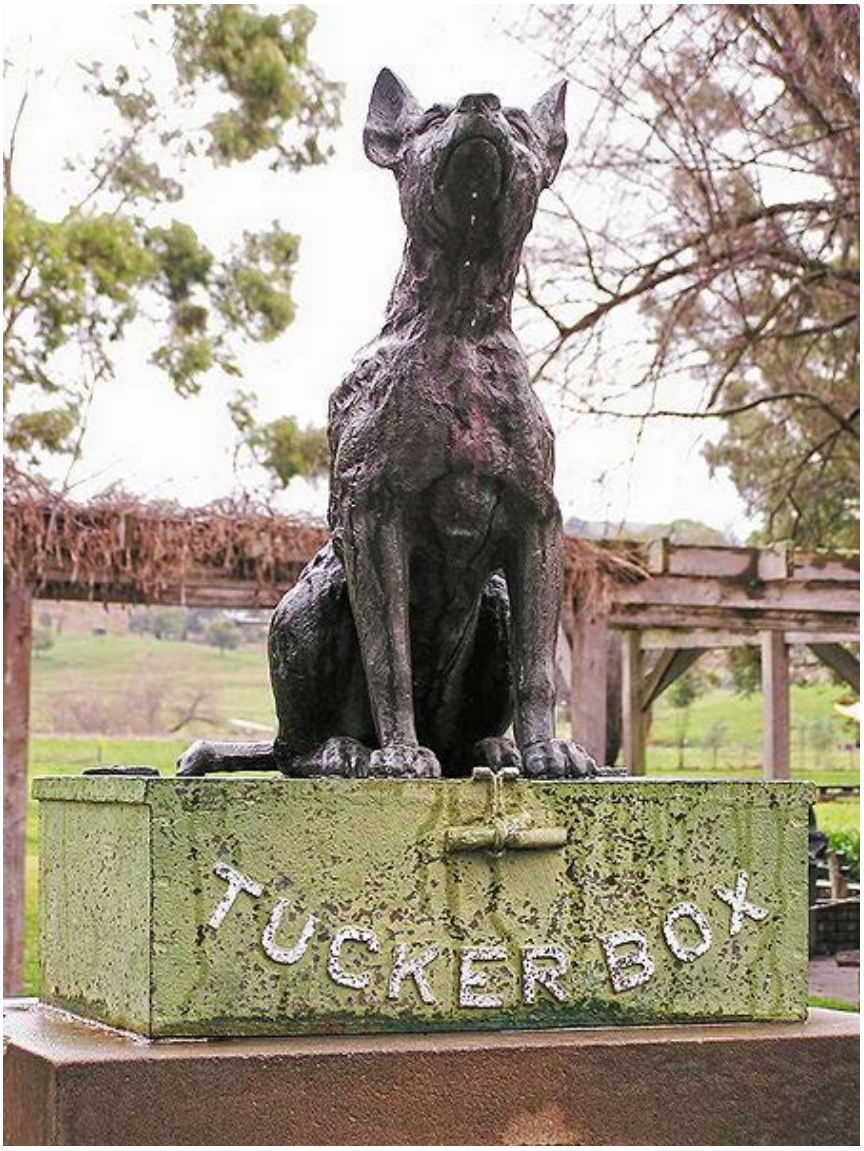
Department of Primary Industries

Exercise Tuckerbox

A foot-and-mouth disease desk-top tracing exercise conducted in New South Wales in April 2012



"I'm used to punching bullock teams across the hills and plains
I've teamed outback these forty years in blazing droughts and rains
I've lived a heap of troubles down without a blooming lie
But I can't forget what happened to me nine miles from Gundagai

"Twas getting dark the team got bogged the axel snapped in two
I lost my matches and my pipe ah what was I to do
The rain came on twas bitter cold and hungry too was I
And the dog sat on the tucker box nine miles from Gundagai"

Traditional, adapted from
http://alldownunder.com/australian-music-songs/nine-miles-from-gundagai.htm

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More information

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Acknowledgments

The exercise used real data about animals and properties recorded on databases by various people in accordance with NLIS business rules and state legislation, and their assistance in this respect is acknowledged.

The assistance of Livestock Health and Pest Authority State Council information technology staff for providing annual return data, and of the DPI Resource Information unit for providing the maps of traced premises, is acknowledged.

Cover image: Wikipedia http://en.wikipedia.org/wiki/Dog_on_the_Tuckerbox

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Contents

Foreword

This report describes a desktop livestock tracing exercise undertaken by the New South Wales Department of Primary Industries (DPI) in April 2012. The exercise was named in honour of the legendary bullocky's dog[1] associated with the town of Gundagai which was the locality of the index property selected for the exercise.

This was an **exercise only**. The foot-and-mouth disease alert scenario on which the exercise was based is fictional. However, real data about properties and animal movements were used and some of this data is included as examples in this report. Personal information about actual premises and people is confidential.

Abstract

Objective To test and compare the mob-based tracing system for sheep and goats with the device-based tracing system for cattle under the National Livestock Identification System (NLIS), and to develop enhanced tracing tools.

Results Nearly 240,000 sheep and a small number of goats were traced using the NLIS database to 232 properties, 11 saleyards and most sheep abattoirs in NSW. Over 181,000 cattle were similarly traced to 1,715 properties, 33 saleyards and all cattle abattoirs in NSW. Significant numbers of sheep were traced to Victoria and cattle to Victoria and Queensland, and a small number of both species were traced to three other jurisdictions. Saleyards accounted for 85% and 58% of sheep and cattle movements respectively. It was not possible to trace movements of other FMD susceptible species during the exercise. Tracing was completed using the equivalent to up to 7 staff working a single 12 hour shift.

Conclusions The NLIS systems for cattle based on individual electronic devices, and for sheep and goats based on mobs, are both capable of tracing for FMD and meeting national tracing standards using the NLIS database as the primary tracing tool. Tracing can be completed using current systems, tools and resources. The NLIS database was efficient and effective. The main limiting factors for tracing for all species are the completeness, timeliness and accuracy of the stock movement data uploaded to the NLIS database, and the availability of staff resources to run and collate database reports in an accurate and timely manner. More automated tracing tools for extracting and collating data from the NLIS database would be useful and are under development.

Background

Foot-and-mouth disease (FMD) is an acute and highly contagious disease of cloven-hoofed animals including cattle, sheep, goats, pigs, deer, buffalo, alpaca and other camelids. The incubation period is from a few to fourteen days and clinical signs last for several days. Pre-clinical animals can shed large amounts of virus, and the virus can be readily spread by animal movements, aerosols and fomites including vehicles, equipment, fodder and people. The disease has the potential to significantly disrupt trade in livestock products and cost Australia billions of dollars.

The Australian Veterinary Emergency Plan (AUSVETPLAN) Disease Strategy for FMD[2] describes the epidemiology of disease and the policy for responding to an outbreak in Australia. The Strategy emphasises the importance of livestock movements in disease spread and of tracing those movements.

The National Livestock Traceability Performance Standards (NLTPS)[3] (Table 1) detail the requirements for tracing in Australia. Standard 1.1 relates to back-tracing for FMD to determine where an infected animal and hence the disease might have come from. Standard 1.2 relates to forward tracing for FMD to determine where infected or exposed animals and hence the disease might have spread to. All tracing must cover the last 30 days and be completed within 24 hours which is consistent with the epidemiology of FMD and urgency of the situation.

Table 1 National Livestock Traceability Performance Standards for FMD (part)

Applicable to all FMD susceptible livestock species	
1.1	Within 24 hours of the relevant CVO being notified, it must be possible to determine the location(s) where a specified animal was resident during the previous 30 days.
1.2	Within 24 hours it must be also possible to determine the location(s) where all susceptible animals that resided concurrently and/or subsequently on any of the properties on which a specified animal has resided in the last 30 days.

The National Livestock Identification System (NLIS)[4] is in place in Australia for cattle, sheep and goats, and is under development for pigs. There are two tracing systems, based either on individual devices (cattle) or mobs (sheep, goats and pigs). Both tracing systems have four core elements:

- Property identification codes (PICs), which provide the core tracing information on tags, movement documents and the NLIS database.
- Tags, either radio frequency identification devices (RFIDs) for cattle, visual ear tags for sheep and goats, or body brands or ear tags for pigs.
- Movement documents such as national vendor declarations (NVDs) or state waybills, including transported stock statements in NSW.
- Uploads of movement data to the NLIS database, which is a national database managed by NLIS Ltd, a subsidiary of Meat and Livestock Australia.

These requirements are mandated in NSW under the *Stock Diseases Regulation 2009* [5].

The NLIS database[6] is the most critical element as it provides the tool for rapidly tracing large numbers of animal movements as required by the national standards and the epidemiology of a highly contagious disease such as FMD.

Aims

The principle aim of Exercise Tuckerbox was to test and compare the mob-based tracing system for sheep and goats with the device-based system for cattle.

A further aim was to develop standard operating procedures, work instructions and templates for tracing. We also used the exercise to scope a tracing report to extract data from the NLIS mirror database available to DPI. Other aims related to enhancing the Department's overall emergency response preparedness.

Methods

The exercise was designed to be consistent with AUSVETPLAN, the NLTPS and the epidemiology of FMD. Commencing with a single index premises, back and forward tracing was carried out for the previous 30 days for all FMD susceptible species, reflecting the multi-species nature of the disease and the national tracing standards.

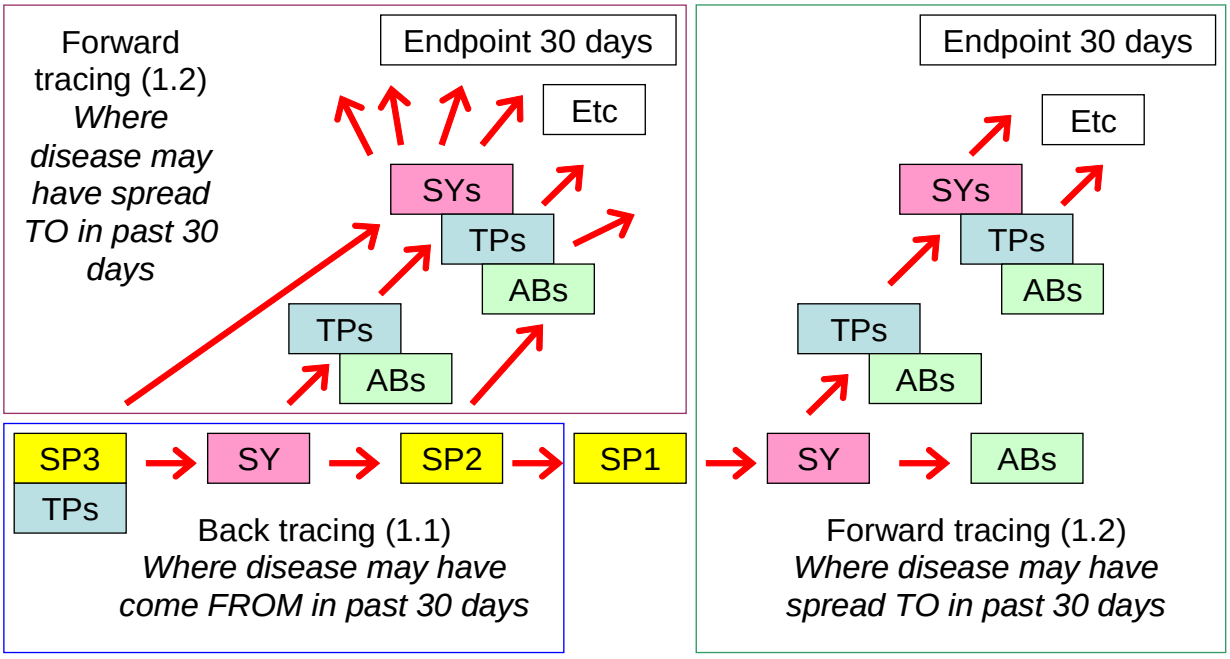
The exercise was based on the fictional scenario that FMD was suspected in sheep on a property near Gundagai on the south west slopes of NSW on 21 February 2012. The NSW Chief Veterinary Officer (CVO) was notified and activated the alert phase of an emergency disease response. Tracing over the previous 30 days (22 January to 21 February 2012) was urgently required to scope the outbreak, better inform national decisions at an imminent meeting of the Consultative Committee on Emergency Animal Diseases (CCEAD), and prepare to deploy resources to manage the outbreak if confirmed.

The exercise was done during normal work days with a time log kept by all staff. We did not dedicate a 24 hour block to tracing due to the logistics of organising this around other work commitments and as the exercise was aimed at testing systems rather than people.

Tracing principles and steps

The principles and steps using for tracing during the exercise are illustrated in Figure 1.

Figure 1 Tracing principles and steps



Starting with the first suspect premises (SP1), back tracing was carried out in accordance with national tracing standard 1.1. This identified sheep movements to SP1 from a second suspect premises (SP2). Further back tracing indentified sheep movements onto SP2 from a third suspect premises (SP3) via a saleyard (SY).

Forward tracing was then carried out, in accordance with standard 1.2, from each SP. This identified large number of sheep and cattle movements to numerous saleyards (SYs), properties (traced premises or TPs) and abattoirs (ABs). If any cattle, for example, moved off a traced cattle property to a saleyard, then all cattle sold at that sale were traced to their destination property or abattoir on the assumption that any or all of them were exposed to the disease risk. Subsequent movements off those destination properties were then traced to additional properties, saleyards and abattoirs. Tracing stopped when the end of the 30 day tracing period was reached.

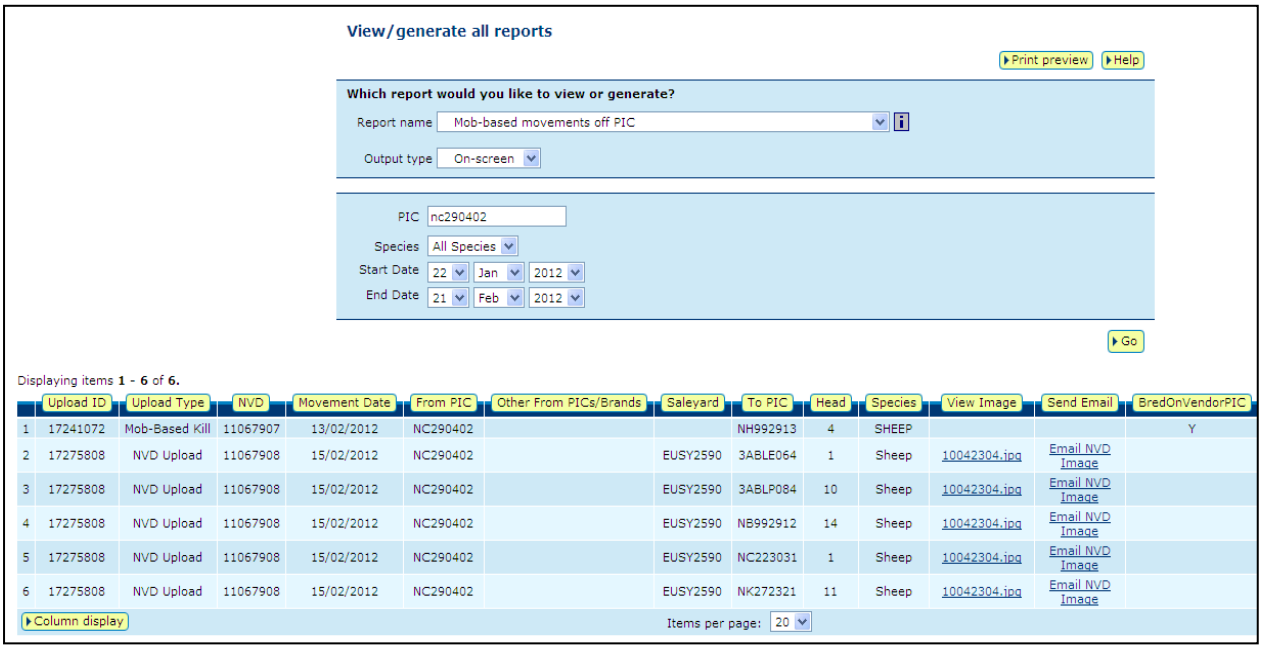
Traces to saleyards in particular resulted in an almost exponential expansion of traces as a small number of animals sent to a saleyard from one traced property could result in dozens of traced premises to which purchased stock were sent. With one of the larger sheep sales, for example, 20,312 head were traced to 40 destination PICs.

Using the NLIS database

Cattle, sheep and goats were traced using standard summary and mob-based reports available to all jurisdictions through 'SDA' (state department of agriculture) accounts on the NLIS production database. The reports used are listed in Appendix 1 and further information on the use of each report is available to SDA account holders from the NLIS database. There were no movements of other FMD susceptible species recorded on the NLIS database.

Mob-based reports for sheep and goats provide the From PIC (PIC of origin), To PIC (PIC of destination), Saleyard (identifier, if applicable), Movement Date and Head (number of animals in the consignment). Additional information about or from national vendor declarations (NVDs) was also available but was not needed to complete the tracing for the exercise. Summary reports for cattle provided similar information; detailed reports which list individual RFIDs were available but not required for the exercise. The relevant NLIS database report was run in turn for each property for the date range of risk, or for each saleyard by sale date of risk. An example of an NLIS database report for sheep is shown in Figure 2.

Figure 2 NLIS database report 'Mob-based movements off PIC' (example)



	Upload ID	Upload Type	NVD	Movement Date	From PIC	Other From PICs/Brands	Saleyard	To PIC	Head	Species	View Image	Send Email	BredOnVendorPIC
1	17241072	Mob-Based Kill	11067907	13/02/2012	NC290402			NH992913	4	SHEEP			Y
2	17275808	NVD Upload	11067908	15/02/2012	NC290402		EUSY2590	3ABLE064	1	Sheep	10042304.jpg	Email NVD Image	
3	17275808	NVD Upload	11067908	15/02/2012	NC290402		EUSY2590	3ABLP084	10	Sheep	10042304.jpg	Email NVD Image	
4	17275808	NVD Upload	11067908	15/02/2012	NC290402		EUSY2590	NB992912	14	Sheep	10042304.jpg	Email NVD Image	
5	17275808	NVD Upload	11067908	15/02/2012	NC290402		EUSY2590	NC223031	1	Sheep	10042304.jpg	Email NVD Image	
6	17275808	NVD Upload	11067908	15/02/2012	NC290402		EUSY2590	NK272321	11	Sheep	10042304.jpg	Email NVD Image	

Collating the data

The data was copied and pasted into an Excel® spreadsheet template for collation and analysis. This template[7] was developed during and subsequently refined after the exercise (Figure 3). The template analysed the traced PICs based on lookup tables and highlighted priorities for further tracing, especially NSW properties and saleyards and interstate traces. The latter were summarised in pivot tables (Figure 4) for prompt advice to other jurisdictions as would be required in a national exercise or real incident.

The process was repeated each time a new property or saleyard (sale date) was traced, resulting in hundreds of database reports being run and ultimately collated in the same spreadsheet.

Figure 3 Data collation spreadsheet template (sample)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	AF	AV	BF	BQ
1	Date	From PIC	Saleyard ID	SY Previous Trace	Saleyard	Saleyard State	To PIC	PIC Previous Trace	To Type	To State	To District	Head	OtherPICs	Species	System	Row	Row	Row	Row	
2																Mob-based movements by NVD				
3																	Mob-based movements off PIC			
4																		Cattle transferred out of saleyard (sum		
5																			Cattle transferred off PIC (summ	
6	4/09/2012	NA180728	EUSY2646	TRUE	Corowa	NSW	3INEL004		VIC Property	VIC		22		SHEEP	MBM	346				
7	3/09/2012	NG010834	EUSY2646	TRUE	Corowa	NSW	3ABXN013		VIC Abattoir	VIC		33		GOATS	MBM	347				
8	3/09/2012	NG010834	EUSY2646	TRUE	Corowa	NSW	3ADLP004		VIC Abattoir	VIC		56		SHEEP	MBM	348				
9	3/09/2012	NG010834	EUSY2646	TRUE	Corowa	NSW	3ABXJ206		VIC Abattoir	VIC		29		SHEEP	MBM	349				
10	3/09/2012	NI321855	EUSY2646	TRUE	Corowa	NSW	SK900816		SA Abattoir	SA		57		SHEEP	MBM	350				
11	3/09/2012	NI321855	EUSY2646	TRUE	Corowa	NSW	SK900816		SA Abattoir	SA		1		SHEEP	MBM	351				
12	3/09/2012	NI321855	EUSY2646	TRUE	Corowa	NSW	3ABLM069		VIC Abattoir	VIC		2		SHEEP	MBM	352				
13	3/09/2012	NI321855	EUSY2646	TRUE	Corowa	NSW	3ADKJ006		VIC Abattoir	VIC		2		SHEEP	MBM	353				
14	3/09/2012	NI321855	EUSY2646	TRUE	Corowa	NSW	3ABXW688		VIC Abattoir	VIC		34		SHEEP	MBM	354				
15	3/09/2012	NH321861	EUSY2646	TRUE	Corowa	NSW	NF995512		NSW Abattoir - Export	NSW	Junee	8	NA010489	SHEEP	MBM	355				
16	3/09/2012	NI021061	EUSY2646	TRUE	Corowa	NSW	NI100100	3/09/2012	NSW Property	NSW	Murray	4	Ditto	SHEEP	MBM	356				
17	3/09/2012	NH321861	EUSY2646	TRUE	Corowa	NSW	3ABXS043		VIC Abattoir	VIC		4	Ditto	SHEEP	MBM	357				
18	3/09/2012	NH321861	EUSY2646	TRUE	Corowa	NSW	NF995512		NSW Abattoir - Export	NSW	Junee	44	Ditto	GOATS	MBM	358				
19	3/09/2012	NH321861	EUSY2646	TRUE	Corowa	NSW	NF995512		NSW Abattoir - Export	NSW	Junee	8	NA341413	SHEEP	MBM	359				
20	3/09/2012	NH321861	EUSY2646	TRUE	Corowa	NSW	NI180108	3/09/2012	NSW Property	NSW	Murray	4	Ditto	SHEEP	MBM	360				
21	3/09/2012	NI021061	EUSY2646	TRUE	Corowa	NSW	3ADXS043		VIC Abattoir	VIC		4	Ditto	SHEEP	MBM	361				
22	3/09/2012	NH321861	EUSY2646	TRUE	Corowa	NSW	NF995512		NSW Abattoir - Export	NSW	Junee	44	Ditto	SHEEP	MBM	362				
23	3/09/2012	NI180562	EUSY2646	TRUE	Corowa	NSW	NI180108	3/09/2012	NSW Property	NSW	Murray	1		GOATS	MBM	363				
24	3/09/2012	NI180562	EUSY2646	TRUE	Corowa	NSW	NC992711		NSW Abattoir - Export	NSW	Goulburn	3		SHEEP	MBM	364				
25	3/09/2012	NI180562	EUSY2646	TRUE	Corowa	NSW	3ABSS246		VIC Abattoir	VIC		47		SHEEP	MBM	365				
26	3/09/2012	NI180562	EUSY2646	TRUE	Corowa	NSW	3ABXN612		VIC Abattoir	VIC		12		SHEEP	MBM	366				
27	3/09/2012	NI180562	EUSY2646	TRUE	Corowa	NSW	3ABXS043		VIC Abattoir	VIC		41		SHEEP	MBM	367				
28	3/09/2012	NI180562	EUSY2646	TRUE	Corowa	NSW	NF995512		NSW Abattoir - Export	NSW	Junee	6		SHEEP	MBM	368				
29	3/09/2012	ND011807	EUSY2646	TRUE	Corowa	NSW	NF995512		NSW Abattoir - Export	NSW	Junee	100		SHEEP	MBM	369				
30	3/09/2012	ND011807	EUSY2646	TRUE	Corowa	NSW	3ABLE064		VIC Abattoir	VIC		54		SHEEP	MBM	370				
31	3/09/2012	NC011610	EUSY2646	TRUE	Corowa	NSW	NC011610	3/09/2012	NSW Property	NSW	Hume	23		SHEEP	MBM	371				
32	3/09/2012	NC011610	EUSY2646	TRUE	Corowa	NSW	3ABLM069		VIC Abattoir	VIC		32		SHEEP	MBM	372				
33	3/09/2012	NC011610	EUSY2646	TRUE	Corowa	NSW	3ABLL006		VIC Abattoir	VIC		34		SHEEP	MBM	373				
34	3/09/2012	NC011610	EUSY2646	TRUE	Corowa	NSW	NC011610	3/09/2012	NSW Property	NSW	Hume	54		SHEEP	MBM	374				
35	3/09/2012	NI180108	EUSY2646	TRUE	Corowa	NSW	3ABSS246		VIC Abattoir	VIC		45		SHEEP	MBM	375				
36	3/09/2012	NI180108	EUSY2646	TRUE	Corowa	NSW	3ABXN612		VIC Abattoir	VIC		40		SHEEP	MBM	376				
37	3/09/2012	NI100100	EUSY2646	TRUE	Corowa	NSW	3ADSS246		VIC Abattoir	VIC		23		SHEEP	MBM	377				
38	3/09/2012	NI180108	EUSY2646	TRUE	Corowa	NSW	3ABXS043		VIC Abattoir	VIC		1		SHEEP	MBM	378				
39	3/09/2012	3INBK038	EUSY2646	TRUE	Corowa	NSW	NC992711		NSW Abattoir - Export	NSW	Goulburn	29	NHZ22492	SHEEP	MBM	379				
40	3/09/2012	NA341317	EUSY2646	TRUE	Corowa	NSW	3ABSS246		VIC Abattoir	VIC		15	3MIWP010	SHEEP	MBM	380				

Figure 4 Pivot table of interstate traces (sample)

	A	B	C	D	E	F	G	H
1								
2								
3	To State	To PIC	To Type	Species	Date	Saleyard	Data	Total
4	VIC	3ABWA228	VIC Abattoir	SHEEP	6/02/2012		Animals	78
5							Mobs	1
6		3ABXH243	VIC Abattoir	Cattle	7/02/2012	Bega	Animals	11
7							Mobs	8
8					13/02/2012	Wagga	Animals	25
9							Mobs	8
10					31/01/2012	Bega	Animals	2
11							Mobs	1
12					26/01/2012	Bega	Animals	2
13							Mobs	2
14		3BSGR063	VIC Property	Cattle	26/01/2012	Bega	Animals	48
15							Mobs	7
16		3EGON784	VIC Property	Cattle	26/01/2012	Bega	Animals	3
17							Mobs	1
18		3INEN048	VIC Property	SHEEP	20/02/2012	Corowa	Animals	99
19							Mobs	1
20		3MIZW621	VIC Property	SHEEP	10/02/2012	Urana	Animals	228
21							Mobs	1
22					13/02/2012	Urana	Animals	228
23							Mobs	1

Using the NSW PIC register

The indicative number of susceptible animals on traced properties was obtained from the NSW PIC register held in the Livestock Health and Pest Authority (LHPA) administrative system, *FARMS*. This data was based on information provided by ratepayers in accordance with the *Rural Lands Protection Act 1998* [5] through annual returns of land and stock as at 1 June 2011.

The data was analysed to find out how many properties to which cattle were traced also had sheep, goats, pigs, camelids or deer, and how many properties to which sheep were traced also had cattle or the other species. The number of animals of each species on each property was also collated.

Assumptions and limitations

Tracing was done entirely from data sources available at the desks of tracing staff – there was no field investigation or verification for any species.

Animals traced to an interstate PIC were collated but not traced any further in this exercise. This is consistent with the NLTPS, previous national exercises and a real outbreak where interstate traces would be notified to the other jurisdiction's CVO for further tracing. Furthermore, the NLIS production database blocks access to interstate data, precluding further tracing by a different jurisdiction.

Animals traced to abattoir PICs were not further traced. In practice, it would be important to confirm that the animals had been slaughtered and the disposition of the product, especially if destined for overseas markets.

There was no tracing of fomites which are likely to be involved in the spread of FMD. The NLTPS apply only to livestock and there are no legislative requirements or databases for recording movements of fomites. Livestock vehicle movements may be traceable with the assistance of paper-based transported stock statements which are mandatory in NSW under the *Rural Lands Protection Act 1998* [5], but not within the 24 hours stipulated by the tracing standards.

There were a number of other assumptions and limitations inherent in the design and conduct of the exercise. These applied equally to all species.

- For saleyards, it was assumed that all animals of the same species present on a sale day were at equal risk of being exposed to and subsequently spreading the disease; that each sale was of a single species; and that there was no carry over of risk to subsequent sales. For example, if one suspect sheep was traced to a saleyard, then all sheep in that sale were deemed suspect and further traced, however cattle that may have been present at the same saleyard or at a cattle sale the next day were not traced.
- For properties to which cattle were traced, only subsequent cattle movements off those properties were further traced, not sheep or goats. The same applied to properties to which sheep were traced. In a real event it would be important to trace movements of all FMD susceptible species from each traced premises.
- Animals transferred to agent and district codes were not further traced. These codes are used for the temporary transfer of animals on the NLIS database when their final destination is not known at the time, or the property does not have a PIC. (District codes have since been disbanded for stock movements in NSW as PICs are now mandatory for all properties with designated livestock, and the use of agent codes is being progressively constrained in NSW).
- Cattle sighted at shows[8] were not traced.

In a real outbreak, epidemiological risk assessment and field verification would be essential to ensure high risk movements were targeted and confirmed, and other movements (not recorded on the NLIS database) were detected.

Results

Sheep and goats

Nearly 240,000 sheep and a small number of goats were traced to 232 properties, 11 saleyards and most sheep abattoirs in south eastern NSW. Significant numbers of sheep were traced to Victoria and a small number to three other jurisdictions. The total number of sheep and goats (head and mobs) and premises (PICs) traced for these species is summarised in Table 2.

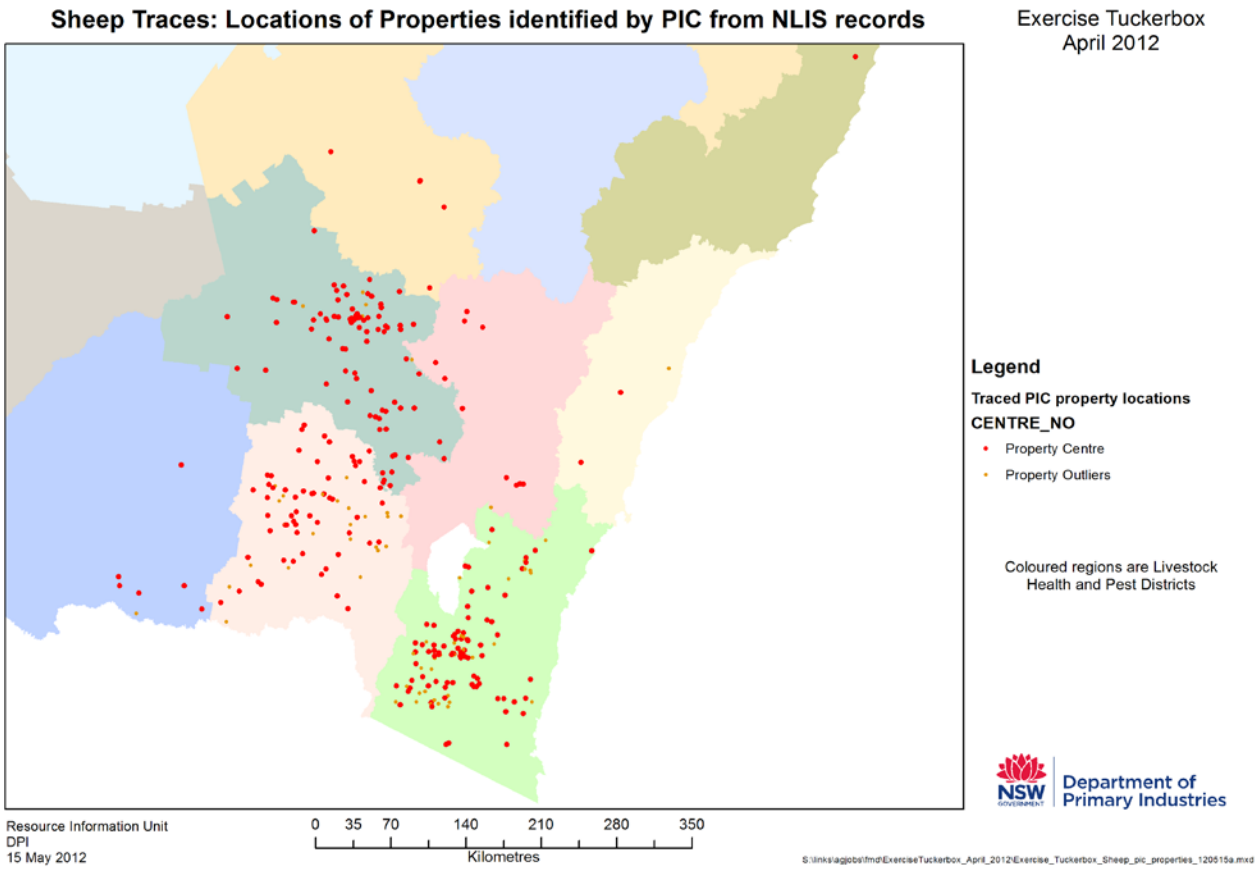
Table 2 Sheep and goat tracing results

Destination PIC Type	Number of PICs	Number of Head (% of total head)	Number of Mobs
Sheep			
NSW Property	232	57,463 (24%)	1,007
NSW Saleyard	11	*Included in totals for destination PICs after sale*	
NSW Agent	7	2,324 (1%)	41
NSW Abattoir	14	99,862 (42%)	1,879
VIC Property	15	4,040 (2%)	80
VIC Agent	4	8,044 (3%)	152
VIC Abattoir	18	58,272 (24%)	1,711
ACT Property	1	1 (0%)	1
SA Abattoir	3	5,500 (2%)	72
QLD Abattoir	1	3,846 (2%)	128
Deceased	-	23 (0%)	17
Goats			
VIC Abattoir	1	44 (0%)	1
Total	**305**	**239,375**	**5,088**

Fifty-three percent of properties to which sheep were traced had other movements off those PICs during the 30 day tracing period. Saleyards accounted for 85% of sheep movements, 6% of movements were from properties to abattoirs, and 9% of movements were between properties.

The distribution of traced sheep and goat premises in NSW only is shown in Figure 5. These are spread throughout south-east NSW. Traced premises in other States, especially Victoria, are not shown as we did not have access to geocoding information for those PICs.

Figure 5 Map showing locations of traced sheep premises



Cattle

Over 181,000 cattle were traced to 1,715 properties, 33 saleyards and all cattle abattoirs and knackeries throughout NSW. Significant numbers of traces were found to Victoria and Queensland and a small number to two other jurisdictions. The total number of cattle (head and mobs) and premises (PICs) traced for this species is summarised in Table 3.

Table 3 Cattle tracing results

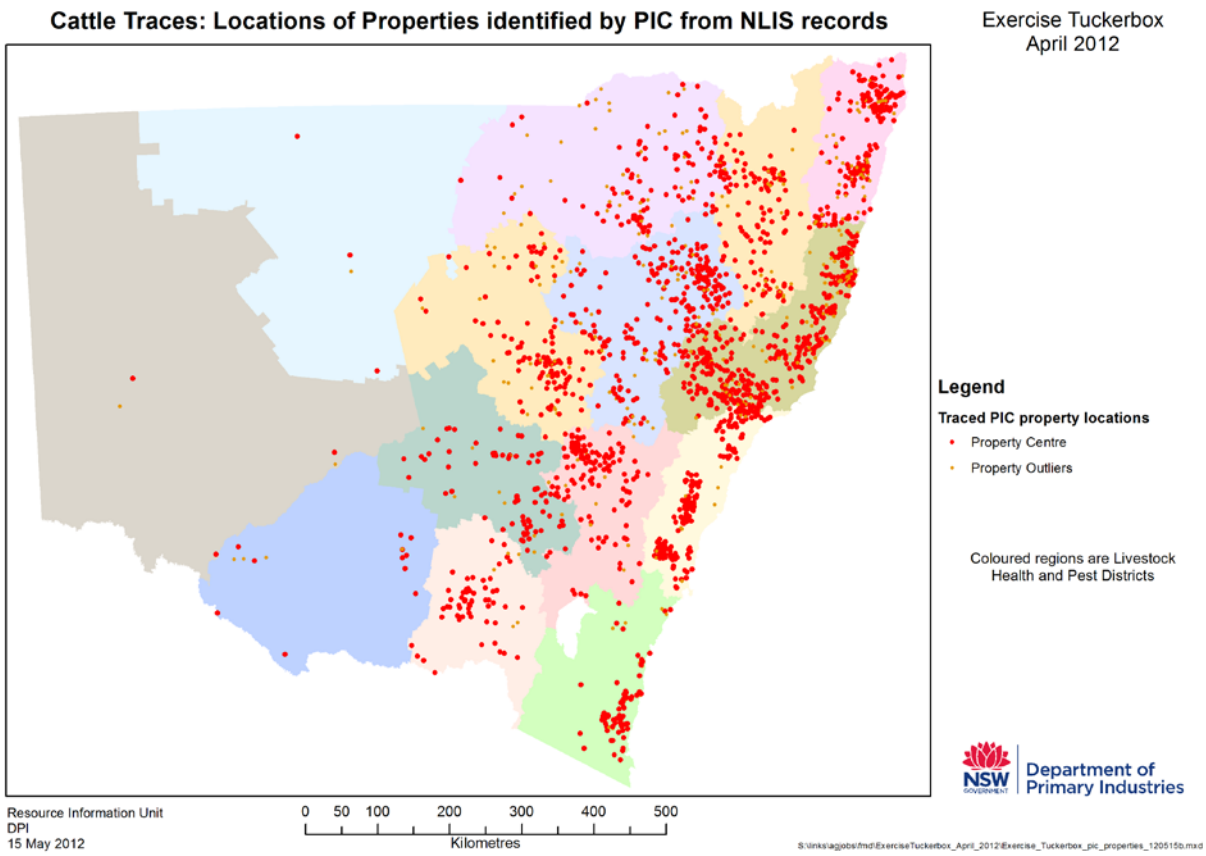
Destination PIC Type Cattle	Number of PICs	Number of Head (% of total head)	Number of Mobs
NSW property	1,715	68,756 (38%)	9,656
NSW saleyard	33	*Included in totals for destination PICs after sale*	
NSW agent	49	7,949 (4%)	874
NSW abattoir	24	72,859 (40%)	7,265
NSW district code	3	33 (0%)	22
Deceased	-	880 (0.5%)	203
VIC property	55	1,280 (1%)	250
VIC saleyard	2	56 (0%)	7
VIC agent	7	335 (0.2%)	170
VIC abattoir	18	8,656 (4%)	1,183
QLD property	34	10,064 (5%)	1,267
QLD saleyard	1	6 (0%)	2

Destination PIC Type Cattle	Number of PICs	Number of Head (% of total head)	Number of Mobs
QLD abattoir	12	9,581 (5%)	761
TAS property	1	12 (0%)	1
TAS abattoir	1	257 (0.1%)	3
SA abattoir	1	304 (0.2%)	2
Total	**1,956**	**181,028**	**21,666**

Thirty-four percent of properties to which cattle were traced had other movements off those PICs during the 30 day tracing period. Saleyards accounted for 58% of cattle movements, 30% of movements were from properties to abattoirs, and 12% of movements were between properties.

The distribution of traced cattle premises in NSW only is shown in Figure 6. These are spread throughout NSW, reflecting cattle movements and populations. Traced premises in other States are not shown for the same reason as for sheep and goats.

Figure 6 Map showing locations of traced cattle premises



Pigs and other species

Consistent with the epidemiology of FMD, the NLTPS and the exercise aim, we looked at tracing other FMD-susceptible species using the NSW PIC register which included annual returns of land and stock collected by LHPAs.

Table 4 shows that a few percent of traced sheep and cattle properties also had pigs or camelids (mostly alpaca), and a small number of properties had deer.

Table 4 Traced properties with other susceptible species

	Pigs	Alpaca, Llama, Camel	Deer
Number of traced properties with other species as a percent of all traced properties	46 2%	82 3%	7 0.3%
Number of animals of each species on traced properties	27,076	546	88

This value of this data is limited by an 81% rate of return of the annual returns. Furthermore, the data was based on stock holdings as declared by producers at the end of June 2011, several months before the exercise. Only 71% of traced sheep properties and 85% of traced cattle properties were declared as having sheep or cattle respectively at that time, suggesting that the presence of stock on some properties is variable or that some producers underestimate their stock holdings.

In the absence of any national movement database for these species, it was not possible to trace any movements of pigs, camelids or deer during the exercise.

Time and resources for tracing

It took 4 people a total of 66 hours 40 minutes spread over about 2 weeks to complete the tracing. This comprised 42 hours 30 minutes for cattle, 21 hours 35 minutes for sheep and goats, and 2 hours 35 minutes for other species. This is equivalent to up to 7 staff working a single 12 hour shift with breaks. The national tracing standards require all tracing to be completed within 24 hours.

Compared with previous national exercises, we were able to trace similar numbers of properties and stock with substantially fewer people. In Exercise Cowcatcher 2007, 28 staff were required to complete the tracing for standards 1.1 and 1.2 within 48 hours real time in NSW using the NLIS production database. In Exercise Sheepcatcher 2007, 20 staff took 36 hours in real time to complete 96% of tracing to the same standards in NSW using movement documents and commercial records as there was no mob-based movement database at that time.

Data accuracy and completeness

The tracing was based entirely on the data available in the NLIS database or the NSW PIC register. As such, the results are limited by the accuracy and completeness of that data. This reflects a number of parameters which are common to all tracing systems and species.

- Whether movement data is uploaded: Routine compliance monitoring by DPI, LHPAs and the NSW Food Authority suggests that a high proportion of movements of cattle, sheep and goats to saleyards and abattoirs are uploaded to the NLIS database. However, a lower but unknown proportion of property to property movements are uploaded.
- The timeliness of uploads: NSW legislation requires movements through saleyards and abattoir kills to be uploaded no later than the close of the next business day, and between properties within 7 days. In practice for cattle, 92% of saleyard movements were uploaded within 2 days, 84% of abattoir kills within 2 days, and 80% of property to property movements within 7 days. For sheep, the comparable figures were 84% for saleyards, 70% for abattoirs and 64% for properties. Late uploads, and even the 7 day rule for property movements, can impact significantly on the available data when tracing starts ‘today’ and extends back for only 30 days.

- The accuracy of PICs. Tracing from the NLIS database is fundamentally based on PICs. The incorrect origin or destination PIC may be uploaded due to human error or other reasons and this would not have been detected during the exercise. Use of disbanded PICs, default PICs such as 8A and 8Z, and district codes (which at the time of the exercise could be lawfully used in NSW for properties without a PIC) negate traceability. However, only a very small number of these latter PICs were found in the exercise. Agent codes, although lawful, can also compromise traceability as the physical location of the stock has to be determined from the stock agents' paper records rather than the NLIS database.

DPI routinely monitors the performance and compliance of various sectors with NLIS database uploads which is regularly reported to national NLIS committees under SAFEMEAT. The data for the January to March 2012 quarter provided further benchmarks at the time of the exercise. The compliance of each sector was weighted according to the number of animals transferred through that sector during the exercise. These calculations are summarised in Table 5.

Taking all of these factors and data into account, it was estimated that the tracing data was about 92% complete and accurate for cattle and 90% for sheep.

Table 5 Completeness and accuracy of tracing data obtained from NLIS database

Sector	Cattle			Sheep		
	Head		Compliance	Head		Compliance
Saleyards	103,524	54%	97%	206,668	84%	95%
Abattoirs	58,571	30%	96%	15,372	6%	93%
P2P	22,572	12%	59%	20,769	8%	41%
Shows	965	0.5%	0%	1,225	0.5%	9%
Districts	33	0%	0%	0	0%	0%
Agents	8,235	4%	86%	2,195	1%	72%
Total	**192,935**		**92%**	**245,004**		**90%**

Discussion

This exercise demonstrated that both the mob-based NLIS for sheep and goats and the device-based NLIS for cattle can be effectively used to trace stock in the event of an FMD alert and in accordance with the relevant national standards. Nearly half a million sheep and cattle were traced to over 2,000 properties throughout NSW and to most other states and territories using available staff resources which, if dedicated to the task, could complete the task well within the 24 hours required by both the national tracing standards and the reality of an emergency response.

The exercise was only conducted in NSW. Although not a national exercise, we collated data as though it were to be reported to other states and territories and used tracing reports available to all other jurisdictions. Subject to staff availability and the completeness and accuracy of the data on the NLIS database, similar tracing outcomes could be achieved throughout Australia.

The exercise was designed to benchmark against the national tracing standards 1.1 and 1.2 which are principally for FMD. Other national standards provide benchmarks for lifetime traceability, principally for bovine spongiform encephalopathy (BSE) in cattle (standards 2.1, 2.2 and 2.3) and for scrapie, Johne's disease or other chronic conditions in various livestock species (standards 3.1 and 3.2). Due to its limited scope, no conclusions can be drawn from this exercise about the effectiveness of the NLIS for lifetime traceability for any species.

Mob-based verses device-based tracing systems

Although both the mob- and device-based tracing systems under the NLIS performed similarly in this exercise, there are some differences between the two systems.

The NLIS for sheep and goats uses visual ear tags which are printed with the PIC of the property of birth or other property on which the sheep were tagged. All sheep and goat movements must be accompanied by a movement document such as an NVD on which the PIC of the consignment property (the From PIC) is printed. If the sheep or goats were bred and tagged on that property, then the PIC on the ear tags matches the PIC on the NVD. If the stock were bred and tagged on a different property, then the PIC on all tags must be hand written on the NVD. This rule is designed to ensure that a sick animal in a saleyard or abattoir lairage can be back-traced via its movement document to the property from which it has just moved. Once this link has been established and forward tracing commences, all subsequent tracing is done from the NLIS database rather than from tags and movement documents.

A limitation of the mob-based system is the extent to which all other tag PICs are accurately written on the NVD, and at the time of the exercise this was only 83% reliable (91% by the end of 2012). However, once tracing from the NLIS database commences, the essential link between properties at risk is provided by the From and To PICs on the NLIS database, not tags or NVDs. The latter were not used in this exercise and, apart from the initial sick sheep, tags or NVDs would not be a limiting factor in an emergency tracing response for FMD using the NLIS database, although NVDs and commercial records would be useful for field verification.

The NLIS for cattle relies on a unique RFID attached to each beast. A movement document must similarly accompany all movements to provide the From PIC. If a sick cow is detected in a saleyard or abattoir, rather than using the visual NLIS identifier printed on the tag and the NVD, the tag would be electronically scanned and the RFID number matched to the PIC to which that device is currently registered on the NLIS database through a 'beast inquiry' report. However, this is only accurate about 94% of the time, based on 6% 'system transfers'* into saleyards and abattoirs. In other words, about 6% of cattle devices are registered to the incorrect PIC at the time of movement, and it will not be known whether the sick beast is one of these at the time as the correct PIC has yet to be determined. (*A system transfer is automatically triggered on the NLIS database when a beast is transferred off a different PIC to that to which the device is currently assigned or registered on the database. The main reasons are failure to record property to property transfers, and transfers from and to incorrect PICs. System transfers are recorded as 8X (XXXXXXXX) on the NLIS database which flags a gap in traceability and lifetime traceable (LT) status is lost.)

Notwithstanding this limitation of the device-based system, once tracing from the NLIS database commences, the essential link between properties at risk, as for sheep, is provided by the From and To PICs on the NLIS database. NVDs and other records would be used for verification of movements in the field, as for sheep.

Cattle RFIDs were not used in this exercise as it was not necessary to trace individual animals. By assuming that all animals on a suspect or traced premises or saleyard were potentially equally in contact and of risk as discussed above, then all subsequent movements off those PICs had to be traced. There would be limited value in focussing on traces for individual animals as, within 30 days, the risk of an infected animal ranges from infected but not shedding, preclinical and shedding, clinical and shedding, recovering and low shedding, to recovered and not shedding. By the end of the 30 day tracing period, an individual exposed to FMD at the beginning is likely to be a lower risk than in-contact animals which should therefore be a higher priority for tracing.

Another consideration was that detailed database reports which listed all RFIDs would have slowed down tracing due to the greater volume of data to collate, summarise and assess. For example, at one of the larger traced cattle sales, 3,138 cattle were sold in 581 buyer mobs. The summary report contained 581 lines of data which can be copied and pasted into the template

spreadsheet in several seconds, whereas a detailed report with 3,138 lines of data would have taken several times longer to similarly copy and paste, or to export and import through additional steps.

Nevertheless, RFIDs are essential for cattle in order to record their movements on the NLIS database, and some traces could be enhanced by RFIDs. An animal moved to an identification code which is not linked to a physical property, such as an agent code, district code or 8A, is not necessarily in contact with all other animals registered to that code at the same time, so it would not be appropriate to simply trace all movements off those codes. These codes accounted for 4% of cattle and 1% of sheep movements during the exercise. Although not further traced during the exercise, in practice cattle transferred to these non-property based codes would be traced through their RFIDs and sheep through NVDs, in both cases limited by the extent that subsequent movements off those codes and mobs had been recorded on the NLIS database.

Implications for FMD tracing and response

Starting with a single index premises, over 2,200 other PICs were traced through livestock movements over a 30 day period. Over half of the traced sheep premises and a third of traced cattle premises had additional movements on or off during the 30 days, showing that these properties were actively trading stock and potentially disseminating the disease risk. This may be a reflection of the prevailing seasonal and market conditions and the fact that the traced premises were by definition those that were actively moving livestock.

Every year over 5 million cattle and 14 million sheep are moved to NSW saleyards, abattoirs and properties (based on NLIS data) and the movements occur from and to all states and territories and especially those bordering NSW (Queensland, Victoria, the Australian Capital Territory and South Australia). It should therefore be anticipated, and this exercise confirms, that FMD has the potential to spread quickly and widely throughout eastern and southern Australia due to normal livestock movements. Although prior movements have already occurred, a total livestock movement standstill should be an essential component of the initial emergency response to FMD to minimise the risk of further spread.

The exercise adopted a ‘broad brush’ approach to tracing by assuming that, once an animal of risk had moved to a property or saleyard, all other animals of the same species on those premises at the same time (or subsequently in the case of properties) were potentially in contact and therefore at risk. In practice, this seemingly simplistic approach is the only one that can be realistically taken for the initial tracing of a highly contagious disease and until veterinary investigation teams are dispatched to each traced premises to assess risk based on the actual circumstances of livestock holdings, contacts and movements. This risk-based data is not available for any species on the NLIS database.

On the other hand, the exercise assumed that animals present at subsequent sale days in saleyards were not at risk. In a real event it would be essential to assess this on the ground as it is likely that there would be some residual contamination and risk to stock in sales over the next week due to retained livestock, environmental contamination and fomites.

FMD risk is also influenced by weather conditions, with aerosol spread and virus survival favoured by cool moist conditions. This exercise was conducted at the height of the Australian summer with maximum temperatures likely to exceed 35°C on most days at most inland properties and saleyards. These conditions in practice would have been unfavourable for the survival and spread of the virus.

For practical reasons, the exercise only traced movements of the same livestock species to and from each premises, not other FMD susceptible species which may have been in contact. NSW PIC register data indicates that 46% of traced sheep properties also run cattle, 20% of traced cattle properties also run sheep, and 2-3% of all properties also run goats. In a real event, it would be essential to trace the movements of all susceptible species from these mixed grazing

properties as well as mixed sales at smaller saleyards and adjacent sale days at larger saleyards.

Epidemiological and risk assessment of movements and congregations of livestock are essential to focus responses with limited resources, and additional guidelines in AUSVETPLAN on tracing priorities would be useful.

Other FMD susceptible species

Although we were able to estimate which traced properties had other FMD susceptible species and their approximate number from annual returns and the NSW PIC register, we were unable to trace any movements of these animals in the available time as there are no national movement databases for these species. A mob-based movement database is proposed for pigs, which are a high risk FMD susceptible species. Buffalo and bison could come under the same system as cattle and are already included in some jurisdictions. Alpaca and other camelids are a lower epidemiological risk for FMD and no movement database is being planned at this stage. DPI has brought the consideration of an NLIS for deer to the attention of SAFEMEAT.

Implications for the NLIS database and other tracing tools

The only way to quickly trace large numbers of livestock movements is through a national database.

The NLIS database proved to be very fast, reliable and effective and was not a limiting factor in the exercise. Minor changes to existing reports and the development of a new tracing report for livestock sighted off a PIC, as discussed below, could be useful. However, the main gains to the speed and accuracy of tracing are to be made in developing more automated systems for extracting, collating and to some extent analysing livestock movement data from the NLIS database in either its production or mirror forms. NSW DPI has commenced the development of these systems, and it is understood that some other jurisdictions and NLIS Ltd have or are developing similar tools. An essential enhancement would be to allow all FMD susceptible species to be traced simultaneously and irrespective of the tracing system.

Shows present a moderate FMD risk due to the large numbers of events (about 200 each year in NSW) and the congregation and dispersal of moderate numbers of mixed susceptible species. Movements of sheep and goats to and from shows would have been detected during the exercise to the extent that they were recorded as mob-based movements on the NLIS database. Cattle movements would also have been found if recorded as device-based property to property movements. However, sighted cattle[8] were not traced as there is no report currently available on the NLIS database which readily lists cattle that were present on a traced PIC but which were sighted on a different PIC during the tracing period. The development of such as report has been raised with NLIS Ltd as an enhancement to the otherwise comprehensive set of monitoring and tracing reports already available to authorities through ‘SDA’ accounts.

One of the main challenges was keeping track of traces to avoid either duplication or gaps, and collating large data sets in a way that allowed meaningful interpretation. The exercise fulfilled its aim of developing a system for doing this and the resulting template is now available for future emergency use. Nevertheless, subsequent data analysis has identified some duplicated traces (the same sale days traced twice) and some missed traces (sale days to which a small number of traced animals moved but for which movements from the sale were not traced). Duplicated traces are a lower risk as they only waste time and inflate the overall statistics, but missed traces could be critical to detecting the limits of disease spread. This highlights the risks associated with manual tracing, especially under time and resource pressure, and the value of developing more automated data extraction and collation tools. NLIS Ltd provides a copy (‘mirror’) of the NLIS database to any jurisdiction on request which is updated hourly, and DPI is currently

developing enhanced tracing tools for extracting, collating and analysing stock movement data from our mirror database.

Conclusions

We conclude from this exercise that the NLIS systems for cattle based on individual electronic devices, and for sheep and goats based on mobs, are both capable of tracing for FMD and meeting the national tracing standards for FMD by using the NLIS database as the primary tracing tool.

Tracing can be completed using current systems, tools and resources. The NLIS database was efficient and effective. The main limiting factors for all species are the completeness, timeliness and accuracy of the data routinely uploaded by industry participants to the database (data in), and the availability of sufficient trained staff in animal health authorities to run and collate numerous database reports in an accurate and timely manner (data out).

A national database of pig movements is required as a priority due to their high epidemiological risk for FMD. Movement databases for other susceptible species would also be desirable. It would be most practical for producers, shows, saleyards and abattoirs which deal with multiple species, and for animal health authorities for monitoring, regulatory and tracing purposes, if all of this data were available from the one source, and the NLIS database is well designed and set up in this respect. It is understood that negotiations are taking place between NLIS Ltd and other livestock industry organisations with a view to facilitating this outcome.

References

1. Wikipedia
2. AUSVETPLAN Disease Strategy for Foot-and-mouth Disease
3. National Livestock Traceability Performance Standards on Animal Health Australia website
4. NSW DPI National Livestock Identification System (NLIS) web page
5. NSW DPI legislation page
6. NLIS database – Help tools
7. Tracing template NSW DPI TRIM reference INT13/36228, copy available on request
8. NLIS database Tech Tip: Sighted livestock

Appendix 1 – NLIS database reports used in the exercise

The following standard NLIS database reports available to SDA accounts were used for this exercise.

Sheep and goats:

- Back tracing:
  - Movements onto a property – *Mob-based movements onto PIC* with input parameters of property PIC, start date of 22/01/2012, end date of 21/02/2012 for the index property or the date the back-traced movement off that PIC occurred for other suspect premises.
- Forward tracing:
  - Movements off a property – *Mob-based movements off PIC* with input parameters of property PIC, start date of the earliest date that a risk movement onto that PIC was found, end date of 21/02/2012.
  - Movements out of a saleyard – *Mob-based movements by NVD* for, with input parameters of sale date (being the date that a traced animal was transferred to the saleyard) then filtered for the saleyard ID.

Cattle:

- Back tracing:
  - Movements onto a property – *Cattle transferred onto PIC (summary)* with input parameters of property PIC, start transfer date of 22/01/2012, end transfer date of 21/02/2012 for the index property or the date the back-traced movement off that PIC occurred for other suspect premises.
- Forward tracing:
  - Movements off a property – *Cattle transferred off PIC (summary)* with input parameters of property PIC, start transfer date of the earliest date that a risk movement onto that PIC was found, end transfer date of 21/02/2012.
  - Movements out of a saleyard – *Cattle transferred out of saleyard (summary)* with input parameters of saleyard ID and the sale date (being the date that a traced animal was transferred to the saleyard) as both the start sale date and end sale date.
- Other summary or detailed reports could alternatively have been used.