Department of Conservation
Te Papa Atawhai

TONGARIRO FOREST KIWI SANCTUARY ANNUAL REPORT

July 2014– June 2015

TONGARIRO DISTRICT OFFICE, CENTRAL NORTH ISLAND REGION

Ngati Hikairo ki Tongariro

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Cover photo: Tongariro Forest Kiwi Sanctuary – "Royal" in Tongariro Forest West, Jenny Hayward on quad bike, "Little Moa's" nest and his three eggs

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. This season (2014/15), 34 kiwi eggs were taken to Kiwi Encounter and 23 chicks were released at TKFS.

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 small mammal indexing, transporting kiwi eggs to The National Kiwi Trust at Kiwi Encounter and 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, including kiwi. TFKS and Ngati Hikairo have gifted 14 kiwi to Maungatautari and Ngati Koroki-Kahukura to be part of a founder population there. Since 2010, 14 kiwi (the offspring of some of the original founders) have been released into TFKS.

OTOROHANGA KIWI HOUSE

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 (Potae 2012). This has created a pest free environment which can be used to benefit threatened plants and animals. The sanctuary was officially opened in 2011 and is utilized as a kiwi crèche when undertaking Operation Nest Egg ™ (O.N.E).

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. 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 and the revised aim of growing the population to 100+ pairs by 2019 (Kiwi Sanctuaries Strategy draft 2014-2019) is a more realistic goal.

One of the key current research projects in TFKS has been the assessment of the effect of a large scale 1080 operation on kiwi chick survival. An aerial 1080 operation was undertaken in August 2014. Twenty nine adult kiwi were monitored in TFKS in 2014/15. There were 22 confirmed nests this season with a total of 39 eggs. Eight of the eggs did not hatch and there were 31 chicks (Table 3). A total of 28 kiwi chicks were monitored at TFKS in the 2014 / 15 season.The survival rate (Kaplan Meier) was 34.8% compared to pre-1080 levels of 27.2%.

Small Mammal Index monitoring (using a network of tracking tunnel lines) has been undertaken in TFKS since 2001. Two weeks after the 1080 operation on the 25th August 2014, rat numbers were knocked down to 5% but were found to have re-colonised the forest faster (10 months after 1080 drop) than was the case following previous operations. Mustelids were tracking at 0% immediately after the operation and have stayed low ever since (2.9% in June 2015)

One hundred and three O.N.E sub-adult kiwi have been released into TFKS since 2000. Of these, 97 have been closely monitored, along with 60 wild hatched sub-adults. The survival rate as at the end of the 2014/15 season was 65.7%, with survival rate lower for female than male. The average age of first breeding is 3.84 years old. Fifteen sub-adults are currently monitored but only a few males will be kept for breeding recruitment as the study has drawn to an end.

A kiwi call survey was undertaken in early June this year using acoustic recorders at the traditional seven sites throughout the TFKS. Additional recorders were also set at 19 extra sites. Less calls were heard with acoustic recorders this year (0.61 calls per hour) than last year (1.24 calls per hour) at the traditional sites but more birds were heard (1.78) than last year (1.56) at twenty common recording sites. Within the 4082ha covered by acoustic recorders and during ten fine nights, 1.14 calls per hour were heard which translates to 70 individual birds.

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).

One of the key current research projects in TFKS has been the assessment of the effect of large scale 1080 operations on kiwi chick survival. 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.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 potentially two consecutive seasons in TFKS (see Figure 4). Other forest birds also benefited from aerial 1080 operations with increased nest success for fantails for one or two consecutive seasons after 1080 operations (ref the last report with fantail results).

Our proposed research focus for the next five years from 2014 onwards is to measure the benefits of even lower sowing rates of aerial 1080 to kiwi chick survival (Scrimgeour et al. 2015). We have moved from distributing 2kg/ha of toxin in 2006, to 1kg/ha in 2011 and down to 0.75kg/ha in this season's operation, monitoring chick survival in response.

In addition to this research, other work includes ongoing monitoring of adult kiwi for survival and breeding purposes, monitoring of sub-adult kiwi for survival, dispersal and breeding and kiwi call survey. 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 2014/15 financial year.

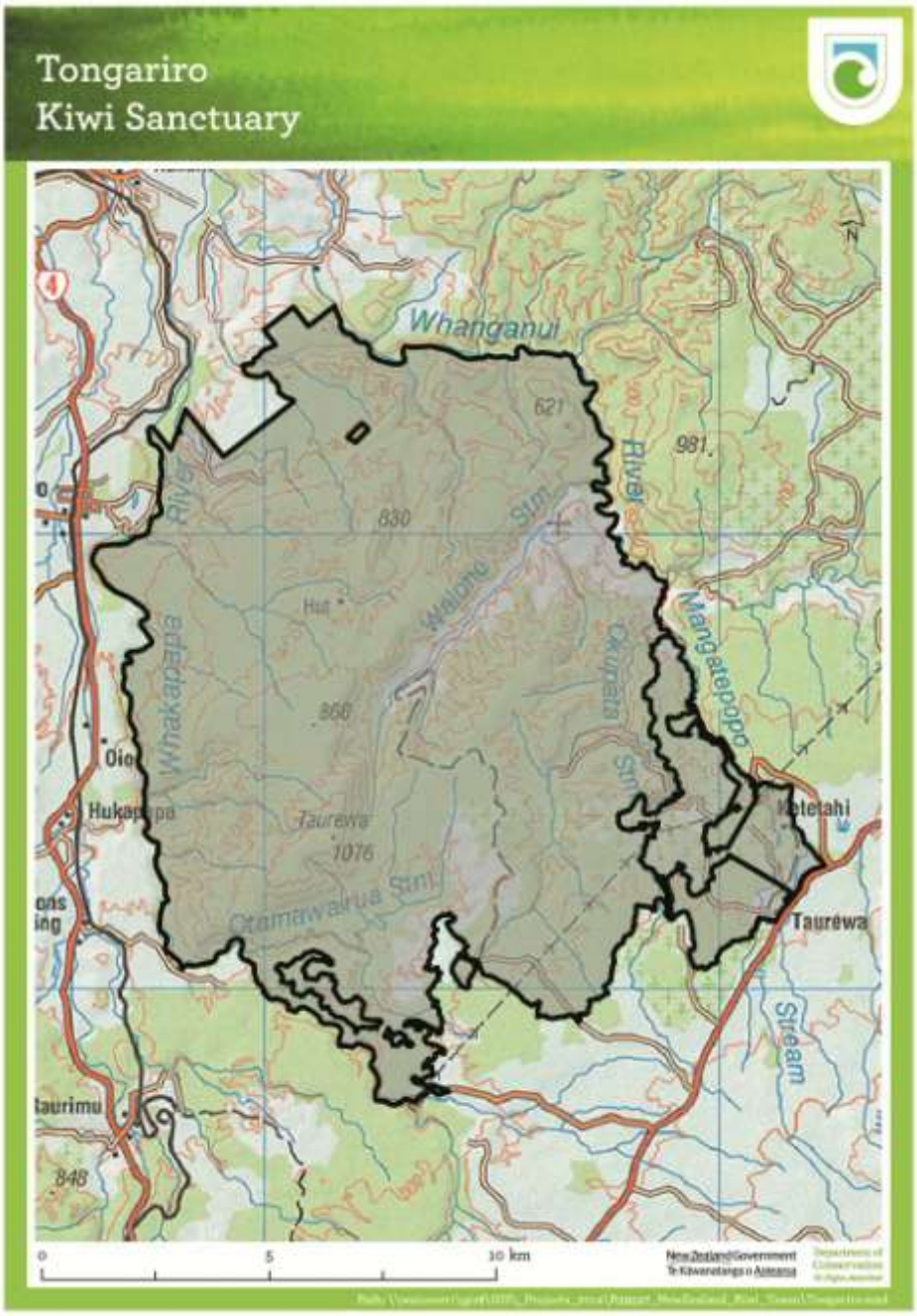

FIGURE 1: LOCATION MAP FOR TONGARIRO FOREST KIWI SANCTUARY, CENTRAL NORTH ISLAND REGION

SANCTUARY OBJECTIVES AND ACTIONS

(Kiwi Sanctuaries Management Plan 2015-2018 -DOCDM-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	Not started but sub-adult study to be progressed in the next 12 months
4.6	Publish research on benefits of aerial 1080 on kiwi chick survival by 2014/15	TFKS & KRG	Essential	On track

AERIAL 1080 OPERATION AUGUST 2014

A joint funding agreement has been reached between TB Free NZ and DOC for three yearly treatments at this site for the next ten years (2014-2024). 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. 2kg/ha in 2006, and 1kg/ha in 2011). 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).

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. Tracking tunnels have been run in TFKS since 2001.

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

The SMI results demonstrated a major decrease 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). Therefore both result targets were met immediately after the operation.

However, it appears rats re-colonised the forest faster (10 months after 1080 drop) than was the case following previous operations (respectively 18 months and 13 months after the 2006 and 2011 operations). We are unsure whether this is due to a potential mast event which may have produced plenty of food and allowed rat numbers to recover more rapidly from the surrounding area. It may be that the lower sowing rate was less effective, as re-colonisation appeared to occur faster as sowing rates decreased each previous operation. It should be noted that Whanganui National Park achieved less than 5% tracking rates for rats using similar sowing rates (but different distribution method), and their rat tracking rates remains low. Therefore the distribution method may have left wide enough gaps for some rats to not encounter a bait and allow a small resident population to re-colonise quicker than normal. This issue will be addressed in discussions leading up to the next operation.

The mouse tracking rate, which was low since rats returned to pre 1080 levels in September 2012, increased rapidly with reduced rat numbers but the extent of it was brought to a halt by the rapid re-colonisation of the rats (Figure 2).

The mustelid population has recovered more slowly and increased steadily over time (2.9 % in June 2015). However, SMI are known to not accurately reflect real densities of stoats, and the

more sensitive outcome measure of kiwi chick survival suggests that stoat numbers recovered more quickly than previously (see Chick Monitoring Section).

TFKS is entering into its 14th 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.

Photo: Tracking Tunnel – J-Line, Tongariro Forest West

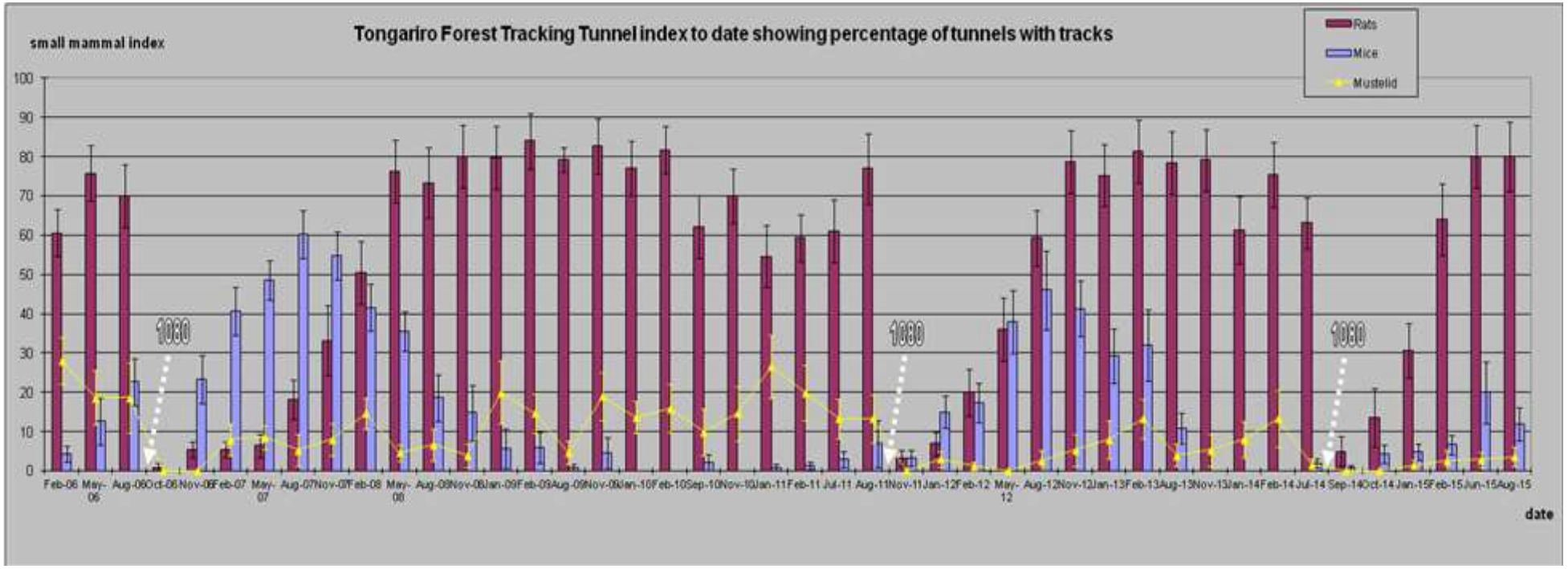

FIGURE 2: SMALL MAMMAL INDEXING RESULTS, TONGARIRO FOREST KIWI SANCTUARY, FEBRUARY 2005 – AUGUST 2015

ADULT KIWI MONITORING AND NESTING

A total of 29 adult kiwi were monitored in TFKS in 2014/15, consisting of 26 males and three females (Table 1).

Between February 2009 and September 2011, there were 24 adult and two sub adult kiwi deaths; 13 of these were confirmed ferret predations and the others were suspected ferret predations based on the proximity and timing to other mortalities. Between April and June 2014, an adult male and two sub-adult kiwi were found dead and were deemed likely to be or confirmed as mustelid or ferret predations.. These two incursions occurred during the third year following a 1080 operation. However, since the aerial 1080 Operation in August 2014 there have not been any adult or sub adult kiwi found dead in TFKS, confirming the good results obtained after the 2011 operation which suppressed kiwi adult deaths from ferret and sustained no deaths among adult and sub-adult kiwi for more than two years.

During the latter part of the season transmitters were removed from three of the female adult kiwi as females are only monitored until such time as they pair up and we are able monitor the males so as to lift eggs from their nests. Two of these kiwi had been found to have paired with adult males who already had transmitters fitted. The third female, "Pebble" was found in a burrow with an unknown male. He was fitted with a transmitter and named, "Catamarca" and Pebble was cut free.

NESTING AND EGG OUTCOMES

There were 22 confirmed nests this season with a total of 39 eggs. In order 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.

Eight of the eggs did not hatch, resulting in 31 chicks (Table 3). Two of the chicks died at Kiwi Encounter and one chick was hatched very late in the season at the start of winter so was released at Wairakei to remain there until stoat safe weight (1200g) and was not monitored at TFKS. Therefore a total of 28 kiwi chicks were monitored at TFKS in the 2014 /15 season. Twenty-three chicks were fitted with chick mortality transmitters and returned to their natal territory in TFKS at hatch weight (approximately two weeks of age).

The five remaining chicks who were monitored were intercepted in the wild and fitted with chick mortality transmitters and left in the nest. Chick interceptions were timed to intercept both chicks (this can usually be ascertained by assessing the birds 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).

TABLE 3: NEST AND EGG OUTCOME SUMMARY

	Confirmed Nests	Hatched in captivity	Wild Hatched	Total eggs	Eggs not hatched	Total Chicks
Otoro	1	2	0	2		2
Loggerross	1	2	0	2		2
Pumpkin	1	2	0	2	1	1
Dani	2	2	2	4		4
Doug	1	2	0	2	2	0
Hiver	1	2	0	2		2
Dino	2	3	0	3		3
Max	3	3	1	4	1	3
Koroki	1	1	0	1		1
Gulliver	1	3	0	3	1	2
Rocket	2	2	1	3		3
Taika	2	2	1	3		3
Murphy	1	2	0	2		2
Drogon	1	2	0	2	1	1
Te Hokinga	1	1	0	1	1	0
Little Moa	1	3	0	3	1	2
	22	**34**	**5**	**39**	**8**	**31**

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 respectively 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 2014/15 season was the first season after the 1080 operation 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 in order 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

This season, a total of 28 chicks were monitored within TFKS. The first chick was released into TFKS on 10th October 2014, and the last chick was released on 16th February 2015. One chick dropped its transmitter and nine chicks have reached sub-adult status (>183 days of age), and are no longer part of the kiwi chick survival study.

Eighteen chicks were found to have died this season; two due to misadventure (one drowning and one was suspected to have died from emaciation due to a broken leg) and one chick was determined by the NZ Wildlife Health Centre at Massey University as having died due to disease. There were five cases where the cause of death was unknown as there were insufficient remains to confirm the likely cause of death. However in each of these five cases, there was evidence of either predation or scavenge as the remains were fragmented and damaged and often found cached in a hole or burrow as is consistent with mustelid behaviour. There were ten predations. Of these, The NZ Wildlife Health Centre positively identified eight as likely to have been mustelid predations, and one further kiwi chick was identified as likely mustelid predation by kiwi practitioners due to evidence at the location where the bird was found and examination of the remains. One kiwi chick was confirmed as having been killed by a dog. The first predation event was recorded on the 1st December 2014, and the most recent on the 18th March 2015.

Figure 3 depicts the results from the last three aerial 1080 operations. The operational target of 50% survival post-operation was unfortunately not met.

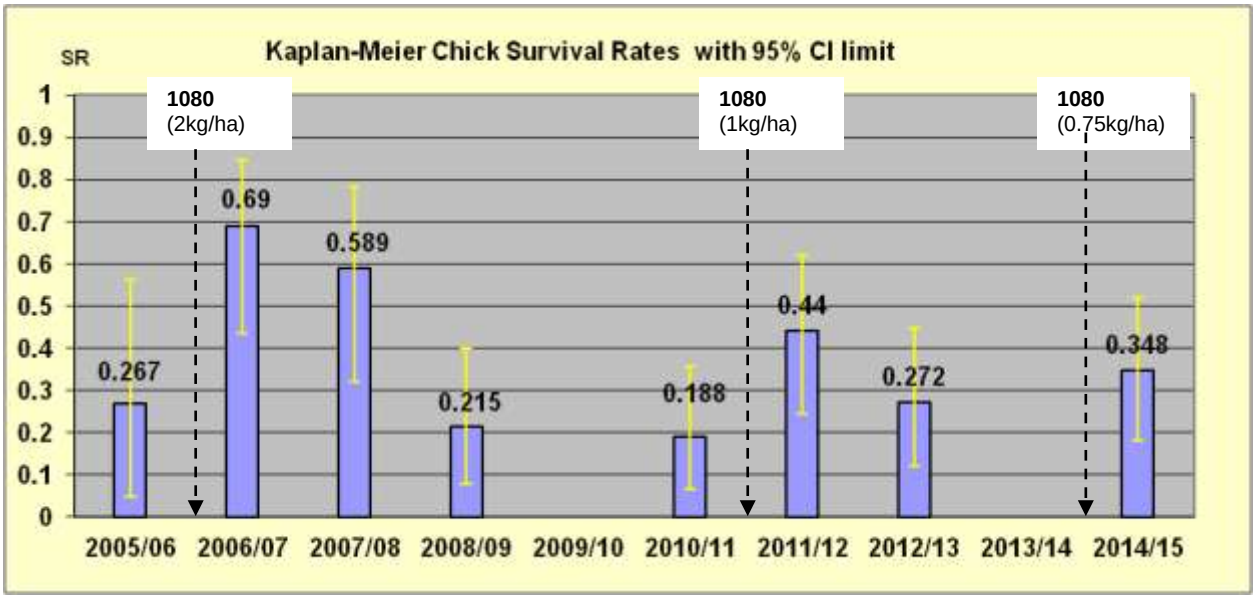

FIGURE 3: KAPLAN-MEIER KIWI CHICK SURVIVAL ESTIMATES FOR THE EIGHT BREEDING SEASONS, 2005-2015*

**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 appears to be a notable increase in chick survival rate with each aerial 1080 operation when compared to non-treatment years. However, as sowing rates have decreased, survival rates also appear

to decrease. The last 1080 operation had the lowest sowing rate trialled to date, and kiwi chick survival was only marginally higher than non-treatment years. It is unclear whether this may have been due to a faster recovery rate of small mammals, possibly in response to seasonal and environmental factors (such as a possible mast event - see Small Mammal Index results in previous section). As previously discussed, it may also be as a result of the strip sowing method tested here. The next aerial 1080 operation will continue to explore low sowing rates and distribution methods to help us better understand the relationship between sowing rates and chick survival.

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 (see Kiwi Call Count Section). We separated survival rates between the two areas, and a notable difference has appeared. (Figure 5)

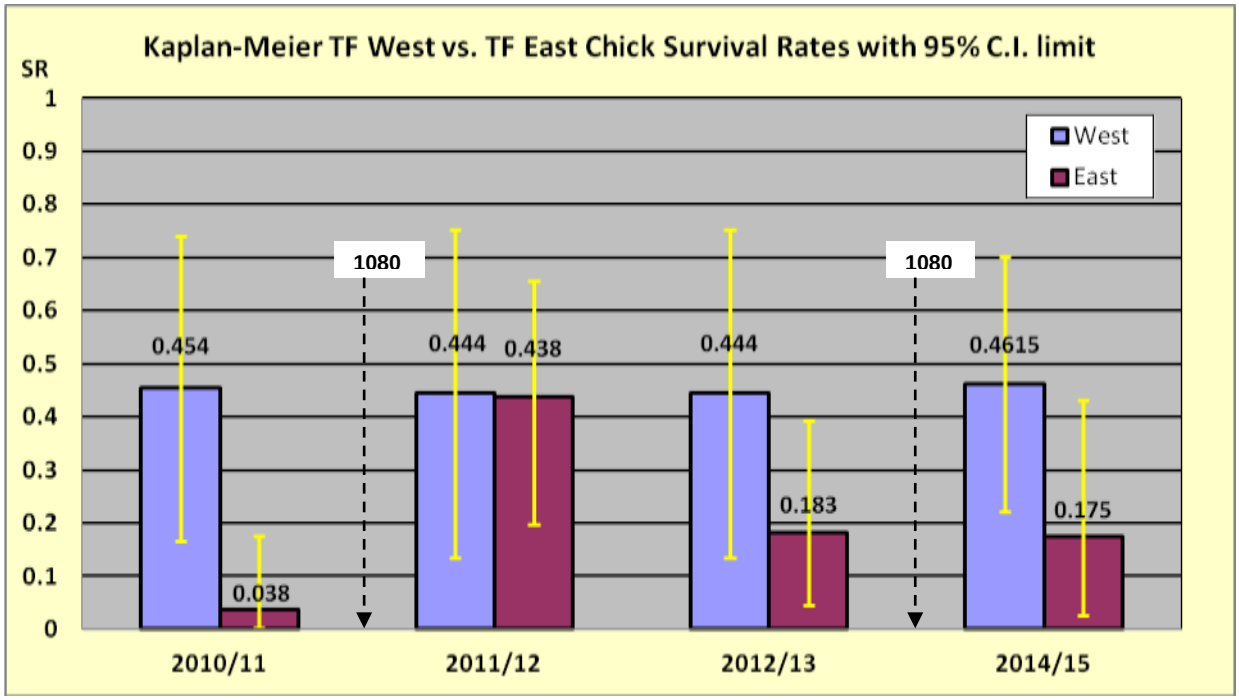

FIGURE 4: COMPARISON KAPLAN-MEIER KIWI CHICK SURVIVAL ESTIMATES BETWEEN EAST AND WEST OF TONGARIRO FOREST*

**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. The eastern side has much lower survival rates comparatively. This shows that the number of chicks released on each side in any given monitoring year may influence the overall survival rate.

For instance, this season 17 chicks were released on the western side and 11 on the eastern side. If numbers had been even on both sides the overall survival rates would have probably been lower than 34.8%. To compare with the 2012/13 season showing similar results on each side, 18 chicks were released on the eastern side whereas only 9 were released on the western side. The result was a lot lower at 27% (Figure 3 and Table 4). If the sample size had been equal for both sides the non-treatment year's survival rate may have been higher.

TABLE 4: 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	
	S.R.	*n*	*S.R.*	*n*	*S.R.*	*n*	*S.R.*	*n*
TF West	0.454	11	0.444	9	0.444	9	0.4615	17
TF East	0.038	14	0.438	16	0.183	18	0.175	11

**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.

FUTURE DIRECTIONS

Another season of chick survival monitoring in Tongariro Forest Kiwi Sanctuary is planned for 2015/16. These results will allow further comparison of kiwi chick survival post 1080 operations and between west and east, making sure that numbers are even between the two sides.

The next aerial 1080 operation will be in August 2017. 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%).

SUB-ADULT KIWI MONITORING

Juvenile[1] and sub-adult[2] kiwi lifted from TFKS as eggs, as part of the BNZ Operation Nest Egg ™ (O.N.E) program, were released back into TFKS at between 1100g-1200g. A number of them have been radio-tagged to give data on the overall picture of population dynamics of kiwi (Robertson 2004), providing information on age at first breeding, survival and dispersal.

One hundred and three O.N.E sub-adults have been released since the creation of TFKS in 2000 (136 since the launch of O.N.E in the 1990's). Of the 136, 97 have been closely monitored, as well as 60 wild hatched sub-adults (WH), which have been followed and treated as a separate sample in the study to determine if they behave differently. Fifteen sub-adults are currently monitored but only a few males will be kept for breeding recruitment as the study has drawn to an end.

[1] 50 days < age > 183 days
[2] 183 days < age > 4 years

SURVIVAL RATES

Of the 157 (97 O.N.E., 60 wild hatched and five wild caught) continuously monitored sub-adults, 36 have died since 2000. The causes of mortality were predation (n=15), natural causes/misadventure (n=10) and unknown causes (n=11). None have died since the last 1080 operation in August 2014. Twenty nine males and fifteen females have been confirmed as reaching adulthood (4 years old or age of first breeding). Of the remaining 77, 15 are still considered sub-adults and the rest have been lost from the study either through signal loss or transmitter. The data collected from these birds was still useful in calculating overall survival rates.

This season, four birds had their transmitters removed (as the study is winding down), two birds disappeared (could be from transmitter failure), two birds dropped their transmitters.

Using Kaplan-Meier to analyse survival rates, O.N.E. birds appear to have a slightly higher survival rate than wild-hatched, and males had a better survival rate than females (Table 5).

TABLE 5: SURVIVAL RATE OF SUB-ADULT KIWI IN TONGARIRO FOREST

	Survival Rates (SR %)	Female SR (%)	Male SR (%)	Sample size in transmitter years*
O.N.E (n=97)	69.2	67.5	71.5	163
Wild-hatched (n=60)	63.4	57.3	65.9	96
Wild caught (n=5)	N/A	N/A	N/A	9
Overall (n=157)	**65.7**	**63**	**66.9**	**268**

* Cumulated monitoring time from 1998 to 2015

It is not yet clear whether the difference in survival rates is significant or not. However, the survival rates may be influenced by dispersal. Wild-hatched birds tended to disperse further on average than O.N.E. birds, and similarly females tended to disperse further than males. This may have decreased their survival rates as they encountered more hazards.

TERRITORIALITY AND AGE AT FIRST BREEDING

After 11 years of study, we have gained information on territoriality for 59 kiwi, and on age at first breeding for 34 kiwi (25 O.N.E. and nine wild hatched). Again, differences between O.N.E. and wild-hatched birds were detected, as well as between males and females (Figure 5).

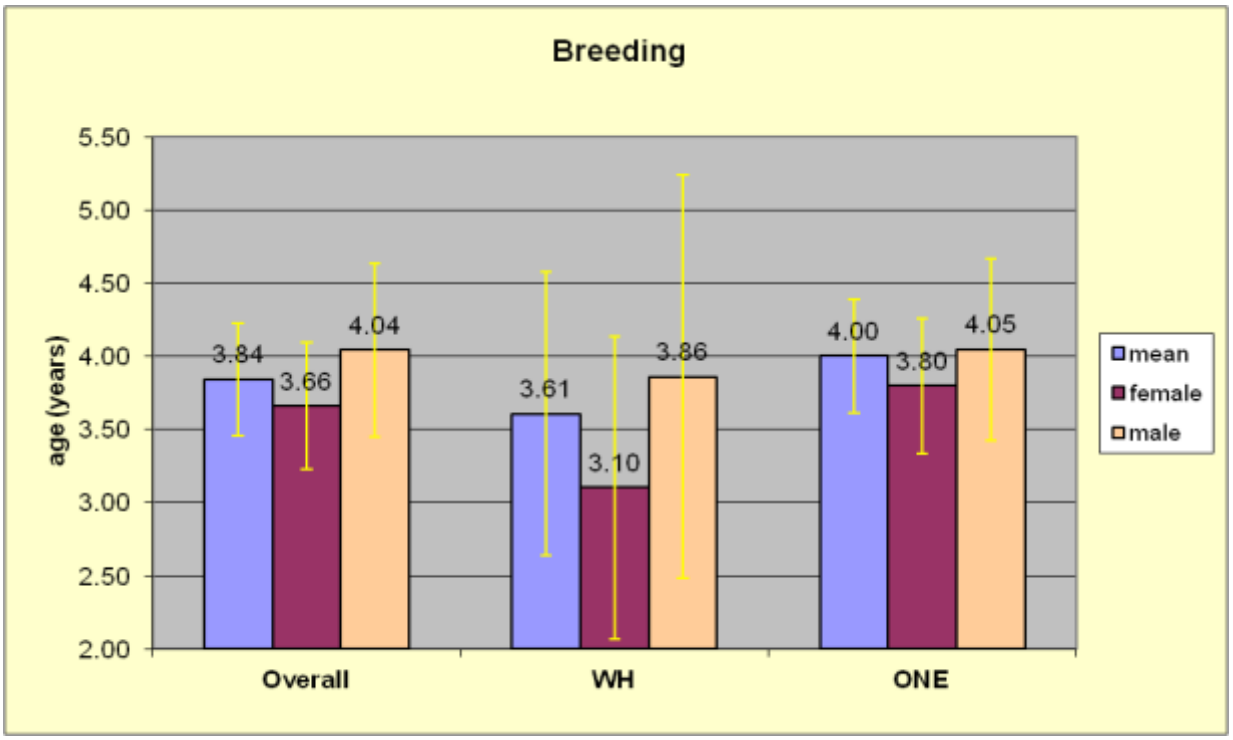

FIGURE 5: THE MEAN AGE AT FIRST BREEDING FOR BROWN KIWI IN TFKS FOR THE YEARS 2004 TO 2015

However, there was no discernible difference between O.N.E. and wild-hatched for mean age of territoriality. It has been found that females bred earlier, but seemed to settle at a higher age (2 than males (Figure 6). It is possible that females are likely to start breeding as soon as they have found a

male occupied territory, whereas males establish first their territory and could wait a long period of time before attracting a female.

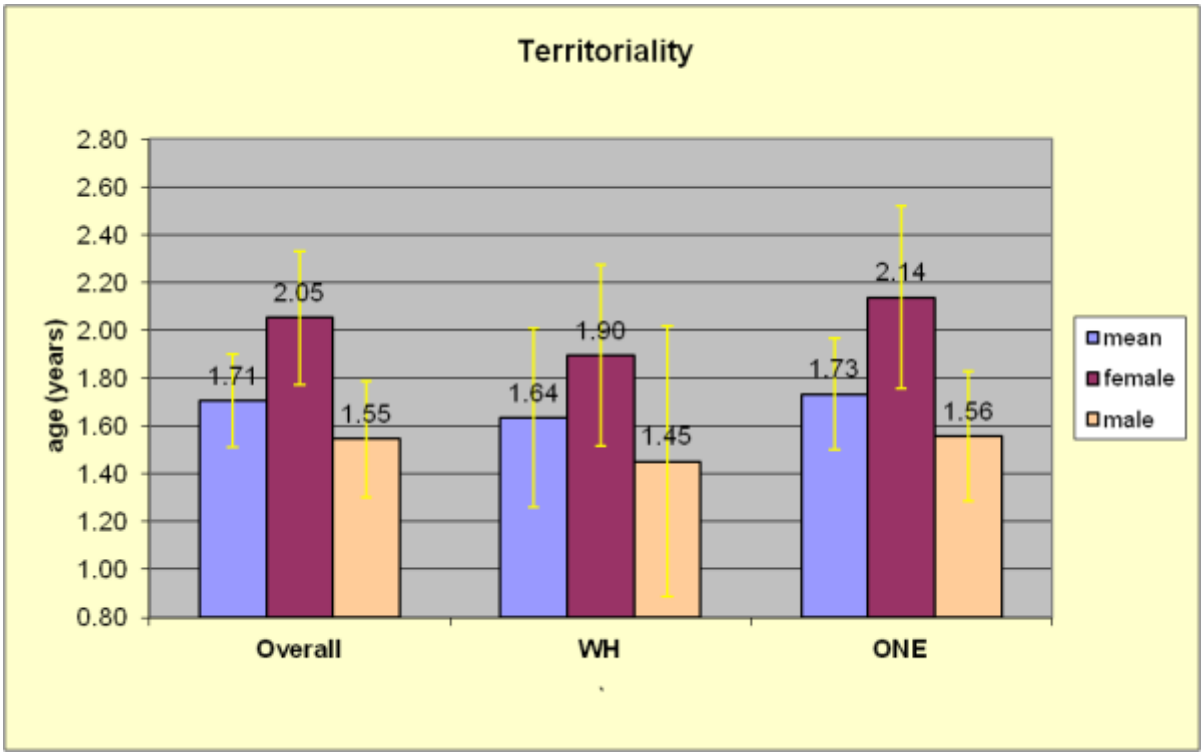

FIGURE 6: MEAN AGE WHEN SETTLED IN TERRITORY FOR BROWN KIWI IN TFKS FROM 2004 TO 2015

DISPERSAL PATTERNS

The study of O.N.E sub-adult movements between 2002 and 2010 showed that most kiwi remained within an approximate 5000 ha area, situated on the eastern side of the forest, which is where O.N.E kiwi were initially released between 2002 and 2006. Approximately 10% of these kiwi have dispersed out of TFKS.

Since 2010, kiwi were released from the western side of TFKS which was considered safer from ferret incursions. Their dispersal patterns (mainly through the western side), along with dispersal by wild hatched sub-adults, has allowed to re-define the distribution of kiwi within the sanctuary. An additional 3000 ha to the north of the Waione was revealed to be an extension of the 5000 ha area previously mentioned above and an approximate 1400 ha, situated around and south of quartz creek, has attracted a substantial number of birds which indicates the existence of a wild sub-population in that area.

The total area within which kiwi have been known to distribute evenly is about 10400ha. Little is known about the rest of the Sanctuary partly due to the loss of many birds that had dropped or failed transmitters while dispersing. Only an extra small population around the Whakapapa intake is believed to subsist within the Sanctuary.

Outside the Sanctuary, two additional sub-populations could survive in the area north of OPC between the Mangatepopo and Whanganui Rivers and at the far north of the Sanctuary, in the Whangapeki area.

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 will give us a more robust estimation of the population number and distribution.

KIWI CALL COUNT MONITORING

Introduction:

Call surveys have been undertaken in TFKS during the following years; 1993-1997, 2001, 2004-2007, 2011, 2013, 2014 and 2015 in an effort to detect long term population trends amongst Tongariro Forest kiwi. The Kiwi Best Practice Manual (2003) recommends that call surveys are to be done annually for three years, and then once every five years after that, to detect any large, long term changes in population density and distribution. The 2014 survey in conjunction with the sub-adult dispersal study and the population modelling exercise produced last year, gave us a conservative population estimate of 196 kiwi.

In the years prior to 2013 these surveys were solely performed by human observers. For the 2013 and 2014 surveys, the seven human observer points were used in conjunction with automatic acoustic recording devices to make a comparison of the calls per hour and male to female ratio using the two different methods. Due to inclement weather, only acoustic recorders could be used this season and this prevented any further comparison between observers and recorders.

Method

A total of 26 recorders were placed throughout the forest and 23 of these were placed at the same locations as the previous season (2013 /14). These are considered permanent locations for future surveys. Three extra recorders were placed on the less occupied periphery of core territories in order to expand the network so as to capture future population increases (call rates may be slower to change in sites already occupied). These recorders were left in the forest from the 2nd and 30th of June and set to record from 1800 to 2200 each evening. Data from the 5th to 8th of June were used for the traditional four day kiwi call survey as it was the only period of steady weather and the closest in time to previous surveys.

As a whole, data from ten fine nights were analysed between the 2nd and the 17th of June to give more information as to how many individual birds could be heard within the monitored area.

Results

Between the 5th and 8th of June, during the first two hours of listening, the acoustic recorders positioned at the human observer sites (n=7) detected fewer calls per hour compared to last year. However, the wider listening area, that is: all recorders including those placed at human observer sites (n=26) detected an increase (Table 6). This highlights the limit of the traditional call survey which results fluctuate greatly and don't seem to reflect the big picture.

TABLE6: 2 COMPARISON BETWEEN CALL RECORDERS RESULTS IN 2014 AND 2015

	2014 call survey	2015 call survey
Call per hour with 7 recorders	1.24	0.61
Call per hour with 20 recorders	1.54	1.78

Number of Kiwi Heard:

Analysing the overall data from 10 nights of recording (26 recorders, 732 hours, 833 calls) and using a map of known kiwi territories, the number of known and unknown kiwi that were heard has been

established; a total of 70 individual kiwi were heard, 30 known and 40 unknown (assuming that a kiwi heard on a single recorder is always the same individual bird unless there is strong evidence to suggest otherwise) (Table 7). The 70 kiwi were heard across the area sampled which was approximately 5000ha.

TABLE 7: NUMBER OF CALLS AND INDIVIDUAL KIWI DETECTED FROM ALL ACOUSTIC RECORDERS COMBINED

	2014 call survey (23 sites)	2015 call survey (26 sites)
Number of hours listened	590	732
Number of calls heard	765	833
Number of individual birds	**65**	**70**
Calls per hour- east	1.79	1.41
Calls per hour –west	0.58	0.51
Calls per hour-total	**1.30**	**1.14**

Discussion

The decline in call rates from last year may be due to normal variability within call behaviour of kiwi rather than an actual decline, although only repeated measures will be able to detect the long-term trend of the population. The increase in stations across the sanctuary may give us the ability to detect change sooner than with the original seven stations.

Of note is the difference in call rates between the eastern and the western parts of the sanctuary. We do not know why there appears to be more kiwi on the eastern side, but it does show that there is not an even distribution of kiwi throughout the sanctuary. This means that we cannot extrapolate call counts or number of individual kiwi across the entire 20,000 ha. It is of particular interest considering that chick survival appears to be higher on the western side than eastern, leading us to expect more kiwi to persist on the western side..

More needs to be done in terms of kiwi survey in those areas in order to have the most accurate estimation of the current population. The aim is to have more recorders (at least 50) evenly spread throughout the whole Tongariro Forest Kiwi Sanctuary; this will possibly be done in May 2017 prior to the next 1080 operation.

REFERENCES

Dawson, D.G., Bull, P.C. 1975. Counting birds in New Zealand forests. *Notornis 22*: 101-109.

Gillies, C, Williams, D. 2001. Using tracking tunnels to monitor rodents and other small mammals. Department of Conservation. Unpublished best practice protocol.

Haigh, A. 2014. Rat, Possum and stoat control in Tongariro Forest Kiwi Sanctuary 2014. Unpublished operational plan. Department of Conservation, Whakapapa. DOCDM-1334298

McLennan, J. 2006. Western North Island brown kiwi (Apteryx mantelli): pathways to conservation and recovery. A technical report prepared for the Wanganui, Tongariro/Taupo and Waikato Conservancies of the Department of Conservation.

McLennan, J.A.; Potter M.A; Robertson H.A.; Wake G.C.; Colbourne R.; Dew L.; Joyce L.; Mccann A.J.; Miles J.; Miller P.J.; Reid J. 1996. Role of predation in the decline of kiwi, apteryx spp., in New Zealand. New Zealand Journal of Ecology 20(1): 27-35

Potae, K.R. 2012 Wairakei Golf + Sanctuary Kiwi Annual Report 2011/12

Robertson, H.A.; Colbourne, R.; McLennan, J. 2003. Kiwi Best Practice Manual.

Robertson, H.A.; Westbrooke, I.M. 2005: A practical guide to the management and analysis of survivorship data from radio-tracking studies. Department of Conservation Technical Series 31. Department of Conservation, Wellington. 47p.

Robertson, H. 2004. Research and monitoring plan for the kiwi sanctuaries. Science for Conservation 241. 24p.

Robertson, H.A.; Demonchy, P.J. 2012: Varied success from the landscape-scale management of kiwi *Apteryx* spp. in five sanctuaries in New Zealand.

Scrimgeour, J.; Germano, J.; Robertson, H.; Colbourne, R.; Sporle, W.; Beath, A.; Booth, A.; Livingstone, J.; Tawa, D.; Whitwell, L. National Kiwi Sanctuaries Management Plan 2015-2018. Unpublished report. Department of Conservation, Taupo. DOCDM-1570100.

Tongariro Forest Kiwi Sanctuary Operational Plan. July 2010-June 2015. Department of Conservation, Ruapehu Area.

Kiwi Sanctuaries Strategy Draft, 2014-2019, Kiwi Recovery Group

New Zealand Government