Response of wild kiwi to orange and cinnamon lured possum baits

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Published by
Department of Conservation
Head Office, PO Box 10-420
Wellington, New Zealand

This report was commissioned by the Northland Conservancy.

ISSN 1171-9834

Reference to material in this report should be cited thus:

Ward-Smith, T., Potter, M., 1999.
Response of wild kiwi to orange and cinnamon lured possum baits. *Conservation Advisory Science* Notes No. 259, Department of Conservation, Wellington.

Keywords: kiwi, olfactory response, possum bait, lures.

1. Introduction

Cereal baits are used widely in New Zealand to carry poisons such as sodium monofluoroacetate (1080) and brodifacoum to kill possums. In areas of large and inaccessible tracts of forest, poisoned baits are distributed by aircraft and fall on the ground, where they are accessible to a range of non-target species. Where greater precision is required, baits may also be placed within bait hoppers, although they may still be accessible to some non-target species. Herbivorous and omnivorous ground-feeding birds are particularly at risk from feeding on toxic baits intended for possums (Spurr 1979). Consequently, baits have been modified to reduce their attraction to non-target species and to increase target mortality (Caithness &Williams 1971). One method has been to add a flavour to baits which acts as a lure to possums and deters some bird species. Cinnamon was identified in an early trial on Kapiti Island as meeting both criteria (Udy & Pracy 1981, Pracy et al. 1982), and has been added routinely to baits for possum control since 1983 (Morgan et al. 1986; Morgan 1990).

However, despite being used widely to lure baits, there has been only limited testing of the effectiveness of cinnamon as a repellent to non-target native bird species (Spurr 1993). The purpose for adding flavours to baits in the past has focused mainly on attracting the pest species, with little known about the repellency, or attractiveness of the flavours to birds. Recently, orange flavour has also been used to lure baits. Orange has been found to be more attractive to possums than cinnamon (Morgan 1990) but is not used currently as a standard bait lure and has not been tested on non-target animals such as birds.

Kiwi (*Apteryx spp.*) have a large olfactory bulb ratio in comparison to forebrain size and are therefore considered to have a well developed sense of smell (Wenzel 1968). They may therefore have a greater capacity to discriminate flavours than other bird species, and could be at greater risk of consuming toxic baits that contain a flavour which kiwi find attractive. There has, however, been little work which has investigated the response of kiwi to flavours used as bait lures. In a captive study, cinnamon flavour did not deter kiwi from feeding on their normal diet despite the food smelling strongly to human observers (McLennan et al. 1992). This places serious doubt over the effectiveness of cinnamon at repelling wild kiwi from baits.

Being omnivorous and ground dwelling, kiwi are likely to encounter and possibly feed on toxic baits on the ground. In 1990, particular concern over the potential to poison kiwi, resulted in several studies which monitored kiwi survival throughout aerial 1080 operations (Pierce & Montgomery 1992; Lyall 1995; H. Robertson pers. comm.;Walker 1997). Although kiwi are reported to have fed on cereal baits lured with cinnamon, all birds which have been monitored through actual 1080 possum control operations survived (Pierce & Montgomery 1992; Lyall 1995; H. Robertson pers. comm.; Walker 1997). More recently, during a control operation using cereal baits containing the poison brodifacoum, at least one bird was know to have died (H. Robertson pers. comm.). It is not known whether this death was a result of the kiwi ingesting

toxic baits (primary poisoning) or invertebrates containing poison (secondary poisoning).

Most kiwi monitoring studies have tracked the survival of radio-tagged individuals. While this provides valuable information on the fate of birds, it fails to determine whether those kiwi have survived because they have rejected bait, failed to encounter bait, or are encountering and feeding on bait when it is no longer toxic. While kiwi have been monitored during operations using cinnamon lured cereal baits, there has been inadequate monitoring of kiwi throughout similar operations using baits lured with orange. There have also been no direct observations of kiwi encounters with bait in the wild, and it is unknown whether wild kiwi are attracted, deterred or indifferent to cinnamon or orange lures.

2. Objective

To directly observe the response of wild kiwi to non-toxic cereal No. 7 baits lured with cinnamon or orange flavours

3. Methods

3.1 STUDY BIRDS

The kiwi used were radio-tagged nesting males from Rarewarewa Bush (35°37'S, 174°08'E), Whangarei, Northland. Nesting males were used since they are known to return to the same nest location throughout incubation. This enabled the same individual to be tested over consecutive nights, and avoided moving video equipment nightly to individual roost sites.

3.2 PRE-TREATMENT OF KIWI

The kiwi had been previously exposed for five nights to a variety of non-toxic plain baits used for possum control, and these included cereal No. 7 baits (see Ward-Smith 1998). Earthworms had also been presented to kiwi for one night outside their nest entrances. This was to determine whether kiwi would feed on food items presented to them by humans, to ensure that any bait rejection was not a result of kiwi never feeding in the vicinity of their nest, or kiwi being deterred by human smell.

During the prior bait encounters kiwi showed no signs of feeding on any of the plain No. 7 baits offered (Ward-Smith 1998). In contrast, all but one of the six male kiwi were observed feeding on invertebrates placed outside their nests. Since no kiwi fed on plain cereal No. 7 baits it was only possible in this

study to investigate whether the addition of orange or cinnamon flavours encouraged kiwi to feed on baits, and not whether the addition of these flavours was effective at deterring kiwi from feeding.

3.3 BAITS USED

Non-toxic No. 7 cereal baits (4-6 g) were prepared at Massey University Feed Processing Unit from a loose mix supplied by Animal Control Products, Wanganui. Baits were dyed green with V200 (conc. 0.1% wt:wt) and surface coated with orange or cinnamon oil (conc. 0.1 % wt:wt).

3.4 STUDY DESIGN

Trials ran between July and September 1997 and involved video recording the response of individual kiwi to orange and cinnamon flavoured baits. Approximately 100 g of bait was placed on the ground outside the entrance of each kiwi nest. One flavour was presented for two nights, then the second flavour for a further two nights. The flavour presented first to each kiwi was chosen randomly. A "bait encounter" was defined as the duration that kiwi spent within 0.5 metres of baits. Encounters were recorded using an infra-red camera as kiwi emerged and re-entered their nests during the night. The camera was positioned approximately two metres from the nest, either behind or up a tree, and recorded continuously from dusk until dawn. All bait investigation by kiwi such as probing (defined as kiwi contacting bait with their bills) or feeding on baits was recorded.

4. Results

During this study six wild kiwi were exposed to cinnamon No. 7 baits, and seven wild kiwi were exposed to orange cereal No. 7 baits. Six of these birds were nesting males and one was an adult female kiwi which passed close to a nest during video recording.

4.1 FEEDING ON NATURAL FOODS

Five out of the six male kiwi had been previously recorded feeding on food items presented to them outside their nest during a previous trial (see Ward-Smith 1998), and this justified presenting them with flavoured baits. However, two kiwi were also observed to feed on invertebrates around their nest during the flavoured bait trials. Kiwi 3 fed twice on invertebrates in the presence of cinnamon flavoured baits, while Kiwi 5 fed on invertebrates once in the presence of cinnamon flavoured baits and twice in the presence of orange flavoured baits. Although the invertebrates had not been presented to kiwi, these observations still show that kiwi will feed around their nest.

4.2 RESPONSE OF KIWI TO ORANGE AND CINNAMON FLAVOURED BAITS

The male kiwi encountered flavoured cereal No. 7 baits each time they emerged or re-entered their nest during the night. Each nesting kiwi was video recorded encountering baits for four nights in total (two nights with each of cinnamon and orange flavours), although two males left their nest more than once during some nights and therefore encountered baits more frequently (Kiwi 3 and 5, Table 1; and Kiwi 5, Table 2).

In total, kiwi encountered cinnamon baits 34 times, for a total duration of 57 min 6 sec (Table 1), and orange baits 29 times, for a total duration of 37 min 12 sec (Table 2). During these recorded encounters there was only one occasion where a bait was picked up. This bait was orange flavoured and was dropped immediately by the kiwi (Table 2). Kiwi were observed to sniff and sometimes probe baits (Tables 1 and 2) but no other attempts were made to pick baits up, or to feed on them.

4.3 BEHAVIOUR OF MALES AS THEY EMERGED AND RE-ENTERED THE NEST

With the exception of one kiwi, all nesting males emerged from their nest and began covering the entrance with sticks and leaf material. Kiwi then stepped forward continuing to flick material towards the entrance and eventually moved out of view using a route similar to that which they had used previously during the earlier unflavoured bait trials (see Ward-Smith 1998). When kiwi returned to their nest they approached the entrance again via a regular route and entered quickly. This behaviour was observed with all but one of the kiwi tested. This male frequently sniffed the air in the direction of the flavoured baits as he emerged from the nest. He began flicking stick and leaf material towards the entrance but stepped back after sniffing towards the flavoured baits. He then either climbed up the back of the nest, or clambered over branches piled up at the side, instead of walking out at the front. This behaviour was observed during encounters with both cinnamon and orange cereal No. 7 baits and had not been previously recorded during trials with unflavoured baits. The male, however, re-entered the nest quickly at the front by walking over or between the baits.

The female kiwi which passed close to the nest entrance (Kiwi 7, Table 2) encountered orange flavoured cereal No. 7 baits only once. The bird walked up to the nest entrance, probed the ground close to the piles of baits and then backed away from the nest without making any contact with the baits.

5. Discussion

No wild kiwi fed on any of the non-toxic cinnamon or orange flavoured No. 7 baits during this study. An orange flavoured bait was picked up on one occa-

sion and this represented only 3% (1 out of 29) of total kiwi encounters with orange flavoured baits. No cinnamon flavoured baits were picked up by kiwi during any of the 34 observed encounters. These results show that kiwi are unlikely to feed on orange or cinnamon flavoured cereal-based baits, and support other studies which have found kiwi to be unaffected by possum control operations using these bait types and flavour lures (Pierce & Montgomery 1992; H. Robertson, pers. comm.; R. Pierce, pers. comm.).

Generally, each night of the flavoured bait trials, kiwi emerged from their nest and immediately began to flick material towards the entrance. Kiwi then moved away out of camera view via a route that had been used previously during encounters with unflavoured baits (see Ward-Smith, 1998). Only one kiwi altered his behaviour in the presence of flavoured baits. Instead of stepping forward over baits as he had done during encounters with unflavoured baits, the kiwi either climbed out at the back of the nest, or out at the side, apparently choosing to completely avoid the area where baits had been laid. For this kiwi, but not others, it appeared that flavoured baits had some deterrent effect.

While the addition of orange or cinnamon flavours to cereal No. 7 baits did not attract kiwi to feed on baits, these flavours had no obvious deterrent effect either. The orange and cinnamon flavours did not prevent kiwi from probing baits and there is therefore potential for kiwi to ingest small quantities through contact with baits which may have softened through weathering. The only other study which has reported kiwi contacting with flavoured baits was in Waipoua, Northland, where kiwi fed on non-toxic cinnamon flavoured cereal bait (Pierce & Montgomery 1992). Cinnamon did not appear to have any deterrent effect on kiwi in that study, and the results of these flavoured bait trials largely support this.

This work testing the response of wild kiwi to flavoured baits was intended as a pilot study. Flavoured baits were presented to kiwi on nights which followed consecutively after a trial in which unflavoured baits had been offered to the birds. For this reason caution is required with interpretation of the results. For example, prior exposure to the unflavoured baits may have influenced kiwi to reject flavoured baits. However, of primary interest was whether the addition of cinnamon or orange flavours attracted kiwi to feed on baits, and in this study no kiwi did.

Typically, wild kiwi responded to flavoured baits in a similar manner to unflavoured baits. It is therefore likely that cinnamon or orange flavours have a neutral effect on kiwi, neither deterring nor attracting them to feed on baits. Recently it has been suggested that alternating bait types with different lures such as cinnamon and orange (which has been shown to be an effective alternative to cinnamon (Morgan 1990)) may help to reduce bait shyness in the target species (Morgan et al. 1996). That neither orange or cinnamon flavours attracted kiwi to feed on cereal baits is positive for kiwi, since these flavours are likely to be used more widely on ground-laid (R. Pierce, pers. comm.) and aerially distributed baits.

Kiwi are known to face a number of threats to their continued survival on mainland New Zealand (McLennan et al. 1996). It is therefore essential that

poisoning operations do not place them at greater risk, particularly as there is increasing need for possum control in areas of kiwi habitat. Possums (the main targets for control operations) are known to be predators of kiwi eggs (McLennan 1988; Pat Millar, pers. comm.), and may also kill adult kiwi (McLennan 1996). The direct benefits by reducing possum numbers are likely therefore to outweigh the possible risk of kiwi feeding on baits and dying. Additionally, control operations may also benefit kiwi by reducing rats (Murphy & Bradfield 1992; Warburton 1989) and stoats and cats through secondary poisoning (Gillies 1997; Murphy 1997). There is, however, need for further investigation into the effect on kiwi, of the use of cereal baits carrying brodifacoum poison, since there may be potential for both primary and secondary poisoning with this substance.

The decision to use poison in an area containing rare species (e.g. kiwi) should only be made if the need to poison is high (e.g. to protect habitat of rare species) and the proportion in a population of wild birds likely to feed on bait is low (Spurr 1993). This study indicates that the proportion of kiwi likely to feed on baits in the wild is extremely low. Cinnamon and orange lures appear to neither attract kiwi to feed nor deter them from probing bait, although there is greater scope for further work in this area with regard to poison operations using orange as a lure.

6. Recommendations

Management

- In high-density kiwi populations orange lured No. 7 baits should be used with caution, i.e. placed in bait stations. Aerial distribution should be avoided until work has further investigated the level of attraction of orange flavour to kiwi.

- Every opportunity should be taken to monitor radio-tagged kiwi (adult and juvenile, male and female) throughout future possum control operations, particularly those using orange as a lure.

Research

This work could be expanded by:

- increasing the number of individual wild kiwi video recorded encountering flavoured baits;

- increasing the number of nights individual wild kiwi are exposed to flavoured baits to investigate their response after longer periods of habituation;

- investigating the response of other wild kiwi such as females, roosting birds, and juveniles to orange and cinnamon lured baits;

- investigating the response of wild kiwi to weathered baits that have been impregnated with flavour rather than surface coated.

7. Acknowledgements

Many thanks to Di Morgan, John Ewen, Christine and Murray Potter for their enthusiastic battery carrying; Ray Pierce for providing accommodation; Pat Millar for advice and help with locating suitable nests; Nigel Millar for the use of video equipment, and Murray Potter for supervision and comments on the report.

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Table 1. Total number and duration of kiwi encounters with cinnamon flavoured cereal No. 7 baits, and number of times baits were probed by kiwi. Kiwi numbers 1 to 6 are nesting males.

Kiwi	Total No. encounters with orange No.7	Total duration (min : sec) of encounters with orange No.7	Total No. of times kiwi observed probing orange No.7
1	4	03:09	0
2	4	05:22	0
3	4	05:42	1
4	4	04:29	4
5	8	08:01	0
6	4	09:52	3
7	1	00:37	0
Total	**29**	**37:12**	**8**

Table 2. Total number and duration of kiwi encounters with orange cereal No. 7 baits, and number of times baits were probed by kiwi. Kiwi numbers 1 to 6 are nesting males. Kiwi number 7 is a female which passed by a nest. indicates a bait which was picked up and dropped immediately.

Kiwi	Total No. encounters with cinnamon No.7	Total duration (min: sec) of encounters with cinnamon No.7	Total No. times kiwi observed probing cinnamon No.7
1	4	02:03	0
2	4	05:29	1
3	6	17:33	3
4	4	02:33	0
5	12	17:44	6
6	4	11:44	0
Total	**34**	**57:06**	**10**