Long-term nutrient and vegetation changes in a retired pasture stream

Frontispiece. Top—Whangamata Stream immediately below Whangamata Road bridge in 1974, before stream retirement in 1976. Photo courtesy of Environment Waikato.

Bottom—The same view in 1998.

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Monitoring programme and vegetation survey 1999–2003, updating data from 1976

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Cover: Lower reaches of the Whangamata Stream in March 2003, when the stream was flowing at a rate of approximately 40 litres per second. Sedges and toe-toe are colonising old pasture vegetation on the stream banks. Watercress and musk in the stream channel are already overgrown by native sedges on the left-hand side of the picture.

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Monitoring programme and vegetation survey 1999–2003, updating data from 1976

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ABSTRACT

This report is part of an on-going long-term study on the Whangamata Stream, north of Lake Taupo, New Zealand, since the stream margins were protected from pastoral farming by the establishment of riparian strips in 1976. The dataset is unique in New Zealand for its continuity and allows a quantitative assessment of the extent and time scales of change in stream restoration programmes. The five years covered here include data from the 2- to 3-monthly samples of flow rate and water quality at two stream sites, a continuation of the photographic record, and a vegetation survey of the stream margins. The biodiversity of the vegetation in the riparian strips continued to increase at a rate of 3% per year. Vascular plants totalled 172 species, of which 70 were indigenous. There was a 2% turnover in species every year and a continuing increase in the proportion of woody species as the vegetation matured. Stream discharge decreased from 0.15 m^3/s to 0.03 m^3/s, the lowest since 1995. There was a trend for the discharge at the bottom end of the stream to be lower than at the top, which needs further investigation as it implied water loss between the upstream and downstream sampling sites. Both concentration and mass flow of suspended solids declined in the monitoring period, with lowest values recorded in summer at the time of maximum vegetation growth. Marked differences in nutrient concentrations between the top and bottom sampling sites in mid-summer reappeared, and proportionately more nutrient was stripped from the through-flowing water. Intensification of catchment use from pasture to forestry and recent extensive urban development indicate that further changes to this highly valued stream are inevitable.

Keywords: riparian strips; nitrogen discharge; phosphorus discharge; wetland restoration; stream rehabilitation, plant biodiversity, Lake Taupo, New Zealand.

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1. Introduction

This study provides a continuation of the long-term study (Howard-Williams & Pickmere 1994, 1999a) of Whangamata Stream, in the northern part of Lake Taupo catchment (central North Island, New Zealand), entering Lake Taupo near Kinloch. This stream was retired from use in pastoral agriculture in 1976 by the establishment of riparian strips along the stream margins. Although the primary aim of this stream protection was originally to minimise the impacts of soil erosion (Waikato Valley Authority 1966), reduction of the effects of nutrient runoff from farmland was also seen as an important objective. The emphasis on nutrients has grown over the years owing to increasing nutrient loads reaching Lake Taupo (Ministry for the Environment 2002). Over recent years the land use in the Whangamata Stream catchment has changed markedly from purely pastoral agriculture to forestry and life-style block development and, more recently, urban development.

Following the riparian fencing in 1976 (Frontispiece), the process of rehabilitation of the stream margins was assisted by some plantings of native species, including stream-bank wetland species (flax, toetoe) on the pasture-grassed banks. However, in areas where there were no assisted plantings, the protected old pasture proved very resistant to invasion by native species, and in 1998, extensive areas of rank grass (cf. the original pasture species) were still intact within sections of the riparian strip. Where assisted planting had occurred and along the stream banks, a dense wetland vegetation had established. In 1998 there were 148 vascular plant species, of which 41% were native (Howard-Williams & Pickmere 1999).

1.1 BACKGROUND

Over 27 years of protection up to 2003, the ability of the stream-bank vegetation to remove nutrients has changed considerably, with a period of high nutrient removal from 1979–87 and one of reducing nutrient removal to 1994. By 1997, nutrient removal was negligible. Suspended sediment loads have reduced significantly over time and since retirement. There have been significant improvements to wildlife, trout spawning and biodiversity values (Howard-Williams & Pickmere 1999).

The last significant report on the stream-monitoring programme was to the Department of Conservation and to Environment Waikato in 1998. This resulted in the publication of a Department of Conservation monograph (Howard-Williams & Pickmere 1999) and a public lecture in Taupo (Howard-Williams 1999). Since then there has been a series of three unpublished annual reports on the programme. This publication reports on the monitoring programme up to June 2003 and summarises the data from 1999 to June 2003.

1.2 AIMS

The aims of this project for the period 1999–2003 were to:

- carry out flow gaugings and conduct water quality sampling at two sites on the stream on a series of sampling occasions each year;
- sample the tributary spring waters at least once each year;
- photograph the stream from standard sites and other sites of interest;
- analyse the water samples for: total suspended solids, nitrate -N, ammonium -N, dissolved organic nitrogen, dissolved reactive phosphorus, and dissolved organic phosphorus;
- update the stream water quality archive database;
- carry out a vegetation survey of the stream margins in 2003 (five years after the previous survey), compile a species list and analyse vegetation changes;
- produce interim annual reports and a final report in 2003.

2. Methods

2.1 SITE DESCRIPTION

The stream study section is a 2.0 km-long second-order, spring-fed stream, flowing into Whangamata Bay, Lake Taupo (Fig. 1). Two springs, Right Hand Spring and Left Hand Spring, provide the source of water. The stream has been described in detail in several previous publications referenced in Howard-Williams & Pickmere (1999).

2.2 SAMPLING

Two sampling sites, Top Site (Fig. 2), and Bottom Site, are shown on Fig. 1. Occasional sampling was undertaken just below Right Hand Spring and in the tributary from Left Hand Spring just above Top Site. While the water quality of Right Hand Spring is likely to reflect spring water itself, the tributary from Left Hand Spring is over 1 km in length, so water quality is likely to have been modified during downstream passage from the spring to the sampling site.

Stream flows were estimated from average velocities (10 readings) measured at 0.3 times water depth at 10 cm intervals across the channel. Discharge was calculated as velocity multiplied by area for each 10 cm segment and then added across the stream.

Duplicate water samples were collected at each site at approximately quarterly intervals from June 1998 to June 2003. Analyses for dissolved nutrients were carried out with a Technicon II autoanalyser system using the methods detailed in Downes (1998). Only two nutrient compounds are discussed in detail in this report, nitrate-nitrogen (NO_3-N) and dissolved reactive phosphorus (DRP). Ammonium-nitrogen (NH_4-N), dissolved organic nitrogen (DON), and dissolved organic phosphorus (DOP) were in low concentrations and did not make significant contributions to the dissolved nitrogen and phosphorus budgets (see Appendix 1 for data). Total dissolved nitrogen (TDN = NO_3-N + NH_4-N + DON) and total dissolved phosphorus (TDP = DRP + DOP) values are presented in Table 1.

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