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Research article

Physical and ecological effects of rehabilitating the geothermally influenced Waikite Wetland, New Zealand

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ABSTRACT

Pressure to optimise land use and to maximise the economic viability of land has had a detrimental impact on wetlands worldwide. Rehabilitating wetlands has been identified by resource managers as increasingly important to enhance environmental values and restore ecosystem functions that may have been lost through developments effecting wetlands. This paper investigates rehabilitating a geothermally influenced wetland that had been drained and used for grazing stock.

The Waikite Wetland (New Zealand) is a relatively unique wetland because the primary water source to the wetland has a significant geothermal water component. This results in the area hosting populations of rare flora and fauna that are significant to New Zealand. A range of management actions that included diverting a geothermal stream back into the wetland, blocking drains, pest control, weed control, native plantings, fencing and building a weir to increase water levels were used to rehabilitate the wetland. This was done to promote thermotolerant vegetation growth, restore wetland water levels and minimise pest plant species re-establishing while minimising the effects on geothermal surface features and allowing indigenous wetland vegetation to re-establish.

Physical, chemical and vegetation monitoring show that management actions have increased thermotolerant vegetation growth in the wetland while having a small potential impact on geothermal discharges into the wetland. Increasing the water level in the wetland appears to be helping control plant pest species close to the weir, but has also made sensitive vegetation growing close to the waterways more susceptible to flooding caused by high-intensity rainfall events.

1. Introduction

1.1. General

The importance of wetlands to ecosystem values and the hydrological cycle is well documented. Functions of wetlands may include nutrient removal from water, sediment retention, floodwater retention, and to sustain biodiversity values (e.g. Naiman and Décamps, 1997; Bachand and Horne, 1999; Martinez-Martinez et al., 2014; Liu and Yang, 2002) depending on the type of wetland, soil characteristics, hydrological conditions and biological activity. The importance of wetlands to the global environment is also recognised through their potential contributions to greenhouse warming as a sink for carbon dioxide (positive contribution) or as an emitter of methane (negative contribution) depending on wetland conditions (Gorham, 1991; Laine et al., 1996).

Pressure to optimise land use and to maximise the economic viability of land has had a detrimental impact on the area and the functionality of wetlands worldwide. For example, Song et al. (2012) report a reduction of 64% in wetland area between 1954 and 2005 in the Muleng-Xingkai Plain, China; Davidson (2014) estimates that the worldwide area of wetland has reduced by 54–57% since 1900, with a possible 87% loss in wetland area since 1700. Ausseil et al. (2007) estimate the extent of wetland in New Zealand has reduced by 90% since 1840. This has, in part, led to increases in rehabilitating natural wetlands, and, developing artificial wetlands as part of watershed management policies and plans worldwide (Peimer et al., 2017).

Much work has focussed on wetland processes in fresh water and saline water wetland environments. Wetlands with geothermal inputs provide unique environments where the primary water source to the wetland has a significant geothermal component. Wetlands that receive geothermal fluids have been documented to contain elevated

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concentrations of heavy metals (e.g. Arsenic) (Chagué-Goff et al., 1999) that can restrict vegetation types, but also provide heat enabling frost-sensitive species to survive (e.g. Given, 1980). Although geothermal wetlands are well documented around the world (e.g. Elmarsdóttir et al., 2015; Channing et al., 2004), development of these types of wetlands are rare because of the inherent dangers of developing on/close to geothermal activity, or, because environmental values for the ecosystem are more important than the benefits of development.

This study investigates the physical, chemical and vegetative responses of rehabilitating a geothermally influenced wetland that had been developed for grazing cows. The aims of the study are to:

- promote thermotolerant vegetation growth, that are unique to these areas
- reduce and minimise plant pest species impacts on indigenous vegetation re-establishment
- minimise effects on geothermal surface features from the rehabilitation

1.2. Study area

The study area (Fig. 1) focuses on a nine-hectare plot of land that has undergone major hydrological changes in the last 80 years due to development of the land for grazing. The area is located in the Waikite Valley, approximately 20 km south of Rotorua, New Zealand (Fig. 1) and lies within the Waikite Geothermal Field. The geothermal field is characterised by surface thermal features that include hot springs, hot lakes, fumaroles, sinter deposits and streams, which range in temperature from 7.7 °C to 98.4 °C (Glover et al., 1992). The geothermal features are aligned roughly northeast-southwest along the Paeroa Fault Scarp (Fig. 1) over about six kilometres. Water chemistry of the geothermal fluids are generally considered to be alkaline (pH between 2.75 and 8.9, but with most features having a pH > 7.2) with high HCO_3, which are typically found on the margins of major up-flow zones of geothermal systems (Giggenbach et al., 1994; Glover et al., 1992). Amorphous silica and/or calcite deposition is occurring at some springs (Jones et al., 1996), making this collection of geothermal springs unique in New Zealand (Cody, 1995).

The Otamakokore Stream (Fig. 1) is the primary source of water into the wetland and originates from springs (some geothermal)

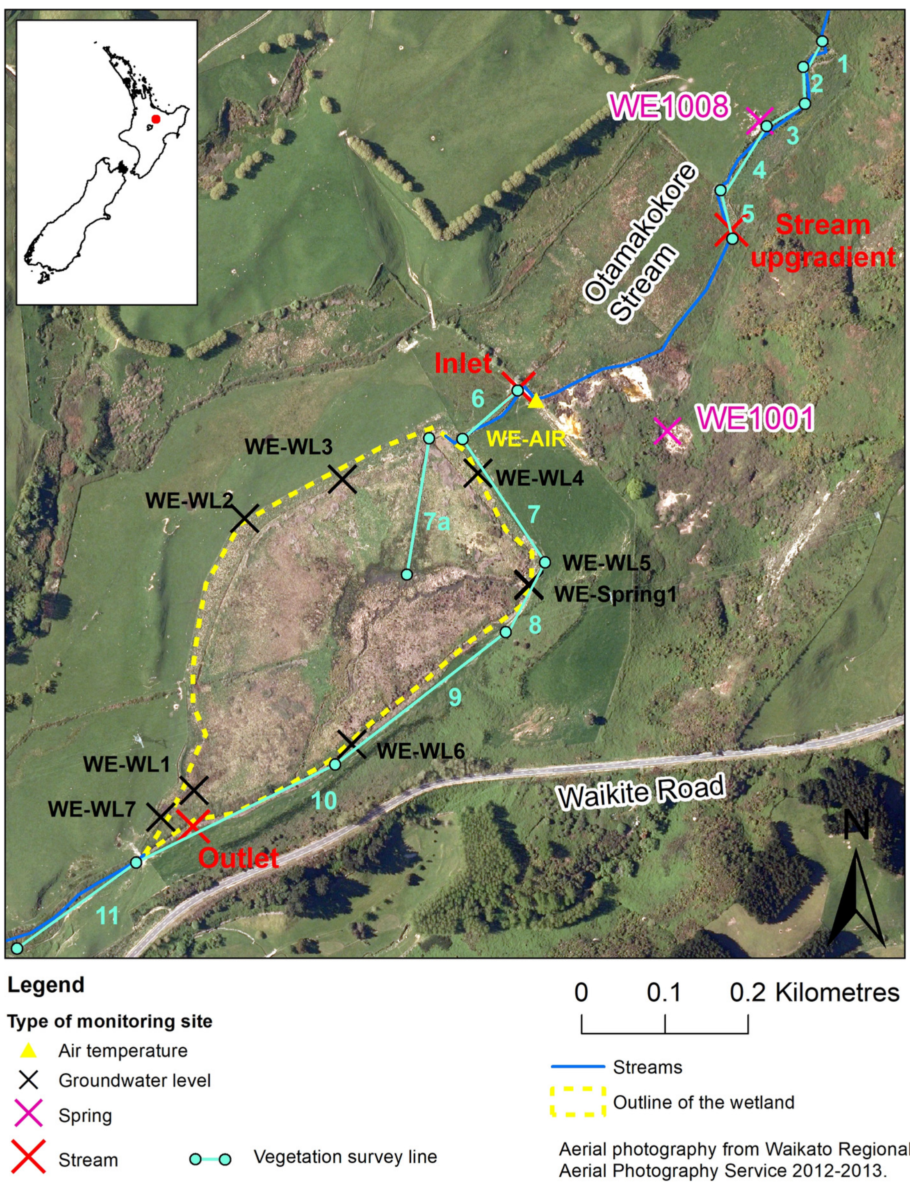

Fig. 1. The Waikite Wetland with monitoring sites. Stream and spring sites were used for both water quality and water flow measurements.