BIRD MONITORING IN THE VICINITY OF THE OHAU CHANNEL DIVERSION STRUCTURE AT LAKE ROTOITI - 2008 PROGRESS REPORT

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Report No. 2004

Prepared for:

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1. INTRODUCTION

Environment Bay of Plenty has been granted resource consent to build a wall structure in Lake Rotoiti, to stop water from flowing from Lake Rotorua into the main body of Lake Rotoiti via the outlet to the Ohau Channel. One of the 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 of 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".

Environment Bay of Plenty commissioned Wildland Consultants 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 2007 to May 2008.

2. BACKGROUND

The wall structure is anchored into the floor of Lake Rotoiti and rises 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 down 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 through the Ohau Channel.

With this type of proposal, it is difficult to assess ecological affects with precise accuracy prior to its construction. Monitoring of ecological effects, including birds, was undertaken for two years before wall construction, which commenced in May 2007. Preliminary results from this period were presented in Wildland Consultants (2007). This report provides results for the construction period between June 2007 and May 2008. The wall was nearing completion at the end of this period.

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.

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

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Wildlands

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

Follow-up monitoring is reported on by Wildland Consultants (2007).

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 has been 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 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 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

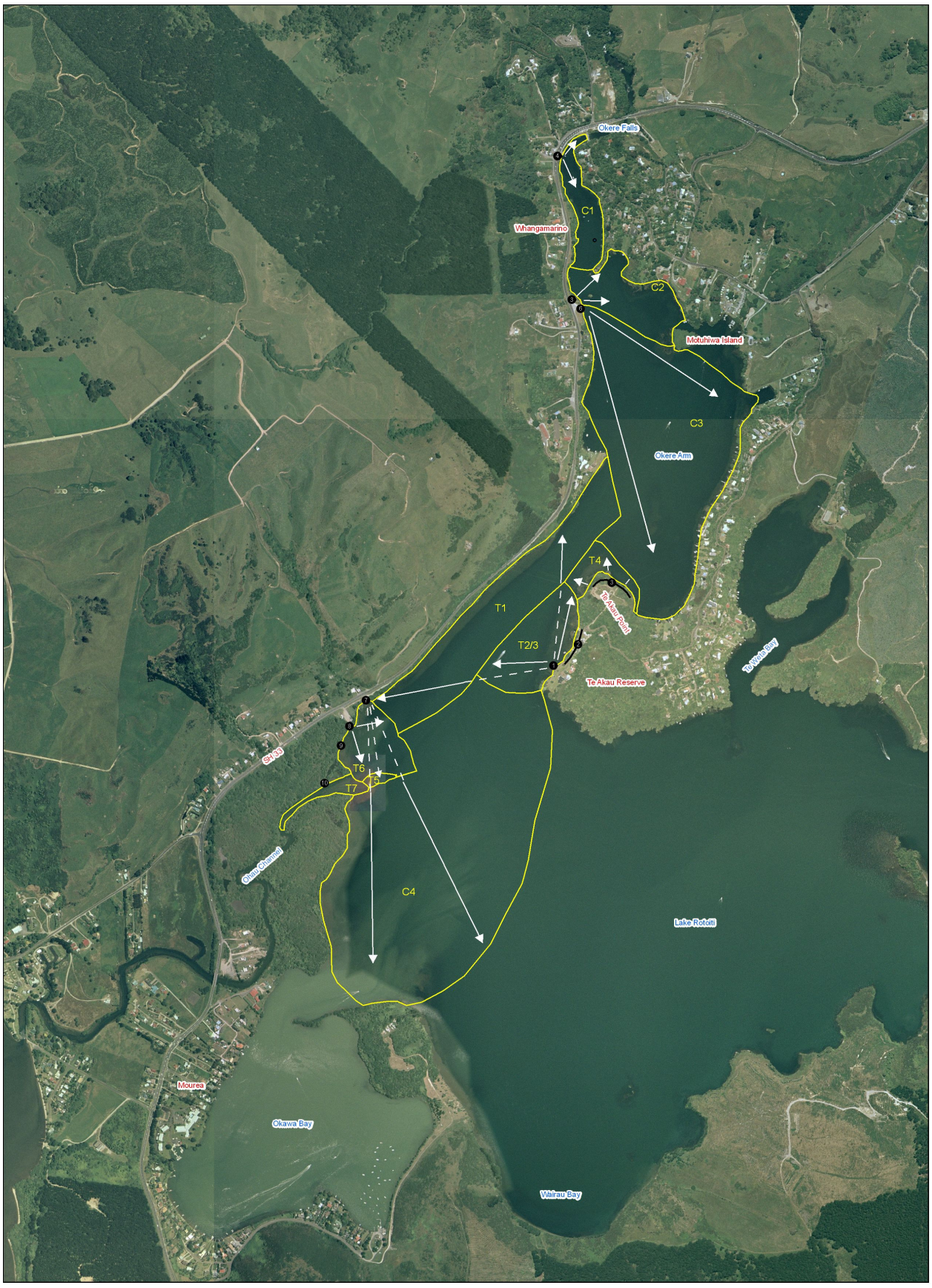
Monthly bird monitoring for this study commenced at Lake Rotoiti in May 2005 and is ongoing. Counts are undertaken at monthly intervals. Figure 1 shows the location of the study area and the diversion wall at the western end of Lake Rotoiti.

Study Areas

The study has six pre-construction monitoring sites prior to May 2007 adjacent to the diversion wall and four control study sites away from the wall. The six treatment sites (T1, T2/3, T4, T5, T6, and T7 - refer to Figure 2) encompass most of the open water habitats adjacent to the diversion wall. The four control sites (C1, C2, C3, and C4 - refer to Figure 2) have also been surveyed since July 2005, and are located in open bodies of water away from the diversion wall. Comparisons between control and treatment survey areas will enable analysis of any 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 at different times of the year and seasons due to both environmental and human-induced events. In total, birds have been counted and recorded in ten survey areas from ten stations (see Table 1 and Figure 2 for location of each survey area and survey stations, and methods utilised for each survey area).

From March 2008 Site T1 has been 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;
- T1B - the wall now obscures some areas viewed previously from shoreline sites, and T1B includes birds recorded from the western side of the survey area.



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Legend

- 1 Bird survey station
- C1 Bird survey areas

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

0 500 1,000 m

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Wildlands

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

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 magpie. Juvenile 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.

Optical Aids

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

Weather

Counts were generally undertaken during settled weather as waves make accurate counts too difficult.

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) refer to factors that reduce or increase numbers recorded compared to actual numbers present. These are outlined below with some additions relevant to this particular study.

Factors that May Reduce a Count

- 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 users (e.g. boats, canoes on lake, and people fishing on margins).
- Misidentifications (most likely in this survey for birds that are in the distance, particularly between red-billed gulls and black-billed gulls; Australian coots and New Zealand scaup; and little black shag and juvenile little shags).
- Actively moving birds.
- Dense populations (e.g. little black shags and little shags on Ohau Channel Delta) where birds can be hidden behind other birds.
- Uncounted birds - birds leaving the count zone and flying to other parts of survey area that have already been counted.

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]	North-western side of the proposed diversion wall	10-15 minutes	*c.*17.9 ha	Station 1 (from jetty).	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). Since March 2007 this area has been split into three sub-sites - see Section 4.
T2/3	South-eastern side of the proposed diversion wall	5-10 minutes (as well as walk along shoreline for Station 2)	*c.*7.3 ha	Station 1 (from jetty) and any additional birds recorded along shoreline while doing a walk through inspection in front of houses (Station 2).	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 here. Do not record any birds recorded in Survey Area T1. 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.* 2.2 ha	Station 3.	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.*3.6 ha	Station 4.	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.*6.5 ha	Station 5	Record any birds in the central end of Okere Inlet to approximately the south end of Motuhiwa Island. Do not count any birds that

[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.

[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
					have/will be recorded in Areas C1 or C3.
C3	Okere Inlet (south)	5-10 minutes	*c.*37.2 ha	Station 6	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.*60.3 ha	Station 7	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.*43.7 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 such a distance).
T6	Boat ramp	5 minutes, and any additional birds recorded from Station 9 (quick inspection only)	*c.*4.0 ha	Station 8 and 9	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)
T7	Ohau Channel mouth	5-10 minutes	*c.*1.1 ha	Station 10	Record all birds in Ohau Channel (not recorded in areas C4, T5 and T6)

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 reappearing in other parts of the lake which have not yet been counted.

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 2005-2008

A total of 40 bird species have been recorded during the first three years of monitoring (Table 2). Twenty-seven of these species are indigenous and 13 species are introduced. One additional species (feral goose) was recorded in the June 2007 to May 2008 surveys. Seven of the indigenous species are classified as threatened or at risk by Hitchmough *et al*. (2007). Of the species recorded previously during the surveys, the following nine species were not recorded in the May 2007 to May 2008 period: grey teal, Australasian shoveler, California quail, pheasant, skylark, dunnock, yellowhammer, greenfinch, and redpoll. None of these species were commonly recorded in the 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 2008. Threat status is given for indigenous species (as per Hitchmough *et al*. 2007)[1].

Common Name	Scientific Name	Status
Grebes (family name: podicipedidae)		
New Zealand dabchick (weweia)	*Poliocephalus rufopectus*	Sparse
Shags (phalacrocoracidae)		
Black shag (kawau)	*Phalacrocorax carbo*	Sparse
Little black shag	*Phalacrocorax sulcirostris*	Range restricted
Little shag (kawaupaka)	*Phalacrocorax melanoleucos*	Not threatened
Herons, bitterns and egrets (ardeidae)		
White-faced heron	*Ardea novaehollandiae*	Not threatened
Waterfowl (anatidae)		
Black swan	*Cygnus atratus*	Not threatened
Canada goose	*Branta canadensis*	Introduced
Feral goose	*Anser anser*	Introduced
Paradise shelduck	*Tadorna variegata*	Not threatened

[1] 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*), morepork (*Ninox novaeseelandiae*).

Common Name	Scientific Name	Status
(putangitangi)		
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 (accipteridae and falconidae)		
Australasian harrier (kahu)	*Circus approximans*	Not threatened
Gamebirds (phasianidae)		
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	*Himantopus himantopus*	Not threatened
Plovers, dotterels and lapwings (charadriidae)		
Spur-winged plover	*Vanellus miles*	Not threatened
Gulls, terns and noddies (laridae)		
Black-backed gull	*Larus dominicanus*	Not threatened
Red-billed gull	*Larus novaehollandiae*	Gradual decline
Black-billed gull	*Larus bulleri*	Serious decline
Caspian tern	*Sterna caspia*	Nationally vulnerable
Cuckoos (cuculidae)		
Shining cuckoo	*Chrysococcyx lucidus*	Not threatened
Kingfishers (alcedinidae)		
Sacred kingfisher	*Todiramphus sanctus*	Not threatened
Swallows and Martins (hirundinidae)		
Welcome swallow	*Hirundo tahitica*	Not threatened
Thrushes (muscicapidae)		
Blackbird	*Turdus merula*	Introduced
Song thrush	*Turdus philomelos*	Introduced
Australasian warblers (acanthizidae)		
Riroriro, grey warbler	*Gerygone igata*	Not threatened
Monarch flycatchers (monarchidae)		
Piwakawaka, North Island fantail	*Rhipidura fuliginosa* subsp. *placabilis*	Not threatened
White-eyes (zosteropidae)		
Silvereye	*Zosterops lateralis*	Not threatened
Honeyeaters (meliphagidae)		
Bellbird	*Anthornis melanura*	Not threatened
Tui	*Prosthemadera novaeseelandiae*	Not threatened
Finches (fringillidae)		
Chaffinch	*Fringilla coelebs*	Introduced
Greenfinch	*Carduelis chloris*	Introduced
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

Table 3: Status of birds in study area during the first three years (May 2005-June 2008) 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 2007 Surveys	Broods/ Nesting Recorded June 2007-May 2008	Notes
New Zealand dabchick	Common	Common	✓	✓	Common and have bred throughout study area. Three records only in treatment area between May 2007 and June 2008. No broods recorded in control area over the same period.
Black shag	Occasional	Occasional			Recorded occasionally from open water habitats. Often roosts on lake margins and jetties.
Little black shag	Common	Common			Common throughout open water habitats. Roost on jetties, lake margins and delta.
Little shag	Common	Common			Common throughout. Roost on jetties, lake margins and regularly present at delta.
White-faced heron	Occasional	Occasional			Found in shallow water and lake margins.
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	Expected - not recorded	Occasional			Has occasionally been recorded from control sites, including in 2007-2008.
Feral goose	Expected - not recorded	Occasional			
Paradise shelduck	Occasional	Not recorded			Occasionally seen in open water habitat and around the Ohau Channel Delta (72 birds at the delta in March 2007).
Mallard	Occasional	Occasional	✓		Recorded occasionally throughout study area.
Australasian shoveler	Occasional	Not recorded			Recorded occasionally at 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 common species present in study area. Broods recorded from control and treatment sites in June 2007 to May 2008 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. One brood recorded in control area in June 2007 to May 2008 survey.
Australian coot	Common	Common	✓	✓	Very common in open water habitats of western Lake Rotoiti. Present throughout open water habitats and occasionally on lake

Bird Species	Status in Vicinity of Proposed Wall	Status at Control Sites	Broods/ Nesting Recorded May 2005-May 2007 Surveys	Broods/ Nesting Recorded June 2007-May 2008	Notes
					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 margins habitat of study area.
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.
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 SPECIES

Threatened species (as per Hitchmough *et al*. 2007) recorded in the project area are listed below, with comments on their respective New Zealand populations:

'Acutely Threatened - Nationally Vulnerable'

Caspian tern - *c.*3,000 in New Zealand. Colonies sizes vary from year to year, but rarely exceed 100 pairs. An almost cosmopolitan species (Heather and Robertson 1996).

'Chronically Threatened - Serious Decline'

Black-billed gull - *c.*50,000 pairs in 1996, but numbers have been declining since the 1970s for unknown reasons (Heather and Robertson 1996). A New Zealand endemic.

'Chronically Threatened - Gradual Decline'

Red-billed gull - three colonies with >5,000 breeding pairs (Heather and Robertson (1996), however there is evidence of a population decline at the three largest colonies in recent years (Hitchmough *et al.* 2007).

'At Risk - Range Restricted'

Little black shag - between 1,000 and 5,000 pairs in New Zealand (Hitchmough 2007). More common in the north than south of New Zealand.

'At Risk - Sparse'

New Zealand dabchick - a population of 1700-1800, with *c.*500 present in the Volcanic Plateau of the Central North Island (Heather and Robertson 1996). A New Zealand endemic, presumed extinct in the South Island.

Black shag - 5,000-10,000, scattered throughout New Zealand (Heather and Robertson 1996).

7. RESULTS FOR SELECTED OPEN WATER SPECIES

A summary table of key waterbird species for each year of the study is presented in Table 4.

Table 4: Summary table of mean number of key open water bird species in the vicinity of the wall, both during (2007-8) and prior (2005-6 and 2006-7) to construction. C = control; T = treatment (or pre-treatment for 2005-2007); GT = grand total.

Species	2005-2006			2006-2007			2007-2008		
	C	T	GT	C	T	GT	C	T	GT
New Zealand dabchick	17.2	18.0	3.68	15.3	15.3	30.5	13.3	13.3	26.58
Black shag	<0.1	0.0	<0.1	0.2	0.3	0.5	0.3	0.0	0.3
Little black shag	3.3	2.6	5.5	2.8	23.9	26.8	9.9	6.3	16.3
Little shag	1.5	2.5	4.0	3.0	2.7	5.7	2.6	3.6	6.2
Black swan	24.2	14.3	38.3	19.6	29.6	49.2	31.8	16.5	48.3
New Zealand scaup	55.7	61.9	113.0	99.8	111.7	211.4	142.7	139.2	281.9
Australian coot	93.0	103.8	198.2	104.1	66.1	170.2	129.0	66.5	195.5
Black-backed gull	0.6	6.3	7.5	0.8	4.4	5.2	0.0	3.2	3.2
Red-billed gull	0.3	3.3	3.6	0.8	0.8	1.6	<0.1	3.8	3.9
Black-billed gull	0.3	3.3	3.5	1.1	33.3	34.4	0.3	18.2	18.4
All gulls (including unidentified species)	1.2	12.8	14.0	4.3	39.2	43.4	0.5	29.9	30.5
Caspian tern	0.0	2.2	2.2	0.0	3.4	3.4	0.0	1.8	1.8

New Zealand dabchick

Dabchicks are scattered throughout the study area, with larger numbers generally occurring on larger areas of water (e.g. Treatment 1 and Control 3 sites - see Table 1 and Figure 2). In the vicinity of the proposed diversion wall (pre-treatment/treatment survey areas), a monthly mean of 18, 15, and 13 dabchicks were recorded in 2005-6, 2006-7 and 2007-8 respectively. The maximum number of dabchicks (31) in the pre-treatment area was recorded in April 2007.

Black shag

Black shags are only occasionally recorded in the study area, with birds being recorded during four surveys of the first 24 months of surveys for this study. A maximum of four birds were recorded in December 2006 and November 2007, with individuals having been recorded in control and treatment (pre-treatment) areas.

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. A maximum 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 varied greatly between surveys. Survey areas in the vicinity of the proposed diversion wall (pre-treatment/treatment survey areas) had means of 2.6, 23.9, and 6.3 birds, recorded in 2005-6, 2006-7, and 2007-8 respectively.

Little shag

Little shags are common in the study area and have been recorded at least once from each survey area during the first two years of this study. The maximum number of 17 birds was recorded in the vicinity of the proposed diversion wall (pre-treatment/treatment survey area) in May 2008, with means of 2.5, 2.7, and 3.6 birds recorded in 2005-6 and 2006-7, 2007-8 respectively.

Black swan

Black swan are common in the survey area with a maximum number of swans recorded in March 2006 (140 birds with 24 birds in control survey areas and 116 birds in pre-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 the first three years of this study. The largest numbers have been recorded from the largest areas of open water (e.g. Treatment 1 and Control 4). In the pre-treatment (treatment) survey areas a mean of 14.3, 29.6, 16.5 black swans were recorded in 2005-6, 2006-7, and 2007-8 respectively.

New Zealand scaup

New Zealand scaup are very common throughout the study area. Scaup have been recorded from all survey areas during the first three years of this study. A maximum number of 487 scaup were recorded in the study area in September 2006 (with 322 birds in the control survey areas and 165 in treatment survey area). Means of 61.9, 111.7, and 139.3 scaup were recorded in the pre-treatment (treatment) survey area during the 2005-6, 2006-7, and 2007-8 seasons respectively.

Australian coot

Australian coot are very common throughout the study area. A maximum of 384 coot were recorded in the study area in July 2005, with 246 birds present at pre-treatment survey areas and 138 birds at control survey areas. Means of 103.8, 66.1, and 66.5 coot were recorded at the pre-treatment (treatment) survey area in 2005-6, 2006-7, and 2007-8 respectively.

Black-backed gull

Black-backed gulls are occasionally found throughout the study area, but in some surveys particularly large numbers of birds were recorded at the Ohau Channel Delta. Larger numbers were present at the delta in April 2006 (51), May 2006 (10), August 2006 (16), December 2006 (15) and September 2007 (13). Means of 6.3, 4.4, 3.2 black-backed gulls were recorded from the pre-treatment (treatment) survey area in 2005-6, 2006-7, and 2007-8 respectively.

Red-billed gull

Red-billed gulls have been found throughout the survey areas, being recorded from all survey areas except the Ohau Channel survey area (T7). A maximum of 28 birds was

recorded in February 2006. Means of 3.3, 0.8, and 3.8 red-billed gulls were recorded from the pre-treatment (treatment) survey areas in 2005-6, 2006-7, and 2007-8 respectively.

Black-billed gull

Black-billed gulls have been recorded throughout the survey area with all sites except one - Control 1 (the northern section of Okere Arm) - having black-billed gulls present. A maximum of 124 black-billed gulls was recorded in August 2006, with 122 birds present at the Ohau Channel delta. A mean of 3.3, 33.3, and 18.2 black-billed gulls were recorded from the pre-treatment (treatment) survey areas in 2005-6, 2006-7, and 2007-8 respectively.

All three gull species combined (including unidentified gull)

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 12.8, 39.2, and 29.9 gulls were recorded from the pre-treatment (treatment) survey areas in 2005-6, 2006-7, and 2007-8 respectively.

Caspian tern

All records of Caspian terns have been from the Ohau Channel delta. Caspian terns were present at the delta during June 2005 (12 birds), September 2005 (2), May 2006 (12), June 2006 (12), September 2006 (3), October 2006 (6), May 2007 (3), June 2007 (18), July 2007 (3), and October 2007 (1).

8. BREEDING

Juveniles of five species - New Zealand dabchick, black swan, mallard, New Zealand scaup, and Australian coot - were recorded during monthly surveys in the first two years of this study. All of these species, excluding mallard were recorded from the 2007-8 monthly survey. Broods or nests of other species that are generally present in vegetation on lake margins recorded in previous two years were not recorded during 2007-8, specifically, grey warbler, and shining cuckoo nests or broods have been seen on lake margins, or in riparian vegetation in previous years. Two pukeko young were recorded in 2007-8.

New Zealand dabchick

- *June 2005 to May 2007*

  Dabchick juveniles were recorded between November and March in the 2005-6 breeding season[1], and December to March in the 2006-7 breeding season. Broods have been recorded from both the pre-treatment and control sites. Nine juveniles

[1] The breeding season for this project coincides with the study year running from the June survey through to the May survey.

were recorded during the 2005-6 breeding season, while 8 juveniles were recorded during the 2006-7 breeding season.

- *June 2007 to May 2008*

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

Black swan

- *June 2005 to May 2007*

  Only two broods of black swan were recorded during the 2005-6 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 2006-7 breeding season, but it was recorded as production from the 2005-6 breeding season. Broods were common between November 2006 and May 2007 in the 2006-7 breeding season, in both the control and pre-treatment populations. Eight juveniles were recorded in the study area in the 2005-6 breeding season, while 18 juveniles were recorded in the 2006-7 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.

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.

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 have been highly productive during the first two years of this study. In the 2005-6 breeding season all young (18) were recorded between December and January. In the 2006-7 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 in nine broods were recorded with four broods in control areas, and five broods in treatment areas.

Australian coot

- *June 2005 to May 2007*

  Australian coot appears to be amongst the most prolific species breeding at the western end of Lake Rotoiti. In the 2005-6 breeding season, 47 young were reported between October and March. During the 2006-7 breeding season, 64 juveniles were reported between December and April.

- *June 2007 to May 2008*

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

9. USE OF THE WALL DURING CONSTRUCTION

Birds have begun to utilise the wall for roosting, with the following species recorded utilising the wall during site visits:

Date	Species
November 2007	Black-backed gull (10)
December 2007	Little black shag (2) Black-billed gull (13) Little shag (1)
March 2008	Little black shag (4) Little shag (1) Red-billed gull (10)
April 2008	Little black shag (12) Little shag (2) Black-billed gull (2)
May 2008	Little black shag (8) Little shag (8) Red-billed gull (1) Black-billed gull (2)

10. DISCUSSION

Results from the first two years of this study provided a useful baseline assessment of bird species in the vicinity of the proposed diversion wall. Sites were selected to cover most of the area adjacent to the structure (pre-treatment sites), as well as several control sites well away from it. Monthly records over this time will enable analysis of seasonal and yearly differences in bird populations. The 2007-8 monitoring included

the beginning of the construction stage of the wall. Since June 2007, the pre-treatment sites are now considered as treatment sites.

Key data to be analysed following completion of wall construction will be the records for birds of open water habitat, especially 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 winter roosting of Caspian tern at the delta and the large fluctuations in the population of little black shag (also at the delta) have been the most interesting findings to date. The survey area provides very good habitat for open water birds, particularly New Zealand dabchick, black swan, New Zealand scaup, and Australian coot. The wall has already become a prime roosting site for gull and shag species. A further year of data collection will be required before any detailed analysis comparing bird populations and breeding near the vicinity of the wall are undertaken. Preliminary results show that key bird species of open water habitats are still utilising the habitats in the vicinity of the wall, and that all breeders utilising the 'wall area' prior to construction are still breeding in the area.

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