

DISPERSION AND DISPERSAL OF THE DOMINICAN GULL IN WELLINGTON, NEW ZEALAND

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INTRODUCTION

Between 1961 and 1965 a study was made in the Wellington district of the Dominican gull, *Larus dominicanus*, to examine population structure, production of young and mortality. The results presented here concern the dispersion of the population as indicated by total censuses, fixed transects and a banding programme. The study area (Fig. 1) occupied the south-west corner of the North Island, south of a curved line from the north end of Kapiti Island through Lake Wairarapa to Cape Palliser. Much of this area is mountainous (Fig.

2) and largely unoccupied by gulls which, away from breeding colonies, congregate in and around Wellington harbour and other settled areas. Over the last quarter century, the Dominican gull has increased in numbers generally throughout New Zealand, and particularly around Wellington (Fordham 1967). Published records and information from local residents show that some breeding colonies have multiplied several times in this period; the six largest colonies near Wellington have increased in numbers from two to 11 times in the last 20–25 years. The establishment since 1883 of two meatworks, an abattoir and numerous

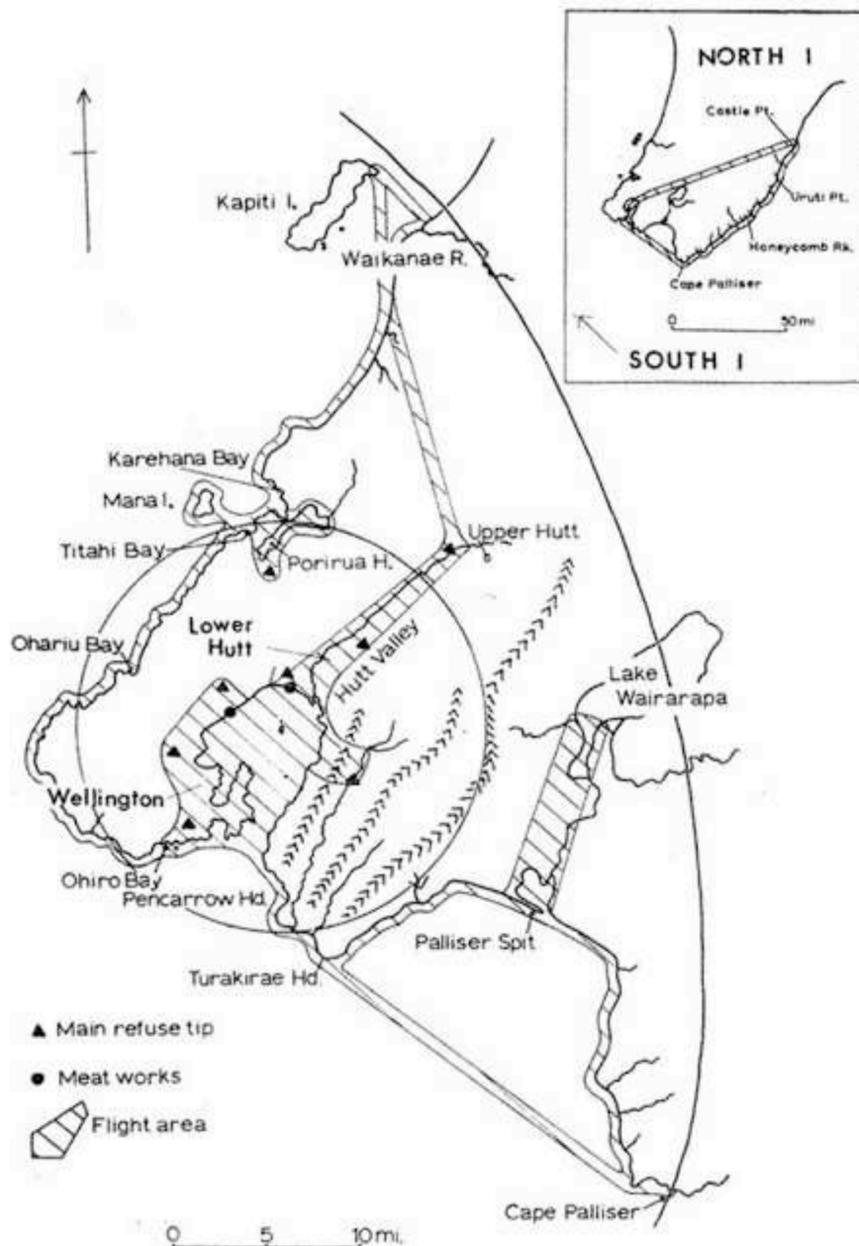


FIGURE 1. Study area and area covered by aerial surveys.

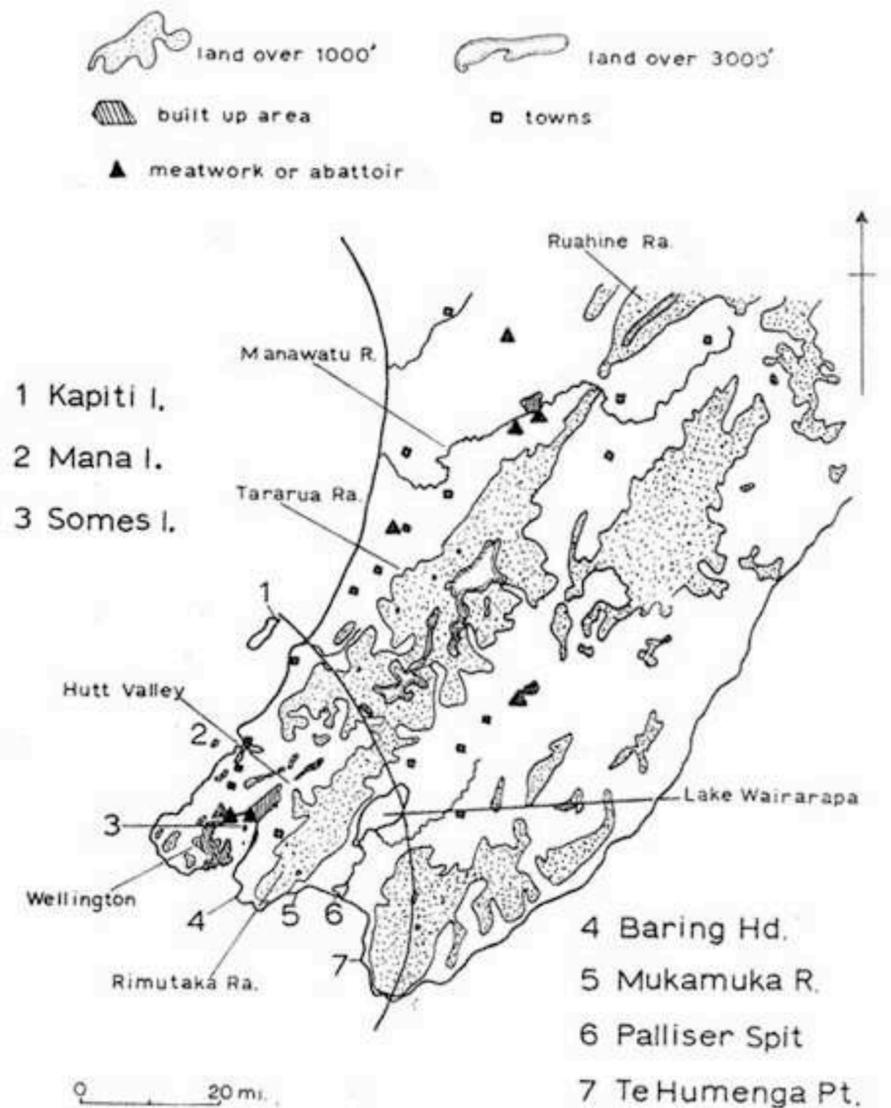


FIGURE 2. Location of colonies in which banding was done, and the high country and built-up areas of the southern North Island.

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refuse tips at or near Wellington Harbour has provided good sources of food for the omnivorous gulls and has probably been an important factor influencing growth and distribution of the population. An increase in numbers was recorded by Buller (1888), so the dispersion and dispersal of the species in Wellington must be viewed against a background of an increasing human population (especially over the last quarter century) and an increased supply of "artificial" feeding sites concentrated in and around the city.

DISTRIBUTION OF THE POPULATION

During summer (December–January) the adult breeding population is concentrated in breeding colonies. In the 1963–64 season the population comprised an estimated $5,700 \pm 500$ breeding pairs belonging to 31 colonies ranging in size from four to about 2,000 pairs (Fordham 1967). Ten of the colonies were on islands and 21 on the mainland; two of the latter being at Lake Wairarapa about 10 miles from the coast. During the non-breeding season the gulls are mainly distributed in flocks which form in places relatively free from disturbance, but mainly near food sources. In late summer and autumn (February–May) flocks begin to increase in size and numbers as adults and young return from the breeding colonies, and they reach maximum size between March and May (Fig. 3). Attempts were made to carry out a census of the population and examine its distribution during this period. On 30 July 1964 and 14 April 1965 aerial surveys were made of the Wellington area in which the coast was followed; all main feeding and resting sites were included and all breeding colonies visited except four small ones off Kapiti Island (Fig. 1). The surveys were made on weekdays when refuse tips and meatworks were operating, and in fine calm weather not immediately preceded by rain (which often causes some gulls to scatter on to farmland or playing fields). Flights were made at 90–100 knots, and flocks photographed from an altitude of 800 feet. Stray birds were counted individually. There was an important reason for not trying to cover the entire study area by strip transects: three preliminary surveys, together with ground observations made during numerous trips to various mountain ranges, indicated that although the gulls ranged over mountains or country uninhabited by man, the number of birds involved was very small compared with the number frequenting towns or settled areas.

The greatest population in Wellington Harbour occurs in autumn (March–May), so discussion centres on the survey of 14 April 1965. This

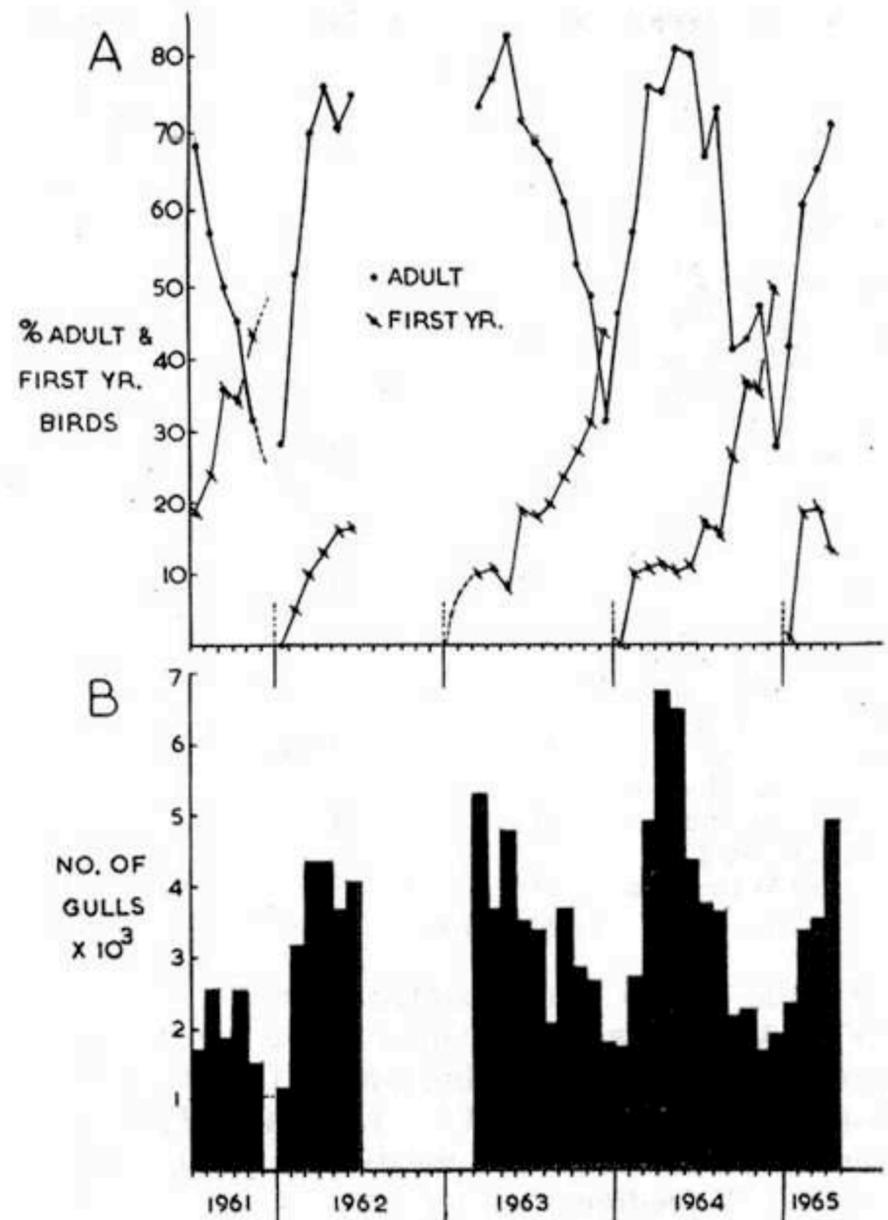


FIGURE 3. Seasonal fluctuations in flocks: A. Percentages of adult and first-year birds. B. Total number of gulls in the transect.

revealed 12,236 gulls in the Wellington area, 10,288 (84.1%) being within 11 miles of the harbour. Colonies were deserted—only 93 gulls (0.8%) were in their immediate vicinity. Because the entire area was not covered by strip transects the density of birds in different localities was assessed by comparing the numbers of gulls per mile of coast. One hundred and fifty miles were traversed, and 7,285 gulls counted (either on the sea-shore or immediately adjacent to it) giving a mean number of 48.5 birds per mile. Table 1 shows the sub-regional totals.

There was a strong contrast between the density of gulls in Wellington Harbour and that along other stretches of coast, particularly those uninhabited or thinly populated by man, such as the west coast (Titahi Bay–Ohiro Bay) and Palliser Bay. In Porirua Harbour where there is considerable human activity, the number of birds per mile of coast rose to 71.4.

TABLE 1. *Aerial survey of gulls in the Wellington area.*

	No.	%	No. at coast	Miles of coast	Gulls per mile of coast
Waikanae R. south to, but excluding, Karehana Bay (including Kapiti I.)	359	2.9	359	18.75	19.1
Porirua Harbour (Karehana Bay to, and including, Titahi Bay)	1,981	16.2	1,231	17.25	71.4
Titahi Bay to, but excluding, Ohiro Bay (including Mana I.)	574	4.7	574	33.75	17.0
Wellington Harbour (Ohiro Bay-Pencarrow Hd.) and environs and Hutt Valley	8,324	68.0	4,169	38.25	108.9
Pencarrow Head-Turakirae Head	814	6.7	814	7.5	108.5
Palliser Bay & Lower Wairarapa	184	1.5	138	34.5	4.0
Totals	12,236	100.0	7,285	150.0	48.5

Of the 12,236 birds counted during the survey, 5,977 (48.8%) were at or near refuse tips or meatworks; and in the Wellington and Hutt Valley districts alone, 5,267 (63.3%) of the 8,324 birds were at or near tips and meatworks. Thus, major "artificial" feeding sites tend to cause a clumped distribution. A similar pattern was obtained in the census made during winter 1964 (30 July 1964). Although this census did not indicate the peak non-breeding season population (because numbers had already declined from the autumn maximum), 74.8% of the 7,221 birds were within 11 miles of Wellington, and nearly 60% of those in Wellington and Hutt Valley were at or near tips and meatworks.

To compare the overall density of gulls in Wellington with that found outside the area, I made an aerial survey on 9 June 1965 of the east coast between Cape Palliser and Castle Point (Fig. 1) where the human population is limited to farms and a small holiday settlement. Birds were scattered, mostly in flocks of 10 or less which were

TABLE 2. *Aerial survey of the coast east of Wellington.*

	Miles of coast	No. Gulls	%	Gulls per mile
Cape Palliser to Honeycomb Rk.	34.5	69	38.3	2.0
Honeycomb Rk. to Uruti Pt.	22.5	103	57.2	4.6
Uruti Pt. to Castle Pt.	18.25	8	4.5	0.4
Totals	74.25	180	100.0	2.4

generally near farms. A total of 180 gulls were counted along just over 74 miles of coast (i.e. 2.4 birds per mile). Table 2 shows the sub-regional totals. Although this survey was made two months later than the one in Wellington, it was made under similar conditions. The conclusions to be drawn from both is that the distribution of this scavenger is influenced greatly by food supplies of human origin, and that the Wellington area has a dense population compared with an adjacent region where the human population is light.

FLUCTUATIONS IN FLOCKS

Mixing of flocks

Other than in breeding colonies and roosting sites, most gulls congregate in flocks which, for convenience, have been classed as feeding or resting. Flocks usually form each day at the same sites (especially feeding sites) which tend to be constant. These are usually in regions occupied by man. Members of a flock do not all come from the same colony or roosting site, nor do they necessarily stay together during the day or engage in similar activities at the same time. When disturbed, flocks fragment. Some gulls are not found in flocks but alone or in pairs, and numbers fly between sites which they may visit for a few minutes or hours. These birds are termed itinerants. Repeat sightings of banded or recognizable gulls suggest some have regular habits and visit the same area or feeding site frequently, in some cases daily. But flocks do not have unchanging membership, for birds may visit several resting and feeding sites during the day, according to the location of roosting sites, availability of food and local disturbances. Birds are very often driven away from flocks by other members; thus movement may also be influenced by intra-specific aggression. Feeding flocks are clearly composed of gulls from many colonies, but even apparently isolated flocks some miles from any others have a changing membership of itinerant birds which comprise an average of 9.4% of the population throughout the year (see below). Direct observations of dawn and dusk flights made at roosting sites, vantage points around the city and during aeroplane flights showed that there is considerable mixing of gulls which tends to 'knit' the whole population together.

Numbers of gulls

There are marked seasonal fluctuations in the structure and size of flocks (Fig. 3) with peak numbers present in autumn and minimum numbers

TABLE 3. Seasonal fluctuations in the Wellington population.

Year		Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1961	Total	—	—	—	—	—	—	*1,717	2,583	*1,862	2,574	1,518	—
	Total aged	—	—	—	—	—	—	537	1,329	1,029	1,512	655	—
	% adult	—	—	—	—	—	—	68.5	57.1	50.0	45.1	31.6	—
	% yearlings	—	—	—	—	—	—	18.6	23.9	35.8	33.9	43.4	—
1962	Total	*1,151	3,182	4,338	4,336	3,645	4,029	—	—	—	—	—	—
	Total aged	492	1,610	2,177	1,615	1,506	1,072	—	—	—	—	—	—
	% adult	28.0	51.7	69.7	76.2	70.4	75.0	—	—	—	—	—	—
	% yearlings	0	5.1	9.9	12.8	16.1	16.2	—	—	—	—	—	—
1963	Total	—	—	5,032	*3,650	4,767	*3,502	3,384	*2,049	*3,640	2,844	2,644	1,799
	Total aged	—	—	1,628	1,385	2,862	1,648	1,747	1,195	1,944	1,170	1,092	984
	% adult	—	—	73.4	76.8	82.3	71.5	69.0	66.5	61.1	53.2	48.5	31.1
	% yearlings	—	—	10.1	10.5	8.2	18.8	18.0	19.4	23.5	26.9	31.0	43.5
1964	Total	1,747	2,695	4,900	6,747	6,469	*4,381	3,750	3,611	*2,150	2,234	1,645	1,918
	Total aged	755	1,729	3,108	2,767	3,521	2,015	1,286	2,047	1,343	1,147	1,056	652
	% adult	46.1	57.3	75.8	75.1	79.2	78.5	67.4	73.3	41.3	42.7	47.3	27.5
	% yearlings	0	9.8	10.4	11.0	10.1	10.9	17.3	15.5	26.6	36.1	35.1	49.5
1965	Total	2,346	3,378	*3,525	4,899	—	—	—	—	—	—	—	—
	Total aged	796	1,945	1,928	3,553	—	—	—	—	—	—	—	—
	% adult	41.7	60.5	65.3	71.2	—	—	—	—	—	—	—	—
	% yearlings	0.4	18.3	18.7	13.0	—	—	—	—	—	—	—	—

* Transect probably affected by tide, weather or human activity.

in summer. Between July 1961 and June 1962 flocks were counted at monthly intervals along a 33-mile transect around the harbour. This transect which was made again from March 1963 to April 1965 (Table 3) included populated and uninhabited coast, and many feeding and resting sites. Four age classes (first-, second-, third-year and adult) were recognised from characteristics of the plumage and soft parts (unpubl. observations and Kinsky 1963) but special attention was paid to first-year and adult birds because they were clearly identifiable throughout the year. The transects were mostly done about the middle of each month but were affected at weekends when meatworks and refuse tips were usually closed and more people were present on beaches than during the working week. They were also affected (a) when tides were out of phase with those during other transects so that some beaches were largely covered by water which prevented gulls from standing there, (b) by heavy rain for several days before the transect which thus induced some birds to visit water-logged fields away from the harbour, and (c) by any unusual human activity. In each instance (except in September 1963) the effect was to give a total lower than expected.

The harbour population is at a minimum from November to January during peak breeding; the first major influx of birds is in February. Peak numbers occur between March and May; but from June (the start of winter) onwards numbers decline steadily until the next breeding season. Although the minima for the three breeding seasons between 1961 and 1965 were not greatly

different, the autumn maxima showed an increase between 1962 and 1964 of about 53% (2,400) birds, and the mean number present during the year (March–February) in 1964–65 was 15% higher than the mean number present in 1963–64 (Table 4). This increase was probably a reflection of the rapid expansion of the gull population which occurred during the preceding five to 10 years.

TABLE 4. Mean numbers present on transect, 1963–65.

	Autumn–Winter (Mar.–Aug.)	Spring–Summer (Sept.–Feb.)	Whole year (Mar.–Feb.)
1963–64	3,730	2,561	3,146
1964–65	4,976	2,278	3,627

The mean numbers present each month in spring and summer 1963–64 and 1964–65 were respectively 68.6% and 47.5% of the mean numbers present during the peak months between autumn and winter 1963 and 1964 (Table 4). The greater numbers present in 1963–64 were probably caused by the bad weather that apparently delayed breeding in spring, 1963. The numbers of itinerant birds varied through the year, and were at a minimum in January (during breeding). During the non-breeding season wide fluctuations in total numbers were recorded and the pattern was different each year. For the period March 1963–February 1965 the mean percentage of itinerants amongst all the birds encountered on the transect was 9.4 (range 4.0–26.1%), and in 1963 and 1964 the percentage was at a maximum in winter and early spring.

Composition of flocks

Seasonal changes in the proportions of adult and first-year birds occurred each month (Fig. 3) and were related, where possible, to the effects of death, emigration or immigration (proportions refer only to flocks where all the birds present were classified according to age). Adults begin to leave breeding colonies in January, and the number and percentage of adults in flocks increases rapidly from February until March or May; thus the period of peak adult mortality, i.e. summer and autumn (Fordham, unpubl.) occurs during the rapid growth of flocks after breeding and may be related to feeding pressure caused by the combined feeding of adults, and local and immigrated young of the year at meatworks, refuse tips, etc. From July–August onwards the percentage of adults in flocks declines more or less steadily as birds begin to gather at breeding colonies.

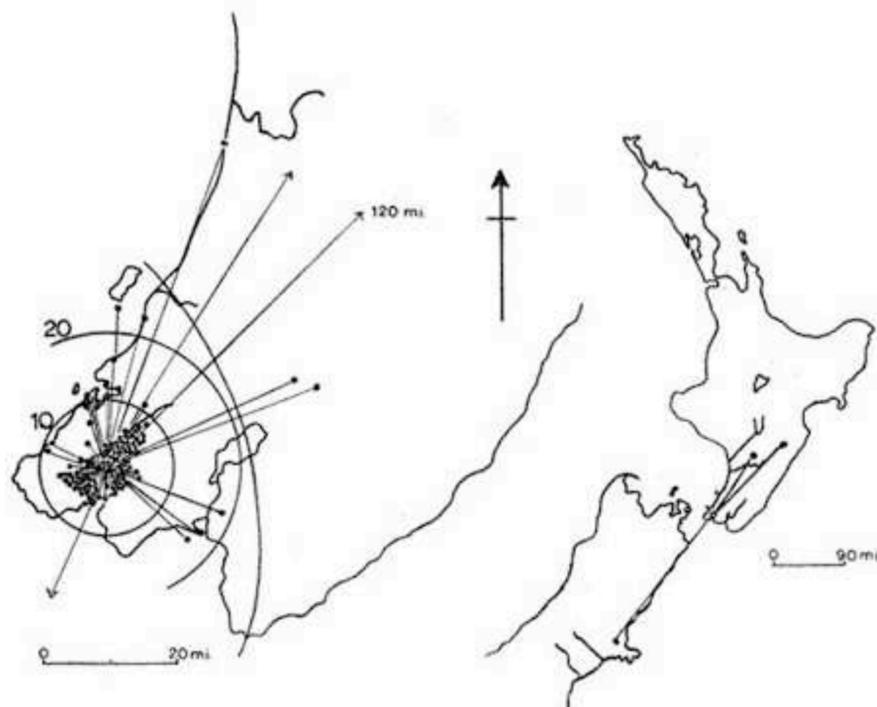


FIGURE 4. Dispersal of *Somes Island* gulls banded as fledglings.

Very few young of the year join flocks in the first half of January (in 1962 and 1964 none were found) and most appear to arrive in February and March. The increase in the percentage of first-year birds during the year is related to at least three factors: 1. the very sedentary behaviour of young gulls raised in or near Wellington Harbour (Figs. 4 and 5); 2. the immigration of young birds from flocks adjacent to the city (Figs. 5 and 6); and 3. (after June) the gradual dispersal of adults to breeding colonies. Gulls raised in or near the harbour apparently do not disperse to distant food supplies. For example, whaling at the Tory Channel Station (now closed) extended from about July to October, i.e., mid-winter to mid-spring (McIl-

waine 1964) and succeeded the heavy killing period at the city meatworks. However, complete absence of recoveries of banded Wellington gulls from the whaling station suggested that they were not attracted across Cook Strait for food. By contrast, sight records and recoveries of dead birds banded as fledglings in colonies outside Wellington Harbour indicate that a considerable number of these gulls come in autumn and early winter to feed at refuse tips and meatworks around the harbour. This immigration partly coincides with the period of heaviest killing at the meatworks which is from November to June, with a peak in January and February (McIlwaine 1964). Immigration of young towards Wellington was also suggested by six transects near Porirua Harbour (about nine miles north of Wellington) between mid-July and early September 1964, which revealed large flocks, each composed of several hundred gulls in paddocks and on beaches (Table 5). These flocks con-

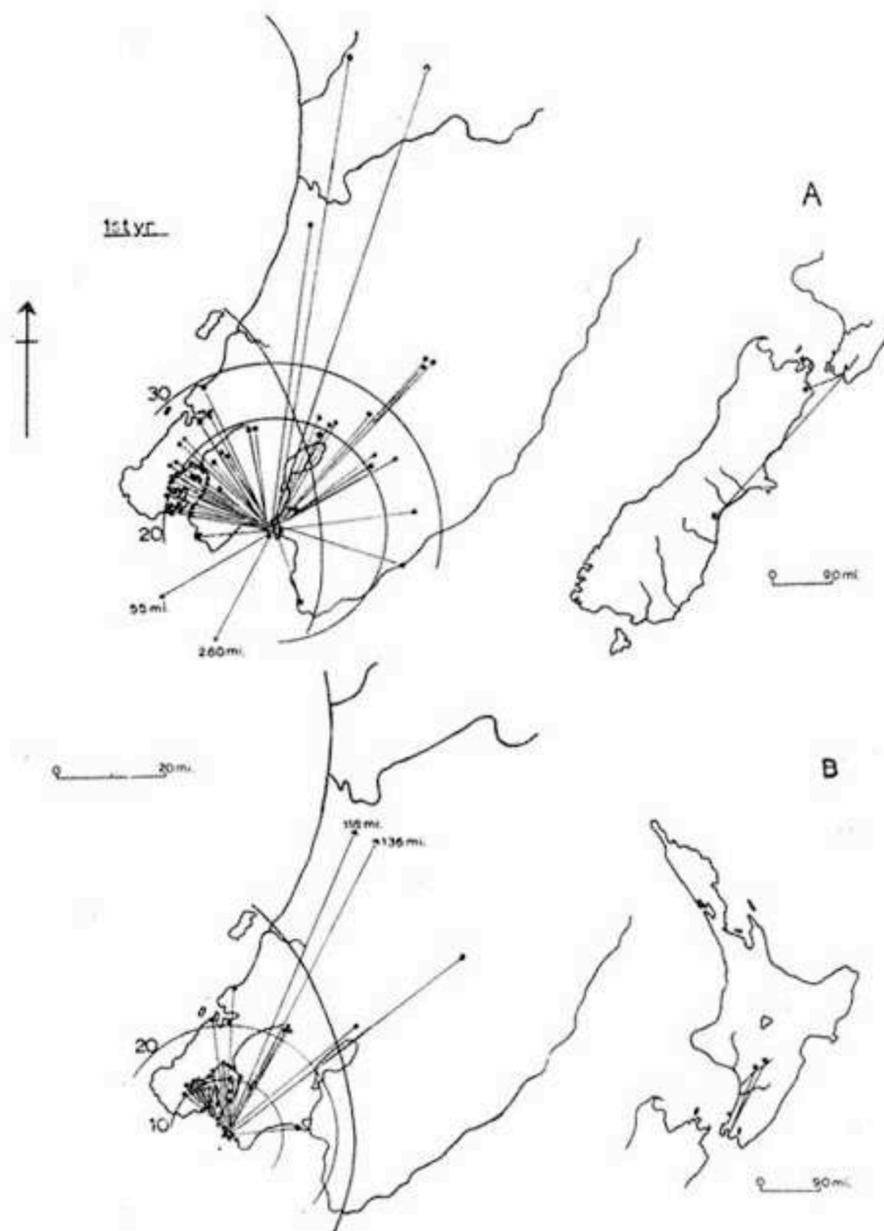


FIGURE 5. A. Dispersal of *Palliser Spit* gulls banded as fledglings. B. Dispersal of *Baring Head* gulls banded as fledglings.

TABLE 5. Juvenile : adult ratio near Porirua Harbour, 1964.

		Flock site				Average ratio at Wellington Harbour
		a	b	c	d	
Jul.	21	0.06	0.05	—	0.03	0.26
	28	0.08	0.08	—	—	—
Aug.	4	0.03	0.5	0.06	—	—
	11	0.08	0.08	0.06	—	0.22
	18	0.09	0.1	—	—	—
Sept.	1	0.09	0.07	0.02	—	0.67

tained relatively fewer juveniles than the ones in Wellington, suggesting that young birds were seeking food elsewhere. The overall effect of these three factors is, therefore, that the percentage of young in the harbour increases during the year.

The average percentages of first-year birds in flocks during autumn (March–May) were different each year (Table 6) but in 1963 and 1964 they were very significantly lower ($P < .005$) than those in autumn 1962 and 1965 and may have been related to the high mortality of young in breeding colonies in the 1962–63 and 1963–64 seasons (Fordham, unpubl.). The percentage of young in flocks was apparently related to the proximity of major feeding sites. Thus, flocks at feeding sites usually had more than the average percentage of young (taken over the whole transect — Table 3) whereas flocks at resting sites (which were not near a regular or major food supply), e.g. reclaimed land, estuarine sand bars, usually had less (Table 7).

TABLE 6. Average percentage of first-year birds in flocks in autumn (Mar.–May).

	Total aged	% first-year birds
1962	5,298	12.5
1963	5,875	9.3
1964	9,396	10.4
*1965	5,481	15.0

* March and April only.

1962 and 1963 highly significantly different ($P < .005$); 1963 and 1964 significantly different ($.01 < P < .025$); 1964 and 1965 highly significantly different ($P < .005$).

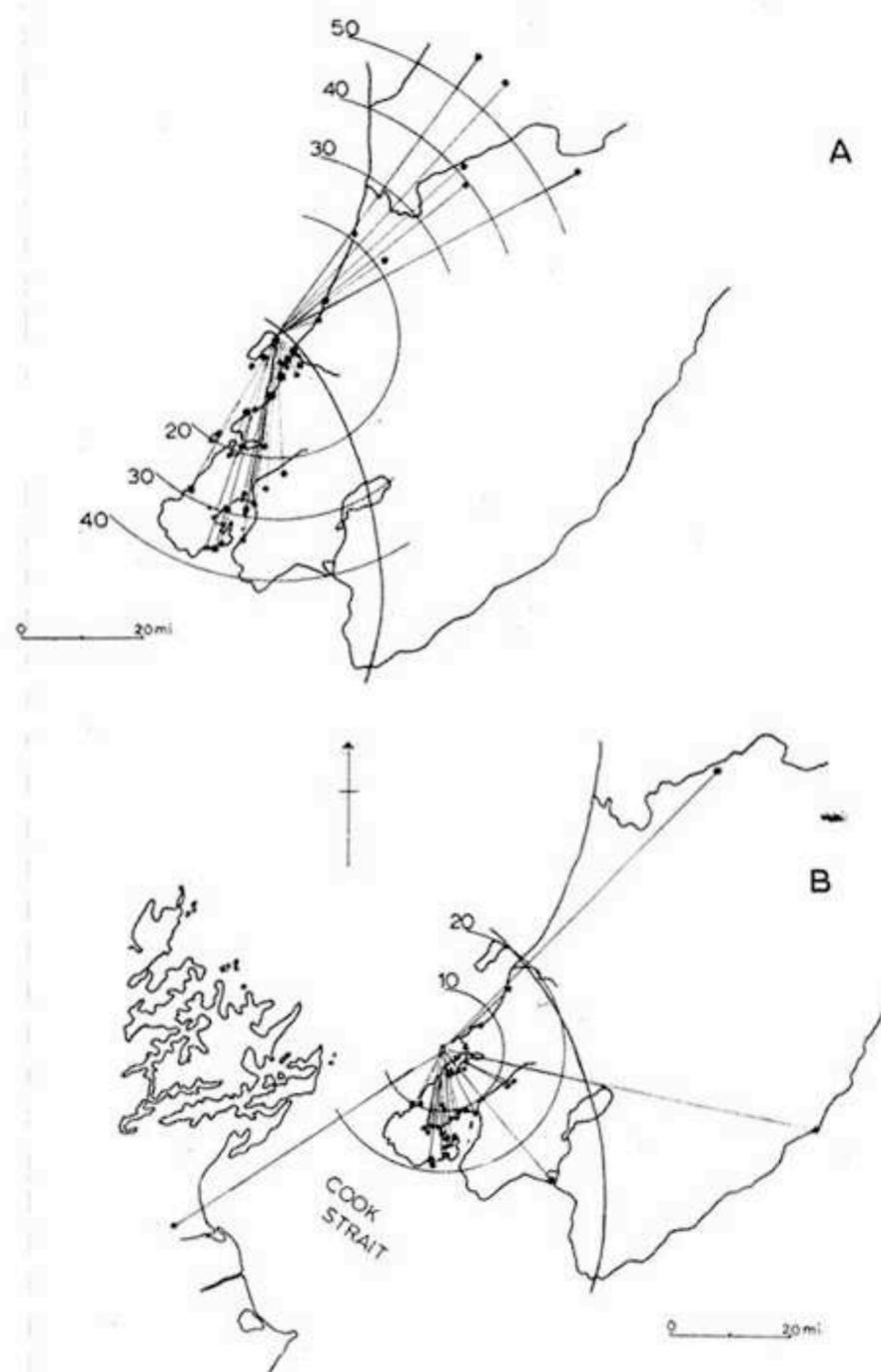


FIGURE 6. A. Dispersal of Kapiti Island gulls banded as fledglings. B. Dispersal of Mana Island gulls banded as fledglings.

Although no flock may be described as wholly resting or feeding, the distribution of first-year birds suggests they spend more time feeding than do adults. This difference is probably related to growth in the first year (Fordham, unpubl.). The size of flocks varied widely, but those at major feeding and resting sites were usually large; hence there was no simple relation between flock size and the percentage of young. The overall distribution of young was affected by the tendency for most flocks to form somewhere near a source of food even if it was irregular. Thus, at one time or another, nearly all flocks had more than the average proportion of young. Flocks comprised mainly or entirely of one age class were sometimes recorded. The occurrence of such flocks may have had their origin in the feeding or breeding requirements of the absent class or classes.

Flock composition in summer was apparently related to the proximity of breeding colonies, since adults tended to visit flock sites near colonies rather than ones further away. Although no flock site was very far from a colony, I compared two groups of sites that were either relatively near, or far away from colonies. Both groups contained

sites that were used mainly for feeding and others that were used mainly for resting. The mean percentage of adults in flocks near breeding colonies during breeding (43.3%) was significantly higher than the percentage in flocks further away from colonies (34.9%) ($P < .005$, Table 8).

TABLE 7. *Percentage of first-year birds in flocks from March 1963–April 1965.**

AT MAJOR FEEDING SITES			
Flock site	Records (Months)	Months when % young above av.	Months when % young below av.
a	24	20	4
b	17	12	5
c	24	18	6
d	19	15	4
e	19	14	5
NOT AT MAJOR FEEDING SITES			
Flock site	Records (Months)	Months when % young above av.	Months when % young below av.
f	17	1	16
g	19	3	16
h	21	5	16
i	15	2	13
j	21	3	18
k	17	5	12
l	12	—	12
m	22	8	14
n	23	8	15
o	20	7	13

* January transects omitted because the percentages of young in the population were zero or very low.

The number of breeding birds absent from a colony in summer varies during the day as birds leave to feed, bathe, etc. Counts of gulls in part of the Somes Island colony made at five-minute intervals for 17 hours showed that an average of six (19%) out of 30 birds (i.e., 15 pairs) were absent at any one time (range 0–37%). Thus in periods of minimum attendance at colonies, flocks may be supplemented by up to 37% of the breeding adults. This limited evidence suggests that the numbers of adults in flocks also fluctuate during the day and are complementary to those in the breeding colonies.

TABLE 8. *Mean numbers of adults in flocks during breeding season.**

Relative position of flock	No.	Total no. of birds	% adult
Near colonies	8	3,137	43.3
Further away	7	3,357	34.9

* Taken from Sept.–Jan. over the seasons 1961–62, 1963–64 and 1964–65. The same flock sites were examined each season. Eggs are sometimes laid in February, when most birds have left the colonies.

DISPERSAL OF WELLINGTON GULLS

Introduction

In 1961 a programme for colour-banding Dominican gulls was started on Somes Island in Wellington Harbour as part of the banding scheme of the Ornithological Society of New Zealand. Its aim was to reveal basic dispersal patterns and it was extended up to 1964–65 to include seven colonies (Fig. 2) whose sizes in the 1963–64 season were: Mana Island ca. 2,000 pairs, Somes Island ca. 1,475 pairs, Baring Head ca. 640 pairs, Kapiti Island ca. 600 pairs, Palliser Spit ca. 265 pairs, Te Humenga Point 58 pairs, Mukamuka River 45 pairs. Discussion is centred on the five largest colonies since only small numbers of chicks were banded in the other two. Prior to 1961, C. N. Challies and C. P. Gallop had banded fledglings at Palliser Spit and Baring Head, and they generously permitted use of their data so that records were available of 7,096 gulls banded as fledglings, and 337 adult and immature gulls banded while roosting on Somes Island. The dispersal patterns described are based on 275 (3.7%) gulls recovered dead outside the colony in which they were banded, and sight records of colour-banded gulls up to 30 June 1965.

As a considerable part of the Wellington area is at an altitude of more than 1,000 feet (a habitat mostly unoccupied by Dominican gulls) and the human population is concentrated round Wellington Harbour, there was regional variation in the probability of a dead bird being recovered. Chances of recovery were also affected by the numbers of people in the large thinly populated areas and mountain country adjacent to the Wellington area (Fig. 2), but this apparent bias in recovery rate was not as important as first appeared. Aerial surveys of the area during the non-breeding season had shown that nearly all the birds were in or near centres of human activity and the distribution and density of flocks was strongly correlated with the distribution and density of the human population. Observations from the air and ground suggest that the time taken to fly from one preferred area to another over country uninhabited by gulls probably represents only a small fraction of the total daily activity. Most of the time that a bird is exposed to risk of death is spent with others of its kind in breeding colonies, roosting flocks or other flocks closely associated with man's activity. Hence, although the gulls range from mountains to off-shore waters, the small numbers

of recoveries from uninhabited or mountain country does not significantly distort the picture of dispersal but simply reflects true habitat preference and distribution.

TABLE 9. *Recovery distance (in miles) during the first year.**

Colony	0-10	10-20	20-30	>30	Total	Mean dist.
Somes I.	53	3	—	2	58	7.9
Baring Head	13	11	5	1	30	13.6
Mana I.	7	5	—	2	14	16.4
Kapiti I.	2	3	6	5	16	27.5
Palliser Spit	4	11	10	5	30	31.3
	79(54%)	33(22%)	21(14%)	15(10%)	148	16.8

* The first year is taken from the time of banding until the end of the following December. The table includes post-fledging recoveries of dead gulls up to the end of 1964. Twelve birds were recovered in their natal colonies but have been excluded to avoid recording birds that died before fledging.

Recovery distance

Direct line measurements (in miles) from the colony to point of recovery are summarised for first-year birds in Table 9.

The mean recovery distance was 16.8 miles; over half the birds were recovered within 10 miles of their natal colony and only 10% of the recoveries were over 30 miles. There was a strong contrast between the mean recovery distances of birds from Kapiti Island (27.5 miles) and Palliser Spit (31.3 miles), and those of the other three colonies. The proportion of Somes Island birds recovered within 10 miles (91%) was much greater than that for any other colony and, in fact, most (79%) were recovered within five miles. Baring Head and Mana Island birds showed a slightly less restricted dispersal.

All recoveries for birds in their second to sixth years have been grouped, and direct line measurements from the natal colony to point of recovery appear in Table 10.

The mean recovery distance was 11.6 miles — about five miles less than that of birds in their first year — and proportionately fewer were recovered over more than 20 miles from their natal colony. However, more were recovered dead in their natal colony. If this category is ignored the mean recovery distance is 14.4 miles, only about two miles less than that for first-year birds.

TABLE 10. *Recovery distance (in miles) after the first year.**

Colony	In colony	0-10	10-20	20-30	>30	Total	Mean dist.
Somes Island	2	26	3	—	2	33	9.2
Baring Head	5	2	3	1	1	12	9.6
Kapiti Island	—	1	1	—	—	2	10.0
Palliser Spit	6	—	9	3	2	20	17.0
	13(19%)	29(43%)	16(24%)	4(6%)	5(8%)	67	11.6

* Sight records excluded.

Direction of movement

Location of recoveries for all age groups is shown in Table 11, and Figures 4-6. All age groups have been treated together because the dispersal patterns of young and old birds were apparently the same. About Wellington City, sightings of colour-banded gulls from some colonies (especially Somes Island and Baring Head) were made so often and in such large numbers that after 1961 they were recorded only in areas where there had been no recoveries of dead banded gulls. Outside the city, however, all colour bands were recorded. Records of colour and numbered bands up to 30 June 1965 that are representative of areas not covered by recoveries of dead banded gulls are therefore included in Figures 4-6, but only to give more complete dispersal patterns. Dispersal has been analysed with special reference to three main regions which, as the movement was largely non-directional, have been chosen arbitrarily to accommodate the bulk of the recoveries. The regions are: Wellington and Lower Hutt cities, which are important because of their numerous feeding sites; Wairarapa district (east of the main N-S axial mountains); and Manawatu district (west of the main N-S axial mountains).

Movement was restricted and randomly directed. Nearly all recoveries were made in or near towns or built-up areas, and very few were made on the coast. Most (64%) were made in Wellington and Lower Hutt cities, and the proportion recovered from each colony was directly related to its distance from the cities. Most recoveries in the Wairarapa and Manawatu districts were from the colonies closest to each, i.e., Palliser Spit and Kapiti Island respectively. Although the boundary of the "Wellington area" was arbitrary, it is significant that 201 (86%) of all the recoveries were

made within it. Most dispersal away from the Wellington area came from the two colonies near the boundary (Palliser Spit and Kapiti Island) with respectively 35% and 32% of recoveries outside it. With colonies near the centre of the area, the proportions recovered outside Wellington were much lower, cf. Mana Island 10%, Baring Head 9%, Somes Island 4%. Although gulls accompany inter-island vessels across Cook Strait (F. C. Kinsky and E. B. Slack, pers. comm.), only four dead recoveries and one sight record of Wellington gulls were made in the South Island, and no birds were recovered at the whaling station in Tory Channel, Marlborough Sounds. The recovery involving the greatest distance was that of a Palliser Spit gull found dead 280 miles south of the colony (Fig. 5). Thus, dispersal to the South Island was apparently very limited, and overall dispersal restricted. The pattern of dispersal varied with the colony and was apparently related to the food supply and number of feeding sites nearby; i.e. meatworks, abattoirs and refuse tips (cf. Olsson 1958; Murray and Carrick 1964).

TABLE 11. *Location of dead recoveries (all ages) beyond natal colonies.*

Colony	Wellington and Lower Hutt cities	Wairarapa	Manawatu	Elsewhere	Total
Somes I.	89	3	1	10	103
Palliser Spit	19	19	2	8	48
Baring Head	25	3	—	14	42
Kapiti I.	6	—	9	7	22
Mana I.	11	1	1	7	20
	150 (64%)	26 (11%)	13 (5%)	46 (20%)	235

Dispersal from the Somes Island roost

In autumn and winter, 1961 and 1963, 337 adult and immature gulls were banded while roosting on Somes Island. Recoveries of these birds were treated separately because those caught may not have been reared there. The dispersal pattern was again restricted however; 15 birds were recovered dead on the island, and 37 (93%) of the 40 dead recoveries beyond were in Wellington City and Hutt Valley. A sight record in Auckland (about 300 miles to the north) of a bird of unknown age was the furthest record of a gull banded in Wellington.

Sight-records of live colour-banded gulls

In May 1964, at the time of peak harbour population, a survey of colour-banded gulls (i.e. gulls

banded in the Wellington colonies) was made in Wellington Harbour and along the west coast. A total of 4,292 gulls were inspected for colour bands, and 205 (4.7%) found. In Wellington Harbour 5.5% of the birds were banded and on the west coast 2.0%. Thus banded gulls (particularly those from Somes Island and Baring Head) were concentrated in the harbour. Dispersal patterns were similar to those described, except that relatively more Mana Island and Kapiti Island birds were in the general vicinity of their colonies than was indicated by dead recoveries. The proportions of banded birds at the south and north ends of the harbour were similar, but there were many more gulls around the harbour than on the west coast. There were significantly more Somes Island gulls at the north end of the harbour near important feeding sites than at the south end ($P < 0.25$), and many more in the whole harbour than on the west coast. Relatively more Baring Head birds were at the south end of the harbour, i.e. the end nearest their colony, than at the north end ($P < 0.005$).

Immigration from adjacent areas

Between 1959 and 1964, 1,378 fledglings were banded by other workers in six colonies at the northern end of the South Island (Nelson, Wairau River, Wairau Lagoons, Lake Grassmere, Flaxbourne River mouth, Clarence River mouth). Up to the end of 1964, 12 of the 25 dead recoveries, and nine sight records were made in the Wellington area, and all but two of these were in or near Wellington City. The number of recoveries is small, but indicates some dispersal to the North Island.

On the coast west of Wellington, the next major breeding colony is about 41 miles north of Kapiti Island; on the east coast there are only a few small scattered roosting flocks or breeding colonies for more than 70 miles north of Cape Palliser (Fig. 1). There has been no banding in these colonies, but because of the very limited dispersal shown by Wellington gulls I consider the majority of birds from these colonies would not move into the Wellington area. However, recoveries in Wellington of birds from other parts of New Zealand indicate that populations are mixed to a certain extent.

Comparison with other species

There was a slight tendency towards greater dispersal in the first year, but recovery data for all ages combined show the mean recovery distance was only 15.2 miles. Movement was randomly directed and there was no evidence of dispersal

northwards in winter. Mean recovery distance for first-year great black-backed gulls, *L. marinus*, in Britain is just under 100 miles (Harris 1962b) and mean dispersal distance from two separate colonies of Danish herring gulls *L. argentatus* was about 56 and 135 miles respectively (Paludan 1953). Thus the Wellington gulls are much more sedentary than the Scandinavian representatives of a species closely related ecologically and taxonomically; but their dispersal pattern is very similar to that outlined for the British herring gull by Harris (1964).

There are no previous accounts of dispersal patterns of Dominican gulls, but Murphy (1936) concluded that migratory movements of *L. dominicanus* depend on latitude and that in "milder parts of the range, as in northern Peru, migration is doubtless irregular and sporadic". On isolated islands such as South Georgia and Macquarie, or wherever the climate permits, the gulls are generally sedentary, and the majority stay throughout the whole year (Ainsworth 1915). In west Antarctica, however, the species is definitely migratory (Gain 1914), and at the Falklands and South Shetlands a proportion of gulls departs during winter (Abbott 1861; Lester 1923). Seasonal migration in gulls is well marked in only a few species, the remainder show simple dispersal; and in different populations of the same species there is individual variation in dispersal (Dorst 1962). Thus, although the lesser black-backed gull, *L. fuscus*, and the American herring gull, *L. argentatus smithsonianus*, disperse hundreds or even thousands of miles (Gross 1940; Hofslund 1959; Smith 1959; Harris 1962a) other gulls display much less movement, e.g. the British herring gull, great black-backed gull, common gull, *L. canus*, and black-headed gull, *L. ridibundus* (Munk 1951; Paludan 1953; Tinbergen 1953; Olsson 1958; Dorst 1962; Radford 1960 and 1962; Harris 1962b and 1964).

Migratory movements of gulls as a whole are conservative compared with some terns and skuas, e.g. the Arctic tern, *Sterna macrura*, Arctic skua, *Stercorarius parasiticus*, and Pomarine skua, *S. pomarinus* (Dorst 1962). Another species which is closely related to *L. dominicanus* is *L. fuscus*, and it is interesting that the latter is a notable migrant (Tinbergen 1953; Harris 1962a) whereas the former is migratory only at the southern extreme of its range.

SUMMARY

The basic population structure of the Dominican gull, *Larus dominicanus*, in Wellington, New Zealand, was examined by total censuses, fixed transects, and by banding. A census during the period of peak autumn population in 1965 revealed 12,236 in the Wellington area, and over 84% within 11 miles of the harbour. There was an average of 48.5 birds/mile of coast; 48.8% of all gulls were at or near refuse tips or meatworks. On mainly uninhabited coast there was an average of only 2.4 birds/mile, showing the distribution of the species is now greatly influenced by human occupation. Flocks are not discrete but comprise some birds that attend more or less regularly, and varying numbers of itinerants (from several roosting sites) that tend to 'knit' the population together. The population is at a minimum from November to January during breeding, and maximum from March to May. Itinerants comprised an average 9.4% of the population.

The number and percentage of adults in flocks increases rapidly from February until April or May and then declines. First-year birds begin to appear in flocks in January and increase in number and percentage during the year. This increase is affected by the very sedentary behaviour of local young gulls, the immigration of young from flocks adjacent to the city and, after June, to the departure of adults to breeding colonies. The percentage of young was apparently related to the proximity of feeding sites; flocks feeding usually had relatively more young than those resting, thus suggesting the young spend more time feeding than adults. There was no simple correlation between percentage of young and flock size. During summer breeding birds tend to visit flock sites near their colonies rather than ones further away. In periods of minimum attendance at colonies the flocks may be supplemented by up to 37% of the breeding adults. Attendance at flocks was also affected by the location of roosting sites and (for feeding flocks) by the type of food available.

Dispersal patterns were obtained from 275 dead recoveries as well as from sight records of 7,096 birds banded as fledglings in five colonies, and 337 gulls banded while roosting. The low proportion of recoveries in mountains or uninhabited country, and the high proportion in towns or populated areas does not distort the picture of gull dispersal but simply reflects true habitat preference and distribution as shown by aerial surveys. Mean recovery distance in the first year was 16.8 miles, after the first year (second to sixth years only) 11.6 miles and all ages combined 15.2 miles. If birds recovered in their natal colonies are ignored, the mean recovery distance after the first year was 14.4 miles. Dispersal was restricted and randomly directed, 64% came from Wellington and Lower Hutt cities. Dispersal to the South Island was very limited and was apparently related to the food supply and number of feeding sites near the colonies. There was no movement north in winter.

The dispersal pattern of gulls banded while roosting on Somes Island was apparently not different from that of birds born on the island. A survey of colour-banded birds showed again that gull distribution was affected by feeding sites near the colonies. A small number of

recoveries in Wellington (which, however, represents half the total from gulls banded in colonies at the north end of the South Island) indicates some dispersal across Cook Strait to Wellington. In comparison with other species Dominican gulls in Wellington are remarkably sedentary.

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