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Breeding Seabirds of Gambier Islands, Eastern Polynesia: Numbers and Changes during the 20th Century

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Summary: We report numbers and distributions of the breeding seabird community of the Gambier Islands (Eastern Polynesia, South Pacific Ocean), obtained in 1995 and 1996. Comparing these data with those collected in 1922, 1965–69 and 1971, we assess the extent of changes in distribution and numbers of seabirds. None of the 14 species recorded previously to 1995–96 has disappeared, but numbers and ranges of all the tern species have decreased. Breeding of three additional species (*Pterodroma* spp.) has

been discovered or confirmed in 1995–96, though their numbers are very small. We also identified an unknown *Cookilaria* petrel, of which a wing was collected in 1922 on Mangareva, but which was not recorded later. Although seabird diversity on Gambier Islands is high, no species breeds in large numbers. Indeed, several species have tiny population sizes, and concern is therefore expressed for the future of this seabird community.

Data on seabirds in Eastern Polynesia are scanty, owing to the difficulties of reaching the 141 main island groups, which are spread over more than 4 000 000 km². Moreover, no breeding site has been monitored regularly during the 20th century. Information related to seabirds comes from a few expeditions mostly led by natural history museums (see Holyoak & Thibault 1982 for details): in the 1920s by the Whitney South Sea Expedition for the American Museum of Natural History, New York (account in several issues of *American Museum Novitates*); in the 1960s by the Muséum National d'Histoire Naturelle (Lacan & Mouglin 1974); in the 1970s by the École Pratique des Hautes Études (Holyoak & Thibault 1984); and since 1980 by several institutions and the Government of French Polynesia (e.g. Thibault & Varney 1991; Brooke 1995). The aims of this paper are to present comparative data on numbers and distribution of breeding seabirds of the Gambier Islands during the 20th century, using results from previous expeditions as well as recent data collected in 1995 and 1996.

Study area and methods

The Gambier archipelago (23°03'S, 135°W) is located in the subtropical Pacific Ocean, south of the Tuamotu archipelago. It consists of 21 islands and islets, covering overall c. 2550 ha and is approximately half way between Australia and South America (Fig. 1). A reef barrier with several coral islets closes the north and east

of the lagoon, but the lagoon is open to the ocean in the south. Mangareva, the largest island, covers 1540 ha and rises to 441 m (Mt Duff) and 425 m (Mt Mokoto). The human population was estimated at 620 in 1988 (Anon. 1993).

Historical information comes from: (1) Journals of Ernest Quayle and Rollo H. Beck (lodged at the American Museum Natural History, New York) written during the Whitney South Sea Expedition (WSSE). They visited the Gambier Is. from 27 April to 11 May 1922 (Bryan MS). Quayle visited most islets and Beck the mountains of Mangareva; (2) The Mangarevian Expedition (Emory 1939); (3) Lacan & Mouglin (1974), and unpublished data (Lacan & Mouglin MS) collected in November 1965, May 1966, April 1967, April 1968 and April 1969 for the Muséum National d'Histoire Naturelle; most islands and islets were visited; (4) Thibault (1973) visited the Gambier Islands from 28 July to 10 August 1971 (mainly Mangareva, coral islets and Motu Teiku); and (5) finally, specimens collected here by the WSSE were examined at the American Museum of Natural History, New York in March 1997; where these sources have not been published, but are available, they are listed in the references as, for example, Beck MS.

We visited the archipelago twice, from 13 to 27 December 1995 (VB) and from 25 July to 11 August 1996 (JCT), visiting most islands and islets by day and night (only Taravai, Kamaka and the northern-most coral islets could not be visited). Diurnal seabird numbers

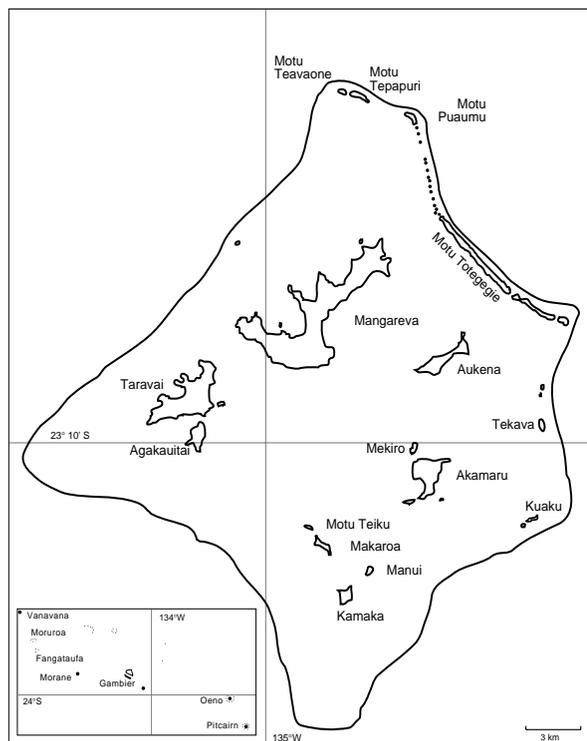


Figure 1 Gambier archipelago, central Pacific Ocean.

were estimated by counting nests with egg or chick to give the total adult population on the island. Burrow-dwelling petrels and White Terns were estimated using plots (c. 1000 m²) when possible, the number of breeding pairs were then estimated on the basis of the total area available for the birds. However, it was not always possible to use plots, due to the topography and heterogeneity of islets, which include some very steep areas. When neither plots or transects could be established, estimates of breeding population were extrapolated from aerial activity (Christmas and Audubon's Shearwaters) at dusk or from calling activity at night. On elevated islands (i.e. Mangareva, Makaroa and Akamaru), nocturnal petrels breed in small numbers and on cliffs, and populations were estimated by localising and counting calling birds. We also counted landed birds at night (Manui and Teiku). Overall, we feel that our estimates should be considered as minimal estimates rather than absolute numbers.

Results

Species accounts (see Table 1)

Tahiti Petrel *Pseudobulweria rostrata*

First recorded in 1995; probably missed by previous observers owing to the small population size. Mangareva: up to nine birds calling simultaneously, and ten pairs estimated, on cliffs or just beneath cliffs of Mt Duff but not recorded on Mt Mokoto. Akamaru: three birds calling simultaneously, 1-3 pairs estimated on north side of the islet. Manui: two birds calling, 1-3 pairs estimated.

Tahiti Petrels were previously unknown in this area, even at sea. This new locality is c. 2000 km away from the breeding distribution of this little-known species. Calls differ between the subspecies *rostrata* and *trouesarti* (Bretagnolle et al. 1998; VB unpubl. data), which argues for their taxonomic distinction (de Naurois & Erard 1979; Bretagnolle et al. 1998). Vocalisations from the birds of the Gambier suggested that they belong to the taxon *rostrata*. A genetic survey has shown also that birds from the Gambier and Tahiti were more similar to each other than either is to those of New Caledonia (Bretagnolle et al. 1998). Birds from Gambier represent the southernmost and easternmost population of this species.

Herald Petrel *Pterodroma arminjoniana/heraldica*

On 10 May 1922, visiting Mangareva, R. Beck (MS) wrote 'I saw a pair of Ducie shearwaters over the peak here in a strong wind seeking a nesting site', but he did not identify the birds definitely or collect any specimens. In early May 1966 and at the end of April 1967 Lacan & Mougin (MS) saw single birds on the ridges of Mangareva. In July 1971, numbers of Herald Petrels were estimated at less than 40 on Mangareva and c. 10 on Akamaru. However, no nest was found (Thibault 1973). In 1996 breeding was proved for the first time, the number being estimated at 62-98 pairs on Mangareva, and 15-20 pairs on Akamaru. We could not confirm its breeding on Taravai where inhabitants described vocalisations of a diurnal petrel to E. Quayle (MS). They breed on cliff ledges on the southern side of Mt Duff and Mt Mokoto, and also under ferns and in open holes on their northern slopes.

Recently, Brooke & Rowe (1996) split *P. arminjoniana* into two species on Henderson Island, the black form being *P. atrata* and the light form *P. heraldica*. Black, light and intermediate morphs, however, were

Table 1 Numbers of pairs and trends of breeding seabirds on Gambier Islands.

Species	Number in 1995–96	Number of localities	Trend in 20th century
<i>Pseudobulweria rostrata</i>	12-26	3	Unknown, stable?
<i>Pterodroma arminjoniana</i>	77-118	2	Unknown, stable?
<i>Pt. ultima</i>	5-10	1	Unknown, stable?
<i>Puffinus pacificus</i>	60-85	2	Probably stable
<i>Pu. nativitatis</i>	450-850	2	Probably stable
<i>Pu. lherminieri</i>	660-1085	6	Probably stable
<i>Nesofregetta fuliginosa</i>	200-500	2	Unknown, possibly extinct on 1-2 localities (see Text)
<i>Phaethon rubricauda</i>	1-2	1-2	—
<i>Ph. lepturus</i>	15-22	2-5	Probably stable
<i>Sula leucogaster</i>	3-5	1	Stable
<i>Procelsterna cerula</i>	60-123	3-4	Possible decrease on Manui; extinct on Mangareva
<i>Anous stolidus</i>	150-242	5-6	Seems to be decreasing on Manui; extinct on three coral islets
<i>A. minutus</i>	< 50	1	Extinct on two coral islets
<i>Gygis alba</i>	< 600	7-8	Extinct on three coral islets

present in the Gambier (black morph = 13.6%, light and intermediate = 86.4%, $n = 44$), as they are on Marquesas (J-CT & VB unpubl. data). In these two localities, we saw mixed pairs, a situation that apparently does not occur on Henderson (Brooke & Rowe 1996). Before the taxonomic status of *P. arminjoniana/heraldica* is fully elucidated in the Pacific, we prefer to use both names for the birds present on Mangareva.

Murphy's Petrel *Pterodroma ultima*

Recorded previously only in flight, in November 1965 at Manui (Lacan & Mougin MS), and July and August 1971 at Tekava and Totegegie respectively (Thibault 1973). None were observed in December 1995, but in 1996, proof of breeding was obtained on Manui and numbers were estimated at 5-10 pairs. They were breeding at the top of the islet under tussocks of grass on eastern slope and under groves of *Pisonia*.

Murphy's Petrel is rare over its breeding range, except on Ducie (Brooke 1995).

Wedge-tailed Shearwater *Puffinus pacificus*

Mangareva: not recorded before December 1995 when fewer than ten pairs (six calling birds simultaneously) were localised on Mt Duff. Manui: four juveniles collected on 8 May 1922 by WSSE; present in 1965–68 (Lacan & Mougin MS), but no estimate; in December 1995, number estimated at a minimum of 25 pairs, most of them breeding at the summit in burrows shared with rabbits. Quayle (MS) obtained feathers attributed to this species or to *Pu. nativitatis* on Agakautai but no birds were recorded in December 1995. Lacan & Mougin (1974) considered that it also bred on Makaraoa, but we failed to find any in 1995.

Christmas Shearwater *Puffinus nativitatis*

Manui: 3 adults and one chick collected on 8 May 1922 by WWSE; several tens of pairs in November 1965, according to Lacan & Mougin (MS); number estimated at 100 pairs in 1995. Motu Teiku: breeder and 14 specimens collected on 4 May 1922 by WSSE; several tens of pairs in 1965, Lacan & Mougin (MS); number estimated at more than 100 pairs in 1995. Makaraoa: breeder and five specimens collected on 3 May 1922, WSSE; numbers estimated at more than 250 pairs in 1995, most of them breeding on cliffs. Quayle (MS) obtained feathers attributed to this species or *Pu. pacificus* on Agakautai but no birds were recorded in December 1995. Breeding on Kamaka (T. Reasiu pers. comm.) needs to be confirmed.

Audubon's Shearwater *Puffinus lherminieri*

Motu Teiku: breeding, 14 specimens collected on 4 May 1922 by WSSE; $c.$ 100 pairs estimated in November 1965, Lacan & Mougin (MS); number estimated at more than 300 pairs in December 1995, as well as in July 1996. Manui: breeder and six specimens collected on 4 May 1922 by WSSE; several tens of pairs recorded in 1965–68, Lacan & Mougin (MS); number estimated at 500 pairs in December 1995. Mangareva: first recorded in 1995–96 when ten adults were calling simultaneously at dusk on Mt Duff. Estimated at 10–20 pairs on Mt Duff and 5–10 pairs at Mt Mokoto. Makaraoa: five specimens collected on 3 and 8 May 1922; breeder in May 1966, Lacan & Mougin (MS); number estimated at 50 pairs in December 1995. Akamaru: first recorded in 1995 when 3–5 pairs were calling. Kamaka: heard at night on 5 May 1922, Quayle MS; breeder according to T. Reasiu (pers.

comm). Agakaitai: possible breeder according to Quayle (MS), but absent in December 1995. Status unknown on Taravai. On Motu Teiku and Manui, it breeds mostly in burrows in deep soil. Audubon's Shearwater breeds all year round on the Gambier, so population estimates at a given period are largely underestimates. Population may actually be twice that recorded.

White-throated Storm-Petrel *Nesofregatta fuliginosa*

First recorded in 1965 (Lacan & Mougin MS). Motu Teiku: c. 10 pairs in November 1965 at the end of breeding season (Lacan & Mougin MS); number estimated at 100-200 pairs in 1996. Manui: one non-breeder recorded in May 1966 (Lacan & Mougin MS); number estimated at 100-300 pairs in 1996. Breeding (misidentified, presumably, as *Fregatta grallaria*) suggested by Quayle (MS) on Agakaitai and Motu'ari on the basis of feathers and information from inhabitants, but not confirmed in 1996. It breeds mostly within tussocks of grass, more often than in burrows, but sometimes in the open.

Red-tailed Tropicbird *Phaethon rubricauda*

A rare breeding species, seldom reported: on Makarua (one pair breeding in May 1966 and April 1968; Lacan & Mougin MS) and on Manui (one pair displaying in August 1996). None observed in December 1995.

White-tailed Tropicbird *Phaethon lepturus*

Mangareva: five specimens collected in May 1922 (WSSE); one specimen collected on 19 December 1934 (Mangarevan Expedition); recorded in small numbers in 1966-67 (Lacan & Mougin MS); estimated at 10-15 pairs in 1996, breeding in cliffs (Mt Duff, Mt Mokoto and Pt. Teakaruanine). Akamaru: number estimated at 5-7 pairs in December 1995 and July 1996. Makarua: several pairs recorded in 1966 and 1968 (Lacan & Mougin MS) but not later. Also recorded, but breeding unconfirmed, on Manui (one pair in 1995), on Kamaka (4-5 individuals seen on 5 May 1922 by Quayle (MS)); regular during the 1990s (T. Reasiu pers. comm.). Aukena: (1-3 pairs in May 1922, Quayle MS). Status unknown on Taravai.

Brown Booby *Sula leucogaster*

Breeds only on Manui. Fewer than ten pairs recorded in 1965 (Lacan & Mougin MS). Three nests with eggs, one with a large chick and two empty nests in December 1995, and one nest with a large chick in August 1996.

Blue Noddy *Procelsterna cerulea*

Motu Teiku: one nest recorded in 1971 (Thibault 1973) and 1-3 pairs in July 1996; none were observed in December 1995. Makarua: two specimens collected on 3 May 1922 where noted as uncommon (Quayle MS); seen and considered as possible breeder in 1966-67 (Lacan & Mougin MS); singly in December 1995. Manui: main breeding site; one collected on 1st May 1922 (WSSE); c. 1000 in 1965 (Lacan & Mougin MS); number estimated at 50 pairs in 1995-96. Mangareva: one collected on 1 May 1922 (WSSE); possible breeder recorded in 1966-1968; not recorded latter. Kamaka: two specimens collected on 5 May 1922; 10-20 pairs in the 1990s (T. Reasiu pers. comm.).

A subspecies has been described for the population of Gambier Island (*P. c. murphyi*, Mougin & de Naurois 1981), although these birds present characters intermediate between nominate (northern populations) and *albivitta*, from Lord Howe to San Felix and San Ambrosio (Holyoak & Thibault 1984).

Brown Noddy *Anous stolidus*

Mangareva: collected in April-May 1922, but breeding numbers not reported; recorded in small numbers in 1967-68; 5-7 pairs recorded in December 1995 on cliffs of Mt Duff. Motu Teiku: numerous nests found in 1922; recorded in small numbers in 1965 and 1968; estimated at 100 pairs in 1995. Makarua: recorded in small numbers in 1966-68; estimated at 20-25 pairs in 1995. Manui: 'abundant' on 8 May 1922 (Quayle MS); several hundred breeding on ground (Lacan & Mougin MS); c. 100 nests found in December 1995. Akamaru: 5-7 pairs recorded in December 1995. Tekava: several hundred recorded in 1965 (Lacan & Mougin MS, 1974); non-breeder in 1995-96, but a few birds at roost. Kuaku: several pairs recorded in 1922 (Quayle MS), 1966-68 (Lacan & Mougin MS); non-breeder in 1995-96. Tauna: recorded in 1968 in small numbers (Lacan & Mougin MS) but not later. Taravai: several adults and one chick recorded in 1922 but not visited later.

Black Noddy *Anous minutus*

Tekava: several tens of pairs recorded in 1965-68 (Lacan & Mougin MS) and 1971 (Thibault 1973) but not later. Kuaku: several pairs in 1922 (Quayle MS) and 1966-68 (Lacan & Mougin MS) but not latter. Motu Teiku: c. ten pairs in July 1996. Manui, Makarua and Totegegigie: recorded in small numbers in 1995-96 without any proof of breeding.

White Tern *Gygis alba*

Mangareva: was breeding in moderate numbers in 1922 (Quayle MS); not abundant in 1965, but well distributed in 1968 (Lacan & Mougin MS); estimated at 50 pairs in 1996. Akamaru: uncommon in 1965 (Lacan & Mougin MS) and December 1995. Manui: abundant in 1922 (Quayle MS); several thousand birds in 1965 (Lacan & Mougin MS); estimated at c. 500 pairs in December 1995; all breeding stages. Agakautai and Makaroa: small number in 1995, less than 20 pairs on each. Kamaka: 'abundant' in 1934 (Emory 1939) but number estimated at 10–20 pairs in 1995–96. Kuaku: recorded in small number in 1922 (Quayle MS), during the 1960s (Lacan & Mougin MS), and in 1995 (where only one egg was found). Tekava: breeding in small number in 1965 (Lacan & Mougin MS) and 1971 (Thibault 1973) but not later. Tauna: breeding in small numbers in 1965 (Lacan & Mougin MS) but not later. Aukena: breeding in small number in 1922 (Quayle MS) and 1965 (Lacan & Mougin MS) but not found in December 1995. Taravai: several pairs in 1922 (Quayle MS) but not visited later.

Several other species were also recorded, extinct or possible occasional breeders. A small *Cookilaria* petrel was collected at Mangareva by Beck (MS): 'May 11. I went to top of Mangareva Island and found a body of Ducie Shearwater eaten by cat (?) on hillside, near top'. The only remains of this bird is a wing in a museum collection (AMNH, label no. 191743). It belongs to a small petrel: the wing pattern, as well as size, suggest that it is a *Cookilaria*, possibly close to *P. leucoptera*; it may represent a specimen of an extinct or an unknown population. No evidence of the presence of such a population (e.g. vocalisation) was obtained in 1995–96 during at least 10 nights on Mangareva.

Roosts of Red-footed Booby *Sula sula* were recorded at Tekava (non-breeder, Lacan & Mougin 1974), Manui (75–95 individuals in December 1995 and five in August 1996), and Makaroa (3–5 individuals in December 1995). Roosts of Great Frigate-bird *Fregata minor* were also recorded regularly in small numbers on Manui (May 1922, Quayle MS; 1965–68, Lacan & Mougin MS; 1995–96), Motu Teiku (one collected on May 1922 by Quayle MS) and Kamaka (female/immature plumage and male displaying during the 1990s, T. Reasiu pers. comm.). Crested Terns *Sterna bergii* have been regularly seen since 1922 in the lagoon but evidence of breeding is lacking; second-hand data noted

by Lacan & Mougin (MS) reported possible breeding during the 1950s at Kuaku and Vaiatekeue.

Discussion

There are no data on seabirds before the 20th century but it is likely that the avifauna of Gambier has experienced two waves of extinctions due to predation, hunting and habitat changes. First, Polynesian people arrived during, or even before, the 12th century (Belwood 1978), as in other islands of Polynesia (see Steadman 1989 for a general review, and Steadman & Olson 1984 and Wragg 1995 for nearby Henderson Island). Second, Europeans arrived in 1797 at Mangareva (Vallaux 1994) and colonised Gambier mainly during the 19th century.

During the 20th century, the seabird assemblage has remained relatively stable, including 14 species (of which seven are petrels). In particular, no species has disappeared since the WSSE visit. The only uncertainty concerns the *Cookilaria* of which a population may have gone extinct or is still to be discovered. In terms of breeding distribution, no trend can be detected during the 20th century for the Procellariiformes, except perhaps the White-throated Storm-Petrel whose breeding range has possibly decreased since the visit of the WSSE, according to second-hand information from local people concerning its past presence on two other islets (Quayle MS). Conversely, the breeding of three additional species has been confirmed in 1995–96, probably due to more intensive survey and to the timing of the visit during a season (December) when visits have not been made by previous observers. We cannot, however, definitely exclude an hypothetical immigration of Murphy's Petrel from the nearby Tuamotu atolls where it breeds in small numbers (Holyoak & Thibault 1984), or from Ducie Island (250 000 pairs estimated in 1991–92, Brooke 1995), as for Herald Petrel from Ducie or Henderson Islands, where more than 21 000 pairs breed (Brooke 1995). However, immigration seems unlikely, as it obviously is for the Tahiti Petrel of which nearest neighbour localities are Society (1750 km) or Marquesas Islands (1800 km). In contrast to petrels, a serious decline has been recently noted for all terns (noddies and White Terns) between the 1970s and the 1990s, especially for populations breeding on coral reefs (Tekava, Kuaku and Tauna). Present until the 1960s, the Blue Noddy has disappeared from the cliffs of Mangareva for no apparent reason.

If neither community diversity nor distribution have shown major changes during the 20th century, it should

be noted however that all species are present in only small numbers, ranging from a few pairs to several hundred (Table 1). We believe that the major reason is the presence, today, of many introduced species except on the two smallest islets. A relationship between decline of seabird populations and the introduction of the Black Rat *Rattus rattus* or the Norway Rat *R. norvegicus* has been shown for several species (Atkinson 1985). Petrels are endangered when their body weight is equal to or less than that of rats (Imber 1975, Moors & Atkinson 1984). Rat behaviour differs according to species, locality and density. Black Rat predation on petrels is well documented (e.g. eggs of Bonin Petrel *Pterodroma hypoleuca*, Seto & Conant 1996; chicks of Cory's Shearwater *Calonectris diomedea*, Thibault 1995). Predation by the Polynesian Rat *Rattus exulans* has been reported for adult Laysan Albatross *Diomedea immutabilis*, eggs of the Bonin Petrel (Kepler 1967), young of the Red-tailed Tropic-bird (Fleet 1972), eggs (Imber 1984) and newly hatched chicks of gadfly petrels (Brooke 1995), and eggs of the Little Shearwater (Booth et al. 1996).

Available data on introduced animals are presented in Table 2. A relationship between presence of rats and distribution of breeding sites is evident only for the White-throated Storm-Petrel: it is now strictly restricted to rat-free islands (Manui and Motu Teiko). These sites

also hold the highest numbers of Audubon's Shearwater. Distribution of storm-petrels, restricted only to small and isolated islets where Polynesian Rats are absent, is a situation existing elsewhere in Polynesia (e.g. islets off Rapa, Thibault & Varney 1991). But the presence of Polynesian Rats may not limit range and numbers of larger bodied species. This is the case for the Christmas Shearwater on Makaroa, where, however, they only breed in cliffs. Similarly, on Mangareva, where Black Rat and Polynesian Rat have been introduced, Procellariiformes are mostly restricted to inaccessible cliffs. Predation by rats on eggs of Herald Petrel on the slopes of Mt Mokoto and Mt Duff is likely to limit successful breeding to a few sites.

All tern populations have decreased both in range and in numbers, and it seems that the main cause of this decline on coral islets is the introduction of cats *Felis catus* during the 1980–90s to preserve coconut groves against rats. The only exception within the terns is the recent recolonisation of Kamaka by the Blue Noddy (*T. Reasiu* pers. comm.) after eradication of cats. Goats *Capra hircus* disturb the breeding seabirds; more importantly, their presence leads to over-grazing (Daly & Goriup 1987), creating poor conditions in the long run for the petrels that breed in burrows. Forests vanished from all high islands, probably a long time ago; photographs taken by the WSSE show similar landscapes

Table 2 Introduced animals on Gambier Islands.

Island	Area (ha)	Polynesian Rat	Black Rat	Rabbit	Pig	Goat	Cattle	Cat	Domestic fowl
Mangareva	1540	x	x		*, x	*, x	x	x	x
Taravai	570	—				x		—	x
Akamaru	210	x			x	x			x
Aukena	135	—				?			
Agakautai	< 50	x				x			x
Makaroa	< 50	*, x				x			
Manui	< 50			*, **, x		*, +			*, x
Kamaka	< 50	x				*, +		+	
Mekiro	< 10	?				x			
Motuo'ari	< 10	?				x			
Tekava	< 10	x						x	**
Tauna	< 10	—						—	
Kuaku	< 10	—						—	

Recorded by: *, WSSE; **, Lacan & Mouglin (MS); x, in 1995–96. +, extinct in 1995–96 but present before; —, presence suspected in 1995–96; ?, presence unknown.

on Mangareva as those found today. Similarly, Manui presents clear marks of soil erosion due to overgrazing by rabbits *Oryctolagus cuniculus*, even if they are not numerous. Consequences of the introduction of domestic fowl *Gallus gallus* are not documented (Long 1981) but their presence on a small islet (Manui) might be compared to the threat to seabirds represented by the Weka *Gallirallus australis* (Atkinson & Bell 1973) (e.g. predation of White-throated Storm-Petrels).

Given the very small population sizes of many seabird species on the Gambier archipelago, with apparently safe populations on only two small islets, we believe that the situation of all seabirds of Gambier Islands might be improved by eradication of rats from southern islets (Makaroa and Kamaka), domestic fowl and rabbits from Manui, cats from coral islets and goats from volcanic islets. Control of rats in breeding areas of Herald Petrel on the ridges of Mangareva should be considered.

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