

Monitoring and management of the  
New Zealand fairy tern/*Tara iti*  
(*Sternula nereis davisae*) and other  
shorebirds at Mangawhai, for the  
2022 – 2023 Breeding Season



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Isabella Holst and Shannan Courtenay  
Department of Conservation

## SUMMARY OF THE BREEDING SEASON

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### Tara iti/New Zealand Fairy Tern

The New Zealand fairy tern (*Sternula nereis davisae*), or tara iti, with a population of fewer than 40 individuals, is New Zealand's rarest breeding endemic bird (Hansen, 2006; Ismar et al, 2014). This endemic subspecies is under intensive management by the Department of Conservation to protect, and increase, the remaining population at its five breeding sites: Mangawhai, Papakānui, Waipū, Te Ārai, and Pākiri.

Mangawhai sand spit is the largest breeding site for tara iti, with the bulk of the populations' breeding pairs nesting there each season. Three large shell patches have been used for nesting in the recent past: South Sea Valley (SSV), North Bund, and Dredge. Over the past few years, tara iti have predominantly nested at SSV, a natural shell patch located on the eastern side of the Mangawhai sand spit. This site is also the least stable due to its proximity to the mean high tide mark, small dunes, and the sparse vegetation surrounding it. Due to concerns of sand movement and flooding, SSV was dismantled pre-season (in 2021, and again in 2022) and attempts were made to enhance the Dredge site to encourage nesting there.

Dredge is an artificial breeding site consisting of four slightly separate shell patches on the estuary side of the sand spit. All six breeding pairs at Mangawhai this season nested within 40m of one another on one of these shell patches (Dredge Bowl). Of the three pairs that re-nested, two used scrapes that had already been used for nesting this season, and the other nested in between them. Dredge was also used regularly as a roosting site for unpaired males, immature tara iti and Northern New Zealand potters, particularly during November and December 2022.

Six breeding pairs laid thirteen eggs in nine nests this season. Between day seven and fifteen, five eggs from three nests were taken to Auckland Zoo to become part of the planned captive rearing programme.

Due to nest abandonment during adverse weather, the remaining four eggs from three nests at Mangawhai were recovered to the Auckland Zoo between day two and day fifteen. Two of these embryos did not develop and the other two embryos became part of the captive rearing program, as there were no wild nests available to return them to.

Three pairs laid second clutches 14-16 days after abandonment/release. Of the four eggs in these three nests, two were predated, likely by a harrier, at days eleven and thirteen; one embryo did not develop; and the other egg was uplifted during adverse weather and eventually transferred to Waipu nest 469, where it hatched on 11 January 2023.

Table 1. Summary of tara iti nests of 22/23 season. \*As these eggs were part of the captive rearing program, please see the captive rearing report for further information on the outcome.

Fairy Tern pair	Nest number	Egg fate/Chick fate
WM-RW & R-pGM	460*	2 fertile eggs part of captive rearing programme
W-BM & BK-M	461*	1 fertile egg abandoned, became part of captive rearing programme
K-KM & W-KM	463*	1 fertile egg part of captive rearing programme
R-KM & pGM-R	465*	2 fertile eggs part of captive rearing programme
RM-K & pG-YM	466*	1 fertile egg abandoned, became part of captive rearing programme
pGY-pGM & KM-R	467*	2 eggs, did not develop
WM-RW & R-pGM	470	1 fertile egg transferred to Waipu nest 469 after nest abandonment
R-KM & pGM-R	471	2 eggs, predated
pGY-pGM & KM-R	472	1 egg, did not develop

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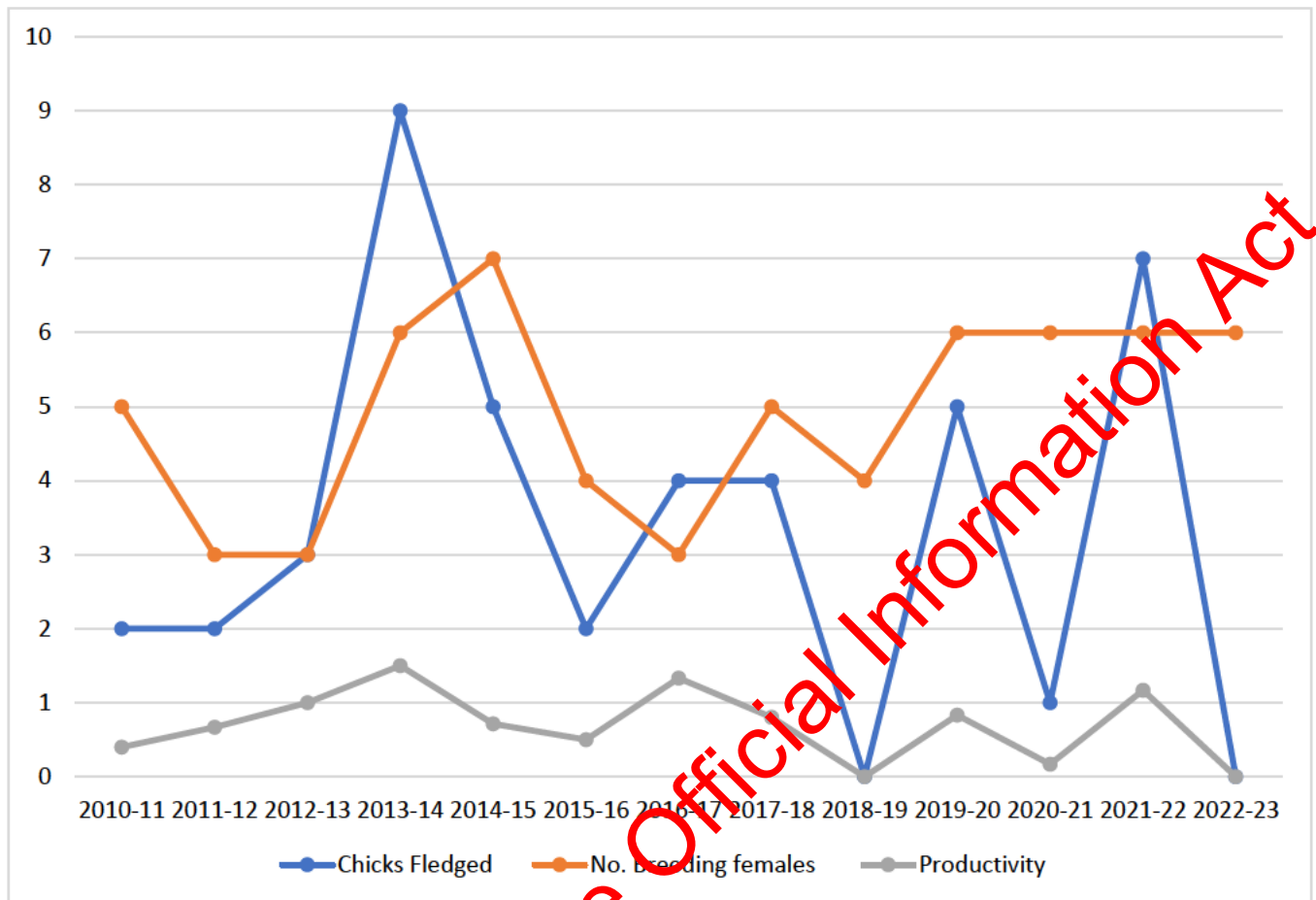


Figure 1. Number of tara iti breeding females compared to the number of chicks fledged at the Mangawhai breeding site from 2010-2011 breeding season to the 2022-2023 season. Productivity is the number of chicks fledged per laying female.

\*\*\* 5 of the 7 chicks that “fledged” within the captive program and were subsequently released were from Mangawhai eggs

### Predator Control

The number of traps on the Mangawhai sandspit were increased this year, with the addition of another trapline in the vegetation and dunes around North Bund and 19 Steve Allans installed in three targeted areas. A total of 117 traps were stationed across the sandspit; 42 DOC200’s, 38 Victor professional rat traps, 19 Steve Allans, 14 Victor legholds, 4 cage and box traps. A total of 20 predators were caught this year. See Table 8 for more information.

Harrier numbers were low this season, as were other predator numbers. Although cats were caught along the edge of the Wildlife Refuge, there was no evidence of cats found on the sandspit from mid-November until end of January.

On 1 January 2023 two tara iti eggs were predated from nest 471, likely by a harrier. A trap-shy harrier became a problem at Dredge for a week between 25/12/2022 – 01/01/2023. Targeted trapping was unsuccessful until 1 January 2023, when an adult female and juvenile harrier were caught, however the two tara iti eggs had been predated earlier that morning.

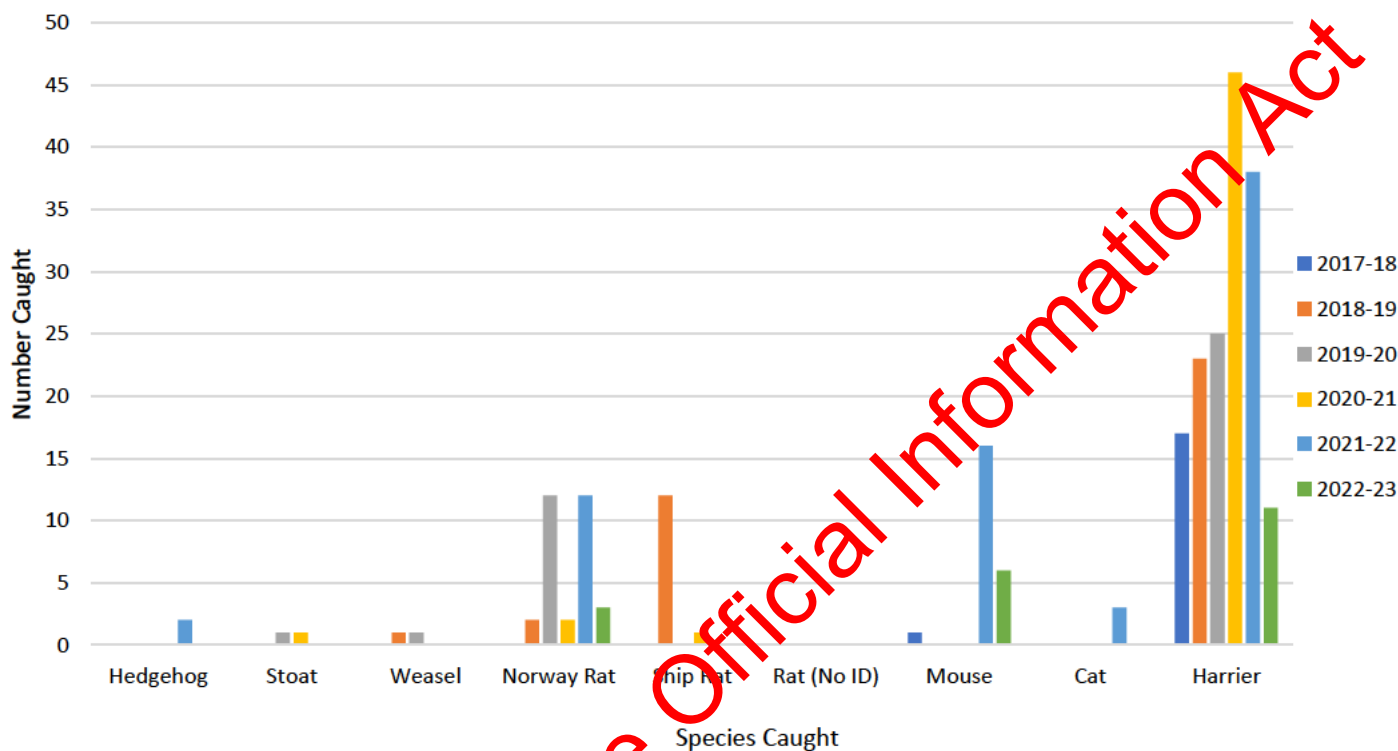


Figure 2. Predator capture data from the 2017-2018 breeding season to the 2022-2023 season at Mangawhai site

### Compliance and advocacy

There were only five advocacy opportunities this season, and no reported compliance issues. It's likely the adverse weather reduced sandspit use, resulting in fewer people on the refuge. Over the summer holidays estuary use increased and boats and jet skis would often break the five-knot speed limit. Low-flying aircraft were not an issue this season.

### Shorebirds

Due to nesting habits and limited time of rangers, the data collected on other shorebirds on the Mangawhai sandspit does not accurately reflect their true numbers. However, there were noticeably less NNZ dotterels and variable oystercatcher nests and chicks around than in the previous two seasons. This season rangers recorded only 13 NNZ dotterel nests with six fledglings, and 16 variable oystercatcher nests with 10 fledglings. Three banded dotterel pairs attempted to nest in and around North Bund this season, however there were no confirmed fledglings. Two pied stilt chicks were also observed near the lake at North Bund, though no nests were found.

Caspian terns and red-billed gulls began nesting in October. Caspian terns nested in the same location on the beachfront north of SSV. Rangers recorded 52 nests with 19 chicks fledgling by early January 2023. Red-billed gulls nested at the estuary walkway entrance to North Bund this season, opposite the boat ramp. Rangers counted over 100 nests and 36 chicks; most had fledged by early January 2023. White-fronted terns did not attempt to nest on the sandspit this season.

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# TABLE OF CONTENTS

<b>Summary of the breeding season</b> .....	<b>2</b>
Tara iti/New Zealand Fairy Tern.....	2
Predator Control.....	4
Compliance and advocacy.....	5
Shorebirds.....	5
<b>Tara iti / NZ Fairy Tern monitoring</b> .....	<b>9</b>
1.1 Introduction.....	9
1.2 Methods.....	9
1.3 Results .....	10
Nest 1 (M1): 460.....	10
Nest 2 (M2): 461.....	11
Nest 4 (M4): 465 .....	13
Nest 5 (M5): 466 .....	14
Nest 6 (M5): 467.....	15
Nest 7 (M7): 470.....	16
Nest 8 (M8): 471.....	17
Nest 9 (M9): 472.....	18
Date .....	23
Site.....	23
Bird.....	23
Observation.....	23
Observer.....	23
<b>2 Habitat Enhancement</b> .....	<b>25</b>
2.1 Shell patch enhancement.....	25
2.3 Weed control.....	25
<b>3 Shorebird Monitoring</b> .....	<b>26</b>
3.1 Introduction.....	26
3.2 Methods.....	26
3.3 Results and Discussion.....	26
3.3.4 Other Species.....	28
<b>4 Predator Control</b> .....	<b>29</b>
4.1 Introduction.....	29
4.2 Methods.....	29
4.3 Results and Discussion .....	30
4.4 Predator control outside of the tara iti breeding season .....	34
<b>5 Compliance and Advocacy</b> .....	<b>39</b>
5.1 Introduction.....	39
5.2 Methods.....	39
5.3 Results and Discussion .....	39
Watercraft.....	39
<b>5.4 Advocacy</b> .....	<b>41</b>
<b>6 Recommendations</b> .....	<b>42</b>
<b>7 Acknowledgements</b> .....	<b>43</b>

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### 1.1 Introduction

With an estimated population of less than 40 individuals, The New Zealand fairy tern, or tara iti (*Sternula nereis davisae*), is New Zealand's rarest endemic breeding bird (Hansen, 2006). Tara iti are one of three subspecies of the Australasian species. The two other subspecies occur in New Caledonia (*S. n. exsul*), and Australia (*S. n. nereis*). Tara iti have a conservation status of Threatened-Nationally Critical in New Zealand (Ismar et al, 2014; Ferreira et al., 2005), whereas the species *Sternula nereis* is ranked as "Vulnerable" globally (Ismar et al, 2014). Tara iti are the smallest tern species found in New Zealand, weighing around 70g, and are described as solitary breeders (Ismar et al, 2014).

This species relies on a combination of estuarine, marine, and sandspit systems for breeding and such sites are now very limited within the species' range. Tara iti have five recent known breeding locations in New Zealand, all north of Auckland (Ismar et al, 2014). Four breeding sites are situated on the east coast (Mangawhai sandspit, Waipū sandspit, Te Ārai and Pākiri), and one on the west coast (Papakānuī).

Monitoring of tara iti by the Department of Conservation (DOC) has been carried out since the 1980s (Ferreira et al., 2005). This has developed into an intensive seasonal monitoring programme that is undertaken over the breeding season. Full-time rangers and dedicated volunteers provide daily, and onsite, management of the species.

### 1.2 Methods

Two rangers were present on site seven days a week from 19 September 2022 - 24 February 2023. The rangers' role consisted of monitoring tara iti, Northern New Zealand dotterels, and variable oystercatchers; erecting fences and signs to protect nesting birds; monitoring the public and responding to non-compliant activities; trapping predators; and advocating for tara iti and other shore birds.

Access to the site was through Tern Point and onto the Mangawhai sandspit using tracks or below the mean high tide mark along the coast.

Tara iti monitoring conducted daily by rangers and volunteers, included: searching for breeding pairs, identifying nesting sites, monitoring the nest, collecting data, and monitoring the chicks/fledglings. This included gathering feeding and disturbance data.

At the beginning of the breeding season, the rangers monitored the resident tara iti, recording their movements and behaviours to discover if any pair bonds had formed, and where eggs may be laid. After the eggs were laid, monitoring focused on the pair and their nest from a viewing hide, which reduced human disturbance on the site.

### 1.3 Results

The outcome of the breeding season is outlined in Tables 1-3.

Table 2. Results of the 2022 – 2023 Breeding Season for tara it at Mangawhai in comparison to previous seasons.

Season	No. Breeding Females	Nesting Attempts	No. Eggs	No. Known Fertile Eggs	No. Clear Eggs*	No. Eggs Transferred In	No. Eggs Transferred Out	No. Chicks Hatched	No. Chicks Fledged	Productivity (fledglings/pairs)
2012-13	3	3	5	4	1	2	2	3	3	1.0
2013-14	6	6	11	7	4	2	0	9	9	1.5
2014-15	7	11	18	10	8	5	4	8	5	0.7
2015-16	4	4	5	4	1	2	3	3	2	0.5
2016-17	3	3	4	3	1	1	0	4	4	1.3
2017-18	5	5	9	8	0	2	2	5	4	0.8
2018-19	4	6	9	4	1	1	2	2	0	0.0
2019-20	6	7	12	8	3	0	2	6	5	0.8
2020-21	6	11	18	16	2	11	15	8	1	0.2
2021-22	6	8	15	13	0	1	3	9	7	1.2
2022-23	6	9	13	10	3	0	10	0	0	0.0

\*Eggs that are either infertile, fertile but not developed, or early embryonic death has occurred. In all instances embryonic development is not visible without optical support.

#### Nest 1 (M): 460

Date Found	20/11/22 and 22/11/22
Parent band combination	WM-RW (female) & R-pGM (male)
No. eggs laid	2
No. natal eggs hatched in natal nest	0
No. natal chicks fledged from natal nest	0
Trail camera date in/out	22/11/22 / 6/12/22

Nest location including GPS location	Dredge, E1744176, N6003419
Hide location and proximity to the nest	E1744228, N6003404 and E1744162, N6003329
Nest camera installation	23/11/21 at 1430, approximately 2m from the nest
Egg candling date and results	05/12/2022, fertile and developing

### Nest Specific Information

#### Planned egg collection for captive rearing

A key decision regarding this nest was the planned removal of the egg to Auckland Zoo for captive rearing. On 5 December 2022 at 1032 the eggs were collected and were replaced with two sterilised, dummy eggs by two of the rangers on site. The male, R-pGM, returned to sit on the dummy eggs within one minute and a changeover was observed 23 minutes later.

The natal eggs were placed directly into a cotton wool lined, portable MX45 incubator, connected to a battery pack. The incubator temperature was at 36°C and relative humidity (RH) was 60% at the time of the transfer. At approximately 1100 two rangers walked the incubator and battery pack to tern point where it was collected by two other rangers for transfer to Auckland Zoo

The nesting pair were released on 6 December 2022 at 0941 and were next seen at Dredge on 9 December 2022. They re-nested on 19 December 2022.

#### Other information

A Northern NZ dotterel nest with one egg was removed on 6 December 2022, approximately 30m from nest 460. No nest movement, other species management, or other tara iti nest management was required for this nest. The nesting area was checked daily for any sign of predators. This is a historical pairing.

#### Nest 2 (M2): 461

Date found	23/11/22
Parent band combination	W-BM (female) & BK-M (male)
No. eggs laid	1
No. natal eggs hatched in natal nest	0
No. natal chicks fledged from natal nest	0
Trail camera date in/out	23/11/22 / 21/12/22
Nest location including GPS location	Dredge, E1744179 N6003433
Hide location and proximity to the nest	E1744228, N6003404 and E1744162, N6003329

Nest camera installation	23/11/21 at 1430, approximately 2m from the nest
Egg candling date and results	5/12/2022, fertile and developing

### Nest Specific Information

#### Emergency egg collection

The nesting female abandoned incubation on 3 December 2022. During this time, the nesting male continued to incubate the egg over high tide. During low tide, the male would incubate for 30–60 minute periods and spend a similar amount of time away from the nest.

On 7 December 2022 strong easterly winds hit Mangawhai. As winds increased throughout the day, the nesting male spent 2.5 hours off the nest over low tide, returning at 1429. With weather predicted to worsen overnight, the egg was recovered from site at 1456 and replaced with a dummy egg. The nesting male returned to sit on the dummy egg within one minute.

The natal egg was placed directly into the MX45 incubator, with the temperature at 29°C, RH 55%. The onsite rangers walked the incubator and attached the battery back to Tern Point, arriving at 1527, incubator at 33°C, RH 65%. The egg was driven to the ranger's house and transferred into the Brinsea Ovation EX incubator at approximately 1730, set at 36.5°C and RH 58%.

The next day the dummy egg had been abandoned. The natal egg was taken to the Auckland Zoo in the MX45 incubator, set at 36°C, RH 57%, and became part of the captive rearing program. W-BM was next sighted at Dredge on 24/12/2022, with BK-M.

#### Other information

W-BM abandoned incubation when the embryo was 10 days old and was next seen at Dredge 15 days later, on 18 December 2022.

W-BM and BK-M were a new pair this season. Previously BK-M was paired with KB-M who is presumed dead. Whereas, W-BM was previously paired with nil-pGM, who still has a foraging territory at Mangawhai estuary and has been observed with BR-WM at Dredge.

On 24 November 2022 two NNZ dotterels were spotted making scrapes, and copulating, approximately 2m from the nest. These scrapes were removed by the ranger on the same day.

On 7 December 2022 at 1258, two large logs were placed approximately 4m away from the nest to help protect it from north easterly and easterly winds. The nesting male returned to the nest after placement. No nest movement, or other tara iti nest management, was required for this nest. The nesting area was checked daily for any sign of predators.

Nest 3 (M3): 463

Date found	24/11/22
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Parent band combination	K-KM (female) & W-KM (male)
No. eggs laid	1
No. natal eggs hatched in natal nest	0
No. natal chicks fledged from natal nest	0
Trail camera date in/out	26/11/22 / 6/12/22
Nest location including GPS location	E1744152, N6003394
Hide location and proximity to the nest	E1744228, N6003404 and E1744162, N6003329
Nest camera installation	23/11/21 at 1511, approximately 2m from the nest
Egg candling date and results	5/12/2022, fertile and developing

#### Nest Specific Information

##### Planned egg collection for captive rearing

A key decision regarding this nest was the planned removal of the egg to Auckland Zoo for captive rearing. On 5 December 2022 at 1032, the egg was collected and was replaced with a sterilised dummy egg by two of the rangers on site. The female (K-KM) returned to the nest within three minutes.

The natal egg was placed directly into a cotton wool lined, portable MX45 incubator, connected to a battery pack. The incubator temperature was at 36°C and relative humidity (RH) was 60% at the time of the transfer. At approximately 1100, two rangers walked the incubator and battery pack to tern point. It was then collected by two other rangers for transfer to Auckland Zoo.

This nest was furthest from the other active nests, so the pair were released the same day as the egg transfer. The pair were seen at the shell patch the following day. They were next seen at Dredge on 14 December 2022 but did not display any signs of re-nesting.

##### Other information

No nest movement, other species management, or other tara iti nest management was required for this nest. The nesting area was checked daily for any sign of predators. This is a historical pairing.

#### Nest 4 (M4): 465

Date found	25/11/22 and 28/11/22
Parent band combination	R-KM (female) & pGM-R (male)
No. eggs laid	2
No. natal eggs hatched in natal nest	0
No. natal chicks fledged from natal nest	0
Trail camera date in/out	30/11/22 / 6/12/22
Nest location including GPS location	Dredge, E1744166, N6003402
Hide location and proximity to the nest	E1744228, N6003404 and E1744162, N6003329

Nest camera installation	30/11/21 at 1008, approximately 2m from the nest
Egg candling date and results	5/12/2022, fertile and developing

#### Nest Specific Information

##### Planned egg collection for captive rearing

A key decision regarding this nest was the planned removal of the egg to Auckland Zoo for captive rearing. On 5 December 2022 at 1033, the natal eggs were collected and replaced with 2 sterilised dummy eggs by the rangers onsite. The male, pGM-R, returned to the nest within one minute and a changeover between the pair was observed 47 minutes later.

The natal eggs were placed directly into a cotton wool lined, portable MX45 incubator, connected to a battery pack. The incubator temperature was at 36°C and relative humidity (RH) was 60% at the time of the transfer. At approximately 1100, two rangers walked the incubator and battery pack to tern point, where it was collected by two other rangers for transfer to Auckland Zoo.

On 6 December 22 at 0941 the pair were released from the dummy eggs.

The pair were next seen at the shell patch on 9 December 2022, and re-nested at Dredge on 20 December 2022.

##### Other information

On the morning of 7 December 2022, a NNZ dotterel attacked R-KM, dragging her off the nest by her nape. The attack lasted less than three seconds. At 1033, two NNZ dotterel eggs were found behind a patch of pīngao (*Ficinia spiralis*), approximately 2m from nest 466. These eggs were removed, and the scrape destroyed. No nest movement, or other tara iti nest management, was required for this nest. The nesting area was checked daily for any sign of predators. This is a historical pairing.

#### Nest 5 (M5): 466

Date found	25/11/2022
Parent band combination	RM-K (female) & pG-YM (male)
No. eggs laid	1
No. natal eggs matched in natal nest	0
No. natal chicks fledged from natal nest	0
Trail camera date in/out	30/11/2022 / 21/12/2022
Nest location including GPS location	Dredge, E1744174, N6003425
Hide location and proximity to the nest	E1744228, N6003404 and E1744162, N6003329
Nest camera installation	30/11/2022 at 1008, approximately 2m from nest
Egg candling date and results	5/12/2022, fertile and developing

#### Nest Specific Information

#### Emergency egg collection

On 7 December 2022 when strong easterly winds hit Mangawhai, this nest was left unattended between 0952 and 1124. No changeovers were observed throughout the day and the bird on the nest left again at 1225. With weather predicted to worsen overnight, the egg was recovered from site at 1456 and replaced with a dummy egg.

The natal egg was placed directly into the MX45 incubator, at 29°C, RH 55%. The onsite rangers walked the incubator and attached the battery back to Tern Point, arriving at 1527, incubator at 33°C, RH 65%. The egg was transferred into the Brinsea Ovation EX incubator at approximately 17:30, set at 36.5°C and RH 58%.

The next day the dummy egg had been abandoned. The natal egg was taken to the Auckland Zoo in the MX45 incubator, set at 36°C, RH 57%, and became part of the captive rearing program.

The nesting female was next seen at Pākiri on 12 December 2022. The nesting male was next seen at Dredge in Mangawhai on 14 December 2022.

#### Other information

RM-K last nested at Mangawhai in the 2020/2021 breeding season.

No nest movement, or other tara iti nest management, was required for this nest. The nesting area was checked daily for any sign of predators.

#### Nest 6 (M5): 467

Date found	3/12/2022 and 6/12/2022
Parent band combination	CV-pGM (female) & KM-R (male)
No. eggs laid	1
No. natal eggs hatched in natal nest	0
No. natal chicks fledged from natal nest	0
Trail camera date in/out	07/12/2022 / 09/12/2022
Nest location including GPS location	Dredge, E1744146, N6003416
Hide location and proximity to the nest	E1744228, N6003404 and E1744162, N6003329
Nest camera installation	07/12/2022 at 1258, approximately 6m from nest
Egg candling date and results	Candled at Auckland Zoo on 14/12/22, not developing

#### Nest Specific Information

##### Emergency egg collection

When the rangers arrived onsite at high tide on 7 December 2022 the nesting pair were not present at the shell patch. After two hours a tara iti adult (KM-R) returned to sit on the nest. No changeovers were observed throughout the day and the male, KM-R left again at 1158. With weather predicted to worsen overnight, the eggs were recovered from site at 1456, and replaced with two dummy eggs.

The natal eggs were placed directly into the MX45 incubator, at 29°C, RH 55%. The onsite rangers walked the incubator and attached the battery back to Tern Point, arriving at 1527, incubator at 33°C, RH 65%. The egg was transferred into the Brinsea Ovation EX incubator at approximately 1730, set at 36.5°C and RH 58%.

The next day the nesting pair had abandoned the dummy eggs. The natal eggs were taken to the Auckland Zoo in the MX45 incubator, set at 36°C, RH 57%. On arrival at Auckland Zoo eggs were candled and found to be not developing.

KM-R was next seen at Dredge shell patch on 11 December 2022, and pGY-pGYM on 13 December 2022. This pair re-nested on 21 December 2022.

#### Other information

pGY-pGM is a 3-year-old female who nested with KM-R last season, however their eggs did not hatch. No nest movement, or other tara iti, nest management was required for this nest. The nesting area was checked daily for any sign of predators.

#### Nest 7 (M7): 470

Date laid found	19/12/2022
Parent band combination	WM-RW (female) & R-pGM
No. eggs laid	1
No. natal eggs hatched in natal nest	0
No. natal chicks fledged from natal nest	0
Trail camera date in/out	21/12/2022 / 08/01/2023
Nest location including GPS location	Dredge, E1744166, N6003402
Hide location and proximity to the nest	E1744228, N6003404 and E1744162, N6003329
Nest camera installation	21/12/2022 at 1045, approximately 10m from nest
Egg candling date and results	4/01/2023, fertile and developing

#### Nest Specific Information

##### Emergency egg collection

On 03 January 2023 already strong winds were predicted to increase to gale force over 2-3 days. The eggs were uplifted and replaced with a dummy egg. The nesting bird returned to incubate the dummy egg within one minute of placement.

The natal egg was placed directly into the MX45 incubator, at 29°C, RH 55%. The onsite rangers walked the incubator and attached the battery back to Tern Point, arriving at 1020, incubator at 33°C, RH 65%. The egg was transferred into the Brinsea Ovation EX incubator at approximately 1430, set at 36.5°C and RH 58%.

On 06 January 2023 at approximately 0820, the egg was transferred from the Brinsea Ovation EX incubator to the MX45 incubator which was at 36°C. At approximately 0830, the rangers departed and arrived at the Waipū



Southern carpark at approximately 0900, the incubator was 36°C. At 1158, a ranger entered the site to transfer the egg into nest W469. The ranger departed the site at 1200, and the adult female tara iti was back on the nest at 1200.

Although logs had been placed approximately 2m from nest 470 to protect it from the easterly and north easterly winds, the dummy egg was abandoned on 05 January 2023.

#### Other information

No nest movement, or other tara iti nest management, was required for this nest. The nesting area was checked daily for any sign of predators.

#### Nest 8 (M8): 471

Date found	20/12/2022 and 20/12/2022
Parent band combination	R-KM (female) & pGM-R (male)
No. eggs laid	2
No. natal eggs hatched in natal nest	0
No. natal chicks fledged from natal nest	0
Trail camera date in/out	21/12/2022 / 01/01/2023
Nest location including GPS location	Dredge, E1744151, N6003390
Hide location and proximity to the nest	E1744228, N6003404 and E1744152, N6003329
Nest camera installation	21/12/2022 at 1045, approximately 10m from nest
Egg candling date and results	Not candled

#### Nest Specific Information

##### Egg predation

When the ranger arrived onsite at low tide on 1 January 2023, R-KM or pGM-R were not at the shell patch. The two eggs were gone, and what looked like remains were found on the edge of the shell patch and in the dunes behind the nest. No predator prints were found. Review of the nest camera showed it was triggered at 0514 on 1 January 2023, although it was too dark to make out the photo.

Two dummy eggs were placed in the nest, and PGM-R returned to incubate the dummies at 1341. However, the nesting pair were not seen at the shell patch over the following days, and the dummy eggs were collected on 8 January 2023.

##### Other information

On 26 December 2022, a harrier attempted to take a large variable oystercatcher chick from near the estuary but was deterred by the ranger and shorebirds in the area. After briefly seeing the oystercatcher chick after the attack, it was not seen again. It was presumed dead as its parents had returned to the area the following day without the chick.

A series of five traps had been set up in the flight path of the harrier and around Dredge. On 27 December 2022 two of these had been set off. Evidence indicated that the harrier was familiar with traps as it had come in through the back of the hazing to approach the bait. The traps were adjusted to target a trap-shy harrier.

At 0730 on 1 January 2023, two harriers were caught in the traps, an adult female and a juvenile, likely male. No harriers were observed flying over the shell patch for the remainder of the season.

No nest movement, or other tara iti nest management, was required for this nest.

**Nest 9 (M9): 472**

Date laid and/or found	28/12/2022
Parent band combination	PGY-pGM (female) & KM-R (male)
No. eggs laid	1
No. natal eggs hatched in natal nest	0
No. natal chicks fledged from natal nest	0
Trail camera date in/out	21/12/2022 / 08/01/2023
Nest location including GPS location	Dredge, E1744166, N6003401
Hide location and proximity to the nest	E1744228, N6003404 and E1744166, N6003329
Nest camera installation	21/12/2022 at 1045, approximately 10m from nest
Egg candling date and results	4/1/2023, not developing

**Nest Specific Information**

**Emergency egg collection**

On 3 January 2023, already strong winds were predicted to increase to gale force over 2-3 days. The eggs were uplifted and replaced with a dummy egg. The nesting bird returned to incubate the dummy egg within one minute of placement.

The natal egg was placed directly into the MX45 incubator, at 29°C, RH 55%. The onsite rangers walked the incubator and attached the battery back to Tern Point, arriving at 1020, incubator settings were 33°C and RH 65%. The egg was transferred into the Brinsea Ovation EX incubator at approximately 1430, set at 36.5°C and RH 58%.

On 04 January 2023 at approximately 0845, the egg was candled and was not developing. The egg was taken for analysis.

Although logs had been placed about 2m from the nest to protect them from the easterly and north-easterly winds, the dummy egg was abandoned on 5 January 2023.

**Other information**

No nest movement, or other tara iti nest management, was required for this nest. The nesting area was checked daily for any sign of predators.

#### Overall discussion of nest success/failures

This season was impacted by frequent and intense low-pressure systems, above average rainfall and strong north-easterly and easterly winds (NIWA Taihoro Nukurangi 2022). In early October, a polar southerly dropped temperatures down to 6°C, however, by the second half of the month temperatures were above average – a trend which continued throughout the remainder of the season. It was the warmest November on record for Aotearoa New Zealand and sea surface temperatures were 1.1-1.7°C above average (NIWA Taihoro Nukurangi 2022).

Due to the timing, intensity, and length of two major storms, direct intervention was required for all eggs not intended for the captive rearing program or predated. Even with added protection to the nests, all dummy eggs were abandoned throughout these storms resulting in the transfer of four eggs to Auckland Zoo, and one egg transfer to Waipū nest 469. The two eggs from nest 471 were predated before Cyclone Hale hit in early January.

Except for nest 467, all eggs were transferred when they were between 7-15 days old. The two eggs laid by female pGY-pGM and male KM-R, from nest 467 were transferred prior to a storm, at ages two and four days old. This pair laid another egg in a second clutch which was candled at day 24. All three embryos did not show any signs of development. This pair nested for the first-time last season but similarly the two embryos did not develop.

Three females each laid only one single egg clutch this season. One of these females abandoned the nest when the embryo was 10 days old and was not seen for 15 days. Although this was a new pairing, the male, BK-M continued to incubate the egg for another five days until it was taken to Auckland Zoo. Although the chick hatched it did not survive. See Captive Rearing report for more details.

It is possible that weather made fishing in the estuary difficult for tara iti this season. Based on observed mate-feeding and flight direction, the marine environment may have been an important source of food leading up to, and during, nesting. Four females spent long periods away from their nests, with changeovers regularly occurring only once in a 3-4 hour period over low tide. In late December, the weather settled for a week during the summer holidays, however incubation patterns remained similar. This short period of calm weather coincided with extensive use of the estuary by humans and dogs, which likely impacted foraging ability.

Foraging territories were determined in October and the estuary continued to be checked regularly for any changes (see Appendix map below). Although most foraging territories within the Mangawhai Estuary were similar to last season, KM-nil, an unpaired male was observed foraging in parts of the estuary previously used by M-R and BK-M. KM-R also extended his territory on both edges by approximately 50m, pushing into W-KM and BK-M's foraging territories. The nesting male pG-YM, who was paired with RM-K from nest 466, was not observed at the estuary throughout the season and his foraging territory has not been identified. R-YM was not observed in his foraging territory by rangers, but others confirmed sightings of him there early in the season. North Bund, and South Sea Valley shell patches were not used for nesting by tara iti this season. Around 150 metres of coloured flagging had been installed at South Sea Valley in early September to discourage tara iti from nesting there. This shell patch is exposed to north easterly, and easterly winds and is also at risk of tidal inundation. Throughout November and December, most of the shell at this site was covered with sand and tara iti were seen on the beachfront but not on the shell patch. An unpaired male, R-YM was occasionally seen at

North Bund in October, but by November this shell patch was only being used by NNZ dotterels, variable oystercatchers, and banded dotterels.

Other nest site management included: positioning logs to protect nests from strong winds and sand movement, and removing other shorebird nests at Dredge within approximately 40m of any fairy tern nest. Logs 1-2m long were installed approximately 2m from the nests, usually the day before an expected weather event. Birds were recorded returning to incubation within three minutes of placement. This technique can be effective for reducing sand movement and wind intensity but as some nests are positioned on steep mounds, the logs/sandbags do not always work.

On 8/12/2022 a NNZ dotterel was observed pulling R-KM off nest 465 by her nape. R-KM returned to the nest immediately and the dotterel walked behind the mound. Later that morning rangers found the dotterel nest in some pīngao, approximately 2m from nest 465. The two eggs were removed and placed in a New Zealand dotterel nest on the beach. That same day another NNZ dotterel nest was found approximately 40m from nest 466. The egg was removed and placed in a NNZ dotterel nest near the estuary. There were no further issues with shorebirds.

Unpaired and juvenile tara iti were present at Dredge throughout the season but did not cause much disturbance. Nesting pairs showed mostly tolerant behaviour toward them.

Table 3. Egg Measurements, Candling Results and Fate of Eggs/Chicks

Nest Number	Pair: Nest	Date Found	Candling Date	Candle Age (d)	Weight (g)	Length & Width (mm)	Candling Result / Comments	Fate of Egg & Chick,
460	WM-RW & R-pGM	20/11/22 22/11/22	See Captive report					Captive rearing programme
461	W-BM & BK-M	23/11/22	5/12/22	12	n/a	34.5 (L) 25 (W)	Fertile & developing	Captive rearing programme
463	K-KM & W-KM	24/11/22	See Captive report					Captive rearing programme
465	R-KM & pGM-R	25/11/22 28/11/22	See Captive report					Captive rearing programme
466	RM-K & PG-YM	25/11/22	5/12/22	10	n/a	35.5 (L) 23.4 (W)	Fertile & developing	Captive rearing program
467	PGY-pGM & KM-R	3/12/22 6/12/22	14/12/22	12 9	n/a	n/a	Clear	Did not develop

470	WM-RW & R-pGM	19/12/22	n/a	n/a	n/a	n/a	Not candled	Transferred to nest 469. Found deceased after cyclone.
471	R-KM & pGM-R	20/12/2022	4/01/23	14	n/a	n/a	Fertile & developing	Predated
472	PGY-pGM & KM-R	21/12/2022	4/01/23	15	n/a	n/a	Clear	Did not develop

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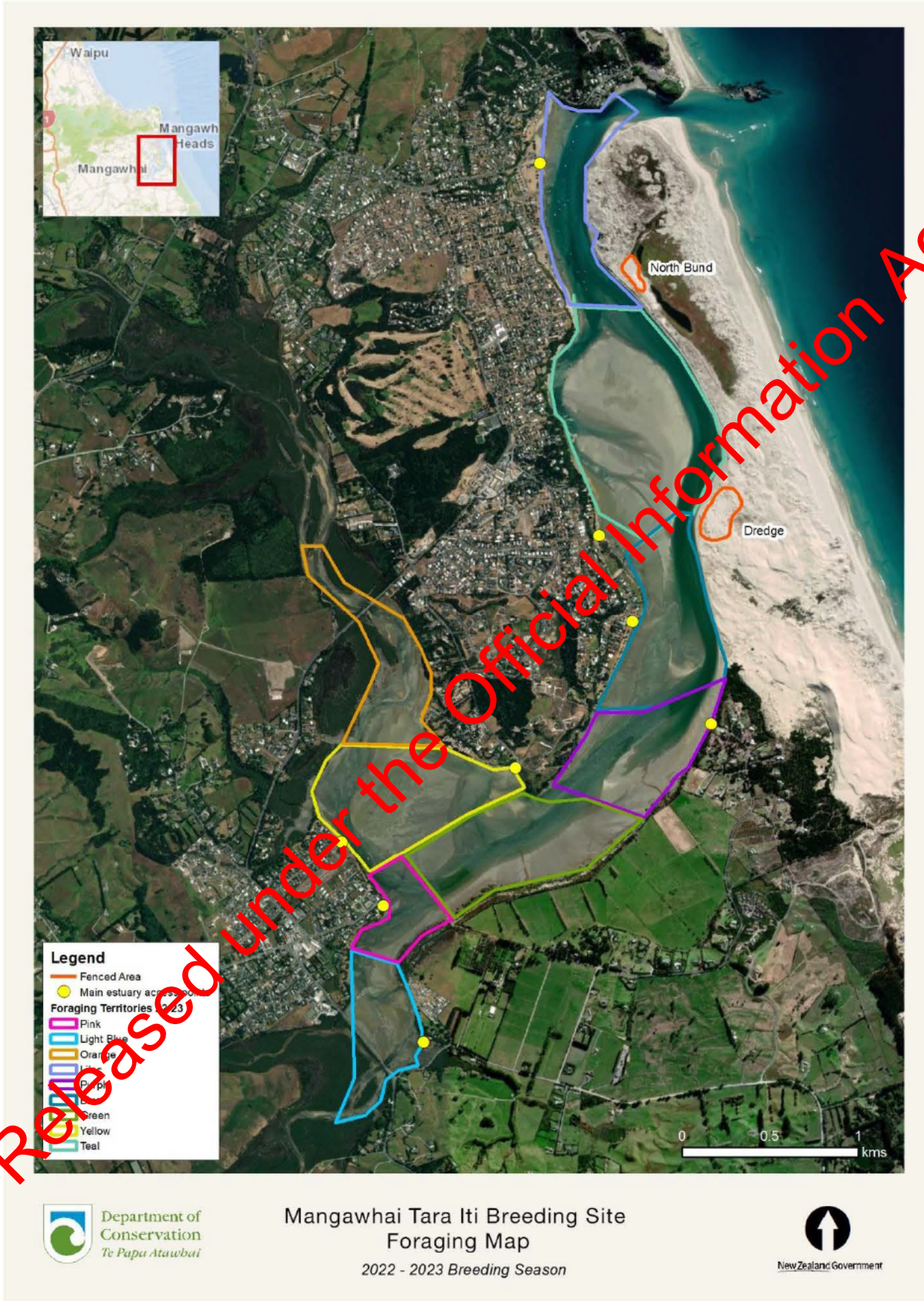


Figure 3. Tara iti feeding territories within Mangawhai estuary over the 2022-2023 breeding season.

Table 4. Colour key for foraging male foraging territories corresponding to Figure 3.

Territory	Male Bands	Partner Bands	Nest Location
Pink	M-R	Unpaired	N/A
Light Blue	R-pGM	WM-RW	Dredge, 460, 470
Orange	(K)-pGM	Unpaired	N/A
Lilac	R-YM	Unpaired	N/A
Purple	BK-M	W-BM	Dredge, 461
Blue	KM-(W)	Unpaired	N/A
Green	KM-R	pGY-pGM	Dredge, 467, 472
Yellow	pGM-R	R-KM	Dredge, 465, 471
Teal	W-KM	K-KM	Dredge, 463
Unknown territory	PG-YM	RM-K	Dredge, 466

Table 5. First 2022 - 2023 breeding season sightings of other NZ Fairy Tern by Rangers at Mangawhai sandspit.

Date	Site	Bird	Observation	Observer
19/9/2022	Estuary	W KM	Foraging in pink territory	Shannan Courtenay
29/9/2022	Dredge	RM pGB	Roosting at the bowl	Arthur Bensana
29/9/2022	Dredge	pGM R	Roosting at the bowl	Arthur Bensana
3/10/2022	Dredge	BR WM	Roosting at the bowl	Shannan Courtenay
3/10/2022	Dredge	K KM	Roosting at the bowl	
3/10/2022	Dredge	WM RW	Roosting at the bowl	
3/10/2022	Dredge	(K)-pGM	Roosting at the bowl	
3/10/2022	Dredge	M R	Roosting at the bowl	
3/10/2022	Dredge	R KM	Roosting at the bowl	
3/10/2022	Dredge	R pGM	Roosting at the bowl	
3/10/2022	Dredge	R YM	Roosting at the bowl	
3/10/2022	Dredge	pGY pGM	Roosting at the bowl	
4/10/2022	Estuary	KM R	Foraging in lime foraging territory. Seems to be trying to lure pGY pGM from teal foraging territory into lime	
4/10/2022	Estuary	R KM	Foraging in blue territory	
5/10/2022	Estuary	BK M	Foraging in his old territory	
5/10/2022	Estuary	W BM	Foraging with BK M	
15/10/2022	Dredge	RM K	Copulation with pGM R at bowl	
17/10/2022	Dredge	pGM YB	Resting on shell at the bowl	
17/10/2022	Dredge	WB YM	Juvenile, roosting	
17/10/2022	Dredge	K M	Resting on shell at the bowl	
17/10/2022	Dredge	KM-(W)	Resting on shell at the bowl	
24/10/2022	Dredge	YM YR	Attempted copulation with pGM-nil at the bowl	
24/10/2022	Dredge	PGM nil	Attempted copulation at the bowl	

24/10/2022	Dredge	BpG RM	Juvenile, on shell at the bowl	
26/10/2022	Dredge	pG YM	Arrived at the bowl with RM K	
26/10/2022	Dredge	BM-pGB	Resting on shell at the bowl	
24/10/2022	Dredge	pGB YB	Resting on shell at the bowl	
Key: B = blue, G = green, M = metal, pG = pale green, R = red, Y = yellow, UB = unbanded				
*Only record metal band if 100% confirmed ID				

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## 2 HABITAT ENHANCEMENT

### 2.1 Shell patch enhancement

Since 2008, DOC, with support from the Tara iti Community, have been creating raised shell patches and enhancing existing ones for tara iti to nest on across all the breeding sites. The aim of this is to reduce the impacts of high tides and storm events which have washed out low-lying nests in the past. It also aims to stabilize the nest sites by stopping or slowing sand movement which can cover nests.

During 2020, at Mangawhai two new patches were created, and two existing patches received new shell, sourced from the Whangarei harbor and the Mangawhai Sandspit itself. 37 tonnes of shell were helicoptered on to the spit with the assistance of the NZ Defence force.

In 2021, the decision was made to disable SSV as it was an unstable site. This site was disabled with the installation of five lines of 100m of coloured flagging, about 5-10m apart, covering the entire shelled area. The flags were suspended 0.5m off the ground. No attempts to nest in this area were made in 2021. The flagging was again installed in 2022, also with no nesting attempts made.

The other shell patches were sprayed and hand-weeded to clear vegetation prior to the start of the breeding season.



Figure 4. Ranger installing flagging at South Sea Valley (SSV)

### 2.3 Weed control

At Mangawhai site weed control was carried out targeting weed species such as gorse, pampas, saltwater paspalum, lupin, and marram grass which modify sand dune systems.

In 2022, during pre-shorebird breeding season, a concentrated effort to target lupin was carried out in the middle area of the spit. The lupin is a known cover for rabbits on the sandspit, control was deemed necessary to reduce rabbit numbers alongside the toxin operation.

### 3.1 Introduction

Mangawhai Refuge is used as a breeding and feeding ground for many native and endemic New Zealand birds. Among these are the endemic Northern New Zealand dotterel (*Charadrius obscurus aquilonius*), of which approximately 2,200 individuals remain. These birds, along with the endemic variable oystercatcher (*Haematopus unicolor*) and banded dotterel (*Charadrius bicinctus*), nest at Mangawhai sandspit in the dunes, and on the beachfront.

These species share very similar breeding ecology. They are monogamous, and nests are usually laid over the summer months. Nests are usually simple scrapes in the substrate or laid straight on vegetation. Normally a clutch comprises 2-3 eggs, and incubation is shared between the parents. Chicks depart the nest soon after hatching and remain with the parents until fledging (Dowding, J. E., 2014; Lord, A et al. 2009).

When time allowed, the rangers searched for, and monitored dotterel and oystercatcher nests to gain an understanding of the breeding success of these birds. Caspian terns and red-billed gulls were also loosely monitored.

### 3.2 Methods

NNZ dotterels, variable oystercatchers, and banded dotterels were not consistently monitored throughout the 2022-23 season. The rangers kept a daily lookout for any nests and chicks on the sandspit, but this was dependent on time. Monthly surveys were taken of individuals in October, November, and January, and where possible, nests, eggs, and chicks were recorded. Nests were discovered by observing the behaviour of the adult birds. If any adults displayed territorial behaviour indicating there was a nest nearby, the rangers would spend time searching for the nest with minimal disturbance to the birds. Once found, a record was made of the nest location and how many eggs/chicks were found.

Due to the nature of the site, nests of both species were often difficult to find. The rangers continued to check potential nest sites to attempt to confirm a nest. In all cases of dotterel, nests were inferred by the presence of chicks in an area, rather than physically locating each nest.

### 3.3 Results and Discussion

This season numbers of NNZ dotterel and variable oystercatcher nests were low compared to the last two years, with rangers only recording 13 New Zealand dotterel nests, with 6 fledglings, and 16 variable oystercatcher nests, with 10 fledglings.

It is likely that many nests were washed away with the tide, which regularly reached the dune line this season. At least one variable oystercatcher chick was predated by a harrier and two were caught as by-catch in DOC 200 traps near North Bund. The remains of two NNZ dotterel eggs were found in December.

Three banded dotterel pairs attempted to nest in, and around, North Bund this season. However, there were no confirmed fledglings.

Table 6. NNZ dotterel, variable oystercatcher, and banded dotterel breeding success over the 2022-2023 season.

\* = Assumed fledged for those seen at 2 weeks or older

	NNZ dotterel	Variable oystercatcher	Banded dotterel
No. breeding pairs	28	32	3
No. nests (found + assumed)	14	16	3
No. eggs	25	39	9
Nests below high tide mark (likely flooded)	4	5	0
Known predated eggs	2	0	0
Known predated chicks	0	1	0
Chicks fledged	5	10	0

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### 3.3.4 Other Species

Caspian terns and Red-billed gulls began nesting in October 2022. Caspian terns nested in the same location on the beachfront north of SSV. Rangers recorded 52 nests with 19 chicks fledged by early January 2023. Red-billed gulls nested at the estuary walkway entrance to North Bund this season, opposite the boat ramp. Rangers counted over 100 nests and 36 chicks; most had fledged by early January 2023.

White-fronted terns did not attempt to nest on the sandspit this season, although up to 16 individuals were seen resting on the beach in front of the Caspian tern colony. Pied stilts also nested at North Bund this year and although two chicks were seen, no nests were found.

Table 7. Threatened, vagrant and migrant species at Mangawhai from October 2022 to February 2022. Threat rankings from Robertson et al, 2021.

Species	Conservation status	Observations
New Zealand fairy tern ( <i>Sternula nereis davisae</i> )	Nationally Critical	See Table 5
Caspian tern ( <i>Hydroprogne caspia</i> )	Nationally Vulnerable	Nested on beach front in usual location
Banded dotterel ( <i>Charadrius bicinctus bicinctus</i> )	At Risk/Declining	Three pairs observed attempting to nest on and near North Bund
Sanderling ( <i>Calidris alba</i> )	Vagrant	On the estuary
Ruddy Turnstone ( <i>Arenaria interpres</i> )	Migrant	On the beach in front of Caspian tern colony
Lesser knot ( <i>Calidris canutus rogersi</i> )	At Risk/Declining	Feeding on the beach
White-fronted tern ( <i>Sterna striata striata</i> )	At Risk/Declining	On beach in front of Caspian tern colony
Red-billed gull ( <i>Larus novaehollandiae scopulinus</i> )	At Risk/Declining	Nested along estuary walkway
South Island pied oystercatcher ( <i>Haematopus finschi</i> )	At Risk/Declining	In flock near Dredge
Bar-tailed godwit ( <i>Limosa lapponica baueri</i> )	At Risk/Declining	In a flock on the beach in front of Caspian tern colony
Northern New Zealand dotterel ( <i>Charadrius obscurus aquilonius</i> )	Nationally Increasing	See Table 6
Variable oystercatcher ( <i>Haematopus unicolor</i> )	Recovering	See Table 6

#### 4.1 Introduction

Mangawhai site is visited by various pests and/or predators of tara iti, including *Felis catus* (cats), *Rattus norvegicus* (Norway rats), *Rattus rattus* (ship rats), *Mus musculus* (house mice), *Mustela erminea* (stoats), and *Circus approximans* (Australasian harriers) throughout the breeding season. Predator control is critical to the breeding success of tara iti on Mangawhai site.

#### 4.2 Methods

A total of 117 traps were set on the Mangawhai sandspit this season, consisting of DOC 200s, Victor Professional Rat Traps, Victor legholds, cage/box traps, and Steve Allen (SA2) traps. From 12 October 2022, DOC 200 and Victor Professional Rat Traps, targeting mice, rats and stoats, were checked weekly. From 17 October 2022, SA2 traps, targeting cats, were checked every three days. Live traps, targeting Australasian harriers and cats, were used from 08 October 2022 until 1 January 2023. Data was recorded on Trap NZ and a Microsoft Excel spreadsheet.

This season, a bait trial was undertaken across all tara iti breeding sites. This involved trialing the effectiveness of three different bait types:

- Macadamia nuts
- PoaUku long life lures
- Salted rabbit

At North Bund, an alternating line of 31 DOC 200s, and 32 Victor Professional Rat Traps were baited weekly with alternating macadamia, PoaUku or salted rabbit. From 14 November 2022, 12 traps in the centre of this line became flooded due to heavy rain. The traps were moved to higher ground, despite this, continuous bouts of heavy rain led to periodic flooding. Consequently, these traps were baited irregularly for the remainder of the season. At Dredge, an alternating line of seven DOC 200s and six Victor Professional Rat Traps were also baited weekly with alternating macadamia, PoaUku or salted rabbit.

19 SA2 traps were dispersed along three lines:

- North Bund (6) - situated around the northern part of the spit, near North Bund shell patch.
- Internal Edge (6) - located in the vegetated centre of the spit, south of Dredge shell patch.
- Boundary Zone (6) - located along the southern boundary fence of the refuge.

These traps were baited every three days, initially with jelly meat, then eventually with alternating possum mince and terracotta salmon lures.

Throughout the season a total of 14 Victor legholds were deployed around North Bund, Dredge, south of Dredge, and the Boundary Zone. These were baited with eggs, decoy eggs, salted mackerel, salted rabbit, and fish oil depending on the target species. Additionally, from 7 November 2022, two cage traps, and one box trap, were set at Dredge, south of Dredge, and the Boundary Zone. This was in response to cat prints being found at Dredge and an influx of cats, caught along the boundary of the refuge and Tern Point land, by New Zealand Fairy Tern Charitable Trust trapper 9(2)(a). In late November, one leghold was moved to the edge of the wildlife refuge

to target cats but on the 1 December 2022, the trap was stolen by a member of the public and dog prints were found at the scene. It is worth noting that Victor legholds targeting Australasian harriers were only set when harriers were seen on site.

Throughout September 2022 to February 2023, a contractor was employed to target feral cats in the refuge. This work was completed during the night with the use of firearms and thermal imagery. The contractor would monitor for cat sign during the day and target those areas at night.

On 13 November 2022, what appeared to be mustelid footprints were found entering the Dredge nest site. In response, four additional DOC 200 traps, and one cage trap were deployed at Dredge and baited with stoat bedding, salted rabbit, and eggs.

Black backed gull nests were managed by pricking eggs fortnightly during November and December. A total of 66 eggs from 45 nests were pricked.

#### 4.3 Results and Discussion

A total of 20 predators were caught over the 2022-2023 season, consisting of Australasian harriers, Norway rats, and mice. The most caught predator was Australasian harriers (11) followed by mice (6), then Norway rats (3) (Figure 8). The greatest number of predators (14) was caught during November, with Norway rats and mice only being caught during this month, and the greatest number of Australasian harriers (5) also being caught during this month (Figure 9).

The greatest number of predators were caught in Victor leghold traps (11), followed by DOC 200 traps (6). Only two predators were caught in Victor Professional traps, and one in a cage trap (Table 8). Out of the DOC 200 catches, five were at North Bund, at one at Dredge, while both Victor professional catches were both at North Bund. It is worth noting that during the season, traps at Dredge, particularly DOC 200s, were continuously impacted by sand - this may have reduced the number of predators caught in this area.

Out of a total of 11 Australasian harriers caught the majority were adults (9) and more males (7) were caught than females (3). The greatest number of Australasian harriers were caught in November (5), and equal numbers (2) were caught in October, December, and January (Figure 9). From 25 December 2022, a trap-shy Australasian harrier avoided targeted traps, and predated nest 471 on 1 January 2023, before being eventually caught later that day.

No cats or mustelids were caught by DOC rangers during the 2022-2023 season, although both cat and mustelid prints were found on the sand spit in mid-November. However, 15 cats were caught by NZ Fairy Tern Charitable Trust traps, 9(2)(a) in the Boundary zone (11) and Tern Point (4). At least one cat was shot by contracted shooter. It is likely that this contributed to lower numbers of cats out on the sand spit by creating a buffer.

By-catch included one Californian quail on the edge of the wildlife refuge and 2 VOC chicks at North Bund. The Californian quail was caught and predated overnight in a Victor leghold, and the VOC chicks were caught in DOC 200 traps.

Overall, numbers of predators caught by rangers on the sandspit this season were lower than previous seasons. A possible reason for this is that diphacinone and pindone administration reduced numbers of rats, and rabbits,

respectively. This would have reduced prey for other predators such as cats and mustelids. The low number of Australasian harriers may have been because of the low numbers of shore birds nesting on the sandpit this year, and therefore low food supply. This also may have driven the predation of nest 471.

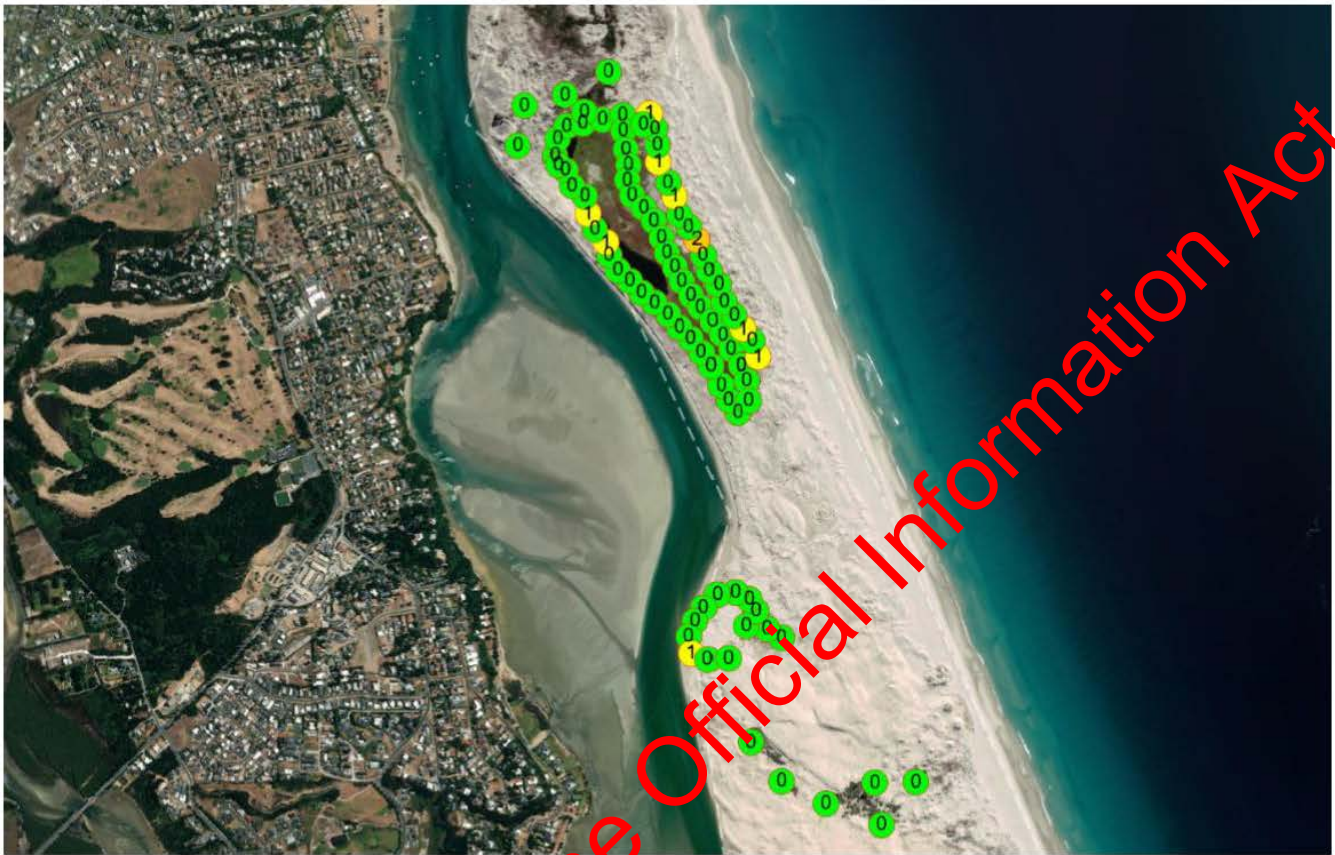


Figure 7. Trap records map from Mangawhai site during September 2022 - March 2023

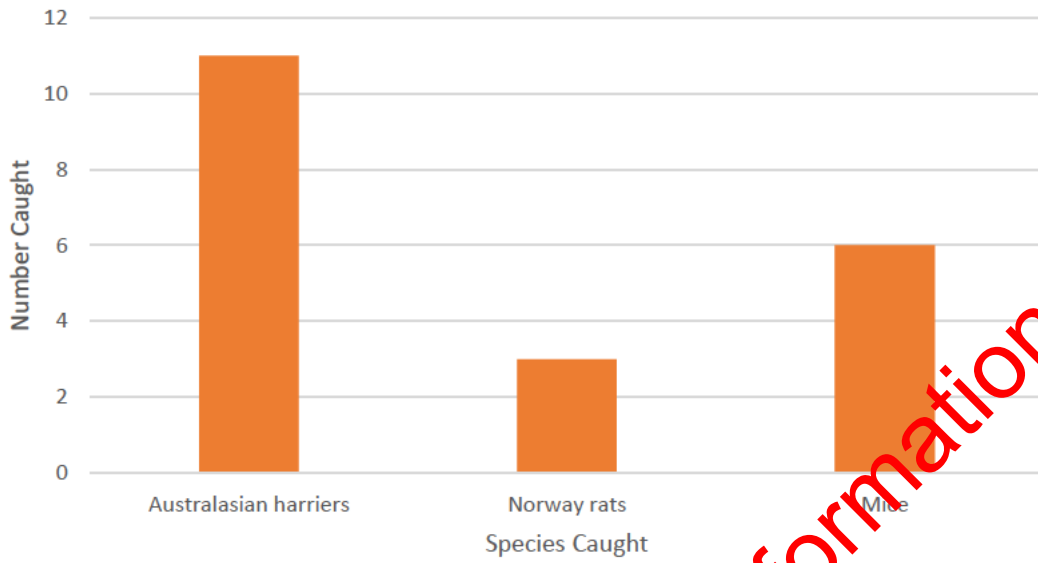


Figure 8. Total number of each predator species caught at Mangawhai during the 2022-2023 season

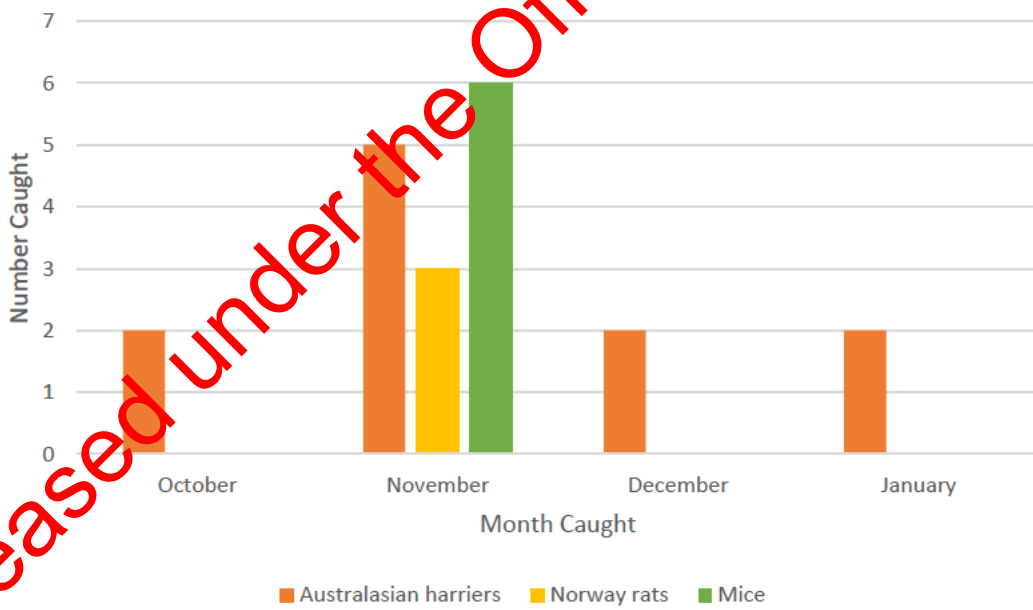


Figure 9: Number of each predator species caught at Mangawhai per month during the 2022-2023 season



Table 8. Overview of traplines, their active monitoring period by DOC rangers and catch

Trap line	Location	Trap type	Bait	Active dates	Number of traps	Predators caught
NB	North Bund	DOC200	Macadamia, PoaUku, salted rabbit	12/10/2022 - 24/02/2023	31	3 mice, 2 Norway rats
		Victor Professional	Macadamia, PoaUku, salted rabbit	12/10/2022 - 24/02/2023	32	2 mice
D	Dredge	DOC200	Macadamia, PoaUku, salted rabbit	12/10/2022 - 24/01/2023	7	1 mouse
		Victor Professional	Macadamia, PoaUku, salted rabbit	12/10/2022 - 24/01/2023	6	0
SA	North Bund	Steve Allen	Jelly meat, possum mince, salmon lure	24/10/2022 - 15/01/2023	7	0
	Internal Loop	Steve Allen	Jelly meat, possum mince, salmon lure	23/10/2022 - 15/01/2023	6	0
	Boundary Zone	Steve Allen	Jelly meat, possum mince, salmon lure	11/10/2022 - 15/01/2023	6	0
L	North Bund, Dredge Wildlife boundary	Victor leghold	Eggs/decoy eggs	08/10/2022 - 01/01/2023	9	11 Australasian harriers
			Salted rabbit, salted mackerel, fish oil	20/10/2022 - 01/01/2023	5	0
C	Dredge, Shipping container	Cage/box trap	Salted rabbit, fish oil	07/11/2022 - 01/01/2023	3	1 Norway rat
S	Dredge	DOC200	Salted rabbit, egg	13/11/2022 - 24/01/2022	4	0
		Cage trap	Salted rabbit, egg	13/11/2022 - 01/01/2023	1	0

#### 4.4 Predator control outside of the tara iti breeding season

At the Mangawhai site, and in Tern Point, winter trapping was carried out by 9(2)(a) (New Zealand Fairy Tern Charitable Trust) on a fortnightly basis using chicken eggs.

At Mangawhai site two toxin operations were carried out by DOC Whangarei Operations from August 2022 to February 2023. A Pindone operation was carried out in July and August 2022 to target rabbits. Pre-operational monitoring found high levels of rabbits present using the McLean scale. The majority of rabbits are in the highly vegetated areas of the spit, with McLean levels 4-6 in some areas. This operation was upscaled this season to increase the target zones to include areas with significant rabbit sign (see figure 5). 200g of Pindone pellets were laid on mats in areas of rabbit sign, three pulses of toxin were applied. Uptake, or consumption, of the toxin after the first pulse was quite high with a 77% on average bait uptake. The highest percentage of uptake was in the northern area of the spit with 87% average, and lowest in the southern area with a 57% average uptake. The middle area had an average uptake of 70%.



Figure 5. Target areas of 2022 pindone operation.

Key: purple = Northern area, green = Middle area, yellow = Southern area

During November 2022, a Diphacinone operation was carried out to target Norway rats. 300g of RatAbate Paste 0.05g/kg Diphacinone was applied in mini Philproof bait stations in 9 lines in targeted areas on the spit (see figure 6). The target areas are known to have Norway rats present. Two lines were installed near the Dredge site as that is the site favoured by tara iti for nesting. Bait was left in the stations through December and January. Uptake of the bait was minimal with less than 50% bait take.

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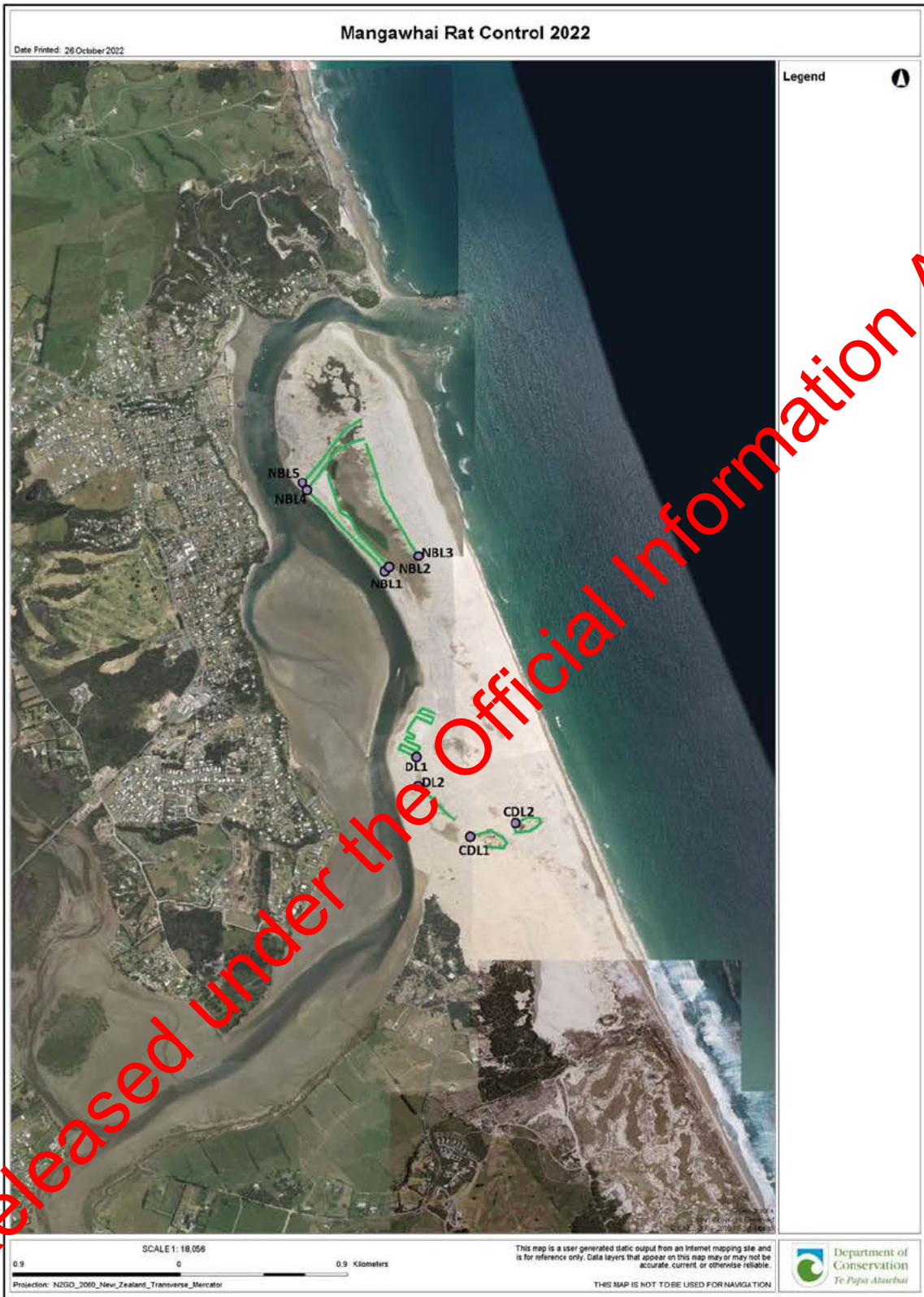


Figure 6. Bait station lines from 2022/2023 Diphacinone toxin application.  
 Key: NBL# = North Bund Lines 1-5, DL# = Dredge lines 1 & 2, CDL = Central Dunes Lines 1 & 2

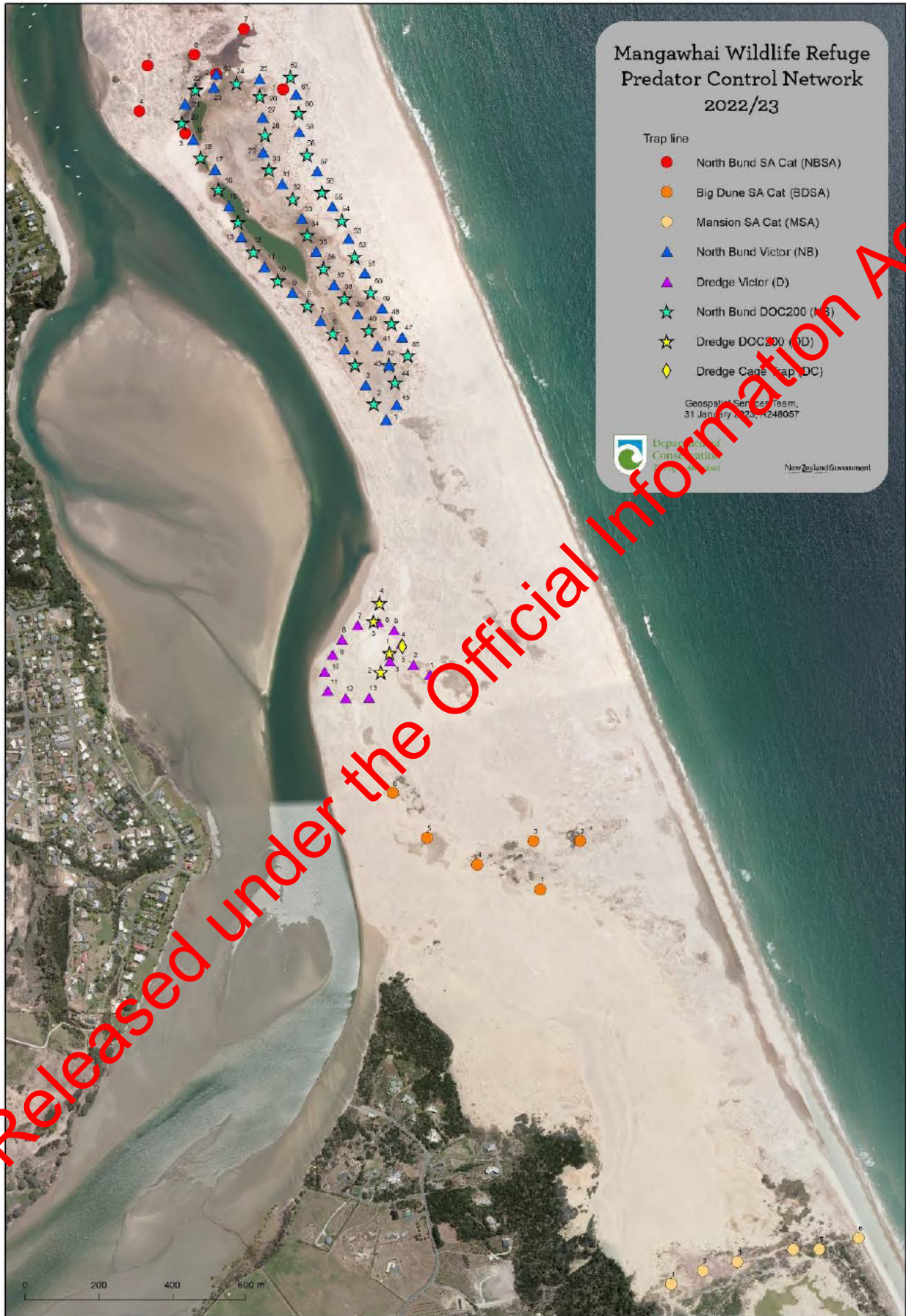


Figure 10. Map of DOC traplines for the 2022-2023 breeding season

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### 5.1 Introduction

Advocacy is a critical part of the ranger's role on site. Getting the public on board plays a large part in the protection of the species. As tara iti, dotterels, and oystercatchers all nest on the ground in open areas, they are often susceptible to nest disturbance, or destruction, due to human activities. Therefore, educating the public about the birds is critical at breeding sites so they are aware of the potential disturbance, and can be responsible for their behaviour.

At Mangawhai, a range of activities are banned under various bylaws for the protection of nesting birds. Monitoring any non-compliant activities is another essential component of the ranger's daily tasks.

### 5.2 Methods

The rangers checked the beach and estuary regularly for non-compliant activities when they were on site. Checks could be carried out by moving intermittently to the beach during periods of nest monitoring, to check on the behaviour of the public and to look for any advocacy opportunities.

When approaching any members of the public for either compliance or advocacy reasons, tactical communication was employed. All compliance incidents were recorded and evidence gathered. If non-compliant activity continued, then the offender was reported to the appropriate authority.

### 5.3 Results and Discussion

There were no major compliance issues this season. In October the rangers found dog footprints on the dune immediately southwest of Dredge. More dog signs were erected in the area. In mid-January there were sightings of horses on Big Dune, however this was in the evening when rangers were not onsite. Further evidence of this incident was found on social media and reported to a compliance officer. Contact with the offender was made and a warning was issued.

#### Low Flying Aircraft

Throughout the season low-flying aircraft were not an issue, with planes and helicopters both avoiding the restricted area.

#### Watercraft

Watercraft broke the five-knot restrictions daily over the summer holidays and long weekends. Jet skis were the most common watercraft breaking the five-knot restriction. No further details were recorded for these events as they were far too numerous and fast for rangers to record.

Table 9. Compliance and Law Enforcement incidents recorded at Site over the 2022-2023 Summer.

Type of Incident	Observed directly (OB) or Evidence only (EO)	Number reported to authorities
Boat /Jet-ski*	0	0
Kiteboarders	0	0
Vehicles	0	0
Dogs	EO	0
Horses	EO	1
People**	0	0
Fires	0	0
Drones	0	0
Total	1	0
Key: * = Speed Over 5 Knots ** = Disturbing nesting birds by being too close or inside the fencing.		

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## 5.4 ADVOCACY

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Due to the relative isolation of the sandspit and the bad weather, there were only five advocacy opportunities with the public throughout the season. Most interactions occurred on the beach near Tern Point.

In December, the ranger visited three campsites around Mangawhai to remind them about the nesting birds on the sandspit and to drop off pamphlets.

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## 6 RECOMMENDATIONS

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Several future recommendations have been made due to observation by rangers throughout the season:

### Tara iti

1. Solar charged Ring cameras could be installed in the hide instead of on shell patch, reducing need to enter site to put cameras in.
2. New signage eg: "Please do not enter", "No horses", or tara iti specific sign.

### Pre-breeding season

1. Mound enhancement at Dredge to enable better positioning of logs for nest protection during season.
2. New vegetation southeast of Dredge removed.
3. Set traplines up pre-season to minimise neophobic avoidance of traps.

### Shorebird

1. Set up a monthly shorebird survey with the volunteers during the season.
2. Investigation into influx of blue penguins washing up on beachfront.

### Predator Control

1. Adjust DOC 200 traps and Victor Professionals in September to help prevent chick bycatch.
2. Continue using SA2s over winter along the southwest border of the refuge.
3. Use Victor professional traps on sand dunes instead of DOC 200 traps to reduce sand movement around traps.
4. Trial using A24's on sandspit, targeting rats.

### Compliance and Advocacy

1. Encourage hiring a harbourmaster to patrol the estuary, particularly around summer holidays and long weekends.
2. Install more signage on the estuary regarding ski-lane speed and location.

Thank you to the Fairy Tern Charitable Trust and Mangawhai volunteers for your ongoing support and dedication to the tara iti. A special thank you to 9(2)(a) for organising volunteer logistics and communications, 9(2)(a) and 9(2)(a) for ferrying everyone over to the sandspit this season, and of course 9(2)(a) and 9(2)(a) for their trapping efforts, including catching 15 cats before they could reach the sandspit. A big thank you 9(2)(a) and 9(2)(a) from About Tern Waipu for your extra assistance over the summer holidays.

Thank you to the incredibly hard working tara iti team at DOC for all your efforts this season. A special thank you to Tony Beauchamp for your brilliant technical advice, knowledge and support, and to Joseph Alker and Nikki Hartley for their support and guidance. A shout out to Kelsie, Kallan, Jake and John for their help with egg transfers. We would also like to thank the other tara iti rangers for all their assistance.

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