

# THE DISTRIBUTION AND NUMBERS OF GANNETS (*Sula serrator*) IN NEW ZEALAND

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## ABSTRACT

The 1980/81 distribution of the Australasian Gannet (*Sula serrator*) in New Zealand is described and population changes since 1946 are examined. A brief history of the 26 breeding colonies and 23 roosts is given. Over 99% of gannets nested in the 23 colonies round the northern half of the North Island in 1980/81. Gannet roosts are mostly near the breeding colonies.

The results of three national censuses taken since 1946 give an indication of the changes of the New Zealand gannet population in 34 years. The 1946/47 population was assessed at 21 115 pairs; 37 774 pairs were counted in 1969/70 and 46 004 in 1980/81. The mean annual rate of increase for the whole population between 1946/47 and 1980/81 was 2.3%. In comparison with gannets in Australia, South Africa, and the North Atlantic, the gannet in New Zealand seems to be the only one steadily increasing and free from human interference.

## INTRODUCTION

Gannets (Sulidae) comprise three geographically widely separated species — the North Atlantic Gannet (*Sula bassana*) in the eastern and western parts of the North Atlantic and in the North Sea, the South African Gannet (*Sula capensis*) round the southern coast of South Africa, and the Australasian Gannet (*Sula serrator*) in New Zealand (Falla *et al.*, 1979), Victoria, South-eastern Australia and Tasmania. The breeding range of the Australasian Gannet is marked by the parallels of 29°S and 47°S latitude and the meridians of 141°E and 178°E longitude.

Gannets are one of the very few vertebrate species in which the whole population can be assessed with a high degree of accuracy. As gannets congregate at breeding colonies, during the nesting season the whole breeding population may be counted. National censuses of the Australasian Gannet in New Zealand have been done in the 1946/47, 1969/70 and 1980/81 breeding seasons, allowing an assessment to be made of the changes in gannet numbers in New Zealand over a 34-year period.

## METHODS

The first (1946/47) census of gannets in New Zealand (Fleming & Wodzicki 1952) was based partly on direct observations and partly

TABLE 1 — Time of day aerial photographs taken in 1969/70 and 1980/81 censuses (excluding RNZAF photographs 1968, 1969)

TIME	<u>1969/70 Census</u>		<u>1980/81 Census</u>					
	Day One (20/10/69)	Day Two (21/10/69)	Day One (22/10/80)	Day Two (11/11/80)	Day Three (12/11/80)	Day Four (13/11/80)	Day Five (14/11/80)	Day Six (25/11/80)
10.00-10.59	Tolaga Bay (10.00)	Poor Knights Is (10.00)		Three Kings Is (10.45)	White I. (10.45)	Kawhia (10.00)	Nuggets (10.35)	
11.00-11.59	White I. (11.30)				Schooner Rocks Aldermen Is Mercury Is Cuvier I. Arid I. (11.15-13.15)			Marlborough Sounds (11.30)
12.00-12.59		Cape Karikari Stacks (12.00)	Tolaga Bay (12.00)	Cape Karikari Stacks (12.30)			Little Solander I. (12.10)	
13.00-13.59		Muriwai (13.00-14.00)	Hawkes Bay (13.30)		Mokohinau Is (13.30)			
14.00-14.59	Aldermen Is (14.00)			Cavalli I. (14.15)	Mahuki I. (14.00)			
	Colville/ Horuhoru (14.30-16.00)				Colville (14.45)			
15.00-15.59		Kawhia (15.00)		Tikiliki I. (15.00) Bird Rock (15.10) Poor Knights Is (15.30) Sail Rock (15.45)	Horuhoru (15.45)			
16.00-16.59	Mahuki I. (16.30)			Muriwai (16.30)				
17.00-17.59	Mokohinau Is (17.15)	Hawkes Bay (17.00)						

on indirect methods such as aerial photography. Direct observations included walks through a gannetry counting the numbers in the regularly arranged rows of nests. An alternative for gannetries with shy birds was to make several counts using binoculars and to average the counts. Fleming and Wodzicki found that small gannetries of up to 100 nests could be counted on the ground without significant error but that counts of large congregations of 1000 or more nests might differ by up to 10%. They found aerial photographs to be satisfactory for counting gannets, except when the weather had deteriorated during the taking of photographs. They estimated that "with good photographs the margin of error in counting nesting gannets is small" but that "with poor photographs the margin of error may be up to 25%."

The 1969/70 and 1980/81 gannet censuses were based solely on aerial photographs. Those used were taken on 17, 25 October and 5 December 1968 and 20-21 October and 17 November 1969. In the 1980/81 breeding season photographs were taken on 22 October and 11-14 and 25 November. All the photographs were taken in fine weather from altitudes of 150-500 m in 1968/69 and 200-650 m in 1980. Because gannet numbers fluctuate during the day and during the breeding season, the times when photographs were taken are summarised in Table 1.

The Three Kings gannetries were photographed by the RNZAF at 12.00 h on 25 October 1968 and at 12.30 h on 17 November 1969 at 150-500 m. For all islands except Arbutus Rock, only the 1969 photographs were used for counting because the photographic coverage was more comprehensive than in the 1968 series. A small section of the South West Island gannetries was not photographed. The Nuggets gannetry was photographed by the RNZAF at 12.00 h on 17 October 1968 and Little Solander Island on 5 December 1968.

Other gannetries were photographed in 1969 from a Piper Cherokee 6 aircraft. The plane was piloted by P. Wilson and navigated by D. G. Cooper, and photographs were taken through the open door by C. J. R. Robertson. RNZAF photographs were taken in black and white 130 x 120 mm film. Other photographs were taken with a Pentax camera and 135 mm telephoto lens in Agfacolor colour transparency and Ilford FP4 black and white 35 mm film.

In 1980 the Department of Civil Aviation provided extensive assistance by making available a Piper Seneca twin-engined aircraft and a single-engined Cessna 172 aircraft for all localities except the most southern colonies. R. Shand and J. Snow were the main pilots while R. Cossee and G. Park provided navigation and other assistance. All photographs were taken through an open door or window. A. Wright photographed the Nuggets and Little Solander Island gannetries with a Pentax 35 mm camera and 80-220 zoom telephoto lens. C. J. R. Robertson photographed all other gannetries using Nikon 35 mm automatic-exposure cameras with motor drives and 70-210 mm zoom

telephoto lenses. All photographs were Ektachrome 64 colour transparencies and Ilford FP4 black and whites.

When conditions allowed, air speeds were restricted to 80-110 knots. To prevent camera shake and aircraft movement from blurring the film image, all exposures were above 1/500th of a second. The best coverage of gannetries was obtained by means of a direct intercom link between photographer and pilot to assist with aligning the aircraft and by means of automatic-exposure motor-drive cameras.

In November and December 1968 C. J. R. Robertson (unpubl.) tested the accuracy of comparative counts taken from aerial photographs and ground counts (where each nest site was checked) at a gannetry with 200-400 sites. These tests showed that, although aerial photographs could not allow the breeding status of gannets to be assessed reliably (also referred to by Nettleship 1976) the counts were accurate to within  $\pm 3\%$  of nest sites recorded on the ground.

As the number of birds present on a gannetry can vary according to nesting or site-occupying status, time of day, inter- and intra-seasonal fluctuations and latitude, any counts taken from aerial photographs may be subject to several sources of error. These factors will be discussed and related to the census data in a separate paper. However, with improved photographic methods, gannetries can be counted over a short period of time and the population size can be assessed more reliably.

Photographic transparencies from the 1969/70 and 1980/81 census surveys were projected on to a plain sheet of white paper and all sites with one or two gannets were marked on the paper. The marked sheets were then divided up into groups of up to 50 sites, and the groups were counted and totalled.

Each site with one or two birds was counted as a single site representing one site-occupying pair. Throughout the rest of the paper, we shall refer to these 'site-occupying pairs' as 'pairs.'

#### NEW ZEALAND GANNETRIES AND ROOSTS: A BRIEF HISTORY AND PRESENT STATUS

The first count of gannets breeding in New Zealand was provided by Wodzicki & McMeekan (1947). They listed 12 'breeding localities' with an estimated total population of 11 777 pairs. Fleming & Wodzicki (1952) described 32 'gannet stations' in New Zealand in 1946/47. However, nine of these were roosts or extinct gannetries, and so there were 23 breeding stations in 1946/47. In this paper we use the word 'colony' to represent a collection of occupied sites completely separate from any other collection, and 'gannetry' to represent a collection of colonies in the same geographic location. Thus, the terms 'localities' and 'stations' are synonymous with 'gannetries.'

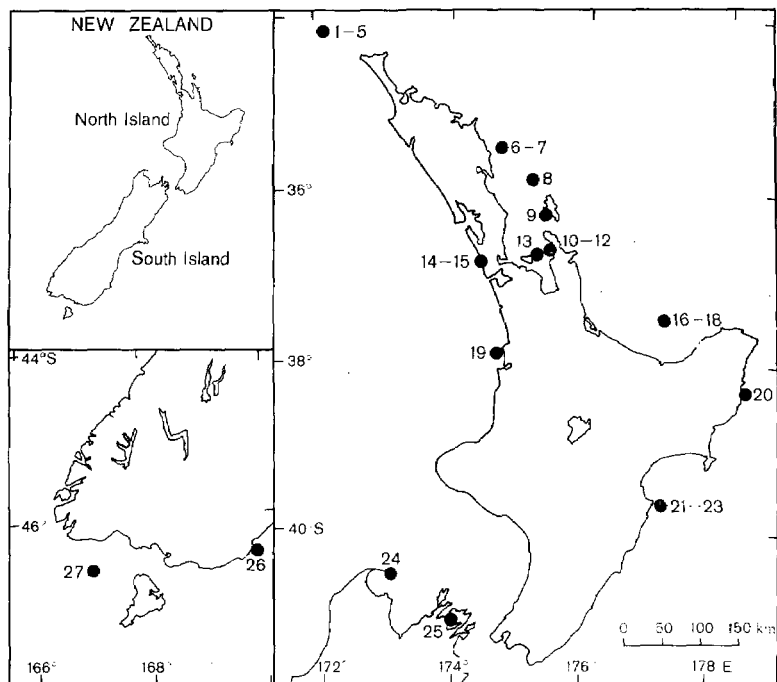


FIGURE 1 — Distribution of breeding gannetries in New Zealand

- |                         |                            |
|-------------------------|----------------------------|
| 1. South West Island    | 15. *Muriwai Stack         |
| 2. Hinemoa Rock         | 16. West Point             |
| 3. Hole-in-the-Wall     | 17. Rocky Point            |
| 4. Tutanekai Rock       | 18. Gannet Point           |
| 5. Arbutus Rock         | 19. Gannet Island (Karewa) |
| 6. High Peak Rocks      | 20. Moutara Rock           |
| 7. Sugarloaf            | 21. Black Reef             |
| 8. Cathedral Rocks      | 22. Cape Kidnappers Saddle |
| 9. Mahuki Island        | 23. Plateau                |
| 10. Double Island Stack | 24. †Farewell Spit         |
| 11. Bush Island         | 25. *Waimaru Bay           |
| 12. Motutakapu          | 26. Nuggets                |
| 13. Horuhoru Rock       | 27. Little Solander Island |
| 14. Oaia Island         |                            |

(established since the 1946/47 (\*) or 1980/81 (†) census)

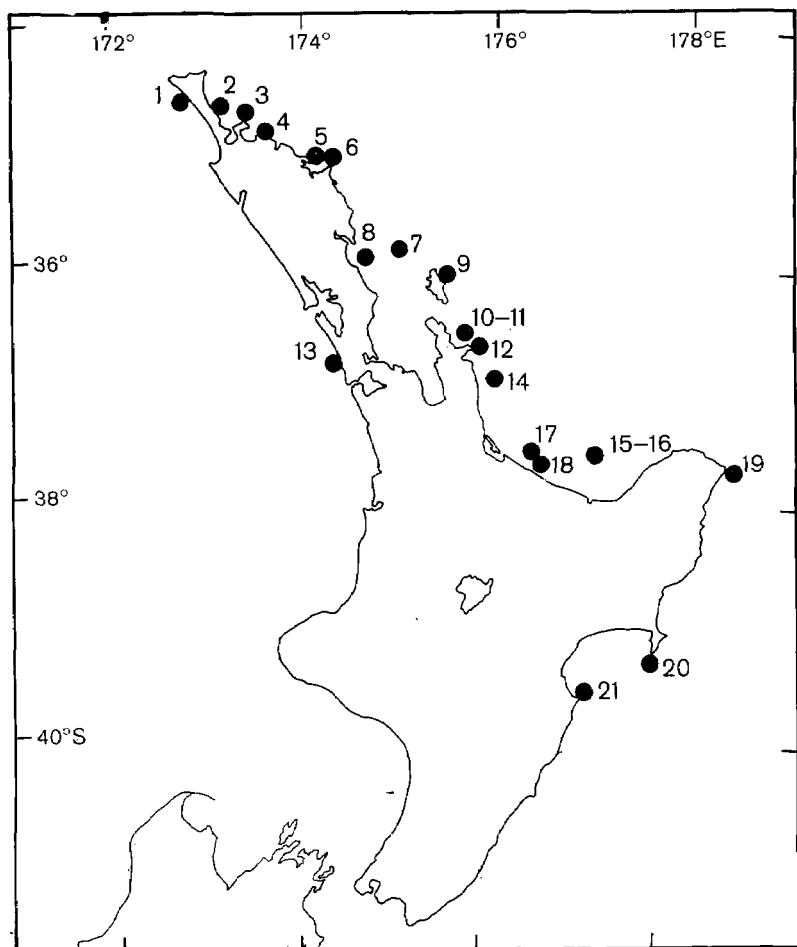


FIGURE 2 — Distribution of gannet roosts in New Zealand

- |                         |                      |
|-------------------------|----------------------|
| 1. Matapia Islet        | 12. Korapuki Island  |
| 2. Hapuku Rock          | 13. Muriwai Mainland |
| 3. Cape Karikari Stacks | 14. Sugarloaf Rocks  |
| 4. Berghan Point        | 15. Dam Site         |
| 5. Tikitiki Rock        | 16. Club Rock        |
| 6. Bird Rock            | 17. Motuhaku Islands |
| 7. Groper Rock          | 18. Motunau Island   |
| 8. Sail Rock            | 19. East Island      |
| 9. Arid Island Stack    | 20. Portland Island  |
| 10. The Sisters         | 21. Plateau Beach    |
| 11. Never Fail Rock     |                      |

In 1980/81, 34 years later, we recorded 26 gannetries in New Zealand. This figure does not include the Farewell Spit gannetry, established after the 1980/81 census, or the gannetry contained within the Napier Marineland. Information on the history, distribution and subdivisions of the present gannetries is given below. Descriptive material given in Fleming & Wodzicki (1952) has not generally been repeated. Gannetries are listed from north to south. Roosts have been distinguished from breeding gannetries by means of (R) or (G), respectively, after the names (see also Fig. 1 and 2 and Table 2).

### THREE KINGS (G) 34°11'S 172°02'-172°04'E

This group consists of five gannetries (South West Island, Hinemoa Rock, Hole-in-the-Wall, Tutanekai Rock and Arbutus Rock), described in Fleming & Wodzicki (1952). Note that in Figure 5 of Fleming & Wodzicki (1952), Tutanekai Rock should be labelled as Hinemoa Rock. Gannets were presumably breeding in this area when noted near the Three Kings by Captain Cook in 1769. Breeding was first reported in 1889. Pairs counted were 4134 in 1946/47, 7235 in 1969/70, and 9855 in 1980/81. Changes in the numbers of pairs at each gannetry are given in Table 2.

By 1980 there were some new colonies on South West Island and some of the 1946/47 colonies had changed or disappeared. Vegetation encroachment recorded in the 1969 photographs had continued and it is possible that some nest sites were obscured. On all other islands there had been a steady increase in the extent and size of surrounding vegetation between 1946 and 1980.

### MATAPIA ISLET (R) 34°38'S 172°49'E

For the history and description of this roost see Fleming & Wodzicki (1952). The nearest established breeding colony is at the Three Kings Islands c. 60 km away. No recent records of roosting.

### SIMMONDS ISLAND (R) 34°45'S 173°09'E

Hapuku Rock, about 41 m long by 23m wide, lacks vegetation, rises 6-9 m above the water, and is often covered during high seas. Roosting was reported on Hapuku Rock in December 1965 (Wagener 1966). During the day small flocks of 5-10 birds were seen fishing around Simmonds Island and at dusk about 20 roosted on the north-east portion of the rock. The nearest established breeding colony is at the Three Kings Islands c. 140 km away.

### CAPE KARIKARI STACKS (R) 34°46'S 173°24'E

An estimated 30 pairs were first reported breeding on the two small rocks in 1946/47. There was no breeding in 1947/48 (Fleming & Wodzicki 1952) and no birds were present in 1969/70 or 1980/81. Currently regarded as an abandoned gannetry, the nearest established gannetry is at the Three Kings Islands c. 115 km away.

## BERGHAN POINT (R) 34°55'S 173°35'E

After a report of gannets roosting on the islet at the end of Berghan Point in large numbers (up to 200 per night), Stein (1962) visited the point in December 1960. He saw about 20 ashore near midday and 24 at daybreak but there was no sign of nesting. No birds were seen in the 1969/70 and 1980/81 censuses. The nearest breeding colony is at the Poor Knights Islands c. 130 km away.

## TIKITIKI ROCK (R) 35°09'S 174°09'E

This small steep island at the northern entrance to the Bay of Islands has some vegetation on the summit. During the census in November 1980, a tight group of 22 birds was on part of the summit and some birds were in the air. There was no evidence of breeding. Roosting birds were also present on 11 January 1981 (C. J. R. Robertson, unpubl.). The nearest established breeding colony is at the Poor Knights Islands c. 65 km away.

## BIRD ROCK (R) 35°11'S 174°17'E

This small bare rocky islet with a gently rounded top about 20 m a.s.l. is inside the southern entrance to the Bay of Islands. Fleming & Wodzicki (1952) discussed possible sporadic breeding up to 1933. During the 1969/70 census no gannets were present, but the island was white with guano. In November 1980, 147 birds were present, covering some 60% of the top of the island. On 11 January 1981, on a close approach by boat, 125 roosting birds but no chicks were recorded (C. J. R. Robertson, unpubl.). The nearest established breeding colony is at the Poor Knights Islands c. 60 km away.

## POOR KNIGHTS ISLANDS

*The Pinnacles or High Peak Rocks* (G) 35°33'S 174°43'E

(Northwest and Southwest Pinnacles and Gannet Stack)

These were described by Fleming & Wodzicki (1952) as the 'Poor Knights Rocks.' Gannet Stack was the only one occupied in 1946/47, with 100 pairs. The correct names and positions of the High Peak Rocks are shown in Fig. 3. Note that the relative positions of the three members of the Pinnacles (or High Peak Rocks) are incorrect in Fleming & Wodzicki's map. Fleming & Wodzicki in their text also described Gannet Stack as 'nearer to the Poor Knights,' whereas it is actually to the east of the other two Pinnacles (E. G. Turbott, *in litt.* 1983).

In the 1969/70 aerial survey the largest of the three islands (Northwest Pinnacle) had 89 pairs of gannets whereas in 1980/81 the several groups on this island totalled 960 pairs. The colonies on this location are apparently increasing and reducing the amount of scrubby vegetation on the islet (E. G. Turbott, *in litt.*, 1983). On the second largest island (Southwest Pinnacle) a group of 36 birds was present in 1980/81, but they may have only been roosting.



*Sugarloaf* (G) 35°38'S 174°43'E

This stack (Fig. 4) has been used as a breeding colony since the late 19th century. There were 1410 pairs in 1946/47, 2462 in 1969/70 and 2617 in 1980/81.

A total of 1510 pairs was counted at the Poor Knights Islands in 1946/47 but the margin of error was accepted as being large. There were 2990 pairs in 1969/70 and 4170 in 1980/81.

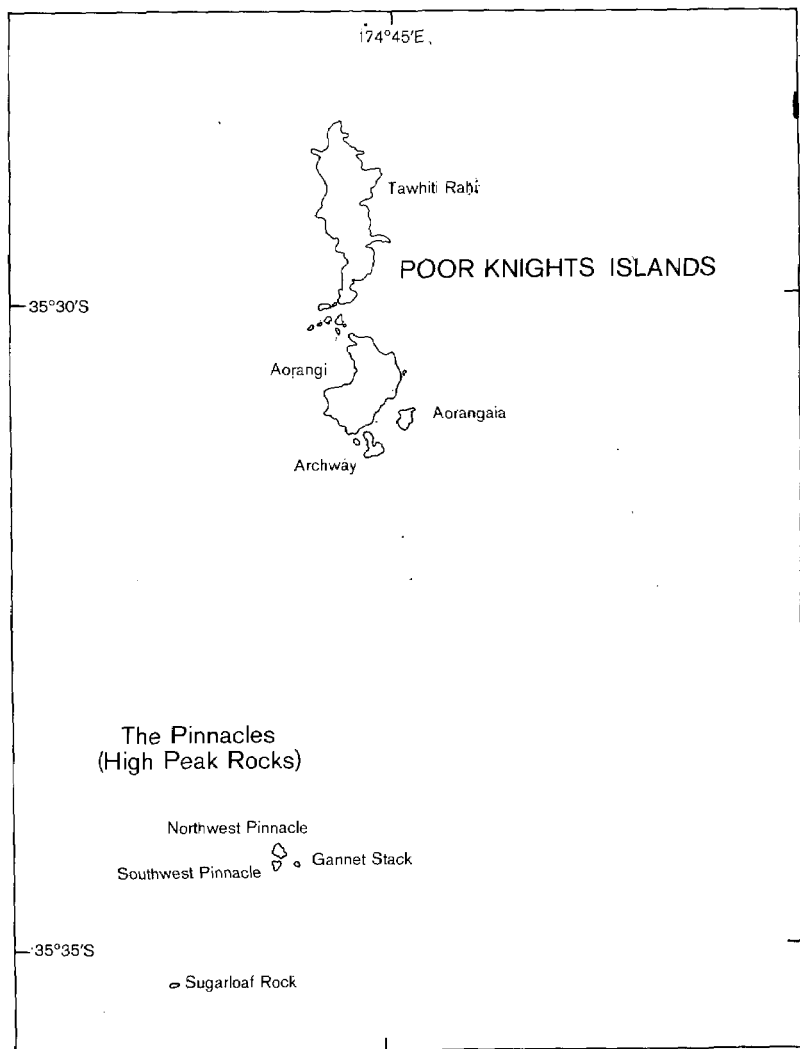


FIGURE 3 — Location of the Poor Knights Islands gannetries (after Turbott 1983)



FIGURE 4 — The Sugarloaf, Poor Knights Islands in October 1965, as an example of a stack gannetry  
(Courtesy of NZ Wildlife Service, C. J. R. Robertson)

## MOKOHINAU ISLAND

*Groper Rock* (R) 35°54'S 175°10'E

Gannets were first noted as probably breeding on this rock in 1945/46 but it was not visited during the 1946/47 census (Fleming & Wodzicki 1952). No birds were present in the 1969/70 and 1980/81 censuses. The nearest established breeding colony is at Cathedral Rocks c. 10 km away.

*Cathedral Rocks* (G) 35°55'S 175°10'E

Two prominent bare rocks which were probably first used only for roosting. Twelve pairs attempted to breed in 1947/48. Three small groups, totalling 25 pairs on the smallest rock and groups of 18 and 6 on the largest, gave a total of 49 pairs present in 1969/70. In 1980/81 a single colony of 92 pairs was on the smaller rock and three groups of 158, 83 and 11 were on the larger rock, giving a total of 344 pairs.

## HEN AND CHICKEN ISLANDS

*Sail Rock* (R) 36°00'S 174°42'E

During the 1980/81 census, 26 gannets were photographed occupying ledges on the steep northern face of this island, which is probably a roost. From the photographs it appears that four sites were occupied by pairs of birds. Landing is probably impossible, and so any breeding here would be hard to confirm. The nearest established colony is at the Mokohinau Islands c. 40 km away.

## GREAT BARRIER ISLAND

*Arid Island Stack* (R) 36°07'S 175°30'E

Breeding is not known on the stack off Arid Island, but a few roosting gannets were noted in 1937 and 1944 (Fleming & Wodzicki 1952). No roosting was recorded in the 1969/70 and 1980/81 censuses. The nearest established breeding colony is at Mahuki Island c. 20 km away.

*Mahuki Island* (G) 36°14'S 175°18'E

Locally known as Gannet Island, this is the most south-westerly of the Broken or Pig Islands south of the southern entrance to Port Fitzroy. This old, established gannetry on a narrow north-west promontory of the island is known to have existed before 1867. In 1946/47 the colony seemed to have been raided before counting as only one chick, 50 eggs and 600-700 adult birds were present. An estimate of 325 pairs was used for the 1946/47 census (Fleming & Wodzicki 1952).

By 1969/70 the gannetry had expanded considerably, with 1869 pairs recorded. In 1980/81, 2092 pairs were on the peninsula and a further four groups of gannets, totalling 589 pairs, were to the south and north along cliff tops within a few hundred metres of the main

colony. These extra groups were probably largely young birds holding sites, but possibly not yet breeding.

### MERCURY ISLANDS

*The Sisters* (R) 36°37'S 174°46'E

These two small stacks off Huruhi Bay, Great Mercury Island, were not occupied by gannets in the 1920s. Between 1935 and 1938 there were unconfirmed reports of breeding. There was evidence of roosting in the 1940s and again in 1963 (Skegg 1963) but no sign of birds in 1969/70 and 1980/81. The nearest established breeding colony is at Colville, Coromandel Peninsula, c. 35 km away.

*Never Fail Rock* (R) 36°37'S 175°48'E

This is a small rock just north-east of Great Mercury Island. One pair of gannets was seen breeding there in 1960/61 and 1961/62, but definitely not in 1959/60. On 27 November 1962 the rock was examined from Arimiwhai, Great Mercury, and no gannets could be seen (Skegg 1963). There was no sign of birds in 1969 or 1980. The nearest established breeding colony is at Colville, Coromandel Peninsula, c. 40 km away.

KORAPUKI ISLAND (R) 36°40'S 175°51'E

A roost was discovered on a small stack off the southern extremity of Korapuki in 1962. On 4 September 1962, three gannets were sitting on the stack and six were circling it (Skegg 1963). The amount of droppings on it suggested that it was in regular use, but there was no sign of gannets in the 1969/70 or 1980/81 censuses. The nearest established breeding colony is at Colville, Coromandel Peninsula, c. 40 km away.

### COLVILLE

Gannetries are on three of the islands named Motukawao Group, south-west of Colville on the west side of the Coromandel Peninsula.

*Double Island Stack* (G) 36°40'S 175°24'E

An estimated five pairs were breeding in 1946/47. The aerial photograph for 1969/70 was too blurred for an accurate count, and an assessed 50 pairs in one group was used for the census. In 1980/81 there were two colonial groups with a total of 96 pairs.

*Bush Island* (G) 36°41'S 175°24'E

This has the largest population of the group, and the gannets there were the subject of a 3-year study by E. Waghorn from 1978 to 1980 (Waghorn 1982). In 1946/47, the four colonies on the island had a total population of 1513 pairs, rising to 2834 in 1969/70 and 3530 in 1980/81. Expansion is now becoming restricted by terrain and vegetation at some colonies.

*Motutakapu* (G) 36°41'S 175°23'E

This long-established gannetry has a first estimate in 1928 of 200 pairs. Some 288 pairs were counted in 1946/47, 777 in 1969/70 and 925 in 1980/81.

Thus, for the Colville group of gannetries the total population had increased from 1806 pairs in 1946/47 to 3661 pairs in 1969/70 and 4551 pairs in 1980/81.

*HORUHURU ROCK* (G) 36°43'S 175°10'E

This gannetry off Waiheke Island was established well before 1900. The population increased steadily from about 1000 pairs in 1928 to 1228 in 1946/47. Further counts gave 1503 pairs in November 1949 and 1573 pairs in November 1958 (Stein 1971). After this date a new part of the island was colonised, a low rocky platform at the northern end. In 1969/70 a total of 2526 pairs was present, increasing slightly to 2647 by 1980/81.

*MURIWAI**Oaia Island* (G) 36°50'S 174°25'E

The gannetry on this small dome-shaped islet was apparently occupied well before 1914. In 1940 the number was estimated to be 160 pairs, but by 1946/47, the population had risen to 338 pairs. The total was 892 pairs in 1969/70, decreasing to 761 in 1980/81.

*Muriwai Stack* (G) 36°50'S 174°26'E

This gannetry was recently established on Sugarloaf Rock, about 30 m offshore from the coastal cliffs between Maori Bay and the south end of the main Muriwai Beach. The nearest established gannetry is Oaia Island, about 2 km seaward. Sugarloaf Rock is sheer-sided and high with a flat top sloping towards the mainland. Gannets began breeding there in 1975/76 (Reed 1979). Twenty-eight nests were occupied on 22 November 1975, and the colony has increased rapidly since then, with 93 chicks being observed on 23 January 1978. Some 298 pairs were recorded in 1980/81.

*Muriwai Mainland* (R) 36°50'S 174°26'E

This roosting site on the Muriwai mainland consists of two platforms adjacent to the new Muriwai Stack colony. Breeding was attempted in 1979 but was disrupted by visitors and dogs. This is a popular place for viewing the gannetry on Sugarloaf Rock.

*ALDERMEN ISLANDS**Sugarloaf Rocks* (R) 36°58'S 176°05'E

A few gannets (5-10 pairs) were breeding there between 1921 and 1927. No gannets were seen there in the 1946/47 and 1947/48 breeding seasons (Fleming & Wodzicki 1952) or in 1980/81. The nearest established breeding colony is at Horuhuru c. 85 km away.

## WHITE ISLAND

This group is situated on an active volcano and consists of three gannetries: *West Point* (37°03'S 177°10'E), *Rocky Point* (37°32'S 177°11'E) and *Gannet Point* (37°32'S 177°12'E). Breeding was recorded before 1872 (Fleming & Wodzicki 1952). These gannetries were described by Robertson & Wodzicki (1948) and Wodzicki & Robertson (1959). Since early this century the volcano has attracted many visitors, which has helped to provide historical information on the gannetries. In 1946/47, the counts were taken late in the season and there was evidence of some disturbance by muttonbirding parties. According to P. Burstall, former Conservator of Wildlife, Rotorua (*in litt.* 1983), Maoris used to take gannets from White Island, more as a sideline to their muttonbirding activities than as a distinct activity, but after prosecution in the 1960s this practice seems to have ceased.

The 1946/47 total of 5227 pairs at White Island increased slightly to 6713 in 1969/70 and has remained relatively stable with 6793 pairs in 1980/81.

Eruptions of the volcano may have affected gannet numbers. After a major eruption in December 1976, the breeding population at the beginning of the 1977/78 breeding season was estimated at 2755 pairs (Wodzicki 1978). However, V. T. Davis (*in litt.*), who has banded gannet chicks at White Island for many years, did not notice any change in numbers in the 1977/78 season. In April 1979, after further eruptions occurred, he reported that, although the land and sea had been affected, the gannets appeared to be breeding in the usual numbers.

*Dam Site* (R) 37°32'S 177°12'E

An estimated 100-150 birds were seen there in 1925-27, although it was noted that this locality might not be regularly occupied. Gannets were not seen at this site in 1912, in the 1946/47 breeding season (Fleming & Wodzicki 1952) or later. The nearest established breeding colony is at Gannet Point, also on White Island.

*Club Rock* (R) 37°33'S 177°11'E

Breeding was reported on this group of small rocks off White Island in 1912. In 1925-27 gannets were present but not breeding, and in January 1947 no birds were present (Fleming & Wodzicki 1952), nor have there been any since. The nearest established breeding colony is at Gannet Point on White Island.

## KAWHIA

*Gannet Island (Karewa)* 37°57'S 174°35'E

This is the largest single gannetry in New Zealand and one of the oldest recorded, as Captain Cook noted it as a gannet nesting place in 1770. There was always a large gannet population, and

counts in 1946/47 gave a total of 3715 pairs. In 1969/70 the total was 6132 pairs, and in 1980/81 it had risen to 8003 pairs.

#### MOTUHAKU ISLANDS OR SCHOONER ROCKS (R)

37°35'S 176°32'E

At the northern end of the largest rock, 6-8 birds were seen roosting at 1600 h on 13 November 1972 (L. Moran, pers. comm.). The nearest established breeding colony is at White Island c. 60 km away.

#### MOTUNAU OR PLATE ISLAND (R) 37°40'S 176°34'E

At the north-eastern end of the small stack at the northern end of the main island, 6-8 birds were seen roosting in the early evening of 14 November 1972 (L. Moran, pers. comm.). The nearest established breeding colony is at White Island c. 60 km away.

#### EAST ISLAND (R) 37°40'S 178°35'E

During December 1979, groups of gannets were seen roosting on a small, low, rocky islet south-west of East Island by several observers. About 50 birds were photographed on 6 December 1979 (E. J. Jones, pers. comm.). Local fishermen saw 30 roosting on a point of East Island in mid-December 1979, and the whole of a point at the north-east corner, about 60 m a.s.l., was covered with birds in the last two weeks of January 1980 (Cade, pers. comm.). The nearest established breeding colony is at Moutara Rock c 80 km away.

#### TOLAGA BAY (G) 38°25'S 178°21'E

Moutara Rock is about 5 km south of Tolaga Bay and about 300 m off Moutara Point at the northern end of Waihou Bay. This gannetry was not recorded in the 1946/47 census, being first described by Blackburn (1956). However, local residents had reported to Blackburn the presence of nesting gannets about 30 years before, in the late 1920s. The rock on which the gannetry is situated is bare, rises about 15 m a.s.l. and has a total area of c. 1.6 ha. The nesting area covers two low hummocks and a basin in between and is exposed to north-easterly winds. During Blackburn's first visit several estimates were made and the numbers of gannets averaged 230. Access to the colony is difficult and population estimates are few. In 1969/70 two groups of 388 and 79 were present (467 pairs). Only the smaller group has continued to expand and in 1980/81 the two groups numbered 384 and 227 (611 pairs).

#### PORTLAND ISLAND (R) 39°18'S 177°52'E

Birds were first reported roosting on the beach at the end of a spit at the north end of the island, close to a Black-backed Gull colony and the island airstrip, in about 1972. Twelve were present at the same spot in January 1973. On 24 December 1973, 25 birds were on the spit site. Two eggs and one chick had been seen at that site earlier in the breeding season. In the same season another

12 birds were recorded at a new site on the flat top of cliffs by the lighthouse at the southern end of the island. On 10 December 1974, 60 birds were roosting at the spit, and on 21 December 1974, 65 birds were roosting on a steep grassy slope on the south-eastern side of the island about 50 m above the sea, below the previous cliff-top site. However, no birds have been reported since 1975. The nearest established breeding colony is at Cape Kidnappers c. 80 km away.

**NAPIER MARINELAND (G) 39°30'S 176°55'E**

This captive colony at Marineland on the Napier foreshore originated in 1970 from a few juvenile gannets deserted by parents at the Plateau colony at Cape Kidnappers and brought into captivity for a study of plumage changes by C. J. R. Robertson. Subsequently, young birds stranded on beaches have been added to the original stock. The colony (Fig. 5) gradually grew, and at present it is kept at a maximum of some 20 gannets allowed for by the Marineland Zoo licence. They are provided with food and shelter but are able to fly in and out, free to return to the wild should they choose to do so. As this is a man-made and man-maintained colony, it has not been included in Table 2.

The first egg was laid in the 1977/78 nesting season but was infertile. A year later a chick was hatched in captivity for the first



FIGURE 5 — The gannet colony at Marineland, Napier, in 1983  
(Courtesy of G. J. Macdonald)



time.' Although more chicks have hatched since then, many eggs that have been laid did not hatch. The colony represents a successful attempt to have Australasian Gannets permanently living and nesting in a man-made environment. It also provides a year-round opportunity for the public to view gannets at close quarters. The nearest established breeding colony is at Cape Kidnappers, c. 25 km away.

#### CAPE KIDNAPPERS

This group comprises three gannetries: Cape Kidnappers or Saddle, Black Reef and Plateau. The existing records (Fleming & Wodzicki 1952) state that the Cape Kidnappers gannetry was probably already occupied in about 1879 and that the first use of the Black Reef locality was reported in 1938/39. Nesting was first reported from the Plateau gannetry in 1936 (W. B. Stewart, pers. comm.). The Cape Kidnappers gannetries have been extensively studied between 1947 and 1964 by K. Wodzicki and since 1959 by C. J. R. Robertson. Annual ground counts have been made at the Plateau gannetry in the period 12-25 December since 1945 (except in 1975) and many aerial surveys have been made and photographs taken during each year since 1966 to keep a record of population changes. Wodzicki (1967a) recorded details of the colonies and population changes on all three Cape Kidnappers gannetries between 1945 and 1964.

*Black Reef (G)* 39°38'S 177°07'E

In 1980/81 this gannetry comprised 11 groups of gannets on low flat-topped stacks and one on the mainland. The existing records show that most of the colonies started as roosts (C. J. R. Robertson, unpubl.). The mainland part of the colony became well-established in 1977 after ladders allowing public access to the nesting sites were removed. Black Reef gannet numbers rose from 263 pairs in 1946 to 1579 pairs in 1969 and 1821 pairs in 1980.

*Cape Kidnappers (Saddle)* 39°38'S 177°08'E

The area occupied by this gannetry has declined since 1939, mainly because of the reduction of nests on the landward and seaward slopes and on the northern edge of the saddle. Wodzicki (1967a) suggested that erosion may have caused this decline, but C. J. R. Robertson believes that a preference for nesting on flat ground could be a contributory factor. The matter might be more complicated, however, as in recent years a large former nesting area on previously flat ground has remained unoccupied (Fig. 9). The build-up of guano within the adjacent colony is producing an increasingly steep smooth slope towards the northern edge, which is not being reoccupied by nesting birds. This gannetry, which had risen from 2337 pairs in 1946/47 to 2705 in 1969/70, decreased to 2200 pairs in 1980/81.

*Plateau (G)* 39°38'S 177°08'E

Fifty roosting birds were photographed here in 1934 (N. Carroll, pers. comm.) and breeding was first reported in 1936 (W. B. Stewart,

pers. comm.). Since 1946, this colony has been the main viewing area for the public and its growth was restricted by this both directly and indirectly (by increased Black-backed Gull predation, Taylor & Wodzicki 1958 and Robertson 1964) until 1968, when a low guide-wire fence was erected to keep visitors from approaching too closely.

The colony originally comprised one group, but a second group developed between 1946 and 1950. After the erection of the guide wire in 1968 the groups joined together, and they have developed as one colony since.

*Plateau Beach* (R) 39°38'S 177°08'E

During the 1972/73 season various groups of birds roosted on the steep slopes and beach south-east of the Plateau gannetry. From 1974 to 1980 the main roost was a raised sandy beach, extending on to a steep slope at the back of the beach. Eggs were laid in 1975 and 1976, but no chicks were reared. This site is subject to disturbance by stock, goats and fishermen.

*FAREWELL SPIT* (G) 40°27'S 173°00'E

Gannets were reported roosting on a sand spit approximately 15 km from the base of the inner beach between 11 and 15 November 1981 (B. D. Bell, pers. comm.). Some of these birds had scraped the ground and were displaying. Additional birds were observed joining and leaving the group. In excess of 300 gannets were reported roosting on the shell banks at the end of the Spit from 13 to 23 January 1983 (B. D. Bell, pers. comm.). Much activity and displaying were noted.

On 23 November 1983 about 600 gannets were noted at shell banks on Farewell Spit. These birds were divided into two groups, each of which had 35-40 nests, most apparently containing eggs (B. D. Bell, pers. comm.). As the first record of breeding at Farewell Spit was made 3 years after the 1980/81 census, their numbers are not included in Table 2.

*MARLBOROUGH SOUNDS* (G) 41°04'S 174°00'E

Roosting birds were first reported from Forsyth Island in 1969 (A. Galsworthy, pers. comm.). Breeding was attempted in 1970/71, and in 1971/72 at least four nests were reported. Although two chicks were reared, the site was abandoned in following years (R. Redwood, pers. comm.). Between 1972/73 and 1975/76, breeding was attempted at West Entry point but apparently no chicks were raised (W. Brown, pers. comm.). This site has since been abandoned (R. H. Taylor, pers. comm.). N. Judd (pers. comm.) reported 14 birds roosting and displaying on neighbouring Te Puraka Point on 20 November 1974.

The present colony is at Waimaru Bay on a small rocky islet which is 6 m a.s.l. and separated from the mainland only at high tide, at the tip of a peninsula forming the northern part of the bay. Five nests were recorded in 1975/76 (W. Brown, pers. comm.). On 7

January 1978, nine live chicks and two dead chicks were present with 26 adults (P. Gaze, pers. comm.). On 10 January 1980, 11 live chicks, 2 dead chicks and 20 adults were counted (C. J. R. Robertson, unpubl.). During the 1980/81 season, two ground counts were made. Of 29 nests counted on 21 October 1980, 8 had eggs, 16 had chicks and 5 were empty (P. R. Wilson & R. H. Taylor, pers. comm.). By 24 December 1980 there were 22 live chicks, one dead chick and one egg (D. A. Harvey, pers. comm.).

## OTAGO

*The Nuggets* (G) 46°27'S 169°51'E

Apparently gannets were nesting for some time before 1946 when 40 pairs were estimated (Fleming & Wodzicki 1952). Only 10 pairs were recorded in 1969/70, and 9 pairs in 1980/81.

## FOVEAUX STRAIT

*Little Solander Island* (G) 46°36'S 166°57'E

Although confined to one group with 20 pairs in 1946/47 and 17 in 1969/70, by 1980/81 this had increased to three groups with a total of 62 pairs. This suggests some immigration to this location.

## RESULTS

The census results of 1946/47, 1969/70 and 1980/81, showing the increase in the New Zealand gannet population, are given in Table 2. During the 1946/47 census some present gannetries were overlooked (Tolaga Bay) or the numbers were simply estimated (Double Island, Colville). However, as these gannetries are relatively small, the results of the three censuses can, in our opinion, be compared. Figure 6 shows the change in gannet numbers at various localities and gives the mean annual percentage increase since 1946/47.

In 1980/81 the New Zealand gannet population was 46 004 pairs (Table 2). The increase or decline at individual gannetries is of interest, and Table 2 shows that numbers at various gannetries changed greatly. Table 2 shows that between 1946/47 and 1969/70 only four gannetries declined — two gannetries at Three Kings and those at the Nuggets and Solander Islands. All the other gannetries showed increases ranging from 13% (West Point, White Island) to 500% (Black Reef, Cape Kidnappers). Between 1969/70 and 1980/81, only five gannetries declined — Tutaneikai at Three Kings, Oaia Island at Muriwai, Rocky Point at White Island, the Saddle colony at Cape Kidnappers and Nuggets, South Island. Increases at the other gannetries ranged from 5% (Horuhoru) to 602% (Cathedral Rocks, Mokohinau Islands).

Table 2 also shows the overall changes in numbers at the gannetries for the whole period 1946/47 to 1980/81. Within this period only three gannetries decreased (Rocky Point at White Island, the Saddle colony at Cape Kidnappers and the Nuggets, South Island).

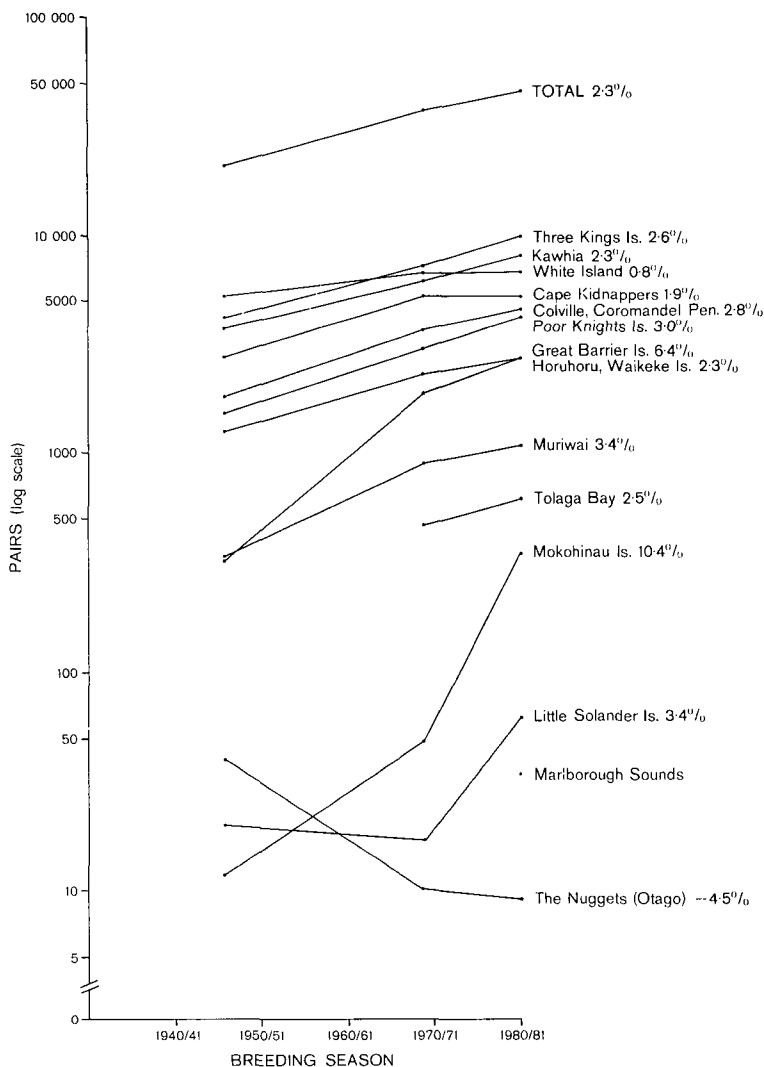


FIGURE 6 — Mean annual percentage change in gannet numbers at various gannetries 1946/47 to 1980/81 (except Tolaga Bay 1969/70 and 1980/81)

Over the same period increases at other gannetries ranged from 24% (West Point, White Island) to 2767% (Cathedral Rocks).

When we examine the census results for groups of gannetries, we can see that the overall numbers for some groups increased, even though numbers at some of their component gannetries declined, e.g. at Three Kings between 1946/47 and 1969/70. Alternatively, the overall numbers for some groups remained constant because some of the component gannetries increased in size while others decreased, e.g. at the Cape Kidnappers group between 1969/70 and 1980/81.

In conclusion, we find that the New Zealand gannet population has been steadily increasing since the 1946/47 census.

## DISCUSSION

### *Census methods*

In 1943, Fisher & Vevers stated that of all the species of birds and mammals which were not regarded as rare, accurate world figures were available for only four, including the North Atlantic Gannet. Several other non-rare species had been counted world-wide, but less accurately. With new techniques this number has increased, as has the reliability of the assessments. Such censuses are important because they provide information on the distribution and numbers of whole species and, if repeated at reasonably long intervals (perhaps every decade), may supply information on the species' welfare within that period.

Until the technique of aerial photography was suitably developed, nesting gannets were counted mainly by direct counts of occupied nests by eye, with binoculars, or from ground photographs. Indirect methods included counting eggs and young or estimating the total area occupied by gannet nests (Fisher & Vevers 1943, 1944, Nelson 1978). Nelson (1978) has classified gannets on gannetries at nesting time into five categories: (1) breeding pairs; (2) non-breeding nest owners; (3) non-breeding site owners; (4) casuals; and (5) club birds.

Our experience that aerial photographs are the best way to assess gannet populations has been confirmed by other research workers. Nettleship (1976) found that aerial photography is the most satisfactory method for population analysis, provided the camera is about 550-600 m from the colony. However, since only attended sites are counted, the assessment of a "... breeding population represents the number of nest-site holders rather than the number of true breeders."

The work of Wanless *et al.* (1982) on cliff-nesting seabirds in Orkney shows the difficulties in determining correct numbers of birds due to natural fluctuations in the location of nests and technical difficulties in sampling. The latter applies less to New Zealand gannets, whose nesting colonies are mostly on flat terrain.

Fleming & Wodzicki (1952) assessed the New Zealand gannet population as nesting pairs, using a mixture of ground counts, aerial

TABLE 2 — Census results for breeding colonies

Gannetry	1946/47 A	Pairs 1969/70 B	1980/81 C	Percentage A/B	Difference Census B/C	Between A/C	Mean Differences A/B	Annual Between B/C	Percentage Census A/C
Three Kings									
South West Island	824	804	1135	-2	41	38	-0.1	3.2	1.0
Hinemoa Rock, Princes Islands	1520	3232	4136	113	281	172	3.3	2.3	3.0
Hole-in-the-Wall Rock, Princes Is.	490	618	1530	26	148	212	1.0	8.6	3.4
Tutanekai Rock, Princes Islands	300	406	402	35	-1	34	1.3	-0.1	0.9
Arbutus Rock	1000	2175	2652	118	22	165	3.4	1.8	2.9
	4134	7235	9855	75	35	138	-2.1	2.9	2.6
Poor Knights Islands									
High Peak Rocks	100	528	1553	428	191	1453	7.5	10.3	8.4
Sugarloaf Rock	1410	2462	2617	75	6	86	2.5	0.5	1.8
	1510	2990	4170	98	39	176	3.0	3.1	3.0
Mokohinau Islands									
Cathedral Rocks	12	49	344	308	602	2767	6.3	19.4	10.4
Great Barrier Islands									
Manukū Island	325	1869	2681	475	43	725	7.9	3.3	6.4
Colville (Coromandel Peninsula)									
Double Island	5	est. 50	96	-	-	1820	-	-	9.1
Bush Island	1513	2834	3530	87	25	133	2.8	2.0	2.5
Motutakapu	288	777	925	170	19	221	4.4	1.6	3.5
	1806	3661	4551	103	24	152	3.1	2.0	2.8
Moruhopy Rock	1228	2526	2647	106	5	116	3.2	0.4	2.3
Muriwai									
Gaia Island	338	892	761	164	-15	125	4.3	-1.5	2.4
Muriwai Stagk	-	-	298	-	-	-	-	-	-
	338	892	1059	164	19	213	4.3	1.6	3.4
White Island									
West Point	1254	1419	1550	13	9	24	0.5	0.8	0.6
Rocky Point	1408	1615	1257	15	-22	-11	0.6	-2.3	-0.3
Gannet Point	2565	3679	3986	43	8	55	1.6	0.7	1.3
	5227	6713	6793	28	1	30	1.1	0.1	0.6

TABLE 2 — Census results for breeding colonies (contd.)

	1946/47 A	Pairs 1969/70 B	1980/81 C	Percentage A/B	Difference Censuses B/C	Between A/C	Mean Differences A/B	Annual Between B/C	Percentage Censuses A/C
Kawhia									
Gannet Island (Karewa)	3715	6132	8003	65	31	115	2.2	2.5	2.3
Tolaga Bay									
Moutara Rock		467	611	-	31	-	-	2.5	-
Cape Kidnappers									
Black Reef and Mainland	263	1579	1821	500	15	592	8.1	1.3	5.9
Cape Kidnappers Saddle	2337	2705	2200	16	-19	-6	0.6	-1.9	-0.1
Kidnappers Plateau	160	929	1165	481	25	628	8.0	2.1	6.0
	2760	5213	5186	89	-1	88	2.8	-0.1	1.9
Marlborough Sounds	-	-	33	-	-	-	-	-	-
Otago									
Nuggets	40	10	9	-75	-10	-78	-6.2	-1.0	-4.5
Foveaux Strait									
Little Solander Island	20	17	62	-15	265	210	-0.7	12.5	3.4
	21 115	37 774	46 004	79	22	118	2.6	1.8	2.3

FOOTNOTE. Fleming and Wodzicki (1952) give the census total for 1946/47 incorrectly as 21 033 instead of 21 131. In this paper Cathedral Rocks has been added and Cape Karikari deleted from the list of breeding colonies giving the total of 21 115.

photographs, and qualified estimates. In conclusion, they accepted that there was a large margin of error with a possible range in the population counts from 18 000 to 24 000 pairs. They suggested that the number of birds on a gannetry is subject to inter- and intra-seasonal fluctuations and that there were several sources of error in the actual counting of gannets, depending on the method used.

Waghorn (1982), after three years of observation at the Bush Island gannetry, showed that gannet numbers fluctuated greatly. She found that the largest number of gannets during the day occurs at about 0600 hours. With intra-seasonal fluctuations, the number of gannets at a breeding colony depends on the phase of the breeding cycle. Gannets arrive at the breeding colony from June to August and the numbers increase as pair formation and nesting take place. The numbers reach a peak around laying time and decline when fledging begins. With inter-seasonal fluctuations, Waghorn found that, for the three breeding seasons 1978/79-1980/81 at Bush Island, the earliest and latest median laying dates were 34 days apart. Similar continuing observations of intra- and inter-seasonal variation have been made at the Cape Kidnappers Group since 1959 (C. J. R. Robertson, unpubl.).

It is also known that young birds, before reaching site-holding or breeding age, spend part of each season as casual, club or roosting birds. Although they do not belong to the nesting population it is usually impossible to determine the nesting or roosting status of a bird recorded on a site from an aerial photograph (Robertson, unpubl.).

These data, with inter- and intra-seasonal material from Cape Kidnappers, are still being analysed in an attempt to determine the correlation between sites recorded on aerial photographs and the likely breeding population at a gannetry.

Excluded from the censuses are the large numbers of immature birds which disperse across the Tasman to Australia. It is known that New Zealand gannets can remain in Australian waters until they are 5 years old but may return at the age of 2 or 3 years (Wodzicki 1967b and Robertson, unpubl.). Therefore, a substantial proportion of the total gannet population lives temporarily away from the nesting colonies and is excluded from censuses.

### *Distribution of gannetries and roosts*

New Zealand gannetries are located between 32°S and 47°S and the recorded roosts between 34°S and 40°S. However, examining the distribution of gannetries, we find that in 1980/81 only 104 pairs were in the South Island compared with 45 900 pairs counted in the 23 gannetries in the North Island. We hope that an investigation of gannet food based on collections made in 1981/82 and 1982/83 may help explain the distribution of gannetries in New Zealand. (D. A. Robertson, Fisheries Research Division, Ministry of Agriculture and Fisheries, is currently studying the relationship between gannet feeding and the distribution and numbers of gannets in New Zealand).



Crawford & Shelton (1978) have shown that the distribution and abundance of the Cape Gannet is determined by the availability of pelagic fish.

Note that most roosts lie within the area of the largest concentration of gannet nesting places and that few roosts have been recorded from the South Island. It is also of interest to note that the distance of a roost from the nearest gannetry ranges from 10 to 140 km. The Marineland gannet colony, Napier, is a new development, showing that gannets can live and breed in semi-captivity on land in a man-made environment.

#### *The three censuses compared*

Although the distribution of gannets in New Zealand has altered little, the number of gannetries and the number of birds in individual colonies have changed. In 1980/81 the 26 gannetries ranged in numbers from 9 pairs (Nuggets, Otago) to 8003 pairs (Gannet Island, Kawhia). During the 34 years covered by the censuses, one new gannetry (High Peak Rocks, Poor Knights Islands) was established between 1946/47 and 1969/70 and two new natural gannetries (Muriwai Stack and Marlborough Sounds) between 1969/70 and 1980/81. A further gannetry has been established at Farewell Spit since the last census. No established gannetry disappeared, but five gannetries showed a decrease in numbers between 1969/70 and 1980/81 (Table 2). However, this is more than compensated for by 19 gannetries showing an increase in numbers.

Because the 1946/47 census was only partly based on aerial photographs the three censuses can be compared only in general terms. Figure 6 shows substantial differences in the growth of various colonies between 1946/47 and 1980/81. They range between the West Point gannetry, White Island (0.6% annual increase) to the Cathedral Rocks gannetry, Mokohinau Island (10.4% annual increase). The mean annual rate of increase for the whole New Zealand gannet population between 1946/47 and 1980/81 was 2.3%.

The annual growth rate from 1969/70 to 1980/81 shows certain trends overall or at particular gannetries:

1. The weight of the population has shifted northward slightly with a greater proportion being north of 37°S in 1980/81 than in 1969/70.
2. The most northerly gannetries, containing about 50% of the total population, are increasing at a rate above the national average.
3. Certain gannetries are increasing at rates above 3% p.a., which suggests that immigration has contributed to the increase. This trend has occurred at South West Island and Hole-in-the-Wall (Three Kings), High Peak Rocks (Poor Knights), Mokohinau and Great Barrier Islands.

4. Some gannetries may have become exporters, the available nesting space being fully occupied. Examples where this may have occurred are Oaia Island (Muriwai) and Rocky Point (White Island).

Another important factor to consider in assessing the gannet population is the movement of gannets to new or recently established colonies. The decrease in numbers at the Oaia Island colony, Muriwai, between 1969/70 and 1980/81 coincided with the establishment of the nearby Muriwai Stack colony. Such movements emphasise the need for all colonies to be counted in the one season.

Some gannetries such as the Northwest Pinnacle of the High Peak Rocks, Poor Knights Islands and Cathedral Rocks, Mokohinau Islands, have shown great increases of 1028% and 602% respectively between 1969/70 and 1980/81. It is suggested that such large increases in population numbers are due to immigration. An increase of similar magnitude was seen in the Funk Island gannetry, Newfoundland, where the number of North Atlantic Gannets rose from seven nesting pairs in 1936 to about 3000 pairs in 1959. This increase was attributed to immigration from other colonies, corresponding to a sharp rise in mackerel stocks in the area (Montevocchi *et al.* 1980).

An example of the long-term growth of a gannet population based on the three censuses in the three Cape Kidnappers gannetries

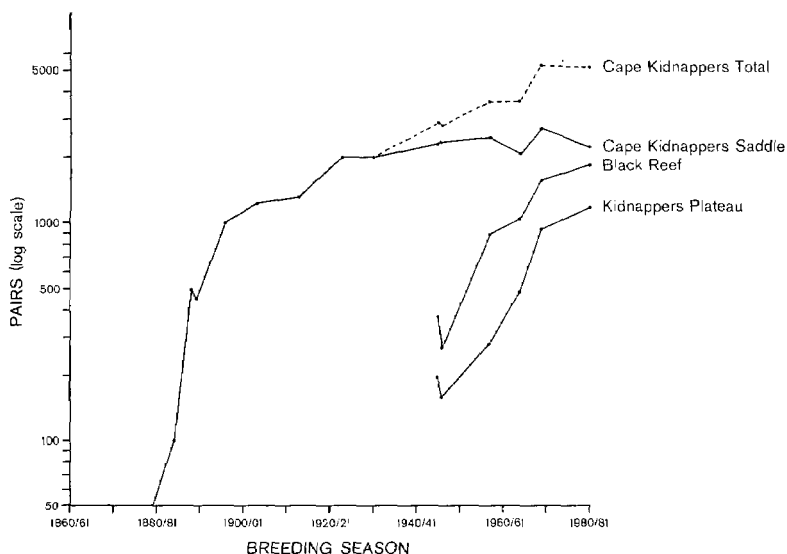


FIGURE 7 — Changes in gannet numbers at Cape Kidnappers over the past century

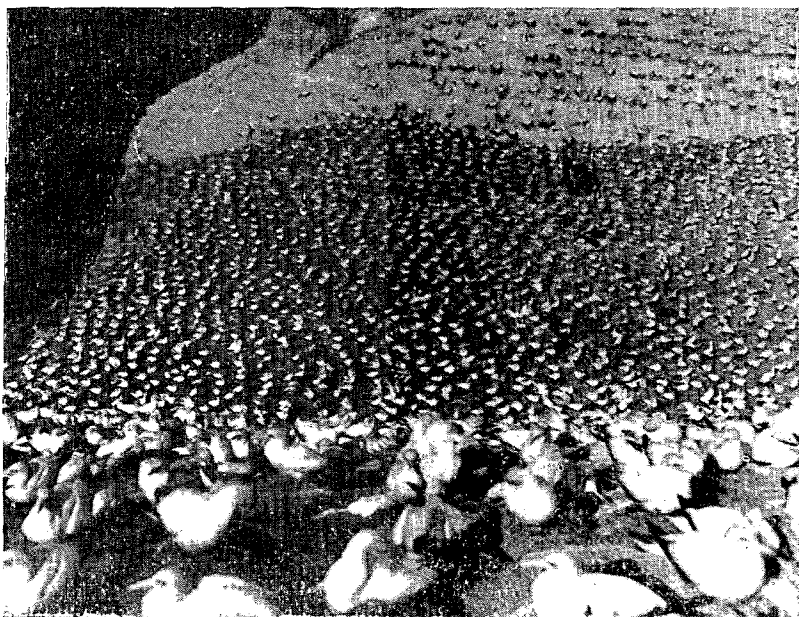


FIGURE 8 — Part of the Saddle colony at Cape Kidnappers, an example of a typical flat gannetry in December 1945

(Courtesy of Ecology Division, DSIR)

is shown in Figure 7. Both the Plateau and the Black Reef gannetries have grown steadily but the Saddle gannetry has remained steady, and even declined, recently, perhaps partly because erosion has forced gannets to abandon the seaward and landward slopes or possibly because of a preference for nesting on flat ground (Fig. 8 and 9).

#### *Comparison with gannets elsewhere*

Because the Cape Gannet and the North Atlantic Gannet have not been counted by repeated large-scale censuses similar to those done in New Zealand, and because the methods of counting have varied, we can draw comparisons between gannets in New Zealand and the other two gannet species only in broad terms.

Between 1956 and 1978 the total Cape Gannet population decreased from approximately 221 000 to 186 000 adult birds (Crawford & Shelton 1981). The development of the inshore fishing industry, the destruction of gannets by fishermen and the loss of nesting sites because of guano collecting have been linked with the decline of the Cape Gannet (Jarvis 1971, Nelson 1978).

In 1976 the world population of the North Atlantic Gannet was 213 000 site-occupying pairs (Nelson 1978). In Canada, gannet colonies at Funk Island, Cape St Mary's, and Bird Rocks, Magdalen Island, have increased or remained unchanged in numbers. Two other colonies (Bonaventure Island and Gullcliff Bay, Quebec) have declined in numbers since 1969 (Nettleship 1975, 1976). Nettleship suggested that contamination by toxic chemicals was a prime cause of this decline.

A comparable census undertaken for the Australasian Gannet in Australia during 1980 and 1981 gave a total of 6660 pairs (C. J. R. Robertson, unpubl.). However, historical data are sparse for some of the seven breeding colonies and at least one was severely endangered by predation. The Cat Island gannetry near Tasmania showed a drastic reduction from 5000-10 000 birds in 1908 to a population of 14 adults and six chicks in 1977 and 12 pairs in 1980. This appalling decrease has been attributed to predation and vandalism by fishermen and others (Warham & Serventy 1978). The Lawrence Rocks gannetry has increased at a similar rate to the trend in New Zealand over the past 20 years (C. J. R. Robertson, unpubl.).

Gannets elsewhere have mostly been counted by techniques different from those used in New Zealand. Nelson (1978) estimated an increase over the period 1939-1969 for the North Atlantic Gannet cf from 2.4% p.a. to 3.4% p.a. This compares with the New Zealand

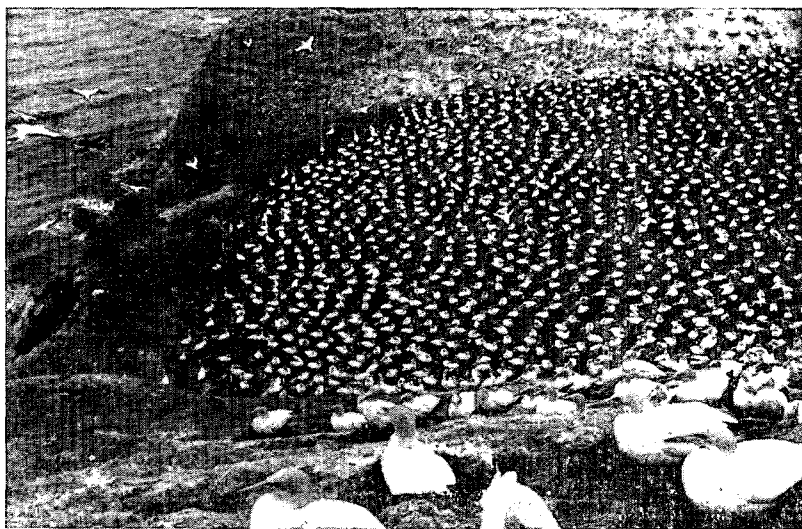


FIGURE 9 — Same view of the Saddle colony in November 1983 showing abandonment of the northern edge by gannets

(Courtesy of L. S. Davis)

increase of 79% (2.5% p.a.) between 1946/47 and 1969/70 and 22% (1.8% p.a.) between 1969/70 and 1980/81. The increase from 21 115 pairs in 1946/47 to 46 004 pairs in 1980/81 gives New Zealand gannets a mean increase of 2.3% p.a.

Both Nettleship's work and our data show that aerial photographs are the most exact direct method of censusing. However, until specific methods for assessing the effect of population variables on counts caused by diurnal, intra-seasonal and inter-seasonal fluctuations and the numbers of roosting and non-breeding site-holders, aerial photographs cannot be used directly to determine the breeding population.

Summing up, we find that the populations of Australasian Gannets in Australia and Cape Gannets in South Africa have been, or still are, affected by human predation. The North Atlantic Gannet, which, in the British Isles, is recovering after a long history of predation by man, may be increasingly vulnerable throughout its range to contamination by toxic chemicals. It appears that the Australasian Gannet population in New Zealand is perhaps the only one that is thriving and is largely free from human interference.

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