Chatham Island oystercatcher (*Haematopus chathamensis*) management techniques

Guidelines for protecting nests and increasing their productivity

Peter J. Moore

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ABSTRACT

The Chatham Island oystercatcher (*Haematopus chathamensis*; torea) is an endangered species ranked by the New Zealand Department of Conservation as 'Nationally Critical', making it a very high priority for conservation management. The goal of the species' recovery plan is to improve productivity and adult survivorship, and to increase the total population to > 250 individuals, thus reducing its chance of extinction and its threat ranking. This report outlines the management techniques used in 1998–2004 to boost oystercatcher productivity. From 1998 to 2004, 16 km of shoreline in northern Chatham Island (Wharekauri and Maunganui) was managed using a combination of three general techniques: predator control, stock exclusion, and movement or raising of nests away from high tide. This three-pronged attack was considered the 'best practice' set of actions that would boost oystercatcher productivity and was a major success. Whereas productivity is usually low on average (0.35 chicks per pair), intensive management resulted in much higher breeding success (1.04 chicks per pair; range = 0.5–1.6). Birds that were reared in managed areas bred at 2–5 years of age, subdivided previously large territories and spread along previously unoccupied shoreline, particularly in northern Chatham Island. Survival of adults (98%) and juveniles (89%) was also higher in the managed zones. In 7 years, the total population increased from 144 to 316 birds, and the number of breeding pairs increased from 49 to 89 as a result of young birds recruiting into the population. The techniques outlined in this report should be of use to future managers of this endangered population of birds.

Keywords: Chatham Island oystercatcher, *Haematopus chathamensis*, torea, management techniques

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1. Introduction

1.1 CONSERVATION STATUS

The Chatham Island oystercatcher (*Haematopus chathamensis*; torea) is an endangered species that is at high risk of extinction due to its very small population size (IUCN 2006; BirdLife International 2009). The species is ranked as 'Nationally Critical' by the New Zealand Department of Conservation (DOC), making it a very high priority for conservation management (Molloy et al. 2002; Hitchmough et al. 2007).

1.2 OYSTERCATCHER ECOLOGY

The Chatham Island oystercatcher is found on the coasts of islands in the Chatham Islands group (Chatham Island (Rekohu), Pitt Island (Rangiauria), Rangatira (South East Island) and Mangere Island; Fig. 1), but also visits the lagoons and ponds of Chatham Island and farmland near the coasts. Birds feed in the tidal zone on molluscs, worms and other invertebrates by probing, picking, chiselling or hammering with the bill. Breeding pairs vigorously defend their territories from neighbouring oystercatchers using loud, shrill, piping calls and displays.

Birds start breeding at 2–6 years of age and generally form long-term partnerships, although they readily take a new partner if the old one dies.

The breeding season is from October to February. Nests are simple scrapes in the sand (Fig. 2) or shingle amongst tidal debris above the high-tide mark or in depressions on rocks. Birds usually nest where they have a good view of their territory but occasionally nest in open or sparsely vegetated sites behind the foredunes.

Birds lay 1–3 well camouflaged eggs (Fig. 2) and temporarily leave the nest at any sign of danger. The earliest clutches are laid about 20 October, but some pairs lay in November to mid-December. If nests are destroyed by predators or the sea, the birds readily lay a new clutch after 8–10 days, and may make up to four breeding attempts in a single season—the latest re-laying occurs in early February, after which birds give up for the year. Eggs hatch after 29 days. The chicks leave the nest in the first 1–2 days but stay with their parents for at least 6 weeks. When disturbed, the chicks hide in rock crevices or tidal debris (Fig. 3), relying on their excellent camouflage and lack of movement to avoid detection by visual predators such as birds (e.g. gulls, skuas, hawks). Once they can fly (usually in February–March), the juveniles may become independent; however, some remain with their parents for several months.

Juveniles and adults have high rates of survival and are long-lived. The oldest banded bird was at least 30 years old when it died (banded as a breeding adult in 1970 and died in 1998). Another bird banded as a chick in 1977 was still alive in 2006, 29 years later.

Figure 1. Chatham Island oystercatcher (*Haematopus chathamensis*) management areas and core census zones, 1998–2006.

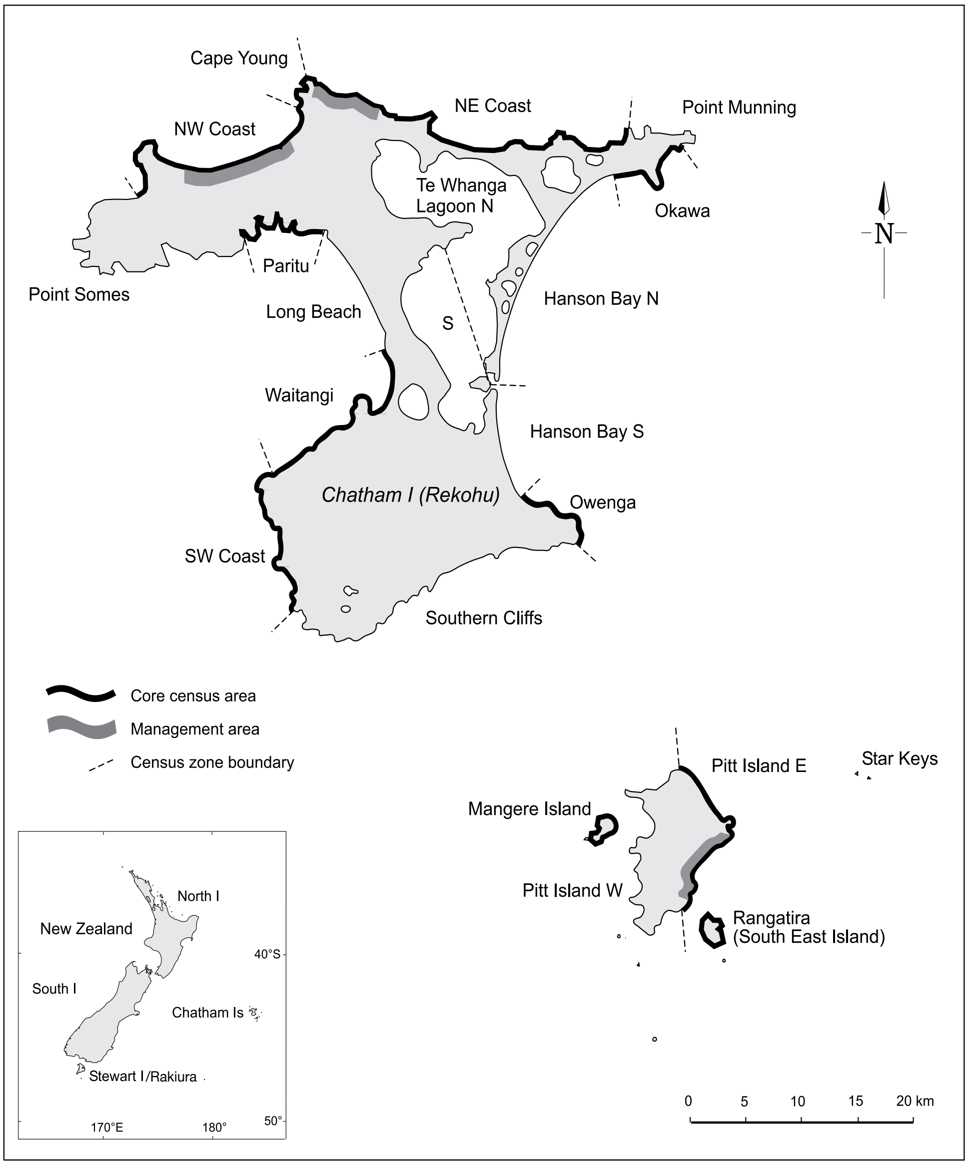


Figure 2. A Chatham Island oystercatcher (*Haematopus chathamensis*) nest on a sandy beach, with a simple scrape in the sand and a small amount of shelter from tidal debris (driftwood and seaweed). *Photo: Rex Williams.*

Figure 3. Chatham Island oystercatcher (*Haematopus chathamensis*) chicks hiding amongst tidal debris. *Photo: Peter Moore.*

1.3 THREATS

Low productivity is a key issue for the Chatham Island oystercatcher population. Predation of eggs and chicks is a major factor, but in stormier years eggs are washed away by the sea before predators take them. Video monitoring of nests in 1999–2001 recorded 19 nest failures: 13 (76%) caused by cats (*Felis catus*), three by weka (*Gallirallus australis hectori*), which were introduced from mainland New Zealand, and one each by a red-billed gull (*Larus novaehollandiae scopulinus*), a sheep (*Ovis aries*), which trampled eggs, and the sea, which washed the eggs away (Moore et al. 2001; Moore 2008; Moore & Reid 2009).

1.3.1 Predators

Breeding success of Chatham Island oystercatchers is generally low in unmanaged areas on Chatham and Pitt Islands because of predation by introduced animals, especially cats (Fig. 4). Cats take a high toll on eggs and chicks, but judging by the occasional corpse of adult oystercatchers, cats are a threat throughout the life cycle of oystercatchers.

Weka predation is opportunistic, occurring when eggs are left unattended, e.g. before incubation has got fully underway. Other opportunistic predators of eggs and chicks include red-billed gulls, dogs (*Canis lupus familiaris*), and probably harriers (*Circus approximans*), spur-winged plovers (*Vanellus miles*), possums (*Trichosurus vulpecula*) and pigs (*Sus scrofa*). The brown skua (*Catharacta skua lonnbergi*) is a predator on Rangatira, Mangere Island and, to a lesser extent, Pitt Island (Aikman et al. 2001). Predation by southern black-backed gulls (*L. dominicanus*) has been observed on Rangatira (Aikman et al. 2001) and is suspected elsewhere.

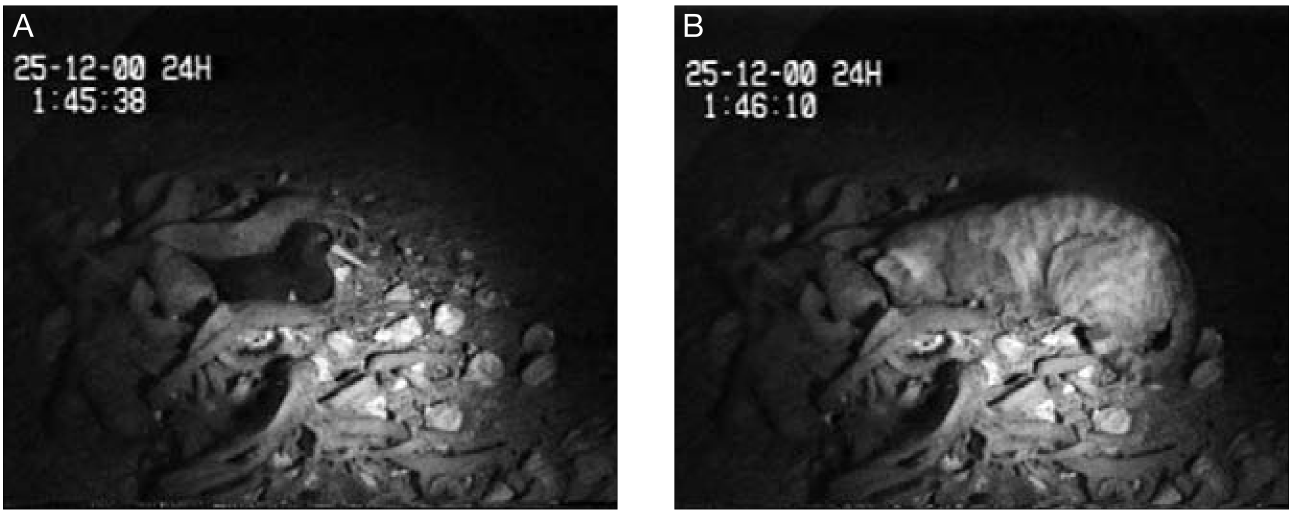


Figure 4. An adult Chatham Island oystercatcher (*Haematopus chathamensis*) incubating its nest at night and photographed by time-lapse video camera (A), shortly before a cat (*Felis catus*) arrives and eats the eggs (B). *Photos: Peter Moore.*

1.3.2 Trampling and disturbance

Figure 5. A nesting Chatham Island oystercatcher (*Haematopus chathamensis*) being harassed by sheep. *Photo: Peter Moore.*

Sheep (Fig. 5), cattle (*Bos taurus*), vehicles and people crush eggs or chicks. They also disturb the adults, causing them to leave the nest, which can result in the loss of eggs due to other factors, such as predation.

1.3.3 Nesting habitat

Since Chatham Island oystercatchers nest on beaches amongst high-tide debris, high seas and storms can wash nests away. This is particularly a problem in stormy years or in areas without safe nesting sites, and has been made worse by marram grass (*Ammophila arenaria*), which was introduced 100 years ago to stabilise dunes. The vigorous growth of marram has reduced the area of sparse vegetation on foredunes and has resulted in the formation of steep-fronted dunes with narrow beaches (Fig. 6). This leaves little space in which the oystercatchers can nest away from wave surges. Consequently, most birds nest on the remaining narrow beaches, where their eggs are prone to being washed away by storm seas (Davis 1988; Aikman et al. 2001; Schmechel 2001). In 1994–1997, 50% of egg losses were caused by the sea (Schmechel & Paterson 2005). Similarly, in stormy years between 1998 and 2004, 40–50% of egg losses were caused by the sea. This is likely to be an increasing phenomenon with climate change and the projected rise in sea levels.

Figure 6. Dense thickets of marram (*Ammophila arenaria*) on foredunes of northern Chatham Island. *Photo: Peter Moore.*

1.4 RECOVERY PLAN

The Chatham Island oystercatcher recovery plan 2001–2011 (Aikman et al. 2001) had two over-arching goals:

- **Ten-year goal**—Improve productivity and adult survivorship to increase the total population to > 250 individuals (to change its International Union for Conservation of Nature (IUCN) conservation ranking from Endangered to Vulnerable)
- **Long term goal**—Restore the natural coastal ecology so that minimal management is required to maintain a population of > 250 individuals

To achieve the 10-year goal, the aim was to improve average productivity from the unmanaged average of 0.34 chicks per pair per year to 1.0 chicks per pair per year through intensive management that combined three general techniques: predator control, stock exclusion and movement of nests away from high tide. The long-term goal will be partially achievable using dune restoration techniques, which will be the subject of a future report.

1.5 OBJECTIVES

With the aim of increasing the size of the oystercatcher population, 16 km of northern Chatham Island (Wharekauri and Maunganui) was managed and monitored from 1998 to 2004. A combination of three techniques was used: predator control, stock control and moving nests. This three-pronged attack for oystercatcher protection was considered by DOC managers to be the 'best practice' set of actions that would boost oystercatcher productivity.

To assist future managers, this report outlines the management techniques used in 1998–2004 and the net benefits and success of these. Years refer to breeding seasons, e.g. 1998 refers to the 1998/99 season. Figure 7 outlines the time line of management and monitoring actions in relation to the oystercatcher breeding season.

	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR
Stage of breeding season		Nest selection (scraping)		Eggs (first clutches and relaying)				
				Chicks				
							Juveniles	
Predator control				Trapping (daily check of traps)				
Stock control	Fix fences and gates			Put electric fences around nests				
Nest protection	Put out nest platforms; clear marram alcoves			Move nests from high tide			Collect nest platforms; spray marram alcoves	
Bird monitoring maximum				Daily checks of pairs and breeding success in managed areas; weekly–monthly checks in unmanaged areas				
				Census				
Monitoring minimum			Check breeding and territorial pairs	Check eggs & chicks		Final check of breeding success		

Figure 7. Time line of management and monitoring during the Chatham Island oystercatcher (*Haematopus chathamensis*) breeding season.

2. Predator control

2.1 AREAS

At Maunganui and Wharekauri, northern Chatham Island, trapping occurred annually from 1998 to 2004. In 2000, the trapping area used in 1998 and 1999 (Bell 1999; Moore et al. 2001) along 14 km of coast at Maunganui and Wharekauri was extended northeast of Tioriori to Tutuiri Creek, to protect about 16 km of coast and include some new territories (Appendix 1, Figs A1.1–A1.4). Initially, the trapping protected 16 oystercatcher territories, but by 2004 the population in the managed area had increased to 35 pairs.

In addition, partial seasons of predator control were conducted in other parts of northern Chatham Island (Paritu in 2002), southwest Chatham Island (Point Gap, Point Durham to Kauaeroa, and Kiringi Creek in 2001, 2003 and 2004) and Pitt Island (1999–2002).

Progress was reviewed in 2005. The main expansion of the oystercatcher population had occurred in northern Chatham Island, with minimal benefit to the southern range. Hence, it was recommended that management be rotated at 5-year intervals between northern Chatham Island, the southwest coast and eastern Pitt Island. Consequently, in 2005 the main trapping effort shifted to 8 km of coast on the east coast of Pitt Island, from North Head to Glory Bay South, to protect eight oystercatcher territories (Appendix 1, Figs A1.5 & A1.6).

2.2 TYPES OF TRAP

During 1998–2004, three types of traps were used to control predator numbers in oystercatcher territories on the Chatham Islands: leg-hold traps, wooden cage traps and metal cage traps. These trap types all needed to be checked daily.

During 2005–2007, trapping on Pitt Island used a combination of cages and *'Victor'* leg-hold traps. Trapping recommenced in 2007 at Wharekauri using a combination of *'Havahart'* cages, wooden cages and six *'Set-n-Forget'* (Pest-Tech Ltd, PO Box 40, Leeston, Canterbury, New Zealand) kill-traps in plywood boxes set at the marram edge.

Details of each of these trap types are provided below.

2.2.1 Leg-hold traps

'*Lanes-Ace*' leg-hold (gin) traps are spring-loaded serrated jaw traps. These were recessed in a wooden base and hidden with tissue paper covered by a thin layer of sand. Fish bait was hung on a nail (or sometimes in a mesh bait holder) on a wooden backing board behind the trap. Wire mesh walls were designed to prevent predators from reaching the bait from the side, forcing them to step on the hidden trap plate (Fig. 8).

Figure 8. A possum (*Trichosurus vulpecula*) caught by a leg-hold trap. *Photo: Peter Moore.*

Although gin traps are very effective at catching target animals when oiled and kept in good condition, there are two main disadvantages: they are less humane than other traps and non-target animals (including oystercatchers, penguins and harriers) can also be injured. The use of these traps is no longer considered acceptable because the serrated jaws often break the legs of a captured animal and up to 24 hours may elapse before the trap is checked. Two oystercatchers were injured by gin traps in 1999–2004 and each had to have a leg amputated. The amount of bycatch can be mitigated to some extent by placing driftwood in front of traps; however, trappers are generally reluctant to do this in case it decreases the chance that predators will approach the trap.

Long spring leg-hold traps such as gins have been phased out and are now restricted (Animal Welfare (Leg-hold Traps) Order 2007 pursuant to section 32 of the Animal Welfare Act 1999). An alternative leg-hold trap is the *'Victor'* soft jaw ('Oneida Victor® Soft Catch® 1½' leg-hold traps; Oneida Victor Inc. Ltd, PO Box 32398, Euclid, Ohio 44132, USA), which are used, for example, in walk-through sets in the Tuku (southwest Chatham Island) to catch cats for protection of the endangered taiko (*Pterodroma magentae*).

2.2.2 Wooden cage traps

Figure 9. A feral cat (*Felis catus*) caught in a wooden cage trap. *Photo: Peter Moore.*

A custom-made design of cage trap that was used consisted of a wooden frame, wire mesh walls and fibrolite trap-door (Fig. 9). A wire runs from a baited hook inside the cage along the roof to a hole in the trap-door, so that movement of the hook triggers the door to close. Cage traps such as these were used in the first few years of the trapping programme close to farm dwellings, so that pet cats could be released unharmed.

2.2.3 Metal cage traps

Figure 10. A weka (*Gallirallus australis hectori*) caught in a metal cage trap. *Photo: Peter Moore.*

'*Havahart 1089*' (Havahart®, Woodstream Corp. 69 N. Locust St., Lititz, PA 17543, USA) is a cage trap made of stainless steel mesh with a door that is triggered by a foot treadle (Fig. 10). The treadle can easily be made inoperable by wind-blown sand, so many of the traps were modified to be triggered by a baited hook, similar to that described previously for the wooden cage. *'Cyclone'* metal traps (Fletcher Easysteel, 575 Great South Road, Private Bag 92803, Penrose, Auckland, New Zealand) were also used in the latter period of trapping (from 2004).

Cage traps have the advantage of being effective at catching target animals and being humane. Setting the trap correctly and in a good location (see section 2.4) appeared to be more important than the type of trap used. Captured animals remained unharmed until the trap was checked, at which time they were dispatched by rifle-shot or a blow to the head (weka). Use of these traps also allowed the option of targeting cats and releasing weka (which was requested by landowners at Maunganui), and eliminated the bycatch of little blue penguins (*Eudyptula minor*) and harriers.

2.2.4 Kill-traps

Kill-traps can be checked less frequently, thus reducing labour costs. However, they do not allow the targeting of cats in preference to weka. Five types of kill-trap for cats have been approved for DOC use (Darren Peters, DOC, pers. comm.).

2.2.5 Trap efficiency

Trap efficiency, as measured by the capture index, was similar in 1998–2002 (5.5–7.5), but decreased to 3.2 in 2004 (Table 1; Fig. 11). The proportion of cage traps used also increased each year, but this does not explain the reduction in trap efficiency, as each trap type was similarly effective (Table 1). Rather, the decrease in efficiency was a result of an overall decrease in the number of animals caught in 2003 and 2004, particularly weka (Table 2; Fig. 12).

TABLE 1. TRAPPING STATISTICS AT MAUNGANUI/WHAREKAURI, NORTHERN CHATHAM ISLANDS, 1999–2004.

	1999	2000	2001	2002	2003	2004
Total no. traps	76	88	95	107	124	122
Trap nights	8864	13 378	11 408	12 817	14 200	11 436
Trap index*	7.5	5.5	6.2	6.2	3.9	3.2
Total captures						
Leg-hold trap	64	62	42	44	29	23
Wooden cage trap	12	26	28	28	24	24
Metal cage trap (*Havahart*)	0	0	25	35	71	75

* Captures per 100 corrected trap nights.

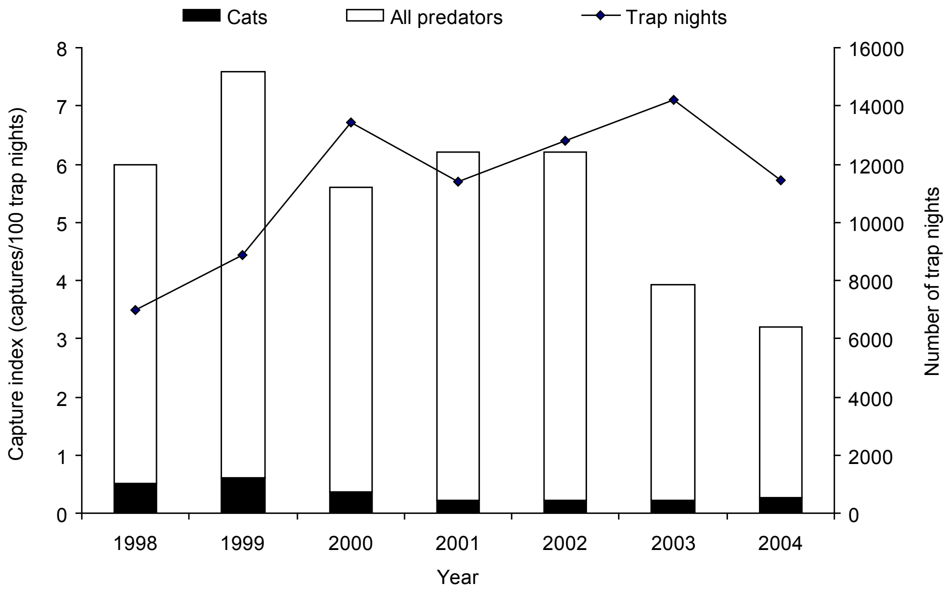


Figure 11. Total trap nights per year (line) and capture indices for cats and all predators (bars) in northern Chatham Island, 1998–2004.

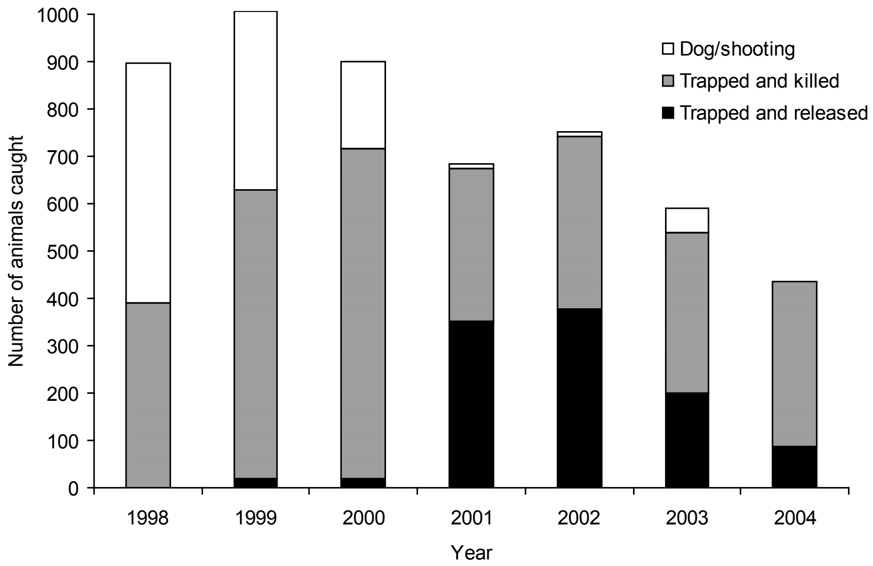


Figure 12. The number of animals killed by dog/shooting and killed or released by trapping in northern Chatham Island, 1998–2004.

TABLE 2. NUMBER OF PREDATORS CAPTURED/KILLED AT MAUNGANUI/ WHAREKAURI, NORTHERN CHATHAM ISLANDS, 1998–2004.

Data from trapping, hunting by dog and shooting are combined.

	1998	1999	2000	2001	2002	2003	2004
Cat	47	51	46	27	26	29	31
Weka	654	719	495	560[a]	660[b]	428[c]	261[d]
Possum	133	61	68	8	16	9	15
Rat	?	44	71	39	21	34	19
Hedgehog	39	41	56	19	11	15	16
Gull	23	53	116	2	11	58	4
Bycatch	?	33	47	29	18	17	12

[a] 327 of the weka were released alive (148 banded birds were recaptured and 30 were subsequently killed in leg-hold traps).

[b] 362 released alive.

[c] 188 released alive.

[d] 78 released alive.

2.3 BAIT

In 1998–2004, fish was used as bait for predators such as cats and weka on the Chatham Islands. Boxes of mackerel were kept in a freezer at Wharekauri farm and chunks were taken during each trapping round to replenish any bait that was missing. Depending on the weather conditions, all bait was replaced every 2–3 days.

2.4 TRAP LOCATION

Most traps were set at the beach/dune edge, but some were also set behind the main dune and, in a few cases, on the edges of small patches of forest close to the beach.

For optimal results, traps should cover as much coastline as possible, with a higher concentration of traps in the oystercatcher territories or areas where predator tracks have been noted. The underlying principles for trap location were:

- The beach front, streams, tracks and fence-lines would act as highways 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 by placing new traps or by shifting traps

Between 1998 and 2004, there was an increase in the number of traps (76 to 124) and trap nights (7000 to 14200) (Table 1; Fig. 11), to protect the expanding number of oystercatcher territories (Appendix 1, Figs A1.1–A1.4). On average, the number of traps per territory was 3.5–4.5 during the study period. Depending on the density of birds and likely predator pathways, traps were placed at 50–100-m intervals along the coast, with occasional gaps of 0.5–1 km where there were no oystercatcher territories (Appendix 1, Figs A1.2 & A1.4). Double rows of traps were placed at either end of the trapping lines, and at stream, track and fence-line access points to increase the chance of catching predators migrating into the managed area. These strategies were successful, as judged by the high level of nest and chick survival in managed areas compared with unmanaged areas.

2.5 TIMING

Trapping should commence in late September or early October and continue until late February (Fig. 7; Table 3). The early period of trapping is designed to remove the resident cats before the oystercatchers begin to lay their eggs (from about 20 October to mid-December). The ongoing trapping removes new cats that migrate into the area during the season, protecting the birds during the chick-rearing period as well as any replacement clutches laid later in the season (through to early February) following the loss of first eggs. Most juveniles are flying and relatively safe by late February, but birds that re-lay in January may still have small chicks at this stage.

TABLE 3. TIME LINE OF PREDATOR CONTROL TO PROTECT CHATHAM ISLAND OYSTERCATCHER (*Haematopus chathamensis*).

MONTH	DATE	MANAGEMENT ACTION
July		• Finalise trapping contractor or staff work programme • Liaise with landowners for access and other logistics • Outline plan of trap types at different locations • Arrange vehicle, trailer and quad motorbike • Arrange accommodation and transport from mainland New Zealand if necessary
Sept	15 Sept	• Set up trap line of numbered traps and begin trapping • Carry out additional hunting with dog if available and/or shooting for an initial knock-down of predators • Take GPS of trap locations, produce a map and record trap types
Sept–Feb		• One-person operation: 6 day per week trapping; backup person to run traps over Christmas period • Two-person operation: continuous trapping • Fill out daily trap sheets • Update trap locations if they are moved or removed • Enter catch data on computer
Feb	28 Feb	• Close trap line and remove traps
Mar		• Clean and store traps, oil leg-hold traps • Finalise computer data files
Apr		• Contractor or supervisor prepares summary report for Chatham Island Species Recovery Group • Provide feedback to landowners • Plan allocation of resources in following year • Arrange for any replacement traps and other gear

Short periods of trapping (e.g. over a few weeks or for part of a season) may partially protect oystercatcher areas. However, although this is an attractive option for managers with scarce resources, oystercatcher breeding success in areas with only partial management tends to be similar to that in areas with no management. For example, in seven seasons of intensive management at Maunganui/Wharekauri, the mean oystercatcher productivity was more than double that in areas with partial or no protection (see section 7). Hence, putting in half the effort yields poor returns.

2.6 INTENSITY

The ideal trapping regime is a continuous 7-day-per-week operation; hence, two people are required—or backup staff to cover the weekends. This occurred on northern Chatham Island for three seasons (1999–2001), when two contractors shared the responsibility for trapping and video monitoring of managed and unmanaged nests. The result was a mean oystercatcher productivity of 1.2 chicks per pair over the three seasons. The alternative regime is a 6-day-a-week operation run by one person, allowing traps to be operational (available for catching predators) for 5 days and nights per week; e.g. traps are set on Monday and closed on Saturday. This occurred for four seasons (1998 and 2002–2004), with periods of continuous operation when support staff were available. In those years combined, the mean productivity was 0.90 chicks per pair per year, although factors such as a high frequency of storm wash contributed to lower success than in the other 3 years.

2.7 OTHER PREDATOR CONTROL

To maximise the control of cats, a standard intensive trapping regime should be supplemented with other control methods, such as shooting and hunting with a trained dog. This occurred in northern Chatham Island in 1998 and 1999, and the early part of 2000 (Fig. 12). The total number of animals killed per year decreased after 1999 (Fig. 12), possibly as a result of the shift to using trapping as the predominant control method combined with a cumulative effect of the annual trapping and natural fluctuations in predator numbers.

2.8 RECORDS

Daily records should be kept of trap catch, sprung traps and bait loss (Appendix 2, section A2.1), and these should then be summarised on an Excel spreadsheet. A trap index is calculated for each trap or area, based on the number of animal captures and the number of nights (24-hour periods) the traps were open and available to catch animals (i.e. a correction is made for the number of nights where traps were closed or had caught an animal).

Predator control work can be combined with monitoring of oystercatcher breeding success, to allow the success of the protection to be gauged and the workers to feel more directly connected to the conservation of the bird.

2.9 RESULTS OF PREDATOR CONTROL

The predator control regime in 1998–2004 removed a variety of potential predators (Table 2). The number of cats caught was highest in 1998–2000 (46–51 per year), but decreased in 2001–2004 to 26–31 per year (Table 2). Up to 719 weka were killed each year (Moore et al. 2001; Table 2), but from 2001 onwards up to 58% of weka were released alive (at the request of the landowners), mostly from Maunganui. Weka captures decreased after 2002, presumably a result of a decrease in their population.

Video monitoring of nests in 1999–2001 found fewer nests were lost or impacted by predators at managed areas compared with unmanaged areas (Table 4; Moore & Reid 2009). The only predation observed on film at a managed area occurred when a red-billed gull (which was not a predator control target) ate the eggs at an island at Wharekauri. Some close calls did occur at managed nests that were filmed; for example, one visit by a cat and two visits by a possum—in all three cases the eggs were investigated by the animals but not eaten (Table 4). In comparison, 16 unmanaged nests failed because of predators, particularly cats, and there were another 13 close calls by predators that were observed on film visiting the nests (Table 4). In several cases the eggs were handled but not eaten (Moore & Reid 2009).

TABLE 4. NUMBER OF EVENTS THAT WERE FATAL TO CHATHAM ISLAND OYSTERCATCHER (*Haematopus chathamensis*) EGGS, OR HAD A HIGH RISK OF EGG LOSS, IN NORTHERN CHATHAM ISLANDS, 1999–2001.

Data from video of 21 nests in managed areas (422 nights) and 27 nests in unmanaged areas (332 nights).

		CAT	WEKA	GULL	POSSUM	STOCK	PEOPLE	SEA	OTHER	TOTAL
Managed	Fatal	0	0	1	0	0	0	1	0	2
	High risk	1	0	0	2	0	1	1	0	5
Unmanaged	Fatal	13	3	0	0	1	0	0	0	17
	High risk	4	4	0	5	32	1	3	4	53

3. Stock exclusion

Stock exclusion fences prevent Chatham Island oystercatcher eggs and young chicks from being trampled by sheep and cattle. However, on much of the Chatham Island coastline, farm animals have unimpeded access to the beaches. A time line of stock control activities is provided in Fig. 7 and Table 5.

TABLE 5. TIME LINE OF STOCK CONTROL AND NEST PROTECTION OF CHATHAM ISLAND OYSTERCATCHER (*Haematopus chathamensis*).

MONTH	DATE	MANAGEMENT ACTION
July		• Finalise staff work programme • Liaise with landowners for access and to discuss fence repairs
Sept	1 Sept	• Depending on condition and inspections: —Repair fences and gates —Repair fence extensions (e.g. Tioriori tie-off) —Renew oystercatcher signs at access points • Clear marram alcoves by hand-pulling seedlings to create space for moving oystercatcher nests into • Place two car tyre nest platforms in selected managed oystercatcher territories
Oct–Jan		• Shift nests in vulnerable territories away from high tide • Place electric fences around nests where stock have access to beaches
Feb	Late Feb	• Spray marram alcoves ready for next season
Apr		• Prepare summary report for Chatham Island Species Recovery Group • Provide feedback to landowners • Plan allocation of resources in following year • Arrange for any replacement gear (new platforms, spray, etc.)

3.1 PERMANENT FENCES

Figure 13. A stock exclusion fence at Tioriori. *Photo: Peter Moore.*

Permanent fences that are parallel to the coastline (Fig. 13) offer varying levels of protection, depending on whether they simply serve to channel wandering stock onto the beach from neighbouring areas of farmland. For example, the fence along the Wharekauri coast (see fence-lines parallel to the coast in Appendix 1, Figs A1.3 & A1.4), which demarcates the 'marginal strip' of Crown land, keeps most stock out from adjacent farmland. Entry to the western end is limited by cliffs around Cape Young; however, sheep can enter the beach from the eastern Taupeka end where the fence ends (beyond trap 1 in Appendix 1, Fig. A1.4). Although incursions by sheep were frequent in some years between 1998 and 2004, the daily trapping round gave the opportunity to herd them back down the fence-line before they had progressed very far.

For permanent fences to be effective, gates must be secure, well-maintained and kept closed by visitors to the beach. Good relations with the landowners are essential, as they can keep an eye out for any problems, and oystercatcher conservation signs at beach access gates can help educate the public about appropriate behaviour.

Plastic mesh attached to the fence and gates (e.g. as used at Tioriori) is used to improve predator exclusion, particularly of weka. Outrigger electric wires also help to protect the fences from stock.

In areas without natural boundaries, such as headlands or cliffs, fence extensions (tie-offs) that run down the beach perpendicular to the coast are required to prevent stock from moving onto the beach. At Tioriori, a fence extension was built in the mid-1990s to prevent stock from entering an oystercatcher breeding area. The outer extension used steel posts concreted onto tidal rocks, heavy wire cables and plastic mesh (Fig. 14). Regular (annual) repairs are required because storms and wave action damage the fence. An alternative to the mesh is a palisade of white plastic poles (Fig. 14), which offers less resistance to the waves and is easier to maintain.

Figure 14. A fence tie-off extension of plastic poles designed to prevent stock entering Tioriori. Part of the original version of steel waratahs, wire cables and plastic mesh is visible to the left of the photograph, and concreted onto tidal rocks in the background. *Photo: Peter Moore.*

3.2 TEMPORARY ELECTRIC FENCES

Figure 15. A temporary electric fence protecting a Chatham Island oystercatcher (*Haematopus chathamensis*) nest in an area where farm animals have access to the beach. *Photo: Rex Williams.*

In areas where farm animals have access to the beaches, portable electric fences can be used to surround nests (Fig. 15). Different models of electric power units are solar charged or use replaceable batteries. The oystercatchers will remain off the eggs while a fence is being set up, so it is important to minimise the time taken (< 15 minutes) before moving on.

The use of an electric fence should be noted on the breeding summary file for each nest (see section 5).

3.3 RESULTS OF STOCK EXCLUSION

In 1998–2004, stock exclusion in managed areas was very effective at eliminating or reducing the chance of egg loss. The nests that were filmed in 1999–2001 had no fatal incidents or close calls (Table 4), although sheep and cattle were seen in the vicinity of some nests. In comparison, some unmanaged areas were frequented by sheep, and often the sheep were curious and investigated oystercatcher nests. The result was multiple close calls as a result of sheep walking close to or sitting beside the nests. One nest was lost when a sheep sat on the eggs (Table 4).

4. Moving and raising nests

Moving nests away from the high-tide mark (by creating new nest scrapes or using platforms) or raising nests (using platforms or mounds), combined with localised marram removal/control, increases the protection of nests from sea action. Although some eggs can survive being washed over or moved a short distance, as birds will make a new scrape or roll them back into the nest, moving nests to safer ground allows eggs to get through the 29-day incubation period unscathed. The vulnerability of nests to sea action varies between sites, so previous oystercatcher monitoring data should be checked before moving nests.

Interestingly, once a pair has been successful at a site, they will often nest there again in following years. Therefore, to some extent you can train the birds to nest further up the beach than they were initially inclined to do.

Spring tides, large swells and onshore winds can push waves further up the beach than usual. During the worst storms, waves can sweep several metres into the dune vegetation, washing away all oystercatcher nests on exposed coasts. In years with frequent storms, 40–50% of egg losses are caused by the sea. Therefore, it is prudent to move as many nests to higher ground as possible during good weather conditions early in the incubation stage (Table 5).

The movement of nests should be summarised on the nest record sheets (see section 5).

4.1 CREATING SCRAPES

Natural nests are easily relocated by creating a new nest bowl and the surrounding pattern of seaweed and driftwood further up the beach (Fig. 2). When moving a nest, it is a good idea to smooth out the old site and use the fingertips to create imitation tracks of the oystercatchers to and from the new nest. Nests can be moved directly up a beach (Fig. 16) or on an angle to a better position, such as a more prominent sand crest or within an alcove in the marram (Figs 17 & 18).

Nests should be moved in small increments (< 3 m per day). Although the birds are well-adapted to an ever-changing beach environment, care is needed, since the adults may abandon their eggs if the nest is moved too far or too quickly (2 nests out of a total of 91 nests were abandoned after they were moved in 1998–2004). It is better

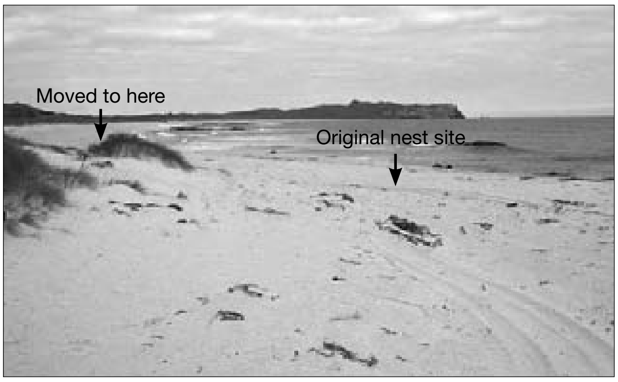


Figure 16. Movement of a nest from the tidal debris zone to a safer position in an alcove of sand in the marram (*Ammophila arenaria*) foredune, Woolshed territory (Wharekauri). *Photo: Rex Williams.*

Figure 17. Movement of a nest site at Awamutu (Wharekauri) to a safer position in a sprayed alcove in the marram (*Ammophila arenaria*) foredune. *Photo: Rex Williams.*

Figure 18. Movement of a nest to an artificial alcove on a very narrow beach (T6 at the east end of Tioriori, Maunganui), and creation of a wall of boulders. *Photo: Rex Williams.*

to move a nest to safety over several days than to change its position abruptly when a storm is on its way. Also, the eggs can be quickly buried by sand and then abandoned in windy conditions if the oystercatcher is off the nest because people are present. Nevertheless, if the situation is urgent, a bold movement (or several staged movements in the same day) may be necessary.

With time and experimentation, an oystercatcher worker will build up experience at successfully moving nests and modifying the site to minimise losses from sea action.

4.2 PLATFORMS

Nest platforms are used to raise the nests and allow for their easy relocation. The raising of the nest by a few centimetres and the wall of the tyre itself may be all that is required to protect a nest from flooding at high tide. A simple design of nest platform is a car tyre tied to a sheet of plywood, which can be dragged up the beach using the rope handle (Fig. 19).

Figure 19. A nest platform made from a car tyre tied to a plywood sheet. *Photo: Georgie Hedley.*

Nest platforms can be placed in all managed oystercatcher territories before the start of the breeding season and stored behind dunes during the winter. Oystercatchers will generally explore a range of nest sites before laying their eggs, so it is useful to position the platforms in a couple of likely spots close to the high-tide or storm-tide zone. Knowledge of where previous nesting attempts occurred is helpful. Once in place, the wooden sheet is covered with sand and the

Figure 20. Chatham Island oystercatcher (*Haematopus chathamensis*) eggs laid in a car tyre platform. *Photo: Rex Williams.*

inside of the tyre circle is filled with sand. A sparse decoration of seaweed or driftwood on the platform may help to attract an oystercatcher, since they use tidal debris at natural nest sites to help camouflage the eggs and baffle the wind (Fig. 20). Birds that nest in tyres often continue to do so in future years.

4.3 MOUNDS

Low-profile beaches, particularly sandy spits alongside streams (e.g. Washout Creek at Maunganui), may have no safe sites to which a nest can be moved. However, a mound (with or without a tyre platform) can gradually be built up over several days. Driftwood or boulder barriers can also help baffle the waves (Fig. 21).

Figure 21. A car tyre nest platform placed under a Chatham Island oystercatcher (*Haematopus chathamensis*) nest, with a mound gradually raised beneath it over a few days. *Photo: Rex Williams.*

4.4 LOCALISED MARRAM REMOVAL

On narrow beaches, there may be no safe nest sites. Consequently, movement of a nest may only be successful if an alcove is first created in the foredune (Figs 17 & 18). It is best to spray a patch of marram with herbicide at the end of the breeding season and weed-eat or pull out the dead material in the spring. Any re-growth of marram can then be pulled out by hand during the season. An area that is approximately 10 m^2 is usually adequate, as it allows the incubating bird to survey its territory and escape predators. The nest is moved to the middle or back of the cleared site depending on the topography of the beach and foredune. If the foredune has a steep front, the nest will need to be moved up the bank gradually to avoid upsetting the birds with too abrupt a change to their nesting position.

4.5 RESULTS OF MOVING AND RAISING NESTS

Because of the relatively narrow, steep beaches at Maunganui/Wharekauri, it was anticipated that moving the nests would improve breeding success. Over the course of seven seasons in 1998–2004, 107 nests were moved, raised or were on tyre platforms. This action undoubtedly helped to protect many eggs from high tides, wind-generated waves and moderate storms, since many of the original nest sites were washed over at least once during the breeding season (Moore & Williams 2005). Table 6 suggests that moving or raising nests had no overall benefit, since 16% of these nests were washed away compared with 11% of nests that were not manipulated. However, this is because the manipulated nests tended to be on vulnerable sites and so suffered greater losses in the stormier seasons when waves washed through the breeding sites and into the foredunes.

The greatest benefit, therefore, probably occurred during years with few storms. For example, the position on the beach profile was measured for 21 nests in 2000 and 2001, and on average they were 8.5 m from the mean high-tide mark (and 0.39 m in elevation above high tide). Most of these were vulnerable to wave action, and four nests were actually below the mean high-tide mark. Nine nests of this measured sample were moved from their vulnerable sites (on average 5.2 m from high tide and 0.16 m elevation) to safer positions (on average 16.7 m from high tide and 1.08 m elevation).

Another benefit of moving nests was that the successful birds often chose to nest higher up the beach profile in subsequent years.

TABLE 6. MOVEMENT OF CHATHAM ISLAND OYSTERCATCHER (*Haematopus chathamensis*) NESTS AT MAUNGANUI/WHAREKAURI, NORTHERN CHATHAM ISLANDS, 1998–2004.

YEAR	TOTAL NUMBER		DISTANCE MOVED (m)			MANIPULATED*		NOT MANIPULATED	
	BREEDING PAIRS	NESTS	MEAN	SD	RANGE	NUMBER OF NESTS	% WASHED AWAY	NUMBER OF NESTS	% WASHED AWAY
1998	16	23	6.2	2.6	2–10	11	36.4	12	16.7
1999	16	21	5.3	4.2	2–15	12	16.7	9	22.2
2000	20	26	8.8	7.8	2–32	23	0.0	3	0.0
2001	24	33	6.2	4.3	1–18	18	0.0	15	0.0
2002	28	32	4.9	2.8	2–10	15	0.0	17	0.0
2003	34	43	4.8	4.0	1–12	11	9.1	32	3.1
2004	33	72	6.3	6.2	2–25	17	52.9	55	32.7
Total		**250**				**107**		**143**	
Mean							**16.4**		**10.7**

* Manipulated nests were moved, raised or placed on tyres.

5. Monitoring breeding pairs, productivity and population change

To gauge the effectiveness of management, the status and numbers of breeding pairs and their productivity should be monitored and compared with areas that are not being managed (Fig. 7; Table 7). In managed areas, the aim is to boost productivity to an average of 1.0 chicks per pair per year.

TABLE 7. TIME LINE OF INTENSIVE MONITORING OF CHATHAM ISLAND OYSTERCATCHER (*Haematopus chathamensis*).

MONTH	DATE	MONITORING ACTION
July		• Finalise contractor or staff work programme (e.g. combine with trapping work) • Liaise with landowners for access and other logistics • Plan for census in December: —Access from landowners —Staff, vehicles, boats —Transport and accommodation • Plan for colour band replacement: —Prepare list of birds requiring band maintenance
Oct–Feb		• Daily check of oystercatcher pairs while doing trapping round • Weekly check of unmanaged areas in the vicinity of managed zones or monthly check at less accessible sites • Record identity of non-breeders (if colour banded) • Update territory maps • Fill out daily data on nest sheets and colour band record sheets • Enter summarised nest data and colour band record on computer files
Dec	8–15 Dec	• Census during the second week of December
Dec–Feb	15 Dec – 28 Feb	• Band and colour band chicks in approved areas • Colour band adults in approved areas • Colour band maintenance: —Trained staff catch and replace any worn colour bands, using band database records to ensure none of the bands are >8 years old
Mar		• Collate data sheets and maps for season • Finalise computer data files • Summarise band recovery data for each individual bird and transfer to oystercatcher band database • Band Operator transfers band data (schedules and recoveries) to Banding Office via their electronic files format
Apr		• Contractor or supervisor prepares summary report for Chatham Island Species Recovery Group • Provide feedback to landowners—letter of thanks and summary of findings in their area • Plan allocation of resources in following year • Arrange for any replacement gear

5.1 INTENSIVE MONITORING

In managed zones, daily checking of breeding pairs can easily be achieved as part of the checking of traps.

At each territory, researchers should:

- Identify adults by band combination (if colour banded)
- Record nesting behaviour (e.g. making scrapes, or being furtive (eggs), aggressive (chicks) or quiet (no nest))
- Locate nest by searching area where birds were before they were disturbed
- Record location of nest with GPS and photograph nest site
- Note any management action taken (e.g. erecting electric fence, moving nests, using tyre platforms, building mounds, clearing alcove)

In unmanaged zones near the managed areas, breeding pairs should be checked weekly to provide a comparison of breeding success. However, it should be noted that some nesting attempts can be missed between visits if eggs are lost shortly after laying. Intensified scraping activity is an indication that eggs will soon be laid.

Records of bird activity and nest progress should be summarised on nest sheets (Appendix 2, section A2.2), and final outcomes and management actions should be summarised for each nest (Appendix 2, section A2.3). A summary report of the season's findings should then be produced.

5.2 MINIMUM MONITORING

The minimum requirement for monitoring is a thorough check of pair status in October or November, nesting activity in December (e.g. as part of an island-wide census) and a follow-up check of breeding success in February to note the presence of juveniles (Fig. 7; Table 7).

5.3 BANDS AND COLOUR BANDING

Long-term monitoring of individual birds is undertaken using uniquely numbered metal bands (size K). Birds banded before 2000 were banded on the lower leg (tarsus), but more recent banding has been on the upper leg (tibia), in line with the best practice for banding of other waders (to reduce band wear). The bands on the tibia tend to be less noticeable from a distance as they can be obscured by feathers. Although the birds are only individually identifiable when they are captured, the presence of banded birds can help distinguish neighbouring pairs. The descriptions of the band positions should be summarised in the notes as NB (not banded), M:– (metal band on left tarsus), –:M (metal band on right tarsus), BLT (banded left tibia) or BRT (banded right tibia).

Detailed monitoring of breeding adults and the survival and movements of their chicks is only possible by marking individuals with colour combinations of plastic bands on the tarsi. Adult birds can be captured by using a noose-mat and decoy, and pre-fledged chicks can be captured by hand. Care must be taken to record the combination correctly and not to confuse similar colours (e.g. blue and green, yellow and orange, white and metal) or the left and right leg. Notebook entries must be double-checked in the field and any uncertain sightings discarded to minimise errors. The standard notation is left leg-right leg and upper followed by lower bands. For example, WR–BG represents white over red (left leg)–blue over green (right leg). Metal bands on the tarsus (but not the tibia) are included as part of the combination, e.g. M–R (metal on left leg, red on right leg).

All banding and colour banding must be conducted under the auspices of a permitted band operator, as approved by the New Zealand National Bird Banding Scheme (National Office, DOC).

Maintenance of colour bands is essential to prevent injury to the birds from eroded or unravelled bands. Initially, it was thought that bands would need to be replaced every 3–5 years. However, recent checks have indicated that colour bands for Chatham Island oystercatchers can be replaced every 8 years (S. O'Connor, DOC, pers. comm.). At the end of an intensive monitoring programme, all colour bands should be removed to prevent any injuries as a result of deteriorating bands.

Sightings of colour-banded oystercatchers should be recorded on the nest sheets for breeders and on a colour band record sheet for other birds (Appendix 2, section A2.4). These entries should then be compiled in a computer spreadsheet. A single entry for the year is usually added to the oystercatcher band database, which contains band data (bands applied and seen) between 1970 and 2006. Currently, the band database is administered by Wellington Hawke's Bay Conservancy, DOC (D. Houston, DOC, pers. comm.). Annual summaries of birds banded and seen are provided to the New Zealand National Bird Banding Scheme, National Office, DOC.

5.4 CENSUS

During management periods, an annual census of Chatham Island oystercatchers is required to measure the population response and recruitment movements of new breeders. During unmanaged periods, a full census should be carried out every 5 years to detect any population trends and to help assess the need for management action. If a census count of 90% of coast and lagoon encounters >320 birds, this probably represents a population of >250 mature individuals. This is the minimum required by the Chatham Island oystercatcher recovery plan 2001–2011 for a well-managed population (Aikman et al. 2001).

The standard timing of the census is during the second week of December (Fig. 7; Table 4).

Methodology and area boundaries for the census used by Schmechel & O'Connor (1999) were modified by Moore (2008). An example of census instructions is provided in Appendix 3 and a census record form in Appendix 2, section A2.5.

Eleven core census zones (northwest coast, Cape Young, northeast coast, Okawa, Owenga, southwest coast, Waitangi, Paritu, east Pitt Island, Mangere and Rangatira; Fig. 1) comprise approximately 167 km of coast and lagoon (36% of the total Chatham Islands coastline) and 96% of the oystercatcher territories that were found in 1998 (Schmechel & O'Connor 1999). These core census zones should be surveyed annually. The nine other lower priority areas of outer coastline (Point Somes, Long Beach, Point Munning, north and south Hansen Bay, southern cliffs, and west Pitt Island) and Te Whanga Lagoon (north and south sections) should be surveyed as often as possible (at least every 3 years on a rotating basis) to locate new pairs spreading out from the traditional breeding sites.

Oystercatcher censuses should be carried out on quad motorbikes or on foot. Areas with difficult access or with potential oystercatcher habitat below cliffs can be searched from vantage points, using binoculars or telescope, or from a boat; however, viewing from a boat should be only be used as a last resort, as the chance of detecting birds is low. Where possible, experienced observers should be used, and the same people should be used to survey the same shoreline each year. Pairs of birds should be categorised as breeders, if nests or chicks are found; suspected breeders, if they show the characteristic furtive behaviour of birds that have eggs or loud and aggressive behaviour normally used by birds defending chicks; or territorial, if they appear to be defending the area. Breeding can be confirmed in some cases from subsequent monitoring of pairs during the season. Floaters include all apparently non-territorial birds (non-breeding adults and immature birds).

6. Public relations

Good public relations are essential if the Chatham Island oystercatcher management and monitoring programme is to be successful. Access to the shoreline is usually over private land, so it is essential that permissions and support for the work are obtained. Regular updates (stopping for a cup of tea) and an annual letter of thanks or summary of findings help maintain the relationship.

The placement of oystercatcher signs at key entry points to the coast helps to keep the public informed about how to avoid disturbing nests or crushing eggs and chicks (e.g. by driving on the beach below the high-tide mark). Occasional articles or entries in the conservation updates in the local newspaper (*The Chatham Islander*) help keep up the oystercatcher profile and remind people about conservation issues, such as the damage that cats (both feral and domestic) do to native wildlife. In 1999–2004, a short documentary about the conservation work being done to help oystercatchers was shown on Chatham Island television. At the end of the study, a fact sheet about oystercatchers was produced and given to all landowners.

7. Oystercatcher population response

The three-pronged management system described in this report was a major success in 1998–2004. It was not feasible to test the three components of management separately. However, since the video monitoring in 1999–2001 showed that predation caused the most losses in unmanaged areas, it is likely that predator control had the greatest impact on Chatham Island oystercatcher breeding success. Stock control and moving/raising nests is likely to have had an additive effect in most or some years.

Breeding success of Chatham Island oystercatchers is generally low without management (Table 8), although this varies annually. Davis (1988) and Schmechel (2001) estimated productivity at 0.22 and 0.44 fledged chicks per pair per year, and an average minimum productivity of 0.35 chicks per pair per year was calculated using a larger dataset (Table 8). Limited or sporadic trapping effort ('some management') resulted in slightly elevated breeding success, but the more intensive management in 1998–2004 resulted in much higher breeding success (1.04 chicks per pair per year; range = 0.5–1.6) (Table 8). During 3 years of detailed monitoring (1999–2001), only 6% of eggs laid in unmanaged areas survived to fledge as chicks, whereas 39% of eggs laid in managed areas survived to produce fledglings. High numbers of chicks (18–35) were produced by 16–35 pairs at Maunganui/Wharekauri during the 7 years of management (Fig. 22). However, in 2005–2006, chick output decreased to pre-management levels, despite the number of pairs continuing to increase to 42. This improved in 2007, with 26 chicks fledged at Maunganui/Wharekauri (Fig. 22), but this was

TABLE 8. BREEDING SUCCESS OF CHATHAM ISLAND OYSTERCATCHER (*Haematopus chathamensis*) UNDER VARYING LEVELS OF MANAGEMENT AND AT DIFFERENT LOCALITIES, 1970–2007.

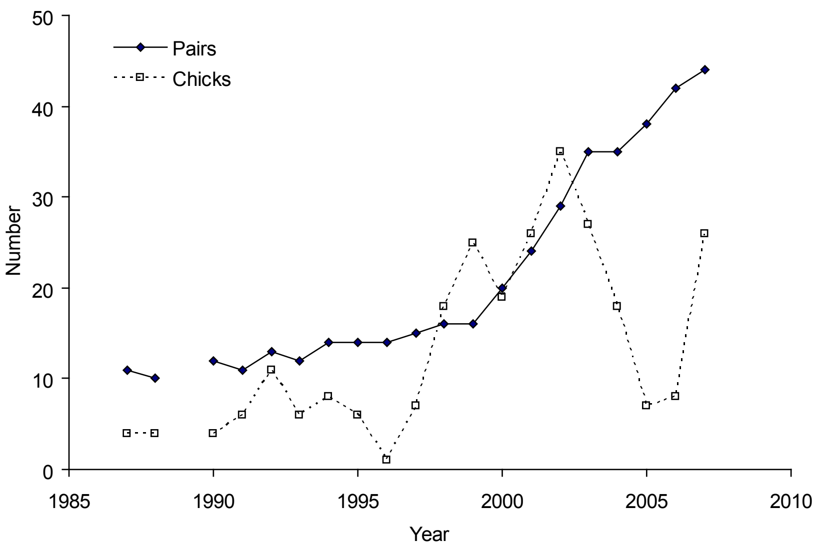
MANAGEMENT LEVEL	MINIMUM NUMBER OF CHICKS PER PAIR			NO. RECORDS	AREAS
	MEAN	SD	RANGE		
Intensive management	1.04	0.34	0.52–1.56	7	Wharekauri/Maunganui (1998–2004)
Some management	0.41	0.30	0.00–0.85	18	Wharekauri/Maunganui (1990–1993, 1997) Taupeka (1999) Whanga (2002) Southwest (2001, 2003–2004) Pitt Island (1999–2002, 2005–2007) Wharekauri (2007)
No management	0.35	0.33	0.00–1.00	41	Wharekauri/Maunganui (1987–1988, 1994–1996, 2005–2006) Maunganui (2007) Other northern Chatham (1987–1988, 1991–2007) Southern Chatham (1987–1988, 1990, 1999, 2002, 2006) Pitt Island (1987–1988, 1999–2003, 2006)
Offshore island reserves	0.40	0.32	0.00–1.00	44	Mangere (1970, 1977–1988, 1999–2007) Rangatira (1974, 1977–1988, 1999–2007)

largely the result of a high output of chicks at the unmanaged Maunganui, rather than because trapping had recommenced at Wharekauri.

The potential effect of management on oystercatcher survival was inconclusive, as estimated by multi-state mark-recapture of 472 birds that were banded between 1970 and 2004 (D. MacKenzie, Proteus wildlife research consultants, Dunedin). Analysis was hampered by the majority of banding and band sighting effort being undertaken in the last 7 years of the 35-year period, and effort being concentrated in the managed areas (D. MacKenzie, pers. comm.). Consequently, there was little difference in annual survival rates for adults (98%), non-breeders (96%) or juveniles (87% increasing to 89%) before and during management at Maunganui/ Wharekauri. There was, however, lower survival in other unmanaged parts of northern Chatham Island (97%, 95% and 84% for the respective age classes) and the rest of the Chatham Islands (92%, 86% and 65%).

During 1998–2004, birds bred at 2–5 years of age and the population expanded in northern Chatham Island. Large territories were subdivided and new breeders spread along previously unoccupied sandy shoreline with little or no rocky habitat, especially at stream mouths. Because oystercatchers tend to recruit close to their natal site, the increased production of chicks in managed areas in northern Chatham Island in 1998–2004 mainly benefited the northern part of the range. Of 170 chicks banded at managed areas in 1998–2004, 87 (51%) had recruited (bred or held a territory) by 2006. Of these recruits, 69% had returned to the managed zones, 25.3% to other northern Chatham Island areas, 4.6% to other parts of Chatham Island and 1.1% to Pitt Island. By 2004, 60% of the population was in northern Chatham Island and only 20% on the southern islands.

Figure 22. Number of pairs of Chatham Island oystercatchers (*Haematopus chathamensis*) and number of chicks produced at Maunganui and Wharekauri, northern Chatham Island, 1987–2007.



In 1998, there were 144 adults (Schmechel & O'Connor 1999), including 49 breeding pairs in the entire population. Over the next 7 years (1998–2004), during the period of intensive management in northern Chatham Island, the minimum total population more than doubled from 144 to 316 birds (121% increase) (Table 9; Fig. 23), comprising 89 pairs (Moore 2008).

In 2005, management effort shifted to Pitt Island. However, because only 1–5 juveniles were produced there in 2005–2006 and productivity in the formerly managed northern Chatham Island also decreased markedly during that time, the total population levelled off. Despite this, the number of pairs increased to 109 as the cohorts of young birds continued to enter the breeding population (Moore 2008).

TABLE 9. MINIMUM POPULATION ESTIMATES OF CHATHAM ISLAND OYSTERCATCHER (*Haematopus chathamensis*) IN DIFFERENT PARTS OF THE CHATHAM ISLANDS, 1970–2006.

	1970	1987	1998	1999	2000	2001	2002	2003	2004	2005	2006
Northern Chatham Island	10	32	68	79	108	136	141	186	189	203	194
Other Chatham Island	8	32	27	20	22	29	38	45	64	58	60
Other islands	34	48	49	47	61	57	60	55	63	56	59
Total	**52**	**112**	**144**	**146**	**191**	**222**	**239**	**286**	**316**	**317**	**313**

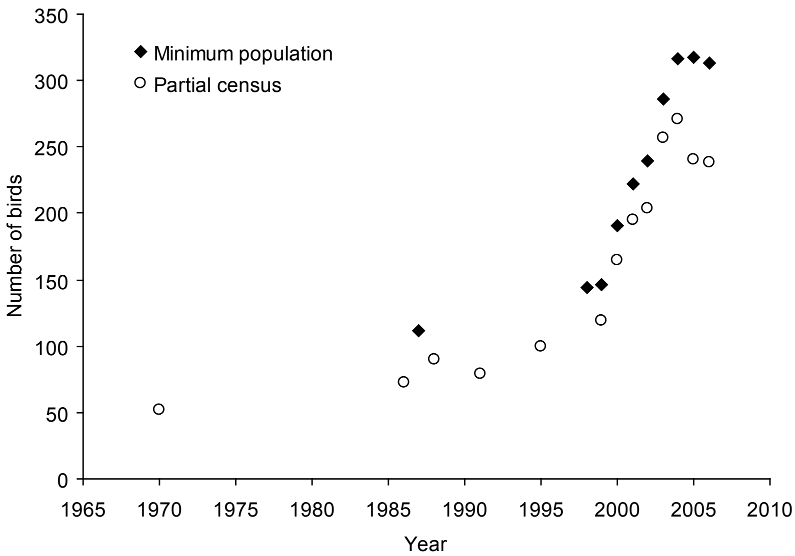


Figure 23. Minimum population estimates and partial censuses of Chatham Island oystercatcher (*Haematopus chathamensis*), 1970–2006.

8. Future management of Chatham Island oystercatcher

The best practice for future management of Chatham Island oystercatcher should combine intensive predator control (continuous trapping from October to February), stock exclusion (permanent or temporary fences) and the movement/raising of nests away from high tide.

Predation causes the most losses in unmanaged areas. Sporadic or partial trapping does not appreciably improve oystercatcher productivity. Stock control and moving/raising nests has an additive effect on productivity in most years, as both stock and wave action cause losses. However, in the stormiest years there is probably little benefit in moving nests, as there are no safe sites to move the nests to. Each individual nest requires 1 month of benign conditions before chicks hatch, but given the wide range in laying dates of oystercatcher pairs and the vulnerability of non-flying chicks, 5 months of full protection is required.

Although 7 years of intensive management on northern Chatham Island successfully boosted the population of Chatham Island oystercatchers, it was still short of the recovery goal of > 250 mature individuals. Consequently, the species remains endangered (IUCN 2006; BirdLife International 2007) and 'Nationally Critical' (Hitchmough et al. 2007), and is still a very high priority for conservation management.

A DOC management review in 2005 (Moore et al. 2006) endorsed the decision of the Chatham Island Species Recovery Group to shift management effort to Pitt Island to secure the southern range of the species. The reviewers recommended rotation of effort over 5-year periods between Maunganui/Wharekauri, Pitt Island and southwest Chatham Island, depending on the outcomes and success of the work at Pitt Island in 2005–2009.

9. Acknowledgements

Many thanks to the Chatham Island landowners for allowing access to the coast for oystercatcher management and research. Many thanks to the Department of Conservation staff, contractors and volunteers who conducted fieldwork in 1998–2006, particularly Mike Bell, Matt Charteris, John Dowding, Richard Goomes, Georgie Hedley, Jo Hiscock, Antje Leseberg, Nathan McNally, Stacy Moore, Shaun O'Connor, Bronwyn Thompson, Dale Williams and Rex Williams, as well as many others who contributed. We are grateful to all the above people for supplying summary maps, reports or data, and also appreciate the great support that staff of the Wellington Hawke's Bay Conservancy and Chatham Area Office of DOC provided during the course of the study.

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Appendix 1

CHATHAM ISLAND OYSTERCATCHER (*Haematopus chathamensis*) TERRITORIES AND POSITIONS OF TRAPS AT MAUNGANUI, WHAREKAURI AND PITT ISLAND

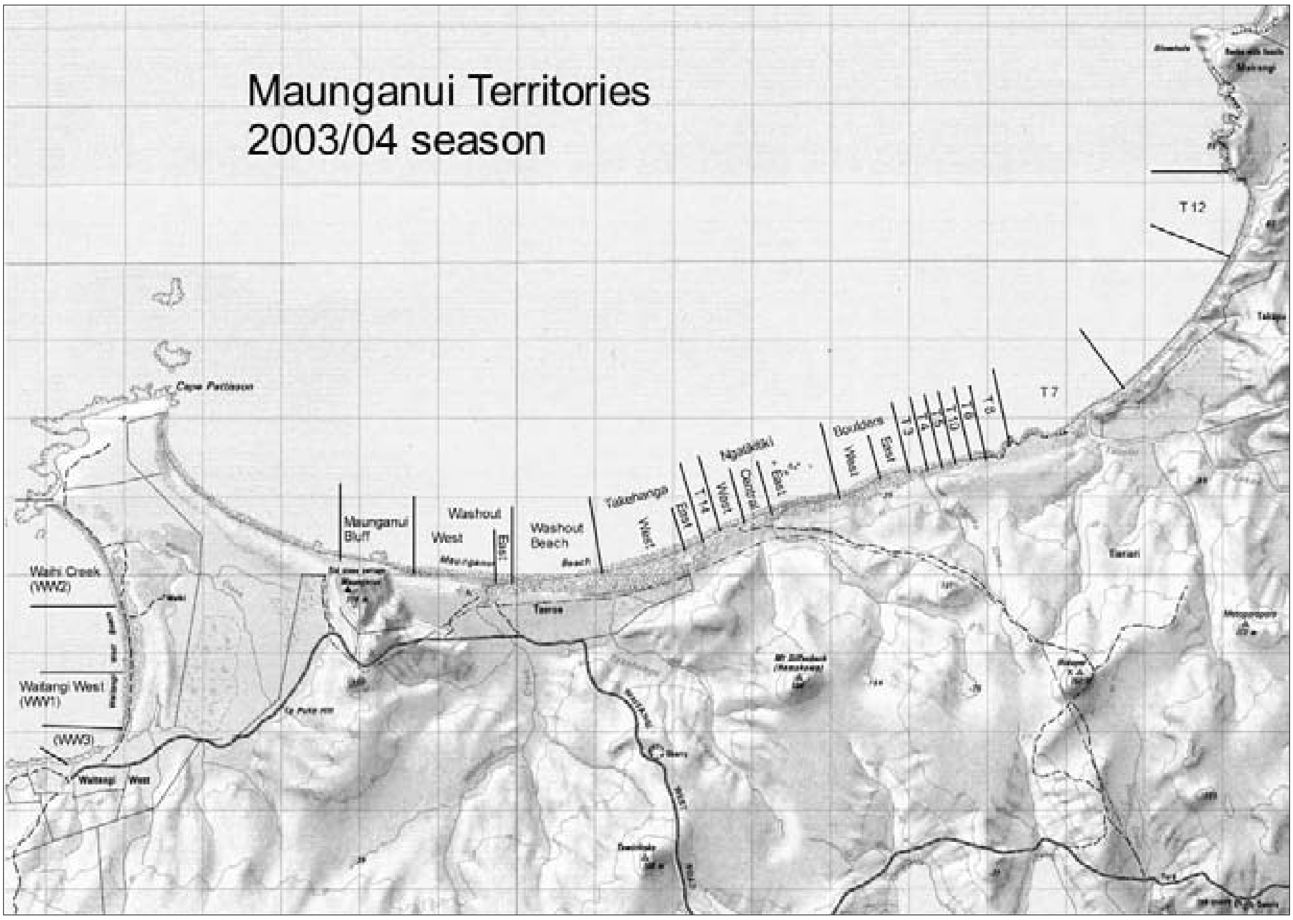

Figure A1.1. Chatham Island oystercatcher territories at Maunganui, northern Chatham Island, in 2003, showing territory name or code and approximate boundaries.

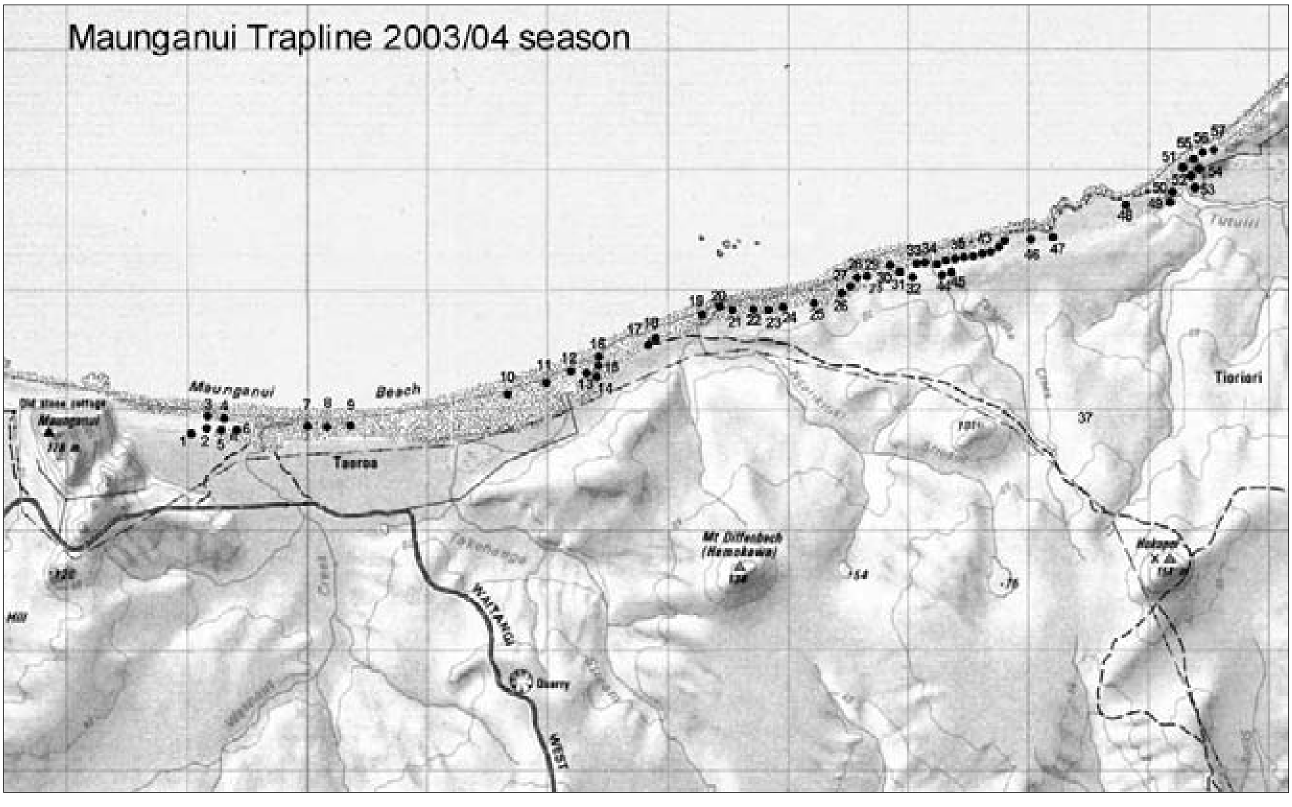

Figure A1.2. Position of traps on the Maunganui coastline in 2003.

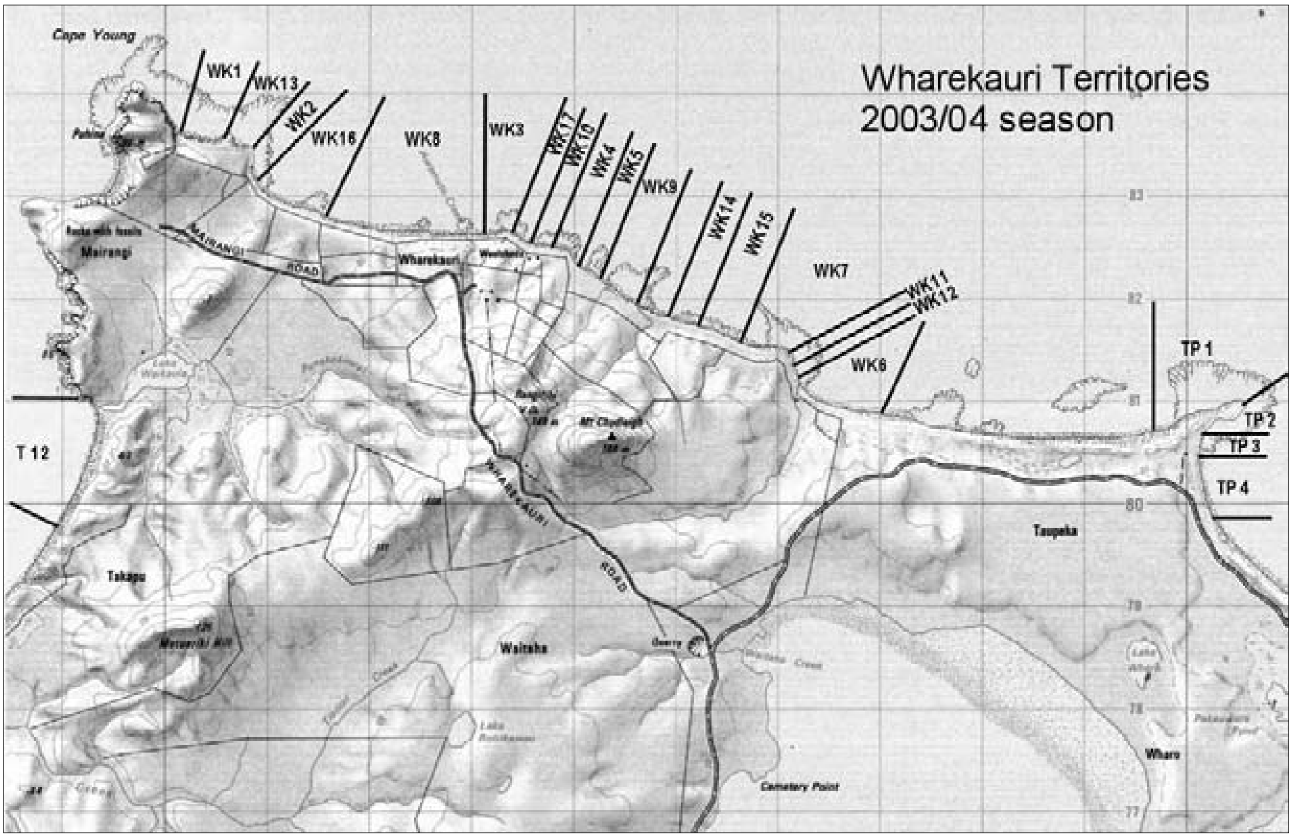

Figure A1.3. Chatham Island oystercatcher territories at Wharekauri, northern Chatham Island, in 2003, showing territory name or code and approximate boundaries.

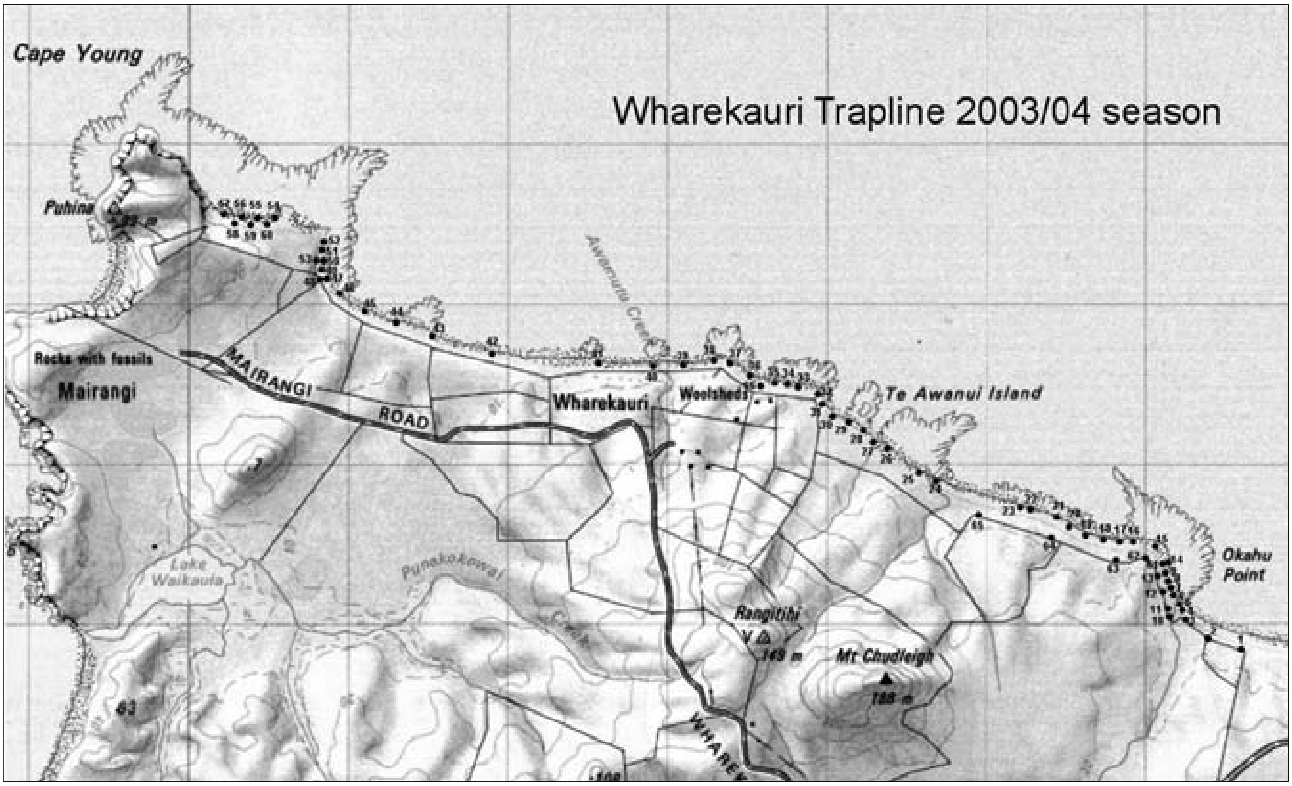

Figure A1.4. Position of traps on the Wharekauri coastline in 2003.

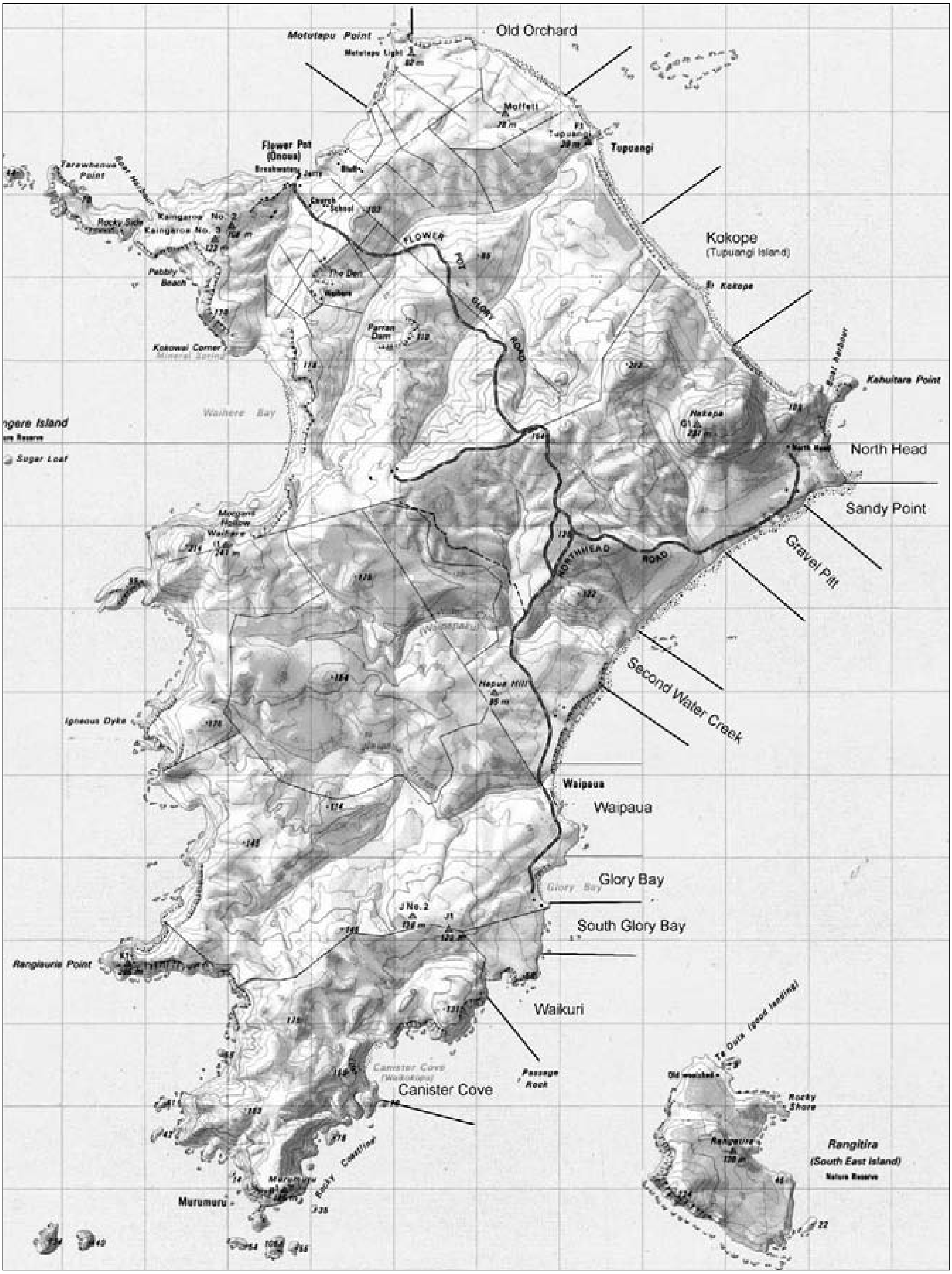

Figure A1.5. Chatham Island oystercatcher territories at Pitt Island in 2004, showing territory names and approximate boundaries.

Figure A1.6. Potential trap-line on the east coast of Pitt Island—trapping in 2005–2007 occurred on the southern half only (south of Kahuitara Point).

Appendix 2

FORMS USED WHEN MONITORING CHATHAM ISLAND OYSTERCATCHERS (*Haematopus chathamensis*)

A2.1 Daily trapping sheet

Wharekauri Daily Trapping Sheet. Date: Observer:

Weather:	**Sea:**

Trap ID + type	Trap result	Reset	comment	Trap ID + type	Trap result	Reset	comment
WK1				WK23			
WK2				WK24			
WK3				WK25			
WK4				WK26			
WK5				WK27			
WK6				WK38			
WK7				WK29			
WK8				WK30			
WK9				WK31			
WK10				WK32			
WK11				WK33			
WK12				WK34			
WK13				WK35			
WK14				WK36			
WK15				WK37			
WK16				WK38			
WK17				WK39			
WK18				WK40			
WK19				WK41			
WK20				WK42			
WK21				WK43			
WK22				WK44			

Trap state	**Code**	**Shooting**	**Code**	**No.**		
Missed	0	Cat	C			
OK	1	Weka	W			
OK/bait gone	2					
Sprung	3					
Sprung/bait gone	4	**Dog kills**	**Code**	**No.**		
Targets		Cat	C			
Cat	C	Weka	W			
Ship rat	SR					
Norway rat	NR					
Hedgehog	H	**Resetting details**	**Code**	**Trap**		Code
Possum	P	Sprung	0	Gin		A
Weka	W	Left set	1	Cage	wood	B
Weka -released	Wr	Reset & bait	2	Cage	metal	C
Non Targets		Moved and set	3	Victor		D
Other mammals	M			Other		O
SBB Gull	SG					
RB Gull	RG	**Target status**	**Code**	**Bait**		**Code**
Aust. Harrier	AH	Female	F	Fish frame		FF
LB Penguin	LP	Male	M	Fish meat		FM
WF Heron	WH	Adult	Ad	Smoked salmon		SS
Other bird	B	Juvenile	Juv	Other		O

A2.2 Daily record of breeding

Chatham Island Oystercatcher Breeding Form - Daily record

Island:				Area:					
Territory:				Terr. Code:					
Date	**Time**	**Obs.**	**Adult 1**	**Adult 2**	**Scrape**	**Eggs**	**Pip/ hatch**	**Chicks**	**Comments**

A2.3 Nest summary

Chatham Island Oystercatcher Breeding Form - Nest summary

Island:	Area:
Territory:	Terr. Code:

	band	band combination
Adult 1		
Adult 2		

Nest Attempt No.:		Grid ref:

	date laid	date lost	how?
Egg 1			
Egg 2			
Egg 3			
total			

Comment

	date hatch	date lost	how?		date fledge		band	band combination
Chick 1								
Chick 2								
Chick 3								
total								

Comment

Management

	Put out	Nested in
Tyre		

	Date	distance	Date	distance	Date	distance	Date	distance	total
Nest moved									

	Date on	Date off							
Elec. Fence									

	Date on	Date off							
Video									
Other									

General comments

A2.4 Band sightings

Chatham Island Oystercatcher - Band sightings

Date	Obs.	Band	Band combination		Status	Age	Partner?	Group size	Island	Area	Territory	Terr code	Grid ref.	Comment

Status	**Code**	**Age**	**Code**	**Island**	**Code**	**Colour**	**Code**	**Other**	**Code**			e.g.
breeder	B	chick	C	Chatham	CI	green	G	black	K	BLT	banded	m ; RW (metal left; red over white right)
suspected breede	SB	juvenile	J	Southeast	SE	orange	O	lime	L		left tibia	_ ; m (no band on left; metal on right)
territorial	T	1-2 year	Y	Mangere	MI	red	R	metal	m			R ; YO (metal on tibia over red tarsus)
floater	F	Adult	A	Pitt	PI	white	W	unbanded	NB			yellow over orange on right tarsus)
unknown	U	unknown	U			yellow	Y					

A2.5 Census form

Chatham Island Oystercatcher Census form **December _____**

	Start point/time:	Finish point/time
Census Zone:	High tide time:	Weather:

Date	Obs.	Band	Band combination		Status	Age	Partner?	Group size	Island	Area	Territory	Terr code	Grid ref.	Comment

Status	**Code**	**Age**	**Code**	**Island**	**Code**	**Colour**	**Code**	**Colour**	**Code**			e.g.
breeder	B	chick	C	Chatham	CI	green	G	black	K	BLT	banded	m ; RW (metal left; red over white right)
suspected breede	SB	juvenile	J	Southeast	SE	orange	O	lime	L		left tibia	_ ; m (no band on left; metal on right)
territorial	T	1-2 year	Y	Mangere	MI	red	R	metal	m			R ; YO (metal on tibia, red on left tarsus,
floater	F	Adult	A	Pitt	PI	white	W	unbanded	NB			yellow over orange on right tarsus)
unknown	U	unknown	U			yellow	Y					

Appendix 3

CHATHAM ISLAND OYSTERCATCHER (*Haematopus chathamensis*) CENSUS INSTRUCTIONS

(Modified from those used in 1999–2004.)

A3.1 Introduction

The census of Chatham Island oystercatchers in mid-December aims to repeat the census of the highest priority areas that are the minimum coverage each year (Table A3.1; Moore et al. 2001; Moore 2008).

Priorities are based on Frances Schmechel's assessment from the 1998 census, but are modified based on the spreading of breeding pairs to other areas in the early 2000s (Fig. 1). Consequently, 11 core census areas were surveyed every year in 1999–2006 (Table A3.1; Moore 2008).

The need to get as complete coverage as possible increased with the population increase and expansion. Hence, the usual aim is to cover all Priority A areas and

TABLE A3.1. CENSUS ZONES.

CENSUS AREA	PRIORITY	LENGTH OF COAST (km)	USUAL METHOD OF SURVEY
Core census areas			
Northwest coast	A	23.9	Quad bike
Cape Young	B	5.3	Quad bike
Northeast coast	A	34.5	Quad bike
Okawa	B	9.3	Quad bike
Owenga	A	9.0	Quad bike
Southwest coast	A	17.5	Walking and quad bike
Waitangi	B	20.5	Walking
Paritu	A	14.5	Walking
Mangere	A	6.5	Walking
Pitt Island—east	A	18.5	Walking
Rangatira	A	7.5	Walking
Total km coast		167.0	
Other census areas			
Point Munning	C	13.0	Walking
Hanson Bay N	C	23.7	Quad bike
North Lagoon	B	63.0	Walking and quad bike
South Lagoon	C	58.0	Walking and viewing from a boat
Hanson Bay S	C	9.5	Quad bike
Southern Cliffs	B	36.5	Viewing from a boat
Long Beach	C	12.5	Quad bike
Point Somes	B	41.0	Walking
Pitt Island—west	B	35.0	Walking, telescope or from a boat
Total km coast		292.2	

as much of the Priority B and C areas as possible. The rarely surveyed sections, such as Southern Cliffs, need to be surveyed at least once every 3 years when carrying out an annual census.

Counts are conducted over as short a period as possible, depending on the availability of experienced personnel and support. Supplementary information from the monitoring of breeding territories will later be added to the census data (e.g. breeding status and birds not seen on the census day). It is best to concentrate on oystercatchers only rather than trying to combine this with a census of other species.

A3.2 Checklist

- Binoculars
- Census form
- Map
- Notebook
- Photocopy of map to mark records
- Pencil and spares

A3.3 Census form and map

- Use the form provided (the data sheet can be found in Appendix 2, section A2.1) or transcribe later onto the form from your notebook. NB: make sure you record all the necessary information in your notebook for each bird. The form is a slight modification on the band sighting form, so that copies can be placed with the band sightings folder.
- Mark each bird and its band combination on photocopied A3 maps of each census zone (master copies are held at Wellington Hawke's Bay Conservancy and Chatham Area Office). Also indicate the start time and direction taken, highlight the total section of coastline covered, and outline which methods were used for each part (e.g. if binocular views were used for some parts).
- On a summary map of the Chatham Islands (e.g. Fig. 1), highlight which census zones and parts of the coastline were surveyed.

A3.4 Heading entries

- Census zone—One of the 16 sectors of Chatham Island (Table A3.1 and summary map, e.g. Fig. 1), or offshore islands
- Start and finish point—Start and finish points and times are noted on the form and on the photocopy map
- Time of high tide
- Weather conditions

A3.5 Entry for each bird on the census form and map

- Date: Census date.
- Obs.: Initials of observer.
- Band: b (banded bird), nb (unbanded bird).
- Band combination: Left leg – right leg combination—see codes and examples on census form (Appendix 2, section A2.5). Take particular care not to mix up the legs or scramble the combination. Write it down then double-check. ***This is very important, as a mis-read combination can mean a bird is assumed alive when it is not.***

- Status: The status of each bird should be recorded as follows:

  —B (breeding bird)—nest found or chick seen, or breeding status already determined by nest monitoring. If you suspect there is a nest, spend some time hunting for eggs or chicks in the area where you first saw the adults, taking care where you put your feet.

  —SB (suspected breeder)—nest or chicks not found. Furtive behaviour in nesting area, hiding behind objects or attempts to draw you away may indicate a nest with eggs. More aggressive, piping calls that get louder in a certain area, or dive-bombing by one of the adults may indicate that chicks are present. Not all birds behave in the same way (e.g. some non-breeders are noisy, birds of a pair can behave very differently and some birds with chicks can be very quiet), so these behaviours can only be used as indicators of breeding activity.

  —T (territorial bird)—member of a pair of birds occupying a territory but not breeding. Look for piping displays and fights between neighbouring birds. Also, if you regularly monitor this section of coast and the pair is always present (not just occasionally) and is not known to have attempted to breed, they can be considered to be territorial.

  —U (unknown status)—single bird, or member of pair or group where there is no indication from behaviour that they fit into the above categories. This includes birds flying by and 'floaters' that do not have territories. Take care not to count birds twice if they move along the coast.

  Although this is an important entry for each bird, the total number of birds is the main object of the exercise, so if in any doubt about which category to use, record the status as 'unknown'. If you already have prior knowledge about a bird's status from the year's breeding monitoring, use that code. Otherwise, use the behaviour patterns of the birds to suggest breeding status. If possible, observe birds from a hidden vantage point using binoculars, or return to the area on another day to re-check the area. Otherwise, scan down the beach with binoculars to see birds before they see you or to see them departing from their nests. Record the actual behaviour in the comments column. Mark a bracket between the lines on the recording form to indicate which birds are paired together. For map entries, mark the numbers of birds with the status for the group; e.g. 2B (a breeding pair) or 3U (group of 3 birds of unknown status).

- Age: Try to determine age based on leg, bill and eye colour:

  —J (juvenile)—< 1 year old with brown bill tip, brown eyes, pale legs

  —Y (young bird)—if you can distinguish ages, separate out the J (juveniles < 1 year old with brown bill tip, brown eyes, pale legs) from the 1–2 year olds (more orange bill tips, brownish eyes, pale legs)

  —A (adult)—orange/red bill, scarlet eyes, reddish legs

  —U (unknown age)—bird was too far away, flying, silhouetted, colours seemed ambiguous

  Most, but not all, chicks have been colour banded in recent years, and many adults were also marked. However, during band maintenance, many colour bands have been removed, and chicks can come from unmonitored areas, so assessing the age of unmarked birds is still necessary. Note the presence of this year's chicks in the comments column—they do not count for the census.

- Partner?: Note the band combination of partner.
- Group size: Bracket the pair or group of birds in this column and note the number of birds in the group; i.e. there should be one entry of 2 for a pair, 3 or more for a group, 1 for a single, etc., so that when you add up the numbers in this column it gives you the total for the census zone.
- Island: See codes on census form (Appendix 2, section A2.5).
- Area: Local name of bay or coast, e.g. Wharekauri.
- Territory: Name used in breeding monitoring for territory, e.g. Washout West.
- Terr code: Territory code number if applicable, e.g. T02.
- Grid ref.: Map grid reference for sighting.
- Comment: Useful comments on bird behaviour and other notes.

Depending on the weather, most core areas can be covered by four people in 3 days and the lower priority areas in another 3 days.

Requirements

- Quad bikes ×2
- Trailers ×2
- Vehicles ×2
- Hire fishing boat for inaccessible coast

A3.6 Individual census zones (notes made for 2004 census)

NB: check with Area Office for names of current landowners and leaseholders.

1. Northwest Coast

Waitangi West, Maunganui, Tioriori to Lake Waikauia

Survey carried out on quad bike over 1 day as part of the normal trapping round, extended around Cape Pattison. Would be good to survey the shore of Lake Waikauia as well, but this needs separate permissions from the normal run along the beach.

2. Cape Young

Mairangi Bay is normally visited by bike as part of the Wharekauri trapping round. The rocky coast has not been checked, as habitat is unlikely and access has not been arranged.

3. Northeast Coast

Wharekauri, Taupeka, Ocean Mail, Matarakau to Kaingaroa

Survey normally carried out by quad bike over 1–2 days as an extension of Wharekauri trapping line and the regular visit to Matarakau to visit the unmanaged territories. Route taken is either along the beach in both directions, or along the beach then back along the road. Most of the landowners will already have been contacted for regular monitoring.

4. Point Munning

Difficult to survey by quad bike, so probably more suitable on foot as a round trip from Kaingaroa or added on to a trip to Okawa.

5. Okawa

Normally surveyed by quad bike as an extension to the regular monitoring check of the breeding pairs.

6. Hanson Bay N

May not require permission to drive the beach by quad bike (except for entry points). Route taken is either there and back from Okawa, or coming down the east side of the lagoon and up from the lagoon mouth. The survey is best done close to low tide, as the sea sweeps up the beach at high tide.

7. North Lagoon

Airport to Waitaha Creek (Wharekauri Quarry)

Surveyed on foot by one person (21 km, 6 hours) or by two people dropped off in the middle at the scenic reserve. Might be worth extending this section around Mihitoroa Point where the lagoon is close to the road again. Non-breeders regularly use the lagoon shore and some may try to nest there as the population increases.

Waitaha Creek to lagoon mouth

At low water levels, the section can be surveyed by quad bike—in normal wind conditions this is fine on the north part, but can still be a bit tricky around the swampy section near Kahupiri Point, as you have to drive in the water to get around some points. Ideally, the survey should be carried out by two bikes, or if only one bike, with a radio schedule at key times.

Survey of the eastern section has been attempted by inflatable boat but it was too shallow for the most part, so required hopping out and wading closer to shore.

Alternatively, this whole section can be surveyed on foot. There are various drop-off and pick-up places.

8. South Lagoon

Airport to lagoon mouth

This area can be adequately covered by boat at high water levels. Alternatively, these sections can be surveyed on foot by drop-off and pick-up (the western side can be divided in half or thirds, and the eastern side by walking down and back from the lagoon mouth). The island and channels at the lagoon mouth need to be searched on foot—this is probably some of the most suitable habitat in the whole lagoon.

Other lakes, lagoons and streams

It would be worth trying to check as many lakes and lagoons as possible during the census, especially if canoes are available.

Birds are known to also use stream edges, but few of these have been surveyed except those right on the coast.

9. Hanson Bay S

Easily surveyed by bike from Gillespie Creek to the lagoon mouth and back; however, surveying has to be carried out at low tide or there is a risk of being cut off by the waves. Checks should be made further round into the lagoon as there are edges and shallows where birds have regularly been seen in the past. Can be combined with the Owenga section.

10. Owenga

Gillepsie Creek, Owenga, Manakau Point, Cape Fournier

Can be surveyed on foot by one person, with a drop-off from the person doing Hanson Bay S; or by two people, with one person going from Gillespie to the gate at Manakau and the second person walking round the Manakau Point to Cape Fournier and back to the vehicle.

11. Southern Cliffs

Cape Fournier to Otawae Point

Normally not surveyed, but it is a priority to complete this section this year [2004]. Access overland is difficult because the area is remote and landowner permission has not been granted. Drop-off by boat also requires permission, Although a few birds have previously been counted from a boat offshore, success is dependent on having very calm weather to get close enough to the rocks. Birds are harder to see from a boat and they do not react in the same way as to people on foot. Therefore, as much of the census as possible should be conducted on foot or from vantage points, as this is the most accurate method.

Pairs and singles have been seen in a number of spots previously, although pairs have been seen most frequently at three particular spots. Pairs (or groups of two birds) have been seen at Opuriri (1985), 2 km northeast of Ko Oreao Point (1986, 1991, 2000), at or inshore of Houruakopara Island (1986, 1987, 1991, 2001—just northeast of the point 400 m east of the gorge creek, nesting on a large rock promontory cut off at high tide) and Cascade Gorge (1987, 1991). Additional single records were at the bay south of Karore (1986), the bay east of Green Point (1987), and Green Point (1987).

12. Southwest Coast

From the bay east of Otawae Point to Awamata Stream

Surveys can be carried out on foot for the northern part and with quad bike access to the coast and then on foot for the southern part. Combine data with knowledge gained by the daily predator trapping/monitoring run if that is occurring.

13. Waitangi

Awamata Stream to Red Bluffs

Waitangi township to Red Bluffs can be surveyed by quad bike.

Waitangi township to Point Webb can be surveyed on foot. Drop off a person at the end of the road above Point Webb so they can walk southwest along the cliff tops before cutting down and along the coast past Heaphy Shoal. A second person can park on the Waitangi Tuku road near Heaphy Shoal, walk across the farmland to the coast and walk the next section to Awamata Stream, where they are picked up by the first person. Total distance from Point Webb to Awamata Stream is 12 km.

14. Long Beach

Red Bluffs to Paritu

Survey can be done on foot from Paritu to Te One. If walking over Red Bluff, permission wil be needed. This is a long walk on a featureless beach, so it is easier to do by quad bike. Access to the beach for a bike is best from the property east of Paritu.

15. Paritu

Paritu to Port Hutt Bay

Survey can be carried out on foot from Paritu to Port Hutt Bay, checking all the known pairs and searching for floaters (15 km, 5 hours).

16. Point Somes

Port Hutt to Waitangi West

Survey can be carried out on foot (two people) and quad bike (one person). The bike comes to Point Somes lighthouse from Waitangi West and that person walks the coast back again (15 km, 5–6 hours). Meanwhile, a boat drops off two people at the western point of Ocean Bay, one of whom walks back to Port Hutt (13 km, 5–6 hours), and the other walks to Point Somes (9 km, 3 hours), collects the bike and proceeds back to Waitangi West—they can then help to finish the last section by leap-frogging the person on foot. Care is required for biking to and from Point Somes, as the routes are not all that obvious and bracken can hide ruts and holes.

Another option with a good early start is to drop two people off at Te Koparuparu Bay, one of whom goes on foot north to Waitangi West and the other goes east to Port Hutt (c. 8 hours).

In 2003, one person walked from Port Hutt to Ocean Bay, two people took a bike to Ocean Bay and walked around to Point Somes, and one person walked from Waitangi West to Point Somes. The first person picked up the bike at Ocean Bay, returned to Waitangi West and rode towards Point Somes to shuttle the walkers home.

Pitt Island

The east side can be surveyed on foot, bike or horse (has occurred on one occasion), and the west and south side can be surveyed on foot—using telescope/binoculars from vantage points on cliffs, and walking down to the easier access bays.

Mangere/Rangatira

Whenever staff are present, they will monitor pairs and record colour bands of non-breeders, to provide an inventory of birds that can be used for the census.

How to manage Chatham Island oystercatcher populations

*The Chatham Island oystercatcher (*Haematopus chathamensis*) has been ranked as 'Nationally Critical' by the Department of Conservation, making it a very high priority for conservation management. Predation poses the biggest threat to this species, but eggs and chicks can also be crushed by stock, and nests are susceptible to being washed away by the sea. This report outlines how productivity can be improved using a three-pronged attack: predator control, stock exclusion, and movement or raising of nests away from high tide.*

Moore, P.J. 2009: Chatham Island oystercatcher (*Haematopus chathamensis*) management techniques: guidelines for protecting nests and increasing their productivity. *Department of Conservation Technical Series 35.* 50 p.

New Zealand Government