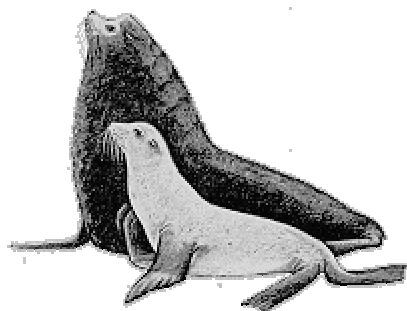




Importation of animals of the Suborder Pinnipedia into Australian Zoos

Final Import risk analysis report



August 2000



AGRICULTURE, FISHERIES AND FORESTRY - AUSTRALIA

The Commonwealth Department of Agriculture, Fisheries and Forestry –
Australia.

Postal address:

GPO Box 858
Canberra
ACT, 2601.

Table of contents

<i>Executive summary</i>	5
<i>ACRONYMS</i>	7
<i>1. INTRODUCTION</i>	8
1.1 Background	8
1.2 Current quarantine policy and practice	8
1.3 The Zoo industry in Australia	9
1.4 Captive pinniped facilities in Australia	10
1.5 Australia's role in the preservation of endangered species	10
1.6 Description of the import risk analysis process	10
1.7 Scope of the risk analysis	11
<i>2. HAZARD IDENTIFICATION AND EXPOSURE PATHWAYS</i>	12
2.1 Hazard Identification	12
2.2 Strengths and weaknesses in available data	19
2.3 Exposure pathway	19
2.3.1 Known routes of infection	19
2.3.2 Pathways of exposure to imported pinnipeds or their disease agents.	20
<i>3. RISK ASSESSMENT</i>	22
3.1 Description of the assessment	22
3.2 Individual disease agents	25
3.2.1 Morbilliviruses	25
3.2.2 San Miguel Sea Lion virus (SMSV).	29
3.2.3 Influenza A virus.	31
3.2.4 Phocid herpesvirus (PhHV)	33
3.2.5 Seal pox	35
3.2.6 Rabies	37
3.2.7 <i>Mycobacterium tuberculosis</i> complex	37
3.2.8 <i>Brucella</i> spp.	39
3.2.9 <i>Trichinella spiralis</i>	39
3.3 Exporting country factors	41
<i>4. RISK MANAGEMENT</i>	42
4.1 General	42
4.1.1 Evaluation of veterinary services of exporting country	42

4.1.2 Evaluation of exporting facilities	42
4.2 Risk management options for specific disease agents	44
4.2.1 Morbilliviruses	44
4.2.2 San Miguel sea lion virus	45
4.2.3 Influenza A virus.	47
4.2.4 Phocid herpesvirus	48
4.2.5 Seal pox	49
4.2.6 <i>Mycobacterium tuberculosis</i>	49
5. REFERENCES	52
<i>Appendix</i>	59
6. QUARANTINE REQUIREMENTS FOR THE IMPORTATION OF PINNIPEDS	<i>i</i>

Executive summary

In mid-1998, AQIS received an access request to allow the importation of Californian sea lions from European zoos to an Australian zoo. The last importation of a seal or sea lion into Australia was in 1997, from New Zealand, and import conditions specific to that case were promulgated.

Since then, AQIS has put in place a formal process for conducting import risk analyses that may cover a species or group of species from all countries, i.e. a generic risk analysis. AQIS, in consultation with stakeholders, chose the routine path for this risk analysis, i.e. it is being conducted “in house” drawing extensively on published literature and personal advice from veterinarians in Australia and New Zealand who are experienced in pinniped management and disease. This document is a generic risk analysis for all pinniped species, including seals, sea lions and walruses. Quarantine requirements to cover these species were developed.

Initially a list of all potential hazards was compiled. Those identified as disease agents of concern and requiring detailed consideration were identified on the following criteria:

- . they are carried by pinnipeds,
- . are infectious,
- . are exotic, or if present in Australia are subject to official controls (including notifiable human diseases),
- . are OIE listed and/or likely to cause significant harm in Australia.

The nine agents selected for detailed examination are:

Morbilliviruses, chiefly phocine distemper virus (PDV)

San Miguel sea lion virus (SMSV)

Influenza A virus

Phocid herpesvirus (PhHV)

Seal Pox virus

Rabies virus

Mycobacterium tuberculosis

Brucella spp.

Trichinella spiralis

Following detailed examination, it was decided that specific quarantine measures in relation to rabies, *Brucellae* species found in pinnipeds, and *Trichinella spiralis* are unnecessary.

Of the agents for which quarantine measures are deemed necessary, phocine distemper virus presents the most serious risk. This agent has been the cause of the most devastating losses in wild seals in recorded history. Australia’s wild seal populations appear not to have been exposed to this agent, and therefore may be highly susceptible. Its exclusion from this region is considered of utmost importance.

Mycobacterium tuberculosis is endemic in seals in Australian waters. The inclusion of this agent for quarantine requirements relates to its serious zoonotic potential and the threat posed to

valuable zoo specimens that may associate with the imported animal.

In developing import requirements for domestic animals, AQIS generally follows the Office International des Epizooties (OIE) health standards as set out in the International Animal Health Code. Of the diseases affecting pinnipeds, few are covered by the International Animal Health Code and AQIS has developed requirements based on available knowledge of these diseases.

The quarantine measures chosen to provide an appropriate level of protection (ALOP) for Australia include; requirements that the exporting institution be free from certain diseases for a specified period of time; the animals spend time in pre-export (PEQ) and post-arrival quarantine (PAQ); and, where applicable, tests be conducted for evidence/absence of infection. For some disease agents the appropriate period to be served in quarantine differs from that for other agents. In constructing the import requirements, the longest period has been adopted.

In determining the required standard for a PEQ facility, AQIS has considered the means of transmission of the disease agents of concern, whether by aerosols, direct or indirect contact or all of these.

Determination of appropriate PAQ measures has similarly been based on the available knowledge of the disease agents.

The quarantine requirements for pinnipeds may be summarised as follows:

Morbilliviruses, chiefly phocine distemper virus	Institution of export must have been free from the disease for one year, testing required, PEQ and PAQ.
San Miguel sea lion virus (SMSV)	Institution of export must have been free from the disease for two years, PEQ and PAQ.
Influenza A virus	Institution of export must have been free from the disease for three months, PEQ and PAQ.
Phocid herpesvirus (PhHV)	Institution of export must have been free from the disease for one year, testing required, PEQ and PAQ followed by permanent confinement in a facility that precludes contact with pinnipeds destined to return to the wild.
Seal Pox virus	Institution of export must have been free from the disease for one year, PEQ and PAQ.
<i>Mycobacterium tuberculosis</i>	Institution of export must have been free from the disease in pinnipeds for six years, PEQ and PAQ surveillance of the animal.

AQIS will permit the importation of live pinnipeds from countries whose Veterinary Authority has been assessed and approved. In the case of countries that have a recent history of exporting live animals and genetic material to Australia in compliance with Australia's quarantine requirements, no further assessment will be required. Where this is not the case, assessment of the Veterinary Authority may be conducted first, with additional AQIS involvement in pre-export procedures.

It is incumbent on the importer to ensure that all other legal requirements, e.g. those under the *Wildlife Protection (Regulation of Exports and Imports) Act (1982)* are followed. Advice to this effect is included in the quarantine requirements.

ACRONYMS

ALOP	appropriate level of protection
AQIS	Australian Quarantine and Inspection Service
ARAZPA	Australasian Regional Association of Zoological Parks and Aquaria
ASMP	Australasian Species Management Program
CDV	canine distemper virus
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CSL	Californian sea lion
IRA	import risk analysis
IUCN	World Conservation Union
IUDZG-WZO	World Zoo Organization
OIE	Office Internationale des Epizooties
PAQ	post-arrival quarantine
PCR	polymerase chain reaction
PDV	phocine distemper virus
PEQ	pre-export quarantine
PhHV	phocid herpesvirus
SMSV	San Miguel sea lion virus
SPS Agreement the Code	Agreement of the Application of Sanitary and Phytosanitary Measures OIE International Animal Health Code
VPC	Vertebrate Pest Committee
WTO	World Trade Organization

1. INTRODUCTION

1.1 Background

The display of exotic animals in zoos provides many functions beyond that of simply a collection of animals for exhibition. The scientific, teaching and conservation roles are clearly defined within a zoo charter and recognised by Australian and international government and non-government organisations. The commitments of many countries to genetic diversity and the conservation of species are recognised.

There have been few importations of pinnipeds to Australia in recent years. Australia has in place conditions for the importation of Californian sea lions (*Zalophus californianus*) from New Zealand. These were developed to cater for a specific import of two animals, and were not designed to allow for the importation of animals from other countries where the disease risks may be different.

An Australian zoo has expressed interest in the acquisition of two young Californian sea lions, currently about two years of age. Further access requests are likely in the future.

1.2 Current quarantine policy and practice

The Quarantine Act (1908) and subordinate legislation, including Quarantine Proclamation 1998, is the basis of human, animal and plant quarantine in Australia. The scope of quarantine is defined in section 4 of the Act as follows:

"In this Act, Quarantine has relation to measures for the inspection, exclusion, detention, observation, segregation, isolation, protection, treatment, sanitary regulation, and disinfection of vessels, installations, persons, goods, things, animals, or plants, and having as their object the prevention of the introduction, establishment or spread of diseases or pests affecting human beings, animals, or plants."

The Act provides that the Governor-General in Executive Council may, by proclamation, prohibit the importation into Australia of any articles likely to introduce any infectious or contagious disease, or disease or pest affecting persons, animals or plants. This power of prohibition may be applied generally or subject to any specified conditions or restrictions that, if applied, must relate to pest or disease concerns.

Under Section 46A of the *The Quarantine Act* (1908), imported animals will normally be required to undergo a period of post-arrival quarantine in a premises approved by AQIS. At the end of the post-arrival quarantine period, zoo animals will normally be released from quarantine under quarantine surveillance (under sub-section 52 (5) of the Act). While under quarantine surveillance they will be subject to prescribed conditions which may include permanent confinement in a zoo or institution approved as an 'approved institution' or an 'approved zoological organization' under the Wildlife Protection (Regulation of Exports & Imports) Act 1982. They will be kept under quarantine surveillance for as long as considered necessary.

Quarantine Proclamation (1998) sets out the conditions that govern the importation of animals and animal products into Australia. Under this proclamation the importation of live animals, other

than domestic cats and dogs from New Zealand, is prohibited unless accompanied by a permit to import granted by the Director of Quarantine.

The Director of Animal and Plant Quarantine (the Secretary of the Department of Agriculture Fisheries and Forestry, Australia) may permit unrestricted entry of products or entry subject to compliance with conditions specified in a quarantine protocol. An import risk analysis (IRA) results in the establishment of quarantine policy that may prohibit importation or allow importation under specified conditions.

The Environment Protection (Impact of Proposals) Act 1974 and the Administrative Procedures under that Act require the consideration of whether Commonwealth action (such as the granting of an import permit) is an action which will, or is likely to, affect the environment to a significant extent or which will have the effect of permitting or facilitating an action by another person which will or is likely to result in such an effect. AQIS considers that decisions to permit the entry of animal products, made under the Quarantine Act and consistent with Australia's conservative approach to risk, would generally be unlikely to constitute actions leading to significant adverse effects on the environment.

Permission to import non-domestic animals must be granted under the *Wildlife Protection (Regulation of Exports & Imports) Act (1982)* and the *Quarantine Act (1908)*.

The *Wildlife Protection (Regulation of Exports & Imports) Act (1982)* is an Act to further the protection and conservation of wildlife by regulating the export and import of certain animals, plants and goods, and by regulating the possession of certain exotic birds, and for related purposes. This Act provides the legislative framework for the administration of CITES requirements in Australia.

Animals listed by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) are subject to strict international rules relating to conservation of the species, including limitations on the source of these animals and how they are managed post-arrival.

Each application for the importation of a non-domestic vertebrate species must be subject to assessment for potential to escape, establish and become a pest. This is done by the Vertebrate Pest Committee (VPC), which acts as a sub-committee of the Standing Committee on Agriculture and Resource Management (SCARM).

1.3 The Zoo industry in Australia

Taronga, Adelaide, Melbourne and Perth Zoos are the four AQIS registered zoos currently gazetted as quarantine stations. Non domesticated animals are normally imported directly into these zoos.

Funding of these zoos is from three main sources. Governments contribute to the capital investment, operational costs are met by gate takings and grants are received from corporate sponsors for particular aspects of the zoos' functions.

These four zoos receive some 3.5 million visitors each year. Conservation, education and public awareness are the major roles of these zoos. Through their umbrella organisation, the Australasian Regional Association of Zoological Parks and Aquaria (ARAZPA), they aim to raise the profile of environmental and conservation education in schools.

Education programs are generally aimed as improving awareness and appreciation of the

environment. They particularly target children. The use of performing animals e.g. Californian sea lions, in these programs helps to capture the attention of children and provide them with a memorable experience.

1.4 Captive pinniped facilities in Australia

In addition to four major zoos, a number of other institutions in Australia hold pinnipeds in captivity for display and/or rehabilitation purposes. Not all of these institutions are members of ARAZPA.

Movement of pinnipeds between these institutions may be for the purpose of permanent acquisition by one institution of surplus stock from another, for breeding purposes and rehabilitation of stranded animals. Of this last group, some animals are returned to the wild when it is considered appropriate, whilst those that have sustained more serious damage may remain in captivity.

Numbers of pinnipeds held at these facilities are small, and largely captive bred. Because there have been few introductions over the years, it is now desirable that the gene pool be expanded. This is particularly true of exotic animals.

1.5 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 membership of CITES, the fifty Australian organisations that are members of the World Conservation Union (IUCN), and the membership of Australia's four biggest zoos with the World Zoo Organization (IUDZG-WZO).

These organisations all contribute to the preservation of endangered species by complementary functions. The role played by zoos involves breeding programs aimed at survival and genetic diversity (*ex situ* propagation). *Ex situ* propagation of endangered species is considered critical to the support of *in situ* survival of these species. 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 ARAZPA. 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.

1.6 Description of the import risk analysis process

The IRA for importation of live pinnipeds followed the principles and procedures adopted by the Australian Government following the 1996 review of Australian quarantine under the chairmanship of Professor Malcolm Nairn. These procedures are outlined in the AQIS Import Risk Analysis Process Handbook.^a The approach set out in the Handbook is consistent with

^a The AQIS Import Risk Analysis Process Handbook. (1998) Australian Quarantine and Inspection Service, Department of Primary Industries and Energy, Canberra.
(Note: Copies of the Handbook may be obtained from AQIS or viewed on AQIS's homepage on the Internet (<http://www.dpie.gov.au/aqis/homepage/aqispub.html>).

Australia's rights and obligations derived principally from the World Trade Organization (WTO) Agreement on the Application of Sanitary and Phytosanitary measures (known as the SPS Agreement). It is also consistent with the recommendations of the Office International des Epizooties (OIE).

The IRA process provides the scientific and technical basis of quarantine policy and procedures. Quarantine Proclamation 1998 states that the Director of Quarantine, in deciding whether to grant a permit to import;

- . must take into account the level of quarantine risk^b if a permit were granted;
- . whether the imposition of conditions on such a permit would limit the level or risk to an acceptable level; and
- . may take into account any other relevant factors.

The report of the IRA sets out relevant information and makes recommendations for the Director of Quarantine to consider before making the final decision on an import access request.

1.7 Scope of the risk analysis

This IRA covers all animals in the Suborder Pinnipedia. This includes Family Odobenidae (walrus), Family Otariidae (fur seals and sea lions) and Family Phocidae (true seals).

The various species of pinnipeds will be mentioned in this document by their common names. The common and scientific names of each species are given in the Appendix.

This IRA identifies infectious agents considered to be hazards of pinnipeds in general. For those considered to be exotic to Australia, and for which data are available, the IRA evaluates the likelihood of introduction and establishment of these agents. Within the limitations of current knowledge, detailed examination is given, consequences of introduction discussed, and risk management measures included for those that are exotic to Australia and/or have the potential to harm pinnipeds, people or other animal populations if they were introduced and became established in Australia.

The IRA is not specific to any one country, i.e. it is a generic IRA, considering pinnipeds from any source.

^b Level of quarantine risk

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

the probability of:

a disease or pest being introduced, established or spread in Australia or the Cocos Islands; and
the disease or pest causing harm to human beings, animals, plants, other aspects of the environment, or economic activities; and
the probable extent of the harm.

2. HAZARD IDENTIFICATION AND EXPOSURE PATHWAYS

2.1 Hazard Identification

The hazard identification involves identifying the pathogenic agents which could potentially produce adverse consequences associated with the importation of pinnipeds.

A list of agents that affect pinnipeds, is given in Table 1. below. In the table agents are dichotomously identified as potential hazards or not, on the following criteria:

- . they are infectious,
- . they are exotic, or if present in Australia are subject to official controls (including agents that cause notifiable human diseases), and
- . which could potentially produce adverse consequences associated with the importation of pinnipeds into Australia.

An extensive literature search resulted in the compilation of the list of agents that have been recorded in pinnipeds. Agents that meet the above criteria have been selected for detailed examination. Those agents are listed in Table 2.

With the exception of tuberculosis, agents already endemic in Australian seal populations were excluded on the basis that further introduction of the same agent would not alter the risk to Australian pinnipeds. Also excluded were those agents, generally multicellular parasites, for which there were occasional reports but with no mention of associated pathology.

The hazard identification process used published data on infectivity, virulence, and prevalence.

Table 1.

Agents known to occur in pinnipeds

Agent	Host	Potential for harmful effects	Means of transmission	Status in Aust.	Source	Selected
Morbillivirus phocine distemper virus and/or canine distemper virus. (PDV-1 suggested to be a new genus, PDV-2 possibly identical to CDV, a third, monk seal morbillivirus, MSMV has been identified).	Common European seals, grey seals (<i>Halichoerus grypus</i>), Siberian seals, harp seals (<i>Phoca groenlandica</i>).	Phocine distemper. Up to 90% mortality in some seal colonies.	Aerosol, direct contact.	Not recorded.	1, 14, 16, 17, 25, 44, 68, 85	yes
Calicivirus (San Miguel sea lion virus) at least 14 serotypes.	A number of pinniped species.	Indistinguishable from vesicular exanthema in pigs. Skin lesions, neonatal mortalities in pinnipeds. Has the potential to severely affect pigs.	The usual portal of entry is presumed to be the oral cavity. Transmission by ingestion has been demonstrated, indirect spread via handlers and through seawater has been suspected.	Not reported.	1, 19, 102	yes
Influenza A virus (H7N7 in 1979, H4N5 in 1982, H4N6 in 1991/92 and H3N3 in 1991/92). It is antigenically related to avian influenza virus.	Harbour seals and other seals of genus <i>Phoca</i> , humans.	Incubation period \leq 3 days. Weakness, incoordination, dyspnoea, highly virulent.	Transmission primarily by respiratory route, also conjunctival. Lake water has been shown to be infective when wild ducks are present.	Not reported.	1,4,70, 91	yes
Phocid herpesvirus, PhHV-1 and PhHV-2.	Harbour seals, California sea lion (CSL), and grey seal. Antibodies detected in Weddell and crabeater seals (Antarctica) and harp and hooded seals (Arctic).	Pneumonia, hepatomegaly, mucosal lesions, heart lesions. Is frequently fatal. Persistent infections exist. Clinical relevance in free-ranging pinnipeds poorly understood.	Transmission by direct contact, close proximity or use of common water.	Virus not reported in Australia. Antibodies detected in Antarctic seals.	4, 13, 87	yes

Table 1. continued

Agent	Host	Potential for harmful effects	Means of transmission	Status in Aust.	Source	Selected
Seal pox virus , two genera, <i>Orthopoxvirus</i> and <i>Parapoxvirus</i>	Wild and captive CSLs, southern sea lions, harbour seals, northern fur seals, grey seals, South American fur seals and humans. Mostly in captive animals.	Proliferative skin disease, self limiting within several months. Also has the potential to cause disease in humans.	Transmission may be by skin contact, aerosol formation or arthropod bites.	Not reported in Australia.	1,4,19, 24, 51, 53	yes
Rabies virus	Isolated from ringed seal in Norway.	Rabies. Only one record, probably of minor significance. Rabies virus has the potential to harm humans and other animals.	Transmitted via saliva of infected animal being introduced through broken skin of recipient.	Absent from Australia. Quarantine measures apply.	4	yes
Adenovirus	Reported in USA in Californian sea lions. Not transmitted to other pinnipeds in same centre. Serosurveys indicate wide distribution.	It is not highly virulent, however animals that succumb die from hepatitis similar to canine hepatitis.	Little information	Unknown.	4, 19, 117	no
Coronavirus (unclassified), cross reacting with porcine transmissible gastroenteritis, infectious feline peritonitis and canine enteric coronavirus.	Harbour seal (<i>Phoca vitulina</i>) One report in 1993, 3 seals involved. Virus not isolated.	Acute necrotising enteritis, death.	Little information	Unknown.	56	no
Retrovirus	Californian sea lion.	Non-oncogenic. Uncertain whether it was associated with disease.	Little information	Unknown.	72	no
<i>Mycobacterium tuberculosis</i> probably a unique cluster within the <i>M. tuberculosis</i> complex.	Wild and captive NZ fur seals & Aust. sea lions, hooded seals, CSLs, wild seals in South America. Humans have been	Highly virulent form of tuberculosis. Serious potential risk to humans, potential for transmission from seals to other domestic animals unknown.	Direct contact and aerosol transmission.	Present in Australia.	1, 8, 10, 77	yes

	infected.					
--	-----------	--	--	--	--	--

Table 1. continued

Agent	Host	Potential for harmful effects	Means of transmission	Status in Aust.	Source	Selected
<i>Mycobacterium fortuitum</i> and <i>smegmatis</i>	Sea lions in USA	Pyogranulomatous dermatitis. Not associated with major disease outbreaks.	Contact with contaminated environment.	Ubiquitous organisms.	84	no
<i>Leptospira</i> spp.	Californian sea lions, northern fur seal, other pinnipeds. <i>L. pomona</i> is the primary cause of leptospirosis in pinnipeds. Zoonosis.	Can occur in epizootics, associated with abortions and renal disease. Possible association with strandings.	Water borne organism.	<i>L. pomona</i> is present in Australia.	1, 20, 49	no
<i>Staphylococcus</i> spp., <i>Erysipelothrix rhusiopathiae</i> , <i>Vibrio</i> spp., <i>Salmonella</i> spp. <i>Escherichia coli</i> , <i>Klebsiella pneumoniae</i> , <i>Pseudomonas</i> , <i>Actinomyces</i> spp. <i>Neisseria</i> spp.	There is a number of reports of these organisms being isolated from pinnipeds. Humans may become infected with a number of these agents.	Infections range from local infections to septicaemias. <i>E. rhusiopathiae</i> has been associated with seal finger (spekk finger).	Infection generally by direct contact, wound contamination or ingestion.	Ubiquitous, present in Australia.	1, 2, 59, 63, 98, 117	no
<i>Clostridium botulinum</i> , <i>Cl perfringens</i>	Various pinnipeds.	Botulism and enterotoxaemia respectively.	Clostridia are common environmental contaminants.	Present in Australia.	117	no
<i>Brucella</i> spp.	Isolates of <i>Brucella</i> that differ from recognised species have been isolated from a number of pinniped species, including wild Pacific harbour seals.	The significance of the presence of <i>Brucella</i> species in marine mammals is unknown and no clinical signs have been reported. Zoonotic potential unknown.	Possibly similar to the means of transmission in terrestrial mammals.	The status of <i>Brucella</i> spp. of pinniped origin in Australia is unknown.	11, 45	yes
<i>Mycoplasma</i> spp.	Numerous Mycoplasmas have been isolated from a number of seals.	Originally thought to be implicated in the PDV outbreak in 1988, but this was later discounted. Has also been found in association with pneumonia in seals with Influenza A infection.	Not specified.	Unknown.	1, 74	no

Table 1. continued

Agent	Host	Potential for harmful effects	Means of transmission	Status in Aust.	Source	Selected
Systemic mycoses: <i>Nocardia</i> spp., <i>Candida</i> , spp., <i>Mucor</i> spp., <i>Aspergillus</i> spp., <i>Blastomyces</i> spp., <i>Histoplasma</i> spp., <i>Coccidioides</i> spp., and <i>Fusarium</i> spp.	Various marine mammals and terrestrial mammals. Wide distribution internationally. Most species present in Australia.	Systemic mycoses, sometime predisposed by captivity stress. <i>Candida albicans</i> disease is common in stressed pinnipeds.	Contact with infected animals and contaminated environment.	Present in Australia.	1, 2, 9, 23, 117	no
Dermatomycoses: <i>Microsporium</i> spp., <i>Trichophyton</i> spp,	Variou. Numerous fungi are isolated from the skin and fur of pinnipeds.	Fur seals easily acquire dermatophytes on their skin and fur but have physiological and anatomical barriers to serious dermatophytosis.	Contact with contaminated environment, animals.	Many species present in Australia.	1,17, 22,116	no
Protozoa, <i>Eimeria</i> spp.	<i>E. phoca</i> found in harbour seal pups captured in Maine, USA.	One report of haemorrhagic necrosis of the colon in pups. Does not appear associated with major disease outbreaks.	Direct life cycle via faeces.	Not reported.	30, 82	no
Other Protozoa: <i>Sarcocystis</i> , <i>Isospora</i> , <i>Toxoplasma</i>	Various pinnipeds.	<i>Toxoplasma gondii</i> associated with disseminated infections in marine mammals.	Life cycle in marine mammals not documented.	Present in Australia.	12	no
Helminths - flukes: <i>Cryptocotyle</i> spp.,	Harbour seals. Common in Europe and Russia.	Adult fluke in intestines. Not recorded as a cause of disease outbreak.	Mammals become infected from eating infected fish.	Unknown.	3, 60, 110	no
- flukes <i>Nanophyetus salmincola</i>	Said to be common, there are 32 species of mammalian host, including cats and dogs, 1 intermediate snail host, 34 species of fish.	Not associated with disease outbreak in pinnipeds. <i>N. salmincola</i> is a vector of the rickettsial agent of salmon poisoning of dogs and cats.	Mammals become infected from eating infected fish.	Unknown. No quarantine measures for other mammalian hosts.	3, 110	no
Other Trematode genera: <i>Odhneriella</i> , <i>Opisthorchis</i> , <i>Orthosplanchnus</i> , <i>Phagicola</i> , <i>Phocitrema</i> , <i>Pricetrema</i> , <i>Pseudamphistomum</i> ,	Various pinniped species.	The flukes parasitise intestines, bile ducts, gall bladder. No information on these agents as a cause of disease.	Complex life cycle involving intermediate stages in molluscs and fish.	Unknown.	3, 60	no

<i>Zalophatrema</i>						
---------------------	--	--	--	--	--	--

Table 1. continued

Agent	Host	Potential for harmful effects	Means of transmission	Status in Aust.	Source	Selected
<i>Mesostephanus neophocae</i> and <i>Ogomaster antarcticum</i>	Australian/Antarctic pinnipeds	Unknown.	Unknown.	Present in Australia	30	no
Cestodes: <i>Adenocephalus</i> , <i>Anophryocephalus</i> , <i>Diplogonoporus</i> , and <i>Pyramicocephalus</i> .	Host species not specified	Alimentary tract parasitism. No reports of these agents as a cause of disease.	Mammals become infected from eating infected fish.	Unknown.	3, 110	no
Cestodes: <i>Phyllobothrium</i> spp., <i>Diphyllobothrium</i> spp., <i>Baylisiella</i> spp., and <i>Dibothrocephalus wilsoni</i> .	Ubiquitous in pinnipeds.	Infections with mature pseudophyllideans are usually innocuous, though they may affect weight gains.	Adult cestode in marine mammal, copepods and fish are intermediate hosts.	Present in Australia.	12, 30	no
Acanthocephalans: <i>Bolbosoma</i> , <i>Corynosoma</i> .	Various marine mammals, wide distribution in Australian pinnipeds.	Local irritation and ulceration in intestines.	Mammals are the definitive host; they become infected after eating intermediate or paratenic hosts.	Present in Australia.	3, 7, 12,30, 110	no
Nematodes: <i>Phocanema</i> spp.	Australian and Sub-Antarctic species.	Stomach.	Unknown.	Present in Australia.	30, 40	no
<i>Contraecaecum</i> spp., <i>Anisakis</i> spp., <i>Stomachus</i> spp.	Pinnipeds and piscivorous birds. Also present in fish. Australian and Antarctic pinniped species.	The most common nematode in pinnipeds. Alimentary parasitism, can have severe local irritation. <i>Anisakis</i> is a zoonosis.	Encysted larvae and adults are found in seals. An amphipod is believed to be the intermediate host.	Present in Australia, NZ, Macquarie Is.	5, 30, 40, 109, 117	no
<i>Capillaria</i> spp.	Described as common parasite of pinnipeds.	Migratory larvae may cause tissue damage.	Life cycle direct, or may use transport host.	Unknown.	3, 110	no
<i>Trichinella spiralis</i>	Walrus meat is a source of infection to humans.	Larvae invade and encyst in fascia, muscle and other tissues. Serious zoonosis.	Sylvatic trichinosis occurs between wild carnivores and their prey or carrion. The walrus strain of <i>Trichinella</i> is resistant to freezing.	An exotic parasite for which quarantine measures are in place.	3, 110, 111	yes

Table 1. continued

Agent	Host	Potential for harmful effects	Means of transmission	Status in Aust.	Source	Selected
<i>Porrocaecum</i> spp., <i>Terranova</i> spp.	Pinnipeds, many fish species are intermediate hosts. Macquarie Is, NZ, Antarctica.	Alimentary tract parasitism.	Adult stage in pinnipeds, larval stage in fish.	Assumed present in Australia.	3, 40	no
<i>Dipetalonema</i> spp., <i>Dirofilaria immitis</i>	<i>Dipetalonema</i> is common, world wide distribution. <i>Dirofilaria</i> recorded in captive harbour seals.	Heart, tissue pathology.	<i>Dipetalonema</i> transmitted by the seal lice <i>Echinophthirius horridus</i> .	Recorded in Australia.	3,12, 60, 61	no
<i>Otostrongylus circumlitus</i>	Free ranging harbour seals (<i>Phoca vitulina</i>).	Lungs, pulmonary artery, heart.	Not specified.	Unknown.	3, 60	no
<i>Parafilaroides</i> spp.	Lungworms, present in a number of pinniped hosts.	Acute bronchitis, verminous pneumonia, caused by larvae.	Life cycle direct.	Present in Australia.	12, 15, 30, 34	no
Hookworms: <i>Uncinaria</i> spp.	Several pinniped species, esp. Northern fur seals. Australian sea lion, southern elephant seals and Aust. & NZ fur seals.	Parasitic anaemia. Parasites in intestines, blubber. Mass mortalities in fur seal pups.	Pups are infected through milk in first few days of lactation. Parasites are shed when pup is three months of age. Re-infection occurs later through skin penetration.	<i>Uncinaria</i> is present in pinnipeds in Australia.	3, 12, 29, 30, 31, 34, 40, 117	no
Anapleura: <i>Antarctophthirus</i> spp., <i>Echinophthirus</i> spp., <i>Haematopinus</i> spp. <i>Proechinophthirus</i> spp.	Various pinnipeds in New Zealand and Antarctic waters. <i>Echinophthirus horridus</i> serves as intermediate host for <i>Dipetalonema</i> sp.	Lice cause little more than mild irritation. Lice are common on pinnipeds.	Direct life cycle. Transmission occurs when pinnipeds are out of the water.	Some are present in NZ, likely to be present in Australia.	3, 12, 26, 117	no
Acarina (mites) <i>Demodex</i> spp.	Various pinnipeds	Causes mange-like skin lesions. The clinical condition may be an expression of lowered immune function.	Close contact required.	Not known.	3, 12	no
<i>Halarachne</i> spp.,	Most Australian pinniped	Nasopharynx, trachea, bronchi, minimal	Complete life cycle not	Present in	3, 15, 30	no

<i>Orthohalarachne</i> spp.	species.	pathogenic effects.	known.	Australia.		
-----------------------------	----------	---------------------	--------	------------	--	--

Table 2

Disease agents selected for detailed examination under the process described in 3.1

Morbilliviruses (PDV & CDV)

San Miguel sea lion virus (SMSV)

Influenza A virus

Phocid herpesvirus (PhHV)

Seal Pox virus

Rabies virus

Mycobacterium tuberculosis

Brucella spp.

Trichinella spiralis

2.2 Strengths and weaknesses in available data

In 1995, Norman said “In Australia, modest resources have been expended in examining disease in free-living seals, although more recently the area of mycobacterial infections has received deserved attention.”⁽³⁴⁾ It follows that much of the information about the agents listed above and discussed below is based on Northern Hemisphere observations and research. Where specific information about diseases agents in wild seals in Australian waters is available, it is assumed that the agent is endemic in Australian waters.

Parasitology in pinnipeds has been studied more vigorously and more data amassed than in the fields of bacteriology and virology. Nevertheless, much of the literature is based on descriptions of parasites without providing data on pathogenicity. Another reason for the dearth of information about bacterial and viral pathogens could be the age of stranded carcasses at the time of autopsy and the distance from appropriate laboratories.

Those agents believed to be the cause of overseas epizootics over the past 10-20 years have been reasonably well studied. This is particularly true of phocid distemper.

2.3 Exposure pathway

2.3.1 Known routes of infection

Aerosols may be involved in the spread of respiratory diseases including tuberculosis and distemper. Animals close enough to inhale airborne droplets from another pinniped would be considered exposed to these agents even though physical contact between the animals did not occur.

Infection by ingestion can occur from a number of sources, e.g.

. contaminated food, water and surroundings. Infectious agents that may be excreted in

urine and faeces, or present in placentae, would be in abundance at haul-out sites for breeding and feeding their young;

- . transmission to the young of agents that are excreted in milk, such as hookworm larvae; and
- . prey that carry the intermediate stages of parasites or other agents, e.g. the fish that are infected with *Anisakis*.

Infection may occur as a result of wound contamination. Pinnipeds have the habit of congregating in large numbers at haul-out sites. The environment becomes heavily contaminated with organisms present in excreta, foetal membranes and carcasses.

Transplacental transmission occurs with some agents affecting land mammals. Whilst information on this mode of transmission in pinnipeds appears unavailable, it should not be disregarded.

Infection may be transmitted between captive seals by common water, aerosols, direct contact and indirect contact via handlers and equipment.

2.3.2 Pathways of exposure to imported pinnipeds or their disease agents.

Species that may be susceptible to agents introduced by imported pinnipeds include pinnipeds, animals other than pinnipeds and humans.

Currently, there is a legal requirement under the *Quarantine Act (1908)* for imported non-domestic animals to remain in permanent quarantine. These regulations are now under review, but it is not anticipated that there will be significant changes in practice. This restriction severely limits the opportunities for exposure of animals other than those in the zoo to imported pinnipeds.

Exposure of zoo pinnipeds.

Pinnipeds in the zoo collection could be directly or indirectly exposed to imported pinnipeds. A number of pathways have been considered possible;

- . if the proximity of animals allowed the aerosol spread of organisms, e.g. distemper virus or *Mycobacterium tuberculosis*;
- . if a water supply was shared by resident and imported seals;
- . if there was a failure of the sterilisation process in recycled water systems permitting the entry of pathogens into other pinniped facilities,
- . through fomites, e.g. feeding and veterinary equipment, handlers and their clothing if there was a breakdown in hygienic procedures; and
- . through the use of common areas, such as treatment rooms and operating theatres.

Exposure of wild pinnipeds.

Direct exposure of Australian native pinnipeds to imported animals is unlikely to occur. It could only occur within zoo precincts, and then, only if housed with imported animals. Whilst some display centres also offer rehabilitation facilities for stranded wild pinnipeds, they are separate from the facilities holding the zoo collection. In the same context, exposure could occur through the use of common areas, such as treatment rooms and operating theatres by zoo and native animals e.g. the use of zoo veterinary facilities for rehabilitation of native animals for return to the

wild.

Indirect exposure could occur where untreated sea water is cycled from the ocean through the seal pools and directly back to the ocean.

The reintroduction of rehabilitated pinnipeds to their colonies is a pathway by which exotic agents could be introduced to a native pinniped population if the rehabilitated animal had been exposed to the agents during its period in captivity.

Exposure of other animal species.

For animals not dwelling in the zoo situation there are few pathways by which they could be exposed to an infectious agent introduced by an imported pinniped. One such pathway is the possibility of handlers carrying organisms on their person when leaving the zoo premises. Zoo staff wear uniforms whilst at work, and are trained to wash their hands after handling animals. AQIS considers that this pathway does not represent a high level of risk.

Native and feral animals not dwelling in the zoo precincts may enter the zoo e.g. a cat or possum or rodent, usually at night, and be exposed to infectious agents from an imported animal. One would not expect cats and possums to be attracted by the aquatic environment of a pinniped enclosure, however, the presence of feral cats in an overseas oceanarium has been reported.⁽⁵⁶⁾

Exposure of humans.

Zoo staff are in close contact with the animals in their charge. Physical contact may be frequent. Zoo staff practise strict hygiene procedures minimising exposure by contact, but aerosol infection is still possible.

Visitors to zoos have almost no direct contact with pinnipeds; aerosol spread between pinnipeds and the public from open enclosures is considered possible but unlikely.

3. RISK ASSESSMENT

3.1 Description of the assessment

The disease agents identified as presenting potential quarantine risk are introduced with a brief description of the agent and its world distribution. They are discussed in detail under the following headings:

Virulence, infectivity and transmission

This discussion places particular emphasis on aspects of relevance in assessing the quarantine risk associated with that agent.

Likelihood of entry, establishment and spread

An assessment is made of the likelihood that the agent: is present in pinnipeds at the time of export; is transmitted to other animals within the zoo premises; is spread to other animals outside the zoo premises, including native pinniped populations, and/or may have zoonotic potential. As far as possible, likelihood of entry, establishment or spread is described using terms such as:

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

Negligible : Chance of 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 establishment of a new disease agent may have a biological effect and consequential effects on industry and the environment. These consequences can be measured in terms of their economic impact, but the social and ecological effects are usually unquantifiable. With domestic and captive wild animals the effects of a disease can be ameliorated to various degrees by the adoption of methods for control or eradication. This is more difficult with uncontrolled wild animals.

Again, while definitions of morbidity and mortality levels in production animals are measured in terms of losses relative to known production or mortality standards, it is difficult to apply these standards to uncontrolled animals in the wild.

Terms used to describe consequences

Generally consequences are linked to harm to human health, animal deaths or production losses, costs of movement restrictions, loss of export markets, compensation costs, the loss of production during control campaigns, and the cost and likelihood of eradication. In this paper particular consideration is given to the effect of a disease on zoo collections and natural pinniped populations in Australian waters. The following terms which 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, the environment and/or social well being at a national level. Their effect may continue for an extended period of time. Alternatively or in addition, they may cause serious, irreversible harm to the environment or constitute a serious threat to human health.

Serious: consequences associated with the establishment of diseases that would have serious biological effects (eg high mortality or high morbidity with significant pathological changes in affected animals), environmental or social consequences. Such effects may be felt for a prolonged period and may not be amenable to prompt and effective control or eradication. These diseases would be expected to significantly harm economic performance at the level of a major national industry or the equivalent. Alternatively or in addition, they may cause serious harm to the environment or constitute a significant threat to human health.

Medium: consequences associated with the establishment of diseases that have less pronounced biological effects. These diseases may harm economic performance significantly at the level of an enterprise, region or industry sector, but they would not have a significant economic effect at the 'whole industry' level. These diseases may be amenable to control or eradication, albeit at a significant cost or their effects may be temporary. They may affect the environment, but such harm would not be serious or may be reversible.

Mild: consequences associated with the establishment of diseases that have mild biological effects and would normally be amenable to control or eradication. Such diseases would be expected to harm economic performance at the enterprise or regional level but to have negligible significance at the industry level. 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 are readily amenable to control or eradication. The economic effects would be expected to be low to moderate at an individual enterprise level and insignificant at a regional level. Effects on the environment would be negligible.

In estimating the consequences of introduction and establishment of exotic disease agents affecting pinnipeds in Australia, this IRA has considered the consequences of introduction and establishment in four different areas, those being:

- a zoo collection
- domestic animal populations,
- as a zoonosis, to zoo staff, and
- pinnipeds in the wild in Australian waters.

Evaluation of the risk

Risk is evaluated as a combination of likelihood of entry, establishment and spread and the consequences.

First, the relationship between the likelihood of entry, establishment and spread and the consequences is used in deciding whether specific risk management options are required. For agents with potentially serious or extreme consequences, importation would not be permitted under conditions where the likelihood of establishment were judged to be any higher than negligible. For those with medium consequences, importation would not be permitted if the likelihood of establishment 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 of entry and establishment.

These rules apply irrespective of the nature of the disease risk agent or of the commodity. They are expressed in the matrix shown below. The risk is determined on the basis of 'no risk management', i.e. it is the estimate of risk associated with unrestricted importation. Where the risk exceeds Australia's ALOP, the importation falls into the "reject" area in the matrix.

The next step is to consider whether or how risk management measures may be applied to reduce the likelihood of establishment to the point where it conforms with Australia's ALOP. If the application of risk management measures cannot reduce the risk to an acceptably low level, the importation would not be permitted. If after applying risk management measures the risk was in line with Australia's ALOP, the risk would be considered acceptable and the importation would be permitted.

Table 3.

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

Options for managing the risk

The analysis presents a range of possible risk management options, the nature of which depend on the estimated risk associated with the agent and the characteristics of the disease. For disease agents affecting farm livestock, there may be existing, internationally accepted risk management measures in the OIE Animal Health Code.

In the case of disease agents affecting pinnipeds, only rabies and trichinellosis are included in the Code. Bovine tuberculosis is included in the Code, but not tuberculosis of non-domestic animals as caused by variants within the tuberculosis complex. In all cases, where the scientific material available has suggested a range of risk management options may be available, they have all been considered.

Appropriate risk management option

The ALOP, as defined in the SPS Agreement, is the level of protection deemed appropriate (as a sovereign right) by the member country establishing or reviewing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory.

Australia has a very high animal health status and adopts a very conservative ALOP. Risk management measures that are judged to meet Australia's ALOP are used.

For importation of products and live domestic animals, AQIS frequently requires that the country of origin be certified free from a particular disease by the Veterinary Authority in the country of origin. This IRA has addressed the difficulties that would arise in asking for country freedom declarations for diseases of wild animals that are not monitored for disease, and roam beyond national borders.

3.2 Individual disease agents

Throughout the literature search it became apparent that research on many diseases had progressed well through the phases of disease recognition, isolation and identification of responsible agents. Surveys of the prevalence of some agents have been done in limited regions of the globe. Far less research has been done on means of transmission, diagnosis in the live animal, tests for carriers, prophylaxis and treatment. Where it has been difficult to assess the level of risk, a conservative approach has been taken.

3.2.1 Morbilliviruses

A distinct Morbillivirus closely related to the canine distemper virus (CDV) is the causative agent of phocine distemper. This virus is known as phocine distemper virus (PDV). The two viruses are capable of infecting several species.

The devastating 1988 outbreak in the North and Baltic Seas killed more than 18,000 harbour seals (*Phoca vitulina*) and a small number of grey seals (*Halichoerus grypus*). The causative agent was shown to be a newly recognised virus, phocine distemper virus (PDV-1).^(14, 35) During the epizootic grey seals did not exhibit the same susceptibility to the disease as harbour seals, and it is apparent that susceptibility varies with species.^(25,78) The antibody responses of free-ranging harbour grey seals was examined, and it was concluded that the antibody response of grey seals was more competent than that of harbour seals in respect of morbillivirus antigens.⁽¹³⁴⁾

An epizootic in Baikal seals (*Phoca sibirica*) and Arctic sled dogs in 1987-1988 does not appear to be epidemiologically linked to the North Sea epizootic of 1988.⁽³⁵⁾ The virus of this outbreak, (PDV-2) is more closely linked to CDV.⁽²⁵⁾

There is evidence that Canadian harp seals (*Phoca groenlandica*), ringed seals (*Phoca hispida*), grey seals, hooded seals (*Cystophora cristata*) and harbour seals have been exposed to morbilliviruses including PDV-1.^(35,85) The harp seal acts as a reservoir for the virus.⁽⁴⁴⁾

Antibodies to infections by CDV-like viruses are present in both North Atlantic and Antarctic pinnipeds, the immunological response being distinct from that to PDV.^(34,35,48) In 1992, harbour seals stranded in New York, USA were shown to have antigen and antibody titres consistent with PDV infection.⁽¹³⁵⁾

Blixenkrone-Møller has presented evidence that an outbreak of distemper in mink on a Danish island was caused by PDV-1.⁽⁹⁹⁾

Mass mortalities in Mediterranean monk seals (*Monachus monachus*) in 1997, off the Mauritanian coast of West Africa, were believed to have been caused by a morbillivirus related to dolphin morbillivirus (DMV).⁽¹⁷⁾

A mass die off of crabeater seals (*Lobodon carcinophagus*) in Antarctica in 1955 is believed, in retrospect, to have been caused by CDV acquired from sled dogs used in the area. Weddell seals (*Leptonychotes weddelli*) and Leopard seals (*Hydrurga leptonyx*) in the area were not affected.^(48, 54)

PDV has not been reported in Australian waters.

a) Virulence, infectivity and transmission

Relative to PDV, CDV has been studied more closely and for many years longer. Some of the characteristics of canine distemper are an incubation period of 5-6 days when pyrexia and viraemia first occur. Virus shedding through the respiratory tract occurs at this time, and if the dog survives, may continue for 2 months.⁽¹³⁶⁾

Clinical signs of phocine distemper resemble distemper in dogs, with high fever, nasal discharge, conjunctivitis, anorexia, gastrointestinal and nervous symptoms. Experimentally-infected harbour seals died within 18 days of showing signs of severe respiratory and/or nervous disease.⁽²⁴⁾

Canine distemper has a rapid effect on the immune system of dogs, rendering them vulnerable to secondary infections, and a similar picture emerged with the 1988 outbreak of PDV in harbour seals.⁽⁸¹⁾ The course of PDV in seals is short and those that die are generally in good condition. Pathological changes have been seen in many organs, in particular the respiratory organs and brain.⁽³⁵⁾

It has been shown that PDV is capable of infecting dogs and mink; in dogs the disease is mild, more severe in mink. Furthermore, transmission of PDV from experimentally inoculated mink to "in-contact" mink occurred, with clinical signs being apparent 24 days following inoculation of the first group.^(80, 93) An attempt to infect puppies with PDV was unsuccessful.⁽⁶⁴⁾ Infection and transmission trials using pigs, calves, sheep and chickens showed that experimentally infected animals seroconverted but did not transmit infection to in-contact, serologically naïve animals.⁽¹⁴⁾

Based on serological studies, it is reasonable to assume that most species of sea mammal including sea lions, walruses, sea otters and whales are susceptible to PDV virus.^(14,35) Moreover

CDV is capable of infecting seals, the severity of infection being dependent on species of host and strain variations.^(42,65)

Harbour seals artificially inoculated with CDV infected tissues had an incubation period of 7-9 days. Viraemia was detected in all inoculated seals between days 3 and 18 post inoculation. In seals that recovered, there was no detectable viral antigen after 5 weeks, which corresponds to studies in dogs that recovered from CDV. CDV was not naturally transmitted to “in-contact” seals.⁽⁶⁵⁾

Mink vaccinated against CDV did not succumb to PDV infection. Specific pathogen free dogs also developed mild disease when experimentally infected with seal tissue homogenates.⁽¹⁴⁾

From studies on CDV we know that this virus is excreted in large amounts in nasal secretions, and that infection can be by direct contact or aerosol transmission.⁽⁶⁸⁾ PDV has been demonstrated to be very similar in this respect.⁽⁴³⁾ There is evidence that freshly contaminated fomites may act as vectors of CDV.⁽⁶⁸⁾

PDV is highly infectious. In the year of the epizootic, in the North and Baltic seas a total of more than 18,000 seal deaths were recorded, mostly among harbour seals.⁽³⁵⁾ Seal numbers the following year were down by 60% around the east coast of England and in the Gattegat and Wadden Sea.⁽⁸¹⁾ Evidence for the continued circulation of PDV-1 in the affected area was presented in 1993.⁽⁹⁷⁾

It is probable that the devastation of this epizootic in harbour seals (*Phoca vitulina*) resulted from the immunological naivety of the population. Atlantic harp seals (*Phoca groenlandica*) were considered possible vectors of the disease agent, as they had moved south from their normal habitat into the area of the epizootic a year earlier.⁽³⁵⁾

Recovered seals have antibodies, moderate titres remaining for up to 6 months.⁽⁵⁸⁾ In locations where mortality rates during the 1988 epizootic were low, immunological evidence indicated that most seals had been exposed to infection. There is maternal transfer of antibodies to young.⁽³⁵⁾ Once the disease is clinically evident, many animals die in spite of developing high levels of antibodies.⁽⁴³⁾ There is evidence that immunity persists once seals have been exposed to morbilliviruses. Young seals that escape infection remain susceptible.⁽³⁵⁾

The maximum incubation period for PDV has not been determined, however, disease and death have occurred within 18 days of experimental infection (route not stated)⁽²⁵⁾ and clinical signs have developed within 11 - 16 days in naturally infected animals.^(35, 57)

b) Likelihood of disease agent entry, establishment and spread

In 1988 three seals captured in Lake Baikal were introduced, apparently directly, to a Japanese aquarium. All developed clinical symptoms of PDV and died within 18 days. Another three Lake Baikal seals that were already domiciled at the aquarium developed clinical signs. One died and the other two recovered after medical treatment. Sera from the recovered two had high titres of CDV-neutralising antibodies.⁽⁵⁷⁾

There is evidence that PDV is still circulating in seal populations in the north Atlantic and contiguous waters.⁽²⁵⁾

If captive bred seals for export to Australia have direct or indirect exposure to wild caught seals from the Northern Hemisphere, the likelihood of introduction of the agent is moderate to high.

The likelihood of agent entry would be significantly less if the imported animal originated from a region believed to be free from the disease.

Some species of pinniped have been shown to become infected and excrete the virus without succumbing to disease, consequently it is possible that any species may be carriers.

An occurrence of the disease in a single animal within a zoo in Australia would be difficult to contain within the zoo because of the highly infectious nature of the agent, and the presumably naive immunological status of pinnipeds in that zoo. The likelihood of spread within a zoo is considered high. Spread to other zoos and aquaria would be easier to prevent because of the low level of transfer of animals between these, but the risk is not eliminated because there is some movement of pinnipeds between these facilities, especially for reasons of veterinary treatment.

Spread to the native populations would be more likely to occur via a rehabilitated animal than by any other means.

It is impossible to assess the likelihood of spread of the agent by non-pinniped carnivores, other than to reiterate that infection of other species has been demonstrated.

Zoos and aquaria that discharge pool water directly into the adjacent ocean may put native animals at risk, but the likelihood of spread this way is very low. It is the accumulation of seals on land that has been seen as the normal means of transmission of the disease.

To summarise, the likelihood of spread of PDV within a zoo to other pinnipeds or susceptible species is high, whilst the likelihood of spread of PDV to native populations is very low.

c) Biological, environmental and economic consequences of agent introduction and disease establishment in Australia

Introduced diseases are more devastating in immunologically naive populations. Once infection becomes endemic, immune animals are continuously present in the population, reducing the epizootic nature of the disease.

Phocine distemper is believed to be exotic to Australia. It is presumed that the Australian native seal populations are immunologically naive. There are no data available regarding the susceptibility of the Australian native population to PDV making it difficult to estimate the consequences of introduction and establishment of PDV in these animals. Serious declines in seal numbers, as occurred in other species overseas should be considered likely.

Control or eradication of the disease in wild pinnipeds has not been possible in the Northern Hemisphere.

To summarise, the estimated consequences of introduction and establishment of PDV are:

- in a zoo collection (pinnipeds), serious;
- in domestic animal populations, negligible,
- as a zoonosis, to zoo staff, negligible, and
- in pinnipeds in the wild in Australian waters, serious to extreme.

d) Estimation of the risk associated with the identified hazard, as a combination of likelihood of entry, establishment and spread and the consequences

Phocine distemper virus has been identified as a hazard, with a high likelihood of entry and spread if unrestricted importation of live pinnipeds were permitted from endemic areas. The consequences of establishment would be most severe in captive or wild pinniped populations.

Risk management measures are warranted for this disease agent and are discussed in Chapter 4.

3.2.2 San Miguel Sea Lion virus (SMSV).

This is a Calicivirus, closely related antigenically to, and having the same infectivity for swine, as vesicular exanthema of swine virus (VESV).⁽¹⁹⁾ The virus has been recorded in a number of pinniped species.⁽¹⁰²⁾

There are many serotypes. Some infect fish and serologic surveys suggest that marine caliciviruses have a broad host range.^(19,102)

Another calicivirus, isolated from cetaceans, is also believed to infect Californian sea lions.⁽²¹⁾

SMSV was first isolated from Californian sea lions on San Miguel Island off the coast of California. Most isolations have been from this region, however it has been detected off the coast of Alaska, and more recently in seals off the coast of Cornwall in the UK.⁽⁸⁶⁾ In 1978 an extensive survey showed 0.1% of Northern fur seals off Alaska to have visible lesions attributed to SMSV, this contrasted to an earlier survey which estimated 2% of fur seals had lesions.⁽¹⁰²⁾ A 1984 outbreak in a California marine mammal centre resulted in 39 of 250 sea lions having lesions.⁽¹⁰²⁾ Northern fur seals are believed to become persistently infected in regions off the California coast that are believed to be a focus of calicivirus activity, and carry the infection north to the Bering Sea.^(19,102)

Small scale investigations in a colony of pinnipeds on the Victorian coast in the late 1970's revealed no calicivirus⁽³⁴⁾; and in 1978, 46 serum samples from southern elephant seal (*Mirounga leonina*) tested negative for five strains of SMSV using the serum neutralisation test (SNT).⁽⁶⁶⁾ In 1987 vesicular lesions were observed in the mouths of southern elephant seals on Macquarie Is, it is unknown if attempts at isolation or serology were made in this case.⁽¹³³⁾ The published literature did not reveal evidence of the virus in the Southern Hemisphere.

a) Virulence, infectivity and transmission

The disease is characterised by vesicular skin lesions that predominate on the flippers. Vesicles usually erupt leaving eroded epithelium. Abortion and diarrhoea also occur.⁽¹⁰²⁾

The usual portal of entry is presumed to be the oral cavity, but the widespread appearance of lesions on the skin and the occurrence of abortions suggests a haematogenous spread. Virus has been isolated from nose, throat, rectum and aborted fetuses. Virus has also been regularly isolated from apparently normal animals.⁽¹⁹⁾

Spread between marine mammals has occurred without direct contact, and it is believed that the animal handlers were the vectors for transmission.⁽¹⁰²⁾

The virus can survive for 14 days in seawater held at 15°C, suggesting the possibility of transmission through water.⁽¹⁰²⁾

Swine have been infected by several routes, including intradermal, intranasal and oral routes. The

single most important route of transmission of marine caliciviruses to terrestrial animals is believed to be the use of marine by-products in feedstuffs.⁽¹⁰²⁾ Swine fed infected seal carcasses developed clinical disease two days later.⁽¹⁰²⁾ In swine, virus shedding occurs shortly before and several days after vesiculation. Virus is shed in faeces, urine, nasal and oral secretions and from vesicles. Indirect transmission through feed, water and fomites has been demonstrated.⁽¹⁰²⁾

Experimental inoculation of a number of mammals, reptiles and fish species has led to infection.⁽¹⁰²⁾ Virus has been isolated from naturally infected healthy animals, and it was not known whether they were recovered animals or asymptomatic persistently infected animals.⁽¹⁰²⁾

Seal pups have shed the virus for up to 4 weeks.⁽¹⁹⁾

The virus is potentially zoonotic. Workers handling the agents have seroconverted, but overt disease did not occur.⁽¹⁹⁾

b) Likelihood of disease agent entry, establishment and spread

The virus has been shown to be spread by a number of routes, including direct contact, animal handlers and possible transmission through virus in sea water. It can infect fish, but apparently without being associated with a documented disease syndrome, thus fish may play a part in transmission in the marine environment.

The virus infects a range of pinniped species. Disease may be mild depending on serotype. Carrier animals have been reported. It appears that southern Californian waters are the central focus of calicivirus activity, and through migrations has spread as far north as the Bering Sea.⁽¹⁰²⁾ It was recently reported in seals on the coast of Cornwall in the UK.⁽⁸⁶⁾ The practice of bringing stranded animals into captive facilities, and the occasional transfer of some to display facilities is a route by which the virus can enter zoos.

In the absence of any preventive measures the likelihood of the disease agent entering Australia in an imported pinniped from an area where the disease is present is moderate, whereas from unaffected parts of the globe would be negligible. The likelihood of establishment and spread to other pinnipeds within the institution could be regarded as moderate.

The likelihood of spread of SMSV in Australia to the pig population is very low. It would have to involve the transport of infected material from within a zoo to domestic or feral pigs, Alternatively infection would need to spread first to native seal populations and from these sources into pig feed. Zoo management procedures make this highly unlikely.

The likelihood of spread to native seal populations is considered very low. The likelihood of establishment of the disease if it should be transmitted to native seal populations is high because eradication of disease in free ranging aquatic animals is probably not possible.

c) Biological, environmental and economic consequences of agent introduction and disease establishment in Australia

Although this virus has been shown to be capable of infecting other species, the two mammalian populations most at risk from the effects of this virus are pinnipeds and pigs. The virus has been isolated from fish, but does not appear to be associated with disease in these species.

Any outbreak of vesicular exanthema in pigs in Australia would have highly significant social and economic consequences, principally because of its similarity with foot and mouth disease. In this respect vesicular exanthema mimics the other vesicular diseases of pigs. The likely immediate

effect of an outbreak of vesicular exanthema in Australia would be a suspension of pig and ruminant exports; and exports of meat, dairy products and possibly wool, at least until FMD was convincingly ruled out but probably longer considering that the virus is absent from most other countries. The acceptance by Australia's trading partners of zoning may greatly reduce the economic impact of vesicular exanthema in the event of an incursion. However there is some uncertainty over whether and when the principle of zoning would be accepted.

Outbreaks of the SMSV in pinnipeds are characterised by abortions and skin lesions. In wild pinnipeds that breed once a year, or less often, widespread abortions could significantly reduce population numbers. It was an investigation of poor breeding performance that led to discovery of the virus. The consequence of introduction of SMSV into Australian native pinniped populations cannot be accurately predicted because there are no data on the susceptibility of these species to the virus. It would most likely affect fecundity among individual colonies. It is unlikely that eradication could be achieved in the wild.

To summarise, the estimated consequences of introduction and establishment of SMSV are:

- in a zoo collection (pinnipeds or suidae), serious;
- in domestic animal populations (pigs), serious
- as a zoonosis, to zoo staff, mild, and
- in pinnipeds in the wild in Australian waters, serious.

d) Estimation of the risk associated with the identified hazard, as a combination of likelihood of entry, establishment and spread and the consequences

SMSV presents a moderate likelihood of introduction via unrestricted importation from endemic areas, but from many regions the likelihood is very low. It presents a very low likelihood of spread to native seal populations and/or pig herds, but would result in serious consequences if this chain of events were to occur. On this basis, risk management measures are warranted for this agent, and are discussed in Chapter 4.

3.2.3 Influenza A virus.

The influenza virus isolated from seals most closely resembles the avian strains of influenza A. In the 1979 pneumonia epizootic along the New England coast of the Atlantic, the virus isolated was A/seal/Mass/1/80 (H7N7)⁽⁶⁷⁾. The 1991 and 1992 isolations from seals off the coast of Massachusetts were H4N6 and H3N3 viruses. H3 influenza virus is frequently detected in birds, pigs, horses and humans.⁽⁷⁰⁾

Antibodies to influenza viruses have been detected in harbour seals and grey seals. Different species of pinniped have different susceptibilities to the virus.⁽⁶⁷⁾

Interspecies transmission of influenza A viruses occurs relatively frequently, mainly from birds to mammalian species.⁽⁹¹⁾

All reports of seal mortalities caused by influenza A virus to date are from the Northern Hemisphere, in particular northern Atlantic areas.

a) Virulence, infectivity and transmission

The 1979-80 outbreak of seal influenza along the New England coast of the USA accounted for

the lives of more than 450 harbour seals, most of them immature. This virus, A/seal/Mass/1/80, had avian characteristics, replicated in mammals, and caused mild respiratory disease in experimentally infected seals. The seal strains of virus are genetically closer to avian strains than to mammalian strains, but they do not produce disease in birds. Primates have been experimentally infected and humans have developed conjunctivitis from handling infected seals.^(39, 91) Experimental adaptation of the virus can produce a strain pathogenic for chickens.⁽⁹⁴⁾

It has been suggested that passage of avian strains of influenza A virus through seals might be a step in the evolution of new mammalian strains.^(104,105)

Infection is probably by the respiratory route. Experimental infections have been achieved with intratracheal inoculation.⁽⁶⁷⁾ Virus was recovered from nasal washings of harp seals one to three days post inoculation and antibodies appeared one to three weeks post inoculation.⁽⁶⁷⁾

Concurrent infection with lungworm and bacterial infections, which are predisposing factors in swine, were ruled out by Geraci as predisposing factors in the Cape Cod outbreak in 1979, but population density and environmental factors may influence epizootics.⁽³³⁾ It has been suggested that mycoplasma may have triggered the epizootic.^(33,67)

The incubation period appears to be 3 days or less.^(4,33) Ducks have been shown to shed influenza virus for up to four weeks, but there is no evidence of persistent infection in birds.⁽⁹¹⁾ Webster, however, refers to persistent infections in pigs, but there is no indication whether this is on a population or individual animal basis.⁽⁹¹⁾ In seals lung lesions are apparent 2 days following experimental infection, and are most severe at 6 days.⁽⁶⁷⁾ Epizootics in seals have been associated with such acute disease that attempts at supportive care have been ineffective.⁽⁴⁾

Epidemics in seals tend to be self limiting.⁽⁹¹⁾

b) Likelihood of disease agent entry, establishment and spread

Because of the short incubation period, infected animals of a species highly susceptible to the virus would be detected quickly and would be unlikely to be imported. The greater risk would be from species with a moderate level of susceptibility that would allow virus replication and excretion without overt signs of disease.

The likelihood of introduction would be dependent on the species of the animal for import, and the prevalence of the virus in the source population whether captive or not, in the period shortly before export. Both of these variables make it impossible to make a single prediction on probability that would apply to all pinnipeds.

The short incubation period of seal influenza would mean that an introduced animal or a contact animal within a zoo would likely be detected quickly. However, the agent is highly infectious and containment may be difficult. The likelihood of infection reaching native populations would be low because of the low likelihood of exposure to imported animals.

In the event of a native animal becoming infected, the highly infectious nature of the virus would mean that, the probability of establishment of the disease is high.

c) Biological, environmental and economic consequences of agent introduction and disease establishment in Australia

Geraci *et al.* described the 1979-80 outbreak of influenza A in seals as an acute and devastating pneumonia. Mortalities up to 25% were reported from some harbour seal populations along the

New England coast in 1979-80.⁽³³⁾ This could be repeated if the local seal populations were similarly susceptible and the necessary chain of events occurred to introduce the virus to native animals.

Geraci *et al.* demonstrated three different levels of virulence in three different species of seals.⁽⁶⁷⁾ No data are available on the virulence of this virus for Australian native pinniped populations.

The immune status of the Australian native pinniped population is unknown, though from the literature available, it seems that local populations have, to date, been spared from influenza outbreaks. It is likely that the local populations would be immunologically naïve and highly susceptible.

An outbreak confined to zoo pinnipeds would have serious consequences for the susceptible species held in zoos. Natural transmission of seal influenza viruses to man has occurred.

To summarise, the estimated consequences of introduction and establishment of Influenza A virus are:

- in a zoo collection (pinnipeds), serious;
- in domestic animal populations, negligible;
- as a zoonosis, to zoo staff, mild, and
- in pinnipeds in the wild in Australian waters, serious.

d) Estimation of the risk associated with the identified hazard, as a combination of likelihood of entry, establishment and spread and the consequences

The likelihood of entry would vary with the source and species to be imported.

The likelihood of establishment within a zoo is moderate and the likelihood of establishment outside a zoo would be low.

The consequences if influenza A were introduced into a zoo collection and subsequently Australian pinniped populations, are potentially serious, but no data are available on which to make an accurate prediction.

In accordance with the matrix at Table 3, quarantine measures to reduce the risk associated with this agent are warranted.

3.2.4 Phocid herpesvirus (PhHV)

Two strains of this herpes virus have been identified, PhHV-1 and PhHV-2. The former is considered to be pathogenic, while the latter is not. PhHV-1 is closely related to feline herpesvirus (FHV-1), and Stenvers has suggested that FHV-1 may have been transmitted to seals via virus-contaminated sewage. It is also known as seal herpesvirus (SeHV).^(3,13, 71, 87, 89, 108)

Infected pinnipeds exhibit species variation in their expression of clinical disease and antibody production.^(71, 107, 108)

A herpesvirus in seals was first isolated from nine harbour seals during an outbreak of disease in a rehabilitation centre in the Netherlands in 1984. Eleven of 23 seals died in this outbreak.⁽⁷¹⁾

Serosurveys have indicated a high prevalence of PhHV-1 or closely related herpesviruses

worldwide.^(95, 107) There is evidence that Weddell and crabeater seals in Weddell Sea have been infected with a virus closely related to PhHV-1. Whilst the Weddell seals do not range widely, crabeater seals are less genetically isolated.^(106,107) Information on the status of this virus in pinnipeds in Australian waters is lacking.

The evidence is that the virus is unique to pinnipeds and not likely to be a zoonosis.⁽³⁾

a) Virulence, infectivity and transmission

High seal mortalities can result from infection with PhHV. Eleven of twenty three orphan seals infected by PhHV in a seal nursery died. The outbreak extended over a two month period. The cause of death was assumed to be a combination of extensive liver damage and pneumonia.⁽⁷¹⁾ Kennedy-Stoskopf, in commenting on the same occurrence, estimated the incubation period at 10-14 days.⁽⁴⁾

Experimental infections give rise to self limiting upper respiratory tract infections, however, in neonatal and immunocompromised animals these infections can be fatal.⁽⁹⁵⁾ In-contact animals also developed antibody titres, although none of the seals became seriously sick, two excreted virus, one on day 2 post inoculation and one on day 15.⁽⁹⁶⁾

Persistent infections, latent infections that re-activate and subclinical infections all occur. Factors such as age, host species and concomitant infections may play a part in the expression of the disease.^(3, 89) Abortion is common.⁽¹⁰⁸⁾

b) Likelihood of disease agent entry, establishment and spread

A three year serological survey in the Arctic regions to the east of Greenland and north of Scandinavia showed that 28-41% of harp seals and 4-7% of hooded seals were positive for herpesvirus.

There is a number of reports of outbreaks in captive facilities.

In the absence of any measures to reduce the risk, the likelihood of PhHV being introduced with imported pinnipeds would range from low to high. The level of risk would depend, *inter alia*, on whether or not the species was susceptible as in the case of harp seals, or relatively resistant as in the case of hooded seals.

Seal herpesvirus is present in a number of wild pinniped populations throughout the world. Its capacity to establish and persist has been demonstrated. The isolated nature of captive environments for pinnipeds would mean that level of exposure of native to captive pinnipeds is very low. However, if it were introduced into a wild population, the likelihood of establishment would be high.

The experience of Northern Hemisphere seal nurseries is that establishment follows introduction, therefore the likelihood of establishment within a zoo would be high.

c) Biological, environmental and economic consequences of agent introduction and disease establishment in Australia

In captive seals, deaths of the order of 50% have been recorded.⁽⁷¹⁾ For animals in the wild, serological data are available indicating that some species are very susceptible to infection. Harder reported that 100% of 25 Weddell seals tested were seropositive, and large numbers of seals in the colony were affected with respiratory disease at the time.⁽¹⁰⁷⁾

It is concluded that the potential of phocid herpesvirus to cause harm to Australian pinniped populations depends to a large extent on the susceptibility of the pinniped species and strain of the virus.

To summarise, the estimated consequences of introduction and establishment of Phocid herpesvirus are:

- . in a zoo collection (pinnipeds), serious;
- . in domestic animal populations, negligible;
- . as a zoonosis, to zoo staff, negligible, and
- . in pinnipeds in the wild in Australian waters, serious.

d) Estimation of the risk associated with the identified hazard, as a combination of likelihood of entry, establishment and spread and the consequences

In estimating the quarantine risk associated with this agent we have considered the high level of prevalence in some pinniped populations in the Northern Hemisphere and Antarctica; the lack of data on the status of the virus in Australia; the demonstrated ability of the virus to become established in native populations; and the unknown susceptibility of Australian species.

We acknowledge that the likelihood of exposure of native animals to imported animals is very low, but we believe it is not negligible.

Using the matrix at Table 3, the combination of a low risk of establishment with the serious consequences of establishment warrants the application of quarantine measures. These are discussed in Chapter 4.

3.2.5 Seal pox

Two pox virus genera have been implicated as a cause of seal pox, a *Parapoxvirus* and an *Orthopoxvirus*. Seal pox has been recorded in several species, and there are several occurrences of infection in humans.^(19, 24,27) Of the two, *Parapoxvirus* is more commonly associated with disease.⁽⁵¹⁾ The disease has been reported in wild and captive seals.

The literature indicates that reports are sporadic and not associated with major outbreaks of disease.

Earlier reports were all from North America, but *Parapoxvirus* was reported from a number of different locations in the UK between 1990-92 and is now said to occur in Europe and an isolated population in Lake Baikal.^(52, 53)

a) Virulence, infectivity and transmission

In spite of an apparently high standard of hygiene, a parapoxvirus virus infection spread through a number of seals in a rehabilitation centre over a 6-8 week period. The seals had been kept in isolation pens so that transmission would have been by aerosol or indirect contact.⁽⁵²⁾ In Canada, grey seal pups developed lesions 9-43 days after capture, which correlated with a previous report of harbour seals developing lesions 31-34 days post capture^(27, 52). Whether the animals were infected before or after capture was not discussed.

The distribution and severity of lesions varies.⁽⁵²⁾ Generally pox viruses do not appear to cause

systemic infections in pinnipeds, but some affected animals have died, presumably from complicating factors.^(4, 24)

Excoriation of the skin in concrete tanks is believed to predispose to infection.⁽⁵²⁾ Aerosols and arthropods are suggested as vectors.⁽²⁴⁾

Estimates of the incubation period range from 3-8 weeks.⁽⁵²⁾ The course of the disease can be about 15 weeks, and virus is probably shed from skin lesions until recovery is complete.⁽²⁴⁾

Seal pox viruses are known to infect man. The course of the disease is usually mild.⁽⁵²⁾

b) Likelihood of disease agent entry, establishment and spread

The literature indicates that the virus has appeared in widely separated pinniped colonies in the Northern Hemisphere, and in several different species. It is present in captive and wild populations. Infection in captive animals seems to be associated with the stress of capture and adjustment to a new environment in young animals.

In the absence of measures to prevent the introduction of this agent, the likelihood of its introduction in imported seals would be very low to moderate depending on the origin, species and age of the imported animal.

Seal pox occurs in natural and captive populations. If native animals were exposed to infection, it is considered the likelihood of establishment would be moderate.

c) Biological, environmental and economic consequences of agent introduction and disease establishment in Australia

Whilst seal pox is seldom fatal, it runs a protracted course and is often accompanied by concurrent disease. The value of individual pinnipeds in institutions in Australia means that the consequences of introduction of a debilitating disease would be medium for an individual institution. Seal pox does not appear to be a cause of major losses to wild pinniped populations and it is considered that the consequence of introduction in the wild would be mild.

The virus is a zoonosis and as such its introduction is undesirable.

To summarise, the estimated consequences of introduction and establishment of sealpox virus are:

- . in a zoo collection (pinnipeds), medium;
- . in domestic animal populations, negligible;
- . as a zoonosis, to zoo staff, mild, and
- . in pinnipeds in the wild in Australian waters, mild.

d) Estimation of the risk associated with the identified hazard, as a combination of likelihood of entry, establishment and spread and the consequences

The prevalence of seal pox in overseas captive facilities, the harmful effects of protracted disease on captive pinnipeds, and the lack of data on susceptibility of Australian native species warrant exclusion of this organism from Australia.

The risk of introduction, establishment and spread is low to moderate, while the consequences are mild to medium. Using the matrix at Table 3, it is concluded that quarantine measures for the

control of this agent are warranted (see Chapter 4).

3.2.6 Rabies

There is only one recorded occurrence of rabies in a pinniped, that of a wild pinniped in Norway.⁽⁴⁾

Rabies virus has wide distribution throughout the world, but has not manifest itself in wild or captive pinniped populations.

a) Virulence, infectivity and transmission

Rabies virus is present in saliva and is transmitted by bites from infected animals. It normally has a long incubation period. There are no recorded cases of pinnipeds transmitting rabies, and they are not considered to be vector animals.

b) Likelihood of disease agent entry, establishment and spread

The number of recorded occurrences of rabies in pinnipeds is one. The likelihood of a pinniped from a captive institution introducing rabies is negligible.

c) Biological, environmental and economic consequences of agent introduction and disease establishment in Australia

In the highly unlikely event of rabies being introduced by a pinniped and becoming established in Australia, the social and economic impact would be highly adverse in terms of initial efforts at control, vaccination of humans and animals and the social costs of having this much feared zoonosis present in the country.

d) Estimation of the risk associated with the identified hazard, as a combination of likelihood of entry, establishment and spread and the consequences

The likelihood of introduction, establishment and spread of this agent is considered negligible. According to the matrix at Table 3, no quarantine measures for this agent are warranted.

3.2.7 *Mycobacterium tuberculosis* complex

Tuberculosis in wild and captive pinnipeds in Australia is caused by a member of the *Mycobacterium tuberculosis* complex, most closely related to *M. bovis*, but antigenically distinct.^(28,38) Studies on isolates from wild seals from Australia^(126,127) and Argentina^(47,128) gave rise to the conclusion that isolates causing seal tuberculosis may be a particular subgroup within the *M. tuberculosis* complex, despite small differences detected between Australian and Argentinean strains using DNA fingerprinting techniques.⁽⁴⁷⁾ In cases of tuberculosis in pinnipeds in Australia, Argentina and NZ⁽¹²⁹⁾ the causative organism has been isolated using culture methods, and genetic tests using PCR have been used to characterise the isolates. In 1987 the isolation of *M. bovis* from six captive Southern sea lions (*Otaria byronia*) in Uruguay was reported, the method of identification in this case was histopathology and culture alone, so any genomic difference could not be detected.⁽¹²⁰⁾

Reports of tuberculosis in pinnipeds in the Northern Hemisphere appear limited to the diagnosis in a sea lion in France⁽¹³⁰⁾ and in a zoo in the UK⁽¹³¹⁾. Tuberculosis has been found in wild and captive populations of five pinniped species.⁽¹³²⁾ Prevalence in wild populations is unknown.⁽²⁸⁾

a) *Virulence, infectivity and transmission*

The course of the disease in seals can be short or chronic. Respiratory lesions are the most common, with liver and meningeal lesions predominating in some cases.^(10,28)

The case of a seal handler developing pulmonary tuberculosis from contact with infected seals⁽³²⁾ indicates that the seal strain of the agent may be spread by the aerosol route as occurs with human and bovine strains. As with all members of the *M. tuberculosis* complex, the agent is not species specific. To date it is known to infect five species of seals and humans.⁽³²⁾ It is likely other species of pinnipeds would be susceptible. No data are available on the infectivity of this agent for terrestrial mammals other than man.

b) *Likelihood of disease agent entry, establishment and spread*

There are limited data available on the prevalence of pinniped tuberculosis internationally. The majority of reports are from the Southern Hemisphere. It is considered that the likelihood of introduction of the agent is low.

The likelihood of spread to and establishment in domestic livestock is negligible.

Considering the history of tuberculosis affecting 10 out of 16 pinnipeds in a captive colony, the likelihood of spread and establishment in other zoo pinnipeds is high.⁽¹⁰⁾

Zoo staff would be at risk if the agent were introduced into a zoo.

c) *Biological, environmental and economic consequences of agent introduction and disease establishment in Australia*

Tuberculosis has been recorded in a wild Australian Fur Seal (*Arctocephalus pusillus doriferus*) from Tasmania, and in wild otariid seals (*Neophoca cinerea* and *Arctocephalus forsteri*) in Western Australia.^(8, 28) Tuberculosis has also been recorded in Australian Sea Lions and New Zealand Fur seals in captivity.⁽¹⁰⁾ The agent can be considered endemic in Australia, and its introduction is unlikely to have a significant impact on wild populations.

If tuberculosis were to become established in a captive institution in Australia, a large number of very valuable animals may have to be destroyed. Tuberculosis is a serious zoonosis and human tuberculosis is a notifiable disease in Australia. Its introduction into a captive facility could have serious consequences for staff.

The presence of this strain of tuberculosis in seals has not affected Australia's international acceptance as a country free from bovine tuberculosis. Tuberculosis in seals is believed to be caused by a different, but related organism to the agent of bovine tuberculosis.

To summarise, the estimated consequences of introduction and establishment of *Mycobacterium tuberculosis* virus are:

- . in a zoo collection (pinnipeds), medium;
- . in domestic animal populations, negligible;
- . as a zoonosis, to zoo staff, medium, and
- . in pinnipeds in the wild in Australian waters, the consequences are unlikely to change the current tuberculosis status.

d) *Estimation of the risk associated with the identified hazard, as a combination of likelihood of entry, establishment and spread and the consequences*

Whilst the risk of introduction is very low, the risk of establishment, if introduced, is high.

Quarantine measures for this agent are warranted. These are discussed in Chapter 4.

3.2.8 *Brucella* spp.

Evidence of *Brucella* infection in several different marine mammals in the Northern Hemisphere has been recently demonstrated. The isolates differ from known species.^(11,45,90) The surveys by Foster and Tryland indicate that *Brucella* infections of marine mammals may be fairly widespread.^(45,137)

a) *Virulence, infectivity and transmission*

The pathogenic effects of *Brucella* spp. in pinnipeds are unknown. It has not been recorded in association with any major disease outbreak.

b) *Likelihood of disease agent entry, establishment and spread*

One author indicated that *Brucella* spp. may be widespread in pinnipeds. On this basis entry of the agent would be likely. However, very few reports of *Brucella* isolations from pinnipeds exist, and it is concluded that it is of either very low prevalence or very low pathogenicity, or both. It is concluded that the likelihood of introduction, spread and establishment is very low.

c) *Biological, environmental and economic consequences of agent introduction and disease establishment in Australia*

Pinniped *Brucella* spp. have not been identified as the cause of any major disease outbreak in pinnipeds.

To summarise, the estimated consequences of introduction and establishment of *Brucellae* in pinnipeds are:

- . in a zoo collection (pinnipeds), negligible;
- . in domestic animal populations, negligible;
- . as a zoonosis, to zoo staff, mild, and
- . in pinnipeds in the wild in Australian waters, negligible.

d) *Estimation of the risk associated with the identified hazard, as a combination of likelihood of entry, establishment and spread and the consequences*

It is estimate that the risk of introduction, establishment and spread is very low and the consequences of this would be negligible to mild. Using the matrix at Table 3, quarantine measures for this agent are not warranted.

3.2.9 *Trichinella spiralis*

This nematode parasite is present in most of the colder and temperate regions of the Northern Hemisphere. Strain differences in *T. spiralis* have been demonstrated, and some believe there should be several distinct species, *T. spiralis* (the agent involved in the synanthropic-zoonotic cycle), *T. nativa* (occurring in a sylvatic cycle in carnivores in the subarctic regions), *T. nelsoni*

(mostly to be found in wild carnivores in Africa) and *T. pseudospiralis* (which has the widest host range and is present in Australia). Others believe all but *T. pseudospiralis* should be regarded as subspecies of *T. spiralis*^(112,121,124)

T. spiralis affects most mammals, but is found more commonly in carnivores and omnivores. Whilst *T. spiralis* is generally believed to be the agent common to swine and synanthropic animals, in some areas this parasite passes from domestic to sylvatic animals, and vice versa.⁽¹²⁵⁾

T. spiralis is recognised as the more serious zoonotic agent, and is not present in Australia. Ten to eighteen percent of cases reported to the Centre for Disease Control in the USA between 1987 and 1996 were associated with the eating of walrus meat.^(110,113,114) The risk associated with other Arctic seals appears to be much lower.⁽¹¹⁵⁾ In Canada, the syndrome in humans associated with eating walrus meat was observed to be different from classical trichinosis due to *T. spiralis*, and has been associated with *T. nativa*.

Arctic strains of *Trichinella* remain viable in frozen carcasses. Some believe freeze tolerance to be a characteristic of *T. nativa*, others believe that *T. spiralis* may be resistant to freezing.^(121,122)

a) Virulence, infectivity and transmission

The literature casts a degree of doubt on whether the *Trichinellae* found in walruses are the same species as the *T. spiralis* typically found in pigs. Pigs are highly susceptible to strains from domestic animals, but weakly susceptible to sylvatic strains. The reverse is the case for Arctic carnivores, e.g. polar bears and foxes.⁽¹²³⁾

The life cycle of *Trichinella* is unusual in that the same host serves as both definitive and intermediate host. Following ingestion of an infective cyst, larvae are released from the cyst and penetrate the intestinal mucosa. It is within the mucosal cells that the female produces juveniles that are carried away by the hepatoportal system through the liver, and then via the blood stream to various muscles. The juveniles enter muscle cells in which they become encysted and enter a period of dormancy until the muscle is eaten by the next host. The production of larvae in faeces has only been demonstrated in rats and mice. Some *Trichinellae* have adapted to surviving passage through fish, thus perpetuating the cycle in marine animals.^(109,110,112)

It has been shown that Arctic strains of *Trichinella* isolated from walruses are resistant to freezing.⁽¹¹¹⁾

b) Likelihood of disease agent entry, establishment and spread

The likelihood of wild caught animals, particularly the walrus of introducing this agent is moderate. The diet of captive bred animals would determine whether or not they were infected with *Trichinella*. Captive animals are frequently fed raw fish that have been frozen. This measure is believed to reduce the risk of parasites being acquired from the fish. The likelihood of a captive bred animal being infected is considered very low. Australian zoos have a policy of importing captive bred animals whenever possible.

Establishment and spread would only be possible if an imported pinniped, upon death, were eaten by rodents or other mammals. The production of free-living juveniles in the faeces by carnivores has not been demonstrated.

Whilst there is a very low likelihood of an imported pinniped being infected with *T. spiralis*, the consequent establishment of the agent is unlikely.

c) Biological, environmental and economic consequences of agent introduction and disease establishment in Australia

Of the susceptible domestic animals, pigs are the most commonly infected, but clinical effects are rarely seen.

Australia has established that it is free from *T. spiralis*, and our meat export trade is enhanced by this freedom. The consequences of introduction and establishment of this parasite would be a threat to the health of Australian meat consumers and disadvantage the meat export industry.

To summarise, the estimated consequences of introduction and establishment of *Trichinella* spp. in pinnipeds are:

- . in a zoo collection (pinnipeds), negligible;
- . in domestic animal populations, mild to medium;
- . as a zoonosis, to zoo staff, negligible;
- . as a zoonosis generally via the food chain, serious, and
- . in pinnipeds in the wild in Australian waters, negligible.

d) Estimation of the risk associated with the identified hazard, as a combination of likelihood of entry, establishment and spread and the consequences

AQIS concludes that the only risk associated with the importation live pinnipeds with regard to this parasite lies in the method of disposal of the carcasses of these animals after they die. Using the matrix at Table 3, AQIS concludes that since the risk of establishment and spread of this agent is negligible, quarantine measures are not warranted.

3.3 Exporting country factors

With the importation of live domestic animals and their products, AQIS frequently relies on information concerning the health status of the national herd. For countries free from a particular disease of concern, the test and quarantine requirements differ from those for a country not free from the disease in question. For non-domestic animals, and particularly those that range off the coast from one country/continent to another, accurate monitoring of disease status is not possible.

4. RISK MANAGEMENT

4.1 General

The ALOP, as defined in the SPS Agreement, is the level of protection deemed appropriate (as a sovereign right) by the member country establishing or reviewing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory. Risk management measures that are judged to be the minimum required to meet Australia's ALOP are specified.

The risk management measures set out below are believed, in each case, to meet the ALOP for that disease. In determining these measures, due consideration has been given to the predicted consequences of introduction and establishment of the agent in Australia. Thus, if the consequences of introduction and establishment are likely to be severe, the risk management measures applied must reduce the likelihood of introduction of the agent to a negligible level.

The tests recommended have, been used on pinnipeds and published results give some credence to these tests. AQIS will not rely on tests results alone to ensure the ALOP. These will be combined, as deemed appropriate, with information regarding the health status of pinnipeds in the exporting institution, and PEQ and PAQ.

All pinnipeds for export to Australia will be inspected for signs of ill health within 48 hours of embarkation. This is a general health requirement to ensure that animals are fit to travel. It is also applicable to specific agents listed below, and will not be repeated under each agent.

4.1.1 Evaluation of veterinary services of exporting country

The Veterinary Authority of the exporting country will be required to provide endorsement of sanitary certification issued by a qualified veterinarian closely associated with the captive facility from which the pinniped is sourced.

It is important that AQIS have confidence in the standard and integrity of the Veterinary Authority in the exporting country. AQIS has developed guidelines for the approval of countries to export live animals and animal products to Australia. These include an assessment of the Veterinary Authority and other official certifying authorities. These guidelines will be employed in determining whether particular countries will be approved to export pinnipeds to Australia.

Those countries that have a recent history of exporting live animals or genetic material to Australia in compliance with Australia's quarantine requirements will not require re-assessment.

4.1.2 Evaluation of exporting facilities

An outbreak of a canine distemper-like disease in an aquarium in Japan occurred when wild caught Lake Baikal seals were apparently introduced directly, without prior quarantine, to existing aquarium seals.⁽⁵⁷⁾ This highlights the need for AQIS to be aware of and have confidence in the normal operational procedures of the exporting facility.

Facilities wishing to export non-domestic animals to Australia will fall into one of three categories.

- . Those that have a history of exporting non-domestic animals to Australia in compliance with Australia's quarantine requirements. In the absence of any new unfavourable information, such trade would be permitted to continue.
- . Those that have no history of exporting non-domestic animals to Australia, but are sited in a country that exports other live animals to Australia in compliance with Australia's quarantine requirements. Approval of this facility to export pinnipeds to Australia would be dependent on assessment by either the Veterinary Authority in the country of export or by an AQIS appointed veterinary officer.
- . Those that have no history of exporting non-domestic animals to Australia, and are sited in a country that does not have a history of exporting any live animals to Australia. Approval of this facility would depend on assessment by an AQIS appointed veterinary inspector. In addition AQIS may require assessment of the Veterinary Authority prior to commencement of pre-export procedures and/or have the pre-export procedures supervised by an AQIS appointed veterinary officer.

Risk management procedures for some diseases may require PEQ and PAQ. The following sets out the standard of facility that AQIS will accept for performance of this quarantine.

4.1.2(a) Standard for pre-export quarantine facility

The PEQ facility must be inspected by a person employed by or appointed by AQIS or an approved Veterinary Authority who is satisfied that it complies with the following minimum standards:

1. The PEQ facility must be serviced by a water supply that is not in direct communication with pens used by other animals or any other source of animal effluent. The water must be clean and not pumped directly from a natural watercourse that is frequented by wild pinnipeds.
2. The PEQ facility must be sufficiently removed from other pinnipeds to prevent transfer of infectious agents in expired air, i.e. a distance that would prevent droplet infection. For practical purposes this would mean the PEQ facility would be under a different roof from facilities used by other pinnipeds.
3. The PEQ facility, whilst in use, must be either serviced by personnel who do not handle other pinnipeds, or serviced by staff who follow strict rules of disinfection prior to entry of the pinniped pen. This would include a change of exterior clothing and boots and thorough washing of hands.
4. All feeding and other utensils for animals in the PEQ facility must be for their use alone, and not used for other animals.

4.1.2(b) Standard for post-arrival quarantine (PAQ) facility

1. The PAQ facility must be sufficiently removed from other pinnipeds to prevent transfer of infectious agents in expired air, i.e. a distance that would prevent droplet infection. For practical purposes this would mean the PAQ facility would be under a different roof from facilities used by other pinnipeds.
2. Entry into the PAQ facility must be prohibited to all unauthorised persons, and visitor

entries recorded.

3. The PAQ facility must be serviced by a water supply that is not in direct communication with any other animal facility. The water used by the quarantine pinniped must not be pumped directly to a natural watercourse without prior sterilisation. Alternatively water may go directly into a municipal sewerage system.
 - Full records must be kept of maintenance of sterilising equipment and must be available to AQIS staff on request.
4. The PAQ facility, whilst in use, must be either serviced by personnel who do not handle other pinnipeds, or serviced by staff who follow strict rules of disinfection upon leaving the pinniped pen. This would include a change of exterior clothing and boots and thorough washing of hands.
5. All feeding and other utensils for animals in the PAQ facility must be for their use alone, and not used for other animals.

Release from the PAQ facility will be dependent on the animal having satisfied all health requirements as determined by the Director of Quarantine and passing a final examination of health by a veterinarian approved by AQIS.

4.2 Risk management options for specific disease agents

AQIS believes that an ALOP against each disease agent of concern will be met by the following requirements. Where the quarantine periods for different agents vary, the most stringent measure will be the one adopted.

4.2.1 Morbilliviruses

Options for managing the risk

For zoo pinnipeds and pinnipeds in the wild, the introduction and establishment of PDV would have serious consequences. In accordance with the risk evaluation matrix under section 3.1 risk management measures for this agent must reduce the likelihood of introduction to an very low level in order to meet Australia's acceptable level of protection.

The infective period for dogs is taken as two months. Research available to date shows seals may have a period of infectivity of 5 weeks. If quarantine alone were used, it would need to exceed the incubation period plus the period of infectivity.

Vaccines have been shown to be effective in preventing or reducing the severity of clinical disease, but not in preventing replication of the virus and its excretion by the challenged animal.^(16,46,79) It has also been demonstrated that post-exposure vaccination is ineffective.⁽⁵⁵⁾

AQIS considered the following options:

1. Animals may be sourced from regions of the world that have not reported cases of PDV. This option would severely limit the source of supply of specimens for Australian zoos.
2. Animals may be sourced from zoos that can reliably certify freedom from clinical phocine distemper.
3. A period of PEQ would prevent direct exposure to infected seals prior to export. This

total period of PEQ and PAQ would have to be equal to, or greater than the maximum incubation period plus infective period for PDV. To cover this, three months is recommended as a suitable minimum quarantine period. For an agent spread by aerosols and secretions such as PDV, the PEQ facility must house the quarantined pinniped under a separate roof from all other pinnipeds and be serviced by dedicated personnel who handle no other pinnipeds (or take appropriate biosecurity precautions) during the quarantine period.

4. A period of PAQ would reduce the likelihood of transmission via direct contact to pinnipeds in Australian zoos. For an agent spread by aerosols and secretions such as PDV, this facility must house the quarantined pinniped under a separate roof from all other pinnipeds and be serviced by dedicated personnel (or take appropriate biosecurity precautions) who handle no other pinnipeds during the quarantine period or for a period of time afterwards.
5. Serological tests for CDV-like antibodies by the use of serum neutralisation tests.
6. Vaccination has been shown to protect animals from clinical disease but not to prevent infection and virus excretion. This is the least satisfactory option.

Appropriate risk management option.

The serious nature of phocine distemper warrants quarantine measures to prevent an infected animal being introduced, even into a quarantine facility. The following risk reduction measures will be adopted so as to minimise the likelihood of introduction of phocine distemper virus to an acceptable level according to the ALOP:

- (a) Animals for export to Australia will only be sourced from zoos/captive facilities that can certify twelve months freedom from clinical phocine distemper.
- (b) Animals for export to Australia must spend a period of at least three months in a PEQ facility as described in section 4.1.2(a) of this document.
- (c) Animals for export to Australia must return a negative serum neutralisation tests for CDV-like antibodies on blood taken within 14 days of export.
- (d) On arrival in Australia the animal must spend 30 days in PAQ in a facility as described in section 4.1.2(b) of this document.

4.2.2 San Miguel sea lion virus

Options for managing the risk:

Virus has been isolated from both seropositive and seronegative animals. Seroconversion has occurred as early as day 2 from infection.⁽¹⁹⁾ Throat and rectal swabs, or fluid aspirated from vesicles are the best samples for virus isolation.⁽¹⁹⁾

Panels of typing sera and antigens for marine calicivirus identification are available in the United States. Serum neutralisation is type-specific, and will not demonstrate whether an animal has been infected with another calicivirus.⁽¹⁹⁾

In his 1987 review, Smith recommended 60 days PAQ for Pacific pinnipeds being admitted to captive facilities. The same review did not provide information on incubation periods. Pups can

excrete virus for four weeks. AQIS prefers PEQ as this alternative is designed to prevent the introduction of unwanted agents. PEQ of imported pinnipeds and adherence to strict hygiene procedures would reduce the likelihood of spread.

For zoo pinnipeds and pinnipeds in the wild, the introduction and establishment of SMSV would have serious consequences. In accordance with the risk evaluation matrix at Table 3, risk management measures for this agent must reduce the likelihood of introduction to a negligible level to be acceptable. Risk management options include the following:

1. Animals may be sourced from regions of the world that have not reported cases of SMSV. This option would limit the source of supply of specimens for Australian zoos. Further, in the absence of any formal disease reporting system for marine mammals, failure to notify cannot be taken as freedom from disease.
2. Animals may be sourced from zoos that can reliably certify freedom from SMSV (see sections 4.1.1 and 4.1.2), and which can demonstrate no contact with wild pinnipeds during the period of disease freedom.
3. A period of PEQ that prevents direct exposure to infected seals prior to export may be used. If quarantine were the only measure used, the total period of quarantine (PEQ and PAQ) would have to be greater than the maximum incubation period plus period of infectivity for SMSV. For an agent that may be spread by aerosols and secretions, this facility must house the quarantined pinniped under a separate roof from all other pinnipeds and be serviced by dedicated personnel who handle no other pinnipeds (or take appropriate biosecurity precautions) during the quarantine period. Smith recommended two months as a suitable quarantine period.⁽¹⁹⁾
4. A period of PAQ may be used to further reduce the likelihood of transmission via direct contact to pinnipeds in Australian zoos. This facility must house the quarantined pinniped under a separate roof from all other pinnipeds and be serviced by dedicated personnel who handle no other pinnipeds or Suidae (or take appropriate biosecurity precautions) during the quarantine period or for a period of one week afterwards.
5. Testing for presence of SMSV antibodies would involve testing for a range of approximately 20 different serotypes. This would involve practical difficulties.
6. Animals may be maintained under permanent quarantine surveillance to ensure that, upon death, carcasses are disposed of in such a manner as to prevent contact or consumption by pigs.

A satisfactory vaccine has not been developed so this is not listed as an option.

Appropriate risk management option.

Whilst serology is possible, there is a large number of serotypes that do not cross react and this would make screening by this method impractical. AQIS recommends, to minimise the likelihood of introducing SMSV, the following quarantine measures be adopted:

- (a) Animals for export to Australia will only be sourced from zoos/captive facilities that can certify two years freedom from San Miguel sea lion virus, and have not permitted the introduction of wild pinnipeds during that period.
- (b) Animals for export to Australia must spend a period of at least two months in a PEQ

facility as described in section 4.1.2(a) of this document.

- (c) On arrival in Australia the animal must spend 30 days in PAQ in a facility as described in section 4.1.2(b) of this document.
- (d) Following release from quarantine, the animal must remain under quarantine surveillance, and upon death, the carcass to be disposed of in an approved manner.

4.2.3 Influenza A virus.

Options for managing the risk

For zoo pinnipeds and pinnipeds in the wild, the introduction and establishment of influenza A virus would have serious consequences. In accordance with the risk evaluation matrix at Table 3, risk management measures for this agent must reduce the risk of introduction to a negligible level in order to meet Australia's acceptable level of protection.

The disease is acute and diagnosis has been confirmed by virus isolation, usually on autopsy specimens.

The existence of carrier animals has not been suggested, and tests for the detection of carriers do not appear necessary.

Antibodies appear some time after virus is excreted in nasal mucus, so tests for antibodies would not detect infectious animals in the early stage of the disease.

Countries of export may not be able to certify to the disease status of free ranging animals in waters adjacent to their coast. Animals within zoos are, however, closely observed, and some zoos may be able to reliably certify whether the premises has been free from seal influenza for a period of time prior to export.

A declaration of disease freedom within a zoo would only be acceptable if there had been no introductions to the zoo over a period of time exceeding the incubation period of the virus, or the pinniped for export was isolated from all other pinnipeds for a similar period of time.

Vaccines are not available.

The options for managing the risk may be summarised as follows.

1. Animals may be sourced from regions free from the disease.
2. Animals may be sourced from institutions that can reliably certify freedom from the disease.
3. Animals may be placed in quarantine for a period of time prior to export; that period must exceed the known incubation and infective period for the virus.
4. Animals may be placed in quarantine after arrival for a similar period of time.

Appropriate risk management option.

Influenza A infection in pinnipeds has a very short incubation period before clinical signs appear. Different species have differing susceptibilities. No evidence was found for persistent infections in pinnipeds. All the following risk reduction measures are included for this agent:

- (a) Animals for export to Australia be sourced from zoos/captive facilities that can certify three

months freedom from influenza A infection in pinnipeds.

- (b) Animals for export to Australia must spend a period of at least one month in a PEQ facility as described in section 4.1.2(a) of this document.
- (c) On arrival in Australia the animal must spend 30 days in PAQ in a facility as described in section 4.1.2(b) of this document.

4.2.4 Phocid herpesvirus

Options for managing the risk

Species variation exists in the susceptibility of pinnipeds to this virus. Diagnosis of diseased animals has mostly been by isolation of the virus from autopsy specimens.⁽³⁾ Antibodies may be detected by serum neutralisation tests.⁽⁸⁷⁾ In view of the potential for sub-clinical and persistent infections, and latent infections that re-activate, any seropositive animal should be considered as infectious.

A recombinant vaccine is under development.^(95,106)

Options for risk management include:

1. Animals may be sourced from regions known to be free from the disease, but this measure would be reliant on scant data.
2. Animals may be sourced from zoos/institutions that have been free from the disease for a period of 12 months.
3. Animals intended for export to Australia may be tested by a serum neutralisation test for evidence of exposure to the virus.
4. Animals may be placed in quarantine prior to export and again after arrival. Given that latent, persistent and subclinical infections occur, this measure on its own would not necessarily be effective.

Appropriate risk management option.

The following risk management measures, used together, are considered necessary to minimise the risk associated with phocid herpesvirus.

- (a) Animals for export to Australia be sourced from zoos/captive facilities that can certify twelve months freedom from phocid herpesvirus.
- (b) Animals for export to Australia must spend a period of at least two months in a PEQ facility as described in section 4.1.2(a) of this document.
- (c) Animals for export to Australia must return a negative serum neutralisation test for PhHV-1 and PhHV-2 antibodies, conducted within 14 days of export.
- (d) On arrival in Australia the animal must spend 30 days in PAQ in a facility as described in section 4.1.2(b) of this document.
- (e) The imported pinniped remain permanently in a facility that precludes contact with pinnipeds destined to return to the wild.

4.2.5 Seal pox

Options for managing the risk

Seal pox has an incubation period up to 8 weeks. The virus has been spread between seals that were in pens isolated from one another, but under the same roof. Infected animals have been shown to excrete virus for up to 18 weeks.

During an outbreak of seal pox, paired serum samples collected two months apart showed the appearance of parapoxvirus-specific antibodies when subjected to an indirect immunofluorescence assay (IFA).⁽⁵³⁾ In spite of this, the use of serology for screening incoming animals for infection does not appear to be in general use.

In 1987 Smith⁽¹⁹⁾ said that vaccines had not been tried at that stage. Since then little has come to light regarding the development of a vaccine, so this option has not been included.

1. Animals may be sourced from countries/regions free from seal pox. It is doubtful that sufficient data are available about wild populations for such certification to be reliable.
2. Animals may be sourced from institutions that can reliably certify to freedom from seal pox for a specified period of time prior to export. Seal pox follows a protracted course, in some cases 18 weeks.⁽¹⁹⁾ There are no data on the survivability of seal pox virus in the environment, but other pox viruses are stable for many months.
3. Animals may spend a period of time in quarantine prior to export, sufficient to allow the expression of disease if an animal were incubating at the time of commencement of quarantine. This must be greater than 8 weeks. Smith⁽¹⁹⁾ recommended the separation of diseased animals for a minimum of 18 weeks, or until complete recovery of affected animals. This relates to the length of time an infected animal excretes virus, and is not related to the incubation period. Quarantine, if used alone should be at least as long as the incubation plus infective periods.

Appropriate risk management option.

PAQ alone may be insufficient as a risk management measure because spread of the virus between animals isolated from each other has been demonstrated. However, a period of PAQ should be considered in conjunction with other measures. The following measures used together are considered to meet Australia's ALOP.

- (a) Animals for export to Australia be sourced from zoos/captive facilities that can certify twelve months freedom from seal pox.
- (b) Animals for export to Australia must spend a period of at least 10 weeks in a PEQ facility as described in section 4.1.2(a) of this document.
- (c) On arrival in Australia the animal must spend 30 days in PAQ in a facility as described in section 4.1.2(b) of this document.

4.2.6 *Mycobacterium tuberculosis*

Options for managing the risk.

Tuberculosis in pinnipeds has been detected on autopsy in animals that appeared clinically normal.⁽¹¹⁹⁾ It has a long incubation period. Very young animals may fail to react to tests.⁽¹¹⁸⁾

Tuberculosis in pinnipeds may run a protracted course.⁽¹⁰⁾ For an institution to claim freedom from tuberculosis there would need to have been no cases for a considerable period. For ruminants AQIS has chosen a minimum of three years, accompanied by a rigorous testing regimen.

No formal surveillance programs are in place for free-ranging animals and clinical disease is not manifest until the advanced stages of the disease; thus the concept of sourcing animals from countries/zones free from tuberculosis is not practical.

1. Tuberculosis in pinnipeds may run a protracted course.⁽¹⁰⁾ For an institution to claim freedom from tuberculosis there would need to have been no clinical cases for a considerable period, with proper investigation of all deaths.
2. Quarantine alone as a risk management measure would need to extend over some months to cover the period from infection to expression of the disease. However, a period of PEQ should be used in conjunction with other measures, to ensure that animals for export are not placed in contact with animals of unknown status.
3. The intradermal tuberculin test has been used on pinnipeds, and was moderately effective in detecting cases with gross pathological lesions. Very young animals and animals in the very early stages of infection may not react.⁽¹¹⁸⁾ The results were described as promising but were not statistically significant.⁽¹⁰⁾ In order to detect animals that may have early infections when tested, a second test 3-6 months later would need to be conducted.
4. Woods recommends the use of an ELISA on serum or PCR on tissues or sputum for wild animals to avoid the double handling involved in the intradermal test.⁽²⁸⁾ The sensitivity of the ELISA appears to be similar to the intradermal test and would probably not contribute more than the intradermal alone.⁽¹¹⁰⁾
5. Chest X-rays would detect pulmonary lesions. These tests could only be performed under anaesthesia, which presents a risk particularly to phocid seals, and appears to be no more accurate than the intradermal test.⁽¹¹⁸⁾
6. PAQ can be used in addition to PEQ, especially as this agent has a long incubation period.

Appropriate risk management option.

AQIS considers that Australia's ALOP will be achieved by the application of the following measures:

- (a) Animals for export to Australia will only be sourced from zoos/captive facilities that can certify that:
 - (i) there has been no case of tuberculosis in pinnipeds during the past 6 years, and
 - (ii) the pinnipeds have not been handled by a human infected with tuberculosis during this period, and
 - (iii) all deaths in pinnipeds have been investigated by a qualified veterinarian during this period, and
 - (iv) any tests for tuberculosis that may have been conducted in this period have been negative.
- (b) Animals for export to Australia must spend a period of at least 120 days in a PEQ facility

as described in section 4.1.2(a) of this document.

- (c) On arrival in Australia the animal must spend 30 days in PAQ in a facility as described in section 4.1.2(b) of this document.

5. REFERENCES

1. Shaughnessy P (1998) "Action Plan for Australian Pinnipeds" in press.
2. Dunn JL (1990) "Bacterial and mycotic diseases of Cetaceans and Pinnipeds." IN *CRC Handbook of Marine Mammal Medicine: Health, Disease and Rehabilitation* (Dierauf, LA ed. CRC Press, Boca Raton, Florida, publ.) Chapter 3, pp 73-87.
3. Dierauf LA (1990) "Marine mammal parasitology." IN *CRC Handbook of Marine Mammal Medicine: Health, Disease and Rehabilitation* (Dierauf, LA ed. CRC Press, Boca Raton, Florida, publ.) Chapter 4, pp 89-96.
4. Kennedy-Stoskopf S (1990) "Viral diseases in marine mammals." IN *CRC Handbook of Marine Mammal Medicine: Health, Disease and Rehabilitation* (Dierauf, LA ed. CRC Press, Boca Raton, Florida, publ.) Chapter 5, pp 97-113.
5. Baker JR (1987) "Causes of mortality and morbidity in wild juvenile and adult Grey seals (*Halichoerus grypus*)." *Brit. vet. J.* **143**: 203-220.
6. Bergin TJ (1976) "Stranded marine mammals." *Aust. Vet. Pract.* **March**: 41-45.
7. Cordes DO and O'Hara PJ (1979) "Diseases of captive marine mammals" *N.Z. vet J.* **27**: 147-150.
8. Cousins DV and Williams SN (1993) "Tuberculosis in wild seals and characterisation of the seal bacillus." *Aust. Vet. J.* **70**(3): 92-97.
9. Dunn JL, Buck JD and Spotte S (1984) "Candidiasis in captive pinnipeds." *J.A.V.M.A.* **185**(11): 1328-1330.
10. Forshaw D and Phelps GR (1991) "Tuberculosis in a captive colony of pinnipeds." *J. Wildlife Dis.* **27**(2): 288-295.
11. Garner MM, Lambourn DM *et al.* (1997) "Evidence of *Brucella* infection in *Parafilaroides* lungworms in a Pacific harbour seal (*Phoca vitulina richardsi*)." *J. Vet. Diag. Investigation* **9**(3): 298-303.
12. Geraci JR and St Aubin DJ (1987) "Effects of parasites on marine mammals." *International Parasitology*, **17**(2): 407-414.
13. Harder TC, Harder M *et al.* (1996) "Characterisation of phocid herpesvirus-1 and -2 as putative alpha- and gammaherpesviruses of North American and European pinnipeds." *J. Gen. Virol.* **77**: 27-35.
14. Kennedy S, Smyth JA *et al.* (1990) "The 1988 European seal morbillivirus epizootic." *Society for Veterinary Epidemiology and Preventive Medicine. Proceedings of a meeting held at the Queen's University, Belfast, April 4th, 5th and 6th 1990.* pp. 101-111.
15. Nicholson A and Fanning JC (1981) "Parasites and associated pathology of the respiratory tract of the Australian sea lion." *Proc. 4th Int. Conf. of the Wildlife Disease Association.* Sydney, Australia, August 25-28, 1981.
16. Osterhaus ADME, Groen J *et al.* (1990) "Mass mortality in seals caused by a newly discovered virus-like morbillivirus." *Vet. Microbiol.* **23**: 343-350.
17. Osterhaus A, Groen J and Niesters H (1997) "Morbillivirus in monk seal mass mortality." *Nature* **388** (6645): 838-839.
18. Phillips PH, Davenport PK and Schultz DJ (1986) "*Microsporium gypseum* dermatophytosis in Captive Australian sea lions, *Neophoca cinerea*." *J. Zoo Med.* **17**(4): 136-138.
19. Smith AW, Appel MJ (1987) "Virus infections of pinnipeds." *Virus infections of vertebrates. I. Virus infections of carnivores*, (publ. Elsevier; Amsterdam, Netherlands) pp. 471-489.
20. Smith AW, Neylan A *et al.* (1978) "Hazards of disease transfer from marine mammals to land mammals: review and recent findings." *J.A.V.M.A.* **173**: 1131-1225.
21. Smith AW, Skilling DE and Ridgway S, (1983) "Calicivirus-induced vesicular disease in cetaceans and

- probable interspecies transmission." *J.A.V.M.A.* **183**(11): 1223-1225.
22. Smith AW, Prato CM *et al.* (1974) "A preliminary report on potentially pathogenic microbiological agents recently isolated from pinnipeds." *J. Wildlife Dis.* **10**: 54-59.
 23. Sweeney JC, Migaki G *et al.* (1976) "Systemic mycoses in marine mammals." *J.A.V.M.A.* **169**(9): 746-748.
 24. Visser IKG, Teppema JS and Osterhaus ADME (1991) "Virus infections of seals and other pinnipeds." *Rev. in Med. Microbiol.* **2**: 105-114.
 25. Visser IKG, van Bresselem MF *et al.* (1993) "Prevalence of morbilliviruses among pinniped and cetacean species." *Rev. sci. tech. Off. int. Epiz.* **12**(1): 197-202.
 26. Walker GE and Ling JK; (1981) "New Zealand sea lion *Phocarcos hookeri*." In *Handbook of marine mammals* (publ. Academic Press, London; New York) Vol 1., 25-38.
 27. Hicks BD and Worthy GAJ (1987) "Sealpox in captive grey seals (*Halichoerus grypus*) and their handlers." *J. Wildlife Dis.* **23**(1) 1-6.
 28. Woods R, Cousins DV *et al.* (1995) "Tuberculosis in a wild Australian Fur Seal (*Arctocephalus pusillus doriferus*) from Tasmania." *J. Wildlife Dis.* **31**(1): 83-86.
 29. Beveridge I (1980) "*Uncinaria hydromidis* sp. N. (Nematoda: Ancylostomatidae) from the Australian Water Rat, *Hydromys chrysogaster*." *J. Parasitol.* **66**(6): 1027-1031.
 30. Arundel JH (1978) "Parasites and parasitic diseases of Australian marine mammals." *Proceedings No 36, Part B, course for veterinarians: University of Sydney Post Graduate Committee in Veterinary Science.* pp 323-333.
 31. Keys MC (1965) "Pathology of the Northern Fur Seal." *J.A.V.M.A.* **146**(10): 1090-1095.
 32. Thompson PJ, Cousins DV *et al.* (1993) "Seal, seal trainers and Mycobacterial infections." *Am. Rev. Respir. Dis.* **147**: 164-167.
 33. Geraci JR, St Aubin DJ *et al.* (1982) "Mass mortality of Harbour Seals: Pneumonia Associated with Influenza A virus." *Science* **215**: 1129-1131.
 34. Norman RJ deB. (1995) "Disease in free living Australian Seals: an examination of the knowledge gulf." *Proceedings of the 1995 Annual Conference of the Australian Association of Veterinary Conservation Biologists.* (Melbourne, May 1995).
 35. Heide-Jørgensen M-P; Härkönen T *et al.* (1992) "Retrospective of the 1988 European seal epizootic." *Dis. Aquatic Org.* **13**: 37-62.
 36. Harwood J and Hall A (1990) "Mass mortality in marine mammals: its implications for population dynamics and genetics." *Trends in Ecology and Evolution.* **5**: 254-257.
 37. Haebler R (1992) "Disease risk to wildlife following reintroduction" *Proceedings Joint Meeting AAZV/AAWV.*
 38. Cousins D (1995) "Tuberculosis in seals in Australia" *Proceedings of the 1995 Conference of the Australian Association of Veterinary Conservation Biologists.* Melbourne, May, 1995. pp 51-57.
 39. Webster RG, Geraci J *et al.* (1981) "Conjunctivitis in human beings caused by influenza A virus of seals." *New England J. Med.* **303**(21): 911.
 40. Johnston TH and Mawson PM (1945) "Parasitic nematodes." *B.A.N.Z.A.R.E. Reports, Series B, Vol V, Part 2.* pp 73-160.
 41. Geraci JR and Lounsbury VJ, (1993) *Marine Mammals Ashore - a Field Guide for Strandings* (Texas A&M Sea Grant Publication, Galveston, Texas)
 42. Forsyth MA, Kennedy S *et al.* (1998) "Canine distemper virus in a Caspian Seal." *Vet. Rec.* **143**: 662-664.
 43. Harder T, Willhaus Th. *et al.* (1990) "Morbillivirus infections of seals during the 1988 epidemic in the Bay of Heligoland: III Transmission studies of cell culture-propagated phocine distemper virus in

- Harbour Seals (*Phoca vitulina*) and Grey Seal (*Halichoerus grypus*): clinical, virological and serological results." *J. Vet. Med.* **37**: 641-650.
44. Duignan PJ, Neilsen O *et al.* (1997) "Epizootiology of morbillivirus infection in harp, hooded and ringed seals from the Canadian Arctic and Western Atlantic." *J. Wildlife Dis.* **33**(1): 7-19.
 45. Foster G, Jahans KL, *et al.* (1996) "Isolation of *Brucella* species from cetaceans, seals and an otter." *Vet. Rec.* **138**:583-586.
 46. Van Bresse MF, De Meurichy J *et al.* (1991) "Attempt to vaccinate orally harbour seals against phocid distemper." *Vet. Rec.* **129**: 362.
 47. Romano MI, Alito A *et al.* (1995) "Genetic characterisation of mycobacteria from South American wild seals." *Vet. Microbiol.* **47**: 89-98.
 48. Bengston JL and Boveng P (1991) "Antibodies to canine distemper virus in Antarctic seals." *Marine Mammal Sci.* **7**(1): 85-87.
 49. Vedros NA, Smith AW *et al.* (1971) "Leptospirosis epizootic among California sea lions." *Science* **172**: 1250-1251.
 50. Cawthorn MW (1994) "Seal finger and mycobacterial infection of man from marine mammals: occurrence, infection and treatment." *Conservation Advisory Science Notes No. 12.* Dept of Conservation, Wellington.
 51. Osterhaus ADME, Broeders HWJ *et al.* (1990) "Isolation of an orthopoxvirus from pox-like lesions of a grey seal (*Halichoerus grypus*)." *Vet. Rec.* **127**: 91-92.
 52. Simpson VR, Stuart NC *et al.* (1994) "Parapox infection in grey seals (*Halichoerus grypus*) in Cornwall." *Vet. Rec.* **134**: 292-296.
 53. Osterhaus ADME, Broeders HWJ *et al.* (1994) "Isolation of a parapoxvirus from pox-like lesions in grey seals." *Vet. Rec.* **135**: 601-602.
 54. Laws RM and Taylor RJF (1957) "A mass dying of crabeater seals, *Lobodon carcinophagus* (Gray)" *Proc. Zoological Soc. Lond.* **129**: 315-324.
 55. Visser IKG, Vedder EJ *et al.* (1992) "Canine distemper virus ISCOMs induce protection in harbour seals (*Phoca vitulina*) against phocid distemper but still allow subsequent infection with phocid distemper virus-1." *Vaccine* **10**: 435-438.
 56. Bossart, GD and Schwartz JC (1990) "Acute necrotising enteritis associated with suspected coronavirus infection in three harbour seals (*Phoca vitulina*)." *J. Zoo and Wildl. Med.* **21**(1): 84-87.
 57. Nunoya T, Tajima M. *et al.* (1990) "Occurrence of a canine distemper-like disease in aquarium seals." *Jap. J. Vet. Sci.* **52**(3): 469-477.
 58. Cornwell HJC, Anderson SS *et al.* (1992) "The serological response of the common seal (*Phoca vitulina*) and the grey seal (*Halichoerus grypus*) to phocine distemper virus as measured by a canine distemper virus neutralisation test." *Sci. of the Total Env.* **115**: 99-116.
 59. Buck JD and Spotte S (1986) "The occurrence of potentially pathogenic vibrios in marine mammals." *Marine Mammal Sci.* **2**(4): 319-324.
 60. Borgsteede FHM, Bus HGJ *et al.* (1991) "Endoparasitic helminths of the harbour seal, *Phoca vitulina* in the Netherlands." *Netherlands J. of Sea Res.* **28**(3): 247-250.
 61. Rose K (1999) Pers. comm. (email communication dated 17/01/99).
 62. Baker JR (1989) "Natural causes of death in non-suckling grey seals (*Halichoerus grypus*)." *Vet. Rec.* **125**: 500-503.
 63. Baker JR, Hall A *et al.* (1995) "Isolation of salmonellae from seals from UK waters." *Vet. Rec.* **136**: 471-472.
 64. Jager M, Liess T *et al.* (1990) "Experimental inoculation of Beagle dogs permits serological differentiation of phocine and canine distemper virus." *Siener Teirärztliche Monatsschrift* **77**: 105-108.

65. Svansson V, Blixenkroner-Møller M *et al.* (1993) "Infection studies with canine distemper virus in harbour seals." *Acrch. Virol.* **131**: 349-359.
66. Morgan IR, Caple IW *et al.* (1978) "Disease investigations of penguins and elephant seals on Macquarie Island." *Res. Project Series* No 47, April 1978, (a joint investigation carried out by the Animal Health Group, Department of Agriculture, Victoria and the Antarctic Division, Department of Science.
67. Geraci JR, St Aubin DJ *et al.* "Susceptibility of Grey (*Halichoerus grypus*) and Harp (*Phoca groenlandica*) seals to the influenza virus and Mycoplasma of epizootic pneumonia of harbour seals (*Phoca vitulina*)." *Can. J. Fish. Aquat. Sci.* **41**: 151-156.
68. Gorman JR (1966) "The epizootiology of distemper" *J.A.V.M.A.* **149**(3) 610-622.
69. Sweeney JC (1973) "Management of pinniped diseases" *Am. Ass. Zoo. Vet. An. Proc.* 1972/73, 141-171.
70. Callan R, Early G *et al.* (1995) "The appearance of H3 influenza viruses in seals." *J. Gen. Virol.* **76**: 199-203.
71. Borst GHA, Walvoort HC *et al.* (1986) "An outbreak of a herpesvirus infection in harbour seals (*Phoca vitulina*)." *J. Wildl. Dis.* **22**(1): 1-6.
72. Kennedy Stoskopf S, Stoskopf MK *et al.* (1986) "Isolation of a retrovirus and a herpesvirus from a captive California sea lion (*Zalophus californianus*)". *J. Wildl. Dis.* **22**(2): 156-164.
73. Harder TC, Vos H *et al.* (1997) "Age related disease in recurrent outbreaks of phocid herpesvirus type-1 infections in a seal rehabilitation centre: evaluation of diagnostic methods." *Vet. Rec.* **140**: 500-503.
74. Kirchhoff H, Binder A *et al.* (1989) "Isolation of mycoplasmas from diseased seals." *Vet. Rec.* **124**: 513-514.
75. Heide-Jørgensen MP and Härkönen T (1992) "Epizootiology of the seal disease in the eastern North Sea." *J. Appl. Ecol.* **9**(1): 99-107.
76. Dierauf LA, Vandenbroek DJ *et al.* (1985) "An epizootic of leptospirosis on California sea lions." *J.A.V.M.A.* **187**:1145-1148.
77. Bernardelli A, Bastida R *et al.* (1996) "Tuberculosis in sea lions and fur seals from the south-western Atlantic coast." *Rev. Sci. Tech. Off. Int. Epiz.* **15**(3): 985-1005.
78. Hall, AJ, Pomeroy PP and Harwood J. (1992) "The descriptive epizootiology of phocine distemper in the UK during 1988/89." *Sci. Tot. Environ.* **115**: 31-44.
79. Visser IKG, van der Bildt MWG *et al.* (1989) "Vaccination of harbour seals (*Phoca vitulina*) against phocid distemper with two different inactivated canine distemper virus (CDV) vaccines." *Vaccine* **7**: 521-526.
80. Osterhaus ADME, Groen J *et al.* (1988) "Canine distemper virus in seals." *Nature* **355**: 403-404.
81. Harwood J (1990) "What have we learned from the 1988 seal epidemic." *Biologist* **37**(1): 7-8.
82. Hsu C-K, Melby EC *et al.* (1974) "Coccidiosis in Harbour seals" *J.A.V.M.A.* **164**: 700-701.
83. Sweeney JC (1974) "Common diseases of pinnipeds." *J.A.V.M.A.* **165**: 805-810.
84. Wells SK, Gutter A and Van Metter K (1990) "Cutaneous mycobacteriosis in a harbour seal: attempted treatment with hyperbaric oxygen." *J. Zoo and Wildl. Med.* **21**(1): 73-78.
85. Ross PS, Visser IKG *et al.* (1992) "Antibodies to phocine distemper virus in Canadian seals." *Vet. Rec.* **130**: 514-416.
86. Stack MJ, Simpson MJ and Scott AC (1993) "Mixed poxvirus and calicivirus infections of grey seals (*Halichoerus grypus*) in Cornwall." *Vet. Rec.* **132**: 163-165.
87. Stuen S, Have P *et al.* (1994) "Serological investigation of virus infections in harp seals (*Phoca groenlandica*) and hooded seals (*Cystophora cristata*)." *Vet. Rec.* **134**: 502-503.
88. Olsen OW and Lyons ET (1965) "Life cycle of *Uncinaria lucasi* Stiles, 1901 (Nematoda: Ancylostomatidae) of fur seals, *Callorhinus ursinus* Linn., on the Pribilof Islands" *J. Parasitol.*

- 51(5): 689-700.
89. Lebach M, Harder TC *et al.* (1994) "Comparative immunological characterization of thy-specific and conserved B-cell epitopes of pinniped, felid and canid herpesviruses." *Arch. Virol.* **136**: 335-347.
 90. Nielsen O, Neilsen K and Stewart RE (1996) "Serologic evidence of *Brucella* spp. exposure in Atlantic walruses (*Odobenus rosmarus rosmarus*) and ringed seals (*Phoca hispida*) of Arctic Canada." *Arctic* **49**(4):383-386.
 91. Webster RG, Bean WJ *et al.* (1992) "Evolution and ecology of influenza A viruses." *Microbiol. Rev.* **56**(1): 152-179.
 92. Fagerholm H-P and Gibson DI (1987) "A redescription of the pinniped parasite *Contraecaecum ogmorhini* (Nematoda, Ascaridoidea), with an assessment of its antiboreal circumpolar distribution." *Biologica Scripta* **16**(1): 19-24.
 93. Blixenkroner-Møller M, Svansson V *et al.* (1989) "Infection studies in mink with seal-derived morbillivirus." *Arch. Virol.* **106**: 165-170.
 94. Shengqiang LI, Orlich M and Rott, R (1990) "Generation of seal influenza virus variants pathogenic for chickens, because of haemagglutinin cleavage site changes." *J. Virol.* **64**(7): 3297-3303.
 95. Harder TC and Osterhaus ADME (1997) "Molecular characterization and baculovirus expression of the glycoprotein B of a seal herpesvirus (Phocid Herpesvirus-1)." *Virology* **227**: 343-352.
 96. Horvat B, Willhaus T *et al.* (1989) "Herpesvirus in harbour seals (*Phoca vitulina*): transmission in homologous host." *J. Vet. Med.* **36**: 715-718.
 97. Visser IKG, Vedder JG *et al.* (1993) "Continued presence of phocine distemper virus in the Dutch Wadden Sea seal population." *Vet. Rec.* **133**: 320-322.
 98. Watts, M (1995) "*E. coli* O101 isolated from common seals." *Vet. Rec.* **137**: 356.
 99. Blixenkroner-Møller M, Svansson V *et al.* (1990) "Phocid distemper virus - a threat to terrestrial mammals?" *Vet. Rec.* **127**: 263-264.
 100. Kurochkin YV and Sobolevsky EI (1975) "Nasal mites *Orthohalarachne attenuata* of northern fur seals." *Rapp. P.-v. Réun. Cons. int. Explor. Mer.* **169**: 362.
 101. Munro R and Synge B. (1991) "Coccidiosis in seals." *Vet. Rec.* **129**(8): 179-178.
 102. Smith AW and Boyt PM (1990) "Caliciviruses of ocean origin." *J. Zoo and Wildl. Med.* **21**(1): 3-23.
 103. Miller JA (1989) "Diseases for our future - global ecology and emerging viruses" *Bioscience* **39**: 509-517.
 104. Hinshaw VS, Bean WJ *et al.* (1984) "Are seals frequently infected with avian influenza viruses?" *J. Virol.* **51**(3): 863-865.
 105. Scheiblaue H, Kendal AP and Rott R. (1995) "Pathogenicity of influenza A/Seal/Mass/1/80 virus mutants for mammalian species." *Arch. Virol.* **140**:341-348.
 106. Harder TC, Harder M *et al.* (1998) "Major immunogenic proteins of phocid herpesviruses and their relationships to proteins of canine and feline herpesviruses." *Vet. Quart.* **20**:50-55.
 107. Harder TC, Plötz J and Liess B (1991) "Antibodies against European phocine herpesvirus isolates detected in sera of Antarctic seals." *Polar Biol.* **11**: 509-512.
 108. Stenvers O, Zhang XM and Ludwig H (1992) "Herpesvirus infection in seals: a summary of present knowledge." *Rev. sci. tech. Off. int. Epiz.* **11**(4): 1151-1154.
 109. Olsen OW, (1974) in *Animal Parasites* 3rd ed. (University Park Press publ. Baltimore, London, Tokyo).
 110. Schmidt GD and Roberts LS (1989) in *Foundations of Parasitology* 4th ed. (Times Mirror/Mosby, College Publishing)
 111. Forbes L, LeEclair D *et al.* (1998) "Characterization of *Trichinella* larvae recovered from walruses in the Canadian Arctic." *Proc. Am. Assoc. Vet. Parasitologists* 43rd Annual meeting, 25 July, 1998 at Baltimore, USA. (abstract only).

112. Soulsby E JL (1982) *Helminths, Arthropods and Protozoa of Domesticated Animals* 7th ed. (Baillière Tindall, London publ.)
113. Moorhead A, Grunenwald PE *et al.* (1999) "Trichinellosis in the United States, 1991-1996: declining but not gone." *Am. J. Trop. Med and Hyg.* **60**(1): 66-69.
114. McAuley JB, Michelson MK and Schants PM (1991) "Trichinosis surveillance, United States 1987-1990." *Morbidity and Mortality Weekly Report* **40**: SS-3, 35-42.
115. Skjerve E (1987) "Trichinella in seal meat. Risks of seal meat consumption." *Norsk-Veterinaertidsskrift.* **99**(3): 228. (English abstract.)
116. Vedros NA, Quinlivan J and Cranford R (1982) "Bacterial and fungal flora of wild northern fur seals (*Callorhinus ursinus*)" *J. Wildl. Dis.* **18**(4): 447-456.
117. Moeller RB (1999) "Diseases of Marine Mammals" *Lecture notes from CL Davis Foundation meeting on the Gross Morbid Pathology of Animals, Armed Forces Inst. Washington D.C. 22 March, 1999.*
118. Cousins DV (1999) Pers. Comm. (email dated 11 June, 1999).
119. Forshaw D (1999) Pers. Comm. (email dated 6 April, 1999).
120. Castro Ramos M, Errico F, *et al.* (1998) "Isolation of *Mycobacterium bovis* from the pinniped *Otario byronia* (Southern sea lion) in Uruguay." *Revista de medicina veterinaria Buenos Aires* **79**(3): 197-200.
121. Bessonov AS (1998) [The taxonomic position of nematodes in the genus *Trichinella* Railliet 1895]. *Med. Parazitol (Mosk)* Jan-Mar (1); 3-6. (English summary)
122. Kapel CM, Pozio E, Sacchi L and Prestrud P (1999) Freeze tolerance, morphology and RAPD-PCR identification of *Trichinella nativa* in naturally infected arctic foxes. *J. Parasitol.* **85**(1):144-147.
123. Artemenko IuG and Artemenko LP (1997) [The susceptibility of different animal species to synanthropic and natural populations of *Trichinella*] *Med Parazitol (Mosk)* Jan-Mar(1): 19-21.
124. Pozio E, La Rosa G, Murrell KD and Lichtenfels JR (1992) Taxonomic revision of the genus *Trichinella*. *J. Parasitol.* **78**(4): 654-659.
125. Pozio E and La Rosa G (1991) General introduction and epidemiology of trichinellosis. *Southeast Asian J. Trop. Med. Pub. Hlth.* **22** Supplement: 291-294.
126. Cousins D V, Williams S N, Reuter R, *et al.* (1993). Tuberculosis in wild seals and characterisation of the seal bacillus. *Aust. Vet. J.* **70**: 92-97.
127. Cousins D V. (1996) Molecular epidemiology and diagnosis of *Mycobacterium bovis* and *M. bovis*-like organisms causing tuberculosis. PhD. Thesis, University of Western Australia.
128. Zumarraga M J, Bernardelli A, Bastida R, *et al.* (1999) Molecular characterization of mycobacteria isolated from seals. *Microbiol.* **145**: 2519-2526.
129. Hunter J E, Duignan P J, Dupont C, *et al.* (1998) First report of potentially zoonotic tuberculosis in fur seals in New Zealand. *N. Z. Med. J.* **111**: 130-131.
130. Thorel M-F, Karoui C, Varnerot A, *et al.* (1998) Isolation of *Mycobacterium bovis* from baboons, leopards and a sea-lion. *Vet. Res.* **29**: 207-212.
131. Cousins DV (2000) pers. comm. (email communication dated 18/06/00)
132. Thorel M-F, Karoui C, Varnerot A, *et al.* (1998) Isolation of *Mycobacterium bovis* from baboons, leopards and a sea-lion. *Vet. Res.* **29**: 207-212.
133. Woods RV (2000) pers. comm. (email communication dated 23/05/00).
134. Duignan PJ, Duffy N, Rima BK and Geraci JR (1997) Comparative antibody response in harbour and grey seals naturally infected by a morbillivirus. *Vet Immunol Immunopathol* **55**(4):341-349.
135. Duignan PJ, Sadove S, Saliki JT and Geraci JR (1993) Phocine distemper in harbor seals (*Phoca vitulina*) from Long Island, New York. *J Wildl Dis* **29**(3):465-469.

136. Gorham, JR (1966) The epizootology of distemper. *J.A.V.M.A.* **149** (5): 610-622.
137. Tryland M, Kleivane L, Alfredsson A *et al.* (1999) Evidence of *Brucella* infection in marine mammals in the North Atlantic Ocean. *Vet. Rec.* May 22, 1999, 588-592.

Appendix

Pinniped species.

Common name - *scientific name*

Atlantic harp seal	<i>Phoca groenlandica</i>
Australian fur seal	<i>Arctocephalus pusillus doriferus</i>
Australian sea lion	<i>Neophoca cinerea</i>
Baikal seal	<i>Phoca sibirica</i>
Californian sea lion	<i>Zalophus californianus</i>
common harbour seal, harbour seal	<i>Phoca vitulina</i>
crabeater seal	<i>Lobodon carcinophagus</i>
elephant seal	<i>Mirounga leonina</i>
grey seal	<i>Halichoerus grypus</i>
hooded seal	<i>Cystophora cristata</i>
Leopard seal	<i>Hydrurga leptonyx</i>
Mediterranean monk seal	<i>Monachus monachus</i>
New Zealand fur seal	<i>Arctocephalus forsteri</i>
New Zealand sea lion	<i>Phocarctos hookeri</i>
northern elephant seal	<i>Mirounga angustirostris</i>
ringed seal	<i>Phoca hispida</i>
southern elephant seal	<i>Mirounga leonina</i>
Walrus	<i>Odobenus</i> spp.
Weddell seal	<i>Leptonychotes weddelli</i>

J:\ANIMAL_Q\PROJECTS\ZOO\100006_E.doc

- 1.6 Animals must be tested according to the requirements laid down in 2.4 below. All laboratory tests must be conducted in a laboratory approved by the Veterinary Administration of the country of export.
 - 1.6.1 It is a recommendation, but not a stipulation, that the pinnipeds be subjected to the tests in 2.4.1 and 2.4.2 below, immediately before or at the commencement of the pre-export quarantine (PEQ).
 - 1.6.2 Additional testing as required by the importing zoo is a matter for the importing and exporting institutions to agree.
- 1.7 The captive facility in which the animal(s) is to perform PEQ must meet AQIS standards and be approved by the Veterinary Administration of the exporting country, or AQIS. An example of the standard required is at Attachment 1.
- 1.8 AQIS may require that an Australian Quarantine Officer oversee the PEQ and/or accompany the shipment to Australia at the importer's expense.
- 1.9 Costs associated with the selection, testing, transport, quarantine (including any extension to the quarantine period for whatever reason) and any Australian Government veterinary supervision of the animals during each quarantine period and during transport to Australia will not be met by the Australian Government.
- 1.10 These requirements may be varied or reviewed at any time at the discretion of the Australian Director of Quarantine (herein called the Director).

2. CERTIFICATION

The Animal Health Certificate must attest that:

- 2.1 The pinnipeds have been bred in captivity or have been resident in a captive institution of equivalent health status to the exporting facility for a period of not less than 12 months or since birth; and
 - 2.1.2 The exporting institution has not received pinnipeds brought in from the wild during the previous two years.
- 2.2 Deaths and illness in marine mammals in the exporting facility are routinely investigated by a qualified veterinarian, and there has been no evidence of any of the following diseases for the stated period:

Phocine distemper	12 months
San Miguel sea lion virus	2 years
Influenza A in pinnipeds	3 months
Phocid herpesvirus	12 months
Seal pox	12 months
Tuberculosis in pinnipeds	6 years, and

to the best of his/her knowledge, and after due enquiry, the animals for export have not been closely handled by a person infected with tuberculosis during the same period.

[For the purpose of these quarantine requirements, freedom from disease will mean no evidence, whether the evidence be clinical disease, autopsy findings or results of tests conducted.]

- 2.3 The animals were held, for a minimum period of 120 days immediately prior to export, in approved PEQ premises.
- 2.4 TESTS.
 - 2.4.1 Within 21 days of the scheduled date of export, each animal was tested for phocine distemper by a serum neutralisation test with a negative result.
 - 2.4.2 Within 21 days of the scheduled date of export, each animal was tested for phocid herpesvirus by a serum neutralisation test with a negative result.
- 2.5 Each animal was treated with a broad spectrum external parasiticide containing (active ingredients) effective against lice and acarids within 96 hours of the expected time of embarkation.
- 2.6 Each animal was treated with internal parasiticides containing (active ingredients), effective against nematodes and(active ingredients), effective against cestodes, within 96 hours of the expected time of embarkation.
- 2.7 Each animal was examined by an Official Veterinarian within 48 hours prior to leaving the PEQ premises for the port of export and was free from clinical evidence of infectious or contagious disease and external parasites and appeared fit to travel.
- 2.8 The vehicles for the transport of the animals to the port of export were cleaned and disinfected prior to loading. The containers used for transporting the animals were new or were cleaned and disinfected prior to loading. Containers constructed of timber were permanently immunised against insect infestation or fumigated prior to loading as required by AQIS.
- 2.9 During transport to the port of export and during loading, the animals were not exposed to animals not eligible for export to Australia.
- 2.10 The compartment of the aircraft or vessel to be occupied by the animals and all removable equipment was cleaned and disinfected prior to loading.

Note: Items 2.1 to 2.8 inclusive should be certified by the Official Veterinarian responsible for supervision of the PEQ. Items 2.9 to 2.10 inclusive may be certified by the same Official Veterinarian if he /she accompanies the animals to the port of export or another Official Veterinarian at the port of export.

3. TRANSPORT

- 3.1 The animals must be consigned to Australia by a route approved by the Director. They may be accompanied by other animals only with the approval of the Director. Any transshipment requires the approval of the Director. Stops on route may need approval from relevant authorities in the country or countries of transit or transshipment.
- 3.2 The design of the containers, the recommended species requirements, the preparation for transport, and the disinfection of the interior of the aircraft or vessel, removable equipment, penning and containers must be in accordance with the recommendations of the OIE Code

and International Air Transport Association (IATA) Live Animal Regulations unless otherwise agreed by AQIS.

4. ENTRY AND POST-ARRIVAL QUARANTINE REQUIREMENTS

- 4.1 Each imported animal must undergo post-arrival quarantine (PAQ) in an approved premises in an AQIS registered zoo for a minimum period of 30 days. The premises must conform to standards described in Attachment 2.
- 4.2 Any animals sharing the PAQ premises with the pinnipeds during PAQ must remain in the premises until the pinnipeds are released from PAQ. No pinnipeds destined for return to the wild may share the PAQ premises whilst an imported pinniped is performing PAQ.
- 4.3 Any crates, bedding remaining on the aircraft at arrival, or accompanying the animal to PAQ must be sterilised, destroyed or otherwise dealt with as directed by a quarantine officer at the ports of unloading.
- 4.4 As soon as possible after arrival, each animal must be inspected by an Official Veterinarian for signs of disease. Additional inspections whilst the animal is in PAQ will be at the discretion of the Director of Quarantine.
- 4.5 After completion of PAQ, each animal imported under these conditions will be held under quarantine surveillance during its time in Australia.
- 4.6 During PAQ and while the imported animals remain under quarantine surveillance, they, and any in-contact animals, may be subjected to any testing or treatment prescribed by the Director, at the owner's expense.
- 4.7 If any animal fails a test or shows signs of disease, that animal and any or all other animals in the PAQ premises may, at the Director's discretion, be detained in quarantine for further testing and/ or observation, or exported at the importer's expense, or destroyed without recompense. The death of any animal in PAQ must be reported to AQIS as soon as possible.
- 4.8 Pinnipeds sharing the same PAQ facility may not be released from quarantine until the most recently arrived animal is due for release, and no animals have shown signs of exotic disease during this time.
- 4.9 The importer will be charged for services provided by the Australian Government. If any animals die or are destroyed during any period of control, the Australian Government will not pay compensation.

SARAH KAHN
Assistant Director
Animal Quarantine Policy Branch

Attachment 1.

STANDARD OF PRE-EXPORT QUARANTINE FACILITY FOR PINNIPEDS FOR EXPORT TO AUSTRALIA.

Premises to be used for pre-export quarantine (PEQ) of pinnipeds to Australia must comply with the following operational and structural standards.

- . The PEQ facility was serviced by a water supply that was not in direct communication with any other animal facility. The water was clean and not pumped directly from a natural watercourse that is frequented by wild pinnipeds.
- . Entry into the PEQ facility must be prohibited to all unauthorised persons, and visitor entries recorded.
- . The PEQ facility was under a different roof from facilities used by other pinnipeds.
- . The PEQ facility, whilst in use, was either serviced by personnel who did not handle other pinnipeds; or, by staff who followed strict rules of disinfection prior to entry of the pinniped pen.
- . All feeding and other utensils for animals in the PEQ facility were for their use alone, and not used for other animals.

Attachment 2.

STANDARD OF POST-ARRIVAL QUARANTINE FACILITY FOR PINNIPEDS FOR EXPORT TO AUSTRALIA.

Premises to be used for post-arrival quarantine (PAQ) of pinnipeds imported into Australia must comply with the following operational and structural standards.

- . The PAQ facility must be sufficiently far removed from other pinnipeds to prevent transfer of infectious agents in expired air, i.e. a distance that would prevent droplet infection. For practical purposes this means under a different roof from facilities used by other pinnipeds.
- . Entry into the PAQ must be prohibited to all unauthorised persons, and visitor entries recorded.
- . The PAQ facility must be serviced by a water supply that is not in direct communication with any other animal facility. The water used by the quarantined pinniped must not be pumped directly to a natural watercourse without prior sterilisation. Alternatively the water may go directly into a municipal sewerage system.
 - Full records must be kept of maintenance of sterilising equipment and must be available to AQIS staff on request.
- . The PAQ facility, whilst in use, must be either serviced by personnel who do not handle other pinnipeds or Suidae, or serviced only by staff who follow strict rules of disinfection prior leaving the pinniped pen. This would include a change of exterior clothing and boots and thorough washing of hands on entry and leaving the facility.
- . Records of the health of all pinnipeds in the facility must be kept, including all treatments and tests, and must be available to AQIS staff on request. Any pinniped that dies must be autopsied as soon as possible and the autopsy report and laboratory reports made available to AQIS. The death of any pinniped must be notified to AQIS as soon as possible.
- . All feeding and other utensils for animals in the PAQ facility must be for their use alone, and not used for other animals.
- . Pinnipeds sharing the same facility will all perform quarantine until the most recently arrived is eligible for release.