Department of Conservation
Te Papa Atawhai

TONGARIRO FOREST KIWI SANCTUARY ANNUAL REPORT

July 2016– June 2017

TONGARIRO DISTRICT OFFICE, CENTRAL NORTH ISLAND REGION

Ngati Hikairo ki Tongariro

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Cover photo: Top left: Volunteer & kiwi contractor John Polstra holding 'Comet'. Bottom left: Adult brown kiwi 'Max' in a burrow. Right: Ranger Jerome Guillotel holding 'Matarirki' the two-toned kiwi.

PARTNERSHIPS

Partnerships between the Department of Conservation and Ngati Hikairo, The National Kiwi Trust at Kiwi Encounter, Maungatautari Ecological Island Trust, Project Tongariro, Wairakei Golf + Sanctuary and Kiwis for Kiwi Trust continue to be an essential part of the work in the Tongariro Forest Kiwi Sanctuary (TFKS).

THE NATIONAL KIWI TRUST AT KIWI ENCOUNTER

The National Kiwi Trust at Kiwi Encounter plays a crucial role in the success of the TFKS, through the incubation and successful hatch of eggs lifted from nests via Operation Nest Egg™ (ONE). This season 2016/17, 16 kiwi eggs were taken to Kiwi Encounter, seven chicks were released to Wairakei Golf + Sanctuary and one was gifted to Maungatautari (under an existing agreement).

NGATI HIKAIRO

Ngati Hikairo plays an important part in the TFKS and has a role and responsibility as kaitiaki for the enhancement of Western North Island brown kiwi within their rohe. Ngati Hikairo support recovery efforts by the Department of Conservation and are intent on kiwi conservation goals and objectives being met within Tongariro Forest.

PROJECT TONGARIRO

Project Tongariro are involved in ecological projects throughout Tongariro National Park and surrounding areas. Their volunteers assist the TFKS team regularly with work such as transporting kiwi eggs and chicks to and from The National Kiwi Trust at Kiwi Encounter and carrying out other advocacy work.

MAUNGATAUTARI ECOLOGICAL ISLAND TRUST

Maungatautari is a forested volcanic cone in the Waikato, and is the site of an ecological restoration project headed by the Maungatautari Ecological Island Trust (MEIT), aiming to eliminate all mammalian predators and re-introduce native species. In 2006, the Department of Conservation and Ngati Hikairo made an agreement with Ngati Koroki-Kahukura to contribute 20 founders to the kiwi population at Maungatautari and have so far gifted 15 kiwi. In return, since 2010, 14 kiwi (the offspring of some of the original founders) have been released into TFKS.

OTOROHANGA KIWI HOUSE

The Otorohanga Kiwi House is a captive facility and has an active brown kiwi breeding programme which, to date, has successfully hatched more than 150 kiwi chicks. Since 2010, there has been a nationwide initiative to release brown kiwi of Western Taxon from captive breeding institutions into multiple wild sites, following the completion of a new western provenance DOC translocation plan. This is to enable captive institutes to have increased capacity to work with other (more endangered) species of kiwi. Eleven kiwi including one breeding pair have been released at TFKS since 2012.

WAIRAKEI GOLF + SANCTUARY

Wairakei Golf + Sanctuary is a privately-owned golf course situated north of Taupo. A five kilometre "Xcluder" predator proof fence has been installed around the perimeter. This has created a pest free environment which can be used to benefit threatened plants and animals. The sanctuary is utilized as a kiwi crèche when undertaking Operation Nest Egg ™. This season, seven chicks from Tongariro were released into the predator free enclosure.

EXECUTIVE SUMMARY

Tongariro Forest Kiwi Sanctuary (TFKS) was established in 2000 for the development and testing of kiwi protection techniques, namely the use of Operation Nest Egg™ (ONE) and aerial 1080 operations. Up to 2010, TFKS aimed to achieve and maintain a representative sample of 200+ pairs of Western North Island brown kiwi by 2017 (Tongariro Forest Kiwi Sanctuary Operational Plan, 2009) and to involve the community and enhance public awareness. This target has been significantly compromised by ferret predation events in 2009 and 2014, and most recently in 2017, leading to the revised objective of growing the population to 100+ pairs by 2019 (National Kiwi Sanctuaries management plan 2015-2020). This is in line with the target set up by the government in 2015, through the "Save Our Iconic Kiwi" (SOIK.) initiative, to achieve a minimum population growth rate of 2% per year for all kiwi taxa.

A key research focus of TFKS is to assess the effectiveness of cyclic landscape-scale aerial 1080 (19,840 ha) operations on kiwi chick survival and long-term population growth. The population stopped declining in response to five-yearly aerial 1080 operations undertaken between 1995 and 2011, although this appeared insufficient for population recovery (TFKS annual reports 2013/14 and 2015/16). Therefore, the programme shifted to a three-yearly cycle aimed at achieving an annual growth rate of 4% (Population Modelling, TFKS annual report 2015/16), well above the national target. The last 1080 operation occurred in August 2014 and was the second drop since the new 3-year cycle experiment was initiated in 2011.

Twenty-eight adult kiwi males were monitored in TFKS in 2016/17 (19 breeding males). The aim this season was to focus on ONE to increase the monitored kiwi population (although not all the eggs could be taken due to limited capacity at Wairakei). There were ten confirmed nests this season with a total of 16 eggs, resulting in eight successfully hatched chicks. A total of seven kiwi chicks were monitored at Wairakei Sanctuary + Golf, and six were released back to TFKS.

Up to thirteen sub-adults were monitored this season for recruitment into the tagged breeding population. This monitoring also provides information about distribution of kiwi across the forest. Of these, two presumably died from ferret predation and two others lost their transmitters.

Small Mammal Index monitoring, undertaken in TFKS since 2001, documented a dramatic decrease in small mammal tracking rates after the 2014 1080 operation. Rat tracking rates, returning to pre-1080 levels eight months after that operation, have remained at 60 and 80 % since. Like previous operations, mustelids have continued their slow recovery to reach a peak tracking rate of 20% over the summer.

INTRODUCTION

Tongariro Forest Kiwi Sanctuary (TFKS) is a 20,000ha area in the central North Island (Figure 1) established in 2000 for the protection and recovery of Western Brown Kiwi (*Apteryx mantelli*). It is one of five sanctuaries set up throughout the country to maintain significant populations of the different kiwi taxa, and to develop and improve techniques in kiwi protection, specifically aiming to increase the survivorship of young kiwi (Robertson 2004).

This involves determining survival rates of kiwi chicks before and after aerial 1080 operations (Table1). TB Free NZ in conjunction with the Department of Conservation carried out aerial 1080 operations as part of their regional TB-vector/possum control regime and for kiwi protection research in September 2006, 2011 and August 2014 (Appendix 1). This research is of national importance, indicating whether 1080 can be used as an effective tool for maintaining kiwi in large and/or relatively inaccessible areas throughout the country. Initial results have shown that aerial 1080 operations have benefited kiwi chick survival for two consecutive seasons in TFKS and other forest birds have also benefited from aerial 1080 operations with increased nest success for fantails for one or two consecutive seasons after 1080 operations (depending on the timing of the rat re-colonisation).

Our research focus for the five years from 2014 onwards was to measure the benefits of low sowing rates of aerial 1080 to kiwi chick survival (Scrimgeour et al. 2015). We have moved from distributing 4kg/ha of toxin bait in 2006, to 2kg/ha in 2011 and down to 0.75kg/ha in the last operation (Appendix 1), monitoring chick survival in response (Table2).
However, the focus for testing and pushing for low sowing rates has been re-examined and it has been decided, based on the latest results from TFKS and from the national predator control programme called “Battle For Our Birds” (BFOB), that the recommended sowing rate for the proposed 2017 1080 operation would be 1.5kg per ha.

In addition to this research, other work includes ongoing monitoring of adult kiwi for survival and breeding purposes, monitoring of sub-adult kiwi for breeding recruitment and kiwi call surveys. Mustelid and rodent numbers are also monitored using the standard tracking tunnels methodology (small mammal indexing) and using a recently added 21-day mustelid survey (repeated during the year).

This report presents results from these key areas of work for the 2016/17 financial year.

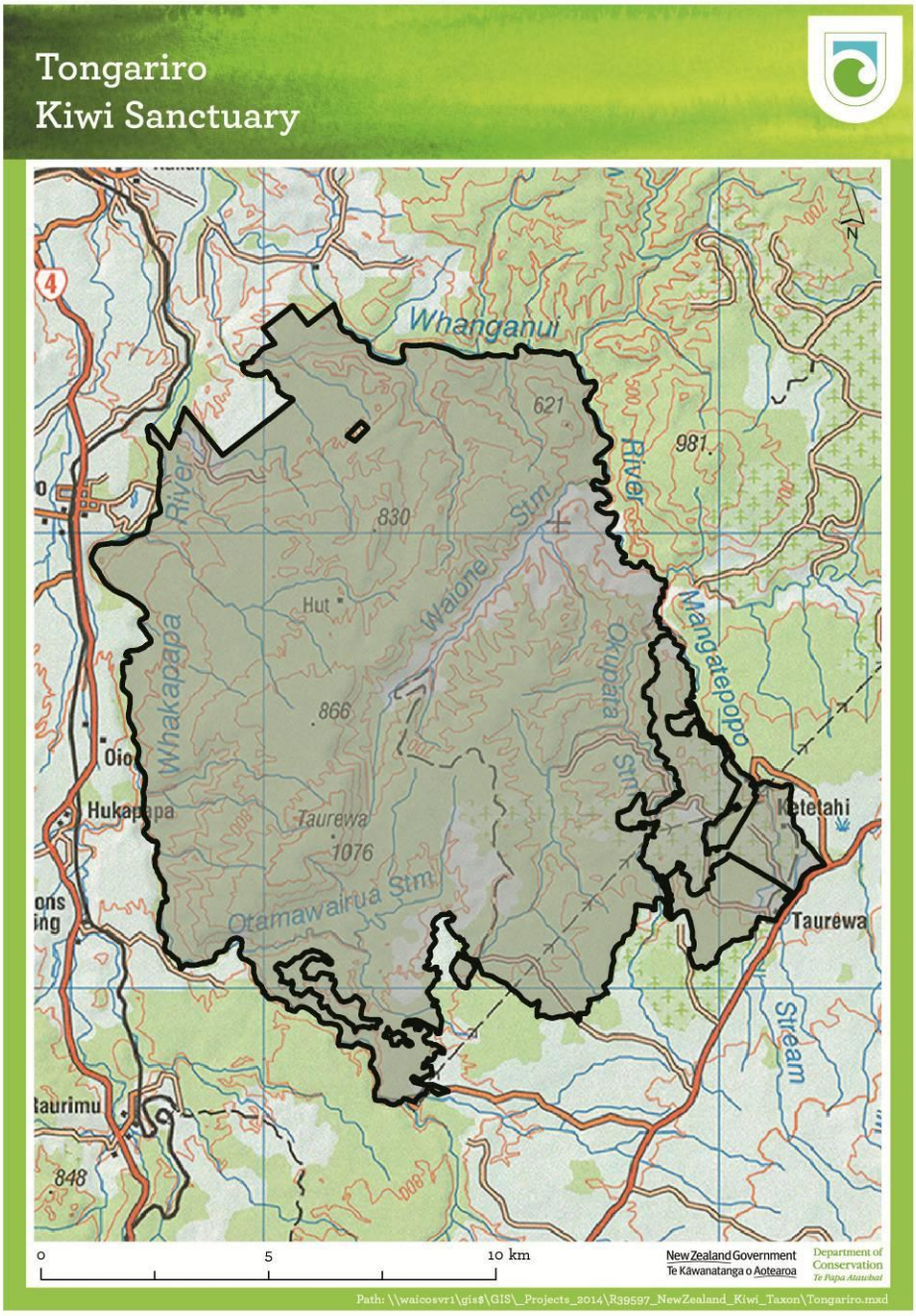

FIGURE 1: LOCATION MAP FOR TONGARIRO FOREST KIWI SANCTUARY, CENTRAL NORTH ISLAND REGION

SANCTUARY OBJECTIVES AND ACTIONS

(National Kiwi Sanctuaries Management Plan 2015-2020 -DOC-1570100)

TABLE 1: TFKS OBJECTIVES BY 2019

Purpose
1. Investigate the efficacy of low sowing rates of 1080 as a tool to protect and recover kiwi populations 2. Protect a population of Western brown kiwi at Tongariro Forest.
Objectives
1. The benefits to kiwi populations of low sowing rates for aerial 1080 operations are measured and understood. 2. The study is robust with adequate sample sizes and repetition to allow for clear conclusions. 3. Our understanding of the relationship between populations of rabbits and any future ferret incursions is improved.

TABLE 2: TFKS ACTIONS BY 2019

#	Actions	Accountability	Priority	Progress
4.1	Undertake low sowing rate aerial 1080 operations in late winter/spring of 2014 and 2017.	TBFree NZ	Essential	On track
4.2	Measure chick survival the season immediately after aerial 1080 operations in 2014 and 2017.	TFKS	Essential	On track
4.3	Undertake ONE in non-treatment years.	TFKS	High	On track
4.4	Implement rabbit abundance indexing in conjunction with Regional Council monitoring to determine whether rabbits act as predictor for ferret incursions. Undertake monitoring annually.	TFKS and Regional Council	Medium	Sanctuary budget reduction means this will not occur unless further funding found
4.5	Complete and publish the study on sub-adult survival, dispersal, territoriality and breeding age by 2016.	TFKS	Essential	Ongoing, to be completed by the end of 17/18 season
4.6	Publish research on benefits of aerial 1080 on kiwi chick survival by 2014/15	TFKS & KRG	Essential	Completed Being peered reviewed before publishing by end of 17/18 season

SMALL MAMMAL INDEXING (SMI) USING TRACKING TUNNELS

Tracking tunnels for indexing rodent and mustelid (weasel, stoat and ferret) abundance were run on the 'Operation Ark' timing (i.e. January, February, August and November) to catch the peak in stoat abundance. Methodology follows current DOC best practice (Gillies & Williams 2001). There are 15 lines within TFKS; each line is 450m long with ten tunnels, giving a total of 150 tunnels. TFKS is entering its 17th year of small mammal indexing data gathering, making one of the longest tracking tunnel data set in the country. This supports and increases our knowledge and understanding of small mammal population dynamics in relation to aerial 1080 use.

TRACKING TUNNEL RESULTS, THIRD SEASON AFTER THE 2014 AERIAL 1080 OPERATION (0.75kg/hectare of pellets) AND ONE SEASON PRIOR TO THE 2017 AERIAL 1080 OPERATION.

Immediately after the 2014 1080 operation, SMI results showed a dramatic decline in both rat and mustelid tracking rates. Rat tracking reduced from 70% to 5% (although the three preceding 1080 operations resulted in rat tracking rates of <1%) and stoat tracking dropped from 13.3 % to 0% (Figure 2). As expected, rats re-colonised the forest faster (about eight months after the operation) than was the case following previous operations (between 13 to 18 months). The distribution method (strip sowing) and the lower sowing rate could explain why rats recovered faster after the 2014 1080 operation (TFKS annual report 2014/15). The rat tracking rate was 63% in January 2017.

The steady and slow recovery of mustelids followed trends recorded after the three preceding operations and reached a peak of 20% in January 2017 (Figure 2).

Mouse tracking rates have remained below 5% since the typical post-1080 population boom faded out (Figure 2). The mice tracking rate was 2.3% in January 2017.

This season, we have trialled an extended 21-day mustelid tracking index using salted rabbit meat lure, and this will continue alongside kiwi chick survival monitoring after the Spring 2017 1080 Operation. To date, this method has shown more sensitivity in terms of mustelid detection across the landscape, with more lines tracked in February 2017 than the traditional three-day method. This method has the potential to more accurately measure mustelid re-colonisation in the six months after a 1080 Operation.

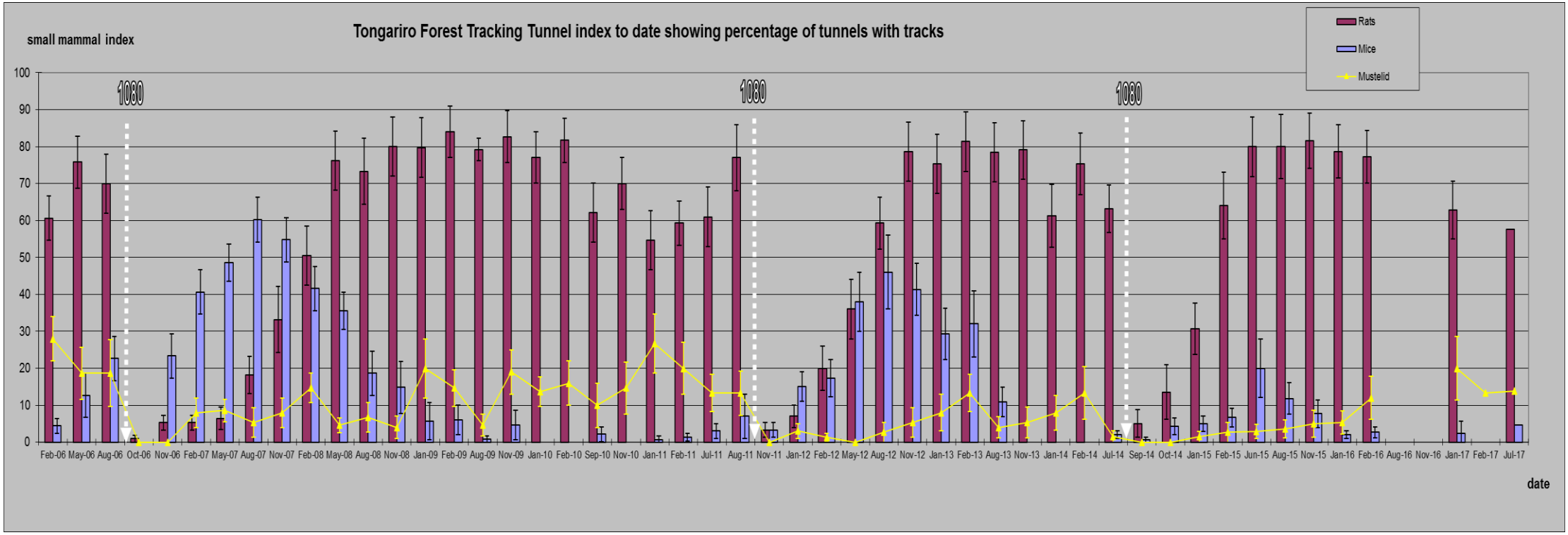

FIGURE 2: SMALL MAMMAL INDEXING RESULTS, TONGARIRO FOREST KIWI SANCTUARY, FEBRUARY 2005 – JUL 2017

ADULT KIWI MONITORING AND NESTING

A total of 30 adult kiwi were monitored in TFKS in 2016/17, consisting of 28 males and two females. This season one male "Zazu" started nesting at 2.8 years old, lifting him from sub-adult to adult status. A new unknown male, named "Fitz" has also been found in the burrow with a known female "Bangle" during a transmitter change. A transmitter was placed on Fitz while Bangle had hers removed as females are only monitored until such time as they pair up. The males are closely monitored so as to lift eggs from their nests.
Of the 28 males monitored, 19 of these nested in the 16/17 season (Table 5).

FERRET INCURSIONS

During the two seasons following the 2014 1080 operation, no deaths were recorded among the adults and sub-adults (this also was the case after the 2011 operation). However, this third post-1080 year, at least two ferret incursions occurred on the eastern and for the first time on the western side of the forest, resulting in 10 kiwi deaths (including eight breeding adults, Table 3). This was a repeat of episodes from the two preceding 1080 cycles where ferret predation was recorded in year three after each 1080 operation. Since 2009, 39 kiwi deaths (including 33 adults) have been attributed to ferret predation.

Western side of TFKS:

The first adult being killed by a ferret this season (a female) was found dead on the 17th of August 2016 in the western side of TFKS, downstream from the first "Mako crossing". Fifty-six DOC 200 and 250 traps were deployed during the following weeks, and no ferrets were captured until the 16th of March 2017, when a male ferret was trapped along one of the 42 Traverse side tracks linking to farmland. In the meantime, five other kiwi died on this side of the forest. Of these, one was confirmed being killed by a ferret and two others (a pair found dead in same burrow) were deemed as likely ferret predation from the Massey University diagnosis. The two others (including a sub-adult), were too decomposed to gather any evidence (Table 3).
Two other ferrets were caught; a female, along the Dominion Road on the 3rd of May 2017, and a male, in the same trap as the first captured one, on the 7th of July 2017. Despite these captures, a breeding kiwi male was killed by a ferret while nesting on the 3rd of August 2017 (2 weeks before the 2017 1080 drop), near where the first female was killed the year before (along Mako track).

Eastern side of TFKS:

This season, three breeding birds and a sub-adult died between the 27th December 2016 and the 4th of April 2017. Of these, three were assessed by kiwi practitioners as to be from ferret predation (typical red marks on neck, entrails missing etc.) and one was too decomposed to tell (Table 3). Twenty traps

were also deployed in the vicinity of where the dead birds were found, but no ferrets have been caught to date.

This is the side where ferret incursions have occurred during the third year of the 2006 five-year 1080 cycle and the 2011 three-year 1080 cycle. Each time the mortalities stopped following respectively the 2011 and 2014 1080 operations and subsequently suppressed adult and sub-adult kiwi deaths for more than two years.

TABLE 3: MONITORED KIWI DEATH 2016/17 SEASON

	sex	Age (years old)	Date of death	Location	Cause of death
Opposum	Female	4.8	17/8/16	West	Ferret predation
Mufasa	Male	4.8	16/9/16	West	Ferret predation
Mufasa's mate	Female	unknown	16/9/16	West	Ferret predation
Piwi	Male	8	7/11/16	West	Too decomposed
Rettalick*	Male	1.2	13/12/16	West	Too decomposed
Logger Ross	Male	>17	27/12/16	East	Too decomposed
Chance	Male	5.3	11/2/117	East	Ferret predation
Hail	Male	5.6	27/3/17	East	Ferret predation
Digit*	Male	1.5	4/4/17	East	Ferret predation
Otoro	Male	>10	3/8/17	West	Ferret predation

**Sub-adults*

In the absence of ferrets, the estimated annual adult survival rate (SR) is 96.9% (using the Mayfield method) and the mean life expectancy is 32 years. Ferret predation has greatly reduced the mean adult life expectancy to 11.8 years under a five-yearly 1080 regime (SR=91.5%) and to 19 years under a 3 yearly 1080 regime (SR=94.8%) (Table 4).

TABLE 4: IMPACT OF FERRETS ON KIWI ADULT LIFE EXPECTANCY

	Adult life expectancy (years old)
No ferrets	32
With ferrets (no management)	8
With ferrets in 5y 1080 cycle regime	11.8
With ferrets in 3y 1080 cycle regime	19

NESTING AND EGGS OUTCOME

For the 2016/17 season (non-treatment year), Operation Nest Egg™ was undertaken. Egg lifts took place after approximately 55 days of incubation and all eggs lifted were taken to The National Kiwi Trust at Kiwi Encounter to be incubated and hatched in captivity. The resulting chicks were released

at Wairakei Golf + Sanctuary until they reached 1100g at which point they were released back into TFKS. Due to the maximum capacity at Wairakei Golf + Sanctuary being set at 16 chicks and chicks being crèched there from from Rimutaka Forest Trust and Rangataua Forest, a limited number of eggs could be lifted.

A total of 16 eggs were lifted from ten nests. Six of which were either not viable or did not develop correctly and did not hatch. Of the ten eggs which survived to full term, two did not survive, leaving eight healthy chicks (Table 5). One of these, named "Phil", was gifted to Maungatautari (MEIT) as part of an agreement between MEIT & DOC & Iwi to provide 20 unrelated founder kiwi to Maungatautari. The remaining seven chicks were released into Wairakei Golf + Sanctuary.

TABLE 5: NEST AND EGG OUTCOME SUMMARY

Male kiwi (represents a breeding pair)	**Unconfirmed Nests***	**Confirmed Nests**	**Total eggs**	**Hatched in captivity**	**Eggs not hatched**	**Chicks euthanized**	**Total**
Apollo		1	2		2		
Chance**	1						
Comet		1	1		1		
Dani	1						
Dino		2	3	3		2	1
Fozzie		1	1	1			1
Gulliver	1						
Hail**		1	2	1	1		1
Hiver	1	1	2	2			2
Koroki	1						
Little Moa	1						
LoggerRoss**	1	1	1		1		
Matariki	2						
Murphy	1						
Otoro**		1	2	2			2
Peter Pan	1						
Rocket	1						
Speedy	1	1	2	1	1		1
Te Hokinga	1						
Total	14	10	16	10	6	2	8

** Nesting signal obtained*

*** kiwi which died during the season*

WAIRAKEI GOLF + SANCTUARY KIWI CHICK MONITORING

Kiwi chicks have been shown to be vulnerable to stoat predation (McLennan *et. al.* 1996), and stoats are considered the main limiting factor to kiwi recovery in the wild. Aerial 1080 operations were carried out in August/September 2001, 2006, 2011 and 2014 for possum control and also targeted rats and thus stoats via secondary poisoning. Kiwi chicks have been monitored during the 2001/02 season and during the seasons since 2005 to assess the effect of large scale pest control operations (aerial 1080) on kiwi chick survival.
The 2016/17 chick survival rate (SR), being a year 3 after a 1080 operation, was likely to be very low, similar to that of the pre-1080 from previous cycles (SR=20%). In response to these findings we do not monitor chicks in TFKS in the third season post-1080 and instead Operation Nest Egg™ is undertaken with the resulting chicks placed in to the kiwi crèche at Wairakei Golf + Sanctuary.

MONITORING METHODS

Since November 2016, Renee Potae from TFKS has been seconded into the role of Kiwi Coordinator at Wairakei Golf + Sanctuary and with assistance from Jeff Willis, TFKS staff and volunteers, she has been responsible for handling the kiwi and performing the health checks at Wairakei.

All chicks were captured regularly to obtain bill and weight measurements as well as replacing the transmitters and straps as required. They were first caught once a month until they reached 800g and then every one to three months thereafter depending on the condition and sex of the bird. Signals were obtained twice a week and the kiwi team was notified as soon as possible if a mortality signal was detected. Any dead birds were sent to Massey University for necropsy to establish the likely cause of death.

KIWI CHICK OUTCOMES

This season, a total of nine TFKS chicks were held at Wairakei, all of which were a result of egg lifts followed by incubation and hatching at Rainbow Springs Kiwi Encounter. Seven of these chicks are from this season, one was from a very late last season egg and the other was a juvenile remaining from last season but was released in September 2016. Not all nests detected in TFKS had eggs or chicks taken. The first chick was released into Wairakei on the 25th of August 2016 and the last for the season on the 20th of October 2016.

As at the 30th of June 2017, six chicks had reached safe weight of at least 1100g and were released back into TFKS. One chick, Mr Funky Feet, was found dead on the 25th of October in Wairakei. The

cause of death is not certain but deemed possible to be avian predation[1]. His remains were found not far from the roosting area of the resident Australasian harriers (2017 Wairakei Golf + Sanctuary Kiwi Report).

Two TFKS chicks remain at Wairakei over the winter and will be released in Spring 2017.

[1] The remains were found scattered in a circular area of approximately 1m by 1m and the skin had been peeled open. There were accumulations of non-kiwi avian scat next to the remains.

MINI KIWI CALL SURVEY, EASTERN SIDE OF FOREST, USING ACOUSTIC RECORDERS

INTRODUCTION

On the eastern side of TFKS, call surveys have been undertaken since 1993 in an effort to detect any large, long term changes in the TFKS population density and distribution. A population modelling exercise was produced in June 2014 and established that during a five-year 1080 cycle the population remained approximately constant and that under a 3-yearly regime, the population should increase by about 4% per annum (Appendix 2). Since 2011, three-yearly operations have been implemented and a population growth well above the target of 2% set by the New Zealand government in 2015 should be achieved. However, this was not observed during the subsequent call count surveys undertaken throughout the forest in 2013, 2014 and 2015, probably due to the fact that new sub-adults kiwi recruits are silent for the first few years of their existence. Kiwi call rate was at its lowest during the 2015 survey with 1 call per hour.
This year, call counts were carried out to detect recruitment from the 2014 1080 operation. For the first time, call counts have increased significantly to an average of 2.3 calls per hour (Table 6).

METHOD

A total of nine recorders were placed throughout the eastern side of the forest and four of these were placed at the same traditional locations used since 2011. The five other recorders were placed within the core eastern area to capture any population increase and with the view of capturing new breeding males. These recorders were left in the forest from the 24th of May to 19th of June and set to record from 1800 to 2400 each evening. Data from the 24th to 27th of May was used for the traditional four-day kiwi call survey as it was the period chosen in advance which is the closest in time to previous surveys.

RESULTS

Between the 24th and 27th of May, during the first two hours of listening, the acoustic recorders positioned at the traditional sites on the eastern sites (n=4) detected a lot more calls per hour compared with previous years (Table 6).

TABLE 6: COMPARISON BETWEEN CALL RECORDERS RESULTS IN 2011, 2013, 2014, 2015 AND 2017

	2011*	2013	2014	2015	**2017**
2h/night, 4 sites	1.15	1.27	1.29	1.03	**2.31**

**Start of the 3-yearly 1080 cycle operations*

Analysing the overall data from the nine recorders, it appears that call counts have increased within the core area and have decreased on the outskirt of the sanctuary where predators such as ferrets are more likely to enter. The closest acoustic recorder to the boundary of the Sanctuary (Carcass hill), has shown a dramatic drop in call rates from 2 calls per hour in 2013 to 0.125 calls per hour this season, whereas a recorder placed near the Waione River at a location called Slipway (passed Lucky's corner), call rates dramatically increased from 1.4 calls per hour in 2013 to 4.9 calls per hour this season (Figure 3).

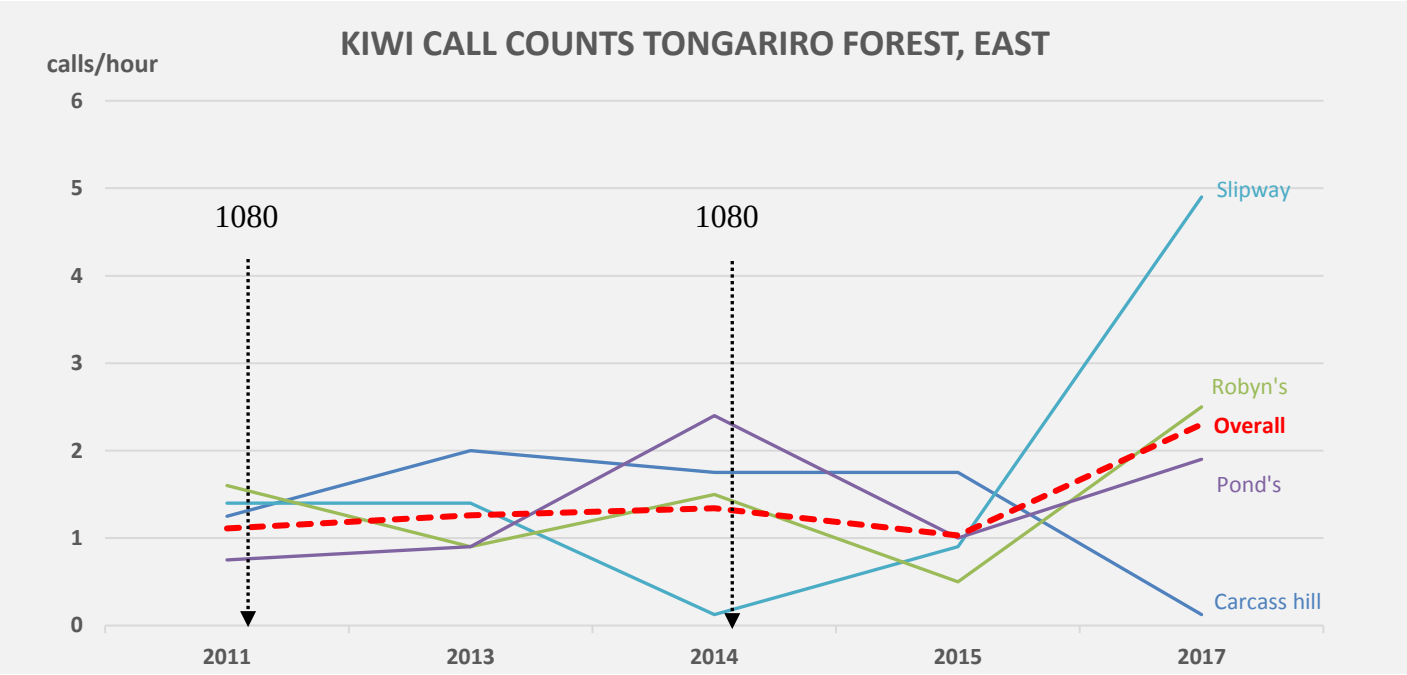

FIGURE 3: CALL RATES BETWEEN 2011 AND 2017 AT THE FOUR TRADITIONAL SITES ON THE EASTERN SIDE OF TONGARIRO FOREST.

DISCUSSION

The decline in call rates in 2015 may be due to normal variability within kiwi call behaviour rather than an actual decline, although only repeated measures will detect the long-term population trend. This season was year three of the second 3-yearly 1080 cycle and the upward trend in kiwi call rates this year may confirm predictions from the TFKS population modelling that the population is growing and may double by the year 2031 (Figure 4). This is despite the continuous pressure from ferrets, in particular on the outskirts of TFKS.

More needs to be done in terms of kiwi surveys in those areas in order to confirm a real change in kiwi call rates within the core area and it appears that undertaking a comprehensive ferret trapping regime on the outskirts may be essential to allow the population to grow faster and expand beyond its current boundaries.

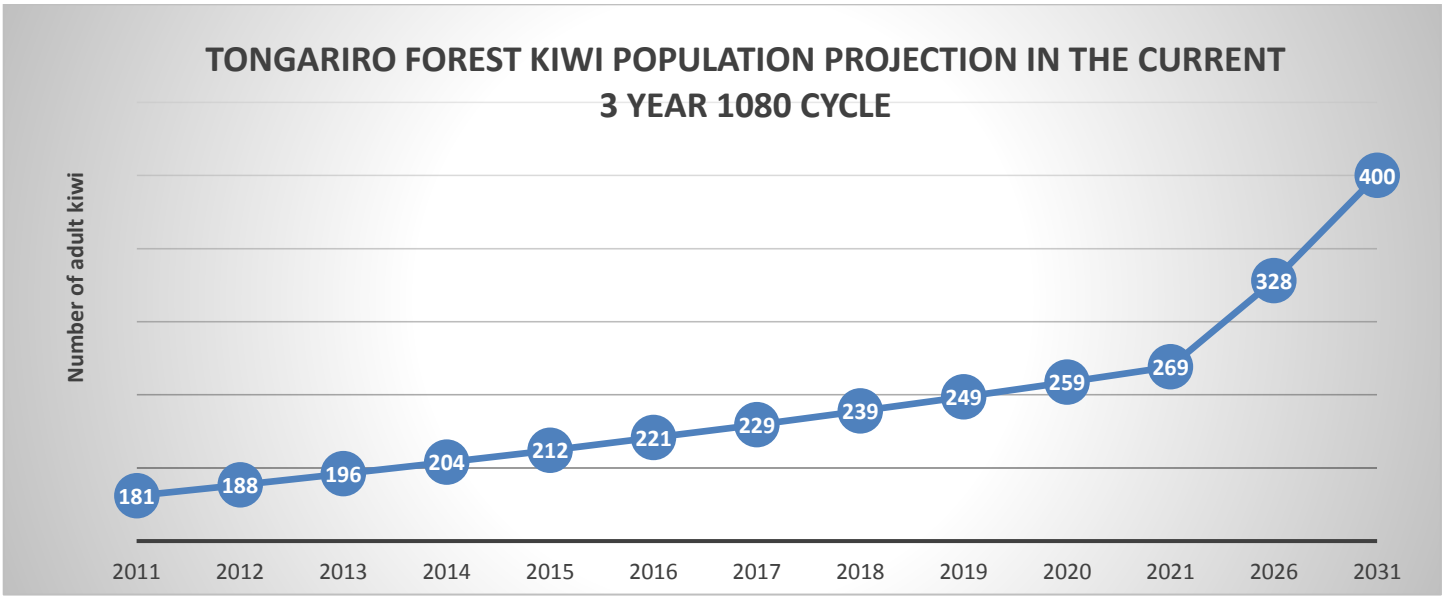

FIGURE4: KIWI POPULATION PROJECTION FROM 2011 WHEN THREE-YEARLY 1080 CYLCLE STARTED

FUTURE DIRECTIONS

The next 1080 operation is scheduled for August this year with a recommended sowing rate of 1.5 kg/ha with no gaps in the distribution this time (e.g. not strip sowing). Kiwi chick survival research will occur again next season 2017/18 and be re-evaluated at the end of the season to determine if a second year of monitoring is needed in 2018/19.

Ideally, chick survival can be tested through four 3-yearly 1080 cycles so that the study is robust and allows for clear conclusions, which would extend the research to the 2023/24 season. However, OSPRI (TB free New Zealand) has indicated that this was going to be their last 1080 operation at TFKS. This means that other sources of funding are needed to continue the research and sustain an ongoing 3-yearly 1080 cycle. Support from Government funded SOIK has become critical.

Tracking tunnel monitoring will continue with modification to fit in with the 21-day mustelid monitoring trial. Camera trap trials are also being considered in TFKS to monitor small mammals in 2018/19.

Lastly, there is a strong sense of urgency to understand ferret/prey dynamics and whether ferret control should be built into the programme. A review of the TFKS programme is currently underway.

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Appendix 1

AERIAL 1080 OPERATION AUGUST 2014 (OPERATIONAL DETAILS)

This operation was undertaken in August 2014, using 0.15% 1080 pellets in a cereal bait at a sowing rate of 0.75kg/ha. The sowing rate was lower than any previously used (i.e. 4kg/ha in 2006 at 0.08% 1080 bait, and 2kg/ha in 2011 at 0.15% 1080 bait). The pre-feed and toxin was distributed in 40m gaps between swaths of 140m, with flight paths 180m apart (called strip sowing). It is noted that this is an unconventional method of distribution which was evaluated at TFKS after trials in Whanganui National Park showed promising results.

The result targets for this operation were:

- less than 5% rat tracking September/October 2014; and
- 0% stoat tracking September/October 2104.

The outcome target was for kiwi chick survival to exceed 50% the season immediately after the operation (Haigh, 2014).

Appendix 2

KIWI RECRUITMENT AND POPULATION GROWTH

WITH FERRETS INCURSIONS (CURRENT SITUATION)

If we were to have no management of the kiwi in Tongariro Forest, the population would decline at a rate of 6.7% per year into eventual extinction (table 7).

The TFKS population modelling shows that an aerial 1080 regime every five-years is enough to maintain the existing population, but not to grow the population. If we wanted to achieve population growth, then a 3-yearly 1080 regime would grow the population, eventually doubling the existing population by the year 2031 (Figure 4).

TABLE 7: RECRUITMENT AND ANNUAL GROWTH UNDER DIFFERENT MANAGEMENT REGIMES

Management regime	Mean chick SR 0-6mths (%)	Adult SR (%)	Recruitment (%) for Stable population	Actual Recruitment (%)	Annual growth (%)
3y 1080 cycle	33.3	94.8	10.1	21.9	+ 4.3
5y 1080 cycle	25.4	91.5	16.3	16.7	+ 0.1
No management	13.5	87.5	24.1	8.8	- 6.7

NO FERRETS

If we were able to suppress ferret predation by implementing an efficient ferret control method (yet to be defined), a five-year 1080 regime would then allow the population to grow at the same annual rate as the current 3 yearly regime (Table 8).

The growth rate of 1.4 % per annum in the absence of 1080 (Table 8) appears to be unlikely (by 2000, the population had declined to a mere 150-180 birds). This shows that ferrets have certainly always been preying upon adults and a scenario in the absence of ferrets is merely theoretical. This population modelling exercise has the advantage to show the huge impact that ferrets have on the TFKS kiwi population.

TABLE 8: RECRUITMENT AND ANNUAL GROWTH IN THE ABSENCE OF FERRETS (IF FERRETS WERE SUPPRESSED) UNDER DIFFERENT MANAGEMENT REGIMES

Management regime	Mean chick SR 0-6mths (%)	Adult SR (%)	Recruitment (%) for Stable population	Actual Recruitment (%)	Annual growth (%)
3y 1080 Cycle	33.3*	96.9	6	22.7	6
5y 1080 Cycle	25.4*	96.9	6	17.3	4.3
no 1080	13.5*	96.9	6	9.2	1.4

**Assuming kiwi chick survival is no different whether ferrets are present or not*