

# THE MOULT GATHERINGS OF PARADISE SHELDUCK IN THE GISBORNE-EAST COAST DISTRICT

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## ABSTRACT

Paradise Shelducks (*Tadorna variegata*) were found moulting at 13 sites in the Gisborne-East Coast district in 1977. These moulting sites were mainly large empoundments that had open aspects with steep pasture-covered hillsides rising from the water's edge and overhead escape-cover nearby. Individual birds mainly moulted at the same site each year and were flightless for about four weeks. Males took longer to moult than females. Non-breeding birds and failed breeders were flightless in January, successful breeders in February and March, and both sexes arrived to moult at the same time. The areas to which birds dispersed after completing their moult were determined from the return of bands by hunters. About 60% of all banded birds shot were within 32 km of their moulting site, females being recovered closer to the moulting site than males, and almost all recoveries were from the Gisborne-East Coast area. Moult gatherings allow the wildlife manager to monitor annual changes in regional and local populations. By constructing empoundments in new localities and inducing shelducks to moult there, regional populations may be subdivided into smaller units and managed with greater sensitivity.

## INTRODUCTION

Most species of shelduck migrate from their breeding areas to assemble in large flocks for their annual wing moult. The moulting assemblages of the Common Shelduck (*Tadorna tadorna*) in the shallow waters of the Heligoland Bight are especially spectacular with over 100 000 birds from the British Isles and coasts of western Europe from Norway to France gathering on the Grosser Knechtsands (Goethe 1961, Oelke 1969). Moulting flocks of other shelducks are smaller but hundreds, sometimes thousands of moulting Ruddy Shelduck (*T. ferruginea*), Australian Mountain Duck (*T. tadornoides*) and Cape Shelduck (*T. cana*) have been reported (Dementiev & Gladkov 1952, Delacour 1954, Frith 1967). Similar assemblages of Burdekin Duck (*T. radjah*) have not been reported.

In New Zealand, the Paradise Shelduck (*T. variegata*) also assembles in flocks for its annual moult, using large stock ponds, reservoirs, lakes and rivers. Little is known about these assemblages except that both adults and newly-fledged young are present, that the same sites are used each year and that in January and February, breeding territories are abandoned and all birds are at moulting sites.

During a study of shelduck biology in the hill-country farmland of the Gisborne-East Coast district (Williams 1979), I recorded details of these moult gatherings with four questions in mind:

1. What are the characteristics of moulting sites ?
2. Do individual shelducks attend the same moulting site each year ?
3. When do birds of different breeding status attend ?
4. To which areas do birds from each moulting site disperse ?

The answers to these questions are important to the wise management of this game species. If the essential characteristics of moulting sites are known, empoundments can perhaps be created that the birds will use. Changes in numbers at various sites may be better interpreted if the attendance behaviour of individual birds is known, and better recorded by counting when all birds are present. If shelducks at each moulting site disperse over relatively discrete areas, the shelducks of the Gisborne-East Coast district may be considered as a series of sub-populations and managed with greater sensitivity than by applying the same hunting regulations throughout.

TABLE 1 — The location and characteristics of moulting sites in Gisborne-East Coast.

Site No.	Name of site	NZMS 1. map ref.	Approx. size. (ha)	Grazing to edge	Marginal escape cover	Hillside alongside	Aspect	January count 1977
1	Huiarua 1	N80/379059	0.2	+	-	+	c	300
2	Huiarua 2	N80/435017	1.5	+	+	+	o	*40
3	Matanui	N80/455995	1	+	-	+	c/o	1200
4	Puketawa	N80/435978	1.5	+	-	+	c/o	1900
5	Puketawa 1	N80/453913	0.4	+	-	-	o	0
6	Puketawa 2	N80/468913	0.4	+	-	+	o	500
7	Parehaka	N89/392765	2	+	+	+	o	1800
8	Puhatikotiko	N88/219647	2.5	+	-	-	o	1500
9	Holdsworth	N97/213568	8	+	+	+	o	250
10	Ngakaroa	N98/347566	3	+	-	+	c/o	400
11	Burke's Dam	N98/342537	8	+	+	+	o	100
12	L. Repongaere	N98/262458	52	-	-	-	o	3000
13	Noble's Lake	N106/930277	16	+	+	+	c/c	200

+ = present

c = closed aspect

c/o = partially closed aspect

- = absent

o = open aspect

\* = moulting flock of over 300 birds present in February

### CHARACTERISTICS OF MOULTING SITES

Thirteen major moulting sites (Fig. 1) and several others used by few birds (10-20) were found in the Gisborne-East Coast district in 1977. The characteristics of the major sites are summarised in Table 1.

Most sites were large water empoundments about which flocks of non-breeders remained for all or part of the breeding season. Lake Repongaere near Gisborne, the largest lake in the Gisborne-East Coast



FIGURE 1 — The locations of Paradise Shelduck mouling sites in the Gisborne-East Coast district in January 1977. The identity and map reference of each site are given in Table 1. Site 14 is at Whakaki Lagoon.

district, is located amongst farmland containing numerous small stock ponds where shelducks are extremely abundant.

Three major moulting sites near Tokomaru Bay and Tolaga Bay, Huiarua 2, Matanui and Puketawa yards, are the largest empoundments on the East Coast. Of the many lakes at Tiniroto, however, the shelducks moulted on one of the smallest, probably because many of these lakes were used extensively for public recreation and moulting had to occur on the most secluded. Three small stock ponds on the East Coast were used. Puketawa 1 and 2 were only a few hundred metres apart and the use of Puketawa 2 followed two years of harassment at Puketawa 1. A small flock of non-breeders remained about these ponds throughout the year. Huiarua 1, a small secluded pond less than 1 km from the larger Huiarua 2 site, was not used as a breeding territory nor regularly by non-breeders. Shelducks have moulted there since 1956, prior to the construction of the larger empoundments nearby.

It was characteristic of moulting sites that grazing was available immediately at the water's edge (Fig. 2), an important requirement because moulters feed extensively during both daylight and dark and seldom move far from the safety of the water. Only Lake Repongaere was an exception. Its entire perimeter was ringed by a wide, dense stand of raupo (*Typha occidentalis*) and few moulters ventured to the nearby pasture during daylight. There, moulters fed almost exclusively at night.

Most sites had a relatively high open hillside rising directly from the water's edge (Fig. 3). From these hillsides, the usual resting and feeding areas for all moulters and some fliers, the birds had a panoramic view of the empoundment and the surrounding terrain. So important was this panoramic view that moulting sites did not occur in relatively narrow gullies. Some sites had high hills rising on all sides (Noble's Lake) or on two opposite sides (Ngakaroa, Matanui, Puketawa Yards) but the large expanse of water created an impression of openness and the view from one or both sides was extensive.

Six sites contained dense escape cover: Lake Repongaere, Holdsworth and Parehaka had raupo along their edges, Noble's Lake and Huiarua 2 had bush or scrub immediately alongside, and on Burke's Dam a single large willow (*Salix babylonica*) in the middle of the empoundment provided refuge.

The numbers of birds present at these moulting sites in January 1977 (Table 1) could not be correlated with the size of the water body or with any topographical feature.

#### THE TRADITIONAL USE OF MOULTING SITES

The same moulting sites were used each year and Lake Repongaere has been used ever since shelducks first reached the district in about 1947 (Williams 1971). This traditional use is probably first established amongst newly fledged young when they accompany their



FIGURE 2 — Puketawa 2 moulting site showing the grazing that is available to the water's edge.



FIGURE 3 — Puketawa yards moulting site showing steep hillsides rising directly from the water's edge.

parents to the moulting site and may be further reinforced when they remain there as a flock throughout most of the subsequent year.

Many birds returned to the same site each year. During January 1974 and 1975 shelducks were trapped at five sites. Most of the birds banded in 1974 and recaptured in 1975 were caught on the site where they had originally been banded (Table 2).

TABLE 2 — The percentage of shelducks banded as moulters subsequently retrapped at the same moulting site.

Moulting site	No. banded birds retrapped	% retrapped at banding site
Parehaka	199	77.4
Noble's Lake	72	91.7
Huiarua 1	54	96.3
Burke's Dam	54	40.7
Lake Repongaere	88	77.3
TOTAL	467	77.5

Disturbance from the annual banding operations probably caused some birds to change moulting sites. For example, up to 500 birds were recorded in some years at Burke's Dam but after banding commenced in 1969 there was a steady decline, even though shelduck numbers increased throughout the Gisborne-East Coast district, and only 100 were present in January 1977. More than half of the birds originally banded at Burke's Dam and subsequently retrapped were caught elsewhere, especially at nearby Lake Repongaere. Few banded at Noble's Lake were caught elsewhere, perhaps because this is an isolated moulting site with no others nearby. Two birds from there were retrapped at Huiarua, a straight-line movement of 84 km.

Only two of 54 banded at Huiarua 1 were retrapped elsewhere, both at nearby Parehaka. However, intensive banding operations at the Huiarua sites since 1974, including the retrapping of birds in February and March, had by 1977 resulted in birds moulting at six sites within a radius of 6 km, at all of which birds banded at the two Huiarua sites were retrapped. From 1974 to 1976, 35 shelducks banded at other moulting sites were retrapped at Huiarua 1 and 2; nine each from Burke's Dam and Lake Repongaere, two from Noble's Lake and 15 from Parehaka.

## PHENOLOGY OF THE MOULT AND ATTENDANCE AT THE MOULTING SITE

### *Onset of the moult*

Adults with young showed their first signs of moult when their ducklings were about 40 days old. The female began first, having a generally shabby appearance, the down showing through on breast

and abdomen and the breast slowly losing its bright chestnut colour and darkening as new feathers with predominantly black tips replaced the old. Males started later; in 12 of 14 pairs the male showed no obvious plumage disarray until the ducklings had fledged. Once the ducklings had fledged, however, the adult body and tail moult was rapid.

The body moult of breeders who failed to produce young usually began in early November, apparently irrespective of when their breeding attempt had failed. Four pairs lost their nests in mid-October and showed signs of body moult two weeks later. One pair lost their young within two days of hatching in late September and four pairs lost their nests in mid-September but in all I did not detect the start of their body moult until mid-November.

Amongst non-breeding birds which had remained in a flock throughout the breeding season I first observed signs of body moult in early October, and most birds were in heavy body moult by mid-November.

By the time birds reached the communal moulting site, most of the body moult had been completed. Only then were all remiges and coverts shed simultaneously and the wing reduced to a down-covered stub. I do not know how long elapsed between their arrival at the moulting site and the onset of flightlessness.

The earliest date on which I saw a flightless bird was 26 November at Puhatikotiko, the latest was 24 March on Huiarua 1.

#### *Juvenile moult*

In two years when selected moulting sites were trapped in January, February and March, 84 banded juveniles were caught. Most (85%) completed their wing moult during January (Table 3) and only one was caught in early March.

TABLE 3 — The numbers of flightless juvenile Paradise Shelducks caught in January, February and March.

Month	No. of juveniles trapped		
	Male	Female	% of total
January	29	42	85
February	3	9	14
March	1	0	1

#### *Adult moult*

Thirty-three birds of known breeding status were caught in two years when selected moulting sites were trapped in January, February and March. The successful breeders were flightless mainly during February and March, the failed breeders during January (Table 4).



TABLE 4 — The numbers of flightless adult Paradise Shelducks of known breeding status caught in January, February and March.

Month	Breeding males		Breeding females	
	Successful breeders	Failed breeders	Successful breeders	Failed breeders
January	1	5	3	2
February	12	1	7	
March	2		1	

The four successful breeders that were flightless during January had all successfully fledged their young by mid-November. All three successful breeders that moulted in March had been involved in successful reneesting attempts, while the only failed breeder caught flightless in February was an unsuccessful reneester, her second nest having been lost in early December.

Amongst these 33 birds were seven pairs. Both members of five pairs were caught on the same moulting site at the same time, those of one pair on the same site but in different months, and those of the seventh pair were caught at different sites at the same time.

#### *The duration of flightlessness*

The interval between successive retrappings of banded birds at various moulting sites provided an indication of the duration of the wing moult (Table 5).

TABLE 5 — The percentage of Paradise Shelducks which were flightless when first trapped and which were still flightless 28-44 days later.

Interval (days) between trappings	MALES		FEMALES	
	No. initially trapped	% retrapped	No. initially trapped	% retrapped
28	100	25	103	9
30	17	18	9	0
32	35	11	36	6
34	106	6	84	1
44	52	0	45	0

Significantly fewer ( $X^2 = 9.6$ ,  $0.01 > p > 0.001$ ) females than males were recaptured 28 days after their initial trapping, suggesting that most females completed their wing moult faster than males. Few birds spent longer than one month flightless.

*Wing moult of males and females*

At six moulting sites, all flightless birds present in January, February and March were caught. In each month equal numbers of males and females were present (Table 6), showing that they do not moult at different times. Counts of all the birds (fliers and flightless) at another three sites recorded equal numbers of both sexes (January 49.2% of 982, February 51.9% of 792, March 50.5% of 499 were females).

TABLE 6 — The numbers of flightless Paradise Shelducks caught in January, February and March and the percentage of them which were females.

Month	No. of sites	No. of birds trapped	% female
January	6	3133	51.2
February	6	1775	49.7
March	6	320	52.5

*Spread of moulting*

The numbers of birds at moulting sites increased during January as more birds arrived, mainly the successful breeders, often accompanied by their newly fledged young. However, most birds moulted in January. At the six sites where all flightless birds were trapped in January, February and March, 5228 birds were caught: 3133 (59.9%) in January, 1775 (34.0%) in February and 320 (6.1%) in March. Some birds handled in February and March had also been caught in the previous month and by correcting these totals according to data in Table 5, this suggests that 4891 individuals were handled, 64.2% in January, 30.9% in February, and 5.0% in March. The maximum number of birds present at a moulting site probably occurred in mid-February.

## DISPERSAL FROM MOULTING SITES

The areas to which birds dispersed after completing their moult were determined by plotting the locations at which banded birds were shot during the annual game season in May. This method is not completely satisfactory because sportsmen probably did not hunt with equal intensity throughout the area over which the birds dispersed. However, it does reflect the area from which hunters obtained birds coming from particular moulting sites, an important management consideration.

Flightless birds were first banded at Lake Repongaere in 1961. Birds at other sites were banded later; at Noble's Lake in 1965 and then 1970-1974 inclusive, at Burke's Dam 1965 and 1969-1974 inclusive, at Parehaka 1969-1974 inclusive and at the two Huiarua sites in 1974 and 1975.

The birds were caught and banded early in January each year and although they were simply designated as 'adults,' it is likely that most were juveniles undergoing their first wing moult.

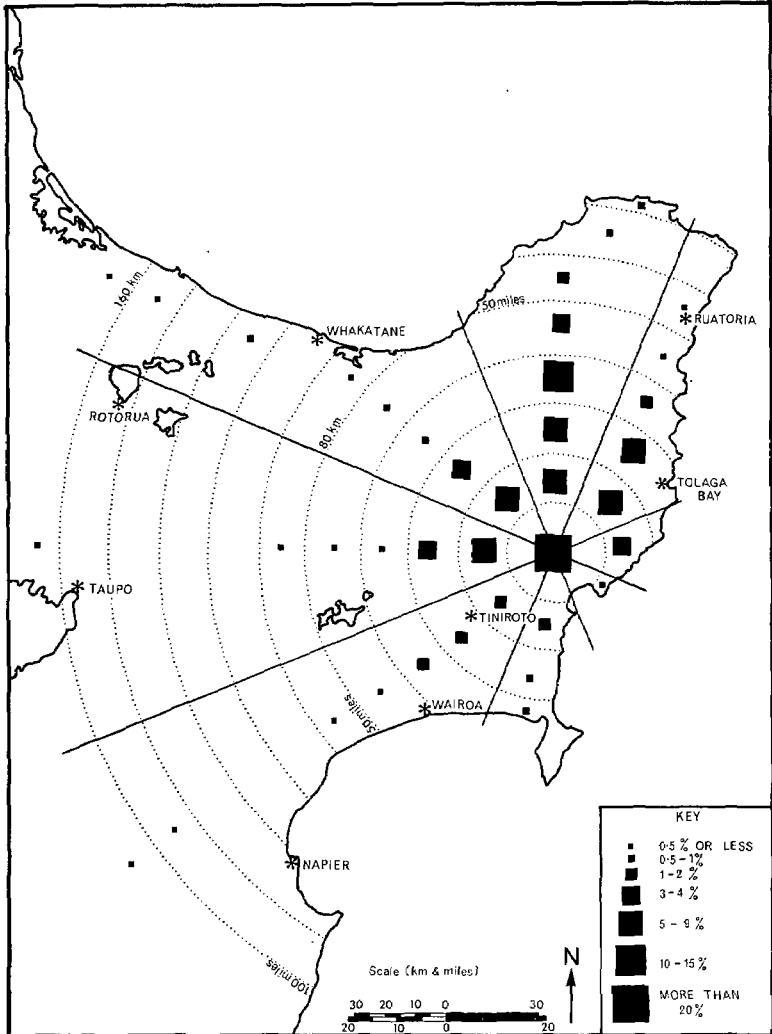


FIGURE 4 — The locations of recovery of 760 Paradise Shelducks banded at Lake Repongaere between 1961 and 1974. The numbers recovered in each sector are expressed as a percentage of the total recoveries.

TABLE 7 — The numbers of male Paradise Shelducks banded at Lake Repongaere between 1961 and 1974 that were reported shot at various distances and directions from the banding site between 1961 and 1975.

DIRECTION	DISTANCE (km)											TOTAL
	0	17	33	49	65	81	97	113	129	145	161	
	16	32	48	64	80	96	112	128	144	160	+	
NORTH	23	23	19	50	22	7	4	5				153
NORTH-EAST	2	28	19	10		1						60
EAST	8	13										21
SOUTH-EAST	3											3
SOUTH	9	6	2	4								21
SOUTH-WEST	1	6	7	6	3	2				2	3	30
WEST	12	24	11	2	2	1						52
NORTH-WEST	1	16	24	3	5	2		3			1	55
BANDING SITE	22											22
TOTAL	81	116	82	75	32	13	4	8	0	2	4	417
% OF TOTAL	19.4	27.8	19.7	18.0	7.7	3.1	1.0	1.9		0.4	1.0	
CUMULATIVE %	19.4	47.2	66.9	84.9	92.6	95.7	96.7	98.6		99.0	100	

TABLE 8 — The numbers of female Paradise Shelducks banded at Lake Repongaere between 1961 and 1974 that were reported shot at various distances and directions from the banding site between 1961 and 1975.

DIRECTION	DISTANCE (km)											TOTAL
	0	17	33	49	65	81	97	113	129	145	161	
	16	32	48	64	80	96	112	128	144	160	+	
NORTH	22	20	19	37	9	5	1	2				115
NORTH-EAST	3	26	29	5	1							64
EAST	11	7										18
SOUTH-EAST	2	1	1									4
SOUTH	4	2	2	1								9
SOUTH-WEST	2	6	3	3							1	15
WEST	10	24	10		1						1	46
NORTH-WEST	2	33	12	2	2			1			1	53
BANDING SITE	19											19
TOTAL	75	119	76	48	13	5	1	3	0	0	3	343
% OF TOTAL	21.9	34.7	22.1	14.0	3.8	1.4	0.3	0.9			0.9	
CUMULATIVE %	21.9	56.6	78.7	92.7	96.5	97.9	98.2	99.1			100	

*Lake Repongaere*

By the end of the 1975 game season the bands of 760 (18%) of the 4240 birds banded at Lake Repongaere had been returned to the banding office. Tables 7 and 8 summarise, for males and females separately, the locations of recovery in relation to distance and direction from the lake, and these are shown in Figure 4. More than 90% of all recoveries were made within 80 km and approximately two-thirds within 48 km of the lake. Only nine birds were shot 130 km or more away, six in southern Hawkes Bay, two in Bay of Plenty and one at Taupo.

Most recoveries from beyond a 16 km radius were made to the north on the East Coast (concentrated around Tolaga Bay, Tauwhareparae and the headwaters of the Mata River) with a smaller westward dispersal toward Matawai, Rere and Wharekopae. Recoveries south of the lake were few and imply that birds resident near Tiniroto, Nuhaka and Wairoa did not migrate to Lake Repongaere.

Similar proportions of the two sexes were shot within 16 km of Lake Repongaere, significantly more females ( $X^2 = 4.2$ ,  $0.05 > p > 0.02$ ) within 16-32 km, while beyond 48 km from the lake only 21.3% of the female recoveries were made compared with 33.1% of the male recoveries, a very significant difference ( $X^2 = 13.1$ ,  $p < 0.001$ ). These results show that females tend to remain close to their area of birth whereas males disperse more widely.

*Noble's Lake, Tiniroto*

Of the 559 moulting birds banded at Noble's Lake, 101 (18.1%) were reported shot by the end of the 1975 game season. The distribution of these recoveries is summarised in Table 9 and shown in Figure 5.

TABLE 9 — The numbers of Paradise Shelducks (both sexes) banded at Noble's Lake in 1965 and between 1970 and 1974 that were reported shot at various distances from the banding site between 1965 and 1975.

DISTANCE (km)	0	17	33	49	65	81	97	113	129	145	161	
	16	32	48	64	80	96	112	128	144	160	+	TOTAL
<u>MALES</u>												
NUMBER	31	8	6	2	4		6			1	2	60
% OF TOTAL	51.7	13.4	10.0	3.3	6.6		10.0			1.7	3.3	
CUMULATIVE %	51.7	65.1	75.1	78.4	85.0		95.0			96.7	100	
<u>FEMALES</u>												
NUMBER	18	7	4	1	6	4		1				41
% OF TOTAL	44.0	17.0	9.8	2.4	14.6	9.8		2.4				
CUMULATIVE %	44.0	61.0	70.8	73.2	87.8	97.6		100				

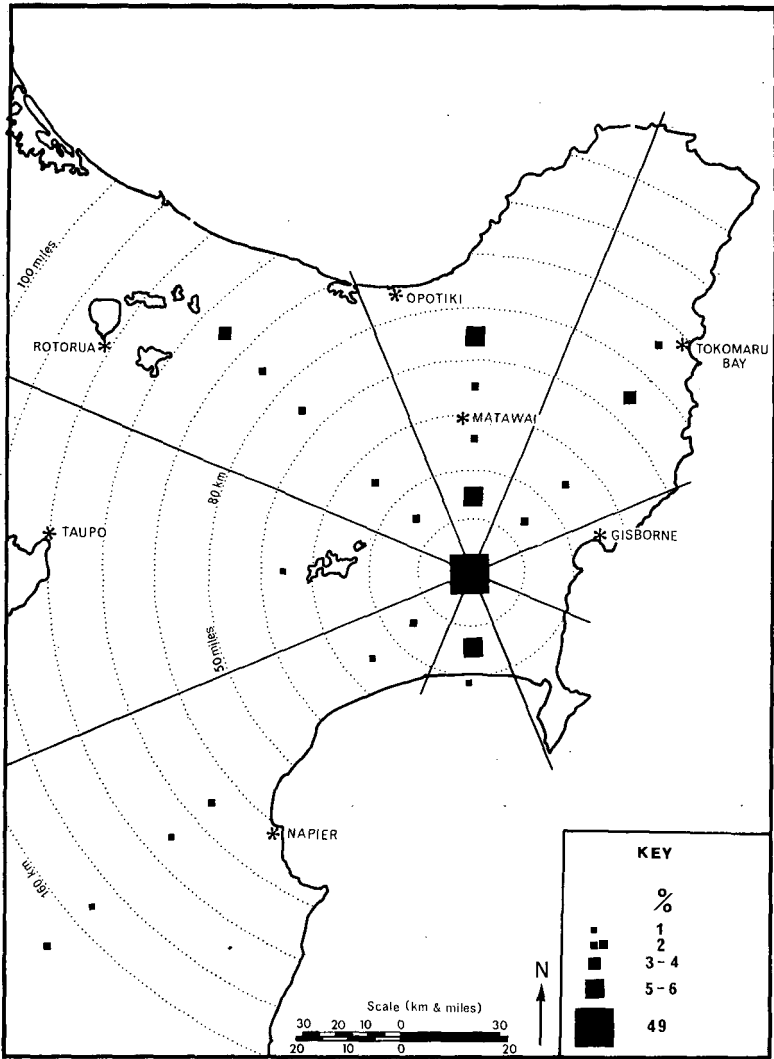


FIGURE 5 — The locations of recovery of 101 Paradise Shelducks banded at Noble's Lake, Tirioto, in 1965 and between 1970 and 1974. The numbers recovered in each sector are expressed as a percentage of the total recoveries.

Half of the recoveries were made within 16 km of the banding site and three-quarters within 48 km. Ten birds, nine of which were males, were recovered more than 100 km away.

Some movements were outstanding and involved crossing the forested ranges. Two were shot near Waiouru, a straight-line movement of over 180 km SW, and eight were recovered in the eastern Bay of Plenty. Four others were shot in central Hawkes Bay, south of Napier.

Most birds recovered beyond the 16 km radius were from north of Tiniroto; 11 from the East Coast, 4 from the Ormond-Te Karaka area, and 10 from the area between Tiniroto and Lake Repongaere. Those which dispersed into the East Coast were probably birds that had moulted away from Tiniroto in the year after banding; eight of these 11 birds were shot two or more years after banding.

#### *Burke's Dam*

A total of 1138 moulting shelducks were banded at Burke's Dam, and by the end of the 1975 game season 245 (21.5%) had been reported shot. The distribution of these recoveries is summarised in Table 10 and shown in Figure 6.

TABLE 10 — The numbers of Paradise Shelducks (both sexes) banded at Burke's Dam in 1965 and between 1969 and 1974 that were reported shot at various distances from the banding site between 1965 and 1975.

DISTANCE (km)	0	17	33	49	65	81	97	113	TOTAL
	16	32	48	64	80	96	112	+	
<u>MALES</u>									
NUMBER	39	48	17	9	8	1	3	0	125
% OF TOTAL	31.2	38.4	13.6	7.2	6.4	0.8	2.4		
CUMULATIVE %	31.2	69.6	83.2	90.4	96.8	97.6	100		
<u>FEMALES</u>									
NUMBER	50	26	16	17	9	0	2	0	120
% OF TOTAL	41.7	21.7	13.3	14.1	7.5		1.7		
CUMULATIVE %	41.7	63.4	76.7	90.8	98.3		100		

About 36% of all recoveries were made within 16 km of Burke's Dam, a significantly higher figure ( $X^2 = 25.1$ ,  $p < 0.001$ ) than for nearby Lake Repongaere, and two-thirds within 32 km compared with only 51% from Lake Repongaere.

Of the 156 birds recovered beyond the 16 km radius, only 19 (12.2%) came from south of the moulting site. The principal direction of movement was north and north-east, mainly to the Tolaga Bay and

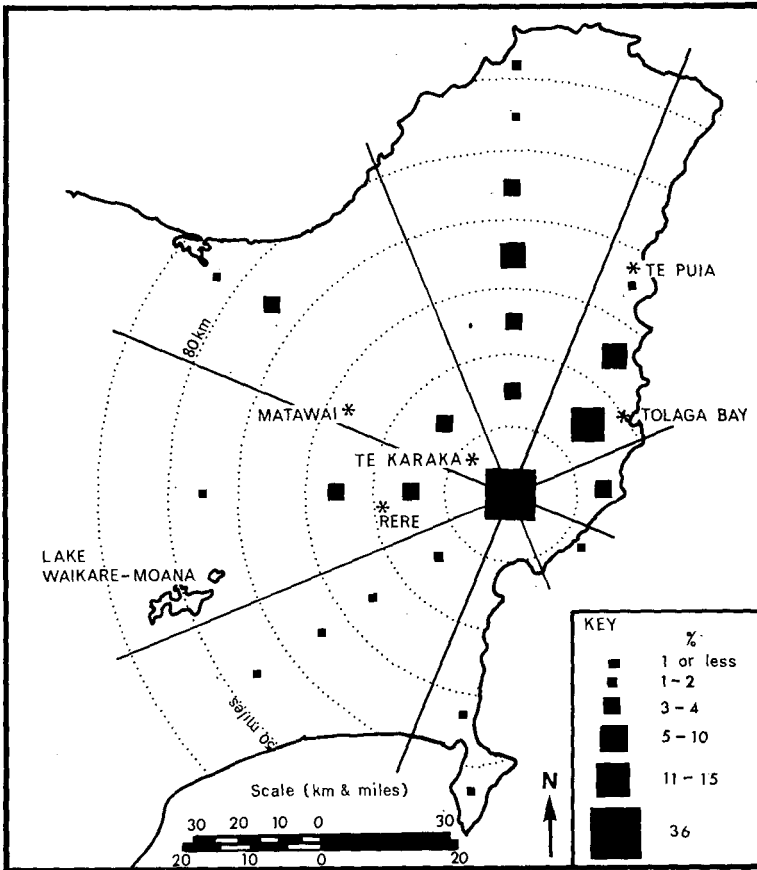


FIGURE 6 — The locations of recovery of 245 Paradise Shelducks banded at Burke's Dam in 1965 and between 1969 and 1974. The numbers recovered in each sector are expressed as a percentage of the total recoveries.

Tokomaru Bay areas. There were few distant movements of consequence; seven birds were recovered from the Opotiki area and six from north of Ruatoria, but none more than 112 km away.

There was no significant difference in the pattern of dispersal of males and females.

Burke's Dam and Lake Repongaere are only 10 km apart, and many birds originally banded at Burke's Dam were retrapped on Lake Repongaere. The above results suggest that the two moulting populations differ in that the Burke's Dam moulters primarily live close to their moulting site.



*Parehaka*

Of the 1502 Paradise Shelducks banded at Parehaka, 76 (5.1%) had been reported shot by the end of the 1975 game season. This is a very low return compared with that from other moulting sites and implies that these birds dispersed over an area where little hunting occurred. Table 11 summarises the distribution of these recoveries and they are shown in Figure 7.

TABLE 11 — The numbers of Paradise Shelducks (both sexes) banded at Parehaka between 1969 and 1974 that were reported shot at various distances from the banding site between 1969 and 1975.

DISTANCE (km)	0	17	33	49	65	81	97	TOTAL
	16	32	48	64	80	96	+	
<u>MALES</u>								
NUMBER	11	11	5	3	2	3	0	35
% OF TOTAL	31.4	31.4	14.3	8.6	5.7	8.6		
CUMULATIVE %	31.4	62.8	77.1	85.7	91.4	100		
<u>FEMALES</u>								
NUMBER	21	10	9	0	1	0	0	41
% OF TOTAL	51.0	24.5	22.0		2.5			
CUMULATIVE %	51.0	75.5	97.5		100			

Thirty-two (42%) recoveries were made within 16 km of the moulting site and most of the females were shot within 48 km. Eight (23%) of the males were recovered beyond 48 km, two in Bay of Plenty, one near Wairoa, and five on the East Coast north of Ruatoria. No bird was recovered more than 96 km from the moulting site.

Most of the 44 birds recovered more than 16 km from Parehaka were shot to the north or north-east. Only 16 (36%) were recovered south of Parehaka, eight of them at Lake Repongaere.

*Huiarua*

In 1974, 196 moulting adults were banded at Huiarua and a further 958 in 1975. By the end of the 1977 game season, 34 (2.9%) had been reported shot. The distribution of these recoveries is summarised in Table 12.

Most recoveries came from hill-country farms near the moulting site; of 21 (62%) recovered within 32 km, most were within the Mata and Waitahaia River valleys. Twenty-four (71%) of the recoveries were from north of Huiarua, including two from near Hick's Bay and three from Te Kaha on the Bay of Plenty coast. The most distant recovery was of a female shot at Nuhaka in northern Hawkes Bay, approximately 112 km south.

*Discussion*

The distribution of the locations at which banded birds have been shot suggests that for the majority of shelducks the moult migration does not exceed 32 km. However, those birds which moulted at Lake Repongaere tended to be recovered over a wider area than those from elsewhere. Banding there extended over 14 years, from the time when the species was establishing in the district until the time when it became widespread and numerous. As the population increased, moulting occurred at new localities and as a consequence birds did not travel so far. This is shown by data in Table 13 where I have divided the recoveries into two periods 1961-1969 and 1970-1975. For both sexes

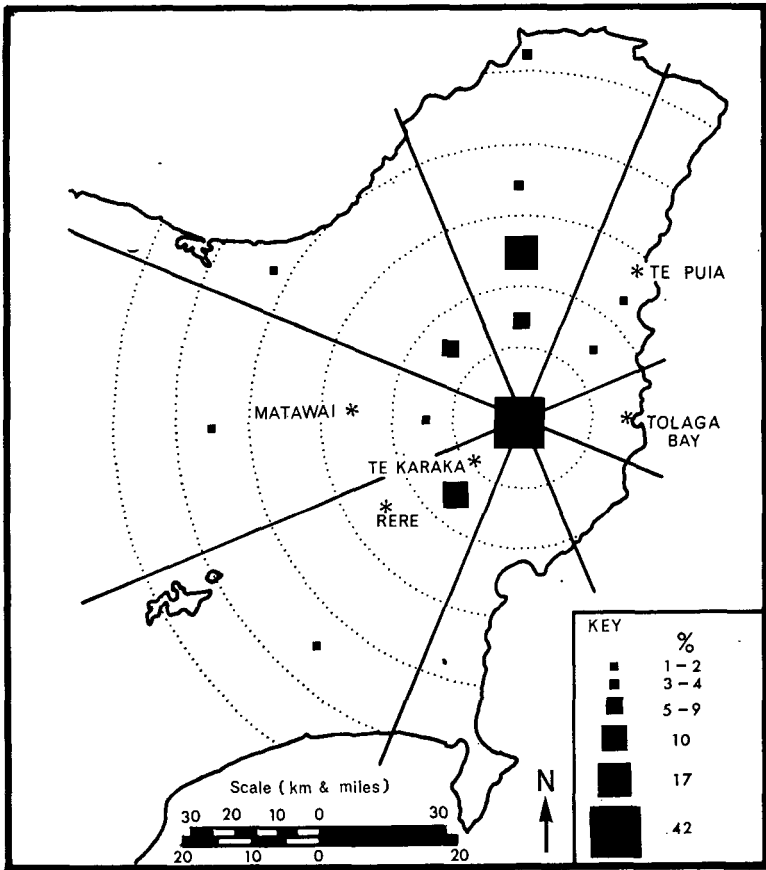


FIGURE 7 — The locations of recovery of 76 Paradise Shelducks banded at Parehaka between 1969 and 1974. The numbers recovered in each sector are expressed as a percentage of the total recoveries.

TABLE 12 — The numbers of Paradise Shelducks (both sexes) banded at Huiarua Station in 1974 and 1975 that were reported shot at various distances from the banding site between 1974 and 1977.

DISTANCE (km)	0	17	33	49	65	81	97	113	TOTAL
	16	32	48	64	80	96	112	+	
<u>MALES</u>									
NUMBER	6	4	2	3	3				18
% OF TOTAL	33.3	22.2	11.1	16.7	16.7				
CUMULATIVE %	33.3	55.5	66.6	83.3	100				
<u>FEMALES</u>									
NUMBER	7	4	1	3			1		16
% OF TOTAL	43.8	25.0	6.2	18.8			6.2		
CUMULATIVE %	43.8	68.8	75.0	93.8			100		

TABLE 13 — The cumulative percentage of the total recoveries of Paradise Shelducks banded at Lake Repongaere between 1961 and 1974 and reported shot at various distances from the banding site during the periods 1961 to 1969 and 1970 to 1975.

DISTANCE (km)	M A L E S		F E M A L E S	
	1961 - 1969	1970 - 1975	1961 - 1969	1970 - 1975
0 - 16	16.3	29.0	21.1	23.2
17 - 32	46.2	50.3	52.8	64.6
33 - 48	65.5	75.3	75.6	86.7
49 - 64	83.4	88.2	91.9	94.9
65 - 80	91.1	96.8	96.4	96.9
81 - 96	95.0		97.9	97.9
97 - 112	96.3	97.8	98.4	
113 - 128	98.4	98.9	99.6	
129 - 144				
145 - 160	98.8	100		100
161 +	100		100	
SAMPLE SIZE	324	93	244	99

a higher percentage of total recoveries was made closer to the lake after 1970; significantly more females ( $X^2 = 5.5, 0.02 > p > 0.01$ ) were recovered within 48 km of the lake after 1970 than before while, within the same radius, the difference between the male samples was almost significant ( $X^2 = 3.0, 0.10 > p > 0.05$ ).

The birds banded at all five sites were mostly recovered near the banding sites and within the Gisborne-East Coast district. Recoveries from Hawkes Bay and Wairoa were few and the physical barrier of the forested Raukumara and Huiarau Ranges probably prevented all but a minor movement west into the Bay of Plenty and to Rotorua-Taupo. The small number of recoveries from East Cape probably reflects the low density of hunters there rather than the number of banded birds reaching the area. No moulting sites are known north of Huiarau Station and on the East Coast and my observations of Huiarau-banded birds near Ruatoria, Tikitiki and Te Araroa suggests none occur.

The locations at which banded birds were shot suggest that birds moulting at Noble's Lake and at the Huiarau sites can be regarded as relatively discrete sub-populations, and that those moulting at Parehaka, Lake Repongaere and Burke's Dam (and probably the other smaller sites in the Te Karaka-Ormond area) can be regarded as a third sub-population. The extent to which the Noble's Lake population is separate from those birds which moult further south could be determined by a short-term banding study at the Whakaki Lagoon moulting site near Wairoa.

### MANAGEMENT IMPLICATIONS

The moult gatherings of Paradise Shelducks are very important to the wildlife manager because with all birds, breeders, non-breeders and fledglings, concentrated at moulting sites during January and February, they offer a unique opportunity to census regional populations, and because most birds return each year to the same moulting site, an opportunity to monitor changes in local populations.

Obviously the manager must know of all the moulting sites in his district. In the Gisborne-East Coast district, for example, 13 major sites were known in 1977, but as the shelduck population there increases, some of the minor sites containing only 20-30 moulters in 1977 will gradually increase in importance and they too should be monitored. Without knowing of new sites the manager cannot always properly interpret the changes in numbers at a particular site. A change in numbers may reflect a true change in the local population because of changes in mortality rates, emigration, immigration or breeding success, or it may indicate the development of another moulting site nearby. An example of this is recorded in Table 1; the Huiarau 2 site, where in 1976 almost 800 birds were caught, contained only 40 moulters in January 1977. The considerable disturbance caused by banding operations there had caused birds to moult at another site

about 3 km away. Such major drops in numbers clearly indicate changes in moulting site, but smaller fluctuations such as those which have occurred at Burke's Dam are more difficult to interpret unless all the moulting sites are well known.

The timing of counts is also important. Counts made in early January may record only about two-thirds of the population and exclude many of the successful breeders and their progeny. The time when adults and fledglings arrive at their moulting site may differ year to year, and so in a poor breeding season most adults may be present in early January, whereas in a successful season most adults and their young may not arrive until early February.

Although the Paradise Shelducks of the Gisborne-East Coast district can be regarded as a single population, the pattern of their dispersal shown by band returns suggests a division into three sub-populations; those birds moulting at Noble's Lake, those moulting at or near Huiarua Station, and those moulting at Lake Repongaere, Burke's Dam, Parehaka and elsewhere in the Ormond-Te Karaka area. By using these subdivisions, shelducks within the district can be managed with increased sensitivity, for example, by monitoring population trends in the three areas and, if necessary, applying different hunting restrictions.

No moulting site is known north of Huiarua Station and the recoveries and sightings of banded birds suggest that at least some birds resident near East Cape moult at Huiarua. As Paradise Shelducks are less intensively hunted north of Ruatoria than in the area of Tokomaru Bay and Tolaga Bay, it would be advantageous to induce the birds of the two areas to divide into two moulting populations by creating a suitable moulting site north of Ruatoria and so to follow population trends in the two areas more accurately. The principal characteristics of moulting sites in the Gisborne-East Coast district included large water areas with high grass-covered hillsides rising directly from the water's edge and with dense escape cover nearby. The construction of a large empoundment conforming to these characteristics would be a useful first step in this management exercise and thereafter techniques to induce birds to moult there could be tested. Should this experiment prove successful the same management procedure could be used widely throughout the hill-country of the North Island.

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## SHORT NOTES

### OBSERVATIONS ON THE CHATHAM ISLAND PIGEON IN CASCADES GORGE

In March 1977, A. E. Billing and I formed a small Wildlife Service party that searched for 12 days in the Cascades Gorge region (c.20 ha) of Chatham Island for the endangered Chatham Island Pigeon (*Hemiphaga novaeseelandiae chathamensis*).

To determine whether pigeons were in the gorge, I spent the first day scanning the forest from vantage points along the rim of the gorge. In six hours, nine sightings were made. The Chatham Island Pigeon, being large and noisy of flight like the New Zealand Pigeon, was most obvious when flying above the canopy of the forest. On sunny days, the birds were often conspicuous from a great distance as they rested on prominent perches where their dazzling white breast plumage stood out against the darker background.

At the time of our visit, the adult pigeons were undergoing tail moult, and we could recognise individuals at close quarters by differences in their tail shape.

#### *Population*

During our visit, ten different Chatham Island Pigeons were recognised in the gorge. Seven were adults, two were juveniles — each closely accompanied by an adult — and a single fledgling was seen once, accompanied by its parents.

The two juveniles were similar to adults in plumage colour but their eyes were hazel brown instead of crimson as in adults and the otherwise brightly coloured bill was still dark at the tip.

The fledgling pigeon was much duller than the parent birds. Its head and neck were drab grey, and slightly paler than on the adult, and around the eye was a faint area of buff. The eye itself was dark, almost black, the bill appeared shorter than that of an adult, and was purplish brown, blacker towards the tip. The feet were dull purplish red.