PARADISE SHELDUCK BAND RECOVERIES IN THE WANGANUI DISTRICT

By RICHARD J. BARKER

ABSTRACT

Post-moult dispersal of Paradise Shelducks (*Tadorna variegata*) in the Wanganui district was examined during 1987 and 1988 from hunting season band recoveries. Birds were banded at five locations, two coastal (Lakes Waipu and Marahau) and three hill country (Kakatahi, Parihauhau, and Mangamahu). Birds banded at different sites dispersed differently, with birds banded at the two coastal sites and Parihauhau more dispersive than those banded at Kakatahi and Mangamahu. Males dispersed more widely than females. Band recoveries were clustered into two separate groups, those from Kakatahi and Mangamahu, and a group comprising birds banded at coastal moulting sites and at Parihauhau. Coastal areas accounted for more than 70% of the hunting effort in the 1987 and 1988 hunting seasons, and it is suggested that the two groups of moulting birds be managed as separate population units.

INTRODUCTION

In the Wanganui Acclimatisation District, Paradise Shelducks account for an estimated 18% of the total waterfowl harvest (Wanganui Acclimatisation Society, unpubl. data). Hunting is regulated by varying the length of the hunting season and the daily bag limit, based on January counts of Paradise Shelducks on their moult sites (Williams 1979). As these counts are made 3.5 months before the hunting season, the relationship between the distribution of birds at the time of moult and their distribution during the hunting season must be understood. Williams (1979) also identified the importance of defining areas over which management regulations should be targeted.

Paradise Shelduck banding studies in other parts of New Zealand suggest that variations in patterns of dispersal seem to be related to topography (Williams 1981), especially slope and fragmentation. Birds in more broken country tend to be less dispersive than birds living in flatter areas. These findings suggest that post-moult dispersal of Paradise Shelduck in the Wanganui district may differ between moult sites in coastal and hill country areas.

The distribution of moulting Paradise Shelduck in the Wanganui Acclimatisation District is not even. In 1989, hill country moult sites accounted for approximately 72% of the known moulting population (Table 1.) Differences in the pattern of post-moult dispersal identified by Williams, and the uneven distribution of moulting birds, raises the question of whether the hill country and coastal segments of the moulting population are subject to the same hunting pressure. The distribution of humans in the Wanganui District is the reverse of the moulting Paradise Shelduck. The majority of people reside along the coast. If hunting pressure matches the distribution of people, the coastal and hill country segments of the Paradise Shelduck population may be subject to disparate hunting levels. This in turn may warrant different management strategies.

The principal aim of the study was to determine the relative hunting pressures applied to different moulting populations first by examining the pattern of post-moult dispersal for birds moulting at different locations and second by quantifying the distribution of hunting effort.

A second aim of this study was to examine fidelity of birds to their moult site. Because the moult counts do not completely cover the moulting population, the counts are only an index. If there is extensive movement of birds between moult sites each year, annual changes in the counts may reflect changes in moulting location rather than changes in the size of the population. Birds may either move to moult sites located outside of the district or they may move to unidentified moulting locations. This is especially important for interpreting changes observed over the last 10 years because several new sites have been identified during this period.

METHODS

Birds were trapped and banded at five moult sites (Table 1) in January 1987 and January 1988. The Kakatahi group comprised birds banded at three lakes located within 5 km of each other, with one lake accounting for more than 85% of the Kakatahi bandings and recoveries. Kakatahi, Parihauhau, and Mangamahu banding sites were located within 15 km of each other. Analysis of hunting season recoveries was restricted to recoveries reported to the Department of Conservation Banding Office by January 1989. Recoveries were categorised by moult site and a vector used to describe recovery location with respect to the banding site.

TABLE 1 — Altitude, topography, and estimated use by moulting birds of the banding sites

Site	Altitude	Topography	Number of birds moulting (1988)	Percent of birds
Lake Marahau	50m	Coastal plain	400	14
Lake Waipu	50m	Coastal plain	400	14
Kakatahi	240m	Steep hill	930	32
Parihauhau	400m	Steep hill	100	4
Mangamahu	260m	Steep hill	1070	37

Recovery probability was determined from the proportion of birds available to be recovered at the time of banding that were reported shot by January of the year following banding. The estimate for 1988 included birds

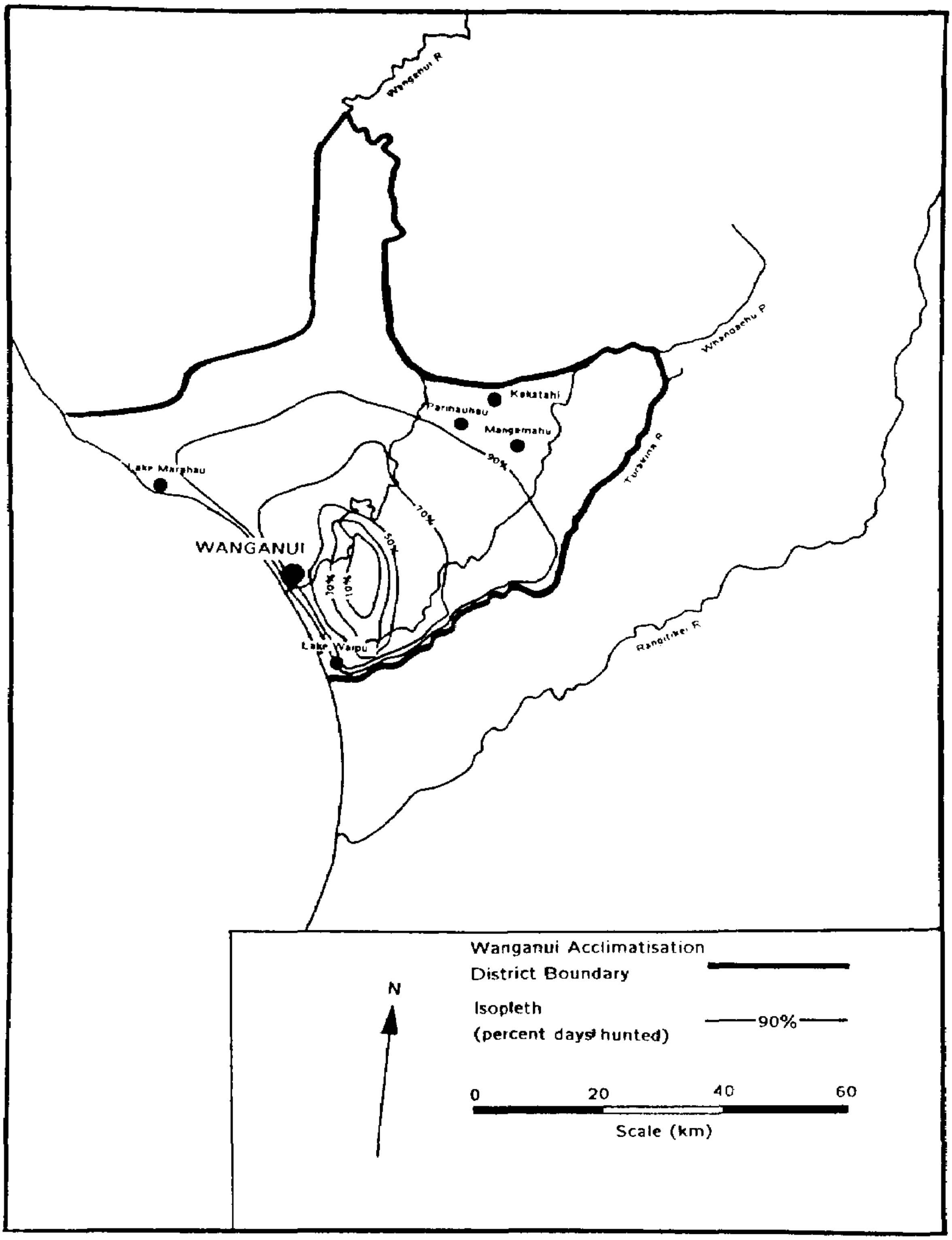

FIGURE 1 — Distribution of hunting effort in the Wanganui Acclimatistion District during the 1987 and 1988 hunting seasons. Each isopleth represents the boundary of the region about the centre of hunting activity containing the corresponding proportion of hunting effort

that were banded in 1987 but were re-trapped during 1988 banding. Recoveries were modelled as binomial random variables and tests for differences in recovery probability were carried out using likelihood ratio statistics to compare a model with site specific recovery probabilities with a constrained model with the same recovery probability for all sites in a year. Differences in recovery probability between years were tested for each banding site using a z statistic.

Patterns of geographical dispersal of band recoveries were compared between groups using the multiresponse permutation procedure of Biondini *et al.* (1988), a nonparametric technique for comparing Euclidean distances. Patterns of dispersal were compared between sexes, and banding sites. Two types of analysis were carried out. The first was a comparision of dispersion with respect to the banding site, when recovery location was expressed as a vector from the banding site. This tested the hypothesis that the mean distance between any two recoveries within a group was the same for all groups in the comparision. Because all recoveries were expressed with respect to the banding site in this analysis, the test was sensitive to differences in dispersal away from the banding site but not to geographical separation of recoveries resulting from birds banded at different sites dispersing to different areas. This analysis was carried out between sexes, between all banding sites, and for each of the 10 possible pairwise comparisons between banding sites. For each pairwise comparison, the estimated probability of a type 1 error (α) was multiplied by 10.

In the second analysis, recovery location was expressed as a vector with the same origin for all banding sites. This test was sensitive to geographical separation of recoveries. This analysis was carried out for all of the 10 pairwise comparisons. Test statistics from each of the pairwise comparisons were used to construct a similarity matrix based on similarity of geographical location of recoveries. This similarity matrix was used to cluster banding sites using hierarchical clustering with complete linkage (Anderberg 1973).

The distribution of hunting effort in the Wanganui Acclimatisation District was estimated by plotting reported locations of hunting trips for randomly selected hunters in the 1987 and 1988 seasons (Wanganui Acclimatisation Society, unpubl. data). Isopleths defining the geographical boundaries of regions containing differing proportions of total effort (days hunted) were derived using the method of Dixon & Chapman (1980). The centre of hunting activity was determined using the minimum value of the harmonic mean evaluated at each of 441 intersections of a grid laid over the study area. The isopleths depict estimates of the boundary of the region about the centre of activity containing the corresponding proportion of hunting effort.

RESULTS

Band recoveries

In 1987, 1182 males and 896 females were banded, of which 27 males and 16 females were reported shot during the following hunting season. In 1988 1296 males and 1061 females were banded, of which 130 males and 67 females were reported shot during the 1988 hunting season. There was evidence that proportionately more males than females were reported shot ($\chi^2_2 = 5.99$, $p = 0.05$) There was also evidence that mean separation between recovery locations was higher for males ($\bar{\chi} = 39.27$ km) than for females ($\bar{\chi} = 32.14$ km) ($p = 0.02$).

Recovery probability differed between years and banding sites. The proportion of birds banded and recovered in the first hunting season after banding was lower in 1987 than 1988 for each of the banding sites (Table 3). In both years there was evidence that recovery probabilities varied among banding sites (1987: $\chi^2_4 = 10.519, p = 0.03$; 1988: $\chi^2_4 = 12.88, p = 0.012$) with

TABLE 2 —Number of birds banded and recovered at each banding site

Site	Males banded		Males recovered		Females banded		Females recovered	
	1987	1988	1987	1988	1987	1988	1987	1988
Lake Waipu	360	343	15	52	148	168	4	15
Lake Marahau	49	352	0	28	29	301	2	14
Kakatahi	393	421	6	32	363	404	4	23
Parihauhau	308	69	6	11	266	57	5	2
Mangamahu	72	111	0	7	90	131	1	13

TABLE 3 —Estimated year specific band recovery probability[A] for Paradise Shelduck banded in the Wanganui Acclimatisation District in 1987 and 1988

	1987		1988		z test	
Site	$\hat{f}$	$\hat{se}(\hat{f})$	$\hat{f}$	$\hat{se}(\hat{f})$	z	p
Lake Waipu	0.037	0.008	0.098	0.013	-3.91	0.000
Lake Marahau	0.026	0.018	0.060	0.009	-1.67	0.100
Kakatahi	0.013	0.004	0.055	0.008	-4.63	0.000
Parihauhau	0.019	0.006	0.032	0.016	-0.76	0.445
Mangamahu	0.006	0.006	0.074	0.017	-3.80	0.000

[A]For 1988 recoveries, the proportion includes birds banded in 1987 that were retrapped in 1988.

TABLE 4 — Mean separation between band recoveries for each banding site and results of the pairwise comparisons between banding sites

Site	Mean separation between recoveries (km)	Comparison between pairs of sites (Probability of a greater difference by chance)				
		Waipu	Marahau	Kakatahi	Parihauhau	Mangamahu
Waipu	37.99	-	0.022	0.000	0.000	0.000
Marahau	36.89	-	-	0.000	0.005	0.003
Kakatahi	24.50	-	-	-	0.005	0.069
Parihauhau	38.80	-	-	-	-	0.008
Mangamahu	21.39	-	-	-	-	-

point estimates of recovery probability higher for coastal birds than for birds banded at the three hill country sites.

The geographical dispersion of band recoveries with respect to the banding site (Table 4) differed among banding sites. All pairwise comparisons of the mean separation between recovery locations were significant ($\alpha = 0.05$) except the comparison between birds banded at Kakatahi and Mangamahu ($p = 0.07$). The greatest dispersion of recoveries was for birds banded at Lakes Waipu and Marahau and birds banded at Parihauhau.

All pairwise comparisons of mean separation between recovery locations, when recovery was expressed with respect to a common origin, were significant ($\alpha = 0.05$), indicating that birds from different banding sites were dispersed into different areas by the start of the hunting season. Based on the clustering analysis, the banding sites with the most similar pattern of recovery locations were Kakatahi and Mangamahu, and Parihauhau and Lake Marahau (Figure 2). Lake Waipu recoveries were most closely associated with recoveries from Lake Marahau. These results suggest that, by the hunting season, Paradise Shelduck had dispersed into two separate groups: a sub-population of coastal moulting birds associated with birds from Parihauhau and a sub-population comprised of birds moulting in the Kakatahi-Mangamahu area.

Band recovery during trapping

During 1988 banding, 491 banded birds were recaptured; of these, 2 had been banded before 1987. Excluding Lake Marahau, over 70% of recaptured birds were caught at the moult site where they had been banded, and more than 95% were recaptured at moult sites within 15 km of the original site of banding (Table 5).

TABLE 5 — Banding site of 489 Paradise Shelduck banded during January 1987 and recovered during trapping January 1988

Banding site	Recovery site					
	Waipu	Marahau	Kakatahi	Parihauhau	Mangamahu	Other
Waipu	27	0	0	1	0	0
Marahau	9	24	2	6	0	20
Kakatahi	4	0	223	51	10	0
Parihauhau	1	0	1	69	0	0
Mangamahu	2	0	8	1	29	0

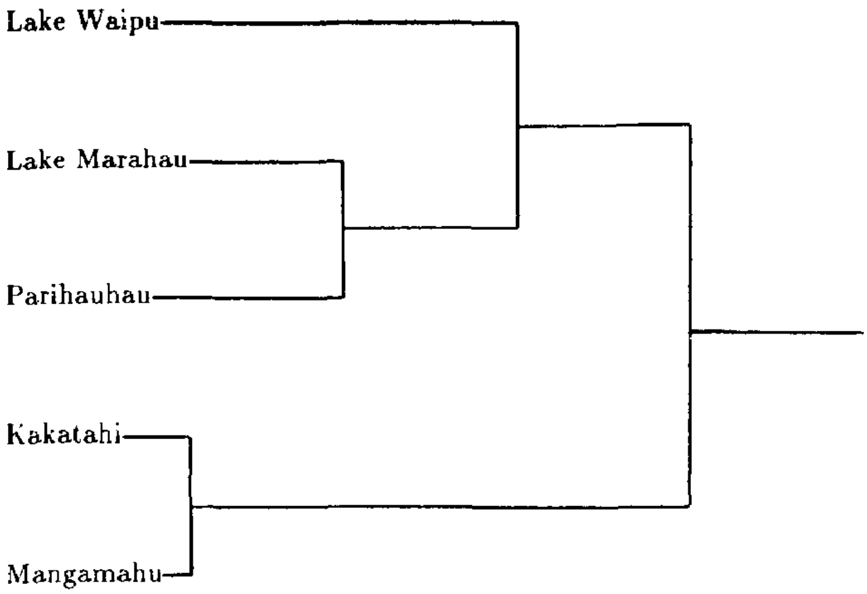

FIGURE 2 — Clustering of banding locations based on the similarity of geographical locations of band recoveries

At Lake Marahau, only 39% of recaptures were originally banded at Lake Marahau. However, 87% were birds banded at coastal lakes (Marahau, Waipu, and Waiau) and more than 95% had been banded at or less than 35 km from Lake Marahau.

Hunting effort

Most hunting effort in the 1987 and 1988 seasons was concentrated in a small region of the Wanganui Acclimatisation District within 30 km of Wanganui City, accounting for more than 70% of the estimated hunting effort (Figure 1). This region includes only two moult sites, Lakes Waipu and Marahau, accounting for 28% of moulting Paradise Shelducks in the 1989 counts (Table 1).

DISCUSSION

Williams (1981) reported variations in dispersal distance for birds banded at different moult sites throughout New Zealand. He concluded that Shelduck dispersal characteristics are probably predetermined by habitat, birds of irregular hill-country farmland being less dispersive than those of flatter grasslands. My results support this conclusion with evidence that birds moulting at coastal moult sites dispersed more widely than those from hill-country moult sites. I also found evidence that birds moulting at different moult sites disperse into areas subject to different hunting pressures. This was reflected in the higher band recovery probabilities for birds banded at the two coastal banding sites.

An assumption underlying the procedures used to analyse the dispersal data is that the recoveries represent a simple random sample from the banded population of birds. Because bands were recovered by hunters and hunting pressure varied between areas, this assumption was violated. The reduced hunting pressure in hill country areas means that band recoveries close to the banding site in these areas would be underrepresented and recoveries toward the coastal areas overrepresented. Thus dispersal distances for hill-country birds were probably overestimated and for coastal birds underestimated, masking differences between these areas. Therefore the most likely effect of violation of the assumption was for the test procedures to understate differences between banding sites.

The percentage of banded Shelducks retrapped at the site where the birds were originally banded varied between 39% and 97%, similar to that reported by Williams (1979). Shelducks do not appear to be entirely faithful to a given moult site each year, with a proportion moving between sites. Birds moved among hill country moult sites, and among coastal sites, but moved little between hill country and coast.

The results reported here have direct implications for management. First, movements of birds between moult sites, especially at Lake Marahau, highlight the importance of locating all moult sites during the January moult counts. Also, counts from neighbouring Acclimatisation Districts should be considered. Large changes in birds counted at a given moult site between years may be due to some birds changing moult site rather than to a change in population size. Second, birds moulting in the Kakatahi and Mangamahu areas should be considered as a separate management unit from birds moulting in the coastal and Parihauhau areas. Hunting pressure is highest in the coastal areas, and so the component of the Shelduck population moulting at Lakes Waipu and Marahau, and at Parihauhau, will probably be more sensitive to changes in hunting intensity.

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RICHARD J. BARKER, *Florida Fish and Wildlife Cooperative Research Unit, University of Florida, Gainsville, Florida 32611, U.S.A.* Address for correspondence: *U.S. Fish and Wildlife Research Centre, Laurel, Maryland 20708, U.S.A.*

SHORT NOTE

Chick expulsion by a Fiordland Crested Penguin

The crested penguins (*Eudyptes*) usually lay two eggs but raise only one chick to independence (Warham 1975). If the second and larger egg hatches, it almost always becomes the successful chick. The smaller sibling dies from a combination of parental neglect and an inability to compete for food with its larger nestmate (Lamey, in press; St. Clair 1990; pers. obs.).

In some crested penguin species, the parents may actively cause brood loss by kicking eggs from nests (Warham 1975; Lamey, in press). However, for those species in which both eggs often hatch, there is no evidence that parents actively cause chick loss. Here I describe an observation of a parent Fiordland Crested Penguin (*Eudyptes pachyrhynchus*) kicking the smaller chick out of the nest.

At 1535 h on 15 September 1989, I was watching a nest containing two small chicks on Taumaka I., Open Bay Islands (near Haast). The chicks, which had been marked with red or blue dye on the breast, were being guarded by the male. (Males guard the chicks for the first three weeks after hatching Warham 1974.) The chick marked blue, which was obviously smaller, had hatched from the smaller egg (C. St. Clair, pers. comm.). The chicks were about 4 days old. My field notes (slightly edited) read: