BIRD MONITORING IN THE VICINITY OF THE ŌHAU CHANNEL DIVERSION STRUCTURE AT LAKE ROTOITI: 2014 PROGRESS REPORT

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1. INTRODUCTION

Bay of Plenty Regional Council was granted resource consents to build a diversion wall structure in Lake Rotoiti, which was completed in September 2008. The objective of the structure is to divert water flowing from Lake Rotorua into Lake Rotoiti, via the Ōhau Channel, by redirecting the bulk of the Ōhau 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 of 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. It should be noted that the Regional Council has now extended this monitoring beyond the five-year period required by the consent conditions. This report presents a summary of findings from monthly bird counts at the Lake Rotoiti site, from June 2013 to May 2014.

2. BACKGROUND

The diversion wall structure is set into the floor of Lake Rotoiti and extends to just above water level. The wall is *c.*1,200 metres long, extending from the Ōhau 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 Ōhau 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 Ōhau Channel. The diversion is expected to improve water quality in Lake Rotoiti, as research has shown that 70 percent of the nutrients entering Lake Rotoiti come from Lake Rotorua via the Ōhau Channel.

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

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

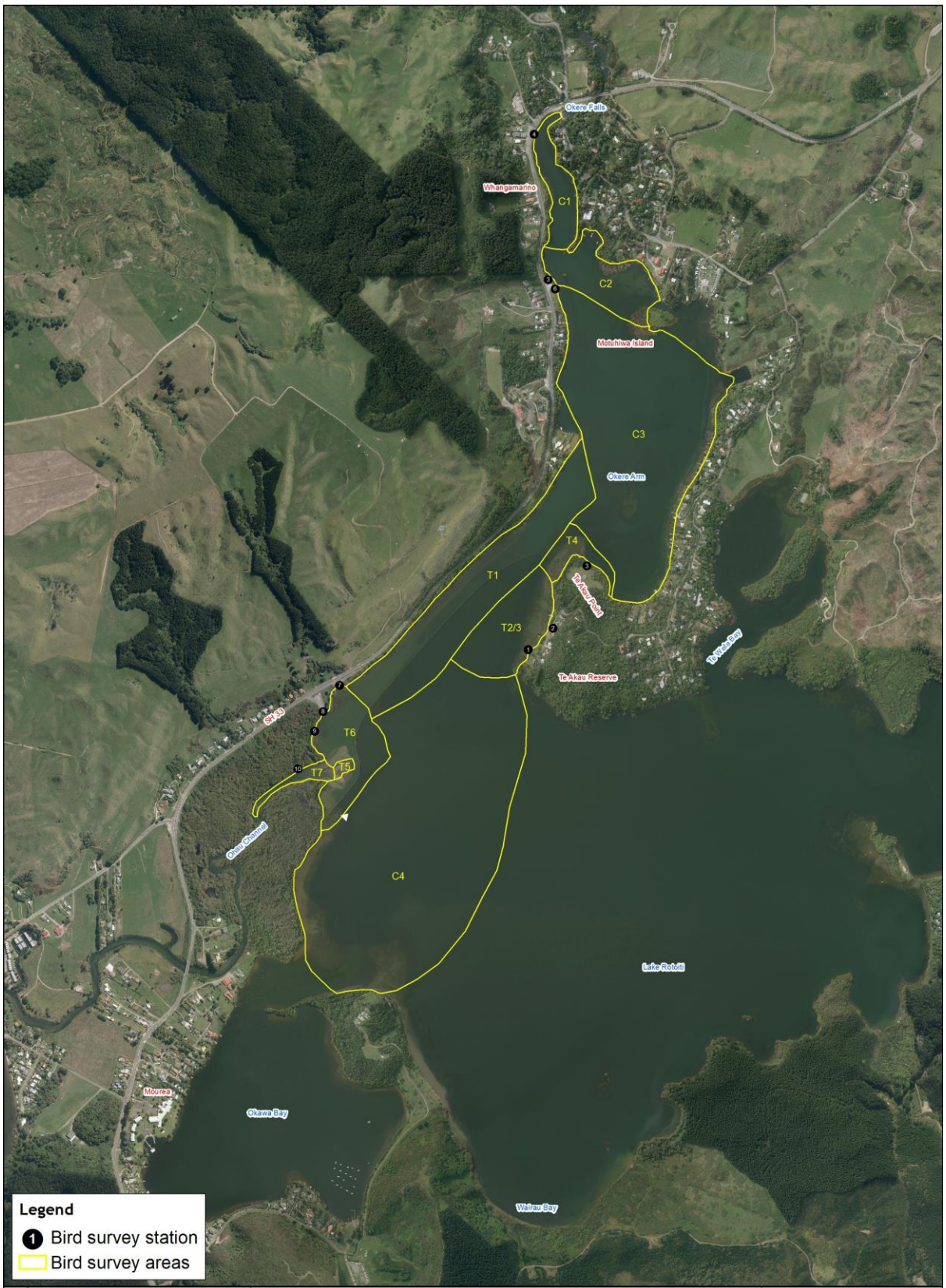

Figure 2. Bird survey stations and survey areas at Lake Rotoiti

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 Ōhau 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 2013 (see next section).

3. EXISTING INFORMATION

An initial 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 2012, have been reported previously: Wildland Consultants (2007, 2008, 2009, 2010, 2011, 2012, and 2013).

Lake Rotoiti was included in a major region-wide 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 have been surveyed on a five-yearly basis at Lake Rotoiti (and 16 other Rotorua lakes) in 1985, 1991, 1996, 2001, 2006, and 2011. 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 dabchick at the Ōhau 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 and has continued to May 2014 (nine years), and is ongoing.

Figure 1 shows the location of the study area and the diversion wall at the western end of Lake Rotoiti.

Study Area Sectors

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

From March 2008, count area T1 has been split into three sub-sites and related observation locations, to enable 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 roosting on the wall).

- T1A - all birds roosting on the wall, as observed from a 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 an observer walking along SH 33).

From December 2007, count area T6 has been split into two sub-sites, to reflect that the newly-constructed wall now comprises the eastern and southern boundary of the count area:

- T6 - all birds on the water that can be seen from the boat ramp jetty adjacent to SH 33, near the mouth of the Ōhau Channel.

- T6A - all birds roosting on the section of wall south of a 'line' between the Te Akau Road jetty and the SH 33 jetty.

The four control areas are located in open expanses of water away from the diversion wall. Monitoring of treatment sites began in May 2005, while monitoring of control sites began in July 2005. Comparison between control and treatment survey areas enables 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, and human-induced events or processes.

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

Survey Area	Site Name	Count Duration[1]	Approximate Area (ha) of Survey Area	Observation Station(s)	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 Ōhau 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: • 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 Ōhau 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 Area	Observation Station(s)	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[1]	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.
T5	Delta	5-10 minutes	*c.*0.6 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 Ōhau Channel. If the delta is submerged, record any birds in the vicinity of the delta.

[1] C1-C4 are 'control' sites, outside of the construction zone.

Survey Area	Site Name	Count Duration[1]	Approximate Area (ha) of Survey Area	Observation Station(s)	Notes
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 Ōhau Channel boat ramp. Station 9 - shoreline between boat ramp and Ōhau 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	Ōhau Channel mouth	5-10 minutes	*c.*1 ha	Station 10 - water level stage, Ōhau Channel.	Record all birds in Ōhau Channel not recorded in areas C4, T5, and T6.

Recording

Each water bird seen or heard within each survey area during the monitoring period was identified and recorded. Terrestrial bird species were generally recorded by presence/absence only, although numbers have been recorded for seven terrestrial species: pheasant, California quail, kereru, 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

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

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 from 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 the difficulty of differentiation between red-billed gulls and black-billed gulls; and little black shags and juvenile little shags).
- Actively-moving birds.
- Large groups (e.g. little black shags and little shags at the Ōhau Channel Delta), where individual birds can be hidden behind other birds.
- Uncounted birds - birds leaving a count zone, prior to the count, and flying to other parts of a survey area that has already been counted.

Factors that May Increase a Count

- Birds fleeing from observers and other people using the lake and being counted twice (see above).
- Misidentifications (see above).
- Actively-moving birds.
- Counted birds leaving a count zone and then 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. All field surveyors know the birds that are likely to be present at Lake Rotoiti, which means that misidentifications are unlikely.

5. MONITORING RECORDS 2005-2014

A total of 48 bird species have been recorded over the period May 2005 to May 2014 (Table 2). Thirty of these species are indigenous, while 18 species are introduced (including mallard/grey duck hybrids). Nine of the indigenous species are classified as 'Threatened' or 'At Risk' by Robertson *et al*. (2013). No new species were recorded in the study area in the 2013-14 survey. Of the species recorded previously during the first seven years of this study, 12 were not recorded in the June 2013 to May 2014 period: Australasian bittern, royal spoonbill, feral goose, grey teal, Australasian shoveler, California quail, pied stilt, kereru, eastern rosella, skylark, yellowhammer, and Australian magpie. None of these species were commonly recorded in monthly surveys in the two years prior to wall construction.

Table 2: Bird species recorded during surveys at the western end of Lake Rotoiti between May 2005 and May 2014. Threat status is from Robertson *et al.* 2013. [1]

Common Name	Scientific Name	Threat Classification
Grebes (family name: podicipedidae)		
New Zealand dabchick; weweia	*Poliocephalus rufopectus*	Threatened-Nationally Vulnerable
Shags (phalacrocoracidae)		
Black shag; kawau	*Phalacrocorax carbo*	At Risk-Naturally Uncommon
Little black shag	*Phalacrocorax sulcirostris*	At Risk-Naturally Uncommon
Little shag; kawaupaka	*Phalacrocorax melanoleucos*	Not Threatened
Herons, bitterns and egrets (ardeidae)		
White-faced heron; kotuku	*Ardea novaehollandiae*	Not threatened
Australasian bittern (matuku)	*Botaurus poiciloptilus*	Threatened-Nationally Endangered
Royal spoonbill	*Platalea regia*	At Risk-Naturally Uncommon
Waterfowl (anatidae)		
Black swan	*Cygnus atratus*	Not threatened
Canada goose	*Branta canadensis*	Introduced

[1] Morepork (*Ninox novaeseelandiae*) have not been recorded in monthly surveys undertaken to date. Morepork are likely to utilise lake margin habitats present, but as all surveys have been during daylight hours this nocturnal species has not been recorded.

Common Name	Scientific Name	Threat Classification
Feral goose	*Anser anser*	Introduced
Paradise shelduck; putangitangi	*Tadorna variegata*	Not threatened
Mallard	*Anas platyrhynchos*	Introduced
Grey teal; tete	*Anas gracilis*	Not threatened
Australasian shoveler; kuruwhengi	*Anas rhynchotis*	Not threatened
New Zealand scaup; papango	*Aythya novaeseelandiae*	Not threatened
Raptors (accipitridae and falconidae)		
Australasian harrier; kahu	*Circus approximans*	Not threatened
Game birds (phasianidae)		
California quail	*Callipepla californica brunnescens*	Introduced
Pheasant	*Phasianus colchicus*	Introduced
Rails, gallinules and coots (rallidae)		
Pukeko	*Porphyrio porphyrio*	Not threatened
Australian coot	*Fulica atra*	Coloniser
Stilts and avocets (recurvirostridae)		
Pied stilt; poaka	*Himantopus himantopus*	At Risk-Declining
Plovers, dotterels and lapwings (charadriidae)		
Spur-winged plover	*Vanellus miles*	Not threatened
Gulls, terns and noddies (laridae)		
Black-backed gull; karoro	*Larus dominicanus*	Not threatened
Red-billed gull; tarapunga	*Larus novaehollandiae*	Threatened-Nationally Vulnerable
Black-billed gull	*Larus bulleri*	Threatened-Nationally Critical
Caspian tern; taranui	*Hydroprogne caspia*	Threatened-Nationally Vulnerable
Parrots (Psittacidae)		
Eastern rosella	*Platycercus eximus*	Introduced
Pigeons and doves (columbidae)		
New Zealand pigeon; kereru	*Hemiphaga novaeseelandiae*	Not threatened
Cuckoos (cuculidae)		
Shining cuckoo; pipiwharauroa	*Chrysococcyx lucidus*	Not threatened
Kingfishers (alcedinidae)		
Sacred kingfisher; kotare	*Todiramphus sanctus*	Not threatened
Larks (alaudidae)		
Skylark	*Alauda arvensis*	Introduced
Swallows and Martins (hirundinidae)		
Welcome swallow	*Hirundo tahitica*	Not threatened
Accentors (prunellidae)		
Dunnock	*Prunella modularis*	Introduced
Thrushes (muscicapidae)		
Blackbird	*Turdus merula*	Introduced
Song thrush	*Turdus philomelos*	Introduced
Australasian warblers (acanthizidae)		
Grey warbler; riroriro	*Gerygone igata*	Not threatened
Monarch flycatchers (monarchidae)		
North Island fantail; piwakawaka	*Rhipidura fuliginosa* subsp. *placabilis*	Not threatened
White-eyes (zosteropidae)		
Silvereye; tauhou	*Zosterops lateralis*	Not threatened
Honeyeaters (meliphagidae)		
Bellbird; korimako	*Anthornis melanura*	Not threatened
Tui	*Prosthemadera novaeseelandiae*	Not threatened
Finches (fringillidae)		
Yellowhammer	*Emberiza citrinella*	Introduced
Chaffinch	*Fringilla coelebs*	Introduced
Greenfinch	*Carduelis chloris*	Introduced

Common Name	Scientific Name	Threat Classification
Goldfinch	*Carduelis carduelis*	Introduced
Sparrows and Weavers (ploceidae)		
House sparrow	*Passer domesticus*	Introduced
Starlings and Mynas (sturnidae)		
Starling	*Sturnus vulgaris*	Introduced
Indian myna	*Acridotheres tristis*	Introduced
Bell Magpies (cracticidae)		
Australian magpie	*Gymnorhina tibicen*	Introduced

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

6. THREATENED AND AT RISK SPECIES

Bird species recorded in the project area and ranked as Threatened or At Risk species in Robertson *et al*. (2013) are listed below, with comments on their respective New Zealand populations; summarised from Heather and Robertson (2005) and www.nzbirdsonline.org.nz.

Threatened-Nationally Critical

Black-billed gull - New Zealand endemic. *c.*90,000 individuals in New Zealand in 1996 (5% of these are in the North Island) (McClellan and Habraken 2013). Threat classification has increased from Chronically Threatened-Serious Decline (Hitchmough *et al.* 2007) and Threatened-Nationally Endangered (Miskelly *et al.* 2008).

Threatened-Nationally Endangered

Australasian bittern - Indigenous. Widely distributed in freshwater wetlands throughout New Zealand. The current population is thought to be fewer than 900 individuals in New Zealand, but data is poor (Williams 2013). Population is likely to have declined through wetland drainage and infilling, and pastoral development of extensive lowland habitats (Heather and Robertson 2005).

Threatened-Nationally Vulnerable

Caspian tern - *c.*1300-1400 breeding pairs in New Zealand (Fitzgerald 2013). Sizes of colonies vary from year to year, but rarely exceed 100 pairs. An almost cosmopolitan species - breeding in all temperate continental regions except South America (Heather and Robertson 2005). 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 (Heather and Robertson 2005). Threat classification has deteriorated from Chronically Threatened-Gradual Decline (Hitchmough *et al.* 2007).

Table 3: Status of birds in study area during the nine years (May 2005-May 2014) of surveys associated with the Ōhau Channel diversion wall at Lake Rotoiti.

Bird Species	Status in Vicinity of Proposed Wall	Status in Control Sites	Broods/ Nesting Recorded May 2005-May 2012 Surveys	Broods/ Nesting Recorded June 2013-May 2014	Notes
New Zealand dabchick	Common	Common	✓	✓	Common and have bred throughout study area Dabchick broods have been recorded in treatment and control areas in most years..
Black shag	Occasional	Occasional (may be increasing)			Recorded occasionally from open water habitats between 2006 and 2010. Recorded with increased numbers since August 2010, roosting on the diversion wall by the Ōhau 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 Ōhau Channel.
Black swan	Common	Common	✓	✓	Common in open water habitat and lake margins throughout the study area. Broods recorded regularly in control and treatment areas.
Royal spoonbill	Occasional	Not recorded			One bird recorded on two occasions: October and November 2012.
Canada goose	Occasional	Occasional (increasing)	✓		Recorded occasionally up to April 2009, mostly in control areas, but also occasionally present near the delta and Ohau channel. Recorded regularly, mainly at the Okere Falls end of the lake (C2), since April 2009. No broods recorded in 2013-2014
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 Ōhau Channel delta (sometimes in large flocks e.g. 72 birds in March 2007, 46 birds in March 2011), or in the Ōhau Channel itself. Rare in 2013-14 in the study area.

Bird Species	Status in Vicinity of Proposed Wall	Status in Control Sites	Broods/ Nesting Recorded May 2005-May 2012 Surveys	Broods/ Nesting Recorded June 2013-May 2014	Notes
Mallard	Occasional	Occasional	✓		Recorded occasionally throughout study area.
Australasian shoveler	Occasional	Not recorded			Recorded occasionally in delta area (east of Ōhau Channel).
Grey teal	Occasional	Occasional			Recorded occasionally, throughout study area.
New Zealand scaup	Common	Common	✓	✓	Common throughout open water habitats. One of the most common species present in study area. Broods recorded from control and treatment sites in June 2010 to May 2011 surveys.
Australian harrier	Occasional	Occasional			Recorded occasionally, flying over study area.
California quail	Occasional	Occasional			Recorded for the first time during the monthly surveys in November 2011. Likely to be common in surrounding terrestrial habitats.
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 2013 to May 2014 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 Ōhau Channel Delta.
Black-backed gull	Usually present	Occasional			Recorded occasionally throughout the study area. Seen regularly at Ōhau 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 at Ōhau Channel delta, particularly during winter months, Note: habitat suitable for Caspian terns were not always present every year prior to wall construction.
Eastern rosella	Occasional	Occasional			More common in surrounding terrestrial habitats than on lake margins.

Bird Species	Status in Vicinity of Proposed Wall	Status in Control Sites	Broods/ Nesting Recorded May 2005-May 2012 Surveys	Broods/ Nesting Recorded June 2013-May 2014	Notes
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.
Dunnock	Common	Common			Occasionally present in lake margin terrestrial habitat.
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.
Yellowhammer	Occasional	Occasional			More common in surrounding terrestrial habitats than on lake margins.
House sparrow	Common	Common			Common in lake margin terrestrial habitat.
Chaffinch	Common	Common			Common in lake margin terrestrial habitat.
Greenfinch	Occasional	Occasional			More common in surrounding terrestrial habitats than on lake margins.
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.

New Zealand dabchick - New Zealand endemic. An estimated population *c.*1,900-2,000, almost all in the North Island (Szabo 2013b), with *c.*500 present on the Volcanic Plateau (Heather and Robertson 2005). 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 - Unknown population, but probably increasing slowly and may number several thousand birds in New Zealand (Armitage 2013) . More common in the north than south of New Zealand.

Black shag - No attempt has been undertaken to assess the population of black shag on a nationwide basis, however the population in 2012 was estimated to be between 5,000-10,000 individuals, scattered throughout New Zealand (Powlesland 2013).

Royal spoonbill - the population appears to be increasing, with censuses undertaken in 1977 (52 birds) and 1996 (659 birds) Szabo (2013a).

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 have fluctuated over the period 2005 to 2014.

New Zealand dabchick

Dabchick have been observed most commonly on larger areas of open water such as the Treatment 1 and Control 3 sites, but are usually scattered throughout the study area. Total numbers counted have fluctuated throughout the 2013-14 year ranging from three birds in April 2013 to 52 birds in October 2013.

Over the period of this study the highest number of dabchicks (31) in the treatment area was recorded in April 2007.

The average number of birds recorded during each year in the treatment and control sites has been relatively stable, with the total number of birds recorded remaining within the range of the standard deviation.

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 Ōhau Channel diversion structure: June 2005 to May 2014.

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)
2011-2012	18.8	(6.8)	12.9	(5.1)
2012-2013	17.3	(7.0)	10.2	(1.9)
2013-2014	14.1	(8.6)	12.1	(5.2)

Black shag

Black shag, previously recorded only occasionally in the study area, have been recorded in generally greater numbers since August 2010. The highest count of 39 birds was recorded in December 2011, with 20 of these being in the treatment area. Black shag regularly use the wall for resting and drying their wings, and have used the wall on a regular basis since November 2009.

Little black shag

Little black shag are common throughout the study area. The highest number (194) was recorded in August 2006, with *c.*163 birds present on the Ōhau Channel Delta (T5). The number recorded varies greatly between surveys. Little black shag are most commonly seen roosting on the diversion wall, adjacent to the Ōhau 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 shag are common in the study area, and have been recorded throughout the duration of the study. The highest number of little shag recorded in the vicinity of the diversion wall was 64 in August 2012. Little shag are most commonly seen roosting on the diversion wall adjacent to the Ōhau Channel mouth, or roosting (but in lower numbers than little black shag) 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 swan are common, with the highest number 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 swan appear to congregate in the largest areas of open water (e.g. Treatment 1 and Control 4). Results to date indicate that numbers of black swans fluctuate between

years, and within season, rather than showing any long-term trend. Analysis of long-term data since May 2005 shows that black swan are most common on the lake during summer, while numbers are lowest over winter. The 2013-2014 reporting year had the highest average number of black swans recorded (101.4 birds) since the beginning of the project in 2005-2006. The previous highest monthly average in a recording year was in the 2009-2010 reporting year, with a monthly average of 79.2 birds.

New Zealand scaup

New Zealand scaup are very common throughout and have been recorded from all survey areas over the duration of this study. The greatest number recorded in the project area to date was 590 in January 2010 (388 birds in the control areas and 202 within the treatment areas). While numbers fluctuate between years and within seasons, numbers have remained relatively even between control and treatment areas. Overall the fluctuations between years appears greater than any long-term change in numbers.

Australian coot

Australian coot are very common throughout the study area. The highest count, of 450, was recorded in July 2010, with 238 present in treatment areas and 212 within control areas. Fluctuations vary from year to year but, overall, the population appears to be stable.

Black-backed gull

Black-backed gull are occasionally present, occurring throughout the study area, although relatively large numbers of birds have been recorded at the Ōhau Channel delta. Highest tallies were recorded at the delta in April 2006 (51), August 2006 (16), and December 2006 (15).

Red-billed gull

Red-billed gull have been recorded in moderate numbers throughout the survey areas. The highest count of 46 birds was recorded in February 2013, with 45 of these in treatment areas. Red-billed gulls are continuing to make use of the wall for roosting.

Black-billed gull

Black-billed gull have been recorded throughout the survey area and have been recorded at least once from all sites since monitoring began. However most birds observed are within treatment sites. A high of 124 was recorded in August 2006, with 122 present at the Ōhau Channel delta. The lowest average monthly number of black-billed gulls recorded since monitoring began as part of this project was in the 2013-2014 reporting year with an average of 2.8 gulls recorded. The previous lowest value recorded was 3.2 in 2005-2006 reporting year, before the wall was constructed.

Table 5: Monthly mean numbers of key open water bird species in the vicinity of the Ōhau Channel diversion wall before, during, and after wall construction (C = control area; T = treatment area), June 2005 to May 2014.

Project Phase (approximate)	Pre-Construction (to end of May 2007)						Construction Period (June 2007-Sept 2008)			Post-Construction (Oct 2008 - May 2014)																
Species	2005-2006			2006-2007			2007-2008			2008-2009			2009-2010			2010-2011			2011-2012			2012-2013			2013-2014		
	C	T	Total	C	T	Total	C	T	Total	C	T	Total	C	T	Total	C	T	Total	C	T	Total	C	T	Total	C	T	Total
NZ 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	18.8	12.9	31.8	17.3	10.2	27.4	14.1	12.2	26.3
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	9.3	9.9	18.4	4.3	3.0	7.3	6.3	5.6	11.1
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	8.9	10.8	19.8	7.9	18.6	26.5	5.1	14.8	19.8
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	4.5	19.0	23.5	1.2	10.4	11.6	2.3	9.9	12.3
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	34.3	27.9	62.3	32.8	37.8	70.7	63.2	38.3	101.4
NZ 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	151.0	126.4	277.5	61.2	108.8	169.9	58.8	107.3	166.1
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	93.3	77.3	170.5	101.6	85.1	186.7	116.5	110.3	226.8
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	0.3	4.3	4.6	0.4	2.8	3.3	0.8	2.3	3.2
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	0.5	7.5	8.0	2.8	10.3	13.1	2.2	7.1	9.3
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	1.6	4.9	7.1	1.1	7.9	9.0	0.6	2.3	2.8
All gulls (including unidentified spp.)	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	2.4	16.8	19.3	4.3	21.0	25.4	3.6	11.6	15.3
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	0.0	<0.1	,0.1	0	2.1	2.1	0.0	2.2	2.2

Caspian tern

Caspian tern have been recorded at the Ōhau Channel delta over most of the study period. They were recorded over the period 2005-2009, between the months May to October, but were not recorded in 2010-2011. Only one was recorded in 2011-2012, recorded flying over the control area in September 2011. Caspian tern were present at the delta in 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 likely explanation for the absence of records during 2010-2012 is that the small 'island' at the delta had become overgrown with vegetation, reducing its suitability as roosting habitat for Caspian tern. In 2011-12 much of the delta was under water as the lake level was relatively high and vegetation on the 'island' has died, making it usable again as a roost site.

In 2012-13 Caspian terns were present over a much wider period than other years, being present at the delta in June (12), July (1), September (2), October (1), December (1), January (1), March (1), April (4), and May (2). A small group (4) were also recorded in June 2012 (W.B. Shaw, Wildland Consultants Ltd, pers. obs), outside of the monthly counts.

Caspian terns continued to be present over a wider part of the year in 2013-14. Caspian terns were present at the delta in the following months (number of birds in brackets): June (1), July (1), August (1), September (1), October (2), November (2), April (1), and May (17).

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 2014. Juveniles of all of these species, except for pukeko, Canada goose, and mallard were recorded in the 2013-2014 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 season[1], 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.

[1] Each breeding season is within the relevant study year.

- *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).

- *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).

- *June 2011 to May 2012* (*Post-Construction*)

  Individual dabchick young were recorded between January and April 2012, but no young were recorded earlier in the 2011-12 breeding season. In control areas, birds were recorded in Areas 5A and 5B, with four young recorded in January, and one in March. In treatment areas, one large juvenile was recorded near the jetty at the Ōhau Channel outlet in February 2012, two large juveniles in March between the wall and the highway, and one large juvenile was present in April.

- *June 2012 to May 2013* (*Post-Construction*)

  Dabchick young were recorded between October 2012 and March 2013. For control areas, young were recorded in Areas 5A, 5B, and in the area of open water south of the wall at the western end of the lake (Area C4). In treatment areas, young were recorded close to the wall in October 2012, February 2013, and March 2013.

- *June 2013 to May 2014* (*Post-Construction*)

  Dabchick young were recorded between December 2013 and February 2014. For treatment areas, young were recorded in open water near Te Akau Reserve (T4) and in open water near the wall (Area T1). Young were also recorded from control area in the northeastern end of the lake.

- *Summary*

  Dabchick have been recorded with broods in open water habitats, prior to wall construction, during wall construction, and throughout the post-construction phase and young have been recorded on the lake in each reporting year.

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-Ōhau 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-Ōhau Channel mouth).

- *June 2011 to May 2012*

  No black swan young were recorded in treatment areas in the 2011-12 breeding season. Individual cygnets were recorded during July 2011 (two large), November (one medium), December (two medium) and January 2012 (two large). All records of cygnets in the 2011-12 year were from the Okere Falls sector of the lake.

- *June 2012 to May 2013*

  Black swan cygnets were recorded in treatment and control areas between September 2012 and May 2013.

- *June 2013 to May 2014*

  Black swan cygnets were recorded in treatment and control areas throughout the reporting year.

- *Summary*

  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.

- *June 2011 to May 2012*

  Only one group of mallard young was recorded in the 2011-12 breeding season: five small juveniles in open water adjacent to the reserve at the end of the Te Akau peninsula.

- *June 2012 to May 2013* and *June 2013 to May 2014*

  No records.

- *Summary*

  Mallard are occasionally using habitats in the vicinity of 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).

- *June 2011 to May 2012*

  Scaup were considerably more productive in the 2011-2012 year than during the previous year. Juveniles recorded in 2011-2012 were:

  - December 2011: 13 small juveniles and one medium-sized juvenile were recorded from control areas and three small juveniles were recorded from treatment areas.
  - January 2012: four small juveniles and two medium-sized juveniles in control areas, and seven medium-sized juveniles in treatment areas.
  - February 2012: one small and two medium-sized juveniles in control areas, and four small and four medium-sized juveniles in treatment areas.
  - March 2012: no juveniles in control areas, three medium-sized juveniles and one large juvenile in treatment areas.

- *June 2012 to May 2013*

  All scaup broods were recorded between December 2012 and March 2013:

  - December 2012: one small juvenile was recorded from control areas, no young were recorded from treatment areas.
  - January 2013: four medium juveniles and one small-sized juvenile were recorded from treatment areas, no young were recorded from control areas.
  - February 2013: four large-sized juveniles were recorded in control areas. No young were recorded from treatment areas.
  - March 2013: three medium-sized juveniles were recorded in treatment areas and three medium-sized young were recorded in control areas.

- *June 2013 to May 2014*

  All scaup broods were recorded between January 2013 and February 2014:

  - January 2014: 16 small juveniles were recorded from control areas and no young were recorded from treatment areas.
  - February 2014: four large-sized juveniles were recorded in control areas. No young were recorded from treatment areas.

- *Summary*

  New Zealand 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*

  Coot broods were only 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*

  Coot broods were only recorded between January and May 2009. During this period, 19 were recorded in control areas and nine were recorded in treatment areas.

- *June 2009 to May 2010*

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

- *June 2010 to May 2011*

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

- *June 2011 to May 2012*

  Considerably more coot juveniles were recorded in the study area in the 2011-12 breeding year than in the previous year. All but one bird (one small juvenile in January 2012) were recorded from control sites. In control sites, two small and two large juveniles were recorded in November; two small and three medium-sized juveniles in December, seven small and three large juveniles in January, seven large juveniles in February, three small and one large juvenile in March, two medium-sized juveniles in April, and one large juvenile in May.

- *June 2012 to May 2013*

  Unlike 2011-12, juvenile coot were recorded across control and treatment sites in 2012-13. Broods were recorded between December 2012 and May 2013. Monthly counts included 23 juveniles in control areas, and eight juveniles in treatment areas.

- *June 2013 to May 2014*

  Broods were recorded from control and treatment parts of the survey area. between October 2013 and May 2014.

- *Summary*

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

9. USE OF THE WALL AS A ROOST

Shags and gulls regularly roost on the wall, individually or in small groups, as well as occasionally being observed in the water or flying within 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 following construction) have increased substantially since construction of the wall, mainly due to the increased availability of roosting habitat (Table 6). This was particularly noticeable for shags in the 2011-12 year. Gulls have also increased adjacent to the wall since construction began in June 2007.

Table 6: Mean monthly count totals of shags and gulls roosting on the Ōhau Channel diversion wall, in Survey Areas T1, T1A, T6, and T6A, at the western end of Lake Rotoiti.

Species	Phase					
	Pre-Construction (May 2005-May 2007)	Construction (June 2007-September 2008)	Post-Construction			
			October 2008-May 2011	June 2011-May 2012	June 2012-May 2013	June 2013-May 2014)
Black shag	0.0	0.0	1.2	8.7	1.1	3.8
Little shag	0.8	1.7	5.7	10.1	4.8	9.1
Little black shag	2.9	3.3	9.9	18.5	1.5	13.8
Total shags	**3.7**	**5.0**	**16.8**	**37.3**	**7.4**	**26.7**
Black-backed gull	0.1	0.4	2.6	4.1	0.5	1.3
Red-billed gull	0.5	2.7	6.7	6.0	7.4	5.5
Black-billed gull	1.0	5.9	8.9	4.3	3.5	1.0
Total - all gulls (incl. gulls not identified to species)	**1.6**	**9.0**	**18.2**	**14.3**	**11.4**	**7.8**

10. DISCUSSION

Bird count data collected from May 2005 to May 2007 provides a useful baseline measure of species and numbers utilising habitats in the vicinity of the diversion wall prior to construction. Data collected from June 2007 to May 2013 have enabled analysis of seasonal and yearly differences in bird populations during the construction and post-construction phases.

Key open water bird species with 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 until 2009, then the absence of records in 2010-2011 and only one bird in 2011-2012, although they were seen at the delta, but outside of the formal monthly counts. Caspian terns have utilised habitats adjacent to the diversion structure prior to, during, and following wall construction. In 2012-13 and 2013-14 Caspian terns were present over a much longer period of the year than in previous years, including summer and autumn months, when they have not been recorded previously in this survey. The number of Caspian terns using this part of the lake can be expected to vary depending on suitable roosting habitat being available, particularly in relation to the small 'island' at the delta. Vegetation cover on this 'island' reduces bird use, but it is currently more open. Numbers of Caspian tern are likely to vary naturally from year-to-year, regardless of whether the wall had been constructed.

Other observations of interest since construction of the diversion wall are:

- All key water bird species have continued to utilise the control and treatment survey areas selected to monitor the effects of the diversion wall.

- Numbers of dabchick have fluctuated between years but, overall, the number of birds appears to have remained relatively stable in both control and treatment areas.

- The top of the diversion wall has become a locally important roosting site for three gull species and three shag species. Black shag numbers in the vicinity of the wall increased markedly in the 2011-12 year. Although such a high number has not been recorded again, numbers recorded are consistent and higher than pre-construction. Numbers recorded in 2013-2014 were higher than the previous year.

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