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A Contractor Industry that Underpins a National-Scale Pest Control Programme

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ABSTRACT: In New Zealand, bovine tuberculosis is a major problem for livestock industries (i.e., dairy, beef, and deer). The disease is managed by TBfree New Zealand (formerly the Animal Health Board) under a National Pest Management Plan with a fixed annual budget of about \$53 million. The strategy used to reduce herd infection involves: 1) herd testing and slaughter to remove infection from herds, 2) herd movement controls to minimise the risk of TB being spread between farms, and 3) control of the key wildlife TB vector, the brushtail possum. The management of brushtail possums is the most costly of the three strategy components, and those costs have driven the development of a highly cost-effective possum control contracting industry. Development of an integrated TB management programme involving possum control contractors has required: 1) a defined control target/threshold density for possums that requires numbers be reduced to and maintained at or below for five-seven years for TB to be eliminated, 2) an industry-accepted method for independently assessing whether the control target has been achieved, and 3) training and certification of contractors to independently monitor the possum control contractors. The successful implementation of these three requirements has enabled the industry to develop a performance-based control contract system in which control contractors get paid only if they achieve the required trap-catch target (i.e., contractors take all the risk). PDA/GPS systems with related online databases have been developed to support the management and auditing of contractors, and to capture data about both spatial coverage and control of possums (about 30,000 point data collected per month). The effectiveness of this integrated vector-control programme has enabled more than 1.5 million hectares to be declared TB-free, and reduced infected herds from about 1,700 in the early 1990s to 35 by February 2016.

KEY WORDS: bovine tuberculosis, brushtail possum, contract pest control, control strategy, disease, efficacy, monitoring, *Mycobacterium bovis*, New Zealand, *Trichosurus vulpecula*

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INTRODUCTION

In New Zealand and a number of other countries, tuberculosis (TB) due to *Mycobacterium bovis* infection has become established in one or more wildlife hosts capable of independently maintaining the disease. The host or suite of hosts differs between countries, and in New Zealand the primary wildlife host is the brushtail possum (*Trichosurus vulpecula*). Possums were introduced to New Zealand from Australia in 1858 to establish a fur trade (Clout and Ericksen 2000) and subsequently spread to occupy virtually all vegetated habitats in the North and South Islands of New Zealand from the coast to high mountains, including extensive forest lands, farmland, and semi-urban habitats (Clout and Ericksen 2000). Following their confirmation as TB hosts in the late 1960s, possum control was instigated to prevent, or at least reduce, the potential transmission of disease to farmed livestock, predominantly cattle (beef and dairy) and red deer (Davidson 1976).

Over the following three decades, TB spread widely through New Zealand resulting in 32 geographically discrete areas, referred to as Vector Risk Areas (VRA), totalling about 10.6 million hectares. The importance of possums in transmitting TB to cattle and the effectiveness of intensive lethal possum control as a way of managing this problem were both demonstrated as early as 1972, when control of possum populations sympatric with *M. bovis*-infected beef and dairy herds resulted in an immediate reduction in herd infection (Livingstone et al. 2015). Subsequent epidemiological modelling and

collection of empirical data indicated that if possum numbers were reduced and maintained at low levels for at least five years (using lethal control), then TB was eradicated from possum populations (Barlow 1991, Caley et al. 1999, Ramsey and Efford 2010).

Along with livestock testing and movement control policies, possum control has led to a 95% reduction in the number of infected cattle and deer herds, from a peak of 1,694 in June 1994 to 35 in February 2016. To achieve the necessary wide-scale and effective possum control required to deliver this outcome, a competitive possum control industry, along with robust control targets and objective and defensible methods for measuring control effectiveness, needed to be developed. In the last five years as more VCZs have moved from known TB infection towards TB eradication, contractors have had to shift from solely killing possums to also collecting data for use in models for determining the probability that an area could be declared free of TB ("TB freedom" is "statistical freedom" and is generally accepted when an area has a 0.95 probability that it is free of TB). A range tools and bespoke online databases have been developed to support this process.

THE DEVELOPMENT OF A NATIONAL MONITORING PROTOCOL

Prior to 1995, the effectiveness of possum control operations was monitored using faecal pellet counts, spotlight counts, bait take from bait stations, and trapping, but there was no agreed-upon method or methodology.

Before a possum control contractor industry could be developed, there was a need to develop a standard monitoring method that was: 1) easy to apply, 2) easily understood by contractors who also accepted the results, 3) able to be used consistently in a wide range of habitats, 4) able to provide suitable data so that the relationship between changes in possum abundance and disease prevalence could be determined, and 5) able to generate consistent results between habitats and seasons. To this end, in 1995 the Animal Health Board (now TBfree New Zealand) commissioned a review of potential monitoring methods in order to develop a standardised method that could be applied nationally. As a result, a trap-based methodology was recommended (Warburton 1996) and based on this, a National Trap-Catch Protocol for monitoring possums was developed (most recent version NPCA 2014). This then led to the development of a series of training modules and training courses (<http://www.npc.org.nz/index.php/possum-control-courses>, accessed 23 Feb 2016). The protocol and training have two main components: one for “planners” that includes survey design, statistical issues, and field application; and one for “field operatives” that includes only the field application of the method. Briefly, the monitoring method is based on randomly located lines of 10 No.1 foothold traps set for three fine nights. Currently there are 29 people certified as planners and 230 people certified as field operatives. Although the proposed method, if applied pre- and post-control, could enable the percentage possum kill to be determined, most control operations are monitored using just a post-control monitor and comparing the result with a target trap-catch (e.g., 2%; that is, two possums captured from 100 trap-nights). A target trap-catch of 2% is generally accepted as necessary to “break” the TB cycle within a possum population.

A COMPETITIVE CONTRACTOR INDUSTRY

Before 1995, possum control on farmland was carried out by regional government staff using a range of control methods, but often with no clear control targets or standardised method for assessing control effectiveness. If control was carried out under contract, the contracts were input-based; that is, the control methods and intensity were specified and the contractor had to follow this recipe. The efficacy of the control operation was often not monitored, and the contractor got paid for delivering the inputs.

With the development of a National Trap-Catch Protocol and an understanding of the target trap-catch required to eliminate TB from possum populations, TBfree New Zealand was able to develop a competitive possum control contractor industry that essentially shifted the risk of control failure to the contractor. That is, if the contractor achieved the trap-catch target, they got paid, but if they did not, then they had to carry out further control until they met the contracted target, or they did not get paid. This competitive performance-based industry steadily built up over the period 1997-2007 and is currently a significant component of the possum control industry in New Zealand.

There are currently 49 contracting businesses that

deliver ground-based control services using primarily traps, and Feratox® (a pelleted cyanide product), but also cyanide paste, brodifacoum, and sodium fluoroacetate (1080) baits (Warburton and Livingstone 2015). There are also six contracting businesses that deliver both aerial and ground-based control (i.e., using aircraft to apply 1080 baits over large areas of forest that are difficult to traverse by foot). Note that in New Zealand there are no native land mammals that are at risk from poisoning. Businesses range in size from one to 35 staff. There are also currently 15 businesses that carrying out independent monitoring to ensure independence of control and monitoring, and these contractors are not allowed to carry out control contracts.

Control operations are put out for tender, and contractors’ tender documents are assessed against a set of weighted criteria including, for ground-based operations: 1) relevant experience and track record, 2) management/administration and technical skills, 3) quality assurance plan, 4) operational plan, 5) health and safety plan, and 6) price. Successful contractors then undertake the required control and when completed, their control effectiveness is assessed by an independent monitoring contractor. The mean trap-catch achieved from performance contracts in 2011, 2012, and 2013 were 0.65%, 0.46%, and 0.4%, respectively, considerably lower than the commonly contracted trap-catch targets of 2%. They need to achieve these lower post-control densities to ensure they pass the monitor and get paid. Additionally, 93% of about 200 performance-based operations contracted each year achieved their trap-catch target on their first post-control monitor, with the remainder requiring extra work and re-monitoring.

To assist TBfree New Zealand operational staff to manage contracts and monitoring data, a bespoke database (VectorNet) was developed (Figure 1). This tracks the contracting process from the initial planning stage, when an area is identified as requiring control, through to capturing the independent trap-catch monitoring results so decisions can be made on whether or not to pay the contractor. Monitoring contractors use a database (VectorLink) which links their data into VectorNet. An additional database was also developed (VectorCheck) for processing contractor invoices.

FROM VECTOR CONTROL TO DATA COLLECTION

Because of the control success of the performance-based possum control industry along with the associated herd testing and movement controls, TBfree New Zealand believed TB had been eliminated from some areas; however, apart from having no infection detected in livestock and wildlife, they had no objective method for determining the probability that an area was free of TB. To address this problem, they contracted the development of a Proof-of-Freedom (POF) tool that used 1) information on possum control history, possum surveillance data obtained from trapping operations, and detection surveys using coreflute chewcards (Sweetapple and Nugent 2011) to detect the presence of possums and thereby guide subsequent trapping effort, and 2) TB sentinel data [i.e., TB absence in samples of wild pigs

Figure 1. Screen-shot of the VectorNet database used for capturing and managing control activities and monitoring data.

Figure 2. Linkages between the bespoke databases for managing and querying a range of spatial data captured by control and monitoring contractors.

(*Sus scrofa*), ferrets (*Mustela putorius furo*), and deer – mainly red deer (*Cervus elaphus*)] that were sympatric with the possum population (Anderson et al. 2015).

Although in many managed areas possum abundance was very low (i.e., <2% trap-catch), contractors still needed to carry out control operations to prevent possum populations from increasing. Such control is typically done using traps or using detection devices such as chewcards followed by trapping. Because the GPS location of each device is used in the POF tool to generate the spatial surveillance sensitivity that is used for estimating the probability of TB freedom, control contractors are required to collect those data for input into the tool. Additionally, any possums killed are required to be collected for subsequent necropsy, along with the GPS location of where they were caught, to check for TB infection. As a result, possum control contractors have become more collectors of data than possum controllers. To assist contractors to collect the required data and

operational staff to manage the large quantities of data generated, additional databases and processes were developed. These include VectorTrax, a database of vector control field activities that enables control contractors to collect data in the field on Personal Digital Assistants (PDAs) that read bar-codes and record GPS locations against a range of activities that can then be uploaded to VectorTrax. Each device (trap, chewcard, bait-station) is tagged with a bar code that can be easily scanned into the PDA. There are about 30,000 trap and detection device records uploaded each month. An additional database, VectorPal, is used to manage post-mortem data, and these data are then uploaded into VectorNet for subsequent querying. Finally, a geospatial querying tool, TB Investigator (TBI; Eagle Technology, Auckland, NZ), based on ArcMap, is used to query VectorNet to generate the spatial data required for the POF tool and for planning monitoring surveys (i.e., random start points for trap-lines) (Figure 2).

CONCLUSIONS

Reducing infected TB herds in New Zealand from a peak of 1,694 in June 1994 to 35 in February 2016 resulted from successful implementation of a three-pronged approach to disease management (livestock testing, herd movement, and vector control) with control of the main wildlife vector (possums) being a key contributor to that success. Successful TB control and eradication through possum control happened because seven critical requirements were met: 1) the control outcome (number of infected herds) could be measured, 2) there was a known relationship between possum abundance and TB persistence (i.e., a control target could be set), 3) there was a standardised monitoring method for assessing if contractors had achieved the control target, 4) contractors had effective control tools available, 5) data were used to progressively improve effectiveness of possum control and TB surveillance, 6) there was legislative and regulatory support, and 7) long-term funding was available to support the programme (Warburton and Norton 2009).

Development of a competitive performance-based contracting industry provided a method to constrain costs and enable the maximum area to receive control within the fixed budget. A competitive model also encouraged contractors to innovate and find cost-effective and competitive methods for achieving the control targets at least cost. Bearing the risk of failure resulted in contractors weighting their prices to cover additional work that might be required if they did not achieve their control targets, but the extent to which they did this is not known.

Managing a large number of complex contracts, and more laterally managing a very large amount of data, required the development of a range of bespoke databases along with portable but robust GPS-capable PDA systems that contractors could use in the field. This has resulted in contractors becoming competent in using portable technology, data collection, and data management. Those contractors who could not make the transition from just possum control to data collection left the industry, because they could not provide the necessary services required by TBfree New Zealand.

In the last five years as the incidence of TB has been reduced, some contracts have shifted back from performance-based to input-based. That is, for collecting data for the proof-of-freedom model, specific contract specifications are set for habitat coverage and tools to be used (e.g., traps only), and because the collection of the coverage data and carcass collection for necropsy is more important than the post-control trap-catch achieved, some contracts are tendered as input contracts rather than performance-based. Contractors still compete on price, but they do not carry any significant financial risk of failing because a control target is not set. They do, however, get audited to ensure they are adhering to the contracted specifications of habitat coverage, control intensity (e.g., number of traps nights), and tools to be used (e.g., chew-cards followed by leghold trapping).

The success of this approach over the past two decades led a recent National Pest Management Proposal review recommending that the TB management programme should attempt to achieve national TB-freedom

from livestock by 2026, national TB-freedom from possums by 2040, and TB eradication from livestock and wildlife throughout New Zealand by 2055.

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