Project No: R-80660-01

Effects of Prefeeding on Ground and Leaning-board Trap Sets, and the Relationship between WaxTag and Trap-catch Possum Monitoring Indices.

A Partial Replication of Project R-80660
“Best Practice for Monitoring Low Density Possum Populations”.

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Summary

Project and Client
The purpose of this study was to reinvestigate aspects of “Project R-80660, Best Practice for Monitoring Low Density Possum Populations” reported in Henderson et al. 2007 (referred to in this report as the Henderson study). The work was carried out by Pest Control Research Ltd (PCR) and Biodiverse Ltd (BD) between January 2008 and January 2010 for the Animal Health Board (AHB).

Background
The Henderson study compared 10 alternative monitoring systems with standard ground set trap-catch and WaxTag monitoring methods as defined in the NPCA national trap-catch (NTCP) and national 2005 WaxTag (NWTP) protocols. The aim of the study was to identify more effective methods for possum monitoring where populations are low, or where the presence of ground birds requires traps to be raised above ground (-leaning-board sets). The main findings of the Henderson study were:

1. A 2.1 x increase in the Residual Trap-catch Index (RTCI) when traps were prefed.
2. The WaxTag Bite-mark Index (BMI) using the NWTP was unreliable.

The study recommended that the following changes be made to the NTCP and the NWTP.

1. Ground sets should be prefed for 3 nights, and then trapped for 2 nights (the existing NTCP recommends 3 nights without prefeeding).
2. Raised sets should be restricted to leaning-board sets and prefed for 3 nights, and then trapped for 2 nights (the existing NTCP recommends 3 nights without prefeeding).
3. The NWTP should be reviewed or stopped on the grounds that the method is unreliable, particularly where possum populations are “shy”.

Adoption of any of these recommendations, either prefeeding of traps, or discontinuance of the WaxTag methodology, would comprise a significant change in the way possum monitoring is undertaken. Because of the magnitude of the potential changes the AHB requested a replication of the Henderson study so more information would be available before making important decisions regarding changes to the national possum monitoring protocols.
Objectives
To further investigate elements of the Henderson study by:

1. Comparing prefed ground set RTCI estimates (recommended in the Henderson study) with non-prefed ground set RTCI estimates as used in the current NTCP.

2. Comparing prefed leaning-board set RTCI estimates (recommended in the Henderson study) with non-prefed leaning-board set RTCI estimates as used in the current NTCP.

3. Reviewing the WaxTag methodology (recommended in the Henderson study) by comparing WaxTag BMI estimates with ground and leaning-board set RTCI estimates.

Methods
- A total of 10 study sites were selected in New Zealand. All were integrated with existing possum monitoring operations undertaken by possum monitoring contractors for their clients. All monitoring lines were randomly placed as specified in the NTCP and NWTP. The study sites were divided into 2 lots of five with five examining ground set traps and five examining leaning-board set traps.

- Each of the 5 ground set sites had the following treatments.
  - 10 non-prefed standard ground set lines undertaken by monitoring contractors for their clients using the NTCP\(^1\).
  - 10 prefed ground set lines undertaken by monitoring contractors for PCR and BD (as recommended in the Henderson study where all traps were unset but flour lured for 3 nights and then set for 2 nights).
  - 10 WaxTag lines undertaken by monitoring contractors for PCR and BD using the NWTP\(^2\).

- The remaining five leaning-board set sites were allocated the following treatments;
  - 10 to 35 non-prefed standard leaning-board set lines undertaken by monitoring contractors for their clients using the NTCP.

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\(^1\) The standard trap catch monitoring comprises 10 traps spaced at 20 m along a line, lured with a flour and icing sugar mix, set for 3 nights and checked daily. The measure is reported as a “Residual Trap Catch Index” (RTCI), essentially being the mean percentage of trap nights which caught a possum.

\(^2\) The standard WaxTag monitoring comprises 20 WaxTags spaced at 10 m along a line, lured with a flour and icing sugar mix and including a photo luminescent lure, placed for 7 nights and checked after the final night only. The measure is reported as a “Bite Mark Index” (BMI), essentially being the mean percentage of WaxTags which show evidence of possum interference.
10 prefed leaning-board set lines (as recommended in the Henderson study where all traps were unset but flour lured for 3 nights and then set for 2 nights) undertaken by monitoring contractors for PCR and BD.

10 WaxTag lines undertaken by monitoring contractors for PCR and BD using the NWTP.

- Results were analysed to determine whether significantly higher RTCI estimates occurred when traps were prefed (as found in the Henderson study) compared to standard non-prefed trap sets, for both ground and leaning-board sets. In addition the WaxTag BMI estimates were compared with standard non-prefed ground and leaning-board RTCI estimates as undertaken in the Henderson study.

- It is important to note that the methods deployed in this study were not a direct replication of the Henderson study as they differed in the following ways:
  - The Henderson study utilised “mark-recapture” to estimate actual population density. Therefore the relationships reported in the Henderson study were derived from comparisons of “index with density” (although the study did make secondary comparisons of RTCIs with BMIs). This study does not attempt to measure actual possum density but makes comparisons of “index with index”.
  - The WaxTag placements in the Henderson study did not include a flour and icing sugar lure (which was consistent with the NWTP at that time). This study did use a flour and icing sugar lure, consistent with the revised 2008 version of the NWTP, and consistent with all other studies investigating WaxTags for possum monitoring.

**Results**

- The 2.1 x increase due to prefeeding reported in the Henderson study was not replicated in this study. There were no statistically significant differences in prefed and non-prefed RTCI estimates. This was true for both ground and leaning-board trap sets.

- There was a robust correlation between ground set RTCI estimates (using the NTCP), and WaxTag BMI estimates ($R^2 = 0.9$). However there was no correlation between leaning-board sets (using the NTCP) and WaxTag BMI estimates ($R^2 = 0.08$).

- The use of leaning-boards at one site resulted in the contractor passing the performance standard but a high WaxTag BMI indicated that this was an under estimate and that many possums still remained at the study site.
Conclusions

- While the Henderson study found increased RTCI estimates where prefeeding was deployed (2.1 x) this study did not support those findings.

- A good correlation was found between ground set trap RTCI estimates and WaxTag BMI estimates which is consistent with previous studies. However no correlation was found between leaning-board RTCIs and WaxTag BMIs.

- This study supports previous studies that show that raised sets provide inconsistent RTCI estimates, irrespective of prefeeding. It shows that in some cases leaning-board sets do not accurately measure possum densities. At Kumara the AHB assumed that possums had been controlled to very low levels (an RTCI of 0.17% and possum activity recorded on 5% of lines). However the 20.1% BMI with possum activity recorded on 80% of lines indicated that possum density was more likely to be around 4% RTCI.

- While the Henderson study concluded that some possums were WaxTag shy, based on comparisons of RTCI and BMI estimates, this study did not support that conclusion. The reported shyness in the Henderson study may have been due to the absence of a flour and icing sugar lure which is inconsistent with all other studies investigating WaxTags for possum monitoring.

- There is evidence in the literature to suggest that shy possum populations could be poorly measured by the WaxTag method. In other cases however, the WaxTag method outperforms the trap-catch method as shown at the Kumara site (see above). This study found that a performance target of 10% BMI or less would have passed and failed the same control operations that were passed or failed using a 2% RTCI performance target using ground set traps.

Recommendations

- The current non-prefed trap methodology described in the NTCP should be retained.

- The RTCI indices derived from leaning-board sets should continue to be interpreted with caution, as presently recommended in the NTCP. Alternatively the WaxTag method should be used where the presence of ground birds precludes the use of ground set traps.

- The present caution suggesting that cyanide paste “shy” possum populations may not be accurately measured by the WaxTag method should be retained in the NWTP.

- The current use of a flour and icing sugar lure should be retained in the NWTP to ensure consistent possum interference rates.
1. Introduction

The purpose of this study was to reinvestigate aspects of “Project R-80660, Best Practice for Monitoring Low Density Possum Populations” reported in Henderson et al. 2007 (referred to in this report as “the Henderson study”). The work was carried out by Pest Control Research Ltd (PCR) and Biodiverse Ltd (BD) between January 2008 and January 2010 for the Animal Health Board (AHB).

2. Background

The two nationally standardised protocols

Currently there are two nationally standardised protocols for possum monitoring in New Zealand, the national trap-catch protocol (NTCP, NPCA 2008a) and the national WaxTag protocol (NWTP, NPCA 2008b). The NTCP uses the proportion of possums captured in leg-hold traps (Fig. 1) over 3 nights to estimate the “Residual Trap Catch Index” (RTCI). The NWTP protocol uses the proportion of WaxTags bitten by possums (Fig. 3) over 7 nights to estimate the “Bite-Mark Index” (BMI).

The trap-catch method

The NTCP specifies randomly located lines of 10 leg-hold traps (Fig. 1) at 20m spacings that are normally set for 3 nights based on the findings of Batcheler et al. (1967). The traps are inspected daily and the RTCI determined by calculating the proportion of trap-nights where possums are captured on each line. The RTCI is an average of the line estimates and is normally reported with a 95% confidence interval (CI).

Fig. 1. A No. 1 leg-hold trap used to measure possum abundance using the NPCA trap-catch protocol.
Because traps can capture protected native ground birds such as weka (*Gallirallus australis*) and kiwi (*Apteryx sp.*) there is provision in the NTCP to raise the traps above the ground so that they are out of the reach of these birds. These trap sets are commonly called leaning-board sets because a board is used to encourage the possum to climb to the trap (Fig. 2). The Department of Conservation has made the use of leaning-board sets mandatory where ground birds are present and the AHB has specified that only leaning-boards are to be used to raise the sets above ground.

**Fig. 2.** A leaning-board set.

The trap-catch method can give false negatives (Thomas et al. 2003) and it can underestimate possum densities, especially when monitoring is undertaken immediately after control (Forsyth et al. 2005). One method to lessen the impact of these deficiencies is to increase the likelihood of a trap catching a possum (i.e. by increasing trap sensitivity). The AHB has been mindful of this need and commissioned the Henderson et al. (2007) study to investigate potential methods to increase trap sensitivity.

**The WaxTag method**

The NWTP specifies randomly located lines containing 20 WaxTags spaced at 10m intervals and left out for 7 nights. The mean percentage of WaxTags bitten by possums is calculated and the mean percentage bitten from all lines together with 95% CIs is used to give the BMI. The WaxTag method was developed by
PCR in 2001\(^3\) and uses a light-weight device consisting of a wax block attached to a plastic tag that can be nailed to a tree (Fig. 3). Possums bite the wax block leaving behind possum specific bite-marks. The plastic tag increases the visibility of the wax block and this is further enhanced by a flour and icing sugar blaze (Warburton and Yockney 2000) and a photo-luminescent lure (Thomas & Maddigan 2004). Since the development of the WaxTag several studies have investigated its ability to monitor and map possum populations (Bearman 2002, Thomas et al. 2003, Thomas et al. 2004, Thomas et al. 2007 and Henderson et al. 2008).

**Fig. 3.** WaxTags (left) were developed by Pest Control Research Ltd specifically for possum monitoring. They were designed to improve deficiencies in the bait interference and trap-catch methods. The device consists of a wax block located on a plastic tag, to improve visibility (left). Possum bite-marks are shown on the WaxTag (right).

**Project R-80660 “Best Practice for Monitoring Low Density Possum Populations” – the Henderson study.**

**Background to the study**
In 2006 the AHB commissioned Pest-Tech Ltd to undertake the study “R-80660 Best practice for monitoring low-density possum populations”. Its purpose was to compare the accuracy and precision of existing possum monitoring methods and to investigate methods that have the potential to improve possum monitoring. Results of the Henderson study were reported in Henderson et al. (2007).

\(^3\) PCR owns the intellectual property associated with the WaxTag in the form of a patent (NZ patent no. 516900) and a registered design (NZ design no. 402424). The WaxTag is sold by PCR for $0.85c + GST.
Methods used in the Henderson study

Several possum monitoring methods were investigated in the Henderson study but for the purpose of this study only the trap-catch and WaxTag methods are investigated because these are the only ones used by agencies to monitor possum populations. The Henderson study determined the precision and accuracy of RTCI and BMI estimates by comparing them with measures of absolute possum density derived from tagged and released possums and from numbers of possums obtained from intensive trapping and cyanide poisoning. The study also directly compared RTCI estimates with BMI estimates. The research was undertaken at 5 study sites, one in the Central North Island and the remainder in Westland.

In addition, what the Henderson study referred to as prefeeding, was investigated. Prefeeding was described as locating the traps in the field using the procedures described in the NTCP (NPCA 2008a), including luring with flour and icing sugar, but with the traps left unset (the protocol specifies that the traps are set). After the traps were left unset but lured for 3 fine nights the flour and icing sugar lure was replenished and the traps were set. The traps were checked daily after 2 fine nights trapping (the protocol recommends 3 fine nights) and trap outcomes were recorded.

Main outcomes from the Henderson study

Outcomes from the Henderson study relating to the NTCP

The main outcome relating to the NTCP was described on page 28 of the report i.e. “On average the RTCI for prefed leg-hold traps monitored for 2 days was 2.1 times greater than the RTCI for standard-leg-hold traps set for 3 days. Managers should be mindful of this fact when setting targets for contract work. For example, a 2% RTC under the existing system (a common contract target) is equivalent to a 4.2% RTC with prefed leg-hold traps”.

The report concluded (page 33) that “The use of pre-feed prior to setting leg-hold traps facilitates higher rates of capture (ROC), mitigates problems with low capture rates on leaning boards when possums are ‘shy’, and ameliorates differences between the RTCI of traps set on the ground and set on leaning boards”

The report recommended (page 42) that: “The existing protocol for monitoring possums with leg-hold traps and leaning boards should be amended so that when monitoring low density populations;

a) traps are pre-fed for 3 nights before they are set ; and
b) traps are monitored for 2 nights instead of 3”.

Outcome from the Henderson study relating to the NWTP

The main finding relating to the NWTP was that the method was unreliable where possums are expected to be shy. Page 4 of the report stated that “At 2 sites that were each occupied by c.235 ‘shy’ possums’ interference with WaxTags was 0%
(i.e. 0/200 WaxTags) and 0.5% (i.e.1/200 WaxTags). The corresponding 3 day RTCl of standard leg-hold traps set at these sites was 1.3% and 5.6%”.

Despite these results from the “shy” study sites, the Henderson study found that the BMI was reasonably well correlated with absolute possum density calculated from mark-recapture (r = 0.85). That correlation was similar to that found for the 3 day trap methods (r= 0.84) and for prefed and non-prefed ground trapping (r = 0.82, Table 7, page 25).

The Henderson study also concluded on page 36 that “In recent studies where luminescence was not used and WaxTags were fed with flour and icing sugar, bite-marks on WaxTags were well correlated with possum abundance (Thomas and Maddigan 2006). Therefore, WaxTags (without luminescence) may be useful for trend monitoring of possum populations where levels of ‘shyness’ have not been changed by exposures to fast-acting poisons such as cyanide”.

The Henderson report made the recommendation (page 42) that “The use of WaxTags for monitoring possums should be reviewed by the NPCA and AHB on the basis of empirical data presented in this report and field data from other agencies”.

**The research questions**

Based on the results of the Henderson study the following research questions were identified as requiring further investigation.

1. Will comparative prefed and non-prefed RTCl estimates support the 2.1 x increase in prefed RTCl estimates reported in the Henderson study?
2. Are BMI indices as useful as RTCl indices for estimating relative possum density?

**3. Objectives**

To further investigate elements of the Henderson study by:

1. Comparing prefed ground set RTCl estimates (recommended in the Henderson study) with non-prefed ground set RTCl estimates using the current NTCP.
2. Comparing prefed leaning-board set RTCl estimates (recommended in the Henderson study) with non-prefed leaning-board set RTCl estimates using the current NTCP.
3. Reviewing the WaxTag methodology (recommended in the Henderson study) by comparing WaxTag BMI estimates with ground and leaning-board set RTCl estimates.
4. Methods

Data collection

Study sites
A total of 10 study sites (5 for ground sets and 5 for leaning-board sets) were selected throughout New Zealand. The sites are representative of the different habitat types where the AHB commonly monitors possums (i.e. farm and forest). Possum monitoring, using the current NTCP (NPCA 2008a) the current NWTP (NPCA 2008b) and the “prefed” trap-catch methods described in Henderson et al. (2007) were undertaken by selected commercial possum monitoring contractors. Only those contractors that have proven track-records for undertaking thorough and accurate possum monitoring using both monitoring protocols where chosen to undertake the work (Table 1). The study sites were those that were due to undergo routine monitoring to measure contractor performance or possum population trends by the monitoring contractors for their clients. Therefore the information presented in this report reflects real operational practice.

Table 1. Commercial possum monitoring contractors used to undertake the possum monitoring used in the study.

<table>
<thead>
<tr>
<th>Monitoring contractors used in the study</th>
<th>Name</th>
<th>Contact</th>
<th>Address</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualmons Ltd</td>
<td>Sean Littlefair</td>
<td>PO Box 121 Turangi</td>
<td><a href="mailto:sean@esalez-nz.co.nz">sean@esalez-nz.co.nz</a></td>
<td></td>
</tr>
<tr>
<td>H&amp;M Monitoring Ltd</td>
<td>Helen Hoar</td>
<td>1/21 Ngatiwa Street, Nelson 7010</td>
<td><a href="mailto:mikehoar@xtra.co.nz">mikehoar@xtra.co.nz</a></td>
<td></td>
</tr>
<tr>
<td>Dinneen Environmental Monitoring Ltd</td>
<td>Brent Dinneen</td>
<td>PO Box 7368 Taradale</td>
<td><a href="mailto:dinneen@xtra.co.nz">dinneen@xtra.co.nz</a></td>
<td></td>
</tr>
</tbody>
</table>

Location of the monitoring lines
At each study site monitoring lines (10 to 35 standard trap-catch lines, 10 prefed trap-catch lines and 10 standard WaxTag lines) were randomly located as specified in the NTCP and the NWTP (NPCA 2008a and 2008b). This design provided a comparative sample for each treatment type (i.e. 10 to 35 standard, 10 prefed and 10 WaxTag lines). The study site location, number of lines and contractor undertaking the work is shown in Table 2.
Table 2. Study site locations, contractors undertaking the monitoring and numbers of lines used. Type of monitoring, either ground set or leaning-board set, is shown in parenthesis.

<table>
<thead>
<tr>
<th>Study Site</th>
<th>Location</th>
<th>Contractor</th>
<th>Number of lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiouru North</td>
<td>2751418E 6198393N</td>
<td>Qualmons Ltd</td>
<td>10 non-prefed 10 prefed 10 WaxTag</td>
</tr>
<tr>
<td>(ground)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woodhill</td>
<td>2624460E 6510625N</td>
<td>Qualmons Ltd</td>
<td>10 non-prefed 10 prefed 10 WaxTag</td>
</tr>
<tr>
<td>(ground)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turangi</td>
<td>2828579E 6292013N</td>
<td>Qualmons Ltd</td>
<td>10 non-prefed 10 prefed 10 WaxTag</td>
</tr>
<tr>
<td>(ground)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ngaruoro GS1</td>
<td>2811710E 6174390N</td>
<td>Dinneen Environmental Monitoring Ltd</td>
<td>10 non-prefed 10 prefed 10 WaxTag</td>
</tr>
<tr>
<td>(ground)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ngaruoro</td>
<td>2821540E 6177260N</td>
<td>Dinneen Environmental Monitoring Ltd</td>
<td>10 non-prefed 10 prefed 10 WaxTag</td>
</tr>
<tr>
<td>(ground)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buller</td>
<td>2383565E 5935275N</td>
<td>H&amp;M Monitoring Ltd</td>
<td>20 non-prefed 10 prefed 10 WaxTag</td>
</tr>
<tr>
<td>(leaning-board)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Creek</td>
<td>2430432E 5933728N</td>
<td>H&amp;M Monitoring Ltd</td>
<td>20 non-prefed 10 prefed 10 WaxTag</td>
</tr>
<tr>
<td>(leaning-board)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waiouru South</td>
<td>2761203E 6195992N</td>
<td>Qualmons Ltd</td>
<td>10 non-prefed 10 prefed 10 WaxTag</td>
</tr>
<tr>
<td>(leaning-board)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kumara</td>
<td>2361565E 5837925N</td>
<td>H&amp;M Monitoring Ltd</td>
<td>35 non-prefed 10 prefed 10 WaxTag</td>
</tr>
<tr>
<td>(leaning-board)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waiouru NT</td>
<td>2733698E 6190036N</td>
<td>Qualmons Ltd</td>
<td>10 non-prefed 10 prefed 10 WaxTag</td>
</tr>
<tr>
<td>(leaning-board)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Protocol used by the monitoring contractors

A trap and WaxTag setting protocol specific to this study was written by PCR and supplied to the selected possum monitoring contractors prior to undertaking the monitoring. This detailed precise trap setting procedures for the 4 different standard and prefed trap sets and for the standard WaxTag sets. The 5 set types specified were:

1. Standard ground sets used to supply monitoring information to their clients using the NTCP (NPCA 2008a).


3. Standard leaning-board sets used to supply monitoring information to their clients using the NTCP (NPCA 2008a).


5. Standard WaxTag sets using the NWTP (NPCA 2008b).

The trap setting protocol given to the contractors contained the following details for each monitoring method.

1. The standard ground trap sets
These trap sets were as normally used by the contractors for their clients following the ground set method described in the NTCP (NPCA 2008a). There were 10 to 35 randomly located trap lines containing 10 traps each. Traps were set on day 4 and left set for 3 fine nights (see Table 3) checked every day, lure replenished and all trap outcomes recorded.

2. The “prefed” ground trap sets
These trap sets were located in the field 3 fine nights prior to locating the standard trap lines (see Table 3). The traps were located at the sites following the method described in the NTCP (NPCA 2008a) but were not set. All trap sites were “prefed” using the same luring method described in the NTCP (NPCA 2008a) but using the timing described in the Henderson study. The traps were revisited on day 4 (see Table 3) and were set. Trap checking, trap outcome recording and lure replenishment was undertaken as described in the NTCP (NPCA 2008a) but for 2 fine nights not 3 fine nights as recommended in the NTCP.

3. The standard leaning-board trap sets.
These trap sets were as normally used by the contractors for their clients and were located in the field on day 4 (see Table 3). The leaning-boards used were as specified on page 18 of the NTCP (NPCA 2008a) including the V shaped notch, holes, hinges and notch for the trap chain. The traps were attached using ‘strips of rubber’ and using the new specification that the dog be located ‘away
from the tree’ (NPCA 2008a). Luring included the new specification of ‘a small handful of flour at the base of the board on the ground’ (NPCA 2008a) as recommended by Henderson et al. (2007).

4. The prefed leaning-board trap sets.
These trap sets were located in the field for 3 fine nights prior to locating the standard trap lines (see Table 3). The leaning-boards and traps were located at the sites following the method described in the NTCP (NPCA 2008a) but the traps were not set. The traps were revisited on day 4 (see Table 3) and were set. Trap checking, trap outcome recording and lure replenishment was undertaken as recommended in the NTCP (NPCA 2008a) but for 2 fine nights and not 3 fine nights as recommended in the NTCP.

5. Standard WaxTag lines
A total of 10 randomly located WaxTag lines that contained 20 WaxTags at 10m spacings were located at all 10 study sites. The WaxTags were lured with a flour and icing sugar blaze and a photo luminescent lure following the NWTP (NPCA 2008b). The WaxTags were left in the field for 7 nights and collected and examined for the presence of possum bite-marks.

Timing of the monitoring methods
To ensure that accurate comparisons were made between the different sets (i.e. standard ground sets c.f. prefed ground sets c.f. WaxTag sets and standard leaning-board sets c.f. prefed leaning-board sets c.f. WaxTag sets) the contractors were asked set the devices on the same nights to negate any differences in possum behavior that may have occurred due to differences in weather conditions i.e. all prefeeding and WaxTag location was to be undertaken prior to the setting of the standard traps using the timing schedule outlined in Table 3.

Table 3. Monitoring schedule supplied to commercial possum monitoring contractors describing the timing of standard and prefed trap sets and WaxTag sets.

<table>
<thead>
<tr>
<th>Day</th>
<th>Standard sets</th>
<th>Day</th>
<th>Prefed sets</th>
<th>Day</th>
<th>WaxTags</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>Do nothing</td>
<td>Day 2</td>
<td>Do nothing</td>
<td>Day 3</td>
<td>Do nothing</td>
</tr>
<tr>
<td>Locate and lure with flour</td>
<td></td>
<td>Locate unset traps and “prefed”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do nothing</td>
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**Statistical analysis**

**Objective 1: Comparing standard non-prefed ground set RTCI estimates with prefed ground set RTCI estimates**

The three night standard non-prefed ground set RTCI’s and the 2 night prefed ground set RTCI’s were compared using t-tests to determine whether significant differences occurred between RTCI estimates.

**Objective 2: Comparing standard leaning-board set RTCI estimates with prefed leaning-board set RTCI estimates**

The three night standard leaning board set RTCI’s were compared with 2 night prefed leaning board set RTCI’s using t-tests to determine whether significant differences occurred between RTCI estimates.

**Objective 3: Comparing both standard non-prefed and prefed ground set and standard non-prefed and prefed leaning-board set RTCI estimates with WaxTag BMI estimates**

The 3 estimated indices of relative possum abundance (standard non-prefed RTCI, prefed RTCI and BMI) and their associated standard errors (SE) were graphed to provide visual comparisons of the RTCI and BMI estimates for both ground set and leaning-board set traps and WaxTags.

In addition the relationship between standard ground set RTCI estimates and standard WaxTag BMI estimates and the relationship between standard leaning-board set RTCI estimates and WaxTag BMI estimates were determined from linear regression analysis using the least-squares regression fit. When using this method the closer the R² value is to 1 the closer is the relationship between RTCI and BMI estimates.

These graphs and a graph comparing RTCI and BMI estimates from a previous study (Thomas et al. 2007) were used to determine an appropriate BMI contractor performance target (this was estimated to be a BMI of 10%) that is equivalent to a 2% RTCI performance target. The 10% BMI and the 2% RTCI targets were used to determine whether contractors would have passed or failed their possum control operations at the 10 study sites assuming both estimates were used.

The ability of the various methods to detect possums at low population densities (i.e. their sensitivity) was determined by comparing the number of lines that detected possums based on the method described in Thomas et al. (2003). This measure is independent of the RTCI and BMI indices where it is assumed that the greater number of lines detecting possums is the most sensitive method. The numbers of lines that detected possums in this study were graphed using histograms to provide a direct visual comparison of the sensitivity of the three
monitoring methods used (i.e. standard trap sets, prefed trap sets and WaxTag sets).

5. Results

Objectives 1 and 2: Comparing non-prefed with prefed RTCI estimates for both ground and leaning-board sets

No significant differences were recorded between standard non-prefed ground set RTCI’s and prefed ground set RTCI’s (Table 4). Similarly no significant differences were recorded for standard non-prefed leaning-board set RTCIs and prefed leaning-board set RTCI’s (Table 4).

Table 4. Comparison of mean RTCIs for prefed and non-prefed ground set traps, and prefed and non-prefed leaning-board set traps.

<table>
<thead>
<tr>
<th>Trap sets</th>
<th>Mean RTCI</th>
<th>Mean RTCI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 night (standard) vs 2 night (prefed)</td>
<td>2.5%</td>
<td>3.5%</td>
<td>0.53</td>
</tr>
<tr>
<td>Leaning-board</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 night (standard) vs 2 night (prefed)</td>
<td>1.9%</td>
<td>1.3%</td>
<td>0.56</td>
</tr>
</tbody>
</table>

Objective 3: Comparing both ground set and leaning-board set RTCI estimates with WaxTag BMI estimates

No evidence was found to indicate that possums were “shy” of WaxTags at the 10 study sites as most study sites had higher BMI estimates than RTCI estimates (Figs. 4 and 5).

Ground set traps

Fig 4. Comparisons of 3 night standard ground set RTCIs, 2 night prefed ground set RTCIs, and standard 7 night WaxTag BMIs. Error Bars are ± 1 SE of the mean.
Fig 5. Comparisons of 3 night standard leaning-board set RTCIs, 2 night prefed leaning-board set RTCIs and standard 7 night WaxTag BMIs. Error bars are ±1 SE of the mean.

The correlation between RTCI and BMI estimates
There was a robust correlation between the WaxTag BMI estimates and the standard (3 night) ground set RTCI estimates ($R^2 = 0.90$, Fig 6). Given that the trap-catch method generally provides accurate and precise estimates of population change (Warburton et al. 2004), this relationship suggests that the BMI also accurately reflects relative population abundance.

Fig. 6. Linear correlation of WaxTag BMI indices and standard ground set RTCI indices and the associated $R^2$ value. Error bars are ± 1 SE of the mean.
However no correlation was recorded between the WaxTag BMI indices and the standard leaning-board set RTCI indices ($R^2 = 0.08$, Fig 7).

![Leaning-board set RTCIs and WaxTag BMIs](image)

**Fig. 7.** Linear correlation of WaxTag BMI indices and leaning-board set RTCI indices and the associated $R^2$ value. Error bars are $± 1$ SE of the mean.

**Relationship between RTCI and BMI**

Both the standard ground set RTCI and the WaxTag BMI have previously been shown to correlate well with possum numbers. A previous study demonstrated that WaxTag BMI indices accurately predicted the numbers of possums present at two study sites before and after they had undergone possum control (Thomas et al. 2007, Fig 8). Actual possum numbers at these sites were estimated using extensive grid tag and release trapping undertaken by staff at Landcare Research NZ Ltd.

![Night 7](image)

**Fig. 8.** Linear correlation of WaxTag BMI indices and numbers of possums captured and released and the associated $R^2$ value. The curvilinear line was fitted to show that saturation of the WaxTags did not occur. Error bars are 95% C.I. (from Thomas et al. 2007).
The Thomas et al (2007) study also presented a calibration graph based on a number of studies that compared BMI estimates with RTCI estimates (Fig 9). The results from this study (Fig. 6) are consistent with the results summerised in this graph.

![Graph showing BMI vs RTCI with different night lengths](image)

**Fig. 9** Relative values of WaxTag BMI estimates and trap catch RTCI estimates taken from studies that recorded both indices. The top trend line is for the 7 night night BMI calculated in this study (from Thomas et al. 2007).

**Contractor performance outcomes from RTCI and BMI estimates**

Using the 2% RTCI performance target (a standard AHB specified target) and the 10% BMI performance target (derived from Figs. 6 and 9) contractor performance outcomes were the same at the five sites when ground sets and WaxTags were used (Table 5).

**Table 5.** Contractor performance outcomes determined from standard and “prefed” RTCI estimates for ground set traps and WaxTag BMI estimates at 5 study sites. The performance targets were set at an RTCI of 2% and a BMI of 10% or less for contractors to pass. Outcomes are shown in parenthesis.

<table>
<thead>
<tr>
<th>Site (Ground Sets)</th>
<th>Standard RTCI</th>
<th>2 night “Prefed” RTCI</th>
<th>WaxTag BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiouru North</td>
<td>3.97% (fail)</td>
<td>9.5% (fail)</td>
<td>16% (fail)</td>
</tr>
<tr>
<td>Woodhill</td>
<td>1.66% (pass)</td>
<td>0.5% (pass)</td>
<td>6.5% (pass)</td>
</tr>
<tr>
<td>Turangi</td>
<td>4.93% (fail)</td>
<td>7.5% (fail)</td>
<td>30% (fail)</td>
</tr>
<tr>
<td>Ngaruoro GS1</td>
<td>1.9% (pass)</td>
<td>0% (pass)</td>
<td>3% (pass)</td>
</tr>
<tr>
<td>Ngaruoro</td>
<td>0.3% (pass)</td>
<td>0% (pass)</td>
<td>0% (pass)</td>
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</table>
Contractor performance outcomes were the same for 4 of the leaning-board set sites but conflicting results occurred at the Kumara site (Table 6). At the Kumara site the contractor did better than the 2% RTCI target when monitored with standard leaning-board sets (0.17%) and was paid out by the AHB for fulfilling his contractual obligations. However the WaxTag monitor indicated the contractor had failed to achieve the 10% BMI specified target by recording a 20.5% BMI. Using the calibration graph shown in Fig. 9 this results suggest that the RTCI was more likely to be approximately 4% rather than the calculated 0.17%.

Table 6. Contractor performance outcomes determined from standard and “prefed” RTCI estimates for leaning-board set traps and WaxTag BMI estimates at 5 study sites. The performance targets were set at an RTCI of 2% and a BMI of 10% or less for contractors to pass. Outcomes are shown in parenthesis.

<table>
<thead>
<tr>
<th>Site (Leaning Boards)</th>
<th>Standard RTCI</th>
<th>2 night “Prefed” RTCI</th>
<th>WaxTag BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buller</td>
<td>0% (pass)</td>
<td>0% (pass)</td>
<td>0% (pass)</td>
</tr>
<tr>
<td>New Creek</td>
<td>0.3% (pass)</td>
<td>0% (pass)</td>
<td>0% (pass)</td>
</tr>
<tr>
<td>Waiouru South</td>
<td>6.33% (fail)</td>
<td>2.1% (fail)</td>
<td>10.5% (fail)</td>
</tr>
<tr>
<td>Kumara</td>
<td>0.17% (pass)</td>
<td>2.1% (fail)</td>
<td>20.5% (fail)</td>
</tr>
<tr>
<td>Waiouru NT</td>
<td>3.1% (fail)</td>
<td>2.5% (fail)</td>
<td>29.5% (fail)</td>
</tr>
</tbody>
</table>

The proportion of monitoring lines detecting possums

For the ground set trap study sites the proportions of trap lines that captured possums were similar to the proportion of WaxTag lines detecting possums for 3 of the study sites (Fig 10). However at one site (Ngaruoro) the WaxTag lines did not detect any possums present whereas one trap line did. Conversely at Woodhill only 30% of trap lines detected possums compared to 80% of WaxTag lines.

For 4 of the leaning-board set study sites the proportion of trap and WaxTag lines detecting possums was similar. However at the Kumara site, where the AHB has undertaken extensive possum control and monitoring, only 5% of the leaning-board lines detected possums compared to 80% of the WaxTag lines that detected possums (Fig 11).
**Fig. 10** The proportion of the 3 types of monitoring lines (standard ground set, prefed ground set and WaxTag) that detected the presence of possums at 5 study sites.

**Ground set traps**

![Ground set traps graph]

**Fig. 11** The proportion of the 3 types of monitoring lines (standard leaning-board, prefed leaning-board and WaxTag) that detected the presence of possums at 5 study sites.

**Leaning-board set traps**

![Leaning-board set traps graph]
6. Discussion

In contrast to the Henderson study, this study did not find any significant increase in capture rates when prefeeding was used regardless of whether traps were set on the ground or on leaning-boards. It appears from these results that the prefeeding effect observed in the Henderson study is not a consistent effect. Also leaning-board sets underperformed in this study, when compared to the WaxTag method, irrespective of whether they were prefed or not (see Figs. 4 & 5).

The good correlation found in this study between ground set RTCI and BMI indices ($R^2 = 0.90$, see Fig. 6) is consistent with previous studies establishing that the WaxTag BMI generally correlates well with the RTCI (Thomas et al. 2007). In addition to the good correlation between these respective indices, the WaxTag BMI has also been shown to correlate strongly with possum density ($R^2 = 0.97$, see Fig. 8 after Thomas et al. 2007). Further, this study confirms that the BMI index is generally a more sensitive measure of relative possum abundance than the RTCI as also found in Bearman 2002 and Thomas et al. 2003 (see Figs. 10 & 11).

Both RTCI (ground set) and BMI measures ultimately gave the same contractor performance outcomes showing that those operations which would have been passed or failed by ground trap monitoring would also have been passed or failed using WaxTag monitoring. However leaning-board outcomes were variable, and the author’s conclude that either ground-based trap monitoring or WaxTag monitoring are preferable to leaning-board monitoring.

The most striking failure of leaning-board sets to provide accurate possum density information occurred at the Kumara site. Reasons for this are unknown but one possible reason could be the scrubby nature of the site due to its past gold mining history. This may have compromised the monitoring contractors’ ability to locate the leaning-boards on sufficiently large enough trees that would normally be climbed by possums. However we have no evidence that this caused the low RTCI estimate recorded at the site.

The Henderson report found a correlation between BMI and estimated possum density of $R = 0.85$, which is not as strong a relationship as found in other studies. The Henderson report attributes that outcome to three possible reasons.

1. Bite aversion induced by sub-lethal poisoning where acute toxins have been used.
2. An aversion to luminescent lures, for the same reason as the bite aversion.
3. The absence of a flour blaze used with the WaxTags in the Henderson study.
We address these three possibilities, while acknowledging that any combination of these effects may be causal, we were unable to determine the relative importance of each one because this was not a study objective.

Firstly, bite aversion is likely to be at sites where bait shyness has been induced, particularly by the use of cyanide paste. This effect has been observed on at least three occasions i.e. Thomas et al. 2007, by G. Nugent (as reported pers. com. in Henderson et al. 2007) and the Henderson study itself. Indisputably it is poor practice to use the WaxTag method where induced bait shyness resulting from sub lethal ingestion of cyanide paste is likely. A caution to that effect is currently in the NWTP, and should be retained (NPCA 2008b).

Secondly is the possibility that luminescent lures adversely affect bait shy possums. That may well be true, and the Henderson study found that luminescent lures were the least effective of all lures tested. Similarly, Thomas and Madigan (2004) found the attractive effect of luminescent lures is relatively weak, although they found no evidence of any luminescent lure aversion. It is possible that “shy” possums are wary of luminescence. However, while this cannot be strongly concluded either way, it may be of lesser importance given that WaxTags are not recommended to monitor cyanide paste shy possum populations in any case.

Thirdly is the use of the flour and icing sugar lure. While the initial NWTP in force at the time of the Henderson study did not specify that a flour and icing sugar lure be used (only a luminescent lure was specified) that was perceived to be a mistake. Consequently the Henderson study is the only study conducted that investigates the use of WaxTags without a flour and icing sugar lure. This deficiency was remedied at the first revision of the NWTP in 2008 (NPCA 2008b) where the flour and icing sugar lure was included to make it consistent with previous studies investigating possum monitoring using WaxTags.

Although no direct investigation of the effect of the inclusion of a flour and icing sugar lure is reported in the literature, data from Northland Regional Council (Steve Henderson unpubl. data) indicates that the effect is significant. Monitoring of the Poutu operation in 2002 randomly deployed 20 lines of 20 WaxTags with no lure at all, and another 20 lines using only a flour and icing sugar lure. The mean BMI for the unlured lines was 16% while the flour and icing sugar lured BMI was 51%. That outcome was highly significant using a two sample t-test, \( P < 0.0001 \). Given this result, it is difficult to compare outcomes from the Henderson study, which used WaxTag methodology that differed in such an important way, with all other published WaxTag studies that used a flour and icing sugar lure.
7. Conclusions

- While the Henderson study found increased RTCI estimates where prefeeding was deployed (2.1 x) this study did not support those findings.

- A good correlation was found between ground set trap RTCI estimates and WaxTag BMI estimates which is consistent with previous studies. However no correlation was found between leaning-board RTCIs and WaxTag BMIs.

- This study supports previous studies that show that raised sets provide inconsistent RTCI estimates, irrespective of prefeeding. It shows that in some cases leaning-board sets do not accurately measure possum densities. At Kumara the AHB assumed that possums had been controlled to very low levels (an RTCI of 0.17% and possum activity recorded on 5% of lines). However the 20.1% BMI with possum activity recorded on 80% of lines indicated that possum density was more likely to be around 4% RTCI.

- While the Henderson study concluded that some possums were WaxTag shy, based on comparisons of RTCI and BMI estimates, this study did not support that conclusion. The reported shyness in the Henderson study may have been due to the absence of a flour and icing sugar lure which is inconsistent with all other studies investigating WaxTags for possum monitoring.

- There is evidence in the literature to suggest that shy possum populations could be poorly measured by the WaxTag method. In other cases however, the WaxTag method outperforms the trap-catch method as shown at the Kumara site (see above). This study found that a performance target of 10% BMI or less would have passed and failed the same control operations that were passed or failed using a 2% RTCI performance target using ground set traps.

8. Recommendations

- The current non-prefed trap methodology described in the NTCP should be retained.

- The RTCI indices derived from leaning-board sets should continue to be interpreted with caution, as presently recommended in the NTCP. Alternatively the WaxTag method should be used where presence of ground birds precludes the use of ground set traps.

- The present caution suggesting that cyanide paste “shy” possum populations may not be accurately measured by the WaxTag method should be retained in the NWTP.

- The current use of a flour and icing sugar lure should be retained in the NWTP to ensure consistent possum interference rates.
9. Acknowledgements

We would like to thank the possum contractors Sean Littlefair, (Qualmons Ltd) Brent Dinneen (Dinneen Environmental Monitoring Ltd) and the late Mike Hoar and Helen Hoar (H&R Contracting Ltd) who undertook the possum monitoring. We would also like to thank Chris Pullen (AHB) who assisted in finding suitable study sites in Westland and Steve Henderson (Northland Regional Council) for providing the lured and non-lured WaxTag data.

10. References


