Import Risk Analysis: Tasmanian devils (*Sarcophilus harrisii*/ *Sarcophilus laniarius*) from Australia

DRAFT FOR PUBLIC CONSULTATION

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Executive Summary

This risk analysis examines the risks associated with importing the marsupial Tasmanian devils into New Zealand Zoos. Imported Tasmanian devils will be confined to containment facilities. Therefore, the Tasmanian devils would not have contact with New Zealand domestic, wild or feral animals other than birds, and possibly vermin such as rats and mice that may have access to animal enclosures. The only direct contact with people would be with the staff that are involved with their care.

Few infectious diseases (viral, bacterial, protozoal or fungal) of Tasmanian devils were identified. Other than *Salmonellae*, the infectious diseases identified were assessed to not be hazards in the commodity. Several internal parasites were identified in Tasmanian devils. However, since these are predominantly species-specific and the likelihood that they could be transferred from animals in containment facilities is assessed to be negligible, they were not considered to be hazards in the commodity. External parasites were assessed to be potential hazards and options for effectively managing the risk of introduction of external parasites by Tasmanian devils are suggested.

1. Introduction

This risk analysis has been developed in response to a request from the Wellington and Auckland zoos and other participants in the Australasian Species Management Program (ASMP). Tasmanian devils (*Sarcophilus harrisii* also called *S.laniarius*) are currently dying in large numbers due to devil facial tumour disease (DFTD) and the free living Tasmanian devils are considered to be at risk of extinction. A captive breeding program, aimed at ensuring the survival of the species, is already in operation and 73 Tasmanian devils have been sent to Australian mainland wildlife parks. The aim is to increase this number to 500 (Department of Primary Industries and Water 2008). Importation of Tasmanian devils into New Zealand would allow an additional DFTD-free breeding population to be established outside of Australia.

2. Scope

This qualitative risk analysis is limited to the description of the risks involved in the importation of Tasmanian devils (*Sarcophilus harrisii*) from Australia. It is also limited to disease-causing organisms, as defined in the Biosecurity Act, that could be carried by Tasmanian devils. Genetic diseases and other risks that may be of commercial importance to the importers are not considered. Matters relating to the importation of any new species of animal (Tasmanian devils) are the responsibility of the Environmental Risk Management Authority (ERMA) and are not considered in this risk analysis. However, it is expected that the imported Tasmanian devils will remain contained in a zoo or equivalent facility that is a registered containment facility.

There are no dasyurid marsupials living outside of these registered facilities. Therefore, the likelihood of disease transmission to other dasyurids will be negligible. The only Australian marsupials present in New Zealand are feral possums and wallabies. The likelihood of direct contact between these species and Tasmanian devils kept in zoos will be negligible. The potential for direct contact with animals other than birds and rodents, which may have access to animal enclosures, is negligible.

Contact with humans will be limited to the staff that care for them. Indirect contact will be limited to parasites that can move between enclosures within the containment facility, or to parasites or infectious agents that could be carried by attending staff to animals outside the containment facility. Therefore, this risk analysis is restricted to a consideration of whether any of the diseases of Tasmanian devils can be transmitted to humans such as zoo staff and visitors to zoos, or birds or rodents such as rats and mice that may enter areas or buildings in which the animals are confined.

3. Commodity Definition

The commodities to be introduced are Tasmanian devils (*Sarcophilus harrisii)* from Australia. The animals will be introduced from registered Australian zoos or wildlife parks in which DFTD has not occurred. In addition the animals to be imported will have met all the conditions specified by the Australian Department of the Environment, Water, Heritage and the Arts (DEWHA) for the overseas transfer of Tasmanian devils (DEWHA 2008).

Tasmanian devils for import into New Zealand should be inspected for contaminating plant material (in the hair, between the digits) prior to export, and be certified as free from weeds and weed-seeds.

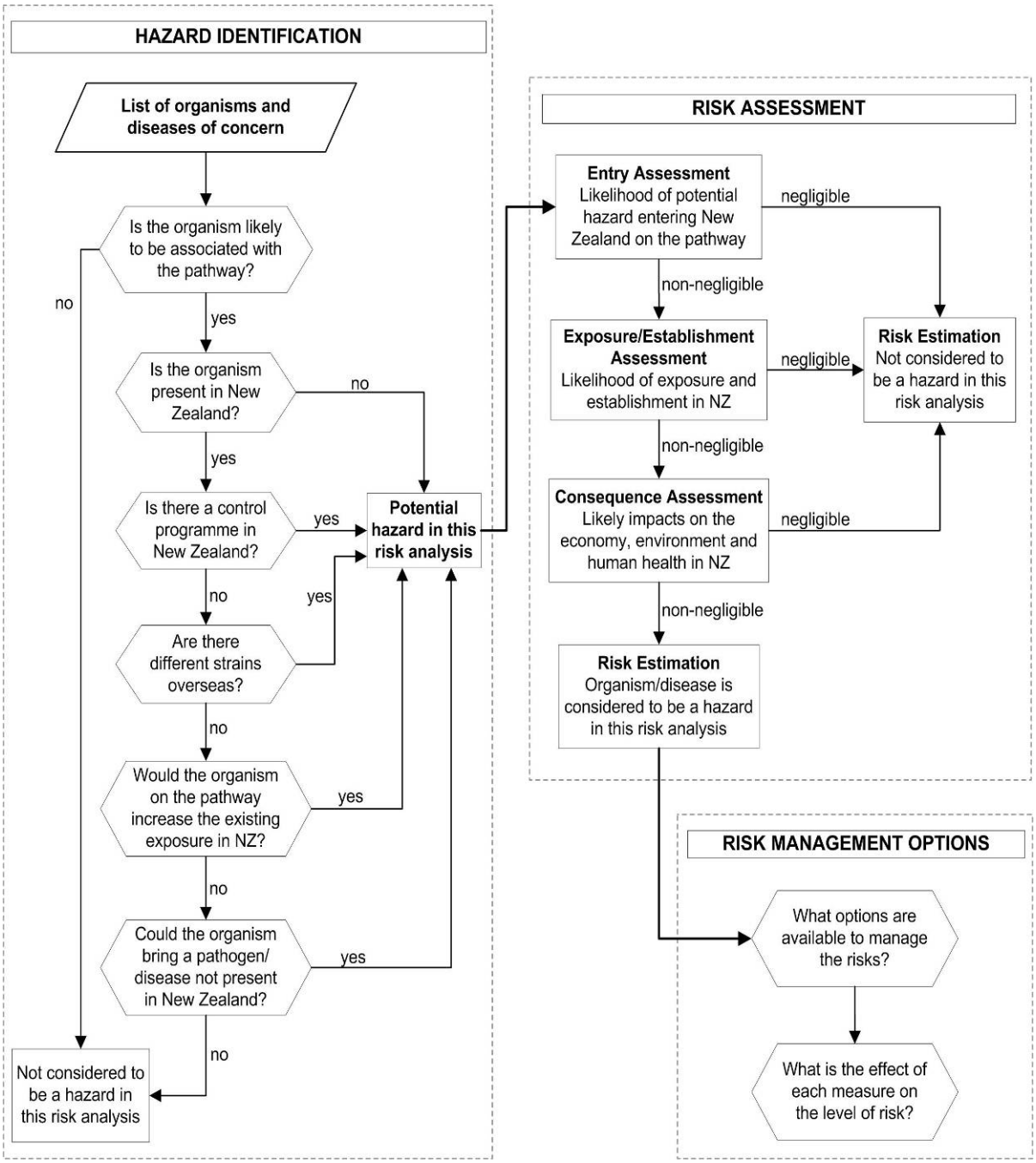
At the time of shipment Australia must be officially free from bovine tuberculosis, Aujeszky's disease, Japanese encephalitis, rabies and surra.

4. Risk Analysis Methodology

The methodology used in this risk analysis is described in MAF New Zealand's *Risk Analysis Procedures – Version 1* (MAF 2006) and is consistent with the guidelines in Section 2.2 of the World Organisation for Animal Health (OIE) Terrestrial Animal Health Code (*Code*) (OIE 2008).

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

Figure 1. The Risk Analysis Process



4.1. PRELIMINARY HAZARD LIST

The hazard identification process begins with the collation of the organisms likely to be associated with the commodity. The basis for the preliminary hazard list is a list of all the hazards identified in an extensive literature search for diseases of Tasmanian devils and

related dasyurids (carnivorous marsupials). The literature search included a search of three electronic databases, the publication list of the Australian Registry of Wildlife Health (Taronga Conservation Society) and relevant publications (Rice and Wilks 1996; Rose 2005).

Preliminary hazards are those organisms identified as causing disease in Tasmanian devils that meet the following criteria as agreed between MAFBNZ and the Ministry of Health (MoH):

Animal disease agents

- All disease agents that are exotic to New Zealand and present in an exporting country or about which there is 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 but do occur in an exporting country and are potentially harmful.
- Organisms that occur in New Zealand and an exporting country and for which an eradication programme administered by a pest management strategy under the Biosecurity Act is in place.

Disease agents 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 the occurrence of diseases associated with them.
- Disease agents that occur in an exporting country and only in well defined geographically bounded areas of New Zealand.

Few reports of infectious or parasitic diseases of Tasmanian devils could be located.

Expansion of the search to include other dasyurids produced few additional viral infections of dasyurids. A considerable number of internal parasites of dasyurids were identified, many of which do not occur in Tasmanian devils. Therefore, subsequent discussion has been mainly limited to those specifically occurring in Tasmanian devils. Many external parasites of Tasmanian devils are not host specific and therefore discussions on external parasites often include information about other dasyurids.

The following diseases of concern were identified.

Devil facial tumour disease (DFTD)

DFTD is a disease of unknown aetiology characterised by tumours on the face. It is not known to occur in other animals. The disease first emerged in 1996 and has spread through a large part of Tasmania (McGlashan et al 2006). Many authors consider that it could result in extinction of Tasmanian devils in the wild (Lachish et al 2007; McCallum 2008; McCallum and Jones 2006; McGlashan et al 2006; Robertson 2005). This disease is considered a preliminary hazard and is subjected to risk analysis.

Tyzzer's disease

Clostridium pilliforme the aetiological agent of Tyzzer's disease has been described in Tasmanian devils and many other animals. However, it is endemic in New Zealand (Nuttal 1990; Townsend 1994) and is therefore not considered to be a potential hazard in the commodity.

Mycobacteriosis

Cutaneous mycobacteriosis has been reported in Tasmanian devils and quolls. It is caused by a variety of saprophytic mycobacteria which act as opportunistic pathogens. Organisms such as *Mycobacterium fortuitum, M. smegmatis, M. chitae, M. ulcerans, M. avium and M. abcessus* have been implicated (Holz 2008a; Holz 2008b). The organisms occur in the environment and are not primary pathogens and most and perhaps all occur in New Zealand. Mycobacterial skin infections occur in cats, dogs and cattle in New Zealand (De Lisle 1987; De Lisle 1993). Systematic mycobacteriosis affecting several organs has been reported in Tasmanian devils. It is usually caused by *M avium* or *M abscessus* (Holz 2008a) both of which occur in New Zealand. *Mycobacterium bovis* has been eradicated from Australia. Therefore, the mycobacterial species causing mycobacteriosis in Tasmanian devils are not considered to be potential hazards in the commodity.

Salmonellosis

Several *Salmonella* serotypes have been isolated from Tasmanian devils (Holz 2008a) Since Salmonellae can be transmitted to humans and other animals Salmonellae are assessed to be preliminary hazards in the commodity.

Degenerative leukoencephalopathy and myelopathy

This condition has been described in Tasmanian devils and quolls aged 3 years and older. There is no evidence that it is an infectious disease and it has been suggested that it is an age-related degeneration (Holz and Little 1995). Therefore, it is not considered to be a potential hazard in the commodity.

Cytomegalovirus infection of the prostate of dasyurid marsupials.

Cytomegalovirus was demonstrated by electron microscopy in the prostate of the dasyurids *Phascogale tapoatafa, Antechinus stuarti* and *Antechinus swainsoni* (Holz 2008a). The prevalence of lesions was highest in mature animals during the breeding season. Infection with the virus can incite an inflammatory response, but is probably not detrimental to the host (Barker et al 1981). The effect of the infection on the host is unknown because all adult male *P tapoatafa, A stuarti* and *A swainsoni* die at the end of the breeding season. Since there are no adult males for some months after the breeding season it is postulated that the virus is transmitted vertically by the females. It has also been suggested that the virus may be transmitted venereally from heavily infected males to females during the breeding season (Barker et al 1981). Since most herpes viruses exhibit a high degree of host specificity it is unlikely that the virus is transmissible to animals other than dasyurids. The virus probably is not pathogenic or minimally pathogenic in its known hosts and has not been described in Tasmanian devils. Therefore, it is not considered to be a potential hazard in the commodity.

Internal parasites

Several internal parasites are known to occur in Tasmanian devils (Spratt et al 1991). Therefore, internal parasites are considered to be preliminary hazards in the commodity and are subjected to risk analysis.

External parasites

Several external parasites are known to occur in Tasmanian devils (Beveridge and Spratt 2003). Therefore, external parasites are considered to be preliminary hazards in the commodity and are subjected to risk analysis.

Protozoal parasites

The only protozoal parasites reported from Tasmanian devils are *Toxoplasma gondii* which is endemic in New Zealand and a sarcocyst that has been described in the musculature. The sarcocyst in the musculature is the intermediate stage of a parasite with a complex life cycle (Beveridge and Spratt 2003). For completion of the life cycle the parasite would have to be ingested by an unknown definitive host of the parasite. Clearly the life cycle will not be completed if sarcocysts are imported in Tasmanian devils, as the imported animals will not be eaten by potential hosts. It is therefore not considered to be a potential hazard in the commodity.

The Preliminary Hazard list is:

- DFTD agent
- Salmonella spp.
- Internal parasites
- External parasites

4.2. HAZARD IDENTIFICATION

Each organism identified as a possible hazard in Section 4.1 is subjected to hazard identification that includes a discussion on its epidemiology. However, the discussions are generally restricted to information relevant to importation of Tasmanian devils.

Organisms that are present in New Zealand are not potential hazards unless there is evidence that strains with higher pathogenicity than the endemic strains are likely to be present in the commodity to be imported, or the organism is under official control in a pest management strategy or is of concern to human health as defined in Section 4.1.

If the hazard identification process identifies the organism as a potential hazard it is subjected to risk assessment (Section 4.2.2).

4.3. RISK ASSESSMENT

The risk assessment procedure is summarised below:

Risk assessment

a) Entry assessment - the likelihood of the organism being imported in the 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, establishment or spread of the organism.

d) Risk estimation - a conclusion on the risk posed by the organism based on the entry, exposure and consequence assessments. If the risk estimate is non-negligible, then the organism is classified as a hazard.

If the risk assessment process leads to a conclusion that the organism is a hazard it is subjected to risk management which includes suggested options for the effective management of the hazard in the commodity (Section 4.2.3). It is important to note that all of the above steps may not be necessary in all risk assessments. The MAF Biosecurity New Zealand and OIE risk analysis methodologies make 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 release 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. 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 the Application of 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

Internal and external experts and other government departments will extensively review this draft import risk analysis. It will then be issued for a 6 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 will also be invited to present alternative risk management options they consider necessary or preferable.

Following this period of public consultation on this draft document, a review of submissions will be produced and a decision-making committee will determine whether any changes need to be made to the draft risk analysis.

Following this process of consultation and review, the Imports Standards Group of MAF Biosecurity New Zealand will decide on the appropriate combination of sanitary measures to ensure the effective management of identified risks. These will be presented in a draft IHS that will also be released for a 6 week period of stakeholder consultation. Stakeholder submissions in relation to the draft IHS will be reviewed before a final IHS is issued.

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5. Devil facial tumour disease (DFTD)

5.1. HAZARD IDENTIFICATION

5.1.1. Aetiological agent

The aetiological agent is unknown but it is generally accepted that the disease is an infectious tumour that can be transmitted by allograft (transfer of affected cells).

5.1.2. OIE list

Not listed.

5.1.3. New Zealand status

Not listed as a notifiable or unwanted disease. However, it is an exotic disease.

5.1.4. 5.1.5 Epidemiology

DFTD is a disease that was first identified in Tasmania in 1996 (McGlashan *et al* 2006). Since then there has been a 64% decline in the sightings of Tasmanian devils across Tasmania and a 95% reduction in the north-eastern region where it first emerged. Up to 83% of animals at some sites are affected (Department of Primary Industries and Water 2008).

DFTD is rarely seen in animals less than 2 years of age with males and females being equally represented. Incubation period is unknown, but one animal developed DFTD after 10 months in captivity without apparent exposure to tumour cells during that time. (Holz 2008)

The tumour is described as an undifferentiated soft tissue neoplasm, composed of infiltrative nodular aggregates of round to spindle shaped cells. The tumours are locally aggressive and metastasis to abdominal and thoracic viscera occurs in 65% of cases (Bender 2008; Loh et al 2006). Affected animals always die within 6 months (Bender 2008) mostly due to starvation as the tumour destroys facial bones and dental arcades (Holz 2008). In all cases the chromosomes of the tumours have been rearranged in a complex but always identical manner. This indicates that the tumour is transmitted by allograft. Infectious cells are believed to be passed through bite wounds caused by fighting which is common amongst Tasmanian devils (Bender 2008; Pearse and Swift 2006).

Affected animals have only been found in the eastern half of Tasmania. Animals from the west mount an immune response to tumour cells and initial transmission studies indicate that these devils may be resistant to DFTD disease (Holz 2008). No other animal species have been identified with the disease.

There are no diagnostic tests for the disease and it cannot be diagnosed until clinically obvious tumours develop. DFTD tumours can be differentiated from other tumours histologically.

5.1.5. Hazard Identification Conclusion

The disease occurs only in Tasmanian devils, a species that is not present in New Zealand. It is not caused by a conventional infectious or parasitic agent and is transmitted only by the transfer of diseased cells. For these reasons the introduction of DFTD by Tasmanian devils could only be transmitted amongst the group of imported animals and does not represent a biosecurity risk. Therefore, it is not considered to be a potential hazard in the commodity.

It is important for the success of the conservation project that imported animals are free from the disease, and importation of disease-free animals is the responsibility and key focus of both the importer and exporter.

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6. Salmonellae

6.1. HAZARD IDENTIFICATION

6.1.1. Aetiological agents

The genus *Salmonella* contains two species with *Salmonella enterica* being of primary importance. *S enterica* contains six subspecies and *Salmonella enterica* subspecies *enterica* contains thousands of serotypes and phage types. Several serotypes have been reported from Tasmanian devils (Holz 2008) and many more could potentially infect them.

6.1.2. 6.1.2 OIE list

Not listed

6.1.3. 6.1.3 New Zealand status

Many *Salmonella* serotypes and phage types have been isolated in New Zealand. A full record of New Zealand isolates is maintained by the Institute of Environmental Science and Research (ESR 2008). All exotic *Salmonella* spp. affecting animals are classified as unwanted organisms.

6.1.4 Epidemiology

Salmonella spp. occur worldwide and are mainly transmitted by the faecal-oral route. They are carried asymptomatically in the intestines or gall bladder of many animals, and are continuously or intermittently shed in the faeces. They can also be carried latently in the mesenteric lymph nodes or tonsils; these bacteria are not shed, but can become reactivated after stress. Vertical transmission occurs in birds within eggs, and can also be transmitted *in utero* in mammals (CFSPH 2005).

Excreted organisms contaminate the environment and become a source of infection via fomites (Blood et al 1994). *Salmonella* spp. can survive for long periods in the environment, particularly where it is wet and warm. *S. typhimurium* and *S. dublin* have been found to survive for over a year in the environment (CFSPH 2005).

For humans, most *Salmonella* infections are acquired by handling or consuming contaminated food products, particularly foods of animal origin. Infections also are acquired by direct and indirect contact with farm animals, reptiles, and occasionally pets.

Isolates of salmonellae from Tasmanian devils are reported to be incidental findings from healthy animals (Holz 2008). There is no indication that salmonellosis is a common disease of Tasmanian devils.

Carriers of infections can be detected by culturing faeces samples but because excretion is intermittent repeated sampling and culture is necessary. Serology may be useful but is best applied on a herd basis (Davies 2008). No practical method exists for detecting individual carrier animals (Hansen et al 2006).

6.1.4. Hazard Identification Conclusion

Salmonellae are frequently isolated from healthy Tasmanian devils and could potentially infect humans and animals. It is possible that serovars that have not occurred in New Zealand could be involved. Therefore, salmonellae are considered to be potential hazards in the commodity.

6.2. RISK ASSESSENT

6.2.1. Entry assessment

Animals infected with *Salmonella* spp. may carry the organism for long periods and excrete the organism intermittently in their faeces. Salmonellae are reported to be isolated from healthy Tasmanian devils, without observable clinical signs. Therefore the likelihood of entry of an exotic *Salmonella* serovar into New Zealand is non-negligible.

6.2.2. Exposure assessment

The requirement that Tasmanian devils be kept in containment facilities will significantly limit the exposure of both people and other animals to any associated *Salmonella.* However, undetected carrier animals would excrete the organism intermittently in their faeces. Therefore zoo staff could be occupationally exposed, and salmonellae could also infect birds or rodents that may have access to the animal enclosures. Drainage run-off or waste material removed from enclosures is also likely to contribute to potential exposure.

The likelihood of exposure of New Zealand animals and humans to the organisms is therefore assessed to be low but non-negligible.

6.2.3. Consequence assessment

The potential consequences of the emergence of new serovars of *Salmonella enterica* in human and animal populations have been adequately demonstrated by the emergence of *S* Brandenberg in sheep (Clark et al 2004; Clarke and P. 2004) and *S* Typhimurium DT160 in birds and humans (Alley et al 2002). In the former case there were significant economic consequences for sheep farmers and in the latter a large number of human infections occurred after the emergence of the serovar (ESR 2008) and mortalities occurred in sparrows and other birds (Alley et al 2002).

There is a low likelihood that introduction of infected Tasmanian devils could lead to the establishment of new *Salmonella* spp. that have the potential to cause disease in humans and animals. Therefore the consequences are assessed to be non-negligible.

6.2.4. Risk estimation

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

6.3. RISK MANAGEMENT

6.3.1. Options

When considering options for effectively managing the risks the following points should be considered:

- Only a small number of Tasmanian devils will be introduced and they will be confined to containment facilities and not have contact with humans or animals, except for zoo staff and possibly rodents or birds that gain access to the animal enclosures.
- Because the number of Tasmanian devils that will be imported is low the likelihood of introducing a *Salmonella* carriers is low.

- Since many *Salmonella* serovars, including the serovars most commonly found in Australia already occur in New Zealand, the likelihood that any introduced carrier would be carrying a *Salmonella* serovar that is not already in New Zealand, is low.
- DEWHA has prescribed conditions under which Tasmanian devils may transferred overseas (DEWHA 2008). These conditions are:

2. PRE EXPORT REQUIREMENTS

2.1 Tasmanian Devils to be exported from Australia must be isolated from animals not of similar health status for a minimum of 28 days prior to export. If more than one animal is being exported, they should preferably be housed separately in a manner that would prevent transmission of pathogens between animals. The animals may be housed in a group, however, should an animal fail pre-export health screening due to the detection of an infectious disease it may preclude the others from being exported. Additional quarantine requirements may be required to address the issue of Devil Facial Tumour Disease (DFTD). However, knowledge of the disease and its transmission is changing rapidly. Any additional measures will be applied in the context of information available at the time of application.

2.2 Within the period of isolation, each Tasmanian Devil must be examined under anaesthetic by a veterinary surgeon experienced in the care and treatment of Tasmanian Devils. The examination should be conducted early in the isolation period to ensure that results are available well before the export date.*

2.3 If the animal has been examined by a veterinary surgeon without evidence of disease being detected, then a Certificate of Health will be issued by the examining veterinary surgeon in respect of each Tasmanian Devil to be exported. The Certificate of Health for each Tasmanian Devil to be exported must be provided to DEWHA before the animal is exported.**

2.4 The Certificate shall indicate:

a) age;

b) sex;

c) the weight and body condition based on assessments taken twice during isolation ***. An interpretation of any significant changes should be given;

d) condition of teeth;

e) the results of a parasite (internal and external) examination and the name and amount of drugs given if required;

f) the results of the veterinary examination and of one complete haematological and serum biochemical examination with comments on interpretation;

g) that the Tasmanian Devil does not have any unresolved health problems (a medical record for the animal must be supplied to the receiving institution);

h) that the Tasmanian Devil is free from clinical signs of disease or abnormalities;

i) transponder implant number and the details of other identification including studbook number;

j) that the Tasmanian Devil is not carrying young.

2.5 Each Tasmanian Devil to be exported must be implanted with a suitable microchip/transponder identification system implanted by a veterinary surgeon. If a microchip/transponder is not already implanted in the animal implantation will occur at the same time as the animal is examined during its 28 day period of isolation. Details of the data recorded on the implant must be supplied to DEWHA.

* It is recommended that when selecting animals for export prior to isolation that they are screened as per this protocol to minimise the risk of selecting animals that may fail pre-export health screening.

**It is the responsibility of the exporting institution to ensure that all aspects of the transaction are carefully planned and coordinated well in advance of the export.

***Relevant personnel, other than the veterinary surgeon, such as the appropriate keeper or other trained staff may carry out these measurements during the course of isolation.

Available options, in ascending order of stringency, for the effective management of the hazard in the commodity are:

Option 1.

Since many *Salmonella* serovars occur in New Zealand and because the small numbers of imported zoo animals are not regarded as important in the epidemiology of *Salmonellosis*, Tasmanian devils that meet the DEWHA requirements could be imported without further restrictions.

Option 2.

i. In addition to the DEWHA requirements, faecal samples from all animals to be imported could be cultured for *Salmonella* spp. during PEI. Animals not carrying Salmonellae could be imported.

ii. Any animals shown to be infected could be treated with suitable antibiotics and again tested to see whether the organism had been eliminated. After successful treatment animals could be imported.

NB. this option may not detect intermittent shedders

Option 3.

In addition to the DEWHA requirements, 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, 2008). 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 could be at the discretion of the importer of the animals to decide whether to proceed with the importation.

NB. This option is more likely to detect intermittent shedders than Option 2

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7. Internal parasites

7.1. HAZARD IDENTIFICATION

7.1.1. Aetiological agents

The aetiological agents are nematode, cestode, trematode and acanthocephalan parasites of Tasmanian devils.

7.1.2. OIE list

Parasites of Tasmanian devils are not listed.

7.1.3. New Zealand status

Since Tasmanian devils are not present none of their host specific parasites are present in New Zealand. Some parasites that have a broad host range are present (see below).

7.1.4. Epidemiology

The following internal parasites of Tasmanian devils are listed in the records of the South Australian Museum (Spratt et al 1991).

Trematodes

- *Mehlisia acuminata*: This species infects some dasyurid species but no other marsupials (Spratt et al 1991). Although the life cycle of this parasite has not been elucidated, all trematodes have complex life-cycles requiring intermediate hosts and sometimes additional paratenic hosts. Therefore, the likelihood of the parasite completing its life cycle, when Tasmanian devils are confined in a New Zealand containment facility is negligible. In addition, since no records were found of any member of the genus infecting animals other than marsupials or monotremes, *M acuminata* is not considered to be a hazard in the commodity.
- *Fibricola sarcophila*: No records were found of the species infecting dasyurids other than Tasmanian devils. Although the life-cycle has not been elucidated, completion of the life-cycle when Tasmanian devils are confined in a containment facility is unlikely to be possible. No records were found of any member of the genus infecting animals other than marsupials. Therefore, this parasite is not considered to be a hazard in the commodity.
- *Neodiplostomum diaboli*: The parasite has been described in *Dasyurus viverrinus* (eastern quoll) and the Tasmanian devil (Spratt et al 1991). Completion of the life cycle of the parasite is unlikely to be possible when Tasmanian devils are confined to a containment facility. No other animals are known to be infected and therefore the parasite is not considered to be a hazard in the commodity.

  NB. *Fibricola* and *Neodiplostomum* are now considered to be synonyms with *Neodiplostomum* now recognised as the correct genus name (Cribb and Pearson 1993).

Cestodes

- *Spirometra erinacei* (*mansoni, erinaceieuropaei*) is a parasite of cats, dogs and wild carnivores, Tasmanian devils and occasionally man (Zajac and Conboy 2006b).

Spirometra erinacei/erinaceieuropaei has been described in New Zealand in a feral cat (Urgarte et al 2005). Since a feral cat is unlikely to have had contact with any exotic animal the parasite is probably endemic. The first intermediate host is a copepod or crustacean and the second intermediate host may be a wide variety of species including frogs and snakes (Zajac and Conboy 2006b). Infection of humans with the larval stages is rare but it can cause a condition known as sparganosis which may be fatal and requires surgical intervention (Sparganum was the old name for the plerocercoids of *Spirometra* spp.). Humans can be infected by drinking water contaminated with infected copepods. The Tasmanian devil is as an accidental intermediate host. Therefore, it would not be possible for the life cycle of the parasite to be completed in imported Tasmanian devils confined to containment facilities.

- *Anoplotaenia dasyuri* is a tapeworm of Tasmanian devils and tiger cats, which are the definitive hosts (Beveridge and Jones 2002; Beveridge et al 1975; Gregory and Munday 1975). The intermediate hosts are other marsupials. Natural infections with metacestodes (tapeworm cysts) were found in pademelons (*Thylogale billiardieri*), potoroos (*Potorous apicalis*), Bennett's wallabys (*Macropus rufogriseus*), possums (*Trichosurus vulpecula*) and kangaroos (*Macropus giganteus* and *Macropus fuliginosus*), and mice and guinea pigs were experimentally infected (Beveridge and Jones 2002; Beveridge et al 1975). Metacestodes from wallabies developed to adults when fed to Tasmanian devils and tiger quolls but failed to develop in dogs and cats (Gregory and Munday 1975). The likelihood that Tasmanian devils confined to New Zealand containment facilities could infect wallabies or possums is low. Even if possums should be infected the likelihood that infected possums would be eaten by a competent host to complete the life-cycle is negligible. Therefore, the parasite is not considered to be a hazard in the commodity.
- *Dasyurotaenia robusta*: this species has only been described from Tasmanian devils and other species from the same genus are confined to Australian dasyurids (Spratt et al 1991). Since no potential hosts exist outside of containment facilities in New Zealand, it is not considered to be a hazard in the commodity.
- *Taenia pisiformis* is a tapeworm with a world-wide distribution. It is found in dogs and cats and has been found in Tasmanian devils. Its intermediate host is the rabbit and it is common in New Zealand wild rabbits (Townsend 1994). Therefore, it is not considered to be a hazard in the commodity.

Nematodes

- *Trichinella* sp.: The records of the South Australian Museum list *Trichinella* sp. as occurring in Tasmanian devils. However, it is now known that the species concerned is most likely to be *Trichinella pseudospiralis* (Obendorf et al 1990). This species has not been described in New Zealand except for a single imported case in a human (Andrews et al 1995). Although Tasmanian devils may harbour the adult parasite in their intestines the life-cycle is indirect and transmission to other animals is only from ingestion of encysted larvae that are found in the muscles of host species. Therefore, if introduced in a Tasmanian devil the parasite could not be transmitted to another animal or man unless the meat of the Tasmanian devil was eaten. Therefore, the likelihood of establishment of the parasite in New Zealand is negligible and it is not considered to be a hazard in the commodity. Tasmanian devils can also be infected with *Trichinella spiralis* (Holz 2008). *T spiralis* is endemic in New Zealand

cats, rats, pigs and man (McKenna 1997) so is not considered to be a hazard in the commodity

- *Woolleya sarcophili*: This species has only been described in Tasmanian devils (Spratt et al 1991) and the genus is confined to dasyurids. Therefore, it is not considered to be a hazard in the commodity.
- *Baylisascaris tasmaniensis*: There is good evidence that Tasmanian devils become infected with this parasite by eating the meat of wombats which contain granulomata containing larval forms of the parasite (Munday and Gregory 1974). Larval forms of the parasite have also been described in pademelons. Adult forms have been described in some other dasyurids (Spratt et al 1991). The life cycle would not be able to be completed in Tasmanian devils confined to a containment facility. Therefore the parasite is not considered to be a hazard in the commodity.
- *Physoptera sarcophili*: Typically members of this genus have a complex life cycle requiring coprophagus beetles as intermediate hosts and other animals such as lizards and rodents as paratenic hosts (Zajac and Conboy 2006a). It is likely that *P. sarcophili* which has only been described from Tasmanian devils and quolls (Spratt et al 1991) would require similar Tasmanian intermediate hosts. The likelihood that the parasite would complete its life cycle in Tasmanian devils confined in a containment facility is negligible. Therefore, it is not considered to be a hazard in the commodity
- *Cyathospiruria seurati* (*dasyuridis*) is predominantly a parasite of dasyurid marsupials (Ladds et al 2006) and feral cats (Coman 1972; Gregory and Munday 1976; Milstein and Goldsmid 1997; Ryan 1976a) and more rarely dogs, dingoes (Coman 1972) and foxes (Ryan 1976b). *C seurati* may occur in nodules or free in the stomach. Reports of the parasites in domestic cats are rare (Junker et al 2006). It is concluded that infections of domestic cats and dogs are rare and of little consequence. Since there will be no contact between imported Tasmanian devils and dogs and cats it is not considered to be a hazard in the commodity.
- *Cercopithofilaria johnstoni*: This filarial parasite is found in dasyurids, platypuses and possum gliders as well as eutherian mammal hosts in Australia. The parasite is transmitted by ticks particularly *Ixodes* spp. Since the vectors of the parasite do not occur in New Zealand the parasite will not be able to establish and it is therefore not considered to be a hazard in the commodity.
- *Angiostrongylus cantonensis* (rat lungworm): This parasite is a metastrongylid nematode for which rats are the definitive host. Adults live in the pulmonary arteries where larvae migrate into the airways, are then swallowed into the gastrointestinal tract shed in the faeces. Larvae are ingested or penetrate snail or slug intermediate hosts. When these are then ingested by Tasmanian devils as aberrant hosts, the larvae migrate extensively throughout the CNS causing clinical signs including death. Larvae may be detected in faeces (Holz 2008). The pre-patent period is around 6 weeks and albendazole anthelmintics have been used as treatment (Taylor et al 2007). Mebendazole has also been used in other species but this compound is toxic to marsupials causing neutropenia, bone marrow suppression, severe enteritis and haemorrhagic septicaemia (Holz 2003).
  This parasite can infect people, but only by ingestion (intentional or accidental) of snails or slugs. It can cause eosinophilic meningitis but people usually recover without treatment and are not infectious. (CDC 2008) Tasmanian devils are infected

as accidental hosts, but no evidence was found to indicate that they are infectious. Therefore, it is not considered to be a hazard in the commodity.

- *Marsupostrongylus spp*: These parasites are species specific lungworms found in dasyurids and most other marsupials. They are transmitted by ingestion and cause dyspnoea resulting from eosinophilic bronchopneumonia (Holz 2003).Since species from this genus are restricted to marsupials they are not considered to be hazards in the commodity.
- *Ophidascaris robertsi:* Snakes are the definitive hosts of this ascarid nematode. The very large larvae of this species have been found in the viscera and subcutaneous tissues of a range of dasyurids. (Holz 2008) Completion of the life-cycle depends on a snake (python) ingesting a mammalian host infected with a viable larva or larvae (Beveridge and Spratt 2003). Since there are no snakes in New Zealand it is not considered to be a hazard in the commodity.

Acanthocephalans

No acanthocephalan parasites have been described in Tasmanian devils.

Unknown internal parasites

Since Tasmanian devils are predominantly wild animals and probably not regularly submitted to detailed examination it is possible that they could carry undescribed parasites. The Australian indigenous marsupials evolved over millions of years in isolation from animals on other continents. During this period the parasites they carried evolved with them and as a result many of the parasites are unique to their marsupial hosts.

The rate of endemicity of marsupial parasites at the generic level is 36% for trematodes, 60% for cestodes and 76% for nematodes. However, at the species level endemicity is 96% for trematodes, 99% for cestodes and 97% for nematodes (Beveridge and Spratt 1996). Therefore, new species of parasites that may be identified are likely to be endemic parasites that are specific for their marsupial hosts and not pathogenic for domestic animals, humans or New Zealand feral or wild animals, except for introduced marsupials (possums and wallabies). In addition dasyurid parasites are unlikely to be parasites of herbivorous marsupials unless the herbivorous hosts act as paratenic or intermediate hosts.

7.1.5. Hazard identification conclusion

Since a large number of parasites of dasyurids and other marsupials are known and their various host associations may not yet be fully understood, internal parasites are assessed to be potential hazards in the commodity and are submitted to risk assessment.

7.2. RISK ASSESSMENT

7.2.1. Entry assessment

A large number of internal parasites have been described in Australian dasyurids and it is likely that others may still be discovered. Most dasyurid parasites are species specific. Therefore, the likelihood of introducing a newly described parasite which is not species specific, and could infect New Zealand animals or humans, is low. However, since the species of parasite that could be introduced is unknown the likelihood of entry is assessed to be non-negligible.

7.2.2. Exposure assessment

Imported Tasmanian devils will be kept isolated in containment facilities. If an imported animal is carrying an undescribed parasite it is likely that it would be a genus specific parasite that could only establish in a population of Tasmanian devils and possibly in other dasyurids. Since there are no dasyurids in New Zealand it is unlikely that an introduced parasite could establish here. It is also unlikely that parasite eggs would be carried by a keeper or someone who has access to the animal enclosure to a competent host or vector outside of the zoo. Therefore, the likelihood that a parasite carried by an imported Tasmanian devil would establish in New Zealand is very unlikely. However, adoption of a conservative approach suggests that the likelihood of introducing an exotic parasite is non-negligible for an unknown parasite.

7.2.3. Consequence assessment

Since the species of parasites that could be introduced is unknown the consequences are essentially unknown. Although the consequences of introducing a parasite are likely to be minimal adoption of a conservative approach leads to the assessment that the consequences are assessed as non-negligible

7.2.4. Risk estimation Risk estimation

Entry, exposure and consequence have been assessed as non-negligible. As a result the risk estimate for introduction of internal parasites is non-negligible and they are classified as hazards in the commodity. Therefore, risk management measures can be justified.

7.3. RISK MANAGEMENT

7.3.1. Options

When drafting options for exclusion of internal parasites the following points were considered:

- DEWHA has prescribed conditions under which Tasmanian devils may transferred overseas (DEWHA 2008). These conditions are given in Section 6.3.1.
- Animals to be imported will be confined in premises that are containment facilities and there will be no direct contact between imported dasyurids and other animals.
- There are no dasyurids in New Zealand.
- The assessments of entry, exposure and consequence were all non-negligible. However, these conclusions were based on a conservative approach and in each category the likelihood was considered to be low.

Available options for the effective management of internal parasites in the commodity devils, given in ascending order of stringency, are:

Option 1

The requirements could be limited to those specified by DEWHA for the overseas transfer of Tasmanian devils. [See Section 6.3.1] This requires a minimum 28 day pre-export isolation, with a clinical examination under anaesthetic for signs of parasitism, and treatment if required.

Option 2

i. In addition to the requirements specified by DEWHA, faecal samples from all animals to be imported could be examined for internal parasites using floatation, sedimentation and larval culture techniques. Animals free from parasites could be imported.

ii. Animals found to be carrying parasites could be treated using suitable anthelmintics and retested to ensure that the parasites have been eliminated before being cleared for importation.

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8. External parasites

8.1. HAZARD IDENTIFICATION

8.1.1. Aetiological agents

Many species of external parasites have been found on dasyurid hosts. It is not clear how many of these parasitise Tasmanian devils. However, for this analysis all dasyurid parasites are considered to be potential parasites of Tasmanian devils. The dasyurid arthropod parasites include lice, ticks, fleas, louse flies and mites.

8.1.2. OIE list

No parasites of dasyurids are listed.

8.1.3. New Zealand status

Dasyurids including Tasmanian devils are not present in New Zealand. Therefore, parasites specific to dasyurids do not occur in New Zealand. Only one species of tick, *Haemaphysalis longicornis*, occurs in livestock in New Zealand.

8.1.4. Epidemiology

Information on external parasites of dasyurids in this document has been taken mainly from a review (Beveridge and Spratt 2003).

Lice

All lice found in dasyurids belong to the order Amblycera and the family Boopidae. Seven species of the Boopidae are restricted to dasyurid marsupials

Ticks

The six species of ticks found on dasyurids belong to the genera *Ixodes* and *Haemaphysalis*. The most important species is *Ixodes holocyclus* which causes tick paralysis in a wide range of animals and man. It is also the vector of the nematode *Cercopithofilaria johnsoni* in dasyurids and Queensland tick typhus (*Rickettsia australis*) in humans.

Mites

A broad range of mites have been described from dasyurids. These include 32 species of trombiculid mites which are not species specific and of which only the larval stage are found on the dasyurid hosts. These mites are important as vectors of scrub typhus (*Orientia tsutsugamushi*). Fifteen species of mesostigmatid mites of which all stages are parasitic on dasyurids are also know as well as several astigmatid mites including three members of the Sarcoptidae. *Demodex* spp. have been found on some dasyurid species but have not been described as occurring on Tasmanian devils.

It is not clear how many of the dasyurid mites are found on Tasmanian devils.

Fleas:

Uropsylla tasmanica also known as the stick-fast flea of Tasmanian devils and quolls (Holz 2008a; Holz 2008b) Adults are found mainly on the scrotum, lower limbs, face and ears. They attach their eggs to the basal portion of hairs. After hatching the larvae burrow into the skin

and feed on subcutaneous tissues of the host until pupation causing irritation leading to formation of pustules, self-trauma and hair loss (Obendorf 1993). However, this is a parasite of Tasmanian devils and quolls and unlikely to infect any New Zealand animals.

Flies:

Hippoboscid spp of louse flies (usually associated with birds) can reside in all species of marsupials fur with no clinical signs (Holz 2003). They are vectors of haematazoa in birds but are not known vectors of dasyurid disease agents or parasites.

8.1.5. Hazard identification conclusion

In view of the large range of arthropod parasites that occur on dasyurids and the importance of some of these as vectors of zoonotic diseases, external parasites are considered to be potential hazards on the commodity.

8.2. RISK ASSESSMENT

8.2.1. Entry assessment

A large number of parasites could be present on Tasmanian devils. Since these may not be seen even if the animals are carefully examined, the likelihood of introduction of new parasites is non-negligible.

8.2.2. Exposure assessment

External arthropod parasites could be transferred to people who have contact with the animals (keepers etc) or to wild birds and rodents that may have access to enclosures. Infested people or wild birds/rodents could in turn transfer the parasites to other animals or people outside of the zoo. Some parasites such as ticks could move short distances to animals in adjacent animal enclosures. The likelihood of exposure is therefore non-negligible.

8.2.3. Consequence assessment

Introduction and establishment of new parasites could result in the introduction of diseases such as tick paralysis in animals and humans and rickettsial diseases in humans. Introduction of ticks could also result in direct production losses in infested animals. Introduced ticks would also be potential vectors for various tick-borne diseases, if the disease agents are introduced. Parasites such as mites could cause skin diseases. The consequences of introduction would be non-negligible.

8.2.4. Risk estimation

Entry, exposure and consequence have been assessed as non-negligible. As a result the risk estimate for introduction of external parasites is non-negligible and they are classified as hazards in the commodity. Therefore risk management measures can be justified.

8.3. RISK MANAGEMENT

8.3.1. Options

When drafting options for exclusion of external parasites the following points were considered:

- DEWHA has prescribed conditions under which Tasmanian devils may transferred overseas (DEWHA 2008). These conditions are given in Section 6.3.1.

- Animals to be imported will be confined in premises that are containment facilities and there will be no direct contact between imported dasyurids and other animals.
- There are no dasyurids in New Zealand.

Available options, for the effective management of external parasites in imported Tasmanian devils, given in ascending order of stringency, are:

Option 1

The requirements could be limited to those specified by DEWHA for the overseas transfer of Tasmanian devils.[See Section 6.3.1] This requires a minimum 28 day pre-export isolation, with a clinical examination under anaesthetic for signs of parasitism, and treatment if required.

Option 2

In addition to the DEWHA requirements, Tasmanian devils for export could be treated with a broad spectrum insecticide/acaricide 7-10 days prior to entering pre-export isolation (PEI).

Option 3

In addition to the DEWHA requirements:

i. Tasmanian devils for export could be treated with a broad spectrum insecticide/acaricide 7-10 days prior to entering pre-export isolation (PEI).

ii. Tasmanian devils 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 backpack spray unit).

iii. Premises in which the animals for export are isolated could have an 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.

iv. Tasmanian devils 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.

v. The veterinary inspection specified in the DEWHA requirements could take place at least 10 days after entering PEI. The Tasmanian devils could be meticulously inspected for ticks and other ectoparasites, and if still infested the treatment could be repeated and animals inspected again at least 10 days later. Treatments and inspections 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.

vi. Tasmanian devils could be treated with an acaricide within the 3 days prior to shipment.

One or a combination of the following measures could be considered in order to mitigate the risk of importing exotic tick species:

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