THE SULPHUR POINT (LAKE ROTORUA) GULL COLONY

By DENISE and BRIAN REID

INTRODUCTION

The New Zealand gull population comprises two endemic forms; the Black-billed *(Larus bulleri)* and the Red-billed *(L. novaehollandiae scopulinus)*, as well as the circumaustral Black-backed Gull *(L. dominicanus)*. All three breed on the volcanic plateau, the first two in the Rotorua district and the last around Taupo and possibly at Rotorua. The main Rotorua breeding area for both Red-billed and Black-billed gulls is along the city margin of the lake where they have colonised part of Sulphur Point and several of the small silica islets in the surrounding bay. This area will be discussed more fully later.

Other known breeding grounds at Rotorua include a small thermal lakelet (Roto-a-tamaheke) in the Whakarewarewa reserve and the Arikikapakapa golf-course. The age of the Whakarewarewa colony is not known but the writers remember gulls congregating there in the 1949-50 and 1950-51 seasons. It is not known whether they bred. Daniels (1963) records the 1962-63 breeding population as 40 pairs of Black-bills and one pair of Red-bills. According to Black (1960), Red-bills first bred on a mud flat at the golf course in 1959. He has since given the size of this 'subsidiary' colony as about 200 pairs.

The breeding of both Red-billed and Black-billed Gulls in Rotorua district is interesing, as neither species would normally be expected to occur there. Their establishment in the district has undoubtedly followed 'in the wake of the plough.'

Red-billed Gulls are widely distributed, breeding around the coast of New Zealand and on outlying islands from Campbell and the Auckland Islands in the south-west, to the Chathams in the east and the Three Kings in the north. They can, in general, be regarded as coastal breeders (i.e. near salt water), but at Rotorua they are inland.

The Black-billed Gull is mainly a South Island species. Although they breed around the coast they are specially characteristic of rivers and inland lakes. They have long been known as visitors to the southern regions of the North Island. The Rotorua population is well removed from the normal range.

PREVIOUS RECORDS

Records of Black-billed and particularly Red-billed Gulls at Rotorua are few. Available information is summarised below.

Red-bills: A considerable population has been in the Rotorua district for many years. G. A. Buddle reports them breeding with Black-billed gulls on small rocky islets off the mouth of the Whaka stream during the 1939-40 summer. In April 1941 C. A. Fleming counted over 400 (including many immature) behind the Ward Baths; i.e. the present colony site. Over 1,000 birds were noted in this general vicinity in May 1945 by R. B. Sibson.

M. S. Black (1961) is of the opinion that the population has increased during the last 20 years. He considers the winter populations

are larger than formerly and are also probably greater than the summer breeding population as many wintering birds appear to depart for coastal breeding grounds.

Although spot counts are of limited value in indicating the size of a breeding colony the following figures do point to a population increase.

On 17/11/45 H. R. McKenzie counted over 50 birds and 27 nests. On about the same date two years later (i.e. 21/11/47) J. M. Cunningham recorded 44 birds and 21 nests. It can be reasonably assumed that in both these years the breeding population was much the same. Black states that about 70 pairs nested in both the 1951-52 and 1954-55 seasons (i.e. roughly twice the 1945 and 1947 number). His figure for the 1956-57 season is about 150 pairs, which is twice that for the 1951-52 and 1954-55 summers.

In some years breeding occurs early, in others later. During 1958 the birds started gathering at Sulphur Point in August. In 1954 a flock of 300 had arrived by September 10th and there was much activity claiming territories (M.S.B.). Laying had just started on 2/10/57 (D. Merton). In 1945 it appears to have been about a month later, for according to H. R. McKenzie only seven nests out of the 27 built on 17/11/45 contained clutches.

The nearness of the colony to the city has heavily handicapped the breeding success. For example, of the 1945-46 season — "the colony was later completely destroyed by vermin" (H.R.McK.); 1947-48 season — "Later the entire colony was robbed of eggs by humans" (J.M.C.); 1954-55 season — "not one chick left the nest, all were ruthlessly destroyed by humans" (M.S.B.). However Black mentions that 'many young' were successfully fledged from the 1956-57 season and Cunningham notes the successful re-nesting of some birds. These notes on losses and re-nesting refer to Black-bills also.

Black-bills: These have been known in the Rotorua district for a long time; e.g. Oliver, 1930 writes "Has been recorded (*not recently*) from Lakes Tarawera and Rotomahana." They were first reported breeding in the district on the Sulphur Point islets in May 1932 by M. E. Fitzgerald and A. H. Hooper; and independently by C. A. Fleming. In 1939 Buddle records that between 75 - 100 pairs were nesting on rocky islets off the mouth of the Whaka Stream (i.e. Puarenga Stream which flows into Sulphur Bay about 650 yards S.E. of the present Sulphur Point colony). During the early 1940's the Rotorua district was the only known breeding area of *L. bulleri* in the North Island, although Sibson (1953) considered that they may breed elsewhere on the volcanic plateau and mentions "a rather inaccessible lake on Mount Tongariro." The knowledge of Rotorua breeding grounds at that time appeared to be confined to Sulphur Point as a definite area and Lake Rotomahana as a probable area.

Sibson thought it possible that odd pairs may nest elsewhere in the North Island and this has since been confirmed. (e.g. Porangahau Estuary, Hawkes Bay; first recorded 11/1/45 by K. A. Wodzicki and J. M. Cunningham. Ngaruroro River, Hawkes Bay; first recorded 9/1/54 by D. H. Brathwaite. Gisborne harbour, first recorded 19/1/54; and Murphy's Beach, Gisborne, first record 19/1/59, both by A. Blackburn. These are all small colonies.

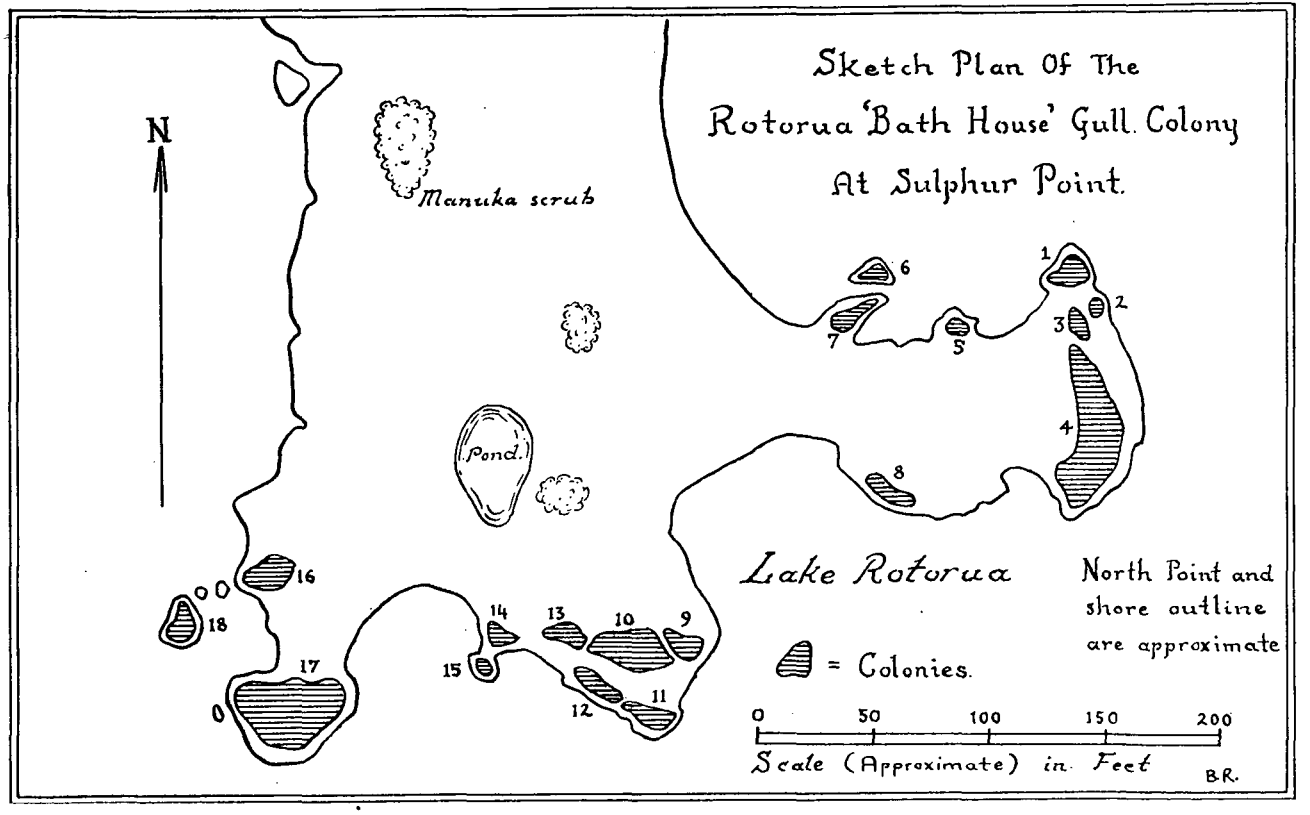
Black (1955) mentions that the vanguard of the Rotorua Black-billed summer-breeding population appears in August (e.g. 3/8/54 — 30 birds; 7/8/53 — 40 birds; 17/8/48 — 200 birds; 18/8/58 — 200 birds, M.S.B.). The numbers swell throughout September and October reaching their maximum in November. Counts recorded in the *Classified Summarised Notes* indicate that the population build-up varies from year to year — e.g. September counts: 9/9/41 — 200 birds (R.B.S.); 13/9/46 — 500+ birds (C.A.F.); 20/9/54 — 200+ birds (M.S.B.). One October count is available when only 160 birds were noted on the first day of that month by M.S.B. Three November counts give: 20/11/44 — 400 birds (H.R.McK.); 17/11/45 — 500 birds (H.R.McK.); and 21/11/47 — 600+ birds (J.M.C.). The November counts suggest a steady increase in the population over the four-year period 1944-47. This may be a gradual, steady increase which is still continuing; for Fleming (1947) considered the population had probably increased since 1932 and the writers' counts in 1961 show that the upward trend is being maintained.

The start of laying does not appear to bear directly on the population build-up. Laying may begin early or late regardless of the percentage of the total breeding population that is present. On 17/11/45 H.R.McK. counted 500 birds but these had not started nesting. At the same period two years later (i.e. 18/11/47) 99 nests were counted (84 with one egg, 15 with two eggs) and yet the adult tally was roughly 100 fewer than in 1945. F. C. Kinsky (*pers. comm.*) visited the colony on 21/12/59. Of subcolony 16 — he mentions this was composed of Black-bills with the exception of one Red-billed pair — most of the nests still contained eggs; a few had chicks. Hatching had started within the last few days as no chicks were running around. In 1961 this stage was reached by November 1 or seven weeks earlier. In 1961 the colony composition was the same — all Black-bills except for one pair. Black gives the following routine sequence for the Sulphur Point colony — "after the arrival of the main body comes the claiming of territory which goes on for several weeks before any attempt is made at nest building. This starts in earnest about mid-October. After the nests are built comes a period of inertia lasting 5 - 10 days. Then the first egg is laid."

Of the breeding population Black states — "The most successful season for many years was that of 1951-52 when a maximum of 220 nests contained clutches — in mid December when nesting was at its peak." He also records that 200 pairs bred in 1956-57.

The main exodus from the breeding to the wintering grounds usually occurs between mid-April and the end of May but the decline in numbers is not particularly apparent until mid-May. A few stragglers remain behind at Rotorua over the winter months but the population is not stable. Flocks may suddenly appear in Sulphur Bay, and just as suddenly disappear. Black records two such occasions; — in June 1952 when over 200 were counted; and in July 1954 when over 160 were seen.

As early as 1942 Sibson suggested that the Black-bills frequenting the Firth of Thames coast around Miranda in the winter months probably came from Rotorua, and considered that if such were the case, "the Rotorua population must run into several hundreds."


Sketch Plan Of The
Rotorua 'Bath House' Gull Colony
At Sulphur Point.
N
Manuka scrub
Pond.
Lake Rotorua
North Point and shore outline are approximate
= Colonies.
0 50 100 150 200
Scale (Approximate) in Feet
B.R.
1
2
3
4
5
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18

Fleming (1947) endorses this view and writes — "The differences between summer and winter numbers (at Rotorua and along Firth of Thames) supports the hypothesis that the winter flock at Miranda is composed of Rotorua breeders." Black agrees in part but is also of the opinion that some move north-eastward to the Bay of Plenty, where as long ago as September 1940, Sibson found small numbers at Matata lagoon and the estuaries of the Tarawera and Rangitaiki. This view is held by the writers, as considerable numbers of Black-bills have now been seen in newly ploughed fields on "Windermere" and neighbouring farms at Edgecumbe.

THE 1961-62 BREEDING SEASON

During the 1961-62 breeding season the writers tried to assess the proportions and numbers of the two gulls in the various 'sub-colonies' of the Sulphur Point colony. Observations and counts were confined to the birds breeding on the silica spit and one or two closely adjacent islets. Birds on islets further out in the bay are not included in the counts and the writers cannot even hint at what percentage of the total breeding population were on these islets. The area covered by the census is that which will form the proposed wildlife sanctuary.

The first visit was made on 4/10/61 and two aspects of the colony caused surprise. Firstly, the population was much greater, and secondly, breeding had begun appreciably earlier than available records indicated. At a comparable date in 1957 (i.e. 2 October) Merton found that Red-bills had just started to lay while the Black-bills were still nest-building. On 4/10/61 a rough check showed that (a) over 350 Red-bill nests were occupied and about 300 of these contained eggs; (b) roughly 250 Black-bill nests were occupied and 40+ had eggs.

The Colony — Description

The colonised area of Sulphur Point is the tip of a low-lying silica spit situated about 200 yards east of the Ward Baths. This protrudes southwards into the southernmost bay of Lake Rotorua. The spit is susceptible to flooding. Its shape and area vary according to the level of the lake. When the level is low the spit outline is similar to a spurred boot, there being three extensions at the far end roughly the shape of toe, heel and spur (see plan). When the level is high much of both the toe and heel are either submerged or awash and the spur is cut off to form an islet. The gulls nest on the three extensions. There are seven sub-colonies on the toe, seven on the heel and two on the spur. Another sub-colony (No. 6) is on an islet a few feet north of the toe and sub-colony 18 is on an islet just west of the spur. The spit is geo-thermal. There are several steam vents and three or four hot to boiling pools. A fairly large pool lies between sub-colonies 10, 11 and 12 (not shown on plan). This claimed a considerable number of chicks. The foot of the spit (i.e. toe, heel and spur) is about 400 feet long.

Population Size (Field Data)

The total breeding population was counted twice; on 5 October 1961 and again on 19 October 1961. These counts give a different picture of the colony (in terms of both size and composition), because proportionately more Red-bills were in residence when the first census was made. They breed earlier.

TABLE 1 — Number Occupied Nests; Sulphur Point Colony

Date	5 October 1961				19 October 1961				
Species	Red-bills		Black-bills			Red-bills		Black-bills	
Nests with	0	Eggs	0	Eggs	0	Eggs	Chicks	0	Eggs
Sub Col. 1	3	24	–	–	1	17	8	–	–
2	3	3	–	–	–	4	–	–	–
3	7	8	5	–	–	10	2	2	3
4	9	41	84	9	1	45	2	2	99
5	4	–	–	–	1	1	–	–	–
6	–	1	–	3	–	1	–	1	4
7	2	2	1	–	–	5	–	1	1
8	1	6	2	1	–	6	1	1	2
9	1	2	3	–	–	3	–	1	4
10	7	35	3	4	1	32	12	2	41
11	6	23	–	–	3	20	3	–	–
12	3	18	2	–	1	16	4	2	3
13	1	8	2	–	–	6	3	1	1
14	1	3	5	1	–	3	1	1	7
15	2	4	1	1	–	4	2	2	5
16	–	1	22	13	–	1	–	4	67
17	20	128	55	22	3	123	21	10	163
18	2	16	11	7	–	13	5	–	28
Total Nests	72	323	196	61	11	310	64	30	428
Per Cent. composition	60.6		39.4		45.7			54.3	

From Table 1 it can be seen that there were —

1. a. 652 occupied nests on 5 October 1961. These included 395 (60.6%) Red-bills and 257 (39.4%) Black-bills.
   b. Whereas 323 (81.8%) of the Red-bill nests present contained eggs.
   c. Only 61 (23.7%) of the Black-bill nests present contained eggs.

2. a. 843 occupied nests on 19 October 1961. These included 385 (45.7%) Red-bills and 458 (54.3%) Black-bills.
   b. Whereas the number of occupied Red-bill nests had decreased by 10 (2.5%).
   c. The number of occupied Black-bill nests had increased by 201 (78.2%).
   d. 374 (97.1%) of the Red-bill nests occupied contained eggs or chicks.
   e. 428 (93.4%) of the Black-bill nests occupied contained eggs.

The nest composition data from these two counts is presented in Appendix 1. In addition, extra counts were made of selected sub-colonies to obtain fuller information (Appendix 2). Sub-colonies 1, 11 and 12 were used for Red-bills as there were very few Black-bills in these three breeding congregations and their nests were easily recognised. Sub-colony 16 gave fuller Black-billed data. It contained only one breeding pair of Red-bills.

TABLE 2 — Counts of Selected Sub-colonies

	Black-bills (sub-colony 16)				
	Nests Occupied		Nests with E/Ch.		
Date	No. (A)	%	No. (B)	% (A)	% (B)
5/10	35	46.1	13	17.1	17.8
10/10*					
19/10	71	93.4	67	88.2	91.8
26/10	75	98.7	72	94.7	98.6
28/10*	76	100.0	73	96.0	100.0
2/11	73	96.0	69	90.8	94.5
9/11	52	68.4	48	63.2	65.8
14/11	19	25.0	17	22.4	23.3
21/11	10	13.1	10	13.1	13.7

* Estimated population peaks based on plotting above figures

	Red-bills (sub-colonies 1, 11, 12)				
	Nests Occupied		Nests with E/Ch.		
Date	No. (A)	%	No. (B)	% (A)	% (B)
5/10	77	97.5	65	82.3	90.3
10/10*	79	100.0	72	91.1	100.0
19/10	73	92.4	68	86.0	94.4
26/10	54	68.4	46	58.2	63.9
28/10*					
2/11	29	36.7	26	32.9	36.1
9/11	20	25.3	19	24.0	26.4
14/11	19	24.0	19	24.0	26.4
21/11	15	19.0	15	19.0	20.8

* Estimated population peaks based on plotting above figures

Calculated Breeding Population (1961-62)

By plotting a curve based on the counts (Table 2) of the selected sub-colonies it is possible to obtain the probable maximum number of pairs for these colonies, along with the approximate date when the peak number for each species was reached. If these data are equated with the total counts made on 19/10/61 an estimate of the colony size may be made. With Red-bills it is also possible to arrive at the maximum number of nests used during the occupation peak by using the total count made on 5/10/61 together with the figures for sub-colonies 1, 11 and 12. The total obtained from using the 5/10/61 count agrees within 2.5% with the tally based on the 19/10/61 figures. In the case of the Black-bills there were not enough present for the 5/10/61 count to be reliable.

Red-bills: On 5/10/61 occupied nests = 395 (total colony count).

On the same date 97.5% of the total number of nests were occupied (derived from sub-cols. 1, 11 and 12 data).

Therefore maximum number nests occupied at peak $= \frac{395 \times 100}{97.5}$

$= c.405$

On 19 October 1961 occupied nests = 385 (total colony count). On the same date 92.5% of the total number of nests were occupied (derived from sub-cols. 1, 11 and 12 data).

Therefore maximum number of nests occupied at peak $= \frac{385 \times 100}{92.5}$

$= c.415$

On 19/10/61 374 nests contained clutches (total colony count).

On the same date 94.5% of the maximum number of clutches were present (sub-cols. 1, 11 and 12).

Therefore number of clutches at peak $= \frac{374 \times 100}{94.5}$

$= c.395$

Black-bills: On 19/10/61 occupied nests = 458 (total colony count).

On the same date 93.5% of the total number of nests were occupied (sub-col. 16).

Therefore maximum number nests occupied at peak $= \frac{458 \times 100}{93.5}$

$= c.490$

On 19/10/61 428 nests contained clutches (total colony count).

On the same date 92.0% of the maximum number of clutches were present (sub-col. 16).

Therefore number of clutches at peak $= \frac{428 \times 100}{92.0}$

$= c.465$

Peak Nesting Population

The peak nesting population is estimated at c.900 pairs comprising c.410 (45.5%) Red-bills and c.490 (54.5%) Black-bills. On the data available the probable size and species composition of the 18 sub-colonies is as follows (Table 3).

TABLE 3 — Probable Peak Number of Nesting Pairs

Sub-col.	Red-bill	Black-bill	Total	Sub-col.	Red-bill	Black-bill	Total
1	28	–	28	10	48	46	94
2	5	–	5	11	28	–	28
3	13	6	19	12	23	5	28
4	50	106	156	13	10	3	13
5	4	–	4	14	5	9	14
6	2	6	8	15	7	8	15
7	5	3	8	16	1	76	77
8	7	4	11	17	151	181	332
9	3	6	9	18	20	31	51

Total Breeding Population

It is highly improbable that the peak breeding population for each species would equal their total breeding population as this would imply that no clutches had been lost in the four-week period extending from when the first clutch was laid to the time when the maximum number was reached.

In sub-colony 16 the contents of two nests were lost in the seven day period extending from 26/10/61 to 2/11/61. The number of nests with clutches or chicks had decreased by three (from 72 to 69) but two chicks from one nest were roaming freely. This information permits a rough estimate of Black-billed clutch losses, e.g.

2 clutches were lost in c.500 nesting days (72 nests x 7 days)

Total Black-billed nesting days = No. nests x incubation period
= 465 x 22 = c.10200

Therefore $\frac{102 \times 2}{5}$ = c.40 clutches were lost.

If the same rate of clutch loss is assumed for Red-bills it is found that

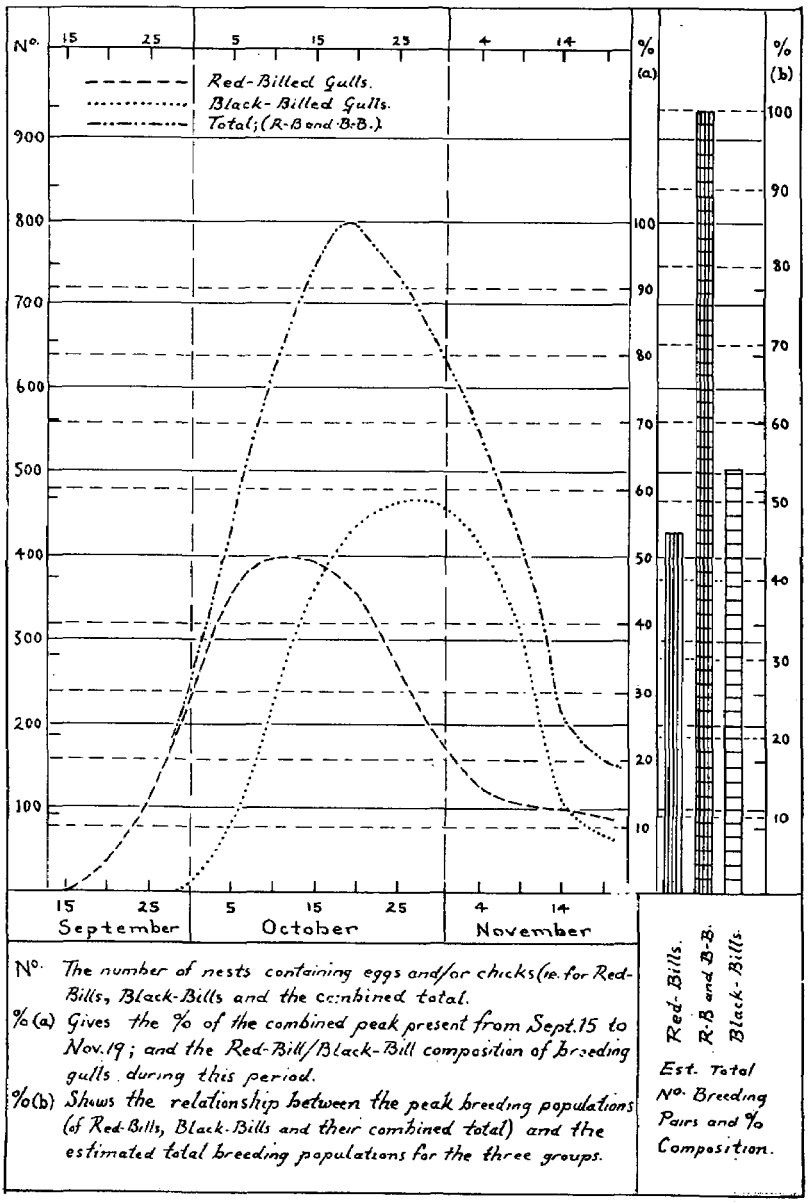
$\frac{87 \times 2}{5}$ = c.35 clutches were lost.

This method suggests that only 8.0% of the total breeding nests lost their clutches. Considering the internal congestion of the colony and the inter-play of the two species along with its susceptibility to outside interference this loss is very low. The actual loss would probably be considerably higher but is masked by the re-laying of lost clutches. The acceptance of an 8.0% clutch loss for Red-billed and Black-billed gulls places the total breeding population of the Sulphur Point colony at c.935 pairs (430 Red-bills and 505 Black-bills).

The Population Build-Up and Breeding

It is not known when the gulls started gathering at Sulphur Point for breeding. The start of egg laying and build-up of nests has been determined in part by extrapolation of curves based on counts starting on October 5 and in part by the beginning of hatching and the subsequent increase in chick numbers.

With both these methods of determining earliest laying dates it appears that the Red-bills started approximately 14 days before the Black-bills. The Red-bill nesting peak was reached 16 days earlier;



No. The number of nests containing eggs and/or chicks (ie. for Red-Bills, Black-Bills and the combined total.

% (a) Gives the % of the combined peak present from Sept. 15 to Nov. 19; and the Red-Bill/Black-Bill composition of breeding gulls during this period.

% (b) Shows the relationship between the peak breeding populations (of Red-Bills, Black-Bills and their combined total) and the estimated total breeding populations for the three groups.

TABLE 4 — Estimated Population Size and Composition During the 1961 - 62 Breeding Season

Date 1961	Calculated Number of Nests with Clutches				Per Cent. Composition		Total Nests with Clutches	Per Cent. of Colony Peak (800 pairs on 19/10/61)			% of Total Breeding Pairs (935 prs.)
	Red-bills		Black-bills		Red-bills	Black-bills		Red-bills	Black-bills	Total	
	No.	%	No.	%							
20/9	35	9	–	–	100	–	35	4.5	–	4.5	4.0
25/9	122	31	–	–	100	–	122	15.5	–	15.5	13.0
30/9	237	60	10	2	96	4	247	29.5	1.5	31.0	26.5
5/10	356	90	83	18	81	19	439	44.5	10.5	55.0	47.0
10/10	395	100	223	48	64	36	618	49.5	27.5	77.0	66.0
15/10	392	99	358	77	52	48	750	49.0	44.5	93.5	80.0
20/10	356	90	437	94	45	55	793	44.5	54.5	99.0	85.0
25/10	268	68	461	99	37	63	729	33.5	57.5	91.0	78.0
30/10	185	47	461	99	29	71	646	23.0	57.5	80.5	69.0
4/11	126	32	414	89	23	77	540	16.0	51.5	67.5	58.0
9/11	106	27	307	66	26	74	413	13.5	38.0	51.5	44.0
14/11	102	26	112	24	48	52	214	12.5	14.0	26.5	23.0
19/11	91	23	70	15	56	44	161	11.5	8.5	20.0	17.0

i.e. on 10/10/61 as against 26/10/61 for Black-bills. (It is possible that the earliest Red-bill clutches were lost, in which case laying could have started a day or two before the estimated date.) Black records that Red-bills as a rule breed from two to three weeks earlier. During the 1947-48 season population and nest counts made on November 18 and 21 indicate that the number of nests with clutches increased at about the same rate in both species. This suggests that both started breeding on about the same date with possibly the Red-bills leading by 2 - 4 days (J.M.C.).

The probable nesting population of the colony (i.e. Red-bills, Black-bills and total) is given in *Table 4* and *figure 1*.

Egg-Laying

Red-billed Gulls: The first egg was laid around 15 September, the last sometime between 9 and 14 November. This gives an egg-laying period in excess of 55 days. Most clutches were laid in late September — early October; over 70% of the total being produced in a two-week period extending from September 22nd to October 6th. A nest in sub-col. 8 contained one teal-blue egg.

Black-billed Gulls: Egg-laying began about September 28th-29th. It lasted about 45 days; the last clutches being completed sometime between 9 and 14 November. Over 70% of the eggs were laid in the two-week period between 5 and 9 October.

Clutch Size

Oliver (1955) gives two eggs in the Red-billed and two or three eggs in the Black-billed clutch. Black (1955) states two eggs is the normal clutch for both species and then gives the following clutches for the Sulphur Point Black-billed population:— One-egg clutches 10%, two-egg clutches 75%, three-egg clutches 15%. He cautions against accepting counts at face value because of the losses that can occur through various causes. Intra and inter-specific competition is quite strong in the mixed Sulphur Point population. Coupled with this internal bickering are the disturbances caused by intruders, both human and animal. The sum effect is a considerable loss of eggs.

An effort was made to determine the clutch sizes during the 1961 season. All nests in the colony were checked twice in October and five additional egg counts were made in colonies 1, 11 and 12 for Red-bills and colony 16 for Black-bills. Corrections based on these counts give the following clutch sizes (Table 5):

TABLE 5

No. Eggs	Per Cent.		Eggs per 100 Nests	
	Red-billed	Black-billed	Red-billed	Black-billed
1	13 max.	12 max.	13	12
2	51 app.	40 app.	104	80
3	34 min.	47 min.	102	141
4	1 app.	1 app.	4	4
	Eggs per 100 nests =		223	237
	Mean clutch size =		2.23	2.37

These percentages which give a mean clutch size of 2.23 eggs for Red-billed and 2.37 for Black-billed probably understate the true mean clutch sizes. They are based on the maximum counts of nests with three eggs and the minimum number of nests with one egg. Proportionately more pairs possibly have three eggs and fewer have one egg than the above figures indicate as a maximum count of three egg clutches will most likely be short of the mark because some clutches are still incomplete and others have lost an egg. The percentages given for two-egg clutches are probably fairly accurate if it is accepted that eggs are lost at the same rate from all nests.

About one per cent. of the nests contained four eggs or chicks. It is not known whether these represent the effort of the occupying female or whether the fourth egg or chick has rolled or wandered in from a neighbouring nest. The latter is more likely as fourth eggs always appeared well after the clutch of three had been laid, and were not known to hatch. Moreover, if the fourth arrival was a chick, it was present several days before the three eggs present hatched. The exact incubation time is not known but is thought to be 22 days ± 1.

Egg and Chick Losses

Several hundred chicks fledged. Direct counts of these were not possible because many of the early hatched birds had left the colony area at a time when chicks of late breeders were still downy and confined to the nest. An estimate of the number of Black-billed eggs and chicks lost during the season, and therefore of the number of chicks that reached flying age can be made from the following figures and observations.

Eggs Laid. It is estimated that c.505 pairs of Black-bills bred and these produced an average clutch of 2.37 eggs. Therefore c.1197 eggs were laid.

Eggs Lost. About 8% of the clutches were lost completely. In the remaining nests (c. 92%) the average clutch was 2.33 eggs at the breeding peak (i.e. on both 26/10/61 and 2/11/61). The mean clutch is taken as at least 2.37 eggs. Therefore about 2% (1.7%) of the eggs were lost from the successful nests.

$$\text{Number of eggs left} = \frac{1197 \times 92 \times 2.33}{100 \times 2.37} = \text{c. } 1082 \quad (90.4\%).$$

Chicks Hatched. About 1080 chicks hatched from the 1197 eggs laid. This gives a 10% recruitment mortality up to the date of hatching.

Chicks Lost. Checks made of dead chicks (Red-billed and Black-billed) in the nests and around the colony indicate that proportionately more die during their first week of life than in subsequent weeks where the mortality rate is similar for all age groups (i.e. from 1 - 2 to 4 - 5 weeks). 15 - 20% of all chicks hatched died in their first week (starved, smothered, driven from nests by disturbances, etc.). Chick losses during subsequent weeks up to the time they are fully fledged, capable of flight and independent, are about half as heavy; i.e. 6 - 9%. As allowance must be made for dead chicks not noticed for various reasons (died under ledges, lost in fissures or hot pools, washed away

by the lake, carried off by intruders, etc.) the writers have taken a 12% mortality as a working estimate. If roughly 12% of all chicks alive at the beginning of each weekly age interval (after the first, i.e. 1 - 7 days) die during it, and observations indicate that the young are flying at five weeks, the Black-billed chick losses would equal c. 560 birds (Table 6).

TABLE 6 — *Estimated Mortality of Black-billed Chicks*

Age Interval Days	Number Alive at Start	Per Cent. Lost	Number Lost	Number Alive at End
1-7	1080	20	215	865
8-14	865	12	105	760
15-21	760	12	90	670
22-28	670	12	80	590
29-35	590	12	70	520

About 520 chicks fledged from a total of c.505 Black-billed nests. Therefore productivity equalled one chick per breeding pair. Of the c.1200 eggs laid 115 (9.5%) were lost during incubation, and 560 (47.0%) were lost as chicks between the age of one and 35 days. 520 fledged young from 1200 eggs gives a 43.5% survival. Red-billed egg and chick losses were similar.

Late Summer Check

The colony was again visited by one of the writers (D.R.) on 20/2/62 when the following conditions were found:—

Toe Section (Sub-cols. 1-8)

All the sub-colonies in this section were deserted. Sub-colony six was joined to the spit as the lake level had dropped. Over 100 birds were congregated along the lake-line to the east of sub-colony four. These included 4 or 5 Black-billed and 90+ Red-billed adults as well as 5 - 6 fully fledged and flying young. There were also two unfledged Red-billed chicks tended by a pair of adults.

Heel Section (Sub-cols. 9-15)

Sub-colonies 9, 10, 13, 14 and 15 deserted. About 30 Red-bills were gathered on the shore line by sub-col. 9. They included 2 - 3 of the season's flying young. Twelve Red-billed and one Black-billed adults, along with 4 - 5 Red-billed flying young were present on sub-col. 12. Around the margin of sub-colony 11 there were 100+ Red-billed adults and 10 - 15 fledged Red-billed chicks. A younger pair of Red-billed chicks were swimming with two adults. Another pair of chicks were on their own in the lake.

Spur Section (Sub-cols. 16-18)

Sub-colonies 16 and 18 were deserted. Four eggs were present in sub-col. 16; three were in abandoned nests, the fourth lying free. Sub-col. 18 was joined to the spit now that the lake level had dropped. Sub-col. 17 contained two single eggs in deserted nests. There were 51 birds present, one Black-billed and 39 Red-billed adults and eleven

fully fledged Red-billed young. Two younger Red-billed chicks were swimming with a pair of adults.

By this date there were only c.325 birds in the colony. These included c.315 Red-bills (270 adults; 45 young) and fewer than 10 adult Black-bills.

THE 1962-63 BREEDING SEASON

During 1962 excessive rain fell in the Rotorua district (about twice the mean annual). The lake level rose by several feet and many low-lying areas around the lake margin including the colony spit were inundated. Three visits were made to the colony.

6/10/62: All the islands used for breeding (i.e. sub-cols. 6 and 18 as well as those further off-shore which were not included in the population counts made during the 1961-62 season) were submerged. The spit itself was greatly reduced in area and several parts were inaccessible.

The 'toe' was cut off from the rest of the spit by a broad channel of water while smaller channels dissected it into two or three small islets. A small population of both Red-billed and Black-billed was present on these islets and some appeared to be nesting.

It was estimated that about 70% of the 'heel' was flooded. Most of the area occupied by sub-cols. 9, 10, 11, 12 and 13 was submerged and the birds were gathered on a higher area just north of sub-col. 14. Whereas on this date in 1961 the 'heel' population comprised about 120 pairs of Red-bills (95+ with clutches) and 25 pairs of Black-bills (5+ with clutches) in 1962 there were c.50 Red-billed nests, one of which contained one egg, and a few Black-billed nests without clutches.

The 'spur' like the 'toe' was cut from the spit by water. Sub-colonies 16 and 18 were under water and sub-col. 17 was an islet. A small mixed population (predominantly Red-billed) was settling in to nest on sub-col. 17.

The next visit was made on 15/11/62. During the intervening 40 days the lake level had risen appreciably and partially flooded some of the occupied areas; but by 15/11/62 the level had dropped to about that of 6/10/62. There were a few nesting birds and young chicks on the islets formed by the highest parts of the 'toe' and 'spur.' There were no chicks on the 'heel' section (spit proper) and only 13 nests with clutches (2 Red-billed, 11 Black-billed). At sub-col. 16 Black-bills were settling in water 2-4 inches deep as if endeavouring to establish themselves on their old sites.

The final visit was made on 6/12/62. Heavy rain had fallen during the preceding three weeks and the lake level was higher than on 6/10/62 or 15/11/62. A few adults and a mere handful of chicks were present. Whereas the 1961-62 breeding season was undoubtedly the most successful in the history of this colony (for both Red-billed and Black-billed gulls) the 1962-63 season was probably the worst.

THE 1963-64 BREEDING SEASON

The colony was visited by one of the writers (D.R.) on 31/1/64. By the population and nest composition; — ratio of Red-bills to Black-bills present and the approximate number of nests with eggs and/or chicks for both species breeding seemed to have started very much

later than in the 1961-62 season. The following position was found on this date:

Toe. Sub-colonies 1, 2, 3, 5, 6, 7 and 8 abandoned and little evidence of nesting on any of these with the exception of sub-colony 1 where 2 - 3 deserted eggs were found. No chicks were seen at sub-col. 1 but these had probably fledged. Several Red-bills were still present among a considerable number of Black-bills breeding on sub-colony 4. Whereas most of the Red-billed nests were deserted the Black-billed nests ranged form new (as yet without clutches) to nests with chicks up to 10 - 12 days old. As in 1961 - 62 the Red-bills of this colony were largely confined to the northern half and the Black-bills to the south end. With the altered state of the spit it is possible that many of the birds which bred on sub-cols. 2, 3, 5, 6, 7 and 8 in 1961 fused with the sub-col. 4 birds in 1963.

'Heel.' The 1962 flooding altered the shape and size of the heel. It is smaller and much of the loose surface material (sand, etc.) has been washed away. Also, while some earlier vents and hot pools have dried up and been replaced by new fissures others have changed in shape and position. These changes have affected the positions of the sub-colonies. Sub-colonies 9, 10 and 13 were fused into one larger colony of c.45 Black-billed ane one or two Red-billed nests. Sub-col. 11 contained only Red-bills (as in 1961-62). These had passed the breeding peak. Sub-col. 12 contained several Red-billed nests (mostly deserted) and four Black-billed nests.

'Spur.' Sub-colony 16 contained 65-67 Black-billed nests. The one Red-billed nest present in the 1959-60 and 1961-62 breeding seasons was not seen, possibly because of the lateness of the visit. A few nests were new and without clutches, others contained one, two or three eggs. Some eggs were pipping. About one third of the nests contained chicks. The biggest Black-billed chicks were less than 10-12 days old. Sub-colony 17 contained many nesting pairs, but appreciably more Black-bills than Red-bills, as many of the latter had finished breeding and their chicks were roaming free. About 60 - 70% of the Black-billed nests had eggs and 30-40% had chicks. A few were new and empty. Sub-colony 18 also contained Black-billed nests at all stages and some Red-billed chicks estimated to be up to six weeks old.

On 31/1/64 it was estimated that the biggest Red-billed chicks were about six weeks old and the biggest Black-billed chicks about 12 days old. This places the start of egg laying for Red-bills somewhere between the 25 - 30 November (9 - 10 weeks later than in 1961); and for Black-bills somewhere around 25 December (11-12 weeks later than in 1961). Black-billed nest composition figures (number eggs/number chicks) for 31/1/64 are also comparable with those obtained 11 - 12 weeks earlier in 1961 (i.e. 2 & 9/11/61).

Chick-Banding

Recoveries of banded birds can give definite evidence on a species' mortality and longevity, breeding age, migration routes and dispersal patterns and can indicate whether the young return to the same colony or area within a colony when they reach breeding age. One of the more interesting questions concerning the Black-billed component of the Sulphur Point colony is where they winter — i.e.

whether the Miranda (Firth of Thames) winter population is in fact composed of Rotorua breeders. During the 1951 - 52 breeding season Turbott and Black banded c. 30 chicks in the hope that light would be thrown on this question. It was a small sample and to the writers' knowledge no significant information has come from their effort. Black points out the difficulties of trying to band in this congested mixed colony.

During the 1961 - 62 season one of the writers (D.R.) banded 184 chicks (112 Red-bills; 72 Black-bills). The details of this banding are given below as, although the same was small, it may at least be adequate to suggest whether the young return to the same colony or sub-colonies to breed. The Red-billed chicks were banded when between 7 - 12 days old and the Black-billed when 7 - 14 days old. Band numbers used: 13701 - 13812 on Red-bills; 14229 - 14300 on Black-bills — distributed thus:—

Sub. Col.	Band Numbers Used	No. Banded
1	13708-19, 23, 29	14
2	13780-81, 803-04, 810-12	7
4	13720-22, 24-28, 82-88, 805	16
11	13703-07, 30-50, 58-77, 90-802, 06-09	63
12	13757	1
15	13778-79, 89	3
18	13701-02, 51-56	8
4	14229-46, 51-52, 62-68, 94,300	34
12	14276, 88-93	7
16	14247-50, 53-61, 69-75, 77-87	31

In the course of banding the operator noticed that the Black-billed chicks have pinkish-brown legs and bills while the Red-billed chicks have grey-black legs.

Ten of the banded Red-billed and one of the banded Black-billed chicks were found dead later in the season. It is not considered that handling while fitting the bands in any way contributed to their deaths.

ACKNOWLEDGMENTS

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LITERATURE

BLACK, M. S., 1955: Some notes on the Black-billed Gull at Lake Rotorua. **Notornis**, Vol. 6, No. 5, pp. 167-170.

The other information cited comes from the Classified Summarised Notes in the various volumes of **Notornis**.

APPENDIX 1 — Nest Counts of the Sulphur Point Colony (i.e. Nest with Eggs and/or Chicks)

Col. No.	5th October, 1961				19th October, 1961									
	Nests with			Total Nests	Nests with									Total Nests
	1 E	2 E	3 E		1 E	2 E	3 E	OE 1C	1E 1C	2E 1C	OE 2C	1E 2C	3 C	
1	6	12	6	24	3	9	5	2	3	1	–	2	–	25
2	1	2	–	3	1	2	1	–	–	–	–	–	–	4
3	2	3	3	8	2	7	4	1	–	–	1	–	–	15
4	17	24	9	50	14	71	59	–	1	1	–	–	–	146
5	–	–	–	–	–	1	–	–	–	–	–	–	–	1
6	1	3	–	4	1	3	1	–	–	–	–	–	–	5
7	–	2	–	2	2	2	2	–	–	–	–	–	–	6
8	–	6	1	7	–	7	1	–	–	–	1	–	–	9
9	2	–	–	2	1	2	4	–	–	–	–	–	–	7
10	4	14	21	39	3	41	29	1	3	1	2	4	1	85
11	1	16	6	23	2	11	7	–	1	1	1	–	–	23
12	5	9	4	18	4	10	5	–	1	–	2	1	–	23
13	–	4	4	8	2	2	3	–	1	1	1	–	–	10
14	1	2	1	4	–	5	5	–	–	–	–	1	–	11
15	–	3	2	5	–	4	5	–	–	1	1	–	–	11
16	6	6	2	14	13	30	25	–	–	5	4	5	2	68
17	26	69	55	150	40	135	111	–	5	–	–	–	–	307
18	5	11	7	23	5	17	19	1	–	–	1	2	1	46
Total	77	186	121	384	93	359	286	5	15	11	14	15	4	802
Tot. Eggs	77	372	363	= 812	93	718	858	0	15	22	0	15	0	= 1721
Tot. Chicks	–	–	–	–	–	–	–	5	15	11	28	30	12	= 101
Total E. & Ch.	–	–	–	812	All chicks hatched up to 19/10/61 were Red-bills									1822

APPENDIX 2 — ADDITIONAL COUNTS OF SELECTED COLONIES 1961

Colonies 1, 11 and 12; Red-bills (The few Black-bill nests excluded)

Date	Total Nests	Nests with													Total E/C	Nests with E and C			
		0	1 E	2 E	3 E	4 E	0E 1C	1E 1C	2E 1C	0E 2C	1E 2C	0E 3C	1E 3C	E/C		1	2	3	4
5/10	77	12	12	37	16	–	–	–	–	–	–	–	–	65	134	12	37	16	–
5/10	73	5	8	29	16	–	2	5	2	3	3	–	–	68	147	10	37	21	–
19/10	54	8	9	12	7	–	2	3	2	7	3	–	1	46	128	11	22	12	1
19/10	29	3	9	11	2	–	1	–	2	–	–	1	–	26	47	10	11	5	–
26/10	20	1	4	13	2	–	–	–	–	–	–	–	–	19	36	4	13	2	–
26/10	19	–	3	12	–	–	–	3	–	–	2	–	–	19	37	3	14	2	–
2/11	15	–	3	9	–	–	–	1	–	2	–	–	–	15	27	3	12	–	–
Colony 16; Black-bills (one Red-bill nest excluded)																			
2/11	35	22	6	6	1	–	–	–	–	–	–	–	–	13	21	6	6	1	–
9/11	71	4	13	30	24	–	–	–	–	–	–	–	–	67	145	13	30	24	–
9/11	75	3	9	31	30	1	–	1	–	–	–	–	–	72	167	9	32	30	1
14/11	73	4	9	17	25	1	2	4	1	4	5	1	–	69	161	11	25	32	1
14/11	52	4	13	5	11	–	4	5	2	2	2	3	1	48	99	17	11	18	1
21/11	19	2	6	1	4	–	2	2	2	–	–	–	–	17	32	8	3	6	–
21/11	10	–	5	1	3	–	1	–	–	–	–	–	–	10	17	6	1	3	–

ADDENDA

THE 1964-65 BREEDING SEASON

By DENISE REID

The Sulphur Point colony was visited on 23/11/64 and some marked changes were observed in the breeding areas. On the Toe, sub-colonies 5, 6, 7 and 8 were more populated than in the 1961-62 season; both sub-cols. 5 and 8 contained c.20 nests.

All the sub-cols. on the Heel (i.e. 9, 10, 11, 12, 13, 14, 15) as well as sub-col. 17 were deserted and a new area on the western shore of the spit, situated just north of sub-col. 16, had been colonized by an estimated 1000+ birds. Many of these birds presumably came from the above mentioned colonies as the sand and loose soil covering the heel and sub-col. 17 was washed away during the 1962-63 floods and the exposed irregular, sharp underlying rock made their old sites unsuitable for nesting. Sub-colony 16 was not yet occupied.

The breeding of Red-billed Gulls was at all stages — from fully fledged chicks (sub-col. 1) to newly formed nests. Several birds, banded as chicks in Nov. 1961, were sitting on nests containing eggs.

The Black-billed Gulls were just starting to breed as only seven nests were present (i.e. two nests in sub-col. 8, two nests in sub-col. 18, two nests on a small rock between sub-cols. 16 and 18, and one nest near the inner margin of the large new colony).

Black-backed Gulls

Two Black-backed Gull nests were seen, each containing three eggs and attended by a solitary adult, just north of the hot pool shown on the map. The writers have not previously known nor seen any Black-backed Gulls nesting in this colony before.

★

SHORT NOTE

ARCTIC TERN ON FOXTON BEACH

During early November, 1963, fresh to strong westerly winds prevailed over central New Zealand. In the course of a beach patrol on 13/11/63 the remains of an Arctic Tern *(Sterna paradisea)* were found on Foxton Beach. The specimen consisted of the entire skeleton with bill, feet and plumage of head, wings and tail intact, the body having been picked clean by fish and/or birds. It was estimated that the bird had died within the last three days, the remains being fresh.

The plumage of crown, nape and forehead to the bill was black; the bill red with the distal one-third blackish; the feet red. On the inner web of the outer primaries next the shaft there was a narrow strip of grey. The tern was evidently an adult. There was no indication of post-breeding moult in the plumage of the head, but the blackening of the bill suggests that the processes of assuming winter appearance had begun.

Measurements taken the following day were:—

Culmen 30.4 mm.; Wing 273; Tarsus 16.2; Tail 164; Toe and claw 24.6.

— M. J. IMBER