

Population trends of braided river birds on the Ashley River (Rakahuri), Canterbury, New Zealand, 1963–2015

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Abstract Eight species of nationally declining river birds currently breed on the Ashley River, less than 1 km from the townships of Rangiora, Ashley, and Waikuku Beach. Threats to their breeding include human interference, mammalian predation, and vegetation encroachment in the riverbed. The numbers of at least 3 of these species appear to have declined from 1963 to 2000, in line with national trends. In 2000, a Rivercare Group commenced a public awareness campaign about the plight of the birds, trapping introduced predators, and clearing vegetation in parts of the riverbed. Annual surveys from 2000 to 2015 show a significant increase in numbers of banded dotterel (*Charadrius bicinctus*), wrybill (*Anarhynchus frontalis*), black-fronted tern (*Chlidonias albostratus*), and pied stilt (*Himantopus himantopus*). Numbers of the other 4 species, including black-billed gull (*Larus bulleri*), the most threatened, have not changed significantly, in contrast to declining national trends. We suggest the Rivercare Group's management actions have contributed to these successes, and support continuation of their actions.

Spurr, E.B.; Ledgard, N.J. 2016. Population trends of braided-river birds on the Ashley River (Rakahuri), Canterbury, New Zealand, 1963–2015. *Notornis* 63 (2): 73–86.

Keywords Ashley River; braided rivers; gulls; population trends; predator control; shorebirds; terns; threatened species; waders

INTRODUCTION

The Ashley River (Rakahuri to Maori) is a small braided river on the east coast of the South Island that is currently a breeding site for 8 nationally declining endemic river bird species. Five species are officially classified as “Threatened”: black-billed gull (*Larus bulleri*), black-fronted tern (*Chlidonias albostratus*), banded dotterel (*Charadrius bicinctus*), wrybill (*Anarhynchus frontalis*), and Caspian tern (*Hydroprogne caspia*; Robertson *et al.* 2013). Three others are classified as ‘At Risk’: South Island

pied oystercatcher (*Haematopus finschi*), pied stilt (*Himantopus himantopus*), and white-fronted tern (*Sterna striata*). In addition, 1 individual of another threatened species, black stilt (*H. novaeseelandiae*), has bred on the river in the past. The Ashley River was once classified as outstanding habitat for wildlife (O'Donnell & Moore 1983). However, because it is only a small river and contains only a small proportion of the total breeding populations of these species it was reclassified more recently as being of regional rather than national significance (Hughey *et al.* 2010).

One of the major threats to successful bird breeding on the Ashley riverbed is human interference. The townships of Rangiora, Ashley, and Waikuku Beach (combined population *ca.*

Received 2 February 2016; accepted 23 May 2016

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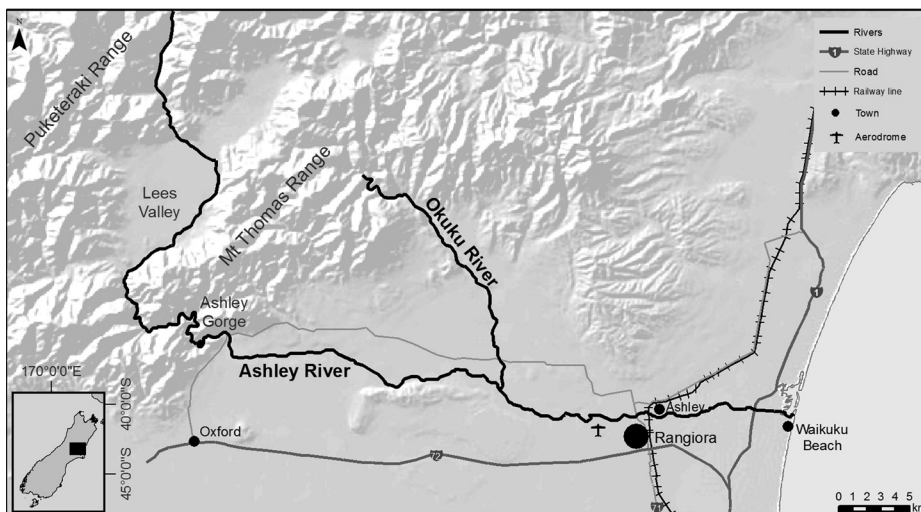


Fig. 1. Ashley River (Rakahuri), North Canterbury.

17,000 in 2013) are located less than 1 km from the river, and public use of the riverbed for recreational activities such as dog-walking, fishing, boating, trail-biking, and 4-wheel-driving threatens the survival of nesting birds (O'Donnell & Moore 1983; Baker 1987; Hughey 1989; Hughey & Warren 1997; O'Donnell 2000). Members of the public have also deliberately killed nesting birds, as in 1983 when an unknown number of adult black-billed gulls were shot (Baker 1987) and in 2012 when *ca.* 50 black-billed gull chicks were stoned to death (*pers. obs.*). Birds nesting on the riverbed are also threatened by predation from introduced mammals such as hedgehogs (*Erinaceus europaeus*), feral cats (*Felis catus*), stoats (*Mustela erminea*) and weasels (*M. nivalis*), invasion of the riverbed by weeds such as yellow tree lupin (*Lupinus arboreus*) and broom (*Cystisus scoparius*), and commercial extraction of shingle (O'Donnell & Moore 1983; Baker 1987; Hughey 1989; Balneaves & Hughey 1990; Hughey & Warren 1997; Bell 2013; Dowding 2013; McLellan & Habraken 2013; Pierce 2013). Natural threats include flooding and avian predation (Sanders & Maloney 2002; Riegen & Dowding 2003; Steffens *et al.* 2012).

In response to concerns about the human-induced threats, the Ashley-Rakahuri Rivercare Group was formed in 1999 to help protect the birds and their habitat (www.ashleyrivercare.org.nz). The Group's activities have included a public awareness campaign about the plight of the birds, clearing vegetation from sections of the riverbed where birds nest, and, since 2003, trapping mammalian predators in the vicinity of black-billed gull, black-fronted tern, and wrybill nests (Ledgard 2015).

In an attempt to measure the effectiveness of its management activities, the Group has organised bird surveys on the Ashley River annually since

2000. The purpose of this paper is to present the results of these surveys and compare them with the results of previous surveys in the 1960s to 1990s.

METHODS

Study areas

The Ashley River originates in the Puketeraki Range, Canterbury foothills (42°96' S, 172°22' E), and flows 92 km eastward into the sea at Waikuku Beach (43°28' S, 172°72' E; Fig. 1). It was subdivided into 3 sections for our study: upper Ashley from the headwaters to Ashley Gorge (43°23' S, 172°23' E; a distance of 50 km), middle Ashley from Ashley Gorge to the Okuku River confluence (43°26' S, 172°47' E; a distance of 20 km), and lower Ashley from the Okuku River confluence to the sea (a distance of 22 km). Some reports refer to the middle Ashley as the upper Ashley (*e.g.*, Overmars & O'Donnell 1981; O'Donnell & Moore 1983).

The riverbed is typical of braided rivers in the South Island, containing multiple channels with islands of shingle between them, on which birds nest. The mean flow rate at Ashley Gorge from April 1972, when records began, to December 2015 was 11.8 m³ s⁻¹ (T. Gray, Environment Canterbury, *pers. comm.*). As a foothills rain-fed river, this flow rate is much lower than for larger snow-fed rivers originating in the Southern Alps, such as the neighbouring Waimakariri River, which averages more than 100 m³ s⁻¹ (O'Donnell & Hoare 2011). Peak flow rates at Ashley Gorge greater than 100 m³ s⁻¹ occurred every year except in 1998 and 2005; 22% were in autumn (March–May), 47% in winter (June–August), and 20% in spring (September–November) when birds were nesting. Spring and early summer floods sometimes caused loss of eggs or chicks (*pers. obs.*). However, floods in autumn and winter

likely benefited birds by clearing extensive areas of encroaching vegetation from the riverbed.

Shingle has been extracted from the lower Ashley River for road works since at least the 1940s. During our study, the average rate of extraction was 73,000 m³ annually (S. McCracken, Environment Canterbury, *pers. comm.*). Extraction occurred mainly outside the breeding season, reducing potential impacts on birds.

In addition to the bird species mentioned above, other species breeding on the Ashley riverbed during the survey period included Canada goose (*Branta canadensis*), paradise shelduck (*Tadorna variegata*), mallard (*Anas platyrhynchos*), grey duck (*A. superciliosa*), spur-winged plover (*Vanellus miles*), and southern black-backed gull (*Larus dominicanus*). Species that used the river for feeding and/or loafing included black shag (*Phalacrocorax carbo*), little shag (*P. melanoleucos*), white-faced heron (*Egretta novaehollandiae*), variable oystercatcher (*Haematopus unicolor*), and black-fronted dotterel (*Elseya melanops*). Red-capped plover (*Charadrius ruficapillus*) was detected on the riverbed previously (Davis 1964; Griffin 2013) but not during our surveys.

Management actions

Public awareness of the plight of birds in the Ashley River was promoted by writing articles in local newspapers, giving talks to local organisations, disseminating comprehensive annual reports (listed in Ledgard 2015), setting up a website and Facebook page (www.facebook.com/ashleyrivercare), blocking vehicle access to the riverbed just before the breeding season, and placing signs in the riverbed around core breeding sites alerting people to the presence of nesting birds (Ledgard 2015). Although not formally measured, there is little doubt that these efforts have improved public awareness and led to less human disturbance of birds (NJL, *pers. obs.*).

Lupins and other weeds were cleared from the riverbed by hand-pulling or bulldozing before the beginning of the bird breeding season in most years until 2012. However, this practice was discontinued because the area that could be cleared was only small (<1 to ca. 5 ha per year) in comparison with the area cleared by floods (>100 ha per year).

Mammalian predators were trapped in the vicinity of black-billed gull, black-fronted tern, and wrybill nests in the lower Ashley each year after 2003. A range of trap types was used, including cage traps, Bushby tunnel traps, Timms traps, PossumMaster traps, and DOC 200 and 250 traps, usually baited with salted rabbit or hen eggs (Ledgard 2015). Traps were set at 4–15 sites for an average of 4710 trap nights annually from September to January, during the breeding season. In addition, since 2012, traps were set for an average of 3880 trap

nights annually from March to August, before the breeding season. Most captures were hedgehogs (0.74/100 trap nights), feral cats (0.09), stoats (0.07), and weasels (0.05).

Bird surveys in the lower Ashley

Adult birds

Surveys in the lower Ashley undertaken by the Rivercare Group from 2000 to 2015 covered 19 km from the Okuku River confluence to SH1 road bridge (43°28' S, 172°69' E), 3 km from the sea (Appendix 1). The survey method was based on methods used in other surveys (O'Donnell & Moore 1983; O'Donnell 1992; Maloney *et al.* 1997; Maloney 1999; O'Donnell & Hoare 2011). Groups of 2–5 observers were spaced 50–100 m apart in a line across the riverbed (width c.200–500 m). They walked slowly down river, keeping in line and in communication with each other, and counted birds as they passed them or as the birds flew upriver passing the observers. The observers counted all waders, gulls, terns, and shags (Appendix 1). The river was usually counted in 3 sub-sections concurrently; Okuku River confluence to Groyne 2 near the Rangiora airfield (43°28' S, 172°55' E), Groyne 2 to Rangiora road bridge (43°28' S, 172°58' E), and Rangiora road bridge to SH1 road bridge (Fig. 1), with a different group of observers in each sub-section. Some years, when the number of observers allowed, the lower sub-section was divided into 2 at Marchmont Road (43°28' S, 172°63' E). The surveys started at about 0900 hours, and were completed in 3–4 hours. An attempt was made to do the surveys in mid to late November each year (when most birds had eggs or chicks), but floods prevented access to the river until early December some years, and completely in 2002. An attempt was also made to survey the birds in early October (when most were on eggs) but in several early years this was prevented by the river being in flood, so early October surveys were discontinued after 2005. The counts are indices of abundance, not censuses, because of factors such as imperfect detectability, observer variability, spatial and temporal variation, and sampling error (Brown & Robinson 2009; Sanders 2000; O'Donnell & Hoare 2011).

Data from surveys undertaken before the Rivercare Group started its management actions were obtained from published scientific papers and unpublished reports held by the Department of Conservation (DOC), Christchurch (Appendix 1). These surveys were made between late October and late November. The 1963 survey covered both the lower and middle Ashley but unfortunately counts in the 2 sections were not published separately, so for comparison with the Rivercare Group's counts in the lower Ashley we divided the 1963 counts by 2 (on the basis that both sections cover a similar length

of riverbed). The 1980 and 1993 surveys were in the lower Ashley only, and thus directly comparable with the Rivercare Group's surveys. In the 1980 survey, black-backed gulls were present but the number not counted, and the number of black-billed gulls was only estimated (Moore 1980). The surveys in 1994 and 1995 are of limited value because they covered such a short stretch of the river. In addition to the surveys in Appendix 1, separate counts of black-billed gulls nesting in the lower Ashley riverbed were made by other observers from 1994 to 1999 (Appendix 2).

Breeding pairs

We visited the lower Ashley at least weekly during most breeding seasons from 2000 to 2015 to locate and count the number of black-billed gull, black-fronted tern, and wrybill pairs breeding (*i.e.*, with nests). We also compared the number of wrybill pairs breeding in a 5-km subsection of the riverbed between the Rangiora aerodrome and Rangiora road bridge from 2000 to 2015 with the number recorded in a detailed study of wrybills in the same stretch of river in 1983 by Hughey (1985).

Pre-fledgling chicks

At the end of each breeding season, we counted the number of pre-fledgling chicks of gulls, terns, and wrybills in the lower Ashley. We compared these counts with the number of pre-fledgling chicks banded or counted (all that could be banded or counted were banded or counted) by other observers in earlier years (Robertson 1964; Hughey 1985; Rowe 2013; S. Petch, *pers. comm.*; L. Rowe, *pers. comm.*; P. Sagar, *pers. comm.*; DOC Banding Office, *unpubl. data*).

Bird surveys in the middle Ashley

Three surveys have been made in the middle Ashley, in 1963, 1981, and 2011 (Appendix 1). As mentioned above, the 1963 survey covered both the middle and lower Ashley but counts in the 2 sections were not published separately.

Bird surveys in the upper Ashley

Two surveys have been made in the upper Ashley, in 2010 and 2011 (Appendix 3). There are no comparable earlier surveys, but the 2011 survey was made on a similar date to the Rivercare Group's surveys in the middle and lower Ashley, providing almost complete coverage of the braided sections of the river for that year.

Statistical analyses

Trends in the annual numbers of adults, breeding pairs, and pre-fledgling chicks counted on the lower Ashley from 2000 to 2015 were analysed separately using linear regression in MS Excel. The

intervals between the 1963, 1980, 1993, and 2000 surveys were considered too long to statistically analyse for meaningful trends between 1963 and 2000, because bird numbers in the intervening years may have been significantly different to those in the surveyed years. The average number of pre-fledgling chicks counted annually between 2000 and 2015 was compared with the average number banded annually between the 1960s and 1980s using the 2-tailed, unequal variance, *t*-test function in MS Excel.

RESULTS

Lower Ashley surveys

Adult birds

Counts of pied oystercatcher, black-backed gull, black-billed gull, and black-fronted tern appear to have been higher in 1963 than in 2000, when the Rivercare Group started its management activities (Fig. 2), although as noted this could not be tested statistically. The 1963 pied oystercatcher count was 1.5 times higher than any subsequent counts, the black-backed gull count 10 times higher, and black-billed gull count twice as high. The 1963 black-fronted tern count was higher than any counts at the same time of year before 2006. In contrast, pied stilt and banded dotterel counts appear to have been lower in 1963 than in 2000 and lower than most counts subsequently. Wrybill and spur-winged plover were not reported as being present in 1963 but were present in 1980, 1993, and 2000 onwards. Since 2000, the numbers of pied stilt, banded dotterel, wrybill, and black-fronted tern counted in annual surveys have increased significantly (Fig. 2). The trends in counts of pied oystercatcher, spur-winged plover, black-backed gull and black-billed gull were not statistically significant.

Breeding pairs

The number of pairs of both black-billed gull and black-fronted tern breeding in the lower Ashley did not change significantly from 2000 to 2015, though the trend for black-fronted tern appeared positive (Fig. 3). However, the number of wrybill pairs increased significantly. The number of wrybill pairs breeding in the 5-km subsection of the lower Ashley between the Rangiora aerodrome and Rangiora road bridge, used as a study area in 1983 by Hughey (1985), also increased significantly from 2000 to 2015. However, the number of pairs in 2015 (4 pairs) was less than recorded in 1983 (6 pairs).

Pre-fledgling chicks

The average number of pre-fledgling chicks counted annually in the lower Ashley from 2000 to 2015 was significantly lower than the average number banded annually from 1960 to the mid-1980s for black-backed gull ($t_{30} = 3.500$, $P < 0.01$) and black-billed

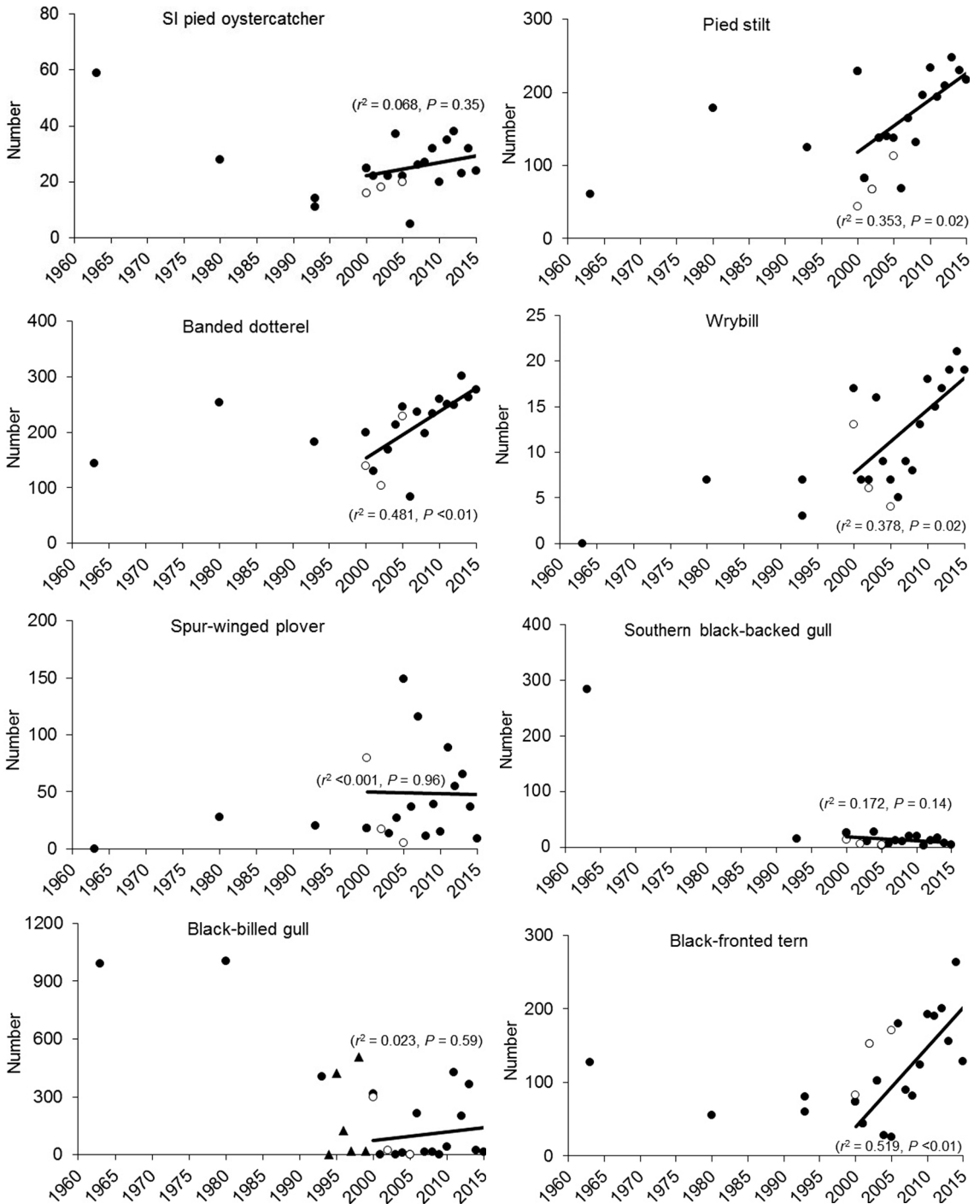


Fig. 2. Number of adult birds counted in the lower Ashley, 1963–2015. Key: ○ early October counts, ● late October–early December counts, ▲ additional counts of black-billed gulls (see methods). Southern black-backed gulls were present but the number not counted in 1980.

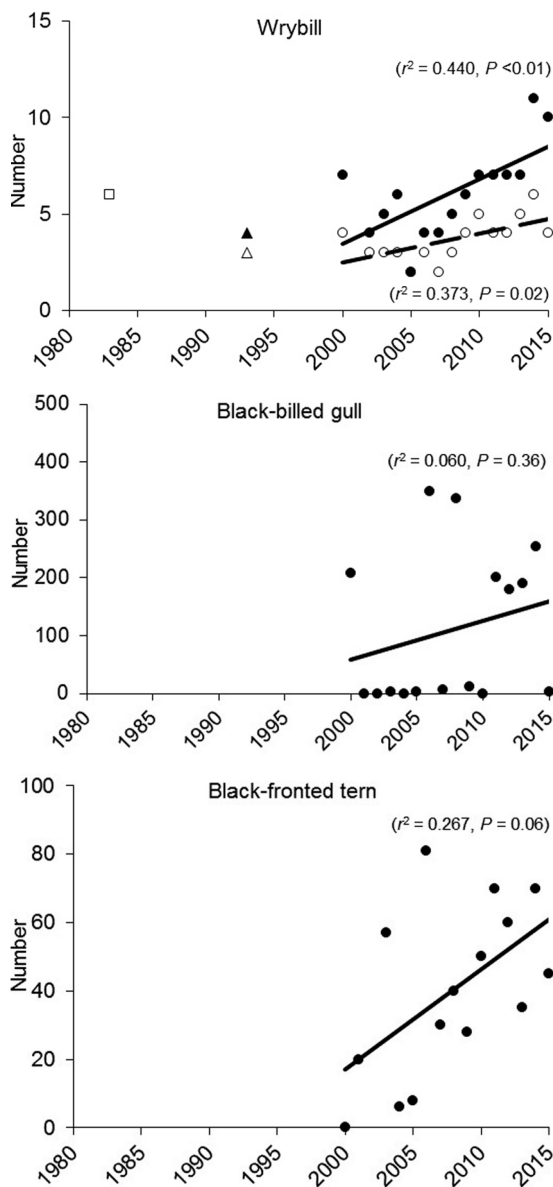


Fig. 3. Number of breeding pairs of black-billed gull, black-fronted tern, and wrybill counted in the lower Ashley (black symbols), and wrybill in a 5-km subsection between the Rangiora aerodrome and Rangiora road bridge (white symbols); □ 1983 (Hughey 1985), ▲ and △ 1993 (Crossland 1993), ● and ○ 2000–2015 (this study).

gull ($t_{32} = 2.745$, $P < 0.01$) but not for wrybill ($t_{13} = 0.411$, $P = 0.69$) or black-fronted tern ($t_{29} = 1.827$, $P = 0.08$; Fig. 4). However, the number of wrybill chicks fledged annually increased significantly from 2000 to 2015 (Fig. 4). The trend in the number of black-fronted tern chicks fledged annually also appeared

to be positive but was not significant owing to the high number fledged in 2006.

Middle Ashley surveys

The numbers of all species counted in the middle Ashley in 2011 appeared to be lower than in 1981, though this could not be tested statistically (Fig. 5). In the combined middle and lower Ashley, pied oystercatcher, black-backed gull, black-billed gull, and black-fronted tern numbers also appeared to be lower in 2011 than in 1963.

Upper Ashley surveys

Large colonies of black-backed gulls were found nesting in the upper Ashley in both 2010 and 2011 (Appendix 3). Other nesting birds included pied oystercatcher, pied stilt, banded dotterel, black-billed gull, and black-fronted tern. No wrybill were seen.

DISCUSSION

Interpreting trends in braided river bird populations on the Ashley River before the Rivercare Group commenced its management activities in 2000 is difficult because equivalent surveys occurred in only 3 years previously (1963, 1980, and 1993). Each year there was only a single count of most species and counts for the lower Ashley in 1963 had to be approximated. Brown & Robinson (2009) noted that for calculating linear trends it is important to have robust estimates of population size at the beginning and end of the time period (*e.g.*, replicate counts within a year or replicate surveys over sequential years). Such robust data are not available for birds in the Ashley before 2000. However, additional information (the number of pre-fledgling chicks banded or counted) is available for 2 nationally declining species to help interpret the survey counts and establish trends.

The apparent decline in counts of black-billed gulls from 1963 to 2000 is supported by chick banding and counting records. The combined evidence indicates that black-billed gull numbers on the lower Ashley declined significantly from the 1960s to 2000. Numbers also apparently declined from the 1960s to 1990s on 6 of 9 braided rivers surveyed in the Mackenzie District (Maloney 1999), and from 1981 to 1990 on the Ashburton River (O'Donnell 1992). The species is currently declining nationally and officially classified as 'Nationally Critical' (Robertson *et al.* 2013). Annual counts on the lower Ashley since 2000 indicate no significant change in the average number there over the last 15 years. The high variability in numbers counted between years reflects variation in the time of year when gulls returned and settled in colonies to breed. In some years gulls did not

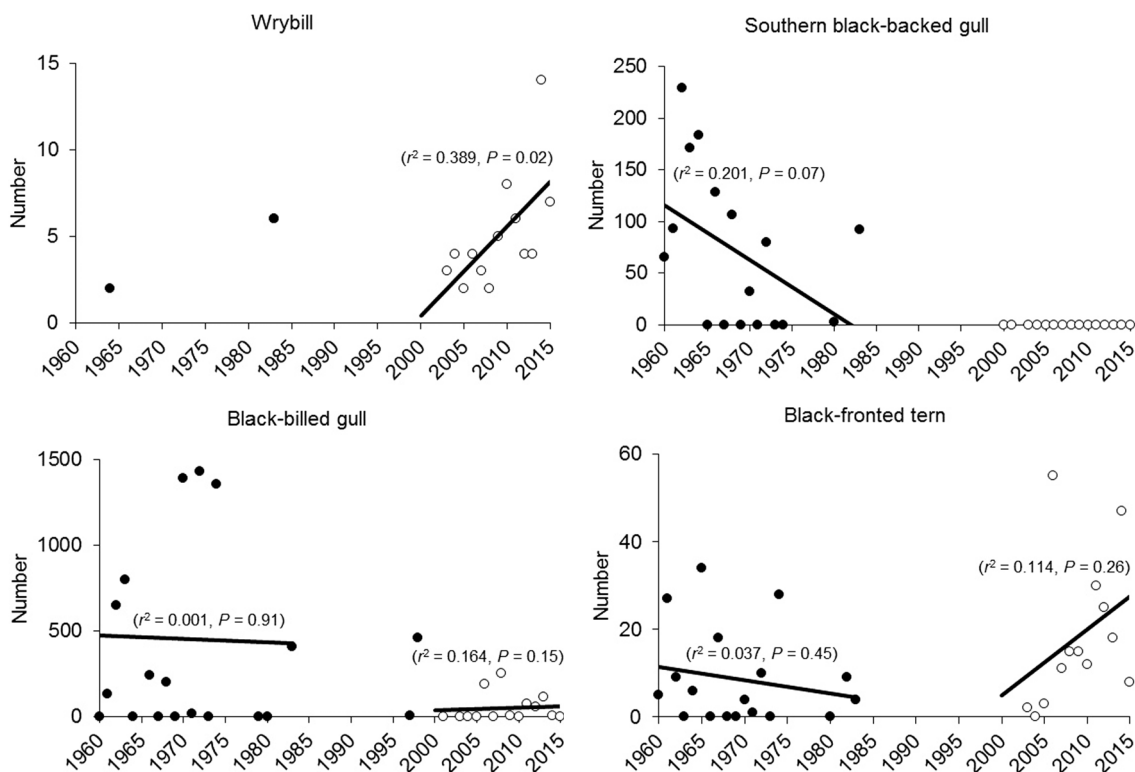


Fig. 4. Number of chicks banded (●) or counted (○) at the end of the breeding season in the lower Ashley, 1960–2015.

return at all, whereas in some years they returned and attempted to nest but abandoned the river before the annual survey (e.g., in 2014), and in other years they returned and nested after the annual survey (e.g., in 2008), perhaps displaced from the Waimakariri River by flooding (*pers. obs.*). More information is needed on population trends on other rivers.

In contrast to the results for black-billed gull, the apparent decline in counts of black-fronted tern from 1963 to 2000 is not supported by chick banding and counting records. The combined evidence indicates no change in the average number of black-fronted terns breeding on the lower Ashley from the 1960s to 2000. In contrast, numbers apparently declined from the 1960s to 1990s on 4 of 9 braided rivers surveyed in the Mackenzie District (Maloney 1999), and from 1981 to 1990 on the Ashburton River (O'Donnell 1992). The species is currently declining nationally and officially classified as 'Nationally Endangered' (Robertson *et al.* 2013). Annual counts on the lower Ashley indicate that black-fronted tern numbers there increased significantly from 2000 to 2015, in contrast to earlier published results showing no significant change over a shorter time-span

(O'Donnell & Hoare 2011; Monks *et al.* 2013).

Additional information (chick banding records and counts of pre-fledgling chicks) is not available for other nationally declining species to help interpret survey counts. By themselves, the 1963, 1980, and 1993 counts of pied oystercatcher, pied stilt, and banded dotterel may not be representative of the numbers of these species breeding on the riverbed in those decades. The numbers of pied oystercatcher apparently declined from the 1960s to 1990s on 5 of 9 braided rivers in the Mackenzie District, while pied stilt apparently declined on 4 of the rivers and banded dotterel on 7 of the rivers (Maloney 1999). All 3 species declined from 1981 to 1990 on the Ashburton River (O'Donnell 1992). All are also currently declining nationally and are officially classified as 'Nationally Vulnerable' or 'At Risk' (Robertson *et al.* 2013). However, counts on the lower Ashley indicate that pied oystercatcher numbers there have not changed significantly since 2000, and pied stilt and banded dotterel numbers have increased significantly.

The absence of wrybill in the 1963 survey is surprising. The species was reported as frequenting the Ashley by Stead (1932) and breeding on the Ashley by Oliver (1955). The 1963 survey field-notes appear

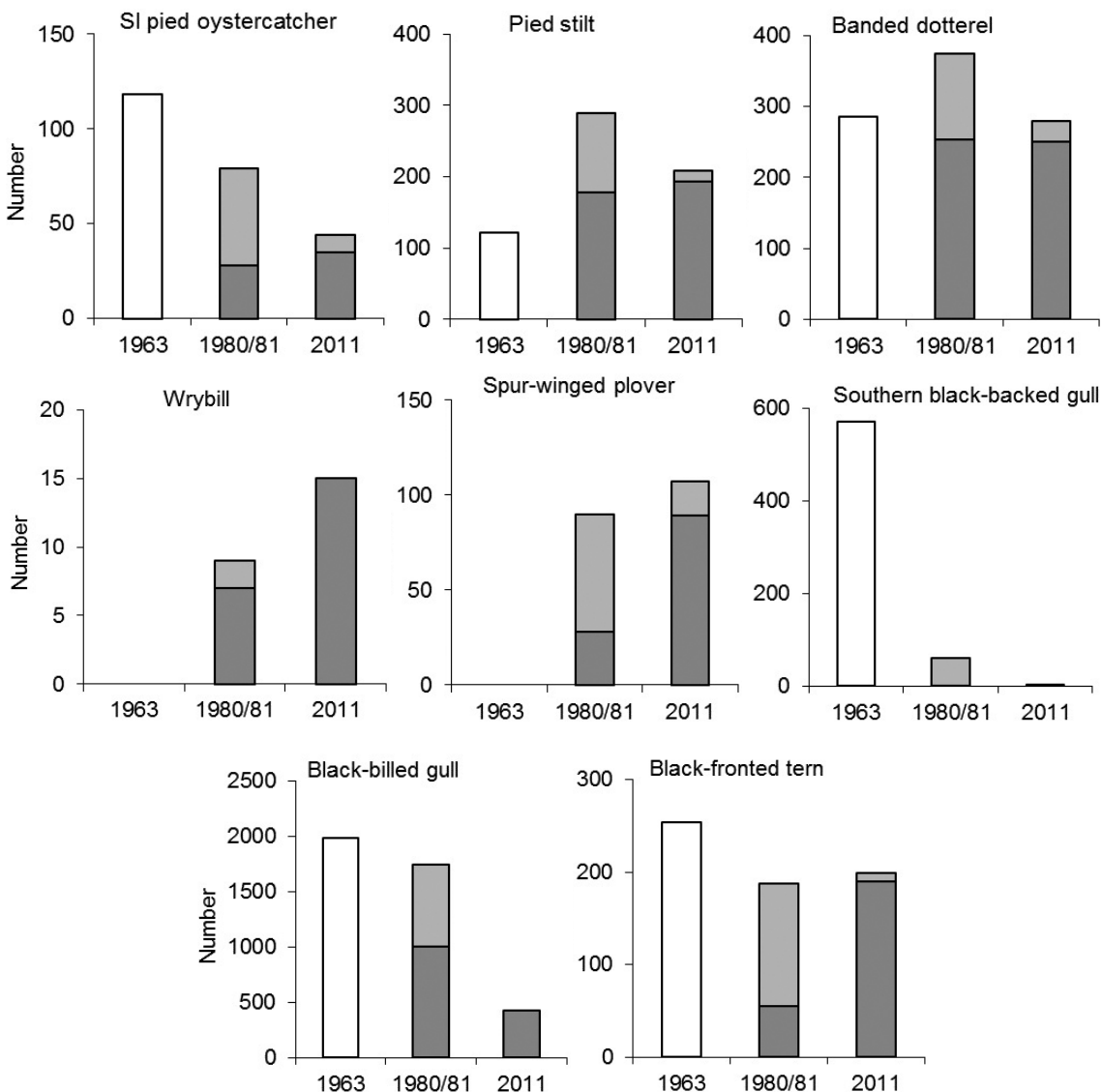


Fig. 5. Number of adult birds counted in the combined middle and lower Ashley in 1963, 1980/81, and 2011. The data for 1980/81 and 2011 are separated into middle Ashley (light grey) lower Ashley (dark grey). Separate data are not available for 1963, but it is likely that at least half the birds would have been in the lower Ashley (see Methods).

to have been lost so it is uncertain now whether no wrybill were present on the riverbed during the 1963 survey, whether they were present in low numbers but not detected, or whether they were present and detected but inadvertently omitted from the report. They were certainly present in 1964, when 2 chicks were banded near the Rangiora railway bridge and at least 1 other pair was seen near Marchmont Road (L. Rowe, *pers. comm.*). Wrybill numbers did not change significantly from the 1960s to 1990s on 8 of 9 braided rivers in the Mackenzie District (Maloney 1999), or from 1981 to 1990 on the Ashburton River

(O'Donnell 1992). The species is currently declining nationally and officially classified as 'Nationally Vulnerable' (Robertson *et al.* 2013). However, counts on the lower Ashley indicate that wrybill numbers there have increased significantly since 2000.

Other nationally declining species breeding in the lower Ashley were detected too infrequently to determine population trends. White-fronted tern was first detected in our 2010 survey, and nested in 2011 and 2012 in association with black-billed gull colonies. They also nested on the riverbed in 1995, when 200 pairs nested in a black-billed gull

colony near SH1 bridge (Petch 1999, *unpubl. data*; K. Harrison, *pers. comm.*) and 1996, when 'a few pairs' nested in a black-billed gull colony a few hundred metres upstream from the Rangiora road bridge, *ca.* 12 km inland (S. Petch, *pers. comm.*). Caspian tern was occasionally detected on the riverbed in our surveys and 1 or 2 pairs nested in some years (*pers. obs.*). A lone male black stilt was present on the riverbed from 2004 to 2009, and bred with a female pied stilt in 2006 and 2007.

The 2 species breeding in the lower Ashley and not declining nationally have contrasting trends – spur-winged plover numbers have increased and black-backed gull numbers have decreased since the 1960s. The absence of spur-winged plover in the 1963 survey is consistent with the history of colonisation of the species, which was still rare in Canterbury in the 1960s (Rowe & Turbott 1964; Heather & Robertson 2005; Woodley 2013; Fraser *et al.* 2014). As on the Ashley, spur-winged plover numbers increased from the 1960s to 1990s on braided rivers in the Mackenzie District (Maloney 1999) though there was no clear population trend from 1981 to 1990 on the Ashburton River (O'Donnell 1992). Counts on the lower Ashley indicate that spur-winged plover numbers there have not changed significantly since 2000. However, the plovers use the riverbed mainly as a post-breeding communal loafing area, and numbers fluctuate greatly.

The apparent decline in counts of black-backed gulls from 1963 to 2000 is supported by chick banding and counting records. The combined evidence indicates that black-backed gull numbers on the lower Ashley have declined significantly since the 1960s. In contrast, numbers apparently increased from the 1960s to 1990s on 5 of 9 braided rivers surveyed in the Mackenzie District (Maloney 1999), and from 1981 to 1990 on the Ashburton River (O'Donnell 1992). Annual counts on the lower Ashley since 2000 show continued low numbers of black-backed gull. The reason for the decline and current low number is unclear because there are large areas of the riverbed suitable for nesting and large areas of irrigated farmland beside the river suitable for feeding, and gulls do feed there. It is possible that the decline may have been triggered by the covering-over of the Rangiora rubbish dump in the 1980s, making the area less attractive for foraging gulls (*pers. obs.*). Improved waste management has been suggested as a cause of localised decline in black-backed gull numbers in other parts of the country (Heather & Robertson 2005; Sachtleben *et al.* 2014; Galbraith *et al.* 2015). Large numbers of black-backed gulls still nest in the upper Ashley.

The apparent decline in numbers of all species counted in the middle Ashley between 1981 and 2011 is in contrast to increased numbers of most

species counted on the lower Ashley. The difference is likely explained by the greater encroachment of vegetation in the middle Ashley (Boyle & Surman 2009) and the management activities of the Rivercare Group in the lower Ashley (see below).

The high variability in counts of most species from year to year may be attributable to factors such as bird detectability, observer variability, spatial and temporal variation, and sampling error (Brown & Robinson 2009; O'Donnell & Hoare 2011). For example, the number of birds counted on riverbed surveys may vary from hour to hour and day to day, perhaps by 2 to 3-fold (Sanders 2000). Such variability is exemplified by the 2 counts in the lower Ashley on 4 and 6 Nov 1993; *viz.* 8 and 14 pied oystercatcher, 3 and 7 wrybill, and 60 and *c.* 80 black-fronted tern (Appendix 1). Despite count variability, however, a sequence of annual counts is likely to enable detection of major changes in bird abundance, perhaps in excess of 50% (Sanders 2000; Brown & Robinson 2009). The numbers of pied stilt, banded dotterel, wrybill, and black-fronted tern counted in annual surveys on the Ashley River all increased by at least 100% (*i.e.*, at least doubled) between 2000 and 2015.

The trends in counts of the 4 main threatened species of birds breeding in the lower Ashley since 2000 (increasing for banded dotterel, wrybill, and black-fronted tern, and unchanged for black-billed gull) are in contrast to declining population trends nationally (O'Donnell & Hoare 2011; Bell 2013; Dowding 2013; McLellan & Habraken 2013; Robertson *et al.* 2013). It is difficult to determine whether this is attributable to the Rivercare Group's management activities because there was no extensive series of annual counts before management started, and except for black-fronted tern mentioned below, no concurrent monitoring in equivalent rivers without management for comparison. The Group's predator trapping has resulted in declining predator capture-rates (Ledgard 2015) and is assumed to have improved the breeding success of nesting birds, as demonstrated in other riverbed studies (Dowding & Murphy 2001; Keedwell *et al.* 2002; Norbury & Heyward 2008; Cruz *et al.* 2013). This assumption is supported by a meta-analysis of population trends of black-fronted terns breeding on 29 rivers from 1962 to 2008; the only river where tern numbers increased was the Eglinton, which had 10 years of continuous landscape-scale mammalian predator control, whereas the 8 rivers where numbers decreased had no predator control (O'Donnell & Hoare 2011; Monks *et al.* 2013). Extending the analysis to 2015 (this study) has shown that tern numbers have also increased on the Ashley, which had predator control in the parts of the riverbed where birds nested. This suggests that the Rivercare Group's management activities

may have contributed to the success of this and other species breeding on the Ashley, and supports continuation of the management activities.

ACKNOWLEDEMENTS

Grateful thanks to T. Crocker, A. Crossland, C. O'Donnell, K. Harrison, S. Petch, L. Rowe, and P. Sagar for supplying unpublished bird count data; B. Alexander for helping organise the bird surveys; members of the Ashley-Rakahuri Rivercare Group Inc, New Zealand Ornithological Society, Royal Forest and Bird Protection Society, Rangiora Tramping Club, Department of Conservation, and Environment Canterbury for helping count the birds; R. Maloney, C. O'Donnell, L. Rowe, and an anonymous reviewer for comments on the draft manuscript.

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Appendix 1. Details of bird surveys and number of adult birds counted on the Ashley River, 1963–2015.

Year	1963	1980	1981	1983	1993	1994	1995	2000	2000	2001	2002	2003	2004	2005	2005	2006	2007	2008	2009	2010	2011	2011	2012	2013	2014	2015
Month	Oct	Oct	Nov	Nov	Nov	Nov	Nov	Oct	Nov	Dec	Oct	Nov	Nov	Oct	Nov	Dec	Nov	Nov	Nov	Nov	Nov	Nov	Nov	Nov	Nov	Nov
Day	26	20	28–29	4	6	17	23	8	25	1	5	22	20	1	19	2	24	22	21	20	27	29	24	16	15	14
Number people	31	5	8	?	12	4	3	17	20	16	25	8	12	19	15	10	16	12	12	16	16	6	16	19	18	21
Section of river ¹	LM	L	M	L	L	SL	SL	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L
Km traversed	c.41	21	c.22	21	c.20	5	5	19	19	19	19	19	19	19	19	19	19	19	19	19	19	22	19	19	19	19
References ²	(1)	(2,3)	(3,4)	(5)	(6)	(7)	(8)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)	(9)
Black shag ³	7	nd	1	10	nd	nd	nd	1	18	3	2	8	7	11	2	2	10	9	6	2	5	7	6	3	4	1
Little shag	0	nd	4	0	nd	nd	nd	5	3	6	14	4	7	7	6	2	4	0	17	6	13	2	11	19	5	6
Variable oystercatcher	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
South Island pied oystercatcher	118	28	51	8	14	0	2	16	25	22	18	22	37	20	22	5	26	27	32	20	35	9	38	23	32	24
Black stilt	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	1	1	1	1	0	0	0	0	0	0	0
Pied stilt	122	178	111	124	nd	27	20	44	229	82	67	138	140	113	137	68	164	131	196	233	194	15	209	247	230	217
Red-capped plover	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Banded dotterel	285	253	129	183	nd	52	66	139	199	130	104	169	213	229	245	84	237	198	233	260	250	29	248	301	263	276
Wrybill	0	7	2	3	7	8	8	13	17	7	6	16	9	4	7	5	9	8	13	18	15	0	17	19	21	19
Black-fronted dotterel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Spur-winged plover	0	28	62	20	nd	0	7	80	18	nd	17	13	27	5	149	37	116	11	39	15	89	18	55	65	37	9
Southern black-backed gull ⁴	570	nd	61	15	nd	0	0	14	26	nd	6	10	27	4	3	5	12	10	19	19	2	0	11	17	7	4
Black-billed gull	1986	1006	684–784	407	nd	0	2	300	314	3	24	0	10	2	1	213	13	16	2	41	425	0	202	364	23	13
Caspian tern	6	0	0	1	nd	0	0	1	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0	1	0	0
Black-fronted tern	254	55	>133	60	c.80	89	30	83	74	44	152	102	28	171	26	180	89	81	124	192	190	9	200	156	263	128
White-fronted tern	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	77	0	6	2	0	0

¹ Section of river: L lower 20 km from Okuku River confluence to SH1 bridge or estuary; M middle 20 km from Ashley Gorge to Okuku River confluence; SL 5-km sub-section of lower riverbed from Rangiora aerodrome to Rangiora railway bridge.
² References: (1) Davis 1964; (2) Moore 1980; (3) O'Donnell & Moore 1983; (4) Overmars & O'Donnell 1981; (5) Moore & Kwant 1993; (6) Crossland 1993; (7) Kwant 1994; (8) Head 1995; (9) Rivercare Group (this study).
³ Black shag and other species: nd = no data because not counted or not reported.
⁴ Southern black-backed gull: present in 1980, but numbers not counted (Moore 1980).

Appendix 2. Additional counts of black-billed gulls nesting in the lower Ashley riverbed 1994 to 1999 (from Petch 1999, *unpubl. data*; K. Harrison and S. Petch, OSNZ, *pers. comm.*)

Year	Number of birds (and source of information)
1994	No nests (K. Harrison, <i>pers. comm.</i>)
1995	Colony 1 km upstream from SH1 bridge, 383 nests occupied on 26 November, 423 nests occupied in total, 343 chicks counted (Petch 1999, <i>unpubl. data</i> ; S. Petch, <i>pers. comm.</i>)
1996	Colony 'a few hundred metres' upstream from Rangiora road bridge, 123 nests on 10 November (S. Petch, <i>pers. comm.</i>), and a colony in the middle Ashley 1 km upstream of Bowicks Rd, about half way between the Okuku River confluence and Ashley Gorge, 137 nests on 14 December (K. Harrison, <i>pers. comm.</i>)
1997	Colony upstream from SH1 bridge (42°17'S, 172°42'E), 180 nests on 6 October, continually harassed by off-road vehicles, with only 20 birds on 12 October, and 6 chicks banded on 21 December (Petch 1999, <i>unpubl. data</i> ; S. Petch, <i>pers. comm.</i> ; L. Rowe, <i>pers. comm.</i>)
1998	Large colony beside the Rangiora road bridge, 460 chicks banded (plus another 50 banded at estuary; 509 or 510 banded in total (Petch 1999, <i>unpubl. data</i> ; L. Rowe, <i>pers. comm.</i>)
1999	A "struggling colony trying without success" in the lower Ashley, and a large colony in the Okuku River, west of Taaffes Glen Rd (43°9'S, 172°24'E), c. 15 km above the confluence with the Ashley River, produced 200+ chicks (Petch 1999, <i>unpubl. data</i> ; K. Harrison, <i>pers. comm.</i>)

Appendix 3. Number of adult birds counted on the upper Ashley, from just below the gorge near Island Hill to Lees Valley road bridge just above Ashley Gorge (c. 12.5 km) (S. Elkington, DOC, *pers. comm.*)

Species	17 November 2010	23 November 2011
Black shag	5	1
Little shag	0	2
South Island pied oystercatcher	35	48
Pied stilt	40	21
Banded dotterel	84	59
Wrybill	0	0
Spur-winged plover	18	22
Black-backed gull ¹	446	775
Black-billed gull ²	152	27
Black-fronted tern ³	14	35
Canada goose	79	96
Paradise shelduck	45	23
Mallard / grey duck	47	5
White-faced heron	6	4

¹ Includes nesting colonies of 120 and 340 in 2010, and 765 in 2011

² Includes nesting colony of 130 in 2010

³ Includes nesting colonies of 8 and 9 in 2011