

# **Knowledge Gaps in Conventional Control of Possums**

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## Contents

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Summary .....	4
1. Introduction .....	7
2. Background.....	7
3. Objectives .....	8
4. Methods .....	8
5. Knowledge Gaps Identified from the Literature and by Colleagues.....	9
5.1 Research needs .....	9
5.2 Management needs.....	13
6. Knowledge Gaps Identified at the NPCA Workshops .....	14
6.1 Research needs .....	15
6.2 Management needs.....	16
7. Results of our Questionnaire .....	18
7.1 Research needs .....	18
7.2 Management needs.....	19
8. Conclusions .....	19
8.1 Research needs .....	19
8.2 Management needs.....	20
9. Recommendations .....	21
10. Acknowledgements .....	22
11. References .....	22
12. Appendix .....	24
Appendix 1 Questionnaire on knowledge gaps in conventional possum control.....	24

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## Summary

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### Project and Client

The gaps in the knowledge underpinning best-practice possum control as perceived by researchers, by possum managers and control staff, and by commercial possum control contractors, were determined from a literature review and via a series of workshops convened by the National Possum Control Agencies (NPCA) and attended by possum control industry personnel. Further industry input was obtained from a questionnaire circulated to workshop attendees. This review was undertaken by Landcare Research for the Animal Health Board between July 2001 and August 2002 (AHB Project Number R-10556).

### Objectives

To determine gaps in the knowledge underpinning cost-effective and environmentally safe conventional control of possums, by:

- Reviewing relevant recent reports and papers on possum control technology and strategies for known and suspected knowledge gaps, and presenting this material at NPCA's annual seminar (November 2001);
- Using this information to structure a series of regionally based workshops on better possum control, held in conjunction with NPCA regional seminars, and involving key representatives from land-managing authorities, pest controllers, technologists and researchers (June and July 2002); and
- Producing a report summarising the main conclusions of both the review and the workshops.

### Findings

- The knowledge gaps in possum management identified in a review of recent literature and from the opinions of Landcare Research senior staff included a range of concerns relating to bait manufacture, bait delivery, control strategies, audits of possum control operations, and the behaviour of possums at low densities.
- The knowledge gaps in possum management identified at the NPCA's national seminar by possum managers and industry control players, and in a questionnaire returned from industry players, included public attitudes to vertebrate pest control, control techniques, population monitoring, and baits and bait delivery. These broad areas of concern were used as foci of discussion on possum control at later NPCA regional workshops.
- The specific gaps in the knowledge of possum management consistently identified both by researchers and by possum industry players were prioritised for future action.

### Conclusions

The key gaps in knowledge underpinning best-practice possum control identified from our science review, NPCA workshops, and questionnaire, and divided into research needs and management needs, are set out below. Those judged of highest priority are underlined.

#### Research needs

*Baits and bait delivery:*

- The development of repellents and modified bait stations that limit access to baits by non-target birds, livestock and pets.

- The development/further development of new control tools (e.g. gel baits) to overcome bait shyness.

*Control techniques and strategies:*

- Tools and protocols to encourage operators to ensure the complete coverage of aerial- and ground-sown bait and of ground-control techniques over all areas targeted.
- Strategies and techniques to exclude non-target species from baits, bait stations, and traps.
- Clarification of the reasons for targeting minor pest species for Tb control.
- Development of improved baits and bait stations for longer palatable bait life.
- The clarification of the costs and benefits of pre-feeding, including any change in risk to non-target species.

*Operational monitoring:*

- Continued research into improving the precision, reliability and identification of the biases when using RTCIs to measure low-density possum populations.
- Development of standard operating procedures and correction factors for use when applying raised traps to determine Residual Trap Catch Indices (RTCIs).
- The development of new monitoring tools to replace the RTCI index.

*Public attitudes to pest control:*

- The use of modern social science methods to encourage public support for local possum control.

**Management needs to meet identified knowledge gaps**

*Baits and bait delivery:*

- The manufacture of commercial baits that consistently meet specifications for size, toxin loading, colour, durability in storage, and lure concentration.
- The manufacture of bait products with increased palatability and field life and hence greater acceptance by possums.
- Better access to the latest research information on newly developed products for possum control.

*Operational monitoring:*

- Improved information flow to control operators on the protocol and supporting logic for the application of RTCIs.

*Public attitudes to pest control:*

- The involvement of local interest groups in all aspects of possum control in their area.
- Improved public support by ensuring all control operations are faultless in their execution.

**Recommendations**

Based on our identification of information gaps, we recommend the following management needs and research be addressed by the different sectors in the possum control industry:

**Manufacturers**

- That companies manufacturing toxic bait be encouraged to improve consistency of bait size, toxic loading, colour, durability in storage and lure concentration, and to increase bait palatability and bait acceptance to possums.

**NPCA**

- That better access be provided to latest research information on newly developed products for possum control.
- That information flow be improved to control operators on the underpinning logic of the RTCI index, and ‘best practice’ in the aerial and ground laying of bait, the use of traps, and the use of monitoring tools.

**AHB**

- That the AHB seek to resolve key concerns involving the better transfer of control-based information from researchers and operational managers to commercial contractors.

**Pest managers**

- That greater and more sophisticated efforts be made by senior possum management staff to involve and gain the support of local communities facing possum control in their regions.
- That operational managers provide additional encouragement to all staff to ensure all operations are faultless in their execution.

**Researchers**

- That further research on population indices of possums is required, to ensure that RTCI and alternative methods better meet the requirements of possum control managers and contractors.
- That emphasis be given to the development of repellents and modified bait stations to limit access to baits by non-target species, and to new control tools to overcome bait shyness.
- That tools and protocols be developed to ensure complete coverage of target areas during control.
- That the costs and benefits of pre-feeding be determined.
- That new approaches be developed to encourage public support for local possum control.

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## 1. Introduction

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The gaps in the knowledge underpinning best-practice possum control as perceived by researchers, by possum managers and control staff, and by commercial possum control contractors, were determined from a literature review and via a series of workshops convened by the National Possum Control Agencies (NPCA) and attended by possum control industry personnel. Further industry input was obtained in a questionnaire circulated to workshop attendees. This review was undertaken by Landcare Research for the Animal Health Board between July 2001 and August 2002 (AHB Project Number R-10556).

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## 2. Background

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The need to protect conservation values or to limit the spread and persistence of bovine tuberculosis (Tb) in livestock has led to the recent diversification of control tools, strategies, and organisations and personnel involved in possum control. Such trends, paradoxically, result in the increasing likelihood that both innovation and ignorance of control methodologies by field operators will increase. This is the historical pattern of the initial development of many of the traditional or current control tools used against possums, i.e. new methods are devised and used by staff working at ‘the coal face’, without such operators having any detailed understanding of how and why possum populations are likely to respond to technology or strategy modifications. The early development of toxic baits and baiting systems for aerial delivery against possums, and the development of strategies for the efficient trapping of possums are two very good examples of this process. The refinement of methods developed by this process is more traditionally the role of research. In contrast, information gaps in approaches to possum control have often been identified serendipitously by researchers during specific and unrelated research investigations (e.g. the bias in Residual Trap Catch Indices (RTCIs) determined immediately after ‘knock-down’ control) or arise from oft-voiced public concerns over existing control methodologies. To ensure the further advancement of cost-effective and environmentally acceptable conventional control tools, Landcare Research sought to systematically identify what information was needed to achieve more effective management of conventional possum control, by reviewing recent, relevant, published and unpublished literature, and by canvassing the opinion of possum control managers and operators. A literature review provided a starting point for a series of New Zealand-based seminars and workshops aimed at encouraging workshop participants experienced in possum control to identify existing practical constraints and ways forward for improved, long-term control.

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### 3. Objectives

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To determine gaps in the knowledge underpinning cost-effective and environmentally safe conventional control of possums, by:

- Reviewing relevant recent reports and papers on possum control technology and strategies for known and suspected knowledge gaps, and presenting this material at NPCA's annual seminar (November 2001);
- Using this information to structure a series of regionally based workshops on better possum control, held in conjunction with NPCA regional seminars, and involving key representatives from land-managing authorities, pest controllers, technologists and researchers (June and July 2002); and
- Producing a report summarising the main conclusions of both the review and the workshops.

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### 4. Methods

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The process we followed in this study is summarised in Fig. 1. We began by reviewing knowledge gaps in current possum control recently identified in publications and reports by New Zealand researchers, and by seeking the opinions of some Landcare Research staff directly or indirectly involved in possum control research.

We then sought to compare these knowledge gaps with those identified by planning and field staff involved directly in possum control. This second stage began with a workshop convened by the NPCA, in conjunction with the National Science Strategy Committee for Possum and Tuberculosis Control (NSSC), and held as part of the NPCA's annual National Technology Transfer meeting in November 2001. At this workshop, we briefly reviewed the gaps we had identified concerning existing possum control technologies and strategies, and explained our intended approach to seek confirmation or clarification of these gaps and of any others identified by those involved directly in the possum control industry. Our review was then summarised by the workshop convenor, Dr Peter O'Hara of NSSC, as a catalyst for a brainstorming session by pest controllers of the knowledge gaps they would like to see discussed in more detail. The results of this workshop, including notes on our literature review and the brainstorming, were then presented by Dr O'Hara to the larger NPCA seminar, and a hard copy of his notes titled 'Making current technology more effective' circulated to all conference attendees.

With input from several senior researchers from Landcare Research, we next developed a questionnaire on better possum control (Appendix 1). This questionnaire sought the opinion of all prospective attendees to the NPCA's regional workshops at Hamilton, Palmerston North, and Christchurch in June and July 2002, on bait and baiting, toxin and lure concentrations, traps and trapping (including raised sets), non-target issues, and monitoring and auditing, and provided an opportunity for respondents to submit unprompted background information on many of these issues. Where relevant, these comments were also used in our analyses. Approximately 200 questionnaires were sent to prospective attendees of the

NPCA's three regional workshops, but only 27 (13.5%) were returned. This low level of response appears to reflect a lack of openness in the commercial possum control environment. The respondents were mostly North Island based (17 of 27), and included 12 commercial operators, 10 employees of the Department of Conservation (DOC), 4 employees of regional councils, and one lecturer from a Polytechnic.

Subsequently, we used a 1-hour time slot at each of the workshops to seek the opinion of pest controllers on the problems faced by the industry. We relied on the NPCA to invite key operators to the regional workshops, i.e. experienced people who are effective in their particular roles within the possum control industry, and whom we hoped would be willing contributors in this work. Other research providers were also invited to participate.

All attendees at the three regional workshops were provided with pre-workshop material that covered the aims of the workshop, and we sought their input to the questionnaire. Our invitation to participate in the workshops made it clear that it represented an opportunity for stakeholders to influence the direction of future research underpinning conventional control, as well as providing a chance to discuss problem areas in possum control with others involved directly in the industry. Each workshop consisted of an introduction to the topic by the senior author of this report (JDC), followed by 30-min discussion in groups and a reporting back session. Notes taken during each 'reporting back' session were collected and collated at the end of each workshop.

Finally, we completed the review by comparing the results of the questionnaire and the workshop notes with the original review. We then used the issues emphasised most often as a means of defining/recording operator input into the best way forward to achieve more cost-effective and environmentally safe conventional possum control.

This report thus summarises the key findings of our review, of all four workshops, and of our questionnaire, and uses this material to assign priorities to the knowledge gaps identified. Broadly speaking, topics reflected either a perceived need for research or for an improvement in practice based on information already available. We have therefore summarised knowledge gaps as either 'research needs' or 'management needs'. Our collation of this information was done with minimal interpretation as we aimed to present a summary of knowledge gaps as seen by those consulted.

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## 5. Knowledge Gaps Identified from the Literature and by Colleagues

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Researchers' key areas of concern and associated knowledge gaps in possum control, summarised but not prioritised for the NPCA annual conference, are set out below. They included the following research and management needs:

### 5.1 Research needs

#### **Making use of operational data**

- There is a need to centralise the collation of operational data as a basis for assessing trends in operational performance. While such a database would lack the rigour of

experimental investigations of particular facets of possum control, it would be useful in identifying ‘best practices’ that could then be subjected to experimental confirmation.

### **Bait characteristics**

#### *Cinnamon concentrations on carrot bait:*

- The current application rates of cinnamon essence on carrot bait is too low, as cinnamon vaporises rapidly following application (50% loss in 24 hours; Henderson & Frampton 1999), and levels are generally well below those recommended when baiting occurs. Higher application rates (i.e. 0.2% in pellets, 0.4% in carrot) and/or slow-release agents are likely to be more effective, but this should be confirmed experimentally with respect to 1080-masking and bait palatability. The effects of different methods of manufacturing baits on cinnamon retention, and the responses of non-target species to higher concentrations, also merit investigation.

#### *Bayer V2000 on carrot and cereal bait:*

- The colour of dyed carrot or cereal bait is often outside approved specifications for these products (Henderson & Frampton 1999). Operators dyeing bait need to ensure baits meet approved specifications, by testing occasional bait runs for colour. If specifications prove too difficult to meet consistently, they should be reviewed and possibly expanded. A dye with greater persistence in bait material than Bayer V2000 is needed.

#### *Consumption of possum baits by rats:*

- Bait losses to rats, if high enough, will reduce the overall success of possum control operations. The evaluation of a rat repellent in traditional baits, such as that incorporated in Ferocol® (Morgan & Rhodes 2000), is recommended.

#### *Field life of baits:*

- Diversification of the existing pellet baits, based on hardness and water-resistance is required to provide bait with differing field life for differing climatic regimes.

#### *Bait consistency:*

- Bait manufacturers need to work to tighter bait specifications (i.e. size, hardness, and toxin concentration) – based on pen trials of toxic bait consumption (to minimise sub-lethal dosing) and the passage of bait through the sowing process (to avoid bait fragmentation).
- Protocols for routine Quality Assurance (QA) are required, and all bait specifications should be checked where bait formulations are changed.
- Specifications should be developed for all bait types, in addition to those developed for 6-g cereal 1080 pellet and 1080 carrot bait.

#### *New bait:*

- New gel baits show great promise but the optimal strategy for their use is still being developed, especially for the long-term control of possum populations (Morgan 1999; Morgan 2002; Morgan & Milne 2001). Further field trials are needed to determine their cost-effectiveness as tools in the maintenance control of low-density possum populations.

### **Bait delivery**

#### *Toxic loading/pre-feeding:*

- The comparative cost-effectiveness against possums of 0.08 and 0.15% loading of 1080 on bait used with and without prefeed remains unclear, particularly for cereal bait

(Henderson et al. 1999). Scrutiny of operational data should be the first step in resolving these questions.

*Sowing rates:*

- Sowing rates of carrot bait vary from about 5–12 kg/ha for prefeed to 3–10 kg/ha for toxic bait. Research indicates both rates should be lower (3–5 kg/ha; Morgan & Hickling 2000), even without pre-feeding, unless other species are being targeted concurrently. The case for higher application rates needs further justification.

*Patchiness of baiting:*

- Bait from sowing buckets may ‘bridge’ and bait flow be interrupted, resulting in undetected gaps in sown bait swaths (Morgan et al. 1997). Effective bait-flow monitors should be developed that link to Global Positioning Systems (GPS)-flight path outputs, and they should eventually be used in all major possum control operations.

*Pre-feeding:*

- Although opinion is still divided, the weight of evidence is that pre-feeding before control may give better results (and thus presumably longer protection from possums) than no pre-feeding (Henderson et al. 1998; Morgan & Hickling 2000). However, comparisons are often confounded by differences in toxin concentration, bait type, and sowing rate. Collation and analysis of comparable operational data should help resolve this question and enable a cost-benefit analysis.
- Pre-feeding strategies should be investigated to help ensure that bait stations raised above ground level for livestock protection are found by possums.

*Bait shyness:*

- Sub-lethal poisoning causes bait shyness in possums (Morgan 2002) and unnecessary animal suffering (B. Warburton, Landcare Research, pers. comm.). While the scale of the problem is unclear, it is likely to be accentuated by the increasing number and frequency of possum control operations now undertaken. In addition to reinforcing the need for high quality baits, ‘best practice’ application, use of ‘bait switching’, pre-feeding (with both standard and recently developed bait types), and sparing use of second-generation anticoagulant baits, new approaches are needed to avert the development of bait shyness. Bait technologists should be encouraged to develop ‘shyness-free’ baits. Better use of Geographic Information systems (GIS) and spatial databases by pest managers would enable thorough documentation of control histories as a basis for managing shyness through rotation of control methods.

## **Control strategies**

*Tb eradication:*

- Proof of eradication of Tb from possum populations is difficult. Greater use of sentinel species is warranted (Nugent & Whitford in press) where evidence of disease eradication is needed before local control work is scaled down.

*Depth of buffers:*

- The cost-effectiveness of buffers of 2, 3 or 4 km for limiting deep-forest possums and deer from accessing farm edges is unclear although critical to Tb control strategies (Coleman et al. 2001). Further field trials on the effectiveness of such buffers appear necessary.

*Frequency of control:*

- Habitat quality influences the rate of recovery of artificially lowered possum populations (Coleman et al. 1999; Ji et al. in press). The frequency of control needed to keep RTCIs

below targeted population levels will therefore vary, but this is generally not allowed for in practice. Guidelines for long-term cost-effective possum control should be developed that allow for habitat-driven variation within major habitat types in the frequency of local possum control.

*Public perceptions of use of toxins:*

- Public mistrust of the science underpinning the use of 1080 control is becoming more entrenched and public comment more vehement (R. Walker, Southern Pest Management, pers. comm.). The greater use of social science methods involving public participation is needed in the development of local possum control operations. Organisations overseeing possum management should involve much wider community interests, either following the model used by Fitzgerald et al. (1996, 2000) or developing their own models when seeking to increase public acceptance of possum management.

*Broad-scale versus targeted control:*

- As Tb livestock herds are not randomly scattered throughout rural New Zealand, there appears to be a case for further increased vector control about problem farms, and parts of them, at the expense of control of similar intensity across many thousands of hectares of Vector Risk Areas (Coleman et al. 2002). While such a strategy is being followed in some locations already, the consequences of such actions are unclear and need to be modelled.

*Need to control 'minor species':*

- The control of infected populations of deer and ferrets remains contentious (Nugent 2001; Caley et al. 2001). Immediate relief of Tb may mean targeting both of these species at some sites. Information should be reviewed as a basis for a policy statement on the need to control 'spill-over' and possible minor 'maintenance' hosts other than possums.

*Non-target issues:*

- Non-target species may be at greater risk of poisoning when pre-feeding precedes aerial baiting than when it does not, as they may be unintentionally encouraged to eat bait before the toxic bait is given. Field trials are needed to test this hypothesis before pre-feeding is further encouraged.

*Trap shyness:*

- Trap shyness is suspected but is unproven (M. Hunter, Environment Southland, pers. comm.). Evaluation of this problem is necessary, where it is reported.

### **Audits of possum control operations**

*Reliability of RTCIs:*

- The accuracy and precision of RTCIs determined for low-density possum populations are unreliable, and is often biased low (Coleman et al. 2002), leading sometimes to a misguided belief in operational success, payment for non-achieved targets, and the failure to meet disease control standards. More precise methods of indexing possum populations are required, probably through completely new monitoring paradigms. Additionally, a better understanding of the bias in monitoring using RTCIs is urgently needed.

*Alternative monitoring techniques:*

- Alternative possum population monitoring techniques are used by some contractors but the techniques lack validation. Until the best of these are evaluated for their accuracy and precision, RTCIs should remain the monitoring tool of choice.

### **Behaviour of possums at low densities**

#### *Acceptance of baits:*

- Although not rigorously assessed in the field yet, anecdotal reports from contractors and pest managers indicate that some possum populations surviving ‘initial control’ show a high degree of bait shyness (e.g. in Hokonui Hills, M. Hunter, Environment Southland, pers. comm.), as predicted by controlled experiments (e.g. Morgan et al. in press). New bait bases and masks are needed for operations undertaken less than 12 months apart.

#### *Canopy versus ground feeding:*

- Possums surviving control operations in forest may do so by spending disproportionately large amounts of time feeding in the canopy, and thus be largely divorced from baits and traps laid on the forest floor (Morgan 1994b). If so, a new baiting strategy is required for ongoing control that ensures the coincidence of possums and the killing devices. Further evidence of this apparent separation of feeding sites is required.

## **5.2 Management needs**

### **Bait manufacture**

#### *1080 loading on carrot bait:*

- The loading of carrot bait with 1080 is thought to be unacceptably variable but it is now rarely independently tested (Henderson & Frampton 1999). A process of regular, independent analysis of the toxin concentration in baits is needed, either before the product is bagged or before it is sown.

### **Bait delivery**

#### *Patchiness of baiting:*

- Complete bait coverage of target areas, including farm, road and stream edges, is critical for the consistent reduction of possum populations (Morgan 1994a) and the elimination of Tb from them (Coleman et al. 2002). All GPS-indicated gaps in flight paths (and hence bait sowings) in all possum control operations should be reflown. An improved auditing of GPS outputs needs to be developed to ensure this happens consistently.
- Operational toxic bait and trap coverage by ground control staff is often incomplete (Coleman & Coleman 2000). GPS monitoring, at least on farmland where the technology is proven, is recommended to ensure all areas targeted are controlled.

### **Control strategies**

#### *Optimal control targets (RTCIs):*

- Operational targets vary between regional councils/contractors, and as such are difficult for operators to understand, and are a ‘bone of contention’ with many contractors (M. Hunter, Environment Southland, pers. comm.). A more transparent, rational, and equitable system of RTCI targets for Tb control should be developed.

### **Audits of possum control operations**

#### *Reliability of RTCIs:*

- GPS is being used by some contractors and appears a helpful adjunct to operational monitoring (M. Hunter, Environment Southland, pers. comm.). Its use should be

encouraged in all environments to improve coverage and assist operators to meet control targets.

*Ground versus raised trap sets:*

- Raised sets vary greatly in the way they are established and, because of that, do not provide RTCIs comparable to those derived from ground sets. Operators should be encouraged to standardise their raised sets and, when used to monitor populations, apply the newly generated correction factors to give meaning to their results (Thomas & Brown 2001). Further evaluation of the catch rates of different raised sets is needed.
- The costs of raised sets are argued by some operators to be substantially higher than the costs of ground sets. Where raised sets are required for monitoring (i.e. where native ground birds exist), the higher costs need to be confirmed in monitored trials and subsequently covered by the funding agencies wherever they are used.

### **Behaviour of possums at low densities**

*Changes in movement:*

- Some possums surviving knockdown control or those immediately adjacent to controlled areas show shifts in home range into controlled areas (Efford et al. 2000). Such behaviour is being evaluated further (Warburton et al. in prep), but current evidence indicates greater possum control efforts and perhaps the development of new strategies of control are needed for use about the periphery of controlled areas.

## **6. Knowledge Gaps Identified at the NPCA Workshops**

Attendees at the NPCA national workshop ‘brainstormed’ the issues of possum control they thought most likely to provide greatest advances in cost-effective possum management. The results of such brainstorming were summarised by Dr Peter O’Hara (see Methods Section). The main issues identified fell under five headings, which in order of priority were:

- Public attitudes to vertebrate pest control
- Control techniques for possums
- Operational monitoring
- Baits and bait delivery
- Other matters.

These topics were further explored in all three NPCA regional workshops, and the combined detailed findings are presented below.

The key issues associated with possum control identified by attendees at the three regional NPCA workshops associated within each of the four specific areas of concern listed by Dr O’Hara are set out below. The issues and needs are again summarised with minimal interpretation as either research needs or management needs (and not necessarily knowledge gaps per se), and those judged most important by attendees at at least two of the three workshops are underlined.

## 6.1 Research needs

### Public attitudes to vertebrate pest control

#### *Overcoming public concerns:*

- Prepare now for the next major public issues (after 1080), e.g. genetic engineering for possum control and its delivery agents, long-term use of control agents and the hazards posed.
- Identify or develop processes to ensure greater cooperation by landowners and easier land access, e.g. with Māori.

### Control techniques

#### *Repellents:*

- Develop effective rat and deer repellents for use on possum bait.

#### *Bait materials:*

- Develop sowing buckets that limit the breakage of pellet bait.
- Encourage the further development of long-life, waterproof baits for use in bait stations.
- Examine the suitability of apple as an alternative to cereal and carrot bait.

#### *Traps:*

- Provide guidelines for the most effective use of raised sets.
- Develop cost-effective self-resetting traps.
- Develop new strategies and traps to capture trap-shy possums.

#### *Bait stations:*

- Develop bait stations that limit access by livestock.
- Encourage the development of fully waterproof bait stations.

#### *Cyanide:*

- Improve the effectiveness of encapsulated cyanide.

#### *New tools:*

- Seek an alternative toxin to 1080 for aerial baiting.
- Trial trained dogs in 'clean-up' operations for possums.
- Accelerate the development of high-technology delivery of toxins, e.g. gels.
- Develop baits with more controlled rates of toxin loss.
- Encourage further evaluation of the benefit of more frequent ground control to limit the build-up of populations.
- Develop a toxic prefeed for rats (for use prior to control for possums).
- Develop suitable lures for use as aerosol sprays.

### Operational monitoring

#### *RTCIs:*

- Seek improvement in the accuracy and precision of RTCIs as a measure of contractor performance.
- Develop corrections in the RTCI bias encountered following initial control.
- Improve the understanding of the role of bait aversion in low-biased RTCIs.
- Provide correction factors for the effect of age, sex, and weather on RTCIs.
- Determine the effect of season on population monitoring.

*Raised sets:*

- Re-evaluate the need for the 70-cm minimum height for set placement.
- Ensure greater standardisation of raised sets by preparation of a valid protocol.

*Reinvasion:*

- Review the research information on the effect of habitat, season, and population density of neighbouring possum populations on the effectiveness of possum control.

*Monitoring tools:*

- Determine and rank the suitability of all commercially available traps for monitoring.
- Determine the suitability of novel tools for population monitoring, e.g. wax tags.
- Review research information on bait interference methodologies (including the influence of contagion).

*Social behaviour:*

- Determine how the re-establishment of social behaviours influences population recovery.

**Baits and bait delivery***Toxins:*

- Determine the effectiveness of the various cyanide pastes.
- Investigate suspected shyness of possums to Feratox® and develop solutions if confirmed.

*Palatability:*

- Develop new baits to overcome bait shyness.
- Field trials of efficacy and field-life of all new baits.
- Extend the life (palatability and toxicity) of bait to avoid sub-lethal poisoning.
- Investigate shyness of possums to bait stations and develop solutions.

*Acceptance:*

- Develop target-specific baits/bait carriers.
- Evaluate the cost-effectiveness of different baits and bait delivery systems.

*Bait manufacture:*

- Develop ways to reduce the loss of lure and cinnamon from baits before use.
- Develop further long-life gel baits for possum control.
- Improve Campaign® bait – make it bigger, more toxic, and load it into bags.
- Develop bait suitable for reuse in bait stations.

*Antidotes:*

- Pursue development of antidotes for 1080 and cholecalciferol for non-targets.

**6.2 Management needs****Public attitudes to vertebrate pest control***Overcoming public concerns:*

- Provide the public and pressure groups (i.e. Māori) with easily understood, accurate, and consistent information on proposed local control operations (i.e.

avoid misinformation).

- Develop systems to ensure a rapid response to public outcries.
- Take into account different cultural perceptions towards both toxins and pests.
- Understand and emphasise positive control outcomes – for both conservation and Tb.
- Understand and deliver science results to the public and sell science-independence.

*1080 issues:*

- Ensure all operators are sufficiently experienced such that all aerial baiting operations are beyond reproach.
- Support open debate on the significance of non-target deaths, i.e. what is tolerable.
- Seek the use of an alternative toxin to 1080 where possible.
- Seek a name change for 1080 to make it more acceptable to the public.
- Ensure the reasons for flight overruns during aerial baiting are understood.
- Make cost considerations of proposed operations more transparent.

### **Control techniques**

*Research results:*

- Improve access by possum control staff to latest research results.

*Aerial baiting:*

- Ensure operators understand the need to pre-feed all aerially baited operations unless there is good evidence that it is not cost-effective to do so.
- Seek a flow monitor for use on all sowing buckets to document bait output.

*Bait stations:*

- Encourage manufacturers to modify stations, including flower pots, to
- further reduce bait spillage.
- Encourage the clearance of all bait from stations at the end of control operations to avoid sub-lethal poisoning of possums.

*New tools:*

- Encourage production of 1080 paste.
- Improve the existing contract system to include more long-term contracts.

*Night shooting:*

- Provide information on implications of shooting for Occupational Safety and Health (OSH).

*Strategies:*

- Resist any further shift away from aerial to ground baiting.
- Encourage farmer-based Locally Initiated Control (LIP) activity.

### **Operational monitoring**

*RTICs:*

- Shift away from determining operational success or failure based on the capture of 1–2 possums on one line only.
- Provide consistent protocols for use during protracted monitoring (DOC has 21-day maximum for any monitor).

*Raised sets:*

- Ensure wider use of correction factors (Thomas & Brown 2001) for indices

generated from raised sets.

*Monitoring tools:*

- Ensure monitoring tools differ from control tools in all audits.

*Tb goals:*

- Provide better information on the consequences of failing to meet performance targets.

**Baits and bait delivery**

*Toxins:*

- Seek the registration of regular off-label use of toxins and baits favoured by operators.
- Identify a database accessible to operators of registered and provisionally registered toxins (including those currently used on experimental use permits).
- Seek the improved consistency of toxic loadings.
- Seek an enlargement of the lettering of 'use by' dates on toxic products.
- Request a clearance for use of brodifacoum on DOC land and of 1080 on Auckland Regional Council land.

*Bait manufacture:*

- Ensure the dyeing of prefeed baits is consistent with that of toxic bait.
- Ensure uniform pellet size at manufacture (to reduce problems of bait bridging during sowing).

## **7. Results of our Questionnaire**

The responses to the questionnaire are included in Appendix 1. The key knowledge gaps identified in the limited number of responses received, separated into research needs and management needs, are listed below. They include:

### **7.1 Research needs**

- A clearer appreciation by commercial bait manufacturers of the need to:
  - Develop repellents to exclude rats from Ferafeed paste
  - Develop lures of greater stability and life in cereal bait
  - Develop cyanide paste that does not progressively harden in storage
  - Produce Ferafeed bait with improved palatability to possums.
- Synthesis of information on the benefits of pre-feeding.
- Methods of avoiding toxin and bait shyness, particular when using cyanide paste and Campaign® bait.
- Techniques to improve the effectiveness of raised bait stations and raised traps.
- Population indices free of bias when used to measure low-density possum populations.
- Methods to circumvent the increase in non-target captures, particularly rats, arising from pre-feeding with cereal bait.
- Physical or chemical methods to exclude rodents from bait stations.

## 7.2 Management needs

- A clearer appreciation by commercial bait manufacturers of the need to produce cereal bait of consistent hardness, durability, and storage capability.
- Registration of some favoured ‘off-label’ uses of toxic products that operators believe will reduce the risk of accidental poisoning of the public, pets, and livestock.
- Greater flexibility in local authority rules and regulations influencing how contractors undertake their work.
- Ways to improve the public perception of vertebrate pest control.

## 8. Conclusions

A review of the relevant literature on possum management and of the outcomes of the NPCA workshops identified many areas of common concern, as well as some areas of unique concern. Those of highest common interest, divided into research needs and management needs, are set out below. They form a list of ‘action items’, that researchers’, possum managers or contractors would like to see implemented to ensure ongoing improvement in possum control. Many of the concerns identified in the research review and workshops were further supported by the findings of our questionnaire, through respondents’ descriptions of both present weaknesses in control methods and perceived alternative approaches.

The key gaps in knowledge underpinning best-practice possum control judged of highest priority in the review, workshops, and questionnaire are underlined.

### 8.1 Research needs

#### *Baits and bait delivery*

- The development of repellents and modified bait stations that limit access to baits by non-target birds, livestock and pets.
- The development/further development of new control tools (e.g. gel baits) to overcome bait shyness.

#### *Control techniques and strategies*

- Tools and protocols to encourage operators to ensure the complete coverage of aerial- and ground-sown bait and of ground-control techniques over all areas targeted.
- Strategies and techniques to exclude non-target species from baits, bait stations, and traps.
- Clarification of the reasons for targeting minor pest species for Tb control.
- Development of improved baits and bait stations for longer palatable bait life.
- The clarification of the costs and benefits of pre-feeding, including any change in risk to non-target species.

*Operational monitoring*

- Continued research into improving the precision, reliability and identification of the biases when using RTCIs to measure low-density possum populations.
- Development of standard operating procedures and correction factors for use when applying raised traps to determine RTCIs.
- The development of new monitoring tools to replace the RTCI index.

**Public attitudes to pest control**

- The use of modern social-science methods to encourage public support for local possum control.

**8.2 Management needs****Baits and bait delivery**

- The manufacture of commercial baits that consistently meet specifications for size, toxin loading, colour, durability in storage, and lure concentration.
- The manufacture of bait products with increased palatability and field life and hence greater acceptance by possums.
- Better access to the latest research information on newly developed products for possum control.

**Operational monitoring**

- Improved information flow to control operators on the protocol and supporting logic for the application of RTCIs.

**Public attitudes to pest control**

- The involvement of local interest groups in all aspects of possum control in their area.
- Improved public support by ensuring all control operations are faultless in their execution.

A related study on the perceptions of contractors and regional-authority possum control staff towards operating ‘best practice’ (Henderson 2000) indicated a need for: better baits, better strategies for reducing reinfestation of possums after control, a review of the competitive contract tendering system, and more funding to encourage the use of more-expensive but more-effective possum control strategies.

Our review supports and expands most of Henderson’s (2000) recommendations, apart from issues of operational tenders, while also including the need to address areas of public concern over baiting and the further development of ways of indexing possum populations. This was hardly surprising as both reviews canvassed the opinions of the same groups within the possum control industry, with the exception of the research summary presented in the present report.

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## 9. Recommendations

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Based on our identification of information gaps (needs), we suggest the following recommendations should be addressed by the different sectors in the possum control industry:

### **Manufacturers**

- That companies manufacturing toxic bait are encouraged to improve consistency of bait size, toxic loading, colour, durability in storage and lure concentration, and to increase bait palatability and bait acceptance to possums.

### **NPCA**

- That better access is provided to latest research information on newly developed products for possum control.
- That information flow is improved to control operators on the underpinning logic of the RTCI index, and ‘best practice’ in the aerial and ground laying of bait, the use of traps, and the use of monitoring tools.

### **AHB**

- That the AHB seek to resolve key concerns involving the better transfer of control-based information from researchers and operational managers to commercial contractors.

### **Pest managers**

- That greater and more sophisticated efforts is made by senior possum management staff to involve and gain the support of local communities facing possum control in their regions.
- That operational managers provide additional encouragement and training to all staff to ensure all operations are faultless in their execution.

### **Researchers**

- That further research on population indices of possums is required, to ensure that RTCI and alternative methods better meet the requirements of possum control managers and contractors.
- That emphasis is given to the development of repellents and modified bait stations to limit access to baits by non-target species, and to new control tools to overcome bait shyness.
- That tools and protocols are developed to ensure complete coverage of target areas during control.
- That the costs and benefits of pre-feeding are determined.
- That new approaches are developed to encourage public support for local possum control.

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## 10. Acknowledgements

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## 11. References

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- Caley, P.; Hone, J.; Cowan, P.E. 2001: The relationship between prevalence of *Mycobacterium bovis* infection in feral ferrets and possum abundance. *New Zealand Veterinary Journal* 49: 195–200.
- Coleman, J.D.; Coleman, M.C. 2000: Rate of increase of possum populations after control. Landcare Research Contract Report LC9900/136 to the Animal Health Board (unpublished). 35 p.
- Coleman, J.D.; Thomas, M.D.; Pracy, L.T.; Hansen, Q. 1999: Fluctuations in possum numbers in the Pararaki Valley, Haurangi State Forest Park. *Science for Conservation* 128. 17 p.
- Coleman, J.D.; Montague, T.L.; Thomson, C. 2001: Effectiveness of 1- and 3-km-wide buffers for reducing possum densities on forest margins in Southern Westland. Landcare Research Contract Report LC0102/002 to the Animal Health Board (unpublished). 20 p.
- Coleman, J.D.; Coleman, M.C.; Hough, S.; Warburton, B. 2002: Eradication of tuberculosis from possum populations. Landcare Research Contract Report LC0102/168 to the Animal Health Board (unpublished). 38 p.
- Efford, M.; Warburton, B.; Spencer, N. 2000: Home-range changes by brushtail possums in response to control. *Wildlife Research* 27: 117–127.
- Fitzgerald, G.; Saunders, L.; Wilkinson, R. 1996: Public attitudes to the biological control of rabbits in New Zealand. *MAF Policy Technical Paper* 96/3. 25 p.
- Fitzgerald, G.; Wilkinson, R.; Saunders, L. 2000: Public perceptions and issues in possum control. In: Montague, T.L. ed. *The brushtail possum – biology, impact and management of an introduced marsupial*. Manaaki Whenua Press, Lincoln, New Zealand. Pp. 187–197.
- Henderson, R. 2000: Optimising the control of possums – views expressed by contractors and regional council staff at workshops on ‘best practice’. Pest-Tech Contract Report PS9900/04 to the Animal Health Board (unpublished). 8 p.

- Henderson, R.J.; Frampton, C.M. 1999: Avoiding bait shyness in possums by improved bait standards. Landcare Research Contract Report LC9899/60 to the Animal Health Board (unpublished). 54 p.
- Henderson, R.J.; O'Connor, C.E.; Morgan, D.R. 1998: Current practices in sequential use of possum baits. Landcare Research Contract Report LC9899/09 to the Animal Health Board (unpublished). 69 p.
- Henderson, R.J.; Morgan, D.R.; Eason, C.T. 1999: Manual of best practice for ground control of possums (version 1.0). Landcare Research Contract Report LC9899/84 to the Animal Health Board (unpublished). 82 p.
- Ji, W.; Sarre, S.D.; Craig, J.L.; Clout, M.N. in press: Demographic responses of a introduced marsupial to local depopulation. *Wildlife Research*.
- Morgan, D.R. 1994a: Improving the efficiency of aerial sowing of baits for possum control. *New Zealand Journal of Agricultural Research* 37: 199–206.
- Morgan, D.R. 1994b: Improving aerial control of possums by precision bait delivery. *Proceedings of the 16th Vertebrate Pest Conference*, Santa Clara, California. Pp. 287–292.
- Morgan, D.R. 1999: Risks to non-target species from use of a gel bait for possum control. *New Zealand Journal of Ecology* 23: 281–287.
- Morgan, D.R. 2002: Long-life baits for enhancing maintenance control. Landcare Research Contract Report LC0102/052 to the Animal Health Board (unpublished). 21 p.
- Morgan, D.; Hickling, G. 2000: Techniques used for poisoning possums. *In*: Montague, T.L. ed. The brushtail possum – biology, impact and management of an introduced marsupial. Manaaki Whenua Press, Lincoln, New Zealand. Pp. 143–153.
- Morgan, D.R.; Milne, L. 2001: Completing the development of cholecalciferol gel. Landcare Research Contract Report LC0102/029 to the Animal Health Board (unpublished). 30 p.
- Morgan, D.R.; Rhodes, A.T. 2000: Selectivity of Ferafeed® paste bait treated with a rodent repellent – a cage trial. *Proceedings of the 53rd New Zealand Plant Protection Conference* 53: 316–320.
- Morgan, D.R.; Thomas, M.D.; Meenken, D.; Nelson, P.C. 1997: Less 1080 bait usage in aerial operations to control possums. *Proceedings of the 50th New Zealand Plant Protection Conference*: 391–396.
- Morgan, D.R.; Milne, L.; O'Connor, C. in press: Learned bait-shyness by possums (*Trichosurus vulpecula*) towards baits containing cyanide, 1080, cholecalciferol, or brodifacoum. *Proceedings of the 20th Vertebrate Pest Conference*, Reno, Nevada.
- Nugent, G. 2001: Deer and pigs as hosts of bovine tuberculosis, and their potential use as sentinels of disease presence. *Proceedings of the New Zealand Society of Animal Production* 61: 64–67.
- Nugent, G.; Whitford, J. in press: Use of released pigs as sentinels for *Mycobacterium bovis*. *Journal of Wildlife Diseases* 38.
- Thomas, M.D.; Brown, J.A. 2001: Calibration of possum density estimates from raised leg-hold traps. *New Zealand Plant Protection* 54: 71–75.

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## 12. Appendix

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### Appendix 1 Questionnaire on knowledge gaps in conventional possum control

*The questionnaire set out below was sent in May 2002 to prospective attendees at the NPCA's regional workshops held in June and July 2002. Our summary of the comment received is shown in italics.*

This questionnaire seeks to improve conventional control of possums by requesting input from relevant contractors. We are trying to find out where there are uncertainties over the best ways of using control tools to achieve cost-effective and environmentally-safe conventional control. The questionnaire and its analysis is funded by the Animal Health Board (AHB), and is seen as a way of helping the contracting industry progress.

The questionnaire has been forwarded to all likely participants in the National Possum Control Agencies (NPCA) regional workshops planned for June 2002. The topic will form a mini-workshop at each of four regional workshops, and all participants are asked to give thought to the questions set out below before the workshop begins. While the completion of the questionnaire is not compulsory, we seek your involvement and ask that the completed forms be brought to the regional workshops for collation, or failing that, sent to the address given at the end of this document. We also invite wider written comment on conventional possum control, provided it relates to the topics dealt with below. Finally, all answers are confidential to the contractor and to Landcare Research, with only our general conclusions going forward to the AHB.

1. Operators name:.....
2. Address: .....
3. Telephone:.....e-mail (if available):.....
4. Experience in pest control (years):

*The respondents had an average of 16.5 years experience in possum management, presumably for the commercial operators at least, much of it based on commercial possum harvesting, with 13 respondents claiming 20 or more years experience.*

## Bait information

### 5. Application

What types of bait do you use in priority order, how do you lay it (i.e., amount and spacing), and are you satisfied with the product?

Ranking in order of use	Bait and concentration	Amount laid		Spacing		Is lure O.K.
		Pre-feed	Toxic	Plots	Lines	
1						
2						
3						
4						
5						

*The toxic bait clearly favoured by most (15/24) respondents was Feratox®, with the preferences of the remaining respondents fairly evenly split between cyanide paste, 1080 cereal pellets, Campaign®, Talon®, and Feracol®. Examination of the respondents second choice of toxic bait indicated that 8 of the 9 respondents favouring products other than Feratox® as their first choice, favoured either Feratox® or cyanide paste as their second choice. Thus, cyanide-based bait was 1st or 2nd choice for 23 of the 24 respondents answering this question. Over all, of the ranked preferences given, Feracol®, Talon®, and Campaign® bait appeared least favoured. Half of all respondents used pre-feed, with most of these using Ferafeed®, in spite of its attractiveness to rats. Ways of excluding rats from pre-feed were requested.*

Do you use non-traditional practices when laying bait? If so, are you faced with any problems in their use?


*Of those using Feratox® bait, all except one pre-fed the toxic bait with a flour mix (9) or Ferafeed® pellets (5). Patterns of pre-feeding of other toxic baits, and particularly the line and bait spacings used when laying all baits appeared highly variable. Problems of use beyond those of the product itself were limited to seeking ways to reduce the risk of use to the public, pets and livestock.*

### 6. Lure concentration

Do you add additional lure to manufactured bait? If so, what lures do you favour and how do you apply it?


*Additional lure was added to manufactured bait by 10 respondents and not added by 11. Where additional lure was added, the product most favoured was cinnamon (5/10), with*

*other oils being orange or a mixture of several off-the-shelf products. Such products were usually incorporated into cooking oil and sprayed onto bait.*

#### 7. Toxin concentration

When using 1080-loaded bait, which loading do you use and why? Do you have problems using existing loadings?


*Twelve respondents reported using 1080-loaded cereal bait, although rarely as the bait of first choice. Eleven of these respondents used baits loaded at 0.15%, while one respondent used baits loaded with either of the currently registered loadings. The choice of loading was rarely explained but from the limited comment given, it appeared to result from a requirement by DOC to use 0.15%-loaded bait on its estate, on the recommendations of researchers, on the reduced risk to stock when using the lower loading, or because that loading 'seemed to work best'.*

#### 8. Bait quality

Are you aware of any problems with:

Bait acceptability	
Bait shelf life	

*Ten of 17 respondents thought most commercially available baits were sufficiently acceptable to possums, with isolated concerns arising from the apparent low palatability of Feracol® bait, shyness to possums of Campaign® bait, and the variable hardness (and hence reduced acceptance) of cereal bait. Ten of 17 respondents (but not the same ones) also agreed that bait life was satisfactory, with some concerns expressed over the evaporation of the lure used (3), and of bait crumbling and going mouldy with age (6).*

#### 9. Long-term use of poison baits

Where you use a sequence of methods, what is your preference to overcome bait acceptance?

Cyanide paste	
Feracol	
Brodifacoum	
Feratox	

*Few respondents commented on any preference for overcoming bait shyness. Of those that did, those using cyanide paste argued for pre-feeding (4) and for the use of different lures, those using Talon® bait argued for its use only when fresh (4) or when mixed or pulsed with Campaign® bait (2), while those using Feratox® bait clearly used it with a wide variety of pre-feeds and lures. No respondents reported any preference for overcoming shyness to Feracol® bait.*

## 10. Ground v raised bait stations

Do you believe raised bait stations are as effective as stations set at ground level?

Yes  No  Don't know

If they are not as effective, how do you increase the bait take from raised stations? What other problems do you encounter?


*Raised bait stations are considered to be less effective at controlling possum populations than ground-set bait stations by most respondents (13/19). Techniques used to improve the efficiency of raised stations include the spreading of lure about the station (8), or by pre-feeding bait either in the station or beneath it (4).*

### Trap information

## 11. Patchiness of baiting/trapping

Bearing in mind problems of human access in some habitats, what trap spacing (in metres) do you allow and still get acceptable kills? What further information do you require?

	Traps
Between lines	
Along lines	

Do you use GPS to confirm the location of bait/trap lines?

Yes  No

Do you treat scrub and forest habitats differently when controlling them, and if so, how?


*The location of trap lines and traps appears to be driven primarily by terrain and possum sign. Six of 14 respondents laid their trap lines at intervals of 75 to 150 m, with the remainder using line intervals based entirely on habitat characteristics or perceived possum density. Eleven respondents laid traps at intervals of 20 to 50 m along trap lines, with those using greater intervals usually emphasising the need to set traps only on possum sign. Lines were located in scrub and scrub-edge habitats by 10 respondents using GPS technology, and these areas were trapped more intensively than in-forest areas. The question of where best to set traps elicited no responses.*

## 12. Ground v raised trap sets

Does the effectiveness of ground and raised trap sets differ?

Yes  No  Don't know

Do these differences extend to costs as well?

Yes  No

Where raised sets are less effective than ground sets but are required, what options (types of sets) and what modifications do you use to improve the effectiveness of raised sets?

*Respondents were unified in believing raised trap sets were less efficient (19/20) and less cost-effective (19/21) than ground-set traps. Modifications suggested to increase the efficiency of raised sets included the use of running boards or natural leaning features (5), various bracket sets (5), and a patent-pending trap set (1).*

## 13. Pre-feeding of traps

Do you use pre-feed for traps?

Always  Sometimes  Never

If so, how, when, and with what do you pre-feed?

--

*Opinions on the pre-feeding of trap sets appeared to vary, with the same number of respondents either sometimes (9) or never (9) using pre-feed outweighing those always using pre-feed (5). Where pre-feed was used, the approach taken was equally diverse, with various flour and lure mixes used most commonly, and feed paste and non-toxic pellets used less so.*

## 14. Trap preference

What trap types do you consider to be:

Most effective and why	
Most humane and why	
Best all round	

*The Victor No. 1 trap was regarded as the most effective by respondents (10/14), Lanes Ace gins the next most effective (3), and a wide range of other leg-hold traps including Duke, Bridger, BMI, and 'baby gins' (= Sleep Creek No. 1 long springs) preferred by individual respondents. No preference was given for any kill trap marketed in New Zealand. Trap effectiveness appeared to be judged primarily by the strength of the trap springs (i.e., the trap holding power) and by catch rate (numbers of escapes). Traps rated most humane included the Timms kill trap, the Victor No. 1 and similar leg-hold traps (6 respondents each), and cage traps. Ratings were based on the rapid kills achieved by the Timms trap or the minimal injuries sustained by possums caught in Victor No. 1 and cage traps. The best all round trap was judged to be the Victor No. 1 (15/19), with a wide range of other leg-hold traps favoured by the remaining respondents.*

### Non-target issues

#### 15. Problems with rodents

Are rodents a significant non-target issue in your operations?

Yes  No  Don't know

If yes, how do you attempt to avoid their interference?

*Rodents were considered a significant problem by nearly all (22) respondents, with most either using alternative anticoagulant toxins as pre-feeds (5) to kill them before targeting possums or ignoring the problem (6). Other actions included adjusting the setting of traps to make them less sensitive to the smaller body weight of rodents, and the use in lures of bittering agents thought to be unacceptable to rodents but not to possums.*

#### 16. Other non-targets

Do you have other non-target concerns? If so, please detail them.

*Other at-risk non-target species listed included hedgehogs, feral cats, domestic pets, native birds such as kiwi and hawks, and surprisingly, falcons and native bats.*

#### 17. Baiting induced non-target problems

Are non-target problems made worse by pre-feeding?

Yes  No  Don't know

Are such problems worse with carrot than cereal bait?

Yes  No  Don't know

*Most (13/17) respondents thought non-target issues were aggravated by pre-feeding, and some (5/6) thought the problem worse with carrot than with cereal bait.*

### Monitoring/auditing possum control

#### 18. Non-regulation monitoring

Do you use non-regulation possum monitoring techniques?

Yes  No

If yes, please describe them?


*Most respondents (16/23) used regulation monitoring techniques. However of those that did not (7), most used toxic bait novel to their operations to indicate the presence of surviving possums, while the remainder used pieces of orange, wax blocks, or modifications of the trapping protocol.*

#### 19. Auditing

Do you believe auditing results are biased low by possums being traumatised by recent control? If so, what is your evidence for this?

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*Monitoring results were, in principle, accepted as unbiased or biased by similar but a small number of respondents (5), but most either did not have an opinion or failed to comment (17/27). The evidence quoted most often for such bias arose from the rapid increases in the numbers of possums recorded following control. However, this evidence appeared to be derived directly from the workshop material presented rather than from personal experience.*

#### Causes of operational failures

#### 20. Trap or bait shyness

Does shyness by possums affect any of your operations?

Yes  No  Don't know

If so, what proportion of your operations are affected?

If noted, is such shyness only found in operations immediately following earlier controls?

Yes  No

Which toxins and bait types create greatest problems of shyness?


How do you attempt to capture/kill trap- or bait-shy possums?


*Twice as many respondents thought shyness by possums affected their operations (16/24), as the number that did not. Of those that were concerned, only 3 thought more than 50% of*

possums were shy of traps or baits, with most (13) believing the problem involved less than 50 % of possums or was insignificant. Eight respondents thought such shyness occurred only immediately following earlier control, while 14 thought cyanide paste and Campaign® baits were the toxins (and baits) most likely to induce shyness with all other toxins of much less concern. The favoured strategies used to overcome such shyness were changing bait types or moving to traps (8), and the pre-feeding of bait or trap lines (5).

## 21. Bait quality

Do you have any concerns with bait quality? If so, what are they?


Most respondents (23) had concerns over bait quality. They included inconsistency of toxin concentration at manufacture and over time (7), inconsistency of Ferafeed and Ferapaste® (cyanide) products (6), pellet breakdown (5), and hardening of cyanide paste (4).

22. What do you consider are the biggest problems you face in using baits and traps cost-effectively (excluding problems of contracts and Public Relations)? Please itemise and rank:

Concern	Rank

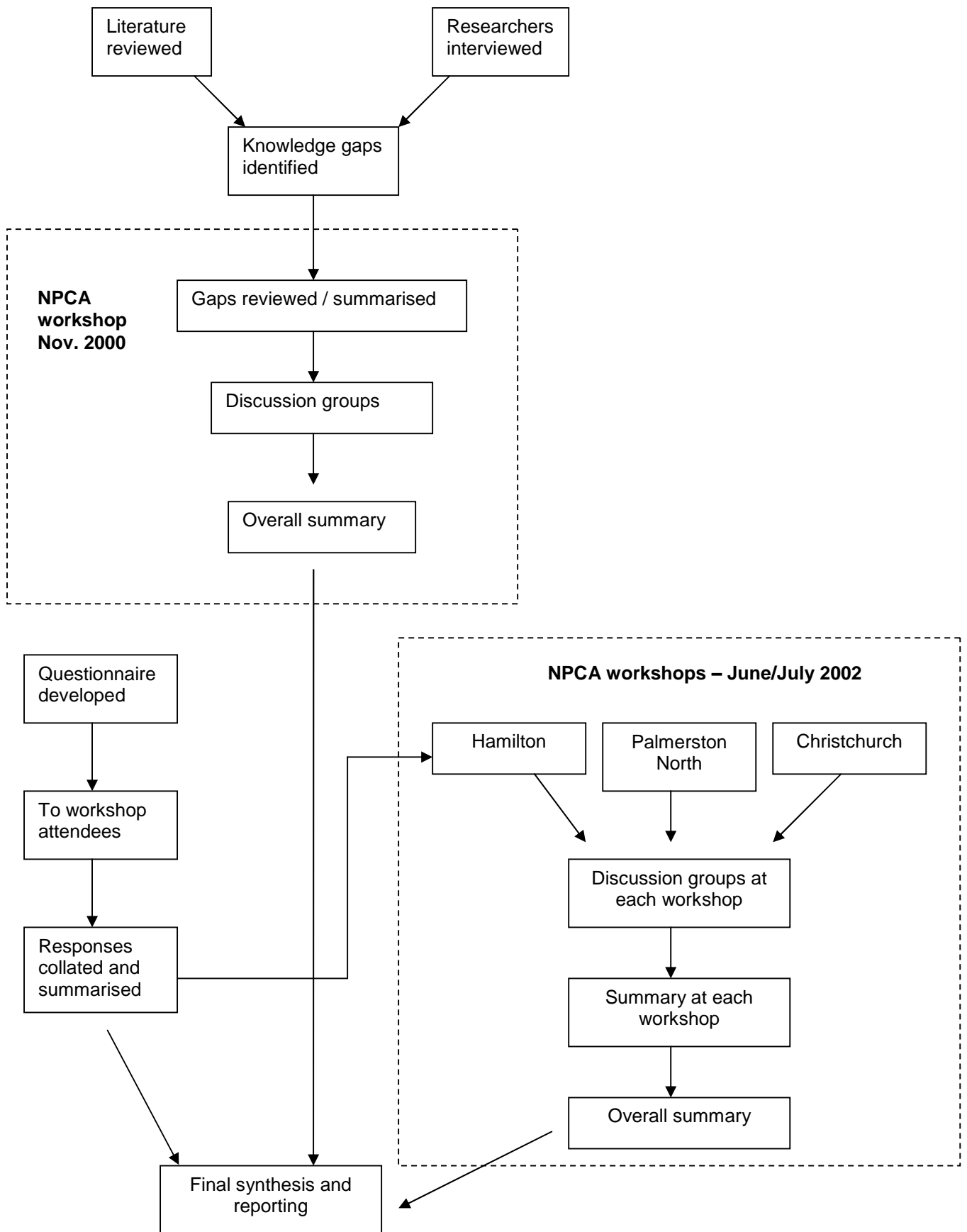
Few respondents were prepared to comment on the problems of cost-effectively using baits and traps, but the most highly rated problems included:

- non-target interference (4),
- bait quality and life (4),
- local authority rules and regulations (3),
- raised sets (2), and
- public perception of pest control (2).

Of concern to single respondents was theft of equipment, monitoring issues, the need for a rodent proof, highly portable feeding station, and the weather.

Thank you for your cooperation. While you may be reluctant to share your innovative ideas, we believe the analysis of this questionnaire and the proposed workshop on the same topic may allow us to help develop improved techniques for all involved in possum control.

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**Fig. 1** Process and pathways followed in this study.