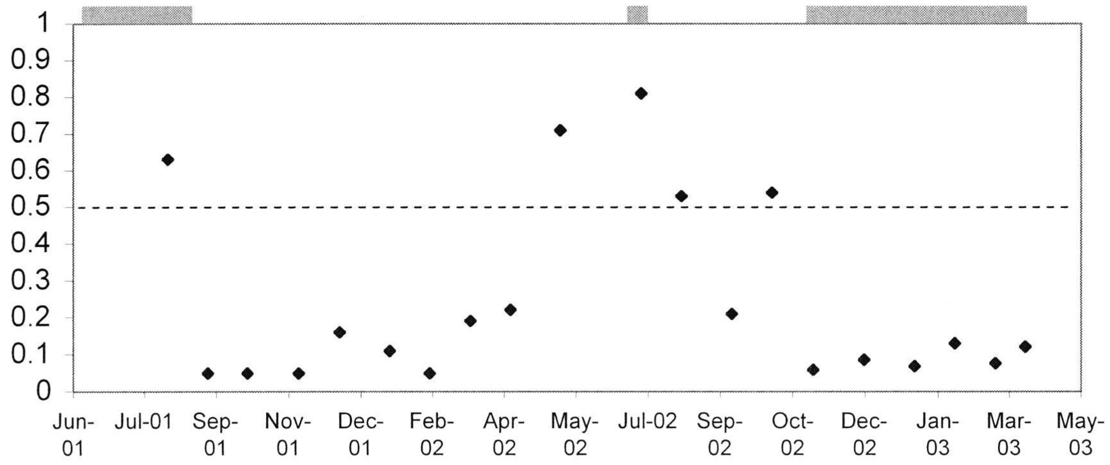
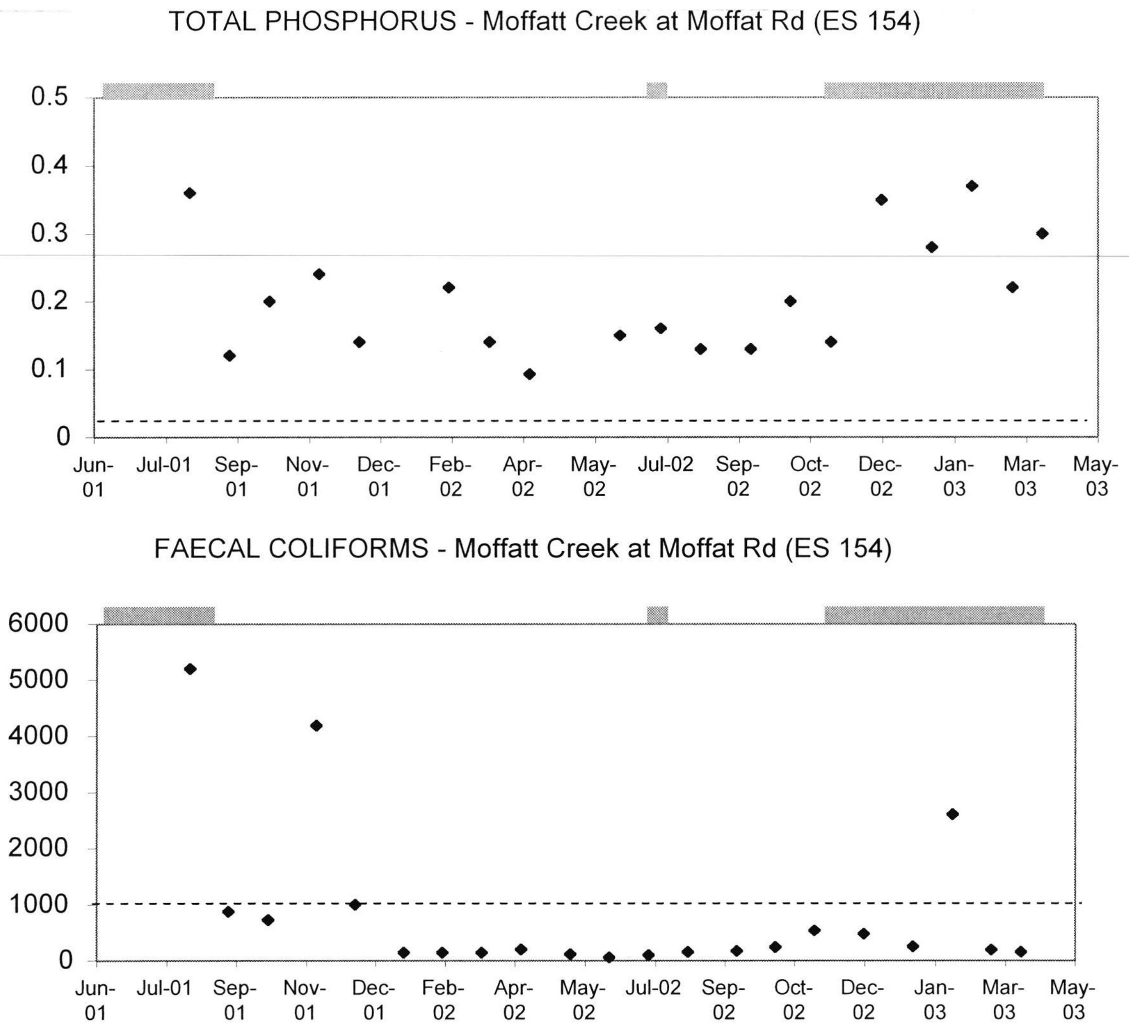


Figure 2.10 *ES water quality data for Moffatt Creek.*



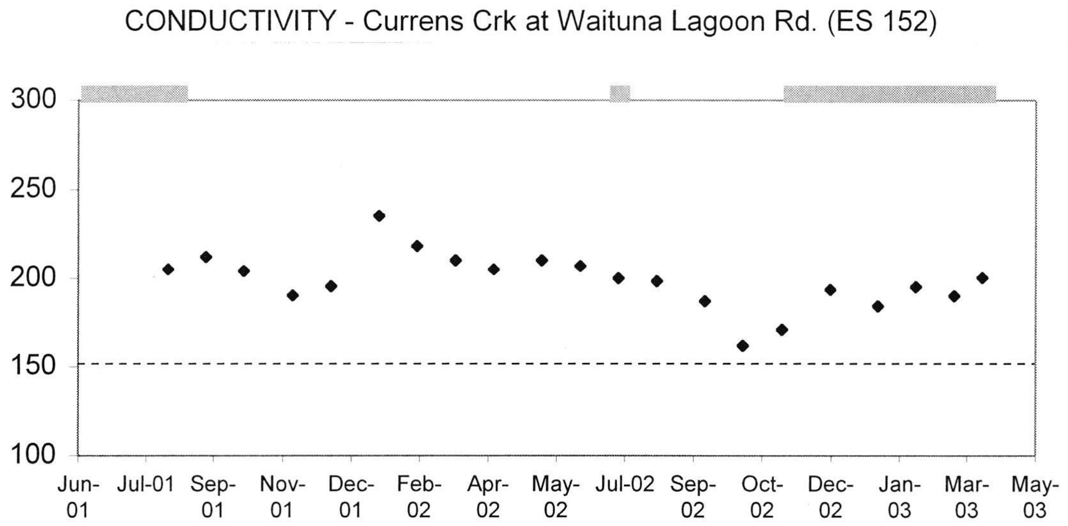
TOTAL PHOSPHORUS - Moffatt Creek at Moffat Rd (ES 154)

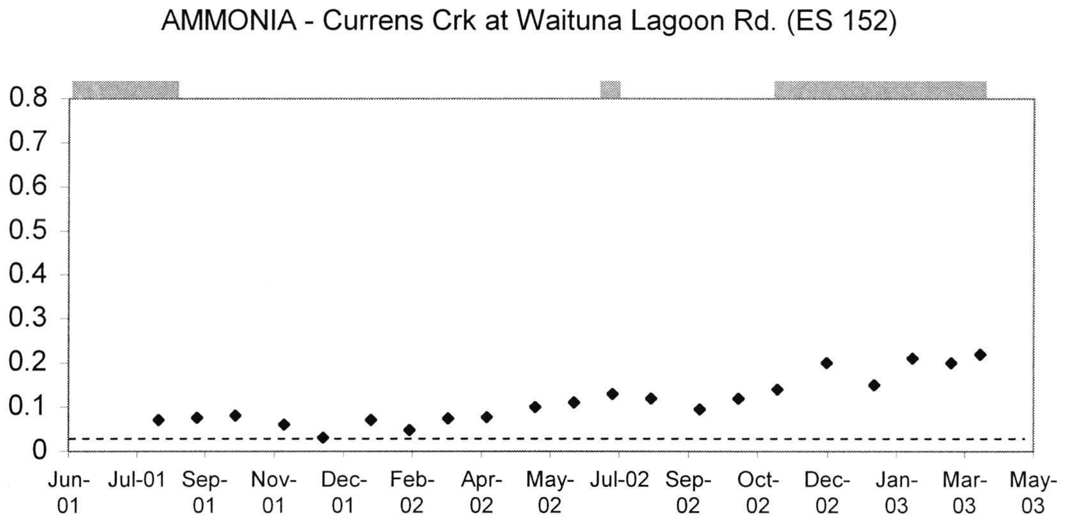
FAECAL COLIFORMS - Moffatt Creek at Moffat Rd (ES 154)

Figure 2.11 *ES water quality data for Moffatt Creek.*

Currans Creek

Currans Creek at Waituna Lagoon Road shows similar patterns to Moffatt Creek, with generally low levels of nitrate, although a slight winter peak (Figure 2.12). Levels of ammonia are low but appear to be increasing. Summer peaks in faecal coliforms and phosphorus are evident (Figure 2.13), possibly indicating that grazing along stream margins may be resulting in faecal bacteria entering the stream. There is evidence of a recent increase in phosphorus values. No clear relationship to Lagoon open/closed status is evident.





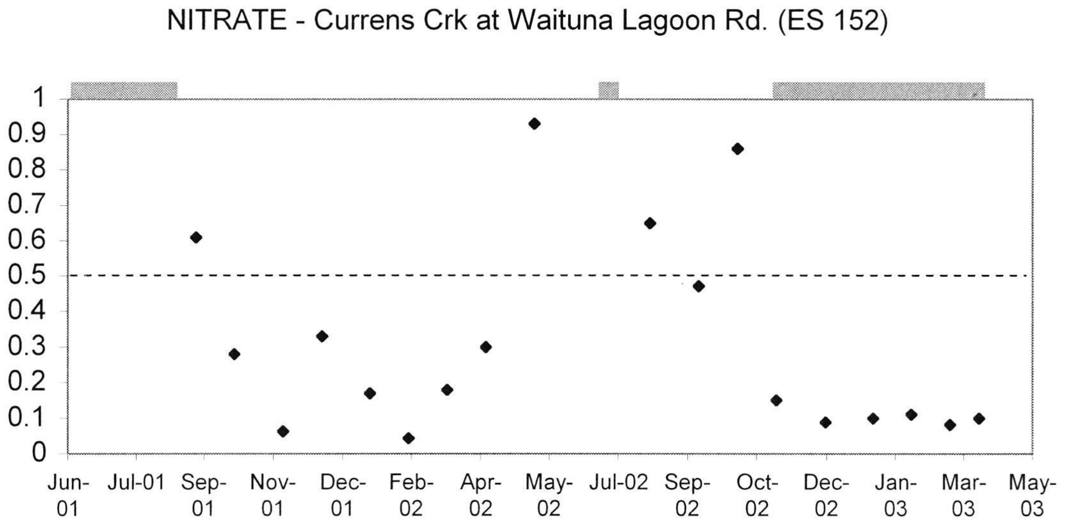


Figure 2.12 *ES water quality data for the mainstem of Currans Creek.*

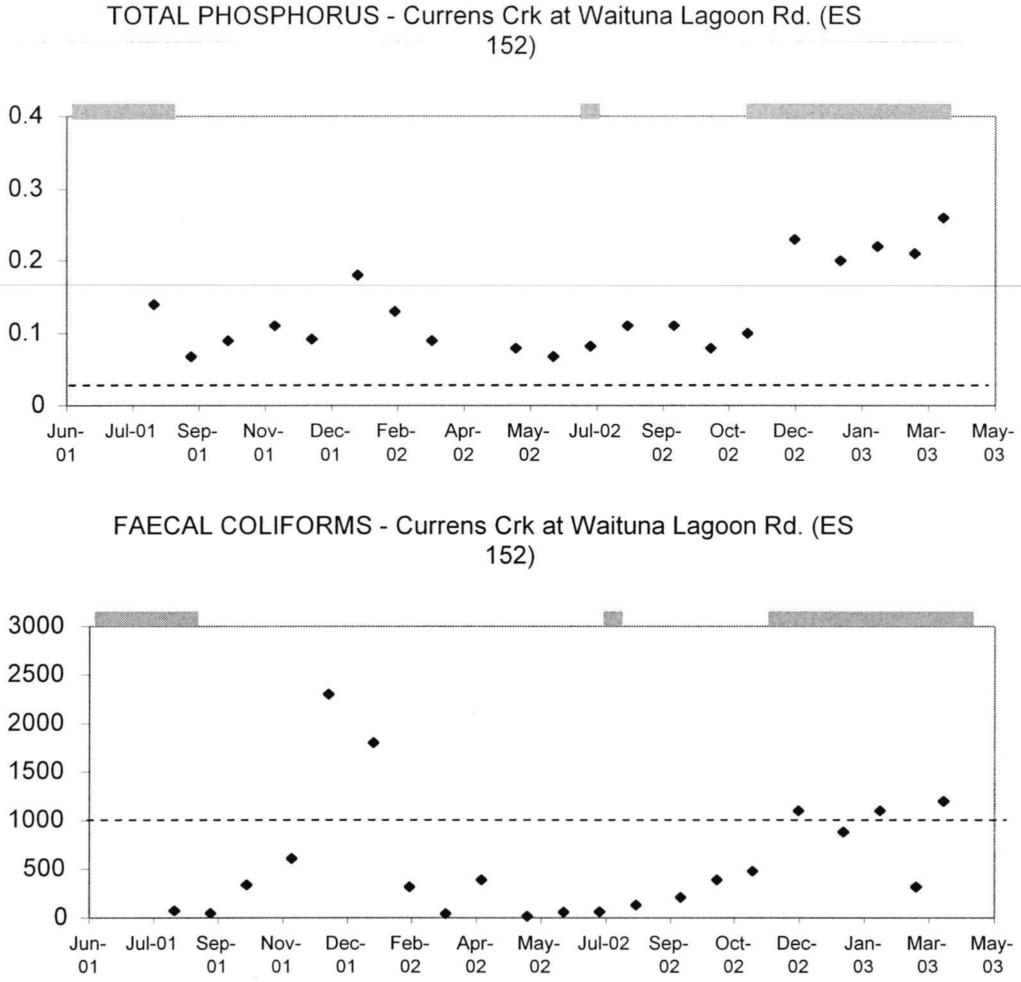
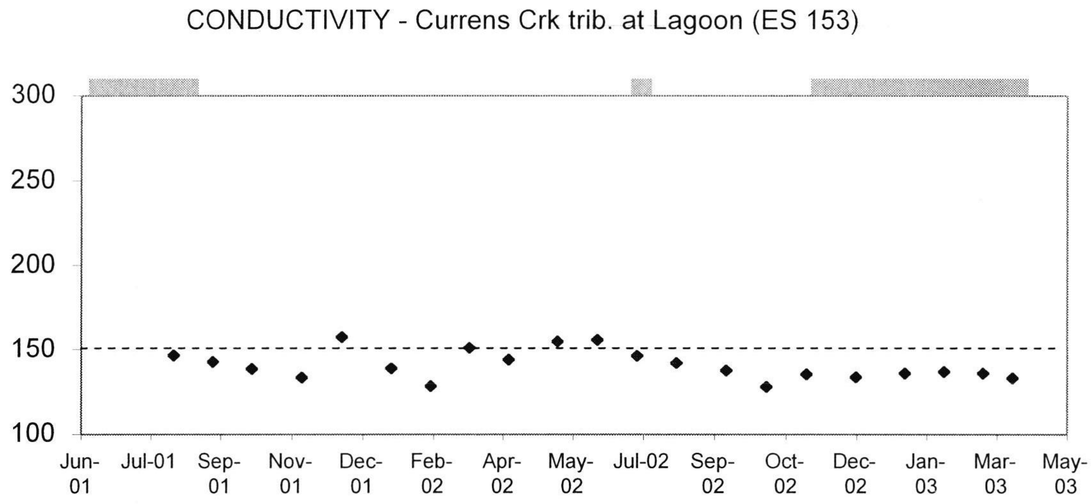
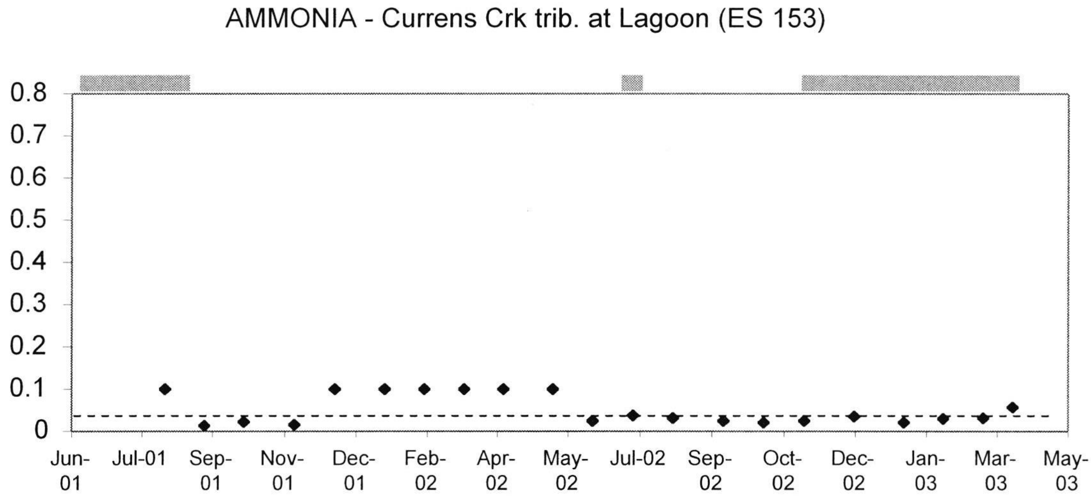


Figure 2.13 *ES water quality data for the mainstem of Currans Creek.*

Currans Creek tributary at the Lagoon. A second site in the Currans Creek catchment is located on a small tributary near the Lagoon. Water quality is generally good (Figure 2.14, 2.15). Only phosphorus exceeds the guidelines with any frequency, with possible peaks occurring in summer. There are no obvious trends through time nor is there any clear relationship to the status of the Lagoon. This site may make a good control site. However, there is a possibility of future dairy farm development near the site.





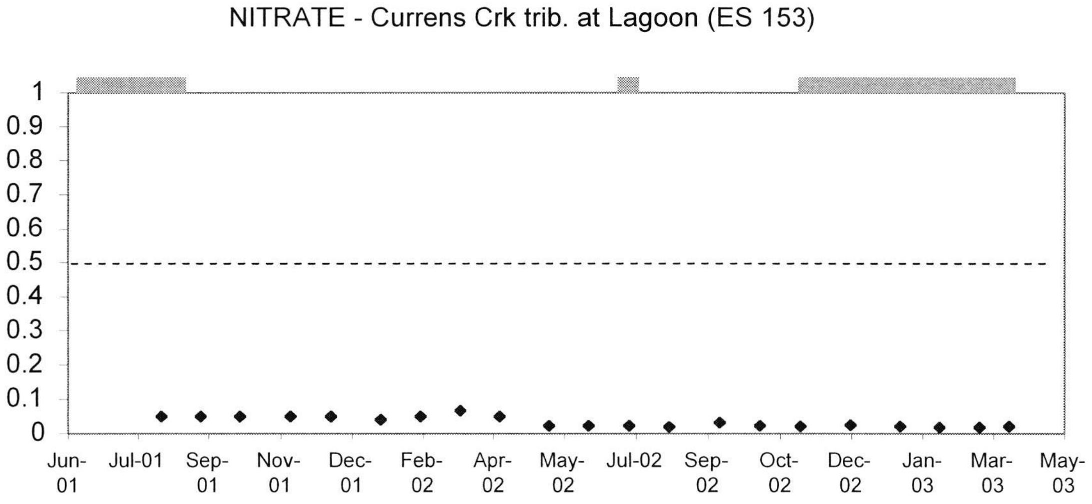


Figure 2.14 *ES water quality data for the tributary of Currans Creek.*

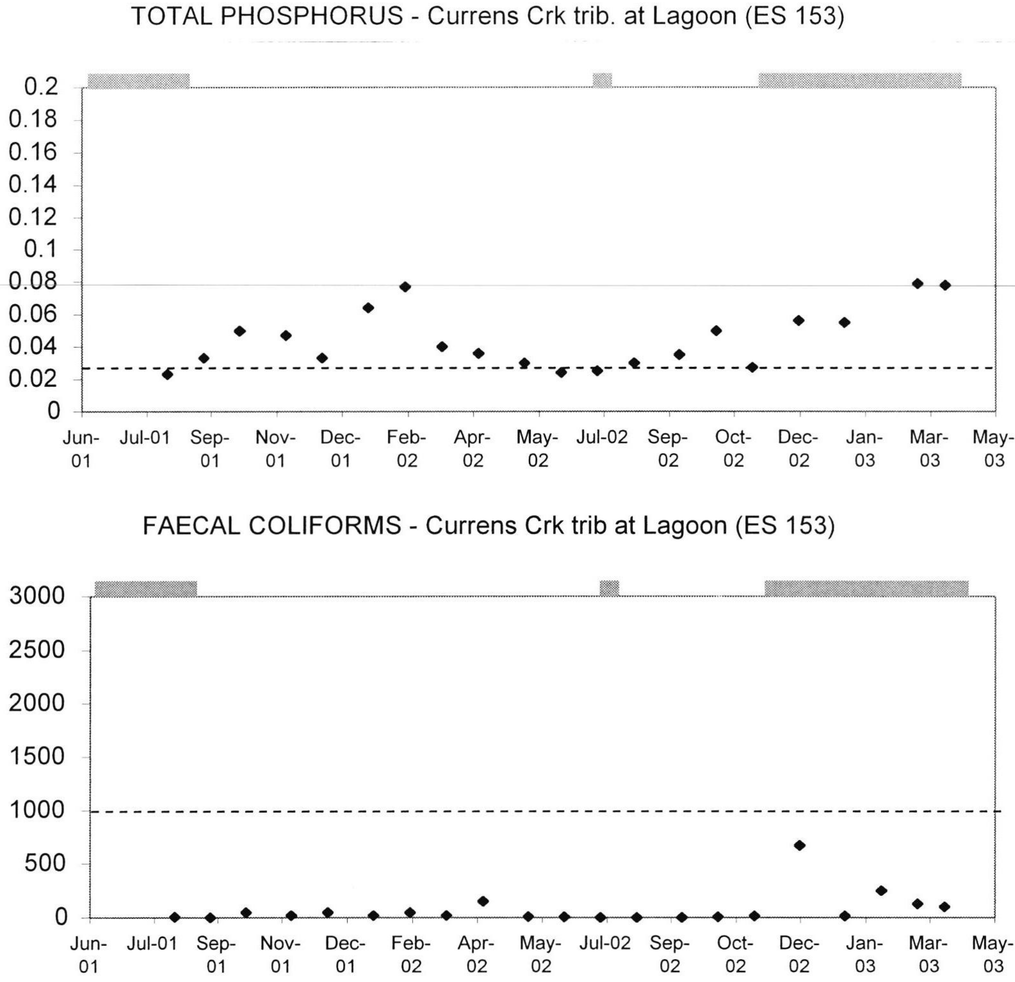
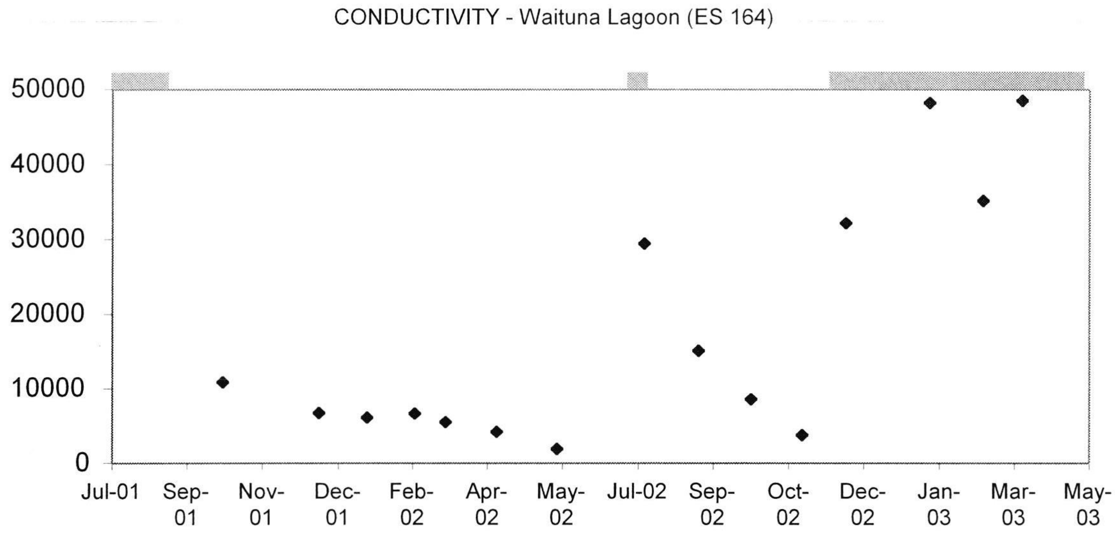
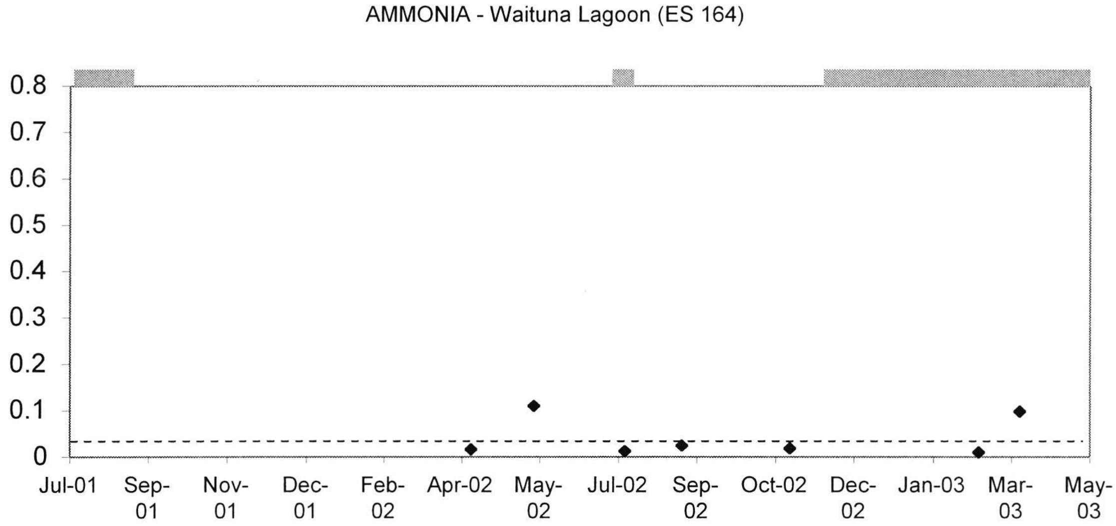


Figure 2.15 *ES water quality data for the tributary of Currans Creek.*

Waituna Lagoon

The Lagoon has been sampled at its centre monthly since September 2001. Conductivity, which is an excellent indicator of salinity, shows a clear relationship with the status of the Lagoon mouth, and can reach as low as 1/100th the conductivity of seawater (Figure 2.16). Nitrate values can exceed the guidelines, particularly in winter, but at this stage appear unrelated to Lagoon status (Figure 2.16). Phosphorus values in the Lagoon show a peak in late winter 2002, but also appear unrelated to Lagoon status (Figure 2.17). Chlorophyll (algae) values in the Lagoon exceed guidelines at times (Figure 2.17). Guidelines used here are for an estuarine, rather than freshwater, ecosystem.





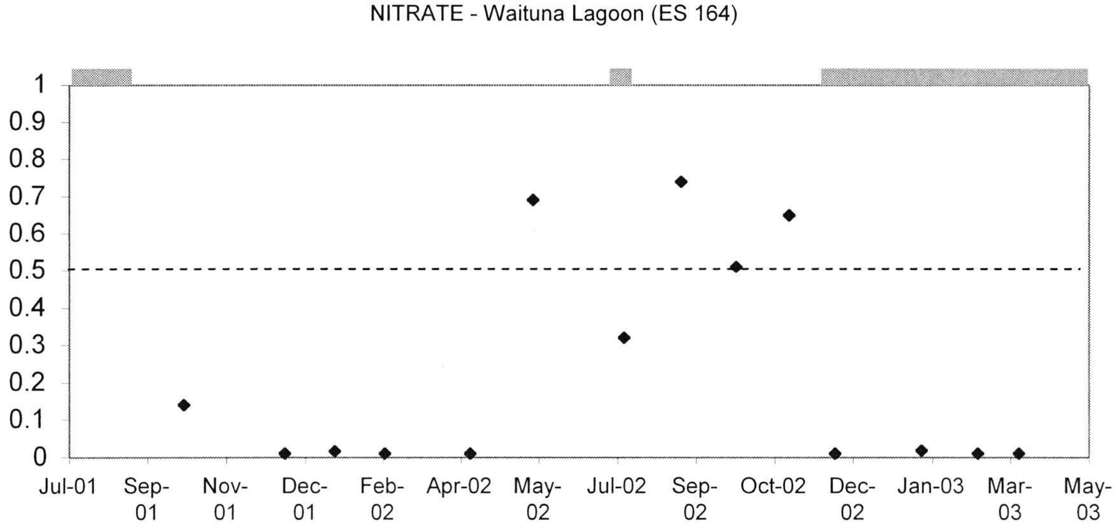
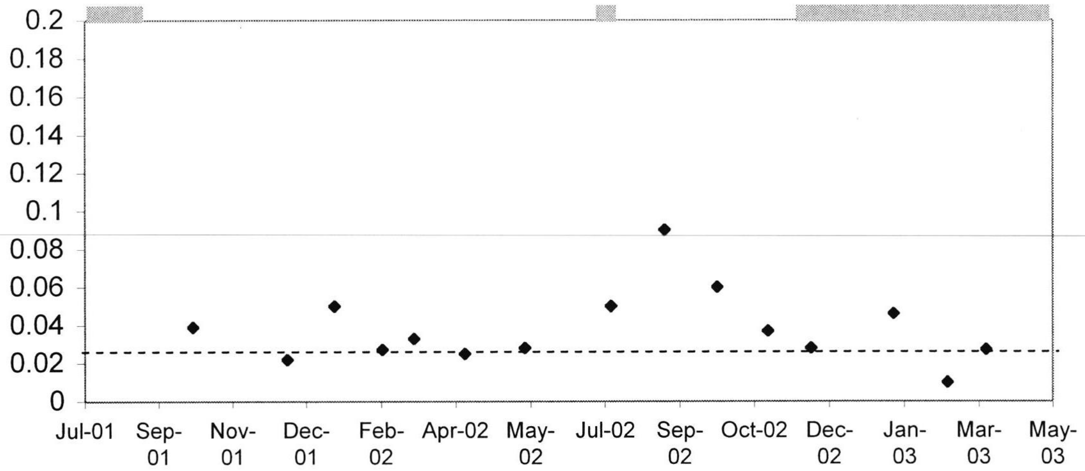
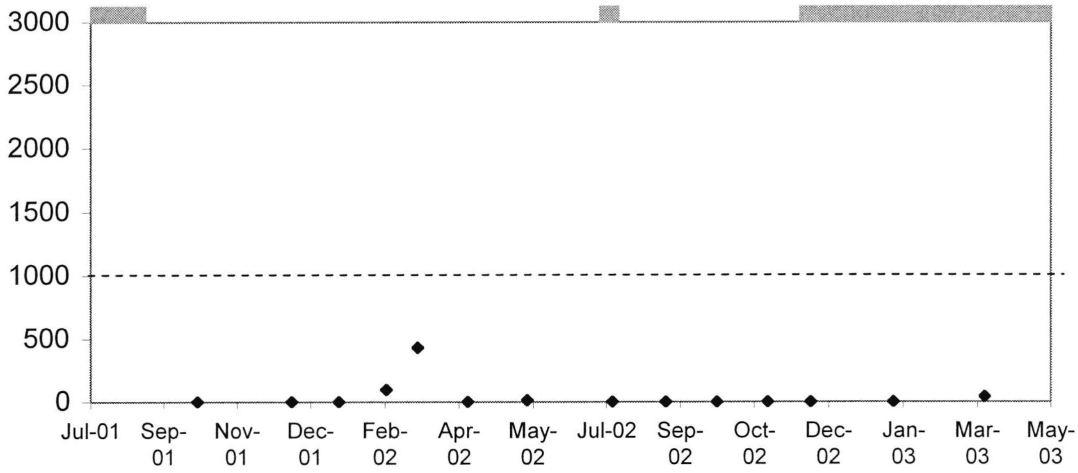


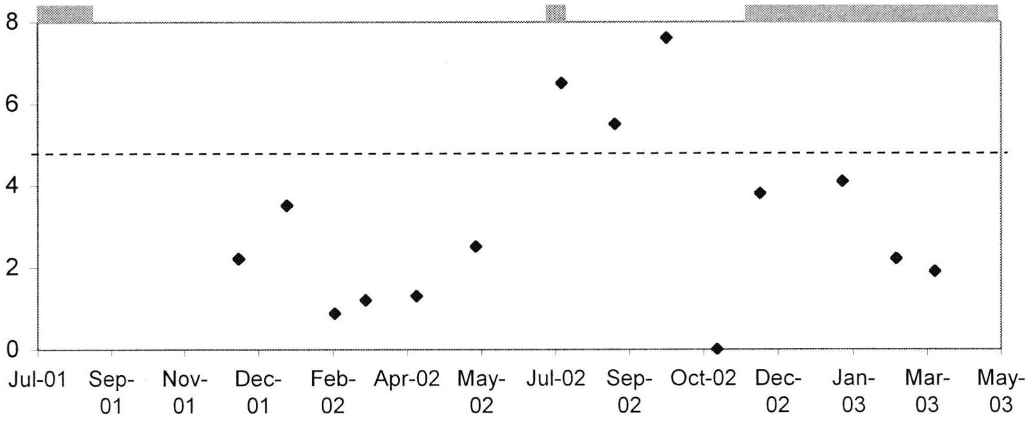
Figure 2.16 *ES water quality data for Waituna Lagoon.*



TOTAL PHOSPHORUS - Waituna Lagoon (ES 164)



FAECAL COLIFORMS - Waituna Lagoon (ES 164)



CHLOROPHYL A - Waituna Lagoon (ES 164)

Figure 2.17 *ES water quality data for Waituna Lagoon.*

2.3.5 Overview

The overall status of the different inflows to the Lagoon are summarised in Table 2.4.

Waituna Creek contains high concentrations of nitrate, which, coupled with the fact that the stream represents the largest inflow, supplies a significant total loading of nitrate to the Lagoon. Nitrate concentrations in other tributaries of the Lagoon are much lower, but show seasonal peaks, with higher values in winter.

Waituna Creek and Moffatt Creek both export significant concentrations of phosphorus into the Lagoon. Currans Creek supplies less phosphorus, but concentrations still exceed guidelines, particularly in summer, and levels may be increasing steeply.

Ammonia levels in Waituna Creek are at times very high. Levels in other inflow streams are lower, but in Currans Creek there appears to be a definite trend towards increasing levels.

Faecal coliform levels in Waituna Creek can be very high and occasionally exceed guidelines. Values in Moffatt Creek can be very high, while summer peaks are evident in Currans Creek.

Saltwater intrusion into the Lagoon is significant, as evidenced by the relatively high salinities encountered at the centre of the Lagoon. Conductivity data, however, suggest that the lower reaches of the streams flowing into the Lagoon are not strongly influenced by saltwater intrusion. At this stage there is no evidence of an effect of Lagoon mouth status (open or closed) on nutrient concentrations within the Lagoon, or in the streams. However, the period over which data has been collected is limited.

Table 2.4 *Overview of water quality in the Waituna catchment, colours indicate whether sites meet guideline values consistently (green), usually (gold), occasionally (orange) or consistently fail (red). Arrows indicate trends through time. Sites with seasonal peaks have the season with the highest values identified in the table.*

Waterbody	**Waituna Crk. (Marshall's Rd.)**	**Waituna Crk. (Mokotua)**	**Moffatt Crk. (Moffatt Rd.)**	**Currans Crk. (lagoon Rd.)**	**Trib. near Currans Crk. (at Lagoon Rd.)**	**Waituna Lagoon (centre)**
ES Site code	63	150	154	152	153	164
Commenced	July 1995	Aug 2001	Aug 2001	Aug 2001	Aug 2001	Oct 2001
Frequency	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly
Conductivity	Moderate ▲	Moderate	Moderate	Moderate	Moderate-low	Very high when open
Ammonia				▲		
Nitrate			Winter	Winter		
DR phosphorus		Summer		Summer	Summer	
Faecal coliforms				Summer		
Chlorophyll						

2.3.6 Conclusions

What is the overall state of water quality in the catchment?

Water quality in the catchment is generally poor. This is particularly true of Waituna Creek, which consistently contains high concentrations of ammonia, nitrate and phosphorus, and is often high in faecal coliforms. This is true of both the upstream and downstream sites. As Waituna Creek is the largest inflow to the Lagoon, it is likely to represent a significant source of contaminants to the Lagoon. Water quality in the other streams tends to be better, although phosphorus is consistently high and nitrate is seasonally high. All of the streams and many of the drains in the Waituna catchment have extensive macrophyte communities that require drain clearance, an activity that further reduces water quality. Extensive macrophyte growths in streams in the catchment are a product of the poor water quality in those streams.

Water quality in the Lagoon itself is relatively poor, with moderate levels of nitrate and phosphorus, and high levels of chlorophyll at times. There is a genuine risk that in a situation where the Lagoon is closed to the sea, a serious algal bloom will develop in the lagoon. This could potentially remove the aquatic plant communities and severely degrade the value of the sports fishery. Continuing trends towards higher values for ammonia in the catchment also put at risk native and sports fish populations in the Lagoon.

On occasions the current faecal coliform levels in the Lagoon make it unsafe for swimming, where previously it has been suitable for this purpose. Levels of faecal coliforms do not exceed the level where secondary contact activities (such as fishing) are considered unsafe. The high levels of faecal coliforms being carried into the Lagoon by some of the streams, however, is of concern and there is the risk that coliform levels within the lagoon could rise to unacceptable levels during long periods of Lagoon closure.

Can water quality patterns be clearly related to land use?

There is evidence that the more developed pastoral catchments have worse water quality. The largest and most intensively developed catchment is Waituna Creek, and this has the poorest water quality. Conversely, the least developed catchment (the Currans Creek tributary) has the best water quality. All streams have reasonably high levels of phosphorus, and this chemical may not be a useful indicator of land use induced changes in water quality.

Seasonal peaks in some nutrients, and in faecal coliforms, may be related to changes in stocking patterns. Summer peaks in faecal coliforms and phosphorus in Currans Creek, for instance, may suggest that stock are accessing waterways at that time of year. Phosphorus is released by disturbance of topsoil (such as occurs when stock trample banks) and is a significant component of faecal material and urine. It is recommended that bio-available phosphorus (DRP) be monitored. Nitrate peaks in winter are probably explained by low rates of nitrate uptake by plants and algae at colder temperatures, but the levels may also be related to land use.

Is there evidence that water quality is declining?

In general there is no strong evidence for a catchment-wide trend towards poorer water quality. In part, this is because water quality has been poor at most sites from the commencement of sampling. There is some evidence of ongoing degradation of water quality in Waituna Creek (seen in increasing conductivity and faecal coliform levels, and a possible increase in ammonia). The trend of increasing phosphorus, ammonia and faecal coliform levels in the main stem of Currans Creek also gives relatively strong evidence for declining water quality.

Is water quality related to Lagoon mouth opening and closure?

Water quality in the streams does not appear to relate to whether the Lagoon mouth is open or shut. Conductivity values suggest that there is relatively little saltwater intrusion into the bottom of the creeks. In the Lagoon itself, the saltwater influence can be profound in terms of conductivity, but there is no evidence that the marine influence is affecting other aspects of water chemistry, particularly nutrients. Reasonably regular opening and closure of the Lagoon ensure that it is a more dynamic system than (for example) a lake. It is possible that shorter-term changes (i.e. less than monthly) are seen in the catchment in response to these Lagoon openings and closures and more frequent sampling (perhaps weekly) may be warranted. The current sampling regime is probably sufficient to determine long term trends, but may miss events of relatively short duration, such as minor algal blooms.

Is the data of sufficient quality to make conclusions?

The length of time that the data has been collected from the majority of sites means that interpreting seasonal patterns and trends through time should be done with caution. However, taken collectively, there is sufficient data to draw limited conclusions about the water quality of the catchment. Continued monitoring and analyses over a longer period will more accurately show whether some of the seasonal trends, and other trends through time, observed in these data, are genuinely valid.

What should be done next in the area of water quality monitoring?

The current water quality monitoring scheme is adequate, and, if continued in its existing form, will provide a reasonable picture of changes in catchment water quality. However, extensive sampling of streams along their length is needed to identify which areas of the catchment are contributing the largest loadings of nutrients and ammonia. Analysis of data at annual intervals will provide useful additional information on trends, both seasonally, and through the years. The introduction of additional sites on the Lagoon (near the outlet and at the closed end of the Lagoon) is proposed (Michelle White, Environment Southland, pers. comm.), and would provide information on whether the high nutrient inflows from some streams are affecting the whole Lagoon or only parts of it. This information will also be needed if any modelling is carried out in the future to predict effects of changes in nutrient loadings on the Lagoon. As stated above, more frequent monitoring in the Lagoon would also be of benefit.

Within the catchment, there is clear evidence that there are water quality issues, particularly with regard to Waituna Creek. Correlating patterns in water quality with known changes in land use will be carried out as part of the catchment management plan.

2.4 Sedimentation

2.4.1 Existing data

There have been reports of increased sediment export from the catchment, causing discolouration of streams and infilling of the Lagoon. Such export of sediment has resulted in changes in Lagoon bed characteristics and expansion of rush beds (Johnson and Partridge 1998; Thompson and Ryder 2002). Sedimentation rates in Waituna Creek and the Lagoon during June/July 2001 are shown in Table 2.5.

Table 2.5 *Sedimentation rates (mean with standard error of mean (S.E.)) in Waituna Creek and Lagoon, June - July 2001 (Environment Southland, unpublished data).*

Site	**Mean (± 1 S.E.) sedimentation rates (mm/day)**
Waituna Creek (near bridge)	0.736 (0.104)
Waituna Creek (lower section)	0.582 (0.049)
Lagoon (Waituna Creek mouth)	1.544 (0.761)
Lagoon (northern shore)	1.045 (0.073)

High inputs of sediment have a number of consequences for the catchment and the Lagoon. The input of fine sediment into waterways increases turbidity, which can reduce quality of habitat for fish and invertebrates. Sediment can reduce the ability of plants to photosynthesise, and also smother algae and directly interfere with fish and invertebrate respiration (Ryder 1989). Accumulation of sediment on the bottom of waterways (a process which is increased by macrophyte growth) reduces the capacity of the channel and necessitates channel clearance operations.

Sedimentation in the Lagoon has a number of consequences. Infilling of the Lagoon by rush invasion is ongoing in several sheltered bays (Thompson and Ryder 2001). Several popular fishing holes have also filled with fine sediment within the last five years (Ray Waghorn, pers. comm.). The smothering of the bed of the lake (formerly comprised of fine quartz sands) with fine organic muds has unknown consequences for aquatic plant communities and the invertebrate communities that live on the bed of the lake. Fine sediment on the lake bed is also prone to re-suspension by wind action, which can increase the turbidity of the lake, with the consequences outlined above.

Additional work has since been carried out for the Waituna catchment to provide a mass balance for the amount of sediment entering the Lagoon (Environment Southland, unpublished data).

Patterns through time for the different inflows are similar, with the highest values occurring in winter, and the majority of sediment entering the Lagoon during a few, peak flow events (Figure 2.18). This pattern is consistent with bank erosion events occurring during high flows and, potentially, also with sediment supply from surface flow over pugged ground in winter. High sediment inputs may also be contributed to by the grazing of forage crops along stream margins over the winter period (pers. obs. from Waituna catchment).

The largest inflow to the Lagoon is Waituna Creek (Figure 2.19), which supplies approximately 65% of the median flows to the Lagoon. Currans Creek has the highest concentrations of sediment, followed by Waituna Creek and Moffatt Creek. However, Waituna Creek has a much higher flow than Currans Creek so, despite its lower concentration, it exports more sediment to the Lagoon (Figure 2.19).

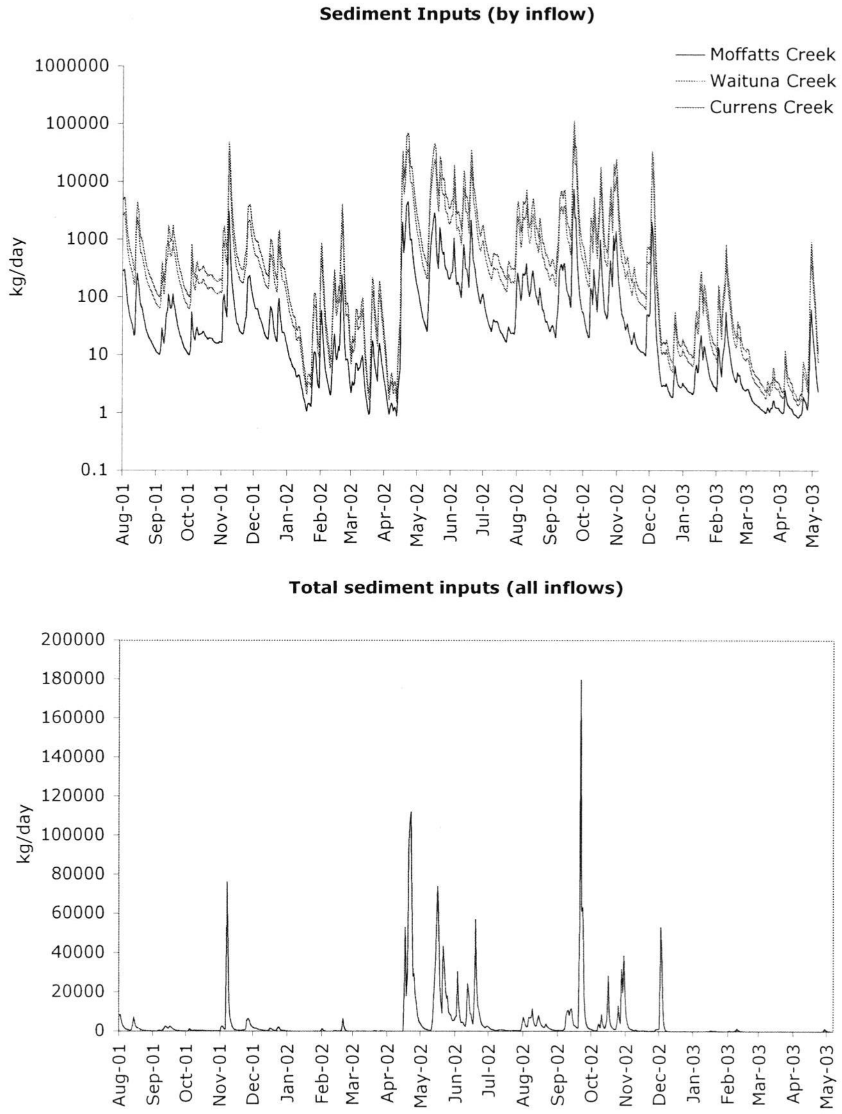


Figure 2.18 *Sediment inputs by inflow to Waituna Lagoon through time (top) and in total (bottom). Note logarithmic scale in top graph.*

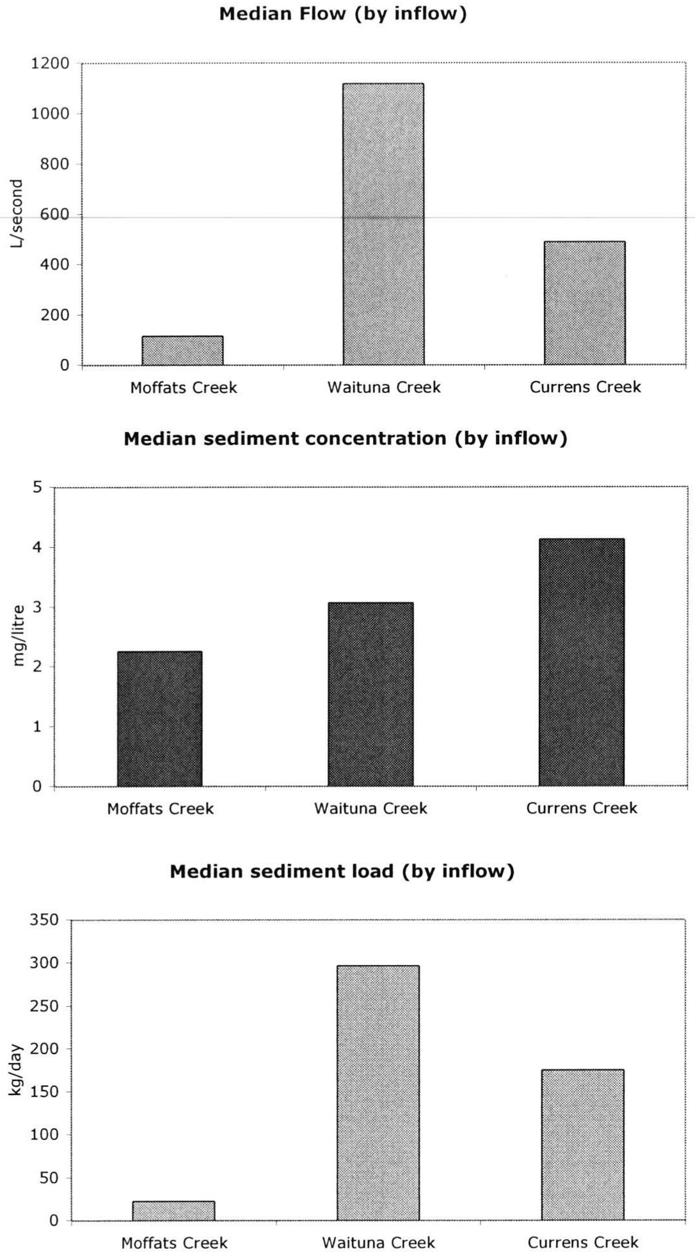


Figure 2.19 *Median flows, sediment concentrations and sediment inputs to Waituna Lagoon.*

2.4.2 Interpretation and summary

Significant amounts of sediment are being exported from the Waituna catchment. This export mainly occurs during a few high flow events in a year. The majority of the sediment is being supplied from Waituna Creek, which is the largest creek. The highest sediment concentrations occur in Currans Creek, and may be related to ongoing development of land in that sub-catchment over the study period (pers. obs.). There is no clear evidence that sediment inputs are increasing through time, but the time over which samples has been taken is probably insufficient to detect such trends at this stage.

2.5 Macroinvertebrates

This section summarises macroinvertebrate data for the catchment of Waituna Lagoon, up until March 2003. The data is interpreted in the context of changes through time, relationships with the status (open or closed) of the Lagoon mouth, and in relation to national guidelines.

2.5.1 Introduction

Freshwater benthic macroinvertebrates are bottom-dwelling organisms that have no backbone and are larger than 250 microns in size. This broad grouping includes insect larvae (e.g. caddisflies, mayflies, stoneflies), aquatic worms (oligochaetes), aquatic snails, and crustaceans (e.g., amphipods, isopods and freshwater crayfish). Macroinvertebrates utilise a variety of food sources depending on the species.

Aquatic macroinvertebrates are good indicators of ecological change in freshwater environments. Changes in density (numbers) can indicate changes in productivity of algae (e.g. periphyton), which may suggest increased nutrient inflows. Because different macroinvertebrate species have different tolerances to environmental factors, such as dissolved oxygen, chemical pollutants and fine sediment, the presence or absence of different species can also indicate changes in water quality.

2.5.2 Sampling methods

Macroinvertebrate samples have been collected in two separate ways.

<u>Environment Southland Sampling</u>

Since 1996 (Ryder 1996), invertebrate samples have been collected annually from Waituna Creek (Figure 2.2) by Environment Southland. Sampling involves the use of a 'kick-net', disturbing an area of approximately 1m^2 of the stream-bed in such a way that invertebrates are dislodged and washed into a downstream net. Samples are preserved and transported to the laboratory for identification. In the lab, samples are sieved through a 250μm sieve to remove fine material and preservative. Contents retained by the sieve are then placed in a white tray and macroinvertebrates removed and identified under dissecting (10-40x magnification) and binocular (100-400x magnification) microscopes using published New Zealand taxonomic keys.

Waituna Landcare Group Sampling.

Waituna Landcare Group have sampled a number of locations (see Figure 2.22) for invertebrates on two occasions; in summer 2001 and autumn 2002, using the NIWA designed Stream Health Monitoring and Assessment Kit (SHAMK). Substrate is taken from the stream and washed into a white tray. Invertebrates are identified in the field.

2.5.3 Analysis

In addition to determining taxonomic richness (number of different types of animals) in each sample, the Macroinvertebrate Community Index (MCI) (Stark 1985) and the Quantitative Macroinvertebrate Community Index (QMCI) (Stark 1993) were calculated. The MCI uses the occurrence of specific macroinvertebrate taxa to determine the level of organic enrichment in a stream, using the following formula:

$$\textbf{MCI} = \frac{(\Sigma \text{ of taxa scores})}{(\text{Number of scoring taxa})} \times 20$$

Taxa are scored between 1 and 10, with low scores indicating high tolerance to organic pollution and high scores indicating taxa that are only found in "pristine rivers" (Stark 1985). A site score is obtained by summing the scores of individual taxa and dividing this total by the number of taxa present at the site, then multiplying by 20. Theoretically, samples scores can range from 0 (no species present) to 200, with different scores indicating different pollution status (Table 2.6).

The QMCI (Stark 1993) uses the same approach as the MCI but weights each taxa score on the abundance of the taxa within the community. As for MCI, QMCI scores can be interpreted in the context of national guidelines (Table 2.6).

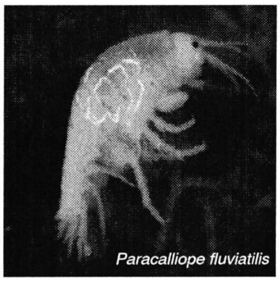
$$\textbf{QMCI} = \Sigma \frac{(\text{Taxa abundance x Taxa score})}{(\text{Total abundance})}$$

Table 2.6 *Interpretation of macroinvertebrate community index values from stony riffles (after Stark 1993).*

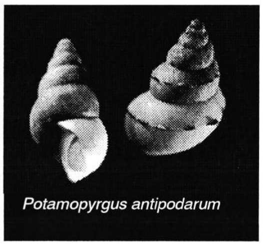
Interpretation	MCI	QMCI
Clean water	>120	>6.00
Doubtful quality	100-119	5.00-5.99
Probable moderate pollution	80-99	4.00-4.99
Probable severe pollution	<80	<4.00

2.5.4 Results and interpretation

<ins>Environment Southland sampling</ins>

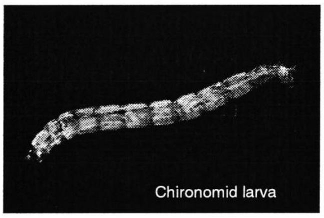


Paracalliope fluviatilis



Potamopyrgus antipodarum

Samples from Waituna Creek have generally been dominated by the amphipod *Paracalliope fluviatilis*, the pond snail *Potamopyrgus antipodarum* and chironomids (small midge larvae) (Table 2.7). The small filtering bivalve *Sphaerium novaezealandiae* ('fingernail clam'), grazing snail *Physella*, sandfly larvae (*Austrosimulium* spp.) and the axe head caddis *Oxytheira* are common on occasions. This species assemblage is typical of that found in lowland rivers in Southland (Environment Southland, unpublished data).



Chironomid larva

The MCI scores for the dominant species range from low (2) to moderate, but species with relatively high MCI scores (= low tolerance to organic pollution) have been found at the site on occasions.

The total number of species found at Waituna Creek (Figure 2.20) varies from low to high (compared to the New Zealand average of 14 species; Quinn and Hickey 1990). This high natural variation does not appear to be associated with the status (open or closed) of the Lagoon mouth. MCI and SQMCI scores (Figure 2.20) are indicative of probable moderate to severe organic pollution. There may be some evidence of a trend towards lower scores since 2000 (when revisions of taxonomy made scores generally higher across the region).

Table 2.7 *Invertebrate data from the Environment Southland sampling site on Waituna Creek 1996-2003. Invertebrate abundances are shown in numbers per sample.*

ES Site Code		63	63	63	63	63	63	63	63
Year		**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
TAXON	**MCI score**								
COLEOPTERA									
Elmidae (*Hydora* species)	6								8
CRUSTACEA									
Chiltonia species	5				7				
Cladocera	5							120	
Ostracoda	3		10		12		5		
Paracalliope fluviatilis	5	220	34	900	20	560	1800	816	150
Paraleptamphopus species	5				23		6		
Paratya species	5						3		
DIPTERA									
Austrosimulium australense group	3	6	5			2	10	120	98
Chironomids	2	147	1		55	240	195	72	765
Culex species	3								8
Nothodixa species	5						1		
EPHEMEROPTERA									
Deleatidium species	8		1	1			2		8
HEMIPTERA									
Anisops species	5							72	
Microvelia species	5						1		
Sigara species	5			2	1		12		
MOLLUSCA									
Physella species	3			1	77		55	1152	
Potamopyrgus antipodarum	4	4	6	20	119	30	100	2808	83
Sphaerium novaezelandiae	3		16	2	8		12		465
ODONATA	3								
Austrolestes colensonis	6				2				
Ischnura aurora	5				1				
Xanthocnemis zealandica	5		11		4	2	100	24	23
OLIGOCHAETA	1	73	3	2	3	14	6		
PLATYHELMINTHES	3	2	2	4			6		
TRICHOPTERA									
Aoteapsyche species	4	1							
Helicopsyche albescens	10					12			
Hudsonema amabile	6	12	2			1	3	48	
Oecetis species	5		12	2			1		
Olinga species	9	4							
Oxyethira albiceps	2			1	6		65		120
Paroxyethira hendersoni	2						4		
Psilochorema species	8						1		
Total richness		9	12	10	14	8	21	9	10
Total abundance		469	103	935	338	861	2388	5232	1728
MCI site score		82	80	78	77	90	84	84	82
QMCI site score		3.5	4.2	5.0	3.5	4.1	4.5	3.9	2.8

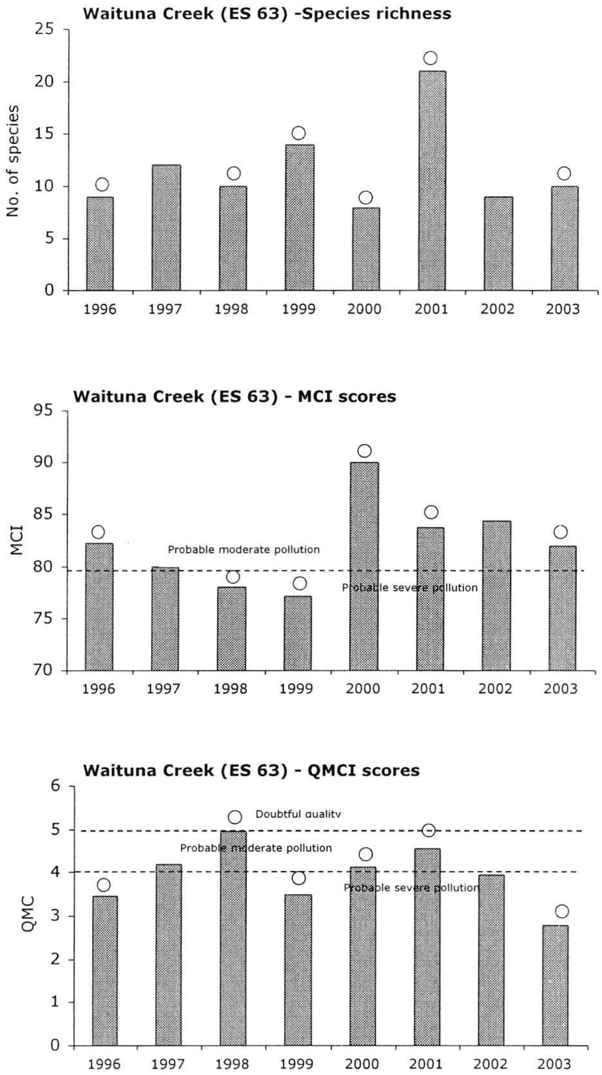


Figure 2.20 *Invertebrate indices from the Environment Southland sampling site on Waituna Creek 1996-2003. Invertebrate abundances are shown in numbers per sample. Dotted lines indicate guidelines for interpretation of MCI and QMCI values. A 'o' above the bar indicates that the Lagoon was open to the sea.*

Waituna Landcare Group sampling

Samples from Currans Creek, Moffatt Creek and other parts Waituna Creek have shown similar patterns to the results from the Environment Southland monitoring site (Table 2.8). At all of the streams, communities are dominated by amphipods, *Potamopyrgus antipodarum* snails and chironomids. The axe head caddis *Oxytheira* was also common on occasions. There were no clear differences between streams or sites moving down Waituna Creek, although the amount of data available makes it difficult to detect patterns. The MCI scores for the dominant species ranged from low (2) to moderate, although higher scoring taxa (such as the mayfly *Deleatidium*) were present in some sites.

The number of species present in the different sites cannot readily be compared to the ES data or to the national average, because the degree of taxonomic detail is lower in the WLG data. The technique used for sampling is also not sufficiently quantitative to allow comparisons of abundance through time. MCI and SQMCI scores from Currans Creek (Table 2.8), Moffatt Creek (Figure 2.24, 2.25) and Waituna Creek (Figure 2.24, 2.25) all infer that the streams are subject to 'probable moderate' to 'probable severe' pollution. MCI scores in the Waituna creek catchment appeared to decline from 2001 to 2002, while QMCI scores increased. This is a result of increases in relative abundance of higher scoring taxa such as amphipods and snails.

It is important to recognise that lowland streams often have lower MCI and QMCI scores due to their low gradient and the presence of soft sediments and macrophytes. The C1 site is in an area that has relatively little agricultural impact, yet the index scores were still low. In general, longer term trends in these values are likely to be more informative than comparisons to the national guidelines.

Table 2.8 *Invertebrate data from the Waituna Landcare Group sites 2001/2002. For site codes see Figure 2. Invertebrate abundances are shown in numbers per sample.*

Date	**Dec-01**	**Dec-01**	**Dec-01**	**Dec-01**	**Dec-01**	**Dec-01**	**Dec-01**	**Dec-01**	**Dec-01**
WLG code	**J1**	**J2**	**M1**	**M2**	**W2**	**W3**	**W5**	**W6**	**W8**
TAXON									
CRUSTACEA									
Amphipoda	3	50	4	16	6	20	40	22	
DIPTERA									
Austrosimulium spp.	2		3	9					1
Chironomids	36		6	21	49	114	10	1	25
Culex species									
Tipulidae			1						
EPHEMEROPTERA									
Deleatidium species						1	1	1	
MOLLUSCA									
Potamopyrgus antipodarum		17	1	3	77	36	67	38	
OLIGOCHAETA									
PLATYHELMINTHES		11		4	12	3	6	5	
TRICHOPTERA									
Unidentified caddis								15	10
Oxytheira spp.	1		1	1	237	4	8	6	
Stone caddis		3			5			11	
Psilochorema species		1			1	1	1		
HIRUDINEA									
Total Richness	4	5	6	6	7	7	7	8	3
Total Abundance	42	82	16	54	387	179	133	99	36
MCI Score	60	100	70	63	83	91	91	85	67
QMCI Score	2.3	4.6	3.3	3.2	2.5	2.8	4.0	4.3	2.9

Table 2.8 *(continued).*

Date	**Apr-02**	**Apr-02**	**Apr-02**	**Apr-02**	**Apr-02**	**Apr-02**	**Apr-02**	**Apr-02**	**Apr-02**	**Apr-02**	**Apr-02**
WLG code	**J1**	**J2**	**M1**	**M2**	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	**W8**
TAXON											
CRUSTACEA											
Amphipoda	5	5		10		1	10		50	80	30
DIPTERA											
Austrosimulium spp.			1		5						1
Chironomids						5					
Culex species					5						
Tipulidae											
EPHEMEROPTERA											
Deleatidium species											
MOLLUSCA											
Potamopyrgus antipodarum	2	20	5	50	50	20	50	20	30	6	20
OLIGOCHAETA						24	4	3	1		
PLATYHELMINTHES											
TRICHOPTERA											
Unidentified caddis											
Oxytheira spp.											
Stone caddis		1		8		54	7				4
Psilochorema species					3						1
HIRUDINEA						1					
Total Richness	2	3	2	3	4	6	4	2	3	2	5
Total Abundance	7	26	6	68	63	105	71	23	81	86	56
MCI Score	90	93	70	93	90	67	75	50	67	90	100
QMCI Score	4.7	4.2	3.8	4.3	4.0	3.7	4.1	3.6	4.6	4.9	4.7

2.5.5 Interpretation and summary

Macroinvertebrate communities in the Waituna Lagoon catchment are typical of those in similar lowland streams elsewhere in Southland. The fauna is dominated by amphipods, snails and chironomids, although a variety of other species can be present in relatively small numbers. At all of the sites the predominant species have low to intermediate MCI scores. The overall MCI and QMCI site scores for the communities reflect this, characterising the status of the streams as being 'probable moderate' to 'severe' pollution. The longer-term monitoring site on Waituna Creek provides some evidence of declining MCI scores although interpretation is made more difficult by changes in taxonomy in 2000. Sites on the other streams have not been monitored for a sufficient time to allow conclusions to be drawn with regard to trends through time.

2.6 Fish

2.6.1 Overview

The Southland area has 22 native and six exotic freshwater or estuarine fish species (Table 2.9), a number that is exceptional by New Zealand standards. Of the native species known to be present in Southland, nineteen have a marine phase to their lifecycle. A number also utilise estuarine habitats either for their entire lifecycle, or for breeding or feeding at some stage of their lifecycle. The Waituna catchment provides ideal habitat for a number of native species, in particular because the Lagoon area is available for breeding. The relatively intact nature of the wetlands around parts of the Lagoon may also favour some native species. In addition, the Lagoon supports a highly valued recreational trout fishery, with fish spawning in the tributaries of the catchment (Riddell *et al.* 1988).

Table 2.9 *Freshwater and estuarine fish species known to be present in Southland (Thompson and Edwards 2002), with details of life history (from McDowall 2001) and conservation status (Molloy et al. 2001).*

Species	Common name	Native/ exotic	Marine stage?	Use estuarine habitat?	Conservation Status
Aldrichetta forsteri	Yelloweye mullet	Native	Marine	Feeding	Not threatened
Anguilla australis	Shortfin eel	Native	Yes	Migration	Not threatened
Anguilla dieffenbachii	Longfin eel	Native	Yes	Migration	In decline
Cheimarrichthys fosteri	Torrentfish	Native	Yes	Migration	Not threatened
Galaxias argenteus	Giant kokopu	Native	Yes*	Breeding (?)	In decline
Galaxias brevipinnis	Koaro	Native	Yes*	No	Not threatened
Galaxias fasciatus	Banded kokopu	Native	Yes*	Breeding (?)	Not threatened
Galaxias gollumoides	Gollum galaxias	Native	No	No	Not threatened
Galaxias maculatus	Inanga	Native	Yes	Breeding	Not threatened
Galaxias paucispondylus	Alpine galaxias	Native	No	No	Not threatened
Galaxias postvectis	Shortjaw galaxias	Native	Yes	Breeding (?)	In decline
Galaxias sp. 'southern'	Southern flathead	Native	No	No	No data
Galaxias sp. 'D'	Poolburn galaxies	Native	No	No	Endangered
Geotria australis	Lamprey	Native	Yes	Migration	Sparse
Gobiomorphus cotidianus	Common bully	Native	Yes*	Yes	Not threatened
Gobiomorphus breviceps	Upland bully	Native	No	No	Not threatened
Gobiomorphus gobiodes	Giant bully	Native	Possible	Estuarine	Not threatened
Gobiomorphus huttoni	Refin bully	Native	Yes	No	Not threatened
Grahamina nigripenne	Cockabully	Native	Marine	Feeding	Not threatened
Oncorhynchus mykiss	Rainbow trout	Exotic	Yes*	Migration	Not threatened
O. tshawytscha	Chinook salmon	Exotic	Yes*	Migration	Not threatened
Perca fluviatilis	Redfin perch	Exotic	No	Yes	No threatened
Retropinna retropinna	Common smelt	Native	Possible*	Estuarine	No threatened
Rhombosolea leporina	Yellowbelly flounder	Native	Yes	Estuarine	Not threatened
Rhombosolea retiaria	Black flounder	Native	Yes	Estuarine	Not threatened
Salmo salar	Atlantic salmon	Exotic	Yes*	Migration	Sparse#
Salmo trutta	Brown trout	Exotic	Yes*	Yes	Not threatened
Salvelinus fontinalis	Brook char	Exotic	No	No	Not threatened

* can form land-locked populations.
# may be locally extinct.

2.6.2 Previous surveys

Several surveys have been carried out of fish in the Waituna catchment, dating from an early survey of the Lagoon in 1970. A detailed survey of the three main catchments and the Lagoon was carried out in 1985 as part of a scoping exercise for possible coal extraction in the area (Riddell *et al.* 1988). Further limited work has been carried out since by NIWA (1999), DoC (2001) and the University of Otago. Southland Fish and Game have carried out a number of assessments of the extent of trout spawning. A major fish survey is planned by Waituna Landcare Group and University of Otago in summer 2003/4.

2.6.3 Methods

To review the existing information on fish in the Waituna catchment, the New Zealand Freshwater Fish Database was accessed and records from the catchment extracted. Additional information was gained from researchers who have carried out unpublished work in the area.

2.6.4 Results

Thirteen species of fish (twelve native) have been recorded from the catchment and Lagoon (Table 2.10). Of those, several (yellow-eye mullet, smelt, cockabully and flounder) can be considered estuarine fish, and have been recorded only from the Lagoon and the extreme lower reaches of Waituna Creek. Eels were reportedly abundant in all of the catchments with some very large eels caught during surveys (Riddell *et al.* 1988). The dominant small fish in all three catchments are inanga and common bullies, although redfin bullies are also present. Giant kokopu, the largest of the galaxiid fishes, and a species considered to nationally be in decline, have been regularly recorded from the catchment (Table 2.10). Large giant kokopu have been observed along the three main streams, and shoals of juveniles have been seen in the lower reaches of Currans Creek (personal observation) and in the mid reaches of Moffatt Creek (B. David, University of Otago, pers. comm.). The area is considered to be a regional stronghold of the species (E. Edwards, Dept. of Conservation, pers. comm.).

A significant population of brown trout is present in the Lagoon, and the fishery is valued for hard-fighting, large fish. The current population is a mix of sea-run and freshwater fish, with known redds being reported in Waituna Creek and Moffatt Creek as early as 1964 (Southland Acclimatisation Society 1964).

Table 2.10 *Freshwater and estuarine fish species described from the Waituna catchment (NZ Freshwater Fish Database, 2003). Numbers of fish caught are shown with length range in brackets below. Superscripts indicate the survey occasion.*

Species	Common name	Waituna	Moffatt	Currans	Lagoon
Aldrichetta forsteri	Yelloweye mullet				3[1] (92-120)
Anguilla australis	Shortfin eel	7[3] (?-800)		10[2] 3[3]	5[1] (380-920)
Anguilla dieffenbachii	Longfin eel	62[1] (200-750) 24[3] (? -850)	18[1] (110-600)	405[1] (100-630) 4[2] 40+[3] (? - 600)	
Galaxias argenteus	Giant kokopu	3[1] (200)	5[1] (110-160)	10[1] (103-305) 3[2] 11[3] (46-271)	
Galaxias maculatus	Inanga	332[1]	90[1] (55-115)	33[1] (65-88) 2[2] Common[3]	48[1] (65-130)
Geotria australis	Lamprey	1[1] (400)			
Gobiomorphus cotidianus	Common bully	170[1]	26[1] (40-75)	39[1] (32-86)	94[1] (30-90) Abundant[5]
Gobiomorphus huttoni	Redfin bully	10[1]	1[1] (35)		
Grahamina nigripenne	Cockabully				1[1] (75)
Paranephrops zelandicus	Freshwater crayfish	4[1] (60)			51[1] (35-135)
Retropinna retropinna	Common smelt	1[1]			246[1] (67-110) Abundant[4]
Rhombosolea retiaria	Black flounder	1[3] (250)			24[1] (38-250) Common[5]
Salmo trutta	Brown trout	19[1] (40-510)		3[1] (80-82)	2[1] (385-400) 1[4]

1.1985 Southland Fish and Game 2.1995 NIWA 3. 1999 NIWA 4.1970 NIWA 5.2001 DoC

A number of other species have been reported to be in the Lagoon, or are likely to be present. Riddell *et al.* (1988) suggests that exotic redfin perch (*Perca fluviatilis*) and native banded kokopu (*Galaxias fasciatus*) are present. Perch are present in similar habitats in Otago (G. Closs, University of Otago, pers. comm.) and may be present in Waituna, although there are no records of them being present in the Lagoon (Z. Moss, pers. comm.). Banded kokopu commonly live in estuarine settings associated with wetlands, and would also seem likely to be present (McDowall 2001). It would seem likely that giant bullies (*Gobiomorphus gobiodes*) are present, as they are widespread in similar habitats along the Southland coast. The area also represents potential habitat for the threatened shortjaw kokopu (*Galaxias postvectis*).

2.6.5 Discussion

The Waituna catchment contains a number of fish species that are valued as a sports fishery (brown trout) and for conservation values (giant kokopu, longfin eels). The frequent availability of passage to the sea, together with access to high quality wetland habitat in places, favours a number of native species which are in decline elsewhere (Minns 1990). The effects of changes in the catchment on fish populations have not been described. However the levels of ammonia present in the major inflows at times reach levels that are potentially toxic to fish, and would act as a disincentive to fish entering the Lagoon or the catchment streams. Other activities may also influence fish populations. Channel clearance is known to result in destruction of fish habitat and direct injury to fish (Ryder 1997, Goldsmith 2000). Loss of riparian wetland habitat and channelisation also tends to remove backwater areas favoured by giant kokopu (David 2002). Areas of riparian vegetation are also known to be used for spawning by inanga, and are thought to be important for the kokopu species. However the most immediate threat to fish populations in the Waituna catchment is likely to be the high levels of ammonia present in the streams. Weed growth, too, will have an effect on physico-chemical water quality parameters, especially nitrogen levels.

SECTION THREE

Review of existing information from the region

3.1 Introduction

Considerable previous work has been carried out in Southland investigating many of the same issues that are of significance in the Waituna catchment. A number of studies have assessed the likely effects of the expansion of dairying in the region (Robertson Ryder 1993; Williams 1993). Catchment-specific studies have been carried out at nearby Oteramika Creek (Hamill 1998; Ryder 1996b, 1997b) and the Mataura River (Ryder 1995, 1998). In addition, research on specific issues such as leaching from fields and land disposal of effluent is reported in the scientific literature. This section of the Catchment Management Plan reviews that information. Although there are unique aspects of the Waituna catchment, in terms of soil type, microclimate and other factors, the general patterns evident in these other studies are likely to also be true for Waituna.

3.2 Effects of land use on nutrient runoff

Poor water quality in the Waituna catchment (see Section 2) appears to be associated with historical and more recent pastoralisation and intensification of land use. The relative roles of different land uses in contributing nutrients to streams has been studied at a number of locations nationally (e.g. Cooke 1980; Wilcock 1986; Niyogi *et al.* unpublished) and regionally (Hamill 1998; Ryder 1998).

A regional overview of nutrient concentrations in streams with different land uses (Figure 3.1) shows that both nitrate and phosphorus are highest in pastoral and urban streams. The result for urban streams is for a single site, and cannot be considered representative of all urban streams.

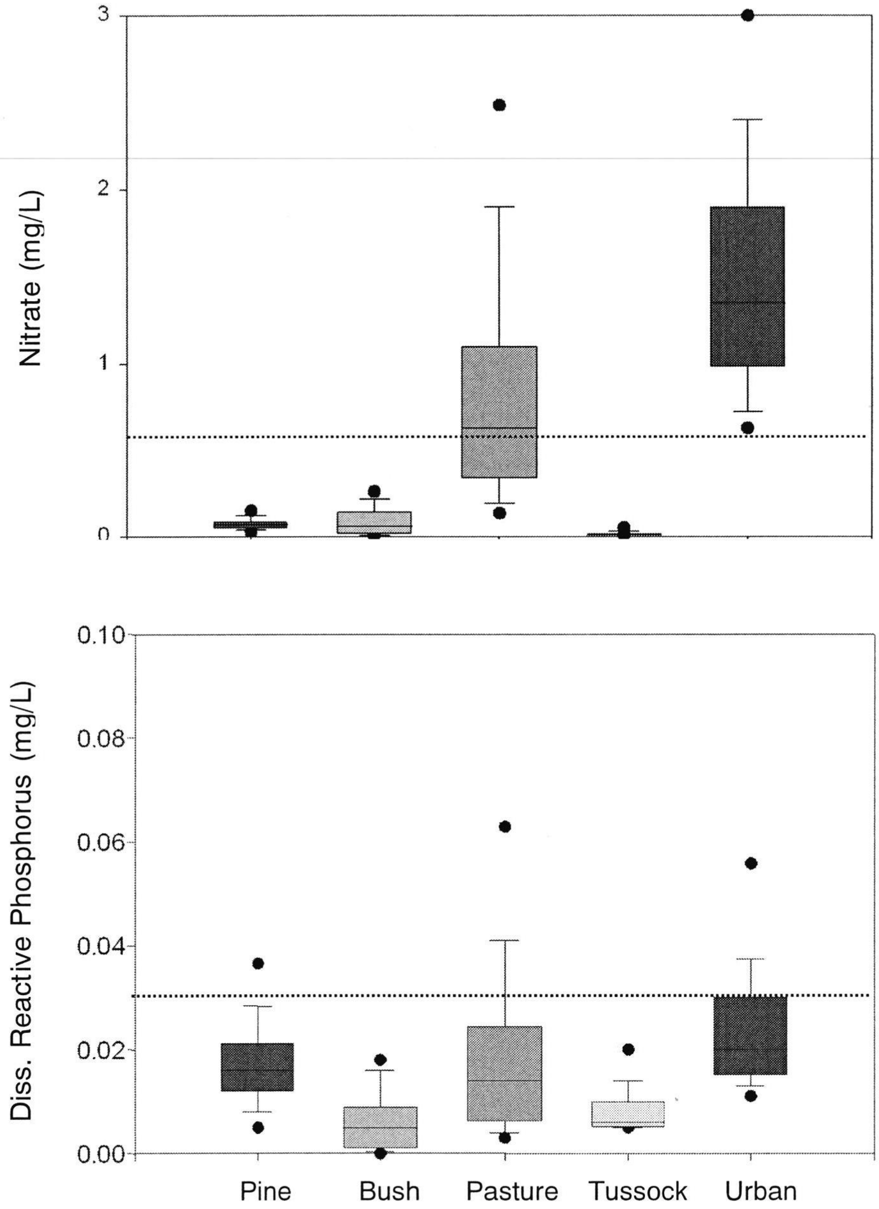


Figure 3.1 *Box and whisker plots of nitrate and dissolved reactive phosphorus in streams in different land uses in the Southland region 1993-2002 (Ryder Consulting 2002). Dotted lines indicate the relevant water quality guideline value. (Note: in these plots the central 'box' is the range over which 50% of values occur, with the 'whiskers' extending from each side indicating the total range with the exception of outliers (black dots). The line in the centre of the box is the median).*

Nutrient budgets produced for Southland (Robertson 1993) support the results of the regional overview of stream concentrations (Figure 3.2). Pasture streams and indigenous forest streams export the largest amounts of nitrogen, while pasture and tussock streams export the most phosphorus.

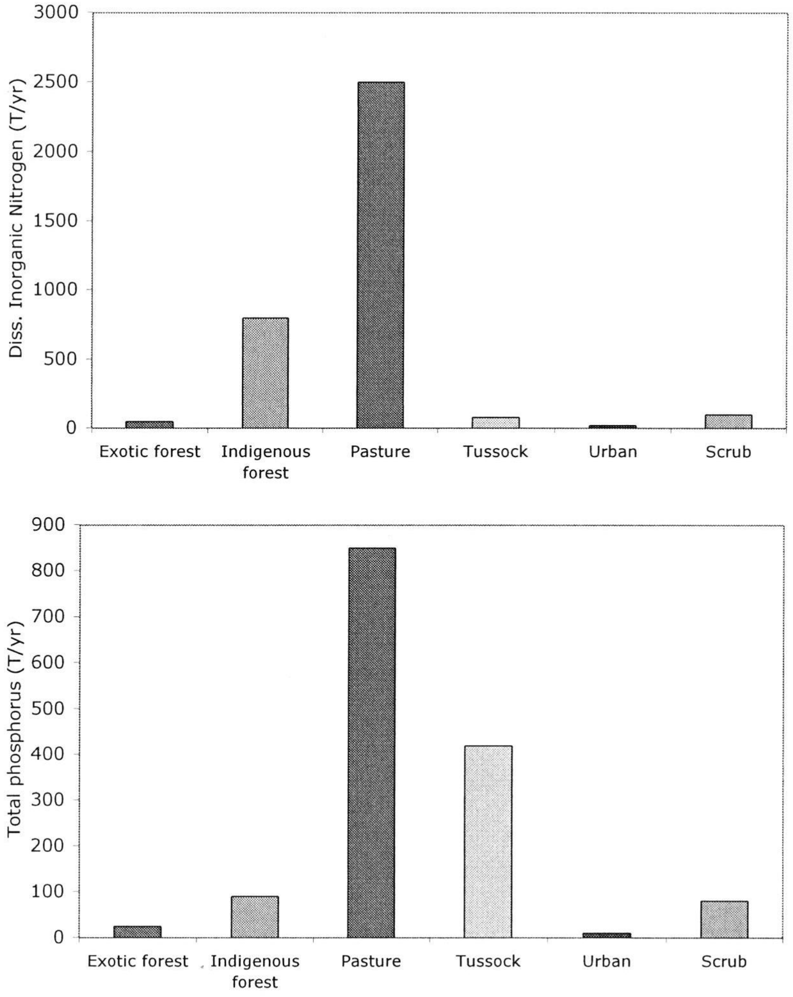


Figure 3.2 *Dissolved inorganic nitrogen and phosphorus exported from different land use classes across the Southland region (excluding Fiordland) in tonnes per year (Robertson 1993).*

A study of nitrate and phosphorus concentrations in different classes of pastoral streams in Otago (Niyogi *et al.* in prep.) revealed that levels of both nutrients were highest in streams on dairy and deer farms (Figure 3.3). However the highest values from intensively grazed sheep farms were equivalent to those from dairy or deer farms.

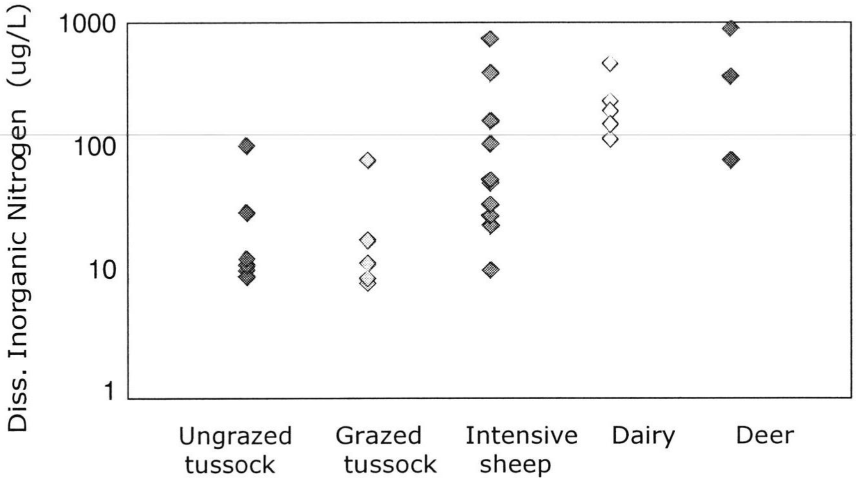


Figure 3.3 *Dissolved inorganic nitrogen levels (in micrograms/L) in streams flowing through different land uses in Otago. Each diamond indicates a site. (From Niyogi et al. in prep.).*

Similar patterns have been observed in Southland, with large increases in both phosphorus and nitrogen observed in the Mataura River associated with increasing intensity of farming along the margins, and inflows from developed catchments (Ryder 1995). Ryder (1995) also observed a strong association between elevated phosphorus and nitrogen and the presence of dairy farming. For the overall Mataura catchment Ryder (1995) estimated that pasture land use contributed 95% of the dissolved inorganic nitrogen and 78% of the dissolved reactive phosphorus loads to the river.

The majority of nitrogen in streams in Southland has been shown to be from leaching of nutrients rather than overland flow (Robertson Ryder 1993, Williams 1993) (Table 3.1).

Table 3.1 *Annual nutrient losses from different farm types via leaching, and as surface run-off (from Williams 1993).*

Farming system	**Leaching (kg N/ha)**	**Surface run-off (kg N/ha)**	**Surface run-off (kg P/ha)**
Dairy	80	7	3
Intensive sheep	15	6	4
Sheep and beef	35	6	4
Cropping	30	3	2
Sheep and diary heifers	35	7	4
Deer farm	20	7	3

A comparison of leaching rates between different farming types using a nitrogen loss model (Thorrold *et al.* 1997) found that rates of loss were greatest from forage crops (Figure 3.4). Land disposal of effluent was approximately equivalent to intensive dairy farming, with loss rates declining as intensity of dairy farming decreased. Mixed farming of cattle and sheep produced values intermediate between high intensity dairy farming and high intensity sheep farming. Conversion of sheep farms to dairy farms was estimated by Robertson Ryder (1993) to increase nitrogen loss by 300%, while the Thorrold *et al.* (1997) model suggests that the increase may be by as much as 800%.

Phosphorus losses from the different land use types as surface run-off were broadly comparable with cropping being the lowest (Table 3.1) (Thorrold *et al.* 1997).

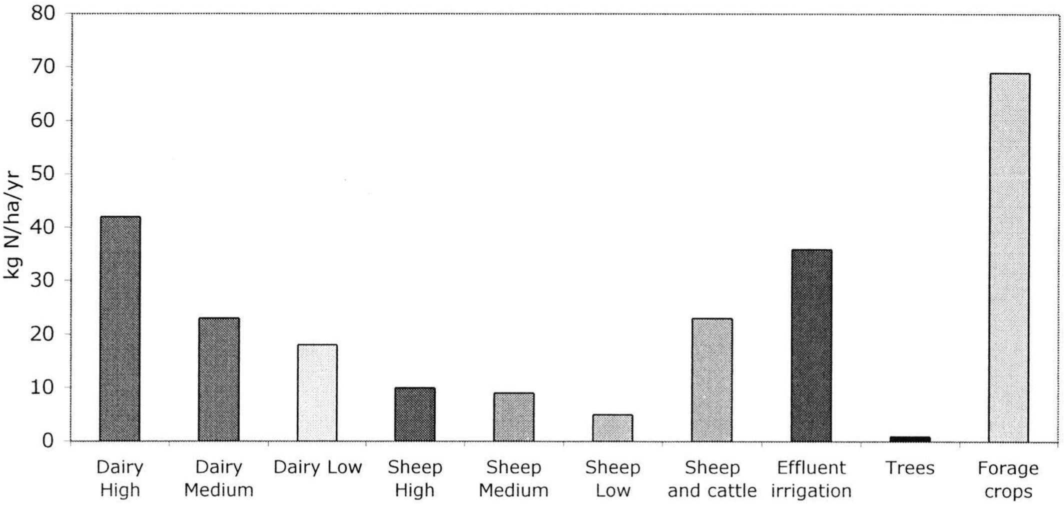


Figure 3.4 *Nitrogen losses as leachate from different land use types derived from a model for the Oteramika catchment (adapted from Thorrold et al. 1997).*

Williams (1993) made a comparison between nutrient loss rates from different dairy systems (Table 3.2). Loss rates via leaching were highest from wintering stock, with higher rates of surface run-off in systems using feed pads.

Table 3.2 *Annual nutrient losses from different farm types (from Williams 1993).*

Dairy system	Leaching (kg N/ha)	Surface run-off (kg N/ha)	Surface run-off (kg P/ha)
Milking platform	73-80	7-8	3
Wintering without feedpad	95	4	4
Wintering with feedpad	91	8	3
Town supply	93	6	3

3.3 Effects of land use on ammonia concentrations

Ammonia is a significant issue in the Waituna catchment. A regional overview of ammonia levels in streams shows higher values in pastoral and urban streams (although as before, only a single urban stream was surveyed) (Figure 3.5). Most streams in the Waituna catchment exceed water quality guideline values on a regular basis, with the exception of the Currans Creek tributary, which seldom exceeds the guideline. Waituna Creek shows some very high levels and Currans Creek exceeds the guidelines on the majority of occasions. Ammonia is produced as an animal waste product, and levels have been shown to increase in association with intensification of land use (Ryder 1998).

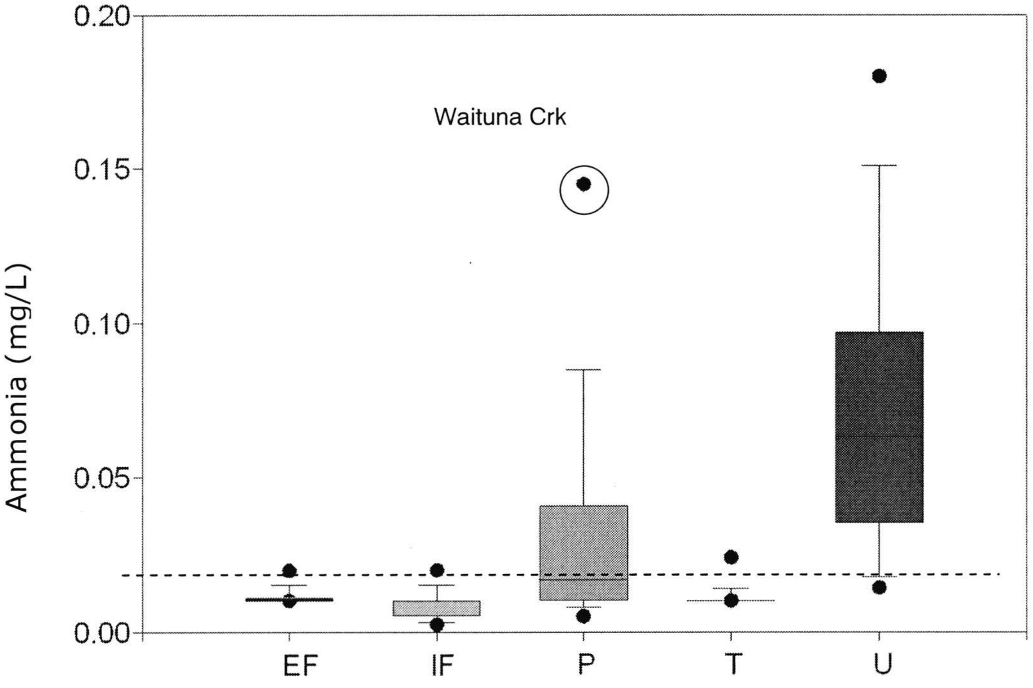


Figure 3.5 *Box and whisker plot of ammonia in streams in different land uses in the Southland region 1993-2002 (Ryder Consulting 2002). Values from Waituna Creek are indicated. EF = pine, IF = bush, P = pasture, T = tussock, U = urban.*

3.4 Effects of land use on sediment yields

Studies of sediment yields from different land uses in Southland have suggested that rates of export from pasture land are more than five times higher than those from tussock land, the next highest exporting land use (Table 3.3) (Ryder 1995). A more detailed study of fine sediment deposition on the bed of streams (Niyogi *et al.*, in prep) found that dairy and deer streams tended to have larger amounts of fine sediment on the bed, but that there was considerable variation (Figure 3.6).

Table 3.3 *Daily loadings of suspended solids from different land uses in the Mataura catchment (adapted from Ryder 1995).*

Land use	Daily loading (kg)
Scrub	214000
Exotic forest	35000
Indigenous forest	714000
Tussock	1643000
Pasture	9857000
Other	2510

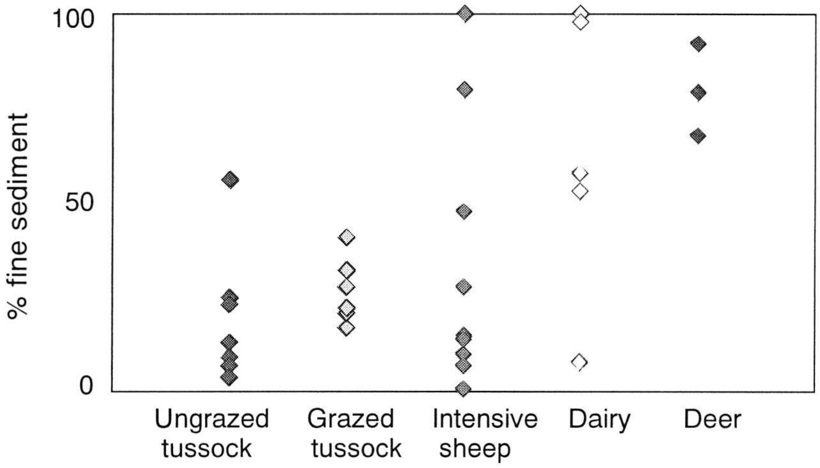


Figure 3.6 *Fine sediment on the bed of streams in five land use classes in Otago (Niyogi et al. in prep).*

3.5 Effects of land use on faecal contamination

Faecal contamination occurs where animal faeces enter waterways directly, or where faecal bacteria are able to enter waterways. Peaks of faecal coliforms in the upper Mataura River have been associated with direct stock access to waterways (Ryder 1995). Ryder (1998) observed increases in faecal contamination in the lower Mataura River that could not readily be associated with any factor other than intensive grazing along the river margins. Ryder (1998) also found that water in tile drains could provide a significant source of faecal contamination to waterways. A regional overview showed that the highest faecal coliform values were associated with pasture, with the highest values within that class associated with dairy farming (and a single urban stream) (Figure 3.7). Studies have suggest that there is an approximate 25% increase in faecal coliforms with sheep to dairy conversions (Robertson Ryder 1993)

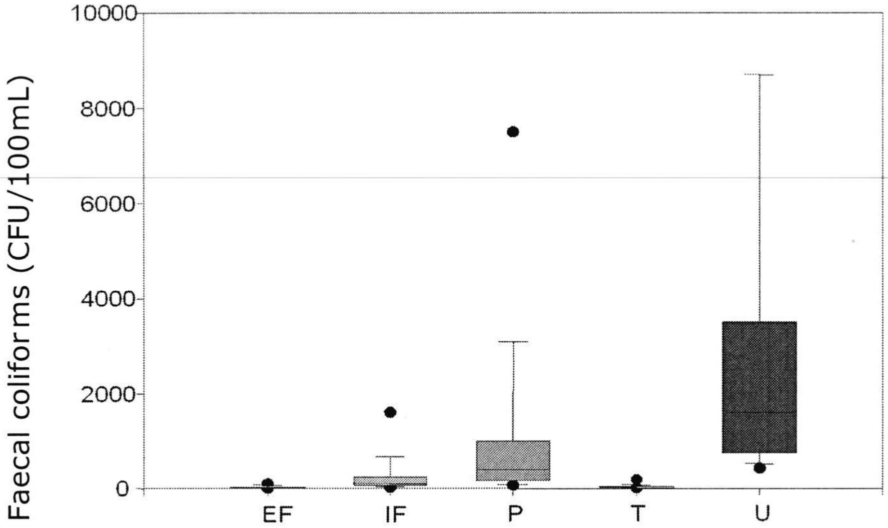


Figure 3.7 *Levels of faecal coliforms in streams within different land use classes in Southland 1998-2002 (from Ryder Consulting 2002). EF = pine, IF = bush, P = pasture, T = tussock, U = urban.*

3.6 Effects of land use on stream biota

Plants and animals which live in streams are also affected by land use effects (see Section 2). A regional overview of streams in Southland showed that streams in pasture had lower scores for the Macroinvertebrate Community Index (MCI) than streams in other land uses (Figure 3.8).

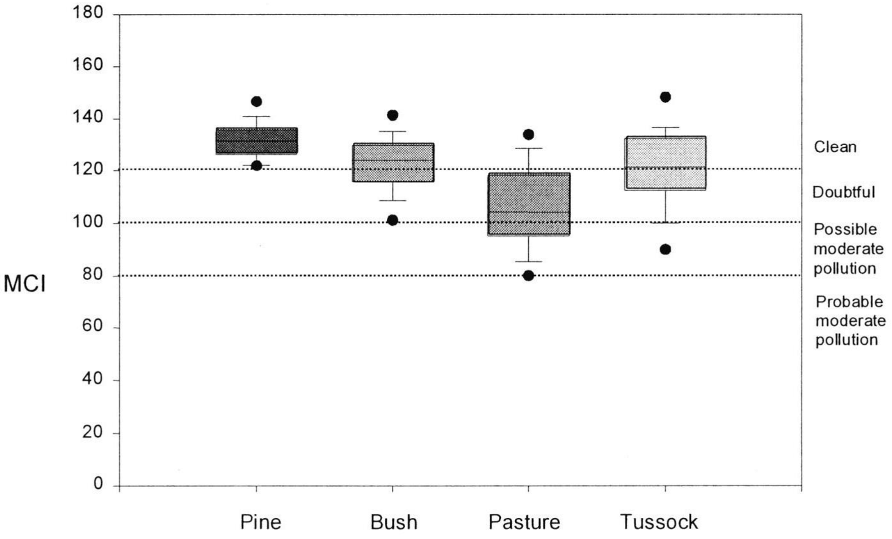


Figure 3.8 *Scores for the Macroinvertebrate Community Index (MCI) in streams within different land use classes in Southland 1998-2002 (from Ryder Consulting 2002). Dotted lines indicate habitat quality classes as defined by Stark (1985).*

A more detailed study in Otago (Niyogi *et al.* In prep.) showed that MCI scores were lowest in intensively managed farms (deer, dairy and sheep) (Figure 3.9), but also that high scoring streams could occur in those farms when riparian fencing was present (D. Niyogi, University of Tennessee, pers. com.).

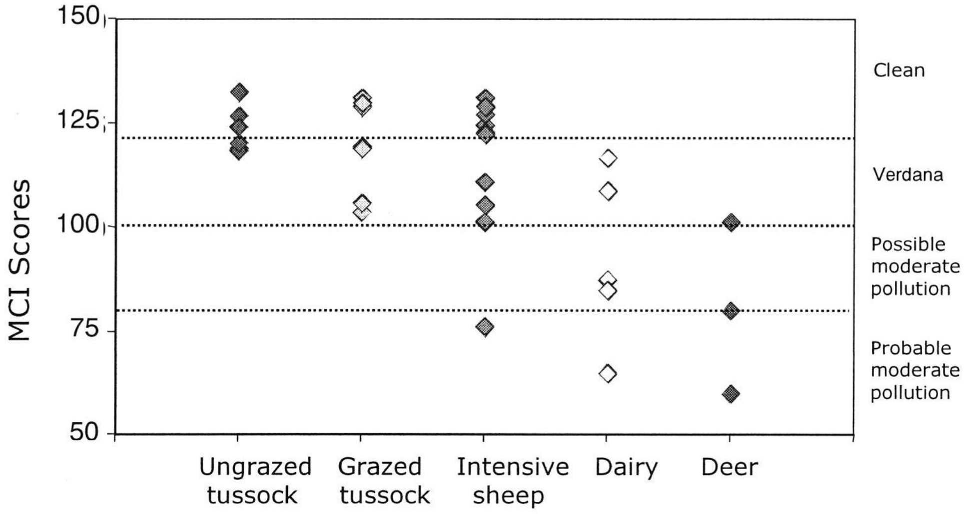


Figure 3.9 *Scores for the Macroinvertebrate Community Index (MCI) in streams within different land use classes in Otago (Niyogi et al. In prep.). Dotted lines indicate habitat quality classes as defined by Stark (1985).*

3.7 Effluent disposal

Disposal of effluent from dairying is a significant regional issue in Southland. Discharges of effluent are significant both in terms of the threat that they can pose to the aquatic environment, and the loss of nitrogen that they represent to the farmer. Concentrated effluent entering waterways causes nutrient and faecal contamination. The high biochemical oxygen demand of effluent can result in deoxygenation of waterways with consequent loss of stream biota.

Discharge of effluent to land rather than waterways increases nitrogen retention by 16% (Robertson Ryder 1993), and significantly reduces nitrogen loss as surface run-off (Table 3.4). Phosphorus retention is improved by 22% with the use of land disposal (Robertson Ryder 1993), and surface run-off is greatly reduced (Table 3.4).

Table 3.4 *Annual nutrient losses from different disposal systems types (from Williams 1993).*

Disposal system	Surface run-off (kg N/ha)	Surface run-off (kg P/ha)
To water	40	7
Spray to pasture	7	3
Injected to pasture	6	3
2 pond then spray	6	3
2 pond then to water	11	4
2 pond then wetland	6	3
2 pond then forest	6	3
2 pond then subsurface drain	6	3

Land disposal of effluent is an effective disposal technique providing that guidelines for application are followed (Southland Regional Council 1998). In Southland these currently limit application rates to 7mm/hr with a return period of 28 days. Total loadings are limited to 150kg N/ha/yr. Problems with land disposal can occur when soils are saturated, where tile drains are present or where incorrect application rates result in effluent pooling on soils. In those situations effluent can flow through soils into waterways (Mongahan *et al.* 2001). All dairy farms in the area currently dispose of effluent to land.

3.8 Fertiliser application

Nitrogen and phosphorus based fertilisers are applied to pasture lands in order to boost productivity. In a survey of farms in the Oteramika catchment practises were found to vary widely (Robertson Ryder 1993). Sheep farmers tended to apply superphosphate at a rate of approximately 300kg/hectare. Dairy, deer and cropping units used fertilisers with a nitrogen and phosphate component, and application rates between 200 and 500 kg/hectare. Urea was used by some farmers as required.

Application of fertilisers can impact water quality if the fertiliser directly enters streams or if the soil is unable to absorb the fertiliser and it enters tile drains or surface flow. Accidental application of fertilisers to waterways does occur, but can be considered a relatively minor issue. Application of fertiliser to soils which are saturated or which are too cold to allow high rates of pasture growth, can result in high levels of the fertilised nutrient in drainage water. However research in Southland has shown that fertiliser is probably not a major contributor to surface water contamination (Monaghan *et al.* 2000).

3.9 Drain management

Pastoralisation of much of Southland has involved the development of an extensive network of drains and modification of natural watercourses to improve drainage. In order to maintain their hydraulic capacity, most drains are subjected to modification (deepening, straightening) and clearance of vegetation.

Clearance of macrophytes from drains is carried out at intervals ranging from annual to triennial. In Southland, this process is most commonly carried out using a digger to scrape macrophytes (and often substrate) from the channel. This is deposited on the stream bank where it is either left or transported elsewhere for disposal. Chemical clearance of weeds is also undertaken in some areas, most often by application of a herbicide such as Roundup© or Reglone©.

A study in the Oteramika catchment (Ryder 1997) observed dead fish amongst channel-clearance spoils, and measured a decline in some invertebrate species in the stream channels. However invertebrate communities as a whole were found to be relatively resilient to the effects of channel clearance. Healthy and abundant invertebrate communities were found in Waituna Creek eight months after an extensive channel clearance operation (Thompson 2002). Other studies have shown dramatic (but short term) effects on invertebrate communities (Wilcock *et al.* 1998).

Goldsmith (2000) studied the effects of mechanical and chemical channel clearance on fish populations in five Southland waterways. She found that while weed biomass was decreased, there were no obvious changes in fish species richness or density and no significant changes in channel characteristics. Fish and invertebrate communities that are present in channels that are frequently cleaned are resilient to this sort of activity.

While effects on stream biota have not been clearly shown, channel clearance affects water chemistry (Madsen 2000). Sediments and plants acts as nutrient traps in streams, and these nutrients are likely to be released during channel clearance. Destabilisation of sediments and associated increased turbidity are also likely to have a significant influence on downstream systems.

Management of bank side vegetation is intrinsically linked to management of macrophytes in the stream channel. Terrestrial vegetation along streams can intercept sediment and nutrients flowing into the channel in overland flow, and act to stabilise banks. Shading provided by terrestrial vegetation can also be an important limitation on macrophyte growth in stream channels. However maintaining vegetation along stream banks can result in problems with weed management and accessing the drains for clearance. Grazing of banks is often used to suppress weeds, but brings with it problems of stock access to waterways increasing nutrient, ammonia and faecal coliform loadings. Hicks (1995) recommends the use of temporary fencing to only allow stock access to banks at some times and in some areas. In the Waikato, complete exclusion of stock reduced the need for channel clearance from once every 2-3 years to once every 10-20 years (Hudson and Harding 2002).

Riparian plantings can also be an effective component of drain management. Plantings on the northern sides of waterways shade the channel and reduce in-stream temperatures and macrophyte growth, while allowing access to the channel from the southern bank.

Hudson and Harding (2002) reviewed drain management practices in New Zealand and identified significant knowledge gaps. In particular, there is no evidence that the presence of macrophytes reduces hydraulic capacity of drains at high flows. Hudson and Harding (2002) speculate that the pushing down of long macrophytes on to the substrate during high flows may act to 'streamline' the bed and increase flows, improving drainage. The loss of gravels during drain clearing procedures may, however, have a detrimental effect on trout spawning areas.

SECTION FOUR

Key land management issues in the catchment

4.1 Introduction

Desire for the development of this catchment management plan was largely driven by concerns over the ways in which catchment management is affecting the health of Waituna Lagoon and its associated wetlands. The catchment-related issues that most directly affect the health of the Lagoon are as follows:

1. Nutrient inputs. Large amounts of nutrients entering the Lagoon could potentially result in algal blooms which permanently alter the lake from its natural 'clear water' state.

2. Sediment inputs. Sediment entering the Lagoon makes the lake turbid and unsightly, and may be altering habitat by smothering sections of the Lagoon bed.

3. Faecal contamination. High loadings of faecal coliforms to the Lagoon make it unsuitable for swimming and other types of recreation activities, such as fishing, on occasions.

4. Ammonia levels. High levels of ammonia entering the Lagoon are likely to repel fish attempting to enter the Lagoon from the sea or trying to move up tributaries to spawn. In places levels may approach those that are toxic to fish.

The other major issue with regard to management of the Lagoon is the practice of artificially opening the Lagoon to the sea to aid in land drainage. This practice is discussed elsewhere (Thompson and Ryder 2002) and will not be dealt with here.

The following section details major land management practises which are likely to have effects, identifies consequences for aquatic systems, then offers recommendations on future practice to reduce environmental impacts.

4.2 Land use intensification

4.2.1 Introduction

Land use intensification is ongoing in the Waituna catchment, as evidenced by drainage of wetlands, installation of tile drains, conversion of farms to dairying and increasing stock rates.

4.2.2 Consequences for aquatic systems

Results of nutrient, faecal coliform and ammonia monitoring strongly suggest that poor water quality in Waituna Creek is a result of historical and present day farming practises. Declining water quality in Moffatt Creek and Currans Creek appear to be due to ongoing land use change in those sub-catchments. In general, the effects of land use intensification are likely to be due to increased stocking rates and changes in the nature of the stock present.

4.2.3 Recommendations

It is not considered feasible to recommend a halt to land use intensification, although this would be the ideal situation. However the development of farms presents opportunities to put in place practices that reduce the potential impacts of land use intensification.

Recommendation: *That farms converting to dairying carry out farm mapping exercises with the aim of locating some structures (e.g., feed pads, dairy sheds, silage pits, lanes) away from areas where they may be problematic, such as where tile drains discharge directly to streams. Lanes should be contoured to avoid drainage into waterways.*

Recommendation: *That Environment Southland staff work closely with land owners developing new dairy units to provide them with information on all aspects of land management in order to reduce environmental impacts.*

Recommendation: *That the remaining wetlands in the catchment be protected for the purposes of water quality treatment.*

Recommendation*:* *That Environmenal Farm Plans (i.e. Outline of nutrient application; soil health; protection of gully systems;indentifcation of likely hot-spots such as silage pitsd; and identification of wood lots)be promoted as a requirement of farm mangement.*

4.3 Effluent disposal

4.3.1 Introduction

Increasing disposal of effluent to land is a product of increasing intensification of land use in the Waituna catchment. Land disposal of effluent for dairy herds of less than 600 individuals is currently a permitted activity in Southland, subject to the restrictions outlined in the Regional Effluent Land Application Plan (Southland Regional Council 1998).

4.3.2 Consequences for aquatic systems

Application of effluent to soils that lack the capacity to absorb it or in a way that encourages pooling can result in flow through of effluent (nutrients, faecal coliforms and ammonia) into waterways.

4.3.3 Recommendations

Recommendation: *That Environment Southland continue to strictly enforce restrictions on land disposal of effluent in the Waituna catchment and increase the area of land used for application. Available topoclimate data should be used to make best use of land for effluent disposal.*

Recommendation: *That effluent should not be applied within 50m of any major waterway in the Waituna catchment.*

Recommendation: *That storage of effluent be appraised by Environment Southland as an option to reduce effluent loadings on wet soils in the Waituna catchment.*

Recommendation: *That during application of effluent on adjacent lands, the conductivity of tile drain outflows be measured to ensure that flow through to waterways is not occurring. Where problem areas are identified these should be avoided for future land disposal of effluent.*

Recommendation: *That effluent application ove tile drains be studied.*

4.4 Faecal contamination

4.4.1 Introduction

Faecal contamination of Waituna Lagoon and its major inflows is evident and strongly indicates that livestock are gaining direct access to waterways, or that effluent is entering waterways.

4.4.2 Consequences for aquatic systems

The presence of faecal coliforms in waterways poses a human health risk for primary contact (e.g. swimming) or secondary contact (e.g. fishing, boating). Levels in the Waituna catchment commonly exceed levels recommended for primary and secondary contact and often exceed levels that are considered suitable for stock water.

4.4.3 Recommendations

Recommendation: *That landowners act to ensure that livestock do not gain direct access to waterway (see section on riparian zones below). Stock water reticulation should be encouraged.*

Recommendation: *That Environment Southland ensure that high faecal coliform readings are followed up immediately and rigorously to identify the source.*

Recommendation: *That Environment Southland institute a study to measure the role of tile drains in conveying faecal coliforms to waterways.*

Recommendation: *That Environment Southland actively publicise faecal coliform levels in local waterways as a means of informing local landowners and stakeholders as to the degree of ongoing contamination.*

4.5 Riparian zones and drain management

4.5.1 Introduction

Riparian zones act as important filters for both overland flow of contaminants and some sub-surface flow. The management of these zones is intrinsically linked to the management of drains and the two issues are dealt with together here.

4.5.2 Consequences for aquatic systems

Riparian zones reduce contaminant loadings to waterways, moderate stream temperatures and reduce macrophyte growth in the channel. In addition, native species provide habitat for adult stages of aquatic insects and litter for aquatic invertebrates.

4.5.3 Recommendations

Recommendation: *That Environment Southland look with urgency at reinstating a financial assistance program for riparian fencing within the Waituna catchment.*

Recommendation: *That during farm redevelopments, where possible, fences should be sited to protect intact riparian vegetation.*

Recommendation: *The riparian plantings should be planned for in order to reduce the costs of drain clearance. These plantings should be of appropriate species including native species as recommended by Hudson and Harding (2002). Plantings should be placed on the northern side of waterways where possible and should be fenced to protect them from stock.*

Recommendation: *That during planting of winter forage crops a strip of 5-10m be left in pasture along stream margins. During grazing of the forage crop electric fences can be used to protect the buffer strip.*

Recommendation: *That Environment Southland fund a study on the effects of macrophytes on hydraulic capacity of channels.*

Recommendation: *That where permanent buffer strips are not feasible, electric fences are used to limit stock access to riparian margins.*

4.6 Tile drainage

4.6.1 Introduction

Tile drains are a widespread feature of the Waituna catchment. The location of drains is often poorly known and this can contribute to the passage of effluent into streams from land disposal or other activities.

4.6.2 Consequences for aquatic systems

Tile drains convey nutrients, faecal coliforms and ammonia into waterways with the consequences outlined above.

4.6.3 Recommendations

Recommendation: *That all new tile drains are mapped and that high intensity activities (dairy sheds, land disposal, silage pits) are sited to reduce chances of waste being transmitted into waterways.*

Recommendation: *That landowners attempt to map existing drains in order to site high intensity activities (dairy sheds, land disposal, silage pits) away from areas that may transmit wastes directly to water.*

Recommendation: *That a catchment wide survey of water quality (particularly conductivity) be used to identify problematic drains and that the source of the contamination to those drains be identified.*

Conclusions

Waituna catchment is not unique in the issues it faces with regard to land use practices and the effects that these have on water quality. However, the catchment is unique in that it drains into a wetland and lagoon complex of international, national, regional and cultural significance. Waituna Lagoon and the surrounding areas are a source of pride for many people in Southland, and their presence in the Waituna catchment gives landowners an added responsibility to act in a way that does not endanger those areas.

Intensification of land use and land management practises that contribute contaminants to the environment are a reality, and it is not useful to condemn those activities out of hand. However, it is important to manage those activities in a responsible way so that the best possible environmental outcome is achieved. If permanent riparian strips are not economically feasible on some farms, then temporary strips using temporary fencing will still provide some protection, which cumulatively across the catchment will improve environmental quality.

Currently, the state of water quality in the Waituna catchment (particularly concentrations of ammonia) is disproportionately poor in relation to the degree of development in the catchment. This suggests that best management practices are not being used as effectively as they are elsewhere in Southland. **The challenge for all landowners in the catchment, regardless of farm type, is to aim to manage all aspects of their activities in order to minimise environmental damage. Collectively this will result in improvement in water quality and will better protect the Lagoon from ongoing change.**

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