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CONTROL OF TUBERCULOSIS IN CATTLE AND DEER IN INTENSIVE PRODUCTION AREAS IN NEW SEALAND : EFFECT OF ANIMAL MOVEMENTS

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Le district du Waikato dans l'Ile du Nord de Nouvelle Zélande est une région d'élevage intensif. Elle compte 1,4 million de bovins et 120 mille cerfs. Le programme national de lutte contre la brucellose vise à l'acquisition du statut officiellement indemne pour cette région (prévalence de troupeaux infectés < 0,2%) dans les 5 années. La prévalence actuelle de troupeaux infectés se situe entre 0,7% et 1,0%.

Des modèles utilisés pour le contrôle de la tuberculose (Mycobacterium bovis) bovine et cervine ont démontré qu'il était important de comprendre les origines possibles de l'infection (à partir de la faune sauvage, de mouvements de troupeaux infectés vers le district, ou à l'intérieur du district). Dans ce but, une étude de 12 mois des mouvements de bovins et de cerfs vers et hors des élevages a été réalisée à partir d'un échantillon d'élevages du Waikato. Un échantillon stratifié géographiquement a été sélectionné, avec un intérêt particulier pour leur risque de contact avec la faune sauvage infectée par M. bovis.

L'intensité des mouvements de bovins et la différence entre les bovins et les cerfs étaient inattendues. Nous estimons que 26% de la population bovine change d'élevage chaque année. Inversement les risques perçus en relation avec le mouvement de cheptel vers le district en provenance de région où la faune sauvage est infectée de façon endémique (Région à risque de tuberculose), et en provenance de marchands de bovins n'ont pas été confirmés. Nous concluons que l'importance de la transmission entre les élevages conventionnels de bovins à l'intérieur du district à été sous-estimée, que les mouvements de bovins contribuent de façon importante au maintien de la tuberculose bovine dans ce district. Ceci est aussi en accord avec les résultats d'études de modélisation réalisées par un autre groupe utilisant les données de cette étude. Ils ont montré qu'avec cette intensité de mouvements, la politique actuelle de contrôle de la tuberculose (la plupart des élevages sont testés 2 fois par an), ne serait pas en mesure d'atteindre la prévalence souhaitée de 0,2%.

INTRODUCTION

In New Zealand there is a continuing problem with *Mycobacterium bovis* infection in cattle and deer. This arises directly or indirectly from wildlife reservoirs of this disease. The Australian possum, which was introduced into New Zealand around 1900 and is now very common, is the most important reservoir host. A permanent solution will be found only when re-infection of livestock can be prevented. With current control technologies, some 'spill-over' occurs, and thus an effective disease eradication program in livestock is still required.

Environmental factors, which include farm management systems, can profoundly influence the epidemiology of infectious diseases. Nowadays cattle and deer are frequently moved from farm to farm, and thus have the potential to carry tuberculosis infection to virtually all areas. The objective of this study was to define the extent and scope of this movement, thereby enabling the scheme managers to design a more effective disease control strategy.

METHODS AND MATERIALS

The study area was the Waikato District of the North Island of New Zealand (Figure 1). This is an area of intensive pastoral livestock production, with approximately 1.5 million cattle (mainly dairy cattle) and 120 thousand deer. The national tuberculosis control strategy calls for this district to achieve 'official' freedom (i.e. < 0.2% infected herd prevalence) within 5 years (The current prevalence varies between 0.7% and 1.0%). Tuberculosis infected wild life have been found in only small areas within the Waikato district and most have been under active control for 5 or more years. However, the extensive Central North Island forests lie to the immediate south; in these areas foci of *M.bovis* infection in possums occur. Farmed cattle and deer are infected sporadically; for this reason such areas are called 'TB risk areas'.

We divided the project into 5 parts. For parts 1 and 2 a random sample of cattle and deer herds, stratified by type and area, was used. Part 3 consisted of a study of so-called 'dealer' herds; i.e. enterprises where there was a very high turnover of cattle. In part 4 data was collected on the origin of cattle used to form new dairy herds. In part 5, the movement of cattle from a large sale-yard in the Central North Island TB risk area was investigated.

Parts 1 to 4 were conducted in the Waikato district. The total area was divided into 8 zones, primarily with reference to the risk of infection from wildlife tuberculosis vectors. Using a random sampling technique, 10 dairy herds, 10 beef breeding herds, 10 beef dry-stock herds, 5 'non-commercial' beef herds and 5 deer herds were selected within each zone,

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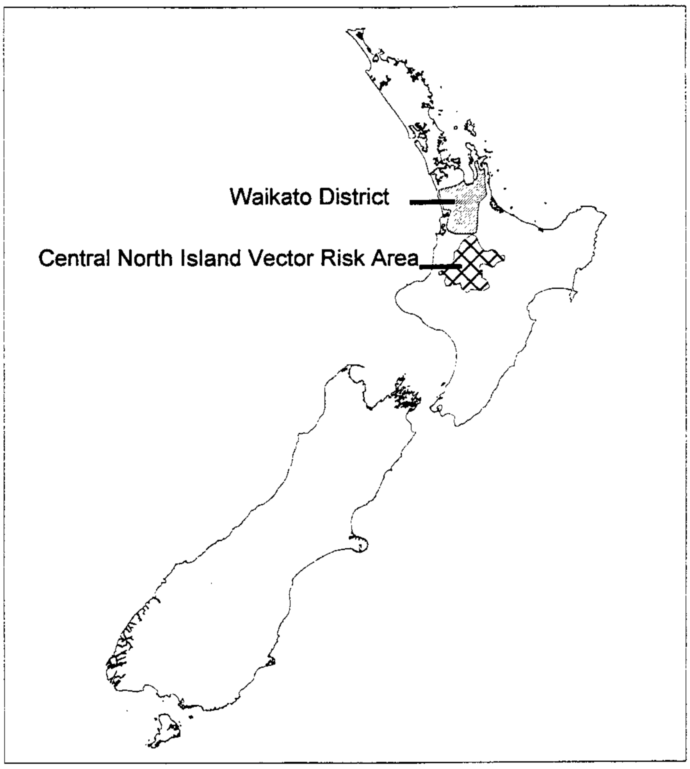
Figure 1
Map of New Zealand showing location of the study area, the Waikato District, and the adjacent Central North Island tubersulosis risk area



The following field-work was undertaken.

1. A census of cattle and deer herds

At the start of the project in July 1993 and again 12 months later, MAF Quality Management (MQM) field officers visited all the cattle and deer herds that had been randomly selected. They recorded the class (breed, age and sex) and number of all animals on the property as at 1 June in the current year.

2. Movements to and from cattle and deer herds

A paper recording system that herd owners could note with ease the date, class (breed, age and sex) numbers and origin/destination of livestock was developed. Herd owners and managers were requested to record all movements over 12 months from 1st June 1993. To encourage compliance, MQM field officers visited the properties 4 times and telephoned the owners/managers each month.

After all data had been entered into a computerised database (see below), a series of reconciliations were conducted. Using the initial census, the records of livestock in and out of the herd, and average reproductive rates, an expected outcome was calculated. This was compared with the second census. Where there was a marked difference, a summary of animal movements was returned to the MQM field officer who discussed it with the herd owner/manager. If the difference could not be reconciled, data from that herd was not used in the analysis.

3. Dealers herds

Cattle owners who have a very high turnover of stock are often termed dealers. Because they have such a very large number of movements, we did not consider it practicable to record all stock movements over 12 months. Instead we recorded movements into and out of 13 dealer herds for 1 week periods in July '93, September '93, November '93, January '94, March '94 and May '94.

The recording method was as in Part 2 above.

4. New dairy herds

The movement of share-milkers' herds and the establishment of new dairy herds is a feature of the Waikato region. Each new herd has to be 'cased' and then registered on the national disease control database. During the '93/'94 dairy season additional data on the source of stock was collected.

5. Movements from a Central North Island saleyard

To gain insight into the direct movement of cattle from the Central North Island TB risk area into the Waikato district, all cattle movements from one major sale were traced via the stock agents records.

Analytical methods

Field data from all parts of the project were entered into a Scientific Information Retrieval (SIR) database.

Data sets were generated from SIR and transferred to a statistical package (SPSS). Some further subsets were transferred via Microsoft (MS) Excel to MS Access for further manipulation, and then read back into SPSS for analysis.

We found that many data distributions (e.g. size of herds, numbers of animals or groups sold or purchased) were severely positively skewed. For this reason we used either non-parametric techniques or log transformed data in

the statistical analyses. In particular we usually calculated means and SEM's from log transformed data.
Using our random sample data, we estimated various population parameters. Confidence limits for these parameters were calculated using the modeling software '@Risk'. Generally simple triangular distributions were used.

RESULTS

Both dairy and beef animals were commonly grazed on all types of cattle properties. The classes of cattle in beef breeding, beef dry-stock and miscellaneous herds were very similar. Contrary to the prevailing view that non-commercial beef herds contain small numbers (i.e. < 10) of cattle, the census showed there were on average 40 head. We estimate that at the time of the study (1993/1994) there were approximately 1.34 million cattle in the Hamilton veterinary district (80% dairy and 20% beef).
The structure of deer herds, with many young stock and stags, was quite different to cattle properties. We estimate the total deer population was approximately 114,000 animals.
Only 7% of the study herds dropped out of the year-long investigation. We found 13% of cattle and 64% of deer herd owner/managers did not introduce stock into their herds. One percent (1%) did not move stock off. The mean number (log transformed data) of introductions were 18 (deer), 33 (beef breeding), 38 (dairy), 57 (miscellaneous) and 157 (beef dry-stock). This is a movement of 26% of the total cattle population and 9% of the deer population over the 12 month period.
Three quarters of movements of cattle onto properties were from other farms, one quarter from saleyards. Twenty seven percent of lines moving onto dairy farms were beef animals. Movement patterns were complex; generally half of lines were sourced locally with the balance from through out the district. Movements from TB risk areas were not common. We estimate only approximately 5000 cattle were introduced from these areas during the year.
Eighty three per cent (83%) of lines that left deer farms and 37% that left cattle herds went directly to slaughter-houses. Owners/managers of cattle moved their animals more commonly to other farms (42%); 21% went to saleyards.
The number of animals moving on and off dealer operations was approximately 6 times that of the highest conventional herd type (i.e. beef dry-stock). Sixty percent (60%) were purchased in saleyards but 80% were subsequently sent for slaughter. Rarely were animals purchased from TB risk areas. Both dairy (25% of the total) and beef (75%) cattle were moved through dealer herds.
Many (42%) new dairy herds were established from a single source; i.e. one herd moving from one farm to another. The rest were built up from 2 to 7 groups (median size 59). Local sources of stock were commonly used, but again there was extensive movement from throughout the study area. Thirteen percent (13%) of animals were from other regions, but only 3 lines were from TB risk areas. One half of herds had been tuberculin tested in the previous 12 months.
The sale in the Central North Island area comprised 3,500 animals, mainly weaner steers and heifers. Most (79%) were returned to farms in the same area. Only 6% were sent to the Waikato district.

CONCLUSIONS

Models of the control of tuberculosis in discrete districts have been developed (Ryan T., 1994.). They show the importance of understanding which of three possible avenues is responsible for new infection when setting control strategies (i.e.. from wildlife, via infected livestock moving into the district or via spread within the district). In the Waikato, although it is well known that there are extensive movements of livestock within the district, it was generally thought was that infection was being maintained by movements of large numbers of infected cattle from the Central North Island risk area. Most also considered 'dealers' had an important role disseminating infection. The results of this study challenge these views.
This is the first time that cattle and deer movements have been measured in an objective manner. The data indicates that cattle movements from risk areas are a very minor part of total movements. Further, dealers (as do deer farmers) generally send their animals direct to slaughter. It seems, therefore, that the amount of spread between conventional cattle herds within the district has been under-estimated.
Interestingly, movements of deer are considerably less than cattle. One would therefore expect residual infection to be cleared more quickly than from the cattle population. Indeed this is occurring.
The results of modeling studies by another group, using the data from this study, are also in agreement. They have found that with this amount of movement, current tuberculosis testing policies (most are tested biennially), we would not achieve the goal of 0.2% prevalence (Barlow N., personal communication).
Perhaps the most important general outcome of the study is the recognition that concepts of discrete herds in the Waikato are misplaced. From a disease control perspective there are grounds for considering that most of the cattle belong to one very large herd.

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