

## Shorebird numbers and nesting habits on the Chatham Islands

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**Abstract** Nesting pairs of brown skuas (*Catharacta lonnbergi*), black-backed gulls (*Larus dominicanus*), red-billed gulls (*Larus novaehollandiae*), white-fronted terns (*Sterna striata*), Chatham Island oystercatchers (*Haematopus chathamensis*) and shore plovers (*Thinornis novaeseelandiae*) were counted during 10 seasons on Rangatira (South East) and Mangere islands of the Chatham Islands. It was concluded that the small numbers of skuas, oystercatchers, and shore plovers on the islands was a result of habitat shortage, but that populations of the colonially-breeding gull and tern were constrained by food limitation in the surrounding seas. Whereas skuas, black-backed gulls, and terns nested in the open with conspicuous nests the other shore species on the islands had concealed nests. Comparison with nesting on Chatham Island, the New Zealand mainland, and subantarctic islands suggested that concealed nesting by red-billed gulls, oystercatchers, and shore plovers was most likely in response to the presence on the islands of the predacious brown skua.

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### INTRODUCTION

Breeding dispersion in birds, from the regular spacing of all-purpose territories to the extreme clumping of colonial species, is held to be largely determined by the distribution of resources, of which food is generally the most significant. Solitary breeding develops where the resource is defensible, colonial breeding occurs where the food is widely distributed, unpredictable and not able to be defended (Brown 1964; Brown & Orians 1970). Superimposed on this broad, resource-determined pattern are secondary factors. Nest and brood predation is correlated with nest site selection and the degree that the nest is protected and defended (Crook 1965; Wittenberger & Hunt 1985). Nest predation is recognised as a strong selective factor in the nesting habits of birds (Nilsson 1984; Martin 1988, 1993a, b). Nest predation hypotheses (e.g., Lack 1968: 4) relating breeding dispersion and nesting behaviour to predation pressure are implicit in all accounts of nesting biology: for predicting whether nests are concealed or in the open, solitary or colonial, on accessible or inaccessible sites.

Gull (*Larus* spp.) and tern (*Sterna* spp.) colonies occur where nesting areas and locally abundant food

occur together during the breeding season (Lack 1968; Gotmark 1982; Furness & Birkhead 1984; Hunt & Schneider 1987). This has been demonstrated most clearly in New Zealand for red-billed gulls (*Larus novaehollandiae*), in which all the large colonies are associated with local upwellings providing predictable enrichment of plankton resources during summer (Mills 1969). The numbers and distribution of gull and tern colonies on Chatham Islands are likely, therefore, to reflect the availability of local food, rather than its general availability within the immensity of the oceans surrounding these isolated islands. Surveys of the distribution of red-billed gull colonies in the New Zealand region revealed a second generality. Whereas colonies on the mainland of New Zealand were on open, bare sites with the nests in compact aggregations, in the Stewart and subantarctic islands they "nest singly and in concealed situations — under overhanging shrubs or ledges, or in clefts or caves" (Gurr & Kinsky 1965: 223). These authors considered that this different nesting dispersion and habit was a result of the presence on these islands of brown skuas (*Catharacta lonnbergi*). Alternatively, it is possible that the birds nest in these places because they lack suitable open sites, or that they nest in this way to avoid bad weather.

The Chatham Islands provide a good testing ground for distinguishing between these hypotheses. As Table 1 demonstrates, direct comparison between

**Table 1** Protected nesting: climate, topography, predators, egg predators, and “blunderers” on Chatham, Rangatira, and Mangere Islands, Chatham group. Species names: Australasian harrier, *Circus approximans*; black-backed gull, *Larus dominicanus*; blue penguin, *Eudyptula minor*; brown skua, *Catharacta lonnbergi*; brush-tailed possum, *Trichosurus vulpecula*; cat, *Felis catus*; cattle, *Bos taurus*; dog, *Canis familiaris*; house mouse, *Mus musculus*; human, *Homo sapiens*; New Zealand fur seal, *Arctocephalus forsteri*; Norway rat, *Rattus norvegicus*; Pacific rat, *R. exulans*\*\*; pig, *Sus scrofa*; sheep, *Ovis aries*; ship rat, *R. rattus*; weka, *Gallirallus australis*. Notes: \*, from Thompson (1983); \*\*, *R. exulans* is currently in low numbers and probably has little impact on shorebirds.

Island	Characteristics				
	Weather	Coastal topography	Predators	Egg predators/disturbers	“Blunderers”
Chatham	Windy, cloudy, marked by rapid changes Mean wind speed c. 26 km h <sup>-1</sup> Mean summer temperature 18°C*	Cliffs Rocky shores Boulder beaches Sandy beaches	Cat Dog Norway rat Ship rat Pacific rat House mouse Pig Possum Human	Black-backed gull Weka Australasian harrier	Sheep Cattle Blue penguin
Rangatira	Similar	Cliffs Rocky shores Boulder beaches	-	Black-backed gull Brown skua Australasian harrier	Fur seal Blue penguin
Mangere	Similar	Cliffs Rocky shores Boulder beaches	-	Black-backed gull Brown skua Australasian harrier	Blue penguin

nesting habits on Rangatira and Mangere islands with those on Chatham Island should allow discrimination between predation and habitat effects on nest site selection. Chatham has a range of mammalian predators (and the introduced predacious, flightless, introduced buff weka (*Gallirallus australis hectori*), which are all absent from the 2 southern islands, which both have substantial breeding and non-breeding populations of brown skuas. All 3 islands have blue penguins (*Eudyptula minor*) as a 'blunderer' species which may well disturb nesting shorebirds, and Rangatira has fur seals (*Arctocephalus forsteri*), but larger animals in this category are found only on Chatham. Although Australasian harriers (*Circus approximans*) occur on Chatham and the surrounding islands they have little impact as a predator on shorebirds on either Mangere or Rangatira. Harriers regularly visit Rangatira but breeding skuas keep them well away from the coastline, and their foraging is confined to the central forested area. They are rarely seen on Mangere. In contrast to faunal differences, weather and oceanic conditions are very similar throughout the Chathams.

With 2 exceptions, the 3 islands have the same suite of nesting shorebirds. All 3 have breeding colonies of black-backed gull (*Larus dominicanus*), red-billed gull, white-fronted tern (*Sterna striata*), and Chatham Island oystercatcher (*Haematopus chathamensis*). Exceptionally, skuas are confined to Mangere and Rangatira islands, and the shore plover (*Thinornis novaeseelandiae*) is found only on Rangatira Island.

This paper has 2 aims: to provide information on shorebird breeding numbers on 2 of the main bird islands of the Chatham group and to examine whether the unusual nesting habits of some of the species on Mangere and Rangatira islands have been determined, at least in part, by the occurrence there of breeding populations of the brown skua, a predator of, and scavenger on, seabirds.

## STUDY AREAS

The Chatham Islands lie between latitudes 43° and 45° south, 870 km east of the New Zealand mainland. There are 6 larger islands and many stacks and islets. The 2 largest islands, Chatham and Pitt, are farmed. Rangatira and Mangere islands lie to the east and west, respectively, of Pitt Island. Both were cleared for pastoral farming, but as reserves for the past 4 decades, are rapidly becoming reforested. Rangatira (216 ha) has 9 km of coastline of which 6.1 km of wide shore platform and boulder beach is accessible to shorebirds. The remainder is precipitous cliff. Mangere (112 ha) has a coastline of 6.3 km of which 2.6 km is suitable for shorebird breeding. Neither island has sandy beaches. All of the shorelines on both islands are exposed, in the sense of Morton & Miller (1968).

Chatham has a much wider range of shore habitats with an unbroken cliff line along the entire south coast and with extensive sand beaches punctuated by rocky headlands elsewhere. The large, brackish, Te Whanga Lagoon occupies a major proportion of the northern half of the island. Sand and shell-grit islets and limestone stacks in the lagoon are occupied by gull colonies, which can be compared with those on the 2 southern islands.

Mangere and Rangatira are 12 km apart, with Mangere, the closest of the 2 islands to Chatham, 40 km from the gull habitats surveyed in the Te Whanga Lagoon.

## METHODS

Nesting shorebirds were surveyed over 10 seasons between 1986/87 and 1995/96 on both Mangere and Rangatira as other work permitted. Surveys were done in early and mid December, over the time when chicks were hatching. Accessible coastlines were surveyed on foot, inaccessible ones and cliff faces were searched where possible with field glasses. There were very few nests on the steep cliffs of any of these islands.

The terminology describing nest sites used in this paper is adapted from Crook (1965: 194) and Alerstam & Hogstedt (1981: 188) for ground nesting species.

Accessible nests for both terrestrial and aerial predators: 1, exposed conspicuous nests (protected by active defence); 2, exposed camouflaged nests, with cryptic eggs and chicks; 3, semi-concealed nests in low vegetation or in broken terrain; and 4, protected and sheltered nests in caves, crevices, holes and burrows (nests can be located by predators but are protected by their immediate location). Inaccessible nests for terrestrial (mammalian) predators: 5, inaccessible nests on cliffs, islands, and stacks.

Nests were characterised as exposed or concealed judged on their visibility to overflying birds. Fully concealed nests were under large boulders, under vegetation, in crevices or caves. Partly concealed nests were tucked against boulders or rock faces and were visible to birds in flight from only some angles.

Attacks on adult shorebirds or nests were looked for during many hours observation from hides in skua territories which contained nesting shorebirds or were close to gull and tern colonies. For several weeks each breeding season, study of the skuas required long periods of work around the coast of both islands where any attacks would have been seen. In addition, foraging skuas were searched for at night around the coast.

Skuas are capable of killing any of the shorebirds on these islands, but their diet is almost exclusively made up of adult and nestling burrowing petrels, especially *Pachyptila vittata*, *P. turtur*, and *Pelagodroma marina*, taken mostly at night. Skuas

carry partly-eaten prey back to the nest area and searches of middens give a good idea of the food being taken. Enumerating prey numbers in middens was done each season and the range of prey tabulated. Searches in middens would record the presence of adult shorebirds, but it is unlikely that the remains of eggs or hatchlings taken by skuas would be found there.

## RESULTS

### Numbers and distribution of nesting shorebirds

There were on average during the period of this study a total of 66 skua territories on the 2 islands (Young 1999): Rangatira had on average 42 pairs and cooperative groups with some 30 non-breeding birds, totalling about 130 birds: Mangere averaged 24 pairs and groups with about 15 non-breeders, totalling about 65 birds. Skua predator impact on shorebirds depends both on the numbers of skuas and on where their territories, roosts and nests were sited. On Rangatira, 23 territories could be classed as coastal, with nesting areas overlooking the shore platform. On Mangere only 8 territories were coastal. Skuas on coastal territories are the ones most likely to be able to carry out opportunistic attacks on shorebirds within the immediate area.

The numbers of nesting terns and gulls are recorded in Table 2. For the 2 islands the maximum number of active nests for each species in any season was 41 for black-backed gulls, 54 for red-billed gulls, and 79 for white-fronted terns.

When I first counted oystercatchers on Rangatira in 1974 there were 13 breeding pairs but subsequently this number declined and during the years of these surveys there were usually no more than 5 or 6 pairs in any year. There were only 1 or 2 pairs on Mangere, nesting among boulders and drift behind a broad (200 m) shore platform on the north coast of the island. Shore plovers nest in vegetation backing the shore platform around the northern coast of Rangatira Island, and on the coast and inland on the barren ground of the south coast. Davis (1994a) recorded 39-43 pairs on the island during the years of these surveys.

The distribution of both gulls and terns has changed during the period I have been visiting these islands. On Rangatira in 1974 there were 30 or more black-backed gull nests on the Landing Point at the northern end of the island, together with 20 or more red-billed gull nests. There were also 15 red-billed gull nests in holes eroded in a low cliff immediately behind the Landing Point, and a mixed colony of red-billed gulls, white-fronted terns, and Pitt Island shags (*Stictocarbo featherstoni*) on the northern face of the north-west point (Young 1978). None of these colonies lasted to the time the current surveys began. The black-backed gulls were the least tolerant of increased

**Table 2** Numbers of black-backed gull (BBG; *Larus dominicanus*), red-billed gull (RBG; *L. novaehollandiae*), and white-fronted tern (WFT; *Sterna striata*) nests in different seasons (late November-mid December) in 1986-1996 on Rangatira, and Mangere Islands, Chatham group. -, no counts made.

Year	BBG	RBG	WFT
Rangatira Island			
1986/87	24	28	18
1987/88	-	-	-
1988/89	22	25	40
1989/90	41	17	62
1990/91	33	20	46
1991/92	28	5	8
1992/93	20	14	13
1993/94	20	8	14
1994/95	-	-	-
1995/96	28	1	7
Mangere Island			
1986/87	1	26	26
1987/88	-	-	-
1988/89	0	16	26
1989/90	0	5	17
1990/91	0	3	7
1991/92	0	3	7
1992/93	-	-	-
1993/94	-	-	-
1994/95	0	2	26
1995/96	0	7	15

human activity in this area with the establishment of the permanent research station, and were the first to leave. At the last survey there was only a single pair of these gulls nesting on the northern coast, on a tidally-isolated reef. Black-backed gull breeding during these surveys was confined solely to the south coast. At the first survey, there was 1 pair of black-backed gulls on Mangere Island, nesting among red-billed gulls and white-fronted terns on the north-western coast, but in later years there have been no black-backed gulls nesting on this island.

### Nesting habits of shorebirds on the islands

The species surveyed show a wide range of nesting habits. These are summarised in order from those in which the nests are always fully exposed in open habitats to those in which they are invariably concealed.

**BROWN SKUA** All nests were exposed, often on barren headlands and rock outcrops, on bare ground or among low vegetation. All nests were lined with grass or woody twigs, and were very obvious. Full descriptions of the nests on these islands are given in Young (1999).

**BLACK-BACKED GULL** Nests on Rangatira were on the rock slope and shore platform of the southeast and south coast, fully exposed on bare rock, often on the highest points of the dissected ridges and

gullies. They were formed of large, untidy heaps of grass and were very obvious.

**WHITE-FRONTED TERN** Nests were exposed among rock outcrops, on the ledges of rock faces or among the boulders and gravel of the upper shore line. Some nests contained a little nesting material, a few twigs, dried leaves or small pieces of *Disphyma*, but a high proportion lacked any nest material so that the eggs lay on bare rock, or within a shallow cup in sand or fine gravel.

**CHATHAM ISLAND OYSTERCATCHER** These birds nested along the inland margin of the shore platform, among boulders, on rock faces or under vegetation. Their nests were generally fully concealed from above and were found under trees or driftwood, in caves, in holes on cliffs and rock slopes or were partly concealed against a cliff or boulder. Very few over the years of the survey were found out in the open on the drifts of gravel or shell-grit that occurred at the very top of the shore platform. The nests contained little nest lining, and in gravels the nest and contents were cryptic and very hard to find.

In 1986/87 there were 11 nests. Six were fully concealed (3 in caves, 2 under trees, 1 beneath driftwood) and 5 partly concealed against a rock face or beside boulders. None in this year were in the open. One nest was spectacularly located in the back of deep cave over 6 m from the entrance, on a ledge on the back wall over 1.5 m above the cave floor. At this successful nest the chicks had to tumble from the ledge to reach the cave floor. The nests under trees were well above the open ground of the shore platform and were formed among branch and leaf debris at least 4 m inside clumps of mature *Olearia traversii*.

**RED-BILLED GULL** The numerous nests found in these surveys were in concealed sites, in holes in a rock face or under boulders or rock fall, or were partly concealed against a cliff face or ledge. None was fully exposed when viewed from above. All contained large amounts of nest material.

**SHORE PLOVER** Nests were fully concealed beneath vegetation. Many were under *Muehlenbeckia* vine where this trailed down over the rock of the upper shore platform.

The contrasting habits of red-billed gulls and white-fronted terns were very clear in their mixed colonies among fallen rock or boulders. In these colonies, the gull nests were fully protected and concealed by being beneath the rocks or boulders, with some nests up to 2 m from the open beneath fallen rock. In contrast, the tern nests were generally on the upper surfaces or on the ground among the boulders. These differences are shown for all the nests on these islands over 4 seasons in Table 3. Whereas the tern nests were distributed more or less evenly among site categories 2 - 5, most gull

**Table 3** Percentage of 141 red-billed gull (*Larus novaehollandiae*) and 237 white-fronted tern (*Sterna striata*) nests in different situations on Rangatira and Mangere Islands. Cumulative totals from 4 seasons during the period 1986/87-1991/92. Nest categories: 1, exposed conspicuous nests; 2, exposed camouflaged nests; 3, semi-concealed nests in low vegetation or in broken terrain; 4, protected and sheltered nests in caves, crevices, holes and burrows; 5, inaccessible nests to terrestrial predators on cliffs, islands and stacks.

	Nest site category				
	1	2	3	4	5
White-fronted tern	1.3	24.0	14.8	24.5	35.4
Red-billed gull	0	5.7	7.8	61.7	24.8

nests fell within the protected and inaccessible categories 4 and 5. These differences were significant ( $\chi^2 = 55.81$ ,  $df = 3$ ,  $P < 0.001$ ). Comparison confined to the accessible nests (categories 2-4) showed this difference even more strongly: 82% of gull nests were in fully concealed sites ( $\chi^2 = 49.1$ ,  $df = 2$ ,  $P < 0.001$ ).

#### Nesting habits of red-billed gulls and white-fronted terns around the shores of Te Whanga Lagoon, Chatham Island

Surveys on 17/18 December 1986 along 2 km of the western shoreline at Te Mataarae, and for > 1 km along the northern shore by the old airport at Hapupu revealed tern and gull colonies on barren offshore stacks and islets but none on the mainland. The colony at Te Mataarae was on 4 limestone stacks 40 m offshore, that at airport was over 150 m from the shore in shallow water on low, drift islands of sand and shell-grit with a sparse cover of grasses and rushes. The stacks had 24 red-billed gull nests and 1 white-fronted tern nest. All nests were on the flat upper surface of the stacks; there were no concealed nests and all had abundant nest material. They were very obvious. There were 25 gull nests on the low islands near the airport. They were all fully exposed.

#### Lack of evidence for predation by skuas on nesting shorebirds or nest contents

No records of predation by the skuas on shorebirds, or on their eggs or nestlings, were obtained during the many hours observation of skua breeding biology carried out in the course of the study of cooperative breeding in these skuas. Seven of the skua breeding groups being monitored were on the northern coast of Rangatira and any attacks on shorebirds within their territories would have been recorded, as would their bringing any of these birds to the nest area. No attacks were seen at night during any of the surveys carried

out by spotlight of skuas on coastal territories, but there was very little chance of seeing such attacks at night. There is more conclusive evidence for minimal skua predation on the shorebirds in the counts of prey in the skua middens. Over the course of the skua study more than 20,000 prey remains were checked on coastal territories. Not a single example of these shorebirds was recorded in the middens, which almost entirely comprised burrowing petrels, along with very small numbers of blue penguins.

## DISCUSSION

### Numbers of each species

The small numbers of each species breeding on Rangatira and Mangere reflect different constraints. For the shore plover and oystercatcher, the constraint is the restricted coastal habitat coupled with territorial behaviour. This has been clearly described for shore plover by Davis (1994a), but applies equally well to the oystercatcher. The other species, the gulls and terns, however, all breed colonially and have abundant sites available to them on the islands. Their low numbers, therefore, cannot be attributed to lack of breeding space. The most likely constraint for these species is food limitation, either throughout the year or more critically during the breeding season.

The red-billed gulls and white-fronted terns are the most interesting of these colonial species. Both species forage at sea during the breeding season and their abundance has been linked to local food availability — gulls, planktonic Crustacea; terns, small fish. Their small numbers on these islands are most likely, therefore, to be a consequence of food shortage during the breeding season, as hypothesised for the gulls by Gurr & Kinsky (1965) and Mills (1969). If this is true then the inshore marine ecology of these islands conforms more closely to the tropical oceanic ones described by Ashmole (1963, 1971) rather than to usually more fertile temperate ones. Alternatively, it might be that the inshore waters are indeed fertile but are usually too rough for the birds to forage easily; or that although fertile, its productivity is largely consumed by foraging petrels. Assessments of plankton number and availability coupled with the knowledge of the amounts being provided to chicks in each foraging bout could resolve this uncertainty. Of course there may well be another explanation, that these 2 species are at the southern limits of their habitat range on these islands so that their small numbers simply reflect their inability to prosper in unfavourable conditions. However, this explanation seems less likely than food shortage during breeding as both species also nest on islands further to the south.

### Nesting habits

The uncertainties clouding the discussion on numbers of each species are also apparent when attempting to deduce the impact of skua predation on nesting dispersion and behaviour. A plausible hypothesis is that the more vulnerable the species is to predation the more likely it is to have sheltered or protected nesting. Black-backed gulls are more or less immune to skua attacks, although Pietz (1987) has recorded attacks on them by south polar skuas (*Catharacta maccormicki*). They nest in the open and have conspicuous nests. At the other extreme, the shore plover, the smallest species, invariably nests under shelter. White-fronted terns are exceptional in this series. Although the 2nd smallest species they are the most pugnacious of all these birds in the defence of their nests, whether in colonies and acting in concert or nesting singly. Individual terns can harry flying skuas from their nesting area and, through unflagging stoop attacks, prevent them roosting or settling anywhere near it. However, an equally plausible hypothesis linking size to nesting habits can be made on their susceptibility to inclement weather — the larger gulls being least susceptible can nest in the open, the shore plover being most susceptible must always nest under shelter. Some progress in testing these hypotheses can be made by comparing breeding habits on Mangere and Rangatira with those on Chatham, and more generally, on the New Zealand mainland.

Comparison between the 2 islands and Chatham shows 2 differences in nesting behaviour. The 1st and most obvious difference lies in the location of nesting colonies of red-billed gulls and white-fronted terns: on the islands these were on the coast, at Chatham Island itself they were on off-shore islets. This difference is most parsimoniously explained by the different suites of predators in each place — mainly mammalian on Chatham, and entirely avian on the islands.

The 2nd difference is in the precise location of the nests of the oystercatchers and red-billed gulls. On Chatham both species nested in the open, as do oystercatchers and these gulls on mainland New Zealand (Baker 1974; Mills 1969). On the islands both had concealed nests. The very clear differences in the nesting behaviour of the gulls on the small islands and on Chatham Island seem conclusive evidence that the gulls on the islands were responding to the skuas rather than to the weather when selecting protected nest sites. Gull nests in Te Whanga Lagoon were all fully exposed to view; none on Mangere and Rangatira were similarly exposed, yet the 2 places have much the same weather and a similar range of nesting habitats. Any uncertainty about this determination would be eased if there were more detailed weather records for the islands. All that can be said is that the weather is

probably fairly similar throughout the Chathams. In support of the contention that climate is less influential than predation risk is that the gulls on Rangatira and Mangere nested identically under shelter whether on the exposed (western/southern) coasts or the more sheltered northern ones.

The reason for the unusual nesting habits of the oystercatchers on these islands is more problematic because they are constrained as well by their territoriality to finding nest sites within a specific section of coastline. Comparisons with nesting on Chatham are less illustrative than for the gulls because most nesting there is on the sandy beaches — a habitat that is missing from the small islands. All nesting on Chatham Island is in the open, with the nests fully exposed (Schmechel 2001). The point at issue for explaining the different nesting habits between these 2 places is whether open sites around the islands are so limited that the birds have to use unusual sites, which by chance are protected from direct skua view, or from easy skua access. My own impression from surveys in each territory is that bare ground suitable for nesting was not so severely limited that it would preclude exposed nesting. About half of the oystercatcher territories on the islands had fine gravels or other open ground for nesting, but there were almost no nesting attempts in these places. Even if open ground was limited, it could still be argued that nesting was being strongly influenced by the presence of local skuas because nest location was so often carried to extreme, with the nests well inside caves or among coastal trees, rather than being at the cave mouth or the bush margin. What for me appeared definitive evidence of the positive selection of concealed nest sites came from the observations of nesting each year on Mangere. Although there was a strip of gravels and small boulders along 300 m of the upper shore platform available for these pairs, they invariably tucked their nests each year under driftwood or sited them closely under or against large boulders. On Chatham Island, nests would be sited in the open. In summary, it seems probable that oystercatchers on these islands select sites that intentionally offer protection and invisibility to flying and roosting skuas, selecting such sites even in places where abundant open ground is available.

Conclusive demonstration that the nesting habits of these birds was determined by the presence of skuas on the islands is hampered by the fact that during the course of the study of skua behaviour I saw only 1 attack on shorebirds. This was an attack on a fledgling black-backed gull (Young 1978). Nor were skuas seen fossicking among the gull and tern colonies. Indeed, a study of 2 mixed colonies of terns and red-billed gulls during the 1974/75 summer recorded little interest by skuas. Predation by resident

red-billed gulls was implicated instead in the low breeding success of the terns (Young 1978).

Nesting skuas were, however, very sensitive to any incursions near their nests, and swoops down from the roost to evict feeding parakeets (*Cyanoramphus novaezelandiae*) and starlings (*Sturnus vulgaris*) were commonly noted during the observation logs of breeding skuas on Rangatira. However, although there were breeding oystercatchers and shore plovers on the same territories which were very visible to the roosting skuas, their activities were directed more towards the shore and only rarely did they provoke these flights. Although it might be argued that adult shorebirds are too agile and alert to be taken by skuas, this still leaves the problem of why the skuas did not prey on eggs and nestlings, especially in places where the nests were very obvious to skuas on nests, at roosts, and in flight.

If these were the only records of skua predation or attack the argument for its role in the nesting behaviour of the other shorebirds would obviously be weak. Fortunately, others have been more successful in recording skua predation. Davis (1994b: 200), on the basis of her observations during field work on the shore plovers on Rangatira, concluded that these skuas 'regularly prey on nests in open sites'. There is also definitive evidence of skua predation on red-billed gulls on Snares Island from 12 records of this species in skua middens (Miskelly *et al.* 2001).

Although the main thrust of this discussion has been of the role of skuas as predators influencing nesting, it is as well to consider whether other predatory or competing species on the islands were instead responsible, or could have a significant role. The 2 avian species most likely to fit this role are black-backed gulls and blue penguins. The 1st could certainly act as a predator on the nest contents of the smaller species, but it is unlikely to have much influence on these islands, because the intense territoriality of the skuas prevented them from foraging over much of the coastal fringe. Both islands, however, had very large populations of blue penguins and their passage to and from the sea and their occupation of sheltered sites among rock falls and in caves bring them into competition with red-billed gulls and white-fronted terns. Once away from the immediate shoreline, penguins tended to follow established paths and would be less likely to blunder into birds nesting among low vegetation above the shore platform. There is, however, no information on interactions between these penguins and other shorebirds. Certainly, no contact between them was seen during searches around the islands at night when penguins were coming ashore. On Rangatira, fur seals were found further and further inland on increasing lengths of the

coastline during the course of this study, intruding on the coastal habitat and coming more into contact with nesting birds. This incursion was, nevertheless, confined to the southern and southeastern corner of the island whereas the nesting behaviour described for the shorebirds occurred universally across this island and on Mangere, which had few seals.

The final point to be considered is whether the unusual nesting habits recorded on these islands were in response to risk to the parent birds or the nest contents, and in any discussion it is important to appreciate the different susceptibilities to predation of adults, eggs and chicks. The gulls, terns, and oystercatchers are boldly patterned and are very obvious on nesting areas. Only skuas and shore plovers could be considered cryptically patterned. In contrast, the eggs of all species are cryptic with brown blotches and markings, and the hatchlings and fledglings are wonderfully camouflaged; so much so that searches for them during surveys are often unsuccessful. Certainly, nesting in broken ground would confer additional protection to the chicks, but because of their camouflage and their concealment when alarmed, this seems a less likely explanation for the siting of these nests than for the protection of the nest itself.

In time, as more studies are undertaken of gull and tern breeding on the southern islands, it should be possible to see the pattern of interaction between climate and predation in nesting behaviour more clearly. More detailed study is needed for shorebirds of southern islands, especially those with significantly more severe climates than occur in the Chatham Islands, and better information is needed as well for Chatham to supplement the few observations recorded here. The usual statistics collected at the standard climate stations do not, however, provide definitive records for comparing environmental conditions. Records are needed of conditions at the breeding colonies themselves. What is patently also needed are studies of the interactions among these species, and between them and skuas. Especially important would be records of attempted predation, during daylight and at night. It is after all *perceived risk* of predation that is the determining factor in selecting nesting habits. Overall, however, it has to be concluded that because of colonial and protected nesting these shorebirds have been able to coexist with a very significant predator.

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