

*Import Risk Analysis: Cattle
from Australia, Canada, the
European Union, and the
United States of America*

FINAL



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Policy and Risk
MAF Biosecurity New Zealand



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Approved for general release

A handwritten signature in black ink that reads 'Christine Reed'.

Christine Reed
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Executive Summary

The risks associated with the importation of cattle from Australia, Canada, the European Union (27 countries), and the United States of America have been examined. Only risks associated with the importation of infectious organisms or parasites have been considered.

Of an initial list of 93 micro organisms or groups of organisms, 43 disease agents or groups of disease agents/diseases that are exotic to New Zealand or are the subject of a national eradication campaign in New Zealand, were included in a preliminary hazard list. Thirty four of these were considered to be potential hazards and were subjected to a risk assessment.

A non-negligible risk was identified with the following hazards:

- Borna disease virus
- Exotic bovine herpes viruses
- Bovine viral diarrhoea virus type 2
- Crimean Congo haemorrhagic fever virus
- Bovine ephemeral fever virus
- Foot and mouth disease virus
- Rabies virus
- Tick borne encephalitis viruses
- Vesicular stomatitis virus
- Bovine spongiform encephalopathy agent
- *Bacillus anthracis*
- Exotic *Brucella* spp.
- *Mycobacterium bovis*
- Exotic *Mycoplasma* spp.
- *Pasteurella multocida* types B and E
- Exotic *Salmonella* spp.
- Exotic *Leptospira* spp.
- *Anaplasma* spp.
- *Chlamydia abortus*
- *Coxiella burnetii*
- *Babesia* spp.
- *Theileria annulata*
- Exotic lice, mites, and ticks
- *Hypoderma* spp.
- Exotic internal parasites
- Exotic weed seeds

Options for risk management measures in order to effectively manage the risk associated with each of these hazards have been presented.

1. Introduction

This risk analysis has been developed in response to a request from the Animals Import section of MAF Biosecurity New Zealand.

2. Scope

This risk analysis is limited to the description of the risks due to disease-causing organisms associated with the importation of cattle from the USA, Canada, Australia, and the European Union (27 countries). Other risk factors that may be of commercial importance to importers (e.g. genetic diseases) have not been considered in the analysis.

The risk analysis does not consider speculative events that could occur in the future, such as the possible establishment of disease vectors such as *Culicoides* spp. due to climate change. MAF has the flexibility to modify any Import Health Standards based on this risk analysis when appropriate.

The risk analysis is qualitative.

3. Commodity Definition

The commodity considered is cattle of the species *Bos taurus* and *Bos indicus*. This risk analysis does not apply to other bovids.

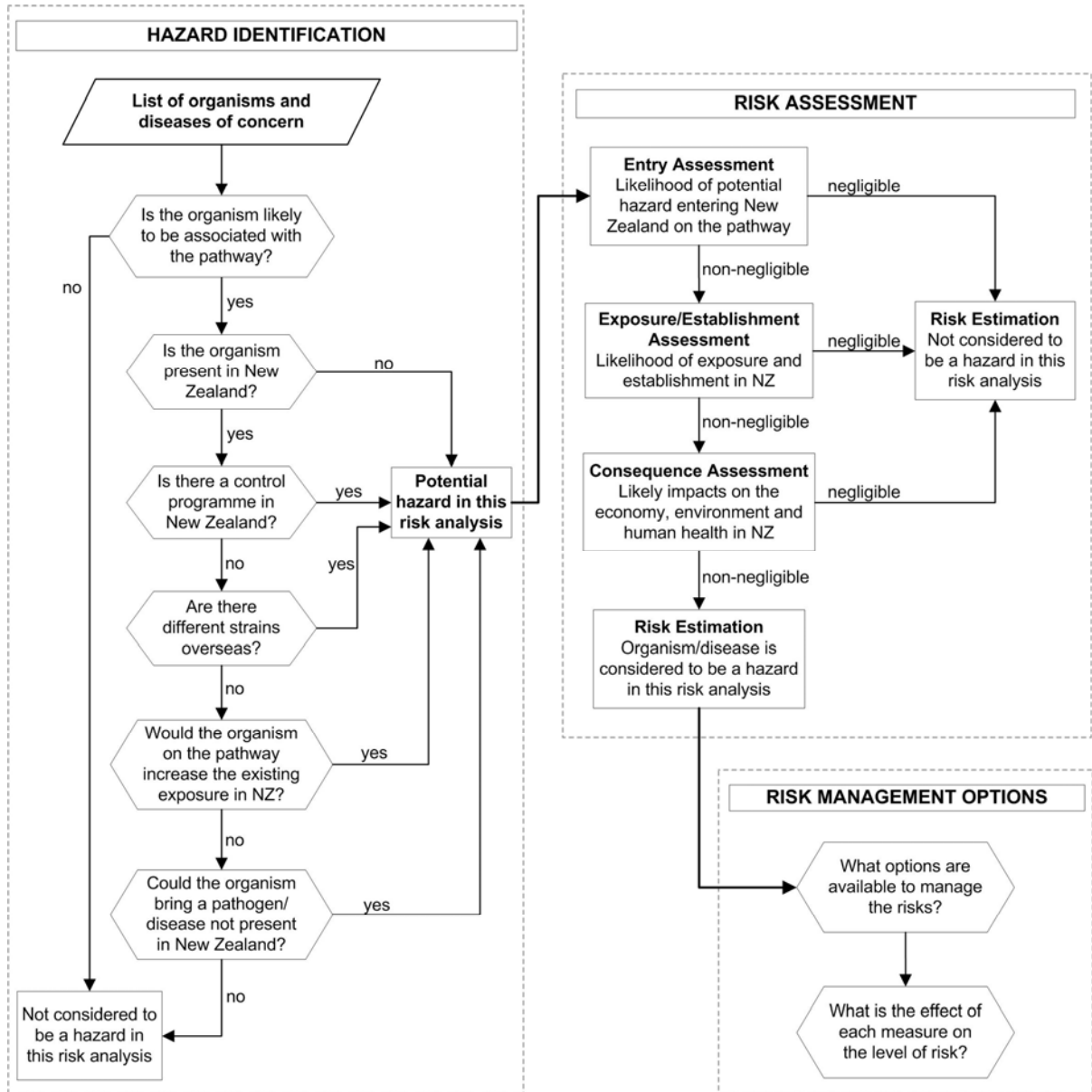
4. Risk Analysis Methodology

The methodology used in this risk analysis follows the guidelines as described in *Import Risk Analysis: Animals and Animal Products* (Murray 2002)¹ and in section 1.3 of the *Terrestrial Animal Health Code* of the World Organisation for Animal Health (OIE 2006).

The risk analysis process used by the MAF is summarised in Figure 1.

¹ Import risk analysis projects which have commenced after 12 April 2006 follow guidelines described in *Biosecurity New Zealand Risk Analysis Procedures – Version 1*. See www.biosecurity.govt.nz/files/pests-diseases/surveillance-review/risk-analysis-procedures.pdf.

Figure 1. The risk analysis process.



4.1. PRELIMINARY HAZARD LIST

The first step in the risk analysis is hazard identification. The process begins with the collation of a list of organisms potentially associated with cattle. The diseases of interest are those that could be transmitted by cattle and could infect domestic, feral or wild animals, or man in New Zealand. In this case an initial list was made of all the cattle diseases that are classified as listed diseases in the year 2005 edition of the OIE *Terrestrial Animal Health Code* and diseases mentioned in the following sources:

- Veterinary Medicine. Blood DC and Radostits OM, 7th edition, 1989, published by Bailliere Tindall, ISBN 0-7020-1286-6.
- Infectious Diseases of Livestock. Coetzer JAW and Tustin RC, Oxford University Press, Cape Town, Oxford, New York. 2004.
- Foreign Animal Diseases “The Gray Book”
http://www.vet.uga.edu/vpp/gray_book/FAD/SGP.htm
- The MAF databases that contain complete listings of all diseases of cattle that appear in Import Health Standards (IHSs) and Overseas Market Access Requirements (OMARs) for all countries for which the information is available.

As a result of internal review by representatives with a responsibility for diseases of interest to the Ministry of Health, Ross River and Barmah Forest viruses, miscellaneous arboviruses and *Sarcosporidia* spp. were included. A section on weed seeds has also been included.

The diseases of cattle that were identified in these sources are listed in Table 1.

Table 1. List of organisms and diseases of concern.

ORGANISM	OIE LIST	ZOONOTIC	NEW ZEALAND STATUS	NOTES
VIRUSES				
Akabane (Simbu group) viruses	No	No	Exotic	
Aujeszky’s disease virus	Yes	No	Exotic	
Adenovirus virus	No	No	Endemic (Vermunt and Parkinson 2000b)	
Bluetongue virus	Yes	No	Exotic	24 serotypes
Borna disease virus	No	?	Exotic	
Bovine calicivirus	No	No	Unknown	
Bovine corona virus	No	No	Endemic (Durham et al 1979; Vermunt and Parkinson 2000a)	
Bovine herpes virus -1 (IBR/IPV)	Yes	No	BHV-1.2b endemic. BHV-1.1 and 1.2a exotic	Some 1.1 and 1.2a strains are abortifacient

ORGANISM	OIE LIST	ZOO NOTIC	NEW ZEALAND STATUS	NOTES
Bovine herpesvirus-2	No	No	Endemic (Vermunt and Parkinson 2000a; Vermunt and Parkinson 2000b)	
Bovine herpesvirus-5	No	No	Exotic	
Bovine parvovirus	No	No	Unknown	
Bovine papular stomatitis virus	No	No	Endemic (Vermunt and Parkinson 2000b)	
Bovine respiratory syncytial disease virus	No	No	Endemic (Motha and Hansen 1997)	
Bovine rhinovirus	No	No	Unknown	
Bovine virus diarrhoea virus	No	No	BVDV1 endemic BVDV 2 exotic (Horner 2000)	Two types
Crimean Congo haemorrhagic fever virus	No	Yes	Exotic	
Enzootic bovine leucosis virus	Yes	No	Endemic	Eradicated from the Dairy Industry
Ephemeral fever virus	No	No	Exotic	
Foot and mouth disease virus	Yes	No	Exotic	7 serotypes multiple strains
Ibaraki virus	No	No	Exotic	
Jembrana disease virus	No	No	Exotic	
Lumpy skin disease virus	Yes	No	Exotic	
Malignant catarrhal fever virus (wildebeest associated)	Yes	No	Exotic	
Malignant catarrhal fever virus (sheep associated)	No	No	Endemic	
Palyam virus group	No	No	Exotic	Many strains
Parainfluenza virus	No	No	Endemic	
Pseudocowpox virus	No	No	Endemic (Hill 1994)	
Rabies virus	Yes	Yes	Exotic	Related rhabdoviruses
Rift Valley fever virus	Yes	Yes	Exotic	
Rinderpest virus	Yes	No	Exotic	Strains vary in virulence
Rotavirus	No	No	Endemic (Durham et al 1979; Vermunt and Parkinson 2000a)	
Ross River virus	No	Yes	Exotic	
Tick borne encephalitis virus	No	Yes	Exotic	Many related viruses in group
Vesicular stomatitis virus	Yes	Yes	Exotic	3 subtypes
West Nile disease virus	No	Yes	Exotic	
TRANSMISSIBLE SPONGIFORM ENCEPHALOPATHIES (TSEs)				
Bovine spongiform	Yes	Yes	Exotic	

ORGANISM	OIE LIST	ZOONOTIC	NEW ZEALAND STATUS	NOTES
encephalopathy (BSE) infective agent				
BACTERIA INCLUDING MOLLICUTES				
Actinobacillus ligniersi	No	No	Endemic	
Arcanobacter pyogenes	No	No	Endemic	
Bacillus anthracis	Yes	Yes	Exotic	
Brucella abortus	Yes	No	Exotic	
Burkholderia pseudomallei	No	Yes	Exotic	
Campylobacter fetus	Yes	No	Endemic	Subsp venerealis and fetus
Campylobacter jejuni	No	Yes	Endemic	
Clostridium spp.	No	No	Endemic	
Corynebacterium renale	No	No	Endemic	
Dermatophilus congolensis	Yes	Yes	Endemic	
Escherichia coli	No	Yes	Endemic	Plasmid and virulence types
Footrot associated organisms	No	No	Endemic	Various species
Haemophilus somni(Haemophilus somnu, Histophilus somni)	No	No	Endemic	
Klebsiella spp.	No	No	Endemic	
Listeria monocytogenes	No	Yes	Endemic	
Moraxella bovis	No	No	Endemic	
Mycobacterium bovis	Yes	Yes	Endemic/ eradication programme	
Mycobacterium avium subsp. avium	Yes	Yes	Endemic	
Mycobacterium avium subsp. Paratuberculosis	Yes	No?	Endemic	
Mycoplasma mycoides subsp. Mycoides SC	Yes	No	Exotic	
Mollicutes various	No	No	Some endemic species	
Nocardia spp.	No	No	Endemic	
Pasteurella multocida B and E	Yes	No	Exotic	
Pasteurella multocida other than B and E	No	No	Endemic	
Pasteurella (Mannheimia) haemolytica	No	No	Endemic	
Salmonella spp.	No	Yes	Some serotypes exotic	
Staphylococcus spp.	No	Variable	Endemic	

ORGANISM	OIE LIST	ZOONOTIC	NEW ZEALAND STATUS	NOTES
Streptococcus spp.	No	Variable	Endemic	
Yersinia spp.	No	Yes	Endemic	
SPIROCHAETES				
Leptospira spp.	Yes	Yes	6 serovars are endemic (Midwinter 1999)	Over 200 serovars
Borrelia burgdorferi	No	Yes	Exotic	
Borrelia theileri	No	No	Exotic	
PROTOZOA				
Babesia spp.	Yes	No	Exotic	
Besnoitia besnoiti	No	No	Exotic	
Cryptosporidium parvum	No	Yes	Endemic	
Eimeria spp.	No	No	Endemic	
Neospora caninum	No	No	Endemic	
Sarcocystis hirsuta. S. cruzi and S. hominis	No	S hominis zoonotic	S hominis exotic	
Theileria parva	Yes	No	Exotic.	
Theileria annulata	Yes	No	Exotic	
Theileria spp. (non-pathogenic)	No	No	Endemic	
Trichomonas foetus	No	No	Endemic	
Trypanosoma evansi	No	No	Exotic	
Trypanosoma spp. (tsetse fly-borne)	Yes	No	Exotic	
RICKETTSIAS AND CHLAMYDIAS				
Anaplasma marginale, A. centrale, A. caudatum	Yes	No	Exotic	
Anaplasma phagocytophilum	No	Yes	Exotic	
Chlamydophila abortus	Yes	Yes	Exotic	
Coxiella burnetii	Yes	Yes	Exotic	
Ehrlichia ruminantium	Yes	No	Exotic	
Eperythrozoon spp.	No	No	Endemic	
Haemobartonella bovis	No	No	Unknown	
PARASITES				
Ticks	No	Some spp.	Mainly exotic	
Screwworm	No	Yes	Exotic	
Lice (cattle species)	No	No	Some exotic	
Mites	No	Some spp.	Some exotic	
Warbles	No	No	Exotic	
Internal parasites	No	No	Some exotic	

Note: Organisms classified as endemic in New Zealand for which no reference is given are commonly identified and reported in the quarterly reports of diagnostic laboratories that are published in the MAF publication *Surveillance*. For less commonly diagnosed endemic organisms a reference is given to substantiate the classification.

Palyam viruses have been listed as exotic on the basis that they have not been recorded as occurring in New Zealand. All other organisms listed as exotic have been classified by MAF as unwanted or notifiable organisms (Ministry of Agriculture and Forestry 2005).

All organisms listed as exotic to, or of unknown status in, New Zealand in Table 1 were transferred to Table 2 (below) and classified as follows:

- Those agents/diseases that are recorded in the OIE Handistatus II database were classified according their OIE status in the countries of concern. Where applicable the symbols used by OIE for the classification of organism/country status were used in Table 2. (see subscript to Table 2).
- For those organism that do not occur in the Handistatus database, a search of the literature was made and disease agents that were found to occur in a country of concern were recorded as present in Table 2. Further information on the geographic distribution of the diseases/agents and references are given in the sections of the risk analysis pertaining to each disease. Organisms/diseases for which no information could be found to indicate that they occurred in a country of concern were classified as not present (NP) in Table 2.

Table 2. Status of disease agents that are exotic to New Zealand in Australia, Canada, the European Union and the USA.

Agent	Status			
	Australia	Canada	EU	USA
Akabane disease virus	P	NP	NP	P
Aujeszky's disease virus	0000	0000	+()	+()P
Bluetongue virus	+?()	(1988)	+()	+()
Borna disease virus	NP	NP	P	NP
Bovine calicivirus	?ww	?ww	?ww	?ww
Bovine herpes virus 1.1 and 1.2	NP	P	P	P
Bovine herpes virus 5	P	P	P	P
Bovine parvo virus	?ww	?ww	?ww	?ww
Bovine rhinovirus	?ww	?ww	?ww	?ww
Bovine viral diarrhoea virus 2	NP	P	P	P
Crimean Congo haemorrhagic fever virus	NP	NP	?	NP
Ephemeral fever virus	P	NP	NP	NP
Foot and mouth disease virus	(1871)	(1952)	(2001)	(1929)
Ibaraki virus	NP	NP	NP	NP
Jembrana virus	NP	NP	NP	NP
Lumpy skin disease	0000	0000	0000	0000
MCF (wildebeest associated) virus	NP	NP	NP	NP
Miscellaneous arboviruses	P(most)	NP	NP	P(some)
Palyam virus	P	NP	NP	P
Rabies virus	(1867)	+	+()	+
Rabies related rhabdovirus	P	NP	P	NP
Rift Valley fever virus	0000	0000	0000	0000
Rinderpest virus	(1923)	0000	0000	0000
Ross River and Barmah Forest viruses	P(most)	NP	NP	NP
Tick borne encephalitis virus	NP	P	P	P
Vesicular stomatitis virus	0000	(1949)	0000	+()
West Nile disease virus	NP	P	P	P

Agent	Status			
	Australia	Canada	EU	USA
<i>Bacillus anthracis</i>	+()	+	+()	+()
<i>Brucella abortus</i>	(1989)	(1989)	+()	+
<i>Burkholderia pseudomallei</i>	P	NP	NP	NP
<i>Mycobacterium bovis</i>	2002	+	+()	+
<i>Mycoplasma mycoides mycoides</i> SC	1967	1897	(most by 1900)	1892
Other <i>Mycoplasma</i> spp.	P	P	P	P
<i>Pasteurella multocida</i> B and E	0000	0000	0000	+()
<i>Salmonella</i> dublin & typhimurium DT104	+	+	+	+
<i>Leptospira</i> spp.	+	+	+	+
<i>Borrelia burgdorferi</i>	NP	P	P	P
<i>Borrelia theileri</i>	P	P	P	P
<i>Babesia</i> spp.	+()	0000	0000 to +	+()
<i>Besnoitia besnoiti</i>	NP	NP	NP	NP
<i>Theileria parva</i>	0000	0000	0000	0000
<i>Theileria annulata</i>	NP	NP	P (Southern countries)	NP
<i>Sarcocystis hominis</i>	?ww	?ww	?ww	?ww
<i>Trypanosoma evansii</i>	NP	NP	NP	NP
<i>Trypanosoma</i> spp. (tsetse fly)	0000	0000	0000	0000
<i>Anaplasma marginale</i> , <i>A. centrale</i> and <i>A. caudatum</i>	+()		+()	+
<i>Anaplasma phagocytophilum</i>	NP	P	P	P
<i>Chlamydophila abortus</i>	0000	+	+	+
<i>Coxiella burnetii</i>	+	+	+	+
<i>Ehrlichia ruminantium</i>	0000	0000	0000	0000
Ticks	P	P	P	P
New World screwworm	0000	0000	0000	1982
Old World screwworm	0000	0000	0000	0000
<i>Hypoderma</i> spp. (warble flies)	NP	P	P	P
Internal parasites	P	P	P	P

- 0000 Never recorded (OIE)
- not reported (date of last outbreak not known) (OIE)
(date) Date of last occurrence (OIE)
? Disease suspected but presence not confirmed (OIE)
+ Reported present or know to be present (OIE)
+? Serological evidence and/or isolation of organism but no clinical sign of disease (OIE)
() Disease limited to specific zones (OIE). For the EU this may refer to zones or countries
P No OIE records. Evidence in literature of presence (See relevant section of risk analysis for details)
NP No OIE records. No evidence of presence found in literature (See relevant section of risk analysis for details)
?ww Possible world-wide distribution

NB. In the case of the European Union which includes 27 countries the information recorded in the table represents the predominant position in the EU but may vary in individual countries.

Information attributed to OIE was obtained from Handistatus (OIE 2006)

A preliminary hazard list constructed from the organisms in Table 2 was based on the following criteria:

Animal disease agents

- All disease agents that are exotic to New Zealand and are present in any of the countries of concern (Australia, Canada, the 27 European Union countries and the USA) or about which there was some uncertainty.
- In addition organisms that occur in New Zealand for which there are known sub-species or strains or host associations that do not occur in New Zealand and are potentially harmful.
- Organisms that occur in New Zealand but for which an eradication programme administered by a Pest Management Strategy under the Biosecurity Act is in place.

Diseases that are of concern to human health

- Disease agents that are already in New Zealand but because of the nature of the imports are likely to significantly increase existing hazards associated with them.
- Disease agents that occur only in well defined geographically bounded areas of New Zealand.

The preliminary list based on these criteria is shown below in table 3.

Table 3. Preliminary hazard list.

VIRUSES	
Akabane disease virus and other Simbu group viruses	Ephemeral fever virus
Aujeszký's disease virus	Foot and mouth disease virus
Bluetongue virus	Miscellaneous arboviruses
Borna disease virus	Palyam group viruses
Bovine calicivirus	Rabies virus
Bovine herpes virus types 1.1 and 1.2a	Rift Valley fever
Bovine herpes virus 5	Rinderpest virus
Bovine parvovirus	Ross River and Barmah Forest viruses
Bovine rhinovirus	Tick-borne encephalitis virus group
Bovine virus diarrhoea virus 2	Vesicular stomatitis virus
Crimea Congo haemorrhagic disease virus	West Nile disease virus

TSE AGENTS	
Bovine spongiform encephalopathy (BSE) infective agent	

BACTERIA	
<i>Bacillus anthracis</i>	<i>Mollicutes</i> of bovines
<i>Brucella abortus</i>	<i>Pasteurella multocida</i> B and E
<i>Burkholderia pseudomallei</i>	<i>Salmonella dublin</i> and <i>typhimurium</i> DT104
<i>Mycobacterium bovis</i>	

SPIROCHAETES

<i>Leptospira</i> spp.	<i>Borrelia theileri</i>
<i>Borrelia burgdorferi</i>	

RICKETTSIAL AND CHLAMYDIAL ORGANISMS

<i>Anaplasma marginale</i> , <i>Anaplasma centrale</i> and <i>Anaplasma caudatum</i>	<i>Coxiella burnetii</i>
<i>Anaplasma phagocytophilum</i>	<i>Haemobartonella</i>
<i>Chlamydophila abortus</i>	

PROTOZOAL ORGANISMS

<i>Babesia</i> spp.	<i>Theileria annulata</i>
<i>Sarcocystis hominis</i>	

INTERNAL AND EXTERNAL PARASITES

Lice	Warble flies
Mange mites	Internal parasites
Ticks	

4.2. HAZARD IDENTIFICATION

Organisms in the preliminary hazard list were subjected to further analysis to determine whether they were considered potential hazards in the commodity and organisms considered to be potential hazards were subjected to risk assessment.

4.3. RISK ASSESSMENT

Under the MAF Biosecurity New Zealand and OIE methodologies, risk assessment consists of:

- a) Entry assessment - the likelihood of the organism being imported in commodity.
- b) Exposure assessment - the likelihood of animals or humans in New Zealand being exposed to the potential hazard.
- c) Consequence assessment - the consequences of entry, exposure, establishment or spread of the organism.
- d) Risk estimation - a conclusion on the risk posed by the organism based on the release, exposure and consequence assessments.
If the risk estimate is non-negligible, then the organism is classified as a hazard.

It is important to understand that not all of the above steps may be necessary in all risk assessments. The MAF Biosecurity New Zealand and OIE methodologies makes it clear that if the likelihood of entry is negligible for a potential hazard, then the risk estimate is automatically negligible and the remaining steps of the risk assessment need not be carried out. The same situation arises where the likelihood of entry is non-negligible but the exposure

assessment concludes that the likelihood of exposure to susceptible species in the importing country is negligible, or where both entry and exposure are non-negligible but the consequences of introduction are concluded to be negligible.

4.4. RISK MANAGEMENT

For each organism classified as a hazard, a risk management step is carried out, which identifies the options available for managing the risk. Where the *Code* lists recommendations for the management of a hazard, these are described alongside options of similar, lesser, or greater stringency where available. In addition to the options presented, unrestricted entry or prohibition may also be considered for all hazards. Recommendations for the appropriate sanitary measures to achieve the effective management of risks are not made in this document. These will be determined when an import health standard (IHS) is drafted. As obliged under Article 3.1 of the WTO Agreement on Sanitary and Phytosanitary Measures (the SPS Agreement) the measures adopted in IHSs will be based on international standards, guidelines and recommendations where they exist, except as otherwise provided for under Article 3.3 (where measures providing a higher level of protection than international standards can be applied if there is scientific justification, or if there is a level of protection that the member country considers is more appropriate following a risk assessment).

4.5. RISK COMMUNICATION

MAF releases draft import risk analyses for a six-week period of public consultation to verify the scientific basis of the risk assessment and to seek stakeholder comment on the risk management options presented. Stakeholders are also invited to present alternative risk management options that they consider necessary or preferable.

Following public consultation on the draft risk analysis, MAF produces a review of submissions and determines whether any changes need to be made to the draft risk analysis as a result of public consultation, in order to make it a final risk analysis.

Following this process of consultation and review, the Imports Standards team of MAF Biosecurity New Zealand decides on the appropriate combination of sanitary measures to ensure the effective management of identified risks. These are then presented in a draft IHS which is released for a six-week period of stakeholder consultation. Stakeholder submissions in relation to the draft IHS are reviewed before a final IHS is issued.

4.6. SPECIAL CONSIDERATIONS

The incubation period and the time for which an animal may remain infectious are critical parameters for determining quarantine periods. An animal could have been infected with a disease on the day it goes into quarantine. After the incubation period for the disease, it could then be infectious for a period that differs for each disease. In many acute diseases the infectious period may correspond with the period for which the animal remains viraemic or bacteraemic. However in cases of chronic diseases animals may be infectious for much longer periods. Animals could be kept in quarantine for a minimum of the incubation period and the time for which they remain infectious. Animals could be quarantined for the maximum known incubation period plus the maximum period for which they remain infectious. Ideally the maximum period would be the mean period plus three standard deviations. This would cover approximately 99% of cases. However, usually the true distribution of incubation period and

infectious period is not known because data are not available from a sufficiently large number of cases or because of technical difficulties in obtaining accurate data. Data quoted may be unreliable because of the small numbers of animals used in experiments or because analysis was done at discrete intervals and therefore exact end-points were not determined. The measurements are also dependent on the accuracy and sensitivity of the method used to detect the infectious agent. For these reasons a conservative margin of error may be added to the best available estimates when determining quarantine periods. The margin of error added cannot be scientifically determined but relies on judgement, taking into account such things as amount and perceived accuracy of the available data, type of disease and the analytical methods used. In some infectious diseases recovered animals remain carriers of the infectious agent for long periods or even for life, and in these cases quarantine is not useful. In this risk analysis quarantine periods are generally adjusted to whole weeks or months.

Where animals for importation have been isolated as a group prior to export, the testing options within this risk analysis assume that any positive or inconclusive test results associated with any individual within that group will be notified to MAF Biosecurity New Zealand for further consideration before any animal from that group is exported to New Zealand.

All risks associated with the importation of bull semen also apply to bulls. Therefore, when importing bulls, applicable risk management options presented in the risk analysis for the importation of semen and embryos from cattle could be considered.

4.7. COUNTRY FREEDOM STATEMENTS

Several important diseases have not been included in this risk analysis because they are not known to occur in any of the countries covered by this risk analysis. However, since the position could change, veterinary certificates provided by the exporting country should certify country freedom from the following disease agents/diseases:

Besnoitia besnoiti (besnoitiosis)
Ehrlichia ruminantium (heartwater)
Ibaraki disease virus
Jembrana disease virus
Lumpy skin disease
Acelaphine herpes virus-1 (Malignant catarrhal fever virus, wildebeest type)
Mycoplasma mycoides subsp. *mycoides* SC (Contagious bovine pleuropneumonia)
Old and New World screwworm
Rift Valley fever virus
Rinderpest virus
Theileria parva (East Coast fever and related theilerioses)
Tsetse fly transmitted *Trypanosoma* spp.
Trypanosoma evansi (Surra)

For importation to be considered from further countries in the future, risk assessments for the relevant diseases from this list may need to be conducted.

In addition, country freedom statements should be provided for any of the diseases in the risk analysis for which a country wishes to declare freedom and thereby obtain exemption from any relevant sanitary measures.

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5. Akabane and other Simbu Group Viruses

5.1. HAZARD IDENTIFICATION

5.1.1. Aetiological agent

Family: Bunyaviridae; Genus: Bunyavirus, Serogroup Simbu. Akabane disease virus and related viruses belong to a group known collectively as Simbu viruses (St George and Kirkland 2004). The group includes viruses such as Aino, Tinaroo, Peaton and Cache Valley viruses that cause similar syndromes.

5.1.2. OIE list

Not listed.

5.1.3. New Zealand status

Listed on the unwanted organisms register as an exotic unwanted organism.

5.1.4. Epidemiology

Akabane and related viruses have been isolated from *Culicoides* spp. (midges) and mosquitoes. *Culicoides* spp. are assumed to be the vectors of these viruses (St George and Kirkland 2004). Cattle and other ruminants including sheep (Charles 1994; Haughey et al 1988; St George and Kirkland 2004) and goats (Han and Du 2003) are susceptible.

Viruses in the Simbu-group occur endemically in large areas of Africa, Asia, the Middle East and Australia (Charles 1994; Haughey et al 1988; St George and Kirkland 2004) and the related Cache Valley virus occurs in Texas (Edwards 1994; Edwards et al 1989). No reference was found to the occurrence of the virus group in Canada or the European Union.

The incubation period (infection to start of viraemia) for Akabane virus is from 1-6 days (St George 1998) and the viraemic period lasts for 3-4 days (St George and Kirkland 2004). In non-pregnant animals infection does not lead to the development of any signs (Gard et al 1989). Akabane virus crosses from maternal to foetal circulation in infected pregnant females and causes the development of malformed calves, particularly cases of arthrogryposis and hydroencephaly (Charles 1994; Parsonson et al 1977; Parsonson et al 1988; St George and Kirkland 2004). In cattle maximal damage occurs when infection takes place at about the 12th to 16th week of gestation (St George and Kirkland 2004). Once a foetus has become immunocompetent it can mount an immune reaction and damage is less apparent or does not occur. Infected calves are usually non viable (Charles 1994). Calves born alive are not contagious and will not infect vectors.

Major epidemics of foetal malformations due to Akabane virus have been reported in Japan and Australia (St George and Kirkland 2004). However, animals that have been exposed to the infection become immune and this leads to the establishment of a mainly immune population of cattle in endemic areas. For this reason foetal abnormalities usually occur sporadically in endemically infected areas but seroconversion in animals is common

(Cybinski and St George 1978; Cybinski et al 1978; Fukutomi et al 2003; St George and Kirkland 2004). There are no reports of the disease having a significant economic impact in enzootic countries.

There are competitive ELISAs for detection of Akabane specific and Simbu-group specific antibodies (St George and Kirkland 2004).

5.1.5. Hazard identification conclusion

In view of the above, Akabane and other Simbu viruses are classified as potential hazards in the commodity.

5.2. RISK ASSESSMENT

5.2.1. Entry assessment

These viruses could only be introduced into New Zealand by animals that are in the incubation period or viraemic at the time of introduction. Since the incubation period is 1-6 days (St George 1998) and the viraemic period is from 3-4 days (St George and Kirkland 2004), the likelihood of introducing a viraemic animal is low but non-negligible.

5.2.2. Exposure assessment

A viraemic animal introduced into New Zealand would not be infectious. These viruses could only be transmitted to other animals in New Zealand by competent insect vectors. Annual surveys reported in the MAF publication *Surveillance* have demonstrated that *Culicoides* spp. are not present in New Zealand. A typical report shows that no *Culicoides* spp. were found in 15,000 insects trapped and that serological conversion to arboviruses did not occur in sentinel cattle (Motha et al 1997). Since *Culicoides* spp. are the main vectors of the disease it is unlikely that New Zealand cattle would be exposed to the virus. The virus has also been isolated from mosquitoes but no work has been done to investigate whether New Zealand mosquitoes are competent vectors. Furthermore, published surveys provide good evidence that New Zealand is free of arbovirus vectors (Motha et al 1997). In the absence of a competent vector in New Zealand, the exposure assessment is considered to be negligible.

5.2.3. Risk estimation

Because the exposure assessment is negligible, the risk estimate for Akabane and other Simbu group viruses is negligible and they are not classified as hazards in the commodity. Therefore, risk management measures are not justified.

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6. Aujeszky's Disease

6.1. HAZARD IDENTIFICATION

6.1.1. Aetiological agent

Family: Herpesviridae; Subfamily: Alphaherpesvirinae; Genus: Varicellovirus, suid herpesvirus 1, Aujeszky's disease virus (pseudorabies virus).

6.1.2. OIE list

Listed

6.1.3. New Zealand status

Listed on the unwanted organisms register as an exotic, notifiable organism.

6.1.4. Epidemiology

Aujeszky's disease (pseudo-rabies) is a disease of pigs that was eradicated from New Zealand by 1995 (OIE 2006). It occurs world-wide except in Australia, Canada, Finland, Sweden, Denmark and the UK. Several countries are attempting eradication (Van Oirschot 2004). The virus can be transmitted to cattle and other animals by close contact with infected pigs but the infectious dose is high. Cattle do not transmit the virus to other animals and are considered to be dead-end hosts (Baker et al 1982; Henderson et al 1995; Herweijer and de Jonge 1977; Van Oirschot 2004). In animals other than pigs the disease is characterized by acute neurological signs and is invariably fatal (Baker et al 1982; Henderson et al 1995; Herweijer and de Jonge 1977; Van Oirschot 2004).

6.1.5. Hazard identification conclusion

In view of the above, Aujeszky's disease virus is classified as a potential hazard in the commodity.

6.2. RISK ASSESSMENT

6.2.1. Entry assessment

Aujeszky's disease is a rare disease in cattle and only occurs when they have been in close contact with pigs. When it occurs the signs are dramatic (Baker et al 1982; Henderson et al 1995; Herweijer and de Jonge 1977; Navetat et al 1994; Sweda et al 1993; Van Oirschot 2004) and the outcome is invariably fatal. Under these circumstances the likelihood infected animals would be exported to New Zealand is considered to be negligible.

6.2.2. Risk estimation

Because the entry assessment is negligible, the risk estimate for Aujeszky's disease is negligible and it is not classified as a hazard in the commodity. Therefore, risk management measures are not justified.

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7. Bluetongue

7.1. HAZARD IDENTIFICATION

7.1.1. Aetiological agent

Family: Reoviridae; Genus: Orbivirus, Bluetongue virus (BTV). There are 24 known serotypes of BTV.

7.1.2. OIE list

Listed.

7.1.3. New Zealand status

Listed on the unwanted organisms register as an exotic, notifiable organism.

7.1.4. Epidemiology

Bluetongue virus can infect many ruminant species. It occurs in most tropical and sub-tropical countries. The global BTV distribution is currently between latitudes of approximately 53°N and 34°S but is known to be expanding in the northern hemisphere (OIE 2008). The virus causes disease mainly in sheep, occasionally in goats and rarely in cattle and deer. In most other species infections are subclinical. It is carried by *Culicoides* spp. (midges) and outbreaks of the disease usually occur in late summer to autumn when midges are most active. Outbreaks cease with the advent of winter when *Culicoides* spp. become inactive. In cattle infection is usually subclinical and mortality low but viraemic cattle can act as a source of infection for *Culicoides* spp. (Verwoerd and Erasmus 2004).

7.1.5. Hazard identification conclusion

In view of the above, bluetongue virus is classified as a potential hazard in the commodity.

7.2. RISK ASSESSMENT

7.2.1. Entry assessment

The incubation period in natural infections is about 7 days and infected cattle remain viraemic for about 50 days (Verwoerd and Erasmus 2004). In countries where many strains of virus are endemic a few strains usually dominate in any one season but as the population becomes immune to these strains the dominant strains are replaced by other strains that then become dominant. In summer and for a period up to 60 days after *Culicoides* spp. become inactive at the onset of winter, susceptible animals may be viraemic. Therefore the likelihood of importing cattle in the incubation period of the disease or viraemic animals is non-negligible.

7.2.2. Exposure assessment

BTV is transmitted by *Culicoides* vectors. A *Culicoides* surveillance programme has been operating in New Zealand since 1991 (Ryan et al 1991), under which around 15,000 insects collected from light traps are examined annually (Motha et al 1997) and sentinel cattle are monitored for seroconversion to viruses transmitted by *Culicoides* spp. (bluetongue, epizootic haemorrhagic disease, Akabane and Palyam viruses). To date, seroconversion to arboviruses has not been detected in sentinel cattle and no *Culicoides* have been trapped.

Bluetongue virus can be excreted in bull's semen (Parsonson et al 1981) but only while animals are viraemic (Bowen et al 1983; Howard et al 1985). Infected cattle may remain viraemic for about 50 days (Verwoerd and Erasmus 2004). Therefore it would be possible for an imported infected bull to excrete the virus in its semen for a period of around two months after infection. The likelihood of exposure of females with which the bull has mated over that time is non-negligible.

Although no reference could be found for iatrogenic transmission of BTV, mechanical transmission of this disease is thought unlikely to be of major significance in disease epizootics (Radostits et al 2007).

7.2.3. Consequence assessment

Female cattle that have mated with an infected imported bull or inseminated with his semen could become infected (Bowen et al 1985; Schlafer et al 1990; Bowen and Howard 1984) and could remain viraemic for up to 50 days. However these animals are unlikely to show clinical signs and would not be infectious for other cattle. The virus could only be transmitted by *Culicoides* vectors and these are not present in New Zealand.

The OIE *Terrestrial Animal Health Code* states that countries that are south of 34° S and are not adjacent to a country not having a bluetongue virus free status may be considered free from bluetongue. Furthermore, the OIE *Terrestrial Animal Health Code* states that "A BTV free country or zone in which surveillance has found no evidence that *Culicoides* likely to be competent BTV vectors are present will not lose its free status through the importation of vaccinated, seropositive or infective animals, or semen or embryos/ova from infected countries or infected zones" (OIE 2008).

Bluetongue is not a zoonotic disease and the virus does not constitute a threat to human health.

It is a disease of ruminants and there is no threat to indigenous animals or birds. Some species of deer are susceptible to the infection. The effect the virus might have on them is not known. However since vectors for the virus do not occur in New Zealand, the consequences of introducing the virus would be negligible.

The likelihood that the virus could establish in New Zealand is negligible, so the consequence assessment is negligible.

7.2.4. Risk estimation

There is a very low likelihood that, if a viraemic bull were imported, it would be used for natural service or semen collection during the period of viraemia. If it were so used, there is a very low likelihood of transmission of BTV to female cattle by this route. Infection of female

cattle (either those infected before importation or those infected from an imported bull) would have negligible consequences as cattle rarely show signs of infection and transmission to other cattle would not be possible due to New Zealand's freedom from *Culicoides* spp. Furthermore, if a single animal were discovered to be viraemic (e.g. by routine serosurveillance), then the OIE *Terrestrial Animal Health Code* states that New Zealand would not lose its BTV-free status. Therefore, the consequence assessment for both male and female cattle is considered to be negligible.

As a result, the risk estimate for BTV is negligible and it is not classified as a hazard in the commodity. Therefore, risk management measures are not justified.

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8. Borna Disease

8.1. HAZARD IDENTIFICATION

8.1.1. Aetiological agent

Family: Bornaviridae; Genus: Bornavirus. Borna disease virus is the only member of this family.

8.1.2. OIE list

Not listed.

8.1.3. New Zealand status

Listed on the unwanted organisms register as an exotic, unwanted organism.

8.1.4. Epidemiology

Borna disease affects horses, sheep, and a variety of other animals including goats, deer, rabbits (Rott et al 2004), lynx (Desgiorgis et al 2000), and foxes (Dauphin et al 2001). Cattle can be subclinically infected (Hagiwara et al 1996). Disease is rare, but acute nervous disease can occur (Rott et al 2004).

The disease has either been under-reported in the past or it is an emerging disease that has now been reported in many different species and countries. It occurs most commonly in Germany and Switzerland. However, serologically positive animals have also been found in Poland, the Netherlands, Switzerland, and Iran (Rott et al 2004) and Borna virus RNA has been found in France (Dauphin et al 2001; Dauphin and Zientara 2003). Reports on the demonstration of antibodies in horses have also come from North America (Kao et al 1993), Japan (Inoue et al 2002), and Israel (Teplitsky et al 2003). The virus has been demonstrated in cats in Britain (Reeves et al 1998). Viral RNA has been demonstrated in the peripheral mononuclear cells of cattle (Hagiwara et al 1996), sheep (Hagiwara et al 1997; Vahlenkamp et al 2000; Vahlenkamp et al 2002), horses (Nakamura et al 1995; Vahlenkamp et al 2002), cats (Nakamura et al 1996; Reeves et al 1998), and humans (Kishi et al 1995; Vahlenkamp et al 2000; Vahlenkamp et al 2002).

A closely related virus has been found in mallards and jackdaws in Sweden (Berg et al 2001). A related virus has been identified as the aetiological agent of wobbly possum disease in New Zealand (O'Keefe et al 1997).

Antibody to Borna disease virus has been found in humans suffering from psychosomatic disorders (Bode et al 1996; Rott et al 1985). However, the exact role of the virus in human infections and as a cause of psychosomatic disorders remains controversial. The specificity of demonstrated antibody and the accuracy and reliability of the PCR test to demonstrate the presence of viral RNA has been questioned, but the issues remain unresolved (Carbone 2001; Staeheli et al 2000).

The route of infection for Borna disease in animals has not been fully resolved. The virus is excreted in nasal secretions, saliva and urine (Rott et al 2004; Vahlenkamp et al 2002). In mice the disease enters the body through the olfactory epithelium and migrates intra-axonally to the brain (Carbone et al 1987; Morales et al 1988; Sauder and Staeheli 2003). The virus can be transmitted experimentally to rats by inoculation into the footpads. However, neurectomy prevents the disease occurring, thus demonstrating that transfer of the virus to the brain is by the intra-axonal route (Carbone et al 1987). In an experimental situation the disease was transmitted from persistently infected rats to naïve rats via the olfactory route. This has led to the suggestion that rats could be a source of infection for farm animals (Sauder and Staeheli 2003). Vertical transmission has not been reported. Most infections are thought to be sub-clinical (Ludwig and Kao 1990) and in sheep the virus persists in carriers for at least 2 years, as demonstrated by the presence of viral RNA in peripheral mononuclear cells. Natural transmission is presumed to occur by direct contact, via fomites and food, by inhalation and ingestion (Rott et al 2004).

The incubation period of the disease is thought to vary from several weeks to months (Rott et al 2004; Ludwig and Kao 1990).

Despite the fact that Borna disease has been known for more than 250 years (Rott et al 2004), knowledge about the disease is still fragmentary and incomplete. The specificity and accuracy of the RT-PCR test and antibody tests has been questioned.

The disease is not regarded by OIE as a disease that is important to trade and it only occurs sporadically in countries where it does occur. However, in Germany it is a notifiable disease and is controlled by a slaughter-out policy (Rott and Herzog 1994).

8.1.5. Hazard identification conclusion

In view of the above, Borna disease is considered to be a potential hazard in the commodity.

8.2. RISK ASSESSMENT

8.2.1. Entry assessment

Borna disease is rarely reported in cattle. In horses and sheep the disease remains mainly confined to Germany and surrounding countries and apparently only occurs sporadically. However, Rott et al have suggested that natural infections may occur more frequently and in a wider number of animals than previously thought (Rott et al 2004). However, since the disease has remained confined to a relatively small part of the world over the last 100 years this indicates that it is not highly contagious and spreads only slowly.

The likelihood that live cattle imported into New Zealand would be infected with the virus is considered to be very low but non-negligible.

8.2.2. Exposure assessment

Virus is shed in nasal secretions, saliva and urine, and spread is presumed to be by contact and via fomites. Since the infected animals may carry the virus for long periods, and imported cattle would be in contact with New Zealand animals the possibility of spread to other animals is non-negligible.

8.2.3. Consequence assessment

Since the disease has remained geographically confined for a long period it is considered that it would be unlikely but not impossible for the disease to establish and spread in New Zealand. The establishment of the disease could result in sporadic cases of disease in cattle or other species particularly horses and sheep. However, considering the history of the disease this seems unlikely especially since New Zealand generally practices an extensive system of animal husbandry that does not favour the spread of diseases.

The association between viral infection and the occurrence of psychosomatic diseases in humans (Bode et al 1996; Rott et al 1985) remains speculative. The consequences for human health of introducing the virus are therefore, uncertain, but are considered to be non-negligible.

The virus is known to infect a wide variety of animals (Dauphin and Zientara 2003; Desgiorgis et al 2000; Rott et al 2004) and birds (Berg et al 2001) and could therefore cause sporadic cases of disease in wild and feral animals and birds in New Zealand. In particular ostriches (Ashash et al 1996) have been infected with the virus and ratites (including Kiwis) might therefore be susceptible. The presence of a related virus in possums has not had any effect on the New Zealand environment apart from the rare occurrence of wobbly possum disease in possums. The effects on the environment are likely to be minimal but in view of the uncertainty, particularly regarding kiwis, it should be regarded as non-negligible.

Since the introduction of the virus could lead to the establishment of a production limiting and possibly zoonotic disease and because the effects the virus could have on kiwis or other native birds is not known, the consequences are considered to be non-negligible.

8.2.4. Risk estimation

Because entry, exposure and consequence assessments are non-negligible, the risk estimate for Borna disease virus is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

8.3. RISK MANAGEMENT

8.3.1. Options

Since Borna disease is not listed by the OIE, no international standards for risk management exist.

Diagnostic methods available include virus isolation (Ludwig and Kao 1990; Rott et al 2004) and demonstration of virus proteins or RNA (Vahlenkamp et al 2002) in tissues. Until uncertainties regarding the interpretation of PCR tests are resolved, demonstration of viral RNA by PCR should be regarded as indicative of the presence of virus. Therefore, PCR tests on peripheral mononuclear cells could be carried out on animals to be imported.

Serology has been used in epidemiological surveys but it is not a reliable indicator of infection in individual animals. Two of six animals that were confirmed as being infected with Borna disease at post mortem were negative in both the ELISA and indirect immunofluorescence test (IFAT) (Allmang et al 2001) and one was positive in the IFAT but not ELISA. These findings indicate that infection does not always result in detectable

antibody production (Muller-Doblies et al 2003). Positive serology is common in sheep without clinical signs (Muller-Doblies et al 2003). Since the disease can have an incubation period of several months, quarantine is not a viable option to prevent the spread of the disease

The importation of animals could be restricted to countries where the disease does not occur.

One or a combination of the following sanitary measures could be considered in order to effectively manage the risk.

- Cattle which have been resident since birth in countries where the virus/disease has never been reported could be imported without sanitary measures for this disease.
- Importation could be restricted to cattle from herds where the disease has not been diagnosed during the previous 5 years.
- A PCR test for detection of viral RNA could be carried out on the peripheral mononuclear cells of imported animals, with a requirement for negative results, within the 2 weeks prior to export to New Zealand.

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9. Bovine Calicivirus Infection

9.1. HAZARD IDENTIFICATION

9.1.1. Aetiological agent

Family: Caliciviridae; Genus: Norovirus, bovine enteric calicivirus and possibly other calici-like viruses.

9.1.2. OIE list

Not listed.

9.1.3. New Zealand status

Not reported to occur in New Zealand.

9.1.4. Epidemiology

Two genotypes of the virus, the Jena and Newbury agents, occur in Europe (Knowles and Clarke 2004) and a third type has been described in the USA (Oliver et al 2003).

Despite identification of the viruses in calves nearly 40 years ago (Woode and Bridger 1978), the role of bovine enteric caliciviruses in calf diarrhoea is not well understood. Experimental infection of gnotobiotic calves and new born calves caused diarrhoea and intestinal pathology (Hall et al 1984). However, in naturally occurring cases of diarrhoea, calves are often infected with several viruses including rotaviruses and coronaviruses that are isolated in higher numbers than the caliciviruses (Knowles and Clarke 2004). Descriptions of diarrhoea associated with the virus are restricted to calves. Adult animals are apparently resistant or immune to infection.

The virus has been described in England (Knowles and Clarke 2004; Woode and Bridger 1978), Germany (Deng et al 2003), the Netherlands (van der Poel et al 2000), and the USA (Smiley et al 2003). Investigations to identify virus or virus antibodies in countries where the virus is known to occur generally indicated a high prevalence of infection. In Germany virus was identified in 8.9% of 381 cases and antibody was found in 99.1% of 824 samples (Deng et al 2003). In the USA 72% of 75 calf faecal samples were positive in an RT-PCR assay (Smiley et al 2003). In the Netherlands 44% of pooled faecal samples from 75 veal farms were found to be positive in an RT-PCR assay, and it was suggested that calves may be a source of infection for humans. However, a recent study suggests that calf strains differ from human isolates and calves are unlikely to be a source of infection for humans (Oliver et al 2003). The virus has been known for almost 40 years but attracts little attention from diagnostic laboratories and research workers. This suggests that it is of minor economic importance.

It is not known whether the virus occurs in New Zealand. However, since it is widely distributed in the world and is a trivial pathogen for which active surveys have not been done, it is likely that the virus may already be present in New Zealand.

9.1.5. Hazard identification conclusion

Since bovine caliciviruses have been described as causing calf diarrhoea and have not been isolated in New Zealand they are considered as potential hazards in the commodity.

9.2. RISK ASSESSMENT

9.2.1. Entry assessment

Excretion of caliciviruses in faeces only lasts for a few days after infection (Woode 1990). Viraemia has not been reported and all descriptions of the disease syndrome are restricted to calves. Under these circumstances the likelihood that adult animals would be excretors of virus is considered to be negligible. The likelihood that calves that are not showing signs of diarrhoea and have been isolated for more than a few days would be excretors of virus is low but not negligible.

9.2.2. Exposure assessment

Imported adult cattle are unlikely to be excreting the virus in their faeces. Calves will only excrete the virus for a few days therefore the likelihood of exposure of New Zealand cattle to virus by contact with imported calves is very low. The likelihood of exposure of New Zealand cattle to the virus is therefore very low but non-negligible.

9.2.3. Consequence assessment

There is nothing in the literature to indicate that the virus causes anything other than trivial infections of calves. In addition the likelihood of release of virus and exposure are very low. These facts taken together indicate that the consequences of introduction of the virus can be considered to be negligible.

9.2.4. Risk estimation

Because the consequences are considered to be negligible, the risk estimate for bovine calicivirus is negligible and it is not classified as a hazard in the commodity. Therefore, risk management measures are not justified.

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10. Bovine Herpes Viruses

10.1. HAZARD IDENTIFICATION

10.1.1. Aetiological agents

Family: Herpesviridae; Subfamily: Alphaherpesvirinae; Genus: Varicellovirus, bovine herpesvirus 1 is associated with infectious bovine rhinotracheitis (IBR) and infectious pustular vulvovaginitis/infectious pustular balanoposthitis (IPV/IPB). Subtypes BHV-1.1 and BHV-1.2 can be identified by restriction endonuclease analysis of DNA (Babuik et al 2004; Engels et al 1981; Wentink et al 1993). Rhinitis and respiratory signs are associated with subtype 1.1, pustular vulvovaginitis and balanoposthitis is associated with subtype 1.2. Strains formerly described as IBRV 1.3 that are associated with encephalitis are now classified as BHV5. Subtype 1.2 strains can be further classified as BHV-1.2a and BHV-1.2b strains. Some subtype 1.1 and 1.2a strains are abortifacient, as shown by association with clinical cases of abortion and by experimental infection of pregnant heifers (Miller et al 1991). Subtype 1.2b strains are associated with respiratory and genital infections but not with abortions (Miller et al 1991; van Oirschot 1995a).

Table 4. Bovine herpesviruses

Type	Syndrome			
	IBR	IPV/IPB	Abortion	Encephalitis
BHV 1.1	+	-	+	-
BHV 1.2a	+	+	+	-
BHV 1.2b	+	+	-	-
BHV5	-	-	-	+

10.1.2. OIE list

Infectious bovine rhinotracheitis and infectious pustular vulvovaginitis are listed by the OIE.

10.1.3. New Zealand status

Only BHV1.2b has been isolated in New Zealand (Wang et al 2006). Abortions have not been seen in New Zealand (Fairley 1996; Horner 1990). An attempt to cause abortion by experimental infection with the New Zealand strain of the virus was unsuccessful (Durham et al 1975). However, at the present time identification of abortifacient strains of the virus from either subtype 1 or 2 strains would require experimental infection of pregnant cows. A more pragmatic approach is to regard BHV1.1 and BHV 1.2a as exotic organisms. Abortifacient strains are classified on the unwanted organisms register as unwanted notifiable organisms.

10.1.4. Epidemiology

IBR/IPV has a world-wide distribution. The virus is endemic in New Zealand and serological surveys have shown that it occurs very widely (Neilson and Grace 1988). Both the IBR and the IPV syndrome have been described (Fairley 1996; Horner 1990; Vermunt and Parkinson

2000). However, in the vast majority of cases there are no or only mild clinical signs (Vermunt and Parkinson 2000).

The acute infections are of short duration and virus is excreted in nasal secretions for up to 14 days after infection. Viraemia is hard to detect (Babuik et al 2004) but can occasionally occur (van Oirschot 2004). Virus spreads to the conjunctiva and trigeminal ganglion by neuronal axonal transport (van Oirschot 2004). Many animals become chronically infected latent carriers of the virus in their trigeminal or sacral ganglia, and may excrete the virus periodically when they are stressed (Babuik et al 2004; van Oirschot 2004). Semen may be infected with virus and insemination with such semen causes infection in recipient females (Parsonson and Snowdon 1975; Schlafer et al 1990; van Oirschot 1995b).

BHV-5 associated with encephalitis (Wentink et al 1993) has been described in Australia (Brake and Studdert 1985), USA (Barenfus et al 1963; Delhon et al 2003), Canada (Gough and James 1975), and Europe (Bartha et al 1969; Moretti et al 1964) but not in New Zealand.

10.1.5. Hazard identification conclusion

Abortifacient strains of IBR/IPV virus are exotic notifiable organisms and they are commonly present in chronic carrier animals. These organisms are therefore classified as potential hazards. However, since practical tests are not available to identify abortifacient strains in the laboratory it is necessary to regard all BHV 1.1 and BHV 1.2a strains as potential hazards. BHV-5 is also exotic and is regarded as a potential hazard.

10.2. RISK ASSESSMENT

10.2.1. Entry assessment

Recently infected cattle may excrete the virus in nasal secretions and aerosols for up to 14 days after infection (Babuik et al 2004). Carriers of the virus may periodically excrete virus particularly during periods of stress (Babuik et al 2004; van Oirschot 2004). The likelihood of entry of virus in the commodity is therefore considered to be non-negligible.

10.2.2. Exposure assessment

Imported animals are likely to be kept in herds with indigenous New Zealand cattle and the likelihood of exposure of naïve indigenous cattle is high. Infection could be spread by contact (Babuik et al 2004) or by insemination or natural mating using infected bulls (Parsonson and Snowdon 1975; Schlafer et al 1990; van Oirschot 1995b).

10.2.3. Consequence assessment

Introduction of abortifacient strains of BHV1.1 or 1.2a or strains of BHV 5 is likely to result in outbreaks of abortion or encephalitis. This would have a negative effect on the economy of the cattle industry and individual farmers.

The virus does not infect humans and therefore the consequences for people are negligible.

Other ruminants can possibly be infected with BHVs since they have been found to have antibody to the virus. However, the antibody that has been detected may be cross-reacting antibody as in the case of deer infected with cervine herpesvirus (Motha and Jenner 2001;

Tisdall and Rowe 2001). No significant disease has been described in other ruminants. The consequences for the environment are therefore assessed to be negligible.

The consequences of importation of cattle are non-negligible for the cattle industry.

The likelihood that there will be consequences for human health or the environment is considered to be negligible.

10.2.4. Risk estimate

Since entry, exposure, and consequence assessments are all non-negligible, the risk estimate for exotic bovine herpesviruses is non-negligible, and they are classified as a hazard in the commodity. Therefore, risk management measures can be justified.

10.3. RISK MANAGEMENT

10.3.1. Options

Serological tests are not specific for sub-types of herpes viruses and it will not be possible to distinguish between the antibodies induced by BHV1.2a, BH1.1 or BHV5 strains from other strains of BHVs. From a practical viewpoint it will be necessary to consider any animal reacting positively to an IBR test to be potentially infected with an exotic strain of virus.

The OIE *Terrestrial Animal Health Code* does not discuss strains of bovine herpes viruses but instead considers the clinical syndromes of IBR and IPV. There are, therefore, no international risk management standards that are directly applicable although it is reasonable to extrapolate from the *Code* to the exotic strains of concern here. The *Code* recommends that animals destined for IBR/IPV free herds, should come from an IBR free herd (as defined in the *Code*), should be isolated in a quarantine station for at least 30 days, and should be subjected to two serological tests at an interval of not less than 21 days (OIE 2006).

One or a combination of the following measures could be considered in order to effectively manage the identified risk.

- Cattle for import into New Zealand could be imported from countries that are free from BHV 1.1 and BHV 1.2a, and come from herds that have no history of encephalitis caused by BHV 5.
- Cattle could come from a herd that is free from IBR/IPV as defined in the OIE *Terrestrial Animal Health Code*.
- Cattle could be placed in quarantine for the 30 days prior to export and during this time be submitted to 2 serological tests for IBR/IPV with an interval of not less than 21 days between tests, with negative results. The serological test used could be an OIE recommended test or one approved by MAF.

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11. Bovine Parvovirus Infection

11.1. HAZARD IDENTIFICATION

11.1.1. Aetiological agent

Family: Parvoviridae; Genus: Parvovirus, bovine parvovirus.

11.1.2. OIE list

Not listed.

11.1.3. New Zealand status

Unknown. Bovine parvovirus has not been identified in New Zealand although it is considered likely to be ubiquitous (Thomson 2004).

11.1.4. Epidemiology

Isolation of the virus has been reported from the USA (Barnes et al 1982), Canada (Sandals et al 1995), Australia (Durham et al 1985a), Germany (Elschner 1995), and Japan (Inaba et al 1973). Information on the disease has been reviewed and it is considered likely to be ubiquitous (Thomson 2004). The virus was isolated from low numbers of calves with and without diarrhoea (Elschner 1995). Durham found that on three epidemically infected farms, calves became infected and developed antibody soon after birth but on only one farm was this associated with an outbreak of post weaning diarrhoea (Durham et al 1985a). Experimental infection of calves led to mild to moderate diarrhoea (Durham et al 1985c) and concurrent subclinical coccidiosis infestation exacerbated the clinical signs (Durham et al 1985b). In 29 herds in Canada the overall seroprevalence was 82% in cattle and the herd prevalence was 100% (Sandals et al 1995).

There is one report of virus crossing the placental barrier and resulting in foetal death. Reports on clinical disease associated with the virus are rare and generally the literature is dated. Even experimental infections are generally mild and antibody occurs widely in clinically normal animals. Thompson has stated that there is uncertainty as to the pathogenic potential of the virus in cattle (Thomson 2004).

11.1.5. Hazard identification conclusion

It is concluded that the virus occurs commonly in healthy cattle and is of doubtful significance as a pathogen. It may occur ubiquitously and could be present in New Zealand since no surveys have been reported to identify the virus or antibody to it. Therefore, bovine parvovirus is not considered to be a potential hazard in the commodity.

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12. Bovine Rhinovirus Infection

12.1. HAZARD IDENTIFICATION

12.1.1. Aetiological agent

Family: Picornaviridae; Genus: Rhinovirus, serotypes 1-3.

12.1.2. OIE list

Not listed.

12.1.3. New Zealand status

Unknown. Bovine rhinovirus has not been identified in New Zealand although it is considered likely to be ubiquitous.

12.1.4. Epidemiology

Bovine rhinoviruses are commonly isolated from the nasal cavities of cattle (Sellers, 1990). The virus occurs in cattle in Germany, England, the USA, Japan, and Sudan (Sellers, 1990; Thomson, 2004), but its distribution is suspected to be world-wide. There are no reports of the virus being recovered from other species. A study of 1,590 cases of respiratory infection, found no significant association between the presence of bovine rhinovirus and disease (Stott et al., 1980). 48% of cattle in a study by Mohanty (1973) were seropositive for bovine rhinovirus (Thomson, 2004).

Experimental infection causes rhinitis and signs of infection include fever, inappetance, lacrymation, conjunctivitis, and nasal discharge (Sellers, 1990; Thomson, 2004). Although lower respiratory infections may occur, it is unproven that the virus is the primary cause of such syndromes and mixed infections with other respiratory viruses may be involved in these cases (Sellers, 1990; Thomson, 2004).

12.1.5. Hazard identification conclusion

It is concluded that bovine rhinovirus occurs in both healthy cattle and those showing signs of respiratory disease. There is no evidence that it is a significant primary pathogen, but may play a role in some respiratory infections in conjunction with other respiratory pathogens. It is likely that it occurs ubiquitously and since no surveys have been reported to identify the virus or antibody to it, it may already be present in New Zealand. There is no evidence to suggest that it is a cause of economically important disease. Therefore, bovine rhinovirus is not considered to be a potential hazard in the commodity.

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13. Bovine Viral Diarrhoea Virus

13.1. HAZARD IDENTIFICATION

13.1.1. Aetiological agent

Family: Flaviviridae; Genus: Pestivirus, genotypes BVDV1 and BVDV2 (Booth et al 1995). In each genotype both cytopathic and non-cytopathic biotypes occur.

13.1.2. OIE list

Listed, although not covered by a chapter in the *Code*.

13.1.3. New Zealand status

Bovine viral diarrhoea virus genotype 1 (BVDV1) is endemic in New Zealand but genotype 2 (BVDV2) is exotic.

13.1.4. Epidemiology

BVDV1 has a world-wide distribution, including New Zealand and Australia (Horner 2000; Vilcek et al 1998). In New Zealand most cattle have been exposed to BVDV1 and the prevalence of antibodies is around 60% (Littlejohns and Horner 1990). BVDV2 occurs in North America (Potgieter 2004), Italy (Falcone et al 2001), the Netherlands (Barkema et al 2001), and in the United Kingdom (Cranwell et al 2005; David et al 1994; Drew et al 2002; Nettleton and Gunn 2002). The only isolation of a BVDV2 strain in New Zealand was from a batch of foetal calf serum imported from the USA (Horner 2000). The virus was contained in the laboratory. BVDV2 has not been described in Australia.

BVDV is normally transmitted by direct contact between infected animals and/or possibly by aerosol transmission over short distances (Potgieter 2004). It is also transmitted in semen particularly from persistently infected bulls which continue to shed virus in their semen for years (Potgieter 2004). However, virus persisted in the semen of bulls that were not persistently infected for several months after challenge (Givens et al 2003).

The incubation period is usually about 3-7 days (Brownlie 2005) and the animals may remain viraemic for 4-15 days after initial infection (Potgieter 2004). Viraemia seldom exceeds 10-14 days (Brownlie 2005). Antibodies develop 2-4 weeks after infection.

BVDV1 infection of non-pregnant cattle usually results in a mild infection typified by pyrexia and leukopenia from about 3-7 days, viraemia and nasal excretion of the virus occurs during this period (Brownlie 2005). The clinical signs are often so mild that they are not observed or only mild signs and occasionally diarrhoea is seen (Potgieter 2004). Since it is widely distributed in most cattle herds, cattle are commonly infected before they become pregnant, resulting in a population of cattle that is substantially immune and do not carry the virus. Infection of naïve pregnant animals, particularly during the first trimester, may result in death of the conceptus or full term or near full term delivery of immunotolerant persistently infected calves (Brownlie 2005; Littlejohns and Horner 1990; Potgieter 2004; Stokstad et al 2003). It

was suggested that 7% of foetal deaths in Swiss dairy cattle may be caused by infection with BVDV (Rufenacht et al 2001). BVDV infection around the time of insemination significantly affected breeding performance (McGowan et al 1993). BVDV2 strains that cause a more severe form of the disease following an initial infection were described in the USA (Pellerin et al 1994). In these cases the mortality rate was up to 10% (Potgieter 2004) and the disease was characterized by severe leucopenia and haemorrhagic disease (Brownlie 2005).

Immunotolerant persistently infected animals may be clinically normal or may be unthrifty and die within a year. They are always infected with non-cytopathic strains of the virus (Brownlie 2005). Superinfection of persistently infected animals with a cytopathic BVDV strain results in the development of mucosal disease (Brownlie 2005; Drew 2004; Potgieter 2004). The cytopathic strain that re-infects the persistent carrier animals may result from a mutation of the persistent non-cytopathic strain or from infection with a new extrinsic cytopathic virus (Brownlie 2005; Potgieter 2004). Mucosal disease is invariably fatal. In acute cases death occurs within 2-21 days while in chronic cases the animal may survive for up to 18 months (Potgieter 2004).

Despite the fact that serologically positive animals are usually no longer infected with virus exceptions are known to occur and a minority of persistently infected animals are also serologically positive. Also in some acute cases at the peak of viraemia, antibody may be present before the virus is cleared (Brownlie 2005).

13.1.5. Hazard identification conclusion

BVDV1 is endemic in New Zealand. However, BVDV2 virus is exotic and can cause severe disease. Therefore BVDV2 is considered to be a potential hazard in the commodity.

13.2. RISK ASSESSMENT

13.2.1. Entry assessment

Animals in the acute stage of a recent infection or persistently infected animals could be excreting BVDV2 when imported into New Zealand. Therefore the likelihood of entry in the commodity is considered to be non-negligible.

13.2.2. Exposure assessment

After importation infectious carriers of BVDV2 will be in contact with and could infect naïve New Zealand animals. The likelihood of exposure is therefore non-negligible.

13.2.3. Consequence assessment

BVDV2 is exotic to New Zealand and, if introduced, it would be expected to spread amongst susceptible cattle and even those immune to BVDV1 would not be fully protected. Although some BVDV2 strains are of low virulence, mortalities of up to 10% could result from initial infection with virulent BVDV2 strains (Potgieter 2004). It is therefore considered that the consequences of introducing the virus would be non-negligible.

The virus does not infect people and there would be no consequences for human health.

BVDV1 is known to infect deer and goats (Horner 2000). Antibody to the virus is known to develop in these species but disease has not been described. It is therefore likely that BVDV2 could also infect deer and goats, but it is not known whether the virus would cause significant disease in these species. The likelihood that there would be any other consequences for the environment is considered to be negligible.

The consequences for cattle are considered to be non-negligible. The consequences for the environment and human health are considered to be negligible.

13.2.4. Risk estimation

Since entry, exposure, and consequence assessments are all non-negligible, the risk estimate for BVDV2 is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

13.3. RISK MANAGEMENT

13.3.1. Options

As there is no *Code* chapter for BVD, there are no international risk management standards for any commodity.

Animals could be imported from countries in which BVDV2 does not occur (Australia) without testing or quarantine.

Since suitable tests to distinguish BVDV1 and BVDV2 are not available, any animal that is carrying BVDV and comes from a country in which BVDV2 occurs could be regarded as being potentially infected with BVDV2 and unsuitable for export.

Serologically negative immunotolerant viraemic animals have been described frequently. Animals at the peak of acute viraemia may become serologically positive before virus is cleared from their systems (Brownlie 2005). In some cases viraemia may persist for several months after infection (Givens et al 2003). In addition, a case has been described of a serologically positive bull that persistently shed virus in its semen (Voges et al 1998). Since it is possible for both serologically positive and serologically negative animals to be viraemic, serological tests alone are not suitable for screening animals for importation. Therefore all animals for importation could be tested serologically and for viraemia. In addition, in the case of bulls, semen could also be tested for the presence of virus.

Cattle that are serologically positive but not viraemic could be classified suitable for importation. Animals that are serologically negative and viraemic would be unsuitable for importation. Animals that are serologically negative but not viraemic could be in the incubation period and could be placed in quarantine and re-tested after 4 weeks. Animals that stay serologically negative and non-viraemic while in quarantine would be suitable for importation. Any animal that becomes serologically positive but is non-viraemic after 4 weeks in quarantine would be suitable for importation. Animals that are viraemic after 4 weeks in quarantine would be unsuitable for importation. Bulls that are excreting virus in their semen would be unsuitable for importation.

An ELISA could be used for antibody detection (Drew 2004). Since antigen detection ELISAs are less sensitive than the reverse transcriptase PCR and virus isolation is subject to technical difficulties when foetal calf serum used for cell cultures is contaminated with pestiviruses (Drew 2004), the reverse transcriptase PCR could be used for detection of virus in blood and semen.

One or a combination of the following measures could be considered in order to effectively manage the risk.

- Animals for importation into New Zealand could be imported from countries that are free from BVDV2 virus (Australia).
- Blood and semen samples from candidate animals could be tested for antibody by an ELISA and semen and blood could be tested by a reverse transcriptase PCR for detection of viral RNA. In that case, animals that are serologically positive and virus-negative (PCR negative) in semen and blood would be considered suitable for importation. Those that are serologically negative and virus-positive in semen and/or blood would be rejected. Bulls that are serologically positive or negative and are excreting virus in the semen would be rejected.
- All animals that are serologically negative and virus-negative in semen and blood could be isolated for at least 28 days and within 14 days of shipment tested for antibody and virus. In that case, animals that have seroconverted and are non-viraemic would be considered to be suitable for importation. Animals that are serologically negative and non-viraemic would also be considered suitable for importation. Any animals that are viraemic or are excreting virus in their semen would be rejected. Any animal that has been held in quarantine with viraemic animals or animals that have become serologically positive while in quarantine would be considered ineligible for importation until the completion of a further isolation period and testing as above.

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14. Crimean Congo Haemorrhagic Fever

14.1. HAZARD IDENTIFICATION

14.1.1. Aetiological agent

Family: Bunyaviridae; Genus: Nairovirus, Crimean Congo haemorrhagic fever virus.

14.1.2. OIE list

Listed, although not covered by a chapter in the *Code*.

14.1.3. New Zealand status

Listed on the unwanted organisms register as an exotic unwanted organism.

14.1.4. Epidemiology

Crimean Congo haemorrhagic fever virus (CCHFV) occurs in Africa, Asia, the Middle East, and Eastern Europe (Swanepoel and Burt 2004). The virus infects humans and a variety of ruminants and other smaller animals such as hares; it can also infect ostriches (Swanepoel and Burt 2004). Serological methods, including the ELISA, can be used to detect antibody against CCHFV (Burt et al 1993; Qing et al 2003) and PCR methods and viral isolation can be used to detect virus (Burt et al 1998; Schwarz et al 1996). Cattle have often been found to be positive in serological surveys (Burt et al 1996; Mariner et al 1995; Swanepoel and Burt 2004; Swanepoel et al 1987). In humans the virus causes a serious disease but in animals it causes a transient inapparent infection (Swanepoel and Burt 2004).

The principle methods of spread are by tick-bite and by contact with infected blood and meat. People involved in slaughtering animals are at risk (Swanepoel et al 1985) and nosocomial infections occurred in a South African hospital (Shepherd et al 1985). The virus has been isolated from at least 30 species of ixodid ticks (Swanepoel and Burt 2004) but not from argasid ticks (Durden et al 1993). Transovarial transmission of the virus in ticks has been described in a few species of the genera *Rhipicephalus*, *Hyalomma* and *Dermacentor* but it has been suggested that this does not occur regularly and that transstadial infection following amplification in a mammalian host is the usual method of transmission (Swanepoel and Burt 2004). *Hyalomma* spp. are the principal vectors of the disease and the distribution of the virus mirrors the distribution of these ticks (Swanepoel et al 1987).

No reference could be found on the incubation period in cattle. In humans, it is 1-3 days after tick bite infection and can be up to a week in people exposed to infected blood (Swanepoel and Burt 2004), but incubation periods of up to 9 days have also been reported (Swanepoel et al 1989; Swanepoel et al 1985). In sheep, it also appears to be around 3 days in experimental infection (Gonzalez et al 1998). It is assumed that the incubation period in cattle will be up to 10 days. The viraemic period lasts for up to 7 days in ruminants and other animals (Swanepoel and Burt 2004). There are no descriptions of long term carriers.

14.1.5. Hazard identification conclusion

CCHFV causes a serious disease in humans. As it is not present in New Zealand, but may be carried by infected cattle, it is classified as a potential hazard in the commodity.

14.2. RISK ASSESSMENT

14.2.1. Entry assessment

Since viraemia occurs for a period of around 7 days (Swanepoel and Burt 2004) and carriers of the virus have not been described, the likelihood of importing animals that are viraemic or incubating the disease is low but non-negligible. If animals are infected with ticks at the time of importation the likelihood of importation of infected ticks is non-negligible.

14.2.2. Exposure assessment

Animals that are viraemic are not infectious to in-contact animals but could infect competent tick vectors. The New Zealand cattle tick *Haemaphysalis longicornis* is not known to be capable of carrying CCHF (Heath 2002). However, since the virus has been isolated from at least 30 species of ixodid ticks (Swanepoel and Burt 2004) it is possible that the New Zealand cattle tick could also be a vector. The likelihood that cattle would be viraemic when or shortly after being imported and then infect ticks which in turn could infect other cattle is very low but non-negligible.

14.2.3. Consequence assessment

If the virus were to become established in New Zealand it would have negligible effects on the livestock industries since infections in animals are invariably subclinical.

The establishment of the disease in New Zealand would require the establishment of a suitable reservoir host/ host tick cycle. Many of the 30 species of ixodid ticks from which virus has been isolated have not been proven to be competent vectors of the virus and the known distribution of the disease mirrors the distribution of *Hyalomma* spp. ticks (Swanepoel et al 1987). It is considered highly unlikely that the disease could establish in New Zealand unless both virus and *Hyalomma* spp. were introduced and the ticks managed to establish. If *Hyalomma* spp. are not introduced the likelihood that an imported animal would be infested by New Zealand cattle ticks while viraemic, is considered to be very low. Overall, the establishment of the disease in New Zealand is therefore considered to be unlikely. If the disease were to become established in New Zealand rare cases of a serious and sometimes fatal human disease would be likely to occur.

The virus might cause subclinical infections in feral ruminants and small mammals.

In conclusion, CCHFV would be unlikely to establish in New Zealand, and if it did, there would be a negligible effect on the livestock farming industries or feral or wild animal populations. However, humans are susceptible to the virus and the possible effects on human health would be non-negligible.

14.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for CCHFV is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

14.3. RISK MANAGEMENT

14.3.1. Options

As there is no *Code* chapter for CCHFV, there are no international risk management standards for any commodity.

One or a combination of the following measures could be considered in order to effectively manage the risk.

- The disease does not occur in Australia or North America or most EU countries. It is only of concern in some eastern European countries and identification of those parts of the EU that may be infected is important. The veterinary authorities of exporting countries could be required to declare whether the disease occurs in their countries.
- The disease has a short incubation period and long-term carriers do not occur. Therefore, quarantine of tick free cattle in tick free premises would be effective in preventing the introduction of the virus. A quarantine period of 21 days could be adequate as the incubation period is 3-9 days (Swanepoel and Burt 2004) and the period of viraemia lasts about 7 days (Gonzalez et al 1998).
- The importation of ticks with cattle should be avoided. Options to manage the risk of introduction of ticks are discussed in Section 46.3.

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15. Bovine Ephemeral Fever

15.1. HAZARD IDENTIFICATION

15.1.1. Aetiological agent

Family: Rhabdoviridae; Genus: Ephemerovirus, Ephemeral fever virus.

15.1.2. OIE list

Not listed.

15.1.3. New Zealand status

Listed on the unwanted organisms register as an exotic unwanted organism.

15.1.4. Epidemiology

Ephemeral fever occurs in Asia, Africa, Australia (St George 2004), and the Middle East (Yeruham et al 2005). The disease has not been described in Europe or in North America.

It is a summer disease of tropical and temperate areas and occurs sporadically during periods of high insect activity. Transmission of the virus is mainly associated with mosquitoes (Murray 1997). The virus has also been isolated from *Culicoides* spp. but they are probably not the main vector of the disease (St George 2004). It is a disease of cattle but not of sheep and goats. The incubation period in experimental infections is usually 3-5 days with an extreme of 10 days, and viraemia lasting 4-5 days (St George 2004). Carriers do not occur. It is not known whether transovarial transmission of the virus occurs in mosquitoes. Outbreaks of the disease result in production losses particularly in dairy cattle.

The disease is characterised by fever and stiffness and affected animals walk with a typical stiff gait. The acute clinical signs usually only last for a few days but a minority of cases may be fatal if animals become recumbent.

15.1.5. Hazard identification conclusion

Ephemeral fever virus is an exotic organism that causes disease in affected cattle. Therefore, it is classified as a potential hazard in the commodity.

15.2. RISK ASSESSMENT

15.2.1. Entry assessment

Animals in the incubation stage or viraemic animals showing mild clinical signs could be introduced. Therefore the likelihood of entry in the commodity is considered to be non-negligible.

15.2.2. Exposure assessment

Bovine ephemeral fever virus cannot be transmitted directly between cattle. It is an arbovirus carried by mosquitoes and possibly by *Culicoides*. Since it is not known whether any mosquitoes that occur in New Zealand could be competent vectors of the disease the likelihood of transmission amongst naïve New Zealand cattle is considered to be low but non-negligible.

15.2.3. Consequence assessment

If the virus can be transmitted by New Zealand mosquitoes it could become established and cause sporadic outbreaks of disease in seasons favourable to the multiplication of mosquitoes. This could result in production losses, especially in dairy cattle.

As the virus does not affect people there would be no consequences to human health.

Bovine ephemeral fever virus is not known to cause disease in animal species other than cattle although antibody is found in African buffalo and some antelope species in Africa and in water buffalo and deer in Australia (St George 2004). The virus is not known to occur in native Australian animals and there is no reason to believe it would affect wild or feral animals in New Zealand. The potential consequences to the environment are therefore considered to be negligible.

15.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for bovine ephemeral fever virus is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

15.3. RISK MANAGEMENT

15.3.1. Options

One or a combination of the following measures could be considered in order to effectively manage the risk.

- Animals could be imported without restrictions from North America and Europe where the disease does not occur.
- In countries where the disease occurs seasonally, animals could be safely introduced from areas where mosquito activity has ceased during the winter and no cases of ephemeral fever have occurred for at least 3 weeks.
- As the disease is characterised by a short incubation period (3-10 days) and a short period of viraemia (4-5 days) and longer term carriers of virus are not known to occur, a quarantine period of 21 days in insect free premises would prevent the entry of the virus.

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16. Foot and Mouth Disease

16.1. HAZARD IDENTIFICATION

16.1.1. Aetiological agent

Family: Picornaviridae; Genus: Aphthovirus, foot and mouth disease virus (FMDV). There are seven serotypes of the virus: O, A, C, SAT 1, SAT 2, SAT 3, and Asia 1.

16.1.2. OIE list

Listed.

16.1.3. New Zealand status

Listed on the unwanted organisms register as an exotic notifiable disease.

16.1.4. Epidemiology

Extensive reviews on foot and mouth disease are available (Sansom 1994; Thomson and Bastos 2004) and much of the information given below is taken from these. The disease has been eradicated from or has not occurred in North America, many European countries, Australasia and some Asian countries such as Japan and Korea (Thomson and Bastos 2004). It can infect all cloven hoofed animals and is considered to be the most contagious and economically devastating animal disease. The outbreaks of the disease in Britain in 2001 (Thompson et al 2002) and in Taiwan in 1997 (Yang et al 1999) cost those countries billions of dollars.

Infected animals excrete the virus in saliva, faeces, urine, milk, semen, ocular and nasal discharges (Sansom 1994; Thomson and Bastos 2004), and it is also discharged in aerosol form in expired air. The incubation period is usually 2-14 days (Sansom 1994). Virus can be excreted in semen from 4 days before until 7 days after the onset of clinical signs (Sansom 1994). Viraemia usually continues from 1 day before until 11 days after signs of disease first appear. Transmission can be from direct contact, contact with infected fomites, ingestion of infected animal products or from inhaling aerosolized virus (Sansom 1994; Thomson and Bastos 2004). Long term carriers excrete small amounts of virus from the pharynx. Cattle may excrete virus in this way for up to 3 years, although the amount of virus excreted by persistent carriers is low and the ability of persistently infected cattle to spread the disease is controversial (Thomson and Bastos 2004).

16.1.5. Hazard identification conclusion

Foot and mouth disease is a devastating highly contagious disease and the virus is an exotic, notifiable organism. Therefore, the virus is classified as a potential hazard.

16.2. RISK ASSESSMENT

16.2.1. Entry assessment

Animals from infected countries could be incubating the disease and could excrete large amounts of virus after importation. Long-term carriers of infection could carry the virus in the pharynx for up to 3 years. The likelihood of entry in the commodity is therefore considered to be non-negligible.

16.2.2. Exposure assessment

Infected animals are highly infectious and could excrete virus in all body discharges and in aerosols. They could infect animals they are in contact with or possibly, via aerosols, some distance from them. They could also infect fomites and their products such as meat or milk could be infectious. Therefore the likelihood of exposure is non-negligible.

16.2.3. Consequence assessment

The infected animals would develop disease and would become highly contagious and likely to infect any cloven hoofed animals they came in contact with or possibly (by aerosol) animals several kilometers from them. In an extreme case where large numbers of pigs were infected, the virus was transmitted by favourable winds from Brittany in France to the Isle of Wight in England (Gloster et al 1982).

Animals that become infected could become the focal point for a serious outbreak of foot and mouth disease. An outbreak of the disease would cause serious disruption to the livestock industries, economic losses to individual farmers, very large expenses for an eradication campaign, and serious disruption to export markets for both animals and animal products. The overall effects could be catastrophic as dramatically demonstrated by the losses that resulted from an outbreak of the disease in Britain where the costs to government were estimated at 3.1 billion pounds (Thompson et al 2002).

Foot and mouth disease infection of humans is extremely rare and of negligible importance (Sanson 1994). Therefore, there would be negligible consequences for human health.

The virus infects cloven hoofed animals and could infect feral pigs, goats and deer thereby establishing the disease in feral populations which could constitute an ongoing source of infection for domestic stock.

16.2.4. Risk estimation

Since entry, exposure, and consequence assessments are considered to be non-negligible, the risk estimate for FMDV is non-negligible, and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

16.3. RISK MANAGEMENT

16.3.1. Options

Isolation and testing procedures could be used to ensure that animals from infected countries could be safely introduced. However, in view of the extreme seriousness of the disease and the catastrophic consequences that could result from its introduction it might be considered that a more conservative approach is appropriate. One or a combination of the following measures could be considered to effectively manage the risk.

- Consistent with Article 2.2.10.10 of the *Code*, animals from FMD free countries or zones where vaccination is not practised could be required to show no clinical sign of FMD on the day of shipment, be kept in an FMD free country or zone where vaccination is not practised since birth or for at least 3 months prior to shipment, and not be vaccinated against FMD.
- Consistent with Article 2.2.10.11 of the *Code*, animals from FMD free countries or zones where vaccination is practised could be required to show no clinical sign of FMD on the day of shipment, be kept in an FMD free country or zone since birth or for at least 3 months prior to shipment, and not be vaccinated against FMD and subjected, with negative results, to tests for antibodies against FMD virus.
- Consistent with Article 2.2.10.12 of the *Code*, animals from FMD infected countries could be required to:
 - i. show no clinical sign of FMD on the day of shipment;
 - ii. be kept in the establishment of origin since birth, or
 - a. for the past 30 days, if a stamping-out policy is in force in the exporting country, or
 - b. for the past 3 months, if a stamping-out policy is not in force in the exporting country,and FMD should not have occurred within a ten-kilometre radius of the establishment of origin for the relevant period as defined in points a) and b) above; and
 - iii. be isolated in an establishment for the 30 days prior to shipment, and all animals in isolation subjected to diagnostic tests (probang and serology) for evidence of FMDV infection with negative results at the end of that period, and FMD should not have occurred within a ten-kilometre radius of the establishment during that period; or
 - iv. be kept in a quarantine station for the 30 days prior to shipment, all animals in quarantine subjected to diagnostic tests (probang and serology) for evidence of FMDV infection with negative results at the end of that period, and FMD should not have occurred within a ten-kilometre radius of the quarantine station during that period;
 - v. not be exposed to any source of FMD infection during their transportation from the quarantine station to the place of shipment.
- Importation of cattle from countries that are infected with foot and mouth disease, or vaccinate against foot and mouth disease could be prohibited.

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17. Miscellaneous Arboviruses

17.1. HAZARD IDENTIFICATION

17.1.1. Aetiological agent

Various arboviruses.

17.1.2. OIE list

Not listed.

17.1.3. New Zealand status

Exotic viruses, not listed as unwanted

17.1.4. Epidemiology

A large group of viruses that are transmitted by mosquitoes or *Culicoides* spp., have been identified. At least 65 different arboviruses are found in the Australian geographical region (Mackenzie et al 1994). Many of these result in sub-clinical or trivial infections of man and animals but more regularly stimulate antibody formation and are identified as circulating in the animals concerned in serological surveys. A few are associated with distinct and sometimes serious viral diseases. Viruses more commonly mentioned in the literature include:

Sinbis virus is a mosquito-borne alphavirus for which the maintenance hosts are generally believed to be birds (Russell 1995). A closely related virus, Whataroa virus, occurs in New Zealand (Miles et al 1971). Humans have antibody to the virus in endemic areas. Antibody to the virus has been demonstrated in cattle. No reports about the virus in cattle more recent than 1977 have been found. No evidence could be found that the virus causes disease of cattle or that cattle are anything but dead-end hosts and it is not considered to be a potential hazard in the commodity.

Epizootic haemorrhagic disease virus is a *Culicoides*-borne orbivirus closely related to bluetongue and Palyam viruses (Maclachlan and Osburn 2004). It causes disease in deer in the United States. In Australia five sero-types of the virus have been isolated from non-clinically infected cattle (Parsonson and Snowdon 1985). The infection is not contagious and is transmitted by *Culicoides* spp. (Maclachlan and Osburn 2004). It is not a zoonotic virus. Since *Culicoides* spp. are not present in New Zealand the virus could not establish. It is not considered to be a potential hazard in the commodity.

Gan Gan virus is a mosquito-borne Bunyavirus, which has only been reported in New South Wales (Russell 1995). Antibody and rare cases associated with disease have been reported in humans and antibody has been found in cattle. However, no reports could be found of clinical disease or viraemia in cattle. Therefore cattle are considered to be unable to transmit the infection to mosquitoes. Gan Gan disease is not considered to be a potential hazard in the commodity.

Kunjin virus is generally confined to northern regions of Australia and sporadically occurs in central Australia in years of exceptional rainfall. It was absent from central Australia for 26 years before reappearing in 2000 (Brown et al 2002). However, it is rarely reported. In 2004 there were 4 cases in the Northern Territory (Liu et al 2005). According to Russell (1995), Whelan found cattle in the Northern Territory to be serologically positive. However, the main vertebrate hosts are believed to be water birds, particularly the Rufus night heron (Marshall 1988 according to (Russell 1995)). Experimental infection of sheep resulted in transient shedding of virus in lymph but virus disappeared with the production of antibodies within 3-4 days of infection (Pearson et al 1976). No evidence could be found to indicate that cattle become viraemic or act as maintenance hosts. Kunjin virus is not considered to be a potential hazard in the commodity.

Murray Valley encephalitis virus is an alphavirus that causes a disease of humans. The virus is active in the Northern Territory of Australia and some parts of Western Australia from December till June, as indicated by a sentinel chicken programme (Broom 2003; Russell 1995). Human cases occur from February to July. Cattle seroconvert and are potential hosts but are poor amplifiers of the virus compared to rabbits and kangaroos (Kay et al 1985). In an experimentally infected sheep the virus was cleared rapidly after the production of antibody 3-4 days after infection (Pearson et al 1976). Waterbirds, particularly night herons, are considered to be the major vertebrate hosts of the virus (Russell 1995). No evidence could be found that indicates that cattle play a role in the maintenance of the virus. Therefore the virus is not considered to be a potential hazard in the commodity.

Chikungunya virus is an alpha virus which has a wide distribution in Africa, India, and South East Asia. It has recently spread to several Indian Ocean islands including Reunion and Mauritius (Chastel 2005). Serological studies have indicated a low prevalence of antibodies in cattle but no record could be found indicating that cattle are efficient amplifiers of virus or are maintenance hosts. Therefore the virus is not considered to be a potential hazard in the commodity.

St Louis encephalitis virus causes serious disease and occasional mortality in humans in the USA, and Central and South America. Sporadic cases have been recorded (Day and Stark 2000; Jones et al 2002). There is a considerable amount of evidence that indicates that birds are the maintenance hosts of the virus (Gruwell et al 2000; Reisen et al 2003; Shaman et al 2003). Although one study indicates that cattle seroconverted (Ulloa et al 2003) no evidence could be found that they had significant viraemias or that cattle are maintenance hosts for the virus. St Louis encephalitis virus is not considered to be a potential hazard in the commodity.

Japanese encephalitis virus causes serious disease in humans. Between 30,000 and 50,000 cases occur annually in the Asian region (CDC 2006; WHO 2006). The disease has recently emerged in Australia in islands in the Torres straits and the Cape York peninsular (Mackenzie 1999; Ritchie and Rochester 2001). Approximately 30 % of cases end fatally and serious complications are common in recovered patients. The disease is transmitted by mosquitoes of the *Culex* genus. The maintenance host for the virus are ardeid birds (herons and egrets) and the virus is amplified in pigs that are sub-clinically infected (CDC 2006; WHO 2006). However, cattle are not known to be involved in the maintenance or amplification of the virus. For this reason the virus is not considered to be a potential hazard in the commodity.

17.1.5. Hazard identification conclusion

In view of the above, none of the arboviruses covered in this section are considered to be potential hazards in the commodity

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18. Palyam Group Viruses

18.1. HAZARD IDENTIFICATION

18.1.1. Aetiological agent

Family: Reoviridae; Genus: Orbivirus, viruses belonging to the Palyam serogroup.

18.1.2. OIE list

Not listed.

18.1.3. New Zealand status

Considered exotic to New Zealand, not listed on the unwanted organisms register.

18.1.4. Epidemiology

The Palyam serogroup of the orbiviruses are represented by a large number of viruses that occur in Australia, Africa, and Asia (Swanepoel 2004). There is some confusion about the identification of some of the viruses and further new viruses are likely to be found in the future. In one review 15 viruses were listed (Swanepoel 2004) and others have been reported (Doyle and Walton 1992). The viruses most commonly infect cattle, but neutralizing antibody has also been found in sheep and goats (Swanepoel 2004). The main vectors for the Palyam viruses are *Culicoides* spp. but they have also been isolated from ticks in Africa and mosquitoes in India (Swanepoel 2004). Large numbers of isolations of arboviruses including many Palyam viruses have been made from the blood of naturally infected cattle without clinical signs, and from *Culicoides* midges in South Africa (Nevill et al 1992; Theodoridis et al 1979) and Australia (Cybinski and St George 1982; Gard et al 1989; Gard et al 1988a; Gard et al 1988b; Littlejohns et al 1988).

Although the viruses usually cause mild or subclinical infections they have been associated with cattle abortions in Zimbabwe. Kasba virus was associated with congenital abnormalities such as hydroencephaly and cerebellar hypoplasia in calves in Japan (Goto et al 1988; Miura et al 1990). Similar congenital abnormalities were reported from Australia (Kirkland et al 1992). Following infection, cattle were reported to be consistently viraemic for 2 weeks and intermittently viraemic for 8 weeks (Swanepoel 2004).

An arbovirus and *Culicoides* surveillance programme has been operating in New Zealand since 1991 (Ryan et al 1991). In a typical year serum samples were collected from 10 sentinel cattle from each of 17 herds, and a total of about 15,000 insects were collected from light traps (Motha et al 1997). No seroconversion has been detected in sentinel cattle and no *Culicoides* have been trapped to date.

18.1.5. Hazard identification conclusion

Although the Palyam virus group does not cause economically important diseases in endemically infected countries, they do occasionally cause abortions or foetal malformations

and could have severe effects in a naïve population of cattle. Therefore these viruses are classified as a potential hazard in the commodity.

18.2. RISK ASSESSMENT

18.2.1. Entry assessment

Cattle infected with Palyam viruses may be intermittently viraemic for up to 8 weeks after infection. Therefore the likelihood of the virus entering New Zealand in cattle imported from endemically infected countries is considered to be non-negligible.

18.2.2. Exposure assessment

Viraemic animals introduced into New Zealand would not be infectious to other animals in contact with them. Although Palyam viruses have been recovered from ixodid ticks and mosquitoes, the majority of isolates from arthropods have come from *Culicoides* midges which are considered to be the natural vectors of these viruses (Swanepoel 2004). However, since *Culicoides* do not occur in New Zealand and surveys have demonstrated that New Zealand is free of arbovirus vectors (Motha et al 1997), the likelihood of transmission is considered to be negligible.

18.2.3. Risk estimation

Since the likelihood of exposure is assessed to be negligible, the risk estimate for Palyam viruses is negligible, and they are not classified as potential hazards in the commodity. Therefore, risk management measures are not justified.

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19. Rabies

19.1. HAZARD IDENTIFICATION

19.1.1. Aetiological agent

Family: Rhabdoviridae; Genus *Lyssavirus*, rabies virus. In addition to the true rabies virus there are a number of closely related lyssaviruses such as the European bat *Lyssavirus* which cause similar diseases.

19.1.2. OIE list

Listed.

19.1.3. New Zealand status

Listed on the unwanted organisms register as an unwanted and notifiable organism.

19.1.4. Epidemiology

Rabies is a disease of all mammals including man. It is characterized by severe nervous signs and is invariably fatal.

Rabies occurs widely around the world, but there are a number of countries including mainly island and peninsular countries that are free from the disease. In some countries such as Denmark and Australia that are free from true rabies virus, bats are endemically infected with closely related lyssaviruses (Swanepoel 2004). Australia and several countries in Europe including Great Britain, Ireland, Sweden, Norway, Denmark, Finland, Portugal, and Greece are free from rabies, but many of these countries have common borders with infected countries. Rabies is endemic in North America.

In all endemically infected countries the virus is maintained in a population of domestic or wild carnivores or bats. True rabies in bats is confined to the Americas (Swanepoel 2004) but infections of bats with related lyssaviruses occur in Europe (Fooks et al 2003), Africa (Swanepoel 2004), and Australia (Thompson 1999).

The virus is carried mainly by carnivores and, in the final stages of the disease, they excrete the virus in their saliva and transmit the disease to other animals when they bite them. Other forms of transmission such as aerosol transmission in bat colonies (Swanepoel 2004) and *per os* infection of kudu (Hubschle 1988) are rare exceptions. Following deposition of virus in a bite wound the virus enters peripheral nerves and is transported through the nerves to the central nervous system. After entering the peripheral nerves the virus is not found in any other body tissues or in the blood. Amputation of limbs of mice experimentally infected in the foot pads has been shown to prevent the virus from progressing to the brain (Swanepoel 2004). The passage of virus through the nervous system is a slow process and depending on the site of infection, the dose of virus and the animal concerned the incubation period before the appearance of clinical signs may vary from weeks to years. In cattle 2-12 weeks has been reported, but an incubation period of 87 weeks was reported in a case of experimental

infection (Swanepoel 2004). The occurrence of viraemia is an exceptional event except in experimental infections of young mice with large doses of virus (Swanepoel 2004).

The virus spreads to the salivary glands at about the stage that there is generalized dissemination of infection in the brain. It then multiplies in the salivary glands and is excreted in the saliva. In the terminal stages of the disease animals become incoordinated and about 50% of infected cattle become aggressive. The disease lasts from a few days to a few weeks and invariably ends fatally. Typically animals become uncoordinated and aggressive and salivate excessively or develop a paralytic form of the disease (Swanepoel 2004). Cattle are generally dead-end hosts since they are unlikely to bite other animals or man. Although the disease is dramatic and a cause for serious concern, the actual prevalence in cattle is low. In South Africa, a typical country where the disease is endemic, over a period of 72 years 3029 cases were reported in cattle (Swanepoel 2004). This is an average of 42 cases per year from a cattle population of approximately 13 million. Therefore, even if the disease was grossly under-reported the prevalence was very low.

19.1.5. Hazard identification conclusion

Rabies virus can infect virtually all mammals. It is an exotic, notifiable disease and is an important zoonosis. Therefore, it is classified as a potential hazard in this commodity.

19.2. RISK ASSESSMENT

19.2.1. Entry assessment

The incubation period may be very long and in a case of experimentally transmitted rabies an incubation period of 87 weeks has been described. However the OIE *Terrestrial Animal Health Code* gives the incubation period for international trade as six months (OIE 2006). Clinically normal animals could therefore be in the incubation period of the disease. The likelihood that animals coming from endemically infected countries could be incubating rabies is therefore considered to be non-negligible.

19.2.2. Exposure assessment

Dogs are infective from 15 days before the onset of clinical signs until they die (Swanepoel 2004). The position in cattle is not known but is assumed to be similar. Salivary gland infection rates greater than 80% have been recorded in cattle (Swanepoel 2004). The only significant manner of transmission of the virus is wound infection with infected saliva. Since cattle do not normally bite people or other animals it is unlikely that they would transmit the disease in this manner. However since about 50% of infected cattle become aggressive it is possible that people attending imported animals or dogs working with rabid cattle could be attacked and sustain injuries which could be contaminated with infectious saliva. For this reason the likelihood of exposure of people or other animals is considered to be low but non-negligible.

19.2.3. Consequence assessment

If the disease is introduced into carnivores it could become endemic since it could be transmitted from rabid carnivores to other animals. Ultimately if established in wild carnivores such as ferrets and feral cats the disease could be hard to control and eradication would be difficult and expensive. Vaccination of dogs and cats would become necessary.

If the disease were to become established sporadic human cases could occur. These cases would require expensive treatment and if not treated promptly would result in deaths.

Feral carnivores could become infected and the disease could become endemic in feral animals.

In conclusion, the consequences for animal populations, human health and the environment are considered to be non-negligible.

19.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for rabies is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

19.3. RISK MANAGEMENT

19.3.1. Options

There are no suitable diagnostic tests that can be used to diagnose rabies during the incubation period. International standards exist for the management of the risk of rabies in domestic ruminants. Animals could be imported from countries that are considered to be free from rabies according to the criteria defined by OIE (OIE 2006). When importing from infected countries allowance must be made for an incubation period defined by OIE as being 6 months (OIE 2006). The OIE recommends that animals should be kept for the 6 months prior to shipment in an establishment where the separation from wild and feral animals is maintained and where no cases of rabies had been reported for at least 12 months.

In light of the international standards for rabies, one or both of the following options could be considered in order to effectively manage the risk.

- Animals could be imported from countries that are free from rabies according to the OIE recommended criteria.
- Animals could be required to be kept for at least 6 months prior to export in an establishment where separation from feral and wild animals is maintained and where no case of rabies has been reported for at least 12 months prior to export.

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20. Ross River and Barmah Forest Viruses

20.1. HAZARD IDENTIFICATION

20.1.1. Aetiological agent

Family: Togaviridae; Genus: Alphavirus, Ross river virus and Barmah Forest viruses.

20.1.2. OIE list

Not listed.

20.1.3. New Zealand status

Exotic.

20.1.4. Epidemiology

Ross River and Barmah Forest viruses are mosquito-borne alphaviruses that occur in Australia. They have not been reported in North America or Europe (Harley et al 2001; Russell 2002; Russell and Doggett 2006). They are zoonotic viruses and are not known to cause clinical disease in any domestic animals.

Approximately 5,000 human cases of Ross River fever (characterised by fever, polyarthrititis, and rash) are notified annually in Australia (Harley et al 2001; Russell 2002; Russell and Doggett 2006). Virus has been isolated from at least 30 species of mosquitoes and transmission has been demonstrated from at least 13 species (Harley et al 2001). The major mosquito vectors are *Culex annulirostris* in freshwater habitats and *Aedes vigilax* and *Aedes camptorynchus* in northern and southern coastal regions. Other species involved in transmission include *Aedes normanensis*, *Coquillettidia linealis*, and *Aedes notoscriptus*. Based mainly on serological evidence, the reservoir hosts for the virus are believed to be large marsupials such as kangaroos and wallabies (Russell 2002; Russell and Doggett 2006; Vale et al 1991). However, antibodies to the virus have been found in a wide variety of placental and marsupial mammals, and viral isolations from naturally infected vertebrates have only been recorded in eight cases including two cases from macropods and two from horses (Harley et al 2001). Humans may also act as reservoirs of infection and a mosquito human cycle probably occurs during outbreaks of the disease.

Infections with Barmah Forest virus occur less commonly and little is known about the hosts of the virus (Russell and Doggett 2006). Effects of infection vary from asymptomatic infection, a transient rash and mild illness to polyarthrititis and chronic illness. Recovery may occur in a few weeks but sometimes signs may persist for months or years (Harley et al 2001; Russell 2002). The virus is normally confined to Australia, Papua New Guinea and the Solomon Islands. In the latter two countries the virus may be introduced periodically from Australia (Russell 2002). A massive outbreak that occurred in the Pacific region in 1979-80 involved outbreaks in Fiji, American Samoa, the Cook Islands, and New Caledonia and probably also Tonga, Kiribati, and Western Samoa. The outbreak seems to have been started by a single traveller from Australia infecting mosquitoes in Fiji (Harley et al 2001; Russell

2002). Since the virus is known to be transmitted by *Aedes aegypti* and *Aedes albopictus* the potential exists for outbreaks of disease to occur in countries where these species of mosquitoes are present.

Ross River and Barmah Forest viruses have not occurred in New Zealand. Two exotic species of mosquitoes *Aedes notoscriptus*, a probable vector of Ross River virus (Russell and Doggett 2006), and *Aedes camptorhynchus*, a known vector of the virus, have become established in New Zealand (Derraik and Calisher 2004). However, *Aedes camptorhynchus* is the subject of an eradication campaign, the outcome of which remains uncertain.

Antibody against the virus has been demonstrated in cattle but no isolations of virus have been reported (Vale et al 1991). There have been no reports indicating that cattle are linked epidemiologically with the disease in humans.

20.1.5. Hazard identification conclusion

Since there is no indication that cattle can act as reservoirs of these viruses, they are not classified as potential hazards in the commodity.

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21. Tick Borne Encephalitis

21.1. HAZARD IDENTIFICATION

21.1.1. Aetiology

Family: Flaviviridae; Genus: Flavivirus. The viruses causing tick borne encephalitis (TBE) are a closely related group of viruses including the agents of: Louping ill, Central European TBE, Far Eastern TBE, Omsk haemorrhagic fever in Siberia, Kyasanur Forest disease in the Indian subcontinent, Langat in Malaysia, Negishi in Japan, Powassan in North America and parts of the former USSR, and four viruses from Asia that have no known veterinary or medical significance (Gilbert et al 2000; Gresikova and Beran 1981; Gritsun et al 2003a; Gritsun et al 2003b; Korenberg and Kovalevskii 1999; Swanepoel and Laurenson 2004).

21.1.2. OIE list

Not listed.

21.1.3. New Zealand status

Louping ill virus is listed on the unwanted organisms register as an unwanted exotic organism.

21.1.4. Epidemiology

Louping ill in the United Kingdom is primarily a disease of sheep but other species can be infected. It has been suggested that at least 32 vertebrate species and a wide variety of ticks can be infected with louping ill virus (Reid 1990). The TBE viruses that occur in Eastern Europe and Russia are primarily pathogens of humans. In Russia 11,000 cases occur annually and another 3,000 cases occur in the rest of Europe (Gritsun et al 2003a).

In animals, transmission of TBE viruses is entirely by ticks (Gresikova and Beran 1981). The main tick vectors are *Ixodes ricinus* or *Ixodes persulcatus*, although other tick species may also be involved (Gresikova and Beran 1981; Korenberg and Kovalevskii 1999). Antibody has been demonstrated in, or virus has been isolated from, a wide range of animals including small rodents, wildlife, and domestic animals such as deer and cattle (Swanepoel and Laurenson 2004). TBE viruses of Russia and Eastern Europe are believed to be sustained mainly in a tick/small mammal cycle although transovarial transmission through multiple generations of ticks also occurs (Gresikova and Beran 1981). In the case of louping ill, small mammals are probably of lesser importance in maintaining the virus (Gilbert et al 2000). No descriptions of other members of the TBE complex causing clinically apparent disease in cattle were found although antibodies to the virus were found in 29% of cattle (Korenberg et al 1984). Histopathological examination of brains of 178 ruminants with encephalitis revealed only one case of encephalitis related to TBE (Bago et al 2001). In sheep, louping ill has an incubation period of 2-5 days. In experimental infection of sheep and goats viraemia lasts 1-5 days and shedding of virus in milk 2-7 days (Gresikova and Beran 1981). It is assumed that the incubation and viraemic periods would be similar in cattle. Reports of cattle, sheep or goats carrying any of the viruses of the TBE complex for longer periods were not found.

Cattle, goats and sheep can excrete virus in their milk (Gresikova and Beran 1981; Reid et al 1984; Reid and Pow 1985; Swanepoel and Laurenson 2004). This occasionally leads to infection in humans drinking raw milk (Gresikova and Beran 1981; Vareta et al 1991) but consumption of raw milk is not considered to be an important method of transmission (Rieger et al 1998).

21.1.5. Hazard identification conclusion

The viruses of the TBE complex are exotic to New Zealand. Louping ill is specifically named as an unwanted organism. The tick-borne encephalitis viruses are zoonotic agents. For these reasons viruses of this complex are classified as potential hazards in the commodity.

21.2. RISK ASSESSMENT

21.2.1. Entry assessment

Infections with TBE viruses are characterised by short incubation (2-5 days) and viraemic (1-5 days) periods. Virus may be excreted in milk for up to 7 days. Therefore, animals are infective for only short periods and the likelihood of introducing infective cattle into New Zealand is low but non-negligible.

21.2.2. Exposure assessment

The viruses of the TBE complex are not transmitted directly by contact between infected cattle and other susceptible animals. They are only transmitted by ticks or rarely through milk. A tick vector animal reservoir cycle would be necessary for the establishment of the disease. The main tick vectors of the viruses are *Ixodes* spp. which are not present in New Zealand. The New Zealand cattle tick is not a known vector of the viruses but the virus may be transmitted by a wide range of tick species (Swanepoel and Laurenson 2004). Therefore the likelihood that the New Zealand cattle tick (*Haemaphysalis longicornis*) could transmit the virus is considered to be non-negligible.

21.2.3. Consequence assessment

If louping ill virus is introduced into New Zealand and establishes in the tick population, cases of louping ill would be likely to occur in sheep, resulting in production losses and occasional mortalities.

Establishment of any of the viruses of the TBE complex could result in sporadic cases of disease in humans. Occasional mortalities could occur.

TBE viruses can infect a wide variety of animals ranging from small wild animals such as rodents, to birds and ruminants (Swanepoel and Laurenson 2004). These animals would probably not show clinical signs of disease but could act as reservoirs of the virus.

In conclusion, the introduction of TBE viruses would result in production losses in sheep and sporadic cases of disease in people. Therefore the consequences are considered to be non-negligible.

21.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate is non-negligible, and TBE viruses are classified as a hazard in the commodity. Therefore risk management measures can be justified.

21.3. RISK MANAGEMENT

21.3.1. Options

The following measures could be considered in order to effectively manage the identified risk.

- Cattle that have lived in a country or zone that is free from TBE viruses for at least the 3 weeks immediately prior to shipment could be imported without further sanitary measures.
- Since TBE viruses are transmitted by ticks it is important not to introduce ticks with imported cattle. Strict measures to prevent the importation of ticks could be imposed. The measures discussed to prevent the introduction of ticks in Section 46.3 could be implemented.
- Since the disease has short incubation and viraemic periods, and long term carriers are unknown, quarantine for a suitable period would prevent the disease being introduced. Therefore cattle could be kept in quarantine in tick free premises for a period of 3 weeks before shipment.

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22. Vesicular Stomatitis

22.1. HAZARD IDENTIFICATION

22.1.1. Aetiological agent

Family: Rhabdoviridae; Genus: Vesiculovirus, vesicular stomatitis virus. There are two main types of vesicular stomatitis virus, Indiana and New Jersey. Indiana has three sub-types and New Jersey contains only a single sub-type.

22.1.2. OIE list

Listed.

22.1.3. New Zealand status

Listed on the unwanted organisms register as an unwanted notifiable organism.

22.1.4. Epidemiology

The disease occurs in horses, cattle and pigs and more rarely in sheep and goats (Schmidt 2004). In addition to being a virus of vertebrates the virus has also been shown to multiply in insects such as blackflies (*Simulium* spp.), sandflies (*Lutzomyia* spp.), mosquitoes (*Aedes aegypti*), and leafhoppers (*Peregrinus maidis*) (Mare and Mead 2004).

Vesicular stomatitis is important mainly because it is clinically indistinguishable from foot and mouth disease (Rodriguez 2002; Schmidt 2002; Sellers and Daggupaty 1990). Therefore, initial diagnosis of the disease before laboratory confirmation of the viral aetiology, may trigger the massive initial response usually reserved for foot and mouth disease. Alternatively, if an outbreak of foot and mouth disease is incorrectly assumed to be vesicular stomatitis, as occurred in Saskatchewan in 1951, the response to the foot and mouth disease outbreak can be delayed (Sellers and Daggupaty 1990).

The disease is endemic in Central and South America and thousands of outbreaks occur each year from southern Mexico to northern South America (Rodriguez 2002). In the USA the disease occurs sporadically in some southern states but is endemic in at least one location in Georgia (Stallknecht 2000). In some seasons the disease spreads northward along riverbeds into northern locations in the USA (Schmidtman et al 1999) and even as far as Canada (Wilks 1994).

Despite the large numbers of livestock exported from North America the disease has only been reported outside the Americas on one occasion and this was in a large consignment of horses exported from North America to France during the First World War. The disease failed to establish in Europe (Mare and Mead 2004).

The most commonly held view is that the virus is transmitted by an insect vector. Virus has been isolated from the sand fly *Lutzomyia shannoni*, which is the most likely vector (Braverman 1994; Comer et al 1994; Rodriguez et al 1996; Schmidtman et al 2002;

Stallknecht 2000). *Culicoides* spp. are also possible vectors and have been infected experimentally (Nunamaker et al 2000). Blackflies (*Simulium* spp.) have also been incriminated in the transmission of the disease (Mead et al 2000). The virus can also be transmitted by teat cups during milking of cows with teat lesions or by infection of wounds and abrasions (Wilks 1994).

The maintenance hosts of the virus have not yet been conclusively established, but deer, raccoon (Stallknecht 2000), and the cotton rat, *Sigmodon hispidus* (Jimenez et al 1996), have been found to have antibody to the virus. The white tailed deer has shown signs of infection and many other species of animals can be infected or develop antibodies against the virus (Blood et al 1989; Hanson and McMillan 1990).

The disease is zoonotic and people are infected by direct contact or as a result of laboratory accidents (Letchworth et al 1999; Wilks 1994).

The incubation period of the disease is 1-3 days (Wilks 1994), but for regulatory purposes a period of 21 days is given in the OIE *Terrestrial Animal Health Code* (OIE 2006).

There is some controversy about the pathogenesis of the disease. Lesions on teats and feet are primary lesions caused by entry of the virus directly at these sites (Wilks 1994). Similarly in experimental infection of pigs lesions occurred at the injection sites but there was no viraemia (Howerth et al 1997). In a description of the pathogenesis of the disease it is stated that virus replicates in the lower layers of the epidermis and there is no description of viraemia (Mare and Mead 2004). Mead states that viraemia does not occur in mammalian hosts but demonstrated transmission of the virus to non-infected blackfly when infected and non-infected blackfly co-fed on the same host (Mead et al 2000). In contrast Blood and Radostits state that there is a primary viraemia with subsequent localization of virus in mucous membranes of the mouth and the skin around the coronets (Blood et al 1989). Viraemia was described in the experimental infection of deer mice (Cornish et al 2001). If viraemia does not occur in cattle, introduction of the disease by clinically healthy live cattle is not possible. This may account for the failure of the disease to spread beyond the Americas.

Serotype specific antibody develops within 5-8 days of infection and can be detected by blocking or competitive ELISAs or virus neutralization. Both New Jersey and Indiana types are used as antigen (Schmidt 2004).

22.1.5. Hazard identification conclusion

Vesicular stomatitis virus is an important exotic pathogen of cattle. Therefore, it is classified as a potential hazard in the commodity.

22.2. RISK ASSESSMENT

22.2.1. Entry assessment

There is a considerable body of opinion that suggests that viraemia does not occur in vesicular stomatitis. Despite this, it has been stated that “subclinical infection is frequent and subsequent excretion of the virus can occur with no clinical signs” (Mare and Mead 2004). OIE suggests that the incubation period for international trade “*shall be 21*” days and suggest that a quarantine period of 30 days should be imposed on animals for export from infected

countries. As many facts relating to the transmission, pathogenesis and excretion of the virus remain obscure, it is prudent to assume that cattle could introduce the virus to New Zealand, while in the incubation period of the disease. The likelihood of entry of virus in the commodity is therefore considered to be low but non-negligible.

22.2.2. Exposure assessment

Infected animals introduced into New Zealand could transmit the virus to other animals through contact exposure involving minor abrasions of the oral mucosa or skin. However this would be an inefficient method of transmission and is unlikely to lead to establishment of the disease. The disease has never spread outside of the Americas suggesting that there are factors unique to this region that are necessary for the establishment of the disease. Whether any competent vectors occur in New Zealand is unknown. Therefore the likelihood that insect vectors in New Zealand could become infected and transmit the disease to naïve cattle in New Zealand is considered to be low but non-negligible.

22.2.3. Consequence assessment

If the virus became established in competent vectors in New Zealand, sporadic cases of disease would be likely in animals, resulting in confusion with foot and mouth disease. Expensive control procedures normally reserved for cases of foot and mouth disease might be activated. There would also be losses due to interference with trade at least until foot and mouth disease could be ruled out. Individual farmers would also incur costs due to production losses.

The virus can cause disease in people, as a result of direct contact or laboratory accidents. Many cases of the disease probably go undiagnosed as the symptoms are similar to influenza. Many people in endemic areas have antibody against the virus. It is likely that the establishment of the disease in New Zealand would result in sporadic infections in humans during outbreaks of disease in livestock.

The exact host range of the virus is not known but infection or antibody production has been described in pigs, white tailed deer, raccoon, skunk, bobtail, kinkajou, two and three toed sloths, night monkeys, marmosets, agoutis, and rabbits (Hanson and McMillan 1990). In view of the wide host range it is possible that wild and feral animals could be infected but indigenous birds are unlikely to be susceptible. Infections in feral and wild species are likely to be subclinical. Therefore the effects on the environment are likely to be negligible.

In view of the above, the consequences of introduction are considered to be non-negligible..

22.2.4. Risk estimation

Since entry, exposure, and consequence assessments are all non-negligible, the risk estimate for vesicular stomatitis is non-negligible, and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

22.3. RISK MANAGEMENT

22.3.1. Options

Animals could be sourced from countries that are free from the disease (Canada, Australia or Europe). The OIE recommendations for live animal trade involving animals from infected countries are that the animals should be quarantined for the 30 days prior to export in a quarantine station and protected from insect attack during this time (OIE 2006). They should also be tested by an OIE recommended serological test (Schmidt 2004) test for vesicular stomatitis, with negative results, at least 21 days after the commencement of quarantine.

One or combination of the following options could be considered in order to effectively manage the risk.

- Cattle could be required to be resident for at least 30 days prior to shipment in a country or zone that is free from vesicular stomatitis.
- Imported cattle could be isolated in an insect free quarantine station for at least the 30 days prior to shipment.
- Cattle could be subjected to an OIE recommended serological test with a requirement for a negative result. This testing could be undertaken after at least 21 days in quarantine.

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23. West Nile Disease

23.1. HAZARD IDENTIFICATION

23.1.1. Aetiological agent

Family: Flaviviridae; Genus: Flavivirus, West Nile virus.

23.1.2. OIE list

Listed.

23.1.3. New Zealand status

Exotic organism, not listed as unwanted or notifiable by MAF.

23.1.4. Epidemiology

West Nile virus was originally isolated in Uganda in 1937. It is found all over Africa and has also been found in France (1962), Romania (1996), and Russia (1999) (Bunning et al 2004). The virus spread to the United States in 1999 and since then has spread throughout the USA (CDC 2003a) and adjoining countries. Disease is seen mainly in humans and in horses but the virus also causes deaths in wild birds. Most cases in humans are asymptomatic but in the epidemic in the USA there have been over 15,000 cases of disease and over 600 deaths (Higgs et al 2005).

The virus is transmitted by mosquitoes and maintained in a bird mosquito cycle (CDC 2003b). At least 43 species of mosquitoes have been suspected of acting as vectors of the disease (Gingrich and Williams 2005). The virus can be transmitted from infected mosquitoes to non-infected mosquitoes when they feed together on non-infected hosts (Higgs et al 2005).

No descriptions of clinical cases of disease in cattle have been reported, but there are several reports of cattle being positive for antibodies in serological surveys (Fontenille et al 1989; Karadzhov et al 1982; Koptopoulos and Papadopoulos 1980; Olaleye et al 1990). This indicates that the virus causes inapparent infections in cattle. Calves infected experimentally with West Nile virus developed antibody but no detectable viraemia was found (Ilkal et al 1988). According to CDC, "People, horses, and most other mammals are not known to develop infectious-level viraemias very often, and thus are probably "dead-end" or incidental-hosts" (CDC 2003b). Infections in cattle are subclinical and they do not develop viraemia (Ilkal et al 1988) and are therefore dead-end hosts.

23.1.5. Hazard identification conclusion

Since cattle are dead end hosts for WNV, the likelihood that the virus would be present in imported cattle is negligible. Therefore, the organism is not classified as a potential hazard in the commodity.

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24. Bovine Spongiform Encephalopathy

24.1. HAZARD IDENTIFICATION

24.1.1. Aetiological agent

Widely believed to be a prion, which is a protein that contains no genetic material.

24.1.2. OIE list

Listed.

24.1.3. New Zealand Status

Listed on the unwanted organisms register as an unwanted notifiable organism.

24.1.4. Epidemiology

A major epidemic of bovine spongiform encephalopathy (BSE) began in the United Kingdom in 1986 (Hillerton 1998). The epidemic peaked in 1992 with a total of 37,490 cases (Hillerton 1998). The total number of cases in the outbreak had reached 184,131 by December 2004 but the number of annual cases had declined to 199 in 2005. Of these, 39 were confirmed cases from 156 suspects and the rest were detected in the targeted surveillance programme in which 551,000 cattle were tested (Burke 2006). This dramatic drop in case numbers indicates that the eradication methods and the premises on which they have been based are sound. The disease has spread to several European countries (OIE 2006). The numbers of confirmed cases that have been reported in the European Union countries varied from none in Estonia, Hungary, Latvia and Lithuania (Anonymous 2004) to 935 in Portugal and 1474 in Ireland. More recently a single case has been reported in Sweden (Anonymous 2006b). Cases have occurred in the USA (Anonymous 2006c), and in Canada (Anonymous 2006a). Australia is recognised by OIE as being free from BSE.

BSE is a progressive disease of the nervous system of cattle. The disease agent is generally believed to be a prion which is an infectious protein that lacks any genetic material (RNA or DNA). It is a food-borne disease that is associated with feeding of protein derived from cattle to cattle. Other forms of transmission are believed to be unlikely although a few cases may be associated with vertical transmission from cow to calf (Braun et al 1998; Donnelly 1998; Donnelly et al 1997; Wilesmith and Ryan 1997; Wilesmith et al 1997).

Wells and his co-workers reported that the minimum time from experimental oral infection to detection of lesions in the brain was 32 months and the time to clinical signs developing was 35 months (Bradley and Verwoerd 2004). The incubation period can be much longer than this, with a probable upper limit of around 8 years. All cases end fatally, with the duration of signs lasting from 7 days to 14 months, but usually from 1-2 months.

The disease affects several species of mammals including cats, kudu, nyala, several species of oryx, cheetah, and puma (Kirkwood and Cunningham 1994). In human infection, it is hypothesised that the BSE agent causes the disease known as variant Creutzfeldt Jakob

disease (vCJD). Up to the 4th of November 2005 there had been 152 deaths due to or probably due to vCJD in the UK and six clinical cases were still alive (Anonymous 2005).

24.1.5. Hazard identification conclusion

BSE is an important exotic notifiable disease of cattle. Therefore, it is classified as a potential hazard in the commodity.

24.2. RISK ASSESSMENT

24.2.1. Entry assessment

Since several hundred cases of BSE are diagnosed annually in European countries, the likelihood of importing affected cattle from European countries is low but non-negligible. Importation of cattle from Canada and the USA would involve an extremely low risk since the prevalence is extremely low in both countries. As Australia is considered free from BSE, the likelihood of importing cattle from that country carrying the agent is considered negligible.

24.2.2. Exposure assessment

Cattle infected with BSE are not infectious and could not infect other cattle. If an infected imported animal was rendered in this country and its rendered products entered the cattle feed chain the BSE agent could be transmitted to other cattle. However, since imported cattle are monitored for their entire lives and rendering them is not permitted, the likelihood of this happening is considered to be extremely low. In addition since there is a statutory ban on feeding rendered products derived from ruminants to ruminants the likelihood of transmission of BSE is considered to be remote.

24.2.3. Consequence assessment

The international market reaction to even a single case being found in New Zealand cattle is likely to be extreme and could result in bans on the importation of New Zealand beef by some countries, or falls in commodity prices. A typical response to the occurrence of the disease at a minimal prevalence is illustrated by the US ban on importing Canadian cattle when a single case was found in Canada and the Japanese ban on American beef imports when more cases of BSE had occurred in Japan than in the USA. Therefore the consequences are considered to be non-negligible.

The BSE agent is widely accepted as the cause of vCJD in humans. However, if a single case of an animal infected with BSE were imported into New Zealand, with the present regulations and controls it is considered that the likelihood of BSE infective agent being transmitted to a person in New Zealand is negligible.

Since the disease is only transmitted by feeding of ruminant protein the likelihood of prions being transmitted to wild or feral animals is negligible. Therefore, the likelihood of damage to the environment is considered to be negligible.

In view of the above, the consequences of introducing BSE into New Zealand are considered to be non-negligible.

24.2.4. Risk estimation

Since entry, exposure, and consequence estimates are non-negligible, the risk estimate for BSE is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

24.3. RISK MANAGEMENT

24.3.1. Options

The OIE *Terrestrial Animal Health Code* classifies countries as being of negligible risk, controlled risk and undetermined risk (OIE 2006). The *Code* recommends conditions under which live animals can be imported from all three country categories.

One of the criteria used by the OIE to determine a country's BSE classification is that meat and bone meal and greaves derived from ruminants has not been fed to ruminants. However, it is very difficult to ensure total compliance with such feed bans and British data (Defra 2007) indicates that clinical cases of BSE can still occur in cattle born more than 14 years after the introduction of a feed ban.

Given the long incubation period of this disease and the possibility of vertical transmission from cow to calf, it is conceivable that infected calves could be derived from an imported individual before infection is detected. International market reaction to the detection of BSE in New Zealand cattle would be likely to result in consequences of a similar or greater magnitude to that which would follow an incursion of foot and mouth disease.

In view of these consequences, one option would be not to import any live animals from countries that have not been categorised by the OIE as posing a negligible BSE risk. The effect of such a position would be to limit the cattle importation from much of the world to germplasm.

Alternatively, one or a combination of the following measures could be considered in order to effectively manage the risk.

- Consistent with Article 2.3.13.7. of the *Code*, animals from a country, zone or compartment posing a negligible BSE risk (as defined by the OIE), could be required to be identified by a permanent identification system in such a way as to demonstrate that they are not exposed cattle as described in point 3)b)iii) of Article 2.3.13.3. of the *Code*, and were born after the date from which the ban on the feeding of ruminants with meat-and-bone meal and greaves derived from ruminants had been effectively enforced.
- Consistent with Article 2.3.13.8. of the *Code*, animals from a country, zone or compartment posing a controlled BSE risk (as defined by the OIE), could be required to be identified by a permanent identification system in such a way as to demonstrate that they are not exposed cattle as described in point 3b)iii) of Article 2.3.13.4. of the *Code*, and were born after the date from which the ban on the feeding of ruminants with meat-and-bone meal and greaves derived from ruminants was effectively enforced.

- Consistent with Article 2.3.13.9. of the *Code*, animals from a country, zone or compartment with an undetermined BSE risk (as defined by the OIE), could be required to be accompanied by certification attesting that:
 1. the feeding of ruminants with meat-and-bone meal and greaves derived from ruminants has been banned and the ban has been effectively enforced;
 2. all BSE cases, as well as:
 - a. all cattle which, during their first year of life, were reared with the BSE cases during their first year of life, and, which investigation showed consumed the same potentially contaminated feed during that period, or
 - b. if the results of the investigation are inconclusive, all cattle born in the same herd as, and within 12 months of the birth of, the BSE cases, if alive in the country, zone or compartment, are permanently identified, and their movements controlled, and, when slaughtered or at death, are completely destroyed;

and cattle selected for export should be identified by a permanent identification system in such a way as to demonstrate that they have not been exposed cattle as demonstrated in point 2 above, and were born at least 2 years after the date from which the ban on the feeding of ruminants with meat-and-bone meal and greaves derived from ruminants was effectively enforced.

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25. Anthrax

25.1. HAZARD IDENTIFICATION

25.1.1. Aetiological agent

Bacillus anthracis.

25.1.2. OIE list

Listed.

25.1.3. New Zealand status

Exotic, notifiable disease last diagnosed in 1954.

25.1.4. Epidemiology

Anthrax is a bacterial disease of most warm-blooded vertebrates including man. The disease occurs in most countries including Australia, Canada, the USA, and most European countries. New Zealand has been free from the disease for 50 years (Gill 1992).

The infectious agent is a spore forming bacillus that can survive in the spore state in suitable soils for many decades. In 1999 an outbreak occurred in Australia on farms where the disease had not occurred for about 100 years. On these properties earthworks in relation to an irrigation scheme possibly resulted in disturbance of old burial sites of cattle (Turner et al 1999a; Turner et al 1999b). A related spore-forming bacillus has been cultivated from palaeozoic slate plugs believed to be 500 million years old (De Vos 1994).

Bacillus anthracis is probably an obligate pathogen that only multiplies in animals and if a carcass is opened, it sporulates resulting in contamination of soil and the environment. In unopened carcasses the organism does not sporulate and is destroyed by putrefaction (De Vos and Turnbull 2004). The disease is not directly transmissible from animal to animal and infection is believed to be associated with ingestion of contaminated soil or other infected material. Biting flies may carry the infection but they were not considered to be important in the transmission of the disease in an outbreak in Australia (Turner et al 1999a). Blowflies may be important in the spread of the disease when they have been feeding on infected carcasses (De Vos and Turnbull 2004). Infection through skin wounds and abrasions may also occur and is a common route of infection for humans (De Vos and Turnbull 2004). In some circumstances infection can occur by inhalation (wool sorter's disease and bioterrorism in humans) but this is not of importance in cattle. Carriers of the disease may occur in partially immunized cattle that recover from natural infection (De Vos and Turnbull 2004).

The incubation period probably varies from one to 14 days and in the peracute form in susceptible species the course of the disease is only a few hours (De Vos and Turnbull 2004). In the acute form of the disease, death usually occurs within 48 hours (Blood and Radostits 1989). Sub-acute and chronic forms of the disease occur in less susceptible animals such as pigs and carnivores (De Vos and Turnbull 2004).

Efficient live spore vaccines are available for control of the disease. The vaccine strain developed by Sterne (Sterne 1937) is usually used. It is a rough strain that has lost plasmid pX02 which codes for the bacterial capsule. The vaccine is non-pathogenic in cattle and provides good immunity for about a year (De Vos and Turnbull 2004).

25.1.5. Hazard identification conclusion

Anthrax is an exotic, notifiable, and zoonotic disease and is therefore classified as a potential hazard in the commodity.

25.2. RISK ASSESSMENT

25.2.1. Entry assessment

If imported directly into New Zealand, cattle could be in the incubation period of the disease which could be up to 14 days. After importation they could die from the disease and if their carcasses were opened the organism could contaminate the environment, particularly soil, with spores which can survive for many years. Therefore the likelihood of entry is considered to be non-negligible.

25.2.2. Exposure assessment

Animals coming into contact with the infected environment created by an infected carcass, even many years after the introduction of the infected animals, could become infected with the disease. Therefore the likelihood of exposure is considered to be non-negligible.

25.2.3. Consequence assessment

If the organism was introduced into the environment, animals that come into contact with and ingest infected soil or water could become infected and again contaminate the environment when they die and their carcasses are opened. The disease could thus become established and lead to the deaths of animals and the need for vaccination to control the disease.

Since anthrax is a zoonotic organism, if the disease became established, sporadic cases of human disease would be likely. These cases would require treatment and some fatalities could be expected.

Since a wide range of animals, especially ruminants can be infected with the organism, cases of anthrax with further contamination of the environment could occur in feral animals such as deer and pigs.

In view of the above, the consequences of introducing *Bacillus anthracis* are considered to be non-negligible.

25.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for anthrax is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

25.3. RISK MANAGEMENT

25.3.1. Options

The OIE *Terrestrial Animal Health Code* states that “there is no evidence that anthrax is transmitted by animals before the onset of clinical and pathological signs” (OIE 2006). Since the incubation period is up to 14 days and the disease runs a peracute or acute course of up to 2 days in cattle and there are not long term carriers of the disease, quarantine is an efficient method to prevent introducing the disease. A quarantine period of 20 days as recommended in article 2.2.1.2 of the OIE *Code* could be imposed on animals to be imported. In addition since highly efficient vaccines are available all animals could be vaccinated before shipment.

One or both of the following measures could be considered in order to effectively manage the risk.

- Cattle could be held in quarantine for at least the 20 days prior to shipment in an establishment where no case of anthrax has ever occurred.
- Cattle could be vaccinated against Anthrax, not less than 20 days and not more than 6 months prior to shipment.

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26. Brucellosis

26.1. HAZARD IDENTIFICATION

26.1.1. Aetiological agent

Brucella abortus is the most common cause of brucellosis in cattle. However, *Brucella suis* and *Brucella melitensis* may occasionally infect cattle. For the purposes of this risk analysis, the term ‘bovine brucellosis’ should be considered to refer to infection of cattle with *Brucella abortus*, *Brucella suis*, or *Brucella melitensis*.

26.1.2. OIE list

Listed.

26.1.3. New Zealand status

Brucella abortus, *Brucella suis*, and *Brucella melitensis* are listed as unwanted notifiable organisms.

26.1.4. Epidemiology

Brucellosis of cattle is a disease that formerly had a world-wide distribution but has now been eradicated from many developed countries. New Zealand has been free from bovine brucellosis since 1989 (Hellstrom 1991; Mackereth 2003). Canada and Australia are free from the disease but it still occurs in the United States and in many parts of Europe (OIE 2006).

Information about the disease has been extensively reviewed (Godfroid et al 2004). *Brucella abortus* infects cattle and rarely other species of ruminants, and causes a serious disease in humans. In cattle the disease is characterised by abortion in females and by orchitis, epididymitis, and infection of the accessory sexual glands in bulls. Infected animals remain chronically infected and females may excrete the organism in their milk and in their uterine discharges after abortions and successive calvings. The uterine discharges contain enormous numbers of organisms that contaminate the environment. The disease is generally transmitted by ingestion of contaminated food or water and via contaminated fomites. The incubation period varies from weeks to years depending on how incubation period is defined and whether the animals were pregnant and the stage of pregnancy when infected. Infection of bulls is less common than cows. Some calves born to infected dams may remain seronegative carriers of the infection and may excrete the organism when they calve.

The disease is diagnosed by serological tests such as the complement fixation test or ELISA and by isolation of the organism from uterine discharge, aborted fetuses, and milk (Nielsen and Ewalt 2004).

Brucella abortus is a zoonotic organism that causes a serious debilitating disease of humans. Humans can contract the disease by drinking unpasteurised milk or by contact with cows at calving.

26.1.5. Hazard identification conclusion

The agents of bovine brucellosis are exotic, notifiable organisms that cause serious diseases of cattle and humans. Bovine brucellosis is therefore considered to be a potential hazard in the commodity.

26.2. RISK ASSESSMENT

26.2.1. Entry assessment

Brucellosis is a chronic disease and the organism can be carried by infected animals for life. Infected females excrete the organisms in uterine discharges and in milk after successive calvings (Godfroid et al 2004). Infected bulls may excrete the organism in their semen (Godfroid et al 2004). The likelihood of entry in the commodity is therefore considered to be non-negligible.

26.2.2. Exposure assessment

Infected animals can shed the organism in their uterine discharges, milk or semen and animals can become infected by ingestion of infected material or more rarely by mating with infected bulls. The likelihood of exposure is therefore non-negligible.

26.2.3. Consequence assessment

Animals exposed to infected imported animals could contract the disease and some months or even years later abort and infect other animals they are in contact with. If left unchecked the disease could gradually spread throughout New Zealand with reversion to an endemically infected state with consequent economic losses to farmers and a loss of the New Zealand's status of freedom from the disease. Introduction of the infection is likely to result in the necessity for an expensive eradication campaign.

Since brucellosis is a serious disease of humans, re-establishment of the disease in New Zealand cattle would be expected to cause some cases of infection in people. Therefore, the consequences for human health are considered to be non-negligible.

As *Brucella abortus* infection has been described in wapiti and elk, it is possible that New Zealand deer could be infected. However, descriptions of serious consequences of infection in these animals are lacking. There were no reports of infection in New Zealand deer when the disease was endemic. The infection in wildlife has been described as only "a marginal problem that poses little risk to the species concerned or to livestock" (Godfroid 2004). The consequences for the New Zealand environment are therefore considered to be negligible.

In conclusion, the consequences of introducing infected animals are considered to be non-negligible since this could result in the establishment of an important infectious disease in cattle and also could have deleterious consequences for human health.

26.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for brucellosis is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

26.3. RISK MANAGEMENT

26.3.1. Options

The OIE recommendations for the importation of live animals (OIE 2006) could be implemented. The OIE defines herds that are officially free from brucellosis (no vaccination) and herds that are free from brucellosis (contains vaccinated animals). OIE recommends that cattle from brucellosis free countries or zones or officially free herds should be tested by a serological test within 30 days of shipment while those from herds that are free from brucellosis should be tested by both the complement fixation test and the buffered antigen test within 15 days of shipment. Animals from other herds should be isolated for 60 days and subjected to a serological test on two occasions with 30 day interval between tests and the last test within the 15 days prior to shipment.

One or combination of the following measures could be considered in order to effectively manage the risk.

- Cattle could be required to show no clinical sign of bovine brucellosis on the day of shipment.
- Cattle could be required to have originated from a herd in which no clinical sign of bovine brucellosis was officially reported during the 6 months prior to shipment.
- Cattle could be required to have originated from a country or zone free from bovine brucellosis, or were from a herd officially free from bovine brucellosis and were subjected to a serological test for bovine brucellosis with negative results during the 30 days prior to shipment.
- Cattle could be required to have originated from a herd free from bovine brucellosis and be subjected to buffered *Brucella* antigen and complement fixation tests with negative results during the 30 days prior to shipment.
- Cattle could be isolated prior to shipment and subjected to a serological test for bovine brucellosis with a requirement for negative results on two occasions, with an interval of not less than 30 days between each test, the second test being performed during the 15 days prior to shipment. These tests could be considered invalid in female animals which have calved during the past 14 days.

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27. Bovine Tuberculosis

27.1. HAZARD IDENTIFICATION

27.1.1. Aetiological agent

Mycobacterium bovis.

27.1.2. OIE list

Listed.

27.1.3. New Zealand status

Endemic, and the subject of a major eradication campaign in the form of a Pest Management Strategy under the Biosecurity Act of 1993.

27.1.4. Epidemiology

Bovine tuberculosis is primarily a disease of cattle but it affects many other species of animals, including humans. In New Zealand it occurs in cattle and deer and in rare cases in sheep and goats. It also occurs in brush tailed possums and feral pigs, goats, and ferrets.

The lesions of the primary complex of infection are localized to the organ of entry and/or the associated lymph node. In many cases the infection remains localized to the primary complex. Sometimes it spreads to infect other organs, or becomes generalized, or occasionally causes miliary tuberculosis (Cousins et al 2004). The clinical signs and pathology vary according to which organs are infected but lesions are essentially epithelioid granulomas with abscessation and sometimes calcification. Transmission is by contact with other infected animals and is usually by the respiratory route but can be by ingestion of infected material.

Bovine tuberculosis has been eradicated from many economically developed countries or is the subject of eradication campaigns. The eradication campaign in New Zealand has failed to eradicate the disease due to its having become established in brush tailed possums which continually re-infect cattle.

The immune response to infection is mainly a cellular response and serological tests are insensitive and of little value. The most commonly used test for the diagnosis of tuberculosis in cattle is still the intradermal tuberculin test (Cousins et al 2004). A more recently developed test that is used in some circumstances is the interferon-gamma test (Wood et al 1991).

The organism can be cultured by standard methods or bacterial DNA can be identified by PCR analysis (Palmer 2004).

27.1.5. Hazard identification conclusion

Mycobacterium bovis is an endemic organism that is the subject of a national eradication campaign administered by the Animal Health Board under a pest management strategy as defined in the Biosecurity Act. It causes severe disease in a number of animal species including cattle and it may affect humans. Therefore *Mycobacterium bovis* is classified as a potential hazard in the commodity.

27.2. RISK ASSESSMENT

27.2.1. Entry assessment

Infected animals may be chronically infected and remain infectious for life. Therefore the likelihood of entry in the commodity is considered to be non-negligible.

27.2.2. Exposure assessment

Animals in contact with imported infected cattle could be infected via the respiratory or oral routes. Infected animals could also contaminate fomites. Animal products such as meat and milk could also be infectious. The likelihood of exposure is therefore non-negligible.

27.2.3. Consequence assessment

Infected cattle may be infectious to in-contact cattle, deer, possums, and other susceptible animals. Establishment of infection in cattle or deer herds and possum populations that were previously free from infection would cause additional expenses in the campaign to eradicate bovine tuberculosis. Individual farms that became infected would be subject to movement restrictions and would suffer losses as a result of condemnation of individual animals and restricted ability to sell animals.

Mycobacterium bovis is a zoonotic organism and any increase in the prevalence of the disease in livestock increases the risk to humans. However, the disease is already endemic in cattle, possums, and deer and *Mycobacterium bovis* infections in humans are rare and the increase in the number of cases caused by introducing infected cattle is likely to be immeasurably small and the overall effect negligible.

Introduction of the organism could lead to infections in feral animals such as possums, pigs, ferrets, deer, and other animals (Coleman and Cooke 2001). New Zealand native birds and animals would not be susceptible.

Since the introduction of infected cattle could lead to new outbreaks of bovine tuberculosis the consequences are non-negligible.

27.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for bovine tuberculosis is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

27.3. RISK MANAGEMENT

27.3.1. Options

The recommendations in the OIE *Terrestrial Animal Health Code* are that administrations of importing countries should require that cattle for breeding or rearing should originate from herds that are free from bovine tuberculosis in a country, zone, or compartment that is free from bovine tuberculosis. Alternatively, they should come from a herd that is free from bovine tuberculosis and be subjected to a tuberculin test, with negative results, within 30 days of shipment, or cattle should be isolated for 3 months and subjected to a tuberculin test, with negative results, on two occasions with an interval of at least 60 days (OIE 2006).

One or a combination of the following options could be considered in order to effectively manage the risk:

- Cattle could be required to have originated from a bovine tuberculosis free herd (as defined in the *Code*), that is in a country, zone, or compartment free from bovine tuberculosis.
- Cattle could be required to have originated from a bovine tuberculosis free herd and be subjected to a tuberculin test, with negative results, within 30 days of shipment.
- Cattle could be isolated for 3 months immediately prior to importation and be subjected to two tuberculin tests with a requirement for negative results, with an interval of at least 60 days between the tests.

It is also noted that, under the SPS agreement, any sanitary measures applied to manage the risk associated with bovine tuberculosis should not be more stringent than the pre-movement testing requirements for domestic cattle in New Zealand. Under the National Pest Management Strategy, the caudal fold tuberculin test and comparative cervical tuberculin test are approved as primary tests for bovine tuberculosis. Interferon-gamma tests and the modified lymphocyte transformation test have been approved as ancillary tests for pre-movement testing of cattle for tuberculosis.

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28. Melioidosis

28.1. HAZARD IDENTIFICATION

28.1.1. Aetiological agent

Burkholderia pseudomallei (formerly *Pseudomonas pseudomallei* and *Malleomyces pseudomallei*).

28.1.2. OIE list

Not listed.

28.1.3. New Zealand status

Listed on the unwanted organisms register as an unwanted exotic organism.

28.1.4. Epidemiology

Melioidosis is a disease of man and animals that occurs predominantly in the tropical and subtropical regions of Asia and northern Australia and in some foci in Africa (Groves and Harrington 1994; Inglis 2004; Inglis et al 2004). A human case has occurred in New Zealand in a traveller returning from Fiji (Corkill and Cornere 1987). The aetiological agent occurs in the environment and is widely distributed in water and soil (Sprague and Neubauer 2004). It has been transmitted to animals via oral mucosa, nasal mucosa, ingestion, parental inoculation, and skin scarification (Groves and Harrington 1994). Infection in natural cases is probably by contact with infected water and mud especially through abrasions and wounds. Water was implicated as a possible source of infections in six locations in one study (Inglis et al 2004).

In animals clinical melioidosis is most commonly seen in sheep, goats and swine. Cattle are thought to be resistant to infection (Groves and Harrington 1994). Isolations were made from pigs, goats, sheep, and birds but not from cattle (Thomas 1981). In animals the agent may cause a wide variety of signs and lesions, varying from septicaemia and acute respiratory infections to localized abscesses.

28.1.5. Hazard identification conclusion

Burkholderia pseudomallei is an organism found very widely in the environment in tropical and subtropical areas, but has not established in temperate climates. It appears to be an opportunistic pathogen and direct transmission from animal to animal is not described. Cattle are resistant to infection. Therefore, it is not considered a potential hazard in the commodity.

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29. Mollicutes Infections

29.1. HAZARD IDENTIFICATION

29.1.1. Aetiological agent

Class: Mollicutes; Order: *Mycoplasmatales*; Family: *Mycoplasmataceae*;

Genus: *Mycoplasma*

Genus *Ureaplasma*

Genus: *Acholeplasma*

29.1.2. OIE list.

Contagious bovine pleuropneumonia (caused by *Mycoplasma mycoides* subsp. *mycoides* SC) is listed.

29.1.3. New Zealand status

The following Mollicutes have been identified in New Zealand and will not be considered further:

Mycoplasma mycoides subsp. *mycoides* LC (Jackson and King 2002), *Mycoplasma alkalescens* (Brookbanks et al 1969), *Mycoplasma arginini* (Belton 1990; Belton 1996), *Mycoplasma dispar* (Hodges et al 1983), *Acholeplasma laidlawi* (Belton 1990; Belton 1996), and *Ureaplasma* spp. (Hodges and Holland 1980; Thornton and Wake 1997).

Mycoplasma hyorhinis and *Mycoplasma hyopneumoniae* have been isolated from pigs (MacPherson and Hodges 1985).

Mycoplasma mycoides subsp. *mycoides* SC is listed on the unwanted organisms register as an unwanted notifiable organism.

The following Mollicutes have not been identified in New Zealand and are considered to be exotic:

Mycoplasma bovis, *Mycoplasma bovirhinis*, *Mycoplasma bovigenitalium*, *Mycoplasma bovis*, *Mycoplasma verecundum*, *Mycoplasma californicum*, *Mycoplasma canadense*, *Mycoplasma group 7*, *Acholeplasma axanthum*, *Acholeplasma modicum*, and *Ureaplasma diversum*

There are probably other unidentified species that occur in both New Zealand and overseas.

29.1.4. Epidemiology

There are at least 124 species in the *Mycoplasma* genus, 8 in the *Ureaplasma* genus and 18 in the *Acholeplasma* genus (Anonymous 2004). These organisms are widely distributed in nature and often occur as saprophytes or commensals associated with specific species of animals. In several cases they have been associated with various disease syndromes but in some cases the

role they play as pathogens is uncertain since they have also been isolated from healthy animals. In diseased animals they sometimes occur as mixed infections and in only a few cases can they be considered to be pathogens for which Koch's postulates can be fulfilled e.g. *Mycoplasma mycoides mycoides* SC in cattle and *Mycoplasma capricolum capripneumoniae* in goats. Many species are best thought of as opportunistic pathogens. In addition to these problems they are sometimes difficult to culture and to classify and there have been some confusing changes to the taxonomy of the organisms. The number of organisms in the group is gradually increasing and it is unclear whether these are truly new organisms or were present in the past but wrongly typed or not typed. For these reasons older literature cannot always be accepted as being completely reliable. Basic information such as incubation periods, how long animals remain carriers for etc is often not available. Finally since the amount of work done to diagnose these infections in New Zealand may not be optimal, a statement that "the organism has not been described in New Zealand", has a clearly different meaning from a statement that "an organism is absent from or exotic to New Zealand".

Acholeplasma spp. are not significant veterinary pathogens (Anonymous 2004). Therefore, *Acholeplasma* spp. are not considered further in this document.

Mycoplasma mycoides mycoides SC is exotic in Australia, Canada, the USA and the EU and therefore not considered further.

Ureaplasma spp. have been isolated in New Zealand from bovine semen, sheath washings, and the female genital tract (Hodges and Holland 1980; Thornton and Wake 1997), but were not identified to species level. *Ureaplasma diversum* will therefore be regarded as an exotic species in this risk analysis.

Mycoplasma bovigenitalum is a common isolate of the urogenital tract of cows and bulls (Trichard and Jacobsz 1985). The organism has been associated with granular vulvovaginitis, necrotizing endometritis, seminal vesiculitis, and poor sperm motility but it is also commonly isolated from the lower reproductive tract of normal animals (Irons et al 2004).

Mycoplasma bovis was first isolated in the USA in 1961 and spread to many countries between 1970 and 2000 (Nicholas and Ayling 2003a). It was the *Mycoplasma* species most commonly isolated in Britain between 1990 and 2000 (Ayling et al 2004). Most isolations were from the lung or upper respiratory tract. It also occurs commonly in France (Le et al 2002). The organism has been described as a major cause of respiratory disease, mastitis, and arthritis, and as being responsible for a quarter to a third of the cases of calf pneumonia in Europe (Nicholas and Ayling 2003a). It has been associated with mastitis (Gonzalez et al 1992; Kirk et al 1997; Pfutzner and Sachse 1996) and with polyarthritis (Henderson and Ball 1999). It has also been isolated from semen (Eder-Rohm 1996; Ozdemir and Turkarslan 1998) and the female genital tract (Irons et al 2004).

Mycoplasma canadense has frequently been associated with mastitis but has also been isolated from normal milk (Ball and Mackie 1986; Baungartner 1999; Infante-Martinez et al 1999; Kaur and Garg 2000; Kirk et al 1997; Mackie et al 2000). Mastitis has been produced by experimental infection with this organism (Ball and Mackie 1986). It has also been isolated from semen and preputial washings (Ball 1990; Ball et al 1987b) and was associated with vulvitis in a heifer (Gilbert and Oettle 1990). However, intrauterine inoculation of the organism into adult cows did not cause lesions or lasting infections (Ball et al 1990; Ball et al 1987a).

Mycoplasma californicum has been associated with mixed infections of *Mycoplasma canadense* and *Mycoplasma californicum* in cases of mastitis (Infante-Martinez et al 1999; Mackie et al 2000). It has also been isolated from udders of dry cows (Mackie et al 1986), bovine foetuses (Boughton et al 1983), and from bull semen (Friis and Blom 1983).

Mycoplasma group 7 organisms have been associated with polyarthritis, mastitis and aborted foetuses (Hum et al 2000; Shiel et al 1982), particularly in Australia. They have also been isolated from cervicovaginal mucous and uterine discharge in buffaloes with a history of abortion (Pal et al 1984) and from preputial washings of male buffaloes (Katoch et al 1984). The organisms have also been isolated from urogenital tracts of cattle and aborted foetuses and from normal cows (Irons et al 2004).

Ureaplasma diversum has been associated with granular vulvovaginitis, endometritis, salpingitis, seminal vesiculitis, granular balanoposthitis, and aborted foetuses, but has also been isolated from normal cattle (Irons et al 2004). It was isolated from five aborted foetuses and four calves that were born prematurely and died. The isolated strain was inoculated onto the vulva of a virgin heifer and caused profuse purulent discharge (Ruhnke et al 1984). In Denmark, *Ureaplasma* spp. was the most frequent isolate from the urogenital tract in outbreaks of granular vulvovaginitis (Friss and Krog 1983). Le Grande isolated the *Ureaplasma diversum* from 74% of semen samples and 40% of normal cattle and found no association between granular vulvovaginitis or breeding performance and infection with the organism (Le Grand et al 1995). In a large experiment in a group of beef heifers, most showed signs of vulvovaginitis before breeding and 44% were positive for *Ureaplasma diversum* (Rae et al 1993).

Other organisms listed in Section 30.1.3 are considered less pathogenic. *Mycoplasma alkalescens*, *Mycoplasma arginini* and *Acholeplasma* spp. do not cause clinical disease. In attempts to transmit the organism experimentally, *Mycoplasma verecundum* did not infect gnotobiotic calves and *Mycoplasma arginini* and *Mycoplasma alkalescens* infected the lower respiratory tract of gnotobiotic calves but caused no signs of disease (Gourlay et al 1979).

29.1.5. Hazard identification conclusion

Amongst the Mollicutes there appears to be a gradation of pathogenicity from primary pathogens such as *Mycoplasma mycoides mycoides* SC to organisms which are clearly non pathogenic commensals such as *Acholeplasma laidlawii*. The diseases or syndromes can be classified as erosion diseases causing a decline in economic efficiency which may vary from significant to minimal depending on the species and the circumstances. Since there is no justification for importing organisms that may be opportunistic pathogens, it would be reasonable to consider excluding all exotic Mollicutes that are known to infect animals. The following organisms are therefore considered to be potential hazards in the commodity:

Mycoplasma bovis

Mycoplasma bovis

Mycoplasma californicum

Mycoplasma canadense

Mycoplasma verecundum

Mycoplasma group 7

Ureaplasma diversum

29.2. RISK ASSESSMENT

29.2.1. Entry assessment

These organisms can be isolated from animals suffering from a wide range of disease syndromes and from normal animals. The organisms can be isolated from a variety of tissues and body secretions (see above). It is therefore concluded that the likelihood that live animals will carry these organisms is non-negligible.

29.2.2. Exposure assessment

Since imported cattle will be integrated into New Zealand cattle herds the likelihood of exposure of New Zealand cattle to any imported Mollicutes is non-negligible.

29.2.3. Consequence assessment

Mycoplasma bovis is regarded as a major pathogen that causes respiratory disease, mastitis and arthritis in cattle (Nicholas and Ayling 2003a). Introduction of the pathogen could cause a variety of disease syndromes in cattle. Other Mollicutes could also be responsible for outbreaks respiratory disease, infertility, mastitis and arthritis in cattle.

There is no evidence to suggest that the introduction of Mollicutes would adversely effect the environment. The species found in cattle are not found in birds and although other ruminants can be infected, these organisms have not been described as causing significant diseases of deer, or wild goats.

Mycoplasmas of cattle do not infect humans. The likelihood that species introduced in cattle would have deleterious effects on human health is considered to be negligible.

In conclusion, although the introduction of new species of Mollicutes would not have deleterious effects on human health or the environment, the likely effects on bovine health and the cattle industry are considered to be non-negligible.

29.2.4. Risk estimation

Since the entry, exposure, and consequence assessments are non-negligible, the risk estimate for these exotic Mollicutes is non-negligible, and they are classified as hazards in the commodity. Therefore, risk management measures can be justified.

29.3. RISK MANAGEMENT

29.3.1. Options

There are few suitable options for preventing the introduction of Mollicutes in live cattle.

Testing animals to detect carriers of all of these Mollicutes is not possible because of the variety of organisms that may be involved and the lack of a suitable range of tests to detect them. A requirement for country, region, or herd freedom is not an option as routine surveillance for these organisms is unlikely to be carried out in the countries considered in

this risk analysis. One or a combination of the following measures could be considered in order to effectively manage the risk.

- Diagnostic methods for *Mycoplasma bovis* include culture of organisms, detection of mycoplasmal DNA by PCR and serological testing. Imported animals could be isolated for a suitable period before being tested by a suitable ELISA for the detection of antibody to the organism (Ghadersohi et al 2005). Animals that are positive to the test could be regarded as possible carriers and excluded from being imported into New Zealand.
- In addition careful clinical examination could be undertaken. If clinical signs of respiratory disease, arthritis, mastitis, or reproductive tract infections are found relevant samples could be taken and cultured for Mollicutes.
- Mollicutes isolated could be identified and a decision made on whether to allow the importation of the animal. Milk samples could be cultured from all animals that are in milk at the time of importation.
- Animals to be imported could be treated with antibiotics to which *Mycoplasma* spp. are sensitive. Several recent investigations indicate that all strains tested have been sensitive to the fluoroquinolone antibiotics such as enrofloxacin (Godinho et al 2005; Rosenbusch et al 2005; Stipkovits et al 2005; Thomas et al 2003). Other effective antibiotics include tulathromycin (Godinho et al 2005) and valnemulin (Stipkovits et al 2005). Resistance to some of the older antibiotics such as tetracyclines, lincomycin, and spectinomycin has developed and is now becoming evident (Ayling et al 2000; Nicholas and Ayling 2003a; Nicholas and Ayling 2003b; Thomas et al 2003). MAF could therefore specify that imported animals are treated with suitable antibiotics and regularly follow the literature and select the most suitable antibiotics for this purpose.
- Cattle for importation could be required to have originated from farms on which there has been no evidence of respiratory disease, mastitis or arthritis caused by *Mycoplasma* spp. during the previous 3 years immediately prior to export.
- In view of the potential limitations of the above sanitary measures, live cattle imports could be prohibited and access to overseas bovine genetics limited to germplasm.

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30. Haemorrhagic Septicaemia

30.1. HAZARD IDENTIFICATION

30.1.1. Aetiological agent

Pasteurella multocida types B and E.

30.1.2. OIE list

Listed.

30.1.3. New Zealand status

Listed on the unwanted organisms register as an unwanted notifiable organism.

30.1.4. Epidemiology

Haemorrhagic septicaemia occurs predominantly, but not entirely, in tropical and sub-tropical countries of Asia and Africa. It does not occur in Australia or Canada, and is a rare disease limited to specific zones in the USA. In the 27 countries that make up the European Union it only occurs in Portugal, Spain, Poland, and Romania (OIE 2006). In Africa it is caused by *Pasteurella multocida* types B and E and in Asia by type B (Bastianello and Henton 2004; Carter 1998).

It is predominantly a disease of cattle and buffaloes. The incubation period in naturally acquired infections is from 1-3 days (Bastianello and Henton 2004; Carter 1998; de Alwis 1992). The course usually varies from peracute to subacute but inapparent infections also occur. Peracute infections are characterized by sudden death, while acute cases show fever, profuse salivation, nasal discharge, and rapid respiration. Firm subcutaneous swellings in the submandibular region are seen in subacute cases. Untreated cases usually end fatally (Bastianello and Henton 2004). Animals that survive infection may be active carriers for 4-6 weeks and then become latent carriers. In herds recently exposed to the infection, up to 23% of animals may be latent carriers and these animals may remain carriers for at least 229 days (Bastianello and Henton 2004; de Alwis et al 1990). In carriers the organism is harboured in the nasopharynx, retropharyngeal lymph nodes, and tonsils and carrier animals may periodically become active shedders of the disease (Bastianello and Henton 2004; de Alwis et al 1990) when stressed. The organism is excreted in respiratory aerosols, saliva, urine, faeces, and milk. Transmission is by the respiratory route or on fomites.

Resistance to antibiotics has not been described and treatment with sulphonamide antibiotics is effective in controlling outbreaks of the disease (Bastianello and Henton 2004). However, treatment is ineffective for curing the carrier state (de Alwis et al 1990).

Animals become septicaemic a few hours before death and culture from blood is only possible in this period (Chandrasekaran and Townsend 2004). Recovered animals and latently infected animals carry the organism in their tonsils. Culturing tonsillar swabs is recommended in the OIE *Terrestrial Animal Health Code* (OIE 2006). Serological tests using the indirect

haemagglutination test are seldom used. High antibody titres are indicative of recent infection (Chandrasekaran and Townsend 2004) and are not valuable for detecting latent carriers of agent.

Vaccination is useful for the control of the disease. A single dose of alum precipitated vaccine protects for 4-6 months and a single dose of oil-adjuvanted vaccine protects for 6-9 months.

30.1.5. Hazard identification conclusion

Pasteurella multocida types B and E are unwanted notifiable organisms that cause serious disease in cattle and are therefore considered to be potential hazards in the commodity.

30.2. RISK ASSESSMENT

30.2.1. Entry assessment

Animals may remain carriers of infection for at least 229 days (de Alwis et al 1990) and may excrete the organism periodically when stressed (Bastianello and Henton 2004). Since imported animals could be active or latent carriers of the agent the likelihood that imported animals could be carriers of the organism is considered to be non-negligible.

30.2.2. Exposure assessment

Imported latent carriers of infection could periodically excrete organisms and infect those animals that they are in contact with. The likelihood of exposure is therefore non-negligible.

30.2.3. Consequence assessment

As a result of exposure of New Zealand cattle to the infection the disease could establish in a herd into which imported animals have been introduced. The disease could spread to other herds by movement of cattle. Establishment of the disease in New Zealand would be a slow process probably taking many years. Sporadic outbreaks of mortality could be expected. Control and eradication would be difficult since detection of latent carriers would be difficult or impossible, but it would probably require the slaughter of infected herds and tracing all movements of cattle from or into infected herds.

Haemorrhagic septicaemia is not a disease of people and there would be no consequences for human health.

Haemorrhagic septicaemia is only a disease of cattle and buffalo and there would be no consequences for the environment.

Since the disease could establish in New Zealand and cause mortalities in cattle the consequences are considered to be non-negligible.

30.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for haemorrhagic septicaemia is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

30.3. RISK MANAGEMENT

30.3.1. Options

Animals could be imported from countries or zones that are free from the disease as defined in the OIE *Terrestrial Animal Health Code* (OIE 2006). When importing from countries where the disease occurs the *Code* recommends that animals should be quarantined for 3 months prior to shipment and examined for the causative organism in the nasopharynx on four occasions, at weekly intervals during the last month of quarantine. The *Code* also recommends that animals from such countries be vaccinated not less than 30 days prior to shipment, and that they should show a positive reaction to the passive mouse protection test. However, the latter test is still under study. The *Code* recommendations could be adopted with the exception of the passive mouse protection test which could be considered when it has been validated and approved by the OIE.

Therefore, one or a combination of the following measures could be considered in order to effectively manage the risk.

- Animals could be imported from countries or zones that are free from the disease according to the OIE definition of country and zone freedom.
- Animals could be kept in a quarantine station for the 3 months prior to shipment and during the last month swabs could be taken from the nasopharyngeal region and cultured for *Pasteurella multocida*, on four occasions at weekly intervals. All isolates could be serotyped and identification of *Pasteurella multocida* serotype B or E could result in disqualification for export to New Zealand.
- Animals could be vaccinated with alum precipitated or oil-adjuvanted vaccine not less than 30 days and not more than 90 days prior to shipment.
- Once the passive mouse protection test has been validated, the inclusion of this test as a requirement for importation could be considered.

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31. Salmonellosis

31.1. HAZARD IDENTIFICATION

31.1.1. Aetiological agent

There are approximately 2,500 known serovars in the *Salmonella* genus (Davies 2004). Most of these belong to the species *enterica* and the subspecies *enterica* and if correct naming conventions are used, the names such as Dublin and Typhimurium, which do not have species status, should not be italicised. The correct name for the serovar *typhimurium* is *Salmonella enterica* subsp. *enterica* serovar Typhimurium. However, in the following discussion for the sake of simplicity names are italicised and abbreviated as though the serovar had species status e.g. *Salmonella typhimurium*.

This analysis is concerned mainly with two important serovars: *Salmonella dublin* and *Salmonella typhimurium* but it also covers other exotic serovars.

Within each serovar there are multiple strains which can be identified by phage typing. In the case of *Salmonella typhimurium*, only the definitive phage type (DT) 104 is specifically considered in this analysis. *Salmonella typhimurium* DT104 is of particular significance because it exhibits multiple resistance to the common mainline antibiotics and is a threat to human health (Hogue et al 1997; Jones et al 2002). It is now widely distributed in the world.

31.1.2. OIE list

Bovine salmonellosis is not a listed disease in the OIE *Terrestrial Animal Health Code*. However, in the OIE *Manual of Diagnostic Tests and Vaccines* salmonellosis is included in the section “Diseases not covered by List A and List B”.

31.1.3. New Zealand status

Salmonella dublin is listed on the unwanted organisms register as an unwanted notifiable organism. *Salmonella typhimurium* is endemic in New Zealand but phage type 104 has only occurred rarely in humans and once in a dog and is classified in the category of “other unwanted organisms”. *Salmonella* spp. exotic to New Zealand are classified as other exotic species on the unwanted organisms register.

31.1.4. Epidemiology

Salmonella spp. isolated in New Zealand from humans and animals are identified to serovar and phage type by the Environmental Science and Research (ESR) laboratory and recorded on a database (ESR 2003 and 2004b).

Information in this section relates mainly but not exclusively to *Salmonella typhimurium* and *Salmonella dublin* which commonly infect cattle.

Salmonella dublin has not been isolated in New Zealand. In other countries *Salmonella dublin* occurs most commonly in cattle but also in sheep.

Salmonella typhimurium is endemic in New Zealand in both animals and humans but DT104 has only been isolated from humans, four times in 2003 and twice in 2004 (ESR 2003 and 2004a; ESR 2003 and 2004b). It has also been isolated from three dogs in a household where the owners suffered from diarrhoea after returning from an overseas visit (Julian 2002). The sporadic occurrence of *Salmonella typhimurium* DT104 in a few cases in humans and once in a dog does not suggest that it has become established in the New Zealand animal population.

Salmonella dublin and *Salmonella typhimurium* DT 104 occur in all the countries covered by this risk analysis. For example *Salmonella dublin* and *Salmonella typhimurium* infections of cattle have been frequently described in England (Hogue et al., 1997; Davies, 2001; Jones et al., 2002; Davies, 2004), mainly in calves but also occasionally in adult cattle.

Salmonella infection is mainly by the oral route and factors such as infecting dose, the particular strain and species, and various stress factors influence the outcome of infection (Fenwick and Collett 2004). The incubation period is variable but the organisms may be found in the bloodstream of newborn calves within 15 minutes of ingestion (Blood et al 1994). After oral infection, *Salmonella* colonise the distal ileum and can be recovered in high numbers from this site within 72 hours. The intestine is initially infected and inflammation of the gut is the primary lesion. Initial infection may be followed by invasion of the gut and mesenteric lymph node barrier followed by bacteraemia and dissemination to several organs. In the case of pregnant animals abortion due to *Salmonella dublin* may occur. Animals that recover from *Salmonella dublin* infections frequently become carriers and may remain carriers for life, shedding organisms sporadically in their faeces. Animals infected with *Salmonella typhimurium* may be carriers of infection for 3-4 months.

Excreted organisms contaminate the environment and become a source of infection (Blood et al 1994). Young animals are more often affected by the disease than adults and very young animals may die after a short period of bacteraemia.

Carriers of infections can be detected by culturing faeces samples but because excretion is intermittent repeated sampling and culture is necessary (Davies 2004). Serology may be useful but is best applied on a herd basis (Davies 2004; Veling et al 2002). It has also been used for the identification of individual carriers but its validity is influenced by age of the animal and is most valid for animals aged over 100 days of age (Nielsen and Ersboll 2004; Nielsen et al 2004a; Nielsen et al 2004b). No practical method exists for detecting individual carrier animals (Hansen et al 2006).

31.1.5. Conclusions

Salmonella dublin is an exotic, notifiable, zoonotic organism and *Salmonella typhimurium* type DT104 is an unwanted and zoonotic organism. Therefore these organisms are classified as potential hazards in the commodity. Other exotic *Salmonellas* are also considered to be potential hazards in the commodity.

31.2. RISK ASSESSMENT

31.2.1. Entry assessment

Animals infected with *Salmonella* spp. may carry the organism for long periods and excrete the organism intermittently in their faeces. Therefore the likelihood of release of the agent/s in New Zealand is non-negligible.

31.2.2. Exposure assessment

Imported carrier animals would be moved into herds of susceptible New Zealand animals and would excrete the organism intermittently in their faeces. Therefore they would be likely to infect New Zealand animals. The likelihood of exposure of indigenous animals is therefore non-negligible.

31.2.3. Consequence assessment

The introduction of animals with exotic salmonellae is likely to result in infection of animals in contact with them. These newly infected animals could become carriers and excretors of organisms and potentially infect other animals and people. The introduction and establishment of any new *Salmonella* spp. could result in spread of the organisms in New Zealand and the establishment of production limiting diseases of livestock.

The establishment of *Salmonella typhimurium* DT104 in animal populations would constitute a source of infection and be of particular concern to human health because of its resistance to antibiotics (Hogue et al., 1997; Davies, 2001). *Salmonella dublin* is also a zoonotic organism that could cause disease in people.

There would be no particular consequences for the environment other than possibly causing sporadic cases of salmonellosis in wild or feral animals. An outbreak of a new phage type of *Salmonella typhimurium* (DT160) occurred in sparrows and in humans in 2001. Infection was associated with several hundred deaths in sparrows (Alley et al 2002). The outbreak was self limiting and did not have any lasting effect on the sparrow population. However *Salmonella* infections can establish in wild bird populations and be associated with sporadic mortalities (Pennycott 2001).

In conclusion, the introduction of infected cattle could lead to the establishment of new *Salmonella* spp. that have the potential to cause disease in humans and animals. Therefore the consequences are non-negligible.

31.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for Salmonellae is non-negligible, and they are classified as hazards in the commodity. Therefore, risk management measures can be justified.

31.3. RISK MANAGEMENT

31.3.1. Options

The OIE *Terrestrial Animal Health Code* does not give any guidance about the risk management options relating to *Salmonella* spp. when importing animals.

Although it may be assumed that animals to be imported would be healthy and in particular would not show any signs of diarrhoea, carriers of *Salmonella* spp are unlikely to show signs of infection. Animals could be held in quarantine for at least 3 weeks. Faecal samples could be cultured for *Salmonella* spp. However since carriers may excrete organism intermittently they would need to be cultured on more than one occasion.

One or a combination of the following measures could be considered in order to effectively manage the risk.

- Cattle could be required to have originated from farms where outbreaks of salmonellosis due to *Salmonella dublin* or *Salmonella typhimurium* DT104 have not been confirmed by laboratory testing in the last 3 years.
- Cattle could be held for at least 3 weeks in a quarantine station in which cases of salmonellosis have not occurred in the previous 3 months.
- Faecal samples from quarantined animals could be cultured on at least 2 occasions with an interval of at least 10 days using suitable pre-enrichment and enrichment media (Davies, 2004). All *Salmonella* spp. isolated could be serotyped (and, where appropriate, phage typed) and the results reported to MAF. Where pathogenic *Salmonella* spp., exotic to New Zealand are isolated, the animals could be considered ineligible for importation for the remainder of its life (unless the organism is no longer considered exotic to New Zealand). Where *Salmonella* spp. that are endemic to New Zealand are isolated it might be left to the importer of the animals to decide whether to proceed with the importation.
- Since it is likely that reliable serological and other diagnostic methods will be developed for diagnosis of carrier animals (especially for *Salmonella dublin*), MAF could consider these methods when they become available.

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32. Leptospirosis

32.1. HAZARD IDENTIFICATION

32.1.1. Aetiological agent

There are over 200 *Leptospira* serovars classified into 23 serogroups (Bolin 2004). A newer alternative scheme based on genomic characteristics classifies the pathogenic organisms into several species. However, for the purposes of this risk analysis, serovars are written as if they were single species e.g. *Leptospira hardjo*, *Leptospira pomona* etc.

32.1.2. OIE list

Leptospirosis is listed by the OIE although the current *Terrestrial Animal Health Code* chapter for this disease is “under study”.

32.1.3. New Zealand status

Leptospira hardjo, *Leptospira pomona*, *Leptospira balcanica*, *Leptospira copenhageni*, *Leptospira ballum*, and *Leptospira tarrasovi* have been isolated from animals in New Zealand (Midwinter 1999). A single isolation of *Leptospira australis* has been reported from a human (Thompson 1980). In humans, serological diagnosis indicates that five of the species endemic in farm animals infect humans but *Leptospira balcanica* which is associated with possums has not been diagnosed in man (Anonymous 2004). Other *Leptospira* spp. are classified by MAF as “other exotic organisms”.

32.1.4. Epidemiology

Leptospirosis is not a single disease but a complex of diseases caused by at least 200 different organisms. Many *Leptospira* serovars are adapted to a particular host species in which an almost symbiotic relationship has been formed. Species other than the maintenance host may be more resistant to infection but if infected are more susceptible to disease. *Leptospira hardjo* for example infects most cattle in an endemic situation but only causes occasional cases of disease in cattle. However, it may be responsible for causing sporadic cases of disease in other species such as man (accidental hosts). In maintenance hosts, *Leptospira* may localise in the kidneys and the animals may continue to excrete the organism in their urine for years. Cattle can remain carriers of *Leptospira hardjo* for at least 450 days (Hunter 2004). In New Zealand the prevalence of the disease in humans is relatively high for a temperate climate country and *Leptospira hardjo* accounts for nearly half the cases (Thornley et al 2002). Leptospirosis occurs world-wide and in all the countries covered by this risk analysis. The endemic serotypes that occur in each country differ but world-wide *Leptospira hardjo* is the most common serovar found in cattle.

Leptospire spread in water and mud contaminated with infected urine. Infection can occur by mouth or through the skin particularly through abrasions and wounds. Diseased animals shed more organisms and are more important sources of infection than chronic carriers (Horsch 1989).

In accidental hosts the incubation period may be from 2-16 days and is followed by a period of bacteraemia. A variety of signs may be shown by diseased animals including abortion, haemolytic anaemia, icterus, and nephritis. The disease can be diagnosed by the isolation of the organism, but because this is a difficult process it is more usually diagnosed by serological methods, with a rising titre signifying recent infection and a stable, often low level titre indicating resolution or a chronic infection. The microscopic agglutination test is still the most commonly used herd test but a number of variations of ELISAs are also available. ELISAs generally lack serovar specificity (Bolin 2004). Leptospirosis is seldom the cause of economically serious disease in animals and is mainly of concern because it is a zoonotic disease that occasionally causes serious disease in humans (Thornley et al 2002).

Leptospira spp. are sensitive to several antibiotics (Alt et al 2001; Gerritsen et al 1994; Gerritsen et al 1993; Murray and Hospenthal 2004; Oie et al 1983). In particular streptomycin and penicillin have been extensively used for prophylaxis and treatment of live cattle, semen and embryos in international trade.

Vaccination of animals against the main serovars occurring in New Zealand is widely practiced, with the aim of developing an immune population and thereby reducing the risk to humans that are in contact with the cattle.

32.1.5. Hazard identification conclusion

Leptospira spp. other than the 6 endemic species are exotic, zoonotic organisms and are classified as potential hazards in the commodity.

32.2. RISK ASSESSMENT

32.2.1. Entry assessment

Acutely infected animals or chronic carriers of infection may excrete the organism in urine and, in bulls, in their semen. Therefore the likelihood of entry in the commodity is non-negligible.

32.2.2. Exposure assessment

Carriers shed the organism in their urine and are likely to infect cattle that are in contact with them. Venereal transmission of the organism is also possible. Since imported cattle will be introduced into New Zealand cattle herds the likelihood of exposure of New Zealand cattle to the organisms is considered to be non-negligible.

32.2.3. Consequence assessment

Introduction of new serovars of leptospira are unlikely to have a significant impact on the New Zealand cattle population. Sporadic cases of disease may occur, but the economic consequences would be negligible.

The establishment of a new *Leptospira* serovar to which humans are susceptible could lead to sporadic occurrence of leptospirosis in humans. The number and seriousness of the cases would depend on the serovars involved and the possibility for contact with infected animals. Some serovars are not important as human pathogens e.g. in New Zealand *Leptospira balcanica* is common in its maintenance host the brush tailed possum, but infections of

humans have not occurred despite the close contact between possums and possum hunters (Anonymous 2004).

There are not likely to be noticeable consequences for feral or wild animals but some species such as *Leptospira grippotyphosa*, *Leptospira canicola*, *Leptospira sejroe*, and *Leptospira saxkoebing* could become established in mice and rats (Horsch 1989) and subsequently be responsible for infecting humans.

The establishment of new *Leptospira* serovars could cause sporadic cases of disease in humans. Therefore, the consequences of establishment are considered to be non-negligible.

32.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for Leptospirosis is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

32.3. RISK MANAGEMENT

32.3.1. Options

Because of the occurrence of long term carriers of infection, quarantine is not a suitable option. Diagnosis by means of serology is complex to perform and the results are difficult to interpret because of the many serovars and the difficulty in interpretation of the meaning of cross reactions and low titre reactions. Testing of urine samples by culture or PCR is problematic because isolation of organisms is difficult and selection of primers for PCR that will recognize all serovars has not yet been achieved. The remaining option is to rely on the use of antibiotics for the elimination of organisms from carriers. This measure has been used for many years and could be continued. Alternatively, live cattle imports could be prohibited and access to overseas bovine genetics limited to germplasm.

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33. Lyme Disease

33.1. HAZARD IDENTIFICATION

33.1.1. Aetiological agent

Borrelia burgdorferi

33.1.2. OIE list

Not listed.

33.1.3. New Zealand status

Listed on the unwanted organisms register as an unwanted exotic organism.

33.1.4. Epidemiology

Borrelia burgdorferi is a tick borne spirochaete that is pathogenic for humans and infects many animal species. The disease occurs in North America and in Europe. There is still some uncertainty about whether the disease occurs in Australia but if it does, it is rare (Russell 1995).

The organism is transmitted by ticks of the *Ixodes* genus, particularly *Ixodes scapularis* and *Ixodes pacificus* in the USA (Anonymous 2004), and *Ixodes ricinus* and *Ixodes persulcatus* in Europe (Alekseev and Dubinina 2000; Hubalek et al 2004; Ogden et al 1997; Utenkova et al 2004). Organisms have been isolated from other tick species including *Haemaphysalis concinna* (Sun and Xu 2003), *Haemaphysalis* spp. (Tian et al 1998), and *Haemaphysalis longicornis* (Sun and Xu 2003; Wan et al 1998; Wang et al 2000). However, it was found that the organism was not transmitted transtadially by *Haemaphysalis concinna* but could be transmitted transtadially by *Ixodes persulcatus* (Sun and Xu 2003). Therefore it is doubtful if *Haemaphysalis* spp. can act as competent vectors. Evidence in man and other animals indicates that the disease is not directly infectious and that it is only tick-borne.

In animals infection seldom results in clinical disease. Dogs have been described as sporadically showing signs of infection similar to those in humans. Chronic infections are characterised by arthritis. Surveys have shown that antibodies to *Borrelia burgdorferi* are common in cattle in Japan (Isogai et al 1992; Takahashi et al 1993), the United States (Ji and Collins 1994; Wells et al 1993), Slovakia (Stefancikova et al 2002), and Great Britain (Carter et al 1996) and there appears to be an association between high antibody titres and clinical lameness in these animals (Wells et al 1993). However, it is possible that a different spirochaete associated with cases of digital dermatitis may cause cross reactions in the ELISA test for *Borrelia burgdorferi* (Blowey et al 1994; Carter et al 1996; Cranwell and Cutler 1996). *Borrelia burgdorferi* has been isolated and demonstrated by immunofluorescent techniques in cattle and DNA has been demonstrated in cattle by PCR (Burgess et al 1987; Burgess et al 1993; Lischer et al 2000). However, the disease is not commonly recognised in cattle and it is likely that subclinical infections are more common than clinical disease.

Nothing was found in the literature about the incubation period in cattle or the length of time for which the animals remain parasitaemic or whether they are infectious for ticks.

Cattle are not described as important reservoirs of infection. The main reservoir hosts in both the USA (Anonymous 2004; Margaletic 2003), Europe (Bunikis et al 2004; Pawelczyk et al 2004; Stefancikova et al 2004), and China (Wan et al 1999) are believed to be small mammals, particularly rats and mice. In North America the main host is the white footed mouse (LoGiudice et al 2003).

33.1.5. Hazard identification conclusion

Borrelia burgdorferi is an exotic unwanted organism that can infect cattle. It is therefore considered to be a potential hazard in the commodity.

33.2. RISK ASSESSMENT

33.2.1. Entry assessment

Since infected cattle have been described, the likelihood of entry in imported cattle is considered to be non-negligible.

33.2.2. Exposure assessment

The organism is transmitted by ticks and cattle are not known to transmit the disease directly to other cattle. Available evidence indicates that *Haemaphysalis* spp. ticks are not competent vectors of the disease (Sun and Xu 2003). Therefore, the likelihood that indigenous cattle ticks could be infected with the organism is considered to be negligible. The likelihood of exposure is therefore considered to be negligible.

33.2.3. Risk estimation

Because the exposure assessment is considered to be negligible, the risk estimate for *Borrelia burgdorferi* is negligible and it is not classified as a hazard in the commodity. Therefore, risk management measures are not justified.

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34. Spirochaetosis (*Borrelia theileri*)

34.1. HAZARD IDENTIFICATION

34.1.1. Aetiological agent

Borrelia theileri.

34.1.2. OIE list

Not listed.

34.1.3. New Zealand status

Not described in New Zealand.

34.1.4. Epidemiology

The organism is transmitted by ticks and can infect horses, cattle, sheep, goats, and antelope (Bishop 2004). It is widely distributed and has been described in Africa, Europe, Australia, South America, Mauritius, and Madagascar. Tick vectors are believed to include species from the genera *Boophilus* and *Rhipicephalus* (Bishop 2004). *Borrelia theileri* causes a mild disease with a low mortality. Most infections are sub-clinical. Anaemia is occasionally seen in splenectomised calves.

34.1.5. Hazard identification conclusion

The organism causes infections that only rarely result in mild clinical disease, and only in animals. Therefore *Borrelia theileri* is not considered to be a potential hazard in the commodity.

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35. Anaplasmosis (*Anaplasma marginale*, *Anaplasma centrale* and *Anaplasma caudatum*)

35.1. HAZARD IDENTIFICATION

35.1.1. Aetiological agents

For the purpose of this risk analysis, the term ‘bovine anaplasmosis’ refers to infection of cattle with either *Anaplasma marginale*, *Anaplasma centrale*, or *Anaplasma caudatum*.

35.1.2. OIE list

Listed.

35.1.3. New Zealand status

Listed on the unwanted organisms register as unwanted notifiable organisms.

35.1.4. Epidemiology

Anaplasmosis is a tick borne disease of cattle caused by *Anaplasma marginale*. A closely related organism, *Anaplasma centrale*, is of low pathogenicity and is widely used as a vaccine (Potgieter and Stoltz 2004). *Anaplasma caudatum* is found in North America and causes mild to severe disease. The *Anaplasma* spp. covered in this section do not infect other farmed animals, including deer (Keel et al 1995).

The disease is widespread in the world but does not occur in EU countries except for Portugal and Spain. It was last reported in Greece in 2001(OIE 2006).

Anaplasmosis is transmitted predominantly by ixodid ticks (hard ticks) but can also be transmitted by the argasid tick (soft tick) *Ornithodoros savignyi* (Potgieter and Stoltz 2004). Transmission in ticks is mainly transstadial but there have been occasional reports of transovarial transmission (Potgieter and Stoltz 2004). As many as 14 tick species from the genera *Boophilus*, *Rhipicephalus*, *Hyalomma*, *Ixodes*, and *Dermacentor* have been described as capable of transmitting the disease, but the validity of some cases has been questioned (McElwain 2004). The organism has been associated with or transmitted by the New Zealand cattle tick *Haemaphysalis longicornis* in Japan and Australia (Heath 2002). It can also be transmitted mechanically by biting flies such as *Stomoxys calcitrans*, Tabanidae and mosquitoes of the genus *Psorophora* and other biting insects (McElwain 2004; Potgieter and Stoltz 2004). It is believed that for successful mechanical transmission to occur the time lapse between feeds on different animals should not be longer than a few minutes (Hawkins et al 1982; Potgieter and Stoltz 2004). The number of infected erythrocytes in blood must be at least 300 times higher for transmission to occur by *Stomoxys calcitrans* than by ticks (Scoles et al 2005). Mechanical transmission is therefore relatively inefficient and endemic areas of anaplasmosis are generally restricted to areas where vector ticks are present.

Young calves from both infected and non-infected cows are highly resistant to the infection up to the age of 6 months. Recovered animals remain life-long carriers of the organism and are immune to reinfection. This allows immune populations of cattle to develop in endemic areas. Spillover of vectors from these areas into neighbouring areas in favourable seasons, may result in outbreaks of disease in susceptible cattle (Potgieter and Stoltsz 2004). Transmission of the organism can also occur iatrogenically when instruments or needles become contaminated with blood (e.g. when inoculating, castrating, dehorning, ear tagging etc.).

If autosterilisation occurs animals again become susceptible to infection. Animals that are cleared of infection by chemotherapy remain resistant to clinical disease for variable periods up to 30 months (Potgieter and Stoltsz 2004). The incubation period (prepatent period) following intravenous inoculation of infected blood may be as short as 4 days but is usually 3-5 weeks, and may exceed 3 months (Potgieter and Stoltsz 2004).

Anaplasma centrale causes only mild signs of infection and is widely used as a vaccine strain.

35.1.5. Hazard identification conclusion

Anaplasma spp. are exotic notifiable organisms that may be carried by and cause disease in cattle. Therefore, *Anaplasma* spp. are considered to be potential hazards in the commodity.

35.2. RISK ASSESSMENT

35.2.1. Entry assessment

Since infected animals remain carriers for life, the likelihood of entry of the organism is considered to be non-negligible.

35.2.2. Exposure assessment

While cattle are not infectious, they can serve as a source of infection for ticks which then become vectors of infection. In New Zealand both the New Zealand cattle tick and potential mechanical transmitters of the organism such as *Stomoxys calcitrans* are present. Therefore the likelihood of exposure of ticks and cattle is considered to be non-negligible.

35.2.3. Consequence assessment

Infection of New Zealand ticks could result in the establishment of the disease in New Zealand. This could lead to infections of cattle with subsequent production losses, necessity for treatment, deaths and the necessity to control ticks by dipping and vaccination of cattle. The consequences are therefore considered to be non-negligible.

As the organism does not infect humans, there would not be any consequences for human health.

The organism and antibody to the disease were not found in white tailed deer but they could be infected experimentally. However, the numbers of organisms in the blood was considered to be too low for them to infect vectors (Keel et al 1995). Anaplasmosis caused by the *Anaplasma* spp. included in this risk analysis has not been described in other wild ruminants

that occur in New Zealand. Therefore the consequences for feral ruminants and the New Zealand environment are considered to be negligible.

35.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for *Anaplasma* spp. is non-negligible and they are classified as a hazard in the commodity. Therefore, risk management measures are justified.

35.3. RISK MANAGEMENT

35.3.1. Options

One or a combination of the following measures could be considered in order to effectively manage the risk.

- The OIE *Terrestrial Animal Health Code* suggests that animals could come from zones that have been free from anaplasmosis for the previous 2 years (OIE 2006).
- Since animals can remain carriers for life, the above measure could be modified to animals that have lived their entire lives in a country or zone that is free from anaplasmosis.
- Animals could be tested with negative results by the competitive ELISA (McElwain 2004) to identify carriers of infection. For detecting persistently infected cattle from an endemically-infected region, the competitive ELISA was shown to have a sensitivity of 96% and a specificity of 95%, when using nested PCR to define true positive or negative cases.
- Animals could be treated with an effective drug that will sterilise them from the infection (OIE 2006).
- Stringent measures (as described in Section 46 of this risk analysis) could also be taken to ensure that imported animals are free from ticks.

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36. Family Anaplasmataceae Infections (Ehrlichiosis/ Anaplasmosis)

36.1. HAZARD IDENTIFICATION

36.1.1. Aetiological agents

Family Anaplasmataceae particularly organisms from the genera *Anaplasma* and *Ehrlichia*, excluding *Anaplasma* spp. described in the previous chapter.

36.1.2. OIE list

Not listed.

36.1.3. New Zealand status

Anaplasma spp. are listed on the unwanted organisms register as unwanted notifiable organisms and *Ehrlichia* spp. are classified as “other exotic organisms”.

36.1.4. Epidemiology

Recent re-organisation of the taxonomy of the organisms in the Family Anaplasmataceae as a result of new information on their genomic structure has resulted in significant changes in their classification. The family now contains four genera, *Ehrlichia*, *Anaplasma*, *Neorickettsia*, and *Wolbachia*. Changes to names and classification of the organisms in this group have been ongoing for several years and it is not known whether this process will continue. Uilenberg has suggested that classification of organisms based only on partial gene sequences may lead to misclassification of some species (Uilenberg et al 2004). The ongoing reclassification has rendered the historical literature confusing and difficult to follow. The recent name changes have been summarised in an article on the internet (Anonymous undated). Sumption and Scott (Sumption and Scott 2004) suggested that the knowledge about the *Ehrlichia* spp. is inadequate and that many new species may be found in the future and drew attention to the problem of “perpetuation of many doubtful species names”. MAF decisions relating to organisms of the Family Anaplasmataceae should therefore be regularly updated to keep pace with the evolving knowledge and taxonomy of these organisms.

Members of the group that cause clearly distinct and significant diseases are *Ehrlichia ruminantium* (formerly *Cowdria ruminantium*) the aetiological agent of heartwater and *Anaplasma marginale*, *Anaplasma centrale*, and *Anaplasma caudatum* which cause bovine anaplasmosis. These organisms are the subject of separate sections of this risk analysis. *Ehrlichia ondiri* which causes a disease of cattle is restricted to areas in East Africa and is not relevant to the countries covered by this risk analysis. *Ehrlichia bovis* has been described in South America, Africa, and the Indian sub-continent (Sumption and Scott 2004), but no reference was found to its occurrence in any of the countries covered by this risk analysis. Therefore this section is restricted to *Anaplasma phagocytophilum* (formerly *Cytoectes phagocytophila* and *Ehrlichia phagocytophila*). The species name used for this organism that is used by various authors in the literature varies irrationally, *phagocytophila*,

phagocytophilia, *phagocytophilum*, and *phagocytophilium* are all used. Generally knowledge concerning the organisms in the family Anapasmataceae is confused and many *Ehrlichias* have a wide host ranges. Therefore it would be beneficial if tests prescribed for *Ehrlichia/Anaplasma* spp. could cross react with a range of related organisms and be used as group identification tests.

Anaplasma phagocytophilum is the agent of tick-borne fever in animals and human granulocytic ehrlichiosis (Grzeszczuk et al 2004). It has a world-wide distribution. The disease primarily affects young cattle and sheep and usually runs a mild course and inapparent infections occur. In cattle decreased milk production and abortions may be seen (Anonymous undated). Experimental infections caused a mild disease (Gokce and Woldehiwet 1999a). Infections with *Anaplasma phagocytophilum* may make animals more susceptible to concurrent infections with other organisms (Gokce and Woldehiwet 1999b). Infected animals may carry the infection for 2 years (Woldehiwet 1983). The main vector in Europe is *Ixodes ricinus* and in the USA it is *Ixodes scapularis* (Alberdi et al 1998; CDC 2000; Telford et al 2002). *Ehrlichia phagocytophilum* DNA was identified in *Haemaphysalis longicornis* from Korea but the report does not confirm whether the tick can transmit the organism (Kim et al 2003). However, it has been suggested that although natural infection of several genera of ticks by single species of *Ehrlichia* occurs, infected species of ticks may not necessarily be competent vectors, and each species of *Ehrlichia* is only transmitted by a single genus of competent ticks (Sumption and Scott 2004). Therefore it seems likely that the competent vectors of the organism are *Ixodes* spp. and that *Haemaphysalis* spp. are probably not competent vectors.

Antibody can be detected by immunofluorescent antibody tests (Petrovec et al 2002; Zeman et al 2004). Organisms can be detected by microscopic examination of bloodsmears or by conventional or real time PCR tests (Ahrens et al 2003; Courtney et al 2004; Courtney and Massung 2003; Hulinska et al 2004).

36.1.5. Hazard identification conclusion

Anaplasma phagocytophilum is an exotic organism that causes mild or subclinical infections in cattle. However, since it is also a zoonotic organism it is considered to be a potential hazard in the commodity.

36.2. RISK ASSESSMENT

36.2.1. Entry assessment

Cattle may remain subclinical carriers of the infection for 2 years and therefore the likelihood of entry of *A. phagocytophilum* is considered to be non-negligible.

36.2.2. Exposure assessment

Since *A. phagocytophilum* is transmitted only by ticks, it would not spread directly to animals in contact with the introduced animals. Although it is transmitted predominantly by tick species that do not occur in New Zealand, *Anaplasma phagocytophilum* DNA has been demonstrated in *Haemaphysalis longicornis* (Kim et al 2003) and it is therefore possible that the New Zealand cattle tick could act as a vector of the organism. Therefore the risk of exposure is considered to be non-negligible.

36.2.3. Consequence assessment

Transmission of the organism to New Zealand cattle ticks and cattle could result in the establishment of an organism that causes only mild disease in cattle. The consequences for the cattle industry would probably be minimal.

The organism infects a large number of different species of animals including deer, wild rodents, horses, llamas, sheep, and bison (Anonymous undated). It therefore seems likely that it could infect wild and feral animals such as deer, goats, thar, and rodents in New Zealand. These animals could become carriers of the organism but it is unlikely that it would cause any significant disease in them.

The organism is a zoonotic organism and is known to cause granulocytic ehrlichiosis (Grzeszczuk et al 2004) a debilitating illness in people.

In conclusion, since *A. phagocytophilum* can cause a serious disease of humans the consequences of introduction are considered to be non-negligible.

36.2.4. Risk estimation

Since entry, exposure, and consequence assessments are all non-negligible, the risk estimate for *A. phagocytophilum* is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

36.3. RISK MANAGEMENT

36.3.1. Options

Imported animals could be submitted to a serological test before importation to identify carriers of *A. phagocytophilum*. The serological test generally used for this organism is the immunofluorescent antibody test (Petrovec et al 2002; Zeman et al 2004), but a PCR could also be used (Ahrens et al 2003). Measures discussed in Section 46.3 could be taken to ensure that introduced animals are tick-free.

One or a combination of the following measures could be considered in order to manage the risk.

- Imported animals could be required to have been resident for at least two years immediately prior to export in countries or zones in which the disease does not occur.
- Animals could be subjected to the quarantine and hygiene measures discussed in section 46.3 to ensure that they are not infested with ticks.
- Animals could be tested by an immunofluorescent antibody test to detect *Anaplasma phagocytophilum* within the 7 days prior to shipment.
- Animals could be tested by a PCR that will detect DNA from a range of *Anaplasma* spp. within the 7 days prior to shipment.

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37. Chlamydiosis (*Chlamydomphila abortus* and *Chlamydomphila pecorum*)

37.1. HAZARD IDENTIFICATION

37.1.1. Aetiological agent

Chlamydomphila abortus and *Chlamydomphila pecorum*.

37.1.2. OIE list

Ovine Chlamydiosis is listed.

37.1.3. New Zealand status

Chlamydomphila abortus is listed on the unwanted organisms register as an unwanted notifiable organism.

Chlamydomphila pecorum has been isolated in New Zealand (Mackereth and Stanislawek 2002).

37.1.4. Epidemiology

Enzootic abortion caused by *Chlamydomphila abortus*, is primarily a disease of sheep and goats (Aitken 1983), but it also infects cattle, causing a disease termed epizootic bovine abortion.

Chlamydomphila abortus does not occur in Australia but is endemic in North America and the European Union (OIE 2006).

Transmission probably occurs by the faecal-oral and venereal routes. Persistent infections are common. Storz et al (1976) described persistent infection of male accessory glands and the presence of *Chlamydomphila abortus* in semen (Andersen 2004). Ewes that have aborted remain long term intestinal carriers (Aitken 1983) and may also be chronically infected in their reproductive tracts (Andersen 2004; Papp et al 1994; Papp et al 1998; Teankum et al 2006). Bulls may remain carriers and excrete the organism in semen for at least 18 months (Domeika et al 1994; Teankum et al 2006)

In *Chlamydomphila abortus* infections the incubation period is variable. Some animals become infected in one season and remain infected and abort in the subsequent season, while in other cases abortion may occur in the same season as infection (Aitken 1983).

The disease is diagnosed by demonstration or isolation of the organism in placental material. Diagnostic techniques include examination of suitably stained smears, antigen detection ELISA, PCR, demonstration of organisms in tissue section by direct staining or immunostaining, or isolation of the organism in tissue culture or embryonated eggs (Aitken and Longbottom 2004; Andersen 2004; Dagnall and Wilsmore 1990; Domeika et al 1994; Szeredi and Bacsadi 2002; Thomas et al 1990). PCR tests are available for the detection of the

organism in semen (Teankum et al 2006). *Chlamydophila abortus* and *Chlamydophila pecorum* can be differentiated by sequence analysis of the 16S rRNA (Mackereth and Stanislawek 2002). Serological tests include the complement fixation test and ELISA, but specificity is not high and cross reactions occur between *Chlamydophila abortus* and *Chlamydophila pecorum* and some gram negative organisms (Aitken and Longbottom 2004). Competitive ELISA tests using monoclonal antibodies and tests using specific recombinant antigens that discriminate between *Chlamydophila abortus* and *Chlamydophila pecorum* have been developed (Aitken and Longbottom 2004).

37.1.5. Hazard identification conclusion

Chlamydophila abortus is an exotic, notifiable disease of cattle and is considered to be a potential hazard in the commodity.

37.2. RISK ASSESSMENT

37.2.1. Entry assessment

Female cattle may be long-term carriers of the infection and may excrete the organism in any body secretions and faeces, especially after calving or abortion (Andersen 2004). Bulls may excrete *Chlamydophila abortus* in their semen (Domeika et al 1994; Storz et al 1976). Therefore the likelihood of entry is considered to be non-negligible.

37.2.2. Exposure assessment

Imported cattle will be integrated into New Zealand cattle herds. Since infected animals are likely to be excreting the organisms and the organism can be transmitted by the faeco-oral or venereal routes, exposure of New Zealand animals is likely.

37.2.3. Consequence assessment

The organism could be transmitted to New Zealand cattle by the faeco-oral or venereal routes (Andersen 2004; Bowen et al 1978). In cattle it would be likely to cause infertility and abortions. If left unchecked the organism could be spread by movement of cattle and become established in New Zealand resulting in the establishment of a production limiting disease in cattle. It could also spread to sheep, where it causes the economically important disease, enzootic abortion.

Chlamydophila abortus is a zoonotic organism that may cause sporadic cases of abortion in women that have been in contact with infected ewes at parturition (Aitken and Longbottom 2004). Although no descriptions of transmission from cattle to women were found it is assumed that women could also be infected directly from cattle. Therefore, introduction of the disease would have consequences for human health.

As the organism infects goats and deer, feral goats, deer, and thar could be infected. However, the consequences for the environment are likely to be minor since it is a disease that is associated with intensive farming and is unlikely to become a problem in free ranging wildlife. It is not known whether the organism could infect any of New Zealand's indigenous or feral animals but because it is a disease associated with intensive farming, the consequences are therefore likely to be negligible.

In conclusion, since the organism could establish in New Zealand and cause economically significant effects on sheep farming and sporadic cases of human disease, the consequences are considered to be non-negligible.

37.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for *Chlamydomphila abortus* is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

37.3. RISK MANAGEMENT

37.3.1. Options

The OIE *Terrestrial Animal Health Code* provides guidelines for safe trade of sheep and sheep semen but not for cattle. Since infected animals may remain long term carriers of infection, quarantine is not a viable option

Although criteria have been defined by OIE for sheep flocks that are considered to be free from enzootic abortion, no such definition is available for cattle herds and it is unlikely that cattle herds will be located in endemic countries that could be classified as *Chlamydomphila* free.

The following measures could be considered in order to manage the risk.

- Cattle for export to New Zealand could be required to have been resident since birth in a country or zone that is free from *Chlamydomphila abortus* infection.
- Cattle herds could be tested serologically to a level that gives a high degree of confidence that they are free from chlamydial infections. A complement fixation test or an ELISA that has high sensitivity could be used.
- Individual animals could be tested using a sensitive serological test.

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38. Q Fever

38.1. HAZARD IDENTIFICATION

38.1.1. Aetiological agent

Coxiella burnetii.

38.1.2. OIE list

Listed.

38.1.3. New Zealand status

Listed on the unwanted organisms register as an unwanted notifiable organism.

38.1.4. Epidemiology

Q fever occurs worldwide with the exception of New Zealand (Worthington 2001) and possibly Norway (Jensenius et al 1997).

Coxiella burnetii probably infects all mammalian species, birds and many arthropods (Marin and Raoult 1999; Marrie 1990). In animals the infections are of minimal economic importance and rarely cause disease, but it is a zoonotic organism that sometimes causes serious disease in humans. Most human infections are asymptomatic or present as a mild flu-like disease, but acute or chronic infections sometimes occur and some of these result in serious complications such as myocarditis, endocarditis, hepatitis and renal failure (Marin and Raoult 1999; Woldehiwet 2004). It causes sporadic abortions in both humans and animals (Hatchette et al 2003; Raoult et al 2002).

Transmission frequently occurs from contact with infected uterine discharges and placentae and probably by inhalation of dust contaminated by animals and their birth products (Behymer and Riemann 1989; Hawker et al 1998; Marin and Raoult 1999; Marrie 1990; Selvaggi et al 1996; Tissot-Dupont et al 1999). Infected ticks may also play a role in spreading the disease. At least 40 species of ticks from 11 genera can be infected (Kelly 2004) and their dried faeces forms dust that can contaminate animal coats. Infected cattle shed the organism intermittently in their milk, after successive parturitions (Kelly 2004).

Infected animals generally show few clinical signs of disease thus making the determination of the incubation period and the interval to the development of antibodies difficult to determine. In humans the incubation period is given as 1-3 weeks and the development of detectable antibody titres takes 2-3 weeks after the onset of symptoms (Marin and Raoult 1999). It is assumed that infected cattle will develop antibody within a similar time interval after infection.

The infection is diagnosed by serological tests or by identification or isolation of the organism (Pepin et al 2000). The ELISA test is considered to be more sensitive than the complement fixation test (Rousset et al 2004).

38.1.5. Hazard identification conclusion

Coxiella burnetii is an exotic, notifiable and zoonotic organism. Therefore, for the purposes of this analysis it is considered to be a potential hazard in the commodity.

38.2. RISK ASSESSMENT

38.2.1. Entry assessment

Cattle remain chronically infected and can excrete the organism in birth products and milk. It is also excreted in the semen of bulls (Kruszewska and Tylewska-Wierzbanowska 1997). Therefore the likelihood of entry is considered to be non-negligible.

38.2.2. Exposure assessment

Imported animals will be introduced into New Zealand herds and exposure to naïve New Zealand cattle is almost certain to occur. Infected imported animals could excrete the organism intermittently in milk, urine, birth products, and semen (Rousset et al 2004; Kruszewska and Tylewska-Wierzbanowska 1997; Kruszewska and Tylewska-Wierzbanowska 1993), and could infect animals in contact with them. Therefore the likelihood of exposure of New Zealand animals to the organism is considered to be non-negligible. It is not known whether the New Zealand cattle tick can become infected with the organism but since at least 40 species of ticks can be infected (Kelly 2004) the likelihood that *Haemaphysalis longicornis* could be infected with the organism is considered to be non-negligible.

38.2.3. Consequence assessment

Since New Zealand animals are likely to be in contact with imported animals that could be excreting the organism, they could become infected and the disease established in New Zealand. Establishment of the infection in New Zealand would be likely to have a negligible effect on the livestock industries as infected animals usually show no clinical signs. However, there is a small likelihood that the introduction into a naïve population might initially cause some abortions. The New Zealand cattle tick could also become infected and play an important role in the organism becoming endemic.

Establishment of the disease would result in sporadic cases of serious disease in people. Virtually all animals including birds, and fish could be infected although these infections are likely to be sub-clinical. The effects on the environment would not be noticeable.

Since the disease could establish in New Zealand and result in sporadic human infections the consequences are considered to be non-negligible.

38.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for *Coxiella burnetii* is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

38.3. RISK MANAGEMENT

38.3.1. Options

There are no recommendations relating to Q fever in the OIE *Terrestrial Animal Health Code*. Infected cattle would be long term carriers of infection and quarantine would not prevent the entry of the organism. The following measures could be considered in order to effectively manage the risk.

- Quarantine in tick free premises would ensure that animals do not become infected while in quarantine. Therefore isolation of imported animals that are kept tick free and serological testing by an ELISA test (Rousset et al 2004), within 7 days of shipment could ensure that the disease is not introduced.
- Animals for export could be treated with a suitable acaricide and inspected to ensure that they are free from ticks and maintained tick-free while in quarantine for 30 days and all measures described Section 46.3 of this risk analysis could be implemented to ensure that ticks are not introduced.

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39. Haemobartonellosis

39.1. HAZARD IDENTIFICATION

39.1.1. Aetiological agent

Haemobartonella bovis.

39.1.2. OIE list

Not listed.

39.1.3. New Zealand status

Exotic (Thompson 1998). Not listed as notifiable or unwanted.

39.1.4. Epidemiology

The organism is not listed as a parasite that occurs in New Zealand (Thompson 1998). The related parasite of dogs is found in New Zealand by the same laboratories that carry out surveillance for all blood parasites. There are therefore no grounds to suspect that the organism would have been missed in the regular examination of blood smears that occurs in New Zealand laboratories. However, the organism could have been overlooked because it is usually only apparent in splenectomised cattle.

The organism is virtually a harmless organism that is only of concern where it causes mild disease in splenectomised animals. Its occurrence may be confused with *Anaplasma* spp. when examining blood smears (Potgieter 2004). Little is known about the natural transmission of the organism but it is generally assumed that it is transmitted by arthropod vectors (Potgieter 2004).

39.1.5. Hazard identification conclusion

Since *Haemobartonella bovis* causes inconsequential infections in cattle only and is of no economic importance, it is not considered to be a potential hazard in the commodity.

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40. Babesiosis

40.1. HAZARD IDENTIFICATION

40.1.1. Aetiological agents/vectors

<i>Babesia bigemina</i>	<i>Boophilus microplus</i> , <i>Boophilus decoloratus</i> , <i>Boophilus annulatus</i> (Kuttler 1998)
<i>Babesia bovis</i>	<i>Boophilus microplus</i> , <i>Boophilus annulatus</i> , <i>Ixodes spp.</i> ? (Kuttler 1998)
<i>Babesia divergens</i>	<i>Ixodes ricinus</i> (Kuttler 1998)
<i>Babesia major</i>	<i>Haemaphysalis punctata</i> (Kuttler 1998)
<i>Babesia jakimovi</i>	<i>Ixodes ricinus</i> (Kuttler 1998)
<i>Babesia ovata</i>	<i>Haemaphysalis longicornis</i> (Kuttler 1998)
<i>Babesia occulans</i>	<i>Hyalomma marginata rufipes</i> (De Vos et al 2004)

40.1.2. OIE list

Listed.

40.1.3. New Zealand status

Babesia spp. are listed on the unwanted organisms register as unwanted notifiable organisms.

40.1.4. Epidemiology

Babesiosis occurs in Australia, the USA, and many European countries but not in Canada (OIE 2006). The most important disease causing species are *Babesia bovis* and *Babesia bigemina* which occur mainly in Africa, *Babesia divergens* and *Babesia major* in Europe, and *Babesia ovata* in Japan. *Babesia occulans* occurs in Africa but is of minor importance.

Babesioses are tick-borne diseases and their main vectors are listed in Section 41.1.1. *Babesia* spp. are transmitted transovarially, at least in *Boophilus* spp. (De Vos et al 2004) and in *Haemaphysalis longicornis* (Ohta et al 1996).

Babesiosis is a serious disease characterised by high morbidity and mortality in naïve cattle when they are introduced into tick infested areas. Typical disease signs are fever and haemolytic anaemia accompanied by haemoglobinuria, from which the common name of “redwater” is derived.

Calves born from immune cows are resistant. Calves less than 2 months of age from non-immune cows are susceptible. . After the age of two months all calves develop an innate resistance which is retained until they reach about 6-8 months. In endemic areas calves become infected while they have resistance to infection and a stable immune population develops. Alternatively, calves may be vaccinated with live organisms at that time in order to build up an immune population (De Vos et al 2004).

After recovery from infection cattle develop a lasting immunity which is not dependent on persistent infection.

Infected animals remain carriers for long periods. The persistence of infection is variable depending on the species of *Babesia* and the species of cattle. *Babesia bovis* may persist in European breeds of cattle for life but zebu cattle lose the infection within two years. In the case of *Babesia bigemina* persistence is generally shorter, rarely lasting more than a year. Cattle infected with *Babesia bovis* generally remain infective for ticks for up to two years while those infected with *Babesia bigemina* are infective for ticks for only 4-7 weeks (De Vos et al 2004).

A number of drugs are used for the treatment of the disease. Imidocarb is a useful drug that has a prophylactic effect that lasts from 4-8 weeks (De Vos et al 2004) and is recommended by OIE for the treatment of cattle for international trade (OIE 2006).

Examination of blood smears is used for the diagnosis of acute infections but in persistent infections the number of parasites in the blood is too low to be reliably detectable by this means. PCR tests are available (De Vos et al 2004). An ELISA is available for the diagnosis of *Babesia bovis* but not for *Babesia bigemina*. An indirect fluorescent antibody test is widely used for both *Babesia bigemina* and *Babesia bovis* but cross reactions occur between different *Babesia* spp. (De Vos et al 2004).

40.1.5. Hazard identification conclusion

Babesia spp. are exotic unwanted organisms that cause serious disease in cattle. They are therefore considered to be potential hazards in the commodity.

40.2. RISK ASSESSMENT

40.2.1. Entry assessment

Animals infected with *Babesia* spp. are likely to be long term carriers of the organism (De Vos et al 2004). Imported animals could also be infested with ticks that are exotic to New Zealand and infected with *Babesia* spp. The likelihood of entry in the commodity is therefore considered to be non-negligible.

40.2.2. Exposure assessment

Imported cattle will be integrated into New Zealand cattle herds. They may also be exposed to parasitism by the New Zealand cattle tick, if they are located in northern or central areas of New Zealand. *Haemaphysalis longicornis* is a recognised vector for *Babesia ovata* (Cho et al 2002; Higuchi et al 1989a; Higuchi et al 1989b; Higuchi et al 1991; Higuchi et al 1987; Higuchi et al 1994; Luo et al 2005; Ohta et al 1996) and it is possible that it could be a vector of other *Babesia* spp. Ticks on imported cattle could also infest New Zealand cattle. The likelihood of exposure of New Zealand cattle and ticks to *Babesia* spp. is therefore considered to be non-negligible.

40.2.3. Consequence assessment

Exposure of New Zealand ticks to imported cattle from *Babesia* infected countries could result in the establishment of the disease in New Zealand. Alternatively, infected ticks on imported cattle could infest New Zealand animals. Naïve New Zealand cattle will be fully susceptible to the disease. This would lead to outbreaks of disease in exposed cattle with

consequent mortalities and the necessity for treatment and tick control and possibly a national eradication campaign. Economic losses for individual farmers and for the cattle industry generally would be likely.

Babesia spp. particularly *Babesia microti* (a parasite of voles), causes rare cases of babesiosis in people that are immunocompromised. However, these cases would be so rare that the effect on the human population of introducing the *Babesia* spp. that infect cattle is considered to be negligible.

Babesia spp. of cattle are not known to infect ruminants other than cattle, African buffalo, and possibly some antelope species (Worthington and Bigalke 2001). Therefore the consequences for the New Zealand environment are considered to be negligible.

In view of the above, the consequences are considered to be non-negligible.

40.2.4. Risk estimation

Since entry, exposure, and consequences assessments are non-negligible, the risk estimate for *Babesia* spp. is non-negligible and they are classified as hazards in the commodity. Therefore, risk management measures can be justified.

40.3. RISK MANAGEMENT

40.3.1. Options

Since animals infected with *Babesia* spp. may be long term carriers, isolation of imported animals in quarantine is not a useful option. Animals could be tested by a serological test to identify carriers and they could be subjected to treatment with an effective drug (OIE 2006). Animals could also be subjected to quarantine and treatment with acaricides as discussed in Section 46.3, to ensure that ticks are not introduced.

One or a combination of the following measures could be considered in order to manage the risk.

- Cattle could be subjected to a validated serological test with negative results for the *Babesia* spp. that occur in the countries of origin. The tests could be done within 30 days of shipment.
- Cattle could be treated with an effective drug such as imidocarb according to OIE recommendations (OIE 2006).
- All the measures discussed in Section 46.3, to prevent the importation of ticks, could be implemented.

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41. Sarcocystosis

41.1. HAZARD IDENTIFICATION

41.1.1. Aetiological agent

Sarcocystis hominis.

41.1.2. OIE list

Not listed.

41.1.3. New Zealand status

Unknown.

41.1.4. Epidemiology

Protozoa of the *Sarcocystis* genus have a two host life cycle. The parasite is found in the intestine of the definitive host which is always a carnivore. The definitive host sheds infectious sporocysts in their faeces. The intermediate host ingests the sporocysts which develop into sarcocysts in the muscle of the host (Markus et al 2004).

Three species of *Sarcocystis* occur in cattle (Markus et al 2004). *Sarcocystis cruzi* (definitive host: the dog) and *Sarcocystis hirsuta* (definitive host: the cat) are common in New Zealand (McKenna 1998; Mitchell 1988). *Sarcocystis hominis* (definitive host: man) occurs uncommonly in cattle (Fayer 2004) and has not been described in New Zealand.

Experimental infection of humans with *S. hominis* in raw beef caused a transient diarrhoea in one volunteer. Another study where humans consumed up to 14,740 sarcocysts in buffalo meat resulted in abdominal pain and diarrhoea that spontaneously cured without treatment (Fayer 2004).

For the parasite to be introduced by cattle and establish, meat from an imported animal would have to be eaten by a human. Imported animals are monitored by MAF and are prohibited from entry into the human food chain. Therefore, the likelihood of *Sarcocystis hominis* being introduced and establishing in New Zealand is considered to be negligible. The introduction of the organism by a human harbouring the parasite is much more likely.

41.1.5. Hazard identification conclusion

Since the likelihood of the organism establishing in New Zealand is considered to be negligible the organism is not considered to be a potential hazard in this risk analysis.

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42. Theileriosis (*Theileria annulata*)

42.1. HAZARD IDENTIFICATION

42.1.1. Aetiological agent

Theileria annulata.

42.1.2. OIE list

Theileriosis, defined as a highly fatal disease in cattle and buffaloes caused by *Theileria parva* and *T. annulata*, is listed by the OIE.

42.1.3. New Zealand status

Theileria spp. (pathogenic species) are listed on the unwanted organisms register as unwanted notifiable organisms.

42.1.4. Epidemiology

Theileria annulata causes Mediterranean coast fever, which is a serious disease of cattle. In the countries covered in this risk analysis it occurs only in southern European countries such as Portugal (Caeiro 1999; d'Oliveira et al 1995), Spain (Almeria et al 2001; Habela et al 1999), Italy (Loria et al 1999; Maxia et al 1999), and Greece (Papadopoulos 1999).

T. annulata is transmitted transstadially by ticks of the *Hyalomma* genus (Pipano and Shkap 2004). It is not known whether it can be transmitted by *Haemaphysalis* spp. ticks (Bhattacharyulu et al 1975; Heath 2002), but the non-pathogenic *T. orientalis* is transmitted by *Haemaphysalis longicornis* in New Zealand. The water buffalo is a subclinical carrier of *T. annulata* and may act as a reservoir host.

The incubation period for *T. annulata* varies from 9 to 25 days (Pipano and Shkap 2004). The clinical signs may vary from a peracute syndrome, in which death occurs within 3-5 days, to subclinical cases. Typical signs include fever, swollen lymph nodes, diarrhoea, anaemia and icterus. Mortality rates of 20-90% have been reported (Pipano and Shkap 2004).

The disease is diagnosed by examination of blood smears, lymph node smears or liver biopsy smears. Sensitive PCR methods are available that can detect parasitaemia in blood as low as 0.000048% (Pipano and Shkap 2004). Serological tests to detect antibody include the indirect fluorescent antibody test, and ELISAs (Pipano and Shkap 2004).

42.1.5. Hazard identification conclusion

Theileria annulata is an exotic, notifiable organism that causes severe disease in cattle. Therefore it is considered to be a potential hazard in the commodity.

42.2. RISK ASSESSMENT

42.2.1. Entry assessment

Long term carriers of *T. annulata* occur in endemic areas. Therefore the likelihood that animals imported from endemic areas will be carriers of the organism is considered to be non-negligible. It is also possible that cattle introduced from endemic areas could be parasitized by *Hyalomma* spp. ticks that could be carrying the organism.

42.2.2. Exposure assessment

Imported cattle will be introduced into New Zealand cattle herds. Since *T. annulata* is a tick transmitted organism and cattle are not directly infectious they could not infect other cattle in contact with them (Pipano and Shkap 2004). However, they could infect New Zealand indigenous ticks. In addition, if tick-infested cattle are introduced they could transfer ticks to New Zealand cattle. Therefore the likelihood that carrier animals could expose New Zealand cattle ticks to infection is considered to be non-negligible.

42.2.3. Consequence assessment

The only New Zealand tick that infests cattle is *Haemaphysalis longicornis*. This tick is not known as a vector of *T. annulata* (Bhattacharyulu et al 1975; Heath 2002), but since it does transmit *T. orientalis* in New Zealand it is possible that it could also transmit *T. annulata*. Therefore the likelihood that importation of carrier cattle would lead to the establishment of *T. annulata* in New Zealand is considered to be non-negligible. The importation of carrier animals infested with *Hyalomma* spp. ticks could lead to the establishment of a new tick species and the disease in New Zealand. Since it is a serious disease that could cause production losses, mortalities, and expenses for treatment of animals, tick control, and eradication, the consequences of *T. annulata* are considered to be non-negligible.

As *T. annulata* does not infect humans, the consequences for human health are negligible. It is also not known to infest other animals other than water buffalo and therefore will not infect New Zealand native or feral animals. The consequences for the environment are therefore considered to be negligible.

In view of the serious consequences for the New Zealand cattle industry of introducing *T. annulata* in imported cattle, the consequence assessment is non-negligible.

42.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for *T. annulata* is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

42.3. RISK MANAGEMENT

42.3.1. Options

One or a combination of the following measures could be considered in order to manage the risk.

- Cattle could be imported from countries that are free from *Theileria annulata*.
- Cattle for export to New Zealand could be tested by a serological test for detection of carrier animals, such as the ELISA test using antigen prepared from erythrocytic merozoites (Pipano and Shkap 2004) with negative results, during the 30 days prior to shipment.
- The examination of bloodsmears is recommended in the OIE *Terrestrial Animal Health Code* but this could be replaced by the more sensitive PCR test.
- Risk management measures described in Section 46.3 could be adopted to prevent the introduction of ticks.

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43. Lice

43.1. HAZARD IDENTIFICATION

43.1.1. Aetiological agents

The important species of lice that occur on cattle are:

Bovicola bovis
Linognathus vituli
Haematopinus eurysternus
Solenopotes capillatus
Haematopinus quadripertusis

43.1.2. OIE list

Not listed.

43.1.3. New Zealand status

No lice are listed on the unwanted organisms register. The following species occur in New Zealand (Chalmers and Charleston 1980; Tenquist and Charleston 2001):

Bovicola bovis (*Damalina bovis*)
Linognathus vituli
Haematopinus eurysternus
Solenopotes capillatus

43.1.4. Epidemiology

Cattle lice commonly reported in the literature are the biting louse *Bovicola bovis* and the sucking lice *Linognathus vituli*, *Haematopinus eurysternus*, *Solenopotes capillatus*, and *Haematopinus quadripertusis*.

Lice irritate the skin of infected animals resulting in itching and rubbing or scraping of the skin. The coats of infested cattle may appear rough and in some areas the hair may have been rubbed off and the skin damaged. The effect that lice have on production is controversial and it has been reported that there was no difference between weight gain and haematocrit of louse infested and non-infested cattle (Chalmers and Charleston 1980) and that treatment of cattle that have light to moderate infections is not economically justified (Walker and Levot 2003).

Louse eggs adhere to hair shafts of the host animals and then take 8–19 days to hatch as nymphs. The nymphs moult three times before reaching maturity and the whole life cycle takes 3–6 weeks. Many insecticides are effective for the treatment of lice provided they are treated twice at suitable intervals taking the life cycle into consideration. Since treatment with insecticides does not affect the eggs, treatments must be repeated after eggs have hatched but before the hatched lice have reached maturity. A period of two weeks between treatments is

suitable to eradicate lice provided the treated animals have no contact with other infected cattle from which they can become re-infected. Alternatively long acting insecticides should be used.

43.1.5. Hazard identification conclusion

Haematopinus quadripertusis is a cattle louse that is exotic to New Zealand. Since it may cause irritation to cattle and require treatment it is regarded as a potential hazard in the commodity.

43.2. RISK ASSESSMENT

43.2.1. Entry assessment

Since lice are common parasites of cattle and are universally distributed, the likelihood of entry of *H. quadripertusis* on imported cattle is considered to be non-negligible.

43.2.2. Exposure assessment

Since louse infested imported cattle will be integrated into New Zealand cattle herds they are likely to transfer lice to indigenous cattle. The likelihood of exposure is therefore considered to be non-negligible.

43.2.3. Consequences assessment

Importations of new species of lice that are of minor significance overseas are unlikely to have significant economical effects on the New Zealand cattle industry. The imported lice would have to compete with more successful parasites which already infest cattle in New Zealand. However they might cause some minor infestation problems in individual herds that require treatment and therefore increase costs to individual farmers. The consequences are therefore considered to be non-negligible.

Cattle lice will not infest and establish in other animals or man and therefore the consequences for human health or the environment would be negligible.

43.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for *Haematopinus quadripertusis* is non-negligible and it is classified as a hazard in the commodity. Therefore, risk management measures can be justified.

43.3. RISK MANAGEMENT

43.3.1. Options

Since there are a large number of effective insecticides for the elimination of lice, treatment of cattle could be used to eliminate lice from imported animals. Two treatments at a suitable time interval could be applied. Some suitable products for treatment are listed in a publication of the Department of Primary Industries in Australia (Farquar 2002). The treatment method

could be integrated with other treatments for external and internal parasites so as not to impose additional stress on the animals or expense to the importer.

One or a combination of the following measures could be considered in order to manage the risk.

- Cattle could be quarantined for 3 weeks.
- Cattle could be treated prior to entering pre-export isolation and twice while in isolation with an interval of 14 days. Insecticides could be chosen that are already being used for the elimination of other parasites. Treatments for all types of parasites could be integrated and regularly adapted so as to use the most effective insecticides, taking into account the availability of new insecticides and the development of insecticide resistance to commonly used chemicals.
- Cattle could be inspected before shipment to establish that the treatment has been effective. If treatment has not been effective then quarantine treatment could be repeated.

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44. Mange Mites

44.1. HAZARD IDENTIFICATION

44.1.1. Aetiological agents

Sarcoptes scabiei bovis

Psoroptes ovis

Chorioptes bovis

Demodex bovis

Psorergatic bos

44.1.2. OIE list

Not listed.

44.1.3. New Zealand status

No mange mites are listed on the unwanted organisms register. The following species occur in New Zealand (Heath 2002; Tenquist and Charleston 2001):

Chorioptes bovis

Demodex bovis

Psoroptes ovis

44.1.4. Epidemiology

Mange mites occur in all the countries covered by this risk analysis.

Mange mites cause skin lesions which vary in location and lesion type according to the species of mites involved. The diagnosis can be confirmed by identification of the mites in skin scrapings or skin biopsies.

Sarcoptic mange is transferable to man. Although sarcoptic mange mites found on different species of animals are morphologically similar they are regarded as different varieties, subspecies, or forms (Zurek 2004; Kramer and Mock 1996) and have a high degree of species specificity. Humans infested with mites from different species develop mild symptoms which resolve spontaneously (Kramer and Mock 1996).

A range of insecticides can be used for treatment of the condition. Recently ivermectin and related avermectins have been found to be highly effective for treatment (Anonymous 2000). Since the eggs of mites are resistant to treatment cattle should be treated twice with an interval of 2 weeks or once with an insecticide with a persistent action of more than two weeks.

44.1.5. Hazard identification conclusion

Of the mite species discussed above only *Sarcoptes scabiei bovis* and *Psorergates bos* are exotic to New Zealand. Therefore only these two species are considered to be potential hazards in the commodity.

44.2. RISK ASSESSMENT

44.2.1. Entry assessment

The mange mites *S. scabiei bovis* and *P. bos* are endemic in many countries. The likelihood of entry on imported cattle is therefore non-negligible.

44.2.2. Exposure assessment

Imported cattle will be introduced into New Zealand cattle herds and the likelihood of exposure of New Zealand cattle is non-negligible.

44.2.3. Consequence assessment

Infested cattle are known to transmit mange mites to other cattle kept in contact with them. The parasite could become established in a herd into which imported cattle are introduced. Introduction of the parasites could lead to production losses and if untreated even to occasional deaths. Individual farmers would incur costs for treatment.

Sarcoptes scabiei can be transmitted from animals to humans, but the forms of parasites that infest different species are reasonably host specific and people are generally mildly affected by animal forms and spontaneously rid themselves of the parasite (CDC 2005; Kramer and Mock 1996). The consequences for human health are therefore likely to be negligible.

Mange mites are relatively host specific and mange mites from cattle are unlikely to establish on other species of animals.

Since the economic effects of introducing exotic mange mites are assessed to be non-negligible the consequences are considered to be non-negligible.

44.2.4. Risk estimation

Since entry, exposure, and consequence assessments are considered to be non-negligible, the risk estimate for exotic mange mites is non-negligible and they are classified as hazards in the commodity. Therefore, risk management measures can be justified.

44.3. RISK MANAGEMENT

44.3.1. Options

Cattle for import could be carefully inspected for signs of mange mite infestations, and scrapings could be taken from suspected infested areas to identify the type of mites. All cattle could be treated twice with an interval of 2 weeks, with suitable insecticides to eliminate mites. Treatments for mites could be integrated with treatments for other parasites.

One or a combination of the following measures could be considered in order to manage the risk.

- Cattle for export to New Zealand could be carefully inspected for any signs suggestive of mange mite infestations. Skin scrapings or/and biopsies could be taken from all suspicious lesions and examined for *Sarcoptes scabiei bovis* and *Psorergates bos* mites.
- Cattle could be treated with a suitable acaricide to eliminate any possible mite infections. The treatment programme could be integrated with other treatments for parasites using acaricides that have a wide range of activity for external and internal parasites. Because resistance to insecticides is constantly developing current knowledge of insecticide resistance by mites could be considered when designing a treatment programme.
- For animals that were infested with mites before treatment commenced, extensive examinations of skin scrapings from areas showing typical signs of infestation could be examined after treatment has been completed. All scrapings could be required to be negative for *Sarcoptes scabiei bovis* and *Psorergates bos*, before animals are cleared for shipment.

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45. Ticks

45.1. HAZARD IDENTIFICATION

45.1.1. Aetiological agents

World wide there are around 170 species of Argasidae or soft ticks and 650 species of Ixodidae or hard ticks (Allan 2001). Many of these species are known to infest cattle.

45.1.2. OIE list

Not listed. However, several tick species are vectors of diseases included in the OIE list.

45.1.3. New Zealand status

Only one species of cattle tick, *Haemaphysalis longicornis*, occurs in New Zealand. Five genera of ticks are listed as unwanted notifiable organisms in New Zealand:

Amblyomma spp.
Boophilus spp.
Dermacentor spp.
Ixodes spp.
Rhipicephalus spp.

45.1.4. Epidemiology

Ticks cause serious economic losses in countries that are infested with them. Losses are worse in hot tropical climates but also occur in countries with temperate climates. Ticks are vectors for a very large number of diseases and tick toxicoses. Norval and Horak list 33 diseases and toxicoses of livestock that occur in Southern Africa (Norval and Horak 2004). The list is not complete even for Africa and does not include diseases of cats, dogs, wildlife species, and humans. Allan lists 9 diseases that occur in North America (Allan 2001). Many other diseases occur in other countries. The livestock diseases carried by ticks include economically important diseases such as heartwater, babesiosis, anaplasmosis, theileriosis, and African swine fever.

Worldwide losses due to tick-borne diseases and tick control have been estimated to cost several billion dollars annually (Jongejan and Uilenberg 1994). Apart from losses due to diseases carried by ticks, infestations with ticks also cause significant production losses and losses for tick control (Norval and Horak 2004; Jonsson et al 2001).

New Zealand has only one livestock tick, *Haemaphysalis longicornis*, and no significant tick-borne diseases. Many important ticks such as *Amblyomma* spp. might not be able to establish themselves in the New Zealand environment. However, others such as the important European tick *Ixodes ricinus* probably would be able to.

Consideration of the life cycles of ticks is important when designing programmes to prevent the entry of ticks into New Zealand.

Hard ticks (Ixodidae) have a life cycle that is divided into 4 stages: egg; larva with 6 legs; nymphs with 8 legs and no genital pore; adults with 8 legs and a genital pore. Different species of ticks may have one host, two host or three host life cycles. Adults lay batches of several thousand eggs that hatch and the larvae climb up grass stems or other vegetation and await a passing host animal. Larvae are only pin head sized and not easily seen in grass or on an animal's body. Once they have found a host animal they move to a suitable site on the animal, attach and start ingesting blood. They are wasteful feeders and may ingest more than 100 times their own starting weight of blood (Allan 2001). Three host tick larvae can be fully engorged within 3 days. When fully engorged the larvae moult to develop to the next stage. Three host ticks leave the host and moult off the host. Two and one host ticks moult on the host and then continue to feed on the same host. Mature nymphs of two host ticks leave the host when engorged and moult off the host before finding a new host on which to develop to the adult stage. One host ticks remain on the same host throughout larval, nymph, and adult feeding periods. Finally when the adult females are engorged they mate with a male tick while still on the host. Male ticks remain on the host and may mate repeatedly. Females are soft skinned and engorge till they are bloated, mature females of the larger species may weigh 4 grams. Male ticks have a hard dorsal shield and are much smaller. Three host ticks such as *Rhipicephalus appendiculatus* may remain on the host animal for only 3 days while one host ticks such as *Boophilus microplus* may be on the host for about 3 weeks (Norval and Horak 2004).

Soft ticks (Argasidae) are economically less important than hard ticks but there are still several undesirable species that infest cattle including *Otobius megnini* (the spinous ear tick) and *Ornithodoros savignii*. Many of the soft ticks live off the host in cracks, burrows or nests, or buried in the sand and take repeated short meals from a resting host. Therefore soft ticks are unlikely to be imported on live animals.

Many species of ticks in several countries have developed resistance to acaricides used to control them (Jongejan and Uilenberg 1994; Jonsson et al 2000; Li et al 2003; Li et al 2004; Mekonnen et al 2002).

45.1.5. Hazard identification conclusion

All except one species of tick are exotic to New Zealand. Many species are vectors of important diseases and can also cause production losses associated with parasitism of animals including cattle. Ticks are therefore considered to be potential hazards in the commodity.

45.2. RISK ASSESSMENT

45.2.1. Entry assessment

Cattle that have been incorrectly treated for ticks, have been inadequately inspected or are carrying ticks resistant to acaricides could introduce ticks into New Zealand. In some cases small tick larvae may be almost impossible to detect during inspections of cattle. Therefore the likelihood of introducing tick species is considered to be non-negligible.

45.2.2. Exposure assessment

Introduced cattle will be integrated into New Zealand cattle herds. Ticks they are carrying could leave their hosts and complete their life cycles and infest New Zealand cattle. This

could result in exposure of New Zealand cattle to imported ticks. The likelihood of exposure is therefore non-negligible.

45.2.3. Consequence assessment

Exposure of New Zealand cattle to ticks and establishment of new species of ticks in New Zealand could result in transmission of diseases carried by the ticks to domestic ruminants. It could also result in heavy infestations of ticks with associated production losses as well as the expenses incurred to control ticks. In addition, introduced ticks, even if not infected with disease agents, would represent an ongoing potential threat since introduced disease agents could have a ready source of vectors waiting to propagate and transmit them.

Since several human diseases are carried by ticks, establishment of new species of ticks could result in endemic foci of human tick borne diseases being established.

Feral mammals could become infested by ticks imported by cattle and could be infected with several diseases transmitted by ticks.

Since farmed animals, feral animals, and humans could become infected with diseases carried by ticks, the consequences of introducing ticks are considered to be non-negligible.

45.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for exotic ticks is non-negligible and they are classified as hazards in the commodity. Therefore risk management measures can be justified.

45.3. RISK MANAGEMENT

45.3.1. Options

Acaricides could be used to treat all cattle imported into New Zealand. However since resistance to acaricides is a real and increasing problem, acaricide treatment could be supplemented by other management methods.

While in pre-export isolation cattle kept in an open paddock could become infested with ticks. Therefore cattle should not be quarantined in open paddocks. They could be kept in a building with a smooth impervious floor (preferably concrete) and smooth painted walls, or on a fenced, impervious (preferably concrete) pad without walls and surrounded by a cleared area free from vegetation. Before introduction into the building or holding pad, they could be dipped or sprayed to reduce or eliminate their tick burden. The animals could then be moved into the quarantine premises which have been thoroughly cleaned by high pressure hosing or preferably by steam cleaning and sprayed with an acaricide of proven efficacy. Bedding should not be grass, straw or other plant material that could be infested with ticks. Suitable materials are wood shavings, sterilised peat or other inert materials. The food supply could also be tick free. Processed pellets which have been heated in the pelleting process could be used. The pellets could be lucerne pellets or pellets containing some grain etc.

If the animals are infested with 3 host ticks it can be assumed that the larvae or nymphs will leave the animal within about 3 days. When conditions are favourable (temperature and humidity), moulting may occur in as little as 10 days and recently moulted nymphs or adult

tick could re-infest the same host within one quarantine period. It is important to prevent re-infestation taking place. All bedding could be removed from the building every 10 days and disposed of so that ticks cannot re-infest the animals in quarantine. After removal of the bedding the walls and floors could be steam cleaned or cleaned by high pressure hosing and sprayed with an insecticide and clean bedding used in the holding premises. If this procedure is repeated every 10 days eggs and ticks of all stages will be removed and cannot re-infest the quarantined animals.

Two host ticks may be on the animal somewhat longer than one-host ticks but will also be caught up and removed during the regular clean-ups.

One-host ticks, such as the very important *Boophilus microplus* remain on the host animal through larval, nymph and adult stages and mate on the host. They are likely to be on the host for about 3 weeks before dropping off and laying some 2-4,000 eggs. Eggs can hatch within 19 days and a life cycle could be completed in 40 days (Allan 2001). If cattle are housed in a building that is not regularly cleaned or if quarantined in a paddock then it would be possible for a *Boophilus* tick to be fully engorged at the time of entering quarantine and to leave the animals and lay a package of several thousand eggs. These eggs could be hatched and ready to find a host within one 30-day quarantine period. If animals are quarantined in paddocks or in buildings that are not properly cleaned, ticks could be imported into New Zealand. However, regular and conscientious cleaning and disinfection will catch all ticks leaving the host while in quarantine and no single female tick is likely to stay on the host for more than 30 days.

One or a combination of the following measures could be considered in order to manage the risk.

- Cattle could be treated with a pour-on acaricide, 7-10 days prior to entering PEI.
- Cattle could be treated during the 48 hours immediately prior to entering PEI with an insecticide/acaricide solution that is effective against ticks applied to the animals by thoroughly wetting the entire animal including under the tail, ears, the axillary region, between the hind legs, and the interdigital spaces (e.g. using a back pack spray unit). A pour-on treatment should not be used.
- Cattle could be held isolated for 30 days in quarantine premises with impervious washable floor and walls or on a fenced, impervious pad without walls and surrounded by a cleared area free from vegetation. Bedding should not be straw or plant material that could contain tick eggs and larvae. Inert materials such as wood shavings or sterilised peat could be considered suitable. The animals could be fed rations that are free from potential contamination with ticks, tick eggs, larvae or nymphs. Pelleted rations could be preferred.
- Cattle could have all the bedding on which they are housed removed every ten days during the quarantine period and, at this time, the walls and floor could be thoroughly cleaned, and sprayed with an acaricide.
- Cattle could be meticulously inspected for ticks and other ectoparasites, at least 10 days after entering PEI. If still infested, the treatment could be repeated and animals inspected again at least 10 days later. Treatments and testing could be repeated until the animals are found to be free from evidence of ticks. The ectoparasiticide could be altered if the previously used treatment has not been effective.

- Cattle could be treated with an acaricide within the 3 days prior to shipment.

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46. Warble Fly

46.1. HAZARD IDENTIFICATION

46.1.1. Aetiological agent

Hypoderma lineatum and *Hypoderma bovis*.

46.1.2. OIE list

Not listed.

46.1.3. New Zealand status

Hypoderma spp. are listed on the unwanted organisms register as unwanted exotic organisms.

46.1.4. Epidemiology

Hypoderma lineatum and *Hypoderma bovis* occur in the USA, Canada, and Europe (Colwell 2001). Warble flies have been eradicated from Great Britain (DEFRA 2005) and many European countries and are absent from Australia (Animal-Health-Australia 2005) and New Zealand (Anonymous 2005). *Hypoderma lineatum* occurs in countries in the northern hemisphere mainly in the region of 25-60 degrees north with a southern limit of the Punjab of India, Northern Mexico, and Hawaii (Sanchez-Arroyo 2003).

Warble fly infestations of cattle cause serious economic losses due to production losses and damage to hides. In 1986 the cost of warble fly in cattle was estimated at £35 million in Great Britain and \$85 million in Italy (Wilson 1986).

The adult flies lay their eggs on the hairs of animals and the larvae hatch and penetrate the skin, then migrate to the oesophageal region or the spinal canal where they remain dormant for the winter. They then migrate to the sub-cutaneous tissue on the back where they develop into warbles and cut a breathing hole in the skin. Finally, after developing for about 30 days, third-stage larvae emerge through the breathing hole in the skin. They pupate in the soil and after about 36 days emerge as adult flies. The whole life cycle takes a full year (DEFRA 2005).

Hypoderma bovis and *Hypoderma lineatum* are primarily parasites of cattle and bison but occasionally infest horses and man but many of parasites that infest horses are due to other *Hypoderma* spp. such as parasites of deer.

During the time the larvae are in the host animal, the animal makes antibodies against enzymes secreted by the larvae and serological tests can therefore be used to diagnose the presence of larvae in the host. The ELISA was used as a diagnostic method and to confirm the absence of the fly in the eradication campaign in Great Britain (DEFRA 2005). The sensitivity is reported to be in excess of 94% and a specificity greater than 98% (Webster not dated). Infested cattle develop antibody 3-6 weeks after infestation and antibody persists for 3-4

months after third-stage larvae leave the host (Boulard and Moiré not dated; Webster not dated).

Larval infestations are readily treated with insecticides, particularly with avermectins. Ivermectin is effective even at very low doses (Losson et al not dated). Treatment for warble larvae must be timed to coincide with the time when the larvae are in the host.

46.1.5. Hazard identification conclusion

Hypoderma spp. are unwanted exotic organisms that commonly infest cattle. Therefore, they are considered to be potential hazards in the commodity.

46.2. RISK ASSESSMENT

46.2.1. Entry assessment

From the time larvae penetrate the skin until they reach the dorsum and develop into palpable warbles the infestation cannot be diagnosed clinically. About 30 days before the larvae leave the host warbles start to develop on the backs of infested animals and become clinically detectable. Cattle coming from endemically infected countries could be infested with clinically undetectable larvae. Therefore the likelihood of entry in the commodity is considered to be non-negligible.

46.2.2. Exposure assessment

If third-stage larvae leave their hosts after the imported animals are introduced into New Zealand and mature into adult flies they could infest New Zealand cattle. However, it is unlikely larvae in cattle brought from the northern hemisphere could leave their hosts when mature and survive and develop in a southern hemisphere winter. Inability to switch their breeding from a northern hemisphere cycle to a southern hemisphere cycle is the probable reason that warbles are found only in the northern hemisphere. The likelihood that New Zealand cattle will be exposed to *Hypoderma* spp. is therefore considered to be extremely low but non-negligible.

46.2.3. Consequence assessment

If the parasite established it would have significant economic effects on the cattle industry due to production losses. The quality and value of leather would be seriously affected.

Occasional infestations of humans that would require medical treatment could occur. The consequences for feral and wild animals are likely to be negligible since the parasite is host specific and only rare aberrant cases would occur in other animals.

Since there could be negative effects on animal production and occasional cases of myiasis in man the consequences are considered to be non-negligible.

46.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for *Hypoderma* spp. is non-negligible and they are classified as hazards in the commodity. Therefore, risk management measures can be justified.

46.3. RISK MANAGEMENT

46.3.1. Options

One or both of the following options could be considered in order to effectively manage the risk.

- Cattle infested with warble larvae can be effectively treated with systemic insecticides. Therefore all animals introduced from countries that are infested with warbles could be treated before introduction. The treatment could be integrated with other parasite treatments.
- ELISAs could be done to detect larval infestations of cattle, but since this would require extra tests and expense for imported animals it is considered to be a less desirable option.

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47. Internal Parasites

47.1. HAZARD IDENTIFICATION

47.1.1. Aetiological agents

All internal parasites including nematodes, cestodes, and trematodes.

47.1.2. OIE list

Echinococcosis/hydatidosis listed.

47.1.3. New Zealand status

Many parasites occur commonly in New Zealand. *Cysticercus bovis* and *Echinococcus spp.* are exotic, notifiable organisms.

47.1.4. Epidemiology

Internal parasites belong to three basic groups:

Cestodes or tapeworms.

Trematodes or flukes (paramphistomes and liver flukes).

Nematodes (mainly intestinal parasites but also include lungworms and a few other curiosity parasites such as eyeworms (*Thelazia spp.*)).

Internal parasites occur commonly in New Zealand and the importation of species of parasites that already occur here is not regarded as a biosecurity risk. However, anthelmintic resistance of parasites is a major problem that occurs world-wide. Introduction of parasites that are resistant to an anthelmintic type for which resistant parasites do not presently occur in New Zealand should be considered to be a biosecurity risk. Anthelmintic resistance to the commonly used anthelmintics used for nematode control is widespread in New Zealand (Rhodes et al 2006). Anthelmintic resistance in liver fluke has not yet been described but occurs in Australia, the United Kingdom, and Europe (Boray 1999; Moll et al 2000; Sargison 2005).

Paramphistomes are present in New Zealand, and no reports were found of anthelmintic resistance in paramphistomes. Therefore resistant paramphistomes are not considered to be a potential hazard in introduced cattle.

The intestinal (*Moniezia spp*) and liver (*Stillesia hepatica*) tapeworms of cattle occur in New Zealand, but are of minor economic importance. Reports of resistance to anthelmintics in these parasites were not found. Therefore these parasites are not considered to be potential hazards in the commodity. The human/cattle tapeworm *Taenia saginata* could only be introduced by cattle in the cyst stage that occurs in cattle muscles. It would not develop further unless muscle that is infested with cysts is eaten by humans. Since imported cattle are monitored by MAF and not allowed to be introduced into the human food chain the likelihood of introduction by live cattle is considered to be negligible. The cyst form of *Echinococcus*

granulosis could occur in cattle. *Echinococcus granulosis* has been eradicated from New Zealand (Pharo 2002) but the parasite could be re-introduced if an imported animal infested with *Echinococcus* cysts were to be fed to dogs.

Cestodes other than *Echinococcus granulosis* are not considered to be potential biosecurity hazards.

The liver fluke (*Fasciola hepatica*) is present in New Zealand. Resistance to the anthelmintics used to control liver flukes has not been reported in New Zealand. However, anthelmintic resistance to triclabendazole, the main anthelmintic used for control, has been reported in Australia, and Europe (Boray 1999; Moll et al 2000; Sargison 2005). Therefore liver fluke are considered to be potential hazards. Faeces sedimentation tests can be used to identify fluke eggs in faeces.

The numbers of nematode parasites are too large to be considered individually and since most of them occur universally only a few could be considered to be biosecurity threats. Important species of nematodes that are not established in New Zealand include *Oesophagostomum* and *Nematodirus battus* (McKenna 1997). Diagnoses of parasite infections are done by identification of eggs or hatched larvae in faeces. Reliance on diagnosis by faeces examination and treatment with anthelmintics has been the method specified for many years in New Zealand's import health standards and those of our trading partners. No other practical methods are available for this purpose. Identification of single species of parasites as part of a quarantine procedure is not possible and the criterion generally used for imported animals is that they should be entirely free from all parasite eggs in the standard egg flotation method used when examining faeces from imported animals.

47.1.5. Hazard identification conclusion

Exotic parasites and anthelmintic resistant strains of endemic parasites are considered to be potential hazards in the commodity.

47.2. RISK ASSESSMENT

47.2.1. Entry assessment

New species of parasites or anthelmintic resistant parasites could be introduced with imported cattle and would not be obvious at a clinical examination. Therefore the likelihood of entry in imported cattle is considered to be non-negligible.

47.2.2. Exposure assessment

Imported cattle will be mixed with New Zealand cattle and shed eggs and larvae of internal parasites on pastures. New Zealand cattle could therefore be exposed to the parasites. The likelihood of exposure is therefore considered to be non-negligible.

47.2.3. Consequence assessment

Some species of new exotic parasites may have the potential to cause more severe disease syndromes than the species presently in New Zealand and the introduction of anthelmintic resistant parasites could serve to hasten the emergence of anthelmintic resistance in New Zealand.

Cattle parasites are not parasites of humans except for those species that have a shared lifecycle in cattle and humans e.g. *Taenia saginata*. The latter species can only infect humans when they eat undercooked meat infested with tapeworm cysts. Because imported cattle are prohibited from entering the human food chain the likelihood that a person would be infested with tapeworms by eating undercooked meat from an imported animal is considered to be negligible.

If the carcasses of imported cattle infested with *Echinococcus granulosus* were predated by dogs, this could result in transmission to sheep and the re-establishment of a sheep/dog cycle and sporadic cases of human disease.

Other cattle parasites can also infest other ruminants such as sheep and goats and could infest wild and feral ruminants. However, since wild and feral ruminants are not intensively farmed the effects on them are likely to be minimal. The impact on the environment is therefore likely to be negligible.

Since introduction of new or anthelmintic resistant parasites could have a detrimental effect on cattle and sheep farming the consequences are assessed to be non-negligible. The re-establishment of *Echinococcus granulosus* could result in sporadic cases of human disease and the necessity for an expensive eradication campaign.

47.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for exotic parasites and anthelmintic resistant strains of endemic parasites is non-negligible and they are classified as hazards in the commodity. Therefore, risk management measures can be justified.

47.3. RISK MANAGEMENT

47.3.1. Options

New Zealand has eradicated *Echinococcus granulosus* and should seek to preserve this status. The current import health standard for cattle and buffalo from Australia requires an assurance of property freedom from all evidence of *Echinococcus granulosus* infections during the 5 years prior to export based on information provided by the animal's owner(s) and his/her veterinarian. Therefore cattle to be imported into New Zealand could be sourced from properties with no history of *Echinococcus granulosus* infestation during the previous 5 years. However, it is doubtful that any property would be able to produce satisfactory evidence to demonstrate a five-year freedom from *Echinococcus granulosus*. Therefore, if live cattle imports were permitted, the management of the risk associated with *Echinococcus granulosus* would rely mainly upon compliance with domestic legislation.²

² The Biosecurity (Declaration of a Controlled Area) Notice No 1204 of 23 July 2001 declares the whole of New Zealand to be a controlled area to enable the limitation of the spread of *Echinococcus granulosus*. Under this notice:

- (i) The slaughter of ruminants and pigs at home killing facilities within the controlled area shall be conducted within a dog-proof enclosure in such a manner as to ensure that raw offal is not accessible to dogs;

Cattle to be imported into New Zealand could be quarantined for at least 30 days in premises with impervious washable floors. The floors could be regularly cleaned and old bedding removed. If this is done every three days it will integrate well with the recommendations for preventing the importation of ticks. Animals could be treated for internal parasites before and after entry into quarantine. While in quarantine faeces of imported animals could be tested to determine whether they are infested with internal parasites (nematodes and liver fluke). When treatment is unsuccessful the procedure could be repeated using a different anthelmintic type. When shown to be free from parasites the imported cattle could again be treated for parasites within 3 days of shipment. Treatment for other parasites such as ticks mites and lice could be integrated with treatments for internal parasites and where possible treatments that are effective against all parasites could be used.

One or a combination of the following measures could be considered in order to effectively manage the risk.

- Cattle for export to New Zealand could be sourced from properties on which no evidence of *Echinococcus granulosus* has been found in cattle, sheep, or dogs during the previous 5 years prior to export. Given the limited effectiveness of such a requirement, the importers would also need to be made aware of the legal requirements relating to the feeding of carcass material from imported animals to dogs and the requirements for identifying imported animals and reporting deaths or slaughter of imported animals.
- Cattle for export to New Zealand could be treated with an endoparasiticide effective against endoparasites including liver fluke, 7-10 days prior to entering pre-export isolation.
- Cattle for export to New Zealand could be held in quarantine for a period of 30 days in premises with an impervious washable floor or impervious pad. While in quarantine soiled bedding could be removed at least every 10 days and floors could be washed by high pressure hosing or steam cleaning.
- Cattle for export to New Zealand could be treated with an endoparasiticide within 48 hours after entering pre-export isolation. The efficacy of the endoparasiticide could be checked 7-14 days after the endoparasite treatment by examining faeces samples from the treated cattle by the faecal floatation concentration method (Egwang and Slocombe 1982) and sedimentation methods and be required to give a zero roundworm and fluke egg count. Treatments and testing could be repeated on animals that have positive egg counts until they give a zero roundworm and fluke egg count, the anthelmintic type should be changed as necessary. In the case of surviving parasites larval cultures could be made, the parasites identified, and MAF notified of the results.
- Within 3 days of export to New Zealand animals could again be treated with an endoparasiticide.

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- (ii) owners shall control their dogs at all times in such a manner as to prevent them from having access to raw offal of ruminants and pigs;
 - (iii) the offal of ruminants and pigs shall be cooked by boiling for a minimum of 30 minutes before feeding to dogs within the controlled area.

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48. Weed Seeds

48.1. HAZARD IDENTIFICATION

48.1.1. Aetiological agent

All plant seeds and plant material.

48.1.2. OIE list

Not listed.

48.1.3. New Zealand status

Organisms of concern are all exotic plants and plant seeds.

48.1.4. General considerations

Weeds and weed seeds could be found attached to the hair of animals. Large seed heads and pieces of plant material would be easily visible and could be removed before shipment but small seeds would not be visible.

Seeds are specifically adapted to survive unfavourable environmental conditions and most will at least survive from one growing season to another. Many will survive for several years and germinate when favourable conditions occur. Most seeds are highly resistant to dehydration, particularly those from plants adapted to survival in desert or hot dry climates and most seeds retain viability better in dry conditions but some are specifically adapted to remain viable in water. *Mimosa glomerata* seeds survived 221 years in the herbarium of the Museum National d'histoire Naturelle in Paris. *Lupinus arcticus* seeds frozen in a leemings burrow that was dated as 10,000 years old germinated within 48 hours when placed in favourable conditions (Anonymous undated). Some seeds are adapted to environments subjected to periodic fires and survive or are activated by fires. Others are adapted to be dispersed by water including those that are adapted to salt water.

Weed seeds can survive passage through animal's digestive systems and are passed out in faeces (Katovich undated).

Some plants can replicate asexually and are able to be grown from cuttings, and could grow from pieces of plants introduced on animals.

48.1.5. Hazard identification conclusion

It is concluded that weed seed could be introduced on animal's hair or in their faeces. Therefore weed seeds are considered to be potential hazards in the commodity.

48.2. RISK ASSESSMENT

48.2.1. Entry assessment

As seeds and plant material could be introduced attached to animal's hair and in animal faeces, the likelihood of entry in the commodity is non-negligible

48.2.2. Exposure assessment

Weed seeds could become detached from animal's hair or released in faeces. They are generally resistant to most environmental conditions and may remain dormant until conditions are favourable for germination. Therefore the likelihood that seeds could germinate and grow if released into a suitable environment is non-negligible.

48.2.3. Consequence assessment

As a result of the release of exotic weed seeds exotic noxious weeds could be introduced and become established with subsequent deleterious effects on the environment and the economy.

48.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate for weed seeds is non-negligible and they are classified as hazards in the commodity. Therefore, risk management measures can be justified.

48.3. RISK MANAGEMENT

48.3.1. Options

One or a combination of the following measures could be considered in order to effectively manage the risk.

- Since most live cattle that will be imported will be used to being handled they could be regularly groomed and kept free from visible contaminating plant material.
- The measures appropriate to control the introduction of ticks would also greatly reduce the likelihood of introducing weed seeds. Housing the animals for a period of 30 days in facilities with clean impervious flooring on bedding that is not made up of grass hay or straw will reduce the risk contamination with weed seeds. Suitable bedding materials include wood shavings, sawdust, or sterilised peat. During the 30 days in quarantine the plant material eaten by the animals before they were introduced into the quarantine facilities, will have been either digested or passed out in the faeces. Regular removal of faeces and soiled bedding will reduce the likelihood that weed seeds will be present in faeces that could contaminate animals' coats.
- Feeding of processed pellets that are essentially free of weed seeds will ensure that the animals do not ingest new burdens of weed seeds.
- A review of passage times for weed seeds in the digestive tract of herbivores (Barton and Williams 2001) concluded that, to avoid the importation of most unwanted seeds

in the digestive tracts of herbivorous animals destined for New Zealand, they should be fed a seed free diet for at least 10 days prior to their arrival in New Zealand. Cattle passed about half the seeds ingested by 2.5 days and most of them by 7 days. A few seeds were retained for up to 1 month in cattle. The wide variation around the mean seed-passage times was attributed to many factors such as individual animal effects, whether or not the animal was pregnant, and food intake. The most widely reported factor with potential applicability to quarantine protocol was faster seed-passage time in animals fed a high-quality diet.

- An import risk analysis of the importation of weed species by live animals (Ministry of Agriculture and Forestry 1999) recommended that animals should be held, pre-shipment, in areas free of weed species and fed on clean pasture or high quality feed. During transport, provision of high quality feed with little or no weed species contamination or feed that has been treated in such a way as to render seeds non-viable would mitigate the risks associated with the importation of live animals. Dung produced during transport could be safely disposed of, either enroute or on arrival in New Zealand.

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