IMPORTATION OF NON-DOMESTIC FELIDAE INTO AUSTRALIA

IMPORT RISK ANALYSIS, FINAL REPORT

March, 2002

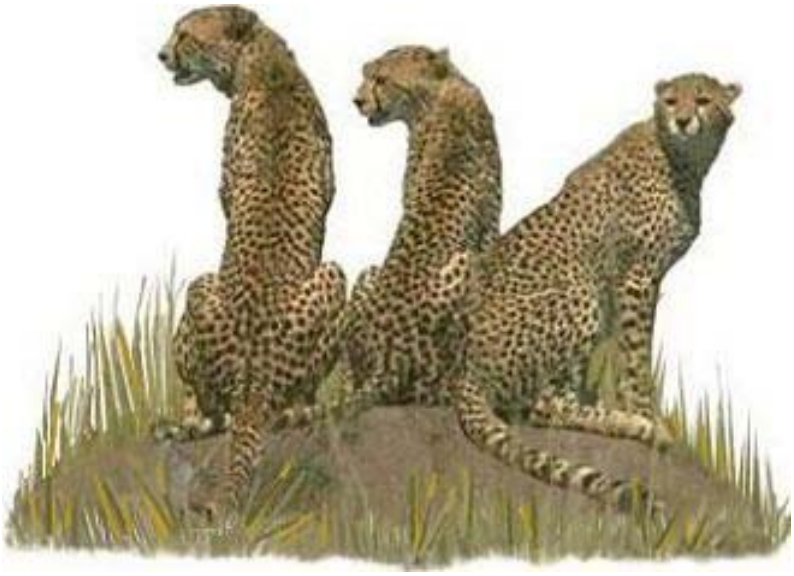

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Following requests for the importation of a number of non-domestic carnivores, AQIS issued INTERIM QUARANTINE REQUIREMENTS FOR THE IMPORTATION OF ZOO CARNIVORES in 1997 with an undertaking to conduct, as soon as possible, a full review of the import risks associated with the importation of exotic carnivores for zoo collections.

There is immense variety within the Order Carnivora, and the range of disease risks associated with each family within this Order is not consistent across the range of species involved. It was decided that an import risk analysis (IRA) of non-domestic Felidae would be conducted initially, with IRAs to cover other families within the Order later.

A draft of this IRA was circulated in February for comment, and this final version incorporates some of the suggestions provided by stakeholders.

This IRA examines a comprehensive list of disease agents known to infect all Felidae, domestic and non-domestic. These agents are classified as a perceived hazard or not, on the following criteria:

. the agent has the potential to have an adverse socio-economic impact through harm to animals, humans or the environment and

. the agent is exotic, or a particularly virulent strain of the agent is exotic; or

. if not exotic, is a notifiable disease in Australia subject to official controls.

Those agents perceived as a hazard are selected for a detailed examination, i.e. risk assessment. Because this is a generic IRA, agents are not excluded based on their absence from any possible country of export.

The assessment of selected agents included examination of relevant factors such as virulence, species affected, incubation periods, mode of transmission and potential for carrier status. Following this, the likelihood of agent entry in zoo carnivores, the likelihood of establishment and the likelihood of spread are estimated. Except where the likelihood of entry, establishment and spread is negligible, there is a discussion on the consequences of establishment and spread for each agent. If risk management measures are warranted, these are discussed in Chapter 4.

The discussion under risk management includes examination of diagnostic techniques, efficacy of treatment, vaccinations and suitable quarantine periods. The risk management measures chosen are considered to reduce the likelihood of introduction, establishment and spread to a level at which the importation would meet Australia's appropriate level of protection. Consistent with Australia's quarantine risk management, emphasis has been placed on pre-export measures in line with Biosecurity Australia's policy of managing risks offshore.

The following agents are found to present a quarantine risk. Risk management measures will be applied for these agents, and these are summarised below.

Summary of import requirements

PEQ = pre-export quarantine, PAQ = post-arrival quarantine.

Disease or agent	Import requirements
Rabies:	The animal for export must have spent the 6 months prior to export in a country free from rabies, or 12 months prior to export in an institution that has not reported any case of rabies for 12 months, or the animal for export to have been vaccinated according to the prescribed schedule with antibody testing.
Burkholderia mallei (glanders):	The animal for export to have spent 6 months prior to export in a country free from *B. mallei*, or the institution of export has been free from glanders for the 12 months prior to export and the animal for export has spent the 6 months prior to export in the institution, followed by 6 months post-arrival quarantine surveillance.
Tuberculosis:	The animal for export to have spent the past 12 months in an institution that has been free from tuberculosis in Felidae and Ungulates for 5 years followed by 6 months post-arrival quarantine surveillance.
Trypanosoma evansi (surra):	The animal for export to have resided since birth in countries free from *T. evansi,* or the animal for export to be blood tested within 30 days prior to export with a negative result.
Echinococcus multilocularis:	Pre-export treatment with an anthelmintic effective against cestodes.
Screw worm fly:	For countries not free from screwworm fly, animals to be examined and treated with an insecticide, within 5 days prior to export.
Canine distemper virus:	Institution freedom for 12 months with 30 days PEQ and 30 days PAQ, or vaccination.
Nipah virus:	Country of export to have been free from the agent for two years prior to export, or animals to serve 30 days PEQ, to be blood tested during that time with a negative result, and to serve 30 days PAQ.
Yersinia pestis:	Country of export to have had no reported cases of plague for two years, or animals to serve 30 days PAQ.
Cytauxzoon felis:	Blood testing for bobcats (*Lynx rufus)* that have been domiciled in North America. No requirements for other species or *L. rufus* born and reared outside North America.
Exotic ticks:	Pre-export treatment with an acaricide.

General measures are applied that relate to the country/institution of export, general health, standards of quarantine facilities, and measures to be taken in the event of an animal failing quarantine.

In accordance with the GUIDELINES FOR THE APPROVAL OF COUNTRIES TO EXPORT ANIMALS (INCLUDING FISH) AND THEIR PRODUCTS TO AUSTRALIA (AQPM 1999/62), non-domestic Felidae will only be imported from countries/institutions approved by Biosecurity Australia for this purpose.

Attached at the end of the draft IRA report are the QUARANTINE REQUIREMENTS FOR THE IMPORTATION OF NON-DOMESTIC FELIDAE INTO ZOOS AND CIRCUSES. These will supersede the interim requirements of 1997 with respect to non-domestic Felidae ibid.

ABBREVIATIONS AND ACRONYMS

AFFA	Department of Agriculture, Fisheries and Forestry - Australia
ALOP	Appropriate level of protection
AQIS	Australian Quarantine and Inspection Service
AQPM	Animal Quarantine Policy Memorandum
ARAZPA	Australasian Regional Association of Zoological Parks and Aquaria
ASMP	Australasian Species Management Plan
BCG	Bacille Calmette-Guérin
BSE	bovine spongiform encephalopathy
CDV	canine distemper virus
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNS	central nervous system
EA	Environment Australia
ELISA	enzyme-linked immunosorbent assay
FIPV	feline infectious peritonitis virus
FIV	feline immunodeficiency virus
IFAT	immunofluorescent antibody test
IRA	import risk analysis
IUCN	World Conservation Union - formerly the International Union for Conservation of Nature and Natural Resources
IUDZG	World Zoo Organization
OIE	Office International des Epizooties (the world organisation for animal health)
PAQ	post-arrival quarantine
PEQ	pre-export quarantine
PRV	pseudorabies virus
RVF	Rift Valley fever
SCARM	Standing Committee on Agriculture and Resource Management
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures
SWF	screw worm fly
TGE	transmissible gastroenteritis
the Code	the OIE International Animal Health Code
TSE	transmissible spongiform encephalopathy
VPC	Vertebrate Pests Committee
WHO	World Health Organization
WTO	World Trade Organisation

COMMON AND SCIENTIFIC NAMES OF EXOTIC FELIDAE

Cheetah	*Acinonyx jubatus*
Asiatic golden cat	*Catopuma temminckii*
Caracal	*Felis caracal* or *Caracal caracal*
Domestic cat	*Felis catus*
Wild cougar, puma, mountain lion	*Felis concolor*
Florida Panther	*Felis concolor coryi*
Wild cat	*Felis lybica*
South American ocelot	*Felis pardalis*
European wildcat	*Felis silvestris*
Jaguarundi	*Herpailurus yagouarundi*
Ocelot	*Leopardus pardalis*
Serval	*Leptailurus serval*
Lynx	*Lynx canadensis*
Lynx	*Lynx lynx*
Bobcat	*Lynx rufus*
Clouded leopard	*Neofelis nebulosa*
Lion	*Panthera leo*
Jaguar	*Panthera onca*
Leopard	*Panthera pardus*
Siberian tiger	*Panthera tigris*
Tiger, Bengal tiger	*Panthera tigris*
White tiger	*Panthera tigris*
Snow leopard	*Panthera uncia* or *Uncia uncia*
Fishing cat	*Prionailurus viverrinus*
Puma	*Puma concolor*

1. INTRODUCTION

1.1 Background

Following applications from some zoos to import non-domestic carnivores, INTERIM QUARANTINE REQUIREMENTS FOR THE IMPORTATION OF ZOO CARNIVORES were issued in January 1997 and an undertaking to perform a full import risk analysis (IRA) was given. In 1998, the Australian Quarantine and Inspection Service (AQIS) consulted with stakeholders through Animal Quarantine Policy Memorandums (AQPMs) 98/14 and 98/58 on the approach to be used in the risk analysis, and a routine (in-house) approach was agreed. A routine approach is usually followed when the analysis is technically less complex or when greater or different risks than usual are not being examined.

1.2 Scope of this risk analysis

The existing protocol for all zoo carnivores addresses a broad range of disease agents, but does not take account of the special susceptibility to particular disease agents that may affect a family or genus within the Order Carnivora. Following an examination of a number of families within Carnivora, it was decided that IRAs for members of this Order would be on a family by family basis, except perhaps in the case of very closely related families.

This IRA is specific for the family Felidae, but does not cover domestic pet cats. Subject to requirements under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), non-domestic Felidae for importation are more likely to be captive bred than wild-caught or rescued. However, it is anticipated that in the future, attempts to save a species from extinction or adverse environmental conditions may necessitate the introduction of animals born in the wild. Almost all non-domestic felids are endangered species and, under CITES requirements, may only be imported into zoos or similar institutions.

This is a generic protocol, and as such, all countries are considered as a possible source of zoo Felidae. The country of residence and other countries in which the animal has been domiciled are all relevant with regard to the health status of that animal.

In Chapters 2, 3 and 4, hazard identification, risk assessment and risk management are discussed respectively. Each chapter is introduced with an outline of the process followed.

The quarantine requirements for the importation of non-domestic Felidae are attached at the end of the document.

1.3 Quarantine Framework in Australia

1.3.1 Legislative framework

AFFA's objective is to adopt biosecurity policies that provide the health safeguards required by government policy in the least trade-restrictive way and that are, where appropriate, based on international standards. In developing and reviewing quarantine policies, disease risks associated with importations are analysed using import risk analysis - a structured, transparent and science-based process.

The *Quarantine Act* and its subordinate legislation, including *Quarantine Proclamation 1998* (QP 1998), are the legislative basis of human, animal and plant quarantine in Australia. The

Quarantine Amendment Act 1999, which commenced in June/July 2000, is a major revision to the *Quarantine Act* to implement, *inter alia*, changes recommended in the report of the Australian Quarantine Review Committee (the 'Nairn Report').

Section 4 of the *Quarantine Act* defines the scope of quarantine as follows:

In this Act, quarantine includes, but is not limited to, measures:

- *for, or in relation to, the examination, exclusion, detention, observation, segregation, isolation, protection, treatment and regulation of vessels, installations, human beings, animals, plants or other goods or things*
- *having as their object the prevention or control of the introduction, establishment or spread of diseases or pests that will or could cause significant damage to human beings, animals, plants, other aspects of the environment or economic activities*

1.3.2 Quarantine Risk

The concept of level of quarantine risk has been introduced as the basis of quarantine decision-making. When making decisions under the *Quarantine Act*, decision-makers must have regard to the level of quarantine risk and must take prescribed actions to manage the risk if it is unacceptably high. For example, Section 44C concerning the examination of goods on importation requires a quarantine officer to order the goods into quarantine if the officer is of the opinion that the level of quarantine risk is unacceptably high. Section 46A concerning approvals for the purpose of goods ordered into quarantine requires consideration of the level of quarantine risk, with regard to a number of matters including the proposed procedures and the construction and management of the premises, before approval may be given to a premises. Section 5D of the *Quarantine Act* includes harm to the environment as a component of the level of quarantine risk:

Section 5D: level of quarantine risk

A reference in this Act to a level of quarantine risk is a reference to:

(a) the probability of:

(i) a disease or pest being introduced, established or spread in Australia or the Cocos Islands; and

(ii) the disease or pest causing harm to human beings, animals, plants, other aspects of the environment, or economic activities; and

(b) the probable extent of the harm.

1.3.3 Quarantine Proclamation 1998

Subsection 13(1) of the *Quarantine Act* provides, among other things, that the Governor-General in Executive Council may, by proclamation, prohibit the importation into Australia of any articles or things likely to introduce, establish or spread any disease or pest affecting persons, animals or plants. The Governor-General may apply this power of prohibition generally or subject to any specified conditions or restrictions.

Quarantine Proclamation 1998 (QP 1998) is the principal legal instrument used to control of the importation into Australia of goods of quarantine interest. A wide range of goods is specified in the *QP 1998* including animals, plants, animal and plant products, micro-organisms, and certain other goods which carry a high risk if uncontrolled importation is allowed, eg soil, water, vaccines, feeds.

For articles or things prohibited by proclamation, the Director of Animal and Plant Quarantine may permit entry of products on an unrestricted basis or subject to compliance with conditions, which are normally specified on a permit. An IRA provides the scientific and technical basis for biosecurity policies that determine whether an import may be permitted and, if so, the conditions to be applied.

The matters to be considered when deciding whether to issue a permit are set out in Section 70 of *QP 1998* as follows:

70 Things a Director of Quarantine must take into account when deciding whether to grant a permit for importation into Australia

(1) In deciding whether to grant a permit to import a thing into Australia or the Cocos Islands, or for the removal of a thing from the Protected Zone or the Torres Strait Special Quarantine Zone to the rest of Australia, a Director of Quarantine:

(a) must consider the level of quarantine risk if the permit were granted; and

(b) must consider whether, if the permit were granted, the imposition of conditions on it would be necessary to limit the level of quarantine risk to one that is acceptably low; and

(c) may take into account anything else that he or she knows that is relevant.

The matters include the level of quarantine risk (see above), whether the imposition of conditions would be necessary to limit the quarantine risk to a level that would be acceptably low, and anything else known to the decision maker to be relevant.

Environment

Recent amendments to the *Quarantine Act* make explicit the responsibility of quarantine officers to consider impact on the environment when making decisions under the *Quarantine Act*. The scope of quarantine (Section 4) has been amended to include the environment, and the level of quarantine risk (Section 5D) also incorporates the environment. As shown below, environment has been broadly defined in Section 5 of the *Quarantine Act* to incorporate all aspects surrounding humans, whether natural or built:

Environment includes all aspects of the surroundings of human beings, whether natural surroundings or surroundings created by human beings themselves, and whether affecting them as individuals or in social groupings.

When undertaking an IRA, the risk of harm to the environment must be fully considered to ensure that the quarantine policies developed reflect the Australian Government's approach to quarantine risk management and protection of the environment.

A new part of the *Quarantine Act*, Part IIA, requires the Director of Quarantine to refer certain decisions to the Environment Minister. Part IIA only applies to decisions made by the Director of Quarantine and decisions made using his/her delegation. Before making a decision under the *Quarantine Act*, the implementation of which is likely to result in a significant risk of harm to the environment, the Director of Quarantine must seek the views of the Environment Minister regarding the risk assessment process to be followed and subsequently the preliminary results of the risk assessment. The Director of Quarantine must take the advice of the Environment Minister into account and inform the Environment Minister of how his advice was taken into account. Part IIA also clarifies arrangements between quarantine decision-making and environment protection legislation, in particular the *Environment Protection and Biodiversity Conservation Act 1999*.

Part IIA—Proposed decisions affecting the environment

11A Definitions

In this Part:

Environment Minister *means the Minister administering the Environment Protection and Biodiversity Conservation Act 1999.*

11B Decisions under this Act not to be regarded as actions for the purposes of the Environment Protection and Biodiversity Conservation Act

To avoid doubt, a decision to do, or not to do, anything under this Act is taken to be a decision to grant a governmental authorisation for the purposes of subsection 524(2) of the Environment Protection and Biodiversity Conservation Act 1999.

11C Requirement to seek from Environment Minister advice about proposed decision involving significant risk of environmental harm

(1) Before making a decision under this Act, the implementation of which is likely to result in a significant risk of harm to the environment, a Director of Quarantine must comply with the requirements of this section.

(2) The Director of Quarantine must give written notice to the Environment Minister:

(a) stating that consideration is to be given to the making of such a decision; and

(b) requesting the Environment Minister to give advice to the Director as to the adequacy of the risk assessment process that is proposed to be followed in assessing the risk of harm to the environment.

(3) After preliminary findings have been made as a result of the risk assessment process, the Director of Quarantine must give written notice to the Environment Minister requesting the Environment Minister to give advice to the Director as to the adequacy of the preliminary findings in relation to the protection of the environment.

11D Provision of advice by Environment Minister

(1) If a Director of Quarantine gives to the Environment Minister a notice in accordance with section 11C requesting advice as to a matter, the Environment Minister may give written advice to the Director about that matter.

(2) Any such advice is to be given within 28 days after the notice was given.

11E Director of Quarantine to take advice into account

If the Director of Quarantine receives any advice from the Environment Minister within 28 days after the notice requesting the advice was given to the Environment Minister in accordance with section 11C, the Director must:

(a) ensure that the advice is taken into account in making the relevant decision; and

(b) inform the Environment Minister in writing as to how the advice was taken into account.

Import risk analyses are not decisions under the *Quarantine Act* in this context. IRA is an administrative process used by AFFA to make quarantine policy determinations. The risk assessments referred to in Part IIA are those undertaken when making decisions under the *Quarantine Act*, such as when as assessment is made of the level of quarantine risk and its acceptability. The Director of Quarantine's power to refer matters to the Environment Minister has been delegated to the Executive Director of AQIS and the Executive Mangers of AQIS Operations and Market Access and Biosecurity.

AFFA and Environment Australia (EA) are developing guidelines to assist AQIS and Biosecurity Australia officers when making decisions or policy determinations to ensure that the likely impact on the environment is taken into account. This document forms part of that documentation. Routinely, EA is given the opportunity to comment on all proposals to develop new biosecurity policies.

1.3.4 Policy framework

The primary purpose of quarantine is to facilitate the movement of goods and people into Australia while protecting Australia from the entry, establishment and spread of unwanted pests and diseases which could damage our way of life, agriculture and the environment. Such pests and diseases may threaten human health, damage crops, livestock and ecosystems, reduce productivity, require expensive control measures and affect the market's acceptance of affected or related commodities.

Successive Australian Governments have maintained a highly conservative but not a zero-risk approach to the management of quarantine risks, evident in the strictness of all quarantine related activities, including policies with regard to imported commodities, procedures at the border and operations against incursions of pests and diseases.

Recent inquiries into Australia's quarantine regime have recognised that it is impossible in practice to operate a zero-risk quarantine regime. In 1979, the Senate Standing Committee on Natural Resources stressed that there is no such thing as a nil risk quarantine policy, which it believed should be better described as "... *scientific evaluation of acceptable risk* ...". In 1988, the Lindsay Review of Australian quarantine concluded that "... *a no risk policy is untenable and undesirable and should be formally rejected* ...". In 1996, the Senate Rural and Regional Affairs and Transport Committee was of the view that a no risk approach was unrealistic and untenable, and that its currency only demonstrated that the concepts of risk assessment or risk management were widely misunderstood. These themes were repeated in the 1996 report of the Australian Quarantine Review Committee (AQRC), chaired by Professor Nairn. In the Government's 1997 response to the AQRC report, the Government confirmed a managed risk approach. Australia will continue to be very averse to accepting quarantine risks. Products will only be permitted entry if any risks can be reduced to very low levels which can be managed with confidence.

Import risk analysis provides the basis for consideration of import applications for the importation of animals and animal-derived products, and plants and plant-derived products. In keeping with the scope of the *Quarantine Act* and Australia's international obligations, only factors relevant to the evaluation of quarantine risk (ie the risk associated with the entry, establishment and spread of unwanted pests and diseases) are considered in the IRA. The potential competitive economic impact of prospective imports is not within the scope of the IRA process, and any discussion on industry support mechanisms would need to remain quite separate from the technical IRA process.

1.3.5 IRA framework

In 1996, the Quarantine Review Committee, chaired by Professor Malcolm E. Nairn, conducted a detailed independent review[a] and, *inter alia*, made recommendations on the process of carrying out import risk analyses (IRAs). The Government's response[b] (DPIE 1997) noted that

[a] Nairn, ME, Allen, PG, Inglis, AR and Tanner, C (1996). *Australian Quarantine: A Shared Responsibility*. Department of Primary Industries and Energy, Canberra, Australia

[b] *Australian Quarantine: A Shared Responsibility - The Australian Government Response*. Department of Primary Industries and Energy, Canberra, Australia

'risk analysis is the foundation stone on which all quarantine policy and action must be built' and agreed with the Review Committee's six principles that should apply to IRAs.

The Committee recommended that IRAs should be:

Conducted in a consultative framework
A scientific process and therefore politically independent
A transparent and open process
Consistent with both government policy and Australia's international obligations
Harmonised through taking account of international standards and guidelines
Subject to appeal on the process

In order to achieve a consistently objective and defensible method, IRAs carried out by AFFA follow the principles laid out in the publication, *The AQIS Import Risk Analysis Process: A Handbook* (AQIS 1998). This process is consistent with Australia's obligations under the SPS Agreement, and relevant recommendations of the Office International des Epizooties (OIE). Copies of the Handbook may be obtained from AFFA, or viewed on the AQIS homepage[c].

Proposals requiring an IRA - those involving significant variations in established policy - are addressed via either the routine or non-routine process. Less complex changes to or reviews of established policy are handled through the former process while the non-routine process is applied where there are potentially significant quarantine risks to be evaluated (not previously studied by AFFA) and where the analysis is likely to be large and technically complex.

1.4 International framework

1.4.1 World Trade Organization

As a member of the World Trade Organization (WTO), Australia has certain rights and obligations under the WTO Agreement, including the Agreement on the Application of Sanitary and Phytosanitary Measures - the so-called 'SPS Agreement'. The SPS Agreement recognises the standards, guidelines and recommendations developed by the OIE, the world organisation for animal health, as the relevant international benchmark. Under the SPS Agreement, measures put in place by a country must be based either on an international standard or upon a scientific risk analysis. A risk analysis must:

- identify the diseases whose entry, establishment or spread within its territory a WTO member wants to prevent, as well as the potential biological and economic consequences associated with the entry, establishment or spread of these diseases
- evaluate the likelihood of entry, establishment or spread of these diseases, as well as the associated potential biological and economic consequences
- evaluate the likelihood of entry, establishment or spread of these diseases according to the SPS measures that might be applied.

The SPS Agreement defines 'appropriate level of sanitary or phytosanitary protection' as the level of protection deemed appropriate by the member country establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory. This is termed 'appropriate level of protection' (ALOP) in Australia. Further information on Australia's rights and obligations arising from the SPS Agreement may be found in the report National Risk Management and the SPS Agreement (Wilson and Gascoine, 1999)[d].

[c] Available at http://www.affa.gov.au
[d] Available at http://www.aqis.gov.au

1.4.2 Office International des Epizooties

Australia is a member of the OIE and actively contributes to the development of international animal health standards. The OIE publication relevant to this IRA is the OIE International Animal Health Code (the OIE Code). The OIE Code provides guidance in relation to trade in terrestrial animals and birds, and their products and, in Section 1.4, outlines the requirements for an IRA. The OIE Code also categorises and lists important animal or zoonotic diseases. Those pertinent to the importation of non-domestic Felidae are described under Hazard Identification.

1.5 Non-domestic Felidae in Australia

1.5.1 The status of zoo Felidae in Australian zoos and circuses

The 1999 Regional Census and Plan lists 21 species of non-domestic Felidae held in Australasian zoos. Importation of some exotic Felidae will be necessary to introduce new genetic material and maintain viability. Among importations planned are Sumatran Tiger from Indonesia and New Zealand, Cheetahs, and Asiatic Golden Cats.

Plans for expansion of groups already present, in many cases, can be met by stock bred within Australia, but others require further importation. There are five endangered species of non-domestic Felidae held in Australian zoos, and there are plans to acquire more animals within these species.

The international movement of breeding stock is essential to minimise the problems of inbreeding.

Zoos and circuses holding animals that remain under quarantine must be registered with AQIS as an approved quarantine premises. If the conditions of importation do not require permanent post-arrival quarantine or quarantine surveillance, then, under current legislation imported zoo Felidae could be kept on premises not registered with AQIS as an approved quarantine premises once released from quarantine.

1.5.2 Current Import Protocol

An interim import protocol was developed in 1997 for all zoo carnivores, replacing earlier conditions, to allow essential importations to continue - it is generic with relation to species and country of origin. This protocol identifies rabies, Aleutian disease, Aujeszky's disease, babesiosis, brucellosis, pseudotuberculosis, transmissible spongiform encephalopathy, trichinosis, trypanosomiasis, tuberculosis and tularaemia as diseases of quarantine significance with regard to the importation of zoo carnivores.

An *Official Veterinarian*[e] must issue health certification regarding freedom from disease and fitness for travel. This covers the animal health status of the exporting institution, the required period of residency, pre-export quarantine (PEQ) period and treatments. Animals for export are required to spend twelve months residence in the exporting institution. Post-arrival quarantine (PAQ) and treatments are covered by the existing protocol, permanent confinement to an AQIS registered A or B class zoo being a requirement. This classification of zoos no longer exists. Nonetheless, exotic animals are still required to be imported into approved premises.

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[e] ***Official Veterinarian***
means a veterinarian authorised by the *Veterinary Administration* of the country to perform animal health and/or public health inspections of *commodities* and, when appropriate, perform certification in conformity with the provisions of Chapter 1.3.2. of this *Code*.

The importation of non-domestic Felidae is also covered by the *Wildlife Protection (Regulation of Exports and Imports) Act* 1982. Not being animals specified in Part I of Schedule 5 of this Act, non-domestic Felidae require a permit from the Minister for the Environment before importation may take place.

Under the Vertebrate Pests Committee's (VPC) classification, all non-domestic Felidae are assigned to Category 2 or 3(a), being animals limited to restricted collections. Quarantine legislation prior to the amendments of 1998 required zoo animals to remain in permanent quarantine. The current existing 1997 protocol was written with these pre-requisites in mind, and required that "*each imported animal must remain in a registered A or B class zoo after release from post-arrival quarantine isolation unless otherwise agreed by the Director of Animal and Plant Quarantine (Australia)"*. Current quarantine legislation does not require the permanent quarantine of zoo animals, and this IRA with its import requirements has taken this into account.

The 1997 protocol has been used for the importation of a number of zoo carnivores, including cheetahs from South Africa, Sumatran tigers from New Zealand, servals from the United Kingdom and an Asiatic golden cat from Germany. A number of carnivores from other families have also been imported, including pandas, otters, meercats and maned wolves.

The new conditions attached to the final IRA will come into place if there is no appeal within a stated period.

1.5.3 Australia's role in the preservation of endangered species

Australia's commitment to the preservation of endangered species is reflected in the Australian Government's role as a Party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); the fifty Australian organisations that are members of the International Union for Conservation of Nature and Natural Resources (IUCN); and the membership of Australia's four biggest zoos with the World Zoo Organization (IUDZG).

Zoos play a role in conservation by the controlled breeding of endangered species (*ex situ* propagation). The ultimate goal of *ex situ* conservation is support of survival in the wild.

Within Australia, the Australasian Species Management Program (ASMP) generates management recommendations and collection planning from the Australasian Regional Association of Zoological Parks and Aquaria (ARAZPA). These recommendations cover, *inter alia,* preferred species for matings and reproduction. The breeding policy developed by ASMP often requires the exchange of animals in order to maintain genetic diversity. It is within this framework that Australian zoos plan for the importation of potential breeding stock.

The Carnivore Taxon Advisory Group (TAG), has identified the Sumatran Tiger as a high priority for conservation of endangered species in the region. Among the TAG's short-term goals are assisting the completion of Captive Management Plans for the Persian Leopard.

2. HAZARD IDENTIFICATION AND EXPOSURE PATHWAYS

2.1. Hazard Identification

The hazard identification is presented in the form of a chart that lists all causative agents of OIE List A and B diseases that have been reported in carnivores, and other disease agents found in Felidae (Table 1). Other exotic disease agents carried by non-domestic Felidae that may impact on domestic cats, other zoo Felidae and in certain cases non-carnivores are also listed.

Of the above, Biosecurity Australia has excluded from further consideration agents that are endemic in Australia and not subject to official controls. Exceptions have been made in the case of agents that present a high risk to animals in the zoo collection or their handlers. Those selected for detailed assessment

. have the potential for an adverse socioeconomic impact through harm to animals, humans or the environment and

- are exotic, or a particularly virulent strain of the agent is exotic; or
- present a particular threat to certain species within zoo collections.

Reports of endemic diseases, exotic diseases, agent isolation and antibodies in wild Felidae and domestic cats were obtained from scientific literature. Experts were consulted on matters where published information was lacking. The list of parasites was based to a large extent on knowledge of the domestic cat.

A number of bacteria that are common and of universal distribution have not been considered.

2.1.1 Special considerations with endangered species

Inevitably, small colonies of endangered species become inbred. This has led, in some cases to a greater vulnerability to common pathogens among these animals.[4,51] Whilst it is not possible to predict the effects of all known pathogens on hitherto unexposed wild animals, where exceptional vulnerability has been noted, this is taken into account in determining whether a hazard exists.

2.2. Exposure Pathways

The pathway of exposure, infection and establishment of disease in Australia commences with the exposure of non-domestic Felidae to disease agents before export to Australia.

2.2.1. Country of origin

Zoo animals are mostly obtained from tightly controlled zoos. However, this may change with increasing pressure to accept endangered species rescued from the wild or from range parks where there is intermingling with other species.

The sourcing of animals from zoos may reduce the risks of importation of exotic pathogens. With knowledge of the disease status of the zoo it provides greater confidence in the health of the animal.

Nonetheless, claims to “disease freedom” within an exporting institution have, in many cases, been based on absence of clinical evidence rather than on objective testing. The risk of contact

with feral and native animals that may trespass in zoo precincts may be unknown. Knowledge of the animal health status of the country of export would assist in identifying the risks associated with feral and wild animals. Only in the case of reportable diseases, which zoos were also bound to report, could this information be reliably provided by the *Veterinary Authority*[f] in the country of export.

Apart from contact with other animals, food may provide a pathway through which pathogens may be introduced to zoo animals. The feeding of uncooked meat to zoo carnivores provides a risk of exposure to pathogens. Cooked food may lower this risk, but would represent a significant departure from the normal diet of these animals.

Insect vectors and mechanical carriers of exotic disease agents present a risk of passing infection to non-domestic zoo Felidae. Unless specific measures against insects were taken, this risk would continue through any PEQ period that may be applied.

2.2.2. Pathways of transmission in the importing country

For a disease agent to become established as a result of importation of non-domestic Felidae, animals beyond the imported consignment must be exposed to the agent in question. This could occur either through direct contact, or indirectly via excreta, aerosols, insect vectors or through contaminated fomites. Whilst normal quarantine procedures would prevent transfer of many disease agents, those relying on insect and tick vectors would not be contained except by the provision of special facilities to prevent access by insects.

Latent disease may become apparent post arrival as a result of stress, and provide a source of infection for susceptible species and vectors.

The susceptibility of animals to pathogens found in Felidae varies. A particular species of non-domestic Felidae may have exceptional susceptibility to agents well tolerated by other species. Felidae may be capable of carrying agents to which unrelated species are more susceptible.

Feral and domestic cats have access to city and free range zoos. Whilst direct contact between a feral or domestic cat and a non domestic felid may be fatal for the cat, indirect exposure could occur via contact with faeces and urine. Aerosols would only be considered a risk for animals within fairly close proximity to the imported animal. In the case of agents transmitted by insects and fomites, direct exposure is not necessary for transmission.

Other species of animals may be susceptible to disease agents, such as *Trypanosoma evansi,* found in Felidae.

Little is known about the susceptibility of native fauna to feline disease agents other than those already present in Australia.

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[f] ***Veterinary Authority***
means a Veterinary Service, under the jurisdiction of the Veterinary Administration, which is directly responsible for the application of animal health measures and for supervising the issuing of international animal health and international sanitary certificates in a specified area of the country.

Table 1. Hazard Identification Chart

Disease agent	Susceptible species	Means of transmission	Australian status	Selected for detailed examination
List A disease agent				
Rift Valley fever virus	Wide host range including man.[3] Antibody evidence in wild Felidae but disease has not been recorded.[9] Kittens infected experimentally.[11]	Mosquito is the principal vector, also transmitted through contact with saliva, fomites and inhalation of virus-contaminated saliva.	Exotic.	Yes
Bluetongue virus	Ruminants – specifically sheep. Dogs have been infected.[6] Antibody evidence in wild Felidae. No clinical disease recorded.[7]	*Culicoides variipennis* and other species transmit the virus. Ingestion of infected meat probably the source of bluetongue antigen in Carnivores. Felidae apparently have no role in transmission	Many strains of virus present in Australia. Clinical bluetongue absent.	No
African horse sickness virus	Equidae family, angora goats, dogs.[1,122,149] Antibody evidence in lions. No clinical disease or viraemia seen in domestic or non-domestic Felidae.[2]	*Culicoides* and *Aedes* sp transmit the virus. Ingestion of infected meat is believed to result in disease in dogs and antibodies in cats.[122, 149] Reservoir hosts are zebras: some have suggested dogs.[2,122,173]	Exotic.	No
List B disease agent (May include related species)				
Rabies virus	Mammals. Carnivores are the main vectors.	Virus present in the saliva of rabid animals is injected below the skin of uninfected animals through bites.[3] Some evidence of aerosol transmission from bats.[190] Incubation periods can be long.	Classical rabies is exotic, but a member of the *Lyssavirus* genus is found in bats in Australia.[1]	Yes
Pseudorabies virus (Aujeszky's disease)	Pig disease but wide host range - including cats. In cats causes acute nervous disease.[3]	Cats infected by ingestion of infected pig material.	Exotic.	Yes
Coronavirus - transmissible gastroenteritis (TGE)	Pig disease, dog, fox and cat may become infected. [28,29]	Virus transmitted to new farms by introduction of infected pigs, contaminated fomites. Evidence of carrier status in pigs.[87]	Exotic.	Yes

Table 1. cont.

Disease agent	Susceptible species	Means of transmission	Australian status	Selected for detailed examination
Japanese encephalitis virus	Inapparent infections in cats.[5]	Transmitted by *Culex* spp. Cats not considered to play a role in transmission.[5]	Australia has high level surveillance in the north of Australia and Torres Strait to detect early incursions. Not considered endemic.	No
Chlamydia psittaci	Wide host spectrum. Zoonosis. Frequently associated with feline respiratory disease.[3]	Direct transmission.	Endemic.	No
Bacillus anthracis	All animals.	Felidae infected through ingestion of contaminated meat.	Endemic. No controls on the movement of carnivores in Australia for anthrax.	No
Burkholderia mallei	The disease glanders occurs in horses, mules, donkeys, dogs and cats. It causes serious, sometimes fatal disease in man.[1,19]	Felidae infected by eating contaminated carcasses.[1]	Exotic.	Yes
Mycobacterium tuberculosis, M. bovis	Wide host range, humans, Bovidae, Primates, Carnivora. Reports of zoo Felidae being infected. Serious zoonosis.	*M. tuberculosis* and *M. bovis* are contracted by carnivores, from infected humans or cattle. In cats, ingestion is the common form of infection. Transmission from cats to other species is less common.[3]	*M. bovis* is exotic. *M. tuberculosis* is a notifiable disease in humans in Australia. Immigration measures apply.	Yes
Leptospira spp.	Many *Leptospira* spp. affect animals and man. Infections mild or inapparent in cats.[3]	Organisms are excreted in the urine and enter a new host via mucous membranes or abraded skin.	*L. interrogans canicola* is the only exotic *Leptospira* sp. for which quarantine restrictions exist, then only in dogs.	No
Francisella tularensis Types A & B	Both type A and type B strains have been isolated from cats. Zoonosis.[3]	Type A rabbit/tick cycle and type B rodent and water-borne outbreaks. Cats usually infected by ticks, can also be infected from eating infected rabbits.	Exotic.	Yes
Trypanosoma brucei brucei (nagana)	Hoofstock most susceptible, dogs and cats also affected.[57]	Transmitted primarily by tsetse flies.[55,69,186]	Exotic. Tsetse flies not present in Australia. Quarantine controls for large animals.	Yes

Table 1. cont.

Disease agent	Susceptible species	Means of transmission	Australian status	Selected for detailed examination
T. vivax	Narrow host range, ungulates mostly susceptible, serological evidence of infection in dogs but not cats.[70]	*T. vivax* can be mechanically spread by biting flies as well as by Tsetse flies.[55,69,186]	Exotic.	No
Trypanosoma evansi (surra)	Wide host range, including dogs and cats. Horses are the most susceptible, dogs more severely affected than cats.[1]	Mechanically transmitted by flies, including *Tabanus* and *Stomoxys* genera.[1]	Exotic.	Yes
T. cruzi (Chagas' disease)	Man is the most seriously affected, dogs, cats, and wild carnivores act as reservoir hosts in the Americas.[182]	Bugs of the family Reduvidae are the vectors of this agent.	Exotic.	Yes
Echinococcus granulomas	Dogs are the definitive host. Not significant in cats. Cyst (intermediate) stage in ruminants, primates, marsupials, lagomorphs, Suidae. Zoonosis.[16]	Intermediate host infected from eggs passed in faeces from carnivore. Definitive host infected from eating raw flesh of intermediate host.	Endemic, notifiable in W.A. and Tas. Only one State has import controls for this parasite.	No
E. granulomas felids	A subspecies that appears to have its adult stage in lions rather than the dog has been identified.[191] The wart-hog, zebra and buffalo are intermediate hosts in the wild.[191]	As above.	Not known if present in captive non-domestic Felidae in Australia.	Yes
E. multilocularis	The fox is the definitive host, less commonly the dog and cat. Rodents are the intermediate hosts, and also humans.[16]	As above.	Exotic.	Yes
E. oligarches	Definitive hosts are wild felids of Central and South America. Human infection not reported[16]		Exotic.	Yes
Trichinella spiralis	Pigs, rodents, cougars, bears, walruses.[16,142]	Larval and adult stages of life cycle in the cat. Infection occurs through ingestion of infected meat.	Exotic (*T. pseudospiralis* is present in Australian wildlife).	Yes
Cochliomyia hominivorax and *Chrysomya bezziana* (screw-worm fly)	Will parasitise all warm blooded animals, including cats.[1]	Larvae feed on mammalian host and then leave to pupate on the ground.	Exotic.	Yes

Table 1. cont.

Disease agent	Susceptible species	Means of transmission	Australian status	Selected for detailed examination
Diseases of concern not listed by the OIE				
Coronaviruses - feline infectious peritonitis (FIP) and feline enteric coronavirus.	All Felidae. Highly pathogenic to cheetahs.[3,30,41,51]	Ingestion, aerosol, bites have all been suggested as means of spread.	Endemic in domestic cats.	No
Borna disease virus	Horses, sheep, ostriches and humans are the most susceptible, cats exhibit neurological disease.[3,71]	Not known if vector involved.	Uncertain, presumed absent.	Yes
Canine distemper virus. Evidence that the Serengeti lions had a strain variant.[102]	All canids, also mustelids, procyonids and viverrids. Has been reported in collared peccaries. Experimental infection of domestic cats only produced seroconversion. Many species of big cats, lions, leopards, tigers, jaguar have been fatally affected.[98,99,100]	Transmission by aerosols, direct contact.	Endemic. Serengeti strain variant has not been recorded in Australia.	Yes
Hendra virus (equine morbillivirus)	Natural infections in horses and man. Cats infected experimentally developed severe disease. Virus has been isolated from a number of species of bats in Australia.[3,49]	Direct cat to cat and cat to horse spread has been demonstrated experimentally.[184] Unknown if vectors/ reservoirs are involved in natural transmission.	Three outbreaks have been recorded, all in Australia. Appears to be endemic in bats.	No
Nipah virus	Pigs, humans and bats are the main hosts, cats have seroconverted.[127]	Unknown.	Exotic.	Yes
Hantavirus	Serious zoonosis. Primarily carried by rodents. A very low prevalence of seropositive cats in USA.[193]	Aerosol transmission from rodents is the principal means of transmission. Cats do not appear involved in maintenance or transmission.[193]	Exotic. No quarantine restrictions on domestic cats for this agent.	No
Cowpox virus (catpox)	Domestic and zoo cats have been infected. Zoonosis.[3, 156]	Transmission via breaks in skin.	Exotic.	Yes
Papillomaviruses	Generally, these viruses are highly host specific. Few reports of the virus in cats.[3]	Virus introduced through skin lesions.	Some strains endemic.	No

Table 1. cont.

Disease agent	Susceptible species	Means of transmission	Australian status	Selected for detailed examination
Feline rhinotracheitis virus (Feline herpesvirus)	May cause disease in cheetahs, also asymptomatic infections, lions have been shown seropositive.[3,197,198]	Aerosols and saliva.	Endemic in domestic cats.	No
Feline calicivirus	Serological evidence that it is endemic in Florida panthers. Only infects Felidae.[3,33]	Transmission by direct contact.	Endemic.	No
Feline panleukopaenia virus	Serological evidence of high incidence in free-ranging mountain lions.[32,200]	Transmission by direct contact with infected cats or their secretions. Also in-utero transmission.	Endemic.	No
Feline rotavirus	Virus has been isolated from kittens with diarrhoea. Appears to be of minor importance.[3]	Presumed as for other rotaviruses.	Endemic.	No
Feline immunodeficiency virus	Virus has been found in domestic and non-domestic cats. Wild animal isolates genetically distinct from those found in domestic cats.[3]	Transmission by intimate contact, blood, bite and fight wounds.	Endemic.	No
Puma lentivirus	Lentivirus related to but genetically distinct from FIV found in domestic Felidae. Does not cause disease in domestic cats.[194]	Intimate contact required for transmission. Vertical transmission suspected.	Unknown.	Yes
Feline syncytium-forming virus	Present in normal cat tissue, not associated with disease.[3]	Unknown.	Unknown.	No
Feline leukaemia virus	Agent of domestic cats. Does not appear to be present in wild Felidae in North America. Infection persists in bone marrow. Lymphomas and leukaemia are characteristic of the disease.[3,32,33]	Transmission by direct contact.	Endemic.	No
Feline sarcoma virus	Few records of natural infection.	Dependent on presence of feline leukaemia virus to replicate.	Exotic.	No
Transmissible spongiform encephalopathy (TSE)	Domestic cat, cheetah, puma.[123,150]	Oral route from BSE-contaminated meat.	Exotic.	Yes

Table 1. cont.

Disease agent	Susceptible species	Means of transmission	Australian status	Selected for detailed examination
Ehrlichia spp.	The species that naturally infects cats has not been determined.[3] Reports of seropositive wild Felidae from Africa. [163]	Presumed to be a tick-borne rickettsia.	Exotic.	Yes
Bartonella spp.	Causative agent of cat-scratch fever.[3]	Infection via skin penetration.	Endemic.	No
Haemobartonella felis	Cats are main host, infections range from sub-clinical to fatal.[3]	Transmitted by fleas.	Endemic.	No
Coxiella burnettii	Wide host range, infection in cats subclinical, zoonosis.[3]	Direct contact, inhalation of contaminated dust, ingestion.	Endemic.	No
Mycoplasma felis	Associated with conjunctivitis and respiratory infections in cats.[3]	Direct contact.	Endemic.	No
Helicobacter felis	Cats.[3]	Mechanism of transmission poorly understood.	Endemic.	No
Yersinia pseudotuberculosis, Y. enterocolitica	Ubiquitous in nature, isolated from dust, soil, water, milk. Natural infections occur in man, birds, rodents, rabbits , guinea pigs, mice. Cats become secondarily involved through contact with rodents and birds.[182]	Circumstantial evidence suggests ingestion is the main source of infection.	Endemic. Public health concern, notifiable in some states of Australia.	No
Y. pestis	Serological evidence of significant incidence in free-ranging mountain-lions.[32] Domestic cats develop clinical disease.[146]	Transmission commonly by flea bite, also through broken skin or mucous membrane.	Exotic.	Yes
Brucella canis	Cats can be infected experimentally, but dogs are the only natural host. Zoonosis.[3]	In dogs it is spread mainly be venereal contact, and occasionally through contact with urine.	Exotic.	No
Burkholderia pseudomallei	Melioidosis. Sporadic cases in cats. Zoonosis.[182]	Soil saprophyte in endemic regions. Infection via inhalation or skin wounds.	Endemic.	No
Mycobacterium lepraemurium	Agent of cat leprosy.[3]	Transmission by direct contact with infected rats.	Present in Australia.	No
Clostridium piloforme	Tyzzer's disease. The agent is a commensal in rodents, causes hepatic lesions in cats and dogs.[3]	Infection by ingestion.	Endemic.	No

Table 1. cont.

Disease agent	Susceptible species	Means of transmission	Australian status	Selected for detailed examination
Blastomyces dermatidis	Soil-borne organism that can cause systemic infections. Dogs and people most susceptible.[3] Zoo Felidae have been seriously affected.[161]	Infection by inhalation.	Exotic.	Yes
Histoplasma capsulatum	Dimorphic fungus. Cats very susceptible, dogs less so.[3]	Infection by inhalation. The organism converts from a mycelial to yeast form at body temperature.	Endemic, occurrence is unusual.	No
Coccidioides immitis	Wide host range, zoonosis, cats not particularly susceptible.[3]	Soil borne organism, route of infection by inhalation.	Exotic, has been found in a returning tourist. No restrictions on other animals or humans for this agent.	No
Cryptococcus neoformans	Infects a variety of domestic and wild mammals; cats commonly infected.[3]	Soil-borne organism also transmitted through pigeon faeces.	Endemic.	No
Sporothrix schenkii	Organism associated with decaying organic matter. Infects dogs, cats.[3]	Contamination via puncture wound.	Endemic, rare in cats.	No
Microsporum and *Trichophyton* spp.	Cause of ringworm and similar fungal skin infections on dogs, cats and humans.[3]	Infection by direct contact with spores.	Endemic.	No
Cytauxzoon felis	Identified in USA as a cat parasite. Another *Cytauxzoon* species is believed to affect African wild ruminants. Invades blood cells and tissues.[3,126]	Transmission believed to be by arthropod, probably tick.	Unknown.	Yes
Babesia felis	Domestic and non-domestic cats.[3,131,132]	Presumed to be tick borne, vector unknown.[138]	Appears to be confined to southern Africa.	Yes
Encephalitozoon cuniculi	Rabbits, mice, cats, dogs, foxes, humans. Natural infections in cats are rare.[3]	Infection by inhalation or ingestion of spores.	Endemic.	No
Leishmania spp.	Cats are rarely infected.[3]	New world *Leishmania* transmitted by *Lutzomyia*. Old world *Leishmania* transmitted by *Phlebotomus* spp. Neither vector present in Australia.	Exotic, vectors not present in Australia.	No
Isospora spp.	Intestinal protozoan infecting cats, with rodents the intermediate host.[3]	Cats may be infected from oocysts in faeces, or from eating infected mice.	Endemic.	No

Table 1. cont.

Disease agent	Susceptible species	Means of transmission	Australian status	Selected for detailed examination
Toxoplasma spp.	Affects cats, sheep, humans.[3]	Carnivorism and faeco-oral transmission.	Endemic.	No
Pneumocystis carinii	Cause of pneumonia in many mammals including humans. Many infections are subclinical.[3]	Infection by inhalation.	Endemic.	No
Sarcocystis and other Sarcocystinae	Mammals, birds, reptiles.	Two-host life cycle. Carnivorism and faeco-oral transmission. Muscle cysts develop in herbivores, these infect carnivores.[3]	Endemic.	No
Hammondia hammondi	Cats and European wild cat are definitive host for this Coccidian genus. Many warm blooded mammals are the intermediate hosts.[3]	Infection by ingestion of infected tissues in the case of cats. Infection by ingestion of oocysts in the case of intermediate hosts.	Endemic.	No
Besnoitia besnoiti, B. wallacei	The cat is probably the definitive host for both these species. Cattle are affected with the intermediate stage of *B. besnoiti.*[165]	Cats have been implicated in the transmission of both these species.	*B. besnoiti* is exotic, *B wallacei* is present in Australia.	Yes
Cryptosporidium spp.	Many species have been described. Most are host specific. Generally non pathogenic in cats.[3]	Faeco-oral transmission.	Endemic in Australia.	No
Giardia spp.	Cat, man, generally wide host range.[3]	Faeco-oral transmission.	Endemic in Australia.	No
Hepatozoon sp.	African carnivores, including big cats, and native American cats. Generally an incidental finding in big cats.[185] Not reported to be pathological.	Transmission believed possible with several *Rhipicephalus* and *Amblyoma* spp.[187]	Unknown.	No
Shistosomes, *Heterobilharzia, Shistosoma* and *Orientobilharzia* spp.	*Heterobilharzia americana* has been reported from bobcats in America, and some *Shistosoma* species have been reported in cats. Cats are minor hosts for these parasites. Significant zoonosis[182]	Eggs are laid in blood vessels adjacent to bladder and intestine then work their way to the lumen and are excreted. Infection is via skin.	Exotic, present in warm regions of Africa, Asia and Nth America.	Yes

Table 1. cont.

Disease agent	Susceptible species	Means of transmission	Australian status	Selected for detailed examination
Paragonimus kellicotti	Has been found in dogs, cats, pigs, though the mink and muskrat are thought to be the natural hosts. Present in North America. Migrating immature flukes cause peritonitis, myositis and pleuritis.[16]	Worms develop in cysts in the lungs. Eggs are contained in the cysts. When these burst, the eggs are passed up with mucus, swallowed and passed in faeces. Snails are the first intermediate stage followed by crustacea.	Exotic, present in Nth America and Asia.	Yes
Platynosomum fastosum	Adult flukes infect cats. Minor pathogenic effects. Present in Asia, Pacific, Americas.[16]	The life cycle involves a snail and crustacea or lizards.	Believed exotic, present in PNG.	No
Alaria spp.	Adult flukes are found in the intestine of a number of carnivores, occasionally cats. Cats are not significant hosts for *Alaria* spp. Heavy infestations of metacercariae may be very pathogenic to animals and humans.[16]	Snails, then tadpoles and frogs are the true intermediate hosts, Many species may be paratenic hosts.	Authors differ on whether the agent is present in Australia.	No
Amphimerus spp.	A liver fluke affecting cats and other carnivores and man. Closely related to *Opisthorchis* and *Chlonorchis*. A minor pathogen.	Intermediate hosts are snails then fish.	Exotic.	No
Eurytrema procyonis (Concinnum procyonis)	Pancreatic fluke of cats. Generally causes no ill health, though fibrotic changes occur in the pancreas.[16]	Snails and arthropods are suggested as the intermediate hosts.	Exotic.	No
Oncicola sp., *Taenia taeniaeformis, Spirometra erinacei, Spirocerca lupi*	Adult worms inhabit the small intestine of cats.[16]	Intermediate host required.	Endemic.	No
Diphyllobothrium latum	Adult worm inhabits the intestine of man, dog, cat and other fish eating mammals. Significant zoonosis.[182]	Intermediate stages in aquatic animals.	Exotic.	Yes
Mesocestoides spp.	Adult and intermediate stages may occur in many mammals. The former is found in the intestine, the latter in body cavities, lung and liver. Cats infrequently infected.[16,203] Zoonosis.	Life cycle presumed to include insects or mites as the first intermediate host and vertebrates (reptiles, birds, mammals) as the second. The definitive hosts include dogs, cats and other mammals.	Exotic.	Yes

Table 1. cont.

Disease agent	Susceptible species	Means of transmission	Australian status	Selected for detailed examination
Capillaria heptica, C. aerophila	Cats are intermediate hosts for this parasite of rodents.[16]	A three host life cycle involving carnivorous animals.	Endemic.	No
Brugia malayi	Chiefly a parasite of man. Monkeys, wild and domestic cats thought to be reservoirs. Cats used as experimental model. Wucherian worm with a predilection for lymphatics.[55,182]	Transmission by mosquitoes.	Exotic. No restriction on entry of infected humans.	No.
Dirofilaria spp., *Angiostrongylus* spp.	Occurs in dog, cats, fox and some species of pinniped.[16]	A number of species of mosquito are involved in the transmission of microfilariae.	Endemic	No
Gurltia paralysans	Adult worms occur in thigh veins of cats. An obscure organism, does not appear to be identified with significant disease in Felidae.[16]	Unknown.	Probably exotic.	No
Gnathostoma spinigerum, Cylicospirura felineus, Physaloptera praeputialis	Adult worm in stomach of dogs and cats.[16,55]	Numerous intermediate hosts, including aquatic species.	Endemic.	No
Ollulanus tricuspis	Relatively harmless parasite of cats.[16]	Direct life cycle.	Endemic.	No
Trichuris campenual	Occurs in the caecum and colon of cats.[16]	Direct life cycle.	Endemic.	No
Strongyloides spp	Intestinal parasite of cats.[16]	Free living and parasitic cycles.	Endemic.	No
Tunga penetrans	Most reports of imported infections in Europe, USA and Australia refer to humans. Dogs appear to be the main animal vector in Central and Sth America, Pigs frequently infected in Africa.[94,95,96]	Flea infestations are contracted directly from contact with infested sand or soil.	Exotic, No restrictions on infected humans entering Australia, but these are generally a dead-end host.	Yes
Ctenocephalides felis, canis (common flea)	Infects cats and dogs.[16]	Eggs laid in soil, bedding, nymphs and adults feed off mammalian hosts.	Endemic in Australia.	No
Cuterebra spp	Predominantly parasite of rodents, lagomorphs. Occasionally parasitises dogs, cats, humans.[16]	Eggs laid near rabbit burrows, larvae penetrate skin and mature there. Larvae leave host and pupate on ground.	Exotic.	No

Table 1. cont.

Disease agent	Susceptible species	Means of transmission	Australian status	Selected for detailed examination
Felicola subrostratus (lice)	Louse specific to cats.[16]	Life cycle may be completed on host.	Endemic.	No
Rhipicephalus sanguineus (brown dog tick)	Predominantly a parasite of dogs, will attach to many other species.[16]	This is a three-host tick with larvae dropping off to moult between engorgements.	Endemic.	No
Exotic ticks, including *Dermacentor* spp.	Blood suckers, cause tick paralysis (flaccid ascending paralysis) Disease transmission - Rocky Mountain spotted fever, St. Louis encephalitis, anaplasmosis, tularaemia. Heavy infestations of *D. albipictus* have killed moose and horses.[133] *D. variabilis* parasitises rodents, dogs, humans, other animals.	Engorged females drop off and lay eggs on ground. Larvae and nymphs feed on small rodents, adults feed on dogs and other animals.	Exotic.	Yes
Notoedres, Demodex, Otodectes, Cheyletiella blakei (mites)	Fairly host specific to Felidae.[16]	Direct life cycle.	Endemic.	No

2.2.3 Summary of disease agents selected for detailed examination.

Viruses:

Rift Valley fever virus
Rabies virus
Pseudorabies virus (Aujeszky's disease)
Coronaviruses
Borna disease virus
Canine distemper virus
Nipah virus
Cowpox virus
Puma lentivirus

Prion agents:

Transmissible spongiform encephalopathy agents

Bacteria and fungi:

Burkholderia mallei (Glanders)
Mycobacterium tuberculosis and *M. bovis*
Francisella tularensis
Ehrlichia canis, E. risticii
Yersinia pestis (Plague)
Blastomyces dermatidis

Protozoa:

Trypanosoma brucei brucei, T. vivax
T. evansi
T. cruzi
Cytauxzoon felis
Babesia felis
Besnoitia besnoiti

Multicellular parasites:

Echinococcus ganulosus felidis
Echinococcus multilocularis, E. oligarthus
Trichinella spiralis
Cochliomyia hominivorax and *Chrysomya bezziana* (Screw worm fly)
Schistosomes
Paragonimus kellicotti
Diphyllobothrium latum
Mesocestoides spp.
Tunga penetrans
Exotic ticks.

3. RISK ASSESSMENT

3.1 General considerations

3.1.1 The IRA format

Table 1 identified agents that potentially present a hazard with the importation of zoo Felidae. A list of those selected for detailed examination is presented in section 2.2.3.

In this chapter, the agent is described, and relevant factors, e.g. infectivity, virulence, species affected, incubation period, potential for latent or sub-clinical infections and mode of transmission are discussed. Data on diagnosis, prevention and treatment are, in the main, discussed in Chapter 4 under Risk Management.

The potential of these agents to be introduced and cause harm is discussed under the following headings:

Likelihood of entry, establishment and spread

An assessment is made of the likelihood that the agent

- will be present in an imported non-domestic felid,
- will be transmitted to other animals or persons within the zoo precinct, and
- will spread to animals or persons beyond the zoo precinct.

The terms used are:

High	:	The event would be expected to occur.
Moderate	:	There is less than an even chance of the event occurring.
Low	:	The event would be unlikely to occur.
Very Low	:	The event would be very unlikely to occur.
Extremely Low	:	The event would be extremely unlikely to occur.
Negligible	:	Chance of the event occurring is so small that it can be ignored in practical terms.

Biological, environmental and economic consequences of introduction and establishment in Australia

The section on consequences examines the impact of the disease on the industries or communities, or environment at risk, including harm to human health, animal deaths, difficulty of eradication and threats to endangered species. In commercial livestock, loss of export markets, compensation costs and the loss of production during control campaigns are considered.

Environmental consequences are expressed in terms of adverse impact on effects on native or wild species and biodiversity, endangered species and the integrity of ecosystems.

The following terms that are used to describe consequences lie within a continuous range and are indicative of the expected outcomes:

Extreme: consequences associated with the establishment of diseases that would be expected to significantly harm economic performance and/or social well being at a national level. An event resulting in devastating losses of native fauna may be considered to have an extreme consequence.

Serious: consequences associated with the establishment of diseases that would have, for example, a high mortality or high morbidity with significant pathological changes in affected animals, a significant threat to human health or significant social effects.

Medium: consequences associated with the establishment of diseases that are less pronounced. These may cause significant disruption to zoo activities and, in the case of agents that affect commercial livestock, harm economic performance at the level of an enterprise, region or industry sector. These diseases may be amenable to control or eradication.

Mild: consequences associated with the establishment of diseases that are mild and would normally be amenable to control or eradication. Effects on the environment would be minor or, if more pronounced, would be temporary.

Negligible: consequences associated with the establishment of diseases that have no significant biological effects, may be transient and/or that are readily amenable to control or eradication. Effects on the environment would be negligible.

Conclusion on risk

The overall risk associated with the identified hazard, is a combination of likelihood of entry, establishment and spread and the consequences of such an event.

The relationship between the likelihood of entry, establishment and spread and the consequences is used in deciding whether specific risk management is required. For agents with potentially serious or extreme consequences, importation would not be permitted under conditions where the likelihood of establishment was judged any higher than negligible. For those with medium consequences, importation would not be permitted if the likelihood were higher than very low; and for those with mild consequences, importation would not be permitted if the likelihood were higher than low. For agents with negligible consequences, importation would be permitted irrespective of the likelihood.

The matrix in Table 2. is used in this determination. This matrix examines the overall risk as it would stand in the absence of any deliberate measures to reduce the risk, i.e. 'risk management'. If this risk is considered unacceptable, risk management measures are recommended to ensure that Australia's appropriate level of protection is achieved. An agent that falls into a "reject" box is one that presents an unacceptable overall risk, and risk management measures must be applied

to reduce the likelihood of establishment to the point where it conforms with Australia's appropriate level of protection.

Where the likelihood of introduction or the likelihood of establishment and spread are negligible, then, under the matrix in Table 2, the import will be accepted without the application of any risk management measures. In these cases, it has been considered unnecessary to include the section on *Biological, environmental and economic consequences of introduction and establishment in Australia.*

If the application of risk management measures cannot reduce the risk to an acceptably low level, the importation would not be permitted.

Table 2.

	High	accept	reject	reject	reject	reject
Likelihood	Moderate	accept	reject	reject	reject	reject
of	Low	accept	accept	reject	reject	reject
Establishment	Very low	accept	accept	accept	reject	reject
	Extremely low	accept	accept	accept	accept	reject
	Negligible	accept	accept	accept	accept	accept
Consequences of Establishment:		Negligible	Mild	Medium	Serious	Extreme

The next step is to consider whether or how risk management measures may be applied to reduce the likelihood of establishment and spread to the point where it conforms to Australia's appropriate level of protection ("accept" in the matrix). These measures are discussed in Chapter 4, Risk Management.

Chapter 5 contains the quarantine requirements for the importation of non-domestic Felidae into Australian zoos. The measures applied are considered to be the minimum necessary to achieve Australia's appropriate level of protection.

3.1.2 Environmental issues

In addition to the assessment below of individual disease agents, Biosecurity Australia has also given consideration to the potential for pestiness of the non-domestic Felidae proposed for import. The Vertebrate Pests Committee has placed all non-domestic Felidae present in Australia in Categories 2 or 3(a). These are:

Category 2. Animals Limited to Restricted Collections[g]

Category 3. Animals Permitted in Other Collections.[h]

For animals in these categories, all importers are advised that an import permit from Environment Australia (EA) must be obtained prior to an import permit from AQIS. In addition, some species of the family Felidae are not present in Australia, and these too, require an import permit from EA.

3.1.3 Additional responsibility of zoos

There may be some disease agents that may be of concern to the zoo, but are not considered a quarantine risk. Common parasites that may affect growth rates, or viruses that are endemic and are not known to have exceptionally serious effects on zoo animals, fall into this category. The consequences of the introduction of these agents would be minimal. Biosecurity Australia considers it the responsibility of zoos to monitor and manage the general health of their collections with regard to these agents.

3.2 Assessment of identified hazards. OIE List A disease agents

3.2.1 Rift Valley fever virus

Rift Valley fever (RVF) is caused by a Phlebovirus genus of the family *Bunyaviridae*. It is an acute disease primarily of young ruminants causing liver and gastrointestinal lesions. In humans, RVF produces an influenza-like disease. Other animals such as antelopes, monkeys, hippopotami, rodents, pigs, horses, carnivores and birds are susceptible to infection.(171)

The course of the disease in ruminants is rapid, with the incubation period being less than 24 hours in some cases. Viraemia develops rapidly, and lasts for a few days to three weeks.(1,8) Virus is excreted in most body fluids and faeces. Excretion commences 1-2 days before the onset of symptoms.(1)

Puppies and kittens under three weeks of age may be severely affected, older puppies do not succumb to infection but develop viraemia. Pregnant bitches may abort.(3)

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[g] Category 2
(a) Animals believed to have a high pest potential, significant conservation value or to be highly dangerous to humans, which may be introduced and/or kept only in statutory zoos or other Restricted Collections which have been granted. Statutory zoos will be permitted to keep all Category 2 animals. Approved Collection Status will only be granted for those Category 2 taxa approved by the Relevant Authority and unanimously endorsed by the VPC.
(b) Animals that are considered to be of high pest potential but are already being kept in significant numbers by private individuals making it impractical to restrict the keeping of the species to Restricted Collections. Can be kept for private or commercial purposes without restriction.

[h] Category 3.
(a) Animals for which permits may be issued to zoological premises maintained primarily for the purpose of exhibition, education, entertainment or conservation which are recognised by the Relevant Authority. (This Category applies to B-Class zoos, circuses and "Recognised Wildlife Parks" as well as statutory zoos.)
(b) Animals which may be kept for private, commercial or exhibition purposes but which require the issue of an appropriate permit. This category will include animals kept in such commercial enterprises as deer or game bird farms.

Antibodies have been demonstrated in free ranging cheetahs (*Acinonyx jubatus*) and lions (*Panthera leo*).[9] Experimental work using domestic cats has shown kittens to be susceptible, but adults resistant.[11]

The course of the disease in ruminants is rapid, with the incubation period being less than 24 hours in some cases. Viraemia develops rapidly, and lasts for a few days to three weeks.[1,8] Virus is excreted in most body fluids and faeces. Excretion commences 1-2 days before the onset of symptoms.[1]

In humans RVF virus can cause several different disease syndromes. People with RVF typically have either no symptoms or a mild illness associated with fever and liver abnormalities. Patients who become ill usually experience fever, generalised weakness, back pain, dizziness and extreme weight loss at the onset of the illness. Typically, patients recover within two days to one week after onset of illness. Approximately 1% - 10% of affected patients may have some permanent vision loss. Approximately 1% of humans that become infected with RVF die of the disease.[233] Various serological tests have different sensitivities, but one survey of humans in Nigeria demonstrated 14.8% positive to haemagglutination-inhibition antibody, with livestock and wildlife workers showing much higher levels of exposure.[232]

Culex and *Aedes* spp. of mosquitos are the principal vectors. However, contact with infected material is responsible for transmission of the virus to humans.[1]

RVF was confined to Africa but since 2000 has spread to the Middle East.[231] It has considerable potential for intercontinental spread through air travel and because of the presence of the insect vectors *Culex* and *Aedes* spp. in many countries.[5]

Likelihood of disease agent entry, establishment and spread

RVF in mature cats would appear to cause only subclinical disease. The incubation period is as short as 24 hours in kittens. Information on infection in cats is based largely on experimentally infected animals. Natural infection is uncommon. The viraemic period is short.

If very young animals were to be selected for importation, clinical expression of any infection would be likely to occur during the preparatory period. However cats do not feature in the epidemiology of the disease, infection is uncommon, and the likelihood of importation of an infected animal, is considered extremely low.

In the unlikely event of an infected animal being imported, it would have to be fed on by a competent vector within the short viraemic period. The mosquito would need access to reservoir species (ruminants) for establishment and spread of the disease. In the extremely unlikely event of this happening, eradication would be difficult, and would be limited by the degree of mosquito control that could be exercised in the affected area.

Biological, environmental and economic consequences

An uncontrolled outbreak of RVF would cause serious stock losses in the sheep, cattle and goat industries. Live animal exports would be affected, although freedom from RVF is not a requirement for many of Australia's meat export markets. The resulting financial losses would have a serious effect on the local economy in the area of the outbreak. Job losses both on farm and in support industries may occur.

Once RVF is eradicated, it can take up to 3 years to regain 'free' status. The cost of vaccination could be considerable. Further, the cost of serological monitoring to demonstrate proof of freedom will be quite substantial.

There would be significant public health effects reflected in lost work days and increased medical costs.

The overall consequences of the entry, establishment and spread of Rift Valley fever virus would be serious.

Conclusion on risk

The strict application of the matrix on page 30, of an extremely low likelihood of entry, establishment and spread, combined with the serious consequences should the event occur, should lead one to conclude that risk management measures are not required for this agent with regard to the importation of non-domestic Felidae. However, two important factors require special consideration.

- The susceptibility of Felidae to RVF is age dependent, and extremely young animals may be a special case in this regard.
- RVF is an important zoonosis.

It has been decided therefore, that risk management measures for Rift Valley fever are desirable.

3.3 Assessment of identified hazards. OIE List B disease agents.

Agents closely related to those on List B have been included in this section.

3.3.1 Rabies virus

Rabies is a usually fatal, viral encephalitis that can affect all warm-blooded animals. Rabies is present worldwide and is common in all continents except Australia and Antarctica. Many island countries, territories and states are also free from rabies.

The rabies virus is the type species of the *Lyssavirus* genus of the family *Rhabdovirus.* Placement within the genus is determined by antigenic sites on the N-protein. There is one serogroup. Within the serogroup, placement of a virus species as rabies or rabies-related is determined by antigenic sites of the G-protein as recognised in virus neutralisation tests. Virus species assigned to the *Lyssavirus* genus are as follows:

Australian bat lyssavirus
Duvenhage
European bat type 1
European bat type 2
Lagos bat
Mokola
rabies virus[215]

Cross protection between these viruses is limited.[1]

The OIE code exempts European bat lyssaviruses type 1 and 2 when setting the requirements for countries to declare themselves free from rabies.[46] Australia is considered free of terrestrial

(genotype 1) classic rabies, although a lyssavirus has been isolated from bats. [3] Australian bat lyssavirus has been defined as a new genotype by the Centers for Disease Control and Prevention (CDC) in Atlanta, USA. It is 8% different from its closest relative, classical rabies, with which it has close antigenic similarity. The hosts are a number of species of bats and flying foxes.[216] It causes rabies-like disease in bats and humans, and has caused two human fatalities.[22, 174] No other terrestrial mammals in Australia have been known to acquire natural infection with Australian bat lyssavirus.

Urban rabies is perpetuated by dogs. In endemic countries, stray and unvaccinated dogs can lead to a high incidence of exposure in humans. Cats become infected, but do not contribute significantly to the perpetuation of the disease.[1] Infection in cats is considered to be a spill over from wildlife rabies.[3]

Rabies is capable of affecting all mammals and is fatal. The virus enters the body at the site of a bite from an infected animal where it slowly multiplies. After a period (weeks to months), the virus travels up the peripheral nerves from the region of the bite to the spinal cord and brain. Virus replicates and spreads within the brain causing neuronal damage and a variety of nervous disorders. Virus also moves outwards to other body tissues, in particular the salivary glands from which large amounts of virus are excreted with saliva.[3]

The OIE Code gives the incubation period for rabies as 6 months, and the infective period in domestic carnivores starts 15 days before the onset of the first clinical signs and ends when the animal dies.[46]

Greene gives the incubation period for cats from 2-24 weeks before clinical signs manifest.[3] The domestic cat is considered highly susceptible to rabies. In cats, the prodromal phase is short, with the disease commonly progressing to the furious form of rabies rather than the dumb form, although one study showed this to be the opposite.[221] Cats infected with rabies can subsequently progress to a paralytic phase, or die from exhaustion.[3] Less is known of the susceptibility of non-domestic cats. Chronic or latent infections are recognised but should be regarded as of minor importance in the epidemiology of the disease.[3]

Rabies in three lions in a zoo in India was believed to have been introduced by a mongoose.[24] There are also reports of cases in lions in a game reserve believed to have been introduced by an incursion of a fox through the perimeter fencing.[40]

Likelihood of disease agent entry, establishment and spread

There are sporadic reports of zoo Felidae developing rabies in captivity.[23,24,25] The reports cited are all from countries in which rabies was poorly controlled at the time.

The likelihood of entry of the rabies virus in a zoo felid is dependent on the rabies status in the country of origin and the level of security under which the animal is housed. Even from an endemic country, importation of non-domestic Felidae from a zoo would present a very low likelihood of agent entry. The likelihood would be higher with an animal from an open-range situation in an endemic country. There is negligible likelihood of agent entry with animals imported from a rabies-free country.

The method of housing of big cats in zoos is designed to prevent their escape and to prevent injury to zoo personnel. Even in open range situations, wide moats and/or high fences provide

secure confinement. This factor would limit to low, the likelihood of spread of rabies from a zoo in case of an imported animal developing signs of the disease after arrival.

Biological, environmental and economic consequences

The introduction of rabies to Australia would impact significantly on social patterns and human health. There would be little disruption to Australia's exports in animal products and, with the exception of the export of carnivores, little disruption to live animal exports.

Rabies, however, is an OIE List B disease that would have significant public health implications, and bring with it significant social changes. It has been said to have a hold on the human imagination out of proportion to the real risks involved. In some rural communities where dog controls are rudimentary, serious threats to human health could exist.

If the agent became established in the feral dog, dingo, fox and feral cat populations found throughout most of Australia, eradication would be difficult.

There are no data on the virulence of rabies in Australian fauna, so the consequences of introduction on fauna are unknown.

Conclusion on risk

Whilst the risk of establishment of rabies as a result of an importation of non-domestic Felidae into a zoo is low, the consequences would be serious. The importation of zoo Felidae from countries not free from rabies, without restriction, would pose an unacceptable threat. Quarantine measures for the control of this agent are warranted.

3.3.2 Aujeszky's Disease (Pseudorabies virus)

Aujeszky's disease, also known as pseudorabies, is caused by an α-*Herpesvirus* in the family Herpesviridae. The pig is the natural host but sporadic outbreaks of disease have been recorded in cattle, sheep, goats, rodents and carnivores.[1,12]

Infection in the domestic cat occurs through ingestion of contaminated pig meat/offal. Virus is believed to enter via the tonsils and spread to the brain via the cranial nerves.[15] Clinical symptoms include increased salivation, depression, dehydration, inappetence, convulsions, hyperaesthesia, recumbency and sudden death.[1,13,44] The incubation period is about 3-6 days and death occurs within 2 days of onset of clinical symptoms.[3] Few cats survive.

In experimentally infected cats virus could not be isolated from oral or nasal swabs, suggesting that they play a minor role in the spread of the virus.[15] Aujeszky's disease has been recorded in a free ranging Florida panther and the course of the disease appeared to be rapid. It was believed to have been infected from eating feral pigs.[14]

Wild animals, including *Felis concolor*, may act as transient reservoirs, but are not important in maintaining the disease. Similarly, Aujeszky's disease infection in dogs and cats only occurs in areas where the disease in enzootic in pigs. The occurrence of clinical disease in pets may be the first indication that the disease is present in the local pig population.[3]

Aujeszky's disease occurs in most countries of the world but not in Australia.

Likelihood of disease agent entry, establishment and spread

Domestic dogs and cats have been imported from endemic countries without pre-export quarantine for many years, and then been quarantined on arrival. No case of Aujeszky's disease has been recorded in an imported dog or cat in quarantine. Whilst zoo Felidae are fed raw meat/offal and whole small animals, in a well-managed zoo, meat from sick animals would not be fed, though meat from an incubating animal could, conceivably be fed. The likelihood of introduction is extremely low.

The incubation period is less than one week in cats, the course of the disease is acute and short and infected animals would be readily detected.

If an infected animal were imported, the likelihood of establishment and spread from the animal quarantined in a zoo would be very low. However, if the disease became established and spread to Australia's feral pig population, eradication would be extremely difficult.

The likelihood of introduction, establishment and spread of the virus in non-domestic Felidae is considered extremely low to negligible.

Biological, environmental and economic consequences

An incursion of this disease in Australia could have a significant adverse economic and social impact. If the disease became established, long-term trade effects, in particular for live pigs, would likely be significant. In the event of an incursion, the existing policy is to eradicate the disease as quickly as possible using quarantine and movement controls, slaughter of positive animals, vaccination and decontamination measures. There would be significant economic and social disruption caused by such measures. There may also be disruption to Australia's exports of pork to SE Asia and New Zealand, although it should be noted that the OIE does not suggest management measures for meat imports in regard to Aujeszky's disease.

There are no data on which to estimate the consequences of establishment of Aujeszky's disease on Australian fauna.

Conclusion on risk

Whilst the potential consequences of establishment of this disease are regarded as medium to serious, the latter if the disease caused significant harm at an industry level, the likelihood of introduction and establishment of this agent via a zoo felid is considered to be extremely low to negligible. According to the matrix in Table 2, risk management measures for this agent in zoo Felidae are not warranted.

3.3.3 Coronaviruses

Transmissible gastroenteritis (TGE) is a List B disease of pigs that may also affect cats, dogs and foxes. It is caused by a coronavirus that is closely related to and cross-reacts serologically with the canine coronavirus and feline infectious peritonitis virus (FIPV).

TGE occurs in Europe, Asia and America.

It is suggested that dogs, cats and foxes may provide a reservoir of infection of TGE for pigs between seasonal outbreaks of the disease.[1]

Cats have been experimentally infected with TGE. Whilst infection was serologically demonstrable, the cats did not develop clinical disease.[28] However, virus was isolated from faeces for up to 22 days after oral infection.[29] There are no reports of TGE in non-domestic cats.

An antigenic relationship has been demonstrated between TGE and FIP. In a leopard naturally infected with FIPV, high TGE virus neutralising titres were found.[28] Cats experimentally infected with TGE virus developed low antibody titres that cross reacts with FIP, but insufficient to immunise them against challenge with FIPV.[78]

Likelihood of disease agent entry, establishment and spread

Whilst cats have been infected experimentally, they are not regarded as vectors of TGE in pigs. The likelihood of introduction is negligible. The likelihood of consequent establishment and spread is negligible.

Conclusion on risk

Cats do not appear to play a role in the transmission of TGE. It is concluded by the matrix at Table 2, that quarantine requirements for this disease are not warranted in the case of non-domestic Felidae.

3.3.4 *Burkholderia mallei* (Glanders)

Glanders is caused by *Burkholderia mallei* (formerly known as *Pseudomonas mallei*), a gram-negative anaerobe. The disease presents as either an acute or chronic form, both forms are often fatal. The acute form is characterised by bronchopneumonia whilst ulcerative and nodular skin lesions occur in the chronic form.

Glanders is principally a disease of horses, mules and donkeys, but may also affect humans and small carnivores such as dogs and cats. Transmission occurs by close contact, but small carnivores have become infected through eating infected carcasses.[34] Glanders has been documented in captive Felidae that were fed infected horse meat.[79,90] Humans are highly susceptible with a high fatality rate in untreated cases.

The International Animal Health Code gives the incubation period for glanders as six months.

Likelihood of disease agent entry, establishment and spread

B. mallei infection of Felidae is rare. Most countries are now free from this agent.

The likelihood of importing potentially infected animals is negligible from countries free from the disease, and very low from countries not free.

In the unlikely event of introduction of an infected zoo animal, establishment and spread of the agent beyond zoo precincts would be most unlikely.

Establishment in Australia outside zoo premises would require close contact between zoo animals or fomites from within the zoo with outside horses. This would not occur under normal circumstances. It is considered that the likelihood of establishment is very low to negligible.

Biological , environmental and economic consequences

Early recognition and eradication of *B. mallei* infection is feasible. In the unlikely event of establishment of glanders in Australia, the effects on Australia's export of horses would be serious. It would also result in some restrictions on horses attending sporting events.

Further, the effects of establishment of *B. mallei* within a zoo, would be significant.

It is a serious zoonosis, and most countries exercise controls for this disease.

Conclusion on risk

Although the likelihood of entry and establishment is negligible for animals from unaffected countries, and very low for animals from affected countries, the consequences of introduction and establishment would be serious. Risk management measures for this agent are warranted.

3.3.5 *Mycobacterium tuberculosis, M. bovis*

The complex of closely related bacteria causing tuberculosis in warm blooded animals are: *Mycobacterium tuberculosis*, chiefly an agent of tuberculosis in humans, but also infects pigs, monkeys, dogs, cats, cattle and psittacine birds; *M. bovis* chiefly an agent of tuberculosis in cattle and deer, but also infects humans, and occasionally pigs, horses, dogs, cats, sheep and ferrets; and *M. avium* chiefly responsible for tuberculosis in poultry, but occasionally infects cattle, pigs, horses and sheep.(34) Another variant has been found in cats in the UK that has been shown on the basis of cultural characteristics to be between *M. tuberculosis* and *M. bovis*.(39) A strain of *Mycobacterium* isolated from pinnipeds has been identified as distinct from but closely related to *M. bovis*.(35)

Cats appear to be more susceptible to *M. bovis* than to *M. tuberculosis* or *M. avium.* The route of infection is usually by the ingestion of contaminated milk or diseased wildlife. Dogs are more prone than cats to develop clinical tuberculosis, usually from close association with infected humans.(34) Feline tuberculosis most often results from *M. bovis* infections and cat to cat transmission occurs. Canine and feline infections with *M. tuberculosis* are usually contracted from humans. (31,175) There is a number of reports of tuberculosis in non-domestic Felidae, mostly from those in captive situations.(36. 37,38,72) A survey of deaths of wild animals in captivity in India showed 5.8% of felines died from tuberculosis.(37)

In 1977 Thoen described the occurrence of tuberculosis in exotic animals in captivity in the USA as widespread and emphasised the public health importance. He did not specify which species were sampled, but non-human primates and hoofstock returned the highest number of positive isolates for *M. bovis* and *M. tuberculosis*.(48) Two more recent reports of *M. bovis* infections in big cats in zoos in the USA provided no information on the possible source of infection.(31,36) Thoen said that there is probably little opportunity for exposure of captive Felidae to *M. bovis*.(202)

Mycobacteria of the tuberculosis group are very infectious. A 1996 report of *M. bovis* infection in a lion in a zoo in Tennessee said that three of 51 people exposed to the lion converted to a positive intradermal test after the incident.(31) An Australian report on an outbreak of *M. bovis* in a cattery mentions that one of the in contact humans tested exhibited a strong positive to the

Mantoux test.[175] In humans, however, clinical expression of disease is usually dependent on other factors such as poor nutrition, age or concurrent disease.[207]

There is a very high incidence of *M. bovis* infection in lions in the Kruger National Park that has resulted from them eating infected buffalo.[128]

The course of infection, and the development of clinical tuberculosis is variable.[80] Chronic weight loss is a consistent feature of infection in cats, lung and bone lesions being common. The lesions of tuberculosis in carnivores differ from those in other species. Granulation tissue, when it occurs, is generally non-specific. Gross lesions are sarcomatous in appearance.[34]

M. bovis does not survive long in the environment, and reservoir hosts are essential for survival of the organism.[3]

M. tuberculosis and *M. bovis* are obligate intracellular parasites, hence cell-mediated immunity rather than serology has been the chief means of diagnosis of this disease in the main hosts.[3] Cats do not respond well to either the purified protein derivative (PPD) or the Bacille Calmette-Guérin (BCG) tests, and culture of biopsy or necropsy samples is considered to be more reliable.[3] This method requires a discharging lesion or death of the animal, and would not be useful in detecting subclinical disease.

Diagnosis of tuberculosis in non-domestic Felidae, in all the reports studied, was made post-mortem indicating difficulty in ante-mortem diagnosis.

Australia is officially free from bovine tuberculosis and it is a notifiable disease in all States. *M. tuberculosis* infection in humans is a notifiable disease. If an animal were to be diagnosed with *M. bovis* within a quarantine approved premises, it could be ordered into quarantine and therefore under Commonwealth control for the purpose of containing/eradicating the agent.

The reporting of *M. tuberculosis* infections appears to be mandatory only when humans are affected, but not for animals.

Likelihood of disease agent entry, establishment and spread

The existence of reports of tuberculosis in zoo Felidae is acknowledged.[80] Biosecurity Australia considers the overall likelihood of introduction to Australia of *M. tuberculosis* and *M. bovis* in zoo felids to be very low.

The likelihood of establishment of infection following introduction within a zoo would be low because zoo Felidae are kept in small isolated groups.

The likelihood of spread of infection beyond the zoo to farm livestock would be negligible. because there is no mixing of zoo and farm animals. However, the likelihood of spread of infection from one zoo to another via animal exchanges for breeding purposes is higher.

The overall likelihood of introduction and establishment within a zoo is considered very low. There is a negligible likelihood of establishment beyond zoos.

Biological, environmental and economic consequences

Australia is officially free from *M. bovis*. A campaign for eradication of bovine TB and brucellosis commenced in 1970 and concluded on 31 December, 1997, when Australia was declared free from bovine tuberculosis. The cost of the campaign over that period was $840 million. An ongoing surveillance program (the Tuberculosis Freedom Assurance Program) has

replaced the eradication program. The occasional pockets of tuberculosis that have been discovered in recent years have all been eradicated quickly. Re-establishment of bovine tuberculosis in Australia would adversely affect Australia's meat export trade. Quarantine of some properties and a protracted period of surveillance would be likely if *M. bovis* gained entry.

The consequences of re-establishment of *M. bovis* in cattle are considered serious, however, as stated above, the likelihood of this occurrence is negligible.

The consequences of a human contracting *M. tuberculosis* or *M. bovis* directly or indirectly from an imported animal must be considered as serious as if that human had contracted the infection from another person.

Conclusion on risk

Although the likelihood of introduction and establishment of *M. bovis* and *M. tuberculosis* is very low, the consequences of this event would be serious. For public health reasons, and for the protection of zoo collections, risk management measures to prevent the introduction of *M. bovis* and *M. tuberculosis* in non-domestic Felidae are warranted.

3.3.6 *Francisella tularensis*

Francisella tularensis is the causative organism of tularaemia. *F. tularensis* is a facultative intracellular parasite that causes a disease mainly affecting rabbits and hares, and is an important zoonosis.

F. tularensis has two main biovars, type A, which is highly virulent for rabbits, and type B. Both strains have been isolated from cats. Ticks are the chief vectors. In the USA *Dermacentor* and *Amblyomma* are vectors as well as reservoirs. Dogs and cats can also become infected from eating infected rabbits. Domestic cats have occasionally transmitted the infection to humans.[93] It is highly infectious to humans, with a fatality rate of 5-7%.[92] As few as 5-10 bacteria can result in disease.[2180 Approximately 150-300 tularaemia cases are reported in the United States annually.[218]

The incubation period for dogs is 48 hours, whereas the OIE, with reference to rabbits, gives the maximum incubation period as 15 days.[46] Valli, on the other hand, says that infection in domestic animals may remain latent for long periods without causing ill health.[217] Nonetheless, rabbits, hares and wild rodents, ticks and flies are considered to be the reservoirs.

In cats, the disease is more severe in young animals that succumb to a systemic infection characterised by lymphadenomegaly and miliary abscesses in the liver and spleen.[3]

Likelihood of disease agent entry, establishment and spread

Cats have been imported for a number of years from countries with endemic tularaemia, with one month's post-arrival quarantine. The agent has not been introduced. The confinement and close observation of animals in the zoos of export would ensure reasonable health checks and further reduce the risk of importation. Together with the uncommon occurrence of tularaemia infection in cats, the likelihood of introduction in a zoo felid is considered extremely low.

Establishment and spread generally involve close contact and/or a reservoir host. Various ticks can act as reservoirs.[92]

The likelihood of *F. tularensis* being introduced in a zoo felid is extremely low, however rabbits and hares exist in Australia, and present a potential reservoir. *Dermacentor* spp. are not present in Australia. In the unlikely event of the agent being introduced in a zoo felid, the risk of establishment is considered extremely low.

Biological, environmental and economic consequences

The significance of this agent lies in its zoonotic potential. The occurrence in man follows a sporadic pattern, and is usually associated with activities that take people into wildlife reservations.

Humans are highly susceptible: the overall fatality rate in the USA was close to 7% prior to the introduction of antibiotics.[182] The death rate for the rarer pulmonary and typhoidal forms is 40-60%.[182]

The establishment of this disease agent in Australia would have mild to serious consequences.

Conclusion on risk

It is concluded that, although the consequences of introduction could be serious, because there is an extremely low likelihood of introduction, the risk of establishment is likewise extremely low. Risk management measures for *F. tularensis* are not warranted in relation to the importation of non-domestic Felidae.

3.3.7 *Trypanosoma brucei brucei*

Trypanosomes are flagellated blood protozoa with two distinct developmental phases to their life cycle, one in mammals and the other in insects. *Trypanosoma brucei brucei* is associated with the disease of ruminants known as nagana. Nagana occurs chiefly in domestic cattle and some non-ruminant animals and is highly pathogenic in naïve populations of cattle. However, in native African ruminants, disease is minimal.[55,69]

Dogs and cats became infected with *T. brucei* after eating the meat of infected ruminants, and this has been suggested as the means of transmission in areas where lions and hyenas are frequently found infected.[57] In the Serengeti 28% of lions had detectable *Trypanosoma* spp, however this incidence was not repeated in other locations. Trypanosomes were not found in cheetahs in the same survey.[141]

Lion cubs have also been infected experimentally by inoculation with a strain that had been passaged through laboratory animals. A low level of parasitaemia appeared within one week. Both animals developed a progressive anaemia and severe weight loss.[58] Naturally occurring infections of *T. brucei* in free ranging lions has been recorded, but cheetah also sampled were negative.[75,141]

T. brucei is only transmitted by tsetse flies, a vector predominantly found in sub-Saharan Africa. Wild animals that inhabit these belts are natural hosts for trypanosomes, and infection does not cause disease. [69]

Likelihood of disease agent entry, establishment and spread

T. brucei could only be present in animals domiciled in tsetse fly regions of Africa. Since most imports are likely to be captive-bred animals that have not been present in these regions, the risk of introduction is very low. In the unlikely event of introduction, establishment and spread would not occur because the vector is not present in Australia. The likelihood of establishment following introduction is considered negligible.

Conclusion on risk

The likelihood of establishment of *T. brucei* is negligible because it depends on the presence of the tsetse fly. Therefore, no risk management measures are warranted.

3.3.8 *Trypanosoma evansi*

Trypanosoma evansi causes the disease known as surra. It is also known, in South America, as murrina or Mal de Caderas. Surra is present in northern Africa, the Middle East, southern states of the former Soviet Union, the Indian subcontinent, China, South-East Asia, Indonesia and South America.[1]

Surra has a wide host spectrum. The disease is most severe in horses, donkeys, mules, deer, camels, llamas, dogs and cats. Disease also occurs in cattle and buffaloes. Occasional mild, chronic or sub-clinical disease occurs in sheep, goats, pigs, capybaras and elephants.[1,16]

There are a number of reports of surra in captive non-domestic Felidae in India.[63,65] Two other reports of surra in circus tigers indicate that prompt treatment produces clinical recovery.[76,82] Natural infections of *T. evansi* have been reported in the South American ocelot (*Felis pardalis*).[61]

T. evansi is transmitted by numerous insect vectors, particularly the genus *Tabanus*.[1,176] The distance travelled by vectors is short. Where animals are >50 metres apart, a *Tabanus* sp. returns to the same animal to feed rather than flying to a new host.[211] The dispersal rate for a population of these vectors is believed to be about 130 m/day.[212] Movement of animals is more important epidemiologically. After feeding on an infected animal, *Tabanus* remains infective for less than 24 hours, with the probability of transmission 0.003 after 3 hours.[176]

Transmission to the dog (and presumably cat) and rodents may also be by ingestion of infected meat.[66]

De Aquino and Machado (1999) showed the average prepatent period in dogs was 11 days and parasitaemia followed an undulating course. The disease was characterised by intermittent fever that was closely related to the degree of parasitaemia. The main clinical signs consisted of pallor of mucous membranes, oedema, progressive emaciation and enlargement of palpable lymph nodes. Diagnostic antibody was detected within 12-15 days post infection by IFAT and at 15-19 days by ELISA. High and persistent antibody levels were detected by both tests and appeared not to correlate with control of parasitaemia.[53] When experimentally inoculated, dogs had an incubation period of 40 to 96 hours and died after 14-41 days.[62]

Chand and Singh (1971) showed that dogs may also develop a chronic infection, with parasites infrequently appearing in the peripheral blood. In these instances, rises in body temperature were not correlated with parasitaemia.[59]

The prepatent period in cats is 2-5 days depending on whether infected by inoculation or ingestion, the former having the shorter prepatent period.[69] In one trial all eight cats experimentally infected became ill.[68] Natural infections in domestic cats are rare.[74]

Likelihood of disease agent entry, establishment and spread

It was not clear from the literature the extent to which non-domestic Felidae may be non-clinical carriers. However in domestic cats infected experimentally the prepatent period is short. For those animals exhibiting clinical disease, illness would be detected soon after infection. It has been suggested that all mammals from endemic countries be considered potential carriers.[176]

The prevalence of *T. evansi* in the country from which the Felidae were sourced would have a large bearing on the likelihood of introduction. Big cats from zoos in an endemic area would present a very low risk of introduction, while animals that had never been domiciled in an endemic country would present negligible risk of introduction.

Potential vectors of *T. evansi* are widespread in Australia. Most zoos have ungulate animals on their premises. There are insufficient data on which to quantify the potential for transmission from infected zoo Felidae to other species. The literature does not indicate that Felidae play a significant part epidemiologically.

Some zoos are outside or on the outskirts of metropolitan areas. If *T. evansi* were to become established within such a zoo, establishment and spread of the agent to animals outside the zoo could occur. This likelihood is considered low to moderate.

Australia has feral populations of goats, buffalo, camels and horses and has large cattle holdings in the northern half of the country. Any disease agent that may be transmitted by insects present in this country, would be difficult to eradicate. Should *T. evansi* be introduced to these populations, the likelihood of *T. evansi* becoming endemic is considered moderate to high.

Biological, environmental and economic consequences

Horses are most seriously affected by this agent. The diverse nature of the horse industry makes it difficult to determine the social and economic impact that establishment and subsequent control of surra would have in Australia. As the population is naïve, it is probable that mortality in infected horses and direct economic loss would be high if a reliable treatment was not readily available.

Australia participates in many international horse events with horses leaving the country or being imported on a regular basis. This trade could be seriously and, if eradication not possible, permanently affected.

Australian native fauna are known to be susceptible. Wallabies (*Macropus agilis*) and pademelons (*Thyogale brunii*) were infected experimentally and suffered pathological changes. They either died or were euthanased *in-extremis*.[213]

Thus, the consequence of disease establishment would be serious.

Conclusion on risk

The likelihood of introduction of *T. evansi* is relative to the source of the animal, and from endemic countries would be low to moderate. However, the consequences of establishment would be serious. Risk management measures for animals originating from or that have been domiciled in endemic countries are warranted.

3.3.9 *Trypanosoma cruzi*

This trypanosome is known as a Stercorarian, as distinct from the other trypanosomes mentioned above (the Salivarian trypanosomes). It is the causative agent of Chagas disease, a serious zoonosis in southern and central America, extending north to the southern states of the USA. In mammals *Trypanosoma cruzi* has a developmental stage in muscle, from which new parasites pass to the blood and are ingested by Reduviid bugs.[55] Domestic dogs and cats are important reservoir hosts for the parasite; one survey in Brazil showed 24% of domestic cats to be infected.[55,60]

The parasite is transmitted by the faeces of Reduviid bugs, of which the genus *Triatoma* is the most common.[55] The only likely vector for *T. cruzi* in Australia is *Triatoma novaeguineae* (alias *T. leopoldi*) which is restricted to Cape York Peninsula in Queensland.[125] The ability of this bug to transmit *T. cruzi* has not been tested. There are currently no zoos in that region that are exhibiting exotic animals.

Whilst infection is known to occur in cats, the clinical picture is better described for dogs. Initially muscle cells become infected at the site of a bug bite and, following multiplication, trypomastigotes are then transported to other parts of the body within macrophages.[3] Parasitaemia may appear as early as 3 days post inoculation, peaks at about 17 days, and is undetectable by day 33.[67] Puppies are the most severely affected. Dogs may remain asymptomatic for months or years in spite of a progressive myocardial degeneration.[3] The relative severity of the disease appears to depend on the age of the dog and the strain or origin of the agent.

T. cruzi has not been recorded in Australia.

Likelihood of disease agent entry, establishment and spread

Sub-clinical infections in adult animals occur, and animals that are sourced from, or have resided in, South or Central America would present a moderate risk of introducing the agent.

Because zoos for the display of these animals are not present in the far north of Queensland, the likelihood of establishment and spread of the agent is negligible.

Conclusion on risk

Given that at present, there are no facilities for the display and breeding of exotic zoo Felidae in the region inhabited by *Triatoma leopoldi*, the risk of establishment and spread is negligible. No risk management procedures are necessary as long as that situation remains.

3.3.10 *Echinococcus granulosus felidis*

Hydatid disease is caused by *Echinococcus* species. They are small tapeworms of the family Taeniidae. *E. granulosus*, (otherwise known as hydatids) typically has its adult stage in dogs (the definitive host), and the intermediate stage in sheep or man. *E. granulosus* is present in Australia.

It is a serious zoonosis and is notifiable in Western Australia and Tasmania. A lion adapted strain is known as *E. granulosus felidis.*

In Africa, the agent classified as *E. granulosus felidis* was shown not to be infective when scolices obtained from wart-hogs and bush-pigs were fed to dogs, but that lions ranging free in the area from which the cysts were obtained harboured heavy *Echinococcus* sp. burdens.[(191)] Parasite-free lions are easily infected with *E. granulosus felidis* cyst material from zebras.[(192)] In addition there are a number of other reports of *Echinococcus* infections in lions, however these do not refer to a separate sub-species.

It appears *E. granulosus felidis* may be sufficiently different from the typical dog/sheep strain to be treated as an exotic agent. The susceptibility of humans to this parasite is unknown, but may be expected to be similar to other *Echinococcus* spp.

Likelihood of disease agent entry, establishment and spread

Because of the confusion in nomenclature, the prevalence of *E. granulosus felidis* in lions and other non-domestic Felidae has not been estimated. The literature indicates the agent is only present in Africa.

Animals that have spent a substantial amount of time in captivity and are fed slaughtered meat would be less exposed to infection than animals that catch their own meat, be it in the wild or a national park.

It is considered the likelihood of entry of the agent to be low.

Subsequent establishment of the agent would require the placement of untreated faeces from infected felines on pastures grazed by susceptible hoofstock. Normal zoo procedures for the disposal of solid excreta include composting or deep burial. These do not permit the contamination of pastures with *Echinococcus* eggs. It is conceivable, however that zoo staff could be exposed to the eggs.

The likelihood of establishment and spread from a zoo to Australian animal populations is considered negligible.

Biological, environmental and economic consequences

The consequences of establishment of this agent beyond the confines of a zoo are not considered because it has been concluded that the risk of this occurrence is negligible. However zoo staff could be exposed, and the risk to them is considered no greater than the risk to which they are exposed handling domestic dogs in Australia.

Conclusion on risk

To what extent the sub-species *E. granulosus felidis* is genetically different from the strain endemic in Australia was not established during this investigation. The consequences are not perceived to change the current situation in Australia with regard to *E. granulosis.*

The risk of establishment and spread is considered negligible, and quarantine requirements for this agent are not warranted.

3.3.11 *Echinococcus multilocularis, E. oligarthus*

E. multilocularis is exotic with distribution through Northern and Eastern Europe, the Middle East, Russia, India, America and Japan. *E. oligarthus* is limited to Central and South America.[16]

E. multilocularis adult worms may be found in foxes, dogs and domestic and feral cats. There are numerous reports of cats being infected with adult *E. multilocularis.* Adult worms do not cause significant disease in their hosts. Larvae may develop as multilocular hydatid cysts within rodents, or humans and may cause death. *E. multilocularis* differs from *E. granulosus* in that the juvenile form does not possess a thick laminated layer, but is thin walled and infiltrates surrounding tissues. These are known as alveolar hydatids. Pieces of these cysts break off and metastasise in other parts of the body. Cysts may be inoperable.

Fortunately, human infection is uncommon, though there is an occupational association among dog handlers and trappers. [16, 17,18,148] Spread from an intermediate host requires consumption of meat or offal by a primary host. In this context, humans are not seen as transmitters of the agent.

E. oligarthus occurs in its adult form in wild Felidae, and the larval stages can be found in rodents.[16]

Likelihood of disease agent entry, establishment and spread

Non-domestic Felidae are occasionally infected with the adult stages of *Echinococcus* species. They would not be expected to show any signs of disease. In the absence of any control measures, there is a low likelihood of introduction in an imported zoo felid.

Subsequent establishment would depend on intermediate hosts having access to imported animal's faeces. Rodents, the intermediate hosts of *E. multilocularis*, may conceivably have such access. The controlled hygienic disposal of excreta from animal enclosures in Australian zoos would substantially reduce the likelihood of establishment of *Echinococcus* spp. from an imported non-domestic felid.

Humans exposed to the faeces of imported zoo Felidae would be at risk of contracting infection, but would be dead end hosts, and not contribute to establishment of the agent in Australia.

The likelihood of establishment and spread of the agent beyond the confines of a zoo is negligible.

Biological, environmental and economic consequences

E. multilocularis is an important zoonosis, and the introduction of an animal excreting viable eggs in its faeces would pose a threat to animal handlers. In the unlikely event of establishment, this agent could have serious consequences to those persons exposed, by occupation or association, to infected animals.

Conclusion on risk

Although the risk of spread beyond the confines of a zoo is negligible, *E. multilocularis* is a serious exotic zoonosis, and within the zoo, poses a hazard for zoo staff. For the protection of zoo staff, quarantine measures for *E. multilocularis* are warranted .

3.3.12 *Trichinella spiralis*

Trichinella spiralis is a nematode parasite of the family *Trichinellidae*. It has been reported in wild cougars (*Felis concolor*) with an incidence greater than 50%.[142] It has also been reported in the lynx (*Lynx canadensis*) and bobcat (*Lynx rufus*).[143] There has been one recorded case of infection in a polar bear in a zoo in Australia.[1]

Its distribution is virtually worldwide, particularly in the temperate and sub-Arctic climates. Infection does not occur in Australia, although lesions in humans who have been outside Australia have been identified on post-mortem.

T. spiralis is unusual in that the same host can be the definitive and intermediate host. Juveniles moult several times in the gut and then migrate into the mucosa. Sexual reproduction takes place here, and the live juveniles are carried away through the hepatoportal system to the liver and other tissues. When they reach skeletal muscle they encyst and remain until the host is consumed by another carnivore or rodent.[55] Larvae can also be passed in the faeces, especially from rodent hosts.

T. spiralis causes no clinical disease in wild Felidae.

Domestic dogs and cats have been imported from endemic countries for many years without specific controls for *T. spiralis.* There have been no reports of the agent in Australia during this time.

Likelihood of disease agent entry, establishment and spread

The likelihood of an imported non-domestic felid introducing *Trichinella* is high for animals that have resided in the wild in the higher latitudes of the Northern Hemisphere. Captivity does not negate the risk of infection, because of the practice of feeding raw meat to big cats in zoos. The likelihood of introduction is low to moderate depending on the geographical origin of the animal.

The likelihood of establishment and spread in Australia would be dependent on a dead infected animal being eaten by say, a rodent, which could then excrete larvae in its faeces to be picked up by other hosts. Whilst the presence of mice and rats in zoos must be considered, it is unlikely the carcass of a valuable exotic animal would be left in a place where rats and mice could eat it. In a controlled zoo situation, the likelihood of this occurrence is extremely low.

The overall likelihood of establishment of this agent in Australia as a result of importation of zoo Felidae is considered negligible.

Biological, environmental and economic consequences

Zoo staff could only be put at risk by consumption of poorly cooked carcass meat, the risk of this is negligible.

Conclusion on risk

Using the matrix in Table 2, it is concluded that no quarantine measures are warranted for this agent in relation to the importation of non-domestic Felidae into Australian zoos.

3.3.13 *Cochliomyia hominivorax* and *Chrysomya bezziana* (Screw-worm fly)

Screwworm fly (SWF) is an obligate parasite of all warm-blooded animals. Two species exist; the Old World screwworm (*Chrysomya bezziana*) and the New World screwworm (*Cochliomyia*

hominivorax). Both are OIE List B diseases for multiple species. The geographical distribution does not overlap but both flies are found in tropical and subtropical areas. New World screwworm occurs in central and southern America and Old World screwworm fly is found in Africa, the Middle East, India, S-E Asia and New Guinea. Both are exotic to Australia with Old World screwworm posing the most direct exotic disease threat.[1,5]

Myiasis is caused by the female fly laying eggs on the surface of a wound. The hatched larvae penetrate the wound and burrow into the underlying tissue to feed on blood. Extensive and deep wounds develop, and lead to death if the animal is untreated. Lesions are characteristic, smelly, and are generally easy to detect.[1,5]

There are a few of records of infestations in domestic and non-domestic cats.[204,205,206]

Likelihood of disease agent entry, establishment and spread

Cats are not animals that are commonly attacked by screwworm fly (SWF), and the likelihood of entry of screwworm fly on a zoo cat is very low. The likelihood of an infection going undetected on a valuable zoo animal, and running the full life cycle of the fly is also very low. However, if larvae were to develop to pupation and maturity, and if ambient temperatures were conducive to development, the likelihood of establishment of the agent within a zoo is moderate.

If establishment within the zoo occurred, and it were located close to livestock enterprises, feral or fauna populations, there is a moderate likelihood of establishment outside the zoo.

Biological, environmental and economic consequences

The Old World or New World SWF could cause major disruption to many animal industries if it became established. It is difficult to predict exactly how SWF might behave in Australia, although modelling predicts a huge suitable habitat over much of the continent, especially during summer. Trade in the export of live animals may be affected. Trade in products other than skins would probably not be affected per se, but productivity would drop on affected farms.[5]

At an industry level, the additional financial burden of surveillance and treatment would be placed on livestock owners in affected areas.

The consequences of introduction of this agent are considered serious.

Conclusion on risk

Although there is a very low risk of introduction of this agent, the consequences of introduction are serious. According to the matrix in Table 2, risk management measures are required.

3.4 Assessment of identified hazards. Non-OIE Listed agents.

3.4.1 Borna Disease virus

An enveloped, non-segmented, negative-stranded RNA virus is the aetiological agent for Borna disease in horses, sheep and other species.[71] An association between BDV seropositivity and psychiatric disease in humans has been demonstrated, and BDV is now considered as a potential zoonosis.[71]

The disease is rare, but occurs over much of Germany and part of Switzerland. BDV-specific antibodies have been detected in horses in several European countries, Israel, Japan, Iran and the

USA. Cats become naturally infected with BDV.[71] BDV RNA has been demonstrated in Japan in healthy cats and healthy sheep.[81,88]

Borna disease virus has not been reported in Australia, but preliminary work suggests a Borna-like virus may be present.[1,162]

The agent is highly neurotropic, and virus spread within the CNS results in low antibody titres in infected animals.[71] Apparently healthy animals may be carriers.[71]

The incubation period in horses and sheep is one to several months.[1] Signs of illness are non-specific in the early stages, with neurological symptoms developing later.[71]

In cats, the disease is known as staggering disease. Experimental intracerebral inoculation in the cat resulted in clinical signs at 2-3 weeks post inoculation.[83] The cat exhibits paraparesis and ataxia, behavioural changes, anorexia, hypersensitivity to sound and light, and seizures.[3] It would appear that infectivity in cats is extremely low because experimental infection of cats is difficult, and requires intracerebral inoculation.[83] In other species the virus is assumed to be transmitted through saliva, nasal or conjunctival secretions; arthropods have also been suggested as potential vectors.

Likelihood of disease agent entry, establishment and spread

The suggested method of spread via contact with body secretions of infected animals may be a reason why caged non-domestic animals have not been reported with Borna disease. Such close association with caged wild animals would be difficult. Biosecurity Australia considers the likelihood of introduction of BDV in non-domestic animals, kept in captivity, to be very low.

Little is known about the infectivity of the virus between cats nor to other animals or humans. However, the presence of virus in saliva and nasal secretions would indicate that spread through contact is possible, whether directly or via handlers. The likelihood of this occurrence is considered very low.

The question of whether zoo staff would be at risk is unresolved.

The likelihood of establishment and spread to other zoo animals and ultimately animals outside the zoo is extremely low. The possible role of arthropod vectors is unresolved.

Biological, environmental and economic consequence

If BDV became established in Australia, the biological consequences could be significant as many species of animal including sheep can be infected, and it is possibly zoonotic. In Germany where the disease is endemic and notifiable, horses showing clinical disease are destroyed.

Effects on fauna cannot be assessed with the current state of knowledge.

Consequences would likely involve loss of individual horses, sporadic losses in sheep, and possibly restrictions on international trade of horses and other species. On a national scale, the consequences of introduction and establishment of this agent are considered mild to medium.

Because of the low morbidity rate in cats, the introduction of BDV is likely to have minimal impact on domestic cat populations.

Conclusion on risk

According to the matrix in Table 2, quarantine measures for this agent are not warranted.

3.4.2 Canine Distemper virus

Canine distemper virus (CDV) causes an acute to subacute viral disease of dogs and is a significant pathogen in non-domestic Felidae. It is a large, enveloped single-stranded RNA virus of the genus *Morbillivirus,* family *Paramyxoviridae*. Infection with distemper has been reported in domestic cats but no clinical disease has been described.[97] Wild and captive lions in the national parks of Africa have been severely affected, where clinical, serological and neurological manifestations are similar to those in dogs.[98, 99] The disease has also been reported in the jaguar, tiger and leopard.[100]

Although only recently reported, studies of preserved tissue samples collected from 1972 to 1992 have demonstrated that CDV was probably the cause of death of lions and tigers in captivity as early as 1972.[101]

It is estimated that one third of the lion population of the Serengeti died from distemper during 1994-5.[103] Lions, spotted hyenas, bat-eared fox and the domestic dog in the Serengeti eco-system were tested for CDV, which was then sequenced. The four species carried closely related CDV isolates that were genetically distinct from CDV isolates from other locations and host species. Carpenter concluded that (i) a particularly virulent strain of CDV emerged among Serengeti carnivores within the last few years; (ii) the strain has recognisable shared-derived genetic differences in both H and P genes when compared to CDV from other parts of the world; and (iii) the CDV strain has frequently crossed species among Serengeti carnivores.[102]

The works of Bolt et al. and Harder et al. also support the concept of CDV strains developing on a regional basis.[105,183]

Wood *et al.* described the disease in a captive lioness where nervous signs predominated and histological lesions included generalised non-suppurative meningoencephalitis.[99] In other reports, anorexia, gastrointestinal and respiratory signs were observed to precede neurological signs.[100] Aerosols and direct contact are the normal modes of transmission of distemper virus. Transplacental transmission also occurs.[3]

Following the outbreak in captive exotic Felidae in USA in 1991-92, neutralising antibodies were demonstrated in animals that had been infected, with the exception of those that succumbed very quickly to the disease. There is also anecdotal evidence that immunity following infection is long lasting in those that survived. A subsequent survey indicated that animals confined in conventional zoos had less exposure to CDV than did animals in open range holdings or circuses.[100]

Likelihood of disease agent entry, establishment and spread

The evidence is that the Serengeti outbreak was caused by a distinct strain of CDV not present at that time in other parts of the world, and that genetic clusters are based on geographical location. The likelihood of introducing a strain that is particularly harmful to lions, would appear greater for lions from Africa, though lions have also succumbed to CDV in USA. There is inconclusive evidence whether the strain that affected big cats in American zoos is a new strain variant.

Exposure to CDV is more limited for zoo animals, although those housed outside in areas that may be unofficially frequented by small carnivores, and those belonging to circuses are less well protected.[100] It is considered the overall risk of introduction of an infected non-domestic felid to be very low.

Direct contact is not essential for the spread of CDV; it may be spread by aerosols. In the unlikely event of an infected animal being imported, the risk of establishment and spread of infection within zoo Felidae and to other susceptible zoo carnivores is high.

If virus were introduced and became established within the precincts of a zoo in Australia, the risk of establishment and spread outside the zoo is considered moderate.

Biological, environmental and economic consequences

Distemper in large Felidae is usually fatal. The introduction of an infected animal into a zoo, and its subsequent establishment in other Felidae would be serious for the zoo in question. In addition to the loss of individual animals, captive breeding programs could be seriously affected.

Domestic dogs in the Serengeti were affected with the same variant that killed the lions.[102] It is believed domestic dogs to the west of the park were the origin of the outbreak. Mortalities in domestic dogs to the west of the Serengeti National Park were constant, but among domestic dogs to the south east of the park there was an increase in mortalities in 1994, about the time of the outbreak among lions.[208]

Australian fauna and domestic dogs have already been exposed to local CDV. The likely effect of the Serengeti strain is unknown, but it seems reasonable to assume it would be similar to effects of the local strain.

Conclusion on risk

The likelihood of introduction and establishment is considered to be low.

The introduction and establishment of a CDV variant, virulent for zoo Felidae, could prove fatal for zoo Felidae. Given that these are almost all endangered species, the impact in terms of biodiversity would be medium to serious. It would likely be virulent for other zoo carnivores, but the opportunities for transmission would be reduced if they were housed at a distance from the felids. Beyond zoo collections, the consequences would be negligible to mild.

The imposition of quarantine measures to protect valuable and possibly endangered species exhibited in zoos is warranted.

3.4.3 Nipah virus

This virus is a Paramyxovirus closely related to, but distinct from, Hendra virus. It was identified in 1999. It has caused fatalities in humans and pigs in Malaysia, and large numbers of pigs have been slaughtered as a part of the control measures for this disease.

Serologically positive dogs, cats, horses and goats were found in the infected areas. More than 50% of dogs in infected areas were seropositive, and 15% of fruit bats, but out of 23 cats tested in the affected area, one was seropositive. This would suggest that cats are relatively resistant to infection.[127] In laboratory conditions, experimentally infected cats have yielded virus.[236]

In humans there are mild to severe clinical signs which may result in death. In the outbreak of 1999 in Malaysia, 100 people died with more than 250 infected. This demonstrates the serious level of public health concern associated with this disease.[127]

In pigs generally, mortality is low but morbidity is high. The mode of spread of the disease between and within pig farms has not been established, but transmission studies carried out at the Australian Animal Health Laboratory demonstrated that pigs in contact became infected quickly and neutralising antibodies were detected at day 14 post exposure. The incubation periods determined were: oral inoculation - 14-16 days; parenteral inoculation - 7-10 days.[127]

Clinical signs include mild to severe coughing, with varying reports of mortality and morbidity. The disease in sows and boars is more pronounced, including moderate to severe respiratory disorder characterised by dyspnoea, convulsions and death.[127]

In dogs the presenting clinical signs were similar to those of affected pigs. At necropsy, kidneys showed severe haemorrhage and congestion. Exudates were present in the trachea and bronchi.[127]

Apart from seropositivity, at this stage there is no information on whether or not the virus causes disease in cats.

Likelihood of disease agent entry, establishment and spread

Information available to date indicates incubation periods of less than three weeks for pigs and dogs. Whilst not yet proven, it is believed that infection is by contact or aerosols. On that basis, an animal could become infected and be incubating at the time of export.

Nevertheless, there are no recorded cases of disease in cats, nor of virus isolation from naturally infected cats. The geographic distribution of this virus is limited to Peninsular Malaysia. The likelihood of introduction is considered negligible from non-affected countries.

There is no evidence that cats are a significant factor in the epidemiology of this disease, and the likelihood of establishment in and spread of the disease from a zoo cat to other animals is considered extremely low.

Biological, environmental and economic consequences

The recent outbreak of Nipah virus in Malaysia was devastating to the pig industry, and a public health problem of major proportions. If Australia were to have the same experience, it would be described as an extreme consequence of an exotic disease introduction.

Conclusion on risk

The Malaysian experience has been that this is a disease with the potential for severe public health consequences. Whilst there is a lack of knowledge of the role played by cats, the serious to extreme consequences of introduction and establishment of this agent, warrants the introduction of risk management measures. These measures need only apply to countries not free from the agent.

3.4.4 Cowpox virus

Poxvirus infections in cats are usually caused by cowpox virus, an *Orthopoxvirus*. This is a double stranded, enveloped, DNA virus. The cat would appear to be an incidental host for the cowpox virus. Other pox virus infections in cats have been recorded but the viruses have not

been characterised. Cowpox virus affects domestic and non-domestic Felidae. In spite of the name, cattle do not appear to be the natural host for this virus.[156]

The reservoir hosts in Europe are voles and wood mice and in Eastern Europe ground squirrels and gerbils. Feline cowpox is a zoonosis.[3] Cowpox virus occasionally causes disease in cattle in Europe, but rarely elsewhere, and is not thought to be a source of the feline disease.[134]

Reports of occurrences in overseas zoos are very few indicating a low prevalence of the agent. Cowpox is exotic to Australia.

There are two forms of feline cowpox infection. The first, and more common is a skin form, the second an acute respiratory syndrome. The latter occurs infrequently and is characterised by pneumonia, conjunctivitis and exudative pleuritis. The mortality rate can be high. This form is more commonly found in exotic Felidae, particularly the cheetah.[3,156]

Poxviruses are highly resistant to environmental conditions but readily inactivated by disinfectants.

Transmission occurs through skin inoculation and droplet infection in the respiratory and oronasal form. Virus is disseminated in scab lesions that can exfoliate at 4-5 weeks after skin ulcers have formed. These form up to 4 weeks after initial infection.[3]

Likelihood of disease agent entry, establishment and spread

Whilst domestic cats are also susceptible, no specific quarantine measures are in place for this agent when cats are imported. There have been no reports of imported domestic cats introducing this agent. Generally, the prevalence of this agent is low. In the absence of any quarantine measures, the likelihood of entry of this agent in non-domestic Felidae is extremely low.

Humans, cattle and other exotic zoo animals are susceptible, but less so than felines, therefore the likelihood of establishment of the virus within a zoo is low. There are no data concerning the susceptibility of Australian fauna.

It appears that small native European mammals are the reservoir hosts for this agent. The likelihood of spread and establishment beyond the zoo is extremely low to negligible.

Biological, environmental and economic consequences

The introduction of feline cowpox would impact upon zoo collections, and in the case of cheetahs, could cause death.

The spread to feral and domestic cats, whilst undesirable, would have negligible consequences at a national level.

There are no data on which to estimate the consequences of introduction on fauna.

The consequences of introduction of this agent would likely be of mild significance.

Conclusion on risk

The consequences of introduction of this agent would have mild to negligible economic impact at a national level. Zoo collections would suffer from the introduction of this agent, but containment should be possible.

In applying the matrix in Table 2, it is concluded that risk management measures to prevent the introduction of this agent in non-domestic Felidae are not warranted.

3.4.5 Puma lentivirus

Puma lentivirus (PLV) is related to, but phylogenetically distinct from feline immunodeficiency virus (FIV). It has been detected in North American non-domestic feline species.[194] A lentivirus that cross reacts with FIV has also been found in East African lions, and one that reacts to puma lentivirus was found in lions, leopards and cheetahs in Botswana.[196,201]

A survey report in 1993 by Roelke *et al.* indicated that the pathogenic effects, if any, for *Felis concolor coryi,* were mild.[33] Pathogenicity for domestic cats appears negligible, although viraemia and seroconversion were demonstrated.[194]

Transmission could be vertical (both placental and mammary transmission suggested), and horizontal via wounds, copulation and ingestion.[33]

Likelihood of disease agent entry, establishment and spread

Puma lentivirus seropositivity of the order 40% has been detected in some wild populations of *Felis concolor* in the USA.[195] Importation of these species would present a moderate likelihood of agent entry. For other species, data are not available.

Because of the intimate contact required for transmission of this agent, establishment of the disease in other species within zoo Felidae, or other genera within or outside the zoo would not be expected to occur.

Biological, environmental and economic consequences

The consequence of introduction of this agent, if not already present in zoo Felidae would be expected to be negligible to mild.

Conclusion on risk

The status of this agent in Australia is not known. Current knowledge of the mode of transmission indicates the rate of spread would be low, and then only within the affected species. The consequences of establishment if not already present, would be negligible to mild. Quarantine measures for this agent are not considered warranted.

3.4.6 Transmissible spongiform encephalopathy agents

Transmissible spongiform encephalopathy (TSE) is caused by prions, infectious protein agents that affect the central nervous system, resulting in a slowly progressive degenerative disease.

Several cases of TSE have occurred in non-domestic Felidae. The first of these was identified in the UK in 1990. [226] Since then it has also been diagnosed in Norway.[227] Circumstantial

evidence indicates that infection may have resulted from ingestion of tissues from cattle affected with bovine spongiform encephalopathy (BSE).[209]

Onset of the disease in a puma (*Felis concolor*) began with ataxia, loss of balance and fine muscle tremors. She was euthanased, and histopathology and immunostaining with TSE prion antiserum confirmed a diagnosis of a scrapie-like spongiform encephalopathy.[123] Cases of TSE in cats and non-domestic Felidae have occurred predominantly in the UK.[124]

One case in an imported cheetah occurred in Australia and one in France, both cheetahs having been bred and spent a period of their lives in the UK, where it is assumed they contracted the infection.[150, 151] The incubation period is long and, in cats, infection appears to occur through consumption of infected carcass parts.[124]

Likelihood of disease agent entry, establishment and spread

The likelihood of TSE entering Australia in an infected animal is extremely low. Changes to slaughter procedures as a result of BSE in cattle in the UK would likely preclude current TSE transmission to carnivores. Older animals may still be affected because of the long incubation period. Theoretically, these animals could be imported, but in practice zoos prefer to import younger animals, therefore the risk of introduction of an infected animal is extremely low.

Dead zoo animals are not destined to end up in the animal food chain in Australia, and the likelihood of a zoo Felid importation resulting in the establishment of a TSE in Australia is negligible.

Conclusion on risk

The conclusion is that negligible quarantine risk is associated with transmissible spongiform encephalopathy in zoo Felidae. No risk management measures are warranted.

3.4.7 *Ehrlichia canis, E. risticii*

Ehrlichiosis is the name given to a broad range of diseases caused by *Ehrlichia* spp. They belong to the family *Rickettsiaceae* and are small, gram-negative, pleomorphic coccobacilli that primarily infect circulating leucocytes. Many Ehrlichiae are zoonoses with the dog being among the reservoir hosts of infection. Ehrlichiae are responsible for two human disease syndromes: monocytic ehrlichiosis and granulocytic ehrlichiosis.

E. canis, E. risticii and *E. equi* are believed exotic to Australia.

E. canis is common in dogs, and *E. risticii* and *E. equi* are more commonly found in horses.

Ehrlichia-like bodies have been detected in peripheral blood of domestic cats in USA, Kenya, France and Thailand, but the organism has not been isolated. Serological evidence points to both *E. canis* and *E. risticii*. Cats have been experimentally infected with *E. equi*, and *E. risticii*. [3,50]

In one report of five cats with suspected Ehrlichial infection, the clinical signs included mild leukopoenia, thrombocytopoenia, dysproteinaemia with antibody titres to *E. canis* and *E. risticii.* Repeated or prolonged periods of antibiotic treatment were necessary, indicating that the parasite may not have been cleared from the blood.[144]

In one experimental study, eight domestic cats were inoculated with *E. risticii*, all cats seroconverted, while only two became ill and yielded organisms.[145]

There is a report of *Ehrlichia*-like organisms being found in the blood of a captive lioness in Nairobi. Clinical signs included emaciation and prominent superficial lymph nodes prior to death.[163] Generally cats are not a significant host for this agent.

Likelihood of disease agent entry, establishment and spread

Because of the low incidence of ehrlichiosis in domestic and non-domestic cats, the risk of introduction of the disease agent in an infected cat is extremely low.

E. canis is transmitted by *Rhipicephalus sanguineus*, a tick present in Australia.

The paucity of reports of *Ehrlichia* infection in cats would indicate that transmission among cats must be an infrequent occurrence. In the unlikely event of the agent being imported in a zoo felid, the risk of establishment would be extremely low.

Biological, environmental and economic consequences

The agent of ehrlichiosis in cats has not been isolated and identified. Infection appears to be an unusual occurrence. It may or may not be *E. canis,* an exotic agent for which Australia has quarantine measures in place.

The consequences to the Australian environment are hard to predict. It is not known if native animals will be clinically affected by ehrlichiosis or whether they would become reservoir hosts for the disease. However, feral carnivores and rodents may become reservoir hosts of the disease.

In the extremely unlikely event of the agent being introduced and becoming established, the consequences are considered mild.

Conclusion on risk

Using the matrix at Table 2, it is concluded that risk management measures are not warranted.

3.4.8 *Yersinia pestis*

Yersinia pestis is a gram-negative bacterium that causes a centuries-old disease in man known as plague. Plague is designated a Class I notifiable disease and confirmed human cases must be reported to the WHO. It is one of three internationally quarantinable human diseases.[177] Rodents are the natural hosts. Humans and cats are equally susceptible, with dogs also being susceptible.[3]

Sylvatic cycles establish in rodent species that have a low susceptibility to the disease, i.e. they do not die but maintain the agent. When it moves to very susceptible species, e.g. *Rattus rattus* spread is rapid and many deaths occur within this species of rat. Because infected fleas leave these dead rats and attack other species (including humans), they are important in amplification and transmission of the agent to humans.[182]

Known foci of plague occur in the USA with about 13 human cases per year being reported. It also occurs in southern Africa, Madagascar, around and east of the Caspian Sea, and Asia.[3] It is exotic to Australia.

Y. pestis is maintained in nature by rodent-flea-rodent transmission. A number of fleas that naturally infest rodents are involved in this cycle. The most common mode of transmission of *Y. pestis* to humans is through the bite of infectious fleas. Less frequently, infection is caused by

direct contact with infectious body fluids or tissues while handling an infected animal or inhalation of infectious aerosols. Particular care is recommended in handling sick cats in endemic areas.[177] Rodents are the chief reservoir for this agent, with spread to humans being by fleas from rodents, or via cats and their fleas as intermediate hosts.[3]

In cats, the disease may be rapid with death in acute cases in 4-9 days; or there is transient infection with fever and lymphadenomegaly; or cats may show no clinical signs at all. Clinical cases have bacteraemia and the agent may be recovered from the blood and oropharnyx. The course of the disease in cats may last from 6-20 days.[3]

Where humans have contracted the disease from cats, the cats have mostly become ill and died at the same time. For cats to infect humans, there appears to be a need for close contact between the two. This would be a significant factor in lowering the likelihood of an imported zoo felid passing infection on to humans. The risk, to humans, of contracting plague is greatest when epizootics cause high mortality in commensal rat populations, thereby forcing infected rat fleas (*Xenopsylla cheopis*) to seek alternative hosts, including humans.[178]

Modes of transmission of plague to humans were determined for 303 patients and included fleabite 78%; direct contact with numerous species of infected animals, including cats, 20% and inhalation of infectious airborne materials, 2%. Those infected by inhalation were mostly exposed to infected domestic cats. Among these was a fatal case of pneumonic plague in a veterinarian. [178]

Likelihood of disease agent entry, establishment and spread

A survey of cats and dogs in California between 1979-1991 covering 4,115 dogs and 466 cats returned an average of 2.1% dogs and 3.2% cats being seropositive to *Y. pestis*. The highest prevalence of positive animals, approximately 41%, was found in animals tested during outbreak investigations.[179] A prevalence of 5.5% was found in healthy domestic dogs in Tanzania.[180] There is serological evidence of a high incidence in mountain lions in California.[32]

From endemic countries with a low incidence, such as the United States, the likelihood of agent entry is extremely low. The likelihood of entry would be higher from countries with a high prevalence of reported cases. From countries where plague does not occur, the likelihood of agent entry is negligible.

The incubation period is short, and early recognition of ill health in an animal being prepared for export could be expected.

The risk of zoo personnel being bitten by fleas from captive Felidae would be lower than the risk of being bitten by a flea from their pet cat. The likelihood of aerosol or direct contact infection of zoo personnel is extremely low, but increases if they are called upon to handle and treat sick animals.

Fleas are the main mode of transmission between animals, but *Ctenocephalides* spp. are not as good vectors as *Xenopsylla cheopis* and other rodent fleas.[3,177]

The USA has been unable to eradicate bubonic plague, and prevention by way of education and vaccination is practiced. In addition to rodents, free roaming dogs and cats are considered carriers in endemic areas. Twenty-two cases positively identified as being caused by cats have occurred in as many years in the USA.[178]

Australia has introduced rodents, and about 50 species of native rodents. If the agent entered Australia, and did spread beyond the zoo precincts, eradication could be extremely difficult.

Biological, environmental and economic consequences

Epidemics are most likely to occur in areas that have poor sanitary conditions and large populations of rats. Such living conditions are rarely encountered in Australia. However, mice plagues occur every few years in the grain growing regions of the country, and home invasion by mice at these times is common.

Isolated cases in humans result from exposure to infected wild or domestic animals or their fleas. Sporadic human cases, occurring from contact with infected wild animals and their fleas, is the situation in the USA, and it is expected that the introduction, establishment and spread of *Y. pestis* in Australia would result in a similar situation. The consequences of the introduction of *Yersinia pestis* into Australia are likely to be serious. The agent has the potential for extreme consequences, but this is considered unlikely in a country with good urban hygiene. It is a disease subject to control measures established under the International Sanitary Code (World Health Organization).

Animals other than rodents are of minor epidemiological importance, though dogs and cats are well documented sources of infection to humans.[3]

There is no information on which to predict the likely consequences of this disease agent if introduced to Australian fauna.

Conclusion on risk

While the likelihood of introduction and establishment is very low, the public health consequences of this event would be serious, though the extreme consequence of a large-scale epidemic is unlikely in Australia. Applying the matrix in Table 2, it is concluded that quarantine measures for this agent are warranted.

3.4.9 *Blastomyces dermatidis*

Blastomyces dermatidis causes the disease blastomycosis. It is a dimorphic fungus, having a mycelial saprophytic form in the soil. This produces spores that are inhaled by mammalian hosts, and in this host change to a yeast form. Dogs are the most susceptible species, with people also being highly susceptible. Infection in domestic cats is uncommon, but deaths have resulted from infection in zoo Felidae.[3,161]

Geographically the current distribution is through much of eastern USA. However, it has been identified in Africa and Central America, indicating that it may spread beyond its native area.[3]

Infection is by the respiratory route, and once established in the lungs, organisms are disseminated throughout the body. Sites of predilection are the lungs, skin, eyes, bones, lymph nodes and subcutaneous tissue.[3]

Blastomyces spp. have been isolated from African lions, Asian lions, a Siberian tiger and a cheetah in an American Zoo. Blastomycosis in these animals was fatal, and where treatment with Itraconazole was attempted, it was unsuccessful.[161]

The affected animals were all adults showing lethargy and weight loss with some but not all showing dyspnoea and sneezing. Blood counts revealed few abnormalities. Radiographs and an agar gel immunodiffusion test (AGID) provided more positive diagnostic results.[161]

Likelihood of disease agent entry, establishment and spread

The likelihood of disease agent entry is dependent on the region of origin of the imported animal. Establishment of the agent within Australia would be dependent on environmental factors.

Opportunities for the introduction of *Blastomyces* by domestic pets, people and articles have existed for years without appearance of the disease in Australia. Either the agent has not been introduced or has been unable to establish.

It is considered the overall likelihood of establishment and spread of this agent to be extremely low.

Biological, environmental and economic consequences

People are most commonly infected by the aerosol route from spores originating in the soil. Direct transmission to humans from infected animals is unlikely. Public health considerations would arise if the agent could become established in Australian soils. The overall consequences of introduction would be mild.

Conclusion on risk

The extremely low risk of introduction and establishment, combined with the mild consequences of same, do not warrant risk management measures for this agent.

3.4.10 *Cytauxzoon felis*

Cytauxzoonosis is a fatal blood protozoan disease of cats first reported in southwestern Missouri in 1976. It has since been reported in parts of the USA restricted to the south central and south-eastern states.[108,116] *C. felis* is an example of a parasite that causes little clinical disease in its natural host, the wild bobcat (*Lynx rufus)*, but is lethal when transmitted by ticks to domestic cats.[115] The first reports of *Cytauxzoon felis* in bobcats in the USA were in 1982, when 13 of 26 apparently healthy bobcats were examined for piroplasms. It was not known whether the parasite had been present in North America for aeons, or whether it was introduced.[115,210]

Cytauxzoon-like parasites have been identified in the blood from domestic cats in Thailand.[119]

There is a report of a Bengal tiger (*Panthera tigris)* born and domiciled in a German zoo contracting a fatal infection of *Cytauxzoon.*[117] It was suggested that the source of the infection was three young bobcats directly imported from the United States into the zoo. A white tiger (*Panthera tigris*) contracted cytauxzoonosis whilst in a Florida breeding facility. There is also a report of *Cytauxzoon*-like organisms in cheetahs that had lived in both the United States and Africa. In this last case, no ill effects were observed.[137]

Members of the genus *Cytauxzoon* have been isolated from African ungulates and giraffe. *Cytauxzoon* bears close similarity to *Theileria* and some have suggested it should be in the same genus, however *Cytauxzoon* differs from *Theileria* in that it has a prominent tissue phase, especially multiplying in macrophages.[108,114] A related, but as yet unidentified piroplasm in lions in South Africa is still under investigation.[126]

C. felis from naturally infected bobcats and domestic cats in the USA is serologically unrelated to African piroplasms.[111]

Experimental transmission of *C. felis* has been achieved in the USA with *Dermacentor variabilis*. Transmission attempts with *Amblyomma americanum* were unsuccessful. There are no data on the competence of other species of ticks. [115,138]

Parasitaemia can persist in bobcats for more than four years.[117] The disease in domestic cats is manifest with fever, anaemia, jaundice and dehydration, with marked enlargement of the spleen. It is usually fatal in domestic cats, death occurring in 2-7 days from onset. In the few non-fatal cases, high serum antibody titres have persisted for many weeks after apparent recovery, raising the possibility of persistent infections. [108,115,116,120] Similar piroplasms, e.g. *Babesia* may persist at low levels following an acute phase and reactivate under stress.

Likelihood of disease agent entry, establishment and spread

The likelihood of introduction in a bobcat from North America is moderate to high. The likelihood of introduction via other zoo Felidae, from North America is very low. The likelihood of introduction in Felidae from other parts of the world is considered negligible.

In the USA *C. felis* is transmitted by *D. variabilis*, a tick not present in Australia, but whether other vectors are involved is unknown.[112]

The true identity of the parasite that affects African big cats, the vector and prevalence are unknown.[139] A *Cytauxzoon* sp. from African ungulates is believed to be transmitted by *Rhipicephalus appendiculatus.*

Biological, environmental and economic consequences

C. felis has been fatal to non-domestic Felidae in zoos, and is also known to be highly fatal for domestic cats. If it were introduced, and if a competent vector were present, the consequences to that zoo's feline collection could be serious.

The overall consequences of introduction would be limited to zoos because the natural reservoir, *Lynx rufus*, is not present in the wild or wider community. On a national scale the consequences would be negligible.

Conclusion on risk

There is a medium to high likelihood of introduction of this agent in one species only, and the agent could have serious consequences to other species of Felidae within the importing zoo. The need to protect valuable zoo collections from harmful exotic agents, requires quarantine measures for this agent in relation to the importation of *Lynx rufus* originating in North America only.

3.4.11 *Babesia felis*

Babesia are intraerythrocytic protozoa. They are generally divided into two forms, large and small.[131] There are many species affecting many hosts. Humans are accidental hosts.

Feline babesiosis has been less well studied than the condition in dogs. The first isolation of

Babesia from Felidae was in 1929 in Africa. Other isolations include a small *Babesia* found in a lynx in a London zoo; small babesia-like organisms found in the puma (*Felis concolor*) and leopard (*Panthera pardus fusca*); large and small *Babesias* isolated from leopards (*Panthera pardus*) in Kenya; and *B. herpailuri* isolated from a jaguarundi (*Herpailurus yagouarundi*) from South America.[131] Feline babesiosis has been reported in India, but not in the United States.[3,131]

Babesia felis may be highly pathogenic and occurs in the Sudan and southern Africa. *B. cati* is less pathogenic and found primarily in India. In endemic areas, most cats have been infected.

Domestic cats may carry an infection for some weeks before clinical disease is apparent. Sick cats display inappetence, lethargy and weakness. They may or may not have an elevated temperature. Untreated animals die.[132]

Likelihood of disease agent entry, establishment and spread

Few countries from which Australia has, to date, permitted the importation of cats, are affected with this agent. Nevertheless, in the context of a generic risk analysis, the possibility of zoo Felidae being sourced from a wider range of countries must be considered, but the likelihood of agent entry is extremely low.

The tick vectors of *B. felis, B. herpailuri* and *B. cati* are unknown[3,138] and on this basis it is impossible to predict the likelihood of establishment and spread.

Biological, environmental and economic consequences

It would appear from the paucity of literature on these three *Babesia* species, that infection is uncommon in domestic and non-domestic Felidae, and the cat strains do not affect other species. Whether or not it could affect Australian fauna is unknown. Nevertheless, Babesias are generally very host specific, and little risk to Australian fauna is anticipated. In the unlikely event of the agent being introduced and established, cats would be the significantly affected species.

It is expected that the consequences of introduction, establishment and spread on a national and economic level would be negligible to mild.

Conclusion on risk

This agent does not appear to have the potential for significant harm, has an extremely low likelihood of introduction and as such, risk management measures are not considered warranted.

3.4.12 *Besnoitia besnoiti*

Besnoitia besnoiti and *B. wallacei* are protozoan parasites, related to the *Toxoplasmidae*, that invade the intestinal mucosal cells of the definitive host, the cat, with sporulated oocysts being passed in the faeces. Infection of cats with *Toxoplasmidae* occurs with the ingestion of various forms of the protozoan that occur in the bodies of animals eaten by the cat.[134] *B. besnoiti* invades the dermis, subcutaneous tissues and fascia and the laryngeal and nasal mucosae of the intermediate host. Infection may be generalised.[16,134] Cattle are the most common intermediate host. Goats and horses have also been infected. It is assumed they become infected from the ingestion of mature isosporan-type oocysts shed in the faeces of cats. Experimental and circumstantial evidence indicate that there may be mechanical transmission between cattle by blood sucking insects.[165]

B. wallacei is endemic in Australia. Cats are the primary hosts and rats and mice are the intermediate hosts.[181]

The wild cat (*Felis lybica*) has been incriminated as the definitive host of *B. besnoiti* in Russia. This cat also has a wide distribution in South Africa.[165] Other work has not confirmed this and numerous attempts to establish the identity of the definitive host in South Africa have been unsuccessful.[188, 189] There is a suggestion that domestic cats may be potential hosts, but there are many gaps in the understanding of the life cycle.[165] In 1988, attempts to confirm the role of Felidae in transmission of the disease were inconclusive, and later text books still adhere to the belief that Felidae are involved.[134, 158, 165]

B. besnoiti is endemic in Africa, Europe, Russia, Asia and South America.[16] As a non-indigenous pathogen to the United States, *B. besnoiti* listed as a pathogen, the importation of which is restricted or prohibited.[152] In South Africa it is more prevalent in warmer regions.[165]

Bovine besnoitiosis is a serious disease in cattle in South Africa. Losses can be severe and the mortality rate may reach 10%.[16, 55] Horses, goats and sheep are also affected. All breeds of cattle seem to be susceptible, though infection of calves under six months is rare. A vaccine is available in South Africa for cattle. It prevents clinical besnoitiosis, but does not prevent subclinical infections.[165]

In bovine besnoitiosis, the incubation period is approximately 1 week, followed by 1-4 weeks of pyrexia, followed by oedema, swelling of lymph glands and severe systemic signs. This is followed by alopecia, exudation and fissuring of the skin. Animals lose condition and remain unthrifty for a long period.[134]

B. besnoiti does not appear to be pathogenic to cats. Little information is available on the detection of infected cats.

Likelihood of disease agent entry, establishment and spread

To date there has been no wide scale importation of cats from endemic areas. The risk posed by the importation of potentially infected cats has not been rigorously tested by practice.

Many countries are free from *B. besnoiti*, and the likelihood of introduction would be limited to free ranging animals in an infected country. The diet of captive animals is likely to be well controlled, and it is considered the overall likelihood of introduction in a captive non-domestic animal is extremely low to negligible.

The agent is believed to be spread from the faeces of an infected cat. Disposal of animal excreta from zoos is controlled, and where removed from the premises must undergo an AQIS approved composting process.

In the unlikely event of the agent escaping from a zoo, Australia's significant feral and domestic cat populations could be considered potential reservoirs for the agent.

The likelihood of both entry and establishment and spread from a zoo to farms is considered negligible.

Conclusion on risk

In view of the negligible risk of the agent entering Australia and spreading from the zoo in which the animals are held, quarantine measures for this agent are not considered warranted.

3.4.13 Schistosomes

Many species of *Schistosoma* and *Heterobilharzia* are associated with the condition known as schistosomiasis. This is a zoonosis, with humans being the most seriously affected host. Schistosomiasis is one of the principal parasitoses of man, and has wide geographical distribution. Domestic animals play an important role in the transmission of *S. japonicum.* (182)

In animals, there may be a chronic form of the disease or an acute intestinal form associated with heavy infestations. Many animals are susceptible to various species of schistosomes, but cats do not feature as being of particular significance.(182)

Transmission requires the combination of slow flowing or stagnant water, as with irrigation systems, and snails that may act as intermediate hosts. Humans must have intimate contact with this water.

Likelihood of disease agent entry, establishment and spread

While the introduction of an infected animal is possible, the likelihood is extremely low. Zoo animals would not be kept in the type of environment that would predispose to transmission and the likelihood of establishment and spread is negligible.

Conclusion on risk

No risk management measures are warranted for this agent.

3.4.14 *Paragonimus kellicotti*

Paragonimus kellicotti is a lung fluke that is found in wild animals, cats, dogs, man and pigs. It has a three-host life cycle, the adult stages being in the lung of a mammal, a snail and crustacea being the two intermediate hosts. The cycle is complete when a mammal eats the freshwater crayfish and the immature flukes mature in the lungs.(169) Infected animals have chronic bronchiolitis, hyperplasia of the bronchiole epithelium and a chronic eosinophilic granulomatous pneumonia. Parasites may become lodged in cysts in the brain.(16)

It is endemic in North America, particularly in the bobcat (*Lynx rufus*). Natural infections in these animals may have no ill effects.(16,167)

Diagnosis is readily made by finding eggs in the faeces.(16)

Likelihood of disease agent entry, establishment and spread

Cats and dogs have been permitted importation for a number of years from the USA and Canada, both countries affected with *P. kellicotti*. Nevertheless, the parasite has not been reported in Australia. This could be due to the effectiveness of current quarantine measures, or that the combination of two suitable intermediate hosts is not present in Australia.

While the diet of zoo Felidae is controlled, the feeding of raw material does occur, the diet would have to include crustacea to permit infection to occur. This is considered highly unlikely. The likelihood of introduction in captive non-domestic Felidae is extremely low.

The likelihood of establishment and spread from captive animals in a well managed zoo is seen as negligible.

The overall risk of introduction, establishment and spread of *P. kellicotti* from a zoo felid is considered negligible.

Conclusion on risk

It is concluded that risk management measures are not warranted for this agent.

3.4.15 *Diphyllobothrium latum*

This cestode has a cycle involving mammals, as the definitive hosts, copepods and fish as the intermediate hosts. All fish eating mammals may become infected, but man is the host of most significance. If big cats were fed on aquatic animals they could be infected. The likelihood is considered very low.

As with *Schistosoma* spp. above, the opportunities for this parasite to complete its cycle and be spread from captive non-domestic Felidae are negligible. No further discussion on this agent is considered necessary.

3.5.16 *Mesocestoides* spp.

This cestode has a three-stage life cycle. While there a gaps in the knowledge here, the first intermediate hosts are believed to be coprophagous orbatid mites, the second intermediate hosts to be amphibia, reptiles, birds and mammals. The definitive hosts are infected when they eat animals infected with tetrathyridia (the second intermediate stage).[16]

In dogs and cats the adult stage has little to no effect on the health of the animal. However, heavy infections with tetrathyridia and cause severe peritonitis. Humans affected with the adult stage may develop severe diarrhoea.[16]

Urquhart *et al*. describe this parasite as being of minor veterinary importance.[234] Acha and Szyfres say that infection in man is rare.[182]

Mesocestoides has been reported from Europe, the Middle East, Africa and North America. There are numerous reports of occurrence in *Felis sylvestris* in Eastern Europe, bobcats (*Lynx rufus*) in North America, the cougar (*Felis concolor*) in North America. In addition, five species of non-domestic Felid in Thailand have been found to harbour this agent.[235] There is currently no positive evidence of this agent being present in Australia.

Likelihood of disease agent entry, establishment and spread

The numerous reports of *Mesocestoides* spp. in free-ranging non-domestic Felidae in Europe and North America give survey figures ranging from 0.8% to 36% animals infected. For domestic cats, however the incidence was generally lower. It may be that the diet of domestic cats results in less exposure to infected organisms. Whether or not this would result in captive non-domestic Felidae being less likely to be infected is a matter for conjecture.

There is a low likelihood some infected animals would be imported.

Felidae harbour the adult stage of the parasite which results in eggs being passed in the faeces. It is believed the new cycle of transmission begins with the ingestion of these eggs by orbatid mites. Zoos in Australia have good hygienic practices for the collection and removal of faeces from animals' enclosures, though in open range situations this may be more difficult.

It is concluded that the likelihood of agent entry, establishment and spread is very low.

Biological, environmental and economic consequences

This is an agent of very low pathogenicity. A wide range of domestic animals are known to carry the parasite. It is occasionally a zoonosis.

The effects of this parasite in Australian native fauna are unknown. The agent is widespread in non-domestic species overseas without being identified particularly harmful.

It is concluded that the biological, environmental and economic consequences of the entry of this agent would be mild to medium.

Conclusion on risk

By application of the matrix at Table 2, it is concluded that no quarantine requirements are warranted for *Mesocestoides* spp.

3.4.17 *Tunga penetrans* (sandflea)

This small flea lives in sand, dust and animal pens. The fertilised female burrows into the skin of its host, sucks blood and lays 200 to several thousand eggs close together under the skin. The female dies, and the larvae emerge.(94)

Tunga penetrans is a native of Central and South America. It is believed that it was transported to the West Coast of Africa late in the 19th century in sand ballast, and from there spread to Madagascar, Pakistan and India, probably in the feet of returning immigrant workers.(182) It is exotic to Australia.(94)

T. penetrans infects humans and animals. Its animal hosts are primarily domestic animals, mostly dogs in South America and the Caribbean, but pigs are important hosts in Africa.(95,96) Reports of infected humans returning to USA, NZ, Europe and other uninfected countries are common. It is considered to be a serious, though uncommon parasite of cattle in Brazil where it invades the coronary band causing lameness and predisposing animals to screw-worm fly strike.(164)

There are at least two reports of humans returning to Australia with *T. penetrans* lesions. In endemic countries people who go barefoot in warm weather run a high risk of infection.(94)

There have been few importations of dogs and cats from endemic areas, having been excluded due to the rabies situation in these countries.

Likelihood of disease agent entry, establishment and spread

Cats are reported to be susceptible.(107) There are no reports of this parasite in zoo Felidae. The risk of agent entry is extremely low.

Worldwide, there have been more reports of introductions of this parasite on human beings than on animals.

The likelihood of spread of this parasite from the confines of a zoo is negligible.

The current distribution of this parasite indicates that it survives well in warm climates and sandy (including beach) environments. Much of Australia answers this description. In the highly unlikely event of the parasite being introduced and establishing and spreading beyond the confines of a zoo, it is considered there would be a moderate likelihood of establishment.

Biological, environmental and economic consequences

T. penetrans is a zoonotic parasite, causing painful infections with local tissue damage. Our climate lends itself to allowing children to go barefoot. If the parasite were to disseminate widely, a significant proportion of the population would be at risk. It is readily amenable to treatment. The consequence of introduction and establishment of this agent from a public health aspect is considered mild.

In domestic animals, it would have mild consequences.

Conclusion on risk

Application of the matrix in Table 2. draws the conclusion that quarantine restrictions for this agent are not warranted.

3.4.18 Exotic ticks

A number of ticks are exotic to Australia, and some of these may transmit agents infectious to man and animals. Protozoan, rickettsial and viral agents may be spread by ticks. A number of these ticks may be found on felines as incidental hosts, others have a predilection for Felidae.

It would not add to the purpose of this document to list all of these parasites by name and detail the agents they transmit. In most instances, the importation of exotic ticks would be seen as undesirable.

Likelihood of disease agent entry, establishment and spread

NZ MAF reported finding 40 exotic ticks over the period 1980 to 1995. New Zealand maintains quarantine standards similar to Australia's, and the likelihood of exotic ticks coming into Australia would be of the same order.[133]

In the event of no preventative measures being taken, the likelihood of introduction of exotic ticks on an imported animal is high. The likelihood of establishment and spread would depend on the environment in which the imported animal is housed, and the availability of other host species. Where the imported animal is placed in or adjacent to other Felidae, this would be likely.

Biological, environmental and economic consequences

The consequences of introduction of exotic ticks would be dependent on the species of tick introduced, and whether or not it was carrying an exotic disease agent.

Conclusion on risk

Measures to prevent the introduction of exotic ticks on non-domestic Felidae are warranted.

3.5 Summary of risk assessment.

Table 3.

Agent	**Likelihood of entry**	**Likelihood of establishment**	**Consequences of establishment**	**Risk management required, yes/no**
Rift Valley fever	Extremely low.	Very low.	Serious.	No
Rabies virus	Very low from endemic countries. Negligible from unaffected countries.	Low.	Serious zoonosis.	Yes
Aujeszky's disease	Extremely low.	Extremely low to negligible.	Medium to serious.	No
Transmissible gastroenteritis	Negligible.	Not relevant.	Not relevant.	No
Burkholderia mallei (glanders)	Very low from affected regions, negligible from unaffected regions.	Within zoo, low; beyond zoo, very low to negligible.	Significant within zoo. Serious if spread to outside equine population. Zoonosis.	Yes
Mycobacterium tuberculosis, M. bovis	Very low.	Within zoo, low; beyond zoo, negligible.	Serious at zoo or national level. Zoonosis.	Yes
Francisella tularensis	Extremely low.	Low.	Serious.	No.
Trypanosoma brucei brucei, T. vivax. (nagana)	Very low from affected regions, negligible from unaffected regions.	Negligible.	Not relevant.	No
T. evansi (surra)	Very low for endemic regions, negligible for unaffected regions	Moderate to high.	Serious.	Yes
T. cruzi (Chaga's disease)	Moderate from endemic regions, negligible from unaffected regions	Negligible	Not relevant	No
Echinococcus granulosus felidis	Low.	Negligible.	Not relevant.	No
E. multilocularis, E. oligarthus (alveolar hydatidosis)	Low.	Negligible.	Zoonosis with serious consequences to exposed zoo staff.	Yes
Trichinella spiralis	Low to moderate.	Negligible.	Zoonosis, but unlikely to affect zoo staff.	No

Agent	Likelihood of entry	Likelihood of establishment	Consequences of establishment	Risk management required, yes/no
Cochliomyia hominivorax and *Chrysomya bezziana* (Screw-worm fly)	Very low.	Low to moderate.	Serious.	Yes
Borna disease virus	Very low.	Insufficient information on transmission.	Medium.	No
Canine distemper virus	Very low.	High likelihood of spread to other susceptible zoo species.	Within zoos consequences could be serious. Beyond zoos, consequences negligible.	Yes
Nipah virus	Very low from endemic country, negligible from other regions.	Extremely low.	Serious zoonosis with extreme consequences.	Yes
Cowpox	Extremely low.	Very low to negligible.	Mild.	No
Puma lentivirus	Moderate for susceptible species only.	Negligible other than to identical species within zoo.	Mild.	No
Transmissible spongiform encephalopathy	Extremely low.	Negligible.	Not relevant	No
Ehrlichia canis, E. risticii	Extremely low.	Extremely low.	Mild.	No
Yersinia pestis (plague)	Low to extremely low from endemic regions, negligible from unaffected regions.	Insufficient data on Australia's potential reservoirs.	Serious zoonosis reportable to the WHO. Potential for extreme consequences.	Yes
Blastomyces dermatidis	Very low.	Extremely low.	Mild.	No
Cytauxzoon felis	In *Lynx rufus* moderate, in other Felidae, negligible.	Very low.	Medium at zoo level, otherwise negligible.	Yes for *Lynx rufus* only.
Babesia felis	Extremely low.	Insufficient data.	Mild.	No
Besnoitia besnoitii	Extremely low.	Negligible.	Not relevant.	No
Schistosomes	Extremely low.	Negligible.	Zoonosis but no particular risk to zoo staff.	No
Paragonimus kellicotti	Extremely low.	Negligible.	Not relevant.	No

Agent	Likelihood of entry	Likelihood of establishment	Consequences of establishment	Risk management required, yes/no
Diphyllobothrium latum	Very low.	Negligible.	Zoonosis but no particular risk to zoo staff.	No
Mesocestoides spp.	Low	Very low	Mild	No
Tunga penetrans	Extremely low.	Negligible likelihood of establishment beyond zoo, but moderate to high likelihood of spread if establishment did occur.	Mild.	No
Exotic ticks	High.	Moderate.	Dependent on species of tick and any disease agent it might carry.	Yes

4. RISK MANAGEMENT

In the following chapter general risk management measures are discussed. The first part relates to the standard of management of the exporting institution, the standard of veterinary services in the country of export, and the standard of pre-export and post-arrival quarantine facilities.

The second part considers risk management options. These are based on the literature used in preparing this IRA and, where applicable, the OIE International Animal Health Code (the Code).

4.1 General measures

AQIS requires that where a generic import protocol exists, live animals and genetic material exported to Australia must come from countries approved by AQIS to provide health certification for live animals. Approval for countries and/or zoos to export zoo Felidae to Australia will be in accordance with the official guidelines.[i]

To ensure that animals for export to Australia have been under veterinary control for a reasonable period preceding export, BA decided that:

. all zoo felids for export must be exported from a zoo or wildlife park that maintains its animals in enclosures that permit close observation of the animals, and

. the animals have been resident in that zoo or wildlife park for a minimum of twelve months, or since birth, prior to export,

. the zoo or wildlife park must be in a country approved to provide health certification for the export of live animals or genetic material to Australia, and

. a registered veterinarian is employed by the zoo or wildlife park, and all disease and deaths of animals are subject to veterinary investigation.

Where the required periods of quarantine for two or more different agents are not the same, the greatest will be the one specified in the QUARANTINE REQUIREMENTS FOR THE IMPORTATION OF NON-DOMESTIC FELIDAE INTO ZOOS.

Where pre-export quarantine is required, animals in pre-export quarantine facilities must have contact only with animals of the same certifiable health status. In addition the distance between quarantined animals and animals not of the same certifiable health status must be sufficient to prevent the spread of disease agents by aerosols.

Prior to export, an import permit must be issued by AQIS central office for each consignment. This permit will specify the minimum health status required of the country/premises of export and what, if any, specific tests for disease must be conducted on each animal and treatments required.

[i] AQPM 1999/62 published the GUIDELINES FOR THE APPROVAL OF COUNTRIES TO EXPORT ANIMALS (INCLUDING FISH) AND THEIR PRODUCTS TO AUSTRALIA.

For the purposes of good management of animals in quarantine, vaccination against the following preventable endemic viruses will be required: feline rhinotracheitis, feline calicivirus, feline panleucopaenia virus)

Within 72 hours of export all animals must be examined by a veterinarian to ensure they are showing no signs of disease, are free from external parasites, and fit to travel.

In order to ensure quarantine security during transport, the animal/s must be consigned to Australia by an approved route. During transport to the port of export, during shipment, and during transport from the port of importation to the post-arrival quarantine facility, the animal/s must have no contact with animals not of the same consignment.

All live animals transported to Australia by air are required to be placed in containers that are in accordance with the standard laid down by the International Air Transport Association (IATA). The specifications may be found in IATA Live Animals Regulations. They stipulate minimum requirements to ensure safety for handlers, and comfort for the animal travelling. The exterior walls must be solid, and ventilation holes covered internally by mesh. This is considered sufficient for quarantine purposes.

The containers must be disinfected and disinsected by an approved method prior to use by the animals for export.

Where post-arrival quarantine is required, animals in post-arrival quarantine facilities must have no contact with animals not of the same consignment. In addition the distance between quarantined animals and animals not of the same consignment must be sufficient to prevent the spread of disease agents by aerosols. The disposal of excreta from these facilities must involve sterilisation or deep burial or other approved treatment.

Whether under post-arrival quarantine or quarantine surveillance, persons responsible for the imported animals must notify AQIS of any illness or death of the animals, and must ensure proper veterinary attention and/or post mortem is carried out.

4.2 Risk management for specific disease agents

4.2.1 Rabies virus

The risk assessment concluded that the importation of zoo Felidae from any country not free from rabies, without restriction, would pose an unacceptable threat of the introduction of rabies. Quarantine measures for the control of this agent are warranted.

Risk Management issues

Objective data showing the effectiveness of vaccines and appropriate levels of seroconversion are not available for most non-domestic animals. Nevertheless, the use of vaccines to prevent rabies infection has been highly successful in domestic dogs, cats and wild foxes.

In the 1970s it was considered that the response of cats to vaccination was less reliable, and the WHO was recommending frequent revaccinations. However, the development of inactivated adjuvanted vaccines has led to reliable immunity.[221]

Artois *et al*, in discussing rabies control in zoo animals, said that vaccination, using inactivated virus, is effective. Live, modified virus vaccines, and oral vaccination were not recommended.

For imported animals, a period of quarantine was recommended if vaccination was not considered to be adequate.[26] Killed vaccines are currently the choice of those overseas zoos and range parks that vaccinate cats.[153,154,155] The preferred regimen is for animals to be over three months of age for primovaccination which is reinforced with a second dose 4-6 weeks later.

The OIE standard for the importation into a rabies-free country of non-domestic carnivores from a country not free from rabies requires that the animal showed no clinical sign of rabies on the day of shipment; and was kept since birth, or for the 12 months prior to shipment, in an establishment where no case of rabies was reported for at least 12 months prior to shipment. This measure, used alone, limits the movement of animals between zoos. Further, it fails to take into account the incursion of wild or feral carnivores into the zoo premises, as occurs in some areas.

Serological testing for rabies antibody in vaccinated non-domestic Felidae does not appear to be routinely conducted. However, a study by Blancou *et al* on the vaccination of domestic cats and feral members of the species would support the use of 0.5 IU/ml as an appropriate measure of effective vaccination for cats.[221] It would seem reasonable to extrapolate from this that 0.5 IU/ml of rabies antibodies in the serum of vaccinated non-domestic Felidae be adopted as a measure of vaccine efficacy.

The question has been raised of allowing the importation of cubs as young as two weeks, to permit "humanisation" and make handling later in life easier. Maternal antibodies can be demonstrated in very young animals, and these can be shown to interfere with vaccination. It would appear that these antibodies do not fully protect the young against infection with rabies virus. [223, 224] It was demonstrated in hamsters that juveniles born to vaccinated dams and themselves vaccinated succumbed to challenge at a far higher rate than juveniles born of unvaccinated dams and then vaccinated. This demonstrated that maternal antibodies, whilst interfering with vaccine response did not provide immune protection.[225] For this reason very young animals, whether vaccinated or not, from a country not free from rabies, would present an unacceptable risk.

A conservative approach would be to consider all of the following:

. the rabies status in the country of origin,

. the level of control under which the animal for export has been maintained; free-ranging, or confined,

. the management of the exporting institution, in particular their rabies control measures such as vaccination, perimeter controls and health protocols for introductions,

. data on the efficacy of vaccination for non-domestic Felidae,

. pre-export quarantine,

. post-arrival quarantine.

Quarantine Measures

To minimise the likelihood of introduction of rabies in imported non-domestic Felidae, Biosecurity Australia has chosen measures to prevent entry with less emphasis on post-arrival quarantine. Whilst zoo staff have a high degree of skill in handling zoo animals, they would be placed in an unacceptably dangerous situation if called upon to handle a clinically diseased animal.

Biosecurity Australia believes an appropriate level of protection will be achieved by the following measures:

Importations may take place either

. from a country that is accepted by AQIS as free from rabies as described in Article 3.1.5.2. of the International Animal Health Code, provided the animal for export has been resident for the six months prior to export (or since birth) in the country of export, or

. from a country that is not free from rabies; and either

- the exporting institution has reported no case of rabies in the 12 months prior to export and the animal for export has spent the past 12 months, or since birth in the exporting institution; and

  .. that the exporting institution has effective controls on the entry of rabies vectors; and

  .. the animal serve 6 months post arrival quarantine; or

- the animal for export spent the past 6 months in the zoo of export, and was vaccinated against rabies using an approved inactivated vaccine

  .. (a) in the case of a primary vaccination, two vaccinations, the first when the animal was at least 3 months old and the second vaccination 4-6 weeks later. The second vaccination was not less than 6 months and not more than one year prior to the scheduled date of shipment; or

  .. (b) in the case of a booster vaccination, not more than one year prior to the scheduled date of shipment; and

- was subjected not less than 3 months and not more than 24 months prior to shipment to a neutralising antibody titration test, and its serum contained at least 0.5 IU/ml.

4.2.2 *Burkholderia mallei* (Glanders)

The risk assessment concluded that, although the likelihood of entry and establishment is negligible for animals from unaffected countries, and very low for animals from affected countries, the consequences of introduction and establishment would be serious. Risk management measures for this agent are warranted.

Risk Management issues

No quarantine measures are in place to prevent the introduction of this agent in domestic cats, however, importations are not permitted from most affected countries by reason of their rabies status.

Glanders is absent from most countries nowadays, and country freedom is an effective quarantine measure that could be applied.

Because the disease is spread by direct contact or ingestion, maintaining a glanders-free situation in a zoo is possible provided the source of raw meat for carnivores is controlled. Pre-export quarantine in a zoo in a country not free from glanders would be ineffective if the quarantined animals were fed infected meat whilst in quarantine. This is of particular concern with *B. mallei*, having an incubation period of six months.

No vaccine or other measure specific to cats has been developed.

Diagnosis is by culture and identification of the causative organism, a procedure not designed to detect infection during the incubation phase.

Post-arrival quarantine or quarantine surveillance would provide an additional measure of security for this disease.

Quarantine Measures

Biosecurity Australia considers an appropriate level of protection is achieved by the following regimen.

Non-domestic Felidae for export to Australia must have either:

. spent the six months prior to export in a country free from *B. mallei*, as described in Article 3.4.8.2. of the Code, OR

. spent the 6 months prior to export in a licensed zoo that has recorded no case of glanders in any animals during the past twelve months; and following arrival remain under quarantine surveillance for six months.

4.2.3 *Mycobacterium tuberculosis* and *M. bovis*

The risk assessment concluded that although the likelihood of introduction and establishment of *M. bovis* and *M. tuberculosis* is very low, the consequences of this event would be serious. For public health reasons, and for the protection of zoo collections, risk management measures to prevent the introduction of *M. bovis* and *M. tuberculosis* in non-domestic Felidae are warranted.

Risk Management issues

Tuberculosis in zoos has sometimes remained a problem even when the disease in cattle has been eradicated in the livestock population of the country.[48] In addition, a number of zoo animals are affected by *M. tuberculosis,* a predominantly human strain of the complex. Reliance on country freedom from tuberculosis in the case of zoo animals may not be appropriate.

Due to the long incubation period of *M. bovis* infections, the USDA requested that three lions, previously in contact with an infected lion, be isolated from contact with other lions for a three

year period.[31] Moreover, Thoen recommended quarantine of 120 days for animals prior to entering a zoo collection. [73]

Diagnosis of *M. bovis* or *M. tuberculosis* is difficult in cats using conventional tests. Morris (1996) said that domestic cats respond very poorly to intradermal injections of tuberculin, and it is not recommended as a diagnostic test.[31]

An ELISA using protein A to bind antibody has been used to detect antibodies against mycobacteria, however, Thoen (2000) stated that the ELISA is only of value in animals with advanced disease.[31,202]

Culture of sputum and tissues for *Mycobacteria* provides a positive diagnosis with 100% specificity. The test is slow - up to 13 weeks - and the collection of specimens from non-domestic Felidae would be difficult.

Radiographic signs of tuberculosis in carnivores include a variety of lesions that would require additional testing to confirm diagnosis.[31]

All of the above methods would require anaesthesia of the subject. Diagnosis of infection in zoo animals is usually done at autopsy or on clinically ill animals, indicating difficulties in detection of subclinical infection.

If the zoo of export rigorously investigated animal deaths, and could certify freedom from tuberculosis, this would provide a measure of surety that the imported animal was not infected. This requirement may need qualification. Primates are particularly prone to human tuberculosis, but because they are housed separately may not necessarily pose a threat to other species.[48] The likelihood of the zoo of export feeding injured hoofstock to their Carnivores must be considered. Hoofstock, as a group, are particularly susceptible to tuberculosis.[48]

If a zoo animal were to develop clinical signs of tuberculosis or any exotic disease for which treatment is difficult, problems could arise as to what to do with the animal. Euthanasia in the case of an endangered species may be unacceptable to some. Prevention of entry, in as far is it is possible, is the preferred option.

Quarantine Measures

Biosecurity Australia considers an appropriate level of protection is offered by the following:

. The institution of export must have been free from tuberculosis in Felidae and Ungulates for 5 years with veterinary investigations of all deaths; and the animal for export must have been resident for the past 12 months, or since birth, in the zoo of export, and

. the animal must remain under quarantine surveillance for a further six months after arrival.

4.2.4 *Trypansoma evansi*

The risk assessment concluded that the likelihood of introduction of *T. evansi* is relative to the source of the animal. If introduced, the risk of establishment would be moderate to high, and the consequences of establishment serious. Risk management measures for animals originating from or that have been domiciled in endemic countries are warranted.

Risk Management issues

Experimental inoculation of domestic cats usually results in clinical disease. Natural infection, especially through ingestion of infected meat also results in disease in Felidae. The prevalence of sub-clinical cases and carriers among Felidae in endemic countries is unknown.

Diagnosis may be by using an IFAT, or an ELISA, however they do not correlate with the level of parasitaemia. This would be expected of a haemoprotozoon that appears sporadically in the peripheral blood.

Trypanosomes in chronically and subclinically infected animals are frequently absent from peripheral blood. Diagnosis by detecting antigen in the blood directly, or indirectly by inoculation of blood into mice is highly specific, but of low sensitivity.

Currently there are no import restrictions on domestic dogs and cats coming from endemic areas to Australia. It should be noted, however, that most surra endemic countries also have a significant rabies problem, and for that reason, importation of dogs and cats directly from these countries has been minimal.

Sourcing animals from countries/regions that are free from the agent is one option.

Because the agent is spread by insect vectors, requiring the exporting zoo to be free from *T. evansi* alone, would not be satisfactory for exports from endemic countries; but it could be used in combination with other measures.

Quarantine Measures

Biosecurity Australia considers either of the following conditions appropriate:

. The country/zone of export is free from *T. evansi* and the animal for export has been domiciled since birth in countries/zones free from *T. evansi*.

OR

. The animal for export has been subjected within 30 days of export to either an antibody ELISA or an IFAT with a negative result.

4.2.5 *Echinococcus multilocularis*

Although it was concluded the risk of establishment and spread beyond the confines of a zoo is negligible, *E. multilocularis* is a serious exotic zoonosis, and the consequences of infection to an animal handler within a zoo would be serious. For the protection of zoo staff, quarantine measures for *E. multilocularis* are warranted .

Risk Management options

Distribution of *E. multilocularis* is limited to the northern hemisphere.[182] It has a sylvatic cycle, thus making it almost impossible for countries in the region to certify freedom.

Faecal tests are effective in detecting actively laying adult worms. The tests would have to be repeated to detect immature worms that were not laying at the time of the first test.

The Code recommends that importing countries require, for dogs, cats and other domestic or wild carnivores, the presentation of an *international animal health certificate* attesting that the animals were treated against echinococcosis/hydatidosis prior to shipment and that the treatment used is recognised as being effective.

Treatment with praziquantel is effective in eliminating cestode infections.

Quarantine Measures

Biosecurity Australia believes an appropriate level of protection can be achieved by following the OIE recommended measure of requiring animals to be treated prior to export with an effective cestodicide.

4.2.6 *Cochliomyia hominivorax* and *Chrysomya bezziana* (Screw-worm fly)

Although there is a very low risk of introduction of this agent, the consequences of introduction are serious. Risk management measures are warranted.

Risk Management issues

Advanced screwworm lesions would be obvious from a distance, but early lesions would require close examination. Close examination of wild animals could only be performed under anaesthesia. This procedure is frequently used at some stage during preparation of animals for export, and examination for SWF could take place at this time.

Ivermectin injection has been effective in eliminating screwworm maggots from lions with screwworm lesions, though some required a second injection.[204]

Prevention of entry of the agent is considered feasible, though in some cases post-arrival checks may be necessary. The following risk management options are considered:

. animals be sourced from countries/zones free from screwworm fly;

. careful examination of animals prior to export. (This could be done when the animals are restrained for other purposes, e.g. collection of blood samples); and

  - treatment of infections where they exist, and
  - application of a long acting insecticide to prevent infection occurring following examination.

. careful examination of animals post-arrival (this may be necessary if restraint for close examination was not carried out pre-export); and

  - treatment of infections where they exist.

Quarantine Measures

In deciding an appropriate level of protection, the difficulties of handling non-domestic Felidae and the serious consequences of a pest incursion were both taken into consideration.

For countries/zones free from screwworm fly, certification to this effect is a sufficient measure.

For countries/zones not free from screwworm fly, examination of animals during the last 5 days prior to export, with treatment of any lesions, followed by application of a long acting external parasiticide.

4.2.7 Canine distemper virus

The risk of introduction and establishment is considered to be low.

The consequences of introduction and establishment of a CDV variant, virulent for zoo Felidae, could prove fatal for zoo Felidae. Given that zoo Felidae are almost all endangered species, the impact in terms of biodiversity would be medium to serious.

The imposition of quarantine measures to protect valuable and possibly endangered species exhibited in zoos is warranted.

Risk Management issues

There have been a number of reports of vaccine induced distemper in non-domestic carnivores; in all cases live attenuated vaccines were used. Killed or subunit vaccines are considered safer.[147,148]

With regard to attenuated live vaccines, caution should be exercised, in that many wild exotic animals have not been tested for susceptibility to the attenuated virus.[99,101] The risk of vaccine-induced infection must be considered. A trial in South Africa using an attenuated vaccine strain produced good antibody titres in lions without virus transmission to in-contact animals.[104]

In Europe there are no generally accepted distemper vaccination protocols for large Felidae in zoos.[106] Vaccination using inactivated vaccines appears to be favoured.[148]

Montali argued that vaccination against CD in captive animals may not be necessary, but said that unless they could be totally isolated, the threat of outbreaks would remain.[147]

Distemper virus may be spread by aerosols or direct contact, and has occasionally been spread by fomites. If either PEQ or PAQ isolation were used as a sole quarantine measure, they would have to be stringent enough to prevent the risk of aerosol transmission of the agent. The usual incubation period in dogs is about 14 days to clinical expression of disease, quarantine would need to be for a period greater than this to allow for a safety margin.

Quarantine Measures

Vaccination prior to importation would provide an appropriate level of protection. The country of export and the availability of vaccines in that country may influence the choice of a killed or attenuated vaccine. This choice will be left to the discretion of the attending veterinarian. Vaccination twice within the six months prior to export is recommended, the second should be at least 14 days prior to export.

An acceptable alternative would be to source animals from an institution that had had no case of distemper in terrestrial carnivores during the 12 months prior to export, and to combine this with a month in pre-export and a month in post-arrival quarantine.

4.2.8 Nipah virus

The evidence of damage done by Nipah disease agent in Malaysia, in particular its effects on human health warrants the imposition of risk management measures for this agent.

Risk Management issues

The serum neutralisation test has been developed and used in surveillance in Malaysia.

To date the disease has been confined to one country, and to require that a country be free from the disease is a reasonable risk management option.

Transmission of the virus and its epidemiology is still under study. It cannot be stated at this point of time whether freedom from Nipah virus on an institutional level only would provide a satisfactory degree of quarantine security.

Quarantine Measures

An appropriate level of protection would be achieved by either of the following.

. non-domestic Felidae must be sourced from a country that has been free from Nipah virus for a period of two years prior to export; or

. animals for export must undergo a period of 30 days pre-export quarantine during which there must have been no case of Nipah disease on the premises; and be blood tested by a serum neutralisation test for Nipah virus antibodies with a negative result; and serve an additional 30 days post-arrival quarantine.

4.2.9 *Yersinia pestis*

While the likelihood of introduction and establishment is very low, the public health consequences of this event would be serious. It is concluded that quarantine measures for this agent are warranted.

Risk Management issues

Vaccines have been developed only for humans, and this does not appear to be an option for Felidae.

Y. pestis has a far higher prevalence in some countries and some regions within countries. Requiring animals to be sourced from a country free from *Y. pestis* is one option but would limit the countries from which zoo Felidae may be sourced.

Pre-export quarantine would contribute to risk reduction if the food fed to the animal during this period did not include rodents.

The incubation period of *Y. pestis* is short and cats generally develop clinical signs. Therefore, post-arrival quarantine of one month should prevent the establishment and spread of plague if it occurred in an imported animal.

Quarantine Measures

It is considered the following measures will ensure an appropriate level of protection. Either:

. the country of export has recorded no case of *Y. pestis* infection in animals or humans in the two years prior to export; or

. the animal serves 30 days PAQ.

4.2.10 *Cytauxzoon felis*

Biosecurity Australia concluded quarantine measures are required for this agent in relation to the importation of *Lynx rufus* originating in North America.

Risk Management issues

Clinical disease is obvious in non-natural hosts for this agent. Only *Lynx rufus* appear to be a reservoir for the agent.

Antibodies may be detected by a microfluorometric immunoassay (FIAX) that was developed using cats experimentally infected with non-pathogenic erythrocyte forms of *Cytauxzoon* of bobcat origin. A positive titre was reached 2 weeks post inoculation with non-splenectomised cats. The test was developed to establish the geographic distribution of the agent in bobcats, which are asymptomatic carriers.(110)

Treatment of Felidae of other species with parvaquone and buparvaquone was unsuccessful.(113) No treatment other than palliative regimes appear to be used.(121) The most often recommended preventative measure is regular treatment with acaricides.

Since the bobcat appears to be the natural host, serological testing of this species would likely detect carriers.

Quarantine Measures

It is considered appropriate to adopt quarantine measures for *Lynx rufus* from, or that have resided in, North America.

It is required that *Lynx rufus* that have resided in North America must be tested by examination of a blood smear and serology for the presence of *C. felis* within 30 days of export. A microfluorometric immunoassay test[j] commercially available in the USA is acceptable for the serology test. Animals returning a positive test may not be exported to Australia.

For all other species of Felidae, and *Lynx rufus* bred and domiciled outside North America, no quarantine requirements are warranted.

4.2.11 Exotic ticks

Measures to prevent the introduction of exotic ticks on non-domestic Felidae are considered warranted. Effective and long acting acaricides are available for use on carnivores.

Quarantine Measure

A thorough pre-export inspection; the careful application of a long acting acaricide, repeated according to the manufacture's instructions; and post arrival inspection will provide the appropriate level of protection.

[j] FIAX 100, Whittaker MA Bioproducts, Walkersville, Md.

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5. QUARANTINE REQUIREMENTS FOR THE IMPORTATION OF NON-DOMESTIC FELIDAE INTO ZOOS AND CIRCUSES

These requirements supersede the INTERIM QUARANTINE REQUIREMENTS FOR THE IMPORTATION OF ZOO CARNIVORES of 28 January 1997 with respect to zoo Felidae only.

Part 1. GENERAL

Exporting countries must have approval from the Australian Quarantine and Inspection Service (AQIS) to provide health certification for the export of live animals to Australia.

DOCUMENTATION

Each consignment of non-domestic Felidae must be accompanied by a copy of a valid AQIS Permit to Import Quarantine Material into Australia, available by application to the Principal Veterinary Officer, AQIS, in the State of import, and an Import Permit from Group of Environment Australia, Wildlife Science and Management Group. Addresses are at Appendix I.

The non-domestic Felidae must also be accompanied by an International Animal Health Certificate in the format of Office International des Epizooties (OIE) International Animal Health Code Model Certificate No. 2 or Model Certificate No. 6. The certificate must be in English and be signed by an *Official Veterinarian*.[k] The certificate must be stamped on each page with an official stamp. The animals for import must meet the requirements specified in Part 2 of this document. This must be certified in the Animal Health Certificate.

Part 2. CERTIFICATION REQUIREMENTS

2.1 DETAILS OF ANIMAL AND PREMISES

The Animal Health Certificate must give details of

- the identification of each animal including scientific name, sex, age, and identifying marks, registration number or microchip implant number and type of implant;
- name and address of exporter and registered or licensed zoo or wildlife park of origin;
- name and address of premises at which the animal for export has been present during the past twelve months or since birth;
- name and address of consignee;
- nature and identification of means of transport.

[k] An *Official Veterinarian* means a veterinarian authorised by the *Veterinary Administration* of the country to perform animal health and/or public health inspections of *commodities* and, when appropriate, perform certification in conformity with the provisions of Chapter 1.3.2. of this *Code*.

2.2 REQUIREMENTS FOR DISEASE FREEDOM, TESTS AND TREATMENT.

2.2.1 The Animal Health Certificate must certify that:

- the premises of origin (institution of export) is a zoo or wildlife park that maintains its zoo Felidae in enclosures that permit regular observation of the animals, and
- a veterinarian is employed by the zoo or wildlife park, and
- all sick animals and deaths are investigated by the veterinarian; and
- the animal for export has resided in the institution of export for the 12 months preceding export, or since birth, and

which addresses, individually, the requirements in 2.2.2 to 2.2.11 below.

2.2.2 Rabies

(i) The country of export is free from rabies as described in Article 3.1.5.2 of the OIE International Animal Health Code; OR

(ii) the exporting institution has reported no case of rabies in the 12 months prior to export, and the exporting institution has effective controls to prevent the entry of rabies vectors; OR

(iii) the animal for export was vaccinated against rabies using an approved inactivated vaccine

- in the case of a primary vaccination, two vaccinations, the first when the animal was at least 3 months old and the second vaccination 4-6 weeks later. The second vaccination was not less than 6 months and not more than one year prior to the scheduled date of shipment (in the case of a booster vaccination, one vaccination not more than one year prior to the scheduled date of shipment); and
- was subjected not less than 3 months and not more than 24 months prior to shipment to a neutralising antibody titration test, and that its serum contained at least 0.5 IU/ml.

2.2.3 Nipah virus

(i) The country of export has been free from Nipah virus for the two year period prior to export; OR

(ii) the animal(s) for export were subjected to 30 days isolation from all other animals not of the same certifiable health status prior to export during which time there was no case of Nipah disease on the premises. The animal(s) for export were, during this 30 day period, blood tested by a serum neutralisation test for Nipah virus with a negative result.

2.2.4 Distemper

(i) The animal for export has been vaccinated against canine distemper twice within the 6 months prior to export, the second vaccination no less than 14 days prior to the date of export, OR

(ii) the exporting institution has been free from canine distemper for a period of 12 months prior to export, and the animal(s) for export were subjected to 30 days isolation from all other animals not of the same certifiable health status prior to export.

2.2.5 *Yersinia pestis*

(i) The country of export has not reported *Yersinia pestis* infection in humans or animals for the two years prior to export; OR

(ii) the country of export has not been free from clinical *Yersinia pestis* infection in humans or animals for the two years prior to export.

2.2.6 Tuberculosis

. The institution of export has been free from tuberculosis in Felidae and Ungulates for the past five years.

2.2.7 *Burkholderia mallei*

(i) The country of export is free from glanders according to the OIE International Animal Health Code Chapter 3.4.8.2; OR

(ii) the institution of export has been free from glanders for the past 12 months.

2.2.8 *Trypanosoma evansi*

(i) The country of export has been free from *Trypanosoma evansi* for the 12 months prior to export; OR

(ii) the exporting institution has no recorded case of *T. evansi* in the past twelve months, and

- the animal for export has been subjected within 30 days of export to either

(a) an enzyme linked immunosorbent assay (ELISA) for *T. evansi* antibodies with a negative result, or

(b) an immunofluorescent antibody test (IFAT) with a negative result; and

- was treated with an insect repellent at the time of collection of the blood.

2.2.9 Miscellaneous parasites and general health

(i) The animal for export was treated, within 5 days prior to export with an anthelmintic effective against cestodes at the recommended dose rate; AND

(ii) The animal was treated, within 5 days prior to export with an anthelmintic effective against gastric/intestinal nematodes; AND

(iii) The animal for export was treated, within 5 days of export with an internal or external preparation effective against insect and tick parasites and their larvae.

(iv) The animal for export was examined within 72 hours of export and was found to be in good health, showing no signs of obvious weight loss, free from external parasites, including any sign of cutaneous myiasis, and considered fit to travel.

(v) Documentary evidence has been sighted that the animal for export has been vaccinated against feline rhinotracheitis, feline calicivirus, feline panleucopaenia virus no less than 14 days and no more that 12 months prior to export.

2.2.10 This section applies only to *Lynx rufus* (bobcats) that have resided, previously or currently, in North America.

The animal for export was tested within 30 days of export by

- a blood smear for the presence of *Cytauxzoon felis,* AND
- a microfluorometric immunoassay test[1] for antibodies to *C. felis*,

both with a negative result.

2.2.11 Shipping container

After due inquiry he /she is satisfied that each animal will be shipped in a container that meets the container requirements specified in the International Air Transport Association (IATA) Live Animals Regulations.

Part 3. TRANSPORT AND IMPORTER'S/AGENT'S RESPONSIBILITIES

TRANSPORT

The animal/s must be consigned to Australia by an approved route. During transport to the port of export, during shipment, and during transport from the port of importation to the post-arrival quarantine facility, the animal/s must have no contact with animals not of the same consignment.

Transhipment en route may only be done with AQIS's prior approval.

Part 4. POST-ARRIVAL

QUARANTINE

. Animals that do not comply with the requirements of 2.2.3(i), but comply with the requirements of 2.2.3(ii); and/or

. animals that do not comply with the requirements of 2.2.4(i) but comply with the requirements of 2.2.4(ii); and/or

. animals that do not comply with the requirements of 2.2.5(i) but comply with the requirements of 2.2.5(ii)

must undergo at least 30 days post-arrival quarantine isolation in an approved quarantine facility and be inspected and found free from signs of infectious disease before they may be released from quarantine under quarantine surveillance.

During post-arrival quarantine isolation, or quarantine surveillance, the animal/s may be subjected to such tests and/or treatments as are specified by the Chief Quarantine Officer (Animals) in the State of import at the importer's expense. If any animal fails any test or shows

[1] FIAX 100, Whittaker MA Bioproducts, Walkersville, Md.

evidence of an exotic disease during post-arrival quarantine, it may be detained in quarantine isolation, exported at the importer's expense or destroyed.

During post-arrival quarantine isolation, or quarantine surveillance, any death or illness in the imported animal must be reported to AQIS as soon as is reasonably possible.

If any animal arrives without certification, incomplete certification or certification that is otherwise unsatisfactory it may be ordered into quarantine, re-exported or destroyed.

Each imported animal must remain under quarantine surveillance in an AQIS approved facility for six months from the time of arrival. In the case of animals serving 30 days PAQ, this period is included. Excreta and carcasses of imported animals must be disposed of in an approved manner.

Part 5 - REVIEW

These conditions may be reviewed at any time at the discretion of the Director of Animal and Plant Quarantine (Australia).

DAVID BANKS
General Manager
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Biosecurity Australia

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