



BIRD MONITORING IN THE VICINITY
OF THE OHAU CHANNEL DIVERSION
STRUCTURE AT LAKE ROTOITI -
2011 PROGRESS REPORT



2711



Bird Monitoring in the Vicinity of the Ohau Channel Diversion Structure at Lake Rotoiti - 2001 Progress Report

Contract Report No. 2711

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CONTENTS

1.	INTRODUCTION	1
2.	BACKGROUND	1
3.	EXISTING INFORMATION	2
4.	METHODS	2
5.	MONITORING RECORDS 2005-2011	10
6.	THREATENED OR AT RISK SPECIES	15
7.	RESULTS FOR SELECTED OPEN WATER SPECIES	16
8.	BREEDING	20
9.	USE OF THE WALL DURING AND AFTER CONSTRUCTION	24
10.	DISCUSSION	25
	ACKNOWLEDGMENTS	25
	REFERENCES	26

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1. INTRODUCTION

Bay of Plenty Regional Council has been granted resource consent to build a diversion wall structure in Lake Rotoiti. The diversion wall was completed in September 2008. The objective of the wall structure is to divert water flowing from Lake Rotorua into Lake Rotoiti, via the Ohau Channel, by directing the bulk of the Ohau Channel outflow towards the Kaituna River, the main outlet from Lake Rotoiti. One of the resource consent conditions is to undertake avifauna monitoring and reporting on these results for Lake Rotoiti:

“The consent holder shall undertake baseline monitoring of waterbird populations on Lake Rotoiti. The monitoring shall comprise monthly counts over the period from May 2005 to a date five years following the construction of the flow diversion wall.”

“The consent holder shall, by 30 June each year, report to the Regional Council’ on the results of the avifauna monitoring carried out, for the previous annual period, pursuant of Condition 10.7”.

Bay of Plenty Regional Council commissioned Wildland Consultants Ltd to undertake monthly bird surveys at Lake Rotoiti and to report on these results to meet the requirements of these resource consent conditions. This report presents a summary of findings from monthly bird counts at the Lake Rotoiti site, from June 2010 to May 2011.

2. BACKGROUND

The diversion wall structure is anchored into the floor of Lake Rotoiti and extends to just above water level. The wall is *c.*1,200 metres long, extending from the Ohau Channel outlet to Te Akau Point, *c.*75 m offshore from State Highway 33 (refer to Figure 1). The structure diverts water flowing through the Ohau Channel from Lake Rotorua, and directs it into the Kaituna River.

It is predicted that the diversion will prevent 180 tonnes of nitrogen and 15 tonnes of phosphorus from entering the main body of Lake Rotoiti from Lake Rotorua each year via the Ohau Channel. The diversion is expected to improve water quality in Lake Rotoiti within five years, as research has shown that 70 percent of the nutrients entering Lake Rotoiti come from Lake Rotorua via the Ohau Channel.

Construction of the wall commenced in June 2007, with the first wall sections being put in place along a central section of the wall opposite the end of Te Akau Road. Installation of wall sections then proceeded north and south from this central section. The boat ramp near the Ohau Channel mouth (at the south-western corner of survey area T1 - see Section 4 and Figure 2) functioned as a construction site, and activity occurring there included use of cranes, generators, power tools and welding equipment, and related vehicle and boat movements.

By September 2007, wall sections were in place along most of count area T1, but had not reached T6 (Figure 2). By November 2007 wall sections were starting to be put in place in area T6, and by December 2007, the crane barge placing the wall sections was adjacent to the Ohau Channel delta, remaining there until May 2008. Major construction activity ceased in July 2008, and completion of the capping rail occurred in September 2008. For the purposes of this study, therefore, the construction phase is defined as being between June 2007 and September 2008.

Monitoring of ecological effects, including effects on birds, started in May 2005, and was undertaken for two years before wall construction commenced in June 2007. Results from this study have been presented in a series of annual progress reports from 2007 to 2010 (see Wildland Consultants 2007, 2008, 2009, and 2010).

3. EXISTING INFORMATION

A previous ecological assessment of the diversion wall project area was undertaken by Wildland Consultants (2005). That report provides descriptions of the vegetation and habitats present, lists of species, an assessment of potential ecological effects, and requirements for future monitoring. Bird monitoring results, for the period prior to June 2010, have been reported on previously (Wildland Consultants (2007, 2008, 2009, and 2010).

Lake Rotoiti was included in a major fauna survey in the early 1980s (Rasch 1989) and was classed as “outstanding wildlife habitat, holding the largest population of New Zealand dabchick in the region”. The western end of the lake and the Okere Arm were specifically highlighted as significant habitats for a diverse range of waterbird species.

Waterbirds were surveyed at Lake Rotoiti (and 16 other Rotorua lakes) in 1985, 1991, 1996, and 2001. Results for the first three of these surveys are reported in Innes *et al.* (1999). The waterbird population was relatively stable in terms of total numbers of all species combined and species composition, although ten of the 19 species counted showed population fluctuations (Innes *et al.* 1999).

There has been other monitoring of New Zealand dabchick at Lake Rotoiti (Innes *et al.* 2000; Harris 2001) and also research into their ecology (Reynolds 1997, Bright *et al.* 2004). Harris (2001) recorded six dabchicks at the Ohau Channel Delta. The effects of structures and boat-pass disturbances on dabchick have also been investigated at Lake Rotoiti, by Montgomery (1991) and Bright *et al.* (2004).

4. METHODS

Overview

Bird monitoring for this study, involving counts undertaken on one day per month, commenced at Lake Rotoiti in May 2005. Figure 1 shows the location of the study area and the diversion wall at the western end of Lake Rotoiti.

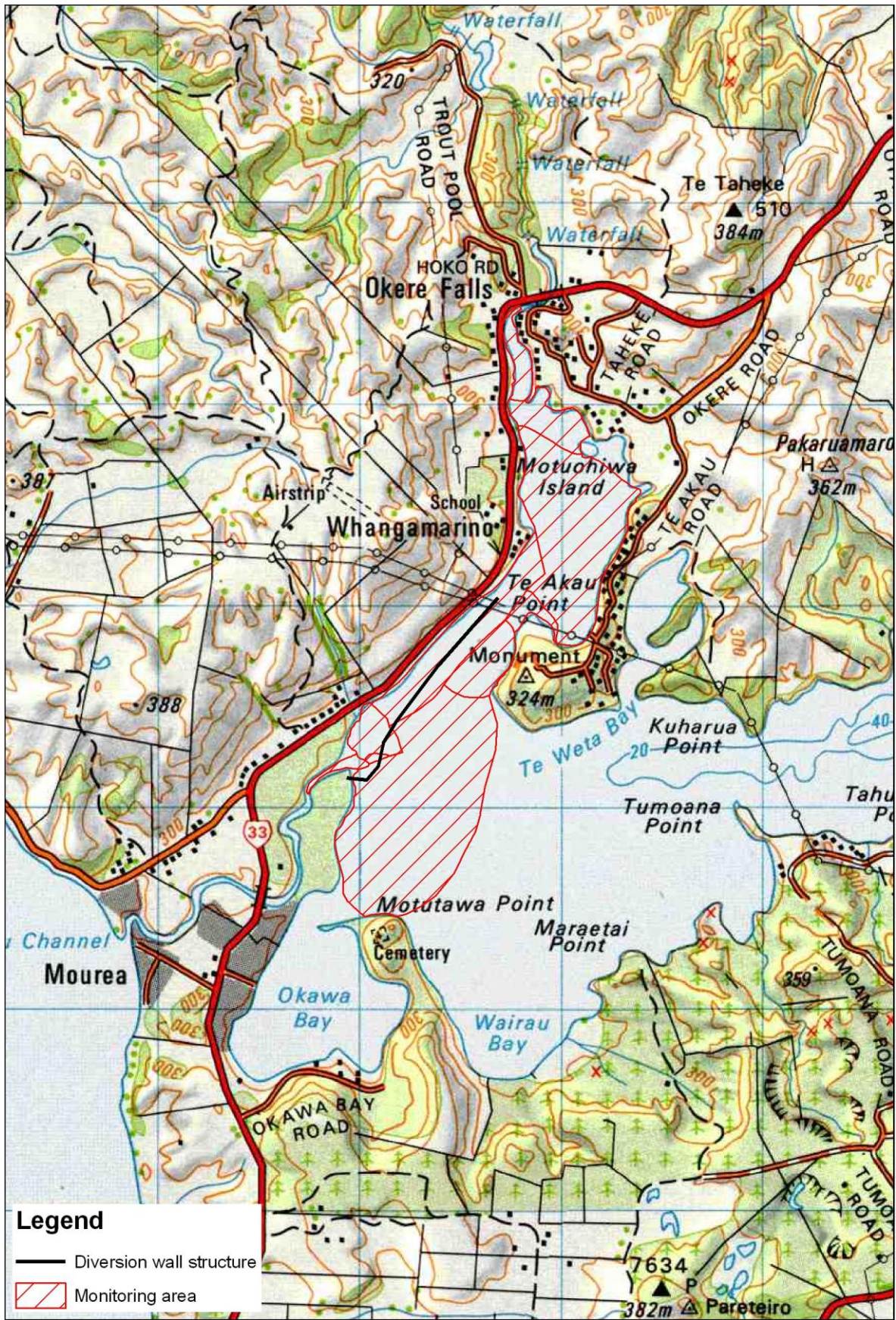
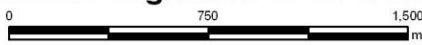


Figure 1. Bird monitoring study area and approximate alignment of diversion wall

Wildlands

Scale: 1:25,000
 Date: 03/07/07
 Cartographer: RPB



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Study Areas

The study area was divided into six pre-construction (i.e. prior to June 2007) treatment areas adjacent to the diversion wall, and four control areas (C1, C2, C3 and C4) away from the proposed location of the diversion wall (see Figure 2 and Table 1). The six treatment areas (T1, T2/3, T4, T5, T6, and T7) encompass most of the open water habitats adjacent to the diversion wall, and counts were undertaken within each of these at monthly intervals.

From March 2008, count area T1 was split into three sub-sites, and observer locations, to allow complete visual coverage of T1:

- T1 - all birds on the water were recorded that could be seen from the jetty on the eastern side of the survey area (near Te Akau Point) (excluding birds on the wall).
- T1A - all birds roosting on the wall (as observed from Te Akau Road jetty).
- T1B - all birds recorded on the water on the western side of the wall (now obscured by the wall, so birds are recorded by observer walking along SH 33).

From December 2007, count area T6 was split into two sub-sites, to reflect that the newly constructed wall now formed the eastern and southern boundary of the count area.

- T6 - all birds on the water were recorded that could be seen from the boat-ramp jetty on SH 33, near the Ohau Channel mouth.
- T6A - all birds roosting on the wall sections south of an imagined line between the Te Akau Road jetty and the SH 33 jetty.

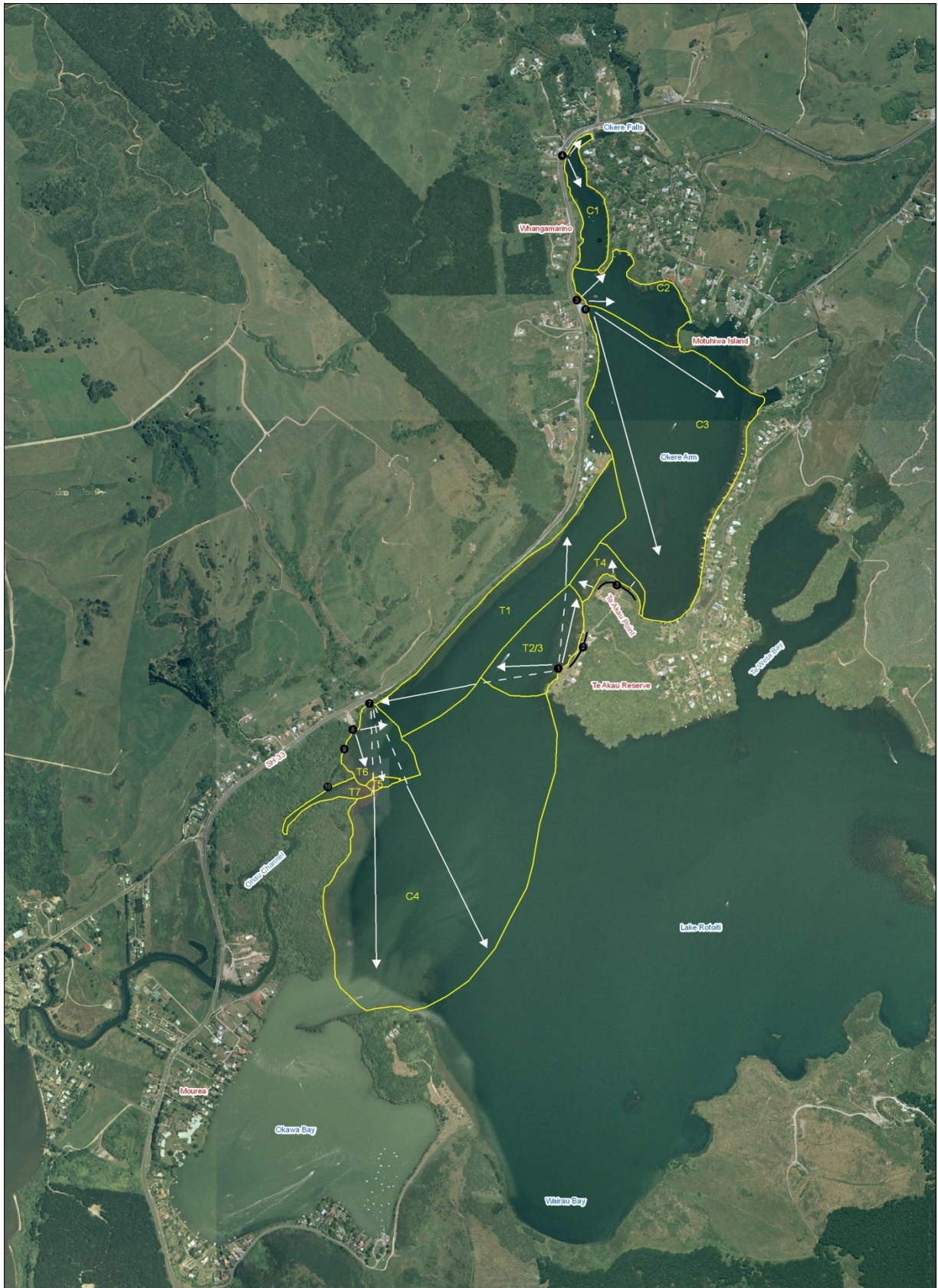
The four control areas are located in open bodies of water away from the diversion wall. Monitoring of treatment sites began in May 2005, while monitoring of control sites began in July 2005. Comparisons between control and treatment survey areas will enable analyses of major changes to populations of bird species in the vicinity of the diversion wall, taking into account seasonal and yearly differences in bird populations. Bird populations can vary in size over annual, seasonal, and daily time scales due to natural fluctuations in numbers, natural environmental change, as well as human-induced events.

Recording

Each water bird seen or heard during the monitoring period at each survey area was identified and recorded. Terrestrial bird species were generally recorded by presence/absence only, although numbers were recorded for five terrestrial species: pheasant, shining cuckoo, tui, bellbird, and Australian magpie. Juvenile water birds were recorded separately in three size classes: small, medium, and large. These data were entered into a Microsoft Excel spreadsheet held by Wildland Consultants Ltd.

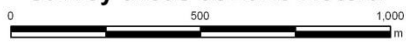
Optical Aids

Most counts were undertaken using a tripod-mounted spotting scope (telescope), with binoculars used for birds located close to observer stations.



- Legend**
- Bird survey station
 - C1 Bird survey areas

Figure 2. Bird survey stations and survey areas at Lake Rotoiti



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Scale: 1:12,500
 Date: 03/07/07
 Cartographer: RPB

Table 1: Survey areas, site names, count times, approximate sizes of survey areas, list of survey stations, and notes on bird monitoring associated with the Ohau Channel diversion wall at Lake Rotoiti. Refer to Figure 2 for location of survey areas.

Survey Area	Site Name	Count Duration ¹	Approximate Area (ha) of Survey Areas	Station(s) Recorded From	Notes
T1 ² , T1A, T1B	North-western side of the proposed diversion wall	10-15 minutes	c.18 ha	Station 1 - jetty at end of Te Akau Road. Station 11 - walk along SH 33 verge, from rest area by Ohau Channel boat ramp north-east to planting site (c.0.8 km in length).	Record all birds that can be seen from the jetty between the boat sheds to the west to as far as can be seen to the northeast. Use a boundary of approximately half-way across the lake to split this Survey Area from T2 (see below). From March 2008 Site T1 was split into three sub-sites: <ul style="list-style-type: none"> • T1 - all birds on the water that can be seen from the jetty on eastern side of survey area (near Te Akau Point) were recorded (excluding birds on the wall); • T1A - includes all birds roosting on the wall, from a line between the jetty at the end of Te Akau Road and the boat ramp on SH 33 adjacent to the Ohau Channel delta, north to the wall's terminus; • T1B - includes birds recorded on the western side of the wall (not visible from the jetty at the end of Te Akau Road), viewed by walking along adjacent SH33.

¹ Count duration is subject to the number of birds present. Low numbers mean that some sites can be counted very quickly, but if high numbers were present then the count duration is as long as it takes to complete the count.

² T1-T7 are 'pre-treatment' sites, where the wall is to be constructed.

Survey Area	Site Name	Count Duration ¹	Approximate Area (ha) of Survey Areas	Station(s) Recorded From	Notes
T2/3	South-eastern side of the proposed diversion wall	5-10 minutes (also walk along shoreline for Station 2)	c.7 ha	Station 1. Station 2 - any additional birds recorded along shoreline while doing a walk through inspection in front of houses at end of Te Akau Road.	Record all birds that can be seen from the jetty to approximately half-way across the lake. Do not record any birds from beyond Namaste Point. Do not record any birds recorded in Survey Area T1. For Station 2 walk the shoreline in front of the houses and record any additional birds not previously recorded from Station 1.
T4	Te Akau Reserve and Peninsula	5-10 minutes	c. 2 ha	Station 3 - walk through survey of shoreline of Te Akau Reserve.	Walk along shoreline boundary in Te Akau Reserve. Record any birds in the vicinity of the proposed flow diversion wall that will not be seen from any of the other stations.
C1 ³	Okere Inlet (north)	5-10 minutes	c.4 ha	Station 4 - mooring platform opposite Okere Falls Store.	Record any birds seen from the platform (except any that will be better recorded in Area C2).
C2	Okere Inlet (central)	5-10 minutes	c.7 ha	Station 5 - grassy area on SH 33, 0.5 km south of Okere Falls Store, higher part.	Record any birds in the central end of Okere Inlet to approximately the south end of Motuhiwa Island. Do not count any birds that have/will be recorded in Areas C1 or C3.
C3	Okere Inlet (south)	5-10 minutes	c.37 ha	Station 6 - grassy area on SH33, 0.5 km south of Okere Falls Store, lower part. Southern end of C3 (south of the green boat shed with distinctively curved door corners) is only viewable from Station 3.	Record all birds to the south of the area surveyed in Area C2. Be careful not to record any birds recorded in area T4.

³ C1-C4 are 'control' sites, outside of the construction zone.

Survey Area	Site Name	Count Duration ¹	Approximate Area (ha) of Survey Areas	Station(s) Recorded From	Notes
T5	Delta	5-10 minutes	c.60 ha	Station 7 - rest area picnic table on SH33, adjacent to boat ramp.	Record any birds that are on the delta near the mouth of the Ohau River Channel. If the delta is submerged record any birds in approximate location of delta.
C4	Beyond delta	5-10 minutes	c.44 ha	Station 7.	Record all birds in the body of water beyond the delta. Do not record any birds in Wairau Bay (it is too difficult to identify species over this distance).
T6, T6A	Boat ramp	5 minutes, and any additional birds recorded from Station 9 (quick inspection only)	c.4 ha	Station 8 - jetty at Ohau Channel boat ramp. Station 9 - shoreline between boat ramp and Ohau Channel mouth.	Record all birds that can be seen from the boat ramp (north of delta) that were not in the survey areas T1, T5 and C4. Record any birds present at Station 9 (that could not be seen from Station 8). From November 2007, wall sections in T6 were recorded as site T6A.
T7	Ohau Channel mouth	5-10 minutes	c.1 ha	Station 10 - water level stage, Ohau Channel.	Record all birds in Ohau Channel not recorded in areas C4, T5, and T6.

Weather

Counts were generally undertaken during settled weather (little or no wind or rain), as waves can make accurate counting of waterbirds difficult. However, in some months, this was not possible due to extended periods of inclement weather.

Limitations of Monthly Counts

Monthly surveys of birds, for set periods of time, can show trends in population numbers over time, but do have some limitations in terms of accuracy. Innes *et al.* (1999) outline factors that reduce or increase numbers recorded compared to actual numbers present. These are set out below with some additions relevant to this particular study.

Factors that May Affect Counts

- Birds may be roosting, moulting and nesting in habitat that will not be viewed by the observer. This effect can be seasonal.
- Birds fleeing observers or other lake users (e.g. boats, canoes on lake, and people fishing on margins). This factor may be affected by changing seasonal levels of human activity.
- Misidentifications (most likely in this survey for birds that are in the distance, particularly differentiating between red-billed gulls and black-billed gulls; Australian coot and New Zealand scaup; and little black shags and juvenile little shags).
- Actively-moving birds.
- Dense populations (e.g. little black shags and little shags on Ohau Channel Delta) where individual birds can be hidden behind other birds.

Uncounted birds - birds leaving a count zone and flying to other parts of survey area that have already been counted.

Factors that May Increase a Count

- Birds fleeing observers and other people using the lake and being counted twice (see above).
- Misidentifications (see above).
- Actively-moving birds.
- Counted birds leaving the count zone and being counted again in a different count area.

This survey has the advantage that most counts have been undertaken by only two people, reducing the bias of survey methods between observers.

5. MONITORING RECORDS 2005-2011

A total of 43 bird species have been recorded during the first six years of monitoring (Table 2). Twenty-nine of these species are indigenous, while 14 species are introduced (including mallard/grey duck hybrids). Nine of the indigenous species are classified as 'Threatened' or 'At Risk' by Miskelly *et al.* (2008). Of the species recorded previously during the surveys, ten were not recorded in the June 2010 to May 2011 period (feral goose, grey duck, grey teal, Australasian bittern, California quail, pheasant, kereru, Australasian magpie, skylark, greenfinch, goldfinch, redpoll). None of these species were commonly recorded in monthly surveys in the previous two years before wall construction began.

Table 2: Bird species recorded during surveys at the western end of Lake Rotoiti between May 2005 and May 2011. The threat status of birds as listed in Miskelly 2008 *et al.* is provided⁴.

Common Name	Scientific Name	Threat Classification
Grebes (family name: podicipedidae)		
New Zealand dabchick; weweia	<i>Poliiocephalus rufopectus</i>	Threatened-Nationally Vulnerable
Shags (phalacrocoracidae)		
Black shag; kawau	<i>Phalacrocorax carbo</i>	At Risk-Naturally Uncommon
Little black shag	<i>Phalacrocorax sulcirostris</i>	At Risk-Naturally Uncommon
Little shag; kawaupaka	<i>Phalacrocorax melanoleucos</i>	At Risk-Naturally Uncommon
Herons, bitterns and egrets (ardeidae)		
White-faced heron; kotuku	<i>Ardea novaehollandiae</i>	Not threatened
Australasian bittern (matuku)	<i>Botaurus poiciloptilus</i>	Threatened-Nationally Endangered
Waterfowl (anatidae)		
Black swan	<i>Cygnus atratus</i>	Not threatened
Canada goose	<i>Branta canadensis</i>	Introduced
Feral goose	<i>Anser anser</i>	Introduced
Paradise shelduck; putangitangi	<i>Tadorna variegata</i>	Not threatened
Mallard	<i>Anas platyrhynchos</i>	Introduced
Grey teal; tete	<i>Anas gracilis</i>	Not threatened
Australasian shoveler; kuruwhengi	<i>Anas rhynchotis</i>	Not threatened
New Zealand scaup; papango	<i>Aythya novaeseelandiae</i>	Not threatened
Raptors (accipitridae and falconidae)		
Australasian harrier; kahu	<i>Circus approximans</i>	Not threatened
Game birds (phasianidae)		
Pheasant	<i>Phasianus colchicus</i>	Introduced
Rails, gallinules and coots (rallidae)		
Pukeko	<i>Porphyrio porphyrio</i>	Not threatened
Australian coot	<i>Fulica atra</i>	Not threatened
Stilts and avocets (recurvirostridae)		
Pied stilt; poaka	<i>Himantopus himantopus</i>	At Risk-Declining
Plovers, dotterels and lapwings (charadriidae)		
Spur-winged plover	<i>Vanellus miles</i>	Not threatened

⁴ Several species have not yet been recorded in the study area during monthly surveys, but are likely to utilise habitats present. These include grey duck (*Anas superciliosa*) and morepork (*Ninox novaeseelandiae*).

Common Name	Scientific Name	Threat Classification
Gulls, terns and noddies (laridae)		
Black-backed gull; karoro	<i>Larus dominicanus</i>	Not threatened
Red-billed gull; tarapunga	<i>Larus novaehollandiae</i>	Threatened-Nationally Vulnerable
Black-billed gull	<i>Larus bulleri</i>	Threatened-Nationally Endangered
Caspian tern; taranui	<i>Hydroprogne caspia</i>	Threatened-Nationally Vulnerable
Pigeons and doves (columbidae)		
New Zealand pigeon; kereru	<i>Hemiphaga novaeseelandiae</i>	Not threatened
Cuckoos (cuculidae)		
Shining cuckoo; pipiwharau	<i>Chrysococcyx lucidus</i>	Not threatened
Kingfishers (alcedinidae)		
Sacred kingfisher; kotare	<i>Todiramphus sanctus</i>	Not threatened
Larks (alaudidae)		
Skylark	<i>Alauda arvensis</i>	Introduced
Swallows and Martins (hirundinidae)		
Welcome swallow	<i>Hirundo tahitica</i>	Not threatened
Thrushes (muscapidae)		
Blackbird	<i>Turdus merula</i>	Introduced
Song thrush	<i>Turdus philomelos</i>	Introduced
Australasian warblers (acanthizidae)		
Grey warbler; riroriro	<i>Gerygone igata</i>	Not threatened
Monarch flycatchers (monarchidae)		
North Island fantail; piwakawaka	<i>Rhipidura fuliginosa</i> subsp. <i>placabilis</i>	Not threatened
White-eyes (zosteropidae)		
Silvereye; tauhou	<i>Zosterops lateralis</i>	Not threatened
Honeyeaters (meliphagidae)		
Bellbird; korimako	<i>Anthornis melanura</i>	Not threatened
Tui	<i>Prothemadera novaeseelandiae</i>	Not threatened
Finches (fringillidae)		
Chaffinch	<i>Fringilla coelebs</i>	Introduced
Greenfinch	<i>Carduelis chloris</i>	Introduced
Goldfinch	<i>Carduelis carduelis</i>	Introduced
Sparrows and Weavers (ploceidae)		
House sparrow	<i>Passer domesticus</i>	Introduced
Starlings and Mynas (sturnidae)		
Starling	<i>Sturnus vulgaris</i>	Introduced
Indian myna	<i>Acridotheres tristis</i>	Introduced
Bell Magpies (cracticidae)		
Australian magpie	<i>Gymnorhina tibicen</i>	Introduced

Notes on the local status of birds recorded in the study area, including records of breeding activity, are presented in Table 3.

Table 3: Status of birds in study area during the first six years (May 2005-May 2011) of bird surveys associated with the Ohau Channel diversion wall at Lake Rotoiti.

Bird Species	Status in Vicinity of Proposed Wall	Status at Control Sites	Broods/ Nesting Recorded May 2005-May 2010 Surveys	Broods/ Nesting Recorded June 2010-May 2011	Notes
New Zealand dabchick	Common	Common	✓	✓	Common and have bred throughout study area Dabchick broods were recorded in 2010-2011 in both treatment and control areas,
Black shag	Occasional	Occasional			Recorded occasionally from open water habitats between 2006 and 2010. Recorded regularly since August 2010, albeit in low numbers, roosting on the diversion wall by the Ohau Channel delta, or feeding in the Okere Inlet between Te Akau point and the diversion wall.
Little black shag	Common	Common			Common throughout open water habitats. Roosts on jetties, lake margins and, in particular, on the diversion wall adjacent to the delta.
Little shag	Common	Common			Common throughout. Roost on jetties, lake margins and, in particular, on the diversion wall adjacent to the delta.
White-faced heron	Occasional	Occasional			Utilises shallow water and lake margins.
Australasian bittern	Occasional	Not recorded			One sighted 18 August 2009 at a shallow pond in willow forest adjacent to the north of Ohau Channel.
Black swan	Common	Common	✓	✓	Common in open water habitat and lake margins throughout study area. Broods recorded regularly in control and treatment areas.
Canada goose	Occasional	Occasional	✓		Recorded occasionally up to April 2009, mostly in control areas, but also recorded once at the delta in 2008-2009. Recorded regularly, mainly in area C2, since April 2009.
Feral goose	Expected - not recorded	Occasional			Recorded on one occasion in 2007-2008 (C3).
Paradise shelduck	Occasional	Not recorded			Occasionally seen in open water habitat around the Ohau Channel delta (sometimes in large flocks e.g. 72 birds in March 2007, 46 birds in March 2011), or in the Ohau Channel itself.
Mallard	Occasional	Occasional	✓	✓	Recorded occasionally throughout study area.
Australasian shoveler	Occasional	Not recorded			Recorded occasionally in delta area (east of Ohau Channel).
Grey teal	Occasional	Occasional			Recorded occasionally, throughout study area.
New Zealand scaup	Common	Common	✓	✓	Common throughout open water habitats. One of the most

Bird Species	Status in Vicinity of Proposed Wall	Status at Control Sites	Broods/ Nesting Recorded May 2005-May 2010 Surveys	Broods/ Nesting Recorded June 2010-May 2011	Notes
					common species present in study area. Broods recorded from control and treatment sites in June 2008 to May 2009 surveys.
Australian harrier	Occasional	Occasional			Recorded occasionally, flying over study area.
Pheasant	Occasional	Occasional			Recorded occasionally, in lake margin habitat.
Pukeko	Common	Common	✓	✓	Common on lake margins and occasionally on open water. No broods recorded in June 2008 to May 2008 surveys, but broods have been recorded in previous years.
Australian coot	Common	Common	✓	✓	Very common in open water habitats of western Lake Rotoiti. Present throughout open water habitats and occasionally on lake margins. Broods commonly present in control and treatment areas.
Spur-winged plover	Common	Common			Commonly recorded on terrestrial habitat surrounding open water habitats and on the delta.
Pied stilt	Occasional	Occasional			Recorded occasionally from Ohau Channel Delta.
Black-backed gull	Usually present	Occasional			Recorded occasionally throughout the study area. Seen regularly at Ohau Channel delta.
Red-billed gull	Common	Common			Common throughout study area. Regularly present at delta.
Black-billed gull	Common	Common			Common throughout the study area. Regularly present on delta.
Caspian tern	Seasonally present (Winter)	Not recorded			Up to 18 birds have been recorded, particularly during winter months, at Ohau Channel delta.
Shining cuckoo	Seasonally common (summer)	Seasonally common (summer)	✓		Common between September and January, in terrestrial margins.
Kingfisher	Common	Common			Common in lake margin habitat within study area.
Skylark	Occasional	Not recorded			Recorded once in open grassland habitat at Te Akau Reserve.
Welcome swallow	Common	Common			Common flying over open water habitat throughout study area.
Silvereye	Common	Common			Common in lake margin terrestrial habitat.
Grey warbler	Common	Common	✓		Common in lake margin terrestrial habitat.
Blackbird	Common	Common			Common in lake margin terrestrial habitat.
Song thrush	Common	Common			Common in lake margin terrestrial habitat.
Fantail	Common	Common			Common in lake margin terrestrial habitat.
Tui	Common	Common			Common in lake margin terrestrial habitat.
Bellbird	Common	Common			Common in lake margin terrestrial habitat.
House sparrow	Common	Common			Common in lake margin terrestrial habitat.

Bird Species	Status in Vicinity of Proposed Wall	Status at Control Sites	Broods/ Nesting Recorded May 2005-May 2010 Surveys	Broods/ Nesting Recorded June 2010-May 2011	Notes
Chaffinch	Common	Common			Common in lake margin terrestrial habitat.
Goldfinch	Common	Common			Common in lake margin terrestrial habitat.
Starling	Common	Common			Common in lake margin terrestrial habitat.
Indian myna	Common	Common			Common in lake margin terrestrial habitat.
Australian magpie	Common	Common			Common in lake margin terrestrial habitat.

6. THREATENED OR AT RISK SPECIES

Bird species recorded in the project area which are ranked as Threatened or At Risk species in Miskelly *et al.* (2008), which superseded Hitchmough *et al.* (2007), are listed below, with comments on their respective New Zealand populations (summarised from Heather and Robertson 2005). The New Zealand threat classification system was reviewed and updated in 2007 (Townsend *et al.* 2008), resulting in several new threat categories, and redefinition of some existing categories. Some previously used categories are no longer used at all (i.e. 'Serious Decline' and 'Gradual Decline'). Threat classifications have deteriorated for four water bird species present in the study area (New Zealand dabchick, little shag, red-billed gull, black-billed gull, and pied stilt).

Threatened-Nationally Endangered

Black-billed gull - A New Zealand endemic. *c.*50,000 pairs in New Zealand in 1996. Numbers have crashed in the South Island since the 1970s, for unknown reasons, but black-billed gulls are slowly increasing in numbers and range in the North Island. Threat classification has deteriorated from Chronically Threatened-Serious Decline (Hitchmough *et al.* 2007).

Australasian bittern - Native. Widely distributed in freshwater wetlands throughout New Zealand. Thought to be in low numbers (580-725 birds in 1980), although population size may have been underestimated due to the species' cryptic habits. Population is likely to have declined through wetland drainage and reclamation, and pastoral development of extensive lowland habitats.

Threatened-Nationally Vulnerable

Caspian tern - *c.*3,000 birds in New Zealand. Sizes of colonies vary from year to year, but rarely exceed 100 pairs. An almost cosmopolitan species - breeding in all temperate continental regions except those of South America. No change in threat classification.

Red-billed gull - Widespread and locally common, the three largest colonies each have >5,000 breeding pairs but have shown evidence of population declines in recent years. Threat classification has deteriorated from Chronically Threatened-Gradual Decline (Hitchmough *et al.* 2007).

New Zealand dabchick - A New Zealand endemic. Population of *c.*1,700, all in the North Island, with *c.*500 present in the Volcanic Plateau. Presumed extinct in the South Island. Threat classification has deteriorated from At Risk-Sparse (Hitchmough *et al.* 2007).

At Risk-Declining

Pied stilt - *c.* 30,000 birds estimated in 1984-1993. A cosmopolitan species thought to have colonised New Zealand as recently as the early 1800s. Threat classification has deteriorated from Not Threatened (Hitchmough *et al.* 2007), attributed to intensification of land use (mainly conversion from sheep to dairying) on the species favoured habitats (Miskelly *et al.* 2008).

At Risk-Naturally Uncommon

Little black shag - between 1,000 and 5,000 pairs in New Zealand. More common in the north than south of New Zealand.

Black shag - 5,000-10,000, scattered throughout New Zealand.

Little shag - 5,000-10,000 pairs, more common in the northern North Island. Threat classification has deteriorated from Not Threatened (Hitchmough *et al.* 2007).

7. RESULTS FOR SELECTED OPEN WATER SPECIES

A summary table of key waterbird species for each year of the study is presented in Table 5. Mean monthly count totals for most waterbird species have either remained relatively stable or fluctuated between 2005 and 2011.

New Zealand dabchick

Dabchicks have been observed most commonly on larger open areas of water such as the Treatment 1 and Control 3 sites, but are scattered throughout the study area. Numbers counted are relatively consistent throughout the year, with numbers counted slightly higher between March and August, and slightly lower between September and February. The maximum number of dabchicks (31) in the treatment area was recorded in April 2007. While there has been a slight downward trend in the number of birds in the treatment area, the changes are within the range of the overall standard deviation (see Table 4). Continued monitoring is recommended, to assess long-term trends.

Table 4: Means and standard deviations (in brackets) of New Zealand dabchick recorded in monthly surveys in treatment and control areas in the vicinity of the Ohau Channel diversion structure: June 2005 to May 2011.

Year	Control	Treatment
2005-2006	15.6 (6.1)	18.0 (6.7)
2006-2007	15.6 (6.1)	15.3 (9.3)
2007-2008	13.3 (5.1)	13.3 (5.9)
2008-2009	14.5 (3.5)	10.2 (3.7)
2009-2010	16.1 (5.3)	13.4 (5.5)
2010-2011	14.2 (5.6)	16.6 (6.5)

Black shag

Black shags, previously recorded only occasionally in the study area, have been recorded regularly since August 2010. A maximum of twenty-one birds were recorded in April 2011, however it is likely this is an over-estimate resulting from counting birds more than once at different parts of the study area. The maximum number seen at any one area was eleven. Black shags have been sighted regularly on the diversion wall since November 2009.

Table 5: Monthly mean numbers of key open water bird species in the vicinity of the Ohau Channel diversion wall before, during, and after wall construction (C = control area; T = treatment area), June 2005 to May 2010.

Project Phase (approximate)	Pre-Construction (to end May 2007)						Construction (June 2007-Sept 2008)			Post-Construction (Oct 2008 -)								
	2005-2006			2006-2007			2007-2008			2008-2009			2009-2010			2010-2011		
Species	C	T	Total	C	T	Total	C	T	Total	C	T	Total	C	T	Total	C	T	Total
New Zealand dabchick	14.5	19.8	34.4	15.3	15.3	30.5	13.3	13.3	26.6	14.5	9.5	24.0	16.1	13.4	29.5	14.2	16.6	30.8
Black shag	0.1	0.0	0.1	0.2	0.3	0.5	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.3	0.3	1.4	3.3	4.8
Little shag	1.3	2.3	3.6	3.0	2.7	5.7	2.6	3.6	6.2	2.4	3.4	5.8	3.7	6.8	10.5	2.8	9.6	12.4
Little black shag	2.8	8.4	11.2	2.8	23.9	26.8	10.3	6.3	16.6	10.7	6.9	17.6	8.8	10.4	19.2	5.3	11.7	16.9
Black swan	20.5	17.7	38.2	19.6	29.6	49.2	31.8	16.5	48.3	27.2	27.4	54.6	44.9	34.3	79.2	25.1	29.3	54.3
New Zealand scaup	47.2	72.0	119.2	99.8	111.7	211.4	142.7	139.3	281.9	134.1	93.2	227.3	108.8	62.8	171.6	103.2	97.2	200.3
Australian coot	78.7	122.0	200.7	104.1	66.1	170.2	129.0	66.5	195.5	76.1	91.3	167.3	131.8	85.7	217.5	117.2	86.3	203.4
Black-backed gull	0.5	5.8	6.4	0.8	4.4	5.2	0.0	3.2	3.2	0.0	1.8	1.8	0.5	2.5	3.0	0.5	4.1	4.6
Red-billed gull	0.2	3.7	3.9	0.8	0.8	1.6	0.1	3.8	3.9	0.2	4.8	5.0	0.1	6.9	7.0	0.2	6.4	6.6
Black-billed gull	0.2	3.0	3.2	1.1	33.3	34.4	0.3	18.2	18.4	0.3	13.8	14.1	0.9	8.3	9.3	1.2	5.3	6.5
All gulls (including unidentified species)	1.0	15.8	16.8	4.3	42.6	46.8	0.5	29.2	29.7	0.6	22.3	22.8	1.5	17.8	19.3	1.9	17.6	19.5
Caspian tern	0.0	2.0	2.0	0.0	3.4	3.4	0.0	1.8	1.8	0.0	4.3	4.3	0.0	2.7	2.7	0.0	0.0	0.0

Little black shag

Little black shags are common throughout the study area, with birds being recorded from each survey area at least once during the first two years of this study. The highest number of little black shags (194) was recorded in August 2006, with c.163 birds present on the Ohau Channel Delta (T5). The number recorded varies greatly between surveys (excluding the August 2006 count, between 1 and 56 per monthly count). If the August 2006 count is disregarded, numbers counted vary throughout the year. Little black shags are most commonly seen roosting on the diversion wall, adjacent to the Ohau Channel delta, or roosting on a fallen tree at Motutawa Point, but are also seen flying over, or on the water, throughout the study area. These results show considerable variations in the number of shags between years, rather than any long-term trends.

Little shag

Little shags are common in the study area, although are less numerous than little black shag, and have been recorded throughout the survey area throughout the duration of the study. The highest number of little shags recorded in the vicinity of the diversion wall was 30 in January 2011. Little shags are most commonly seen roosting on the diversion wall adjacent to the Ohau Channel mouth, or roosting (but in lower numbers than little black shags) on a fallen tree at Motutawa Point, but are seen flying over, or swimming, throughout the study area. Numbers counted vary throughout the year.

Black swan

Black swans are common, with the highest number of swans recorded in January 2010 (193 birds, with 110 birds in control survey areas and 83 birds in treatment survey areas). Black swans have been found scattered throughout the study area, with birds having been recorded from all survey areas at least once during this study. Black swans appear to congregate in the largest areas of open water (e.g. Treatment 1 and Control 4). In the pre-treatment and treatment survey areas, means of 14.3, 29.6, 16.5, 27.4, and 34.3, and 29.3 black swans were recorded in 2005-2006, 2006-2007, 2007-2008, 2008-2009, 2009-2010, and 2010-11 respectively. This indicates that numbers are fluctuating more between years, rather than any long-term trend.

New Zealand scaup

New Zealand scaup are very common throughout the study area, and have been recorded from all survey areas over the duration of this study. A largest monthly number of 590 scaup was recorded in the study area in January 2010 (388 birds in the control survey areas and 202 in treatment survey area). Means of 72.0, 111.7, 139.3, 93.2, 62.8, and 97.2 scaup were recorded in the pre-treatment and treatment survey area during 2005-2006, 2006-2007, 2007-2008, 2008-2009, 2009-2010, and 2010-2011 respectively.

Australian coot

Australian coot are very common throughout the study area. A highest count of 450 coot was recorded in the study area in July 2010, with 238 birds present in

treatment survey areas and 212 birds at control survey areas. Means of 122.0, 66.1, 66.5, 91.3, 85.7, and 86.3 coot were recorded at the pre-treatment and treatment survey area in 2005-2006, 2006-2007, 2007-2008, 2008-2009, 2009-2010, 2010-2011 respectively.

Black-backed gull

Black-backed gulls are occasionally present throughout the study area, although particularly large numbers of birds were recorded at the Ohau Channel delta in some surveys. Highest tallies were recorded at the delta in April 2006 (51), August 2006 (16), and December 2006 (15). Means of 5.8, 4.4, 3.2, 1.8, 2.5, and 4.1 black-backed gulls were recorded from the pre-treatment and treatment survey area in 2005-2006, 2006-2007, 2007-2008, 2008-2009, 2009-2010, and 2010-2011 respectively. Numbers of this species are too low to assess whether changes are significant.

Red-billed gull

Red-billed gulls have been recorded in moderate numbers throughout the survey areas, including all survey areas except the Ohau Channel survey area (T7). A maximum of 30 birds was recorded in February 2011. Means of 3.7, 0.8, 3.8, 4.8, 6.9, and 6.4 red-billed gulls were recorded from the pre-treatment and treatment survey areas in 2005-2006, 2006-2007, 2007-2008, 2008-2009, 2009-2010, and 2010-2011 respectively.

Black-billed gull

Black-billed gulls have been recorded throughout the survey area in all sites except one - Control 1 (the northern section of Okere Arm). However most birds observed are within treatment sites. A maximum of 124 black-billed gulls was recorded in August 2006, with 122 birds present at the Ohau Channel delta. The second highest monthly total recorded was 77 birds in February 2009. Means of 3.3, 33.3, 18.2, 13.8, 8.3, and 5.3 black-billed gulls were recorded from the pre-treatment and treatment survey areas in 2005-2006, 2006-2007, 2007-2008, 2008-2009, 2009-2010, and 2010-2011 respectively.

All three gull species combined (including unidentified gulls)

Gulls have been recorded from all sites throughout the survey. A maximum of 143 gulls was recorded in August 2006, with 139 birds at the Ohau Channel delta. Means of 15.8, 42.6, 29.2, 22.3, 17.8, and 17.6 gulls were recorded from the pre-treatment and treatment survey areas in 2005-2006, 2006-2007, 2007-2008, 2008-2009, 2009-2010, and 2010-2011 respectively.

Caspian tern

All records of Caspian tern have been from the Ohau Channel delta, where they have been recorded 2005-2009, between the months of May to October, but were not recorded in 2010 and 2011. Caspian terns were present at the delta during June 2005 (12 birds), September 2005 (2), May 2006 (12), June 2006 (14), September 2006 (3), October 2006 (6), May 2007 (18), June 2007 (18), July 2007 (3), October 2007 (1),

June 2008 (5), July 2008 (15), August 2008 (6), October 2008 (14), June 2009 (19), September 2009 (7), and October 2009 (6). A possible explanation for the absence of records during 2010-2011 is that the delta has become overgrown with vegetation, reducing its roosting habitat quality for Caspian tern. Ongoing monitoring will help to confirm this.

8. BREEDING

Juveniles of seven water bird species - New Zealand dabchick, black swan, Canada goose, mallard, New Zealand scaup, Australian coot and pukeko - have been recorded during monthly surveys from May 2005 to May 2011. Juveniles of all of these species, except for pukeko, were recorded in the 2010-2011 monthly surveys. Pukeko, which are usually found on lake margins, are unlikely to be affected by the construction and presence of the wall and have not been included in this analysis.

New Zealand dabchick

- *June 2005 to May 2007 (Pre-Construction)*

Dabchick juveniles were recorded between November and March in the 2005-2006 breeding season¹, and December to March in the 2006-2007 breeding season. Broods have been recorded from both the pre-treatment and control sites. Nine juveniles were recorded during the 2005-2006 breeding season, while eight juveniles were recorded during the 2006-2007 breeding season.

- *June 2007 to May 2008 (During Construction)*

Four dabchick young were recorded (all in treatment areas) between December 2007 and April 2008.

- *June 2008 to May 2009 (Post-Construction)*

Two dabchick young were recorded (both in control area C2) between October 2008 and February 2009. No young were recorded in treatment areas.

- *June 2009 to May 2010 (Post-Construction)*

Individual dabchick young were recorded in control areas in November 2009 (one individual in C2) and January 2010 (one individual in each of C2 and C3). In treatment areas, individual dabchick young were recorded in December 2010 (one individual in T4-Park), January 2010 (one in T2-Near), and in February 2010 (one in T2-Near).

¹ The breeding season is included within the study year.

- *June 2010 to May 2011 (Post-Construction)*

Individual dabchick young were recorded in control areas in October 2010 (one individual in C2). In treatment areas, individual dabchick young were recorded in November 2010 (one individual in T2-Near), and March 2011 (one in T1-Far).

- *Summary*

The above data shows that dabchick have been present with broods in open water habitats, during wall construction, and throughout the post-construction phase.

Black swan

- *June 2005 to May 2007*

Only two broods of black swan were recorded during the 2005-2006 breeding season; in October 2005 and May 2006. The May 2006 group of young was probably recorded again in June 2006; which would usually be recorded in the 2006-2007 breeding season, but was recorded as production from the 2005-2006 breeding season. Broods were common between November 2006 and May 2007 in the 2006-2007 breeding season, in both the control and pre-treatment areas. Eight juveniles were recorded in the study area in the 2005-2006 breeding season, while 18 juveniles were recorded in the 2006-2007 breeding season.

- *June 2007 to May 2008*

Twenty-six young from *c.*10 broods were recorded between July 2007 and April 2008. Four of the ten broods were in the treatment area.

- *June 2008 to May 2009*

Eleven young from *c.*4 broods were recorded between November 2008 and February 2009, all of which were recorded from control areas.

- *June 2009 to May 2010*

Black swan broods were recorded between November 2009 and March 2010 (inclusive): November - 10 large cygnets at C1-Kaituna and C3); December - four large cygnets at T7-Ohau Channel mouth; January - two small cygnets at C4-Beyond; February - two large cygnets at C4-beyond; March - two medium-sized cygnets at T1-Far.

- *June 2010 to May 2011*

Black swan broods were recorded September 2010 (three small cygnets at T2-Near), and October 2011 (three medium cygnets at T7-Ohau Channel mouth).

- *Summary*

These data shows that black swan have been present with broods in open water habitats, both prior to wall construction and in the post-construction phase.

Mallard

- *June 2005 to May 2007*

Only one brood of ten young mallard (or mallard-grey hybrids) was recorded in the study area prior to June 2007.

- *June 2007 to May 2008*

No records.

- *June 2008 to May 2009*

One brood of three young mallard (or mallard-grey hybrids) was recorded from a control area in Jan 2009.

- *June 2009 to May 2010*

A single young mallard/mallard-grey hybrid was seen in October 2009, at T6-Jetty.

- *June 2010 to May 2011*

Five mallard/mallard-grey hybrid young were seen in November 2010, at T1-Far.

- *Summary*

These data show that mallard are occasionally using habitats associated with the wall, for breeding, but overall this is not an important site for the species.

New Zealand scaup

- *June 2005 to May 2007*

New Zealand scaup appear to have the shortest breeding season of these five waterbird species at Lake Rotoiti, and were highly productive during the first two years of this study. In the 2005-2006 breeding season all young (18) were recorded between December and January. In the 2006-2007 breeding season, 72 juveniles were recorded between December and March.

- *June 2007 to May 2008*

All broods of scaup were recorded between December 2007 and February 2008. During this period, 42 young were recorded in nine broods, with four broods in control areas and five broods in treatment areas.

- *June 2008 to May 2009*

All broods of scaup were recorded in January and February 2008. During this period 46 young were recorded in control areas, and 17 young were recorded in treatment areas.

- *June 2009 to May 2010*

All scaup broods were recorded between October 2009 and February 2010. In treatment areas: one young was present in October 2009 at T6-Jetty, eight young at T6 in December 2009; three young at T1B-Far Additions and one at T4-Park in January 2010; one young each on T1B and T2-Near in February 2010. In control areas: December 2009 - 12 young at C1-Kaituna, six at C2, three at C3; January 2010 - 14 young at Kaituna, and 10 at C2; February 2010 - eight young at C1-Kaituna.

- *June 2010 to May 2011*

Only one scaup brood was recorded in 2010-2011: two young in December 2010 at T6 (Jetty).

- *Summary*

These data show that scaup have continued to breed in the project area (pre-construction, during construction, and post-construction).

Australian coot

- *June 2005 to May 2007*

Australian coot appears to be one of the most prolific species breeding at the western end of Lake Rotoiti. In the 2005-2006 breeding season, 47 young were recorded between October and March. During the 2006-2007 breeding season, 64 juveniles were recorded between December and April.

- *June 2007 to May 2008*

All coot broods were recorded between December 2007 and March 2008. During this period, 25 young were recorded in 16 broods, with eight broods in control areas and eight broods in treatment areas.

- *June 2008 to May 2009*

All broods of coot were recorded between January and May 2009. During this period, 19 young were recorded in control areas and nine young were recorded in treatment areas.

- *June 2009 to May 2010*

All broods of coot were recorded between December 2009 and May 2010. In control areas: December 2009 - two coot young at C1-Kaituna; January 2010 - six coot young at C1-Kaituna, three at C2, and four at C3; February 2010 - four coot young at C1-Kaituna, five at C2 and one at C3; March 2010 - two coot young at C1-Kaituna, and two at C2; April 2010 - two coot young at C1-Kaituna, and one at C2; May 2010 - one coot young at C2. In treatment areas: January 2010 - two coot young at T1B-Far Additions, and two at T7-Ohau Channel mouth; February 2010 - two coot young at T2-Near; April 2010 - one coot young at T2-Near.

- *June 2010 to May 2011*

Coot young were recorded from only two areas, both in February 2011 (one bird in T1B-Far Additions, and one bird in T2-Near).

- *Summary*

These data show that Australian coot have continued to breed in the project area, pre-construction, during construction, and post-construction.

9. USE OF THE WALL DURING AND AFTER CONSTRUCTION

Shags and gulls regularly roost on the wall, individually or in small groups, as well as occasionally being observed in the water or flying in Survey Areas T1 and T6, within which the wall is located. Counts of shags and gulls in Survey Areas T1 (divided into T1, T1A, and T1B after construction commenced), and T6 (divided into T6 and T6A) have increased substantially since construction of the wall, mainly due to the increased availability of roosting habitat.

Table 6: Mean monthly count totals of shags and gulls in Survey Areas T1, T1A, T6, and T6A at Lake Rotoiti.

Species	Phase		
	Pre-Construction (May 2005-May 2007)	Construction (June 2007-September 2008)	Post-Construction (October 2008-May 2011)
Black shag	0.0	0.0	1.2
Little shag	0.8	1.7	5.7
Little black shag	2.9	3.3	9.9
Black-backed gull	0.1	0.4	2.6
Red-billed gull	0.5	2.7	6.7
Black-billed gull	1.0	5.9	8.9
All gulls (incl. gulls not identified to species)	1.8	10.4	19.7
Grand Total	7.2	24.3	54.8

10. DISCUSSION

Bird count data collected from May 2005- May 2007 provide a useful baseline assessment of bird species in the vicinity of the diversion wall prior to construction. Data collected from June 2007-May 2011 have enabled analysis of seasonal and yearly differences in bird populations during the construction and post-construction phases.

Key open water bird species to be the subject of at least five years of post-construction monitoring (until September 2013) include New Zealand dabchick, black shag, little black shag, little shag, black swan, New Zealand scaup, Australian coot, red-billed gull, black-billed gull, and Caspian tern. The survey area in general provides very good habitat for open water birds, particularly New Zealand dabchick, black swan, New Zealand scaup, and Australian coot.

Interesting findings to date include the winter roosting of Caspian tern at the delta up until 2009, but the absence of such records in 2010-2011, and the large fluctuations in numbers of little black shag (also at the delta).

Observations since construction of the diversion wall indicate:

- All key bird species of open water habitats have continued to utilise the control and treatment survey areas selected to monitor the effects of the diversion wall.
- Similar numbers of New Zealand dabchick (perhaps the most important species from a conservation perspective) were counted in 2009-2010 and 2010-2011. The lower count in 2008-09 has not been repeated and thus does not seem to indicate a long-term trend. Counts in 2010-2011 are similar to those made pre-construction.
- Caspian terns have utilised habitats adjacent to the diversion structure prior to, during, and post-wall construction, but were not recorded in 2010-2011, and this is probably related to their roost site becoming overgrown.
- The diversion wall has become a locally important roosting site for three gull species and three shag species.

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