Department of Conservation
Te Papa Atawhai

TONGARIRO FOREST KIWI SANCTUARY ANNUAL REPORT

July 2015– June 2016

TONGARIRO DISTRICT OFFICE, CENTRAL NORTH ISLAND REGION

Ngati Hikairo ki Tongariro

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Cover photo: The 1500th Operation Nest Egg Kiwi, "Mighty Dash" Release event. From left: Bhrent Guy, Te Rangituamatotoru Maniapoto, Renee Potae, Claire Travers, Jerome Guillotel, Alison Beath, Jeff Willis, Emma Bean, Jenny Hayward

PARTNERSHIPS

Partnerships between the Department of Conservation and Ngati Hikairo, The National Kiwi Trust at Kiwi Encounter, Maungatautari Ecological Island Trust, Project Tongariro, and Kiwis for Kiwi Trust continue to be an essential part of the work in the Tongariro Forest Kiwi Sanctuary (TFKS). Wairakei Golf + Sanctuary has taken up an important role as a kiwi crèche for our area.

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™ (O.N.E). This season (2015/16), 30 kiwi eggs were taken to Kiwi Encounter, 22 chicks were released at TKFS and three chicks were released to Wairakei Golf + Sanctuary.

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 (MEIT)

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, aiming to eliminate all mammalian predators and re-introduce native species. In 2006, TFKS 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 14 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, three chicks from Tongariro were released into the predator free enclosure.

EXECUTIVE SUMMARY

Tongariro Forest Kiwi Sanctuary (TFKS) was established in 2000 for the development of kiwi protection techniques, namely the use of Operation Nest Egg™ (O.N.E) 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 Operation Plan, 2010), and to involve the community and enhance public awareness. This target has been significantly compromised by ferret incursion events first occurring in 2009 and the revised aim of growing the population to 100+ pairs by 2019 (Kiwi Sanctuaries Strategy draft 2014-2019) is a more realistic goal. This is in line with the target set up by the government in 2015 to achieve a minimum population growth rate (r) of 2% per year for all kiwi taxa.

One of the key current research projects in TFKS has been the assessment of the effect of a landscape-scale 1080 (19,840 ha) operation on kiwi chick survival. Between 1995 and 2011, aerial 1080 operations were undertaken every five years and, although the population stopped declining, this appeared not to be sufficient for the population to recover fast enough (r=0.07%, see Population Growth Section). In 2014, it was established that a shift to a three yearly-operation would allow the annual growth rate to reach 4.4%, well above the national target (2013/14 TFKS Annual Report). The last 1080 operation occurred in August 2014 and initiated the new 3-year cycle experiment over a period of 10 years.

Twenty-eight breeding adult kiwi males were monitored in TFKS in 2015/16. There were 20 confirmed nests this season with a total of 33 eggs, resulting in 30 successfully hatched chicks (Table 2). A total of 24 kiwi chicks were monitored at TFKS in the 2015 / 16 season. The survival rate (Kaplan Meier) was 41.3%. This was higher than the previous season (34.8%) immediately after 1080 and the pre-1080 level which was approximately 20%.

Seven sub-adults were monitored this season for breeding recruitment. This also continues to give us information about distribution of kiwi across the forest.

Small Mammal Index monitoring (using a network of tracking tunnel lines) has been undertaken in TFKS since 2001. After the 2014 1080 operation and the dramatic decrease of small mammal tracking rates that followed, rat numbers returned to pre-1080 level 8 months after the 2014 1080 operation and tracking rates have stayed between 70 and 80 % since then. Similarly, during previous operations, mustelids have continued their slow recovery to reach a tracking rate of 12% over 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. 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 (Figure 3) 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 is 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, monitoring chick survival in response. Sowing rates for the proposed 2017 1080 operation are yet to be confirmed.

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 a comprehensive kiwi call survey is planned for 2017. Mustelid and rodent numbers are also monitored using tracking tunnels (small mammal indexing).

This report presents results from these key areas of work for the 2015/16 financial year.

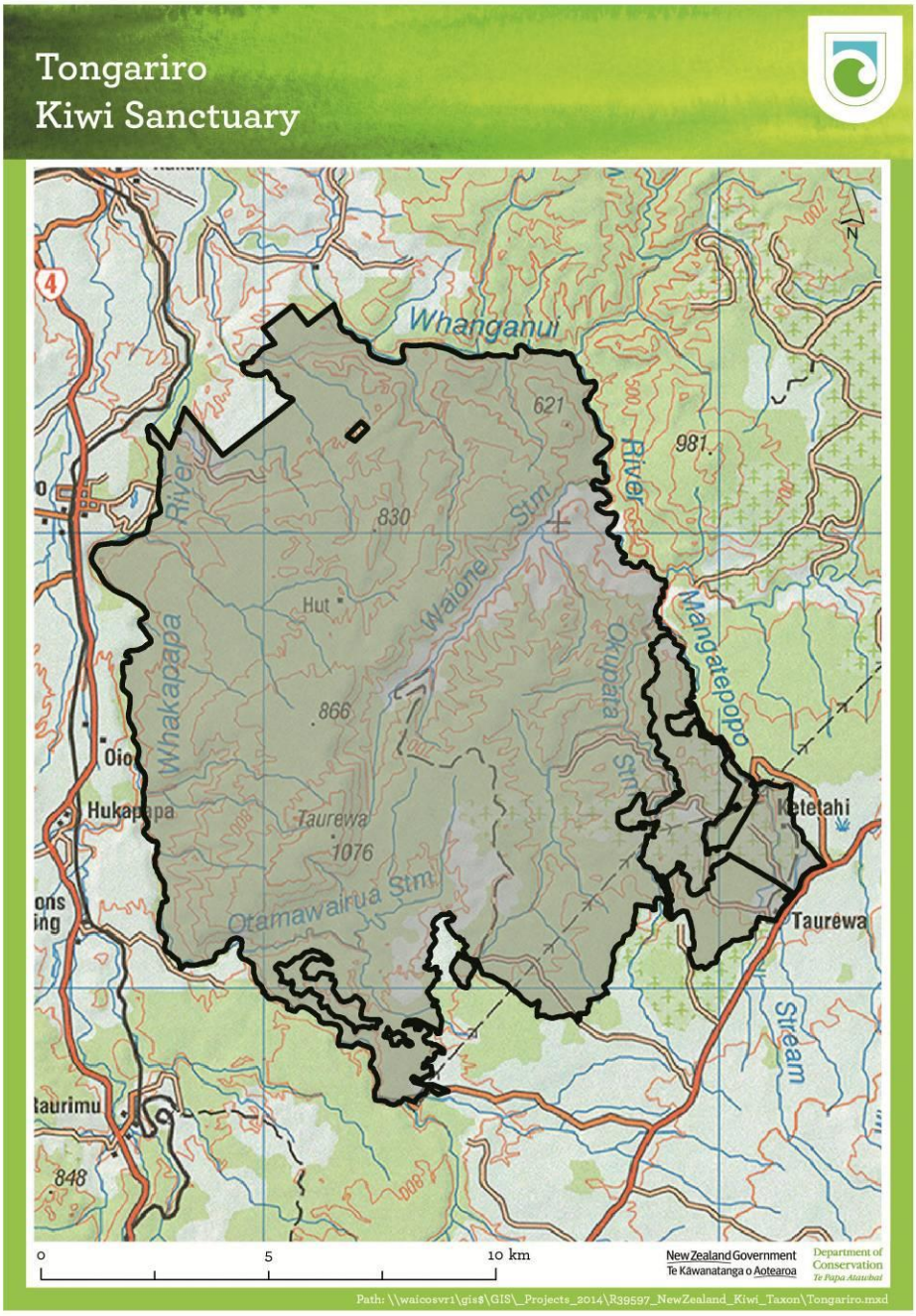


FIGURE 1: LOCATION MAP FOR TONGARIRO FOREST KIWI SANCTUARY, CENTRAL NORTH ISLAND REGION

SANCTUARY OBJECTIVES AND ACTIONS

(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	On track to be completed by December 2016
4.6	Publish research on benefits of aerial 1080 on kiwi chick survival by 2014/15	TFKS & KRG	Essential	On track to be completed by June 2017

SMALL MAMMAL INDEXING (SMI) USING TRACKING TUNNELS

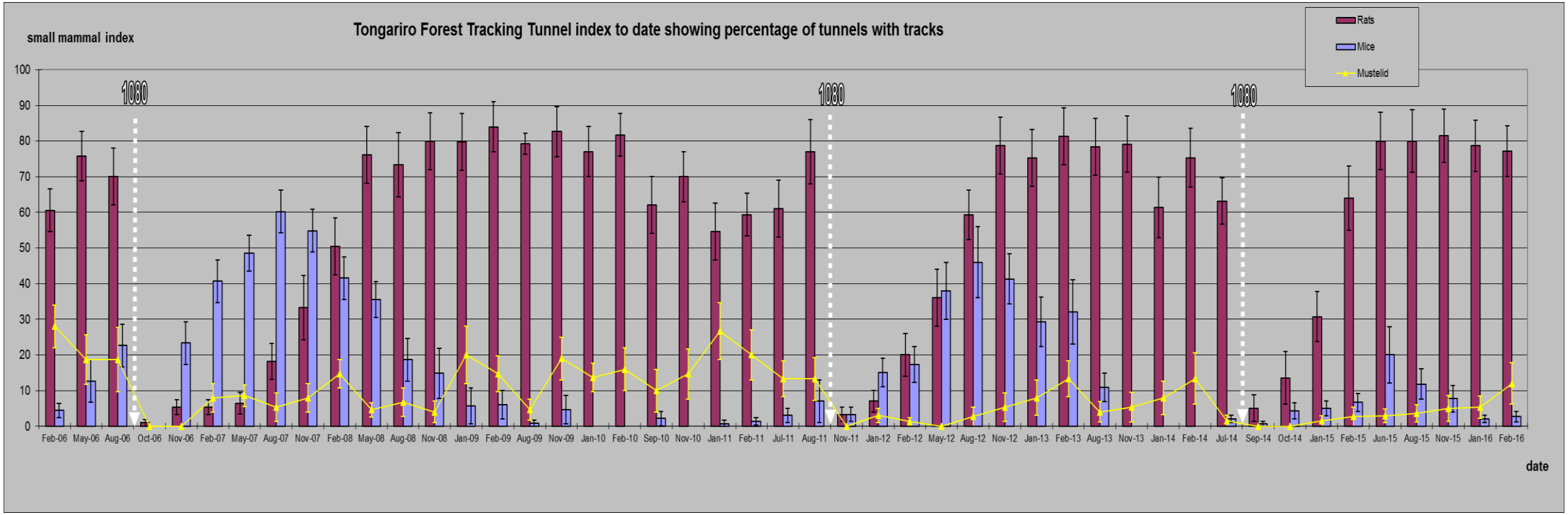
Tracking tunnels for indexing rodent and mustelid (weasel, stoat and ferret) abundance were run on the 'Operation Ark' timing (i.e. January, February, August and November) to catch the peak in stoat abundance. Methodology follows current DOC best practice (Gillies & Williams 2001). There are 15 lines within TFKS; each line is 450m long with ten tunnels, giving a total of 150 tunnels. TFKS is entering its 16th year of small mammal indexing data gathering. This supports and increases our knowledge and understanding of small mammal population dynamics in relation to aerial 1080 use.

TRACKING TUNNEL RESULTS SECOND SEASON AFTER THE 2014 AERIAL 1080 OPERATION (0.75kg/hectare of pellets)

Immediately after the 2014 1080 operation, SMI results showed a dramatic decline in both rat and mustelid tracking rates (Figure 2), rats were knocked down to 5%; they were tracking at 70% or greater prior to the operation. The mustelid tracking rate peaked at 13.3% in February 2014, but none were detected in any of the tunnels after the aerial 1080 operation (0% tracking rate). However, rats re-colonised the forest faster (eight months after 1080 drop) than was the case following previous operations (respectively 18 months and 13 months after the 2006 and 2011 operations). The rat tracking rates were at 77% in February 2016.
The mouse tracking rates, which were low since September 2012, increased rapidly after the 1080 operation with the initial reduction of rat numbers but the extent of it was brought to a halt by the rapid re-colonisation of the rats (Figure 2). Mice tracking rates were at 2.67% in February 2016

The steady recovery of the mustelid population is following the trend of the two preceding operations and has reached the 10% mark during the second post-1080 summer (12% in February 16). The more sensitive outcome measure of kiwi chick survival, which is higher than last season (41%), suggests that stoat numbers haven't recovered yet to level of non-treatment years (see Chick Monitoring Section).

FIGURE 2: SMALL MAMMAL INDEXING RESULTS, TONGARIRO FOREST KIWI SANCTUARY, FEBRUARY 2005 – FEB 2016



ADULT KIWI MONITORING AND NESTING

A total of 29 adult kiwi were monitored in TFKS in 2015/16, consisting of 28 males and one female. During 2015/16, there were no adult or sub-adult kiwi deaths. This was a repeat of the results obtained after the 2011 aerial 1080 operation after which there were also no deaths among adult and sub-adult kiwi for more than two years.

During the latter part of the season radio transmitters were removed from two of the male adult kiwi, "Doug" and "Flygirl". Doug was one of the first wild kiwi to be caught in Tongariro Forest. He was first caught and fitted with a radio transmitter by Murray Potter in 1997. His transmitter was removed in April 2016 as it was agreed that he had served the project well and it was time for him to retire. Flygirl's transmitter was removed in June 2016. He was living in difficult terrain and had not yet been successful at breeding. While he had been found with female kiwi, "Aubrey" in his burrow, Aubrey has also been captured with other male kiwi in the area who have been found to be incubating eggs.

Future kiwi call surveys over the entire forest (2017/18 season) and the continuity of some sub-adults being monitored for recruitment for the next few seasons (seven were monitored this season) will give us a more robust estimation of the population number and distribution.

NESTING AND EGG OUTCOMES

There were 20 confirmed nests this season. To ensure a sample size of at least 16 chicks was achieved, a proportion of the eggs were lifted from nests in the wild and taken to Kiwi Encounter where they were incubated and hatched in captivity (kiwi eggs have a higher hatch rate in captivity than in the wild). Egg lifts took place after 55 days of incubation.

There were 33 eggs in total and three of these were not viable (Table 3). Of the 30 hatched chicks, three were euthanized due to complications and three chicks were released at Wairakei Golf + Sanctuary. They will remain there until stoat safe weight (1200g). One of these chicks was the 1500th kiwi chick to be hatched via Operation Nest Egg ™ at Kiwi Encounter. He was named "Mighty Dash" and remained at Kiwi Encounter until May 2016 when he was released to Wairakei. One chick was thought to have neurological issues and sent to Massey but found to be of good health so was released to Wairakei. The third chick hatched very late in the season (the latest Kiwi Encounter has ever hatched) so was also released at Wairakei for the winter. All three will be returned to Tongariro Forest.

Twenty-four kiwi chicks were monitored at TFKS this season. Twenty-two of these chicks hatched from eggs taken to Kiwi Encounter. Two were hatched in the wild and intercepted at the nest in TFKS. Chick interceptions were timed to intercept both chicks (this can usually be ascertained by assessing the bird's activity output), with the aim of intercepting the oldest chick between 10 and 15 days (a second chick will usually hatch within one week of the first). All monitored chicks were fitted with

chick mortality transmitters and returned to their natal territory, or to a pre-determined release site within the TFKS, at hatch weight (approximately two weeks of age).

TABLE 2: NEST AND EGG OUTCOME SUMMARY

	Unconfirmed Nests*	Confirmed Nests	Total eggs	Hatched in captivity	Wild Hatched	Eggs not hatched	Chicks euthanized	Total Chicks
Catamarca	1							
Chance		1	1	1				1
Comet	2							
Dani		2	3	2	1			3
Dino	1	1	2	2				2
Doug	1							
Drogon	1							
Fozzie	2							
Gulliver	1	1	1	1				1
Hail	1							
Hiver	1	1	2	2				2
Koroki	1	1	1	1				1
Little Moa	1	1	2	2				2
LoggerRoss		2	2	2				2
Max		1	2	1		1		1
Murphy	2	1	2	2				2
Otoro	1	1	2	2				2
Peter Pan	1							
Pumpkin	1	1	2			2		
Rocket		1	2	2				2
Speedy		2	4	4			3	4
Taika	1	1	2	2				2
Te Hokinga		2	3	2	1			3
	19	**20**	**33**	**28**	**2**	**3**	**3**	**30**

*Nesting signal obtained

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 2015/16 season was the second season after the 1080 operation was carried out on 25 August 2014.

MONITORING METHODS

All chicks, whether hatched in captivity or tagged in the wild, were fitted with radio-transmitters. Signals for each chick were obtained weekly, as the transmitters give a mortality signal once they have not moved for 24 hours.

Any mortality signal was investigated promptly to ascertain cause of death. At the scene, the remains were gathered and examined, notes made and photos taken. The carcass remains were sent to the New Zealand Wildlife Health Centre at Massey University for post-mortem examination (when not able to differentiate between weasels, stoats and ferrets, the family group name "mustelid" has been used).

The kiwi chicks were captured on a monthly basis for a health check, to change the transmitter strap (due to growth), and to conduct growth measurements through obtaining weights and bill lengths. In order to compare chick survival over eight seasons, survival rates to 183 days were calculated for each season using the Kaplan-Meier procedure, as recommended by Robertson and Westbrooke (2005), with 95% confidence intervals.

KIWI CHICK OUTCOMES AND SURVIVAL RATES

This season, a total of 24 chicks were monitored within TFKS. The first chick was released into TFKS on 6th October 2016, and the last chick was released on 25th February 2016. One chick dropped its transmitter, 1 was removed from the experiment and nine chicks have reached sub-adult status (>183 days of age).

Thirteen chicks were found to have died this season; two due to misadventure (one fell into a tomo and one was suspected to have died from emaciation due to malformation on both legs). There were two cases where the cause of death was unknown (one was too decomposed, the remains of the other were insufficient to determine the cause of death). There were four cases where the cause of death

couldn't be confirmed but, as the remains were typically cached in a hole or burrow, were assessed by kiwi practitioners as to be from mustelid predation. There were five confirmed predations by The NZ Wildlife Health Centre as "likely" or "possible mustelid predation".

The first predation event was recorded on the 12th November 2015, and the most recent on the 27th February 2016.

Figure 3 depicts the results from the last three aerial 1080 operations.

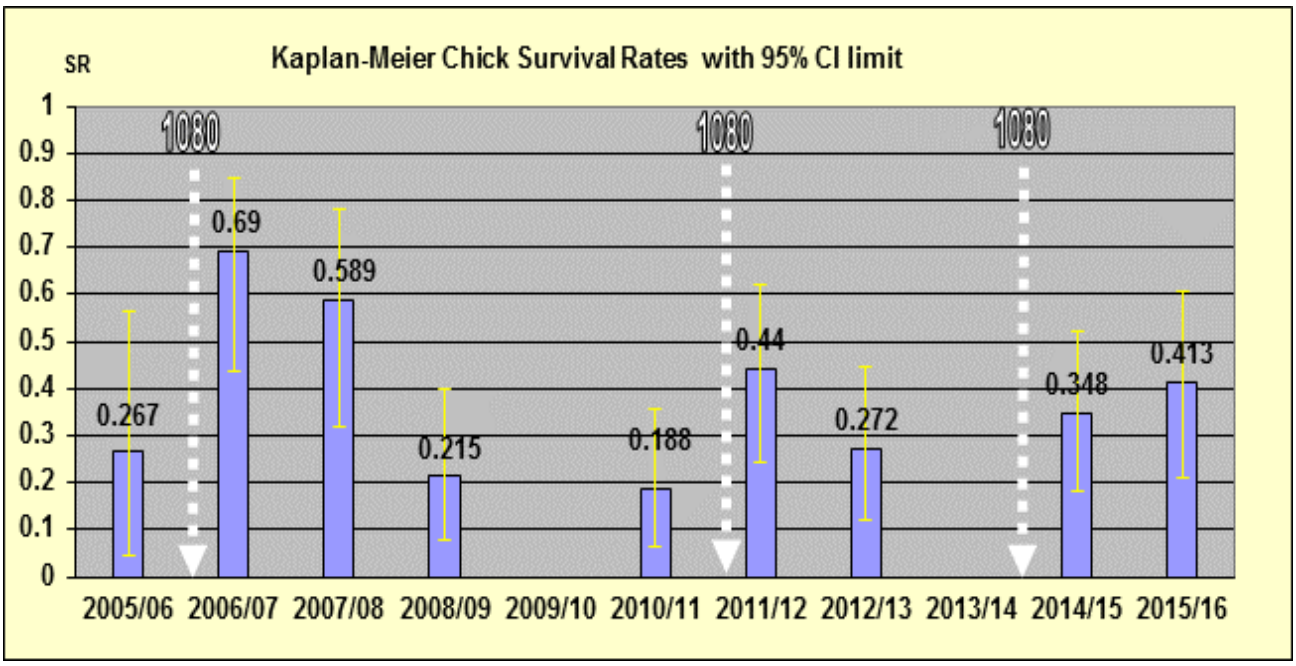


FIGURE 3: KAPLAN-MEIER KIWI CHICK SURVIVAL ESTIMATES FOR THE NINE BREEDING SEASONS, 2005-2016*

**Data from the 2009/10 and 2013/14 seasons are not included as chicks were crèched in predator proof fenced areas (Warrenheip or Wairakei Golf + Sanctuary).*

There is a notable increase in chick survival rate (SR) with each aerial 1080 operation when compared to non-treatment years. However, as sowing rates have decreased, survival rates also appear to decrease the season immediately after (year1), although it is not necessary the case for the second season post 1080 (year 2). Indeed, the chick survival rate this season (41.3%) is unexpectedly better than year 1 (34.8%), which makes this last 1080 operation more successful than the 2011 one if you take in account the two seasons following each 1080 drop. On average, SR=38.2% over the two years after the 2014 operation versus 35.6% over the two years after the 2011 operation (considerably lower than the two years after the 2006 operation; 64%).

Tongariro Forest east vs. west

Traditionally there has been a marked difference between the eastern and western parts of Tongariro Forest, not only in habitat composition (the western side harbouring more mature trees and the eastern side being scrubbier with more tracks connecting to adjacent farms), but also in call rates. We separated survival rates between the two areas, and a notable difference has appeared. (Figure 4)

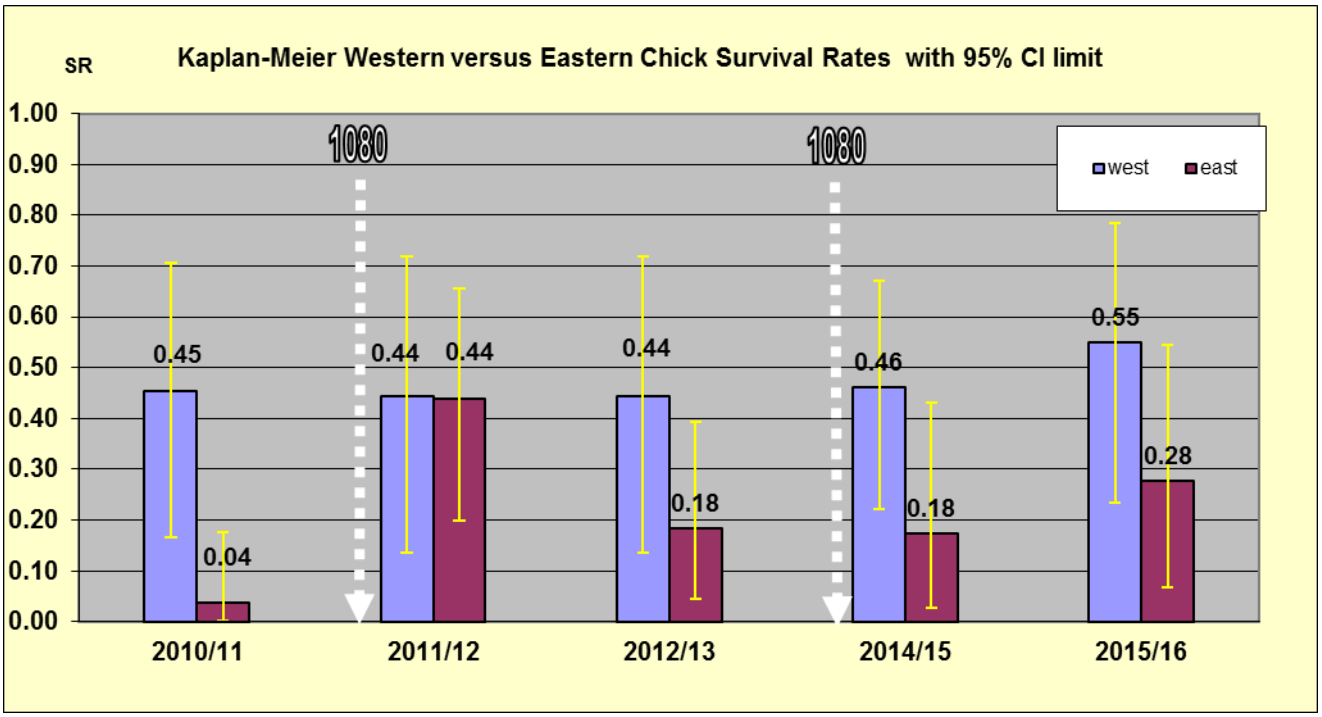


FIGURE 4: COMPARISON KAPLAN-MEIER KIWI CHICK SURVIVAL ESTIMATES BETWEEN EAST AND WEST OF TONGARIRO FOREST*

**Data from the 2013/14 season is not included as chicks were crèched at Wairakei Golf+Sanctuary*

The survival rate on the western side of the forest has remained relatively constant regardless of whether it was a treatment or non-treatment year, with a record survival rate this season of 55%. The eastern side has much lower survival rates comparatively but has experienced an increase as well this year (28%).

This season, particular attention was given to the sample size so that it was even on either side (n=12),

TABLE 3: COMPARISON OF KAPLAN-MEIER KIWI CHICK SURVIVAL ESTIMATES (S.R.) AND SAMPLE SIZES (n) BETWEEN TONGARIRO FOREST EAST AND WEST *

	2010/11		2011/12		2012/13		2014/15		2015/16	
	S.R.	*n*	*S.R.*	*n*	*S.R.*	*n*	*S.R.*	*n*	*S.R.*	*n*
TF West	0.454	11	0.444	9	0.444	9	0.462	17	0.551	12
TF East	0.038	14	0.438	16	0.183	18	0.175	11	0.278	12

**Data from the 2013/14 season is not included as chicks were crèched at Wairakei Golf+Sanctuary*

This demonstrates that there are more variables involved in the eventual outcome than previously thought.

KIWI RECRUITMENT AND POPULATION GROWTH

Kiwi recruitment (R) refers to when sub-adults survive from hatch to be added to the adult population when reaching four years old (immigration is not taken into account as it is negligible in Tongariro Forest). At Tongariro, adult mortality from ferret predation starts occurring in year three after 1080 and consequently adult survival rates vary under the different management regimes. This influences the level of recruitment required to grow the population. For instance, adult survival rate is 91.5% under a 5-year 1080 regime and for the population to be stable, recruitment (R) needs to be about 16.3% per annum. However, under a 3-year 1080 regime, recruitment needs to be about 10.1% per annum (Adult SR=94.3%), (Table 4). Under the current 3-yearly 1080 regime, recruitment is at about 21.2% per year, which translates into a population growth (r) of about 4% per annum (using Microsoft Excel PopTools add-in), (Table 4 & Figure 5).

As a comparison, recruitment would need to be about 23.6% per year if the forest was under no management (in non-treatment years, recruitment is around 9%), (Table 4).

In summary, if we were to have no management of the kiwi in Tongariro Forest, the population would decline at a rate of 6.5% per year into eventual extinction.

This population modelling shows that an aerial 1080 regime every 5-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 2036 (Figure 5).

TABLE 4: RECRUITMENT AND ANNUAL GROWTH UNDER DIFFERENT MANAGEMENT REGIME*

Management regime	Mean chick SR 0-6mths (%)	Adult SR (%)	Recruitment (%) for Stable population	Actual Recruitment (%)	Annual growth (%)
3y 1080 cycle	33.1	94.3	10.1	21.2	+ 4.04
5y 1080 cycle	25.9	91.5	16.3	16.4	+ 0.07
No management	14.1	87.5	23.6	9	- 6.47

**Using Sub-adult (0.5 to 4y old kiwi) survival rate of 63.9% (latest figure from July 2016)*

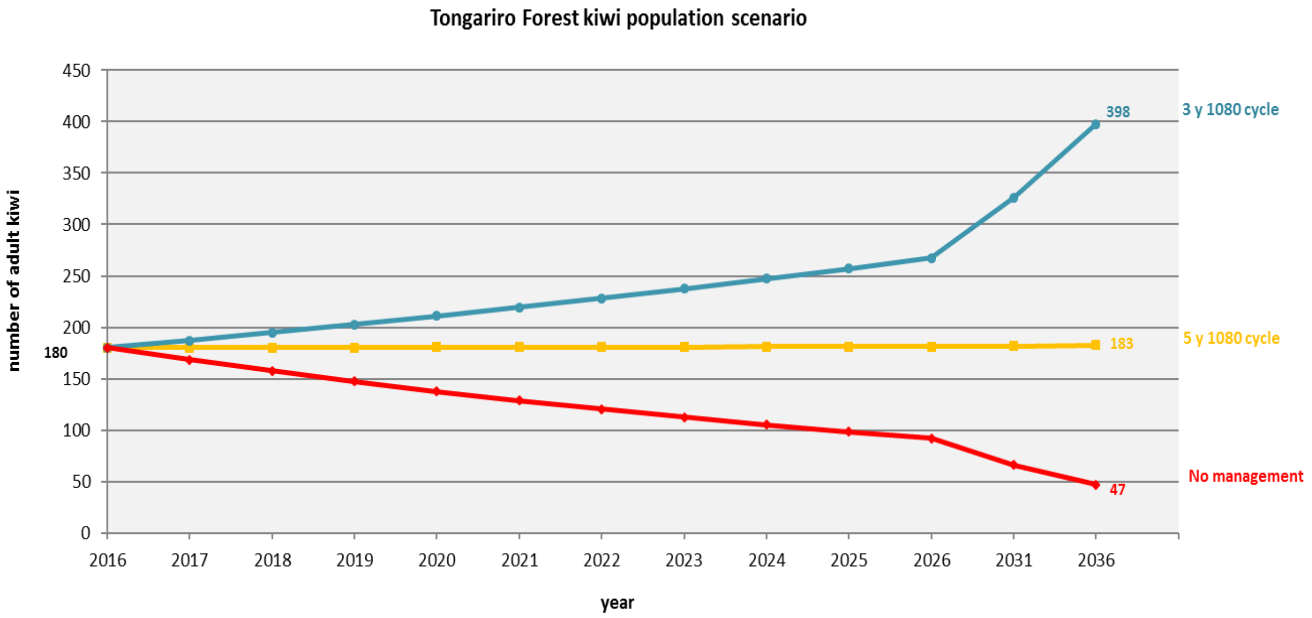


FIGURE 5: KIWI POPULATION PROJECTION FOR THE NEXT 20 YEARS, BASED ON UPDATED RECRUITMENT RATES WITH 1080 OPERATIONS

FUTURE DIRECTIONS

Next year (2016/17) will be a post 1080 non-treatment season. No kiwi chick survival research will occur during 2016/17. Instead the focus of the TFKS will be in lifting eggs to support an agreement with Maungatautari to provide 20 founder kiwi, as well as providing up to six eggs for release through Wairakei into TFKS. The next 1080 operation is proposed for August 2017 (subject to consultation). This adjustment to the timing of aerial 1080 operations (from September to August) is based on our previous research which shows this may be more effective in increasing chick survival. Kiwi chicks will be monitored for two seasons after operations, however chicks will no longer be monitored during pre-1080 seasons (non-treatment years) as we have established a good set of data showing results for kiwi chick survival in the absence of predator control (</= 22%).

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New Zealand Government

Appendix 1

AERIAL 1080 OPERATION AUGUST 2014 (OPERATIONAL DETAILS)

A joint funding agreement has been reached between TB Free NZ and DOC for three yearly treatments at this site from 2014 to 2024. The first of these operations 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).