

## Long-term monitoring of a breeding colony of white herons (*Egretta alba*) on the Waitangiroto River, South Westland, New Zealand

CRAIG MILLER

Department of Conservation, Private Bag 701, Hokitika, New Zealand

cmiller@doc.govt.nz

**Abstract** The population of white herons (*Egretta alba*) at Waitangiroto Nature Reserve has been monitored since 1944. The number of breeding adults (estimated from maximum number of nests at the height of the breeding season, and first recorded in 1958) has increased from 26 to c.100, with a concurrent increase in the number of chicks hatched and fledged. Population growth was greatest between 1964-69 and 1980-84. Chick mortality appears to result largely from the effects of westerly and southwesterly storms in October and November, although infanticide, siblicide, and low levels of predation may account for some chick deaths. The mean number of fledglings nest<sup>-1</sup> has decreased over time as the number of nests has increased, suggesting a density dependent response. The white herons that "invaded" New Zealand from Australia in 1952 and 1957 did not appear to recruit into the breeding population.

Miller, C. 2001. Long-term monitoring of a breeding colony of white herons (*Egretta alba*) on the Waitangiroto River, South Westland, New Zealand. *Notornis* 48(3): 157-163.

**Keywords** white heron; *Egretta alba*; monitoring; reproductive success

### INTRODUCTION

The white heron (*Egretta alba*), a cosmopolitan species, has only 1 New Zealand breeding colony, located between Okarito Lagoon and the Waitangiroto River on the South Island's west coast (Fig. 1). White herons have been given a high conservation ranking by the New Zealand Department of Conservation because the species is considered threatened in New Zealand, although it is secure in other parts of its range outside New Zealand (Molloy & Davis 1994). It is also a protected species under the Wildlife Act 1953.

Surveyor Gerhard Mueller officially discovered the colony of 60 birds in 1865 although it was known to Maori who, in 1860, had requested that a native reserve be marked off which specifically included the colony (Anon 1989). Hamilton (1878) was pessimistic about the chances of survival of the colony following the abandonment of the site when vandals destroyed saplings, nests and eggs. He stated '[i]t is to be hoped that the white herons will find a more secure place for their new home, and thus arrest for a few years their extinction'. Formal protection of the colony began in

1924 when a 60 m-wide strip on both sides of the Waitangiroto River was declared a sanctuary to counter the threat of timber milling in the area, and an honorary ranger was appointed. In 1944 the Department of Lands and Survey appointed a paid ranger to protect the birds 'particularly from shooting', to escort visitors, and to report on his observations. After the acquisition of an adjacent Maori Reserve, the area was gazetted in 1957 as a Wildlife Refuge 'for the preservation of fauna and flora in order to safeguard the habitat of white herons', and this was reclassified as the Waitangiroto Nature Reserve in 1976 (Anon 1989).

Since 1976, visits to the colony have been by permit only, and before 1984 an average of 25 people visited the colony each year. The maximum allowable level was raised during the 1984-86 seasons to 135 visitors year<sup>-1</sup> and the impact of liberalised entry was assessed. There was no obvious impact from the higher numbers of visitors so, in 1988, a commercial concession was allowed to take visitors to the colony. A maximum of 72 people or 6 boat trips day<sup>-1</sup> was set and all visitors were prohibited between 1 August and 28 October so as not to disturb the breeding birds. Kazmierow (1996) concluded that visitor presence at the colony's observation hide had no impact on adult behaviour and

consequently no impact on the survival of chicks at nest, although he suggested that disturbance of fledglings feeding on the river might affect their survival.

There are several factors which may influence the short- and long-term growth and survival of a heron colony, including habitat destruction, storm events, predation, human disturbance, availability of food, and availability of nest sites (Baxter 1994; Baxter & Fairweather 1998; Burger & Gochfeld 1993; Fasola & Alieri 1992; Maddock 1986). It is possible that a colony could be supplemented by birds from other colonies, although most white herons exhibit high natal site fidelity (Baxter 1994). There have been 2 recorded invasions of white herons into New Zealand, assumed to be from Australia, in the past 50 years. Warburton (1957) estimated that at least 50 extra birds were in the country in 1952, and Andrew (1963) estimated that there was a further invasion of  $\approx 150$  herons in 1957.

The collection of nest, chick, and fledgling data from the Waitangirotto colony since 1944 provides the opportunity to review and evaluate the health and conservation status of the colony. In this paper, I examine the population dynamics of the heron colony since 1944, specifically: 1, growth of the colony; 2, chick survival to fledging; and, 3, possible effect of heron "invasions" from Australia in 1952 and 1957.

## METHODS

### Study site

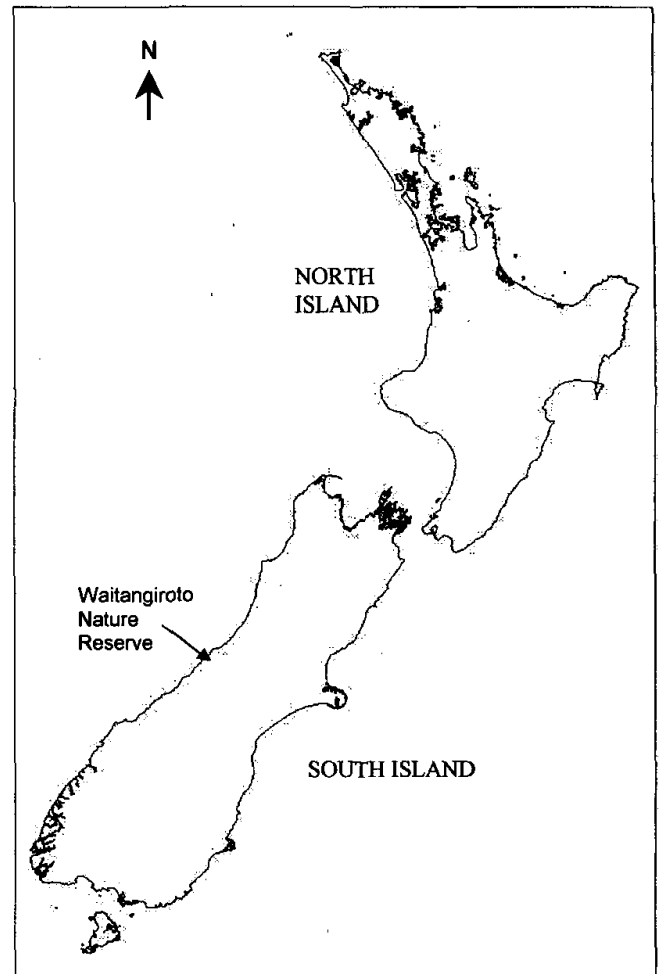
The location (Fig. 1) and vegetation of the Waitangirotto Nature Reserve was described by Wardle (1980). The herons nest in kamahi (*Weinmannia racemosa*), mahoe (*Melicactus ramiflorus*), kowhai (*Sophora microphylla*) and the crowns of tree ferns (*Dicksonia squarrosa*) in a small elbow of the Waitangirotto River. They share the site with little shags (*Phalacrocorax melanoleucos*), while royal spoonbills (*Platalea regia*) nest above in the sparse emergent kahikatea (*Dacrydium dacrydioides*).

### Bird counts

Records have been kept of the number of chicks and fledglings in the colony since 1944, and counts of nests and the number of adults started in 1958. Counts were usually made at weekly intervals between October and February, but daily counts began in 1981 with the employment of a full-time ranger. Records were incomplete between the seasons of 1944-1948 and 1954-1955. No counts at all were made in the 1952, 1988, or 1989 seasons.

### Data analysis

The maximum number of active nests in November each year was used as an indicator of the breeding population and hence colony growth, as the daily 1-off counts of adults tended to underestimate the total number of birds present at the colony and did not



**Fig. 1** Location of the white heron (*Egretta alba*) colony at Waitangirotto, South Island.

distinguish between non-breeding and breeding birds. The annual rate of increase of the number of nests was calculated and tested by Student's *t* test to determine whether the mean rate was significantly different from zero. Spearman's coefficient of correlation ( $r_s$ ) was calculated for the number of active nests, chicks, and fledglings against time, and the number of chicks nest<sup>-1</sup> and fledglings nest<sup>-1</sup> against time and against the number of nests. The assumptions required for analysis by linear regression were not met by the data, therefore this method was not used.

## RESULTS

The number of active nests has been growing since 1944 ( $r_s = 0.899$ ,  $n = 44$ ,  $P < 0.01$ ), with 2 distinct periods of growth between 1964-69 and 1980-84 (Fig. 2). The mean rate of increase (4.3%) was not significantly different from zero ( $t = 1.358$ ,  $df = 41$ ,  $P > 0.1$ ), despite annual changes ranging from -38.5% to +46%. The highest number of breeding birds ever recorded was 130 (calculated from the number of nests), in 1981. However, since 1984 the breeding population has stabilised at about 100 birds.

The mean number of chicks hatched nest<sup>-1</sup> year<sup>-1</sup> ranged from 0.6-2.0 ( $\bar{x} = 1.4$ ,  $SE_{\bar{x}} = 0.05$ ), and the

**Table 1** Number of nests, chicks, fledglings, and proportion of chicks that survived to fledge. -, data not available for that season.

Year	No. of nests	No. of chicks	No. of fledglings	% survival to fledge
1944	-	17	12	71
1945	-	18	14	78
1946	-	12	11	92
1947	-	21	16	76
1948	-	-	13	-
1949	12	-	25	-
1950	14	-	26	-
1951	14	-	19	-
1952	-	-	-	-
1953	7	-	14	-
1954	-	-	18	-
1955	-	-	23	-
1956	21	30	27	90
1957	16	22	20	91
1958	18	28	28	100
1959	13	23	17	74
1960	17	28	28	100
1961	18	30	30	100
1962	17	28	28	100
1963	14	24	24	100
1964	13	24	24	100
1965	17	25	25	100
1966	22	30	30	100
1967	21	17	9	53
1968	30	48	46	96
1969	32	48	48	100
1970	28	38	35	92
1971	27	17	14	82
1972	31	33	32	97
1973	30	54	54	100
1974	33	54	47	87
1975	30	19	17	90
1976	33	42	41	98
1977	28	30	-	-
1978	27	33	-	-
1979	34	37	30	81
1980	-	-	-	-
1981	65	77	60	78
1982	40	36	21	58
1983	52	97	55	57
1984	49	100	35	35
1985	52	70	55	79
1986	53	86	34	40
1987	50	81	24	30
1988	-	-	-	-
1989	-	46	-	-
1990	51	78	29	37
1991	51	31	20	65
1992	-	-	-	-
1993	46	67	44	66
1994	49	63	50	79
1995	54	62	32	52
1996	53	81	10	12
1997	42	45	23	51
1998	49	74	54	73
1999	42	45	23	51

number of fledglings nest<sup>-1</sup> year<sup>-1</sup> ranged from 0.4-2.0 ( $x = 1.1$ ,  $SE_x = 0.08$ ). Between 1960 and 1966, the start of the first major growth period, all chicks that hatched were fledged successfully. There have only been 3 other seasons (1958, 1969, 1973) with 100% fledging (Table 1). Fledging success was lower during the 2nd growth period (1979 - 1984), although the number of chicks hatched and fledged during this time was relatively high.

Over time there has been an increase in the number of chicks hatched ( $r_s = 0.760$ ,  $n = 45$ ,  $P < 0.01$ ) (Fig. 3A) and successfully fledged ( $r_s = 0.331$ ,  $n = 42$ ,  $P < 0.01$ ) (Fig. 3B). However since the mid-1960s both hatching and fledging success were increasingly variable.

While chick and fledgling numbers increased over time, the number of fledglings nest<sup>-1</sup> declined significantly ( $r_s = -0.700$ ,  $n = 37$ ,  $P < 0.01$ ) (Fig. 4A), and this decline was significantly correlated with increasing nest numbers ( $r_s = -0.664$ ,  $n = 37$ ,  $P < 0.01$ ) (Fig. 4B). There was no significant correlation between the number of chicks nest<sup>-1</sup> over time or with the number of nests.

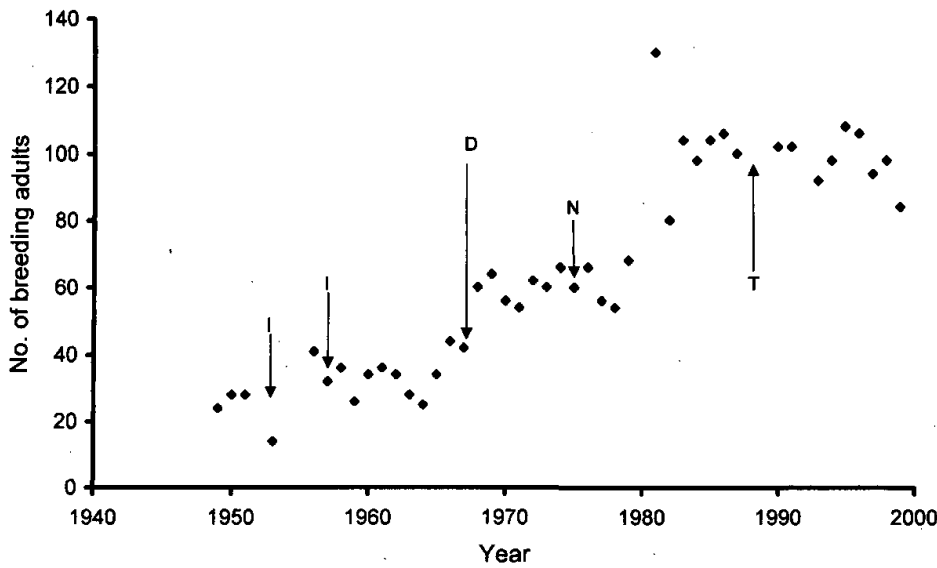
The herons that arrived in the country in 1952 and 1957 (Andrew 1963; Warburton 1957) do not appear to have contributed significantly, if at all, to the breeding population at Waitangirotu (Fig. 2). In fact, the number of breeding adults declined in the year following the 1952 invasion (Fig. 2).

## DISCUSSION

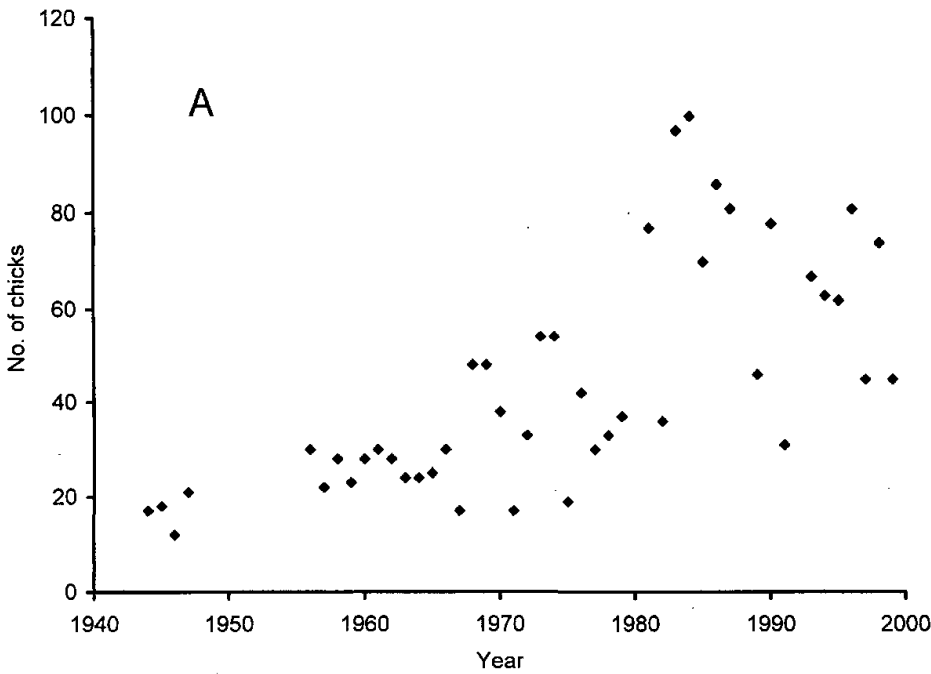
The concern expressed by Hamilton (1878) that the white heron colony at Waitangirotu would become extinct following vandalism of nests has not been borne out. The population recovered and now stands at about 100 breeding herons ( $c.50$  nests season<sup>-1</sup>) along with non-breeding birds. Protection of the vegetation around the colony was probably pivotal in retaining the Waitangirotu as the breeding colony, as the availability and maintenance of suitable vegetation for nesting are critical in determining whether a heronry will maintain a stable or increasing population (Burger & Gochfeld 1993).

The Waitangirotu colony has remained at its present site since the early 1950s. Before this a number of the birds had also been nesting in trees, which subsequently fell, on the north side of the bank. The length of time that the colony has remained at this site is in stark contrast to the normal situation in North America, where the usual life-span of a heron colony is  $c.5$  years before the vegetation is damaged to the extent that birds move to find another site (Telfair & Thompson 1986). Baxter (1994) suggests that heron colonies in New South Wales will remain at 1 site for  $c.18$  years, or until the vegetation is killed. However, American and Australian colonies tend to be significantly larger than the Waitangirotu colony.

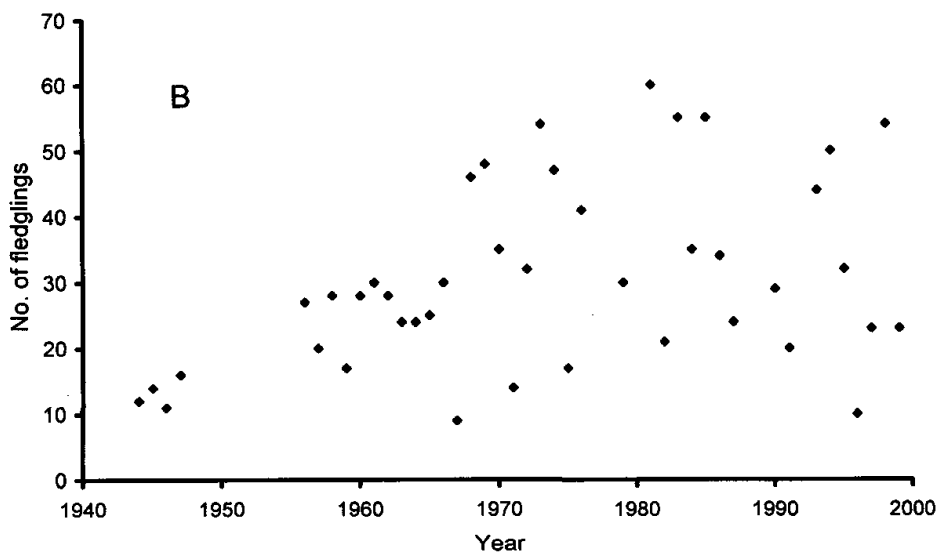
Another important factor in determining the success of a heronry is the maintenance of negligible human



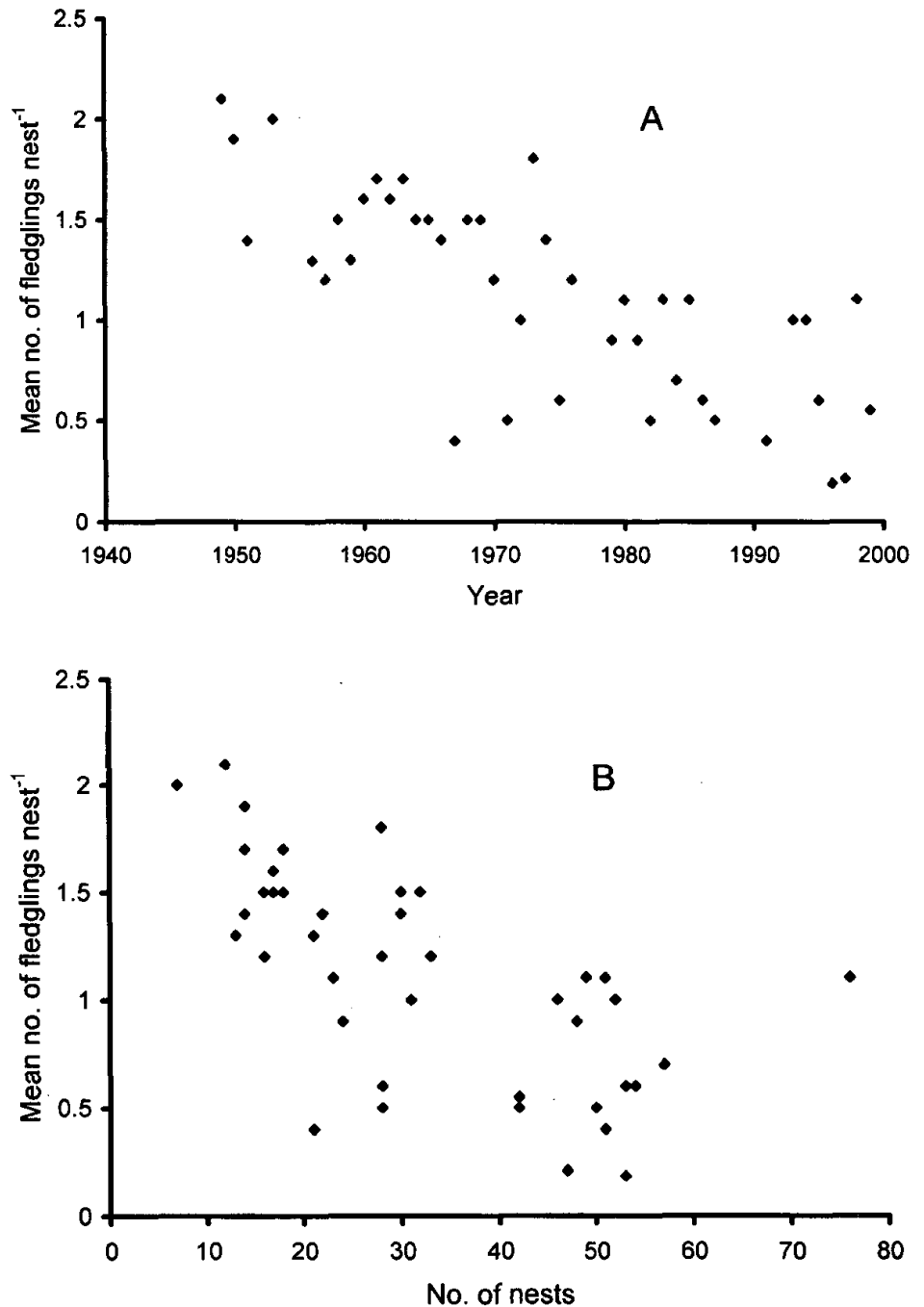
**Fig. 2** Trend in the number of breeding birds year<sup>-1</sup> estimated from the number of active nests. I, years of known heron invasions from Australia; N, nation-wide census; D, natural diversion of the Waitangitona River; T, start of a visitor concession.



**Fig. 3(A, B)** **A**, trend in total number of chicks hatched year<sup>-1</sup>. Spearman's rank correlation  $r_s = 0.760$ . **B**, trend in total number of chicks fledged year<sup>-1</sup>. Spearman's rank correlation  $r_s = 0.331$ .



**Fig. 4 (A, B)** **A**, trend in mean number of fledglings nest<sup>-1</sup> year<sup>-1</sup>. Spearman's rank correlation  $r_s = -0.700$ . **B**, trend in mean number of fledglings nest<sup>-1</sup> nest<sup>-1</sup>. Spearman's rank correlation  $r_s = 0.664$ .



disturbance (Burger & Gochfeld 1993). At the Waitangirotu colony, disturbance has been minimised by visitor restrictions, particularly during the early breeding season, and by the presence of a full-time warden. While these measures are intended to protect the population for nature conservation purposes, they are also in the interest of the concessionaire. Robertson (1998) found that northern royal albatross (*Diomedea epomophora*) at Taiaroa Head abandoned nests that were close to a walking track in favour of nest sites out of view. If the white herons also avoided sites exposed to view, then the visitors' experience would be reduced.

After hatching, access to the colony is by permit only; most visitors reach the site in guided parties. The colony is observed from a hide on the opposite side of the river.

Kazmierow (1996) studied the potential disturbance by tourists, and concluded that the presence of visitors at the observation hide had no impact on adult behaviour, nor consequently, on the survival of chicks. Herons will fly away if humans get too close (Kazmierow 1996), but they will also habituate to human activity (Klein *et al.* 1995).

Since their protection by the Wildlife Act 1953, white herons are less likely to be shot by hunters in New Zealand, although some are still killed in this way. There are also no natural predators of the adults in New Zealand, although stoats (*Mustela erminea*) and the Australasian harrier (*Circus approximans*) prey on chicks and young fledglings at the colony (J. Reid pers. comm.), and hence are controlled at the colony during the breeding season.

### Reproductive success

Numbers at the colony have grown slowly, almost linearly since 1958, although there were 2 short periods of faster growth. While the number of chicks produced has increased over time, the number of chicks fledging has become increasingly variable since the mid 1960s, ranging from 0.4 to 2.1 (Fig. 3B). In 'good' years, the number of fledglings nest<sup>-1</sup> is comparable with the production in heronries in Australia and the USA. Maddock & Baxter (1991) recorded a fledging rate of 1.8-2.5 from nests raising at least 1 chick, over 6 years in the Hunter Valley, New South Wales, and a 7-year study in California had a fledging rate of 1.8-2.3 (Pratt 1974). Unfortunately the monitoring programme of this study does not allow discrimination between nests with at least 1 chick and those that failed to hatch or raise a chick. Therefore the fledging rates are likely to be lower than those recorded by Maddock & Baxter (1991) and Pratt (1974).

In the USA, Kahl (1963) determined that an average production of 2.92 chicks fledged nest<sup>-1</sup> was required to maintain a stable population, based on an adult mortality rate of 26% and a 1st-year fledgling mortality rate of 76%. While there are no New Zealand data on ex-colony mortality, because chicks are not banded, the observed growth of the colony suggests that the mortality rate must be lower than that recorded by Kahl, possibly because there are few, if any, predators large enough to encounter and kill an adult heron. Hunting by humans is unlikely to be a major factor.

The most critical factor determining whether chicks at the New Zealand colony survive immediately following hatching appears to be the timing of westerly or southwesterly storm events (J. Reid pers. comm.). The westerly airflow affecting New Zealand's weather has increased in the past 40 years (1951-1990) (Salinger 1995), and since 1977 the New Zealand climate has experienced a substantial shift. Now, stronger and more persistent westerlies bring more rain and flooding to the West Coast; the summer rainfall on the West Coast is noticeably higher than in 1930-1950 (Salinger & Mullan 1996). Therefore, it is likely that the intensity of storm events encountered by breeding herons has been greater, and perhaps more variable, resulting in higher chick mortality in some years. In 1980, the chief ranger reported many dead chicks after a storm, and that the number of nests fell from 38 to 23. A similar event occurred in the 1984/85 season where a storm between 19-24 November reduced chick numbers from 100 to 35 (Table 1). Balanced against these events, however, were relatively stable breeding seasons in which chick survival was greater.

Food availability also plays a key role in reproductive success (Maddock & Baxter 1991). During the breeding season, white herons forage locally, and the Waitangiroto River and nearby Okarito Lagoon provide a rich source of food including eels (*Anguilla* spp.) and other fish such as *Galaxias* spp., and crayfish (*Paranephrops* sp.). Food

supplies may be limited, however, in times when the lagoon is flooded or the outlet is blocked, and the white herons may then abandon their nests (J. Reid pers. comm.). Herons feed by wading in open shallow water up to 0.3m deep, and generally avoid dry or deeply flooded areas (Marchant & Higgins 1990; Recher *et al.* 1983). The frequency of flooding in the lagoon has increased since 1967, when a severe storm event caused the Waitangitaona River to break its banks and establish a new flow into Lake Wahapo. Consequently, during heavy rains increased discharge from Lake Wahapo can cause prolonged periods of high water in the lagoon.

Interactions between chicks, and between chicks and adults, may also affect reproductive success. Chicks have been observed to fall or be pushed from nests by other chicks, and adults at adjacent nests have also been observed to kill chicks at unattended nests (J. Reid pers. comm.). Mock (1982) proposed that a rigid linear pecking order develops in white heron nests, where the older 2 chicks will monopolise food and dominate the 3rd chick. He suggested that sibling aggression between older and younger birds is a mechanism for brood reduction when food supply is limiting. However this hypothesis does not appear to have been tested in years when the food supply is not limited. Maddock (1986) observed that all 3rd chicks in his study were dominated and subsequently died; only 2 chicks nest<sup>-1</sup> successfully fledged.

Productivity at the Waitangiroto colony, appears to be density-dependent where the mean number of fledglings nest<sup>-1</sup> decreases as the number of nests increases (Fig. 4B). I suspect that this results from increased inter-nest aggressive interactions of chicks and adults, as nests are built closer together, rather than increased sibling rivalry.

### Impact of invasion

While the colony at Waitangiroto is likely to have been established by herons from Australia, herons from the 2 recorded invasions into New Zealand (Andrew 1963; Warburton 1957) do not appear to have contributed significantly, if at all, to the breeding population. The increase observed in breeding adults between 1964-1969 (Fig. 1) can reasonably be explained by the 100% fledging rate in previous years (Table 1). Baxter (1994) found that white herons show a high degree of natal site fidelity, which may explain why the New Zealand population has not been supplemented by subsequent invasions from Australia.

### Conclusion

Protection of the Waitangiroto heron colony since 1924 has minimised the effects of human disturbance and habitat destruction on the breeding population. Nevertheless, growth of the colony has been slow, a result initially of the low number of breeding birds, but later it is more likely a result of changed environmental conditions that caused high rates of chick mortality.

Density-dependent mortality and predation of chicks may have also contributed to low fledging rates, although we do not know whether these factors were significant. Unfortunately there were no data on post-fledging survival and rates of sub-adult return to the colony, so it was not possible to determine if there are any critical points requiring management after birds leave the colony.

White herons will continue to be actively protected at the colony as an iconic species rather than a threatened species. Consequently it is not a high priority for further research by the Department of Conservation, although the population will continue to be monitored at the colony. Nevertheless, there are opportunities for ecological and behavioural research, including examination of density-dependent effects on breeding success. Determining the fate and survival rate of herons once they leave the colony would be desirable and relatively easy to achieve, but because of their iconic and heritage value, disturbance during the breeding season to tag fledglings is unlikely to be allowed.

#### ACKNOWLEDGEMENTS

Thanks are due to the rangers responsible for collecting this data over the past half century; such long-term data sets are few and far between. Thanks also to Max Maddock, Colin O'Donnell, John Reid, John Lyall, Ian James, and Don Newman for comments that improved this manuscript, and to Sam Ferreira for statistical advice. Comments from 2 anonymous reviewers also resulted in the manuscript being improved.

#### LITERATURE CITED

- Andrew, I.G. 1963. White heron invasion, 1957. *Notornis* 10: 311-315.
- Anon. 1989. Waitangirotto Nature Reserve Management Plan. Department of Conservation, Wellington, New Zealand.
- Baxter, G.S. 1994. The location and status of egret colonies in coastal New South Wales. *Emu* 94: 255-262.
- Baxter, G.S.; Fairweather, P.G. 1998. Does available foraging area, location or colony character control the size of multi species egret colonies? *Wildlife research* 25: 23-32.
- Burger, J.; Gochfeld, M. 1993. When is a heronry crowded: a case study of Huckleberry Island, New York, U.S.A. *Journal of coastal research* 9: 221-228.
- Fasola, M.; Alieri, R. 1992. Conservation of heronry Ardeidae sites in North Italian agricultural landscapes. *Biological conservation* 62: 219-228.
- Hamilton, A. 1878. The district of Okarito, Westland. *Transactions and proceedings of the New Zealand Institute* 11: 386-391.
- Kahl, M.P. Jr. 1963. Mortality of common egrets and other herons. *Auk* 80: 295-300.
- Kazmierow, B.J. 1996. Ecological and human dimensions of tourism-related wildlife disturbance at the Waitangirotto White heron (kotuku) colony, South Westland, New Zealand. Unpublished MSc thesis, Lincoln University, Lincoln, Canterbury.
- Klein, M.L.; Humphrey, S.R.; Percival, F. 1995. Effects of ecotourism on distribution of waterbirds in a wildlife refuge. *Conservation biology* 9: 1454-1465.
- Maddock, M. 1986. Fledging success of egrets in dry and wet seasons. *Corella* 10: 101-107.
- Maddock, M.; Baxter, G.S. 1991. Breeding success of egrets related to rainfall: a six-year Australian study. *Colonial waterbirds* 14: 133-139.
- Marchant, S.; Higgins, P.J. 1990. *Handbook of Australian, New Zealand and Antarctic birds, Vol. 1. Part B Pelicans to ducks*. Melbourne. Oxford University Press.
- Mock, D.W. 1982. Brood reduction in herons: the siblicide threshold hypothesis. *Colonial waterbirds* 5: 57.
- Molloy, J.; Davis, C.; 1994. *Setting priorities for the conservation status of New Zealand's threatened plants and animals, 2nd ed.* Wellington, Department of Conservation.
- Pratt, H.M. 1974. Breeding of great blue herons and great egrets at Audubon Canyon Ranch, Carolina. *Western birds* 5: 127-136.
- Recher, H.F.; Holmes, R.T.; Davis, W.E.Jr.; Morton, S. 1983. Foraging behaviour of Australian herons. *Colonial waterbirds* 6: 1-10.
- Robertson, C.J.R. 1998. Factors influencing the breeding performance of the northern royal albatross. pp. 99-104 *In: Robertson, G.; Gales, R. (ed.) Albatross biology and conservation*. Chipping Norton, Australia, Surrey Beatty & Sons.
- Salinger, M.J. 1995. Southwest Pacific temperatures: trends in maximum and minimum temperatures. *Atmospheric research* 37: 87-100.
- Salinger, M.J.; Mullan, A.B. 1996. CLIMFACTS 1995/96. Variability of monthly temperature and rainfall patterns in the historical record. National Institute of Water and Atmospheric Research report AK96051.
- Telfair, R.C.II; Thompson, B.C. 1986. *Nuisance heronries in Texas: characteristics and management*. Non-game Wildlife Programme, Wildlife Division Texas Parks and Wildlife Service, Texas.
- Warburton, H.G. 1957. The white heron (*Egretta alba*) in New Zealand. *Notornis* 7: 98-101.
- Wardle, P. 1980. Scenic Reserves of South Westland. *Biological survey of reserves series no. 5*. Wellington, Department of Lands and Survey.