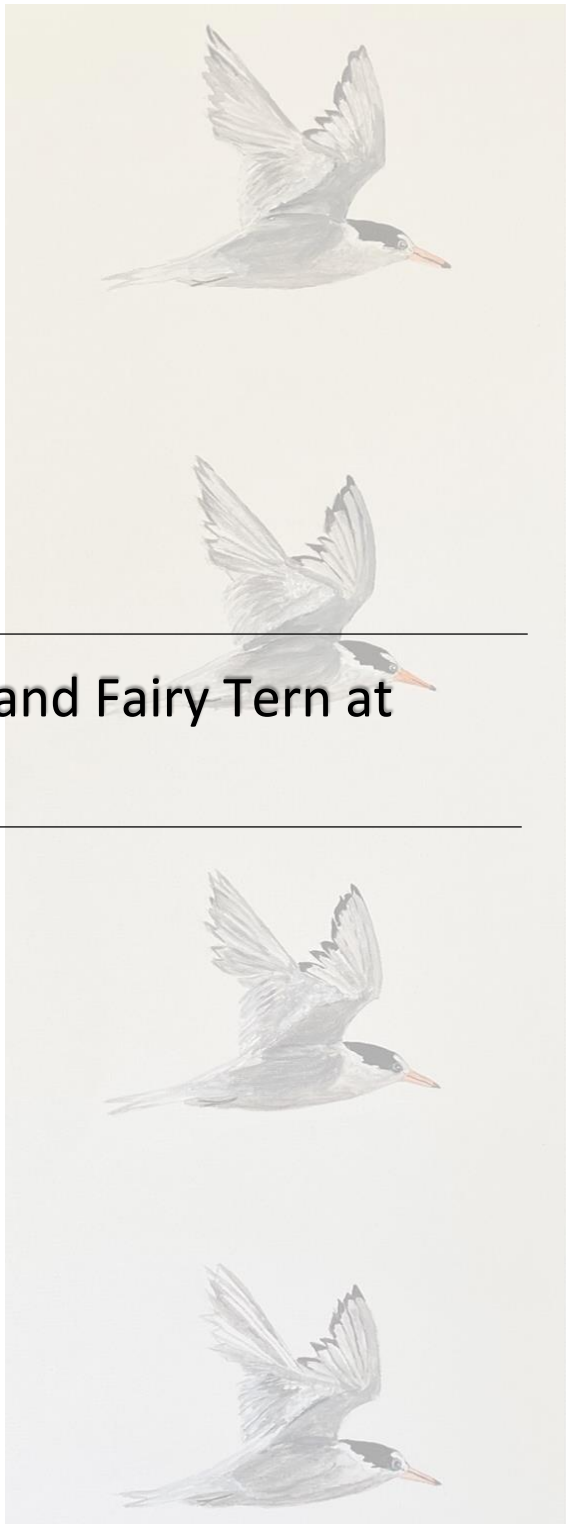

The Survival of the New Zealand Fairy Tern at Mangawhai

Discussion Paper

Phil McDermott

May 2022

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Final, May 2022

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Credentials

Following postgraduate study and employment in the UK, Philip McDermott provided analysis and consulting services in New Zealand, and in Australia, Asia and the Pacific from 1980 to 2020. He covered the impacts of land use change and development in primary production and processing, tourism, housing, transport, and urban development. He spent five years as Professor and Head of the Department of Resource and Environmental Planning at Massey University and has authored twenty internationally refereed publications, as well as book chapters, invited professional and academic papers, and one text.

Disclaimer

Foreword

Tara iti, the New Zealand fairy tern, is a subspecies with a high risk of future extinction. For some, its major strongholds adjacent to rapidly growing human populations is the most troubling feature. For others it offers hope that would not be available if the birds lived in remote areas. It is inevitable that these opposing views will continue to be expressed at future resource consent applications of which there are likely to be many.

Like the author, Phil McDermott, I became involved in this ongoing debate as a result of the Te Arai and the historic wharf restoration consent applications. Without a record of past actions and population responses, arguments often appeared more like advocacy rather than expert testimony. For commissioners unfamiliar with science and ecology, it is unstated assumptions and selective fact sharing that compounds their assessments.

A 2022 paper in the journal Nature[1] compared areas with and without legal protection in many countries around the world. They concluded that the action of passive legal protection offered no benefits to biodiversity – it was active management that achieved a gain. This is reflected in the situation for Tara iti. The resulting investment in the population at Mangawhai and elsewhere that accompanied the development at Te Arai has been a major help to the birds. If the development had been stopped, as some wanted, the birds would be in a far worse situation.

Given the costs of management in New Zealand because of introduced predators especially, it is rare to see adequate financial resources being made available to make a positive difference to our fauna especially. Sensitive development offers the only hope in many situations. In addition, the increasing recreational use of coastal environments along with global warming add urgency to helping this species especially.

I commend this compilation of information by Phil McDermott as a resource for future consent hearings. There is hope that the wider community of interest that he documents will cooperate to further enhance this special bird.

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Former Professor of Environmental Management, University of Auckland
Co- originator of Tiritiri Ecosanctuary
Co-Environmental Designer, Tahi Estate Ltd

[1] Wauchope et al. Nature 20 April 2022

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Preface

I first encountered the New Zealand Fairy Tern (tara iti) in 2005, when assessing options for coastal land purchased by Te Uri o Hau as part of its Te Tiriti o Waitangi settlement. At a time when just four breeding pairs were reported at Mangawhai, Department of Conservation (DoC) staff argued that development would threaten the bird's survival. Tara Iti Golf Club and dwellings have since been developed on the site, while tara iti breeding has increased.

I next encountered tara iti when supporting the 2020 application to restore a timber-piled wharf built for schooners in the 1880s and demolished in the 1950s in the upper Mangawhai Harbour. Opponents said it would threaten tara iti's survival. No evidence was produced to support the assertion that a 100m wharf would undermine breeding. However, the remote possibility that it would disturb one pair of birds and thereby precipitate the collapse of the flock saw the commissioners refuse consent.

Reliance on supposition rather than evidence made me wonder whether advocates are focusing on the wrong solutions to the threat of tara iti's extinction. The basic question is: what is needed to maximise the prospects for the bird's survival given its tenuous existence over recent decades?

To address this, I reviewed relevant scientific, interest group, advocacy, and departmental reports and plans, and considered changes to the harbour itself. It is clear that post-1984 management to control predators and visitors, spit restoration, creation of nesting sites, and intervention in breeding have together been critical to holding numbers at between 30 and 40 birds.

However, it still must be asked whether propping up this small, vulnerable population on an unstable breeding site will ensure its survival? The failure to sustain more than around 40 birds over 40 years of management falls well short of a viable long-term population (at least 250 birds according to DoC).

Managing activity in the breeding environment from season to season is one thing. Investing In tara iti's long-term survival is something else altogether. It means breaking through a population ceiling that leaves the bird exposed to extinction from climate change and its reproductive shortcomings. If the agencies and advocates involved are serious about more than labouring to preserve a small cluster of vulnerable birds, they need to lift their horizons, look beyond the energy and resources spent indiscriminately on resisting inevitable change in the current environment, promote sound land use and water quality management throughout the harbour catchment, move aggressively towards genetic rehabilitation, and expand the fairy tern habitat to new breeding sites.

This review provides an independent appraisal of a record that nowhere offers guarantees for the long-term and is, in places, contradictory and ambiguous. No doubt people will disagree with my interpretation and conclusions. My over-riding conclusion, though, is that strategic investment in the survival of tara iti is urgent and - as with other species - should be founded on firm evidence. It should be progressive rather than regressive. With adequate information, goodwill, and collaboration among the agencies involved, investment in conservation and development can proceed hand-in-hand

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Footnote

Valuable feedback on earlier drafts of the review was provided by people with specialist knowledge. However, the conclusions remain those of the author. In addition, a report completed in late 2021 by DOC on a long term strategy was referred to me when this study was complete. I comment on that in the Postscript.

Phil McDermott
May 2021

Summary

The *Threatened Nationally Critical* New Zealand Fairy Tern (tara iti) is a sub-species of the fairy tern *Sternula nereis,* also found in Australia and New Caledonia. It has long been at risk: in 1983 just three breeding pair were observed in New Zealand. Today, there can be up to 10 pairs and 40 live birds.

Tara iti is confined to lower Northland, nesting in summer between Waipu and Pakiri on the east coast, mainly on Mangawhai sandspit. It winters on Kaipara Harbour in the west. Tara iti has survived over 70 years in this limited summer habitat despite increasing rural activity and afforestation in the catchment, harbour-side settlement, and coastal recreation. Against a backdrop of change in a volatile physical environment, survival prospects have risen, in large part through the management efforts of the Department of Conservation (DoC) and volunteers on Mangawhai spit during the breeding season.

Given persistently small bird numbers, however, episodic events remain a threat, particularly storms and predation. Even with an intensive DoC warden and volunteer support programme, extinction remains a strong possibility. This vulnerability makes tara iti a flash point between those comfortable with increasing coastal settlement and those who resist change as a means of protecting the bird.

This paper reviews scientific and grey literature[1] relating to the survival of tara iti. It examines the evidence - to help prioritise initiatives to lift survival prospects and to provide input into associated water and land use issues. The main findings of the review are as follows:

- The history of the NZFT is uncertain. References to its observation in 1843 are misleading and claims that it was once found in the southern North Island and east coast South Island hard to verify, inconsistent, and consequently irrelevant to the quest for its recovery.
- The fairy tern has been confirmed in the northern North Island since the 1950s. Over the past seventy years it has been observed only in lower Northland, and only in very small numbers.
- Under active management since 1984, the flock has grown slowly and haltingly, with between 30 and 40 birds since 2013, perhaps reaching as many as 45. While it remains vulnerable, it has shown a capacity to recover from episodic setbacks, including a fall to just 26 birds in 2011.
- Its recovery has been based mainly on breeding on Mangawhai Spit where it forages in the littoral zone of the adjoining ocean waters, the sheltered waters of the harbour, and nearby dune lakes.
- Harbour foraging territories are established and defended by males in the spring and play a role in courtship and raising fledglings. They vary in shape and size as breeding pair numbers fluctuate.
- Population gains have been achieved through increasingly intensive seasonal habitat management involving predator trapping, storm shelters, barriers, fences, seasonal patrolling, and signage.
- Habitat management has been complemented by direct intervention in breeding, through shell seeding of nesting areas, nest transfers, egg transfer and incubation, and fostering fledglings.
- Local population growth, increasing coastal recreation, and intensifying use of the harbour do not appear to have impeded recovery. This and the fact that tara iti tolerates intervention in breeding confirms its capacity, like most shorebirds, to habituate to the presence of people.

However, given limited numbers, long-term threats remain. They include:

- Ongoing changes to spit morphology and vegetation;
- Loss of harbour area and productivity through sedimentation and mangrove colonisation;

1 According to Wikipedia, grey literature comprises research produced by organisations outside traditional commercial or academic publishing channels. It includes reports, working papers, government white papers, and documents. To this can be added expert statements before planning and Environment Court hearings, and the newsletters of interest groups.

- Climate change leading to more severe storm events threatening nests and birds; more hot, sunny days leading to chick dehydration; rising sea temperatures impacting on prey fish; rising air temperatures supporting invasive plants and avian competition; increased predation; and, ultimately, the prospect of inundation of much of the spit;
- The impacts of a likely doubling of the resident population within the catchment harbour on water quality and the inter-tidal zone and surface, and increasing on foraging and nesting areas;
- Perhaps most insidious, falling fecundity as a result of inbreeding which could see flock size and composition reach the point beyond which it can no longer reproduce at even current levels.

Given these risks, it is critical to move immediately to a programme aimed at lifting numbers towards a long-term survival target of 250. Three strategic priorities are proposed:

1. **Continuing and expanding habitat protection through;**
   - ***Catchment-wide management to limit mangrove proliferation*** by protecting riparian margins, maintaining appropriate farm stocking and cultivation levels, sensitive fertiliser application, wetland restoration, promotion of forest biodiversity on slopes, and "better-than-best-practice" stormwater and wastewater management in settlements. (This should yield multiple environmental benefits beyond protecting the fairy tern breeding habitat).
   - ***Harbour management***: acknowledging the inevitability and value of increasing harbour use, plan and invest in facilities and amenities that improve access without overwhelming sensitive sites. This might include provision of clearly buffered and marked walking trails and wildlife viewing facilities and enforcement of regulations designed to protect the harbour and its wildlife (covering boat speeds, dog controls, and no-go areas).
   - ***Sandspit management*****:** continuation of current management practices (predator control, eradication of invasive plants, stabilisation planting, sand replenishment, nest seeding) with the addition of managed trails, viewing areas (and ideally hides) to enable controlled public access, supplemented by effective enforcement of no-go areas and the dog ban.

   Such a programme should be aimed at managing the interface between people and wildlife rather than banning access and risking alienating the wider community. It should encourage public vigilance of and compliance with responsible behaviour around shorebirds generally.

2. **Developing a programme for bird translocation**

   This can be achieved by expanding nesting opportunities at Mangawhai, boosting existing secondary nesting sites (Waipu, Te Arai, Pakiri, and Papakānui Spit), and establishing new ones in more remote and stable localities (as identified by the NZ Forest and Bird Society). Such an initiative can select robust, fertile birds from the existing flock to strengthen desirable attributes (including fertility) in the relocated population. **Strengthening and diversifying the gene pool through:**

   - A**vian husbandry** based on selective culling and breeding to strengthen fertility and reinforce attributes favouring longevity, and
   - Researching and progressing the **introduction of eggs** from the Australian subspecies.

Postscript: In October 2021 a report outlining collaboration between DOC and a UCL/Zoological Society of London team considering long term tara iti management options was produced. This is discussed on page 30 of this paper. Based on greater biological and avian husbandry expertise and focusing heavily on nesting and population dynamics, the report raises long-term options broadly similar to this study. The current study, though, places more emphasis on the urgency of the task given far-reaching changes taking place in the wider physical and social environments, and argues that these matters and options for addressing need to be made available to a wider public.

1 INTRODUCTION

Tara iti, the critically threatened New Zealand subspecies of fairy tern (NZFT), is confined to lower Northland.[1] The majority of 10 or 11 pairs (out of around 40 surviving birds) breed on the Mangawhai sandspit, a designated wildlife reserve. This site is separated from one of the country's fastest growing settlements by a busy recreational harbour.

This paper explores the prospects for the long-term survival of tara iti, reflecting on the experience of thirty years of conservation initiatives at Mangawhai.

Mangawhai comprises two villages, one at the harbour mouth and one on the upper harbour. The spit that protects the harbour is where tara iti return to breed in Spring every year. A wilderness of dune and coastal grasses and scrub, including an intermittent dune lake, the spit is 3.5km long and accessible by boat and foot.

The eastern side is an extension of a dune-backed ocean beach running some 6km south to Te Arai Point. Roosting and occasional nesting also take place 3.5km south of the on this stretch of ocean beach at Te Arai Stream, close to the Pakiri River mouth 6km further south, and 14km north of Mangawhai at Waipu river mouth. The birds winter on the Kaipara Coast, around 50km southwest, arriving in late August or September for nesting and breeding and returning to the west from late February, following fledging.

Despite intensive conservation initiatives, tara iti's future remains uncertain. The bird has survived in the shadow of several decades of settlement growth. As the population has increased and harbour use intensified, tara iti has become something of a flash point between people committed to protecting the bird and its habitat and residents and visitors attracted to the recreational opportunities the coast offers.

Advocacy and regulation aiming to limit harbour activities reflect the proposition that people pose a serious risk to the bird's survival. Paradoxically, as the population of Mangawhai has grown, so the probability of tara iti's survival appears to have increased (Ferreira e.al. 2005). Total numbers grew "at an exponential rate" between 1991 and 2001, lowering the demographic risk of extinction from 0.52 to 0.39.[2]

Although fluctuating, the numbers have increased slightly since then, despite increasing resident and holidaymakers use of the coastal environment. They remain low, however, relative to a threshold of 250 considered necessary for long-term survival.

This paper draws on the literature to explore the paradox that gains in the bird population have been made despite increasing development and to identify the initiatives most likely to lead to a significant long-term increase in numbers.

1 Its conservation status was Nationally Critical in the 2016 based on its very small, range restricted population. However, unlike the 2008 and 2012 listings, qualified as stable (Miskelly et al, 2008, Roberston et al., 2008, 2016).

2 This is based on the observed character and dynamics of the population. While the parameters will have been influenced by exogenous events, the impacts of changes in the environment are not been modelled explicitly.

2 THE FAIRY TERN

The fairy tern (*Sternula nereis*) is a shorebird found in New Zealand (c.40 individuals), New Caledonia (100 to 200 pairs), and Australia (over 5,000). It feeds through shallow dives in the pelagic and intertidal zones. It lays one or two eggs a year in open, sandy sites above high tide and clear of coastal vegetation[3].

In Western Australia numbers are considered stable, with at least 1,600 pairs. Numbers have declined "*over the last thirty years*" in South Australia, Victoria, and Tasmania. New Caledonian numbers have also fallen, to between 100 and 200 pairs.

NZFT (*Sternula nereis davisae*) numbers, as reported, climbed from three pairs in 1983 to "*eight to ten pairs and 25-30 birds in 1998*" (Taylor, 2006). In 2006 10 pairs and 35 to 40 birds were reported (S. Garnett[4]), and in 2011 around 10 pairs (P Pridham[5]). Recent figures cited by DoC and advocacy groups vary: website and media releases suggested 40 to 45 birds and 10 to 12 breeding pairs in 2020. [6]

According to *Birdlife International*, fairy tern feed off shoals of predatory fish in the intertidal and pelagic zones (Higgens et al., 1996). Southey (2020) reported that it also feeds on small benthic fish in shallow estuaries and harbours.

2.1 THE HISTORY

Even allowing for uncertainty in the various estimates, the population is undeniably small and fluctuating. In considering the prospects for its survival, it is helpful to establish the past population to give some idea of the challenges facing the establishment of a flock that is viable in the long term.

This is not straightforward. It has been claimed that tara iti was widespread in the 19th century, purportedly observed in the mouths of the braided rivers of Canterbury, in Marlborough, and the lower North Island (Parrish and Pulham, 1995a, citing Heather and Robertson, 1996 and Oliver 1955; DoC, 1997). This claim rests in part on reference to Gould (1843) in, for example, Ismar et al (2014, 72). In fact, Gould described thirty Australian species at the 1842 meeting of the Royal Zoological Society in London. One of these was *Sternula nereis* observed in the Bass Strait.[7] No mention is made of a New Zealand sub-species.

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3 The section is based mainly on *Bird Life International*. 2018. *Sternula nereis*. *The IUCN Red List of Threatened Species* 2018: https://www.iucnredlist.org/species/22694691/132568135#habitat-ecology, Downloaded on 05 December 2020.

4 Cited in BirdLife International (2018). The IUCN Red List of Threatened Species 2018

5 Cited in the *Draft National Recovery Plan for the Australian Fairy Tern* (2019) p.11, Department of Environment and Energy, Australian Government

6 For example, DoC (New Zealand fairy tern/tara iti: Sea and shore birds (doc.govt.nz)), New Zealand Fairy Terns Charitable trust (New Zealand Fairy Tern – Tara-Iti – Help us save this endangered NZ shorebird), Endangered Species foundation (New Zealand fairy tern Endangered species factsheet.pdf), *New Zealand Herald* (DoC team ready to protect Northland's endangered fairy terns / tara iti - NZ Herald) – all accessed March 2021. Curiously, the *Draft National Recovery Plan for the Australian Fairy Tern* (op.cit) reported only six pairs in New Zealand in 2019 (p.11)

7 *Proceedings of the Meeting of the London Ornithological Society, 1841-1843*; p140 (, Meeting of 11 October 1842: pt.9-11 (1841-1843) - Proceedings of the Zoological Society of London - Biodiversity Heritage Library (biodiversitylibrary.org)

Gould was the authority cited in Buller's later *History of New Zealand Birds* (1888)[8] which indicated that the Little White Tern was "*tolerably common on all our coasts and occurs also very plentifully along the shores of Western Australia*". This contrasted with his description of the *white fronted tern* (*sterna albifrons*) which, he observed, was "*extremely abundant on our coasts, flocks of five hundred or more often being met*" They were observed flocking at river mouths and colonising small islands. [9]

Reports of tara iti formerly on the shingle coasts of the South Island do not align with its favoured sand and shell-based nesting habit. Interestingly, Buller noted that the larger, black fronted tern was common throughout the South Island, and observed large numbers on the shingle river beds and plains of the South Island.

19th and early 20th century observations may well have confused the fairy tern with the little tern (Watola, 2009). Little terns are migratory, arriving in New Zealand from Australia and the Northern Hemisphere. They "*inhabit sheltered coastal waters, and may occur in estuaries and harbours right around the New Zealand coast*". Their distribution (Figure 1) suggests that tara iti sightings in these localities were a matter of mistaken identity.

Uncertainty over widespread distribution was noted by Parrish and Pulham (1995b, 175) who called for caution over historical sightings. Beauchamp (2002) said estimates before banding (1991) were unreliable as early sightings could have been Little Terns. Hansen (1997) qualified her summary of sightings, saying they were open to doubt "*because the Eastern Little Tern was not recognised as visiting New Zealand prior to*" 1957 (p5). Southey noted that:

> "*Even museum specimens were misidentified and over-looked. … the little tern is now known to be the commonest small tern in the country over the summer… most of them are northern hemisphere migrants that spend their non-breeding season in New Zealand… "* (Southey, I. 2013. Little tern. *In* Miskelly, C.M. (ed.) *New Zealand Birds Online* www.nzbirdsonline.org.nz.

Compounding the uncertainty, little terns occupy areas inhabited by the fairy tern. Goffin (1978) reported a flock of 25 small terns in the Kaipara, with 13 identified as fairy terns.

With considerable doubt cast over evidence of tara iti prior to the 1950s, questions remain over its historical distribution, or even its presence. Of more immediate interest, though is the capacity of a very small population to survive in a constrained territory for the past 70 or so years. Ferriera et al. (2005) claimed "*a minimum*" of eleven birds, and just two pairs in the 1940s to 1950s. Heather and Robertson (1996) cited an unsourced estimate of "*18 pairs*" – not necessarily nesting pairs – in the 1950s. Parrish and Pulham (1995, 175) referencing McKenzie and Sibson (1957) suggested that "*the breeding population may not have exceeded six pairs*".

Studies by Falla et al. (1979) and Shaw (1985) established fewer than 10 pairs. Baling (2008, p.88) noted only three breeding pairs in 1983. Parish and Pulham (1995b) suggested that since at least 1984 their range had been "*apparently … confined to Papakanui Spit, Mangawhai and Waipu*". They cited an unpublished DoC report indicating that when protection was initiated by the NZ Wildlife Service in 1983/84 the breeding population was just three or four pairs.

A lack of consistency and variability in estimates may, of course, simply reflect the variability of observation protocols and the difficulty of distinguishing between little terns and fairy terns. However, since the formal management programme implemented in 1984 counts can be considered reasonably reliable.

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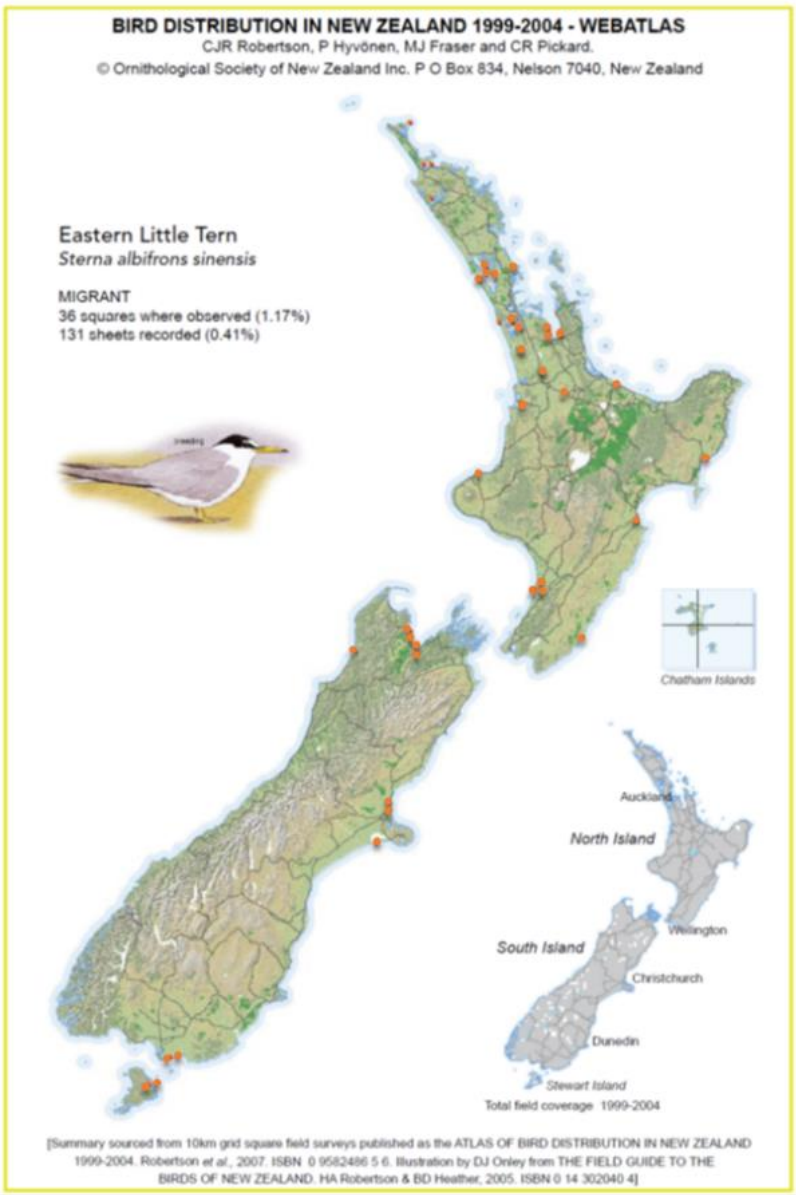
8 And subsequently, following Buller, the 1913 *Reference List of the Birds of New Zealand* compiled by Matthews and Iredale, which suggested that "*the New Zealand specimens are distinctly separated from the Australian forms by their larger size and darker colouration*"

9 Referenced through New Zealand Texts Collection, Victoria University of Wellington

Figure 1: Distribution of the Little Tern



Source: Atlas of Bird Distribution in New Zealand, Maps_for_website_6MAR09 200.pdf (nzbirdsonline.org.nz)

Although evidence that tara iti was abundant and widespread prior to the 1950s is questionable, the possibility is regularly repeated as fact, and is a potentially misleading foundation for conservation initiatives (Box 1). What is a fact is that the fairy tern is classified as endemic and is treated as such for management purposes (Hansen, 1997, 3).

It is also a fact that, despite Nationally Critical status and claims that tara iti is "*on the brink of extinction*"[10] the bird has managed to survive in low numbers for seventy years. The possibility that tara iti is a relative newcomer and has never been in New Zealand in large numbers does not mean that it does not justify endemic status or Nationally Critical classification. Nor does it reduce the intrinsic value of protection and management to reduce the risk of local extinction.

10 E.g., Newsroom, January 2019 "New Zealand's rarest bird on the brink"

Box 1: Fairy Tern Fact Checking

The record suggests that the only reliably documented sightings of the NZFT have been since the 1940s, and then only in small numbers. Consistent and accurate observation has only been in place since DoC implemented its management procedures in the 1980s.

Despite this, the (DoC) website states that:

> *"Records from the 19th century suggest that NZ fairy terns used to be widespread around the coast of the North Island and eastern South Island.".*[11]

Despite lacking verification, the suggestion that fairy terns were widespread has gained currency by repetition. For example, a *New Zealand Geographic* article claimed that:

> *"A CENTURY AGO, fairy terns were all over the country. They bred on coastlines around the North Island, and inland on South Island riverbeds. Today, predators, human disturbance, and destruction of their habitat—dams in rivers, pine plantations along the coast, people accidentally trampling nests—have reduced their numbers to almost nothing"* (Evans and Robinson, 2020).

There are several contestable claims here (underlined). In fact, coastal pine plantations (which in Northland date from the late 1950s and the 1960s) largely replaced native and introduced grasses and shrubs (themselves often overwhelmed by inland migration of dunes following coastal deforestation) rather than invading open dunes. Given that fairy terns nest in shallow scrapes on the open edge of sandy shorelines, stabilisation planting and the damming of South Island rivers are irrelevant. At the same time, clearances of invasive plant species, at least, and their replacement by natural communities, can be considered a constructive move in terms of dune preservation (Bergin and Kimberley, 1999).

In some cases, emotive language can be misleading. For example, the claim that tara iti has "*has teetered on the brink of extinction since the 1970s"* implies misleadingly that numbers were greater before then [12], which the observations since the 1950s establish was not the case.

The Endangered Species Foundation *Taraiti Fact* Sheet[13] goes further. With no evidence it makes the hyperbolic claim that tara iti has declined following changes in the beach environment over 10, 50, and 150 years:

> *"Differences are mainly due to how people now use our beaches and coasts: settlement and farms now butt up against the sand dunes (where exotic marram grass flourishes to protect farms and settlements from wind-blown sand), a wide variety of exotic herbs and shrubs have spread beyond domestic gardens and now festoon the dunes, the sands are regularly travelled by four-wheel drive vehicles and crowds of sun and sea seekers, and exotic predators now roam the beaches day and night".*

Tara iti has not declined over the past 10 years or 50 years and claiming 150 years is a long shot indeed. The habitat description bears little resemblance to Mangawhai spit or similar environments in Northland. Interestingly, there are many large areas of bare sand and scattered shells in Northland, some remote from settlement. Yet, the breeding habitat remains largely confined to an environment subject to intrusion by pest plants, predators, the sea and, in modest numbers, people, usually arriving at the fringes by boat or board.

11 New Zealand fairy tern/tara iti: Sea and shore birds (doc.govt.nz)

12 Media Release, Department of Conservation, 4 March 2022

13 Endangered Species Foundation New Zealand fairy tern Endangered species factsheet.pdf, accessed January 2021

3 FAIRY TERNS AT MANGAWHAI

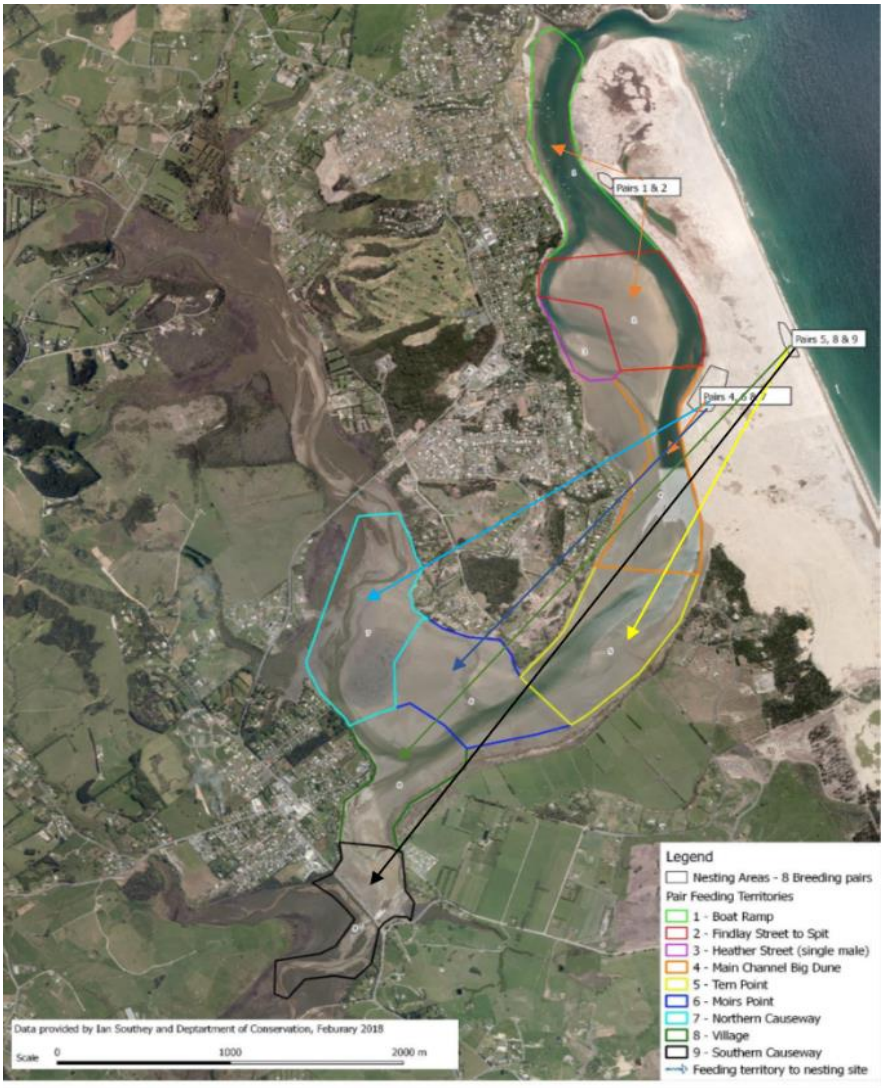
This section considers the recent success of tara iti at its main breeding site, Mangawhai spit.

3.1 USE OF THE HARBOUR

Tara iti reach Mangawhai during September. Nesting, breeding, and fledging take place through to February[14]. Harbour foraging replaces ocean feeding when the weather impedes pelagic fishing. Males also acquire and defend harbour territories to secure a partner, where they fish for it and the chicks. They are also used to teach fledglings to fish (Ismar et al. 2014).

The New Zealand Fairy Tern Charitable Trust (NZFTCT, 2020) mapped nine territories in 2017/18 season (Figure 2:). As mapped, they occupy the whole harbour, from deeper, fast flowing, open channels of the lower harbour through to shallow and highly tidal, mangrove-defined reaches in the upper harbour.[15]

Figure 2: Nesting Sites and Harbour Foraging Territories, 2017



Source: Based on New Zealand Fairy Tern Charitable Trust (2020)

14 Unusually early nesting in October 2018 failed to produce surviving chicks (Drew, 2019, 6,7).

15 The territories are not definitive, being interpolated on the basis of observed dives.

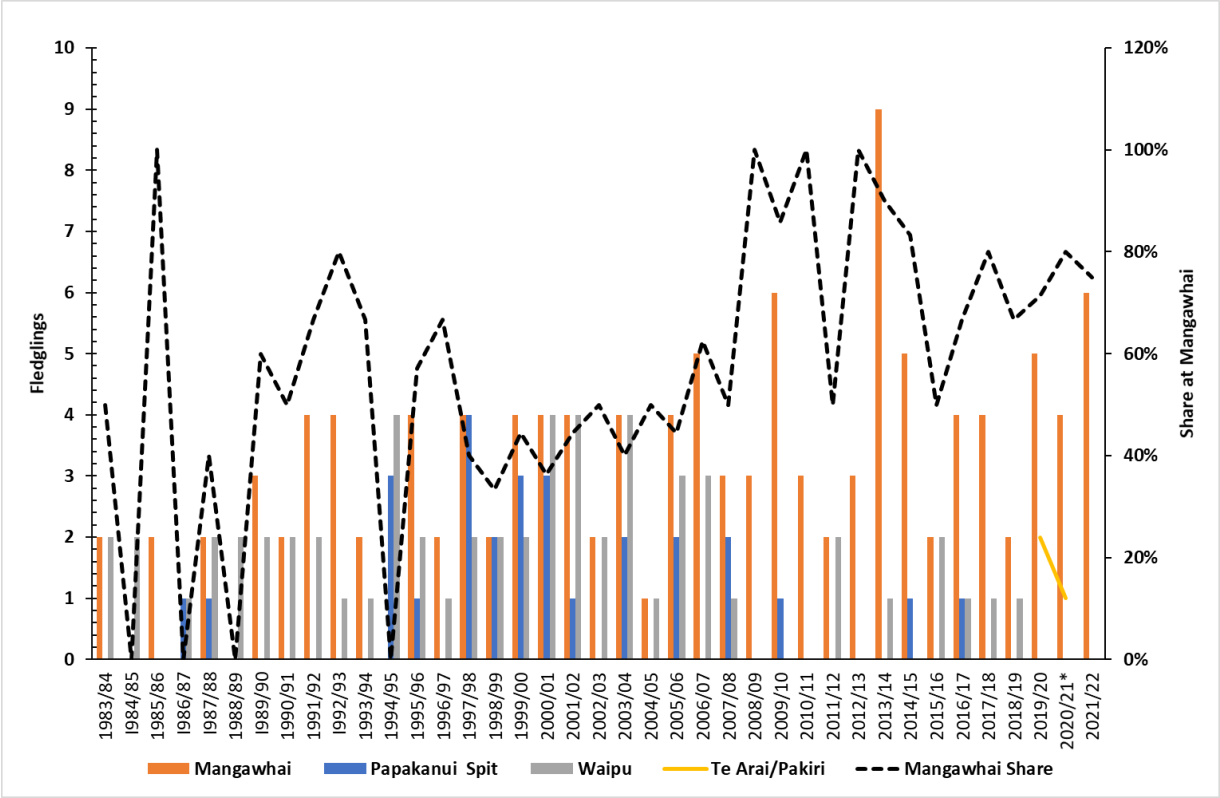
3.2 A Population Holding its Own?

The NZFTC also compiled tara iti numbers using DoC reports and its own observations. Together with those of Parrish and Pulham (1995b) and subsequent figures provided by DoC, they enable assessment of post-1984 trends (Figure 3).[16]

The numbers support the following observations:

- Fledgling numbers climbed slowly after the 1983 low, peaking at 11 in 2000, and averaging 5.5 chicks/year over 39 breeding seasons.
- Despite significant fluctuations breeding success has largely been sustained at these modest numbers.
- The fluctuations indicate an innate capacity for the small population to recover from setbacks, albeit supported by intensive intervention.
- NZFT breeding has become more dependent on Mangawhai since the 1980s with the reduction in fledglings from Waipu and Papakanui spit.

Figure 3: Total Fairy Tern Fledglings, 1984-2020

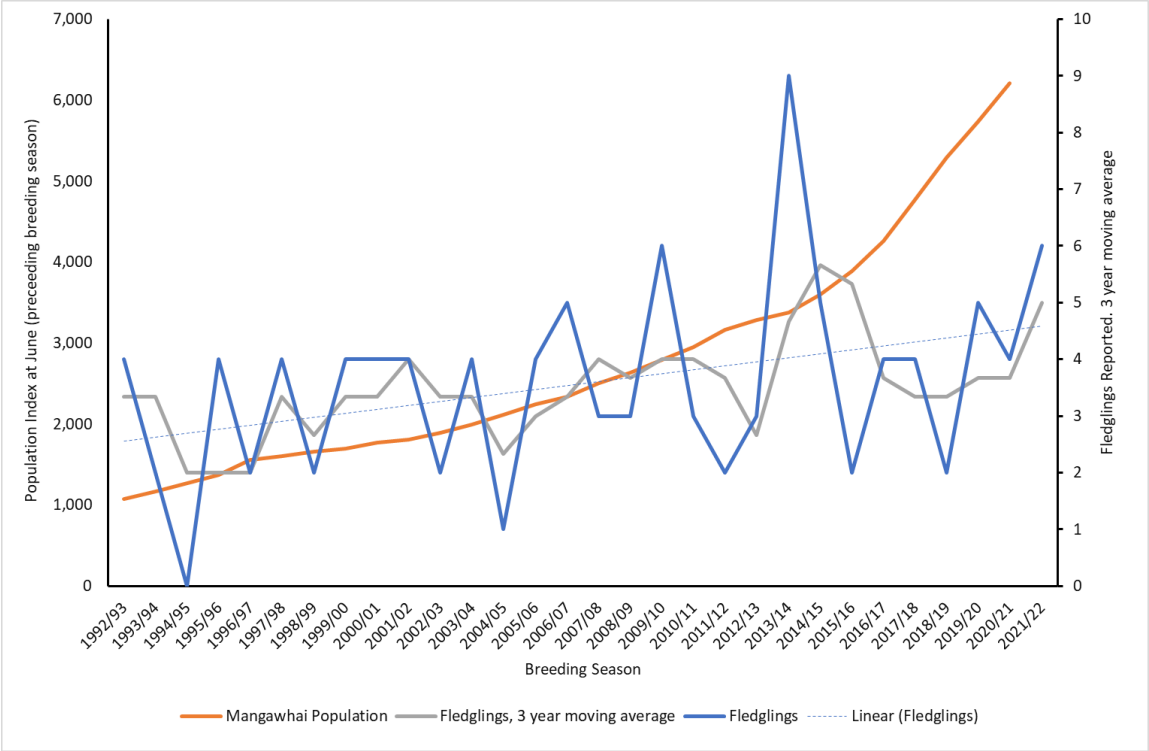


Among other things, the figures indicate a modest upward trend in fledgling numbers since the completion of the Mangawhai Harbour restoration project in the mid-1990s following the closure of the storm-induced breach in the spit. Restoration of the spit involved the formation of a bund from dredged material on the western side which has since provided nesting habitat for the fairy tern. Fencing erected for dune stabilisation has provided a degree of weather protection and subsequent dredging has provided shell beds which have proven ideal nesting sites. Restoration also created a temporary dune lake which for a time became a primary foraging area for tara iti until, with shrinkage, it transitioned into a fresh-water pond.

16 http://www.fairytern.org.nz/html/trust.htm; the figure for 2020 was accessed from DoC; the 2021 figure was sourced from a DoC media release

The growing importance of Mangawhai for tara iti from this period is confirmed by plotting fledgling numbers using a three-year moving average to dampen the impact of periodic disruptions (Figure 4). This suggests a modest upward trend despite five-fold growth in resident numbers over the 30 years for which there is population data: from around 1,070 people in the Village, the Heads, and immediate hinterland in June 1993 to 6,210 in June 2021.

Figure 4: Fledgling Numbers and Resident Population at Mangawhai Three-Year Rolling Average (1986-2019)



To this point, then, it appears that tara iti has benefited from human intervention, both by way of spit restoration and stabilisation and through intensive management of breeding sites, without yet suffering a discernible negative impact from population growth in nearby Mangawhai.

Update:

Since this report was prepared eight fledglings were reported by DoC in the 2021/22 season, six in Mangawhai. This is consistent with decades of fluctuating breeding success noted above. This may reflect a benign breeding season as La Nina's cyclonic storms passed to the east of the spit, and to the resilience of the bird.

4 THE THREATS

Tara iti remains vulnerable. While a small population has more than held its own over seventy years, limited breeding stock means it remains threatened. DoC lists five "*most likely causes of population decline*"[17]. The first four are short-term or episodic in nature:

- Weather events: High tides, floods, and storms – can destroy and wash away nests.
- Predation: Introduced predators such as rats, dogs, cats, hedgehogs, and mustelids prey upon eggs and chicks, as well as other shorebirds.
- Death of embryos: Nesting birds are eaten or chased away by predators, and the embryos are killed or die from exposure.
- Recreational activities can damage nests or eggs or scare adult birds away nests leaving chicks vulnerable to predation or starvation.
- The fifth is habitat change, considered in Section 4.3, below.

Episodic events pose an ongoing threat because tara iti breeds in a confined locality. Nests ("scrapes") may be formed where they are vulnerable to destruction by storm and high tides. They may be exposed to strong winds, excessive sunshine, and predators. Parenting failure may lead to nest desertion. Intrusion by people, dogs and vehicles can destroy nests and chicks (Baling, 2008). If breeding is delayed as a result of intrusion later attempts are unlikely to succeed (Dunlop 2015).

4.1 SHORT-TERM EVENTS

The significance of short-term events is discussed in this section drawing on DoC wardens' reports for breeding seasons from 2010/11 to 2020/21. The records are no doubt influenced by changing management practice and priorities, availability of volunteers, and changing conditions. Nevertheless, collectively they provide insights into the impact of different events.

Warden activities commence in Mangawhai in October as birds start to arrive and the first eggs may be laid. They last until late February, when fledging has been completed. They include fencing, observing, and protecting nesting sites, placing signage, predator trapping, enforcing compliance with wildlife refuge rules, nest and bird monitoring, and intervention in breeding.

4.1.1 2010-2021 Overview

The laying season is defined as the period between the first and last recorded eggs. Incubation averages 23 days. There is considerable variability in timing, length, and breeding success between seasons (Figure 5), leading to fluctuating productivity[18]. A short 2020 season yielded 7 fertile eggs and 5 fledglings to 6 pairs; the longer 2021 season apparently yielded 16 fertile eggs but just 2 fledglings to 6 pairs. The even longer 2019 season, which commenced early, yielded just four fertile eggs, and resulted in no fledglings to four pairs. [19]

There are no obvious relationships between indicators of activity and productivity (eggs and fledglings per breeding pair and fertile eggs as a share of eggs laid)[20]. Longer seasons and more breeding pairs appear do not guarantee productivity (Box 2). Hatching success plays the most

17 https://dxcprod.doc.govt.nz/nature/native-animals/birds/birds-a-z/nz-fairy-tern-tara-iti/

18 Figures incorporate the transfer of eggs into and out of the spit, and among local nests.

19 Recent announcements suggest six chicks fledged from Mangawhai in 2022.

20 This measure is complicated by egg transfer to the zoo for hatching on some occasions, and from the zoo (possibly from other sites) to existing nesting pairs on the spit on others.

significant role in fledgling production, ahead of breeding pair numbers, confirming the importance of intervening to protect, transfer, and incubate eggs.

Figure 5: The Laying Season, 2010/11-2020/21

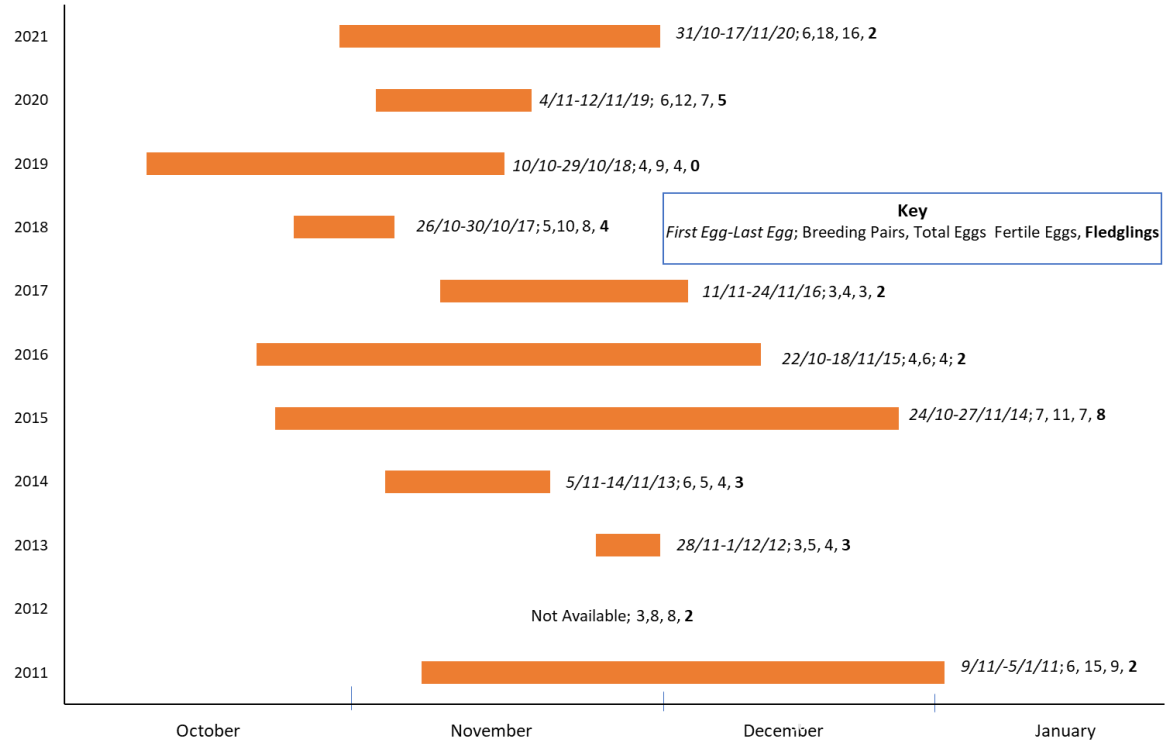
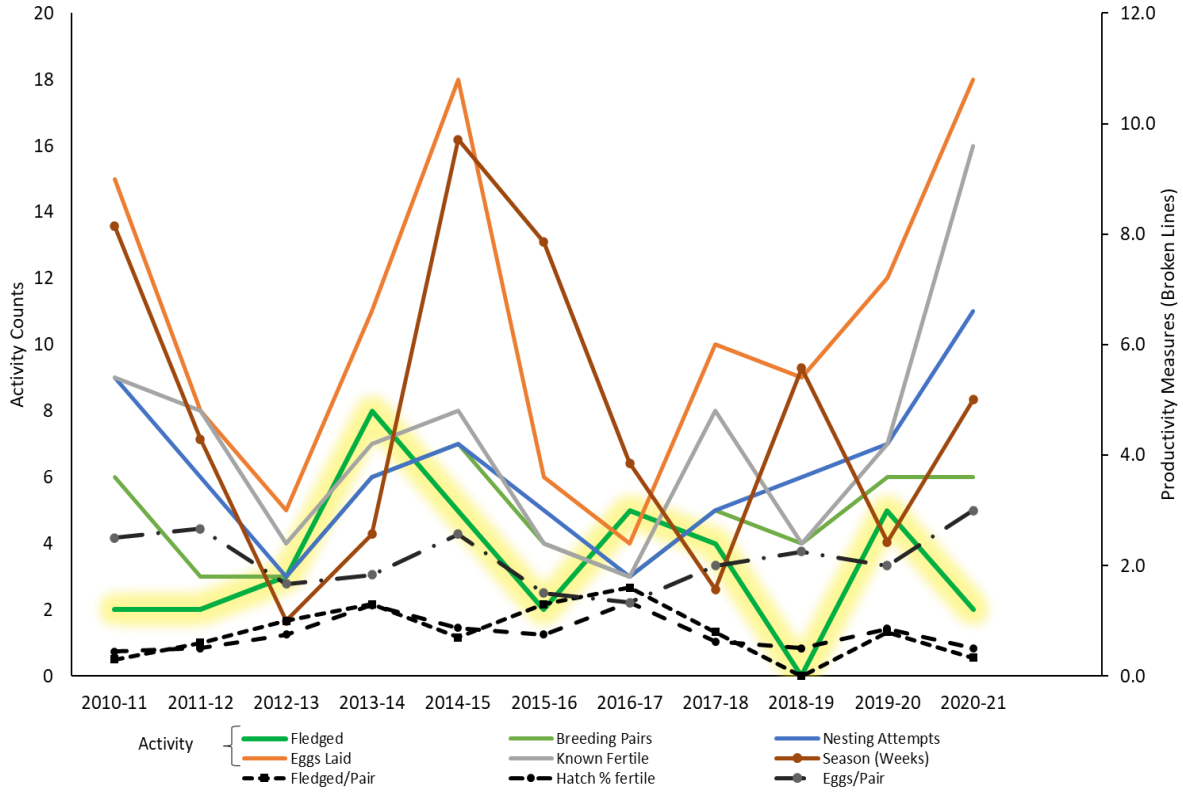


Figure 6: Tara Iti Breeding Activity, Mangawhai Spit 2011-2021



Box 2: What underlies variations in tara iti fledgling numbers?

Correlation with	Fledglings (r)
Length of Season	-0.32
Activity:	
Breeding Pairs	0.37
Nesting Attempts	-0.21
Eggs Laid	0.06
Known Fertile	-0.07
Infertile	0.60
Hatched	0.69
Productivity	
Eggs/Pair	-0.35
% Fertile Eggs	-0.11
Hatch % fertile	0.83
Fledglings/Pair	0.66

Eleven seasons of rangers' observations were analysed to search for relationships between breeding pair numbers, fertility, and fledgling production. Correlation analysis revealed no strong relationships (see panel, left); i.e., no individual measure is associated with a successful fledging season.

A weak negative relationship with length of season (r=-0.32) suggests that long seasons (and repeated nesting attempts) do not support higher numbers.

While the total eggs laid also appears irrelevant (r=0.06), counterintuitively a higher number of infertile eggs seems to align with greater breeding success (r=0.60), perhaps because it is associated with increased nest manipulation by wardens.

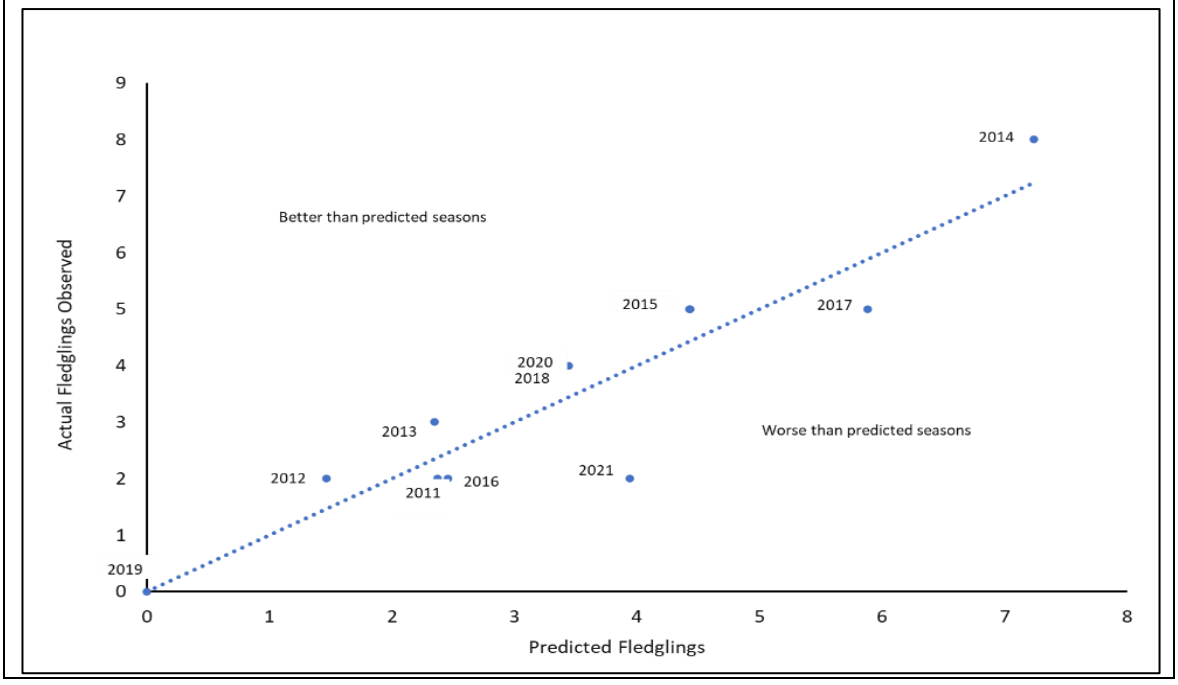
Not surprisingly, when combined through multiple linear regression breeding pair numbers and hatching success together provide a reasonable predictor of fledglings:

Number of Fledglings = -5.9 + 0.99(Breeding Pairs) + 8.8(Hatching Success Ratio)

This equation accounts for much of variation the in seasonal fledgling numbers (r^2=0.82).

While based on only eleven seasons it confirms the joint role of successful incubation (and, by inference, a reduced influence of infertile males) along with sufficient numbers of pairs to offset an underlying negative tendency (given an intercept coefficient of -5.9). This unsurprising conclusion is helpful insofar as it confirms the role that intervention by DoC and volunteers plays in building on hatching success, a role critical to the short-term survival of the flock.

Applying the equation to annual figures lets us compare predicted success with the outcome in each season. By accounting for variations in breeding pair numbers and incubation success the enables us to identify differences in seasonal fledging performance attributable to external factors. In these terms, 2014 stands out as the best performing season and 2021 as the worst.



4.1.1 Weather Events

Craig's (2009) observation that "*the greatest known loss of fairy terns results from weather events*" is borne out by the wardens' records. The impact of adverse weather events is amplified by the vulnerability of shallow nests on unstable dunes close to sea level. This is likely to be even more critical in a period of increasing climatic volatility.

For example, in November 2015 westerly gales led to nests being abandoned while in December a prolonged easterly storm led to the death of three chicks (Zimmerman 2016, 5). This impact is reflected in the "worse than expected" fledgling production in 2015/16 (Box 2).

In contrast, the more favourable weather in the 2013/14 season was seen "*as conducive to breeding success*" (Zimmerman, 2014, 5), leading to a better-than-predicted-season (Box 2). The worst performing season (2021) was "*heavily impacted by three low pressure systems in November, which resulted in six nests being abandoned by nesting pairs*". This, in turn, saw 12 eggs being transferred to Auckland Zoo for incubation. Although several hatched, none survived the return to the spit (Ball, et al, 2021, 1).

The inference is that weather is a major external driver of fledging success. Poor fishing and feeding have also been put down to weather events, with the suggestion that "*fine silt from wind and water action … made fishing difficult*", confining "*decent*" harbour fishing to one hour before and after low tide (Drew, 2019, 3). In addition, the impact of rain events on the intermittent dune lake is considered significant, with its expansion in a wet season flagged as a threat to proximate nesting sites in 2011 (Zimmerman, 2010).

Wardens can take various protective measures to mitigate the impact of weather events. Shelters can be erected for chicks in hot dry periods. With warning of storms or very high tides nests can be sandbagged or moved and eggs can be removed. However, the prospect with climate change of higher sea and air temperatures, and more frequent extreme storm events suggests that weather volatility will remain the major short-term threat to tara iti's survival.

4.1.2 Predation

Mustelids, rats, and hedgehogs are a particular threat to ground-nesting birds. Domestic pets are a problem when nesting is close to settlement.[21] Cat predation was noted in 2013 (two eggs lost) and 2014. Black-backed gulls and harriers also as a problem. While male tara iti attack predators, this leaves chicks unattended and vulnerable to predation by other species.

Cats also accounted for the deaths of "*a number of adult females*" at Waipu between 2008 and 2011 (Beauchamp, 2020, para 3.3.a). Six eggs and two chicks were thought to be taken by cats and one by a variable oystercatcher in 2010, and four by cats the following year.

Dogs are considered a threat, either from a direct attack, or because they chase adults, leaving the chicks vulnerable. However, only one dog encounter was recorded in the wardens' reports (in 2017/18), the owner removing it when informed that dogs are prohibited on the spit.

Predation by shore birds appears to be a bigger a problem. Red billed gulls were thought to have destroyed an egg and chick in 2017, for example. Wardens discourage black-backed gulls and destroy their eggs: eggs from around 30 nests were pricked in 2018 (p.11).

Trapping in 2019/20 was dominated by harrier hawks (25) and rats (6). Dogs were reported as "*a regular nuisance to birds attempting to feed on the far side of the estuary*". With no reports that this has influenced mortality, the wardens have not committed much time to the area.

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[21] Suburban domestic cats with outdoor access may range around 150m from home, free-ranging suburban cats up to 360m; and free-ranging rural cats as far as 1.3km: D Robertson (https://docs.google.com/document/d/1x06uP7fEurVLCo7wqmycoGl0JIk0j1cGhAnPvnlINjA/edit?hl=en&authkey=CI2Gv7YN)

Aggressive behaviour by the terns themselves appears to have played a part in the poor performance in the 2021 season. Crowding of nests and the presence of infertile males can lead to pecking attacks on chicks and necessitates defensive behaviour by parenting pairs.

From their reports, it appears that the activities of wardens and volunteers have contained the threats to survival associated with predation. The main defensive measure wardens take is trapping and destroying predators, with trapping lines and catches reported each year. They also move nests or pairs when over-crowding leads to intra-species aggression. Ultimately, some culling of infertile males may be called for, a practice which would have the benefit of strengthening the genetic base. Additional nesting sites may be established through early season shell seeding and movement of birds and nests.

4.1.3 Human Activity

"Predation by cats, ferrets, and stoats during the breeding season has worsened their population outlook, and although many of the sites have pest control, it's people that remain their biggest threat" (Forest & Bird Society).[22] The presence of wardens along with intensification of trapping programmes suggests supported by the Shorebirds Trust (see Attachment 1) do not the suggestion that predation has led to an deterioration in short-term prospects. In addition, the threat that people may pose does not appear to have materialised.

The presence of people (and their dogs) may lead adult birds to abandon nests, increasing the prospect of predation by species such as black backed gulls. However, reports of disturbance by people are few and far between. They possible egg removal in 2010 by a member of the public at Mangawhai in 2010, and nest damage and loss of an egg at Waipu in 2011.

The people who wardens approach are said to be cooperative and move away without hassle. Regular patrols at points of entry as well as on the spit and clear signage are considered effective preventive measures (Zimmerman, 2016, p24). Later reports suggest compliance is improving, and dog numbers appear to be down. More general intrusion is held to arise from vehicles on the spit, particularly bikes. Yet, again, few such incidents were actually recorded.

Kite surfing at low tide is seen as potentially intrusive. In 2012 three kite surfers were reported in the vicinity of a nest. Consequently, the males returning with fish for the chicks did not make their usual advance calls (Zimmerman, 2013, p.5). This suggests a behavioural response to the presence of people that enables feeding to continue. Subsequent observations also suggested that kite surfers on the harbour do not disturb the birds (Drew, 2018, 11).

The evidence since 2011 indicates that the proximity of people has not been a problem or, at least, has been well managed by wardens. Indeed, tara iti demonstrates a capacity to adapt to people. The activities of DoC staff may themselves provide the strongest evidence of this. They include close observation and handling of nests, eggs, and fledglings. Over the eleven years, 13 eggs were transferred out for incubation at Auckland Zoo and 14 transferred in from the zoo, or elsewhere. Eggs may also be transferred between nests. While improving the survival prospects of tara iti, such interventions rely fundamentally on the bird's capacity to habituate.

4.2 ADAPTATION

Tara iti has also adapted to major changes in the physical environment. In the recent past, this is demonstrated by variations in foraging territories. For example, NZFTCT (2020) published maps of 2008/09, 2009/10 and 2017/18 territories. The earlier maps identified five foraging areas, the 2017/18 map nine (Figure 7:). Based on interpolated boundaries the average foraging area halved (Table 1). Ball et al. (2021, 47) identified nine territories in 2020, with shifts in the estimated boundaries suggesting increasingly intensive use of the upper harbour.

[22] https://www.forestandbird.org.nz/projects/new-zealand-fairy-tern-tara-iti-project

Figure 7: Foraging Territories 2010 and 2018

The boundaries shown are extrapolated from dives recorded by observers. While they suggest significant changes in the intensity of harbour use, and by inference average territory size (Table 1), they do not necessarily indicate the limits to the territories that the harbour might sustain, especially when the variability in territory size is considered. [23]

Table 1: Changing Fairy Tern Territorial Foraging Areas

2009/10		2017/18	
Id.	Ha	Id.	Ha.
1	31	1	43
2	83	2A	48
		2B	15
3	103	3A	48
		3B	55
4	138	4A	59
		4B	49
5	82	5A	38
		5B	33
Area (ha)	437		388
Average ha	87		43

Source: Figure 7

[23] Diving was also seen in the estuary northwest of the Molesworth Bridge in 2021/22 (part of Territory 4 in 2010), suggesting an additional or extended territory there.

Further evidence of adaptation is Preddy and Pulhams' (2017) observation of post-breeding foraging around Te Arai (Figure 2:) and a further 2.5km further south in Spectacle Lake. Observation at Te Arai recorded limited foraging success in the stream but considerable land-based feeding, suggesting that oceanic foraging may occur between the nesting sites on the spit and the roosting site by the stream (Jeffries et al., 2020). Expanding the foraging range is consistent with both population pressure and changing harbour conditions (Harris et al., 2019).

Evidence that tara iti has habituated successfully is consistent with shorebirds generally (Box 3). While an uncontrolled human presence can be damaging, evidence of effective intervention strategies suggests that the main threats to tara iti's long-term survival lie elsewhere.

Box 3: Examples of Shorebird Habituation

Based on a review of studies of nesting sites, Nisbet (2000) strongly criticised the view that disturbance of shorebirds was necessarily adverse: "*little scientifically acceptable evidence that human disturbance causes substantial harm to terns … gulls …, or herons*" (312).

In a study of knot and plover feeding sites Lilleyman et al. (2016) fecundity tended to be higher at more disturbed sites, although more than ten alarm flights a day could affect reproductive capacity.

Baudain et al. (2007) recorded that plover at more disturbed nesting sites showed better nest attentiveness than those at less disturbed sites. Mortality from predators was also lower at sites experiencing more recreational activity, although dogs remained a risk.

Observation of oystercatchers in England by West et al. (2002) indicated that numerous small disturbances to feeding may be more damaging than a few large ones. Disturbance in late winter was most damaging, although did not necessarily increase mortality.

Trulio et al. (2014) showed minimal differences in species richness, bird numbers, or foraging behaviour between nests close to trails and non-trail sites. While still recommending minimum distances between trails and nests, they concluded that "*local or landscape-level factors, such as habitat quality or predation risk, seemed to be greater factors in bird presence and foraging than trail use*" (Gill et al. 2001a; Yasue 2005, 2006).

There is considerable evidence of adaptation to people among Australian shorebirds (Glover et al. 2011), although buffer distances vary by species and human activity. Meta-analysis by Showler et al. (2010) of the impact of disturbance on ground nesting birds found that quantitative analyses were ambiguous. While observational evidence in qualitative studies suggests that human activity can be detrimental to breeding success, they noted exceptions including penguins and two species of tern (p.4).

The studies all confirm that shorebirds habituate to a human presence (to varying degrees). The literature also provides pointers for managing disturbance by actively engaging the public through education about inappropriate activities, provision of interpretation sites, and by creating defined trails and viewing areas at appropriate distances, letting people visually access areas where nesting is taking place. In Mangawhai, such provisions could raise the level of awareness and support for protection among members of the community.

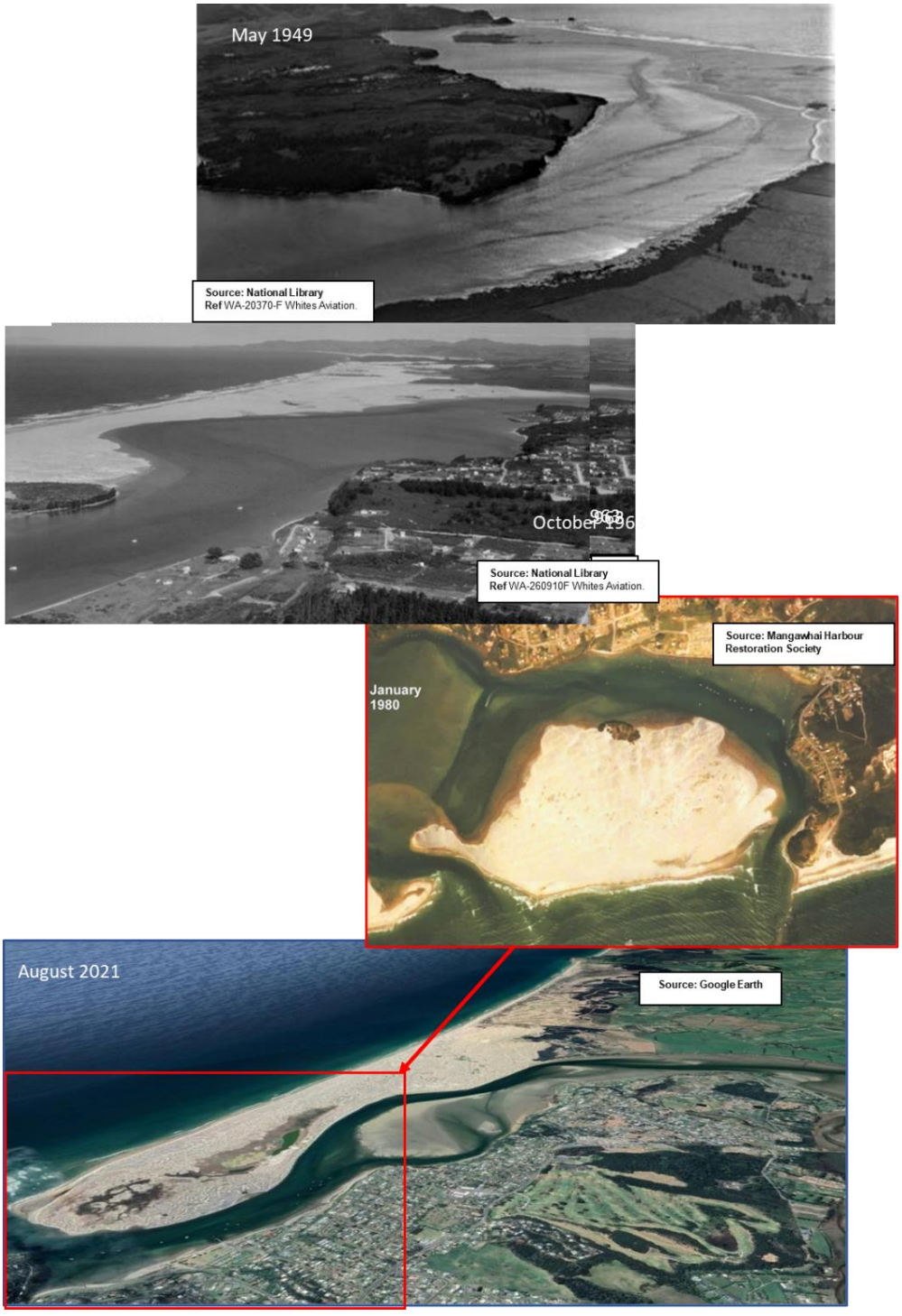
4.3 LONG TERM THREATS

Given a capacity to recover from episodic events, the main threats to tara iti will be from long-term changes in the nesting habitat and the structure of the bird population itself.

4.3.1 A Dynamic Nesting Environment

Aerial photos indicate a narrow spit in 1949, larger at the southern base in 1963 (Figure 8). However, a series of subtropical depressions in the 1970s led to a break-through channel forming a kilometre south of the harbour mouth.

Figure 8: A Dynamic Dune Environment



Restoration of the spit (commencing with excavation and reinstatement of the original channel in 1991) returned it to close to its earlier form. The incursion left a dune lake which fluctuates by season and with short-term rainfall events. A substantial and expanding vegetated wetland persists around the lake today, covering as much as 20ha of the 245ha spit.

Restoration increased the area available for nesting, supporting the growth in fairy tern numbers observed since the 1990s, sustained by placement of dredged sand and shell in areas providing a sheltered nesting environment (supplemented in 2020 by helicopter drops of shell in selected locations).

Changes to spit morphology will continue to play a part in how many birds can breed on it. An immediate issue may be an increase in invasive vegetation, as evident around the dune lake (saltwater paspalum) and golden wattle further south (Dahm and Bergin, 2016). This reduces open nesting options and increases predator cover. Longer-term, sea level rise and storm events may be more than just a seasonal threat to ill-placed nests, potentially again eroding the capacity of the spit to host breeding pairs.

4.3.2 Mangrove Colonisation and Loss of Harbour Area

The physical threat to the carrying capacity of the coastal environment is not confined to the spit. Fairy tern forage in sheltered harbour waters when courting, if sea conditions are unsuitable for foraging, and when training fledglings. This is based on:

"*water edges, shallow channels, and pools of tidal flats of mangrove lined ... parts of the estuary; tidal pools on mud- and sandflats in the lower estuary and lower harbour; the shallow margins of the dredged main channel in the lower harbour; the oxbow lagoons on the sand spit; and coastal shallows*" (Ismar et al., 2014, 72)

Apart from spit modification, the most obvious change to Mangawhai Harbour is the impact of sedimentation on mangrove proliferation. The extensive area of channels and open water west of Insley St causeway in 1955 has since been covered by mangroves (Figure 9). This is also evident in Back Bay and the Tara inlet (Figure 10:). Mangrove removal east of the Insley Causeway and Back Bay since 2015 has restored a modest area. However, comparison of the 2010 and 2021 photos suggests that the channels in the upper harbour, west of the road crossings, continue to shrink as mangroves continue to accumulate sediment.

It was claimed that fairy tern has a "*low-moderate degree of dependency on this type of habitat*" (Bell and Blayney, 2017, 7) based on foraging in mangrove-lined estuaries. However, Beauchamp (2012) excluded them from the "*three* [shorebird] *species using the mangrove zone*", including the pneumatophores (paragraph 34), despite the Bell and Blayney claim that "*NZFT forage within the pneumatophores of fringing habitat*". They cite Ismar et al. (2014) as the authority, although that paper referred only to prey fish sheltering in that zone (p.82).

Furthermore, mapped fishing dives show feeding concentrated in and around main channels (Ismar et al., 2014, Figure 2; Southey, 2020, Figure 5), clear of mangrove areas and fringes which, in any case, are not water covered during the fishing period, either side of low tide.

The claim that temperate mangroves are an important food source is doubtful given their low productivity, with fish species found within them primarily mullet and eels. A South Australian showed that *"mangrove habitats in temperate Australia support no greater abundance or diversity of fish than adjacent mudflat habitats and that mangrove proximity does not influence fish distribution at a habitat scale"* (Payne and Gillanders, 2009, 1).

The impact of mangrove expansion in New Zealand is contentious, and managing them challenging (Lundqvist et al, 2014). They capture and store eroded sediment (Blackett, et al., 2010), with the volumes they detain regulated by tidal movement, with risk of mass sediment release in the event of severe storm or rain events and king tides.

Figure 9: Expansion of Mangroves, Insley Arm, 1955-2021

Figure 10: Expansion of Mangroves Back Bay, Tara Inlet, 1950-2021

Despite these effects, mangroves are claimed to play:

an important part in the ecosystems of our harbours - sheltering young fish, stabilising land and forming a buffer zone to absorb floodwaters.[24]

Such assertions[25] appear to rely on transferring the findings of studies based on diverse tropical and subtropical mangrove forests to New Zealand's temperate monoculture. This uncritical transfer can be traced to Chapman (1983), despite Taylor, in the same collection, observing the paucity of fauna in mangroves in Whangateau Harbour.

Taylor's 1983 study is not the only one to disprove the productivity claims for New Zealand mangroves (see Box 3), claims nevertheless promoted through a chain of self-reinforcing but

24 Mangroves - Northland Regional Council (nrc.govt.nz)

25 For example, Mead and Morse (2003, 3), cite Potter (2001). Neither provide evidence.

misleading references since then.[26] Sheaves et al. (2020) demonstrate how such chains also underlie "*poorly validated science*", overclaiming the benefits of mangroves generally.

The photographic record confirms that Mangawhai was virtually mangrove free in the 1950s, when the introduction of aerial topdressing commenced. This saw more intensive hill country grazing boosting the sediment and nutrient load in run-off (Brooking and Wood, 2013). De Lange and de Lange (2007) highlight the primary role of sedimentation in mangrove expansion. The timeline of colonisation of the Mangawhai Harbour and estuaries (and, indeed, coastal water bodies throughout Northland) is consistent with land use intensification since the 1950s, covering sand with fine silts, raising the bed, accelerating accretion (Stokes, Healey, and Cooke, 2010), reducing open water surface, and most likely lowering estuary productivity (see Box 4).

Measurements of mangrove cover in 2010 using Google Earth suggests that the area of open water in the harbour had been reduced by around 25% (Table 2)[27], mostly in the upper reaches. Even allowing for over-measurement and subsequent removal, it appears that at least 20% of the pre-1960s intertidal area available for foraging has been lost to mangroves.

Table 2: Estimated Mangrove Cover, Mangawhai Harbour, 2010

	Estimated Area	Allow for Channels	Net Area
Harbour Tributaries			
West Insley Causeway	71	25%	53
West Molesworth Drive Bridge	71	25%	54
Black Swamp Rd inlet	3	20%	2
Subtotal	145	70%	109
Other			
Back Bay	36	20%	29
Pearson St Reserve/Sand Island [1]	12	20%	10
Southeast of Insley St Bridge	4	20%	3
Northeast Insley St Bridge [1]	7	25%	5
Lincoln St [1]	1	20%	1
Subtotal	60		47
Total Area of Mangroves	205		156
Mangrove Share [2]	**Total**	**Mangroves**	**Share**
Tributaries	145	103	71%
Mid and Lower Harbour	441	45	10%
Total	586	149	25%

Notes: 1 Area of subsequent mangrove removal (c16ha total)

Reduced by 5% to allow for measurement error

With the increase in area for foraging since mangrove removal in 2015, fairy tern numbers have been maintained if not increased (Figures 5 and 6, above). Territory numbers increased and their average size diminished, which aligns with Alfaro's evidence (2009) of a healthier benthic floor raising the capacity to support the fish population with mangrove removal.

There is no doubt that mangrove proliferation has reduced water area in Mangawhai Harbour, reducing feeding opportunities for both wading and foraging shorebirds. While mangroves may provide shelter for prey fish on the fringes, that possibility needs to be balanced by the long-term threat posed to tara iti (and the harbour ecosystem generally) by reduced water surface, displacement of more diverse ecosystems, and a reduction in the productivity of the harbour.

26 Much of the "evidence" comprises statements in unrefereed reports and pamphlets which seek credibility through cross-referencing rather than empirical evidence.

27 The measured area was reduced by 20% for the calculation to allow for minor prior stands and the difficulty of identifying for minor channels within the mangrove cover..

Box 4: The Productivity of Temperate Mangroves

Rapid mangrove expansion is a distinctive New Zealand problem (Schwarz, 2003) based on sediment accumulation from catchment development (Nicholls and Ellis, 2002, Morrisey et al., 2007). The productivity of local mangroves is limited by the sediment underlying them which derives from the shift to cultivated and urbanised land use (Lovelock et. al., 2007). Booth (2020) saw sediment-induced mangrove expansion in Northland as accompanying "*loss of saltmarsh, uppershore coarse-shell beaches/cheniers, and (probably) intertidal seagrass*".

The fact that mangroves in New Zealand are different from the ecologically diverse tropical and subtropical species was raised by A and R La Bonté (2004), who pointed out that there were no mangroves in Mangawhai Harbour 60 years earlier. Morrisey et al (Table 2, 2010) confirm that mangrove diversity and productivity decline with increasing latitude, with New Zealand's single species (*avicennia marina*) ecosystem being almost unique, even among temperate sites.

It is smaller than tropical and subtropical species, up to 9m in the Far North and down to half a metre at Ohiwa Harbour. This southern limit surveyed by Kuchler (1972) has altered little since, primarily because of lack of suitable estuary environments (de Lange and de Lange, 1994).

Woodroffe (1985) demonstrated the significantly lower biomass of Auckland's mangroves compared with subtropical and tropical species. Gladstone-Gallagher et al. (2014) found their *"detritus in temperate estuaries plays a minor role in shaping the communities on intertidal flats. … the slow decay (low bioavailability) and relatively low productivity of temperate mangroves result in communities…less reliant on mangrove detritus, compared to those in the tropics where rapidly decaying mangrove detritus comprises the base of many food webs".*

This is confirmed by Taylor (1983) and two other Northland studies. Matapouri mangroves were shown to be less diverse with a lower density of benthic organisms than tropical and subtropical mangroves, lower also than proximate non-mangrove habitats in the same estuary (Alfaro 2006). At Mangawhai "*mature mangrove habitats had less total abundance and fewer taxa than all the other habitats sampled*". Significantly, mangrove "*eradication was followed by immediate changes in the sediment from a muddy to sandier environment, which favoured an overall increase in the abundance of crabs, snails, and bivalves*" (Alfaro, 2009). This is visible today in the contrast between cleared and uncleared areas and reflected in increased diversity of wading and foraging shorebird species in cleared areas (Bioresearches, 2018).

In addition, studies in Australia indicate that temperate mangroves are no more important to fish life than other estuarine habitats (Hindel & Perkins, 2005, Payne & Gilanders,2009). This was confirmed for New Zealand by a comprehensive review which concluded that:

"*It has often been stated that New Zealand mangroves are important as spawning grounds for numerous fish species, but this seems highly unlikely"* and that while *"two species of commercial importance (short-finned eels and grey mullet) are likely to have some partial dependence on mangrove habitats for the production of juveniles, their relative contribution will be difficult to separate from that of other associated estuarine habitats, such as seagrass meadows, tidal banks and subtidal basins*" (Morrissey et al., 2007 p78). [28]

28 Overclaiming mangrove productivity is not confined to New Zealand. Sheaves (2017) argued that the oft-cited "*rule*" that "*'75% of commercial fish depend directly on mangroves' is wildly inaccurate, unsubstantiated and, at least given our current knowledge and methods, impossible to substantiate. Mangroves are critical to many species but using an indefensible pseudoscientific paradigm such as this to support conservation efforts, management actions and legal decisions, greatly weakens any arguments that build upon it, putting at risk outcomes that rely on the integrity of the claim*." The same rebuke might be made of current advocacy for protecting mangrove wetlands in New Zealand.

This threat will increase if poor rural and urban land use practices in the catchment continue to release substantial sediment, lifting the potential for significant short-term turbidity and silting with the intensive storm events associated with climate change. Conversely, continuing mangrove containment, if not reduction, along with enhanced catchment management, can be expected to increase harbour productivity and biodiversity, although what evidence is available suggests that full recovery will be take some time.

4.3.3 Climate Change

The current consensus is that climate change in Northland will see higher summer temperatures, more frequent hot days, higher prevailing westerly winds, lower rainfall but more intensive rainfall and storm events, increasing sea temperatures and acidification, and sea level rise (Pearce et al., 2016). Changes in air and water temperatures and circulation will increase climatic instability. While all the impacts on tara iti cannot be known, one risk to a bird that nests in exposed dunes is fledgling dehydration from prolonged periods of intensive sunshine. Nest destruction and burial by storm-borne sand movement may be another.

Climate change will also impact directly on flora and fauna with possible outcomes being a reduction in prey species, increased competition for food, more predation, and continuing intrusion of invasive vegetation on or close to preferred nesting sites.

Harbour foraging conditions will deteriorate as a result of continuing mangrove colonisation as water warms. Intensive storms may increase sediment accumulation and subsequent heavy and damaging release over sandy flats, boosting turbidity, and lowering the productivity of the harbour generally. Climatic instability also raises the prospects of more variable salinity with increased flushing from high rainfall events and changes in the availability and distribution of prey and competitor species. The most fundamental threat, though, may be rising sea levels, frequent inundation, and erosion of the spit once more, leading to loss of nesting habitat.

4.3.4 Settlement

Increasing settlement is cited as a cause of disturbance and displacement that may lead to loss of birds. So far there is no evidence for this. Some 1,000 people lived in and around Mangawhai in 1992[29], increasing to over 6,000 by 2020 with no decline in tara iti numbers.

Alongside growth in the resident population, there have been large gains in holiday makers, with the peak coinciding with the NZFT breeding season. In the 2018 Census, the number of unoccupied houses was 40% higher than in 2006. These mainly holiday homes accounted for 42% of Mangawhai's dwellings. Their typically high holiday occupation levels could easily double the residential population in mid-summer. There is also a large Visitor to Friends and Relatives (VFR) component associated with permanent dwellings.

Many more people stay in three harbour-edge camping grounds. A 63% increase in visitors from 2012 to 2020 is reported by the Heads Park. Riverside Holiday Park reports 75% growth in three years. The three parks receive perhaps 25,000 annual guests in total. This means Mangawhai's mid-summer population – at the height of the breeding season – could exceed 12,000 people, reflecting the amenity value placed on the coastal environment (Figure 11).[30]

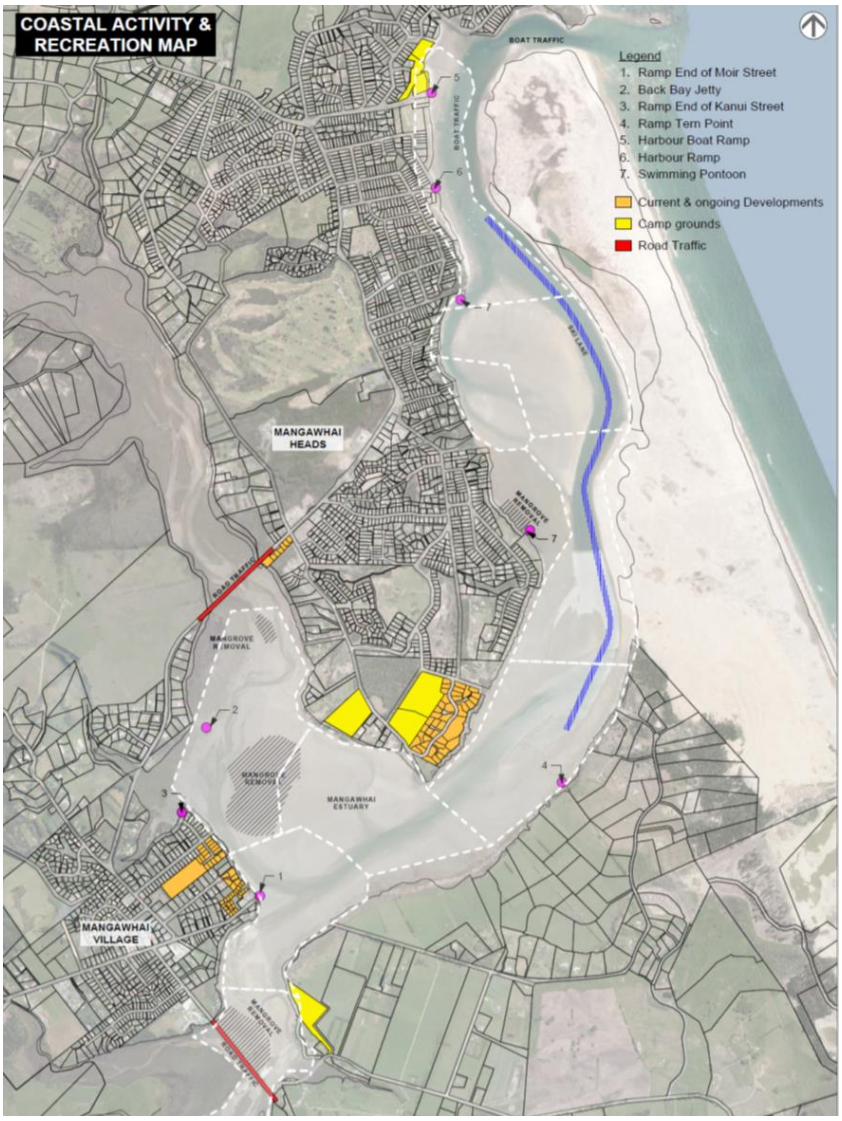
Recreational activity is less intensive in the shallow upper harbour. However, foraging territories there abut residential areas and increasingly busy roads. For example, between 2005

29 Based on Census Area Unit estimates

30 A recent survey of residents' and visitors' values and priorities concluded that: "*the significance of the coastal environment is overwhelming, related to its accessibility for and use by permanent residents, bach occupants, and visitors*" (www.mangawhaimatters.com)

and 2019 Average Daily Traffic Counts on Insley St Causeway increased by 170% (to 4,850 ADT). Traffic on Molesworth Bridge increased by 225% over the same period (to 8,170 ADT)[31].

Figure 11: Recreation Activity, Mangawhai Harbour



There is concern about the possible impact of more people on harbour foraging and tara iti survival prospects (e.g., Beauchamp, 2020; NZFTCT, 2020). To date there is no evidence that even the most intensively used parts of middle and lower harbour, where the boat ramps, ski lane, and most popular swimming areas lie, have prejudiced foraging territories (Figure 2:), or that the rapid growth of recreation on the harbour has had a negative impact on bird numbers.

Despite a substantial increase in human activity, territories have increased in number and reduced in size.[32] When set against the small number of nest disturbances recorded in recent years and egg, fledging, and bird numbers, there is no evidence that the increasing presence of people has adversely impacted on tara iti survival prospects.

That does not mean that there may not be a growth threshold beyond which the bird is adversely affected. The Mangawhai Spatial Plan (Kaipara District Council, 2020) anticipates

31 Source, Kaipara District Council. The comparisons were between counts in March 2003 and estimates in July 2019 so are approximate only. Seasonally aligned gains (e.g., March to March) are likely to be higher.

32 In addition, the remnant dune lake on the spit, considered a major foraging territory, was lost when it desalinated: it is now a freshwater body.

resident numbers more than doubling to around 12,000 within twelve years. Summer visitor numbers will also continue to grow. As numbers grow, more active management of the interface between birds, people and their pets may be called for. To date, though, there are no grounds to suggest that people's presence in the harbour environment is a major threat.

4.3.5 Fairy Tern Fertility and Breeding Behaviour

Tara iti's limited genetic diversity appears a greater threat. Losses documented in various DoC releases reflect the influence of infertile males in the population, infertile eggs and eggs failing to hatch, nest abandonment by one or both adult birds, female infidelity[33], and interference with nesting pairs by a third adult bird. Over the last eleven years at least one third of eggs laid were in fact infertile, 56% (or 10 out of 18) in 2015.

While behavioural shortcomings can be offset by intervention, infertility is an entrenched characteristic of the flock. In 2005 DoC reported some demographic parameters. These are compared with averages estimated from wardens' reports in Table 3.

Table 3: The Fairy Tern Population at Mangawhai - Changing Demographics

Parameter	2005	Ave 2013-20
Proportion of population attempting to breed	63%	**37%**
Proportion of eggs hatching:	38%	**69%**
Chick survival to fledgling:	63%	**66%**
Fledgling recruitment into breeding population	33%	NA
Adult survival:	95%	NA
Average lifespan:	6 years	NA

The earlier figures point to weaknesses in hatching levels and fledgling recruitment into the breeding population. The later figures suggest improved hatching and fledgling outcomes, but a falling share of the population breeding. The first two results are consistent with increasing management on the spit. The lower share of the flock breeding over the later period is a major concern, pointing to a potentially growing population deficiency:

> "*The population could be suffering from inbreeding depression and this may be the cause of the high levels of egg infertility, justifying the breeding site separation and egg or chick manipulation between sites*." (DoC, 2005, p17)

In 2018 the Department of Conservation and University of Canterbury committed to a three-year research programme into NZFT genetics funded by the Mangawhai Shorebirds Trust. Scheduled for completion in March 2021 it aimed to:

- Determine causes and patterns of loss of fertile eggs during the incubation stage;
- Recommend measures to maximize productivity from genetically robust pairs;
- Collect blood samples and undertake genomic analysis;
- Establish pedigrees for breeding pairs to aid decisions about pair management;
- Reassess the classification status of tara iti.

The resulting insights should enhance interventions intended to lift flock fertility, perhaps the most critical parameter in the survival of tara iti.

33 Nordwijk (2002) indicates that this is influenced by how close the birds comprising the original pair are.

5 SAVING THE FAIRY TERN

The persistence of a small population in the face of a dynamic and turbulent physical environment, predation, and increasing human activity can be put down to intervention by DoC and volunteers in the nesting season and to the ability of tara iti to habituate, adapting to the presence of people, their activities, and interventions.

There have been two plans prepared to inform DoC's recovery programme (Parris and Honnor, 1997; Hansen, 2006), and more recently the formation of an inter-agency Fairy Tern Recovery Group to align the interests of various parties in promoting the long-term survival of tara iti. The second plan (Hansen 2005) cited an unpublished report (Taylor et al., 2004) suggesting that the population would only be viable with around 250 birds.

As a volatile, if resilient, population, tara iti appears most at risk from long term shifts compounding the reproduction problems that can become entrenched in a small population (Assersohn et al. 2021). This section sets out three areas (habitat protection, trans-location, and genetic management) that may jointly maximise the prospects for the survival of tara iti.

5.1 PROTECTING HABITAT

Protecting the breeding habitat is a necessary but not sufficient condition for long-term survival. This has been achieved on the spit, where tara iti breeds and where intensive management will no doubt need to be sustained.

Advocates for tara iti have also argued that it is vulnerable to the impacts of people using Mangawhai Harbour. Their focus has been on the potential for disruption of foraging by human presence and reduction of prey fish as a result of mangrove removal. In both cases, however, it can be argued that the advocacy has advanced ahead of the evidence, especially in the light of the demonstrated capacity of tara iti to adapt to the growing presence of people and the gains in productivity and foraging capacity associated with mangrove removal.

5.1.1 Catchment Management

The wider issue that needs addressing in a scientifically informed manner is the health and productivity of the harbour, which is heavily influenced by what flows into it by way of sediment, nutrients, and contaminants. This is a matter of land use management as much as management of the immediate harbour environment. The quality, quantity, and impact of run-off from farmland and settlement (Box 4) is the key to a healthy harbour, and the question is how stormwater and wastewater entering the harbour will influence estuarine ecosystems.

The history of mangrove expansion in Mangawhai aligns with the increasingly intensive use of catchments since the 1950s and a degree of insensitivity, until relatively recently, over the impact of increased production and settlement on estuarine waters. While mangrove reduction should play a role in restoring the productivity of the harbour, and increase the capacity of fairy tern territories, the immediate need is to stem damaging deposition that leads to mangrove proliferation, lowers water quality, smothers sandy flats, and reduces water surface. This will require addressing the conflicting perceptions and motivations of preservationist interests and community groups (Dencer-Brown, 2019, 168)

A long-term commitment to comprehensive catchment management is needed to moderate or, ideally, reverse the impact of land use intensification on runoff and water quality. In farmed environments this means protecting riparian margins, avoiding over-stocking, sensitive fertiliser application, and wetland restoration. In forested and hill country areas it calls for more intensive management of plantation forests and restoring forest biodiversity on steeper slopes. In areas of settlement, it includes adopting "better than best practice" stormwater management and wastewater collection, treatment, and dispersal.

5.1.2 Harbour Access

Increasing use of the harbour is inevitable. It is important then, to promote responsible vessel use, esplanade management, and recreation demands generally. To date, there is no evidence of a threshold at which a growing human presence is incompatible with tara iti's survival or when that might be the case. However, the prospects for Mangawhai's expansion justify investment to support trails, access, and amenities to accommodate growing pressure on harbour use without overwhelming its function as a shorebird habitat.

5.1.3 The Spit

The integrity of the spit is integral to the health – and indeed, the existence – of the harbour. Spit protection entails measures like selective planting for stabilisation, continued dredging to maintain tidal flow, lateral deposition, and a reasonably stable shoreline profile. Barrier fencing and native planting in some areas is used to moderate on-dune sand movement.

Barrier development is an important tool for managing fairy tern breeding. Maintaining a reasonably expansive habitat means taking action to reverse the spread of invasive flora.

As the resident and holiday-maker population grows there may be a need for formed trails on the spit, enabling controlled boat access at key locations, and development of wildlife viewing areas at key localities. Buffer zones can be scientifically informed and designed (and regularly renewed). This should not only manage access. It should also lift public awareness, support, and safeguard of areas and times when the bird is most vulnerable.

Following international practices of trail creation and visitor-oriented site management zones offers the potential benefit of recruiting and reinforcing public support for shorebird management. Increasing the number of people in the vicinity can also encourage public policing of defined no-go areas. The alternative, of absolute exclusion, risks invoking the antipathy evident in sign removal or defacement and defiance of restrictive rules.

Ultimately, climate change may overwhelm measures to protect the spit as a nesting area, through inundation and breaching. This raises a second strategy, the transfer of healthy breeding pairs to new localities.

5.2 TRANS-LOCATION

The 2019-20 breeding season DoC warden's report (Drew and McCool, 2020) drew attention to problems arising from nest crowding. This will get worse if climate change reduces suitable nesting sites, leads to the loss of open sandy areas through storm events and expansion of invasive plants, and if infertility issues among adult males continue to undermine the flock. One obvious step to reduce this would be removal of some of the extensive areas of invasive plants in the wildlife refuge on the northern spit creating more open areas suitable for nesting.

This and the wider threats from climate change mean that extending current habitat at Waipu, Pakiri, and Te Arai and identifying new nesting sites to which breeding pairs might be transferred are critical to the long-term survival prospects of tara iti.

A natural expansion to nearby sites may already be occurring based on recent, if limited, breeding successes at Pakiri, Waipu, and Te Arai. Encouraging as breeding at these localities may be, they are subject to much the same pressures as Mangawhai, from predation, increasing settlement, and long-term threats from climate change. An important initiative in the interests of long-term survival, then, will be to seek out alternative nesting localities.

The Forest and Bird Society investigated the practicality of relocating breeding pairs to alternative Northland sites meeting the following habitat criteria (Brooks et al., 2011):

- Nesting habitat suitability;
- Foraging habitat suitability;

- A sufficient site area suitable for nesting;
- The presence of an existing bird management programme
- Avoidance of large current or potential future settlement;
- The nature and scale of recreation, denoted in part by the presence of camping grounds;
- Protection status and enforcement over breeding and foraging habitat.

They identified and ranked for suitability 24 potential sites. Five ranked as excellent, six high, and 12 medium. Two of the former are the current summer breeding and wintering sites, Mangawhai and the Papakanui Spit, while Pakiri and Waipu ranked high.

The balance comprise sites that have not been used for breeding before, are further removed from centres of population, and jointly provide protection from the potentially devastating impacts of climate change. They include two in the Far North, two on the Kaipara Harbour, one on Great Barrier Island, Poutawa Stream on Pakiri Beach, and Ruakaka, north of Waipu. Papakanui and the last two-mentioned have the advantage of proximity to existing nesting and foraging areas and DoC infrastructure for site management.

The report recommended legal protection for potential sites. This has not happened, expect through the designation of the spit as the Mangawhai Government Purpose Wildlife Refuge in December 2007. The most important message, though, is that tara iti's survival need not rely entirely on Mangawhai. Given DoC's capacity to hatch eggs off-site and foster fledglings, and to move them between nests and localities, it may be timely to trial more ambitious trans-location. This could commence with proximate sites, moving over time to populate more remote, less disturbed localities.

5.3 GENETIC DIVERSIFICATION

If current levels of management can be sustained, medium-term threats reduced by sound catchment and habitat management, and trans-location to new, more remote localities achieved, the prospects of extinction will be substantially reduced. However, the necessary condition to ensure that this can happen, or simply to justify the investment in seeking to achieve it, is assurance that the population has the demographic and genetic capacity to respond to such initiatives (Jamieson, 2007 and 2009).

Low levels of male fertility and a high proportion of infertile eggs are typically associated with problems of inbreeding (Assersohn et al. 2021). So, too, are behavioural issues, including aggressive behaviour towards chicks and parental abandonment of nests. Ultimately, an increasing incidence of infertility in a marginal population can lead to its extinction.

The risks associated with infertility may be tackled through a combination of management measures. These include egg manipulation and removal, and selective hand rearing of fledglings. It may also involve culling infertile males and encouraging breeding between the most robust birds.

Despite such initiatives, the risk will remain that lack of genetic diversity reduces fertility to below replacement level. This prospect justifies considering the introduction of eggs from Australia to strengthen the genetic foundation of the New Zealand Fairy Tern. While the probability of success may be low, the rewards of success would be high.

Early evidence indicated that the New Zealand subspecies is closely related to its Australian equivalent (Chambers and Coddington, 1998). However, given that the data available at the time was too limited to determine fixed genetic differences between the two populations, it was concluded "*prudent to retain the present biological classification thereby regarding them as potential ' evolutionary significant units' (ESU) and practical to regard the New Zealand fairy tern as a 'management unit' (MU) sensu Mortiz* (1994)".

That limited exploration and its qualified conclusion are now up for revision. The genetic research undertaken recently at Canterbury University should help provide answers to the

genetic questions raised by a small population. At the least, an extension of current research could address the integrity and feasibility of introducing fertile eggs from Australia in association with a programme aimed at establishing additional breeding sites in Northland.

5.4 TOWARDS A LONG-TERM STRATEGY – FROM SURVIVAL TO ABUNDANCE?

There is a growing institutional framework committed to the long-term survival of tara iti. The efforts of the Department of Conservation and partner parties in the Tara Iti Recovery Group to date have come together to promote the bird's survival (see Attachment). Their commitment to the future includes the investment in the genetic investigation together with habitat studies at Massey University, both funded by the Shorebirds Trust.

A long-term strategy with the explicit objective of boosting the population calls for the further development of relationships among these organisations so that their individual mandates can be aligned with the shared goal of long-term survival.

This raises some challenges. A necessarily short-term focus on seasonal survival by, for example, the NZFTCT has led to conflict with the longer-term goals of the Mangawhai Harbour Restoration Society. The protection-at-any-cost message espoused by agencies focusing on immediate risks can lead to misleading and contradictory positions that undermine the credibility of their case and, potentially, support for their cause. Antipathy towards any use of the harbour and its surrounds by fairy tern "champions" has the potential to obscure more fundamental long-term issues surrounding catchment management and to alienate the local population.

On the positive side, the Shorebirds Trust has been able to balance and supplement DoC's more immediate protective and short-term husbandry goals by funding basic research that will better inform short-term environmental management and offer some direction for a long-term survival strategy that recognises the risk posed by a small population with a limited gene pool.

There is also a need to align dune planting and other stabilisation measures which address the medium-term threats to the spit of severe weather events and climate change generally, with the immediate challenge of providing a benign nesting environment. There has been some accommodation between the imperatives to plant to limit dune degradation and the need to accommodate the nesting birds' need for open ground. This accommodation needs to be sustained and quite possibly extended by collaboration to reduce invasive flora, particularly in the vicinity of the dune lake and northern end of the spit. on the northern end of

Acknowledging the capacity of the Fairy Tern Recovery Group to encourage broader collaboration and recent scientific initiatives funded by the Shorebirds Trust, the current review proposes that the agencies identified in the Attachment seek common ground enabling them to collaborate around the following strategies.

Protect, maintain, and enhance the qualities of the current habitat

- Develop and implement a comprehensive catchment management plan. Ideally a joint responsibility of Northland Regional Council and the Department of Conservation working alongside land users, this should address rural and urban land use activities and management practices throughout the catchment with a view to maintaining water quality in tributary streams, estuaries, and wetlands. Among other things, it would address the benefits of further mangrove reduction, protect the integrity of the spit and wildlife refuge, and consider the quality and sustainability of stormwater management practices in the face of climate change.
- Create enhanced interpretation resources in and around the harbour and spit on the esplanade reserve and trails using specially prepared viewing sites in key areas.
- Establish a body based on volunteer groups, the Mangawhai Harbour Restoration Society, the Northland Regional Council, and DoC to identify where public access for boating and

other recreation activities might be concentrated and patrolled, as well as areas in which passive and more controlled access can be provided.

Establish additional flocks at new sites and localities

- Trial translocation through the active development of one or more receiving sites for breeding pairs and eggs in the vicinity of Mangawhai/Bream Bay (to enable current personnel to oversee the initiative) building on the knowledge developed from site, nest, and egg management at Mangawhai.
- Select several virgin locations for investigation, protection, and development as new breeding habitat (drawing on the 2011 Forest and Bird Society study).
- Develop and implement a plan to transfer and manage breeding pairs and eggs to selected new sites in more remote and ideally more stable environments.

Explore genetic diversification

- Build on current research to strengthen genetic stock though managed breeding;
- Undertake research aimed at the introduction of new (Australian) eggs for incubation and placement at Mangawhai and any additional locations;
- Develop and implement protocols for doing so.

Postscript: Working Together - Towards a Long-Term Strategy

This report drew on plans, reports, and evidence prepared by or for the Department of Conservation and the New Zealand Fairy Terns Charitable Trust, among others. Draft versions were distributed for comment over 2021, including to members of the Shorebirds Trust, Forest and Bird, and DOC. It was only when the report was finalised in April 2022, however, that I learned of DOC initiatives since 2017 to develop a long-term strategy for tara iti.

This exercise involved application of a structured decision framework brought to the exercise by University College London PhD candidate and researcher for the Institute of Zoology London, Thalassa McMurdo Hamilton, reported in October 2021 (McMurdo Hamilton et al.)

Options for long-term management were developed and evaluated with the participation of 45 experts and advocates. They included fifteen DoC staff, two from Auckland Zoo, three from Birds New Zealand, four from New Zealand Fairy Terns Charitable Trust, two from the Shorebirds Trust, three from About Tern Mangawhai and Waipu, and one from NZ Forest and Bird Society. Seven people represented Māori. Twenty-seven of the participants were involved in working groups on advocacy, biology, the wider ecosystem, costings, and Mātauranga Māori.

Five levels (or fields) of intervention were evaluated involving different degrees and mixes of: predator management, nest protection, habitat management, captive management and manipulation, and new site releases. The "*full recovery plan for tara iti with an operational implementation plan*" derived was summarised as follows:

1. **Improve management of occupied sites**: Increase predator management to the maximum practical effort for all predator species during the tara iti breeding season; extend management into winter months at breeding and wintering grounds; manage nests intensively in the field to reduce the number of eggs needing artificial incubation; maximise the number of constructed shell patches; and improve vegetation management.
2. **Continue to improve communication and co-management**: Many members of the tara iti stakeholder group expressed that they would like to continue working in this mana- enhancing way, working transparently, sharing knowledge and learning together.
3. **Seek financial investment to fulfil the actions for Field 2 + new sites**: Explore partnership options for tara iti management between DOC and the tara iti stakeholder group to identify and seek the resources needed to fully fund the restoration and management of new breeding sites.
4. **Establish and manage new (currently unoccupied) sites within the existing range of tara iti as soon as resources allow**: Restore and manage at least one former and one new breeding site, as per Field 1.
5. **Consultation**: Undertake further discussion with iwi to understand whether they might be more comfortable with the option of removing infertile males from the tara iti population.
6. **Contingent on the results of further iwi consultation, seek financial investment to fulfil Field 2 + Captive 3**: Explore partnership options for tara iti management between DOC and the tara iti stakeholder group and wider community to identify and seek the resources needed to fully fund the establishment of a captive facility and programme.
   McMurdo Hamilton et al., 2021, 17

Field 1 focuses on managing the summer and winter habitat through increased pest control, greater intervention in nest and egg management and protection, and changes in shell seeding and dune management. Field 2 includes pulling mangrove seedlings. More active captive breeding and releasing birds to new sites were seen as later options subject to funding.

The actions correspond broadly with proposals in the current report: intensive habitat management, more local and new distant nesting sites, genetic management, and the possible introduction of eggs from the Australian flock. With its attention to the relationship between population dynamics, nesting, and breeding, the findings focus heavily on habitat and bird management. In contrast, the current report places greater focus on the estuarine and coastal ecosystems, and hence on external factors including climate change, harbour sedimentation,

and changing coastal land and water use. It addresses changing conditions in the harbour within which tara iti forage, including the impacts of sedimentation and mangrove colonisation on harbour morphology, water quality, productivity, and carrying capacity.

Where the DOC approach draws on greater expertise in biological processes and management response probabilities, the current report places greater weight on the threats of sea level rise and increasingly volatile and unpredictable shifts in weather, and dune and coastal processes. These, as much as breeding conditions and performance, will be critical to the long-term survival of tara iti in its current habitat.

In addition, other than addressing Mātauranga Māori, little weight has been given in the DOC report to the social setting. The advocacy working group did acknowledge the importance of engaging positively and proactively with the public or even other stakeholder groups. Yet, while there is a call for better communication, there is no suggestion of encompassing a wider public, with the main proposal being the reinforcement of within-group collaboration.

If the current report is to contribute to the policy process set out in the DOC report, it will be by sustaining and perhaps refining the short term management which has been successful, to date but which is not sufficient to guarantee tara iti's future. While the proposed extension of current initiatives is overdue, the long term threats call for an acceleration in implementation of translocation and genetic enhancement.

The call by the advocacy working group to engage with the public also needs to be taken on board. The risks of omission associated with groupthink arise when participants in resource management decisions are drawn from highly focused, overlapping advocacy, scientific, and management groups. Transparency is essential and an openness to challenge even more important under such circumstances. Those involved can trust a fully informed public to support sound and justifiable initiatives to lift the survival prospects of tara iti. It is somewhat surprising, therefore, that a decision framework intended to engage multiple stakeholders has progressed for several years, apparently without recourse to the wider community.

If the current report draws the attention of the multiple stakeholders in the health of the coastal environment in Northland to the range of threats facing tara iti and the prospects for managing them to reduce the risk of extinction, it will have served its purpose.

Phil McDermott

12 May 2022

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Attachment: The Support Network

There is significant community commitment to saving the fairy tern, headed up by the Department of Conservation. The agencies behind the commitment potentially offer the resources and expertise to support a programme of expanding the flock and its range.

The Department of Conservation

DoC administers the public conservation estate (a network of national parks and reserves, including marine reserves) and is tasked with the protection and restoration of native species. Tara iti is one of twenty Threatened – Nationally Critical birds listed by DoC, and one of eight with a formal recovery programme [36].The population has been subject to management by the Warkworth and Whangarei offices (reflecting the split of nesting sites between the Northland and Auckland conservancies) since 1983.

Management has become increasingly active over the years. It has moved beyond monitoring, site protection, and predation control to direct intervention by way of creating nesting and shelter sites, egg transfer and manipulation, and, in the 2019-2020 season, successful raising of an abandoned fledgling "in the wild" (Ogle 2020).

The DoC budget for tara iti in 2020/21 was $285,500. This was third highest behind southern kiwi ($1,935,000) and kakapo ($1,177,00), with another $2,500 allocated to the running of the Tara Iti Recovery Group. By working closely with volunteers and with funding and material support from the Shorebirds Trust and Tara Iti Golf Club, DoC has been able to leverage off its resources to achieve a high level of management of nesting sites, reflected in the recovery in numbers since 1983 and, again, since 2011.

DoC also provides leadership of the Tara Iti Recovery Group, established in 2019 to coordinate with community groups, including Ngāti Whatua O Kaipara, Patuharakeke Te Iwi and Te Uri o Hau, the New Zealand Fairy Tern Charitable Trust, NZ Forest and Bird Society, Boffa Miskell (environmental planning consultants), and the Shorebird Trust. The aim is "structured decision making" to identify and prioritise management strategies that will achieve the most positive impact on recovery efforts.[37]

Kaipara District Council

The Council is responsible for managing land and resource use other than in the Coastal Marine Area. This includes rural and urban land in the Mangawhai catchment and providing the framework for deciding on what is an appropriate use. It is also responsible for providing services to that land, s has a major influence over the rate and form of development.

The Mangawhai Harbour Restoration Society

The Mangawhai Harbour Restoration Society was established in 1994 to support the health of the harbour following the storm induced breach of the sandspit. The aim of Society was to restore and protect the spit and harbour.

Today the Society raises funds and utilises volunteer labour to undertake planting and rabbit control as part of a longer-term programme aimed at stabilising the dunes. It built a barrier fence (completed in 2008) which has trapped and accumulated sand the length of the spit. Selective revegetation today uses native spinifex grown in a nursery established for the purpose. Harbour dredging maintains the main harbour channel and provides for sand replenishment on the spit, while elective mangrove removal restores water surface and facilitates channel flow.

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[36] Communication of Director Terrestrial Science, DoC, 5 February 2021

[37] https://www.doc.govt.nz/news/media-releases/2019/stepping-up-to-save-new-zealands-most- endangered-bird--the-tara-iti-fairy-tern/

The Society also set up About Tern, a group focused on supporting DoC's management of tara iti with predator control and nest monitoring. When DoC funding was withdrawn in 2009, following 25 years of support, the Society focused on harbour management, establishing the New Zealand Fairy Tern Charitable Trust (NZFTCT) to continue the activities of About Tern.

The New Zealand Fairy Tern Charitable Trust

The NZFTCT aims to ensure the survival of the fairy tern by supporting and participating in the DoC New Zealand Fairy Tern Recovery Project. It provides funding and volunteer support in all facets of nest management and monitoring. Trust activities include education, community involvement, assistance with bird and habitat management, and predator control. Members record details of sightings and nesting, roosting, and foraging behaviour. It undertakes advocacy in planning matters affecting the coast.

Northland Regional Council

NRC is responsible for policies to manage resources of the Coastal Marine Area and the quality of water resources in the wider catchment. It also has a mandate to protect and promote biodiversity. Among other things, it deliberates on applications for amenities and structures adjacent to the coast, supervision of activity in harbours and estuaries, and controls the activities of watercraft on them.

Tern Point Community

Tern Point was established in 2000 as a community of 41 lots on the harbour at the base of the spit some 1,500m from the nesting areas. Only around twelve lots are permanently occupied with many others used extensively. Residents preserve the estuary boundary, plant on the spit, undertake predator control, and track development in common areas.

Tara Iti Golf Club

Tara Iti Golf Club and associated housing (capacity for 46 dwellings) commenced development in 2012 and opened in 2015. Environmental initiatives include predator control and replacing radiata forest with native grasses and shrubs. This has reduced habitat for the predators of ground nesting shorebirds. The development of two associated courses south of Te Arai Point will see predator control extended to the north end of Pakiri Beach.

The *Te Arai Coastal Development Shorebird Management Plan* (Boffa Miskell, 2013) accompanying the club's development sets out a coordinated pest control programme, including the maintenance of protective temporary fencing around the Te Arai stream mouth, bans on dogs and cats, and monitoring, advocacy, and education. The success of this programme is demonstrated by the recovery in numbers since the development began and may be associated with the resumption of breeding at the Te Arai Stream mouth in 2019/20.

The Shorebirds Trust

Established by Tara Iti Golf and supported through an annual charitable golf tournament, the Shorebirds Trust was formed in partnership with DoC in 2017. It maintains several partnerships aimed at enhancing biodiversity and supporting the NZFT. Initiatives include developing best practice predator control standards (with Auckland Council) and a predator free zone from Pakiri through to and including the Mangawhai Wildlife Refuge. It is funding genetic research into the NZFT (Canterbury University) and conservation research in support of biodiversity (Massey University). The Trust it provides material support to the Department of Conservation Fairy Tern Recovery Programme through, among other things, funding shell enhancement of nesting areas in Waipu (2019) and Mangawhai (2020).[38]

[38] https://www.shorebirdstrust.org.nz/projects