Chatham Island oystercatcher—report of 1999/2000 field season

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CONTENTS

Abstract

A joint management-research programme on the Chatham Island oystercatcher *Haematopus chathamensis* was undertaken in 1999/2000. Fifty pairs (at least 40 breeding) and a total of 125–126 birds were counted on the four islands of Chatham Islands, New Zealand. The population increased by 30% overall between 1987 and 1999 but trends varied in different areas, either increasing (northern Chatham Island, eastern Pitt Island), stable (Mangere Island), or decreasing (south Chatham Island, Rangatira (South East Island). Predator control to protect 16 oystercatcher territories on northern Chatham Island killed 51 cats, 719 weka *Gallirallus australis hectori*, 61 possums *Trichosaurus vulpecula*, 44 rats and 41 hedgehogs. Stock were also excluded from these managed areas and nests were moved from the high tide mark to prevent them from being washed away. Twenty-five chicks fledged from the 16 managed pairs (1.6 chicks/pair) and none from 11 unmanaged territories in northern Chatham Island. Principal causes of egg loss were high seas (50%) and predators (41%) at unmanaged nests. Video monitoring of nests observed three fatal predation events (two cats and one weka ate eggs) and another nest was washed away by high seas. Some visits to nests by possums, sheep, cattle, rodents, people and gulls did not result in egg loss. The low number of events on film combined with the high chick output in managed areas indicate that the predator control regime was adequate to protect most nests.

1. Introduction

1.1 BACKGROUND

The Chatham Island oystercatcher *Haematopus chathamensis* is an endangered species with a high risk of extinction because of its very small population and range (IUCN 1990; Collar et al. 1994). The species is ranked by the Department of Conservation as Category A, the highest priority for conservation management (Molloy & Davis 1992; Tisdall 1994). Population estimates range as low as 50 birds in 1970/71 (Baker 1973) but the most definitive coastal surveys found 103 birds and 44 breeding pairs in 1987 (Davis 1988) and 142 adults and 34–41 breeding pairs in 1998 (Schmechel & O'Connor 1999). Although annual adult (88%) and juvenile (48–68%) survival was considered to be high, productivity was low (0.22 fledged young/pair annually) and a population decline to extinction was predicted in 50–70 years (Davis 1988).

The systematics of the oystercatcher family is uncertain (Hayman et al. 1986; Marchant & Higgins 1993) as, despite the large geographic range of the genus *Haematopus*, there is little morphological divergence between the species (Hockey 1996a). The Chatham Island oystercatcher is separable from other New Zealand oystercatchers on the basis of morphology (Baker 1975), although differentiation is considered to be weak (Hockey 1996a). There are dual affinities in ecology and behaviour to both the South Island pied oystercatcher *H. ostralegus finschi* (similar breeding seasons, vocalisations, eggs, lack of the feather louse *Quadraceps ridgwayi* and pied plumage) and variable oystercatcher *H. unicolor* (rock-dwelling, coastal breeding, non-migratory) (Baker 1974; Hockey 1996a). Hence it has been variously described as more closely related to one or the other (Baker 1972; Hayman et al. 1986; Hockey 1996a). Phenetic affinities of Australasian oystercatchers based on seven morphological characters (bill × 3, tarsus, toe, tail and wing) tended to cluster *H. ostralegus finschi* and *H. chathamensis* with the Old World (Eurasian) *H. ostralegus* subspecies and *H. unicolor* with New World (Americas, South Africa, Australasia) forms. Therfore it was suggested that the presence of South Island pied oystercatcher in New Zealand was a result of a secondary invasion from the Northern Hemisphere but the origin of Chatham Island oystercatcher was not discussed (Baker 1977).

The Chatham Island oystercatcher is endemic to the Chatham Islands (Baker 1973; Marchant & Higgins 1993; Turbott 1990). Breeding pairs defend coastal territories comprised of intertidal rock platforms, stream mouths and sandy beaches. They use their sturdy bill to prize or hammer open marine molluscs, and to probe for worms and other small invertebrates (Heather & Robertson 1996; Davis 1988). They also sometimes use adjacent farmland to feed, especially in damp areas and during winter months (pers. obs.; Schmechel 2001).

Introduced predators in New Zealand have had a profound effect on biodiversity and abundance of our native fauna (Diamond & Veitch 1981). Birds evolved behaviour to avoid primarily diurnal avian predators rather than nocturnal mammals and about 35 species of birds became extinct following Polynesian settlement (Clout & Saunders 1995). Many other species are now threatened by the combined forces of habitat destruction, introduced competitors and predators. The latter have been the main agents of decline in range and numbers of New Zealand shorebirds and five taxa have populations of less than 150 individuals (Dowding & Murphy 2001).

The relative importance of different factors which affect bird populations, including shorebirds, in New Zealand has traditionally been difficult to measure, as has the extent of predation itself (Sanders & Maloney 1999). This lack of knowledge makes it difficult to target conservation management (Rebergen et al. 1998). Much indirect evidence has come from eradication of pests from offshore islands and the subsequent recovery of populations of resident or translocated rare wildlife (Clout & Saunders 1995). The concepts developed with islands have been transferred to ecological restoration of mainland sites through the ongoing control (by trapping and poison applications) of a suite of predators and competitors. The success of such management has been shown in the dramatic recovery of some North Island kokako *Callaeas cinerea wilsoni* populations, and the effectiveness of predator control has been tested using experimental and control sites and a switching of treatments between sites (Innes et al. 1998).

Predation of eggs and chicks was identified as a key issue affecting the productivity of Chatham Island oystercatcher (Davis 1988). Other threats to the population included trampling of eggs and chicks by domestic stock (sheep and cattle); disturbance by stock, dogs or people, resulting in predation or exposure of eggs or chicks; over-stabilisation of dunes by introduced marram grass *Ammophila arenaria*, resulting in more limited nesting opportunities and increasing the incidence of nests being washed away by high tides and storm waves (Best 1987; Collar et al. 1994; Aikman et al. 2001; Schmechel 2001).

Conservation management for oystercatchers in the early 1990s centered on predator trapping and fencing to limit stock access to some nesting areas in the north of Chatham Island. Some nests were moved away from the high tide mark (Collar et al. 1994). Unfortunately, the efforts were piecemeal, visits to monitor nesting success were sporadic and record keeping was minimal.

In 1998/99 the Department of Conservation (DOC) began a concerted programme to manage Chatham Island oystercatcher and intensified monitoring, predator control and fencing in the managed zone of Maunganui–Tioriori and Wharekauri in the north of Chatham Island. Trapping, shooting and hunting with a dog from November to February removed 47 cats, 654 weka *Gallirallus australis hectori*, 133 possums *Trichosaurus vulpecula*, 39 hedgehogs and 23 southern black-backed gulls *Larus dominicanus* from about 14 km of coastline (Bell 1999; O'Connor 1999). A fence was upgraded and extended at Tioriori to exclude all stock and most weka from the nesting area of 4–5 oystercatcher territories. Nests were gradually moved up the beach profile to protect them from storms, and to assist this platforms (car tyre on plywood sheet) were placed in nesting areas to encourage the birds to nest in them.

The draft Chatham Island Oystercatcher Recovery Plan (Aikman et al. 2001) aims in the short term (10 years) to improve or maintain productivity and adult survivorship so as to facilitate an increase in their total population to a minimum of 250 individuals. This would involve protecting nests from flooding, trampling by stock and predation. The long-term aim is to restore the natural ecology of the coast so that the oystercatcher population is maintained at or above 250 birds with minimal management (Aikman et al. 2001).

In 1999/2000 a joint DOC management-research programme on Chatham Island oystercatcher commenced. The aim of management is to:

- manage known threats (predators, flooding, trampling by stock) at core oystercatcher strongholds;
- conduct management in a consistent and measurable way;
- support and facilitate the research.

The aim of the Science & Research Investigation 3273 was to:

- establish the causes of nest failure of Chatham Island oystercatcher nests;
- identify key predators using video surveillance;
- help establish consistent and repeatable management methods and record-keeping;
- assess effectiveness of management actions;
- monitor population trends and dynamics.

This report outlines the results of the 1999/2000 field season.

1.2 PERSONNEL

The main DOC staff involved with Chatham Island oystercatcher work in 1999/2000 are outlined in Appendix 1. Other Chatham Island Area Office staff conducted fencing projects and offshore island-based staff and volunteers helped with nest monitoring. The Area Office employed Richard Goomes for the summer (late September 1999–late February 2000) and Science & Research Unit employed Georgina Hedley (after an initial start by Kerri-Anne Edge). These two were the principal workers and they shared the management-research duties. They were mainly based at Wharekauri and used a 4-wheel-drive vehicle and two all-terrain bikes to visit the oystercatcher areas in the north of the island.

1.3 STUDY AREAS

Fieldwork focused on the north of Chatham Island (Fig. 1). Management areas were identical to those in 1998/99 (O'Connor 1999; Bell 1999) on the Maunganui–Tioriori and Wharekauri coasts (Fig. 1). Unmanaged areas that were regularly monitored for nest success and/or nests monitored by video were parts of the north-west coast (Waitangi West–Cape Pattison), Whanga (Whangamoe–Paritu), north-east coast (Matarakau) and Okawa Point (Fig. 1). Unmanaged areas that were less intensively monitored for breeding success included the south-west coast of Chatham Island, the eastern side of Pitt Island, Mangere Island and Rangatira (South East Island)*.

2. Census

2.1 INTRODUCTION

One of the aims of the Chatham Island oystercatcher study was to monitor population trends along key sections of the island group coastline.

2.2 METHODS

A partial census of Chatham Island oystercatcher was conducted from on 13–20 December 1999 following methodology used by Schmechel & O'Connor (1999). Most of the priority areas identified by Schmechel (1999) were surveyed (Fig. 1: census areas marked (a) for highest priority for surveys and (b) for moderate). Omissions of priority areas were Point Somes (b) and parts of the Pitt Island coastline (a or b), which could not be surveyed for logistical reasons. Where possible, similar survey techniques (on foot, or from 4-wheel bike) were used in 1999 as in 1998. Assignment of birds to breeding pairs was a mixture of interpretation of bird behaviour on the day of census, checking for presence of nests, plus supplementary knowledge about breeding attempts during the season. Suspected breeding pairs were those that exhibited breeding behaviour

* Rangatira is also known as South East Island; only the former name will be used in the remainder of the report.

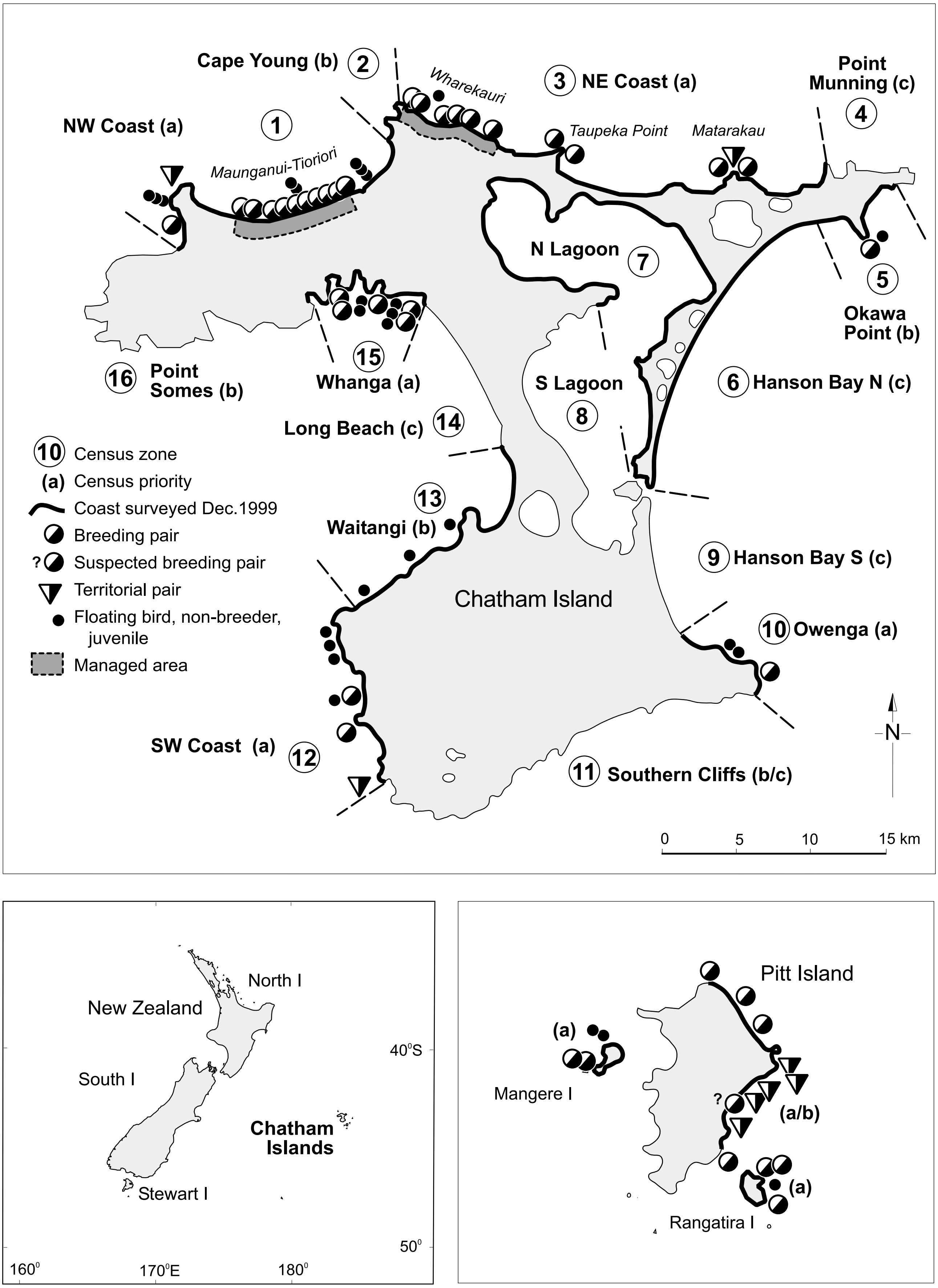


Figure 1. Chatham Island oystercatcher census areas and results December 1999.

TABLE 1. RESULTS OF CHATHAM ISLAND OYSTERCATCHER CENSUS 13-20 DECEMBER 1999.

AREA	DATE	OBS	METHOD	PAIRS			SINGLES/FLOATERS			
				B	S	T	A	F	J	U
North-west coast	13 Dec. 1999	1	Bike	11		1	4		4	
Cape Young	13 Dec. 1999	1	Bike	0						
North-east coast	13-14 Dec. 1999	1	Bike	10		1		1		
Okawa Point	14 Dec. 1999	1	Bike	1			1			
North Lagoon	16, 20 Dec 1999	3	Bike, foot	0						
Hanson Bay N	20 Dec 1999	1	Bike	0						
Owenga	14 Dec. 1999	2	Foot	1			1		1	
South-west coast	14, 17 Dec. 1999	1	Bike, foot	2		1	3	1		
Waitangi	14 Dec. 1999	2	Foot, bike	0			2-3			
Whanga	13 Dec. 1999	2	Foot	5			3	1	1	
Pitt Island	10-15 Dec. 1999	2	Foot	4	1	5				
Mangere Island	22 Dec. 1999	2	Foot	2			2			
Rangatira	17 Dec. 1999	3	Foot	4		1				
Total				40	1	9	16-17	3	6	
GRAND TOTAL				50			25-26			

Key:
B = breeding pair, S = suspected breeding pair, T = territorial pair, A = adult, F = first-year bird
J = juvenile from 1998/99 season, U = unknown status.

but no nest or chicks were found during the season. Territorial pairs were occupying and defending a stretch of coastline throughout the season but were not known to breed or show signs of having bred. Note that the 'floating pair' category used by Schmechel & O'Connor (1999) has not been used in this report and these birds were included in the general floating bird category (Table 1, Fig. 1). Floaters included all non-territorial birds (nonbreeding adults, immatures and juveniles).

2.3 RESULTS

Results of the partial census in 1999 are provided in Figure 1 and Table 1. Fifty pairs (40 confirmed as breeding) were identified in the 12 census areas from four islands. Additionally, 25-26 non-territorial birds were found, bringing the total number of birds to 125-126. This includes some information gained from breeding monitoring. The actual number of birds seen on the days of the census was 120-121. This was because on Chatham Island only one member of two confirmed breeding pairs was seen and on Rangatira only three pairs and one adult were counted, but monitoring at other times found four breeding pairs and one territorial pair.

2.4 DISCUSSION

The Chatham Island oystercatcher may never have been numerous but numbers in the past may also have been limited by hunting pressure, as bones have been found both in dune deposits and middens (Millener 1990). The species was described as being 'not common' Travers & Travers (1872) and 'not particularly abundant…' (Fleming 1939). The species range was 'widely distributed on the

TABLE 2. NUMBERS OF CHATHAM ISLAND OYSTERCATCHERS COUNTED IN 1987, 1998 AND 1999.

AREA	1987			1998			1999		
	PAIRS	F	TOTAL BIRDS	PAIRS	F	TOTAL BIRDS	PAIRS	F	TOTAL BIRDS
Waitangi West-Cape Patterson	0	0	0	1	5	7	2	3	7
Maunganui	0	1	1	4	1	9	5	2	12
Tioriori	6	0	12	5	2	12	5	3	13
Wharekauri	5	1	11	6	3	15	6	1	13
Taupeka	2	1	5	2	1	5	2	0	4
Matarakau	0	0	0	3	0	6	3	0	6
Okawa	0	0	0	0	3	3	1	1	3
Whanga	0	0	0	2	6	10	5	5	15
Rest of north	0	0	0	0	2	2	-	-	-
North Chatham I.	13	3	29	23	23	69	29	15	73
Owenga	1	1	3	1	2	4	1	2	4
Southern cliffs	4	2	10	0	2	2	-	-	-
Southwest coast	7	2	16	6	3	15	3	4	10
Rest of Chatham I.	0	1	1	0	4	4	-	2-3	2-3
South Chatham I.	12	6	30	7	11	25	-	-	-
East Pitt Island	5	2	12	4	16	24	10	0	20
Rest of Pitt Island	4	3	11	1	8	10	-	-	-
Mangere Island	2	0	4	2	0	4	2	2	6
Rangatira	8	1	17	4	2	10	5	-	10
Offshore Islands	19	6	44	11	26	48	-	-	-
Total counted	44	15	103	41	60	142	50	25-26	125-126
Unconfirmed	1	5	110						
Estimate missed	3		116	3		150	4	9	142-143

Key:
Pairs = breeding, suspected breeding and territorial pairs.
F = floaters (non-territorial adults, immatures and juveniles).

rocky shores near Kaingaroa, and other northern areas, and from Ouenga to the Tuku in the south. It is present also on Pitt, Mangare and South East Islands' (Fleming 1939).

In 1970–71 Baker (1972, 1973) estimated there were 50 Chatham Island oystercatchers. However, this was not based on a complete survey and much of information was anecdotal (Best 1987; Davis 1988). At that time it was believed that the small islands of Rangatira and Mangere Island harboured the core of the population (Baker 1973) and excess production supplemented the Pitt and Chatham populations (Davis 1988). Several other surveys, e.g. in 1986 (Best 1987), 1988 (Davis 1989) and 1991 (Page 1992), were of differing intensity, coastal coverage or, to some extent, used unconfirmed sightings and can only provide minimum figures for comparison. However, the more comprehensive surveys in 1987 (Davis 1988) and 1998 (Schmechel & O'Connor 1999) provide the main population estimate baseline. To what extent they are directly comparable in terms of effort, personnel and survey method is difficult to determine, but the counts during those years are compared in Table 2 with the survey of priority areas in 1999. Results from different coastal areas are illustrated in Figures 2 and 3.

Figure 2. Oystercatcher censuses at selected sections of coast.

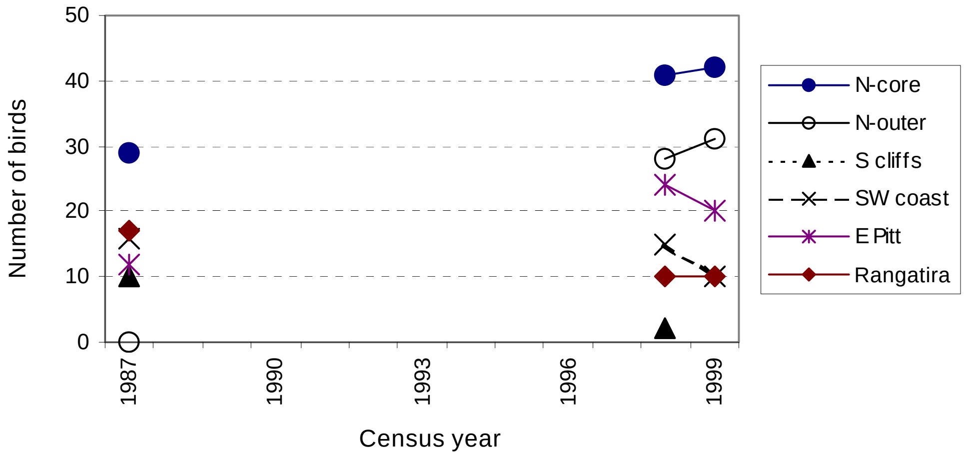
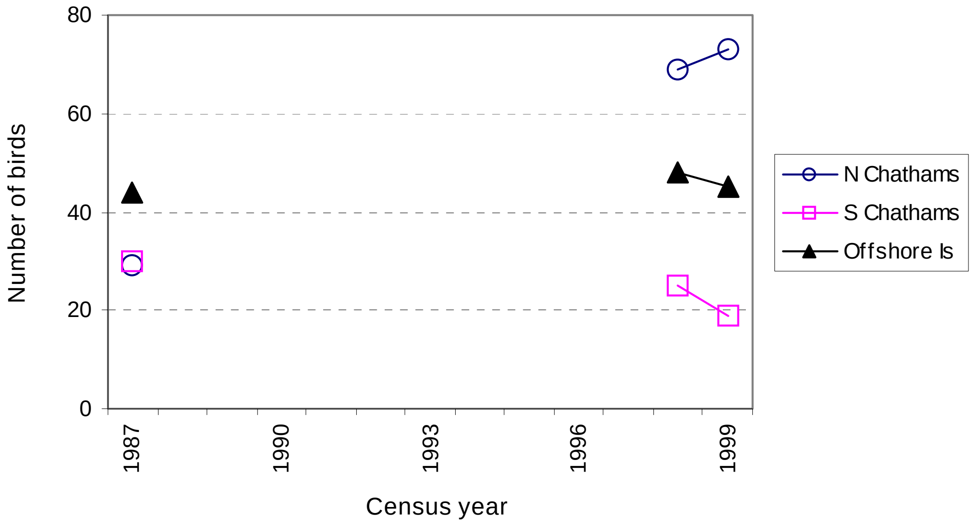


Figure 3. Oystercatcher censuses grouped by locality.



The 1987 census included most of the coastline of Chatham Island, except for the eastern two-thirds of the 'southern cliffs' and the southern two-thirds of Te Whanga Lagoon. The survey was mostly carried out by one person on foot or motorbike between 13 October and 5 December 1987, during the peak of the breeding season. Supplemental observations were made by other workers and locals (Davis 1988). Most pairs that were found were re-checked two or three times during the 1987/88 season and only 23 of the 44 pairs were known to have bred that year (Davis 1988). It is likely, though, that frequency of visits was too low to register failed breeding attempts. The overall population size was confirmed in 1988, when most of the coastline was revisited to count oystercatchers, although there was apparently a slight decrease in numbers (40 pairs and 98 individuals) (Davis 1989).

The 1998 census was more complete, with only small sections of coastline missed on the southern coast of Chatham Island and Pitt Island, and over a shorter period, 13–18 December (Schmechel & O'Connor 1999). A large team of people (35) ranging from expert to inexperienced surveyed the coast by foot, occasionally by 4-wheel motorbike and from a boat. Knowledge of the breeding status during that season supplemented the observations made during the census. Consequently, the number of breeding pairs was undoubtedly underestimated, particularly on Pitt Island where 23 birds of unknown status were counted (but often mapped as 2 birds).

The census of 1999 surveyed areas that were recommended by Schmechel (1999) in order to include most of the previously known breeding birds. In the north of Chatham Island 27 of the 29 pairs were known to have made breeding attempts in 1999/00. The other two pairs may not have been monitored closely enough to detect breeding, or were new birds establishing territories. The number of floating birds was probably underestimated during the census. For example, five colour-banded juveniles were seen in the northern half of Chatham Island during the census period, yet 12 different individuals were seen during the course of the summer.

Between 1987 and 1999 there was an apparent increase from 13 to 18 pairs (+38%) and 29 to 42 birds (+45%) in the northern stretch of coastline between Maunganui and Taupeka (Table 2, Fig. 2: N-core). Most of this change occurred at Maunganui where five pairs established in the interim. A more dramatic increase from 0 to 11 pairs (9 confirmed breeding) and 0 to 31 birds occurred in the other areas of northern Chatham Island (Fig. 2: N-outer). The combined effect was to more than double the population in the north (Fig. 3). Although there was an unconfirmed sighting of a bird at Waitangi West and another at Paritu in 1987 (Davis 1988), no birds were seen during the 1987 census. Similarly, in 1986, a single bird only was found in the peripheral areas of northern Chatham Island (Best 1987). In 1988 a breeding pair was found at Okawa (Davis 1989), and solitary breeding pairs were also reported at Waitangi West, Matarakau and Paritu in 1991/92 (Page 1992). By 1995/96 numbers had built up even further in these areas (Schmechel & O'Connor 1999). The total number of birds counted in the north of Chatham Island was similar in 1998 and 1999 (Table 2). The total number of pairs (breeders, suspected breeders and territorial pairs) increased from 23 to 29 and the number of those known to breed went from 19 to 27. This was a result of the more intensive monitoring during the summer of 1999/00. For example, all five pairs in the Whanga block (Whangamoe–Paritu) made breeding attempts in 1999/2000, yet they were of uncertain breeding status the previous year (Schemechel & O'Connor 1999).

Possible reasons for the apparent doubling in population in northern Chatham Island between 1987 and 1999 were natural changes to the population, some predator control at Wharekauri and Tioriori resulting in better chick production and subsequent recruits establishing in neighbouring areas, or simply that better monitoring was revealing more birds. A longer-term change may have occurred, since local people reported to Davis (1988) that numbers had increased in northern areas prior to 1987. Dowding & Murphy (2001) suggest that the population may be recovering from pressure of hunting and shooting, as also occurred for the mainland species of oystercatcher (Heather & Robertson 1996). Shooting of South Island pied oystercatcher on the New Zealand mainland severely reduced the population prior to 1940 before the species was protected by law (Dowding & Murphy 2001), however there is no direct evidence of a similar situation on the Chatham Islands. Davis (1988) suggested that the availability of feeding territories with volcanic rock platforms limited the size of the population. Similarly, Fleming (1939) stated that oystercatchers were seldom, if ever, seen on sandy shores. In contrast, although rock platforms are very important for foraging, Schmechel (2001) found that some pairs used sandy beach almost exclusively (and were the most successful breeders), others used paddocks for some of the time. Platforms and sand beaches were selected in greater proportions than they were available (Schmechel 2001). It is not known whether these facts indicate a change in habitat use (in turn, possibly a result of a population increase) or were revealed through more intensive study.

In contrast to the situation in northern Chatham Island, the oystercatcher population appears to have decreased in the southern half of the island (Fig. 3), although coverage of the coastline differed in the censuses and this makes interpretation of the data difficult. On the southwest coast only three pairs were found in 1999, compared with 6–7 pairs in the earlier surveys (Table 2, Fig. 2). There were at least four pairs on the 'southern cliffs' coastline in 1986–1989 (Best 1987; Davis 1988, 1989) and three pairs in 1991 (Page 1992), yet only two birds were seen in 1998 (one section of coast was omitted; Schemechel & O'Connor 1999) (Fig. 2).

Numbers of birds on Pitt Island were substantially higher in 1998 than 1987 and the partial coverage in 1999 further indicates that the increase was on the eastern side of the island (Table 2, Fig. 2). The steady population suggested by Schmechel & O'Connor (1999) resulted from an error in their table 2, which recorded 32 adults on Pitt Island in 1987, a misquote of Davis (1988) who found 23 birds.

Amongst the islands, Rangatira has the longest and most continuous history of oystercatcher numbers (Schmechel & O'Connor 1999). The population apparently increased from three pairs in 1937 (Fleming 1939), and five pairs in 1961 (Merton & Bell 1975) to 9–13 pairs in 1970–84, and decreased gradually to five pairs by 1998 (Schmechel & O'Connor 1999). The increase was attributed to removal of sheep when the island was reserved in 1964 (Merton & Bell 1975; Davis 1988); however, the reason for the subsequent decrease is unknown. Human disturbance has been suggested as a contributing factor (Aikman et al. 2001). On the smaller Mangere Island, there was one pair in 1961, three in 1970 (Merton & Bell 1975), but in most subsequent years there have been two pairs (Davis 1988; Schmechel & O'Connor 1999). There were three pairs resident on Mangere Island in 1999/00; however, only the established two pairs bred.

The results of the Chatham Island oystercatcher census in 1999 differed from the 1998 census in some respects (Schmechel & O'Connor 1999). They suggested that since 1987 there had been an increase in numbers in northern Chatham Island, steady numbers in southern Chatham and Pitt Islands and a decrease on Rangatira. The 1999 census found that the oystercatcher population had more than doubled (123–152%, the range being the percentage increase in pairs and total birds) in northern Chatham Island, doubled on eastern Pitt Island, was stable (in terms of pairs) on Mangere Island, and had decreased in southern Chatham Island (42–17%) and Rangatira (38–41%) (Table 2, Figs 2 & 3). The various changes on the offshore islands resulted in an overall slight increase there (Table 2, Fig. 3). The total number of birds counted in 1999 was similar to numbers counted in 1998 and the increase in pairs identified was a result of the higher intensity of breeding monitoring.

Allowing for areas of unsurveyed coastline, it is estimated there were 55 pairs breeding or holding territories on the Chatham Islands in 1999/2000. This is an increase from the 44 territorial pairs known in 1987/88, and total birds increased by approximately 30% in the interim period.

2.5 RECOMMENDATIONS

- Repeat the partial census of core areas in 2000/01
- Extend the census of the southern part of Chatham Island to include the Horns–Cascade section of the southern cliffs and conduct a comprehensive survey of Pitt Island to determine the total number of birds and location of breeding pairs.

3. Management

3.1 INTRODUCTION

Of the original 100 or so bird species present on the Chatham Islands before people arrived, only 25 marine and 15 terrestrial species now still breed there. This reduction is the result of habitat loss, introduced predators and hunting (Millener 1996). Conservation action for rare and threatened species has centred on the offshore islands such as Rangatira and Mangere where introduced pests were eliminated; however, more recently, localised predator control has been undertaken to protect rare endemics that occur on Chatham Island (e.g. Imber et al. 1994).

As noted earlier, the management for Chatham Island oystercatcher in 1999/2000 occurred at two areas on the northern coast of Chatham Island: Maunganui–Tioriori and Wharekauri (Fig. 1). Aims of the management regime were to:

- reduce the risk of predation of oystercatchers, their eggs and young;
- exclude stock to remove the risk of nest trampling;
- move nests away from the high tide line to reduce the risk of being washed away.

3.2 METHODS

3.2.1 Predator control

Predator control in northern Chatham Island was essentially a repeat of the trapping conducted the previous year (Bell 1999).

A trap-line of 76 traps was set up at Maunganui–Tioriori and Wharekauri, along 14 km of coastline (Figs 4 & 5), and consisted of:

- 54 Lanes Ace leg-hold traps which were recessed in a wooden base and hidden with tissue paper and covered by sand. The base had a wooden backing board with a nail to hold the fish bait (and/or a mesh bait holder), and wire-mesh walls ('hazes') to channel predators into the trap.
- 10 leg-hold traps which were placed at the bases of trees, fences or woodpiles and hidden with leaf litter, with a few sticks placed either side of the trap to channel predators.

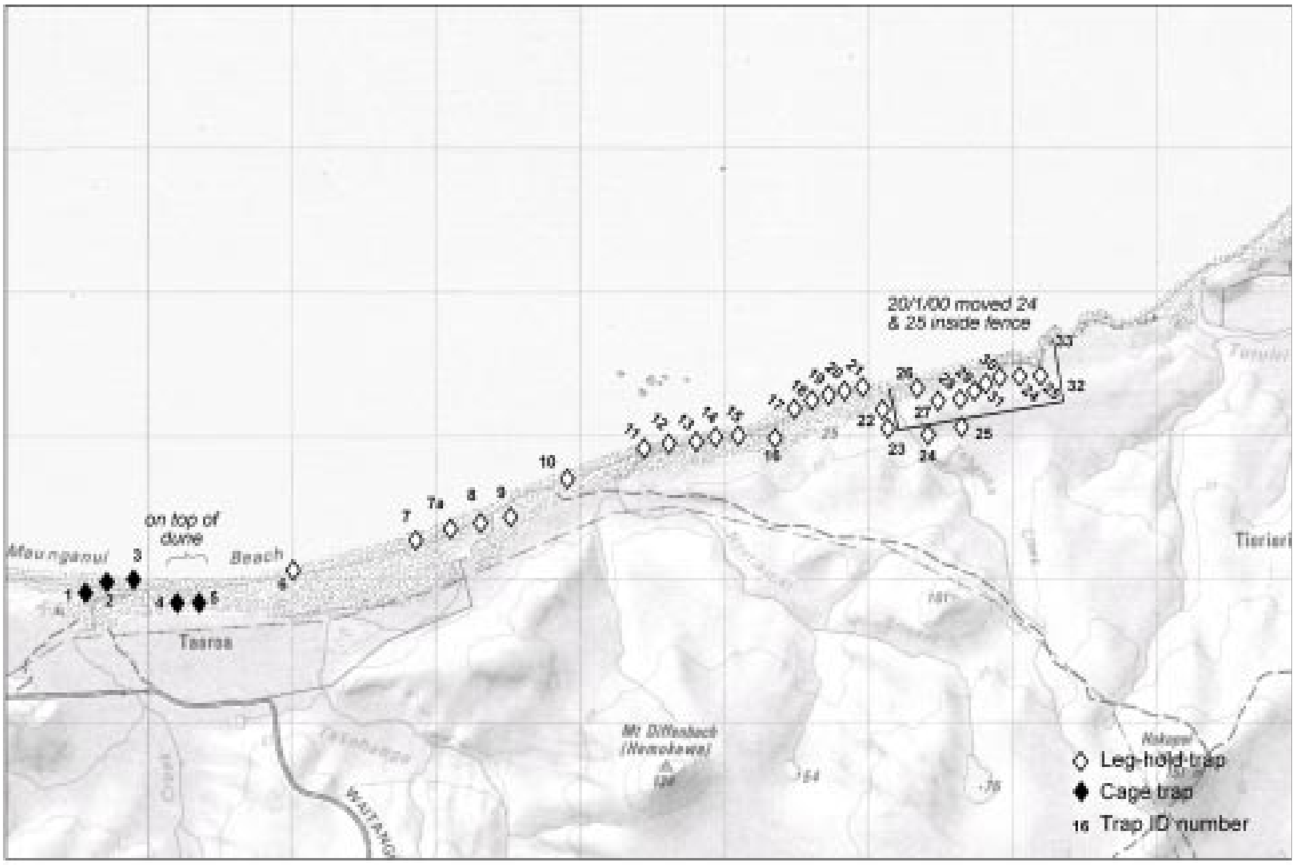


Figure 4. Manganui–Tioriori trapping line.

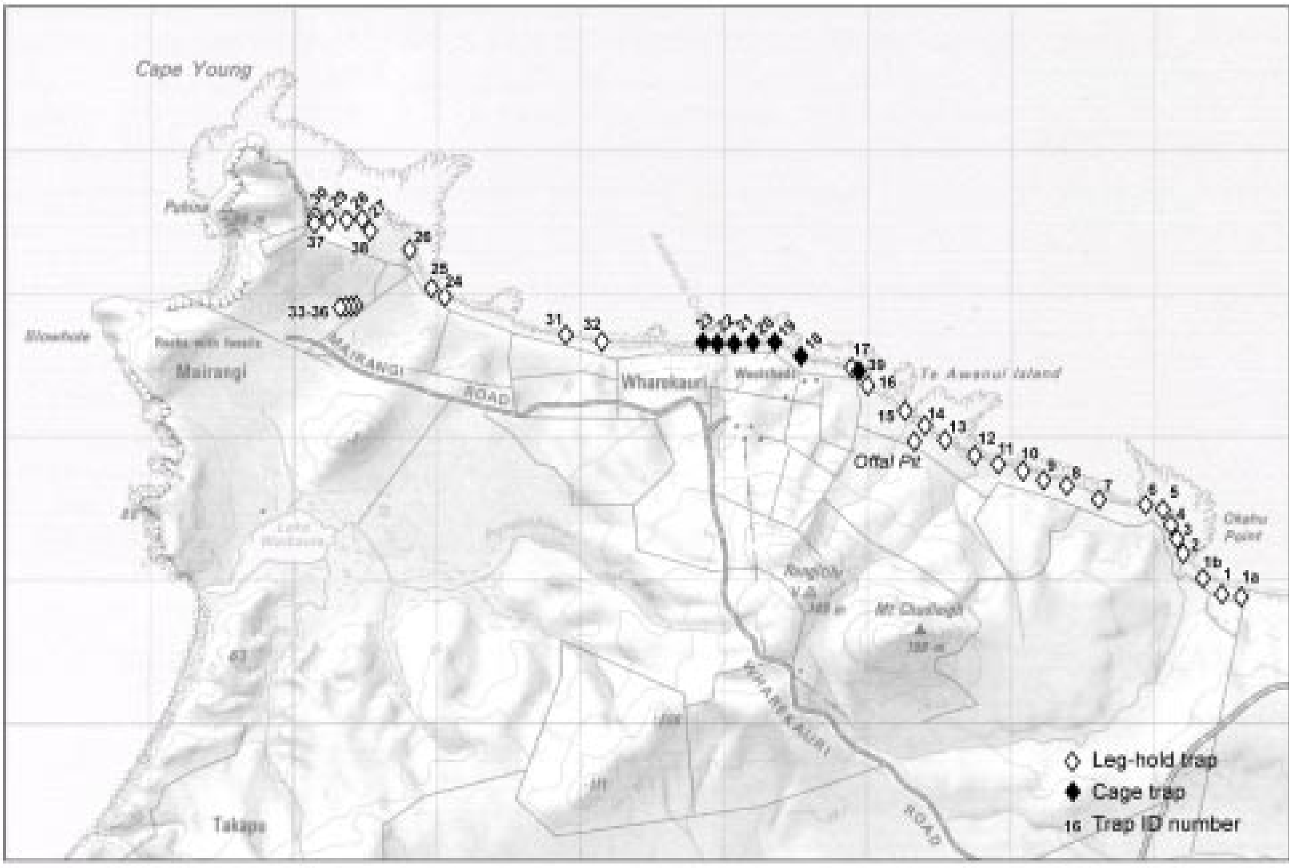


Figure 5. Wharekauri trapping line.

- 12 cage traps which were placed on coastline near farm buildings to prevent the killing or injury of pet cats. Cat collars and bells were given to landowners to identify their pets.

Mike Bell and Richard Goomes set out most of the traps on 23 September 1999 at Wharekauri and 29 September 1999 at Maunganui–Tioriori. Forty-eight traps were at the beach/dune edge, 21 were behind the main dune and 7 were in forest remnants or reserves near the coast. Pieces of fish were used as bait.

Trap location was designed to cover as much coastline as possible, while concentrating on the oystercatcher territories or areas where predator tracks were noted. The underlying principles of trap location were:

- the beach front would act as a highway for prospecting predators;
- traps set at the beach edge in oystercatcher territories would protect nests from predation;
- predator tracks would be visible in the sand and allow trappers to target hot-spots with new traps or by shifting traps;
- nearby forest reserves would be havens for predators.

Predators were also killed on an opportunistic basis by trained dogs and by shooting while conducting the predator trapping daily round.

At the end of each day a recording sheet was filled out that itemised which traps captured animals, were sprung or had lost the bait. Separate sheets were filled for hunting with a dog or shooting. Periodically, data were transferred to a computer spreadsheet, which provided subtotals of the trapping data.

3.2.2 FENCING

The main fencing project prior to the start of the oystercatcher breeding season was the Tioriori 'tie-off'. This entailed creating an extension to the existing fence out over the rock platform to the low-tide mark to prevent stock entering the area via the beach. Fourteen railway irons (2.4 m long) were secured to the rock platform and lined with heavy-duty plastic mesh on horizontal lines of power cable. The design combined a robust vertical structure that would (it was hoped) withstand storm swells, with a weaker horizontal barrier that would give way under the pressure of heavy swells or seaweed build-up. The horizontal cable and mesh was laid in short spans which could give way without affecting the main structure while allowing easy replacement of sections as required.

Each railway iron had a steel base plate welded on and this had four 25-mm holes in each corner. Four corresponding holes were drilled into the rock to a depth of at least 200 mm and four 300-mm lengths of 20 mm diameter galvanised threaded rod were secured in each hole with epoxy resin. Once the epoxy had dried overnight the iron posts were bolted to the rods. A half 44-gallon drum was then placed over each post and filled with a combination of boulders and quick-dry concrete to further secure each foot. Each iron post had 4–5 holes set at 500 mm intervals along its length and power cable was threaded through in spans of 2–3 posts (10–15 m lengths). The cable in each span was tightened with cable strainers and plastic ('cray') mesh was then secured in each section with plastic cable ties and stainless steel tie wire. This project required considerable labour input which was provided mostly by Keith Tuuta, Denny Prendiville and Robin Seymour from the Chatham Area Office.

At Tioriori the existing netting (*Duranet*) on the main part of the fence was repaired to reduce the incidence of weka getting into the area and to channel predators towards traps set outside the fence. The electric wire was checked periodically.

Towards the end of the breeding season work began on replacing the Wharekauri fence-line to exclude stock from the beaches there.

Portable electric fences were placed around oystercatcher nests in seven territories in the managed areas (mainly at Maunganui). These were in areas with no fences between the farmland and dunes or where fences were in disrepair, allowing farm stock access to the oystercatcher nesting areas.

3.2.3 MOVING NESTS AND TYRE PLATFORMS

Nest platforms were placed in all managed oystercatcher territories before the start of the breeding season. The platforms, which were car tyres tied to plywood sheets, were filled and covered with sand and given a sparse decoration of seaweed or driftwood to imitate an oystercatcher nest site. These were designed to provide a raised nest site, for partial protection from the sea and to allow easy relocation of the nest up the beach, away from the high tide mark.

Other nests that were not on platforms were relocated by progressively recreating the nest bowl and surrounding pattern of seaweed and driftwood further up the beach, 1–2 m at a time. The decision to move a nest, and the total distance, was made on the basis of the perceived risk from high seas and the proximity to the dune vegetation.

3.3 RESULTS

3.3.1 Predator control

The results of predator control work between late September 1999 and mid February 2000 are shown in Tables 3 and 4.

During the 4.5 months of trapping most traps at Maunganui were set for 117 nights, and at Wharekauri, 131 nights.

Fewer cats were caught at Maunganui than Wharekauri. In addition to those recorded in Table 3, three domestic cats were caught and released from cage traps. They were recognised as being domestic by having a collar or from physical descriptions given by the owners. No rats or hedgehogs were caught at Maunganui. Both Norway rats *Rattus norvegicus* and ship rats *R. rattus* were caught at Wharekauri. Other predators included southern black-backed gull, Australasian harrier *Circus approximans*, little blue penguin *Eudyptula minor*, white-faced heron *Ardea novaehollandiae* and red-billed gull *Larus novaehollandiae*. Where possible these birds were released; for example, many harriers were caught only by a toe and were apparently uninjured.

TABLE 3. NUMBER OF POTENTIAL PREDATORS OF CHATHAM ISLAND OYSTER-CATCHERS CAUGHT IN THE NORTH OF CHATHAM ISLAND DURING CONTROL OPERATIONS, SEPTEMBER 1999 – FEBRUARY 2000.

AREA	METHOD	CAT	WEKA	POSSUM	RAT	HEDGE-HOG	OTHER
Wharekauri	Trapping	34	213	12	44	41	28
	Dog	4	118	0	0	0	0
	Shooting	0	72	0	0	0	42
Maunganui	Trapping	13	205	20	0	0	16
	Dog	0	111	29	0	0	0
	Shooting	0	0	0	0	0	0
	Total	51	719	61	44	41	86

TABLE 4. NUMBERS OF PREDATORS CAUGHT IN TRAPS AT WHAREKAURI AND MAUNGANUI BY MONTH.

	MONTH	TRAP NIGHTS	CAT	WEKA	POSSUM	RAT	HEDGE-HOG	OTHER
Wharekauri	Sep.	6	6	12	2	2	0	1
	Oct.	18	9	18	1	6	6	4
	Nov.	29	7	43	9	7	15	4
	Dec.	28	5	49	0	8	9	6
	Jan.	29	4	43	0	1	6	6
	Feb.	21	3	48	0	20	5	7
Maunganui	Sep.	1	1	2	1	0	0	0
	Oct.	21	3	32	1	0	0	1
	Nov.	28	0	35	6	0	0	4
	Dec.	28	1	49	1	0	0	5
	Jan.	22	4	56	6	0	0	5
	Feb.	17	3	28	4	0	0	1

The rate of capture of potential predators at Wharekauri was slightly higher than at Maunganui (Table 5). The overall capture index was 0.075 animals caught per corrected trap night (subtracting half the nights where bait disappeared, the trap was sprung or an animal was captured); i.e. each trap caught an animal every 15 days, on average. At Wharekauri the highest capture rates occurred in forest habitat (Table 5) in remnant areas behind the dune at Okahu and in a fenced reserve 500 m from the coast at Mairangi (Fig. 5). One trap (No. 1) at Okahu caught five cats, and another trap at Mairangi (No. 33) caught 21 weka. Although accounting for only 14% of total trap nights the traps in the forest caught 26% of the cats, 29% weka, 41% hedgehogs and 67% of the possums of the total number caught in the trap line as a whole. The few traps placed behind the dune (at the edge of the pasture) also had high catch rates. These traps were at Okahu and at the Wharekauri offal pit where there were dead farm stock and animals from the traps. Traps on the dune front were three times less successful than traps set in the forest, but because there were more traps set on the dune front (to protect oystercatcher territories on the coast), they accounted for most captures. Cage traps were less successful in catching animals than leg-hold traps at Wharekauri (Table 5).

TABLE 5. TRAPPING STATISTICS FROM PREDATOR CONTROL OPERATION IN NORTHERN CHATHAM ISLAND, SEPTEMBER 1999–FEBRUARY 2000.

AREA	NUMBER OF TRAPS	NUMBER OF NIGHTS	TRAP NIGHTS	BAIT GONE/ TRAP SPRUNG	CAPTURE	CAPTURE INDEX
Wharekauri						
Forest	7		674	40	105	0.175
Behind Dune	3		375	26	50	0.148
Dune front	32		3939	296	217	0.059
Cage Traps	7		850	43	44	0.055
Leg-hold traps	35		4138	319	328	0.086
Total	30-42	18-131	4988	362	372	0.081
Maunganui						
Behind Dune	12		1316	33	97	0.078
Tioriori Reserve	7		805	31	27	0.035
Dune front	15		1755	42	130	0.078
Cage Traps	5		585	21	44	0.080
Leg-hold traps	29		3291	85	210	0.067
Total	33-34	37-117	3876	106	254	0.069
Both areas	73-76	18-131	8864	468	626	0.075

At Maunganui similar catch rates occurred at traps placed at the dune front compared to those on or behind the dunes (Table 5). The trap that caught the most animals was at Takehanga East (No. 9) which was set in the dunes and caught 10 weka and seven possums. Lowest catch rates came from within the fenced area at Tioriori. Most of these animals were weka, apparently gaining access from the northern cliffs at the eastern end of the fence. Cage traps at Maunganui were slightly more successful at catching animals than the leg-hold traps (Table 5).

Bait disappeared far more frequently at Wharekauri (Table 5), possibly because of the higher incidence of rats (Table 3), which appear successful at removing bait. A video camera placed on a leg-hold trap recorded a cat removing the bait from the backing board by reaching across the trap, but it was caught 30 minutes later when it returned to the trap.

3.3.2 Nest moving

Two oystercatcher pairs laid clutches in tyre platforms that were placed in their territories, close to where they had nested previously. Often pairs in other territories prospected the tyres and made scrapes but did not lay in them.

Eleven nests were moved away from the high tide mark, generally only 2–4 m because of the proximity to dune vegetation, or the lack of suitable 'high ground'. In most cases this was enough to save the nests from flooding during moderately high seas as on several occasions the sea reached within 1 m of the new nest site. One nest that had been moved was washed away by the sea (see Section 4, Nest monitoring).

3.4 DISCUSSION

The results of predator control are compared between 1998/99 and 1999/2000 in Table 6. Although the amount of effort was not tabulated in Bell (1999), clearly, the number of trapping nights from the 60–80 traps used was fewer in 1998/99, as work started later in the season (2 November 1999). Because only one person was involved, traps were serviced 6 days per week, rather than every day. Consequently, total trap nights may have been at least 20% less than in 1999/2000. In total, 391 animals were caught in traps in 1998/99 compared with 626 in 1999/2000. However, apparently much more effort was put into hunting and shooting predators in the dunes in 1998/99 as 492 animals were killed compared with 376 in 1999/2000. Consequently, the overall total number of cats and weka killed was similar between years. Interestingly, the number of potential predator species that was trapped was higher at Wharekauri than at Maunganui (Table 6) in both years.

TABLE 6. COMPARISON OF PREDATOR CONTROL RESULTS IN 1998/99 AND 1999/2000 IN NORTHERN CHATHAM ISLAND.

YEAR	AREA	METHOD	CAT	WEKA	POSSUM	RAT	HEDGE-HOG	GULLS
1998/99	Wharekauri	Trapping	21	91	9	0	25	12
	Maunganui	Trapping	14	176	36	0	0	7
		Total	47	654	133	0	39	23
1999/00	Wharekauri	Trapping	34	213	12	44	41	9
	Maunganui	Trapping	13	205	20	0	0	2
		Total	51	719	61	44	41	53

Patterns of captures per month, between locations and trap type, were different in the two management areas in 1999/2000. Substantial numbers of animals were captured throughout the season with no peak in number caught, which suggests that the trapping period should not be shortened. Presumably, territorial animals that were killed by traps near the beach were quickly replaced by new individuals moving in from adjacent dunes or farmland.

Where cat tracks were observed on the beach, usually a cat was caught in the same area over the next day or so (rarely up to a week later). On one occasion, a cat was filmed visiting the nest at Mairangi during the night (see section on video monitoring), and the following morning a cat was found caught at the trap closest to the nest. The trapping method relies on the assumption that animals will prospect along the dune front and be attracted to the fish bait on the traps rather than molest the nesting birds on the beach. The two trap types were of similar efficiency, although cage traps were less successful at Wharekauri.

The Wharekauri data suggested that higher capture rates would be obtained by setting traps behind the dunes but this was not borne out by the Maunganui data. Possibly, there was an influence of the offal pit at Wharekauri attracting predators to sites behind the dunes. Redirecting too much effort behind the dunes could miss predators that travel along the beach. The intensity of trapping would appear to be sufficient to protect almost all nests since few eggs or chicks were preyed on. Ironically, the only nest losses in the managed area that were attributed to predators occurred at Tioriori area. The fence presumably limited the invasion of predators, since the capture rate within the fenced area was half the rate that was found in other areas. Eggs disappeared from one nest, near where weka and possums had been caught in traps, and another infertile egg disappeared at a time cat tracks were seen. In some areas, such as Takehanga and Washout Creeks, chicks were taken by their parents across streams which curved inland behind the dunes. Thus chicks were raised, in some instances, behind the front dunes and may, as a result, have been more vulnerable to predators moving in from the farmland.

The approximately 50 cats caught in each of the two seasons (1998/99 and 1999/2000) on the 14 km of coastline in northern Chatham Island would indicate that thousands of feral cats are present on the island, even allowing for the fact that they have large home ranges. The trapping programme to protect taiko *Pterodroma magentae* breeding burrows in the Tuku area in southern Chatham Island removes up to 56 cats annually, and a total of 204 were removed in the 6 years between 1987/88 and 1992/93 (Imber et al. 1994). Increased trapping effort in the Tuku area during the 1999/2000 summer resulted in 92 cats being killed (M. Ogle, pers. comm.).

Weka are abundant and thriving on the Chatham Islands and it is the only place in New Zealand where they are unprotected and harvest is legal (Heather & Robertson 1996). The subspecies buff weka *Gallirallus australis hectori* became extinct in the eastern South Island by the late 1920s but it was introduced to the Chatham Islands in about 1905 where it has survived very well (Bell 1996). Two species of rail had previously become extinct as a result of hunting, collecting and predation by cats (Millener 1996). Most weka subspecies suffered rapid declines in the early 1900s and surviving populations have continued to disappear in recent times (e.g. Beauchamp 1997), possibly a result of a combination of habitat clearance, poisons and introduced mammalian predators (Heather & Robertson 1996). The absence of mustelids on Chatham Islands may be a key to their survival there. Unfortunately, because of their feeding habits, including the eating of eggs of seabirds and ground-nesting birds, weka are often considered to be pests and have been eradicated from some of New Zealand's offshore islands; e.g. Codfish Island to protect kakapo *Strigops habroptilus*. In the Tuku area large numbers of weka are killed to protect taiko; 1572 were killed over 6 years between 1987/88 and 1992/93 (maximum 716) (Imber et al. 1994), and trapping continues annually. In 1999/00, 379 weka were killed there (M. Ogle, pers. comm.). Large numbers (1373) have been killed in northern Chatham Islands over the last two years to protect oystercatchers.

Several pairs of oystercatchers prospected and made scrapes in tyre nest platforms but only two laid eggs in them. Only one pair bred in a tyre the previous season. This may have been a result of poor placement of the tyres and placement after oystercatchers had started to select nest sites (Bell 1999). Eleven nests were moved in 1998/99 but six were still washed away by storms (Bell 1999). The success of moved nests was higher in 1999/2000, probably because storms were less severe during the incubation period. There were several close calls however (see nest monitoring section). There had been some concern expressed that tyres could attract predators. It was noted (S.O. pers. obs.) that freshly placed tyres (before they were covered with sand) on the beach in 1998 were each checked by a cat as it walked through the oystercatcher territories at Tioriori.

The latest design of the tie-off fence at Tioriori withstood a series of large swells over the season. The plastic netting had to be replaced at times but the main structure remained intact.

3.5 RECOMMENDATIONS

- The management regime in northern Chatham Island should be repeated in 2000/01. This will result in 3 years of intensive trapping within the Maunganui–Tioriori/Wharekauri management area.
- A feasibility study for dune modification/revegetation should be initiated in 2000/01 and a trial conducted in winter 2001
- Some fine-tuning of the trapping methods and programme would result in lower catch rates of non-target birds (e.g. roves to limit harriers, driftwood barrier to deter penguins) however they first need to be trialed to ensure that modifications do not deter target species
- More traps could be placed behind the dunes to gain better coverage, protect chicks that move behind dunes and compare trapping efficiency.

4. Nest montitoring and breeding success

4.1 INTRODUCTION

In 1999/2000 it was hoped to gain better insights into breeding patterns and success of Chatham Island oystercatcher from a range of localities on Chatham Island. To look at this issue, emphasis was placed on the managed and unmanaged areas in northern of Chatham Island, followed by the offshore islands and some less intensive monitoring of territories in the south-west of Chatham Island and on Pitt Island.

4.2 METHODS

The most intensive monitoring of nests was in the managed areas where predator trapping necessitated daily visits. Hence, the managed territories received over 100 visits in the season. It was intended that unmanaged areas would be visited about twice per week; however, visit intervals to some territories were highly variable (1–14 days) because of logistical constraints and staff focussed their effort on managed areas or nests with video cameras. Total visits to unmanaged territories were generally 25–35 visits (range 20–68).

Nests were photographed to record their position in the territory and photos were placed in an annotated album.

At each visit to the territories, whether adults were present and the nest contents or presence of chicks (by noting behaviour of parents on some days and searching to locate the chicks on others) were recorded. At the end of each day, data were transferred to nest summary sheets and, periodically, these data were further summarised on a computer spreadsheet.

Daily nest monitoring on Rangatira and Mangere Island was undertaken for 2 clutches of eggs (one on each island) to obtain egg morphometrics, fresh weight and daily weight loss as a benchmark for egg calculations and to fine-tune artificial incubation parameters. All other pairs and breeding attempts were monitored at least once a week to follow breeding success on both of these offshore islands. Data were recorded on the standard sheets.

Coarse monitoring of breeding success occurred at two other areas. On the southwest coast of Chatham Island three pairs were monitored at approximately 3–5 week intervals by Shaun O'Connor and on Pitt Island seven pairs were monitored at least once a month (more frequently for some pairs) by Sandy King.

A standby incubator was turned on whenever a significant northerly storm threatened to swamp nests with large swells in the managed territories of northern Chatham Island. A portable incubator and dummy eggs were held at Wharekauri.

4.3 RESULTS

4.3.1 North Chatham Island

Oystercatcher territories are shown in Figures 6–11, with approximate boundaries and nest sites. Most pairs (n = 32) nested on the beach between the high tide mark and the vegetated dunes or on the shelf behind the beach if there was no dune. Five nests were on rocky outcrops. Another nest was on grazed pasture about 50 m inland of the rocky shore.

The earliest eggs were laid about 19 October (although this particular nest was not found until 23 October) at Washout West (Appendix 2). Mean clutch initiation was 7 Nov. ± 16.9 (range 19 Oct. – 25 Dec., n = 16) at managed areas and 30 Nov. ± 24.9 (range 13 Nov. – 30 Jan., n = 8) at unmanaged areas (Appendices 2, 3).

Clutch size varied from 1–3 eggs. The mean clutch size was 2.2 ± 0.6 (n = 35) but the proportion of 1-, 2- and 3-egg clutches was 10%, 45% and 45% in managed areas and 13%, 80% and 7% in unmanaged areas. Not included in these data are one nest in the managed areas and two in the unmanaged areas which had one egg but had failed before there was an opportunity for a second egg to be laid. All other clutches were considered to be complete if they had the same number of eggs for 3 or more days.

The mean laying interval between the first and second egg was 1.9 ± 0.5 days (range 1–3, n = 14) and between the second and third eggs it was 2.6 ± 0.5 days (range 2–3, n = 7), as deduced from daily visits to nests. Consequently it took 4–5 days to complete a clutch of 3 eggs. Mean incubation time (from clutch completion to the final chick hatching) was 29.4 ± 2.1 (range 26–33, n = 15).

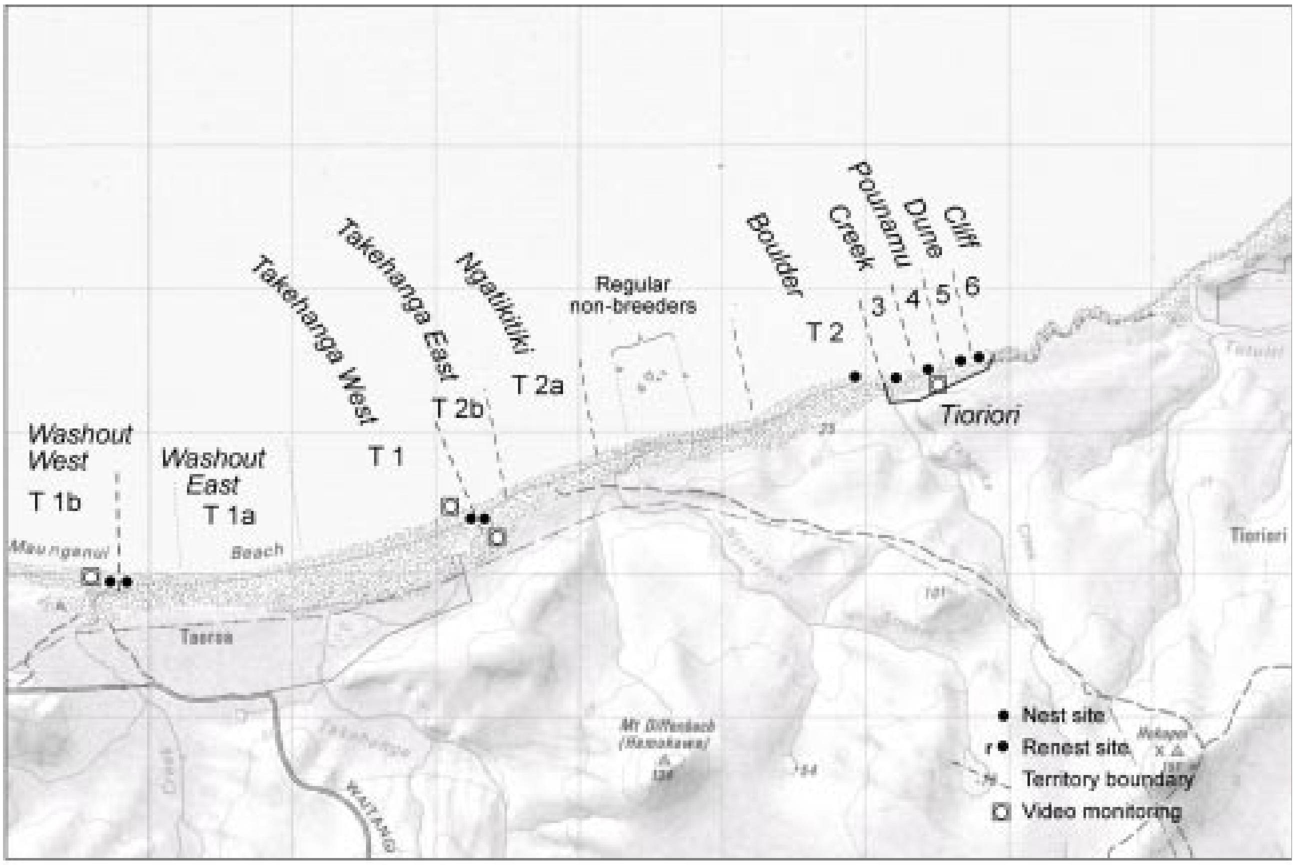


Figure 6. Manganui–Tioriori managed C.I. oystercatcher area.

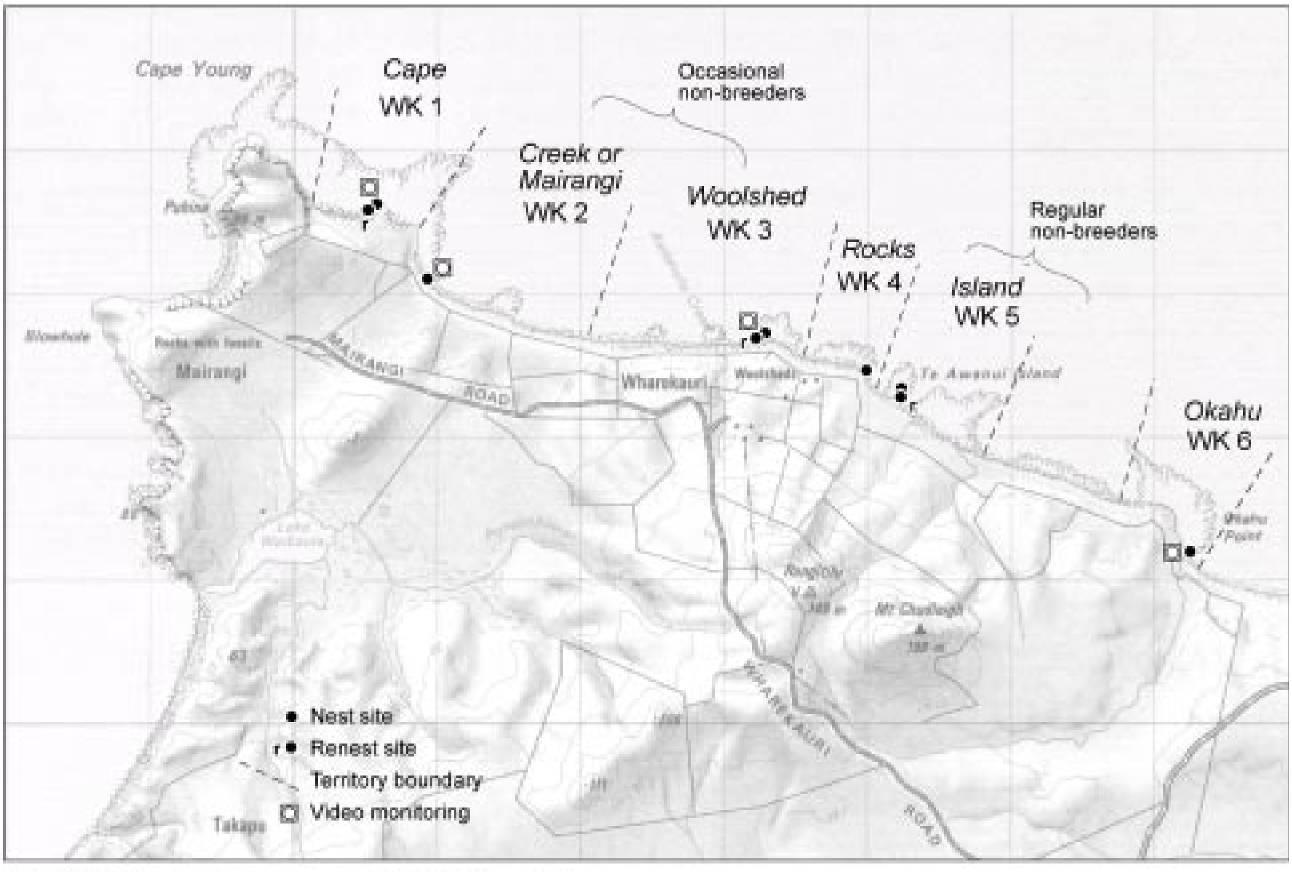


Figure 7. Wharekauri managed C.I. Oystercatcher area.

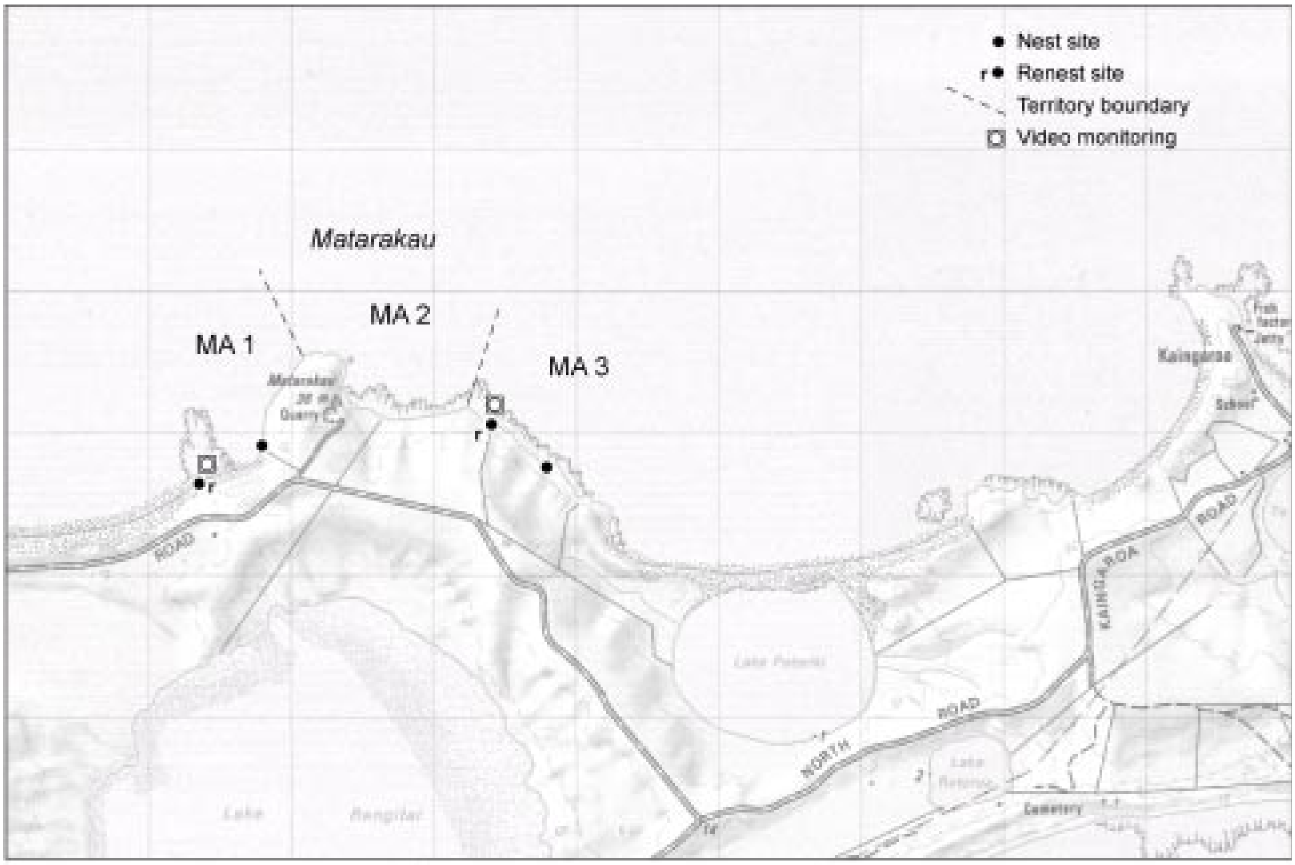


Figure 8. Matarakau unmanaged C.I. oystercatcher area.

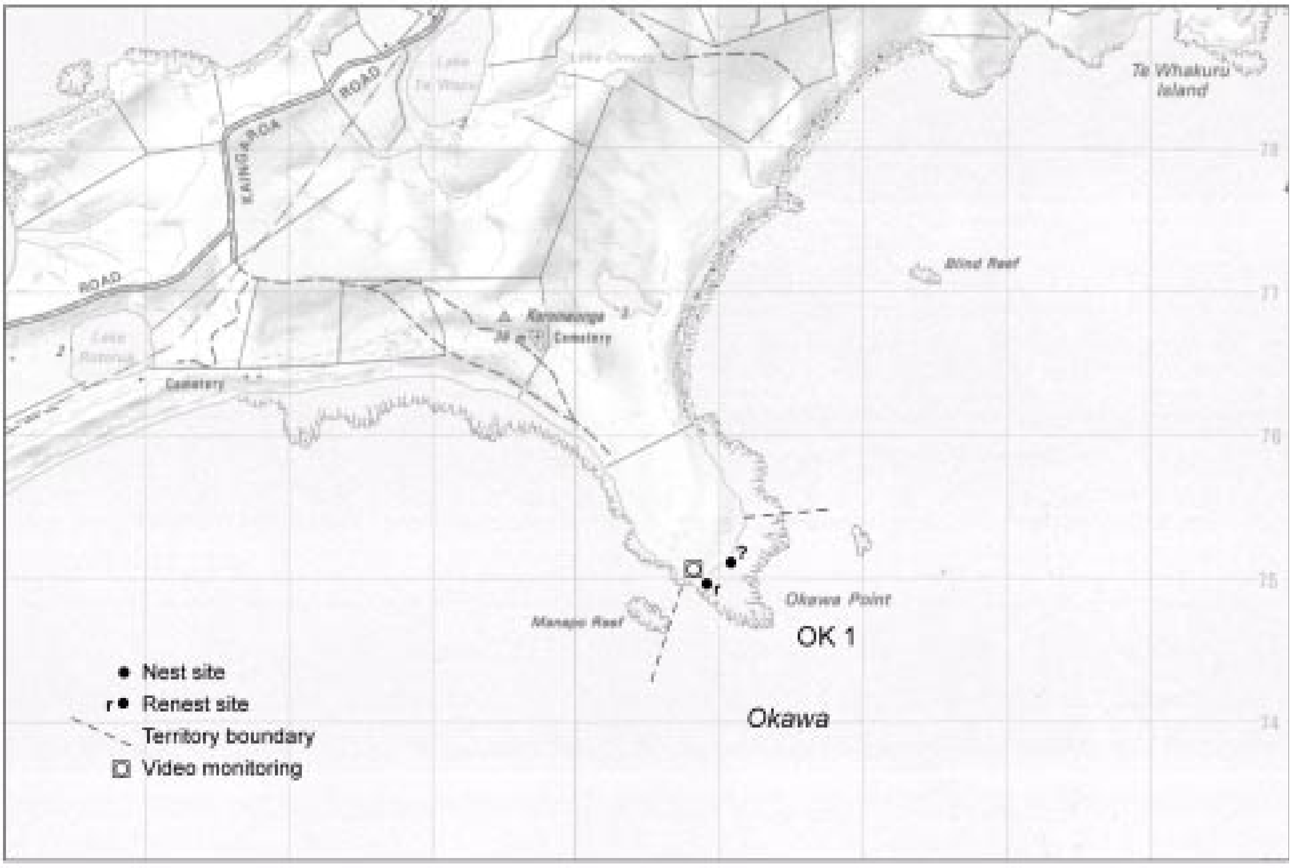


Figure 9. Okawa unmanaged C.I. Oystercatcher area.

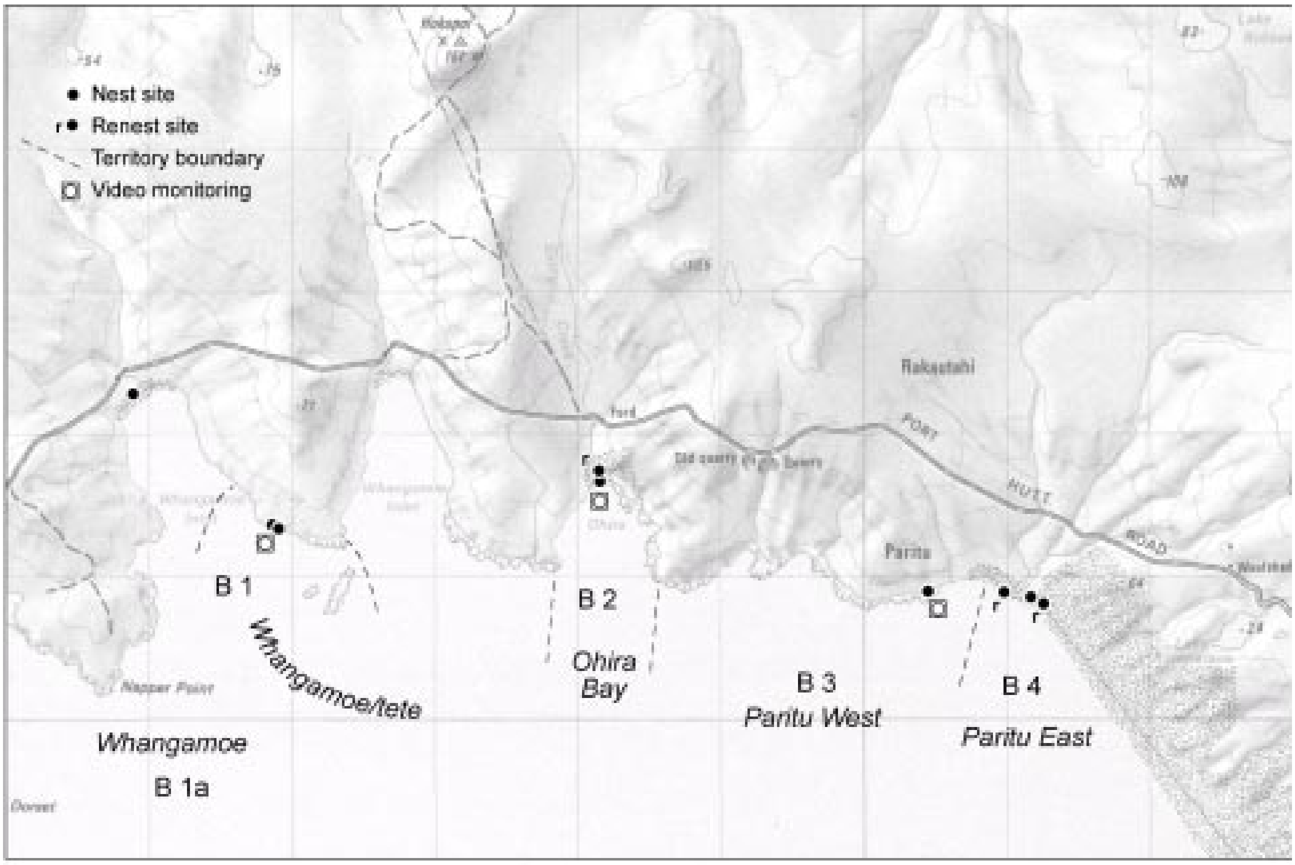


Figure 10. Whangamoe–Paritu unmanaged C.I. Oystercatcher area.

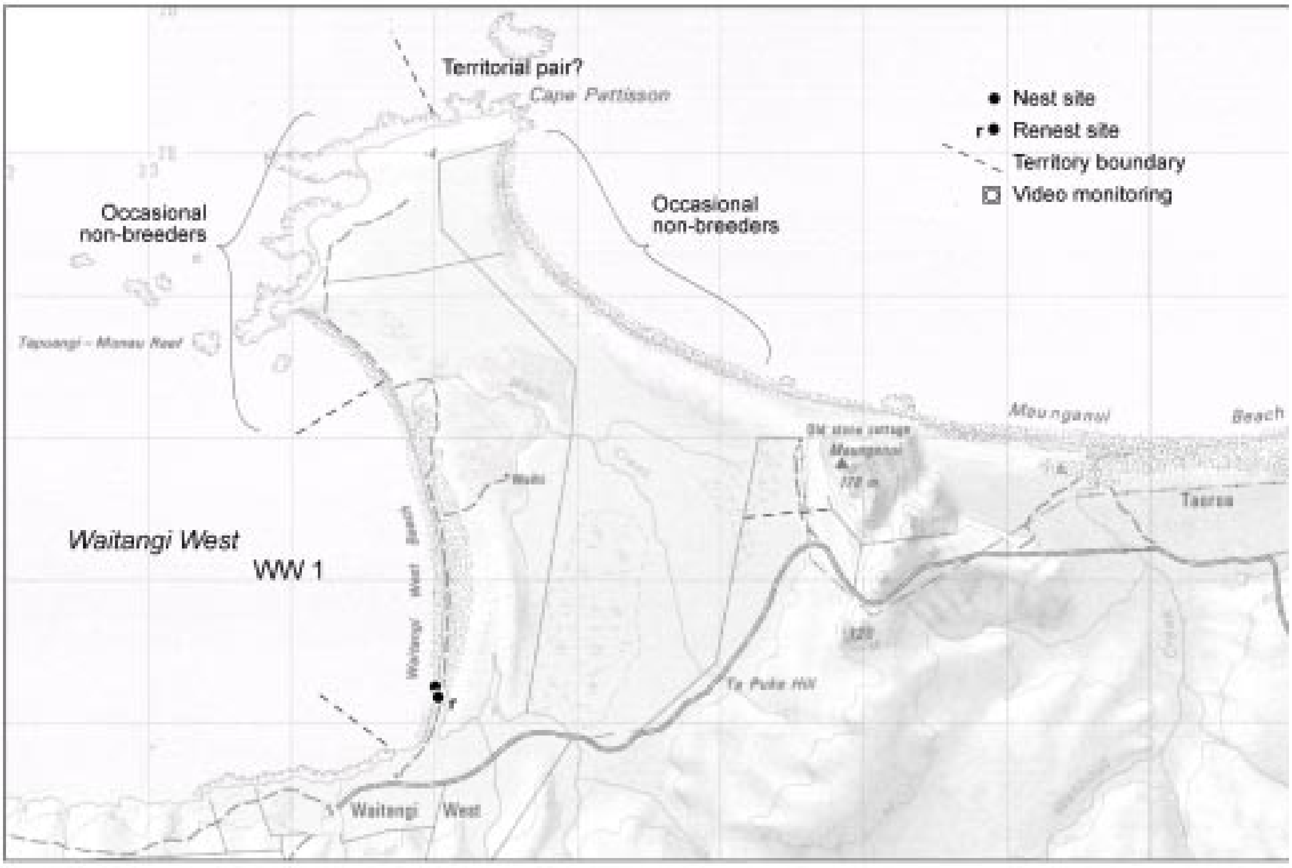


Figure 11. Waitangi West unmanaged C.I. Oystercatcher area.

Pairs nested up to three times in the season if the first two clutches of eggs (or young chicks in one case) were lost (Appendices 2 and 3). Some nesting attempts by pairs in the unmanaged areas were probably missed as a result of infrequent visits. For example, the egg at the second nest at Whangamoe/tete had disappeared the day after it was found. The pair at Matarakau MA2 may have laid and lost eggs between visits, as there was active construction of nest scrapes at times throughout the summer. The mean interval between loss of a clutch and initiation of a new clutch was 12.8 ± 3.6 (range 10–19 days, n = 5) in the managed areas and up to 2–3 weeks in the unmanaged areas. Second clutches tended to be laid between late November and early January and third clutches between late December and mid January. The latest clutch found was initiated on 15 January 2000.

Chicks quickly became mobile after hatching and left the nest after the first 1–2 days. In 2-egg clutches that were visited on consecutive days throughout the hatching period, chicks usually hatched on the same day (n = 8) or a day apart (n = 5). In 3-egg clutches, broods were completed over 2 days (n = 2) or 3 days (n = 1). In four 2-egg clutches that were observed on video, all the chicks apparently hatched during the day and the interval between both chicks hatching (when they were first visible during a change-over, or when the adult stood up) was 0:24, 1:15, 7:05 and 29:36 (hours:minutes). In one 3-egg clutch the intervals were 11:43 and 22:58, i.e. the brood was complete in 34:41 (hours:minutes).

Breeding success of Chatham Island oystercatcher nests in 1999/2000 in the north of Chatham Island is summarised in Appendices 2 and 3. In managed areas there was intensive predator control and nests were moved as far from the high tide mark as possible (see management section), whereas no manipulation occurred in unmanaged areas. The managed areas had the highest breeding success, 14 (87.5%) of the 16 pairs hatched chicks and 13 (81.3%) fledged chicks, a total of 25 young. In contrast, 5 (55.6%) of the 9 unmanaged pairs hatched chicks, but none of the chicks survived. The two territories at Taupeka were rarely visited because of access restrictions, hence the results were sketchy. Two chicks were banded here late in the season (by D. Bell), but because it is possible that some predator control occurred there they are not included in the core data summary statistics (Appendix 2). Nor was the suspected first nest at Okawa included as no details were known.

Losses of eggs and chicks are briefly described in Table 7 (with details in Appendices 2 and 3; and omitting the uncertain results for Taupeka and Okawa No. 1). Over half of all egg losses were a result of high seas wiping away the nests (Table 7). Many nests were vulnerable to moderately high tides because of the narrowness and shelving nature of the beaches. Wind-generated waves swept up the beach or pushed water up and over the edge of narrow sand shelves, in which case thin sheets of water could sweep considerable distances. Generally speaking, winds of 30–40 knots created ocean swells, which upon breaking ashore, swept above the normal high tide mark on the beach. Strong winds from the northerly or westerly quarters threatened beaches on the north coast and those from the southerly quarter threatened the Whangamoe–Paritu coast. Occasionally, large swells built up without strong winds being experienced on the island itself. Gale winds on 11–12 November resulted in 'Woolshed' (No. 1) being washed away. High seas on 19–21 November washed

TABLE 7. PROPORTIONS OF CHATHAM ISLAND OYSTERCATCHER EGG AND CHICK LOSSES TO DIFFERENT CAUSES IN MANAGED AND UNMANAGED AREAS OF NORTHERN CHATHAM ISLAND 1999/2000.

	MANAGED		UNMANAGED		COMBINED
	NUMBER OF EGGS LOST	% OF TOTAL LOST	NUMBER OF EGGS LOST	% OF TOTAL LOST	% OF TOTAL LOST
Egg losses					
Sea	8	53.3	11	50	51.4
Infertile/damaged	4	26.7	1	4.5	13.5
Abandoned	1	6.7	1	4.5	5.4
Predator	2	13.3	7	31.8	24.3
Disappeared	0	0	2	9.1	5.4
Total	15		22		
Chick losses					
Predator	0	0	2	20	11.1
Died young	4	50	2	20	33.3
Disappeared	4	50	6	60	55.6
Total	8		10		

away ‘Island’ nest (No. 1), probably both nests at Taupeka and the pre-nest scrapes of ‘Pounamu’. A more intense period of bad weather (40 knot northerly and 3 m swells, followed by a southwest change) on 13–15 December washed away Waitangi West (No. 1), Matarakau MA1 (No. 1), Cape (No. 2) and Paritu East (No. 1). It is also possible that ‘Cliff’ and Ohira Bay lost young chicks to this event but they apparently disappeared a couple of days later, on about 16–17 December. A southwesterly gale on 9 January swept Paritu East (No. 2) away from the rocks and their renest (No. 3) on the sandy beach was washed over several times between 3–9 February before being abandoned. In one instance, the eggs were moved up to 80 cm by the waves and were collected together again by the birds. Whangamoe (No. 1) was also lost on 4 February. There were several other close calls where the sea came within a metre of the nests. A wind-generated foam ball (seen on video) hit the incubating bird at ‘Woolshed’ (No. 2), soaking the nest, but no harm was done as all three eggs hatched.

The other principal cause of egg loss was predators (cats and weka), particularly in unmanaged areas where they accounted for a third (up to 41% if disappearances are included) of all egg losses (Table 7, Appendix 3). Two clutches were observed on film being eaten by cats (Whangamoe/tete No. 1, Matarakau MA3 No. 2) and one by weka (Whangamoe/tete 3). At ‘Cliff’ there were possible weka tracks near the nest and weka and possum had been caught in nearby traps around that time.

Infertility or egg damage was greater in managed areas, but this was underestimated in unmanaged areas because a low proportion of eggs reached their full incubation term. At ‘Pounamu’ the egg was probably infertile, as it was incubated for more than 43 days before it was eaten by a cat (tracks led to the nest from the marram grass).

Two eggs were abandoned. At the ‘Cape’ this was probably a result of human disturbance (Appendix 2). This occurred when the freshly laid egg was replaced with a dummy egg for one night and the nest was moved 4 m in order to protect it from an approaching storm; however, the birds did not return to the nest. At

Ohira Bay the birds abandoned their second egg (the chick inside was almost ready to hatch and was peeping from within the egg) as hatching was asynchronous and the first chick did not return to the nest after the first day.

Two eggs disappeared. The egg at MA3 may have disappeared before or after hatching, as the nest was not visited to check its contents for 10 days. At Whangamoe/tete (No. 2) the egg disappeared the day after it was found, probably to a predator as the other two attempts by this pair failed for that reason.

Over half of chicks that were lost disappeared for unknown reasons. The chicks at Paritu West were probably eaten by a cat, as evidenced by the remains of feathers and wings found on the beach and cat tracks on the sand. Several chicks died in quick succession just after hatching, as possibly they were too weak upon hatching (asynchronous hatching), or they were trampled accidentally by the parent. At 'Cliff' the weakened chick appeared to be infested with bugs before it died (R.G. pers. obs.).

4.3.1 Rangatira

Five pairs were resident and monitored on Rangatira over the 1999/2000 season. Four pairs bred and three chicks fledged (Appendix 4). A fifth pair was a regular territory holder at mid Thinornis Bay but did not show any sign of breeding activity.

4.3.2 Mangere Island

Three pairs were resident and monitored on Mangere Island over the 1999/2000 season. Two pairs bred but were not successful (Appendix 5), while the 3rd pair was not continuously resident and did not show any breeding activity. Chick disappearances corresponded with periods of bad weather and associated high seas.

4.3.3 Pitt Island

Seven pairs were monitored on Pitt Island, five bred and one pair produced two fledgelings (Appendix 6). Nest tyre platforms were put out in three territories (P1, P3 and P11) on 5 November. The platforms in P11 received 1 scrape but all were found washed out by high seas on 15 January. Some predator control was conducted.

4.3.4 Southwest Chatham Island

Three territorial pairs were monitored on the southwest coast of Chatham Island between Stony Hill and Otawae Point (Appendix 7). The pair at Kiringi Creek produced 1 clutch and the pair at Point Gap double clutched; however, no breeding attempts were noted at Sweetwater (the boulder bay west of Otawae). No chicks were fledged from these areas.

4.3.5 Egg morphometrics and weight loss

Egg dimensions and weights were recorded from 14 eggs on three islands (Mangere, Rangatira and Chatham; Table 8). Fresh weights were recorded for five eggs which, along with the daily weight loss measurements (Table 9), will be useful for running egg calculations for artificial incubation of salvaged eggs during storm events.

TABLE 8. CHATHAM ISLAND OYSTERCATCHER EGG MORPHOMETRICS 1999/2000.

ISLAND	PAIR	EGG	DIMENSIONS (mm)	WEIGHT (g)	INCUBATION TERM (FROM CANDLING/KNOWN)
Rangatira	East Landing	1	56.1 × 42.2	54.0	Fresh
		2	56.9 × 41.5	51.0	Fresh
	Sealers Pt	1	54.3 × 40.0	46.0	2–3 days incubation
		2	57.6 × 39.7	47.0	2–3 days incubation
	Sth Thinornis	1	54.6 × 41.6	47.5	2 days incubation
		2	56.0 × 39.8	46.5	2 days incubation
		3	56.5 × 39.9	46.5	2 days incubation
Mangere Island	Landing	1	52.7 × 38.6	43.5	Fresh
		2	54.4 × 40.2	43.25	Fresh
Chatham Island	Point Gap	1	55.7 × 39.4	40.0	14 days incubation
	Ngatikitiki	1	57.9 × 41.2	50.5	Fresh
	Kiringi	1	56.0 × 39.9	42.0	10 days incubation
	Manukau	1	56.0 × 40.4	40.5	20–23 days incubation
		2	54.8 × 39.7	42.5	20–23 days incubation

TABLE 9. CHATHAM ISLAND OYSTERCATCHER EGG WEIGHT LOSS RECORDED FOR 2 CLUTCHES 1999/2000.

ISLAND	PAIR	EGG	EGG DIMENSIONS (mm)	AVERAGE DAILY WEIGHT LOSS (g)	% WEIGHT LOSS OVER INCUBATION
Mangere Island	Landing	1	52.7 × 38.6	0.25g	16.6%
Landing Pair		2	54.4 × 40.2	0.23g	14.1%
Rangatira	East Landing	1	56.1 × 42.2	0.18g	10.2%
		2	56.9 × 41.5	0.23g	12.7%
Mean		-	-	0.22g	13.4%

Egg weights were recorded daily from a clutch on Rangatira and another on Mangere Island (Table 9). From a sample size of four eggs the average daily weight loss was 0.22 g and an average weight loss of 13.4 % over the incubation period (range 28–30 days).

4.4 DISCUSSION

The fledging of 25 Chatham Island oystercatcher chicks (1.6 chicks/pair) of in the managed zone of northern Chatham Island in 1999/2000 is the highest success yet recorded for the species (Table 10). The previous high of 1.1 chicks/pair was in the same area in 1998/99. Including unproductive unmanaged territories (0.18 chicks/pair from 11 pairs), total production in the north of Chatham Island (managed and unmanaged areas) was about 1.0 for 27 pairs in 1999/2000. Southern areas apparently did not produce any chicks and low numbers fledged on offshore islands (0.45 from 11 pairs).

In the past, oystercatcher breeding success was monitored less intensively, as occasional visits to the dispersed nests were fitted around other work. The best data sets came from the offshore islands (Mangere and Rangatira) as

TABLE 10. BREEDING SUCCESS OF CHATHAM ISLAND OYSTERCATCHER SUMMARISED BY YEAR AND LOCALITY.

ISLAND	YEAR	PAIRS	% EGGS HATCH	% CHICKS FLEDGE	NUMBER OF CHICKS FLEDGED	NUMBER OF CHICKS FLEDGE/PAIR	SOURCE
Chatham Island	1987	32-44			8	0.18-0.25	Davis 1988
N. Chatham	1991	10-11			6	0.5-0.6	F. Schmechel
	1992	12-15			12	0.8-1.0	F. Schmechel
	1993	13-14			6-8	0.5-0.6	F. Schmechel
	1994	11	52	53	8	0.7	F. Schmechel
	1995	14	37	46	7	0.5	F. Schmechel
	1996	14	24	30	2	0.1	F. Schmechel
	1997	15			11	0.7	Bell 1998
	1998	16	50	69-74	18	1.1	Bell 1999, O'Connor 1999
	1999	16	69	76	25	1.6	This report
Unmanaged areas	1998	10			1	0.1	Bell 1999
Core	1999	9	31	0	0	0	This report
Total	1999	11	30	17	2	0.2	This report
South-west	1999	2			0	0	This report
Rangatira	1974-1987	8-13	45 ± 16 (32-68, n = 4 years)	43 ± 14 (25-60, n = 4)		0.5 ± 0.05 (0.2-0.9,n = 12)	Davis 1988
	1999	4	75	33	3	0.75	This report
Mangere Island	1970-1987	2				0.3 ± 0.3 (0-1.0, n = 12)	Davis 1988
	1999	2	88	0	0	0	This report
Pitt Island	1999	5	26	21	2	0.4	This report
Total	1999	40			32	0.8	This report

conservation workers stationed on the islands could more easily keep an eye on the small number of breeding pairs. Mean productivity of 8–13 pairs on Rangatira over 12 years was 0.47 (Davis 1988), whereas the two pairs on Mangere Island produced 0–2 chicks per year (Davis 1988). In 1987/88, only 8 chicks were known to have fledged from 44 pairs throughout the Chatham Islands (Davis 1988), although breeding success was probably underestimated because of infrequent monitoring (Schmechel 2001).

In the early 1990s, 10–15 pairs in northern Chatham Island produced 6–12 chicks per year, or 0.5–1.0 fledglings/pair at a time when predator control effort varied from low to high (data compiled by F. Schmechel). More intensive nest monitoring (visits 14–23 times per season) occurred from 1994–1997 at a time when management actions were minimal (F. Schmechel, unpubl. data). During this time 12–15 pairs fledged 2–10 chicks per year, or 0.1–0.7 fledglings/pair (average 0.44, Schmechel 2001). Egg losses were attributed to sea wash (48%), unknown reasons (26%), failed to hatch due to infertility, embryo death, mishap or abandonment (23%) and predation (3%) (Schmechel 2001). Most chick losses were to unknown causes (Schmechel 2001).

In 1999/2000 visits to territories almost every day (and over 100 times for the season) made determination of breeding statistics and nest outcomes much easier. The less consistent visits to unmanaged areas (26–68 times) resulted in lower reliability of data.

Productivity in Chatham Island oystercatcher (Davis 1988; Schmechel 2001) has been identified as very low compared with other oystercatchers, and may be borderline for population maintenance (Davis 1988). However, this parameter may not be as important as juvenile or adult survival. It has been suggested that by increasing the overall production of Chatham Island oystercatcher and maintaining high adult survivorship, the population will increase (Aikman et al. 2001). It should be noted that it is a characteristic of oystercatcher species to have low breeding success because of high egg losses from predators and storms (Hockey 1996b). Because the intensity of these two factors varies between areas and years, breeding success can be quite variable. For example, 0.2–1.1 fledglings/pair/year for *Haematopus bachmani* at different areas or 0–0.5 fledglings/pair/year for *H. palliatus* in different years at the same site in North America (Hockey 1996b).

Breeding output in most years and localities of the Chatham Islands has been 0–0.5 chicks/pair/year (Table 10). Excess production on Rangatira in the 1980s appeared to allow surplus birds to disperse to Mangere and Pitt and Chatham Islands, despite production being only about 0.45 chicks/pair/year (Davis 1988, Table 10). Interestingly, chick production of 0.3–0.6/pair/year for *H. moquini* on a predator-free island in South Africa might be critical for maintaining the mainland breeding population where production was only 0.03 (Hockey 1996b).

The high productivity in the managed area must relate to the intensive predator control—as few eggs or chicks were lost to predators—and, possibly, the quality of habitat. In contrast, in unmanaged areas several nests were lost to predators in 1999/2000. It is possible that the preceeding years of variable levels of predator control in the north since the early 1990s allowed new recruits to establish in areas such as Whangamoe–Paritu where there were no known breeding pairs in the mid-1980s. This seems likely, as many of these birds are banded, whereas most birds in southern Chatham Island are unbanded. It will be of great interest to see where the colour-banded juveniles from 1998 and 1999 establish and are recruited into the population.

The main causes of egg losses of many oystercatcher species around the world are predators and storms (Hockey 1996b). As found previously (Schmechel 2001), almost half of all egg losses of Chatham Island oystercatchers is caused by the sea. One storm event can wipe out several nests, so a month of settled weather is required for any particular nest to survive. Fortunately, oystercatchers that nest early in the season, readily re-nest at least twice after the loss of eggs. Because birds tend to nest close to the high tide mark they are vulnerable. This would appear to relate to the need for a nesting site close to the feeding ground in the territory with a good view to observe approaching danger or competitors. The stabilisation of sand dunes by the introduced marram grass has decreased nesting opportunities away from the high tide mark, created a steeper beach profile and provide more cover for predators. Some territories had almost no chance of a nest lasting without being washed away because waves regularly reached the vegetated dune, for example the pair at Paritu East lost three nests in succession to high seas. There is circumstantial evidence that the presence of densely vegetated dunes is an important factor in the loss of nests to the sea. Several territories had little dune vegetation, usually because farmland was contiguous with the edge of a pebble/boulder beach or rock platform, and in these cases the birds nested further from the high tide mark, in one case on the farmland itself. The birds had unobstructed views of the whole territory from the nest. At Ohira Bay where the dune was unstable and the sandy beach very wide, the birds nested a long way from the water.

Non-native grasses such as marram were introduced to New Zealand and other countries to prevent dune erosion and drift of sand onto agricultural land (Bergin et al. 1995). The morphology of foredunes has changed in Australia by the different sand-binding properties of introduced grasses compared with native grasses (Heyligers 1985). Consequently, foredunes are higher and steeper than previously was the case (Park 1994). Hooded plover *Thinornis rubricollis* and pied oystercatcher *Haematopus longirostris* once nested on low terraced foredunes where the sparse native grass allowed incubating birds to see all around. Subsequently, these nesting areas were covered with dense marram and birds then nested on the upper beach (Park 1994). A similar problem of dune stabilisation by marram in Oregon caused snowy plover *Charadrius alexaninus* to nest too close to the high tide mark where losses from wave action were more likely. Habitat restoration by flattening the foredune and opening up nesting habitat allowed birds to nest off the beach (Moore 2000).

Replacing areas of dense marram with less dense assemblages of native plants could potentially be used in northern Chatham Island to improve the nesting success of oystercatchers. It is likely that in former times the dunes were lower in profile, due to the weaker sand-binding properties of pingao *Desmoschoenus spiralis* compared with marram, and more extensive in area. Dunes were probably more mobile but the inland progression of sand would have been checked by shrubland and forest. These were largely replaced by farmland.

Predation of eggs and chicks was the other key factor in breeding success which was identified in the north of Chatham Island. (This will be discussed more fully in the video section). It could be argued that predation may not be a significant problem if birds can renest and still be successful. However, the high productivity of the Chatham Island oystercatcher in predator control areas compared to zero production in unmanaged areas would tend to refute that theory.

Other potential causes of nest loss include disturbance by people (and their dogs) and trampling by livestock, both of which have been reported in the past (Aikman et al. 2001; Schmechel 2001) and are considerable problems for other shorebirds in New Zealand and overseas. The variable oystercatcher occupies a similar niche to the Chatham Island oystercatcher. Although it probably faces higher levels of human disturbance on New Zealand coasts, the population is thought to have doubled in the last 30 years as a result of protection by law against indiscriminate shooting (Heather & Robertson 1996; Dowding & Murphy 2001). However, census data from 1971/72 (Baker 1973) and the mid-1990s (Heather & Robertson 1996) may not have been comparable in effort and coastal coverage. Baker (1973) felt that both variable and Chatham Island oystercatchers had probably maintained their numbers over the previous 100 years.

Breeding statistics in 1999/2000 are similar to those found by Davis (1988) and Schmechel (2001). Schmechel (2001) found the earliest egg was about 13

October and estimated an incubation period of 28–29 days. Davis (1988) found a shorter incubation span of 25 days for three pairs on Rangatira Island.

Breeders in the managed zone nested earlier and tended to have larger clutches than the unmanaged nests. Davis (1988) also noted a higher incidence of three-egg clutches in the northern part of the species range. This may relate to better quality territories along the Maunganui–Wharekauri coast allowing the birds to reach high body condition. Also, in the unmanaged areas, because the birds rarely get a chance to breed successfully, they may not have settled into a regular breeding pattern. Adult survival may be low, so new birds in the unmanaged territories may be inexperienced. Alternatively, the monitoring regime may have failed to find early nests in unmanaged areas, since they could lose eggs within a day or two of being laid. For example, first eggs laid by Eurasian oystercatchers *H. ostralegus* have a 40% chance of being preyed on before the second egg is laid (as determined by thrice daily nest visits) (Ens et al. 1996). This means that nesting attempts are underestimated and probably also clutch size, if birds move to another scrape to continue the clutch, or single eggs are lost from a complete clutch. Although nesting attempts by Chatham Island oystercatcher were probably missed in 1999/2000, it would seem that, judging from the less intensive scraping behaviour of the birds in unmanaged areas at the start of the season that clutch initiation was indeed later than in the managed zone. Even within the managed zones there was variation in the timing of clutch initiation, for example all the Washout–Takehanga Creek birds at Maunganui laid eggs in October, whereas the Ngatikitiki–Tioriori birds laid eggs in November–December.

4.5 RECOMMENDATIONS

- A similar nest monitoring programme for Chatham Island oystercatcher should be repeated in 2000/01.
- Unmanaged pairs in northern Chatham Island should be visited twice per week during the season to gather more information on nest success (gaps of 1–2 weeks are too likely to miss breeding attempts).

5. Banding

5.1 INTRODUCTION

The banding programme for Chatham Island oystercatcher aimed to progressively colour-band all monitored pairs in the managed and unmanaged territories of northern Chatham Island, and band the annual cohort of chicks produced there. Additionally, as many chicks as possible that were produced on the offshore islands were to be colour-banded. It was also hoped to remove all jesses (colour leg flags) from oystercatchers as some had caused injuries.

5.2 METHODS

Metal and colour bands were applied to the tarsus. All colour bands were hand made by the operator (S. O'Connor) to ensure high quality. Colour bands were sealed with tetrahydrafuran solvent, which is also being used successfully with colour bands for shore birds (oystercatchers, dotterels, wrybills and shore plover) elsewhere on the Chatham Islands and mainland New Zealand. Chicks older than 10 days were caught by hand, and fledglings and adults were caught using a noose-mat and decoy. Some individuals that were difficult to catch were captured at night using a spotlight.

5.3 RESULTS

Forty-three birds were colour-banded during the 1999/2000 season on Chatham Island. This included all known fledglings from the managed territories (25 fledglings from 16 pairs) and 18 adults (including 5 pairs) from the managed territories. Colour banding was completed by two operators: Shaun O'Connor (36 birds) and John Dowding (7 birds) with assistance from the co-authors. Three fledglings were metal-banded on Rangatira by Helen Gummer. More than 61 birds have been banded with the new colour bands over the last two seasons.

The five remaining birds known to have jesses on Chatham Island were caught and their jesses removed during 1999/2000 (Appendix 8). One bird was caught at night using a spotlight, the others by noose-mat and decoy. One had a severe cut and callus associated with the jess, which had immobilised the tibiotarsus joint. This bird was treated with avian antibiotics. The jesses on the four other birds had not caused injury; however, the fabric was in poor condition (worn, fibre exposed and faded). It is planned to catch and remove a jess from an oystercatcher on Pitt Island as soon as possible. Regular monitoring has not shown any signs of injury.

Some oystercatchers on Pitt and Mangere Islands have old wrap-around colour bands. These birds should be targeted for band replacement, as the colour bands are likely to be in poor condition and should be removed before they cause problems. A bird on Rangatira (K2296, G/Bk ; M) was caught on 14 May 1998 and old bands removed as the outer wrap had completely worn away and the bands were very brittle and sharp and therefore potentially able to cause injury.

2.4 RECOMMENDATIONS

- Colour-band all monitored pairs and their offspring in the managed and unmanaged territories in northern Chatham Island and chicks from other areas
- Actively replace metal and colour bands as part of ongoing maintenance to prevent any chance of injuries

6. Video monitoring of nests

6.1 INTRODUCTION

Time-lapse video surveillance cameras used to continuously monitor activities at nests have recently been used more commonly to identify key predators, quantify the relative impacts of different species, identify the behaviour of predator and prey, and verify the type of sign left at the nest (Innes et al. 1996). This visual data is also invaluable for the advocacy of the pest problem (Innes et al. 1996). However, the technique can have limitations because it is expensive and labour intensive and many studies do not obtain sufficient sample sizes to quantify the relative impacts of different causes of mortality (Sanders & Maloney 1999). Also, for shorebirds and waders (such as oystercatchers), the technique is only useful at the egg stage because chicks are mobile soon after hatching. The alternative is even-more labour intensive monitoring with mobile camera systems, as has been attempted for nesting birds of braided rivers in the Waitaki Basin (R. Maloney pers. comm.). It was thought that monitoring oystercatcher predation with fixed cameras may face a sample size problem because, with potentially low rates of egg-loss (5–30%) to predators, we might expect a maximum of three predation events to be captured on film per year (Moore 1999). That would mean it would take several years to build up a true picture of the predator guild. For example, in South Island braided rivers, different predator species were a problem for nesting birds in different years (R. Maloney pers. comm.). However, non-fatal encounters might also be a measure of the effectiveness of predator removal from managed areas (Moore 1999).

It was hoped in 1999/2000 on Chatham Island to observe predation events and visits by predators to nests of Chatham Island oystercatcher by using using time-lapse video recorders.

6.2 METHODS

Nests were filmed using four video cameras in managed and unmanaged areas of northern Chatham Island in 1999/2000. Camera systems were constructed by the Science & Research Unit Electronics Laboratory (principally by Stuart Cockburn). Each system included a black and white infared-sensitive video camera (three systems had an *Everfocus EX100/C* 1/3" CCD camera + *Panasonic WV-LA408C3E* aspherical high speed 4.5 mm aperture lens; and one system had a *KT&C* CCD cylinder camera + *Avenir* 4 mm F1.2 CCTV lens) housed in a waterproof case (PVC tubing) and mounted on a 0.5 m stainless steel stand. A night-light, comprising a bank of 48 infared diodes, was also mounted on the stand beside the camera and a 50 m cable connected this to a time-lapse video recorder (*Panasonic AG1070*) housed in a waterproof case. The recorder was set on 24-hour time-lapse mode, recording 5.6 frames per second. Each recorder was powered by one 36Ah 12V battery.

Camera operating procedures and data collection were based on that used in the Waitaki Basin (Sancha & Sanders 1998; M. Sanders, R. Maloney pers. comms) but modified to suit the requirements of the Chatham Islands. Previous knowledge about oystercatchers (S.O., pers. obs.) and advice from workers on other shore birds (R. Maloney pers. comm.) suggested that a camera in close proximity to the nest was unlikely to cause behavioural problems or attract predators. Hence the camera was placed immediately in front of the nest rather than being moved gradually closer so the bird would become more accustomed to it. Cameras were placed 1–2 m from the nest and the recorder and battery were hidden in the dunes behind the beach. Initially the cameras were placed about 2 m from nests, but filming under the infared lights was more successful at a distance of 1 m. The infared lights were built with a low output to limit productioin of visible light that could disturb the birds or attract predators. There was less glare from the sand, sea and sky when cameras were placed closer to the nest. Facing the cameras south also reduced glare.

Video tapes and batteries were changed every day and tapes were viewed, usually in the same afternoon or evening. Tapes were viewed on fast-forward, and the time of any interesting occurrences was noted on a recording sheet. These included partner changes at the nest or temporary departures of the birds for which no cause could be ascertained. Visits to the nest by potential or actual predators and farm stock were viewed on slow speed to take detailed notes. These tapes were retained, whereas others were re-used. Some tapes were also retained that had interesting behaviours shown by the birds (e.g. chicks hatching, good close-ups).

An 'event' was defined as any approach to the nest by a predatory bird or a mammal (not including the researchers), or any occurrence that was fatal to the nest or birds (e.g. predation or sea washing the nest away). An 'event group' was considered to be a series of visits by the same animal species (presumably the same individual) during the same evening. Events were also grouped together when a nest failure occurred and subsequent visits by another species were of no relevance to the outcome of the nesting attempt.

6.3 RESULTS

6.3.1 Filming statistics

Sixteen nests were filmed for 2–31 days and nights in 1999/2000, and a total of 255 nights (Table 11). Fewer nights than days were filmed because of malfunctions with the infared lights. Many days had very difficult viewing conditions because of light reflection off the beach and/or water and grit on the lens, both of which affected the auto-iris and auto-focus functions of the cameras. For the most part though, images were clear enough to record activity at the nest. More nights were filmed in managed areas than in unmanaged areas (Table 11).

6.3.2 Events at nests

Unmanaged nests had three times more disturbance (number of 'event groups' per total nights filmed) than managed nests (Table 11), or five times greater if the mean figures are used (Table 11). Because the 'event groups' tended to be multiple events in unmanaged areas the differences are even greater if the single 'events' are compared for managed and unmanaged nests (Table 11).

TABLE 11. CHATHAM ISLAND OYSTERCATCHER NESTS, FILMED BY 24-HOUR VIDEO SURVEILLANCE, AND NUMBER OF 'EVENTS' CAPTURED ON FILM.

AREA	CODE	NEST	DATE STARTED	DATE STOPPED	DAYS FILMED	NIGHTS FILMED	EVENTS	EVENTS/ NIGHT	EVENT GROUPS	GROUPS/ NIGHT
Managed										
Cape	WK1	3	31/12/99	25/1/00	26	26	0	0	0	0
Mairangi	WK2	1	27/10/99	26/11/99	31	31	5	0.16	5	0.16
Woolshed	WK3	1	4/11/99	12/11/99	9	9	1	0.11	1	0.11
Woolshed	WK3	2	31/11/99	24/12/99	23	23	1	0.04	1	0.04
Okahu	WK6	1	5/12/99	1/1/00	25	20	1	0.05	1	0.05
Takehanga E	T2b	1	27/10/99	27/11/99	30	28	0	0	0	0
Washout W	T1b	1	21/11/99	21/11/99	2	2	0	0	0	0
Pounamu	T4	1	20/12/99	4/1/00	4	4	0	0	0	0
Total					150	143	8	0.06	8	0.06
Mean ± s.d.								0.05 ± 0.06		0.05 ± 0.06
Unmanaged										
Paritu W	B3	1	8/12/99	24/12/99	6	6	6	1.0	3	0.50
Ohira	B2	1	16/11/99	14/12/99	22	20	1	0.05	1	0.10
Ohira	B2	2	4/1/00	31/1/00	22	21	1	0.05	1	0.10
Whangatete	B1	1	26/11/99	8/12/99	11	10	2	0.20	1	0.10
Whangatete	B1	3	15/1/00	16/1/00	2	2	3	1.50	1	0.50
Matarakau	MA1	2	19/1/00	14/2/00	25	24	0	0	0	0
Matarakau	MA3	2	25/1/00	16/2/00	21	17	14	0.82	9	0.53
Okawa	OK1	2	25/1/00	6/2/00	12	12	3	0.25	3	0.25
Total					121	112	30	0.27	21	0.19
Mean ± s.d.								0.48 ± 0.56		0.26 ± 0.22

Key:
An 'event' was defined as any approach to the nest by a predatory bird or a mammal (not including the researchers) or any fatal occurrence (e.g. predation or sea washing the nest away).
An 'event group' was considered to be a series of visits by the same species (presumably the same individual) during the same evening, or where one of the visits resulted in the failure of the nest, and subsequent re-visits or visits by another species were of no relevance to the outcome of the nest.

Three fatal predation events (two cats and one weka) were filmed at unmanaged areas, and one nest (but not the camera) was washed away by high seas at a managed area (Table 12). In both instances of cat predation, the cat almost caught the adult (the bird flew from the nest shortly before the cat appeared in view) and then proceeded to eat the eggs. The first nest was at mid-incubation, the second was close to hatching time and the well-developed chicks could be clearly seen being eaten from the eggs. In the case of the weka, the oystercatcher had been absent for 36 minutes before the weka was seen, and the oystercatcher was away from the nest for 6:36 (hours:minutes) altogether. Several pairs had long absences from the nest during several nights near the start of the incubation period.

Other events have been subjectively categorised as 'close calls' in Table 12, as there appeared to be a high chance of nest failure as a result of the visit. These included visits by cats and possums that sniffed or handled the eggs, a weka that repeatedly harassed a brooding bird, sheep and cattle hassling incubating birds, and sea foam covering the nest. A member of a tourist group visiting the Mairangi beach walked within 1 m of the nest without apparently noticing either the nest or the camera (Table 12). Some 'visits to the nest' by animals apparently posed a lower risk to the nest (Table 12).

TABLE 12. CHATHAM ISLAND OYSTERCATCHER NEST EVENTS FROM 24-HOUR VIDEO SURVEILLANCE, GROUPED ACCORDING TO TYPE: FATAL (NEST FAILED); CLOSE CALL (POTENTIAL NEST LOSS); VISIT TO NEST (APPARENTLY NON-THREATENING); AFTER FAILED (HAD NO BEARING ON THE NEST FAILURE).

EVENT TYPE	AREA	CODE	NEST	DATE	WHAT	HOW
Fatal	Whangatete	B1	1	6/12/99	Cat	Almost caught adult, eats eggs
	Matarakau	MA3	2	16/2/00	Cat	Almost caught adult, eats eggs (chicks inside)
	Whangatete	B1	3	15/1/00	Weka	Unattended eggs eaten
	Woolshed	WK3	1	12/11/99	Sea	Wave washes eggs away
						Total = 4
Close call	Okawa	OK1	2	3/2/00	Cat	Sniffs eggs, soon to hatch
	Mairangi	WK2	1	1/11/99	Cat	Sniffs eggs
	Paritu W	B3	1	21/12/99	Weka	Harrasses bird on chicks, in close several times
	Paritu W	B3	1	21/12/99	Weka	Harrasses bird on chicks 2nd time in same night
	Paritu W	B3	1	21/12/99	Weka	Harrasses bird on chicks 3rd time in same night
	Matarakau	MA3	2	10/2/00	Possum	Picks up egg in paws
	Matarakau	MA3	2	14/2/00	Possum	Handles eggs on different night, checks out camera before departing
	Paritu W	B3	1	22/12/99	Sheep	Swoops, nearly catches chick, or adult
	Matarakau	MA3	2	13/2/00	Sheep	3 resting by nest, 1 almost stands on eggs
	Matarakau	MA3	2	15/2/00	Sheep	Nudges bird off nest
	Matarakau	MA3	2	10/2/00	Sheep	Sniffing and nuzzling bird on nest
	Matarakau	MA3	2	13/2/00	Sheep	Sniffing and nuzzling bird on nest
	Matarakau	MA3	2	14/2/00	Sheep	Sniffing and nuzzling bird on nest
	Matarakau	MA3	2	14/2/00	Sheep	Sniffing and nuzzling bird on nest
	Matarakau	MA3	2	14/2/00	Sheep	Sniffing and nuzzling bird on nest
	Matarakau	MA3	2	30/1/00	Cow	Curious, sniffs at bird on nest
	Matarakau	MA3	2	30/1/00	Cow	Same cow nudges bird's tail
	Paritu W	B3	1	20/12/99	Cow	Curious, sniffs at bird on nest
	Woolshed	WK3	2	15/12/99	Sea	Foam knocks bird from nest and soaks eggs
	Mairangi	WK2	1	31/10/99	Human	Walks between nest and camera
						Total = 20
Visit to nest	Mairangi	WK2	1	9/11/99	Rodent	Small, walking around edge of tyre
	Okahu	WK6	1	23/12/99	Possum	Walks over nest without noticing eggs
	Matarakau	MA3	2	26/1/00	Possum	Climbs camera but ignores nest
	Paritu W	B3	1	18/12/99	Cow	Grazing 1m from nest
	Ohira	B2	1	27/11/99	Human	Approaches nest and departs
	Ohira	B2	2	13/1/00	Human	Approaches nest and departs
	Mairangi	WK2	1	31/10/99	RBGull	Passes behind nest, no reaction
	Mairangi	WK2	1	1/11/99	BBGull	2 feed within 1.5 m, no reaction
						Total = 8
After failed	Whangatete	B1	1	7/12/99	Cattle	2 tramp and lick nest site day after cat ate eggs, sniff and lick camera
	Okawa	OK1	2	5/2/00	Cat	2nd cat sniffs abandoned infertile egg, looks closely at camera before departing
	Okawa	OK1	2	6/2/00	Cat	3rd cat tries to eat infertile egg, gives up
	Matarakau	MA3	2	16/2/00	Cat	returns 10 min after eating eggs
	Whangatete	B1	3	16/1/00	Weka	Returns 2nd time to continue eating eggs
	Whangatete	B1	3	16/1/00	Weka	Returns 3rd time to continue eating eggs
						Total = 6

In many cases the oystercatchers left the nest prior to the animal being visible on screen and probably because of the approach of that animal. Birds generally did not leave the nest when approached by cattle, sheep, weka or gulls. When farm animals approached the nests, oystercatchers stayed sitting, even when, for example, sheep sat or walked right beside the nest, although the partner sometimes tried to drive the intruders away. Often the sheep or cattle were curious and sniffed and nuzzled the incubating bird. The birds pecked the intruder on the nose, which seemed to deter cattle more than sheep, and got off the nest only when physically pushed. The birds at Matarakau MA3 were harrassed by stock several times on 6 different days for 2–41 minutes at a time. A group of sheep lay down centimetres from the nest on one occasion. A sheep at Paritu apparently rushed at the nest, pulling up short as the oystercatcher flew off the nest over the sheep's head. When a weka visited the Paritu West nest several times in the same night, the adult was brooding young chicks and sat tight, calling vigorously at the weka and pecking at it when it came too close. Gulls that came close to the nest at Mairangi were not showing predatory behaviour and no reactions were apparent from the oystercatchers.

Events that occurred at night were those involving cats, weka, possums, a rodent and the sea. All others were during daylight hours.

The average duration of events (period for which the disturbing agent was visible) was 9 ± 11 minutes (range 1–41, n = 36) and the duration that birds were away from the nest was 77 ± 119 minutes (range 0:1–6:26 (hours:minutes), n = 18).

6.3.3 Effects of cameras

Some animals (1 cat, 2 possums, 1 cow) interacted with the camera, usually after first visiting the nest. On half these occasions, the nests had already been abandoned by the oystercatchers (Table 12). In one case, a possum, having climbed all over the camera, departed without paying any attention to the nest. Other animal visitors came to the nest at an angle from the camera, suggesting that they were attracted to the nest rather than the camera or light.

There is some evidence that oystercatchers were disturbed by the camera when it was first put out, although this was highly variable between pairs. The mean time between the completion of video set-up and the first time a bird sat on the nest was 34 ± 35 minutes (range 0:09–2:05 (hours:minutes)). One pair took about 5 hours of very unsettled behaviour (more time off the nest than on) before settling into more normal incubation shifts. For some nesting birds, the disturbance effect was prolonged by the researchers checking nearby traps, or passing the nest on their way out of the area. Birds were often unsettled or nervous at times, irrespective of the researcher disturbance. Some oystercatchers may have reacted to the night-light adversely by spending long periods off the nest during the first few nights of filming, although this unsettled behaviour may be a feature of the early stages of incubation. At some nests where filming started later in incubation the birds incubated almost constantly throughout the day and night.

Bird behaviour

In the course of the video monitoring of nests, interesting bird behaviour was filmed, such as partner change-over between incubation shifts and the hatching of chicks. In theory, the duration of incubation shifts could have been measured, but this was hampered by the birds not being individually identifiable. Also, the sitting bird sometimes disappeared from view before the partner appeared, and this could not always be distinguished from a bird leaving the nest briefly and returning rather than swapping nest duties with its partner.

The sitting bird often left the nest while making pecking movements at the ground—apparently part of a ritualised display ('sewing machine display'). When a series of shifts occurred during the day without any other departures off-screen, they were often 20–40 minutes in duration, but longer shifts were also apparent. Change-overs did not occur at night, so one bird of each pair sat for approximately 6–8 hours between dusk and dawn.

The number of change-overs and other departures from the nest observed at two Woolshed nests (WK3 No. 1 from –5 to 2 days after clutch complete, WK No. 2 from 4 to 25 days) showed little pattern during incubation, apart from an apparent peak in change-overs around the time of laying of the third egg (Fig. 12: around day 0). The accuracy of this data is limited by not knowing how many change-overs occurred off-screen; however, the average number observed was 6 per day and 17 other departures for the two Woolshed nests. The average for selected days (N = 27 total days) at different stages of incubation from six nests was 8.4 ± 4.8 change-overs and 17.6 ± 7.0 departures from the nest per day (this is a preliminary result as the larger part of the data has not been analysed).

Often, cameras were placed at the nest early in incubation or even before the clutch was complete. At this stage the eggs were not incubated at night for long periods (up to 9 hours). For example, the two nests by the Woolshed pair are plotted in Fig. 13. The clutch was completed over the first six days of filming, during the first four of which the eggs were left unattended at night for over eight hours. By the time the final egg was laid more continuous incubation was occurring. The maximum time spent off the nest per day is plotted for four

Figure 12. Number of change-overs and departures by Woolshed pair.

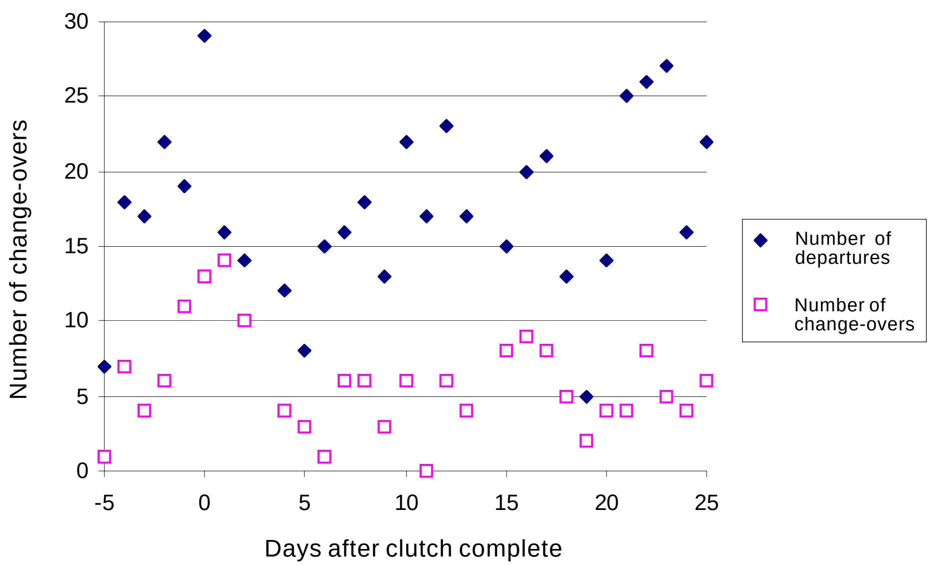
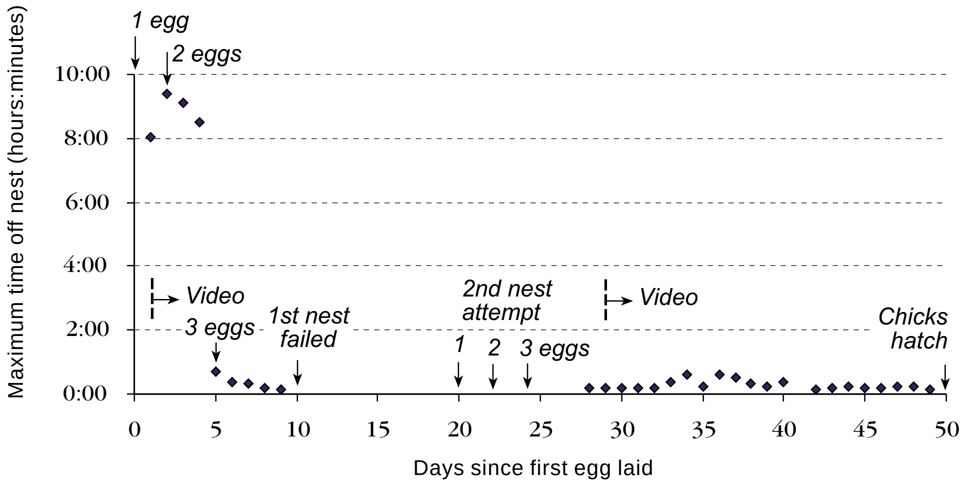


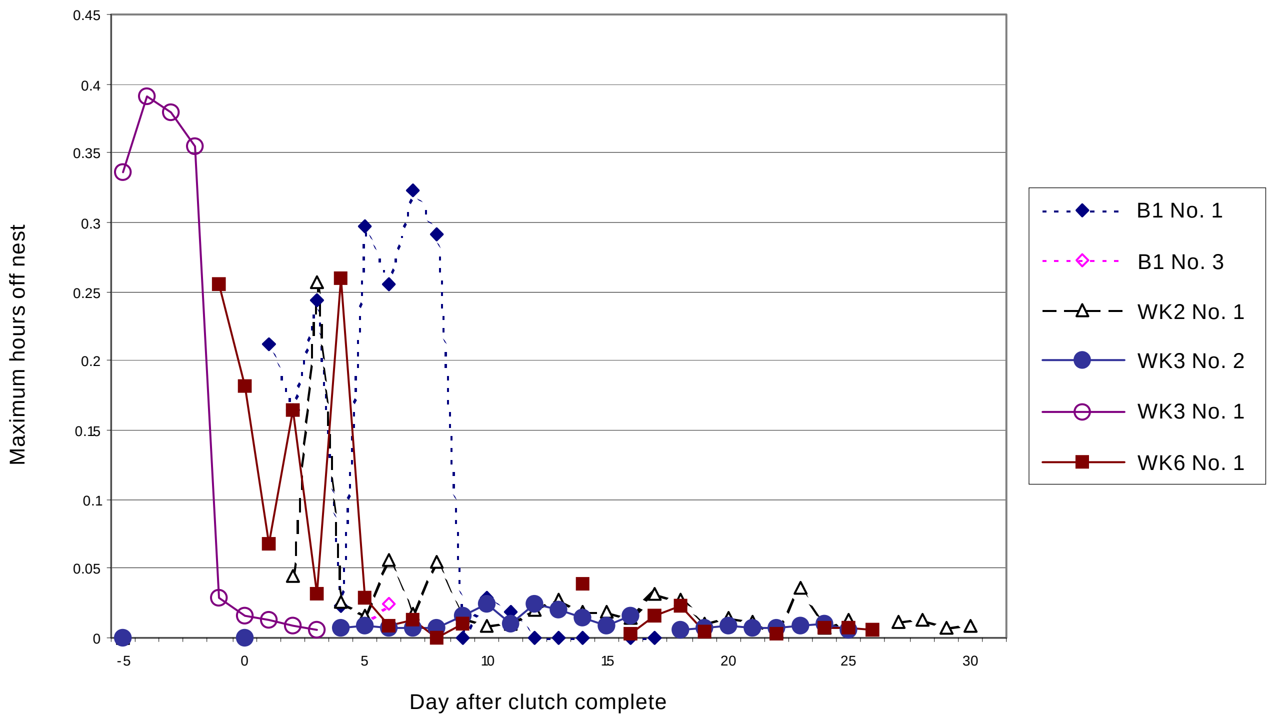
Figure 13. Maximum time off nest per day by Woolshed pair.



breeding pairs and six nests (Fig. 14). The settling-down period was variable between pairs. Incubation tended to be erratic until five days after completion of the clutch of eggs. Whangamoe/tete nest B1 No. 1 was erratic for at least nine days of videoing but, as it was not known when the clutch was completed, the period could have been up to 12 days longer. Further observation ceased when a cat ate the eggs at that nest. Data from other unmanaged nests has yet to be analysed.

Subsequent to the initial five days of poor incubation, in most days the maximum time off the nest was less then 20 minutes, and usually the longest absence was caused by the researchers arriving to check the traps in the area and change the battery and video tape. As soon as people departed the area, the birds returned to the nest. The second Woolshed nesting attempt was not filmed until four days after clutch completion, and there were no absences from the nest greater than 36 minutes (Fig. 13).

Figure 14. Maximum time off nest per day.



Selected days of filming at four Wharekauri nests (WK2, WK3 No. 1 & No. 2, WK6) and two Whangamoe/tete nests (B1 No. 1 & No. 3) (Fig. 14) found that several days after the clutch was completed, eggs were incubated for most of the day (95%) Most absences were short, as shown by the median values in Table 13. Absences from the nests generally could not be assigned to a cause. Occasionally, activity of intruders and the non-sitting birds could be seen in the background, showing that the birds left the nest because of disturbances by intruders (including neighbouring oystercatchers), to interact in some way with the partner or change nest duties. On some days birds were more settled than others.

After eggs hatched or were preyed on, oystercatchers usually removed egg shell from the nest site. Hence, usually there was no evidence of predation, e.g. egg fragments at the nest, the day following an event that was captured on film.

TABLE 13. TIME SPENT OFF THE NEST BY INCUBATING CHATHAM ISLAND OYSTERCATCHERS AS MONITORED BY VIDEO AT WHAREKAURI (WK) AND WHANGAMOE/TETE (B1) FOR SELECTED DAYS OF FILMING.

	NUMBER OF DAYS FILM	MEAN % TIME OFF NEST	TIME OFF NEST (hours:minutes:seconds)					
			MEAN	S.D.	MEDIAN	MINIMUM	MAXIMUM	NUMBER OF TIMES OFF
WK—4 nests								
< 5 days after clutch complete	10	37	0:29:44	1:30:25	0:04:00	0:00:30	9:23:00	171
> 5 days after clutch complete	11	5	0:03:01	0:04:22	0:02:00	0:00:30	0:30:00	214
B1—2 nests	6	11	0:10:41	0:41:39	0:02:00	0:00:30	5:06:00	85

6.3 DISCUSSION

Prior to our study, records of predators of Chatham Island oystercatchers were rare and often they were determined by inference. Records were confined to the more visible diurnal predators such as skuas, black-backed gulls or spur-winged plovers *Vanellus miles*, or were suggested by the anti-predator behaviour shown by oystercatchers to other birds such as harriers (Davis 1988; Aikman et al. 2001). It was assumed that the nocturnal predators, particularly feral cats, must be a significant problem for oystercatcher nests on Chatham and Pitt Islands, but not on Rangatira or Mangere Island where cats are absent (Fitzgerald 1990). However, the relative importance of different predators was not known.

The video surveillance in 1999/2000 confirmed that cat and weka are predators of eggs. Three out of eight nests in unmanaged areas had fatal events caused by predators. Other apparently close calls came from cats, weka, possums, sheep, cattle and humans. Considering the number of visits (30) to active nests and how many eggs were sniffed or handled by predators, it is surprising that the losses were not higher.

Although the sample size is low, cats appear to be the principal threat as four different nests were visited, although only two cats chose, or were able, to eat the eggs. At Okawa three different cats visited the same nest. Because the mammalian predator guild is smaller on the Chathams than on mainland New Zealand, it seems a reasonable assumption that cats will be the key predator of oystercatcher eggs and chicks in most years. It is not known what impact cats have on the survival of adult and juvenile Chatham Island oystercatchers. It appeared that two attacks by cats on Chatham Island could have resulted in adults being killed and an adult oystercatcher on the southwest coast was possibly killed by a cat (Appendix 7; sign consistant with cat predation (J. Dowding, pers. comm.)). During Schmechel's (2001) study one member of a pair disappeared during a breeding season, and it was suspected that some territorial pairs were replaced by new birds between seasons, but causes of these changes could not be determined.

Video monitoring of 137 nests of banded dotterels *Charadrius bicinctus*, black stilts *Himantopus novaezelandiae* and black-fronted terns *Sterna albostriata* over five years in the Waitaki Basin recorded 70 failures which were mainly caused by cats, ferrets and hedgehogs (Sanders & Maloney 1999). Fortunately, there are no mustelids on the Chatham Islands and, although hedgehogs were trapped at Wharekauri, none were seen on film. Cats were the only predator found to kill adult birds at the nest in the Waitaki Basin (Sanders & Maloney 1999). In the Waitaki study 80% of visits to nests by mammalian predators resulted in eggs being removed or eaten and cats were responsible for 40% of nest losses. Although the sample size is low in our study, only 2/6 cats ate eggs and 0/4 possums. The latter is perhaps surprising given that possums have been identified as major predators of forest birds (Innes et al. 1998). Some cats and possums tried and failed to eat eggs which suggests they were naive predators or not hungry enough. In total 3/14 (21%) of visits by predatory species (cats, weka, rodents, possums) and 3/30 (10%) of visits to active nests by all animals resulted in nest failure in our study.

Sheep appeared to be less reactive than cattle to the defensive behaviour shown by nesting oystercatchers although both were curious and sniffed and nuzzled the birds. Sheep on riverbeds have been filmed trampling the nests of banded dotterels. In these cases they slowly approached the nests while grazing and were completely oblivious to the defensive displays of banded dotterels (Sanders & Maloney 1999). The oystercatchers do not seem to see the sheep and cattle as a direct threat, hence they do not abandon the nest the way they do for predatory animals, including humans. Most of the visits to the nest by livestock were considered to be close calls as the animals often nuzzled at the incubating bird and forced it to leave the nest. There seemed to be a high chance that eggs would be trampled by the livestock or broken by the panicked departure of the birds.

Potential predators were not eliminated from managed areas and they were observed at times visiting nests there. However, the low rates of nest visits or predation observed on film combined with the high chick output in managed areas indicate that the predator control regime was adequate to protect most nests from the risk of predation.

The definition of an 'event' in our study differed in some respects from those used elsewhere; e.g. Sanders & Maloney (1999) had a much wider definition of non-lethal events which included non-predatory animals such as moths and rabbits, and hatching of eggs. We did not consider that animals such as penguins, starlings or moths that came close to nests had caused an event or disturbance, especially as there was no reaction from the sitting birds. Oystercatchers left the nest many times a day, usually for short periods. As it was seldom possible to assign a cause (e.g. a farm bike or person seen on the beach in the background), these departures from the nest were not considered to be 'events'. Only occurrences within the immediate vicinity of the nest were treated as events.

More film footage was obtained in managed than unmanaged areas because it was easier to establish a routine of visits in combination with the daily trapping rounds. Also, because managed nests were more successful, the cameras stayed in place for longer. Unmanaged nests often failed before a camera could be established. Interestingly, the prediction that we unlikely to witness more than three predation events per year (Moore 1999) turned out to be accurate. However, the large number of close calls augmented these events to a far greater extent than was predicted.

Some birds may have initially been nervous of the cameras but this was highly variable between pairs and absences from the nests seemed to be related to the stage in incubation—birds not sitting consistently at the early stages. Absences were longer at night than day. No nests were abandoned because of cameras, although this has occurred in other similar studies, usually where additional disturbance such as banding was involved (Sanders & Maloney 1999).

There was little evidence that predatory animals were attracted to the camera or light at oystercatcher nests as they usually approached the nest at an angle from the camera. It is unlikely that birds can detect the infared light used in these camera systems because of the nature of their colour vision, although a small amount of visible light which is emited from the LEDs could be visible to the birds or attract predators (Innes et al. 1996). Fledging rates at filmed and unfilmed nests of kokako are similar, indicating that the negative effects of cameras is not great (Innes et al. 1996). Similarly, no effect of cameras or the type of light used ('visible' or 'invisible' infared lights) was found for banded dotterels and black-fronted terns (Sanders & Maloney 1999).

6.4 RECOMMENDATIONS

- Repeat the video monitoring programme in 2000/01.
- Improve coverage of unmanaged areas in northern Chatham Island to increase sample size and nights filmed.

7. Summary

1. In the 1999/2000 breeding season a joint Department of Conservation management-research programme on Chatham Island oystercatcher *Haematopus chathamensis* was undertaken. The aims were to:
   - manage known threats (flooding, trampling by stock, predators) at core territories in northern Chatham Island using consistent and repeatable methods;
   - assess effectiveness of management by comparing areas where threats were managed and other areas where there was no management;
   - establish the causes of nest failure and identify key predators using video surveillance.

   A longer-term aim was to:
   - monitor population trends and dynamics.

2. Fifty pairs (40 confirmed as breeding) were identified in the census of most of the known breeding areas, among the four islands of the Chatham Islands group. Additionally, 2526 non-territorial birds were found, bringing the total number of birds to 125–126. This was comparable to a full census undertaken in 1998 but the increase in pairs identified was a result of the higher intensity of breeding monitoring. Allowing for areas of unsurveyed coastline, there were probably about 55 pairs of Chatham Island oystercatchers present in the Chatham Islands in 1999/2000.

   Numbers had more than doubled (123–152%) in the north of Chatham Island between 1987 and 1999, doubled on eastern Pitt Island, were stable on Mangere Island, and decreased in the south of Chatham Island (17–42%) and Rangatira (38–41%). Overall, there was 30% increase in number of birds between 1987 and 1999.

   The northern increase in numbers may be a result of natural changes to the population or because sporadic predator control has resulted in better chick production and subsequent recruits establishing in neighbouring areas. The cause of the decrease on Rangatira is unknown.

3. Predator control along 14 km of coastline in two management zones (Wharekauri and Maunganui–Tioriori) killed 51 cats, 719 weka, 61 possums, 44 rats, 41 hedgehogs and captured 86 non-target birds (many of which were released unharmed). The main control technique was a trap-line of 76 traps (64 Lanes Ace leg-hold traps and 12 cage traps). The two trap types were of similar efficiency.

   Stock were excluded from managed territories with permanent fences or portable electric fences. Eleven nests were moved away from the high tide mark, generally only 2–4 m because of the proximity to dune vegetation. This saved several nests from flooding during moderately high seas.

4. A record 25 chicks were fledged from 16 pairs (1.6 chicks per pair) in managed areas of northern Chatham Island. Two chicks fledged (1.0 chicks/pair) from a partially managed area (some private trapping late in the season?). Other unmanaged areas had zero production (11 territories in northern Chatham Island, 2 territories in the southwest of the island). Offshore islands had low pro-

ductivity (0.45/pair at 11 territories), 2 chicks from Pitt Island where some predator trapping occurred, 3 chicks on Rangatira and zero on Mangere Island, both of which are mammal-free nature reserves.

Over half of egg losses (19/37 eggs) in northern Chatham Island were a result of high seas wiping away the nests. The other principal cause of egg loss was predators (2/15 eggs that were lost in managed and 7/22 in unmanaged areas).

5. Forty-three birds (25 chicks and 18 adults) were colour-banded during the 1999/2000 season on Chatham Island. Three other chicks were metal-banded on South East. Five birds had jesses (colour leg flags) removed to prevent injury.

6. Sixteen nests (8 managed and 8 unmanaged) were filmed for between 2–31 days and nights in 1999/2000, and a total of 255 nights were filmed. Thirty-eight events (mishaps or visits to the nest by potential predators) were observed on film, six of which occurred after the nest had failed or been abandoned. Three fatal predation events (two cats and one weka) were filmed at unmanaged areas and one nest was washed away by high seas at a managed area.

   Cats appear to be the principal predator threat as they were filmed visiting four different nests, two of the attacks appeared to be directed at the adults and corpses of one adult and two sibling chicks in unmanaged areas showed signs of cat predation.

   A high number of visits by potential predators did not result in nest failure. 'Close calls' included: visits by cats and possums that sniffed or handled the eggs; a weka repeatedly harassing a brooding bird; sheep and cattle nuzzling the sitting bird and stepping close to the eggs; a tourist nearly standing on a nest; and sea foam swamping another. Lower-risk visits by possums, cattle, rodents, people and gulls were also observed.

   There was little evidence that animals were attracted to the cameras—usually they came to the nest at an angle from the camera, and if they interacted with the camera, it was after visiting the nest. Some birds may have been initially disturbed by the camera and the night light, but this was highly variable between pairs and seemed to relate to unsettled behaviour early in incubation.

   An average of 8.4 ± 4.8 change-overs between partners of a pair and 17.6 ± 7.0 departures from the nest per day were observed per day on film, although the former were underestimated to an unknown extent as they could occur off-screen. Partners changed duties during the day, but not at night. Before and shortly after clutches were complete, eggs were left un-incubated for up to 9 hours per night. This made them vulnerable to predators, and at least one clutch was eaten by weka while it was unattended by an adult. Incubation was erratic until five days after completion of the clutch, although this was variable between pairs. Once the clutch was complete, the maximum time off the nest was usually less then 20 minutes and eggs were incubated for most of the day (95%).

   The low rates of nest visits by potential predators or predation observed on film combined with the high chick output in managed areas indicate that the predator control regime was adequate to protect most nests.

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APPENDIX 1. STAFF AND ROLES IN CHATHAM ISLAND OYSTERCATCHER WORK 1999/2000.

PERSON	DOC UNIT	TASKS	AREAS	DATES
Shaun O'Connor	CIAO	Supervise management programme, banding, census	All	
Richard Goomes	CIAO	Predator control, nest monitoring, video work, census	North C.I.	Sep.–Feb.
Mike Bell	CIAO	Management, pass on expertise to other workers	North C.I.	Sep.–Nov
Kenny	CIAO	Predator control (filling in for main staff)	North C.I.	Jan.
Sandy King	CIAO	Predator control, nest monitoring, census	Pitt	
Tertia Thurley	CIAO	Nest monitoring	Mangere I.	
Helen Gummer	CIAO	Nest monitoring	Rangatira I.	
Peter Moore	SRU	Supervise research programme, video, predator control, census	North C.I.	
Georgina Hedley	SRU	Video, predator control, census, assist management	North C.I.	Oct.–Feb.
Kerri-Anne Edge	SRU	Video, predator control	North C.I.	Oct.
Stacy Gaylord	Volunteer	Video, predator control, census	North C.I.	Dec.–Jan.

Key: CIAO = Chatham Island Area Office
SRU = Science & Research Unit

APPENDIX 2. DETAILS OF BREEDING OF CHATHAM ISLAND OYSTERCATCHERS IN MANAGED TERRITORIES OF NORTHERN CHATHAM ISLAND, 1999/2000.

TERRITORY	CODE	ADULT BAND COMB.[1]	ADULT BAND NO.[2]	NEST [3]	DATE EGGS LAID	EGG LAID	CHICKS HATCH	HATCH DATE	CHICKS FLEDGED	CHICK BAND COMB.[1]	CHICK BAND NO.	CAUSE OF FAILURE
Cape	WK1	- ; M - ; M		1	11/11/99	1	0					Egg abandoned Human or storm 12/11/99
				2	1/12/99 3/12/99	2	0					Storm seas 15/12/99
				3	26/12/99	1	0					Egg cracked, removed 46 d
Mairangi	WK2	- ; M - ; M		1	23/10/99 25/10/99	2	2	26/11/99 26/11/99	1	M ; G/R	K11672	1 chick disap. early < 10 d
Woolshed	WK3	M ; R M ; Y	K11670 K11671	1	3/11/99 5/11/99 8/11/99	3	0					Storm seas 12/11/99
				2	22/11/99 24/11/99 26/11/99	3	3	22/12/99 23/12/99 24/12/99	3	M ; Y/G M ; Y/B M ; W/O	K11669 K11668 K11680	
Rocks	WK4	- ; M NB		1	30/10/99 1/11/99 4/11/99	3	2	5/12/99 6/12/99	2	M ; Y/W M ; B/G	K11667 K11666	1 egg cracked
Island	WK5	- ; M NB		1	3– 8/11/99	3	0					Storm seas 19/11/99
				2	1/12/99 1/12/99	2	2	31/12/99 31/12/99	2	M ; G/Y M ; B/W	K11677 K11678	
Okahu	WK6	- ; M NB		1	1/12/99 3/12/99 5/12/99	3	2	1/1/00 1/1/00	2	M ; G/W M ; G/B	K11675 K11676	1 egg infertile

APPENDIX 2 *continued*

TERRITORY	CODE	ADULT BAND COMB.[1]	ADULT BAND NO.[2]	NEST[3]	DATE EGGS LAID	EGG LAID	CHICKS HATCH	HATCH DATE	CHICKS FLEDGED	CHICK BAND COMB.[1]	CHICK BAND NO.	CAUSE OF FAILURE
Washout W	T1b	NB NB		1	24/10/99 25/10/99	2	2	21/11/99 21/11/99	1	Y/R ; M	K11734	1 chick disap. early or as pip.
Washout E	T1a	Y ; M NB	K11733	1	<23/10/99	2	2	17/11/99 17/11/99	2	O/Y ; M O/G ; M	K11731 K11732	
Takehanga W	T1	M ; - - ; M		1	28/10/99 29/10/99	2	2	28/11/99 29/11/99	1	G/W ; M	K11738	1 chick died at nest 1 d
Takehanga E	T2b	G ; M - ; M	K11737	1	26/10/99 28/10/99	2	2	26/11/99 27/11/99	2	Y/W ; M Y/G ; M	K11735 K11736	
Ngatikitiki	T2a	M ; M NB		1	17/11/99 19/11/99 21/11/99	3	3	19/12/99 19/12/99 20/12/99	3	B/R ; M Y/B ; M G/B ; M	K11739 K11740 K11741	
Boulder	T2	- ; M - ; M		1	8/11/99 10/11/99 14/11/99	3	3	10/12/99 10/12/99 11/12/99	2	G/Y ; M M ; W/B	K11742 K11743	1 died 1.5 from nest 2 d 11-13/12/99
Creek	T3	W ; M B ; M	K11747 K11746	1	19/11/99 22/11/99	2	2	21/12/99 21/12/99	2	M ; W/Y M ; W/G	K11744 K11745	
Pounamu	T4	- ; M - ; M		1	23- 28/12/99	1	0					Egg infertile plus cat prob. ate
Dune	T5	M ; W R ; M	K11750 K7456	1	4/11/99 5/11/99 8/11/99	3	3	7/12/99 8/12/99 8/12/99	2	M ; B/R M ; Y/R	K11748 K11749	1 dead 30 m from nest 6 d 14/12/99
Cliff	T6	- ; M - ; M		1	9/11/99 11/11/99 14/11/99	3	3	13/12/99 14/12/99 14/12/99	0			1 died < 1 d bugs 2 disap. 3-4 d

APPENDIX 2 *continued*

TERRITORY	CODE	ADULT BAND COMB.[1]	ADULT BAND NO.[2]	NEST [3]	DATE EGGS LAID	EGG LAID	CHICKS HATCH	HATCH DATE	CHICKS FLEDGED	CHICK BAND COMB.[1]	CHICK BAND NO.	CAUSE OF FAILURE
				2	4/1/00 6/1/00	2	0					2 eggs disap. 12/1/00
Total	16			21		48	33		25			
Egg Success							69%		52%			
Chick Success									76%			
Chicks/pair									1.6			

Key: [1] Band notation is left leg ; right leg, M = metal, R = red, B = blue, W = white, Y = yellow, O = orange, G = green, NB = no bands, - = unbanded leg.
[2] Some bands were replacements of old metal bands. This information is on a database held by Chatham Island Area Office.
[3] Nest attempt number for the pair during the breeding season.

APPENDIX 3. DETAILS OF BREEDING OF CHATHAM ISLAND OYSTERCATCHERS IN UNMANAGED TERRITORIES OF NORTHERN CHATHAM ISLAND, 1999/2000.

TERRITORY	CODE	ADULT BAND COMB.[1]	ADULT BAND NO.[2]	NEST[3]	DATE EGGS LAID	EGG LAID	CHICKS HATCH	HATCH DATE	CHICKS FLEDGED	CHICK BAND COMB.	CHICK BAND NO.	CAUSE OF FAILURE
Paritu East	B4	- ; M - ; M		1	18- 24/11/99	2	0					SW gale seas 15/12/99
				2	21- 27/12/99	2	0					SW gale seas 9/1/00
				3	15- 28/1/00	2	0					Washed over sev times pre 21/2
Paritu West	B3	M ; - NB		1	17/11- 2/12/99	2	2	21/12/99 22/12/99	0			Cat? Feathers 11/1/00
Ohira Bay	B2	- ; M - ; M		1	12- 15/11/99	2	2	14/12/99 14/12/99	0			Storm? Disap. <5 days old
				2	29/12/99 31/12/99	2	1	30/1/00	0			1e abandon peep C disap. 3-5 d
Whangamoe/ tete	B1	- ; M M ; -		1	12- 24/11/99	3	0					Cat ate eggs
				2	14- 20/12/99	1	0					Diappeared 21/12/99
				3	8- 13/1/00	2	0					Weka ate eggs 16/1/00
Whangamoe	B1a	- ; M NB		1	29/1- 1/2/00	1	0					Big seas 4/2/00
Waitangi West	WW1	- ; M - ; M		1	26/11/99 27/11/99	2	0					Big seas 13- 14/12/99
				2	Approx. 28/12/99	2	2	30/1/00 30/1/00	0			Diappeared <14d

APPENDIX 3 *continued*

TERRITORY	CODE	ADULT BAND COMB.[1]	ADULT BAND NO.[2]	NEST[3]	DATE EGGS LAID	EGG LAID	CHICKS HATCH	HATCH DATE	CHICKS FLEDGED	CHICK BAND COMB.	CHICK BAND NO.	CAUSE OF FAILURE
Taupeka	TP1	M ; - NB		1	<19/11/99	1	0					Storm 21/11/99
				2	?	2?	0					2nd nest lost?
Taupeka	TP2	- ; M NB		1	?	0?						Scrape or eggs washed away
				2	?	2?	2	?	2			
Matarakau	MA1	NB NB		1	24/11–1/12/99	2	0					Storm? 13-14/12/99
				2	3–9/1/00	2	2	13/2/00 14/2/00				Weak chicks died 1-2 days
Matarakau	MA2	NB NB										
Matarakau	MA3	- ; M - ; M		1	18/11–1/12/99	1	0	18–28/12/99				Lost at egg or chick unknown
				2	11–19/1/00	2	0					Cat ate eggs 17/2/00
Okawa	OK1	NB NB		1	<14/12/99	?	?					Assume lost
				2	<10/1/00	2	1	5/2/00				1 egg infertile 1C disap. <14d
Core data[4]	9			17		32	10		0			

APPENDIX 3 *continued*

TERRITORY	CODE	ADULT BAND COMB.[1]	ADULT BAND NO.[2]	NEST [3]	DATE EGGS LAID	EGG LAID	CHICKS HATCH	HATCH DATE	CHICKS FLEDGED	CHICK BAND COMB.	CHICK BAND NO.	CAUSE OF FAILURE
Success							31%		0			
Est. total [5]	11			22		40	12		2			
							30%		5%			
									17%			
									0.18			

Key:

[1] Band notation is left leg ; right leg, M = metal, R = red, B = blue, W = white, Y = yellow, O = orange, G = green, NB = no bands, - = unbanded leg,

[2] Some bands were replacements of old metal bands. This information is on a database held by Chatham Island Area Office.

[3] Nest attempt number for the pair during the breeding season

[4] Core data excludes data from Taupeka and Okawa (nest 1) because of poor monitoring there. Two chicks apparently were banded and fledged from Taupeka predator control here late in the season.

[5] Estimated data includes guesses for egg production at Taupeka and Okawa and the 2 chicks produced at Taupeka. It is not known whether MA2 pair at Matara

APPENDIX 4. DETAILS OF BREEDING OF CHATHAM ISLAND OYSTERCATCHERS ON RANGATIRA, 1999/2000.

TERRITORY	CODE	ADULT BAND COMB.	ADULT BAND NO.	NEST	EGG LAID	CHICKS HATCH	HATCH DATE	CHICKS FLEDGED	CHICK BAND COMB.	CHICK BAND NO.	CAUSE OF FAILURE
East landing (cave)		M ; - - ; M		1	2	1	3/1/00	0		-	1 egg inf./EDE 1 chick disap.
Sealers Point (cave)		- ; M - ; M		1 2	2 1	2 0	2-3/12/99	0 -		-	2 chicks disap. 1 egg broken
South Thinornis (base of tree)		- ; M - ; M		1	3 2	2 2	2-3/12/99 25/1/00	0 1		- K11724	1 egg rolled out 2 chicks disap. 1 chick disap.
Hapuka Point		- ; M NB		1	2	2	15-16/1/00	2		K11722 K11723	-
Mid Thinornis Bay		NB NB		-	-	-	-	-		-	-
Total	4			6	12	9		3			
Egg success						75%		25%			
Chick success								33%			
Chicks/pair								0.75			

APPENDIX 5. DETAILS OF BREEDING OF CHATHAM ISLAND OYSTERCATCHERS ON MANGERE ISLAND, 1999/2000.

TERRITORY	CODE	ADULT BAND COMB	ADULT BAND NO.	NEST	EGG LAID	CHICKS HATCH	HATCH DATE	CHICKS FLEDGED	CHICK BAND COMB.	CHICK BAND NO.	CAUSE OF FAILURE
Front landing		B/M ; B/G		1 2	2 2	2 2	7/12/99	-	-		Disappeared Disappeared
Neck		M ; G M ; O	K11704 K11703	1 2	2 2	1 2	10/12/99 27/1/00	-	-		Dead in shell Disappeared
SW Landing		NB M ; -		-	-	-	-	-	-		-
Total	2			4	8	7		0			
Egg success						88%		0			
Chick success								0			
Chicks/pair								0			

APPENDIX 6. DETAILS OF BREEDING OF CHATHAM ISLAND OYSTERCATCHERS ON PITT ISLAND, 1999/2000.

TERRITORY	CODE	ADULT BAND COMB	ADULT BAND NO.	NEST	EGG LAID	CHICKS HATCH	HATCH DATE	CHICKS FLEDGED	CHICK BAND COMB.	CHICK BAND NO.	CAUSE OF FAILURE
Tupuangi Is (kokope)	P10			2	1 1						1 egg infertile or dead embryo 1 egg rolled out
Second Water Creek	P3	M ; - - ; M		-							
Tupuangi Lake Mouth	P9a	R ; Y/M NB		1	2–3	2–3		2			
Sandy Pt	P11	- ; M NB		1	1						1 infertile—rotten
Sandy Pt	P1	- ; M (jess) NB		1	2						Poss. infertile
	P4			1	2	?					unknown
1st rocks Nth of 3rd Water Creek		M ; W Bk/M;Bk/R		-							
Total	5			6	9–10	2–3		2			
Egg Success						26%					
Chick Success								21%			
Chicks/pair								0.4			

APPENDIX 7. DETAILS OF MONITORING OF BREEDING OF CHATHAM ISLAND OYSTERCATCHERS ON SOUTHWEST CHATHAM ISLAND, 1999/2000.

LOCATION	ADULT BANDS	VISIT DATE	CLUTCH NO.	EGGS PRESENT	COMMENTS
Kiringi Creek	NB NB	29/10/99			2 scrapes RH side sandy beach. Weka present. Sign of stock feeding on beach.
	NB	19/11/99	1	1	Nest in centre of sandy beach. Infertile, warm. Only one (incubating) bird pres
	NB NB	14/12/99			4 scrapes LH end of beach. Sign of high seas—possible fate of first clutch?
	NB NB	20/1/00			Two birds in usual spot on sandy beach. One recently predated bird on scrape beach. Head bitten off, mandibles and one leg in scrape, carcass 30 m away. Sig predation. No bird at Cowes Creek, so possible re-pairing at Kiringi?
Cowes Creek	NB	29/10/99			One bird between Cowes Creek and Kiringi Creek. Very vocal.
		19/11/99			Two birds actively chasing one another.
	NB	14/12/99			One bird present, very vocal.
Point Gap	NB NB	29/10/99	1	1	Nest on low stack, on gravel between 3 rocks. Candled/ fertile, mid term, warn
	NB NB	19/11/99			Pair at mouth of Moriori Creek. No sign of chick or defensive behaviour from p
	NB NB	14/12/99	2	2	Renested same site. Candled/ fresh/warm/ approx. 1 day incubation.
	NB NB	20/1/00	2		Sign of chick hatching or broken late term egg in nest (shell fragments, yolk an and defensive, however not seriously so. No sign of chick—predated?
Sweetwater	NB NB	19/11/99			Pair at west end of boulder beach. No sign of breeding activity or behaviour.
	NB NB	14/12/99			One pair seen btwn Otawae and Horns at Waipurua river mouth. No birds at Sw probably same pair.
	NB NB	20/1/00			No obvious breeding activity/ behaviour.

APPENDIX 8. DETAILS OF CHATHAM ISLAND OYSTERCATCHERS CAUGHT IN 1999/2000 TO REMOVE THEIR JESSES.

DATE CAUGHT	LOCALITY	BIRD ID	COMMENTS
19/5/99	Cape Pattison	K7453	Single bird. Grey jess removed from RH leg. Leg immobile, held straight back horizontally. Tibio Large callus cut to bone, raw, but no infection. Medicated.
6/7/99	Cape Young (Cape territory)	K7467	Resident pair. Grey jess removed. Jess worn, no injury.
	Mairangi territory	K7465	Resident pair. Blue jess removed. Jess worn, no injury.
13/1/00	Manukau	K7459	Resident pair. Grey jess removed. Rebanded K11673, O ; M.
8/3/00	Wharekauri	K7477	Single bird, between Te Awanui and Okahu territories. Three (!!) metal bands removed (2 were K7477, K10497, K10350. Rebanded K11679, GO-M.